FOR CONTRACT NO.: 12-0C5704
PROJECT ID: 1200000079

INFORMATION HANDOUT

WATER QUALITY

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SANTA ANA REGION
Clean Water Act Section 401 Water Quality Standards Certification
SARWQCB PROJECT NO. 302012-12

PERMITS

UNITED STATES ARMY CORPS OF ENGINEERS
Nationwide PermitNo. 14
PERMIT NO. SPL-2012-00347-SCH

RAILROAD RELATIONS AND INSURANCE REQUIREMENTS

MATERIALS INFORMATION

FINAL AERIALLY DEPOSITED LEAD ADDENDUM REPORT
Earth Mechanics, Inc.
November 11, 2011

FINAL GEOTECHNICAL DESIGN REPORT
Earth Mechanics, Inc.
January 10, 2012

FINAL MATERIALS REPORT
Earth Mechanics, Inc.
February 1, 2012

FINAL FOUNDATION REPORT
Non-Standard Walls
Earth Mechanics, Inc.
February 14, 2012

FINAL FOUNDATION REPORT
Overhead Sign Structures
Earth Mechanics, Inc.
January 10, 2012

ROUTE: 12-Ora-91-0.9/5.4

FOUNDATION REPORT
Brookhurst Street UC (Widen) – Bridge No. 55-0280
Earth Mechanics, Inc.
September 16, 2011

FOUNDATION REPORT
Euclid Street UC (Widen) – Bridge No. 55-0279
Earth Mechanics, Inc
September 16, 2011

FOUNDATION REPORT
North Anaheim OH (Widen) – Bridge No. 55-0216
Earth Mechanics, Inc.
September 16, 2011

FOUNDATION REPORT
East Street UC (Widen) – Bridge No. 55-0245
Earth Mechanics, Inc.
September 16, 2011

FOUNDATION REPORT
Acacia Street UC (Widen) – Bridge No. 55-0218
Earth Mechanics, Inc.
September 16, 2011

FOUNDATION REPORT
State College Boulevard UC (Widen) – Bridge No. 55-0852
Earth Mechanics, Inc.
September 16, 2011

PROJECT REPORT
AECOM
June 16, 2010

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD (RWQCB) (REGION 8)

CALIFORNIA
Water Boards

EDMUND G. BROWN JR.
GOVERNOR

MATTHEW RODRIQUEZ
SECRETARY FOR
ENVIRONMENTAL PROTECTION

Santa Ana Regional Water Quality Control Board

July 26, 2012

Andrew P. Oshrin
State of California, Department of
Transportation
3347 Michelson Drive
Irvine, CA 92612

CLEAN WATER ACT SECTION 401 WATER QUALITY STANDARDS CERTIFICATION FOR SR-91 WESTBOUND WIDENING PROJECT, COUNTY OF ORANGE, CALIFORNIA (ACOE REFERENCE NO. NOT AVAILABLE) (SARWQCB PROJECT NO. 302012-12)

Dear Mr. Oshrin:

On April 19, 2012, we received an application for Clean Water Act Section 401 Water Quality Standards Certification ("Certification") from the State of California Department of Transportation in cooperation with the Orange County Transportation Authority for a project to provide congestion relief, decrease travel times, and shorten durations of peak traffic periods along westbound SR-91 between SR-57 and I-5 freeways. This letter responds to your request for certification that the proposed project, described in your application and summarized below, will comply with State water quality standards outlined in the Water Quality Control Plan for the Santa Ana River Basin (1995) (Basin Plan) and subsequent Basin Plan amendments:

Project Description: The total length of the proposed widening project is 4.5 miles. As part of the proposed improvements various existing stormwater conveyance facilities associated with SR-91 would be converted from trapezoidal channels to either box culverts or connected via storm drain pipes in order to accommodate the proposed widening. Conveyance of stormwater would continue to flow to existing regional flood control facilities (Carbon Creek Channel and Houston Storm Channel). The work will take place within Section 33 of Township 4 South, Range 11 West, of the U.S. Geological Survey *Anaheim, CA* quadrangle map (33° 51' 16" N/ -117° 56' 36" W).

Receiving water:	Coyote Creek
Fill area:	0.19 acres of temporary impact to unvegetated streambed (1,165 linear feet) resulting from conversion of existing trapezoidal channel to box culvert 0.005 acres of permanent impact to unvegetated streambed (206 linear feet) resulting from placement of reinforced concrete pipe to connect existing drainage patterns
Dredge/Fill volume:	N/A
Federal permit:	U.S. Army Corps of Engineers Nationwide Permit No. 14

You have proposed to mitigate water quality impacts as described in your Certification application. The proposed mitigation is summarized below:

Onsite Water Quality Standards Mitigation Proposed:

- Standard water quality related best management practices (BMPs) will be employed during construction activities.
- The Applicant shall construct 1,246 linear feet of vegetated bioswale. The treatment area would treat new improvements and 17% of existing surfaces, creating a net increase in water quality upon project completion.

Offsite Water Quality Standards Mitigation Proposed:

- None

Should the proposed project impact state- or federally-listed endangered species or their habitat, implementation of measures identified in consultation with U.S. Fish and Wildlife Service and the California Department of Fish and Game will ensure those impacts are mitigated to an acceptable level. Appropriate BMPs will be implemented to reduce construction-related impacts to Waters of the State according to the requirements of Order No. 99-06-DWQ (NPDES Permit No. CAS000003), commonly known as the CalTrans Storm Water Permit, and subsequent iterations thereof.

In May 2010, the State of California, Department of Transportation, approved a Mitigated Negative Declaration for this project. Pursuant to California Code of Regulations, Title 14, Chapter 3, Section 15096, as a responsible agency, the Regional Board is required to consider an EIR or Mitigated Negative Declaration prepared by the lead agency in determining whether to approve the project. A responsible agency has responsibility for mitigating and avoiding only the direct and indirect environmental effects of those parts of the project which it decides to carry out, finance, or approve.

Further, the responsible agency must make findings as required by Section 15091 and, if necessary, 15093, for each and every significant impact of the project. Based on the mitigation proposed and the conditions set forth in this Certification, Board staff has concluded that the project's impacts to water quality will be reduced to a less than significant level and beneficial uses will be protected. The Regional Board has independently considered Orange County's Mitigated Negative Declaration in making this certification and finds that changes or alterations have been required or incorporated into the proposed project which avoid or mitigate impacts to water quality to a less than significant level.

This 401 Certification is contingent upon the execution of the following conditions:

1) The applicant must comply with the requirements of the applicable Clean Water Act section 404 permit.
2) The water quality mitigation identified above shall be timely implemented.
3) All materials generated from construction activities associated with this project shall be managed appropriately. This shall include identifying all potential pollution sources within the scope of work of this project, and incorporating all necessary pollution prevention BMPs as they relate to each potential pollution source identified.
4) The project proponent shall utilize BMPs during project construction to minimize the controllable discharges of sediment and other wastes to drainage systems or other waters of the state and of the United States.
5) Substances resulting from project-related activities that could be harmful to aquatic life, including, but not limited to, petroleum lubricants and fuels, cured and uncured cements, epoxies, paints and other protective coating materials, portland cement concrete or asphalt concrete, and washings and cuttings thereof, shall not be discharged to soils or waters of the state. All waste concrete shall be removed.
6) Motorized equipment shall not be maintained or parked within or near any stream crossing, channel or lake margin in such a manner that petroleum products or other pollutants from the equipment may enter these areas under any flow conditions. Vehicles shall not be driven or equipment operated in waters of the state on-site, except as necessary to complete the proposed project. No equipment shall be operated in areas of flowing water.
7) This Water Quality Certification is subject to the acquisition of all local, regional, state, and federal permits and approvals as required by law. Failure to meet any conditions contained herein or any of the conditions contained in any other permit or approval issued by the State of California or any subdivision thereof may result in the revocation of this Certification and civil or criminal liability.
8) Best management practices to stabilize disturbed soils must be used.
9) Applicant shall ensure that all fees associated with this project are paid to each respective agency prior to conducting any on-site construction activities.

10) Construction de-watering discharges, including temporary stream diversions necessary for project construction, may be regulated under Regional Board Order No. R8-2009-0003, General Waste Discharge Requirements for Discharges to Surface Waters that Pose an Insignificant (De Minimus) Threat to Water Quality. For more information, please review Order No. R8-2009-0003 at www.waterboards.ca.gov/santaana/

Under the California Water Code, Section 1058, and Pursuant to 23 CCR §3860, the following shall be included as conditions of all water quality certification actions:

(a) Every certification action is subject to modification or revocation upon administrative or judicial review, including review and amendment pursuant to Section §13330 of the Water Code and Article 6 (commencing with Section 3867) of this Chapter.

(b) Certification is not intended and shall not be construed to apply to any activity involving a hydroelectric facility and requiring a FERC license or an amendment to a FERC license unless the pertinent certification application was filed pursuant to Subsection §3855(b) of this Chapter and that application specifically identified that a FERC license or amendment to a FERC license for a hydroelectric facility was being sought.

(c) Certification is conditioned upon total payment of any fee required under this Chapter and owed by the applicant.

If the above stated conditions are changed, any of the criteria or conditions as previously described are not met, or new information becomes available that indicates a water quality problem, the Regional Board may require the applicant to submit a report of waste discharge and obtain Waste Discharge Requirements.

In the event of any violation or threatened violation of the conditions of this certification, the holder of any permit or license subject to this certification shall be subject to any remedies, penalties, process or sanctions as provided for under state law. For purposes of section 401(d) of the Clean Water Act, the applicability of any state law authorizing remedies, penalties, process or sanctions for the violation or threatened violation constitutes a limitation necessary to assure compliance with the water quality standards and other pertinent requirements incorporated into this certification. Violations of the conditions of this certification may subject the applicant to civil liability pursuant to Water Code section 13350 and/or 13385.

This letter constitutes a Water Quality Standards Certification issued pursuant to Clean Water Act Section 401. I hereby issue an order certifying that any discharge from the referenced project will comply with the applicable provisions of Sections 301 (Effluent Limitations), 302 (Water Quality Related Effluent Limitations), 303 (Water Quality

Standards and Implementation Plans), 306 (National Standards of Performance), and 307 (Toxic and Pretreatment Effluent Standards) of the Clean Water Act, and with other applicable requirements of State law. This discharge is also regulated under State Water Resources Control Board Order No. 2003-0017-DWQ (Order No. 2003-0017-DWQ), "General Waste Discharge Requirements for Dredge and Fill Discharges That Have Received Water Quality Certification" which requires compliance with all conditions of this Water Quality Standards Certification. Order No. 2003-0017-DWQ is available at:
www.waterboards.ca.gov/board_decisions/adopted_orders/water_quality/2003/wqo/wqo2003-0017.pdf

Should there be any questions, please contact Marc Brown at (951) 321-4584, or Mark Adelson at (951) 782-3234.

Sincerely,

Kurt V. Berchtold
Executive Officer
Santa Ana Regional Water Quality Control Board

cc (via electronic mail):
RBF Consulting – Regulatory Specialist – Chris Johnson
U.S. Army Corps of Engineers, Los Angeles Office - Stephen Estes
State Water Resources Control Board, OCC - David Rice
California Department of Fish and Game - Kevin Hupf, KHupf@dfg.ca.gov
State Water Resources Control Board, DWQ-Water Quality Certification Unit - Bill Orme

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UNITED STATES ARMY CORPS OF ENGINEERS (ACOE)
Nationwide No. 14 Permit

DEPARTMENT OF THE ARMY
Los Angeles District Corps of Engineers
P.O. Box 532711
Los Angeles, California 90053

REPLY TO
ATTENTION OF

July 27, 2012

Regulatory Division

Mr. Andrew Oshrin, Branch Chief, P.E., MBA, PMP
California Department of Transportation, District 12
Atte: Shannon Crossen
3347 Michelson Drive, Suite 100,
Irvine, California 92612

DEPARTMENT OF THE ARMY NATIONWIDE PERMIT VERIFICATION

Dear Mr. Oshrin:

I am responding to your request (SPL-2012-00347-SCH) for a Department of the Army permit. Your proposed project, State Route 91 Westbound Widening Project between Interstate 5 and State Route 57, would result in a discharge of dredged and/or fill material into waters of the United States. Therefore, pursuant to section 404 of the Clean Water Act (33 U.S.C. 1344; 33 C.F.R. parts 323 and 330), your proposed project requires a Department of the Army permit. The State Route 91 Westbound Widening Project between Interstate 5 and State Route 57 is located within a 4.5 mile-long stretch of State Route 91 (SR-91). More, specifically, it is along the westbound portion of SR-91 between SR-57 and Interstate 5, in the cities of Anaheim and Fullerton, Orange County, California (33.85702°N, -117.98029°W to 33.84960°N, -117.87540°W)(as shown on the attached drawing(s)/map(s)).

I have determined construction of the State Route 91 Westbound Widening Project between Interstate 5 and State Route 57 complies with Nationwide Permit (NWP) No. 14, if conducted as described in your application.

Specifically, you are authorized to conduct the following regulated activities:

1. Permanently impact 0.0027 acre of non-wetland waters of the U.S. at drainage D2 West in association with placement of reinforced concrete pipe/extension of an existing reinforced concrete pipe;
2. Permanently impact 0.027 acre of non-wetland waters of the U.S., at drainage D2 East in association with placement of a reinforced concrete pipe/extension of an existing reinforce concrete pipe;
3. Permanently impact 0.00068 acre of non-wetland waters of the U.S., at drainage D16 in association with placement of a drainage pipe;
4. Permanently impact 0.00169 acre of non-wetland waters of the U.S., at drainage D17 in association with placement of a drainage pipe;
5. Temporarily impact 0.067 acre of non-wetland waters of the U.S., at drainage D5 to convert an existing trapezoidal storm water channel to a box culvert; and
6. Temporarily impact 0.125 acre of non-wetland waters of the U.S., at drainage D6 to convert an existing trapezoidal storm water channel to a box culvert.

For this NWP verification letter to be valid, you must comply with all of the terms and conditions in Enclosure 1. Furthermore, you must comply with the following non-discretionary Special Conditions listed below:

1. The permittee shall abide by the terms and conditions of the project's section 401 Water Quality Certification, dated July 26, 2012.

2. The Permittee shall clearly mark the limits of the workspace with flagging or similar means to ensure mechanized equipment does not enter avoided waters of the U.S. and riparian wetland/habitat areas. Adverse impacts to waters of the U.S. beyond the Corps-approved construction footprint are not authorized. Such impacts could result in permit suspension and revocation, administrative, civil or criminal penalties, and/or substantial, additional, compensatory mitigation requirements.

3. Within 45 calendar days of completion of authorized work in waters of the U.S., the Permittee shall submit to the Corps Regulatory Division a post-project implementation memo indicating the date authorized impacts to waters of the U.S. ceased.

4. The permittee shall employ all best management practices (BMPs) to ensure that no debris, soil, silt, sand, rubbish, cement or concrete washings thereof, oil or petroleum can be washed by rainfall or runoff into waterways. When project operations are completed, any and all excess construction material, debris, and or other associated excess project materials shall be removed and if not recycled or reused, disposed of at an appropriate off-site location outside of any jurisdictional area. Similarly, the permittee shall ensure that all vehicle maintenance, staging, storage, and dispensing of fuel occurs in designated upland areas. The permittee shall ensure that these designated upland areas are located in such a manner to prevent any runoff from entering waters of the U.S.

5. A copy of this permit shall be on the job site at all times during construction. The permittee shall provide a copy of this permit to all contractors, subcontractors, and forepersons. The permittee shall require that all contractors, subcontractors, and forepersons read this authorization in its entirety and acknowledge they understand its contents and their responsibility to ensure compliance with all general and special conditions contained herein.

Endangered Species Act:

6. This Corps permit does not authorize you to take any threatened or endangered species. In order to legally take a listed species, you must have separate authorization under the Endangered Species Act (ESA).

Cultural Resources:

7. Pursuant to 36 C.F.R. section 800.13, in the event of any discoveries during construction of either human remains, archeological deposits, or any other type of historic property, the Permittee shall notify the Corps' Regulatory Division staff and Archeology Staff within (Steve Dibble at 213-452-

3849 or John Killeen at 213-452-3861) within 24 hours. The Permittee shall immediately suspend all work within 100 feet of any area(s) where potential cultural resources are discovered. The Permittee shall not resume construction in the area surrounding the potential cultural resources until the Corps Regulatory Division re-authorizes project construction, per 36 C.F.R. section 800.13.

Your verification is valid through July 27, 2014. All NWPs will expire on March 18, 2017. It is incumbent upon you to remain informed of changes to the NWPs. A public notice of the change(s) will be issued when any of the NWPs are modified, reissued, or revoked. Furthermore, if you commence or are under contract to commence this activity before the date on which the relevant NWP is reissued, modified, or revoked, you will have twelve (12) months from the date of the reissuance, modification, or revocation of the NWP to complete the activity under the present terms and conditions of the relevant NWP.

A preliminary jurisdictional determination (JD) has been conducted to determine the extent of U.S. Army Corps of Engineers (Corps) geographic jurisdiction, upon which this NWP verification is based. A preliminary JD is advisory in nature and is a written indication that Corps geographic jurisdiction may be present on a particular site, but is not appealable. An approved JD is an official Corps determination of the precisely identified limits of Corps geographic jurisdiction on a particular site, and is appealable. Should you wish to appeal an approved JD, you may request an administrative appeal under Corps regulations at 33 C.F.R. part 331.

A NWP does not grant any property rights or exclusive privileges. Additionally, it does not authorize any injury to the property, rights of others, nor does it authorize interference with any existing or proposed Federal project. Furthermore, it does not obviate the need to obtain other Federal, state, or local authorizations required by law.

Thank you for participating in our regulatory program. If you have any questions, please contact Sophia Huynh at 213-452-3357 or via e-mail at Sophia.C.Huynh@usace.army.mil.

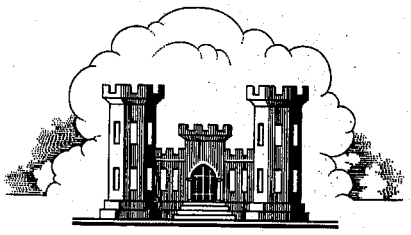
Please be advised that you can now comment on your experience with Regulatory Division by accessing the Corps web-based customer survey form at: http://per2.nwp.usace.army.mil/survey.html.

"Building Strong and Taking Care of People!"

Sincerely,

Mark D. Cohen
Deputy Chief, Regulatory Division

Enclosure(s)



LOS ANGELES DISTRICT
U.S. ARMY CORPS OF ENGINEERS

CERTIFICATE OF COMPLIANCE WITH DEPARTMENT OF THE ARMY NATIONWIDE PERMIT

Permit Number: *SPL-2012-00347-SCH*

Name of Permittee: *Andrew Oshrin, California Department of Transportation, District 12*

Date of Issuance: *July 27, 2012*

Upon completion of the activity authorized by this permit and the mitigation required by this permit, sign this certificate, and return it to the following address:

U.S. Army Corps of Engineers, Los Angeles District
Regulatory Division
ATTN: CESPL-RG-SPL-2012-00347-SCH
P.O. Box 532711
Los Angeles, California 90053

Please note that your permitted activity is subject to a compliance inspection by an Army Corps of Engineers representative. If you fail to comply with this Nationwide Permit, you may be subject to permit suspension, modification, or revocation procedures as contained in 33 C.F.R. § 330.5 or enforcement procedures such as those contained in 33 C.F.R. §§ 326.4 and 326.5.

I hereby certify that the work authorized by the above referenced permit has been completed in accordance with the terms and conditions of the said permit, and required mitigation was completed in accordance with the permit condition(s).

_____ _____

Signature of Permittee Date

Enclosure 1: NATIONWIDE PERMIT NUMBER(S) TERMS AND CONDITIONS

1. Nationwide Permit(s) Terms:

Your activity is authorized under Nationwide Permit Number 14 subject to the following terms:

Note: To qualify for NWP authorization, the prospective permittee must comply with the following general conditions, as appropriate, in addition to any regional or case-specific conditions imposed by the division engineer or district engineer. Prospective permittees should contact the appropriate Corps district office to determine if regional conditions have been imposed on an NWP. Prospective permittees should also contact the appropriate Corps district office to determine the status of Clean Water Act Section 401 water quality certification and/or Coastal Zone Management Act consistency for an NWP.

2. Nationwide Permit General Conditions: The following general conditions must be followed in order for any authorization by an NWP to be valid:

1. 1. Navigation. (a) No activity may cause more than a minimal adverse effect on navigation.
(b) Any safety lights and signals prescribed by the U.S. Coast Guard, through regulations or otherwise, must be installed and maintained at the permittee's expense on authorized facilities in navigable waters of the United States.
(c) The permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

2. Aquatic Life Movements. No activity may substantially disrupt the necessary life cycle movements of those species of aquatic life indigenous to the waterbody, including those species that normally migrate through the area, unless the activity's primary purpose is to impound water. All permanent and temporary crossings of waterbodies shall be suitably culverted, bridged, or otherwise designed and constructed to maintain low flows to sustain the movement of those aquatic species.

3. Spawning Areas. Activities in spawning areas during spawning seasons must be avoided to the maximum extent practicable. Activities that result in the physical destruction (e.g., through excavation, fill, or downstream smothering by substantial turbidity) of an important spawning area are not authorized.

4. Migratory Bird Breeding Areas. Activities in waters of the United States that serve as breeding areas for migratory birds must be avoided to the maximum extent practicable.

5. Shellfish Beds. No activity may occur in areas of concentrated shellfish populations, unless the activity is directly related to a shellfish harvesting activity authorized by NWPs 4 and 48, or is a shellfish seeding or habitat restoration activity authorized by NWP 27.

6. Suitable Material. No activity may use unsuitable material (e.g., trash, debris, car bodies, asphalt, etc.). Material used for construction or discharged must be free from toxic pollutants in toxic amounts (see Section 307 of the Clean Water Act).

7. Water Supply Intakes. No activity may occur in the proximity of a public water supply intake, except where the activity is for the repair or improvement of public water supply intake structures or adjacent bank stabilization.

8. Adverse Effects From Impoundments. If the activity creates an impoundment of water, adverse effects to the aquatic system due to accelerating the passage of water, and/or restricting its flow must be minimized to the maximum extent practicable.

9. Management of Water Flows. To the maximum extent practicable, the pre-construction course, condition, capacity, and location of open waters must be maintained for each activity, including stream channelization and storm water management activities, except as provided below. The activity must be constructed to withstand expected high flows. The activity must not restrict or impede the passage of normal or high flows, unless the primary purpose of the activity is to impound water or manage high flows. The activity may alter the pre-construction course, condition, capacity, and location of open waters if it benefits the aquatic environment (e.g., stream restoration or relocation activities).

10. Fills Within 100-Year Floodplains. The activity must comply with applicable FEMA-approved state or local floodplain management requirements.

11. Equipment. Heavy equipment working in wetlands or mudflats must be placed on mats, or other measures must be taken to minimize soil disturbance.

12. Soil Erosion and Sediment Controls. Appropriate soil erosion and sediment controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date. Permittees are encouraged to perform work within waters of the United States during periods of low-flow or no-flow.

13. Removal of Temporary Fills. Temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations. The affected areas must be revegetated, as appropriate.

14. Proper Maintenance. Any authorized structure or fill shall be properly maintained, including maintenance to ensure public safety and compliance with applicable NWP general conditions, as well as any activity-specific conditions added by the district engineer to an NWP authorization.

15. Single and Complete Project. The activity must be a single and complete project. The same NWP cannot be used more than once for the same single and complete project.

16. Wild and Scenic Rivers. No activity may occur in a component of the National Wild and Scenic River System, or in a river officially designated by Congress as a "study river" for possible inclusion in the system while the river is in an official study status, unless the appropriate Federal agency with direct

management responsibility for such river, has determined in writing that the proposed activity will not adversely affect the Wild and Scenic River designation or study status. Information on Wild and Scenic Rivers may be obtained from the appropriate Federal land management agency responsible for the designated Wild and Scenic River or study river (e.g., National Park Service, U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service).

17. Tribal Rights. No activity or its operation may impair reserved tribal rights, including, but not limited to, reserved water rights and treaty fishing and hunting rights.

18. Endangered Species. (a) No activity is authorized under any NWP which is likely to directly or indirectly jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Federal Endangered Species Act (ESA), or which will directly or indirectly destroy or adversely modify the critical habitat of such species. No activity is authorized under any NWP which "may affect" a listed species or critical habitat, unless Section 7 consultation addressing the effects of the proposed activity has been completed.
(b) Federal agencies should follow their own procedures for complying with the requirements of the ESA. Federal permittees must provide the district engineer with the appropriate documentation to demonstrate compliance with those requirements. The district engineer will review the documentation and determine whether it is sufficient to address ESA compliance for the NWP activity, or whether additional ESA consultation is necessary.
(c) Non-federal permittees must submit a pre-construction notification to the district engineer if any listed species or designated critical habitat might be affected or is in the vicinity of the project, or if the project is located in designated critical habitat, and shall not begin work on the activity until notified by the district engineer that the requirements of the ESA have been satisfied and that the activity is authorized. For activities that might affect Federally-listed endangered or threatened species or designated critical habitat, the pre-construction notification must include the name(s) of the endangered or threatened species that might be affected by the proposed work or that utilize the designated critical habitat that might be affected by the proposed work. The district engineer will determine whether the proposed activity "may affect" or will have "no effect" to listed species and designated critical habitat and will notify the non-Federal applicant of the Corps' determination within 45 days of receipt of a complete pre-construction notification. In cases where the non-Federal applicant has identified listed species or critical habitat that might be affected or is in the vicinity of the project, and has so notified the Corps, the applicant shall not begin work until the Corps has provided notification the proposed activities will have "no effect" on listed species or critical habitat, or until Section 7 consultation has been completed. If the non-Federal applicant has not heard back from the Corps within 45 days, the applicant must still wait for notification from the Corps.
(d) As a result of formal or informal consultation with the FWS or NMFS the district engineer may add species-specific regional endangered species conditions to the NWPs.
(e) Authorization of an activity by a NWP does not authorize the "take" of a threatened or endangered species as defined under the ESA. In the absence of separate authorization (e.g., an ESA Section 10 Permit, a Biological Opinion with "incidental take" provisions, etc.) from the U.S. FWS or the NMFS, The Endangered Species Act prohibits any person subject to the jurisdiction of the United States to take a listed species, where "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. The word "harm" in the definition of "take" means an act which actually kills or injures wildlife. Such an act may include significant habitat modification

or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering.
(f) Information on the location of threatened and endangered species and their critical habitat can be obtained directly from the offices of the U.S. FWS and NMFS or their world wide web pages at http://www.fws.gov/ or http://www.fws.gov/ipac and http://www.noaa.gov/fisheries.html respectively.

19. Migratory Birds and Bald and Golden Eagles. The permittee is responsible for obtaining any "take" permits required under the U.S. Fish and Wildlife Service's regulations governing compliance with the Migratory Bird Treaty Act or the Bald and Golden Eagle Protection Act. The permittee should contact the appropriate local office of the U.S. Fish and Wildlife Service to determine if such "take" permits are required for a particular activity.

20. Historic Properties. (a) In cases where the district engineer determines that the activity may affect properties listed, or eligible for listing, in the National Register of Historic Places, the activity is not authorized, until the requirements of Section 106 of the National Historic Preservation Act (NHPA) have been satisfied.
(b) Federal permittees should follow their own procedures for complying with the requirements of Section 106 of the National Historic Preservation Act. Federal permittees must provide the district engineer with the appropriate documentation to demonstrate compliance with those requirements. The district engineer will review the documentation and determine whether it is sufficient to address section 106 compliance for the NWP activity, or whether additional section 106 consultation is necessary.
(c) Non-federal permittees must submit a pre-construction notification to the district engineer if the authorized activity may have the potential to cause effects to any historic properties listed on, determined to be eligible for listing on, or potentially eligible for listing on the National Register of Historic Places, including previously unidentified properties. For such activities, the pre-construction notification must state which historic properties may be affected by the proposed work or include a vicinity map indicating the location of the historic properties or the potential for the presence of historic properties. Assistance regarding information on the location of or potential for the presence of historic resources can be sought from the State Historic Preservation Officer or Tribal Historic Preservation Officer, as appropriate, and the National Register of Historic Places (see 33 CFR 330.4(g)). When reviewing pre-construction notifications, district engineers will comply with the current procedures for addressing the requirements of Section 106 of the National Historic Preservation Act. The district engineer shall make a reasonable and good faith effort to carry out appropriate identification efforts, which may include background research, consultation, oral history interviews, sample field investigation, and field survey. Based on the information submitted and these efforts, the district engineer shall determine whether the proposed activity has the potential to cause an effect on the historic properties. Where the non-Federal applicant has identified historic properties on which the activity may have the potential to cause effects and so notified the Corps, the non-Federal applicant shall not begin the activity until notified by the district engineer either that the activity has no potential to cause effects or that consultation under Section 106 of the NHPA has been completed.
(d) The district engineer will notify the prospective permittee within 45 days of receipt of a complete pre-construction notification whether NHPA Section 106 consultation is required. Section 106 consultation is not required when the Corps determines that the activity does not have the potential to cause effects on historic properties (see 36 CFR §800.3(a)). If NHPA section 106 consultation is required and will occur, the district engineer will notify the non-Federal applicant that he or she cannot

begin work until Section 106 consultation is completed. If the non-Federal applicant has not heard back from the Corps within 45 days, the applicant must still wait for notification from the Corps.
(e) Prospective permittees should be aware that section 110k of the NHPA (16 U.S.C. 470h-2(k)) prevents the Corps from granting a permit or other assistance to an applicant who, with intent to avoid the requirements of Section 106 of the NHPA, has intentionally significantly adversely affected a historic property to which the permit would relate, or having legal power to prevent it, allowed such significant adverse effect to occur, unless the Corps, after consultation with the Advisory Council on Historic Preservation (ACHP), determines that circumstances justify granting such assistance despite the adverse effect created or permitted by the applicant. If circumstances justify granting the assistance, the Corps is required to notify the ACHP and provide documentation specifying the circumstances, the degree of damage to the integrity of any historic properties affected, and proposed mitigation. This documentation must include any views obtained from the applicant, SHPO/THPO, appropriate Indian tribes if the undertaking occurs on or affects historic properties on tribal lands or affects properties of interest to those tribes, and other parties known to have a legitimate interest in the impacts to the permitted activity on historic properties.

21. Discovery of Previously Unknown Remains and Artifacts. If you discover any previously unknown historic, cultural or archeological remains and artifacts while accomplishing the activity authorized by this permit, you must immediately notify the district engineer of what you have found, and to the maximum extent practicable, avoid construction activities that may affect the remains and artifacts until the required coordination has been completed. The district engineer will initiate the Federal, Tribal and state coordination required to determine if the items or remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

22. Designated Critical Resource Waters. Critical resource waters include, NOAA-managed marine sanctuaries and marine monuments, and National Estuarine Research Reserves. The district engineer may designate, after notice and opportunity for public comment, additional waters officially designated by a state as having particular environmental or ecological significance, such as outstanding national resource waters or state natural heritage sites. The district engineer may also designate additional critical resource waters after notice and opportunity for public comment.
(a) Discharges of dredged or fill material into waters of the United States are not authorized by NWPs 7, 12, 14, 16, 17, 21, 29, 31, 35, 39, 40, 42, 43, 44, 49, 50, 51, and 52 for any activity within, or directly affecting, critical resource waters, including wetlands adjacent to such waters.
(b) For NWPs 3, 8, 10, 13, 15, 18, 19, 22, 23, 25, 27, 28, 30, 33, 34, 36, 37, and 38, notification is required in accordance with general condition 31, for any activity proposed in the designated critical resource waters including wetlands adjacent to those waters. The district engineer may authorize activities under these NWPs only after it is determined that the impacts to the critical resource waters will be no more than minimal.

23. Mitigation. The district engineer will consider the following factors when determining appropriate and practicable mitigation necessary to ensure that adverse effects on the aquatic environment are minimal:
(a) The activity must be designed and constructed to avoid and minimize adverse effects, both temporary and permanent, to waters of the United States to the maximum extent practicable at the project site (i.e., on site).

(b) Mitigation in all its forms (avoiding, minimizing, rectifying, reducing, or compensating for resource losses) will be required to the extent necessary to ensure that the adverse effects to the aquatic environment are minimal.

(c) Compensatory mitigation at a minimum one-for-one ratio will be required for all wetland losses that exceed 1/10-acre and require pre-construction notification, unless the district engineer determines in writing that either some other form of mitigation would be more environmentally appropriate or the adverse effects of the proposed activity are minimal, and provides a project-specific waiver of this requirement. For wetland losses of 1/10-acre or less that require pre-construction notification, the district engineer may determine on a case-by-case basis that compensatory mitigation is required to ensure that the activity results in minimal adverse effects on the aquatic environment. Compensatory mitigation projects provided to offset losses of aquatic resources must comply with the applicable provisions of 33 CFR part 332.

(1) The prospective permittee is responsible for proposing an appropriate compensatory mitigation option if compensatory mitigation is necessary to ensure that the activity results in minimal adverse effects on the aquatic environment.

(2) Since the likelihood of success is greater and the impacts to potentially valuable uplands are reduced, wetland restoration should be the first compensatory mitigation option considered.

(3) If permittee-responsible mitigation is the proposed option, the prospective permittee is responsible for submitting a mitigation plan. A conceptual or detailed mitigation plan may be used by the district engineer to make the decision on the NWP verification request, but a final mitigation plan that addresses the applicable requirements of 33 CFR 332.4(c)(2) – (14) must be approved by the district engineer before the permittee begins work in waters of the United States, unless the district engineer determines that prior approval of the final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation (see 33 CFR 332.3(k)(3)).

(4) If mitigation bank or in-lieu fee program credits are the proposed option, the mitigation plan only needs to address the baseline conditions at the impact site and the number of credits to be provided.

(5) Compensatory mitigation requirements (e.g., resource type and amount to be provided as compensatory mitigation, site protection, ecological performance standards, monitoring requirements) may be addressed through conditions added to the NWP authorization, instead of components of a compensatory mitigation plan.

(d) For losses of streams or other open waters that require pre-construction notification, the district engineer may require compensatory mitigation, such as stream rehabilitation, enhancement, or preservation, to ensure that the activity results in minimal adverse effects on the aquatic environment.

(e) Compensatory mitigation will not be used to increase the acreage losses allowed by the acreage limits of the NWPs. For example, if an NWP has an acreage limit of 1/2-acre, it cannot be used to authorize any project resulting in the loss of greater than 1/2-acre of waters of the United States, even if compensatory mitigation is provided that replaces or restores some of the lost waters. However, compensatory mitigation can and should be used, as necessary, to ensure that a project already meeting the established acreage limits also satisfies the minimal impact requirement associated with the NWPs.

(f) Compensatory mitigation plans for projects in or near streams or other open waters will normally include a requirement for the restoration or establishment, maintenance, and legal protection (e.g., conservation easements) of riparian areas next to open waters. In some cases, riparian areas may be the only compensatory mitigation required. Riparian areas should consist of native species. The width of the required riparian area will address documented water quality or aquatic habitat loss concerns. Normally, the riparian area will be 25 to 50 feet wide on each side of the stream, but the district engineer may

require slightly wider riparian areas to address documented water quality or habitat loss concerns. If it is not possible to establish a riparian area on both sides of a stream, or if the waterbody is a lake or coastal waters, then restoring or establishing a riparian area along a single bank or shoreline may be sufficient. Where both wetlands and open waters exist on the project site, the district engineer will determine the appropriate compensatory mitigation (e.g., riparian areas and/or wetlands compensation) based on what is best for the aquatic environment on a watershed basis. In cases where riparian areas are determined to be the most appropriate form of compensatory mitigation, the district engineer may waive or reduce the requirement to provide wetland compensatory mitigation for wetland losses.

(g) Permittees may propose the use of mitigation banks, in-lieu fee programs, or separate permittee-responsible mitigation. For activities resulting in the loss of marine or estuarine resources, permittee-responsible compensatory mitigation may be environmentally preferable if there are no mitigation banks or in-lieu fee programs in the area that have marine or estuarine credits available for sale or transfer to the permittee. For permittee-responsible mitigation, the special conditions of the NWP verification must clearly indicate the party or parties responsible for the implementation and performance of the compensatory mitigation project, and, if required, its long-term management.

(h) Where certain functions and services of waters of the United States are permanently adversely affected, such as the conversion of a forested or scrub-shrub wetland to a herbaceous wetland in a permanently maintained utility line right-of-way, mitigation may be required to reduce the adverse effects of the project to the minimal level.

24. Safety of Impoundment Structures. To ensure that all impoundment structures are safely designed, the district engineer may require non-Federal applicants to demonstrate that the structures comply with established state dam safety criteria or have been designed by qualified persons. The district engineer may also require documentation that the design has been independently reviewed by similarly qualified persons, and appropriate modifications made to ensure safety.

25. Water Quality. Where States and authorized Tribes, or EPA where applicable, have not previously certified compliance of an NWP with CWA Section 401, individual 401 Water Quality Certification must be obtained or waived (see 33 CFR 330.4(c)). The district engineer or State or Tribe may require additional water quality management measures to ensure that the authorized activity does not result in more than minimal degradation of water quality.

26. Coastal Zone Management. In coastal states where an NWP has not previously received a state coastal zone management consistency concurrence, an individual state coastal zone management consistency concurrence must be obtained, or a presumption of concurrence must occur (see 33 CFR 330.4(d)). The district engineer or a State may require additional measures to ensure that the authorized activity is consistent with state coastal zone management requirements.

27. Regional and Case-By-Case Conditions. The activity must comply with any regional conditions that may have been added by the Division Engineer (see 33 CFR 330.4(e)) and with any case specific conditions added by the Corps or by the state, Indian Tribe, or U.S. EPA in its section 401 Water Quality Certification, or by the state in its Coastal Zone Management Act consistency determination.

28. Use of Multiple Nationwide Permits. The use of more than one NWP for a single and complete project is prohibited, except when the acreage loss of waters of the United States authorized by the NWPs does not exceed the acreage limit of the NWP with the highest specified acreage limit. For example, if a road

crossing over tidal waters is constructed under NWP 14, with associated bank stabilization authorized by NWP 13, the maximum acreage loss of waters of the United States for the total project cannot exceed 1/3-acre.

29. Transfer of Nationwide Permit Verifications. If the permittee sells the property associated with a nationwide permit verification, the permittee may transfer the nationwide permit verification to the new owner by submitting a letter to the appropriate Corps district office to validate the transfer. A copy of the nationwide permit verification must be attached to the letter, and the letter must contain the following statement and signature:

    "When the structures or work authorized by this nationwide permit are still in existence at the time the property is transferred, the terms and conditions of this nationwide permit, including any special conditions, will continue to be binding on the new owner(s) of the property. To validate the transfer of this nationwide permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below."

    _____
    (Transferee)

    _____
    (Date)

30. Compliance Certification. Each permittee who receives an NWP verification letter from the Corps must provide a signed certification documenting completion of the authorized activity and any required compensatory mitigation. The success of any required permittee-responsible mitigation, including the achievement of ecological performance standards, will be addressed separately by the district engineer. The Corps will provide the permittee the certification document with the NWP verification letter. The certification document will include:
    (a) A statement that the authorized work was done in accordance with the NWP authorization, including any general, regional, or activity-specific conditions;
    (b) A statement that the implementation of any required compensatory mitigation was completed in accordance with the permit conditions. If credits from a mitigation bank or in-lieu fee program are used to satisfy the compensatory mitigation requirements, the certification must include the documentation required by 33 CFR 332.3(l)(3) to confirm that the permittee secured the appropriate number and resource type of credits; and
    (c) The signature of the permittee certifying the completion of the work and mitigation.

31. Pre-Construction Notification. (a) Timing. Where required by the terms of the NWP, the prospective permittee must notify the district engineer by submitting a pre-construction notification (PCN) as early as possible. The district engineer must determine if the PCN is complete within 30 calendar days of the date of receipt and, if the PCN is determined to be incomplete, notify the prospective permittee within that 30 day period to request the additional information necessary to make the PCN complete. The request must specify the information needed to make the PCN complete. As a general rule, district engineers will request additional information necessary to make the PCN complete only once. However, if the prospective permittee does not provide all of the requested information, then the district engineer

will notify the prospective permittee that the PCN is still incomplete and the PCN review process will not commence until all of the requested information has been received by the district engineer. The prospective permittee shall not begin the activity until either:

(1) He or she is notified in writing by the district engineer that the activity may proceed under the NWP with any special conditions imposed by the district or division engineer; or

(2) 45 calendar days have passed from the district engineer's receipt of the complete PCN and the prospective permittee has not received written notice from the district or division engineer. However, if the permittee was required to notify the Corps pursuant to general condition 18 that listed species or critical habitat might be affected or in the vicinity of the project, or to notify the Corps pursuant to general condition 20 that the activity may have the potential to cause effects to historic properties, the permittee cannot begin the activity until receiving written notification from the Corps that there is "no effect" on listed species or "no potential to cause effects" on historic properties, or that any consultation required under Section 7 of the Endangered Species Act (see 33 CFR 330.4(f)) and/or Section 106 of the National Historic Preservation (see 33 CFR 330.4(g)) has been completed. Also, work cannot begin under NWPs 21, 49, or 50 until the permittee has received written approval from the Corps. If the proposed activity requires a written waiver to exceed specified limits of an NWP, the permittee may not begin the activity until the district engineer issues the waiver. If the district or division engineer notifies the permittee in writing that an individual permit is required within 45 calendar days of receipt of a complete PCN, the permittee cannot begin the activity until an individual permit has been obtained. Subsequently, the permittee's right to proceed under the NWP may be modified, suspended, or revoked only in accordance with the procedure set forth in 33 CFR 330.5(d)(2).

(b) Contents of Pre-Construction Notification: The PCN must be in writing and include the following information:

(1) Name, address and telephone numbers of the prospective permittee;

(2) Location of the proposed project;

(3) A description of the proposed project; the project's purpose; direct and indirect adverse environmental effects the project would cause, including the anticipated amount of loss of water of the United States expected to result from the NWP activity, in acres, linear feet, or other appropriate unit of measure; any other NWP(s), regional general permit(s), or individual permit(s) used or intended to be used to authorize any part of the proposed project or any related activity. The description should be sufficiently detailed to allow the district engineer to determine that the adverse effects of the project will be minimal and to determine the need for compensatory mitigation. Sketches should be provided when necessary to show that the activity complies with the terms of the NWP. (Sketches usually clarify the project and when provided results in a quicker decision. Sketches should contain sufficient detail to provide an illustrative description of the proposed activity (e.g., a conceptual plan), but do not need to be detailed engineering plans);

(4) The PCN must include a delineation of wetlands, other special aquatic sites, and other waters, such as lakes and ponds, and perennial, intermittent, and ephemeral streams, on the project site. Wetland delineations must be prepared in accordance with the current method required by the Corps. The permittee may ask the Corps to delineate the special aquatic sites and other waters on the project site, but there may be a delay if the Corps does the delineation, especially if the project site is large or contains many waters of the United States. Furthermore, the 45 day period will not start until the delineation has been submitted to or completed by the Corps, as appropriate;

(5) If the proposed activity will result in the loss of greater than 1/10-acre of wetlands and a PCN is required, the prospective permittee must submit a statement describing how the mitigation

requirement will be satisfied, or explaining why the adverse effects are minimal and why compensatory mitigation should not be required. As an alternative, the prospective permittee may submit a conceptual or detailed mitigation plan.

(6) If any listed species or designated critical habitat might be affected or is in the vicinity of the project, or if the project is located in designated critical habitat, for non-Federal applicants the PCN must include the name(s) of those endangered or threatened species that might be affected by the proposed work or utilize the designated critical habitat that may be affected by the proposed work. Federal applicants must provide documentation demonstrating compliance with the Endangered Species Act; and

(7) For an activity that may affect a historic property listed on, determined to be eligible for listing on, or potentially eligible for listing on, the National Register of Historic Places, for non-Federal applicants the PCN must state which historic property may be affected by the proposed work or include a vicinity map indicating the location of the historic property. Federal applicants must provide documentation demonstrating compliance with Section 106 of the National Historic Preservation Act.

(c) Form of Pre-Construction Notification: The standard individual permit application form (Form ENG 4345) may be used, but the completed application form must clearly indicate that it is a PCN and must include all of the information required in paragraphs (b)(1) through (7) of this general condition. A letter containing the required information may also be used.

(d) Agency Coordination: (1) The district engineer will consider any comments from Federal and state agencies concerning the proposed activity's compliance with the terms and conditions of the NWPs and the need for mitigation to reduce the project's adverse environmental effects to a minimal level.

(2) For all NWP activities that require pre-construction notification and result in the loss of greater than 1/2-acre of waters of the United States, for NWP 21, 29, 39, 40, 42, 43, 44, 50, 51, and 52 activities that require pre-construction notification and will result in the loss of greater than 300 linear feet of intermittent and ephemeral stream bed, and for all NWP 48 activities that require pre-construction notification, the district engineer will immediately provide (e.g., via e-mail, facsimile transmission, overnight mail, or other expeditious manner) a copy of the complete PCN to the appropriate Federal or state offices (U.S. FWS, state natural resource or water quality agency, EPA, State Historic Preservation Officer (SHPO) or Tribal Historic Preservation Office (THPO), and, if appropriate, the NMFS). With the exception of NWP 37, these agencies will have 10 calendar days from the date the material is transmitted to telephone or fax the district engineer notice that they intend to provide substantive, site-specific comments. The comments must explain why the agency believes the adverse effects will be more than minimal. If so contacted by an agency, the district engineer will wait an additional 15 calendar days before making a decision on the pre-construction notification. The district engineer will fully consider agency comments received within the specified time frame concerning the proposed activity's compliance with the terms and conditions of the NWPs, including the need for mitigation to ensure the net adverse environmental effects to the aquatic environment of the proposed activity are minimal. The district engineer will provide no response to the resource agency, except as provided below. The district engineer will indicate in the administrative record associated with each pre-construction notification that the resource agencies' concerns were considered. For NWP 37, the emergency watershed protection and rehabilitation activity may proceed immediately in cases where there is an unacceptable hazard to life or a significant loss of property or economic hardship will occur. The district engineer will consider any comments received to decide whether the NWP 37 authorization should be modified, suspended, or revoked in accordance with the procedures at 33 CFR 330.5.

(3) In cases of where the prospective permittee is not a Federal agency, the district engineer will provide a response to NMFS within 30 calendar days of receipt of any Essential Fish Habitat conservation recommendations, as required by Section 305(b)(4)(B) of the Magnuson-Stevens Fishery Conservation and Management Act.
(4) Applicants are encouraged to provide the Corps with either electronic files or multiple copies of pre-construction notifications to expedite agency coordination.

3. Regional Conditions for the Los Angeles District:

In accordance with General Condition Number 27, "Regional and Case-by-Case Conditions," the following Regional Conditions, as added by the Division Engineer, must be met in order for an authorization by any Nationwide to be valid:

1. For all activities in waters of the U.S. that are suitable habitat for federally listed fish species, the permittee shall design all road crossings to ensure that the passage and/or spawning of fish is not hindered. In these areas, the permittee shall employ bridge designs that span the stream or river, including pier- or pile-supported spans, or designs that use a bottomless arch culvert with a natural stream bed, unless determined to be impracticable by the Corps.

2. Nationwide Permits (NWP) 3, 7, 12-15, 17-19, 21, 23, 25, 29, 35, 36, or 39-46, 48-52 cannot be used to authorize structures, work, and/or the discharge of dredged or fill material that would result in the "loss" of wetlands, mudflats, vegetated shallows or riffle and pool complexes as defined at 40 CFR Part 230.40-45. The definition of "loss" for this regional condition is the same as the definition of "loss of waters of the United States" used for the Nationwide Permit Program. Furthermore, this regional condition applies only within the State of Arizona and within the Mojave and Sonoran (Colorado) desert regions of California. The desert regions in California are limited to four USGS Hydrologic Unit Code (HUC) accounting units (Lower Colorado -150301, Northern Mojave-180902, Southern Mojave-181001, and Salton Sea-181002).

3. When a pre-construction notification (PCN) is required, the appropriate U.S. Army Corps of Engineers (Corps) District shall be notified in accordance with General Condition 31 using either the South Pacific Division PCN Checklist or a signed application form (ENG Form 4345) with an attachment providing information on compliance with all of the General and Regional Conditions. The PCN Checklist and application form are available at: http://www.spl.usace.army.mil/regulatory. In addition, the PCN shall include:
   a. A written statement describing how the activity has been designed to avoid and minimize adverse effects, both temporary and permanent, to waters of the United States;
   b. Drawings, including plan and cross-section views, clearly depicting the location, size and dimensions of the proposed activity as well as the location of delineated waters of the U.S. on the site. The drawings shall contain a title block, legend and scale, amount (in cubic yards) and area (in acres) of fill in Corps jurisdiction, including both permanent and temporary fills/structures. The ordinary high water mark or, if tidal waters, the mean high water mark and high tide line, should be shown (in feet), based on National Geodetic Vertical Datum (NGVD) or other appropriate referenced elevation. All drawings for projects located within the boundaries of the Los Angeles District shall comply with the most current version of the *Map and Drawing Standards for the Los*

Angeles District Regulatory Division (available on the Los Angeles District Regulatory Division website at: www.spl.usace.army.mil/regulatory/); and

c. Numbered and dated pre-project color photographs showing a representative sample of waters proposed to be impacted on the project site, and all waters proposed to be avoided on and immediately adjacent to the project site. The compass angle and position of each photograph shall be documented on the plan-view drawing required in subpart b of this regional condition.

4. Submission of a PCN pursuant to General Condition 31 and Regional Condition 3 shall be required for all regulated activities in the following locations:
   a. All perennial waterbodies and special aquatic sites within the State of Arizona and within the Mojave and Sonoran (Colorado) desert regions of California, excluding the Colorado River in Arizona from Davis Dam to River Mile 261 (northern boundary of the Fort Mojave Indian Tribe Reservation). The desert region in California is limited to four USGS HUC accounting units (Lower Colorado -150301, Northern Mojave-180902, Southern Mojave-181001, and Salton Sea-181002).
   b. All areas designated as Essential Fish Habitat (EFH) by the Pacific Fishery Management Council (i.e., all tidally influenced areas - Federal Register dated March 12, 2007 (72 FR 11092)), in which case the PCN shall include an EFH assessment and extent of proposed impacts to EFH. Examples of EFH habitat assessments can be found at: http://www.swr.noaa.gov/efh.htm.
   c. All watersheds in the Santa Monica Mountains in Los Angeles and Ventura counties bounded by Calleguas Creek on the west, by Highway 101 on the north and east, and by Sunset Boulevard and Pacific Ocean on the south.
   d. The Santa Clara River watershed in Los Angeles and Ventura counties, including but not limited to Aliso Canyon, Agua Dulce Canyon, Sand Canyon, Bouquet Canyon, Mint Canyon, South Fork of the Santa Clara River, San Francisquito Canyon, Castaic Creek, Piru Creek, Sespe Creek and the main-stem of the Santa Clara River.

5. Individual Permits shall be required for all discharges of fill material in jurisdictional vernal pools, with the exception that discharges for the purpose of restoration, enhancement, management or scientific study of vernal pools may be authorized under NWPs 5, 6, and 27 with the submission of a PCN in accordance with General Condition 31 and Regional Condition 3.

6. Individual Permits shall be required in Murrieta Creek and Temecula Creek watersheds in Riverside County for new permanent fills in perennial and intermittent watercourses otherwise authorized under NWPs 29, 39, 42 and 43, and in ephemeral watercourses for these NWPs for projects that impact greater than 0.1 acre of waters of the United States. In addition, when NWP 14 is used in conjunction with residential, commercial, or industrial developments the 0.1 acre limit would also apply.

7. Individual Permits (Standard Individual Permit or 404 Letter of Permission) shall be required in San Luis Obispo Creek and Santa Rosa Creek in San Luis Obispo County for bank stabilization projects, and in Gaviota Creek, Mission Creek and Carpinteria Creek in Santa Barbara County for bank stabilization projects and grade control structures.

8. In conjunction with the Los Angeles District's Special Area Management Plans (SAMPs) for the San Diego Creek Watershed and San Juan Creek/Western San Mateo Creek Watersheds in Orange County, California, the Corps' Division Engineer, through his discretionary authority has revoked the use of the

following 26 selected NWPs within these SAMP watersheds: 03, 07, 12, 13, 14, 16, 17, 18, 19, 21, 25, 27, 29, 31, 33, 39, 40, 41, 42, 43, 44, 46, 49, and 50. Consequently, these NWPs are no longer available in those watersheds to authorize impacts to waters of the United States from discharges of dredged or fill material under the Corps' Clean Water Act section 404 authority.

9. Any requests to waive the 300 linear foot limitation for intermittent and ephemeral streams for NWPs 29, 39, 40 and 42, 43, 44, 51 and 52 or to waive the 500 linear foot limitation along the bank for NWP 13, must include the following:
   a. A narrative description of the stream. This should include known information on: volume and duration of flow; the approximate length, width, and depth of the waterbody and characters observed associated with an Ordinary High Water Mark (e.g. bed and bank, wrack line, or scour marks); a description of the adjacent vegetation community and a statement regarding the wetland status of the associated vegetation community (i.e. wetland, non-wetland); surrounding land use; water quality; issues related to cumulative impacts in the watershed, and; any other relevant information.
   b. An analysis of the proposed impacts to the waterbody in accordance with General Condition 31 and Regional Condition 3;
   c. Measures taken to avoid and minimize losses, including other methods of constructing the proposed project; and
   d. A compensatory mitigation plan describing how the unavoidable losses are proposed to be compensated, in accordance with 33 CFR Part 332.

10. The permittee shall complete the construction of any compensatory mitigation required by special condition(s) of the NWP verification before or concurrent with commencement of construction of the authorized activity, except when specifically determined to be impracticable by the Corps. When mitigation involves use of a mitigation bank or in-lieu fee program, the permittee shall submit proof of payment to the Corps prior to commencement of construction of the authorized activity.

4. Further information:

1. Congressional Authorities: You have been authorized to undertake the activity described above pursuant to:
   ( ) Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403).
   (x) Section 404 of the Clean Water Act (33 U.S.C. 1344).
   ( ) Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. 1413).

2. Limits of this authorization.
   (a) This permit does not obviate the need to obtain other Federal, state, or local authorizations required by law.
   (b) This permit does not grant any property rights or exclusive privileges.
   (c) This permit does not authorize any injury to the property or rights of others.
   (d) This permit does not authorize interference with any existing or proposed Federal project.

3. Limits of Federal Liability. In issuing this permit, the Federal Government does not assume any liability for the following:
   (a) Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.
   (b) Damages to the permitted project or uses thereof as a result of current or future activities

undertaken by or on behalf of the United States in the public interest.

(c) Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit.

(d) Design or construction deficiencies associated with the permitted work.

(e) Damage claims associated with any future modification, suspension, or revocation of this permit.

4. Reliance on Applicant's Data: The determination of this office that issuance of this permit is not contrary to the public interest was made in reliance on the information you provided.

5. Reevaluation of Permit Decision. This office may reevaluate its decision on this permit at any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following:

   (a) You fail to comply with the terms and conditions of this permit.

   (b) The information provided by you in support of your permit application proves to have been false, incomplete, or inaccurate (See 4 above).

   (c) Significant new information surfaces which this office did not consider in reaching the original public interest decision.

   Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 CFR 330.5 or enforcement procedures such as those contained in 33 CFR 326.4 and 326.5. The referenced enforcement procedures provide for the issuance of an administrative order requiring you to comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measure ordered by this office, and if you fail to comply with such directive, this office may in certain situations (such as those specified in 33 CFR 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

6. This letter of verification is valid for a period not to exceed two years unless the nationwide permit is modified, reissued, revoked, or expires before that time.

7. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition H below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.

8. You must allow representatives from this office to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished with the terms and conditions of your permit.

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
12	Ora	91	0.9/5.4	X	XX

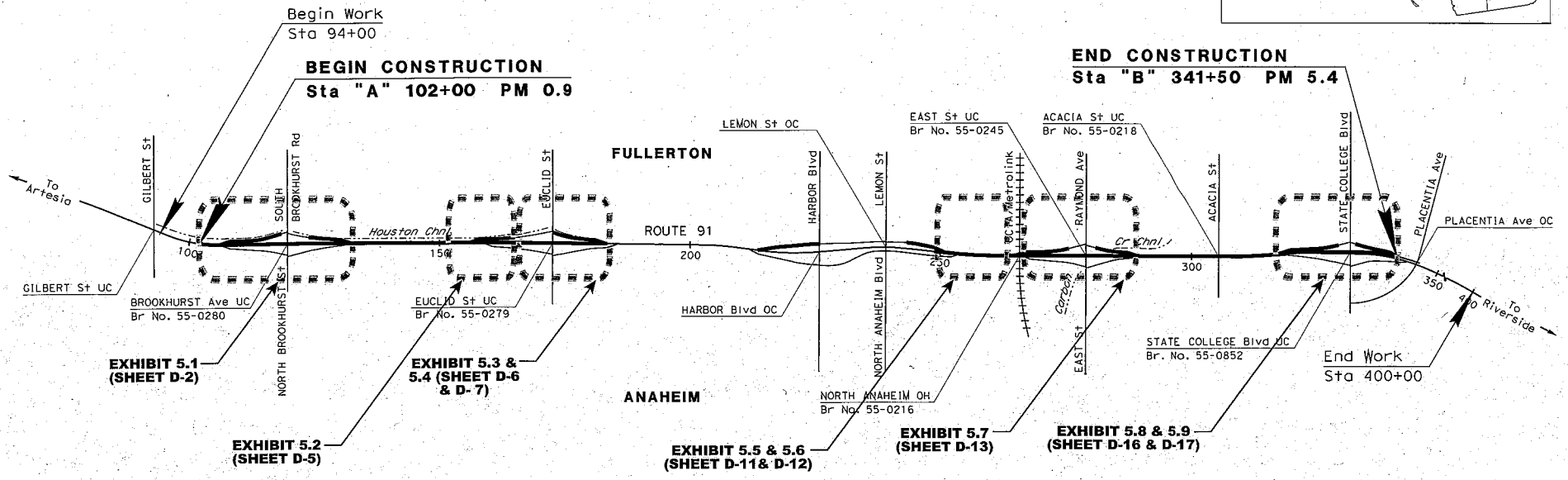
STATE OF CALIFORNIA

DEPARTMENT OF TRANSPORTATION

PROJECT PLANS FOR CONSTRUCTION ON

STATE HIGHWAY

IN ORANGE COUNTY
IN ANAHEIM AND FULLERTON
FROM 0.3 MILES WEST OF BROOKHURST STREET
TO 0.2 MILES EAST OF STATE COLLEGE BOULEVARD



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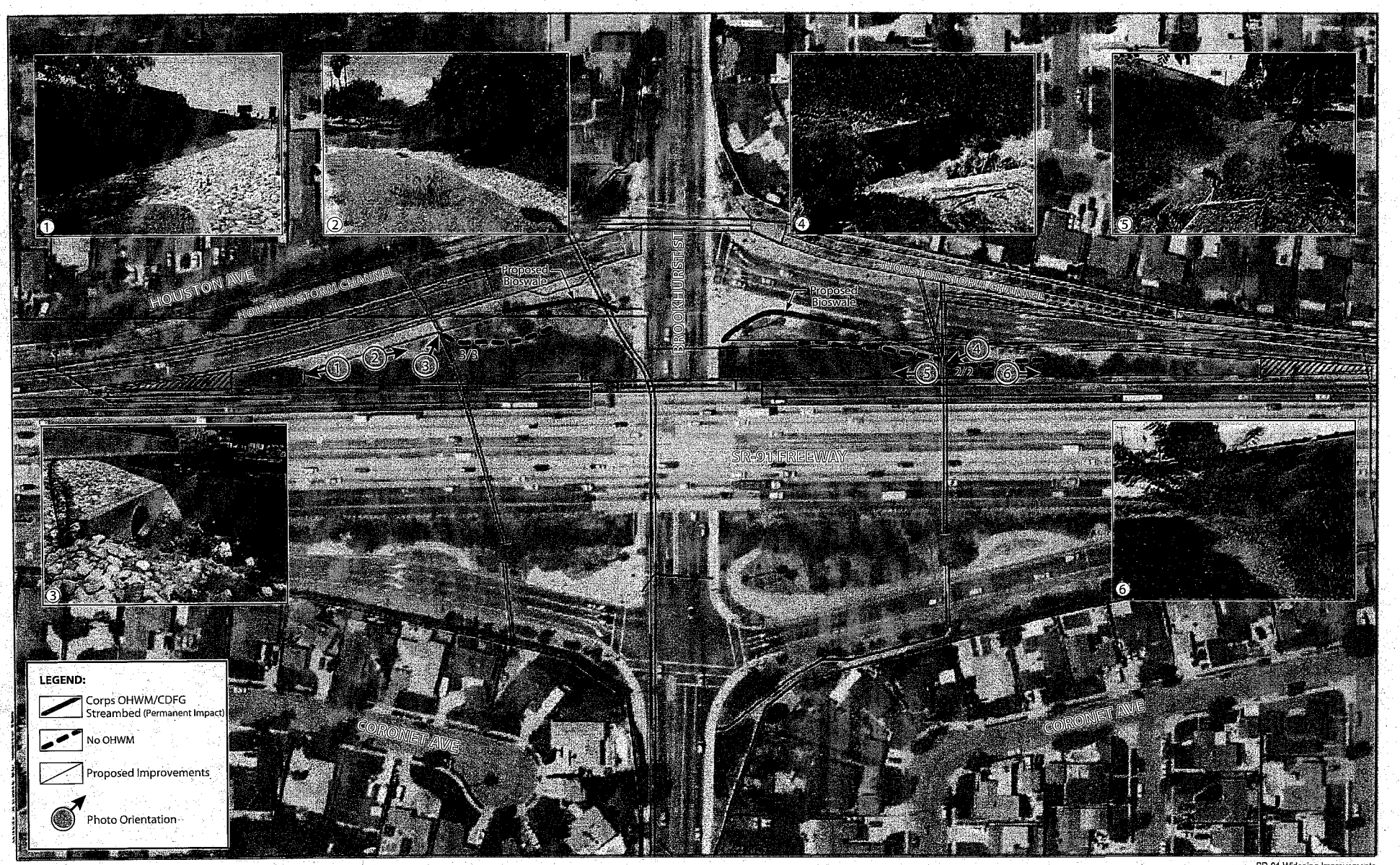
Not to Scale

STATE ROUTE 91 WESTBOUND WIDENING PROJECT

Jurisdictional Map-Index Sheets

Exhibit 5



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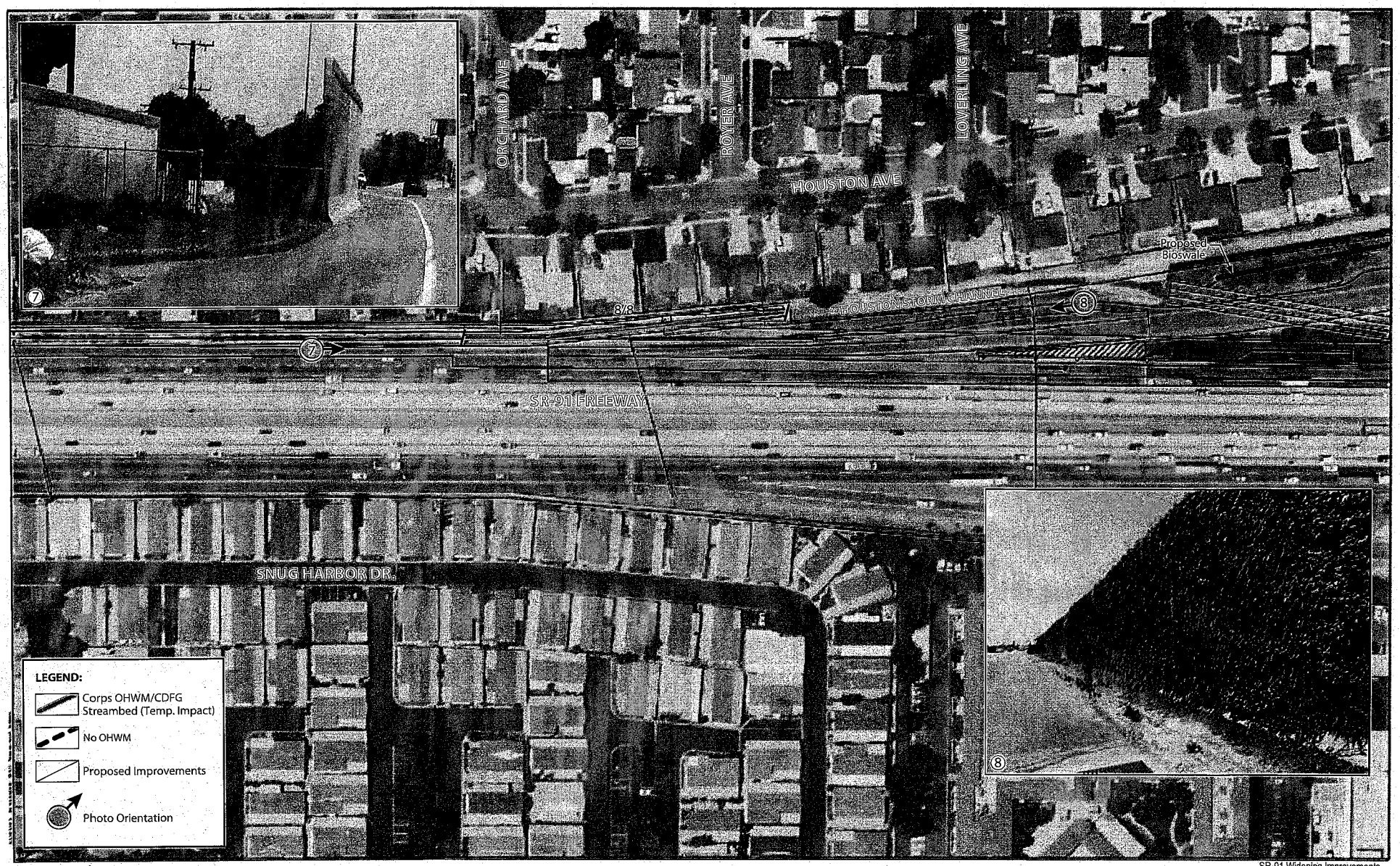
SR-91 Widening Improvements

Jurisdictional Map

Exhibit 5.1 (Sheet D-2)



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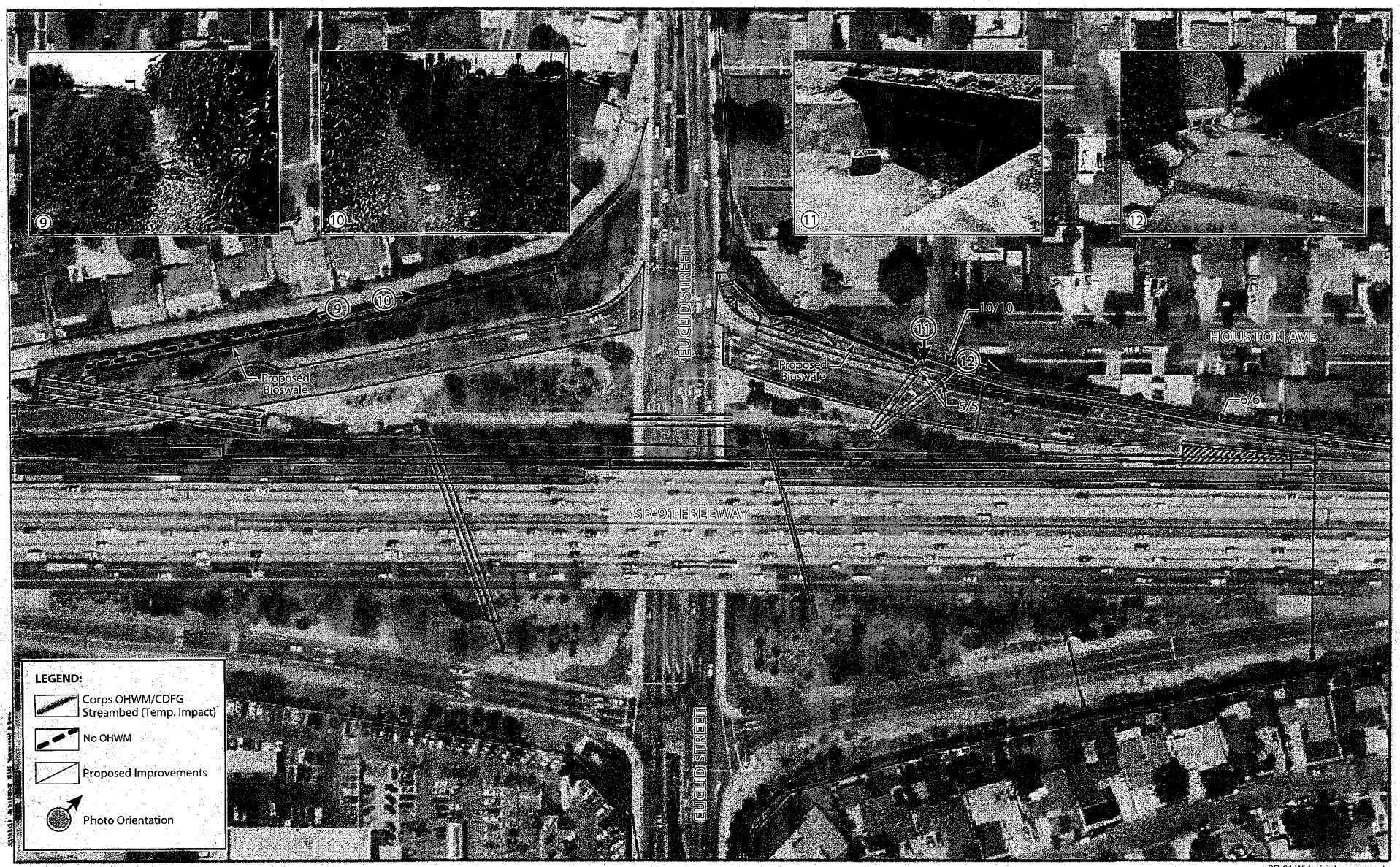
SR-91 Widening Improvements

Jurisdictional Map

Exhibit 5.2 (Sheet D-5)



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Source: Eagle Aerial Imagery 2011

SR-91 Widening Improvements

Jurisdictional Map

Exhibit 5.3 (Sheet D-6)

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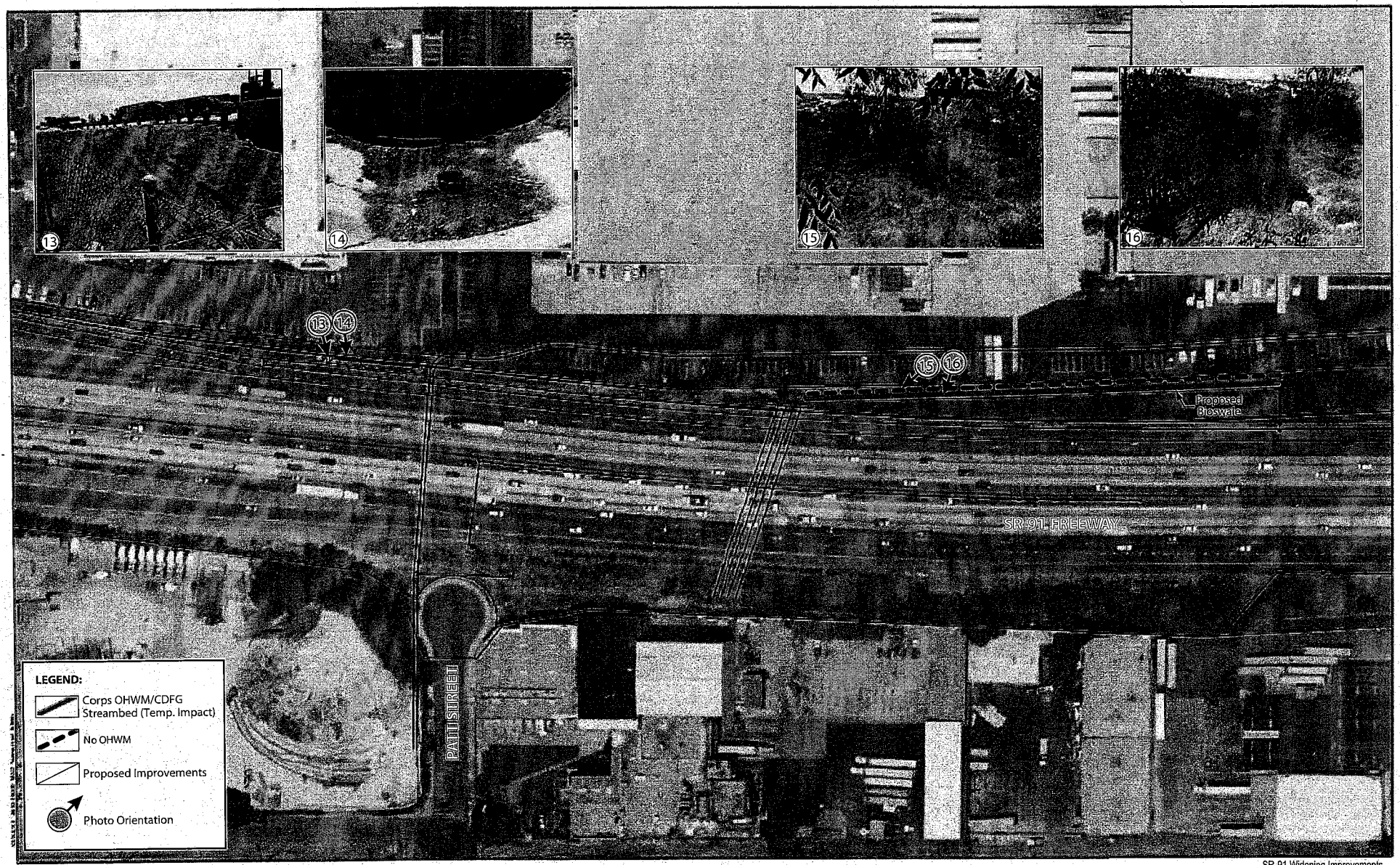
SR-91 Widening Improvements

Jurisdictional Map

Exhibit 5.4 (Sheet D-7)



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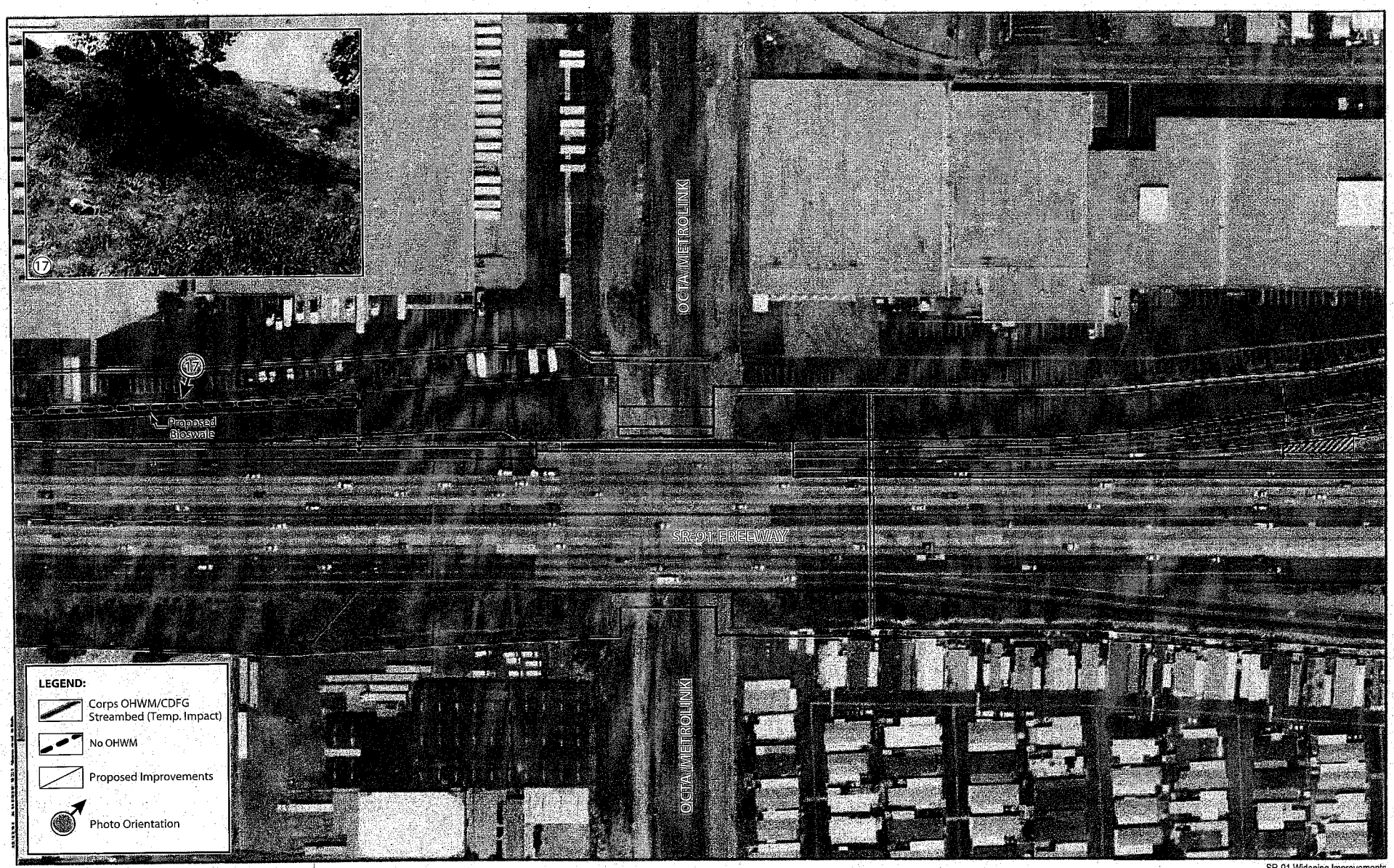
SR-91 Widening Improvements

Jurisdictional Map

Exhibit 5.5 (Sheet D-11)



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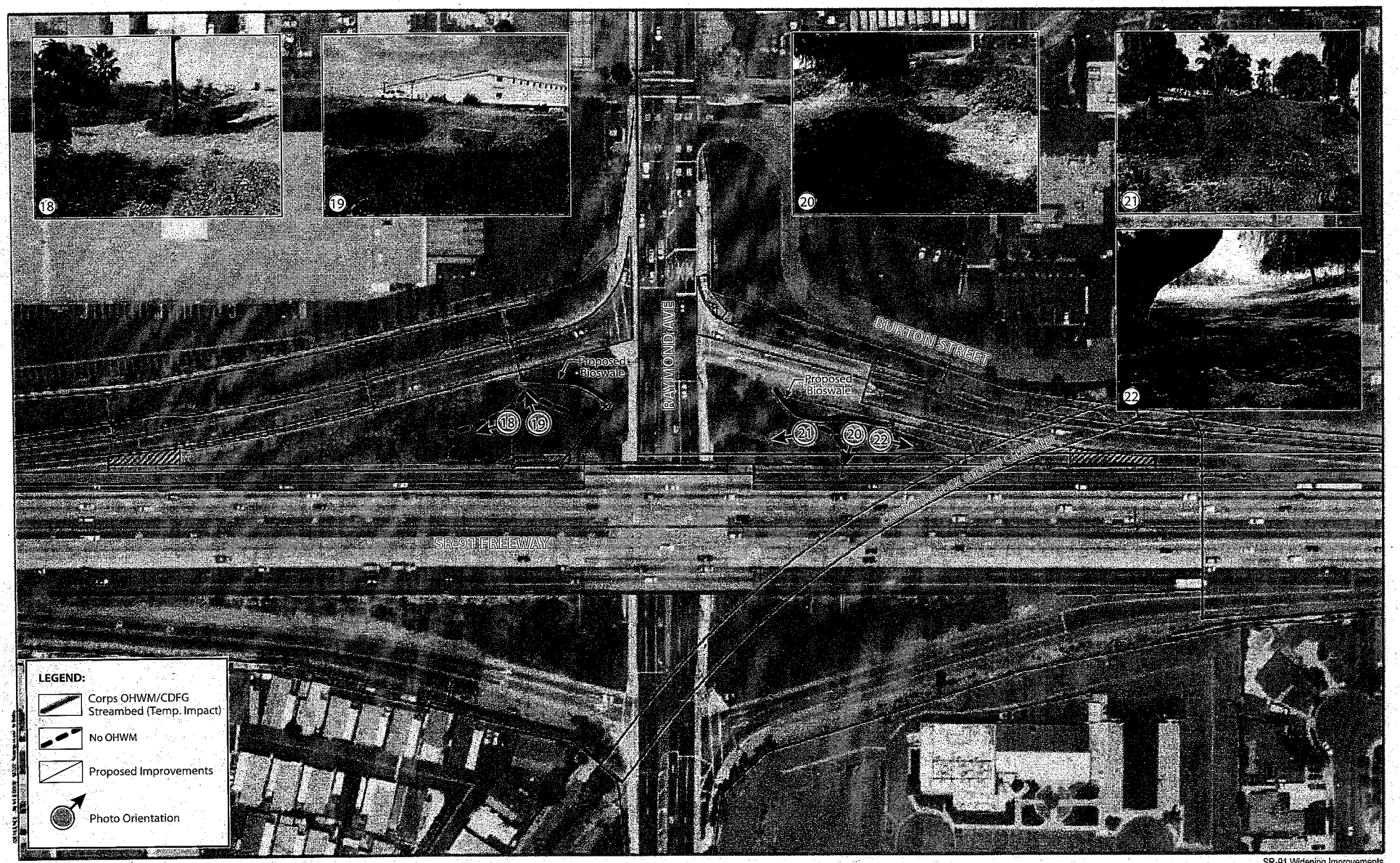
0 50 100 200 Feet

Source: Eagle Aerial Imagery 2011

SR-91 Widening Improvements

Jurisdictional Map

Exhibit 5.6 (Sheet D-12)



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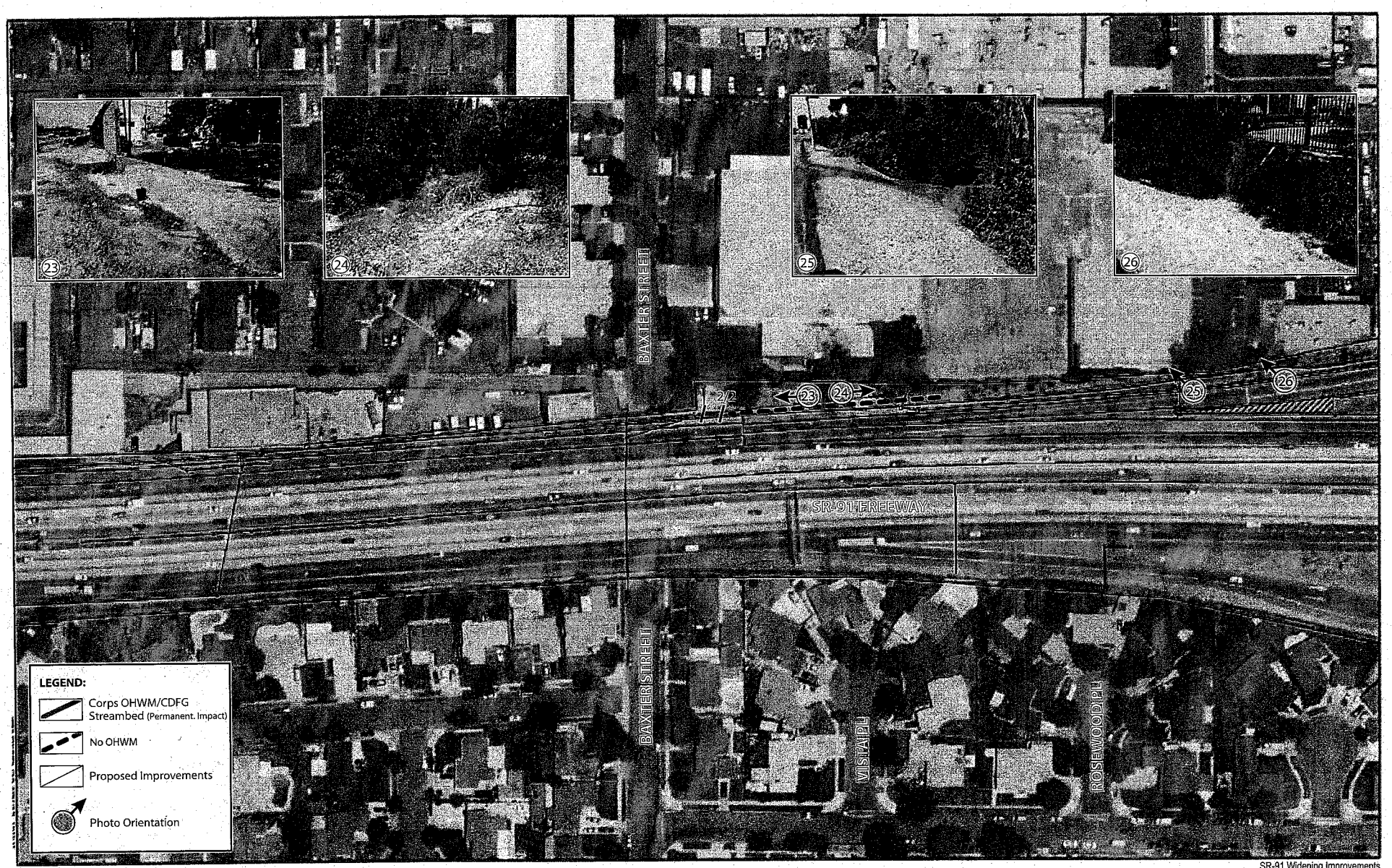
Source: Eagle Aerial Imagery 2011

SR-91 Widening Improvements

Jurisdictional Map

Exhibit 5.7 (Sheet D-13)



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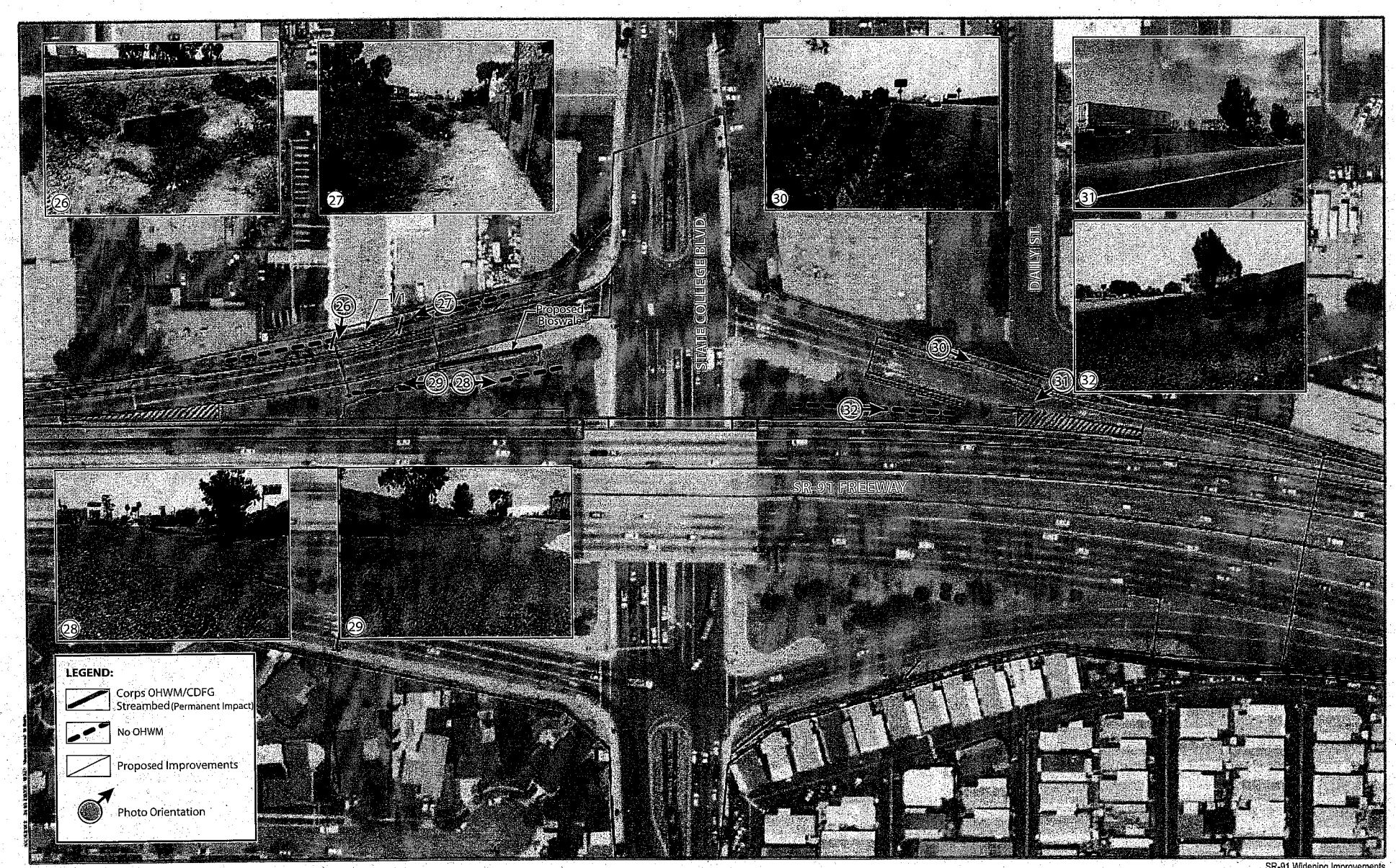
SR-91 Widening Improvements

Jurisdictional Map

Exhibit 5.8 (Sheet D-16)



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SR-91 Widening Improvements

Jurisdictional Map

Exhibit 5.9 (Sheet D-17)

RAILROAD RELATIONS AND INSURANCE REQUIREMENTS

Note: This is an *Information Handout* document to replace "Reserved" in Section 5-1.20C of the Caltrans 2010 Standard Specifications. Comply with the provisions.

"RAILROAD RELATIONS AND INSURANCE REQUIREMENTS"

1.00 GENERAL

The term "Railroad" or "SCRRA" shall mean the Southern California Regional Rail Authority.

It is expected that the Railroad will cooperate with the Contractor to the end that the work may be handled in an efficient manner. However, except for the additional compensation provided for hereinafter for delays in completion of specific unit of work to be performed by the Railroad, and except as provided in Public Contracts Code Section 7102, the Contractor shall have no claim for damages, extension of time, or extra compensation in the event his work is held up by railroad train operations or other work performed by the Railroad.

The Contractor must understand the Contractor's right to enter the Railroad's property is subject to the absolute right of the Railroad to cause the Contractor's work on the Railroad's property to cease if, in the opinion of the Railroad, the Contractor's activities create a hazard to the Railroad's property, employees, and operations.

The Contractor must familiarize itself with the proper manner of protecting the tracks, signals, fiber optic cables, pipe lines, other Property, and tenants or licensees upon, adjacent to, across (under, and/or over), and along SCRRA and Member Agency Property during the construction and/or maintenance activities on or adjacent to Railroad Property. The Contractor must coordinate with SCRRA while performing the work described in the Contract, the Drawings, and the Specifications, and shall afford the same cooperation with SCRRA as it does with the State. All submittals and work shall be completed in compliance with this Section, SCRRA guidelines and other operating rules and engineering requirements as issued from time to time by SCRRA.

1.02 DEFINITIONS

Abbreviations and terms are to be interpreted as provided in Sections 1-1.06 and 1-1.07 of the 2010 Standard Specifications, except as provided below, or when the context otherwise requires.

1.03 SCRRA PROJECT REPRESENTATIVE

The SCRRA Director of Engineering & Construction, acting either directly or through properly authorized agents, the agents acting within the scope of the particular duties delegated to them.

The SCRRA Project Representative for this project is:

Mr. Douglas H. Mays, P.E.
Project Manager 3rd Party Grade Separations
Southern California Regional Rail Authority
279 East Arrow Highway
San Dimas, California 91773
Phone: (909) 394-3259

The Contractor must notify SCRRA Project Representative, not less than thirty (30) calendar days before commencing any work on SCRRA right-of-way. Contractor's notification to SCRRA shall be in writing and must refer to SCRRA File S0000625.

All notices and submittals to SCRRA Project Representative are to be made through the State's Resident Engineer or other designated representative of the State, unless otherwise permitted by mutual agreement between the State, SCRRA, and the Contractor.

1.04 SCRRA

Southern California Regional Rail Authority (SCRRA) is a five-county joint powers authority, created pursuant to California Public Utilities Code Section 130255 and California Government Code Sections 6500 et seq., to build and operate the "METROLINK" commuter train system. The five-county member agencies are:

1. Los Angeles County Metropolitan Transportation Authority ("MTA");
2. Ventura County Transportation Commission;
3. Orange County Transportation Authority;
4. San Bernardino Associated Governments;
5. Riverside County Transportation Commission.

SCRRA builds, operates and maintains a commuter rail system in the five-county area on rail rights-of-way owned by the member agencies.

1.05 PROPERTY

Property as defined in this Section to mean the real property, or personal property, or both of SCRRA or a Member Agency.

1.06 SCRRA CONTRACTOR

SCRRA Contractor is an individual, firm, third party, partnership or corporation, or combination thereof, private, municipal or public, including joint ventures, retained by SCRRA to provide construction or maintenance services which may impact SCRRA Property and who is referred to throughout this document by singular number and masculine gender.

1.07 PUBLIC AGENCY

Public Agency is defined to mean (i) the federal government and any agencies, departments or subdivisions thereof, and (ii) the State of California or any other State, and any Public Agency, city, city and Public Agency, district, public authority, Public Agency, joint powers, municipal corporation, or any other political subdivision or public corporation therein.

1.08 SCRRA FORM 37

SCRRA Form 37 is the "Rules and Requirements for Construction on Railway Property." SCRRA Form 37 is superseded by this Section and any reference in any SCRRA document to Form 37 must be read as referring to this Section 5-1.20C.

1.09 FOULING A TRACK

Placement of an individual or a piece of equipment in such a proximity to a track that the individual or equipment could be struck by a moving train or on track equipment, or in any case is within eight (8) feet of the field side of the nearest running rail.

1.10 SITE SPECIFIC WORK PLAN (SSWP)

The details of each construction activity affecting SCRRA railroad operations, facilities, or right-of-way of SCRRA, or the operations or facilities of other railroads using the right-of-way, must be described in a Site Specific Work Plan (SSWP) prepared by the Contractor and submitted for review by SCRRA. Written approval of the SSWP must be obtained from SCRRA before such construction activity is undertaken.

A written program, plan, and schedule prepared and submitted by the Contractor and approved by SCRRA that accurately describes and illustrates the manner in which Work within the Railroad Right-of-Way (ROW) will be accomplished, the impacts on any elements of the ROW and the manner in which Work will be accomplished within the SCRRA allotted Work Windows. Requirements for the SSWP are described in SSWP Document found on the Metrolink website;

http://www.metrolinktrains.com/agency/page/title/engineering_construction

2. GENERAL REQUIREMENTS FOR WORK NEAR RAILROAD

2.01 GENERAL REQUIREMENTS FOR THE CONTRACTOR

All railroad tracks within and adjacent to the Project site are to be assumed active and rail traffic over these tracks must be maintained throughout the Project. Rail traffic may include both through trains and switching moves to local customers. SCRRA and other railroad traffic and operations can occur continuously throughout the day and night on these tracks and may not be interrupted except as approved by SCRRA. The Contractor shall coordinate and schedule the work so that construction activities do not interfere with rail operations.

The Contractor, and its sub-contractors of any tier (collectively referred to as the Contractor), must coordinate its work with SCRRA during construction of the Project when any of the following conditions are present:

1. Where work is performed on the right-of-way of SCRRA;
2. When the work is over or under or adjacent to the tracks of SCRRA;
3. When excavations are performed within 30-feet of the centerline of the nearest track;
4. When the work has the potential to foul (obstruct) any track or reduce any clearance below the allowable minimum.

The Contractor may not move, relocate, remove, obstruct, or otherwise interfere with any railroad tracks, signals, cables, signs, flags, or other railroad facilities, or any service or connection to any railroad facility. All work on active SCRRA tracks, signals, communication equipment, and other active railroad facilities must be performed by SCRRA. Connections and tie-ins of new or temporary track, signal, communication, and other equipment into active systems must be performed by SCRRA.

The Contractor's ability to enter the SCRRA right-of-way is subject to the absolute right of SCRRA to cause the Contractor's work on the SCRRA right-of-way to cease if, in the sole opinion of SCRRA, the Contractor's activities create a hazard to the SCRRA right-of-way, or SCRRA employees, or SCRRA operations, or any combination thereof.
SCRRA Form 6 - Temporary Right-of-Entry Agreement and this Section are intended to be complimentary. The Contractor shall comply with all requirements stipulated in the Temporary Right-of-Entry Agreement, and shall maintain all insurance in full force during the time that its work is performed on or adjacent to the SCRRA right-of-way. Furnishing Railroad Protective Insurance in the amounts listed in SCRRA Form 6 - Temporary Right-of-Entry Agreement is a requirement of working on or adjacent to the SCRRA right-of-way.

The Contractor shall inform itself of the expected train movements over the tracks in the vicinity of the work prior to developing its plans for any portion of the work. The Contractor must plan, schedule and conduct all work activities so as not to interfere with the movement of any trains.

The Contractor shall provide a detailed construction schedule to SCRRA for review and approval prior to commencement of work within or adjacent to the right-of-way. The Contractor shall use activity codes to identify specific activities that involve work within or adjacent to the SCRRA right-of-way. Activities that involve working within reduced clearances must also be identified by a unique activity code. This schedule shall be updated for all critical events as necessary but not less than monthly so that site visits may be scheduled at the appropriate times. A copy of each schedule update shall be furnished to SCRRA. The Contractor shall also furnish SCRRA, at the beginning of each week, with a look-ahead schedule projecting the Contractor's activities for three weeks in advance of the week in which the look-ahead schedule is issued.

The Contractor shall perform no work on the SCRRA right-of-way until all its employees, including sub-contractors of any tier, have attended and passed the safety orientation class as described in SCRRA Form 6 – Temporary Right-of-Entry Agreement.

2.02 SUBMITTALS

Whenever work is performed within the vicinity of the SCRRA right-of-way, or when work may affect the operation or safety of trains, the method of performing the work shall first be submitted to the SCRRA Representative for approval. Construction submittals requiring SCRRA approval, and Requests For Information (RFI) requiring a reply from SCRRA, must be forwarded to the STATE who in turn will forward to the SCRRA Representative. Where required by SCRRA rules, standards, guidelines, and other requirements, the Contractor shall submit plans, calculations and other documents prepared under the direction of a Registered Professional Engineer licensed to practice in California.

As soon as possible, but no later than fifteen (15) working days after contract approval with any portion of the work, the Contractor shall submit for SCRRA's review and approval, a document control plan that describes and illustrates the process (including roles, responsibilities, and contact information) by which the firms and individuals responsible for submitting, reviewing, and approving all submittals from the Contractor to the STATE, will manage the flow of submittals and information. The document control plan must also include a master list of submittals. A preliminary list of submittal is included in Exhibit A at the end of this Form. The Contractor shall also submit, not later than fifteen (15) working days after the contract approval, a testing and inspection plan that identifies the tests and inspections required, the point during construction at which each test or inspection is to be performed, and the entity responsible for performing each test or inspection on both temporary and permanent work.

The details of each construction activity affecting the operations, facilities, or right-of-way of SCRRA, or the operations or facilities of other railroads using the right-of-way, must be described in a Site Specific Work Plan (SSWP) prepared by the Contractor and submitted for review by SCRRA. Written approval must be obtained from SCRRA before such construction is undertaken.

No work shall take place within the SCRRA right-of-way until both the document control and inspection plan have been reviewed and approved by SCRRA. If a change occurs in the process, involvement of firm, or individuals named in the document control and inspection plan, the Contractor shall immediately revise the document control and inspection plan and submit the changes for approval.

SCRRA shall be allowed 20 working days for review of all submittals. Upon written approval by the STATE, the Contractor or Contractors may make the submittals directly to SCRRA Representative and the STATE simultaneously. However, SCRRA will not approve any submittal for which the approval of STATE is required until the STATE has first reviewed and approved the Contractor's submittal.

The SCRRA's review and approval of the STATE's or the Contractor's plans in no way relieves the STATE and Contractor from their responsibilities, obligations or liabilities under the Agreement between the STATE and the Contractor, or SCRRA Form 6 - Temporary Right-of-Entry Agreement. SCRRA's review and approval will be given with the understanding that SCRRA makes no representations or warranty as to the validity, accuracy, legal compliance or completeness of the designs prepared by STATE or the Contractor, and that any reliance by the STATE or the Contractor with respect to such designs is at the risk of the STATE and the Contractor.

CONTRACTOR SUBMITTAL CHECKLIST

SECTION	DESCRIPTION
2.01	Temporary Right-of-Entry Agreement
	Insurance Certificates
	Construction Schedule
	Weekly Look-Ahead Schedule
2.02	Document Control Plan
	Testing and Inspection Plan
	Site Specific Work Plans
6.01	Demolition and Removal Plans
6.02	Excavation and Backfill Plans
6.03	Shoring and Support of Excavation Plans
	Shoring and Support of Excavations Removal Plans
	Track Monitoring Plan
6.04	Drilling and Pile Driving Plans
6.05	Boring and Jacking Plans
	Boring and Jacking Track Monitoring Plan
6.06	Temporary Structures Plans
	Falsework Design Plans
	Falsework Erection Plan
	Falsework Removal Plan
6.07	Hoisting Plans
6.08	Clearances
6.09	Temporary Traffic Control Plans

3.0 CONTRACTOR SAFETY REQUIREMENTS

3.01 SCRRA EMPLOYEE-IN-CHARGE (EIC)

Work in the proximity of railway track(s) is potentially hazardous where movement of trains and equipment can occur at any time and in any direction. All work performed by the Contractor within or adjacent to the right-of-way of SCRRA must be in compliance with this Section and the requirements of SCRRA Form 6 - Temporary Right-of-Entry Agreement.

The SCRRA Employee-in-Charge (EIC) is responsible for on-track safety anytime that

work is underway on or adjacent to the track. Services of an EIC will be provided by SCRRA using railroad personnel trained and qualified under the rules of the Federal Railroad Administration (FRA) and qualified to work on the SCRRA Subdivision on which they will be providing services. All persons acting as an EIC will be furnished through SCRRA under agreement with the STATE. Personnel of the Contractor may not provide an EIC or perform flagging or other protective services for railroad operations. No work may begin until the EIC is present at the work site and proper protection has been provided.

The EIC will provide job briefings and safety protection to assure the contractor a safe work environment and the safe passage of trains. The EIC will conduct job briefings at the start of every work shift and every change of conditions affecting roadway worker safety during a work shift. The EIC has the authority to temporarily or permanently halt work or to temporarily or permanently remove employees of the Contractor from the right-of-way in order to assure the work is conducted safely. The Contractors' employees must comply immediately with all instructions of the EIC involving work within or affecting the right-of-way of SCRRA.

3.02 RIGHT TO CHALLENGE SUFFICIENCY OF ON TRACK SAFETY

The employees of the Contractor may, during the job briefing process, may request clarification of the protection against trains being provided by the EIC. If an employee of the Contractor does not believe that the protection against trains is sufficient, the employee may at any time, in good faith, challenge the form of protection established by the EIC and must remain clear of all tracks until the challenge is resolved. Federal regulations and SCRRA rules require that the EIC, Contractor supervisor and the SCRRA supervisor must resolve the challenge before work can begin. A Good Faith Challenge Form must be completed by the parties involved.
If the Contractor disagrees with any instructions from the EIC, the contractor and contractor employees must immediately clear the tracks to a safe location. After employees are clear of tracks, the contractor may contact the EIC's supervisor to resolve any disagreement over the instruction provided.

3.03 WORK REQUIRING PROTECTION OF TRACK AND OPERATIONS

The Contractor must request and arrange for an EIC, inspector, or other protective services from SCRRA for the following conditions:

1. When the Contractor's work activities are within the right-of-way of SCRRA.
2. When the Contractor's work activities are located over or under a track or tracks.
3. When cranes, pile drivers, drill rigs, concrete pumps, or similar equipment positioned outside of the right-of-way could foul the track in the event of tip-over or other catastrophic occurrence.
4. When in the opinion of the SCRRA it is necessary to safeguard the employees, trains, engines and facilities of SCRRA.

5. When any excavation is performed below the elevation of the track sub-grade, or track or other railroad facilities may be subject to movement or settlement, within the zone of railroad influence.
6. When work in any way interferes with the safe operation of trains at timetable speeds.
7. When any hazard is presented to railway track, communications, signal, electrical, or other facilities either due to persons, material, equipment or blasting in the vicinity.
8. When clearing, grubbing, grading, or blasting is in proximity to the right-of-way which, in the opinion of SCRRA or representative of an SCRRA member agency, may endanger the right-of-way or operations.
9. When street construction and maintenance activities, located within the right-of-way or in the vicinity of the highway-rail grade crossing, requiring temporary work area traffic control, which may affect or create unsafe conditions for employees, public, trains and vehicles.

The services of an EIC are generally provided by one employee. However, additional personnel may be required to protect the facilities and operations of SCRRA, if deemed necessary by the SCRRA representative or other authorized SCRRA employee. The maximum shift duration for one EIC is 10 hours. Under "Form B" protection, the 10 hours includes 8 hours of the Contractor work and 2 hours to determine the limits of the "Form B", and install and remove "Form B" flags. The Contractor shall not be allowed to work within the Operating Envelope during the 2-hour flag installation and removal. The minimum shift duration for flagging services is 4 hours. If the Contractor desires to perform activities requiring an EIC that are longer than 10 hours' duration, then the Contractor shall coordinate with SCRRA to schedule multiple EICs for the Work. SCRRA will provide any needed EIC's under an agreement with the State at no cost to the Contractor.

The Contractor shall call the phone number provided with the executed copy of SCRRA Form 6 - Temporary Right-of Entry Agreement, a minimum of fifteen (15) working days in advance of the date that services of an EIC will be required. An EIC will not be scheduled until the Contractor has executed the SCRRA Form 6 - Temporary Right-of-Entry Agreement, and the Contractor has attended the required safety training.

3.04 CONTRACTOR GENERAL SAFETY REQUIREMENTS

Safety takes precedence over deadlines, production schedules, and all other considerations. When uncertainty arises, take the safest course. Remember that accidents are often the result of carelessness, unsafe practices, lack of attention, and complacency.

The following rules must be followed at all times:

1. Using, possessing, or working under the influence of alcohol or drugs is not permitted anywhere on railroad property. This includes prescription drugs that cause drowsiness or otherwise impair a person's ability to perform an assigned

task. SCRRA may require employees of the Contractor to submit urine or other toxicological samples to be used for drug and alcohol testing after an accident or incident occurring within the railroad right-of-way.

2. Any employees, agents or invitees of Contractor or its sub-contractors under suspicion of being under the influence of drugs or alcohol, or in the possession of same, will be removed from the SCRRA right-of-way and subsequently released to the custody of a representative of the Contractor's management. An employee removed for violation of the drug or alcohol policy will not be permitted future access to the right-of-way.
3. SCRRA may require employees of the Contractor to submit urine samples for drug and alcohol testing after an accident or incident. Acceptance of this provision is a condition precedent to entering upon the SCRRA Property.
4. The use or possession of unauthorized radio equipment is prohibited. The use of personal radios (including IPod, MP3 players, and similar devices), and cell phone ear pieces while working is prohibited.
5. The use of cellular phones within 25-feet from the nearest rail is prohibited.
6. Horseplay, physical altercations, running or jumping is prohibited.
7. Firearms or other deadly weapons, including knives are prohibited.
8. Work on public streets, roadway crossings, and highway bridges must conform to the California Vehicle Code and the standards given in the California Manual of Uniform Traffic Control Devices, and must be performed with due regard for the convenience and safety of the public.
9. Only authorized employees are allowed on engines, cars, cabooses, track cars or other railroad equipment.
10. Contractor employees must exercise care to prevent injury to themselves or others.
11. Employees must be alert and attentive at all times when performing their work.
12. Any defective tools, machinery and equipment are prohibited from use on SCRRA property and, if found, must be removed immediately.
13. When on or near the tracks, the following precautions must be taken:
14. Keep clear of all tracks unless the EIC has provided a job briefing and identified the On-Track Safety protection in effect. No work may begin until the EIC is present at work site and a job briefing has been conducted.
15. Always look both ways before crossing tracks. Always step over the rails when crossing the tracks. Never walk, stand, or sit on the rails. The rail surface can be extremely slippery.
16. Always face the direction from which the train or on-track equipment is approaching.
17. Avoid track switches. The switch points are controlled from a remote location, can move unexpectedly, and exert enough force to crush ballast rock. Stand 150 feet from track switches when trains are approaching. Stay away from any other railroad device with which you are not familiar.
18. Always walk single file when crossing the tracks in a group.
19. Never stand between adjacent tracks in multiple track territory when a train is passing.

20. Always cross at least 20 feet away from the end of equipment: i.e. engines, railroad cars, or on-track equipment
21. Do not pass between standing locomotives, railroad cars or on-track equipment when there is less than 50 feet between the equipment.
22. Never cross tracks by going underneath, over or through cars, engines or on-track equipment.
23. Work is not allowed within 50 feet of the track centerline while trains are passing the work site. Always stand as far back as possible to prevent injury from flying debris or loose rigging.
24. Always visually inspect all passing trains. If you detect a dangerous condition, inform your EIC or watchman immediately. The EIC or watchman will notify the train crew.
25. Always stop equipment while a train is passing through your working limits. No movement will be allowed toward an approaching train that would cause the engineer to believe the track might be fouled.
26. Trains travel faster than they appear. It may be difficult to hear an approaching train. Trains may operate with cab car or freight car forward in the direction of travel.
27. Employees must not rely on past experience to determine train schedule. Train schedules are unpredictable and are subject to changes delays.

Expect movement of locomotives, railroad cars or on-track equipment on any track in either direction at any time. Trains may stop, reverse direction, set out cars, or run around stopped trains without notice. Always expect a train on any track at any time.

3.05 PERSONAL PROTECTIVE EQUIPMENT

All persons working on, over, or under the SCRRA right-of-way must be equipped with personal protective equipment meeting applicable OSHA and American National Standards Institute (ANSI) specifications. Personal protective equipment must be appropriate for the task performed. Employees, subcontractors, suppliers, agents or invitees of Contractor shall wear the following minimum equipment while on the right-of-way:

1. Safety glasses with side shields conforming to ANSI Z87.1 - Occupational and ducational Personal Eye and Face Protection Devices.
2. Protective Helmets (Hard Hats) conforming to ANSI Z89.1 - Requirements for Protective Headwear for Industrial Workers, Type I or II, Class G or E.
3. Safety shoes with hardened toes conforming to ANSI Z41.1 – Personal Protection - Protective Footwear. Shoes must lace above the ankle and have a defined heel.
4. High visibility ORANGE retro-reflective work wear. (Green and Red shirts, vests, or other outerwear are not permitted within the SCRRA right-of-way because of the use of the same colors as signals to trains).
5. SCRRA railroad safety training card in possession.

Hearing protection, face and eye shields, fall protection, gloves, and respirators must be worn as required by State and Federal regulations.

3.06 MAINTENANCE OF WORK AREA

The Contractor shall not pile or place any materials, articles, or equipment, nor park any machinery or equipment within the SCRRA Right-of-Way, or closer than 25'-0" to the center line of the nearest track, or in a manner that blocks access to SCRRA facilities and equipment. Soil, aggregates, or other similar loose materials must be covered to prevent migration of the material toward the track. Dust or blowing soil or debris must be controlled in accordance with South Coast Air Quality Management District Rule No. 402 and Rule No. 403.

Materials, machinery or equipment must not be stored or left within 250 feet of any highway railroad at-grade crossings, or where storage of the same will interfere with the sight distances of motorists approaching the crossing. For construction on the SCRRA right-of-way the Contractor must establish a storage area with concurrence of the SCRRA prior to beginning work, or as part of a Site Specific Work Plan.

Machines or vehicles must not be left unattended with the engine running. Parked machines and equipment must be turned off and must be in gear with brakes set. If equipped with blade, pan or bucket, the blade, pan or bucket must be lowered to the ground. All machinery and equipment permitted to be left unattended on SCRRA right-of-way must be left inoperable and secured against movement. Vehicles must not be parked over vegetation that might be ignited by the heat from the vehicle's exhaust system.

The Contractor shall not create and leave any conditions at the work site that would interfere with water drainage. Any work performed over water must meet all federal, State and local regulations.

3.07 PRECAUTIONS WHEN WORKING NEAR ELECTRICAL CONDUCTORS

All wires and cables must be considered to carry electric current at high voltage and to be dangerous unless informed to the contrary by proper authority. When using temporary power cords, cords must never be placed over the rails, nor may any metal object be placed across the rails.

For all power lines the minimum clearance between the lines and any part of the equipment or load must meet the State, Federal and OSHA construction safety standards and requirements. If capacity of the line is not known, a minimum clearance of 45 feet must be maintained. A person must be designated to observe clearance of the equipment and give a timely warning for all operations where it is difficult for an operator to maintain the desired clearance by visual means. When the height of overhead wire lines cannot be determined from the available records, the actual height must be determined by field survey.

3.08 SAFETY TRAINING AND COMMUNICATION

All personnel working on, over, or adjacent to the SCRRA right-of-way must attend a railroad safety training class and pass a closed-book examination covering the information presented in the class. Persons not regularly employed on the project, or at the project site only intermittently, are not exempted from this requirement.
Successful completion of the class and attaining a passing grade on the examination will permit a person to work on the Property of SCRRA for a period of one year at which time each person working on the Property of SCRRA must again take the class and attain a passing grade on the examination.

Before beginning any task on the right-of-way of SCRRA, a thorough job safety briefing must be conducted with all personnel involved with the task. The briefing must include the Contractor's job hazard analysis, its plan for conducting the work, and the procedures the Contractor will use to prevent its employees, sub-contractors, suppliers, agents or invitees from moving any equipment adjacent to or across any SCRRA tracks without the appropriate protection for the Contractor and the railroad operations. Additional job safety briefings must be conducted anytime that the job tasks, or conditions affecting the job tasks, are changed or revised.

When Contractor employees are required to work on the SCRRA right-of-way after normal working hours or on weekends, the Engineer and SCRRA Representatives must be notified. A minimum of two Contractor employees must be present at all times. If work is within or near the SCRRA right-of-way an EIC will be required, and a representative of the STATE must also be present on the project site.

The Contractor shall develop and provide an emergency action plan indicating the location of the site, contact names and phone numbers, directions for access to the site, instructions for emergency response, and location of the nearest hospitals. The plan must also cover the Contractor's means of preventing fires arising from the Contractor's operations, and the Contractor's methods of fire suppression. The plan must also include the local direct phone numbers and locations of the nearest fire and police departments. Phone numbers for utility and SCRRA emergency response must be obtained from the SCRRA representative prior to the start of any work and must be posted at the job site.

3.09 EMERGENCY RESPONSE AND ACCIDENT REPORTING

Prior to starting work, the Contractor must provide the EIC with the emergency phone numbers for the project. At a minimum, phone numbers must be provided for paramedics, fire, police, utility response, SCRRA Representative, Contractor Superintendent, Metrolink Operation Center (MOC), and the Metrolink Signal emergency number. A map and directions to the site must be immediately available for the use of the EIC.
In emergency situations the following apply:

1. Immediately report to the EIC any accidents, personal injuries, defects in tracks, bridges, signals utilities or communication facilities or any unusual condition that may affect the safe operation of the railroad.
2. When a person is injured, stop work and ensure everything possible is done for the injured person. Also take the following immediate action: Notify the fire, police, or paramedics as appropriate, and notify the Metrolink Operations Center; provide an individual or individuals to guide emergency response personnel to the site; and make sure that all access ways are cleared for emergency vehicle access.
3. If equipment was involved in the incident, it must not be moved until examined to ensure the equipment was in proper working condition, unless movement is necessary to prevent further injury or risk to persons or property.
4. In case of personal injury, loss of life, or damage to property, the EIC must immediately document the names, addresses and occupation of all persons involved, including all persons at the scene regardless of whether these persons give a Statement about the incident. This information should be included in the incident reports. The Contractor's cooperation with, and assistance to, the EIC is a requirement of accessing the SCRRA right-of-way.
5. If an incident causes personal injury or death, all tools, machinery and other equipment involved, including premises where such accident occurred must be promptly inspected by the EIC. Tools, equipment and machinery must be secured until the EIC, Safety Officer, or other competent person has completed an inspection. A report of such inspection, stating the conditions found and names of persons making the inspection must be promptly forwarded to SCRRA and the supervising officer of person making the inspection.

Information concerning incidents or personal injuries occurring to persons who are not employees, must not be given to anyone except authorized representatives of the SCRRA or an officer of the law.

All damage to the right-of-way, facilities, or Property of SCRRA, or any accident or incident within SCRRA right–of-way, or any hazard noticed on passing trains must be reported immediately to the railroad EIC, if an EIC is present, or in the absence of a railroad EIC, to SCRRA's Metrolink Operations Center (MOC). The phone number for the MOC is (888) 446-9715 or (909) 593-0661.

Any vehicle or machine which comes in contact with the track, signal equipment, structure or other railroad installation or facility, regardless of the force of the impact, may result in the derailment of a train and must be reported immediately to the SCRRA representative and to the EIC, if an EIC is present, or in the absence of a railroad EIC, to MOC.

4.0 BLANK

5.0 TRACK OCCUPANCY AND WORK WINDOWS

5.01 DESCRIPTION OF LOCATION AND TRAFFIC

The Contractor shall obtain permission in writing from SCRRA for movement of equipment on track or across tracks at locations other than public highway crossings.

The mainline tracks, within the limits of Project site, are under direct control of SCRRA dispatcher. No track shall be fouled without authorization and in the presence of an SCRRA EIC. For all work with the potential to foul the track, the Contractor shall allow sufficient time in his work schedule for the EIC to clear trains. Approximately 15 minutes is required for the EIC to clear each train, during which time the Contractor must not foul the track or perform work that has the potential to foul the track.

5.02 COORDINATION WITH RAIL TRAFFIC

The Contractor's operations are subordinate to the operation of trains on the SCRRA right-of-way, whether passenger or freight. All work upon the SCRRA right-of-way shall be done at such times and in such a manner as to not interfere with or endanger the SCRRA Operations. SCRRA will strive to cooperate with the Contractor such that the work may be handled and performed in an efficient manner. However, the Contractor will have no claim whatsoever for any type of damages or for extra or additional compensation in the event its work is delayed by rail operations.

All forecasts of train traffic and schedules are approximate. The public time table or schedule shall be used for planning purposes only and shall not be used for scheduling actual work in the vicinity of the railroad tracks in the absence of a railroad EIC. SCRRA, UPRR, BNSF, and Amtrak may run additional trains as needed to perform their respective obligations. The operation of extra and special trains will be at sole discretion of SCRRA. The Contractor's work may be halted or delayed whenever necessary to accommodate train service.

Persons acting as an EIC are generally dispatched to projects in the order requested. An EIC may not be available at all times without advance notice. The Contractor is encouraged to schedule the services of an EIC or inspector a minimum of 15 working days in advance of any planned operation to avoid delay. Any work to be performed by the Contractor, which requires services of an EIC or inspector, shall be deferred until an EIC or inspector is available at the job site.

5.03 TRACK WORK WINDOWS AND TRACK ACCESS

All work on, over, or adjacent to the tracks must be coordinated with SCRRA, and the Contractor's work is subject to the SCRRA operating rules for work on main tracks and other than main tracks:

1. Work Window: A period of time with specific beginning and ending time and durations for which the track, signals, bridges and other Operating System elements within the Operating Envelope are temporarily removed from service or

modified in some other manner and train and other operations suspended or modified to allow construction or maintenance work to occur. Written authority from SCRRA and an approved Site Specific Work Plan (SSWP) is required before the Contractor is granted a Work Window. The Contractor's Work Window shall have specific geographic limits, which are defined in the approved SSWP. Modifications or suspension of train and on-track equipment movements resulting from a Work Window involves written changes to the Railroad's Rules of Train and On-Track Equipment Operations.

2. Exclusive Track Window: An approved Work Window in which no train movements (except the Contractor or SCRRA work trains or equipment under control of the EIC, in accordance with an approved SSWP) will operate on any track within the window limits. The Contractor may dismantle, remove, reconstruct, or otherwise obstruct tracks within the limits of such a window. This Work may be protected by track out of service, track and time limits, or by "Form B" Track Bulletin.
3. Limited Track Window: An approved Work Window for some, but not all tracks, within a general Work area (e.g. one track remains for operation of trains, other tracks are available for the Contractor's Work). Movement of trains over the track(s) of a Limited Track Window is under the control of the EIC who will not authorize train movement unless and until the Contractor personnel and equipment are clear of the operating track. The Contractor may remove, construct, or obstruct only the track designated by the SSWP and must arrange the Work so that trains can operate without delay on the remaining track(s) in the Work area. This Work may be protected by track out of service, track and time, or by "Form B" Track Bulletin at the discretion of SCRRA.
4. "Form B" Work Window: An approved Work Window in which passenger, freight and all other trains and on-track equipment movements can be prohibited from entering the defined limits of a segment of track. The "Form B" Work Window does not allow the Contractor to remove from service or modify the tracks, signals, bridges, stations or other elements of the Operating System in a manner, which will delay or in any way affect the safe operation of the trains. The "Form B" Work Window allows the Contractor the ability to enter the Operating Envelope and perform construction activities subject to the conditions above. An Employee-in-Charge/Flagman from the SCRRA will exercise strict control over the Contractor's construction activities in conjunction with Roadway Worker Protection requirements, to assure that the Contractor's activities do not delay or impact train service.

5.04 REQUESTING WORK WINDOWS

The Contractor must make requests in writing to the SCRRA Representative for Track Work Windows not less than fifteen (15) working days in advance of the desired Work Windows. An advance notice of Sixty-five (65) days is required when requesting an Exclusive Track Window.

Requests for Work Windows must include an approved site-specific work plan (SSWP) for the work to be performed during the window.

All SSWPs must include a detailed schedule of events, indicating the expected hourly progress of each activity that has duration of one hour or longer. The schedule shall include a time at which each activity planned under the SSWP and the requested Work Window will be completed, and the total duration of all the construction activities shall be less than the approved Work Window. Failure of the Contractor to complete the scheduled activities by the planned time or to put in place an approved contingency plan may adversely affect the operations of scheduled trains.

The SSWP must include the information specified below:

1. All activities necessary to perform construction activities within the Operating Envelope, including use of stations, sidings, and proposed storage areas.
2. A description of any proposed changes in the Operating System between start and finish of the work, including any requested Work Windows.
3. A schedule of the work, showing each activity and where and how it affects normal operation of the Operating System. This schedule shall integrate and allow for the necessary work of the Signal and Communication forces. Each activity in the plan shall include all labor, materials, and equipment required to complete the activity within the SCRRA allotted time period. The Contractor shall identify on the schedule all SCRRA furnished labor, equipment and materials.
4. The Contractor shall have SCRRA approved Contingency plans for putting the Operating System back in operation in case of an emergency, or in case the Contractor fails to perform and complete the work on time. The contingency plans shall address the various stages of activities necessary to restore the System.
5. List all of the approved proposed work plans to be performed under the SSWP, and provide the name(s) and number(s) of the Contractor's supervisor(s) in charge of the SSWP tasks.

The SSWPs must be of sufficient detail, clarity, and organization to permit easy review and approval by the SCRRA before the proposed work is performed. The SSWP shall be submitted to SCRRA as follows:

1. At least 14 calendar days prior to start of the work within the Operating Envelope for work other than signal or third-party activity.
2. At least 30 calendar days prior to the start of work for work involving signal or third-party installation.

SCRRA may request explanations and changes to the SSWP to conform the SSWP to the requirements of SCRRA. If the SSWP is not acceptable, the Contractor shall revise the SSWP to make it acceptable. The Contractor is responsible for submitting a revised SSWP that can be reviewed and approved by the SCRRA at least seven days in advance of any work that affects the Operating System.

The Contractor will be informed if the SSWP is acceptable not less than seven calendar

days prior to the scheduled start of work within the Operating Envelope. Once the plan is accepted, the Contractor shall assemble the resources necessary to perform the work represented by the SSWP, so that necessary resources are available one day before the work is to be accomplished, thereby demonstrating to SCRRA the readiness of the Contractor to perform the Work. At this time, SCRRA will make a final decision as to whether or not the Work is to proceed as planned or be canceled.

5.05 EXTRAORDINARY WORK

Should a condition arise from, or in connection with, the Contractor's work on the Project which requires immediate and extraordinary actions to be taken to protect operations and facilities of SCRRA, or facilities of others occupying the right-of-way, the Contractor shall undertake such actions. If, in the judgment of the SCRRA or the State, such actions are insufficient, SCRRA may undertake any action that it deems necessary. In any event, such actions shall be at the Contractor's expense and without cost to SCRRA. SCRRA, the State, or a or STATE shall have the right to order the Contractor to temporarily cease operations in the event of an emergency or if, in the opinion of SCRRA, the Contractor's operations may interfere or endanger train operations.

5.06 RULES AND HOURS OF OPERATION

This Section outlines requirements and provisions for rules and hours of operation for the Contractor execution of the Work under this Contract. Contractor shall cooperate with the SCRRA in all matters requiring coordination for execution of the Railroad Work including eliminating or minimizing to the greatest extent possible interference and delays to all scheduled passenger and freight trains movements. Information regarding train movements is available to the Contractor, upon request. A sample activity report of train movements for one week may be obtained from the SCRRA.

The Contractor shall keep the SCRRA fully informed regarding any planned night or weekend Work for all Contract Work that has the potential to foul the tracks.

Any damage caused by the Contractor to rails, ties, structures, embankment, third-party property, signal and communications equipment, or any other facilities shall be repaired at the Contractor's expense to a condition equal to or better than the condition prior to the Contractor entry, and as accepted by the SCRRA. At the sole discretion of the SCRRA, SCRRA may direct that repairs be performed by other Contractors. The charges for such repairs shall be deducted from the Contractor’s payment due under this Contract.

The Contractor shall consider the safety of the Work, train operations personnel, and property on and adjacent to the Worksite when determining amount, location, movement, and use of materials and equipment on Worksite. The Contractor shall not load Worksite with excessive amounts of material, equipment, or other items that have the potential to interfere with the Work or with train operations. The Contractor shall relocate stored products, equipment, and materials that interfere with train operations,

public and private utilities, or visibility at railroad crossings. Materials and equipment shall not be so piled, stored, or parked when not in use.

As necessary, the Contractor will preserve and relocate railroad signs (mileposts, speed limits, “no trespassing” signs, station signs, crossing whistle signs, etc.) during the full period of construction. Signs shall be maintained during construction or restored upon completion of the Work. The Contractor shall protect at-grade crossing warning signs.

5.07 PROJECT SPECIFIC WORK WINDOWS

The time limits for all types of Work Windows include the time for the Contractor to restore and test the signal and communication system before the operation of trains; therefore, the full duration of the Work Window is not available for the use of the Contractor. The SSWP shall designate both the time at which the Contractor must make the track ready (in full compliance with the FRA Track Safety Standards and with the SCRRA’s Track Maintenance and Engineering Instructions) for the passage of trains, and the remaining time within the Work Window that will be required for the signal and communications system restoration.

The Contractor’s Railroad Construction Project Manager or the Railroad Track Construction Manager shall personally inspect the track within the Work Window prior to the restoration of train service; confirm with the Authority that the track is in full compliance with the above standards and establish the speed at which trains will operate upon restoration of the service.

Construction activities required for bent 3 retrofit, including demolition, bent and crash wall construction, girder placement and deck and barrier rail construction activity in, over and adjacent to railroad right of way shall be performed at night in accordance with the following work window schedule.

Work windows that apply to this project:

Monday thru Friday:

- Form B may be available daily between 4:00 AM to 10:00 PM.
- Absolute Window – Track Out of Service may be available weeknights Sunday through Thursday, 9:00 PM to 4:00 AM the following morning.
- Absolute Window – Track Out of Service may be available Friday night through Saturday morning, 9:00 PM to 9:00 AM the following morning.
- Absolute Window – Track Out of Service may be available Saturday night through Sunday morning, 6:00 PM to 9:00 AM the following morning.

Work Window Rules and Requirements:

A 65-day advance notification is required to set up Absolute Windows. If the scheduled work during the Absolute Window cannot begin, the Contractor must provide a 65 day advance notice to schedule another Window.

In the event that the scheduled work during the Absolute Window cannot be completed, the Contractor shall provide an additional 65 day advance notification to schedule another Absolute Window.

No Absolute Window will be allowed during the Metrolink “Holiday Train” weekend. This event is tentative scheduled between the Thanksgiving holiday and the Christmas holiday. The Contractor shall coordinate with Metrolink when this event will be scheduled.

All required signal and track testing by the Contractor and SCRRA shall be completed by the end of the Absolute Window.

Additional Requirements and Notes that pertain to work windows:

- Metrolink commuter service system wide begins at 3:58 AM each weekday. It ends at 12:30 AM each weekday. SCRRA weekend commuter services system wide begin at 6:40 AM on Saturday and Sunday and ends at 9:45 PM on Saturday and Sunday.
- The start time for Track Work Windows is an “average” start time dependent on location and train on-time performance, and may vary by 30 minutes either direction.
- Either a Form B or an Absolute Window – Track Out of Service will be required for all work activities on any track within the rail ROW.
- Scheduling of Work Windows, SCRRA EICs and watchmen, and signal support forces during track construction will be strictly controlled by SCRRA and documented in the Contractor Site Special Work Plan and three-week look-ahead schedule. Work Window activities not coordinated in the weekly construction meetings and documented in the look-ahead schedules will not be supported by authorization of Work Windows.
- It is expected that the Contract Time will be considered a sufficient amount of time to substantially complete the work while working a normal workday and workweek on a single shift basis. However, the Contractor is strongly encouraged to work additional shifts as required to finish the Work within the contract time. There shall be no additional payment for night work, weekend work and overtime required for working around live track.

Daily Train Traffic volumes that apply to this project:

Type of Train	Number of Trains	Time Table Speed
Metrolink	42	79 MPH
Freight	4	50 MPH
Total Trains	46	

The table of trains shown above represents the expected number of scheduled trains on a normal day through the project area and is subject to change. On certain days, the number of scheduled trains may vary, particularly on weekends and holidays. Certain number of these trains may operate ahead of schedule and any of the trains may operate behind schedule, depending on operating conditions on a given day. Passenger and freight train schedules are re-issued as necessary through the year, and such re-scheduling is to be expected during the duration of the project.

Freight trains may or may not be scheduled, and vary by the day of the week. However, their schedules are more varied than those of passenger trains. Their operating times are more varied than those of passenger trains. Their operating times are more varied than passenger trains due to the length of their trips, the number and weight of the cars they are carrying, and the nature of the business en-route. Maintenance of way trains, extra trains, or other movements are made up and operated according to the needs of the railroad. These may also be operated on an emergency basis without prior notice, if conditions require.

Extra trains, not shown on passenger schedules or freight schedules may be operated for special events, for freight traffic purposes, for railroad maintenance activities, or in support of this or other projects. The actual operating conditions, the number of trains to be operated and the on-time status of trains on any given day may cause changes in the available Work Window provided for herein.

Under emergency conditions adversely affecting SCRRA, it may be necessary to alter or cancel previously scheduled work windows with little or no advance notice. SCRRA will make every attempt to minimize the occurrence of such events.
The Contractor shall not perform any fieldwork during three annual designated holidays. Fieldwork shall not include receipt or delivery of materials or equipment or work performed in field offices. The designated holidays are Labor Day, Thanksgiving Day and Christmas Day. During these periods, SCRRA will not have the resources (labor and equipment) or construction management personnel to issue track bulletins or to support, inspect, or oversee the Contractor’s Work.

6.0 CONSTRUCTION

6.01 DEMOLITION AND REMOVAL

Where structures over or adjacent to the tracks are to be demolished, the tracks must be protected from damage during the demolition. Equipment used in demolition operations may not be operated on or over unprotected track. Blasting will not be permitted to demolish a structure over or within railroad right-of-way.
The Contractor may employ either of the following methods:

1. During demolition of a bridge deck or overhead structure, a protection shield must be erected over the track to catch falling debris. The protection shield shall be supported from girders or beams and shall not be lower than the allowed temporary clearance from the top of rail. The deck must be removed by cutting into sections and lifting out. All cranes, hoists, winches, and hardware used in connection with the demolition are to include a factor of safety of 150% in addition to the safe working load of the equipment or hardware. Large pieces of deck or other portions of the structure must be handled individually and must not be allowed to fall on protection shield or onto the ground.
2. When an overhead protection shield cannot be installed due to limited clearance or type of superstructure, the track may be protected by timber mats placed over the track structure, subject to approval by SCRRA. Mats must be designed to support all anticipated live and dead loads within the allowable stress range of the lumber used in the mats, however, individual timbers construction of timber mats must not be less than 8" x 8" in cross section dimension. The length of the mat must be sufficient to span the track and ballast section without need to support the mat from the rails. Timber mats shall be made in sections such that they may be lifted in and out as a unit quickly. Mats must not rest on ties or rails. Geofabric or canvas must be placed over the track structure to keep the ballast clean. The mats and ballast protection must cover the full extent of the work zone but not less than 25-ft beyond the existing limits of the overhead bridge or structure.

The Contractor shall submit detailed SSWP and plans of the protection shield or the timber mats to the SCRRA Representative for approval prior to the start of demolition. The plans shall also indicate the location and capacity of the proposed cranes and estimated lifting loads. The design of all load-bearing structures or supports and lifting plans shall be prepared by a registered Professional Engineer and shall bear the seal and signature of the engineer in responsible charge of the design.

The Contractor shall provide timely communication to the SCRRA Representative when scheduling the demolition-related work so that the SCRRA Project Representative or his or her designee may be present during the entire demolition procedure.

The Contractor is responsible for protecting the track and other railroad facilities from damage or degradation resulting from demolition activities. At any time during

demolition activities, the SCRRA Representative may require revisions to the previously approved procedures to address weather, site conditions or other contingencies that may create a potential hazard to rail operations or SCRRA facilities. Such revisions may require immediate interruption or termination of ongoing activities until such time that protection satisfactory to the SCRRA Project Representative.

6.02 EXCAVATION AND BACKFILL

Earthwork for railroad work and railroad structures must conform to Section 19 of the 2010 Standard Specifications except as required in this Information Handout document.

All excavations must be conducted in compliance with applicable law and regulations and, regardless of depth, must be shored when within the zone of influence from the railroad loading, or when necessary to protect structures, facilities, or personnel. Shoring for excavations must comply with the SCRRA "Excavation Support Guidelines." Any excavations, holes or trenches on the SCRRA right-of-way must be covered, guarded and protected when work is not actively prosecuted. When leaving work site areas at night and over weekends, the areas must be secured and left in a condition that will ensure that SCRRA employees and other personnel who may be working or passing through the area are protected from all hazards. All excavations must be backfilled as quickly as practicable.
The Contractor shall submit a plan showing the limits of all excavations within the Right-of-Way of SCRRA, and the method of support when support is required. The Contractor shall not make any excavations on the SCRRA right-of-way, or within the zone of railroad load influence as defined in Figure 2-1 of the SCRRA "Excavation Support Guidelines", until the Contractor's excavation plan, and its plans and calculations for the support of the excavation are approved in writing by SCRRA.

The Contractor must cease all work and notify SCRRA immediately before continuing excavation in the area if obstructions are encountered which do not appear on drawings. If the obstruction is a utility and the owner of the utility can be identified, then the Contractor must also notify the utility owner immediately. The Contractor shall not perform any work if there is any doubt about the location of underground cables or lines of any kind until the exact location of the underground facilities has been determined. There will be no exceptions to these requirements.
The Contractor shall perform excavation and grading so that the finished surfaces are in uniform planes with no abrupt breaks in surface and having positive drainage on the right-of-way away from the track structure, and to approved catchment areas.

6.03 SHORING AND SUPPORT OF EXCAVATION

Shoring, cribbing and sheeting designed to support excavations or embankments shall be designed to support all lateral forces caused by the earth, vehicular traffic, construction equipment, temporary and permanent structures, and other surcharge loads in the vicinity of the excavation. Support or shoring located on the SCRRA right-of-way, or within the zone of influence from railroad loading, shall conform to the SCRRA Excavation Support Guidelines. Designs for all temporary structures

supporting tracks, or excavations adjacent to the tracks and within the zone of influence from railroad loading, shall include railway surcharge loading imposed by a Cooper E-80 live load. Any excavation adjacent to track must be covered and provide a uniform path and include with standard handrails when work is not actively underway.

The Contractor shall submit a detailed SSWP drawings and supporting calculations for any temporary support of excavation for SCRRA review and approval. For the installation of temporary or permanent shoring systems, including soldier piles and lagging, or interlocked steel sheeting on or adjacent to SCRRA's right-of-way, lateral deflection of the shoring system plus top of rail monitoring is required. The frequency of monitoring must comply with the SCRRA "Excavation Support Guidelines." The monitoring program must identify the survey locations, the distance between the location points, and frequency of monitoring before, during, and after construction. The Contractor must submit the monitoring program for the track, roadbed, and shoring for review and approval prior to starting work.

The monitoring survey data must be collected at the approved frequency and immediately furnished to the SCRRA Representative for review. If SCRRA determines that any movement has occurred in the track or supporting structure, SCRRA will notify the Contractor and the Contractor shall immediately take all necessary steps to correct the movement or settlement. SCRRA, at its sole discretion, shall have the right to immediately require all contractor operations to be ceased, or to have the excavated area immediately backfilled, or to perform additional investigations to determine what corrective action is required, or any combination thereof. SCRRA may modify the survey locations and monitoring frequency as it deems necessary during the project. Any corrective action required by SCRRA or performed by SCRRA, including the monitoring of corrective action of the Contractor, will be at the cost and expense of the Contractor.

6.04 DRILLING AND PILE DRIVING

The Contractor must take special precaution and care, in connection with drilling or driving piles or sheets adjacent to tracks, to provide adequate lateral support for the tracks and the loads which they carry, without disturbance of track alignment and surface, and to avoid obstructing track clearances with working equipment, tools or other material. The Contractor shall submit detailed SSWP and plans of the Drilling and Pile Driving Operations to the SCRRA Representative for approval prior to the start of drilling and pile driving.

Pile driving must be carried out so that it does not interfere or endanger train operations. An EIC must be present whenever pile driving or drilling is underway in the vicinity of the SCRRA track. Equipment must be positioned so that no part of machine swings over the track or infringes within 25-ft of the nearest rail without first obtaining permission from SCRRA and SCRRA has established an appropriate work window.

Piles must be secured independently of the hammer or vibrator at all times while driving

until sufficiently anchored in the soil such that the pile will stand without external support during the completion of the driving. Reinforcing steel cages or other internal structural supports in concrete structures must be designed to withstand all loads imposed in handling and setting. A crane must remain attached to the reinforcing steel cage until the reinforcing steel cage is guyed or braced to prevent movement unless it can be demonstrated that the cage or support will resist all loads which may be imposed without collapse or failing.

Large diameter holes and shafts within the zone of influence from railroad loads must be cased to prevent caving and loss of support adjacent to the tracks. If caving occurs, the hole must immediately be filled until additional casing can be advanced in the hole before drilling is continued.

6.05 BORING AND JACKING

The face of all jacking and receiving pits shall be located an outside of the SCRRA right-of-way, or a minimum of 25 feet from the center line of the nearest track, measured at right angle to the track, whichever is greater unless otherwise approved by SCRRA. The use of trench boxes may be permitted for jacking and receiving pits, however, trench boxes, shields, and hydraulic shores are not acceptable inside the zone of influence from railroad loading. Design of the temporary supports for the jacking and receiving pits must be conform to the requirements of the SCRRA "Excavation Support Guidelines."

Boring and jacking of casings and other conduits must conform to the requirements of SCRRA Engineering Standard ES5001 and ES5002. For any conduit that is bored or jacked under the track, the Contractor shall guarantee the work against settlement for two years after the completion of the work, and shall furnish a performance bond against failure or settlement of the soil around the jacked pipe or casing in the amount shown in the following table:

Casing Diameter	Bond Amount	Casing Diameter	Bond Amount
<12"	$45,000	80"	$315,000
24"	$90,000	96"	$360,000
36"	$135,000	108"	$405,000
48"	$180,000	120"	$450,000
60"	$225,000	132"	$495,000
72"	$270,000	144"	$540,000

The Contractor shall submit detailed SSWP and plans for jacking and boring operations, including the design of temporary supports for the jacking and receiving pits, to the SCRRA Representative for approval prior to the start of any work.

6.06 TEMPORARY STRUCTURES

Formwork, falsework, guying, bracing, and other temporary structures must be designed to resist all imposed construction live and dead loads including wind and seismic loads. Railroad track, structures, equipment, or other railroad facilities may not be used to secure or brace temporary or permanent structures during construction.
Designs for falsework above any tracks shall conform to the SCRRA Grade Separation Guidelines and the Caltrans Falsework Manual. Falsework over or adjacent to railroad tracks shall meet the requirements in the Caltrans Falsework Manual for falsework over traffic (traffic openings). The additional provisions stipulated the "Guidelines for Design of Falsework for Structures Over Railroad in Connection with Highway Grade Separation Construction," issued by the Southern Pacific Lines (Falsework Memo No. 7) shall be included in all designs of falsework over SCRRA tracks. Collision posts are required.

The Contractor shall submit a detailed SSWP and procedure for erecting and removal of the falsework spans over railroad tracks. Equipment used for the erection, or removal of structures over railroad facilities, shall have a minimum lifting capacity of one hundred-sixty seven percent (167%) of the lift weight (operational capacity limited to sixty percent (60%) of the tipping load or the boom structural load). The procedure shall indicate the capacity of cranes, location of cranes with respect to the tracks and estimated lifting loads. The erection procedure must be prepared by a California Registered Professional Engineer and shall bear his or her seal and signature. The procedure must be approved by SCRRA.

The Contractor shall furnish, to the SCRRA Representative, four sets of working drawings and a copies of the Contractor's plans illustrating and describing the details of construction affecting SCRRA Property and tracks. The working drawing must include the proposed method of installation and removal of falsework, shoring or cribbing, The Contractor shall also furnish two sets of structural calculations of any falsework, shoring or cribbing. A registered professional engineer licensed to practice in the State of California shall seal and sign all drawings and calculations. The Contractor shall not begin work until SCRRA has reviewed and approved the plans.

6.07 HOISTING OPERATIONS

The Contractor shall submit a detailed SSWP and procedure for any crane, mast, or boom operations, on, over, or adjacent to the SCRRA right-of-way to the SCRRA Representative for approval prior to the start of hoisting operations. The Contractor shall submit four (4) copies of the detailed procedure for erection of the proposed structures over or adjacent to SCRRA's tracks or right-of-way. This procedure shall include a plan showing the locations of cranes, horizontally and vertically, operating radii, with staging locations shown, including beam placement on ground or truck unloading staging plan. Plan should also include the location of all tracks, other railroad facilities; wires, poles, adjacent structures, or buried utilities that could be affected, showing that the proposed lifts are clear of these obstructions. No crane or equipment

may be set on the SCRRA rails or track structure.

The following additional information must be included in the submittal as applicable:

1. All as-built bridge seats and top of rail elevations shall be furnished to SCRRA Representative for review and verification at least 30 days in advance of construction or erection of the bridge span, to ensure that minimum vertical clearances as approved in the plans will be achieved.
2. Computations must be made for the weight of the materials, articles or equipment being lifted and must be submitted for review and approval by SCRRA. Computations shall be made from plans of the structural members being erected and those plans or sections thereof shall also be included in the submittal; the weight shall include the weight of concrete or other materials including lifting rigging.
3. Crane rating sheets showing cranes to be adequate for 167% of the actual weight of the pick. A complete set of crane charts, including crane, counterweight, maximum boom angle, and boom nomenclature is to be submitted. Safety factors that are included by the manufacturer in the crane charts are not to be considered when determining the 167% additional capacity.
4. A data sheet shall be prepared listing the type, size and arrangements of slings, shackles, or other connecting equipment. Include copies of a catalog or information sheets for specialized equipment. All specific components proposed for use shall be clearly identified and highlighted in the submitted documents. The safe working load capacity of the connecting equipment shall be 167% above the calculated weight of the pick.
5. A complete written procedure is to be included that describes the sequence of events, indicating the order of lifts and any repositioning or reconnecting of the crane or cranes.
6. A time schedule for each of the various stages must be shown as well as a schedule for the entire lifting procedure. The proposed time frames for all critical sub tasks (e.g., performing aerial splices, installing temporary bracing, etc.) shall be furnished so that the potential impact to SCRRA operations may be assessed and eliminated or minimized.
7. The names and experience of the key Contractor personnel involved in the operation shall be included in the Contractor's means and methods submission.
8. Design and supporting calculations prepared by the Professional Engineer for items including the temporary support of components or intermediate stages shall be submitted for review. A guardrail or collision post will be required to be installed in a track where a temporary bent is located within fifteen (15) feet from the centerline of that track.
9. The proposed erection procedure must be approved by the SCRRA Representative prior to undertaking work on the project.

The Contractor shall provide timely communication to the SCRRA Representative when scheduling the erection-related work so that the SCRRA Representative may be present during the entire erection procedure.

At any time during construction activities, the SCRRA Representative may require revisions to the previously approved procedures to address weather, site conditions or other circumstances that may create a potential hazard to rail operations or SCRRA facilities. Such revisions may require immediate interruption or termination of ongoing activities until such time the issue is resolved to the satisfaction of the SCRRA Representative. SCRRA shall not be responsible for any additional costs or time claims associated with such revisions.

6.08 CLEARANCES

The Contractor must not pile or store any materials, machinery or equipment closer than 25'-0" to the center line of the nearest SCRRA track, and only then with the permission of SCRRA. Materials, machinery or equipment must not be stored or left within 250 feet of any highway railroad at-grade crossings, where storage of the same will interfere with the sight distances of motorists approaching the crossing. Prior to the start of work, the Contractor must establish a storage area with concurrence of the SCRRA representative.

Unless shown otherwise on the Contract Drawings and approved by SCRRA, the Contractor shall abide by the following temporary clearances during construction. The Contractor shall not place forms, materials, spoils, or other temporary construction, including bracing or work platforms, within the clear area defined below unless approved in writing by SCRRA:

15' -0" Horizontally at right angles from centerline of nearest track
22' -6" Vertically above the top of the highest rail

For all power lines the minimum clearance between the lines and the top of the rail must be as shown below:

27'-0"	Vertically above top of rail for electric wires carrying less than 750 volts
28'-0"	Vertically above top of rail for electric wires carrying 750 volts to 15,000 volts
30'-0"	Vertically above top of rail for electric wires carrying 15,000 volts to 20,000 volts
34'-0"	Vertically above top of rail for electric wires carrying more than 20,000 volts

At no time may the Contractor reduce the minimum clearances required by the California Public Utilities Commission (CPUC) General Order 26-D, or block or restrict the visibility of any signal or railroad warning device.

Any infringement within the clearances established by General Order 26-D due to the Contractor's operations must be submitted to SCRRA and the operating railroads, and must not be undertaken until approved in writing by SCRRA, and until SCRRA has obtained any necessary authorization from the CPUC for the infringement. No extra

compensation will be allowed in the event the Contractor's work is delayed pending approval by SCRRA, the operating railroads, or the CPUC as applicable.

In the case of impaired vertical clearance above top of rail, SCRRA will have the option of installing tell-tales or other protective devices SCRRA deems necessary for protection of SCRRA operations. The cost of tell-tales or protective devices will be borne by the Contractor.

Reduced temporary construction clearances, which are less than construction clearances defined above, will require special review and approval by SCRRA and, if less than the statutory minimum, the CPUC. Any proposed variance on the specified minimum clearances due to the Contractor's operations shall be submitted to the SCRRA Representative and the STATE at least thirty (30) working days in advance of the work. No work shall be undertaken until the variance is approved in writing by the SCRRA Representative.

Parallel to the outer side of each exterior track of multiple operated tracks and on each side of single operated track, an unobstructed continuous space suitable for trainman's use in walking along trains, extending in width not less than twelve feet (12') perpendicular from centerline of track, must be maintained. Any temporary impediments to walkways and track drainage encroachments or obstructions allowed during working hours must be covered, guarded and/or protected as soon as practicable. Walkways with railings shall be constructed by the Contractor over open excavation areas when in close proximity of track, and railings shall not be closer than 9' -0" perpendicular from the center line of tangent track or 10' - 0" horizontal from curved track.

6.09 TEMPORARY VEHICULAR TRAFFIC CONTROL

The Contractor's operations which control traffic across or around SCRRA facilities shall be coordinated with and approved by both SCRRA and STATE, and shall be in compliance with Section 21400 et seq. of the California Vehicle Code and the California Manual of Uniform Traffic Control Devices (California MUTCD). Traffic control in the vicinity of highway - railroad grade crossings shall conform to the Section 6G-19 of the California MUTCD and SCRRA Standard ES4301. The Contractor shall perform no work at, or in the vicinity of a highway-railroad grade crossing without the presence of a railroad EIC, notwithstanding that the work of the Contractor may not be physically located on the SCRRA Right-of-Way.

SCRRA will not permit temporary at-grade crossings unless absolutely necessary and there is no practicable alternative route available to Contractor to access the Project site. Temporary crossings, if permitted, must conform to SCRRA Standard ES4302. All work at temporary crossings that lies between the rails and within 8.5 feet of the center line of the track on each side must be performed by SCRRA at the cost and expense of the Contractor.
The Contractor must comply with all traffic control signs and other devices within

SCRRA facilities, and must observe a maximum speed limit of 20 mph within the SCRRA Right-of-Way. Disregard for posted traffic control signs and devices, or excessive speed within the SCRRA Right-of-Way may lead to revocation of access for the offending individual.

6.10 WORK TO RAILROAD STANDARDS

Construction of railroad tracks, signals, communication systems, fiber optic systems, and civil work associated with any railroad work must be in conformance with SCRRA Standards. SCRRA has the right to inspect the construction, review test records, and witness any quality tests performed. If SCRRA finds any work that wasn't constructed to its standards, the Contractor shall remove the non-conforming work and correct the deficiencies at its expense. SCRRA will have sole authority to determine final acceptance of railroad work.

7.0 UTILITIES

7.01 PROTECTION OF UNDERGROUND FACILITIES

Signal, communication, fiber-optic, petroleum, natural gas, electric power and other utilities are present in the SCRRA right-of-way. Delays and disruptions to service may cause business interruptions involving loss of revenue and profits, danger to train operations, and release of potentially hazardous or flammable compounds. The Contractor must take special precautions and care in connection with excavating, shoring, and other subsurface construction to avoid damage to subsurface facilities.

Before excavating, the Contractor must determine whether any underground pipe lines, electric wires, or cables, including fiber optic cable systems, are present and located within the Project work area by calling the Southern California Underground Service Alert at 811. SCRRA is not a member of Underground Service Alert and SCRRA signal and communication lines must be located by contacting the SCRRA Signal Department at (909) 859-4100 or (909) 859-4112 at least 72 hours prior to commencing work. Calls to SCRRA for cable marking must be made during normal business hours.

All underground and overhead wires must be considered HIGH VOLTAGE and dangerous until verified with the company having ownership of the line. It is the Contractor's responsibility to notify any other companies that have underground utilities in the area and arrange for the location of all underground utilities before excavating. Individual owners of utilities may require that an inspector employed by the utility owner be present during any excavation near the utility.
In case of emergencies involving SCRRA signal or communication facilities, the Contractor shall call (888) 446-9721. The signal and communication emergency phone line is staffed 24 hours a day, 7 days a week. If a telecommunications system is buried anywhere on or near SCRRA right-of-way, the Contractor will coordinate with SCRRA and the telecommunication company to arrange for relocation or other protection of the system prior to beginning any work on or near SCRRA right-of-way. Notice must be

given to the freight railroads and fiber optic companies not less than 72 hours prior to work by calling to permit them to arrange for the location or protection of any lines under their control.

It is the responsibility of the Contractor to make arrangements directly with utility companies involving the protection, encasement, reinforcement, relocation, replacement, removing or abandonment in place of non-railroad facilities affected by the Project. SCRRA has no obligation to supply additional SCRRA right-of-way for non-railroad facilities affected by this Project, nor does SCRRA have any obligation to permit non railroad facilities to be abandoned in place or relocated on SCRRA's right-of-way. Any facility or utility that crosses SCRRA right-of-way must be covered under an agreement or license obtained through SCRRA including, without limitation, any relocation of an existing facility or utility.

SCRRA will, if required, rearrange its communications and signal lines, grade crossing warning devices, train signals, tracks and facilities that are in use and maintained by SCRRA forces in connection with its operation. This work by the SCRRA will be done by its own forces or by contractors under a continuing contract and is not a part of the work under the Contract for the construction of the Project. The Contractor must allow sufficient time in its schedule to permit SCRRA to issue the necessary task orders to its contractors order material, and perform any necessary work.

8.0 HAZARDOUS AND CONTAMINATED MATERIALS

8.01 DISCHARGE

Discharge, release or spill on the SCRRA right-of-way of any hazardous substances, oil, petroleum, constituents, pollutants, contaminants, or any hazardous waste is prohibited and Contractor must immediately notify the SCRRA Representative of any discharge, release or spills in excess of a reportable quantity. The Contractor must not allow SCRRA Property to become a treatment, storage or transfer facility as those terms are defined in the Resource Conservation and Recovery Act or any State analogue.

8.02 NOTIFICATION, CONTROL AND DISPOSAL

If the Contractor discovers any hazardous waste, hazardous substance, petroleum or other deleterious material, including any non-containerized commodity or material, on or adjacent to the SCRRA right-of-way, in or near any surface water, swamp, wetlands or waterways adjacent to the right-of-way, while performing any work on this Project, the Contractor must immediately: (a) notify the Engineer and the SCRRA Representative, of such discovery; (b) take safeguards necessary to protect its employees, sub-contractors, agents and third parties: and (c) exercise due care with respect to the release, including the taking of any appropriate measure to minimize the impact of such release.

9.0 INSPECTION AND OBSERVATION

9.01 SITE INSPECTIONS BY SCRRA AND OTHERS

In addition to the office reviews of construction submittals, site observations will be performed by SCRRA or its designee at significant points during construction as determined by SCRRA. Site visits to observe the progress of the work may be performed at any time throughout the construction process as deemed necessary by SCRRA.
Federal or State representatives may also conduct inspections and tests to verify compliance with laws and regulations. SCRRA maintains an Efficiency Testing program to verify the effectiveness of the Contractor's compliance with 49 CFR 214 – Railroad Workplace Safety regulations and SCRRA third party work rules.

9.02 SCRRA EFFICIENCY TESTS

The Contractor shall cooperate with SCRRA, Federal, and State representatives at all times. Disregard for, or failure to comply with, the requirements of 49 CFR 214 – Railroad Workplace Safety regulations, or SCRRA third-party safety requirements may result in the removal of an offending individual from the SCRRA Right-of-Way. Egregious or repeated disregard for any safety rule or requirement may result in the termination of the Contractor's Right-of-Entry Agreement. SCRRA representatives may make inspections and conduct tests to judge the effectiveness of the safety training, and compliance with SCRRA requirements. These observations and tests are collectively known as Efficiency Tests.

9.03 SCOPE OF INSPECTIONS AND OBSERVATIONS

SCRRA will inspect railroad track, signals, communication systems, and other railroad facilities for compliance with SCRRA standards, guidelines, rules, and agreements, and will generally be limited to the work of the Contractor within or near the SCRRA right-of-way.

The inspection of the railroad work by SCRRA shall not relieve the Contractor of any of its obligations to fulfill the requirements of the Contract, and defective work shall be made good, and unsuitable materials may be rejected, notwithstanding that such work and materials have been previously overlooked by SCRRA and accepted or estimated for payment by the State. If the work, or any part thereof, shall be found defective at any time before the final acceptance of the whole work, the Contractor shall immediately make good such defect without compensation but in a manner that is in conformance with the Contract.

However, in the event that SCRRA finds that a defect necessitating the repair or removal of completed work is due to the use of materials furnished by SCRRA which were when incorporated in the work, or have since become, unsatisfactory or unsuitable from causes for which the Contractor is not responsible, then SCRRA will furnish satisfactory material to the Contractor to replace that previously furnished by SCRRA.

If any material furnished and brought to the jobsite by the Contractor for use in the work, or selected for the same by him, is condemned by the Engineer as unsuitable or not in conformity with the specifications, the Contractor shall forthwith remove and discard such material to a satisfactory distance from the vicinity of work.
Notwithstanding any inspection or site visit by SCRRA, responsibility for compliance with a Contract between the Contractor and a STATE, local codes and ordinances, SCRRA standards and guidelines, and for the inspection of temporary and permanent work and other work site inspections, resides with the STATE and the Contractor. SCRRA by its inspections and comments makes no representations and offers no warranty as to the completeness, accuracy, degree of conformance to codes, compliance with the Contract or local codes or ordinances.

10.0 CLEARING OF RIGHT-OF-WAY

10.01 CLEARING OF RIGHT-OF-WAY

The Contractor shall, upon completion of the work, promptly remove all of the Contractor's tools, implements and other materials whether brought upon the right-of-way by the Contractor or any sub-contractor, employee, supplier, or agent of the Contractor. The Contractor shall also restore the right-of-way of SCRRA, and make arrangements with SCRRA to restore the tracks, wire lines, signals, and other facilities of SCRRA. The Contractor shall leave the premises in a clean and presentable State equal to or better than existed at the start of the project work. All areas must be graded to drain away from the tracks, all fences or other barriers that have been damaged during the work, or removed to facilitate the work, must be replaced with new fencing of an equivalent character. Where the project improvements intersect the natural flow of the runoff, the contractor shall provide facilities for the proper collection, conveyance, and disposal of water reaching the interfering improvements.

METROLINK

Southern California Regional Rail Authority

TEMPORARY RIGHT-OF-ENTRY AGREEMENT

SCRRA FORM NO. 6

SCRRA File No.	
SCRRA Project/Task No.	
Subdivision	
Mile Post	
Thomas Guide Location	

This Temporary Right-of-Entry Agreement ("Agreement") is between the Southern California Regional Rail Authority (hereinafter referred to as "SCRRA") and _____ (hereinafter referred to as "Contractor"). This Agreement is for entry upon, over and under SCRRA and Member Agency Right-of-Way ("Right-of-Way") at or near _____ in the City of _____ or in the Unincorporated County of _____ (as such location is more specifically identified above) for the purpose of _____ _____(as shown on attached drawings).

1. **Definitions**

A. Contractor is an individual, firm, partnership or corporation or combination thereof, private, municipal or public, including joint ventures, which are referred to throughout this document by singular number and masculine gender. For purposes of this agreement, Contractor also includes any subcontractor, supplier, agent or other individual entering the Right-of-Way during performance of work.

B. Indemnitees are SCRRA, Member Agencies and Operating Railroad and their respective officers, commissioners, employees, agents, successors and assigns.

C. Operating Railroad is/are that specific passenger or freight-related railroad company(s) validly operating on SCRRA and Member Agency track(s). Operating Railroads are any combination(s) of the SCRRA (METROLINK), the National Railroad Passenger Corporation (AMTRAK), the Union Pacific Railroad Company (UPRR) and the BNSF Railway Company.

D. Property and Right-of-Way is defined herein to mean the real and/or personal property of SCRRA and/or Member Agencies.

E. SCRRA is a five-county joint powers authority, created pursuant to State of California Public Utilities Code Section 130255 and California Government Code Section 6500 et seq., to build and operate the "Metrolink" commuter train system in the five-county area on rail rights-of-ways owned by the Member Agencies. The five-county Member Agencies ("Member Agency") are comprised of the following: Los Angeles County Metropolitan

Transportation Authority (MTA), Ventura County Transportation Commission (VCTC), Orange County Transportation Authority (OCTA), San Bernardino Associated Governments (SANBAG), and Riverside County Transportation Commission (RCTC).

F. SCRRA Employee-In-Charge (EIC) is a Southern California Regional Rail Authority employee or contractor (SCRRA General Code of Operating Rules and Territory Qualified) providing warning to Public Agency or Contractor personnel of approaching trains or on track equipment and who has the authority to halt work and to remove personnel from the Right-of-Way to assure safe work.

G. SCRRA Safety Trainer is a qualified SCRRA employee or contracted employee (SCRRA General Code of Operating Rules qualified) as authorized by the SCRRA Director of Engineering and Construction to provide Contractor training.

2. **References**

When working on the Right-of-Way, the Contractor must comply with the rules and regulations contained in the current editions of the following documents which are "references" incorporated in this document as if they were set out in full in this paragraph. The Contractor, by its signature on this Agreement, acknowledges receipt of these documents and agrees to abide by said rules and regulations at all times when on the Right-of-Way.

A. Rules and Requirements for Construction on Railway Property, SCRRA Form No. 37.

B. General Safety Regulations for Third Party Construction and Utility Workers on SCRRA Property.

3. **Entry Onto Right-of-Way**

No verbal approvals will be granted. The Contractor shall not enter onto the Right-of-Way unless Contractor has arranged for SCRRA safety training as well as protective services (EIC and/or other protective services to be determined by SCRRA) and has paid all charges and fees. A fully executed copy this Form 6 must be in the possession of the contractor at the job site and must be produced by Contractor upon request by SCRRA, a law enforcement officer or Member Agency's representative. If said Agreement is not produced, SCRRA has the right to suspend work in the Right-of-Way until Contractor demonstrates possession of Agreement at the job site.

4. **Termination of Agreement**

SCRRA or Member Agency reserves the right to terminate or revoke this temporary Agreement at any time upon two hours notice; however, in the event of an unsafe condition on the Right-of-Way, SCRRA shall have the right to terminate this Agreement immediately, without any advanced notice. Unless subsequently modified, extended, terminated or revoked by SCRRA, this temporary Agreement shall extend until the work authorized hereunder is completed or accepted by SCRRA. In any event, however, the Agreement shall be automatically terminated if or when the insurance that the Contractor is required to maintain hereunder lapses or expires. The Contractor agrees to return the Property to a condition substantially the same as before construction, including replacement, repair, or reinstallation of railroad signs and property. Railroad signs include but are not limited to "No Trespassing", "Speed Limit", "Milepost", "Whistle", "Station Stop" and "Fiber Optics". The Contractor agrees

to notify SCRRA, in writing and orally, when use of the Right-of-Way or work is completed (see Section 18 of this Agreement for SCRRA contact). Under no circumstances shall the temporary right of entry provided for under this Agreement be construed as granting to the Contractor or its Subcontractors and agents any right, title or interest of any kind or character in, on or about any Property.

At the request of SCRRA or Member Agency, Contractor shall remove from the Right-of-Way any employee or other individual who has not completed safety training or otherwise fails to conform to the instructions of SCRRA's or Member Agency's representative in connection with work on the Right-of-Way. Any right of Contractor to enter upon the Right-of-Way shall be suspended until such request of SCRRA or Member Agency is met. Contractors shall defend, indemnify and hold harmless SCRRA and Member Agency against any claim arising from the removal of any such employee or other individual from the Right-of-Way.

5. **Indemnification**

Contractor, on behalf of itself and its employees, subcontractors, agents, successors and assigns, agrees to indemnify, defend, by counsel satisfactory to SCRRA and Member Agency, and hold harmless "Indemnitees", and each of them to the maximum extent allowed by law, from and against all loss, liability, claims, demands, suits, liens, claims of lien, damages (including incidental consequential damages), costs and expenses (including, without limitation, any fines, penalties, judgments, actual litigation expenses and experts' and actual attorneys' fees), that are incurred by or asserted against Indemnitees arising out of or connected in any manner with (i) the acts or omissions of the Contractor or its officers, directors, affiliates, subcontractors or agents or anyone directly or indirectly employed by them or for whose acts the foregoing persons are liable (collectively, "Personnel") in connection with or arising from the presence upon or performance of activities by the Contractor or its Personnel with respect to the Right-of-Way, (ii) bodily and/or personal injury or death of any person (including without limitation employees of Indemnitees) or damage to or loss of use of Property resulting from such acts or omissions of the Contractor or its Personnel or (iii) non-performance or breach by Contractor or its Personnel of any term or condition of this Agreement, in each case whether occurring during the term of this Agreement or thereafter.

The foregoing indemnity shall be effective regardless of any negligence (whether active, passive, derivative, joint, concurring or comparative) on the part of Indemnitees, unless caused by the sole negligence or willful misconduct of Indemnitees, and is in addition to any other rights or remedies, which Indemnitees may have under the law or under this Agreement.

Claims against the Indemnitees by the Contractor or its Personnel shall not limit the Contractor's indemnification obligations hereunder in any way, whether or not such claims against Indemnitees may result in any limitation of the amount or type of damages, compensation or benefits payable by or for the Contractor or its Personnel under workers' compensation acts, disability benefit acts or other employee benefit acts or insurance.

The provisions of this section shall survive the termination or expiration of this Agreement.

6. **Assumption of Liability**

To the maximum extent allowed by law, the Contractor releases Indemnitees from and assumes any and all risk of loss, damage or injury of any kind to any person or property, including without limitation, the Property and/or Right-of-Way and any other property of or

under the control or custody of, the Contractor or its personnel in connection with any acts undertaken under or in connection with this Agreement. The Contractor's assumption of risk shall include, without limitation, loss or damage caused by defects in any structure or improvements (including easement, lease or license agreements for other existing improvements and utilities) on the Right-of-Way, accident or fire or other casualty on the Right-of-Way or electrical discharge, noise or vibration resulting from SCRRA, Member Agency and Operating Railroad transit operations on or near the Right-of-Way and any other persons or companies employed, retained or engaged by SCRRA or Member Agency. The Contractor, on behalf of itself and its Personnel (as defined in Section 5, "Indemnification") as a material part of the consideration for this Agreement, hereby waives all claims and demands against the Indemnitees for any such loss, damage or injury of the Contractor and/or its Personnel. The Contractor waives the benefit of California Civil Code Section 1542, which provides as follows: "A general release does not extend to claims which the creditor does not know or suspect to exist in his favor at the time of executing the release, which if known by him must have materially affected his settlement with the debtor."

The provisions of this Section shall survive the termination or expiration of this Agreement.

7. **Insurance**

The Contractor, at its sole cost and expense, shall obtain and maintain in full force and effect during the term of this Agreement insurance as required by SCRRA or Member Agency in the amounts, coverage, and terms and conditions specified, and issued by insurance companies as described on Exhibit "A". SCRRA or Member Agency reserve the right, throughout the term of this Agreement, to review and change the amount and type of insurance coverage it requires in connection with this Agreement. Prior to entering the Right-of-Way or performing any work or maintenance on the Right-of-Way, the Contractor shall furnish SCRRA with insurance endorsements or certificates in the form of Exhibit "B", evidencing the existence, amounts and coverage of the insurance and signed by a person authorized by the insurer to bind coverage on its behalf. In most instances, SCRRA and Member Agency do not allow self-insurance; however, if the Contractor can demonstrate assets and retention funds meeting SCRRA and Member Agency self-insurance requirements, SCRRA and Member Agency may in SCRRA's sole and absolute discretion permit the Contractor to self-insure. The right to self-insure with respect to any coverage required hereunder may be granted or revoked at the sole and absolute discretion of SCRRA or any Member Agency. SCRRA or Member Agency shall not be liable for the payment of any premiums or assessments for insurance required to be maintained by the Contractor under this Agreement. Contractor affirms that all subcontractors covered by this Agreement are insured to the same limits required of the Contractor or included in Contractor's policy.

Prior to the expiration of any policy, the Contractor shall furnish SCRRA with certificates of renewal or "binders" thereof. Each certificate shall expressly state that such policies shall not be cancelable or otherwise subject to modification except after thirty (30) days prior written notice to SCRRA and Member Agency.

8. **No Assignment**

The Contractor shall not assign this Agreement or any right hereunder without SCRRA's and Member Agency's prior written consent.

9. **Compliance by Contractor**

The Contractor shall take all steps necessary to assure that its subcontractors comply with the terms and conditions of this Agreement and applicable laws and regulations. The Contractor shall assure that no lien is placed against the Right-of-Way arising from performance of work hereunder by Contractor or any subcontractor, and in the event of such a lien, Contractor shall immediately remove or cause to be removed such lien.

10. **Safety Orientation Class**

The Contractor and his subcontractors shall be required to attend a SCRRA Safety Orientation Class prior to receiving permission to enter the Right-of-Way. The Contractor shall notify SCRRA's contractor for safety and flagging services at 1-877-452-0205 to arrange for third party safety training. Allow 24 to 72 hours from the request for safety training to arrange the training. Upon completion of safety training, the Contractor shall notify SCRRA's contractor at (714) 920-9037 a minimum of fifteen (15) working days prior to beginning work on the Right-of-Way and secure any protection SCRRA deems necessary. This prior notification does not guarantee the availability of on track safety protection for the proposed date of construction. To the full extent of Paragraph 5 above (Indemnification), Contractor agrees to indemnify SCRRA against any and all claims resulting from sickness or any other absence.

11. **SCRRA Safety and Protective Services**

The Contractor must request and arrange for on track safety protection satisfactory to SCRRA in the following circumstances:

A. When the Contractor's work activities are within the right-of-way of SCRRA.

B. When the Contractor's work activities are located over or under a track or tracks.

C. When cranes, pile drivers, drill rigs, concrete pumps, or similar equipment positioned outside of the right-of-way could foul the track in the event of tip-over or other catastrophic occurrence.

D. When in the opinion of the SCRRA it is necessary to safeguard the employees, trains, engines and facilities of SCRRA.

E. When any excavation is performed below the elevation of the track sub-grade, or track or other railroad facilities may be subject to movement or settlement.

F. When work in any way interferes with the safe operation of trains at timetable speeds.

G. When any hazard is presented to railway track, communications, signal, electrical, or other facilities either due to persons, material, equipment or blasting in the vicinity.

H. When clearing, grubbing, grading, or blasting is in proximity to the right-of-way which, in the opinion of SCRRA or representative of an SCRRA Member Agency, may endanger the right-of-way or operations.

I. When street construction and maintenance activities, located within the right-of-way or in the vicinity of the highway-rail grade crossing, requiring temporary work area traffic control, which may affect or create unsafe conditions for employees, public, trains and

vehicles.

The Contractor, and his subcontractors, shall complete SCRRA's Safety Orientation Class, as instructed in Item 10. Upon completion individuals will received a safety sticker which shall be adhered to their hardhat while working on railroad Right-of-Way as proof of completion of safety training.

12. **Reimbursement of Costs and Expenditures**

The Contractor agrees to reimburse SCRRA or Member Agency for all cost and expense incurred by SCRRA or Member Agency in connection with said work, including without limitation the expense of engineering plan review, staff costs to process approvals and agreements, safety training, furnishing an SCRRA Railroad Employee and protective services as SCRRA deems necessary. Contractor agrees to reimburse SCRRA for all construction related services including but not limited to installation and removal of falsework beneath tracks, restoration of railroad roadbed and tracks, installation of appropriate protective devices, temporary and permanent repairs of signal or communication equipment, restoration of the Right-of-Way to a condition satisfactory to SCRRA's and Member Agency's representative.

The Contractor agrees to reimburse SCRRA or Member Agency actual cost and expense reasonably incurred for all services and work performed in connection with said work, including SCRRA's allocated overhead and fringe benefits. SCRRA will charge the Contractor four hours minimum for the mandatory safety training class and for other services four hours or less in duration. SCRRA will charge the Contractor for eight hours minimum if the Contractor cancels SCRRA services after SCRRA Railroad Employee or SCRRA Safety Training Officer is on site on the day of the appointment.

The Contractor also agrees to reimburse SCRRA, Member Agency and/or Operating Railroad for any and all cost and expense incurred as a result of Contractor's work which may result in (i) unscheduled delay to the trains or interference in any manner with the operation of trains, (ii) unscheduled disruption to normal train operation, (iii) unreasonable inconvenience to the public or private user of the system, (iv) loss of revenue and (v) alternative method of transportation for passengers. SCRRA will submit final bills to the Contractor for cost incurred.

Prior to commencement of work, the Contractor shall deposit with SCRRA the sum of _____ dollars ($)_____ representing the estimated expense to be incurred by SCRRA and Member Agency in connection with said work. As the work progresses, SCRRA may require additional progress payments as the scope of work changes or becomes clearer. SCRRA may discontinue services to Contractor pending receipt of progress payments. The deposit and progress payments shall be applied to SCRRA's and Member Agency's actual costs and expenditures. The Contractor shall be responsible to pay any amount exceeding the above payments upon receipt of notice or invoice by SCRRA. SCRRA shall exercise its best efforts to provide final invoicing to Contractor within 90 days following completion of the work; however, Contractor acknowledges that it shall be responsible for payment of all expenses incurred by SCRRA and Member Agency in connection with the work even if the final invoicing is provided to Contractor thereafter. Upon satisfactory completion of all work, any payments in excess of SCRRA's and Member Agency's costs and expenditures shall be returned to the Contractor within reasonable time.

If there is no amount indicated in the blank space provided above for the deposit to be made by the Contractor, and if prior SCRRA written approval is obtained, in lieu of such deposit,

Contractor shall cause surety bond to be executed by a reliable surety acceptable to SCRRA and Member Agency, conditioned upon the faithful performance of the provisions of this Agreement.

13. **Temporary Traffic Control**

Temporary traffic control shall be used when a maintenance or construction activity is located on the Right-of-Way or when the activity is located in the vicinity of a highway-rail grade crossing, which could result in queuing of vehicles across the railroad tracks. Temporary traffic control will comply with the current editions of the CA MUTCD, WATCH and SCRRA Engineering Standard ES4301. Refer to SCRRA's "Temporary Traffic Control Guidelines" for further information on definitions, referenced standards, traffic control plans, submittals, traffic control elements and responsibility/authority for temporary traffic control at highway-rail grade crossings. The guidelines provide acceptable alternatives and procedures, which prescribe appropriate temporary traffic control measures at highway-rail grade crossings and are available on the SCRRA website. (http://www.metrolinktrains.com).

14. **Environmental Health and Safety Plan**

Contractor shall immediately notify SCRRA and the appropriate regulatory agency (ies) of any spill, release, discharge or discovery of any hazardous material or contaminants in, on or under the Property. After providing such notice to SCRRA and the appropriate regulatory agency (ies), any contaminated soils or hazardous materials which are spilled, released, discharged or discovered by the Contractor, shall be promptly removed and disposed of by Contractor in accordance with all the applicable laws at Contractor's sole cost and expense. To the extent preexisting contamination or hazardous material, which was not caused or contributed to by Contractor, is discovered or unearthed by Contractor, Contractor shall only be obligated by this provision to removing and disposing of that portion of the contaminated soils or hazardous materials that are unearthed or otherwise disturbed during Contractor's operations. Prior to entry onto the Property, Contractor (s) performing trenching, excavations or soil borings may be required by SCRRA to submit a "Hazardous Materials Work Plan." If required, said plan shall include Contractor's site-specific health and safety plan and any other information that SCRRA may require. Contractor shall ensure that all documentation for transportation or disposal of contaminated soils of hazardous materials is prepared in the Contractor's name only and that neither SCRRA nor Member Agency shall have any responsibility or liability therefor. Contractor shall defend and indemnify SCRRA for any spill, release or discharge of contaminants or hazardous materials by Contractor in connection with activities hereunder in accordance with Section 5 Indemnification (Page 2 of 14)

15. **Warranty for Plan Review**

Review and or approval of the plans and calculations by SCRRA shall not relieve the Contractor of responsibility for full compliance with contract requirements, correctness of design drawings and details, proper fabrication and construction techniques and coordination with other government and private permitting agencies, nor shall such review or approval by SCRRA in any way relieve Contractor from, or otherwise modify, Contractors' indemnity obligations (Section 5) or assumption of liability obligations (Section 6). Execution of this right of entry does not imply design warranty or responsible charge on the part of SCRRA engineering employees. The parties expressly agree that SCRRA makes no warranty of any kind and assumes no responsibility therefore.

16. **Miscellaneous**

Wherever the context of this document so requires, words used in the masculine gender shall include the feminine and neuter genders; words used in the neuter gender shall include the masculine and feminine genders; words in the singular shall include the plural; and words in the plural shall include the singular.

17. **Emergency Telephone Numbers**

The Contractor must immediately contact SCRRA in case of accidents, personal injury, defect in track, bridge or signals or any unusual condition that may affect the safe operation of the railroads. The following are SCRRA's emergency numbers:

Signal Emergencies and Grade Crossing Problems	**(888) 446-9721**
Metrolink Chief Dispatcher	**(909) 593-0661 or (888) 446-9715**
Metrolink Sheriff's Dispatcher	**(323) 563-5280 or (323) 563-5000**
Signal and Communications Cable Location	**(909) 859-4100 or (909) 859-4112**

18. **Notices**

Except as otherwise provided in this agreement, all notices, statements, demands, approvals or other communications to be given under or pursuant to this agreement will be in writing, addressed to the parties at their respective addresses as provided below and will be delivered in person or by certified or registered mail, postage paid or by telegraph or cable, charges pre-paid.

SCRRA: Assistant Director, Standards and Design
Southern California Regional Rail Authority (SCRRA)
279 East Arrow Highway, Suite A
San Dimas, California 91773
Attn: Mr. Christos Sourmelis - ROW Encroachments Coordinator
E-mail: sourmelisc@scrra.net
Office Number: (909) 394-3418

Contractor: Contractor's address is shown on the next page.

19. **California Law**

This agreement shall be construed and interpreted in accordance with and governed by the laws of the State of California. Venue shall be located in courts in Los Angeles County.

The Contractor hereby agrees to the terms as set forth in this Agreement and hereby acknowledges receipt of this Agreement and of the insurance certificate forms (Exhibits A & B) herein provided.

(*Name of Contractor*)	(*Signature*)
(Address)	(*Print Name*)
	(*Title*)
(*Telephone*)	(*Contractor's State License No.*)
(Fax)	*(Email)*

Receipt of the foregoing agreement and certificated of insurance furnished by the Contractor are hereby acknowledged on this _____day of _____20 _____.

SOUTHERN CALIFORNIA REGIONAL RAIL AUTHORITY

By: _____
ROW Encroachments Coordinator

By: _____
Assistant Director, Standards and Design

[Approved As To Form By Legal Counsel]

EXHIBIT "A"
INSURANCE REQUIREMENTS FOR RIGHT OF ENTRY AGREEMENTS

Contractor shall procure and maintain for the duration of the contract insurance against claims for injuries to persons or damages to Property, which may arise from or in connection with the performance of the work by the Contractor, his agents, representatives, employees or subcontractors.

1. **Minimum Scope of Insurance**

Coverage shall be at least as broad as:

☒ Insurance Services Office Commercial General Liability coverage (occurrence form CG 0001).
☒ Insurance Services Office form No. CA 0001 (Ed. 1/87) covering Auto. Liability, code 1(any auto).
☒ Worker's Compensation insurance as required by the State of CA. & Employer's Liability Insurance.
☐ Course of Construction insurance form providing coverage for "all risks" of loss.
☐ Property insurance against all risks of loss to any tenant improvements or betterment.
☐ Contractor's Pollution Liability

2. **Minimum Limits of Insurance**

Contractor shall maintain limits no less than:

☒ General Liability: $2,000,000 per occurrence for bodily injury, personal injury and Property damage.
☒ If Commercial General Liability Insurance or other form with a general aggregate limit is used, either the general aggregate limit shall apply separately to this project/location or the general aggregate limit shall be twice the required occurrence limit.
☒ Automobile Liability: $1,000,000 per accident for bodily injury and Property damage.
☒ Employer's Liability: $1,000,000 per accident for bodily injury or disease.
☐ Course of Construction: Completed value of the project.
☐ Property Insurance: Full replacement cost with no coinsurance penalty provision.
☐ Contractor's Pollution Liability: $1,000,000 per occurrence/$2,000,000 annual aggregate

3. **Certificate Holder/Additional Insured**

Certificate holder and/or insured will be the following:

Southern California Regional Rail Authority (SCRRA)

Additionally Insured will be the following:

Los Angeles County Metropolitan Trans. Auth. (MTA)
Orange County Transportation Authority (OCTA)
Riverside County Transportation Commission (RCTC)
San Bernardino Associated Government (SANBAG)
Ventura County Transportation Commission (VCTC)
Burlington Northern Santa Fe Corp. (BNSF)
Union Pacific Railroad Company (UPRR)
National Railroad Passenger Corp. (AMTRAK)

4. **Railroad Protective Liability Insurance**

☒ Railroad Protective Liability Insurance

The Contractor shall provide, with respect to the operations they or any of their subcontractors perform on the Property, Railroad Protective Liability Insurance, AAR-AASHTO (ISO/RIMA) in the name of the railroads and Member Agencies shown in Section 3 above.

The policy shall have limits of liability of not less than **$2 million per occurrence**, combined

single limit, for coverage and for losses arising out of injury to or death of all persons and for physical loss or damage to or destruction of Property, including the loss of use thereof. A **$6 million annual aggregate** shall apply.

If coverage is provided on the London claims-made form, the following provisions shall apply:

A. The limits of liability shall be not less than $3 million per occurrence, combined single limit. A $9 million aggregate may apply.

B. Declarations item 6, extended claims made date, shall allow an extended claims made period no shorter than the length of the original policy period plus one year.

C. If equivalent or better, wording is not contained in the policy form, the following endorsement must be included:

> It is agreed that "physical damage to Property" means direct and accidental loss of or damage to rolling stock and their contents, mechanical construction equipment or motive power equipment, railroad tracks, roadbed, catenaries, signals, bridges or buildings.

For certain low-hazard activity, Contractor may request that the SCRRA and Member Agency waive the requirement to provide the Railroad Protective Liability Insurance. If the exposure to the track is physically separated by a building, floor or a continuous fence (no thoroughfares) and the employees of the Contractor are explicitly notified that they are not permitted to have any contact with the track, the Railroad Protective Liability Insurance requirement may be waived by SCRRA's Manager Public Projects or his/her designated representative.

5. **Deductibles and Self-Insured Retentions**

Any deductibles or self-insured retentions must be declared to and approved by SCRRA and Member Agency. At the option of SCRRA, either: the insurer shall reduce or eliminate such deductibles or self-insured retentions as respects SCRRA and Member Agency, its officials and employees or the Contractor shall procure a bond guaranteeing payment of losses and related investigations, claim administration and defense expenses.

6. **Other Insurance Provisions**

The General Liability and Automobile Liability policies are to contain, or be endorsed to contain, the following provisions:

A. SCRRA and Member Agency, its subsidiaries, officials and employees are to be covered as insureds as respects: liability arising out of activities performed by or on behalf of the Contractor; premises owned, occupied or used by the Contractor, or automobiles owned, leased, hired or borrowed by the Contractor. The coverage shall contain no special limitations on the scope of protection afforded to SCRRA and Member Agency, its subsidiaries, officials and employees.

B. For any claims related to this project, the Contractor's insurance coverage shall be primary insurance as respects SCRRA and Member Agency, its subsidiaries, officials and employees. Any insurance or self-insurance maintained by SCRRA and Member Agency, its subsidiaries, officials and employees shall be excess of the Contractor's insurance and shall not contribute with it.

C. Any failure to comply with reporting or other provisions of the policies including breaches of warranties shall not affect coverage provided to SCRRA and Member Agency, its

subsidiaries, officials and employees.

D. The Contractor insurance shall apply separately to each insured against whom claim is made or suit is brought, except with respect to the limits of the insurer's liability.

E. Each insurance policy required by this clause shall be endorsed to state that coverage shall not be suspended, voided, canceled by either party, reduced in coverage or in limits except after thirty (30) days' prior written notice by certified mail, return receipt requested, has been given to SCRRA and/or Member Agency.

Course of Construction policies shall contain the following provisions:

A. SCRRA and Member Agency shall be named as loss payee.

B. The insurer shall waive all rights subrogation against SCRRA and Member Agency.

7. **Acceptability of Insurers**

Insurance is to be placed with insurers with a current A.M. Best's rating of no less than A:VII, unless otherwise approved by SCRRA and Member Agency.

8. **Verification of Coverage**

Contractor shall furnish SCRRA with original endorsements effecting coverage required by this clause. The endorsements are to be signed by a person authorized by that insurer to bind coverage on its behalf. The endorsements are to be on forms provided by SCRRA. All endorsements are to be received and approved by SCRRA before work commences. As an alternative to SCRRA's forms, the Contractor's insurer may provide complete, certified copies of all required insurance policies, including endorsements effecting the coverage required by these specifications.

9. **Subcontractors**

Contractor shall include all subcontractors as insured under its policies or shall furnish separate certificates and endorsements for each subcontractor. All coverage for subcontractors shall be subject to all of the requirements stated herein.

10. **Train Services**

Approximate daily train traffic is _____ passenger trains and _____ freight trains.

11. **Submittal**

The original insurance policy (s) shall be submitted to:

Assistant Director, Standards and Design
Southern California Regional Rail Authority (SCRRA)
279 East Arrow Highway, Suite A
San Dimas, California 91773
Attn: Mr. Christos Sourmelis - ROW Encroachments Coordinator
E-mail: sourmelisc@scrra.net
Office Number: (909) 394-3418

METROLINK
Southern California Regional Rail Authority

EXHIBIT "B"
RAILROAD PROTECTIVE LIABILITY POLICY
DECLARATION

POLICY

Insurance Company:
Policy Number:
Policy Period: _____ _____ From: To:
12:01am Standard time at location

CERTIFICATE HOLDER AND ADDITIONALLY INSURED

Certificate Holder/Insured:

Southern California Regional Rail Authority (SCRRA)
279 E. Arrow Highway, Suite A, San Dimas, CA 91773

Additionally Insured:

Los Angeles County Metropolitan Transportation Authority (MTA)
Orange County Transportation Authority (OCTA)
Riverside County Transportation Commission (RCTC)
San Bernardino Associated Governments (SANBAG)
Ventura County Transportation Commission (VCTC)
Burlington Northern Santa Fe Corporation (BNSF)
Union Pacific Railroad Company (UPRR)
National Railroad Passenger Corp. (AMTRAK)

LIMITS OF INSURANCE

Aggregate Limit $6,000,000 Each Occurrence Limit $2,000,000

DESCRIPTION OF WORK AND JOB LOCATION(S)

NAME AND ADDRESS OF DESIGNATED CONTRACTOR

NAME AND ADDRESS OF INVOLVED GOVERNMENT AUTHORITY OR OTHER CONTRACTING PARTY

PREMIUM

Contract Cost _____
Premium Base _____ Rate per 1,000 of _____ Advance Premium _____

FORM OF ENDORSEMENT

Title **Number**

COUNTERSIGNATURE

Countersigned by _____ Date _____
(Authorized Representative)

METROLINK
Southern California Regional Rail Authority

EXHIBIT "B

CERTIFICATE OF INSURANCE Southern California Regional Rail Authority (SCRRA)	ISSUE DATE (MM/DD/YY)
PRODUCER INSURED	THIS CERTIFICATE OF INSURANCE IS NOT AN INSURANCE POLICY AND DOES NOT AMEND, EXTEND OR ALTER THIS COVERAGE AFFORDED BY THE POLICY BELOW. **COMPANIES AFFORDING COVERAGE** COMPANY LETTER **A** COMPANY LETTER **B** COMPANY LETTER **C** COMPANY LETTER **D** COMPANY LETTER **E**

COVERAGES
THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED NAMED ABOVE FOR THE POLICY PERIOD INDICATED, NOTWITHSTANDING ANY REQUIREMENTS, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN. THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

CO LTR	TYPE OF INSURANCE	POLICY NUMBER	POLICY EFFECTIVE DATE (MM/DD/YY)	POLICY EXPIRATION DATE (MM/DD/YY)	LIMITS	
	GENERAL LIABILITY ☐ COMMERCIAL GENERAL LIABILITY ☐ CLAIMS MADE ☐ OCCUR. ☐ OWNER'S & CONTRACTOR'S PROT. ☐ OTHER _____				GENERAL AGGREGATE PRODUCTS-COMP/OP AGG. PERSONAL & ADV. INJURY EACH OCCURRENCE FIRE DAMAGE (Any one fire) MED. EXPENSE (Any one person)	$ $ $ $ $ $
	AUTOMOBILE LIABILITY ☐ ANY AUTO ☐ ALL OWNED AUTO ☐ SCHEDULED AUTOS ☐ HIRED AUTOS ☐ NON-OWNED AUTOS ☐ GARAGE LIABILITY				COMBINED SINGLE LIMIT BODILY INJURY (Per person) BODILY INJURY (Per accident) PROPERTY DAMAGE	$ $ $
	EXCESS LIABILITY ☐ UMBRELLA FORM ☐ OTHER THAN UMBRELLA FORM				EACH OCCURRENCE AGGREGATE	$ $
	PROPERTY INSURANCE ☐ COURSE OF CONSTRUCTION				AMOUNT OF INSURANCE	$
	WORKER'S COMPENSATION AND EMPLOYER'S LIABILITY				STATUARY LIMITS EACH ACCIDENT DISEASE-POLICY LIMIT DISEASE-EACH EMPLOYEE	 $ $ $

DESCRIPTION OF OPERATIONS/LOCATIONS/VEHICLES/SPECIAL ITEMS

THE FOLLOWING PROVISIONS APPLY:

1. None of the above-described policies will be canceled, limited in scope of coverage or nonrenewed until after 30 days' written notice has been given to SCRRA at the address indicated below.
2. As respects operations of the named insured performed on behalf of SCRRA, the following are added as additional insured on all liability insurance policies listed above: SCRRA, its Member Agencies, Operating Railroads, its subsidiaries, officials and employees.
3. It is agreed that any insurance of self-insurance maintained by SCRRA will apply in excess of and not contribute with, the insurance described above.
4. SCRRA is named a loss payee on the property insurance policies described above, if any.
5. All rights of subrogation under the property insurance policy listed above have been waived against SCRRA.
6. Any failure by the insured to comply with reporting or other provisions of the policies including breaches of warranties shall not affect coverage provided to SCRRA, its Member Agencies, its subsidiaries, officials and employees.
7. The worker's compensation insurer named above, if any, agrees to waive all rights of subrogation against SCRRA for injuries to employees of the insured resulting from work for SCRRA or use of Member Agencies premises or facilities.

CERTIFICATE HOLDER
Southern California Regional Rail Authority (SCRRA)
279 E. Arrow Highway, Suite A, San Dimas, CA 91773

ADDITIONAL INSURED
MTA, OCTA, RCTC, SANBAG, VCTC, BNSF, UPRR, AMTRAK

AUTHORIZED REPRESENTATIVE

SIGNATURE _____
TITLE _____
PHONE NO. _____

FINAL AERIALLY DEPOSITED LEAD (ADL) ADDENDUM REPORT

Earth Mechanics, Inc.

November 11, 2011

FINAL AERIALLY DEPOSITED
LEAD ADDENDUM REPORT

SR-91 Westbound Widening Project
State College Blvd to Brookhurst Street
Orange County, California
12-ORA-91, PM 0.9/5.4
EA 12-0C5701
EMI Project No. 10-126
Date: November 11, 2011

EARTH MECHANICS, INC.

Geotechnical and Earthquake Engineering

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

November 11, 2011

EMI Project No. 10-126

RBF Consulting
14725 Alton Parkway
Irvine, California 92618

Attention: Mr. Steve Huff

Subject: ***Final Aerially Deposited Lead Addendum Report***
SR-91 Westbound Widening Project (State College Blvd to Brookhurst Street)
County of Orange, California
12-Ora-91, PM 0.9/5.4, EA 12-0C5701

Dear Mr. Huff:

Attached is our Final Aerially Deposited Lead (ADL) Addendum Report for the subject project. This final addendum report presents the details of our field and laboratory investigations and the results of our revised analyses and recommendations for handling, disposal and re-use of potentially lead-contaminated soils as part of the structure and roadway improvements for the subject project.

EMI submitted the ADL Addendum Report for the subject project, dated March 16, 2011, to Caltrans. The Caltrans Environmental Engineering Branch District 12 Division reviewed and accepted the report. Caltrans approval memorandum is included in Appendix E.

We appreciate the opportunity to provide our services for the project. If you have any questions please call us.

Sincerely,
EARTH MECHANICS, INC.

11-11-2011

(Ranjan) G. J. Gunaranjan, PE 71758
Senior Staff Engineer

11-11-2011

Lino Cheang, GE 2345
Project Manager

17800 Newhope Street, Suite B, Fountain Valley, California 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

1.0 INTRODUCTION

1.1 Project Description

The California Department of Transportation (Caltrans), in cooperation with the Orange County Transportation Authority (OCTA) and the cities of Anaheim and Fullerton, proposes to widen the SR-91 Westbound from SR-57 to Interstate 5 (I-5). The proposed project limits cover a distance of about 4.5 miles; however, actual improvements are limited to a total of about 3.8 miles within the project area. A site location map is presented in Figure 1.

1.2 Background

Leighton Consulting, Inc. completed an Aerially Deposited Lead (ADL) investigation and documented their findings and recommendations in an ADL Investigation Report, dated June 23, 2009 (2009 ADL report) for the subject project, which was reviewed and approved by Caltrans on April 13, 2009. The boring location plans from the 2009 ADL report are included in this addendum report. The summary table of the laboratory test results contained in the 2009 ADL report is presented in Appendix A. The approval memorandum from Caltrans for the 2009 ADL report is included in Appendix B. Other remaining items in the 2009 ADL report (such as description of their field work and type of laboratory tests, and results of their statistical analysis) were not used in our assessment and preparation of this addendum report; therefore, they were omitted.

The 2009 ADL report recommends reuse of material generated from the upper 4 feet of soils during the proposed SR-91 widening project according to Caltrans Soil Classification "Y1" (covered with a minimum 1 foot of clean soil and placed a minimum of 5 feet above the maximum ground water elevation) for the entire project limit. It was also indicated that this recommendation applied to the ramps (although ADL samples for testing at the ramps were not collected for the 2009 ADL investigation), and the vertical extent of the "Y1" soils (for both the mainline and the ramps) is down to a depth of 4 feet, which is the maximum depth explored in the 2009 ADL investigation.

In the Caltrans approval memorandum of the 2009 ADL report, Caltrans points out that "Y1" soils were encountered only in Borings ADL-3, -8, -17, -34, -37, -38, -44, -45, and -46 and the soils encountered in the vicinity of these borings should be handled as "Y1" soils, which can be interpreted as a deviation from the 2009 ADL report recommendation.

Based on the above situation and the possibility of the high cost associated with handling a large quantity of "Y1" soils, OCTA/RBF requested Earth Mechanics, Inc. (EMI) to review the 2009 ADL report and check the possibilities of delineating the "Y1" soil zones.

1.3 Work Plan and Objectives

EMI proposed the following work plan:

1) Perform additional ADL investigation for the ramps - to properly investigate and identify the need of special handling or disposal of soil,

2) Perform supplemental ADL investigation for the SR-91 mainline - to refine the 2009 ADL report recommendations and to attempt to delineate the Caltrans Soil Classification "Y1" zones, and
3) Perform lead contamination investigation in yellow traffic striping.

This addendum report presents the details of the above investigation, testing, results, and recommendations.

2.0 FIELD INVESTIGATION AND LABORATORY TESTING

2.1 Soil Sampling

The field investigation, accomplished between January 27, 2011 and May 16, 2011, included excavating twenty-seven (27) shallow borings to collect near-surface samples of on-site soils specifically for ADL testing. The approximate locations of the borings are shown on the attached boring location plans (Figures 2 to 9). Borings were excavated to a depth up to 4 feet below existing grade. Soil samples were collected at depths of about 0.5 ft, 1.5 ft, 3 ft, and 4 ft below existing grade and denoted by a symbol "L". A total of 108 soil samples were collected.

2.2 Laboratory Analysis

Soil samples collected from the field investigation were forwarded to Alpha Scientific Corporation (ASC) of Cerritos, California, a California Certified Analytical Laboratory. The types of tests performed included Total Threshold Limit Concentration (TTLC), Soluble Threshold Limit Concentration (SLTC) using Waste Extraction Test (Wet Citric) and WET – Deionized Water (DI-WET) as the leaching compound, soluble lead using Toxicity Characteristic Leaching Procedure (TCLP), and pH.

A summary of test results is presented in Table 1 as well as the boring location plans (Figures 2 to 9). To facilitate review, the 2009 ADL test results are also included on the boring location plans. Copies of the original laboratory test results, along with the chain-of-custody forms, are presented in Appendix C.

2.3 Investigation for Yellow Traffic Stripes

EMI also conducted testing of lead concentration in yellow traffic stripes located within the project limit. The purpose of this testing was to evaluate the lead concentrations in the traffic stripe yellow paint since it may be removed from the underlying asphalt concrete by grinding or sand blasting, which would create a paint waste stream. Specimens of the yellow traffic stripe paint were sampled by EMI on January 26, 2011 and May 16, 2011 from the following ramps: State College Boulevard, Raymond Avenue, Harbor Boulevard, Euclid Street, and Brookhurst Street. There were no yellow pavement markings and no specimen of pavement markings was sampled as part of this project.

These five paint samples were forwarded to ASC of Cerritos, California. The types of tests performed included TTLC and SLTC using Wet Citric. Copies of the original laboratory test results along with the chain-of-custody form are included at the end of the Appendix C.

3.0 CONCLUSIONS AND RECOMMENDATIONS

3.1 Caltrans Aerially Deposited Lead Soil Management

The following table lists the Caltrans Aerially Deposited Lead Soil Management (2007) following the DTSC Variance.

SOLUBLE LEAD (mg/l)	TOTAL LEAD (mg/kg)	SOIL TYPE	HANDLING
California Testing			
STLC < 5.0	TTLC < 1000	X	Non-hazardous. Notify and require Lead Compliance Plan for worker safety.
	1000 ≤ TTLC <1411 & DI WET < 1.5 mg/l	Y1	Hazardous Variance applies – cover with minimum 1 foot of clean soil*.
	1411 ≤ TTLC < 3397 & DI WET < 150 mg/l	Y2	Hazardous Variance applies – cover with pavement structure*.
	1000 ≤ TTLC < 3397 but Surplus	Z2	Surplus - Hazardous Dispose at Class 1 disposal site.
	3397 ≤ TTLC or 1000 ≤ TTLC < 3397 and DI WET > 150 mg/l	Z2	Hazardous – not reusable under Variance. Dispose at Class 1 disposal site.
STLC > 5.0	TTLC < 1411 & DI WET < 1.5 mg/l	Y1	Hazardous Variance applies – cover with minimum of 1 foot of clean soil*.
	1411 ≤ TTLC < 3397 & DI WET < 150 mg/l	Y2	Hazardous Variance applies – cover with pavement structure*.
	TTLC < 3397 & DI WET < 150 mg/l but Surplus	Z2	Surplus – Hazardous Dispose at Class 1 disposal site.
	3397 ≤ TTLC or DI WET > 150 mg/l	Z2	Hazardous – not reusable under Variance Dispose at Class 1 disposal site.
Federal Testing TCLP > 5.0 mg/l	N/A	Z3	RCRA Hazardous Waste Dispose at Class 1 disposal site as a RCRA waste regardless of TTLC and STLC results.
*Note: For hazardous waste levels of lead – if pH is less than 5.5 soil must be placed under a pavement structure. If pH is less than 5.0 variance cannot be used and the soil must be disposed as Z-2 material.			

3.2 Conclusions

Based on our assessment of all the laboratory test results, the TTLC, TCLP, DI-WET and pH criteria from the Caltrans Aerially Deposited Lead Soil Management table do not govern handling of the onsite soils because:

- TTLC test results are all less than 1000 mg/kg,
- TLCP test results are all less than 5.0 mg/l,
- DI-WET test results are all less than 1.5 mg/l, and
- pH test results are all greater than 5.5.

Only the STLC test results will affect the handling procedure of the onsite soils.

After comparing all the test results and the Caltrans Aerially Deposited Lead Soil Management table, the project site was grouped into: (1) SR-91 mainline and (2) all the ramps. This is a logical division because statistically we believe the level of lead exposure will be similar in each of the two areas.

3.3 SR-91 Mainline Portion

In order to refine the limits of the "Y1" classification areas, the SR-91 mainline portion was divided into five regions:

- Region I – Between Sta. 102+00 (west project limit) and Sta. 136+00 (SR-91 Line): contains the samples collected between Borings ADL-3 and ADL-8,
- Region II – Between Sta. 136+00 and Sta. 157+50 (SR-91 Line): contains the samples collected between Borings ADL-9 and ADL-15,
- Region III – Between Sta. 157+50 and Sta. 275+00 (SR-91 Line): contains the samples collected between Borings L-6 and ADL-33; Borings ADL-26, -27, and -28 were omitted from the analyses because they are located in an area where no project improvements are proposed,
- Region IV – Between Sta. 275+00 and Sta. 321+75 (SR-91 Line): contains the samples collected between Borings ADL-34 and ADL-46, and
- Region V – Between Sta. 321+75 and Sta. 342+00 (SR-91 Line) (east project limit): contains the samples collected between Borings L-18 and ADL-48.

The statistical calculations performed for the above regions are included in Appendix D and the results are summarized below.

3.3.1 Region I - Between Sta. 102+00 and Sta. 136+00 (SR-91 Line)

As shown in Figure 10, a correlation coefficient of 0.947 was obtained in the regression analysis between TTLC and STLC. This indicates that the 95% UCL (Upper Confidence Limit) for TTLC can be correlated to the 95% UCL for STLC. Results of the statistical analyses and the projected STLC based on 95% UCL TTLC are tabulated below.

Depth Interval (ft)	TTLC			STLC		WET-DI		TCLP		UCL		
	No.	Mean (mg/kg)	SD (mg/kg)	No.	Mean (mg/l)	No.	Mean (mg/l)	No.	Mean (mg/l)	95% UCL TTLC (mg/kg)	Distribution	Proj. STLC (mg/l)
0.0-4.0	29	22.8	18.1	4	3.9	2	0.056	2	0.26	30.92	Gamma	2.4

Based on the above 95% UCL of TTLC and the projected STLC, soils in Region I are considered as Soil Type "X", which is non-hazardous. There is no special requirement for on-site reuse and off-site disposal.

3.3.2 Region II - Between Sta. 136+00 and Sta. 157+50 (SR-91 Line)

There were 7 borings drilled in this region and a total of 29 samples were tested. All of the test results for TTLC and STLC indicate the soils are well below the "Y1" Classification threshold. The maximum TTLC is 100 mg/kg and the average TTLC is 30.7 mg/kg; the maximum STLC is 0.5 mg/l and the average STLC is 0.2 mg/l. Therefore, soils in Region II are considered as Soil Type "X", which is non-hazardous. There is no special requirement for on-site reuse and off-site disposal.

3.3.3 Region III - Between Sta. 157+50 and Sta. 275+00 (SR-91 Line)

As shown in Figure 11, a correlation coefficient of 0.9 was obtained in the regression analysis between TTLC and STLC. This indicates that the 95% UCL for TTLC can be correlated to the 95% UCL for STLC. Results of the statistical analyses and the projected STLC based on 95% UCL TTLC are tabulated below.

Depth Interval (ft)	TTLC			STLC		WET-DI		TCLP		UCL		
	No.	Mean (mg/kg)	SD (mg/kg)	No.	Mean (mg/l)	No.	Mean (mg/l)	No.	Mean (mg/l)	95% UCL TTLC (mg/kg)	Distribution	Proj. STLC (mg/l)
0.0-4.0	43	32.0	26.0	9	4.9	6	0.2	7	0.177	40.23	Gamma	1.7

Based on the above 95% UCL of TTLC and the projected STLC, soils in Region III are considered as Soil Type "X", which is non-hazardous. There is no special requirement for on-site reuse and off-site disposal.

3.3.4 Region IV - Between Sta. 275+00 and Sta. 321+75 (SR-91 Line)

A regression analysis was attempted to correlate the TTLC and STLC results. However, the calculated correlation coefficient, R, is less than 0.8, a reference limit indicating a non-linear relationship between data sets. According to Caltrans ADL Guidance (2007), this invalidates any prediction of STLC concentration using the 95% UCL TTLC value in a regression analysis.

There were 12 borings drilled in this region and a total of 50 samples were tested. The mean values are tabulated below:

Depth Interval (ft)	TTLC			STLC		WET-DI		TCLP	
	No.	Mean (mg/kg)	SD (mg/kg)	No.	Mean (mg/l)	No.	Mean (mg/l)	No.	Mean (mg/l)
0.0-4.0	50	35.5	43.3	13	5.9	8	0.13	9	0.29

Since the mean WET-citric soluble lead concentrations exceed the STLC of 5.0 mg/l, soils in Region IV can be subjected to the restrictions as stated in the DTSC Variance as Soil Type "Y1". If the above soils are elected to be disposed offsite, they should be classified as Soil Type "Z2" (hazardous waste).

Since a regression analysis cannot be used to correlate the TTLC and STLC results, the "block-diagram" approach as described in the Caltrans ADL Guidance (2007) cannot be implemented to delineate the vertical extent of the "Y1" soils. Therefore, we also recommend classifying the upper 4 feet of onsite soils within this region as Soil Type "Y1"; the 4-foot depth is the maximum depth explored in this study.

After the above conclusions were reached, there were discussions between the Project Team and Caltrans Environmental Engineering Branch. Based on these discussions, Caltrans issued a Memorandum, dated November 3, 2011, indicating that the soil within Region IV can be classified as Soil Type "X". A copy of this Caltrans Memorandum is included in Appendix F.

3.3.5 Region V – Between Sta. 321+75 and Sta. 342+00 (SR-91 Line)

As shown in Figure 12, a correlation coefficient of 0.992 was obtained in the regression analysis between TTLC and STLC. This indicates that the 95% UCL for TTLC can be correlated to the 95% UCL for STLC. Results of the statistical analyses and the projected STLC based on 95% UCL TTLC are tabulated below.

Depth Interval (ft)	TTLC			STLC		WET-DI		TCLP		UCL		
	No.	Mean (mg/kg)	SD (mg/kg)	No.	Mean (mg/l)	No.	Mean (mg/l)	No.	Mean (mg/l)	95% UCL TTLC (mg/kg)	Distribution	Proj. STLC (mg/l)
0.0-4.0	21	18.0	13.5	3	1.9	0	-	1	0.22	24.25	Gamma	1.4

Based on the above 95% UCL of TTLC and the projected STLC, soils in Region V are considered as Soil Type "X", which is non-hazardous. There is no special requirement for on-site reuse and off-site disposal.

3.4 Ramps

As shown in Figure 13, a correlation coefficient of 0.877 was obtained in the regression analysis between TTLC and STLC. This indicates that the 95% UCL for TTLC can be correlated to the 95% UCL for STLC. Results of the statistical analyses and the projected STLC based on 95% UCL TTLC are tabulated below.

Depth Interval (ft)	TTLC			STLC		WET-DI		TCLP		UCL		
	No.	Mean (mg/kg)	SD (mg/kg)	No.	Mean (mg/l)	No.	Mean (mg/l)	No.	Mean (mg/l)	95% UCL TTLC (mg/kg)	Distribution	Proj. STLC (mg/l)
0.0-4.0	92	21.2	29.9	16	4.1	10	0.24	10	0.15	40.6	Chebyshev	1.6

Based on the above 95% UCL of TTLC and the projected STLC, soils located at the ramps are considered as Soil Type "X", which is non-hazardous. There is no special requirement for on-site reuse and off-site disposal.

3.5 Recommendations

Based on the analytical results and the Caltrans Memorandum, dated November 3, 2011, soils within the project limit, including the ramps, are considered as Soil Type "X" per Caltrans Aerially Deposited Lead Soil Management. For soils classified as Soil Type "X", there is no special requirement for on-site reuse and off-site disposal.

Contractors excavating, transporting, or stockpiling soil should prepare a Lead Compliance Plan in accordance with the Caltrans Code of Safety Practices, California Code of Regulations and Cal-OSHA standards addressing the presence of ADL in the soils within the project area. A Lead content testing results contained herein should be given to contractors handling the soils during construction.

3.6 Conclusion and Recommendations for Yellow Traffic Stripe Paint Analyses

Caltrans SSP states that waste residue from removal of yellow painted traffic stripe and pavement marking is a non-hazardous waste, if it contains lead in average concentrations less than 1000 mg/kg total lead and 5 mg/l soluble lead. The laboratory test results on yellow traffic stripe paint samples are tabulated below.

Sample ID	Lab ID	Sample Description	Ramp Location	TTLC (mg/kg)	STLC (mg/l)
L-S-1	EA101134-1	Yellow Traffic Striping on Asphalt	SR-91, State College Boulevard	61.0	0.96
L-R-1	EA101134-2		SR-91, Raymond Avenue	401	2.2
L-E-1	EA101134-3		SR-91, Euclid Street	516	2.8
L-B-1	EA101134-4		SR-91, Brookhurst Street	12.3	0.1
L-1-1	EA105069-17		SR-91, Harbor Boulevard	98.4	1.0

Based on the results, the highest reported concentration of total lead for the yellow stripe paint samples is 516 mg/kg, less than the TTLC value for lead of 1,000 mg/kg, and the highest reported concentration of soluble lead for the yellow stripe paint samples is 2.8 mg/l, less than the STLC value for soluble lead of 5 mg/l. Therefore, the waste residue from removal of painted yellow traffic stripes at the subject project site is considered as a non-hazardous waste residue. RBF should incorporate the above results and recommendations in the preparation of the SSP for proper handling of yellow traffic stripes and pavement markings into the PS&E package.

4.0 LIMITATIONS

This report is intended for use by RBF Consulting, the Orange County Transportation Authority, and the California Department of Transportation for the proposed SR-91 Westbound Widening Project between State College Boulevard and Brookhurst Street. This report is only relevant as of the date of the latest site visit and is only valid as of the date of the report, and will require an update if additional information is obtained.

The conclusions and recommendations presented herein are based on a limited number of samples collected from in-place soil and widely spaced locations.

Data, opinions, and recommendations herein have no applicability to any other design elements or to any other locations, and any and all subsequent users accept any and all liability resulting from any use or reuse of the data, opinions, and recommendations without the prior written consent of EMI.

Services performed by EMI were conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, expressed or implied, and no warranty or guarantee is included or intended.

5.0 REFERENCES

California Department of Transportation (Caltrans), 2007, Aerially Deposited Lead Guidance, June.

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United States Environmental Protection Agency (EPA); 2007, ProUCL Version 4.00.02 User Guide and Technical Guide, April.

EPA, 1986, Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods, EPA Document SW-846; September.

Leighton Consulting, Inc., 2009, Aerially Deposited Lead (ADL) Investigation Report, SR-91 Westbound Widening Project, Cities of Anaheim and Fullerton, Orange County, California, Prepared for OCTA, Leighton Project No. 602097-002, June 23.

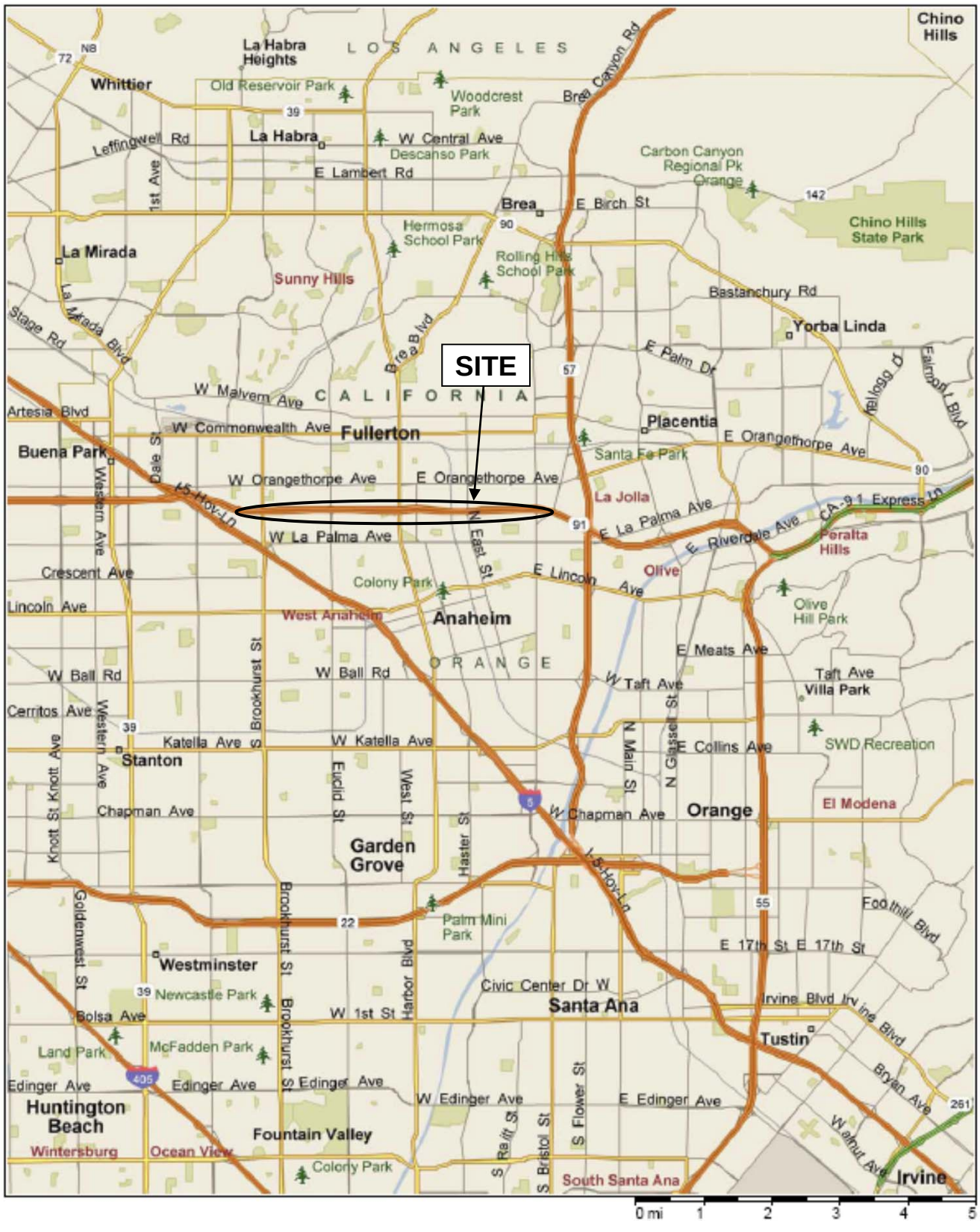
TABLES

Table 1. Summary of Analytical Soil Test Results using EMI Borings (1 of 3)								
Sample ID	Latitude (Deg, Min, Sec)	Longitude (Deg, Min, Sec)	Sample Depth (ft)	Total Lead (mg/kg)	Wet-Citric (mg/l)	DI-WET (mg/l)	TCLP (mg/l)	pH
L-1-1	33° 51' 15.72178"N	117° 57' 36.36472"W	0.5	30.1				
L-1-2			1.5	28.6				
L-1-3			3.0	5.6				
L-1-4			4.0	5.1				
L-2-1	33° 51' 16.61631"N	117° 57' 32.21231"W	0.5	24.6				
L-2-2			1.5	51.3	3.2	0.19	0.1	6.92
L-2-3			3.0	58.9	1.1	0.1	0.1	6.75
L-2-4			4.0	17				
L-3-1	33° 51' 15.56407"N	117° 57' 29.98837"W	0.5	10.6				
L-3-2			1.5	8.8				
L-3-3			3.0	5.3				
L-3-4			4.0	4				
L-4-1	33° 51' 15.82162"N	117° 57' 26.72916"W	0.5	50.8	2.7	0.2	0.17	7.12
L-4-2			1.5	12.4				
L-4-3			3.0	5.4				
L-4-4			4.0	6.7				
L-5-1	33° 51' 15.51440"N	117° 57' 12.73157"W	0.5	7.2				
L-5-2			1.5	9.1	0.15			
L-5-3			3.0	3				
L-5-4			4.0	39.4	1.9			
L-6-1	33° 51' 15.84092"N	117° 56' 44.60498"W	0.5	65.5	3	0.2	0.1	6.54
L-6-2			1.5	100	8.3	0.41	0.15	7.26
L-6-3			3.0	65.3	5.4	0.27	0.1	7.24
L-6-4			4.0	4.7				
L-7-1	33° 51' 16.76218"N	117° 56' 36.28063"W	0.5	38.5				
L-7-2			1.5	7.8				
L-7-3			3.0	5.6				
L-7-4			4.0	4.3				
L-8-1	33° 51' 15.58337"N	117° 56' 35.51943"W	0.5	43.5	2.5			
L-8-2			1.5	27.1				
L-8-3			3.0	33.8				
L-8-4			4.0	95	8	0.24	0.27	7.48
L-9-1	33° 51' 17.27133"N	117° 56' 29.32443"W	0.5	21.7				
L-9-2			1.5	6.4				
L-9-3			3.0	5.1				
L-9-4			4.0	5.2				
L-10-1	33° 51' 15.82944"N	117° 56' 24.87220"W	0.5	57.2	3.7	0.15	0.1	7.42
L-10-2			1.5	5.4				
L-10-3			3.0	2				
L-10-4			4.0	2.1				

Table 1. Summary of Analytical Soil Test Results using EMI Borings (2 of 3)								
Sample ID	Latitude (Deg, Min, Sec)	Longitude (Deg, Min, Sec)	Depth (ft)	Total Lead (mg/kg)	Wet-Citric (mg/l)	DI-WET (mg/l)	TCLP (mg/l)	pH
L-11-1	33° 51' 15.21801"N	117° 54' 30.61044"W	0.5	5.4				
L-11-2			1.5	3				
L-11-3			3.0	3				
L-11-4			4.0	4				
L-12-1	33° 51' 15.84809"N	117° 54' 27.61467"W	0.5	29.3				
L-12-2			1.5	29.4				
L-12-3			3.0	31.5				
L-12-4			4.0	36				
L-13-1	33° 51' 14.65837"N	117° 54' 25.81420"W	0.5	10.6	0.42			
L-13-2			1.5	10.9				
L-13-3			3.0	10.3				
L-13-4			4.0	14.8				
L-14-1	33° 51' 14.58938"N	117° 54' 23.11543"W	0.5	50.9	1.8	0.1	0.1	7.23
L-14-2			1.5	46.9	3.3			
L-14-3			3.0	44.6				
L-14-4			4.0	27.2				
L-15-1	33° 51' 15.79326"N	117° 54' 21.53747"W	0.5	2.2				
L-15-2			1.5	6.1				
L-15-3			3.0	2				
L-15-4			4.0	2				
L-16-1	33° 51' 15.33516"N	117° 54' 19.33611"W	0.5	5.1				
L-16-2			1.5	9.3				
L-16-3			3.0	2				
L-16-4			4.0	4.3				
L-17-1	33° 51' 14.88914"N	117° 54' 12.89544"W	0.5	10.7				
L-17-2			1.5	20				
L-17-3			3.0	179	15.5	0.63	0.39	6.94
L-17-4			4.0	6				
L-18-1	33° 51' 16.06843"N	117° 53' 32.28844"W	0.5	16.9				
L-18-2			1.5	3.4				
L-18-3			3.0	19.6				
L-18-4			4.0	12.6				
L-19-1	33° 51' 16.56024"N	117° 53' 27.27614"W	0.5	7.7				
L-19-2			1.5	6.1				
L-19-3			3.0	2.7				
L-19-4			4.0	15.8				
L-20-1	33° 51' 15.87918"N	117° 53' 23.07578"W	0.5	9.9				
L-20-2			1.5	17.5				
L-20-3			3.0	37.9	1.7			
L-20-4			4.0	27.2				

Table 1. Summary of Analytical Soil Test Results using EMI Borings (3 of 3)								
Sample ID	Latitude (Deg, Min, Sec)	Longitude (Deg, Min, Sec)	Depth (ft)	Total Lead (mg/kg)	Wet-Citric (mg/l)	DI-WET (mg/l)	TCLP (mg/l)	pH
L-21-1	33° 51' 15.92739"N	117° 53' 19.90587"W	0.5	4.6				
L-21-2			1.5	5.9				
L-21-3			3.0	24.9	1.4			
L-21-4			4.0	4.9				
L-22-1	33° 51' 17.44463"N	117° 53' 20.23785"W	0.5	20.4				
L-22-2			1.5	2				
L-22-3			3.0	2				
L-22-4			4.0	2				
L-23-1	33° 51' 16.82083"N	117° 53' 17.82190"W	0.5	43.2	1.9			
L-23-2			1.5	29.1				
L-23-3			3.0	85.2	1.5	0.14	0.1	7.11
L-23-4			4.0	32.6				
L-24-1	33° 51' 15.4800"N	117° 55' 48.0100"W	0.5	40.3				
L-24-2			1.5	140	6.5	0.1	0.23	7.83
L-24-3			3.0	75.4	3.1			
L-24-4			4.0	65.8	4.3			
L-25-1	33° 51' 15.0800"N	117° 55' 42.3800"W	0.5	55.3	2.8			7.3
L-25-2			1.5	6.5				
L-25-3			3.0	2				
L-25-4			4.0	2				
L-26-1	33° 51' 15.0100"N	117° 55' 36.5900"W	0.5	7.9				
L-26-2			1.5	4.3				
L-26-3			3.0	3.3				
L-26-4			4.0	2				
L-27-1	33° 51' 15.5400"N	117° 55' 30.6000"W	0.5	18.5				
L-27-2			1.5	13.6				
L-27-3			3.0	6.4				
L-27-4			4.0	3.8				7.29

FIGURES



SR-91 Westbound Widening Project

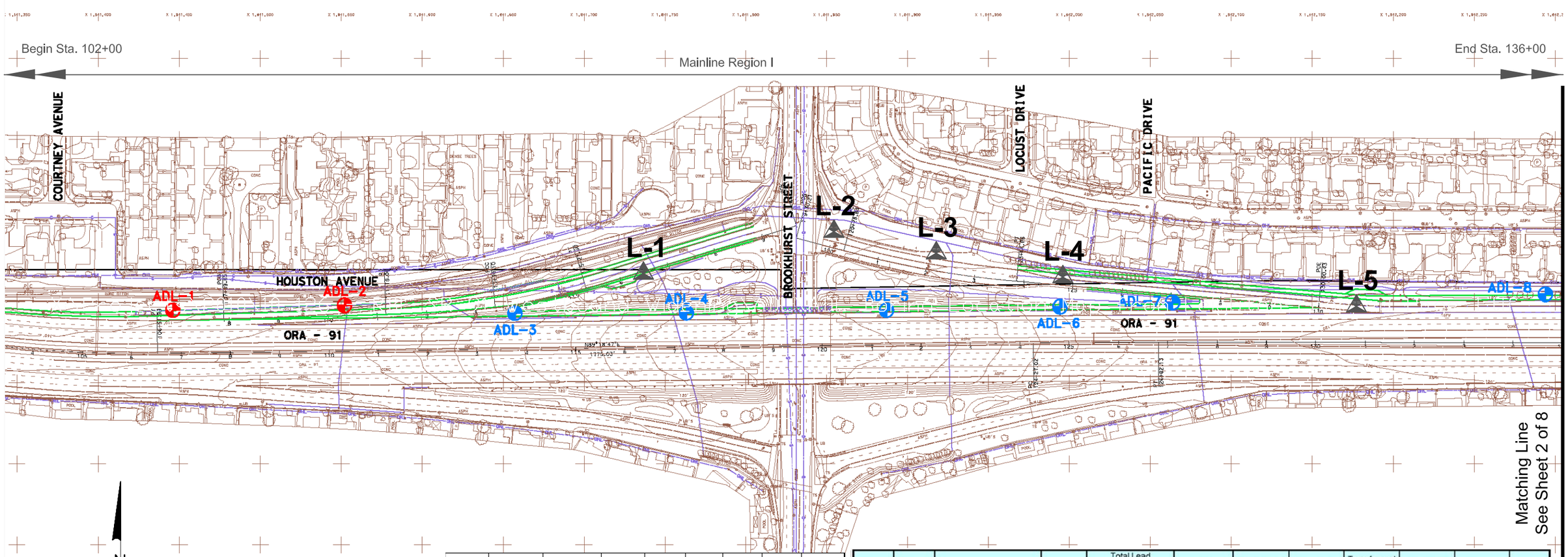
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

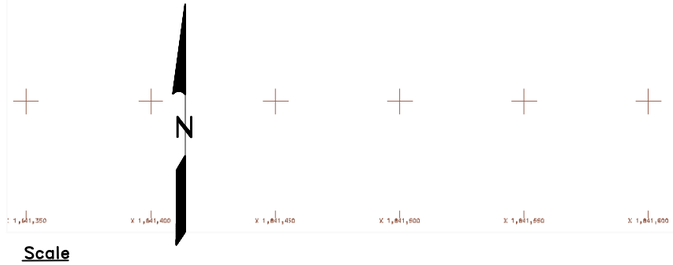
SITE LOCATION MAP

Figure 1

Project No. 10-126

Date: 03-04-11





LEGEND

ADL-48 — LOCATION OF COMPLETED LEIGHTON'S ADL BORINGS (2009)

ADL-1 — LOCATION OF PROPOSED LEIGHTON'S ADL BORINGS LOCATED IN AREAS OF ASPHALT OR CONCRETE (SOIL SAMPLES WERE NOT COLLECTED) (2009)

L-1 — LOCATION OF COMPLETED EMI'S ADL BORINGS (2011)

Sample ID	Latitude (Deg, Min, Sec)	Longitude (Deg, Min, Sec)	Sample Depth (ft)	Total Lead (mg/kg)	Wet-Citric (mg/l)	DI-WET (mg/l)	TCLP (mg/l)	pH
L-1-1	33° 51' 15.72178"N	117° 57' 36.36472"W	0.5	30.1				
L-1-2			1.5	28.6				
L-1-3			3.0	5.6				
L-1-4			4.0	5.1				
L-2-1	33° 51' 16.61631"N	117° 57' 32.21231"W	0.5	24.6				
L-2-2			1.5	51.3	3.2	0.19	0.1	6.92
L-2-3			3.0	58.9	1.1	0.1	0.1	6.75
L-2-4			4.0	17				
L-3-1	33° 51' 15.56407"N	117° 57' 29.98837"W	0.5	10.6				
L-3-2			1.5	8.8				
L-3-3			3.0	5.3				
L-3-4			4.0	4				
L-4-1	33° 51' 15.82162"N	117° 57' 26.72916"W	0.5	50.8	2.7	0.2	0.17	7.12
L-4-2			1.5	12.4				
L-4-3			3.0	5.4				
L-4-4			4.0	6.7				
L-5-1	33° 51' 15.51440"N	117° 57' 12.73157"W	0.5	7.2				
L-5-2			1.5	9.1	0.15			
L-5-3			3.0	3				
L-5-4			4.0	39.4	1.9			

Boring Number	Sample Depth (feet bgs)	Sample Number	Sample Date	Total Lead (mg/kg) Reported Value	Total Lead (mg/kg) Value Used	ln(x) Transformed TTLC Data	STLC WET Citric Acid (mg/L)	Normalized STLC WET Citric Acid	Transformed STLC WET Citric Acid Data	STLC WET Deionized Water (mg/L)	TCLP (mg/L)	pH
ADL-3	0.5	09-015-S-BFM-60	01/15/09	**24**	**24**	3.18	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-61	01/15/09	**27**	**27**	3.30	NR	N/A	NR	NR	NR	**8.96**
	3	09-015-S-BFM-62	01/15/09	**29**	**29**	3.37	NR	N/A	NR	NR	NR	NA
	4	09-015-S-BFM-63	01/15/09	**70**	**70**	4.25	**7.4**	**0.57**	**0.61**	0.10	**0.40**	NA
ADL-4	0.5	09-016-S-BFM-24	01/16/09	**44**	**41**	3.71	NR	N/A	NR	NR	NR	NA
		09-016-S-BFM-25	01/16/09	**38**			NR	N/A	NR	NR	NR	NA
	1.5	09-016-S-BFM-26	01/16/09	**30**	**30**	3.40	NR	N/A	NR	NR	NR	NA
	3	09-016-S-BFM-27	01/16/09	**39**	**39**	3.66	NR	N/A	NR	NR	NR	NA
	4	09-016-S-BFM-28	01/16/09	**34**	**34**	3.53	NR	N/A	NR	NR	NR	NA
ADL-5	0.5	09-016-S-BFM-20	01/16/09	**22**	**22**	3.09	NR	N/A	NR	NR	NR	NA
	1.5	09-016-S-BFM-21	01/16/09	**9.6**	**9.6**	2.26	NR	N/A	NR	NR	NR	NA
	3	09-016-S-BFM-22	01/16/09	**47**	**47**	3.85	NR	N/A	NR	NR	NR	**8.66**
	4	09-016-S-BFM-23	01/16/09	**34**	**34**	3.53	NR	N/A	NR	NR	NR	NA
ADL-6	0.5	09-015-S-BFM-56	01/15/09	**4.5**	**4.5**	1.50	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-57	01/15/09	**12**	**12**	2.48	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-58	01/15/09	**10**	**10**	2.30	NA	NA	NA	NA	NA	NA
	4	09-015-S-BFM-59	01/15/09	**13**	**13**	2.56	NA	NA	NA	NA	NA	NA
ADL-7	0.5	09-015-S-BFM-51	01/15/09	**14**	**14**	2.64	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-52	01/15/09	**2.0**	**2.0**	0.69	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-53	01/15/09	**2.0**	**2.0**	0.69	NR	N/A	NR	NR	NR	NA
	4	09-015-S-BFM-54	01/15/09	**3.3**	**3.1**	1.13	NR	N/A	NR	NR	NR	NA
		09-015-S-BFM-55	01/15/09	**2.9**			NR	N/A	NR	NR	NR	NA
ADL-8	0.5	09-015-S-BFM-48	01/15/09	**5.0**	**5.0**	1.61	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-49	01/15/09	**31**	**31**	3.43	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-50	01/15/09	**54**	**54**	3.99	**6.3**	**0.48**	**0.51**	0.013	**0.12**	**7.91**
	4	Refusal at 3 feet bgs, no sample collected										

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Boring Location Plan
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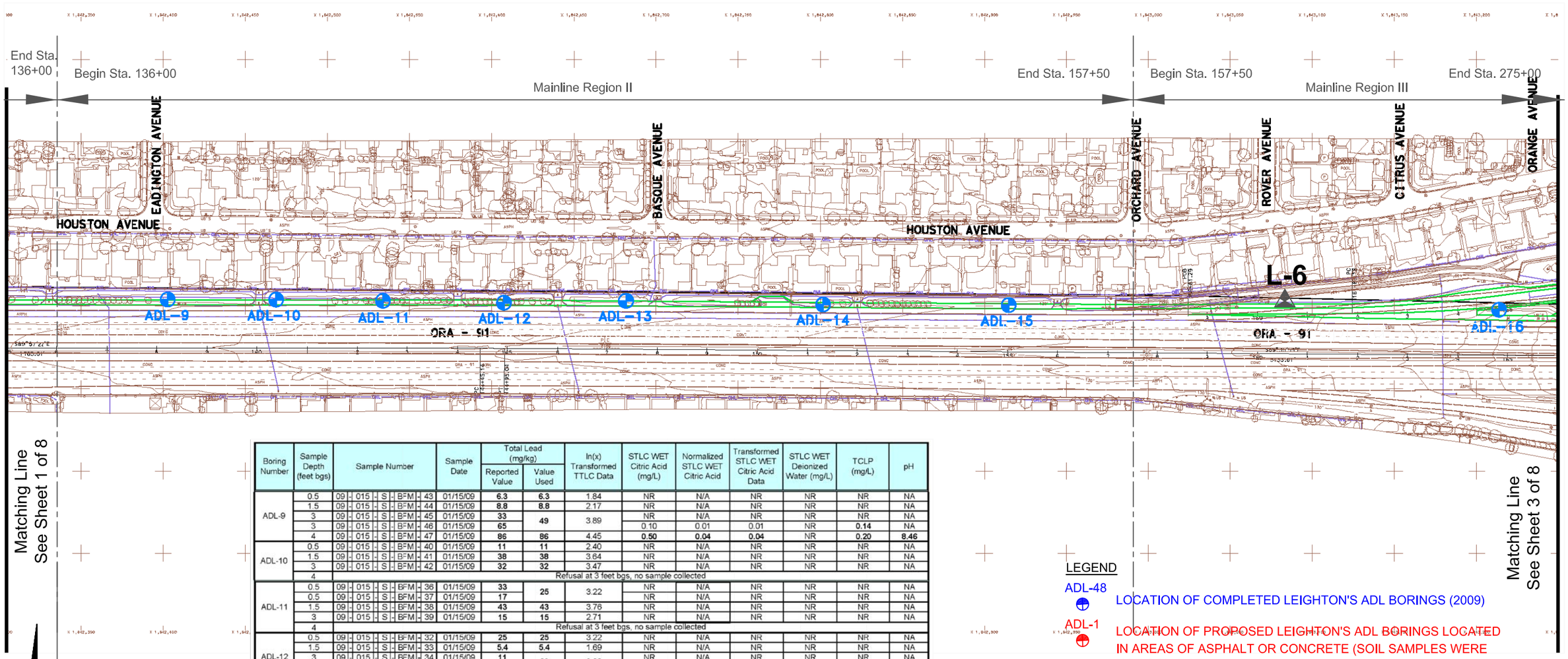
Figure 2



Matching Line
See Sheet 1 of 8

Matching Line
See Sheet 3 of 8

N

Scale
0 200 400 ft

Boring Number	Sample Depth (feet bgs)	Sample Number	Sample Date	Total Lead (mg/kg) Reported Value	Total Lead (mg/kg) Value Used	ln(x) Transformed TTLC Data	STLC WET Citric Acid (mg/L)	Normalized STLC WET Citric Acid	Transformed STLC WET Citric Acid Data	STLC WET Deionized Water (mg/L)	TCLP (mg/L)	pH
ADL-9	0.5	09-015-S-BFM-43	01/15/09	**6.3**	**6.3**	1.84	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-44	01/15/09	**8.8**	**8.8**	2.17	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-45	01/15/09	**33**	**49**	3.89	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-46	01/15/09	**65**			0.10	0.01	0.01	NR	**0.14**	NA
	4	09-015-S-BFM-47	01/15/09	**86**	**86**	4.45	**0.50**	**0.04**	**0.04**	NR	**0.20**	**8.46**
ADL-10	0.5	09-015-S-BFM-40	01/15/09	**11**	**11**	2.40	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-41	01/15/09	**38**	**38**	3.64	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-42	01/15/09	**32**	**32**	3.47	NR	N/A	NR	NR	NR	NA
	4	Refusal at 3 feet bgs, no sample collected										
ADL-11	0.5	09-015-S-BFM-36	01/15/09	**33**	**25**	3.22	NR	N/A	NR	NR	NR	NA
	0.5	09-015-S-BFM-37	01/15/09	**17**			NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-38	01/15/09	**43**	**43**	3.76	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-39	01/15/09	**15**	**15**	2.71	NR	N/A	NR	NR	NR	NA
	4	Refusal at 3 feet bgs, no sample collected										
ADL-12	0.5	09-015-S-BFM-32	01/15/09	**25**	**25**	3.22	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-33	01/15/09	**5.4**	**5.4**	1.69	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-34	01/15/09	**11**	**20**	3.00	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-35	01/15/09	**29**			NR	N/A	NR	NR	NR	NA
	4	Refusal at 3 feet bgs, no sample collected										
ADL-13	0.5	09-015-S-BFM-29	01/15/09	**3.9**	**3.9**	1.36	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-30	01/15/09	**33**	**33**	3.50	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-31	01/15/09	**25**	**25**	3.22	NR	N/A	NR	NR	NR	NA
	4	Refusal at 3 feet bgs, no sample collected										
ADL-14	0.5	09-015-S-BFM-24	01/15/09	**12**	**10.15**	2.32	NR	N/A	NR	NR	NR	NA
	0.5	09-015-S-BFM-25	01/15/09	**8.3**			NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-26	01/15/09	**38**	**38**	3.64	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-27	01/15/09	**20**	**20**	3.00	NR	N/A	NR	NR	NR	NA
	4	09-015-S-BFM-28	01/15/09	**28**	**28**	3.33	NR	N/A	NR	NR	NR	NA
ADL-15	0.5	09-015-S-BFM-19	01/15/09	**49**	**49**	3.89	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-20	01/15/09	**14**	**14**	2.64	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-21	01/15/09	**100**	**86.5**	4.46	0.10	0.01	0.01	NR	0.10	NA
	3	09-015-S-BFM-22	01/15/09	**73**			0.10	0.01	0.01	NR	0.10	NA
	4	09-015-S-BFM-23	01/15/09	**27**	**27**	3.30	NR	N/A	NR	NR	NR	NA
ADL-16	0.5	09-015-S-BFM-14	01/15/09	**38**	**38**	3.64	NR	N/A	NR	NR	NR	NA
	0.5	09-015-S-BFM-15	01/15/09	**38**			NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-16	01/15/09	**34**	**34**	3.53	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-17	01/15/09	**36**	**36**	3.58	NR	N/A	NR	NR	NR	**8.98**
	4	09-015-S-BFM-18	01/15/09	**16**	**16**	2.77	NR	N/A	NR	NR	NR	NA

LEGEND

ADL-48 — LOCATION OF COMPLETED LEIGHTON'S ADL BORINGS (2009)

ADL-1 — LOCATION OF PROPOSED LEIGHTON'S ADL BORINGS LOCATED IN AREAS OF ASPHALT OR CONCRETE (SOIL SAMPLES WERE NOT COLLECTED) (2009)

L-1 — LOCATION OF COMPLETED EMI'S ADL BORINGS (2011)

Sample ID	Latitude (Deg, Min, Sec)	Longitude (Deg, Min, Sec)	Sample Depth (ft)	Total Lead (mg/kg)	Wet-Citric (mg/l)	DI-WET (mg/l)	TCLP (mg/l)	pH
L-6-1	33° 51' 15.84092"N	117° 56' 44.60498"W	0.5	65.5	3	0.2	0.1	6.54
L-6-2			1.5	100	8.3	0.41	0.15	7.26
L-6-3			3.0	65.3	5.4	0.27	0.1	7.24
L-6-4			4.0	4.7				

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Boring Location Plan
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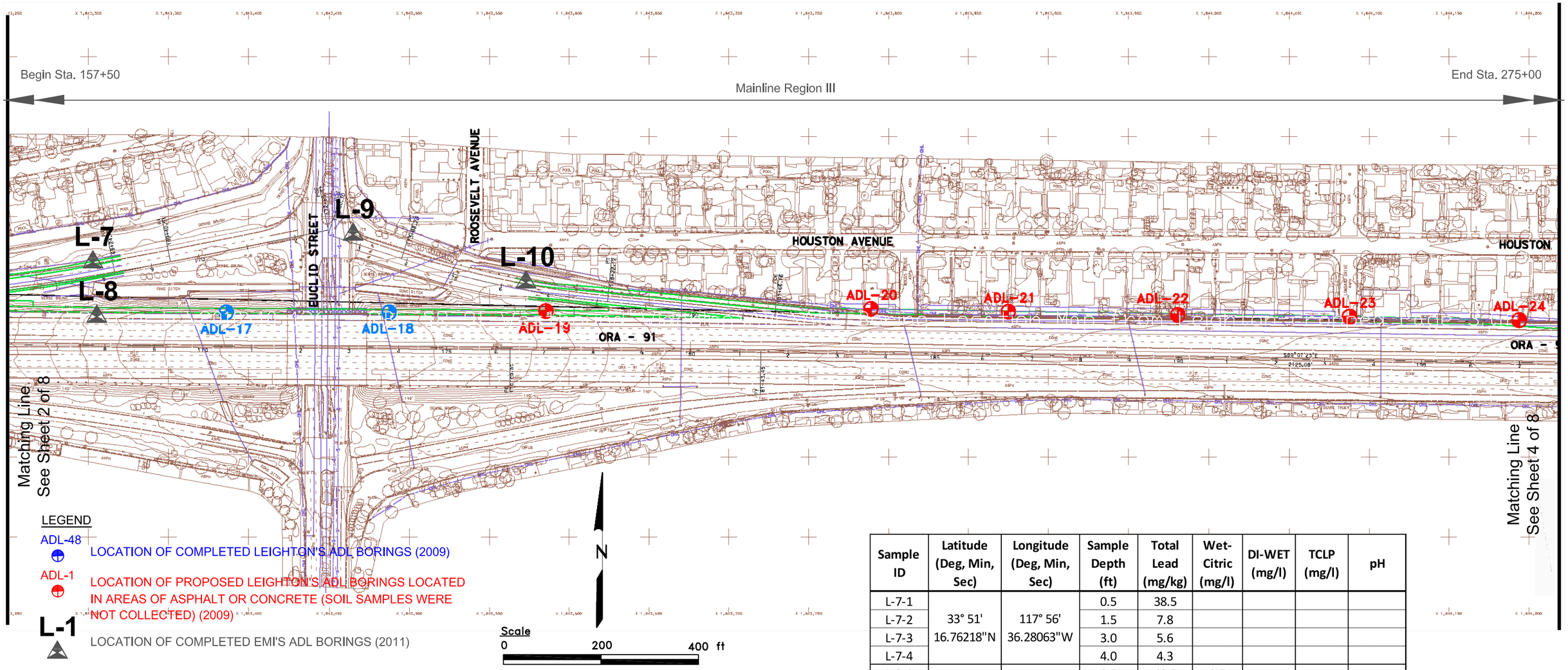
Figure 3



Boring Number	Sample Depth (feet bgs)	Sample Number	Sample Date	Total Lead (mg/kg) Reported Value	Total Lead (mg/kg) Value Used	ln(x) Transformed TTLC Data	STLC WET Citric Acid (mg/L)	Normalized STLC WET Citric Acid	Transformed STLC WET Citric Acid Data	STLC WET Deionized Water (mg/L)	TCLP (mg/L)	pH
ADL-17	0.5	09 - 016 - S - BFM - 15	01/16/09	**87**	**87**	4.47	**5.1**	**0.39**	**0.40**	0.033	**0.26**	NA
	1.5	09 - 016 - S - BFM - 16	01/16/09	**80**	**60.5**	4.10	**5.6**	**0.43**	**0.45**	0.049	**0.20**	NA
	1.5	09 - 016 - S - BFM - 17	01/16/09	**41**			NR	N/A	NR	NR	NR	NA
	3	09 - 016 - S - BFM - 18	01/16/09	**47**	**47**	3.85	NR	N/A	NR	NR	NR	NA
	4	09 - 016 - S - BFM - 19	01/16/09	**57**	**57**	4.04	**2.4**	**0.18**	**0.19**	NR	0.10	NA
ADL-18	0.5	09 - 016 - S - BFM - 10	01/16/09	**20**	**20**	3.00	NR	N/A	NR	NR	NR	NA
	1.5	09 - 016 - S - BFM - 11	01/16/09	**54**	**42.5**	3.75	**3.8**	**0.29**	**0.30**	NR	**0.16**	NA
	1.5	09 - 016 - S - BFM - 12	01/16/09	**31**			NR	N/A	NR	NR	NR	NA
	3	09 - 016 - S - BFM - 13	01/16/09	**49**	**49**	3.89	NR	N/A	NR	NR	NR	NA
	4	09 - 016 - S - BFM - 14	01/16/09	**46**	**46**	3.83	NR	N/A	NR	NR	NR	NA

Sample ID	Latitude (Deg, Min, Sec)	Longitude (Deg, Min, Sec)	Sample Depth (ft)	Total Lead (mg/kg)	Wet-Citric (mg/l)	DI-WET (mg/l)	TCLP (mg/l)	pH
L-7-1	33° 51' 16.76218"N	117° 56' 36.28063"W	0.5	38.5				
L-7-2			1.5	7.8				
L-7-3			3.0	5.6				
L-7-4			4.0	4.3				
L-8-1	33° 51' 15.58337"N	117° 56' 35.51943"W	0.5	43.5	2.5			
L-8-2			1.5	27.1				
L-8-3			3.0	33.8				
L-8-4			4.0	95	8	0.24	0.27	7.48
L-9-1	33° 51' 17.27133"N	117° 56' 29.32443"W	0.5	21.7				
L-9-2			1.5	6.4				
L-9-3			3.0	5.1				
L-9-4			4.0	5.2				
L-10-1	33° 51' 15.82944"N	117° 56' 24.87220"W	0.5	57.2	3.7	0.15	0.1	7.42
L-10-2			1.5	5.4				
L-10-3			3.0	2				
L-10-4			4.0	2.1				

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Boring Location Plan
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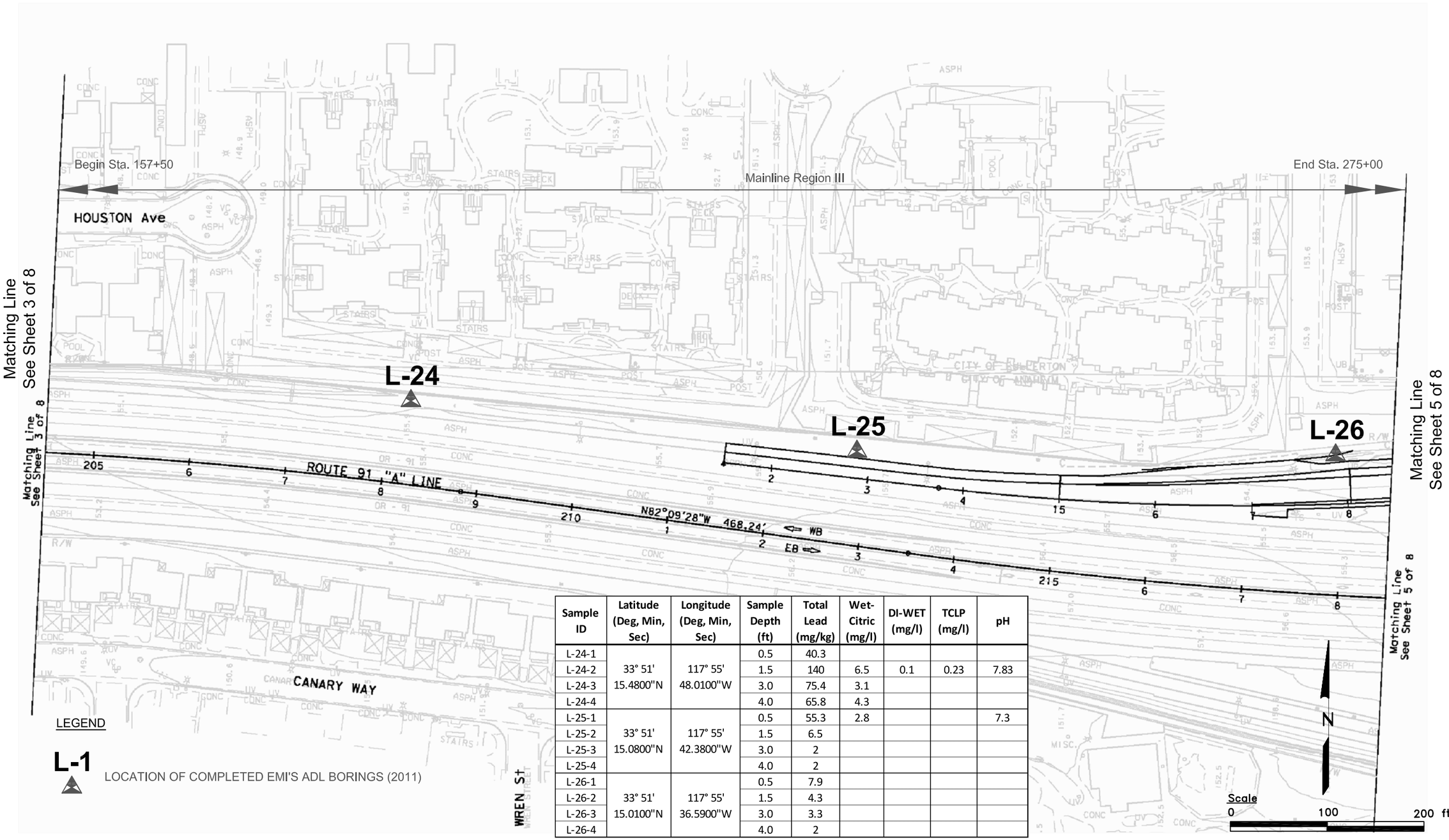
Figure 4



Sample ID	Latitude (Deg, Min, Sec)	Longitude (Deg, Min, Sec)	Sample Depth (ft)	Total Lead (mg/kg)	Wet-Citric (mg/l)	DI-WET (mg/l)	TCLP (mg/l)	pH
L-24-1	33° 51' 15.4800"N	117° 55' 48.0100"W	0.5	40.3				
L-24-2			1.5	140	6.5	0.1	0.23	7.83
L-24-3			3.0	75.4	3.1			
L-24-4			4.0	65.8	4.3			
L-25-1	33° 51' 15.0800"N	117° 55' 42.3800"W	0.5	55.3	2.8			7.3
L-25-2			1.5	6.5				
L-25-3			3.0	2				
L-25-4			4.0	2				
L-26-1	33° 51' 15.0100"N	117° 55' 36.5900"W	0.5	7.9				
L-26-2			1.5	4.3				
L-26-3			3.0	3.3				
L-26-4			4.0	2				

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Boring Location Plan
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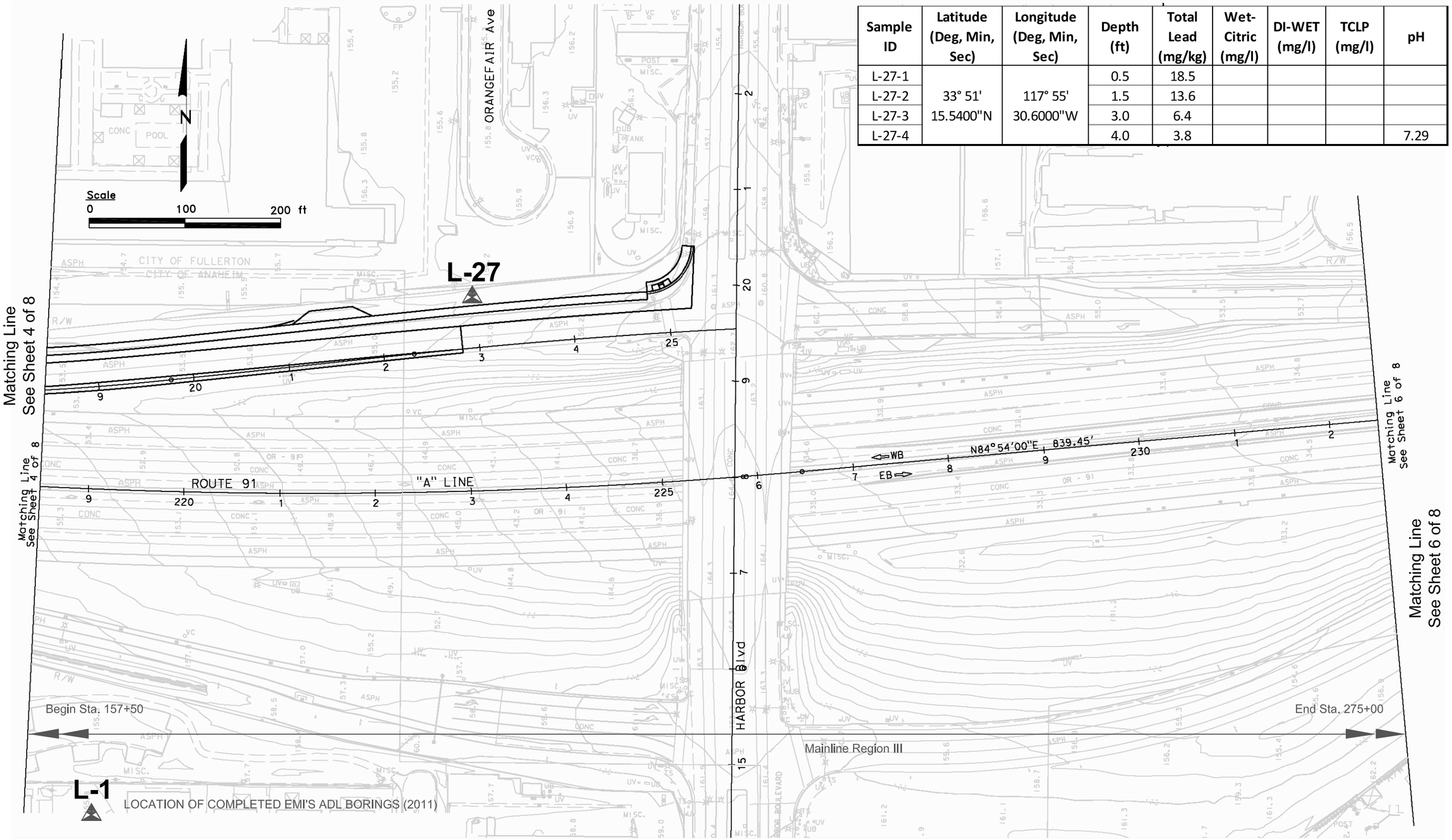
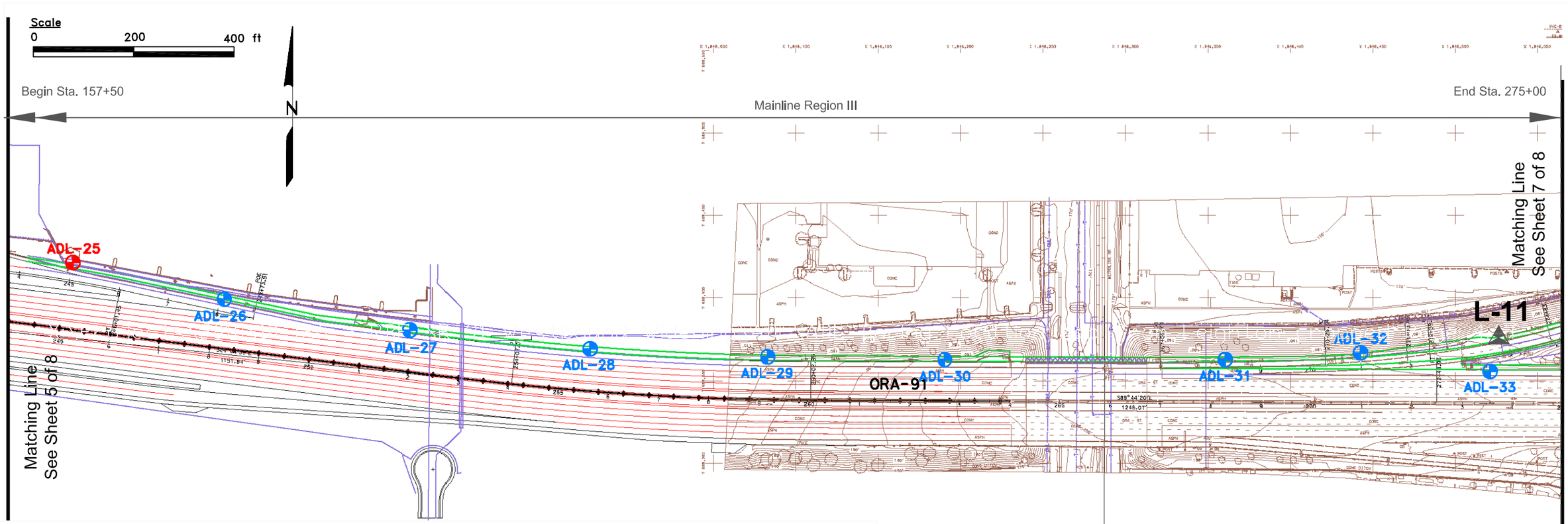
Figure 5

Sample ID	Latitude (Deg, Min, Sec)	Longitude (Deg, Min, Sec)	Depth (ft)	Total Lead (mg/kg)	Wet-Citric (mg/l)	DI-WET (mg/l)	TCLP (mg/l)	pH
L-27-1	33° 51' 15.5400"N	117° 55' 30.6000"W	0.5	18.5				
L-27-2			1.5	13.6				
L-27-3			3.0	6.4				
L-27-4			4.0	3.8				7.29



Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	SR-91 WESTBOUND WIDENING PROJECT		Boring Location Plan Sheet 5 of 8
	EMI Project No. 10-126	Date: 10-25-11	Figure 6

Note: Leighton Borings ADL-26, -27, and -28 were omitted from the analyses because they are located in an area where no project improvements are proposed.



Boring Number	Sample Depth (feet bgs)	Sample Number	Sample Date	Total Lead (mg/kg) Reported Value	Total Lead (mg/kg) Value Used	ln(x) Transformed TTLC Data	STLC WET Citric Acid (mg/L)	Normalized STLC WET Citric Acid	Transformed STLC WET Citric Acid Data	STLC WET Deionized Water (mg/L)	TCLP (mg/L)	pH
ADL-29	0.5	09-014-S-BFM-55	01/14/09	**25**	**25**	3.22	NR	N/A	NR	NR	NR	NA
	1.5	09-014-S-BFM-56	01/14/09	**12**	**12**	2.48	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-57	01/14/09	**40**	**40**	3.69	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-58	01/14/09	4.0	4.0	1.39	NA	N/A	NA	NA	NA	**8.24**
ADL-30	0.5	09-014-S-BFM-51	01/14/09	**9.2**	**9.2**	2.22	NR	N/A	NR	NR	NR	NA
	1.5	09-014-S-BFM-52	01/14/09	**6.5**	**6.5**	1.87	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-53	01/14/09	**4.0**	**4.0**	1.39	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-54	01/14/09	**5.5**	**5.5**	1.70	NR	N/A	NR	NR	NR	NA
ADL-31	0.5	09-014-S-BFM-47	01/14/09	**21**	**21**	3.04	NR	N/A	NR	NR	NR	NA
	1.5	09-014-S-BFM-48	01/14/09	**33**	**33**	3.50	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-49	01/14/09	**11**	**11**	2.40	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-50	01/14/09	**14**	**14**	2.64	NR	N/A	NR	NR	NR	NA
ADL-32	0.5	09-014-S-BFM-43	01/14/09	**6.4**	**6.4**	1.86	NR	N/A	NR	NR	NR	NA
	1.5	09-014-S-BFM-44	01/14/09	**12**	**12**	2.48	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-45	01/14/09	**3.4**	**3.4**	1.22	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-46	01/14/09	**5.0**	**5.0**	1.61	NR	N/A	NR	NR	NR	NA
ADL-33	0.5	09-014-S-BFM-39	01/14/09	**13**	**13**	2.56	NR	N/A	NR	NR	NR	**8.32**
	1.5	09-014-S-BFM-40	01/14/09	**17**	**17**	2.83	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-41	01/14/09	**9.3**	**9.3**	2.23	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-42	01/14/09	**15**	**15**	2.71	NR	N/A	NR	NR	NR	NA

LEGEND

ADL-48 — LOCATION OF COMPLETED LEIGHTON'S ADL BORINGS (2009)

ADL-1 — LOCATION OF PROPOSED LEIGHTON'S ADL BORINGS LOCATED IN AREAS OF ASPHALT OR CONCRETE (SOIL SAMPLES WERE NOT COLLECTED) (2009)

L-1 — LOCATION OF COMPLETED EMI'S ADL BORINGS (2011)

Sample ID	Latitude (Deg, Min, Sec)	Longitude (Deg, Min, Sec)	Depth (ft)	Total Lead (mg/kg)	Wet-Citric (mg/l)	DI-WET (mg/l)	TCLP (mg/l)	pH
L-11-1	33° 51' 15.21801"N	117° 54' 30.61044"W	0.5	5.4				
L-11-2			1.5	3				
L-11-3			3.0	3				
L-11-4			4.0	4				

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Boring Location Plan
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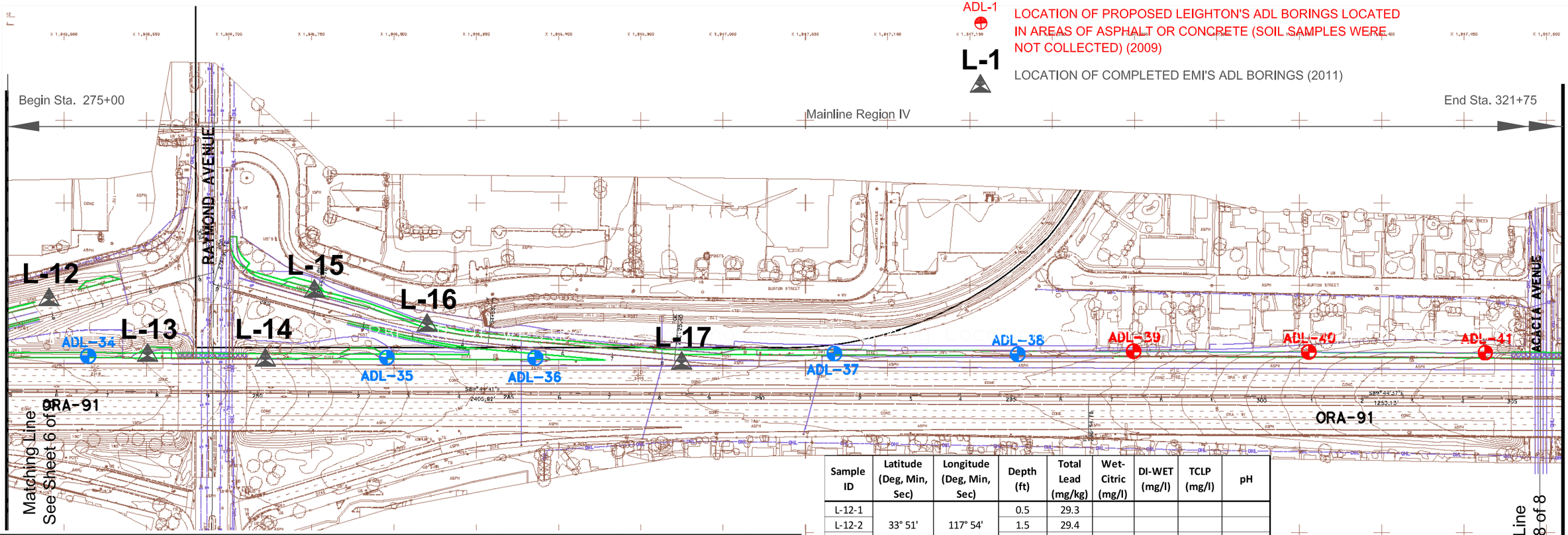
Figure 7

LEGEND

ADL-48 — LOCATION OF COMPLETED LEIGHTON'S ADL BORINGS (2009)

ADL-1 — LOCATION OF PROPOSED LEIGHTON'S ADL BORINGS LOCATED IN AREAS OF ASPHALT OR CONCRETE (SOIL SAMPLES WERE NOT COLLECTED) (2009)

L-1 — LOCATION OF COMPLETED EMI'S ADL BORINGS (2011)



Boring Number	Sample Depth (feet bgs)	Sample Number	Sample Date	Total Lead (mg/kg) Reported Value	Total Lead (mg/kg) Value Used	ln(x) Transformed TTLC Data	STLC WET Citric Acid (mg/L)	Normalized STLC WET Citric Acid	Transformed STLC WET Citric Acid Data	STLC WET Deionized Water (mg/L)	TCLP (mg/L)	pH
ADL-34	0.5	09-014-S-BFM-35	01/14/09	**8.3**	**8.3**	2.12	NR	N/A	NR	NR	NR	**8.22**
	1.5	09-014-S-BFM-36	01/14/09	**12**	**12**	2.48	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-37	01/14/09	**13**	**13**	2.56	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-38	01/14/09	**74**	**74**	4.30	**5.6**	**0.43**	**0.45**	0.023	**0.25**	NA
ADL-35	0.5	09-014-S-BFM-31	01/14/09	**24**	**24**	3.18	NR	N/A	NR	NR	NR	NA
	1.5	09-014-S-BFM-32	01/14/09	**9.7**	**9.7**	2.27	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-33	01/14/09	**29**	**29**	3.37	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-34	01/14/09	**13**	**13**	2.56	NR	N/A	NR	NR	NR	NA
ADL-36	0.5	09-014-S-BFM-27	01/14/09	**7.1**	**7.1**	1.96	**3.5**	**0.27**	**0.27**	NR	0.10	NA
	1.5	09-014-S-BFM-28	01/14/09	2.0	2.0	0.69	NA	N/A	NA	NA	NA	NA
	3	09-014-S-BFM-29	01/14/09	**2.1**	**2.1**	0.74	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-30	01/14/09	**6.8**	**6.8**	1.92	NR	N/A	NR	NR	NR	NA
ADL-37	0.5	09-014-S-BFM-22	01/14/09	**44**	**53**	3.97	NR	N/A	NR	NR	NR	NA
	0.5	09-014-S-BFM-23	01/14/09	**62**			**3.6**	**0.28**	**0.28**	NR	**0.17**	NA
	1.5	09-014-S-BFM-24	01/14/09	**14**	**14**	2.64	NR	N/A	NR	NR	NR	**6.82**
	3	09-014-S-BFM-25	01/14/09	**190**	**190**	5.25	**5.7**	**0.44**	**0.45**	0.0063	0.10	NA
	4	09-014-S-BFM-26	01/14/09	**36**	**36**	3.58	NR	N/A	NR	NR	NR	NA
ADL-38	0.5	09-014-S-BFM-17	01/14/09	**21**	**21**	3.04	NR	N/A	NR	NR	NR	NA
	1.5	09-014-S-BFM-18	01/14/09	**85**	**85**	4.44	**5.2**	**0.40**	**0.41**	0.046	**0.12**	NA
	3	09-014-S-BFM-19	01/14/09	**12**	**12**	2.48	NR	NR	NR	NR	NR	NA
	4	09-014-S-BFM-20	01/14/09	**8.0**	**19.5**	2.97	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-21	01/14/09	**31**			NR	N/A	NR	NR	NR	NA

Sample ID	Latitude (Deg, Min, Sec)	Longitude (Deg, Min, Sec)	Depth (ft)	Total Lead (mg/kg)	Wet-Citric (mg/l)	DI-WET (mg/l)	TCLP (mg/l)	pH
L-12-1	33° 51' 15.84809"N	117° 54' 27.61467"W	0.5	29.3				
L-12-2			1.5	29.4				
L-12-3			3.0	31.5				
L-12-4			4.0	36				
L-13-1	33° 51' 14.65837"N	117° 54' 25.81420"W	0.5	10.6	0.42			
L-13-2			1.5	10.9				
L-13-3			3.0	10.3				
L-13-4			4.0	14.8				
L-14-1	33° 51' 14.58938"N	117° 54' 23.11543"W	0.5	50.9	1.8	0.1	0.1	7.23
L-14-2			1.5	46.9	3.3			
L-14-3			3.0	44.6				
L-14-4			4.0	27.2				
L-15-1	33° 51' 15.79326"N	117° 54' 21.53747"W	0.5	2.2				
L-15-2			1.5	6.1				
L-15-3			3.0	2				
L-15-4			4.0	2				
L-16-1	33° 51' 15.33516"N	117° 54' 19.33611"W	0.5	5.1				
L-16-2			1.5	9.3				
L-16-3			3.0	2				
L-16-4			4.0	4.3				
L-17-1	33° 51' 14.88914"N	117° 54' 12.89544"W	0.5	10.7				
L-17-2			1.5	20				
L-17-3			3.0	179	15.5	0.63	0.39	6.94
L-17-4			4.0	6				

N

Scale
0 200 400 ft

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

SR-91 WESTBOUND WIDENING PROJECT

EMI Project No. 10-126

Date: 03-04-11

Boring Location Plan
Sheet 7 of 8

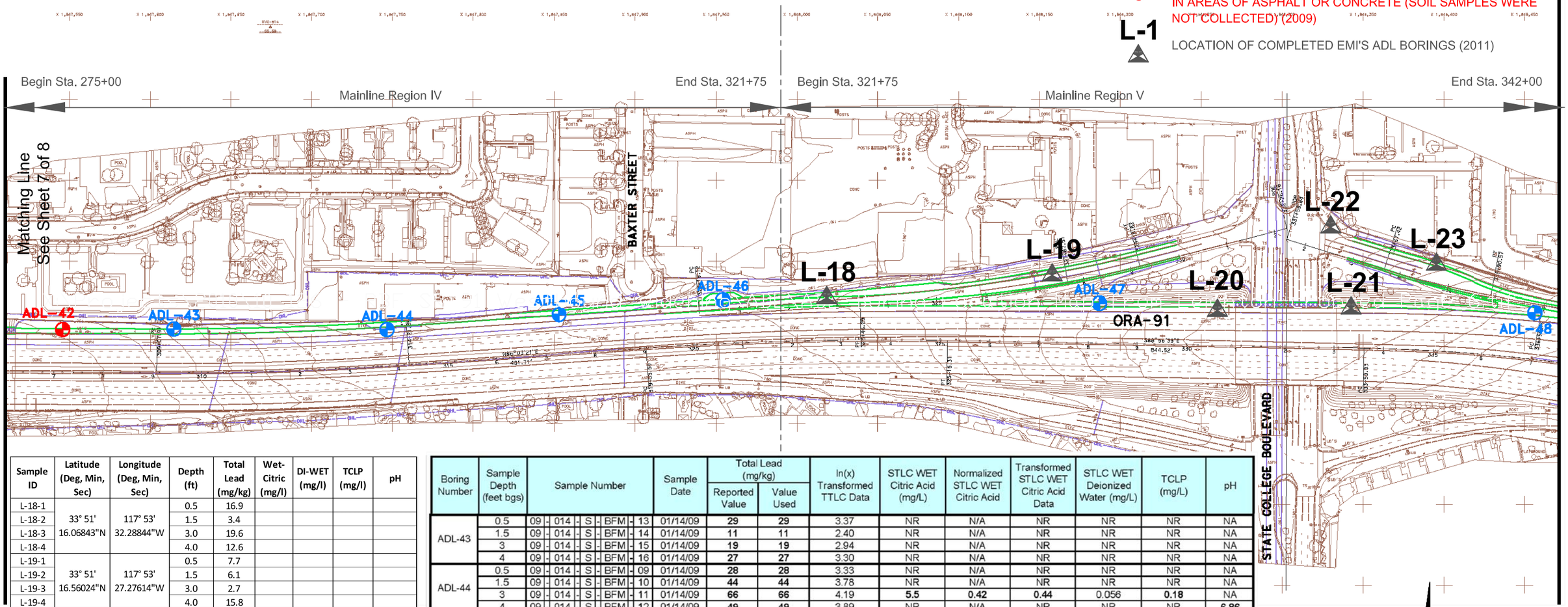
Figure 8

LEGEND

ADL-48 LOCATION OF COMPLETED LEIGHTON'S ADL BORINGS (2009)

ADL-1 LOCATION OF PROPOSED LEIGHTON'S ADL BORINGS LOCATED IN AREAS OF ASPHALT OR CONCRETE (SOIL SAMPLES WERE NOT COLLECTED) (2009)

L-1 LOCATION OF COMPLETED EMI'S ADL BORINGS (2011)



Sample ID	Latitude (Deg, Min, Sec)	Longitude (Deg, Min, Sec)	Depth (ft)	Total Lead (mg/kg)	Wet-Citric (mg/l)	DI-WET (mg/l)	TCLP (mg/l)	pH
L-18-1			0.5	16.9				
L-18-2	33° 51'	117° 53'	1.5	3.4				
L-18-3	16.06843"N	32.28844"W	3.0	19.6				
L-18-4			4.0	12.6				
L-19-1			0.5	7.7				
L-19-2	33° 51'	117° 53'	1.5	6.1				
L-19-3	16.56024"N	27.27614"W	3.0	2.7				
L-19-4			4.0	15.8				
L-20-1			0.5	9.9				
L-20-2	33° 51'	117° 53'	1.5	17.5				
L-20-3	15.87918"N	23.07578"W	3.0	37.9	1.7			
L-20-4			4.0	27.2				
L-21-1			0.5	4.6				
L-21-2	33° 51'	117° 53'	1.5	5.9				
L-21-3	15.92739"N	19.90587"W	3.0	24.9	1.4			
L-21-4			4.0	4.9				
L-22-1			0.5	20.4				
L-22-2	33° 51'	117° 53'	1.5	2				
L-22-3	17.44463"N	20.23785"W	3.0	2				
L-22-4			4.0	2				
L-23-1			0.5	43.2	1.9			
L-23-2	33° 51'	117° 53'	1.5	29.1				
L-23-3	16.82083"N	17.82190"W	3.0	85.2	1.5	0.14	0.1	7.11
L-23-4			4.0	32.6				

Boring Number	Sample Depth (feet bgs)	Sample Number	Sample Date	Total Lead (mg/kg) Reported Value	Total Lead (mg/kg) Value Used	ln(x) Transformed TTLC Data	STLC WET Citric Acid (mg/L)	Normalized STLC WET Citric Acid	Transformed STLC WET Citric Acid Data	STLC WET Deionized Water (mg/L)	TCLP (mg/L)	pH
ADL-43	0.5	09-014-S-BFM-13	01/14/09	**29**	**29**	3.37	NR	N/A	NR	NR	NR	NA
	1.5	09-014-S-BFM-14	01/14/09	**11**	**11**	2.40	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-15	01/14/09	**19**	**19**	2.94	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-16	01/14/09	**27**	**27**	3.30	NR	N/A	NR	NR	NR	NA
ADL-44	0.5	09-014-S-BFM-09	01/14/09	**28**	**28**	3.33	NR	N/A	NR	NR	NR	NA
	1.5	09-014-S-BFM-10	01/14/09	**44**	**44**	3.78	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-11	01/14/09	**66**	**66**	4.19	**5.5**	**0.42**	**0.44**	0.056	**0.18**	NA
	4	09-014-S-BFM-12	01/14/09	**49**	**49**	3.89	NR	N/A	NR	NR	NR	**6.86**
ADL-45	0.5	09-014-S-BFM-05	01/14/09	2.0	2.0	0.69	NA	N/A	NA	NA	NA	NA
	1.5	09-014-S-BFM-06	01/14/09	**5.3**	**5.3**	1.67	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-07	01/14/09	**76**	**76**	4.33	**9.4**	**0.72**	**0.81**	0.079	**0.71**	NA
	4	09-014-S-BFM-08	01/14/09	**47**	**47**	3.85	NR	N/A	NR	NR	NR	NA
ADL-46	0.5	09-014-S-BFM-01	01/14/09	**51**	**51**	3.93	**4.2**	**0.32**	**0.33**	NR	**0.30**	NA
	1.5	09-014-S-BFM-02	01/14/09	**180**	**180**	5.19	**13**	**1.00**	**1.57**	0.10	**0.44**	NA
	3	09-014-S-BFM-03	01/14/09	**3.4**	**3.4**	1.22	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-04	01/14/09	**2.2**	**2.2**	0.79	NR	N/A	NR	NR	NR	NA
ADL-47	0.5	09-016-S-BFM-05	01/16/09	**8.2**	**8.2**	2.10	NR	N/A	NR	NR	NR	NA
	1.5	09-016-S-BFM-06	01/16/09	**21**	**31**	3.43	NR	N/A	NR	NR	NR	NA
	1.5	09-016-S-BFM-07	01/16/09	**41**			NR	N/A	NR	NR	NR	NA
	3	09-016-S-BFM-08	01/16/09	**10**	**10**	2.30	NR	N/A	NR	NR	NR	NA
	4	09-016-S-BFM-09	01/16/09	**8.7**	**8.7**	2.16	NR	N/A	NR	NR	NR	NA
ADL-48	0.5	09-016-S-BFM-01	01/16/09	**14**	**14**	2.64	NR	N/A	NR	NR	NR	NA
	1.5	09-016-S-BFM-02	01/16/09	**32**	**32**	3.47	NR	N/A	NR	NR	NR	NA
	3	09-016-S-BFM-03	01/16/09	**52**	**52**	3.95	**2.7**	**0.21**	**0.21**	NR	**0.22**	**8.65**
	4	09-016-S-BFM-04	01/16/09	**5.1**	**5.1**	1.63	NR	N/A	NR	NR	NR	NA

Earth Mechanics, Inc.
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EMI Project No. 10-126 Date: 03-04-11

Boring Location Plan
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Figure 9

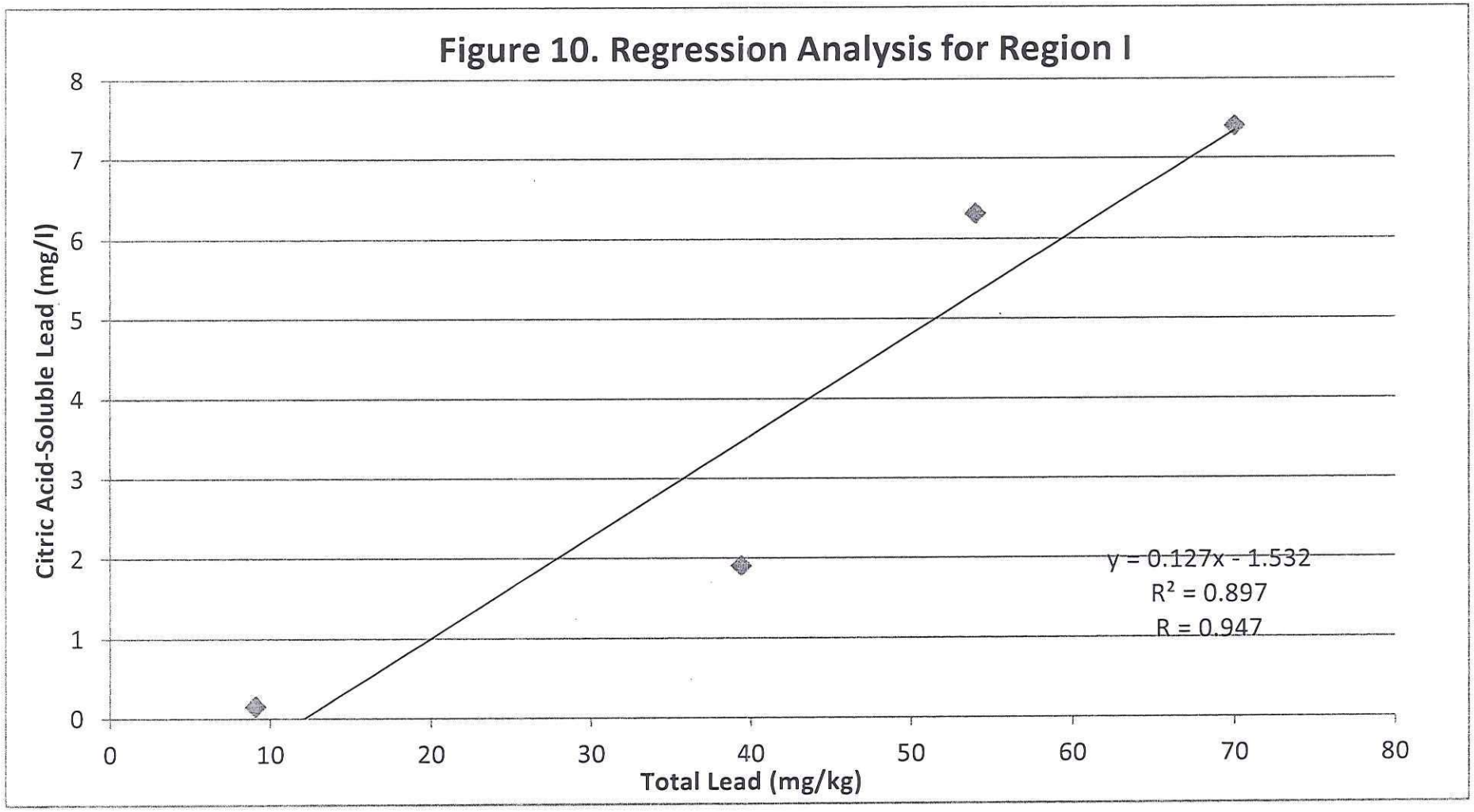
Figure 10. Regression Analysis for Region I
Citric Acid-Soluble Lead (mg/l)
Total Lead (mg/kg)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
y = 0.127x - 1.532
R² = 0.897
R = 0.947

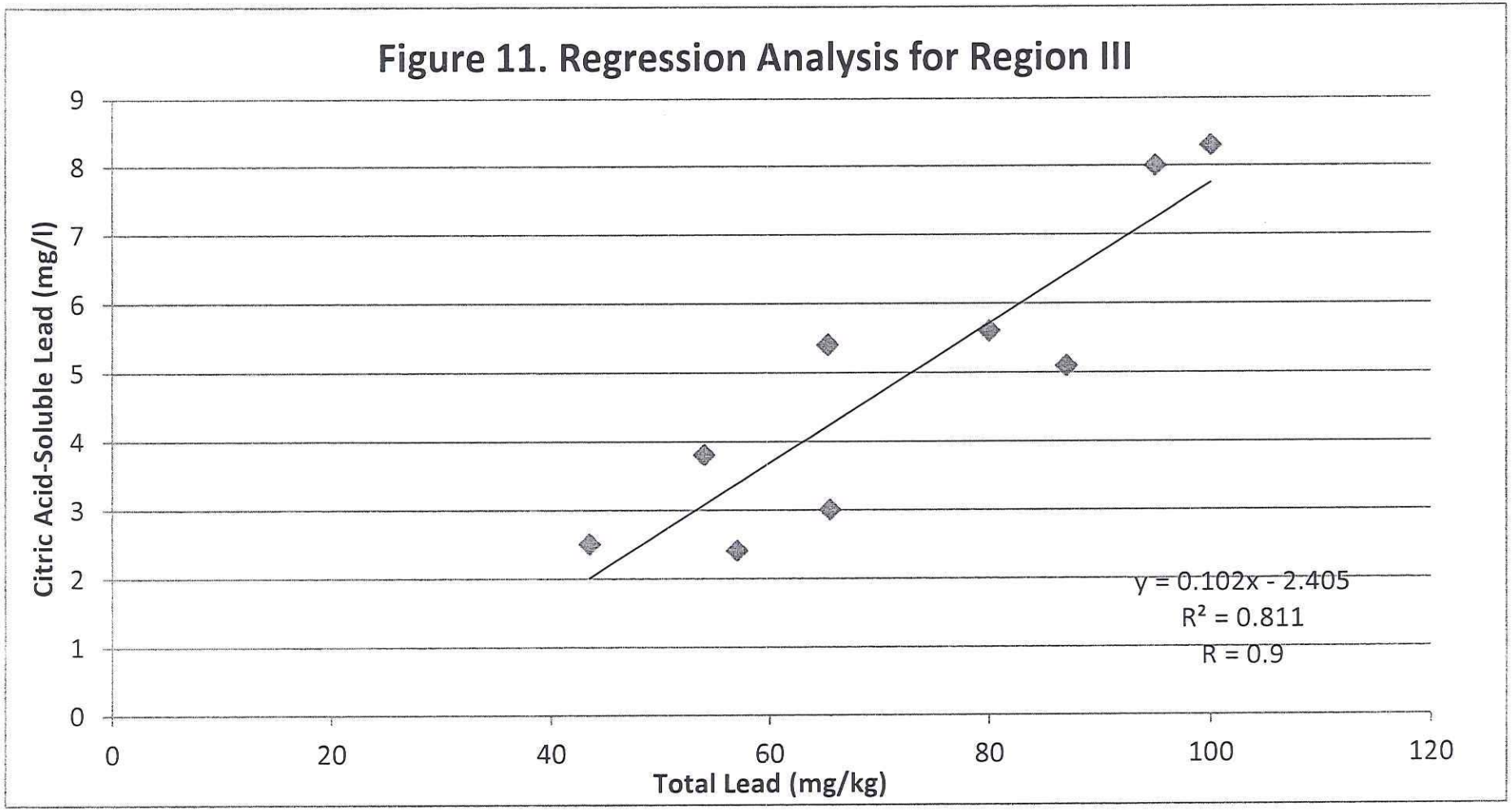
Figure 11. Regression Analysis for Region III
Citric Acid-Soluble Lead (mg/l)
Total Lead (mg/kg)
0
1
2
3
4
5
6
7
8
9
0
20
40
60
80
100
120
y = 0.102x - 2.405
R² = 0.811
R = 0.9

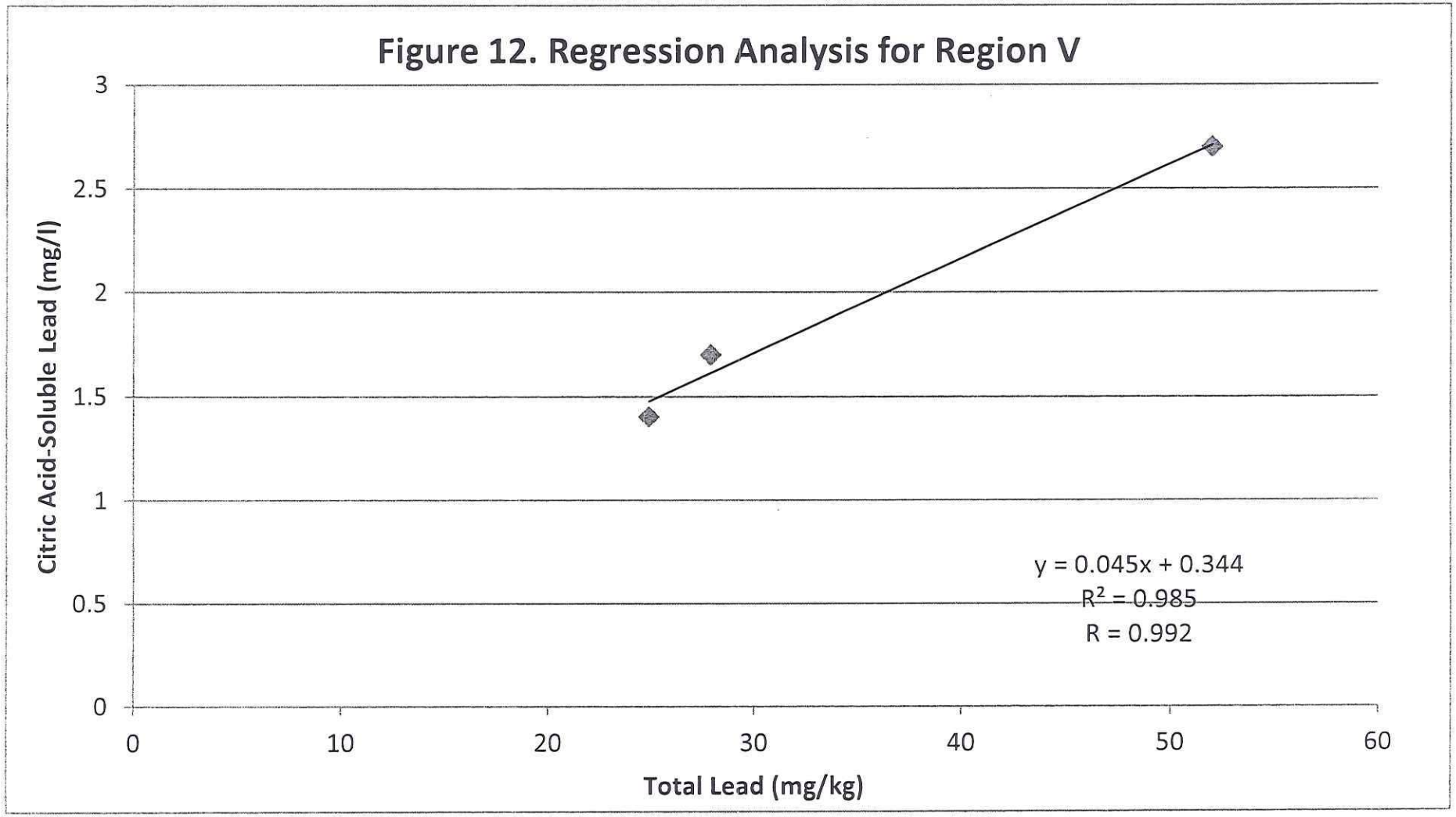
Figure 12. Regression Analysis for Region V
Citric Acid-Soluble Lead (mg/l)
Total Lead (mg/kg)
0
0.5
1
1.5
2
2.5
3
0
10
20
30
40
50
60
y = 0.045x + 0.344
R² = 0.985
R = 0.992

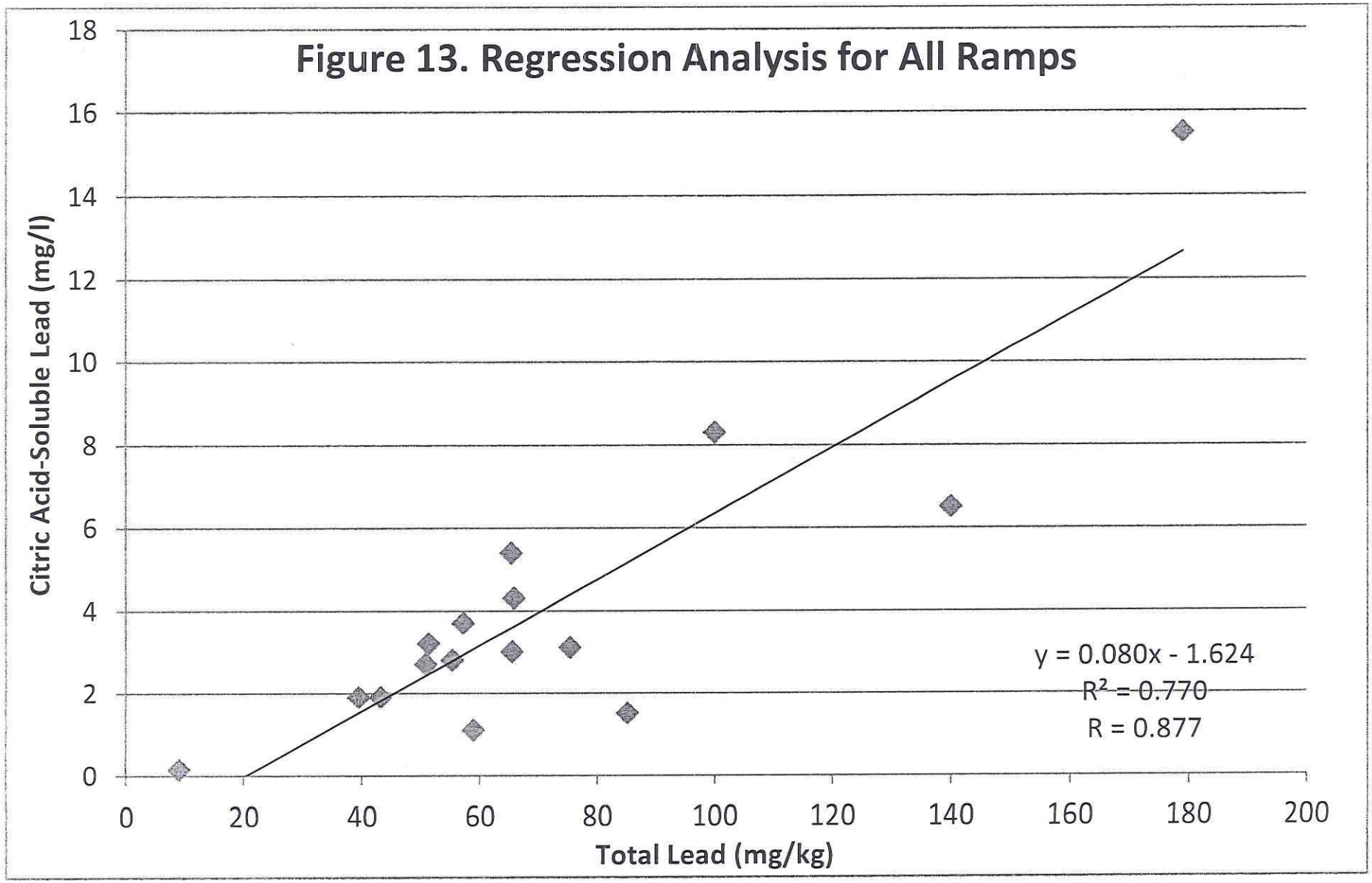
Figure 13. Regression Analysis for All Ramps
Citric Acid-Soluble Lead (mg/l)
Total Lead (mg/kg)
y = 0.080x - 1.624
R² = 0.770
R = 0.877
0
2
4
6
8
10
12
14
16
18
0
20
40
60
80
100
120
140
160
180
200

APPENDIX A

TEST RESULTS FROM 2009 ADL REPORT

TABLE 1
Summary of Sample Locations and Laboratory Results for Aerially Deposited Lead
SR 91 Westbound Widening Project

Boring Number	Sample Depth (feet bgs)	Sample Number	Sample Date	Total Lead (mg/kg)		ln(x) Transformed TTLC Data	STLC WET Citric Acid (mg/L)	Normalized STLC WET Citric Acid	Transformed STLC WET Citric Acid Data	STLC WET Deionized Water (mg/L)	TCLP (mg/L)	pH
				Reported Value	Value Used							
ADL-3	0.5	09-015-S-BFM-60	01/15/09	**24**	**24**	3.18	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-61	01/15/09	**27**	**27**	3.30	NR	N/A	NR	NR	NR	**8.96**
	3	09-015-S-BFM-62	01/15/09	**29**	**29**	3.37	NR	N/A	NR	NR	NR	NA
	4	09-015-S-BFM-63	01/15/09	**70**	**70**	4.25	**7.4**	**0.57**	**0.61**	0.10	**0.40**	NA
ADL-4	0.5	09-016-S-BFM-24	01/16/09	**44**	**41**	3.71	NR	N/A	NR	NR	NR	NA
		09-016-S-BFM-25	01/16/09	**38**			NR	N/A	NR	NR	NR	NA
	1.5	09-016-S-BFM-26	01/16/09	**30**	**30**	3.40	NR	N/A	NR	NR	NR	NA
	3	09-016-S-BFM-27	01/16/09	**39**	**39**	3.66	NR	N/A	NR	NR	NR	NA
	4	09-016-S-BFM-28	01/16/09	**34**	**34**	3.53	NR	N/A	NR	NR	NR	NA
ADL-5	0.5	09-016-S-BFM-20	01/16/09	**22**	**22**	3.09	NR	N/A	NR	NR	NR	NA
	1.5	09-016-S-BFM-21	01/16/09	**9.6**	**9.6**	2.26	NR	N/A	NR	NR	NR	NA
	3	09-016-S-BFM-22	01/16/09	**47**	**47**	3.85	NR	N/A	NR	NR	NR	**8.66**
	4	09-016-S-BFM-23	01/16/09	**34**	**34**	3.53	NR	N/A	NR	NR	NR	NA
ADL-6	0.5	09-015-S-BFM-56	01/15/09	**4.5**	**4.5**	1.50	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-57	01/15/09	**12**	**12**	2.48	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-58	01/15/09	**10**	**10**	2.30	NA	NA	NA	NA	NA	NA
	4	09-015-S-BFM-59	01/15/09	**13**	**13**	2.56	NA	NA	NA	NA	NA	NA
ADL-7	0.5	09-015-S-BFM-51	01/15/09	**14**	**14**	2.64	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-52	01/15/09	**2.0**	**2.0**	0.69	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-53	01/15/09	**2.0**	**2.0**	0.69	NR	N/A	NR	NR	NR	NA
	4	09-015-S-BFM-54	01/15/09	**3.3**	**3.1**	1.13	NR	N/A	NR	NR	NR	NA
		09-015-S-BFM-55	01/15/09	**2.9**			NR	N/A	NR	NR	NR	NA
ADL-8	0.5	09-015-S-BFM-48	01/15/09	**5.0**	**5.0**	1.61	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-49	01/15/09	**31**	**31**	3.43	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-50	01/15/09	**54**	**54**	3.99	**6.3**	**0.48**	**0.51**	0.013	**0.12**	**7.91**
	4	Refusal at 3 feet bgs, no sample collected										
ADL-9	0.5	09-015-S-BFM-43	01/15/09	**6.3**	**6.3**	1.84	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-44	01/15/09	**8.8**	**8.8**	2.17	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-45	01/15/09	**33**	**49**	3.89	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-46	01/15/09	**65**			0.10	0.01	0.01	NR	**0.14**	NA
	4	09-015-S-BFM-47	01/15/09	**86**	**86**	4.45	**0.50**	**0.04**	**0.04**	NR	**0.20**	**8.46**
ADL-10	0.5	09-015-S-BFM-40	01/15/09	**11**	**11**	2.40	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-41	01/15/09	**38**	**38**	3.64	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-42	01/15/09	**32**	**32**	3.47	NR	N/A	NR	NR	NR	NA
	4	Refusal at 3 feet bgs, no sample collected										

TABLE 1
Summary of Sample Locations and Laboratory Results for Aerially Deposited Lead
SR 91 Westbound Widening Project

Boring Number	Sample Depth (feet bgs)	Sample Number	Sample Date	Total Lead (mg/kg)		ln(x) Transformed TTLC Data	STLC WET Citric Acid (mg/L)	Normalized STLC WET Citric Acid	Transformed STLC WET Citric Acid Data	STLC WET Deionized Water (mg/L)	TCLP (mg/L)	pH
				Reported Value	Value Used							
ADL-11	0.5	09-015-S-BFM-36	01/15/09	**33**	**25**	3.22	NR	N/A	NR	NR	NR	NA
	0.5	09-015-S-BFM-37	01/15/09	**17**			NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-38	01/15/09	**43**	**43**	3.76	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-39	01/15/09	**15**	**15**	2.71	NR	N/A	NR	NR	NR	NA
	4	Refusal at 3 feet bgs, no sample collected										
ADL-12	0.5	09-015-S-BFM-32	01/15/09	**25**	**25**	3.22	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-33	01/15/09	**5.4**	**5.4**	1.69	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-34	01/15/09	**11**	**20**	3.00	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-35	01/15/09	**29**			NR	N/A	NR	NR	NR	NA
	4	Refusal at 3 feet bgs, no sample collected										
ADL-13	0.5	09-015-S-BFM-29	01/15/09	**3.9**	**3.9**	1.36	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-30	01/15/09	**33**	**33**	3.50	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-31	01/15/09	**25**	**25**	3.22	NR	N/A	NR	NR	NR	NA
	4	Refusal at 3 feet bgs, no sample collected										
ADL-14	0.5	09-015-S-BFM-24	01/15/09	**12**	**10.15**	2.32	NR	N/A	NR	NR	NR	NA
	0.5	09-015-S-BFM-25	01/15/09	**8.3**			NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-26	01/15/09	**38**	**38**	3.64	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-27	01/15/09	**20**	**20**	3.00	NR	N/A	NR	NR	NR	NA
	4	09-015-S-BFM-28	01/15/09	**28**	**28**	3.33	NR	N/A	NR	NR	NR	NA
ADL-15	0.5	09-015-S-BFM-19	01/15/09	**49**	**49**	3.89	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-20	01/15/09	**14**	**14**	2.64	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-21	01/15/09	**100**	**86.5**	4.46	0.10	0.01	0.01	NR	0.10	NA
	3	09-015-S-BFM-22	01/15/09	**73**			0.10	0.01	0.01	NR	0.10	NA
	4	09-015-S-BFM-23	01/15/09	**27**	**27**	3.30	NR	N/A	NR	NR	NR	NA
ADL-16	0.5	09-015-S-BFM-14	01/15/09	**38**	**38**	3.64	NR	N/A	NR	NR	NR	NA
	0.5	09-015-S-BFM-15	01/15/09	**38**			NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-16	01/15/09	**34**	**34**	3.53	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-17	01/15/09	**36**	**36**	3.58	NR	N/A	NR	NR	NR	**8.98**
	4	09-015-S-BFM-18	01/15/09	**16**	**16**	2.77	NR	N/A	NR	NR	NR	NA
ADL-17	0.5	09-016-S-BFM-15	01/16/09	**87**	**87**	4.47	**5.1**	**0.39**	**0.40**	0.033	**0.26**	NA
	1.5	09-016-S-BFM-16	01/16/09	**80**	**60.5**	4.10	**5.6**	**0.43**	**0.45**	0.049	**0.20**	NA
	1.5	09-016-S-BFM-17	01/16/09	**41**			NR	N/A	NR	NR	NR	NA
	3	09-016-S-BFM-18	01/16/09	**47**	**47**	3.85	NR	N/A	NR	NR	NR	NA
	4	09-016-S-BFM-19	01/16/09	**57**	**57**	4.04	**2.4**	**0.18**	**0.19**	NR	0.10	NA

TABLE 1
Summary of Sample Locations and Laboratory Results for Aerially Deposited Lead
SR 91 Westbound Widening Project

Boring Number	Sample Depth (feet bgs)	Sample Number	Sample Date	Total Lead (mg/kg)		ln(x) Transformed TTLC Data	STLC WET Citric Acid (mg/L)	Normalized STLC WET Citric Acid	Transformed STLC WET Citric Acid Data	STLC WET Deionized Water (mg/L)	TCLP (mg/L)	pH
				Reported Value	Value Used							
ADL-18	0.5	09-016-S-BFM-10	01/16/09	**20**	**20**	3.00	NR	N/A	NR	NR	NR	NA
	1.5	09-016-S-BFM-11	01/16/09	**54**	**42.5**	3.75	**3.8**	**0.29**	**0.30**	NR	**0.16**	NA
	1.5	09-016-S-BFM-12	01/16/09	**31**			NR	N/A	NR	NR	NR	NA
	3	09-016-S-BFM-13	01/16/09	**49**	**49**	3.89	NR	N/A	NR	NR	NR	NA
	4	09-016-S-BFM-14	01/16/09	**46**	**46**	3.83	NR	N/A	NR	NR	NR	NA
ADL-26	0.5	09-015-S-BFM-10	01/15/09	**49**	**49**	3.89	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-11	01/15/09	**340**	**340**	5.83	**0.19**	**0.01**	**0.01**	NR	**1.4**	**7.75**
	3	09-015-S-BFM-12	01/15/09	**5.1**	**5.1**	1.63	NR	N/A	NR	NR	NR	**8.43**
	4	09-015-S-BFM-13	01/15/09	**7.4**	**7.4**	2.00	NR	N/A	NR	NR	NR	NA
ADL-27	0.5	09-015-S-BFM-06	01/15/09	**23**	**23**	3.14	NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-07	01/15/09	**9.8**	**9.8**	2.28	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-08	01/15/09	**96**	**96**	4.56	0.10	0.01	0.01	NR	**0.11**	NA
	4	09-015-S-BFM-09	01/15/09	**170**	**170**	5.14	**0.26**	**0.02**	**0.02**	NR	0.10	NA
ADL-28	0.5	09-015-S-BFM-01	01/15/09	**4.2**	**6.9**	1.93	NR	N/A	NR	NR	NR	NA
	0.5	09-015-S-BFM-02	01/15/09	**9.6**			NR	N/A	NR	NR	NR	NA
	1.5	09-015-S-BFM-03	01/15/09	**17**	**17**	2.83	NR	N/A	NR	NR	NR	NA
	3	09-015-S-BFM-04	01/15/09	**8.3**	**8.3**	2.12	NR	N/A	NR	NR	NR	NA
	4	09-015-S-BFM-05	01/15/09	**45**	**45**	3.81	NR	N/A	NR	NR	NR	NA
ADL-29	0.5	09-014-S-BFM-55	01/14/09	**25**	**25**	3.22	NR	N/A	NR	NR	NR	NA
	1.5	09-014-S-BFM-56	01/14/09	**12**	**12**	2.48	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-57	01/14/09	**40**	**40**	3.69	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-58	01/14/09	4.0	4.0	1.39	NA	N/A	NA	NA	NA	**8.24**
ADL-30	0.5	09-014-S-BFM-51	01/14/09	**9.2**	**9.2**	2.22	NR	N/A	NR	NR	NR	NA
	1.5	09-014-S-BFM-52	01/14/09	**6.5**	**6.5**	1.87	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-53	01/14/09	**4.0**	**4.0**	1.39	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-54	01/14/09	**5.5**	**5.5**	1.70	NR	N/A	NR	NR	NR	NA
ADL-31	0.5	09-014-S-BFM-47	01/14/09	**21**	**21**	3.04	NR	N/A	NR	NR	NR	NA
	1.5	09-014-S-BFM-48	01/14/09	**33**	**33**	3.50	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-49	01/14/09	**11**	**11**	2.40	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-50	01/14/09	**14**	**14**	2.64	NR	N/A	NR	NR	NR	NA
ADL-32	0.5	09-014-S-BFM-43	01/14/09	**6.4**	**6.4**	1.86	NR	N/A	NR	NR	NR	NA
	1.5	09-014-S-BFM-44	01/14/09	**12**	**12**	2.48	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-45	01/14/09	**3.4**	**3.4**	1.22	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-46	01/14/09	**5.0**	**5.0**	1.61	NR	N/A	NR	NR	NR	NA

TABLE 1
Summary of Sample Locations and Laboratory Results for Aerially Deposited Lead
SR 91 Westbound Widening Project

Boring Number	Sample Depth (feet bgs)	Sample Number	Sample Date	Total Lead (mg/kg)		In(x) Transformed TTLC Data	STLC WET Citric Acid (mg/L)	Normalized STLC WET Citric Acid	Transformed STLC WET Citric Acid Data	STLC WET Deionized Water (mg/L)	TCLP (mg/L)	pH
				Reported Value	Value Used							
ADL-33	0.5	09-014-S-BFM-39	01/14/09	**13**	**13**	2.56	NR	N/A	NR	NR	NR	**8.32**
	1.5	09-014-S-BFM-40	01/14/09	**17**	**17**	2.83	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-41	01/14/09	**9.3**	**9.3**	2.23	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-42	01/14/09	**15**	**15**	2.71	NR	N/A	NR	NR	NR	NA
ADL-34	0.5	09-014-S-BFM-35	01/14/09	**8.3**	**8.3**	2.12	NR	N/A	NR	NR	NR	**8.22**
	1.5	09-014-S-BFM-36	01/14/09	**12**	**12**	2.48	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-37	01/14/09	**13**	**13**	2.56	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-38	01/14/09	**74**	**74**	4.30	**5.6**	**0.43**	**0.45**	0.023	**0.25**	NA
ADL-35	0.5	09-014-S-BFM-31	01/14/09	**24**	**24**	3.18	NR	N/A	NR	NR	NR	NA
	1.5	09-014-S-BFM-32	01/14/09	**9.7**	**9.7**	2.27	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-33	01/14/09	**29**	**29**	3.37	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-34	01/14/09	**13**	**13**	2.56	NR	N/A	NR	NR	NR	NA
ADL-36	0.5	09-014-S-BFM-27	01/14/09	**7.1**	**7.1**	1.96	**3.5**	**0.27**	**0.27**	NR	0.10	NA
	1.5	09-014-S-BFM-28	01/14/09	2.0	2.0	0.69	NA	N/A	NA	NA	NA	NA
	3	09-014-S-BFM-29	01/14/09	**2.1**	**2.1**	0.74	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-30	01/14/09	**6.8**	**6.8**	1.92	NR	N/A	NR	NR	NR	NA
ADL-37	0.5	09-014-S-BFM-22	01/14/09	**44**	**53**	3.97	NR	N/A	NR	NR	NR	NA
	0.5	09-014-S-BFM-23	01/14/09	**62**			**3.6**	**0.28**	**0.28**	NR	**0.17**	NA
	1.5	09-014-S-BFM-24	01/14/09	**14**	**14**	2.64	NR	N/A	NR	NR	NR	**6.82**
	3	09-014-S-BFM-25	01/14/09	**190**	**190**	5.25	**5.7**	**0.44**	**0.45**	0.0063	0.10	NA
	4	09-014-S-BFM-26	01/14/09	**36**	**36**	3.58	NR	N/A	NR	NR	NR	NA
ADL-38	0.5	09-014-S-BFM-17	01/14/09	**21**	**21**	3.04	NR	N/A	NR	NR	NR	NA
	1.5	09-014-S-BFM-18	01/14/09	**85**	**85**	4.44	**5.2**	**0.40**	**0.41**	0.046	**0.12**	NA
	3	09-014-S-BFM-19	01/14/09	**12**	**12**	2.48	NR	NR	NR	NR	NR	NA
	4	09-014-S-BFM-20	01/14/09	**8.0**	**19.5**	2.97	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-21	01/14/09	**31**			NR	N/A	NR	NR	NR	NA
ADL-43	0.5	09-014-S-BFM-13	01/14/09	**29**	**29**	3.37	NR	N/A	NR	NR	NR	NA
	1.5	09-014-S-BFM-14	01/14/09	**11**	**11**	2.40	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-15	01/14/09	**19**	**19**	2.94	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-16	01/14/09	**27**	**27**	3.30	NR	N/A	NR	NR	NR	NA
ADL-44	0.5	09-014-S-BFM-09	01/14/09	**28**	**28**	3.33	NR	N/A	NR	NR	NR	NA
	1.5	09-014-S-BFM-10	01/14/09	**44**	**44**	3.78	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-11	01/14/09	**66**	**66**	4.19	**5.5**	**0.42**	**0.44**	0.056	**0.18**	NA
	4	09-014-S-BFM-12	01/14/09	**49**	**49**	3.89	NR	N/A	NR	NR	NR	**6.86**

TABLE 1
Summary of Sample Locations and Laboratory Results for Aerially Deposited Lead
SR 91 Westbound Widening Project

Boring Number	Sample Depth (feet bgs)	Sample Number	Sample Date	Total Lead (mg/kg)		ln(x) Transformed TTLC Data	STLC WET Citric Acid (mg/L)	Normalized STLC WET Citric Acid	Transformed STLC WET Citric Acid Data	STLC WET Deionized Water (mg/L)	TCLP (mg/L)	pH
				Reported Value	Value Used							
ADL-45	0.5	09-014-S-BFM-05	01/14/09	2.0	2.0	0.69	NA	N/A	NA	NA	NA	NA
	1.5	09-014-S-BFM-06	01/14/09	**5.3**	**5.3**	1.67	NR	N/A	NR	NR	NR	NA
	3	09-014-S-BFM-07	01/14/09	**76**	**76**	4.33	**9.4**	**0.72**	**0.81**	0.079	**0.71**	NA
	4	09-014-S-BFM-08	01/14/09	**47**	**47**	3.85	NR	N/A	NR	NR	NR	NA
ADL-46	0.5	09-014-S-BFM-01	01/14/09	**51**	**51**	3.93	**4.2**	**0.32**	**0.33**	NR	**0.30**	NA
	1.5	09-014-S-BFM-02	01/14/09	**180**	**180**	5.19	**13**	**1.00**	**1.57**	0.10	**0.44**	NA
	3	09-014-S-BFM-03	01/14/09	**3.4**	**3.4**	1.22	NR	N/A	NR	NR	NR	NA
	4	09-014-S-BFM-04	01/14/09	**2.2**	**2.2**	0.79	NR	N/A	NR	NR	NR	NA
ADL-47	0.5	09-016-S-BFM-05	01/16/09	**8.2**	**8.2**	2.10	NR	N/A	NR	NR	NR	NA
	1.5	09-016-S-BFM-06	01/16/09	**21**	**31**	3.43	NR	N/A	NR	NR	NR	NA
	1.5	09-016-S-BFM-07	01/16/09	**41**			NR	N/A	NR	NR	NR	NA
	3	09-016-S-BFM-08	01/16/09	**10**	**10**	2.30	NR	N/A	NR	NR	NR	NA
	4	09-016-S-BFM-09	01/16/09	**8.7**	**8.7**	2.16	NR	N/A	NR	NR	NR	NA
ADL-48	0.5	09-016-S-BFM-01	01/16/09	**14**	**14**	2.64	NR	N/A	NR	NR	NR	NA
	1.5	09-016-S-BFM-02	01/16/09	**32**	**32**	3.47	NR	N/A	NR	NR	NR	NA
	3	09-016-S-BFM-03	01/16/09	**52**	**52**	3.95	**2.7**	**0.21**	**0.21**	NR	**0.22**	**8.65**
	4	09-016-S-BFM-04	01/16/09	**5.1**	**5.1**	1.63	NR	N/A	NR	NR	NR	NA

mg/kg = Milligrams per Kilogram
mg/L = Milligrams per Liter
TCLP = Toxicity Characteristic Leaching Procedure
STLC = Soluble Threshold Limit Concentrations
2.0 = Below Laboratory Detection Limits
2.9 = Analyte Detected Above Laboratory Reporting Limit and/or above STLC Limit
NA = Not Analyzed
CI = Confidence Interval
UCL = Upper Confidence Level

Note - If a duplicate sample was collected at a specific depth and location, the average concentration of the two values was used in the statistical analysis.

APPENDIX B

CALTRANS APPROVAL MEMORANDUM OF

2009 ADL REPORT

State of California

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: Andrew Oshrin, Chief
Design Branch "D"
Attention: Allen Soofi

Date: April 13, 2009

File: 12-ORA-91 PM: 0.9/5.4
WB widening from SR-57 to
West of I-5
E.A. 0C5700

From: **DEPARTMENT OF TRANSPORTATION**
DISTRICT 12 DIVISION OF PROJECT DELIVERY
ENVIRONEMNTAL ENGINEERING BRANCH

Subject: Aerially Deposited Lead (ADL) Report Review Comments for Westbound SR-91 widening Project

Please refer to your request on March 16, 2009 for providing review comments for the ADL Report dated March 11, 2009, prepared by Leighton Consulting, Inc.

We have no comment about the ADL Report. Type Y1 contaminated soil were found at Boring Numbers: ADL-3, ADL-8, ADL-17, ADL-34, ADL-37, ADL-38, ADL-44, ADL-45 and ADL-46. We concur to the recommendations of this ADL Report that the soil in the vicinity of these locations can be placed at a minimum of 5 feet above the maximum groundwater table elevation and covered with at least one foot of non-hazardous soil.

If you have any questions, please call Mr. Paul Chang of my staff at Ext. 7814.

R. Aurasteh

REZA AURASTEH, Chief
Environmental Engineering Branch

APPENDIX C

LABORATORY TEST RESULTS

& CHAIN-OF-CUSTODY FORMS

Alpha Scientific Corporation
Environmental Laboratories

02-11-2011

Mr. Lino Cheang
Earth Mechanics Inc.
17800 Newhope Street, Suite B
Fountain Valley, CA 92708

Project: 10-126
Project Site: W/B SR-91 Between I-5 and SR-57
Sample Date: 01-27/28/31-2011& 02-01-2011
Lab Job No.: EA102002

Dear Mr. Cheang:

Enclosed please find the analytical report for the sample(s) received by Alpha Scientific Corporation on 02-01-2011 and analyzed by the following EPA methods:

EPA 6010B (Total Lead)

All analyses have met the QA/QC criteria of this laboratory.

The sample(s) arrived in good conditions (i.e., chilled, intact) and with a chain of custody record attached.

Alpha Scientific Corporation is a CA DHS certified laboratory (Certificate Number 2633). Thank you for giving us the opportunity to serve you. Please feel free to call me at (562) 809-8880 if our laboratory can be of further service to you.

Sincerely,

Roger Wang, Ph.D.
Laboratory Director

Enclosures

This cover letter is an integral part of this analytical report.

Client:	Earth Mechanics Inc.	Lab Job No.:	EA102002
Project:	10-126		
Project Site:	W/B SR-91 Between I-5 and SR-57	Date Sampled:	02-01-2011
Matrix:	Soil	Date Received:	02-01-2011
Digestion Method:	EPA 3050B	Date Digested:	02-06-2011
Batch No.:	0208-MS2	Date Analyzed:	02-08-2011
		Date Reported:	02-11-2011

EPA 6010B for Total Lead
Reporting Units: mg/kg (ppm)

Sample ID	Lab ID	Total Lead	Reporting Limit
Method Blank		ND	2
L-1-1	EA102002-1	30.1	2
L-1-2	EA102002-2	28.6	2
L-1-3	EA102002-3	5.6	2
L-1-4	EA102002-4	5.1	2
L-2-1	EA102002-5	24.6	2
L-2-2	EA102002-6	51.3	2
L-2-3	EA102002-7	58.9	2
L-2-4	EA102002-8	17.0	2
L-3-1	EA102002-9	10.6	2
L-3-2	EA102002-10	8.8	2
L-3-3	EA102002-11	5.3	2
L-3-4	EA102002-12	4.0	2
L-4-1	EA102002-13	50.8	2
L-4-2	EA102002-14	12.4	2
L-4-3	EA102002-15	5.4	2
L-4-4	EA102002-16	6.7	2
L-5-1	EA102002-17	7.2	2
L-5-2	EA102002-18	9.1	2
L-5-3	EA102002-19	3.0	2
L-5-4	EA102002-20	39.4	2

ND: Not Detected (at the specified limit).

Client:	Earth Mechanics Inc.	Lab Job No.:	EA102002
Project:	10-126		
Project Site:	W/B SR-91 Between I-5 and SR-57	Date Sampled:	01-31-2011
Matrix:	Soil	Date Received:	02-01-2011
Digestion Method:	EPA 3050B	Date Digested:	02-06-2011
Batch No.:	0208-MS3	Date Analyzed:	02-08-2011
		Date Reported:	02-11-2011

EPA 6010B for Total Lead
Reporting Units: mg/kg (ppm)

Sample ID	Lab ID	Total Lead	Reporting Limit
Method Blank		ND	2
L-6-1	EA102002-21	65.5	2
L-6-2	EA102002-22	100	2
L-6-3	EA102002-23	65.3	2
L-6-4	EA102002-24	4.7	2
L-7-1	EA102002-25	38.5	2
L-7-2	EA102002-26	7.8	2
L-7-3	EA102002-27	5.6	2
L-7-4	EA102002-28	4.3	2
L-8-1	EA102002-29	43.5	2
L-8-2	EA102002-30	27.1	2
L-8-3	EA102002-31	33.8	2
L-8-4	EA102002-32	95.0	2
L-9-1	EA102002-33	21.7	2
L-9-2	EA102002-34	6.4	2
L-9-3	EA102002-35	5.1	2
L-9-4	EA102002-36	5.2	2
L-10-1	EA102002-37	57.2	2
L-10-2	EA102002-38	5.4	2
L-10-3	EA102002-39	ND	2
L-10-4	EA102002-40	2.1	2

ND: Not Detected (at the specified limit).

Client: Earth Mechanics Inc.
Project: 10-126
Project Site: W/B SR-91 Between I-5 and SR-57
Matrix: Soil
Digestion Method:EPA 3050B
Batch No.: 0210-MS1

Lab Job No.: EA102002

Date Sampled: 01-28-2011
Date Received: 02-01-2011
Date Digested: 02-06-2011
Date Analyzed: 02-10-2011
Date Reported: 02-11-2011

EPA 6010B for Total Lead
Reporting Units: mg/kg (ppm)

Sample ID	Lab ID	Total Lead	Reporting Limit
Method Blank		ND	2
L-11-1	EA102002-41	5.4	2
L-11-2	EA102002-42	3.0	2
L-11-3	EA102002-43	3.0	2
L-11-4	EA102002-44	4.0	2
L-12-1	EA102002-45	29.3	2
L-12-2	EA102002-46	29.4	2
L-12-3	EA102002-47	31.5	2
L-12-4	EA102002-48	36.0	2
L-13-1	EA102002-49	10.6	2
L-13-2	EA102002-50	10.9	2
L-13-3	EA102002-51	10.3	2
L-13-4	EA102002-52	14.8	2
L-14-1	EA102002-53	50.9	2
L-14-2	EA102002-54	46.9	2
L-14-3	EA102002-55	44.6	2
L-14-4	EA102002-56	27.2	2
L-15-1	EA102002-57	2.2	2
L-15-2	EA102002-58	6.1	2
L-15-3	EA102002-59	ND	2
L-15-4	EA102002-60	ND	2

ND: Not Detected (at the specified limit).

Client: Earth Mechanics Inc.
Project: 10-126
Project Site: W/B SR-91 Between I-5 and SR-57
Matrix: Soil
Digestion Method:EPA 3050B
Batch No.: 0210-MS2

Lab Job No.: EA102002

Date Sampled: 01-27/28-2011
Date Received: 02-01-2011
Date Digested: 02-06-2011
Date Analyzed: 02-10-2011
Date Reported: 02-11-2011

EPA 6010B for Total Lead
Reporting Units: mg/kg (ppm)

Sample ID	Lab ID	Total Lead	Reporting Limit
Method Blank		ND	2
L-16-1	EA102002-61	5.1	2
L-16-2	EA102002-62	9.3	2
L-16-3	EA102002-63	ND	2
L-16-4	EA102002-64	4.3	2
L-17-1	EA102002-65	10.7	2
L-17-2	EA102002-66	20.0	2
L-17-3	EA102002-67	179	2
L-17-4	EA102002-68	6.0	2
L-18-1	EA102002-69	16.9	2
L-18-2	EA102002-70	3.4	2
L-18-3	EA102002-71	19.6	2
L-18-4	EA102002-72	12.6	2
L-19-1	EA102002-73	7.7	2
L-19-2	EA102002-74	6.1	2
L-19-3	EA102002-75	2.7	2
L-19-4	EA102002-76	15.8	2
L-20-1	EA102002-77	9.9	2
L-20-2	EA102002-78	17.5	2
L-20-3	EA102002-79	37.9	2
L-20-4	EA102002-80	27.2	2

ND: Not Detected (at the specified limit).

Client: Earth Mechanics Inc.
Project: 10-126
Project Site: W/B SR-91 Between I-5 and SR-57
Matrix: Soil
Digestion Method:EPA 3050B
Batch No.: 0210-MS3

Lab Job No.: EA102002

Date Sampled: 01-27-2011
Date Received: 02-01-2011
Date Digested: 02-06-2011
Date Analyzed: 02-10-2011
Date Reported: 02-11-2011

EPA 6010B for Total Lead
Reporting Units: mg/kg (ppm)

Sample ID	Lab ID	Total Lead	Reporting Limit
Method Blank		ND	2
L-21-1	EA102002-81	4.6	2
L-21-2	EA102002-82	5.9	2
L-21-3	EA102002-83	24.9	2
L-21-4	EA102002-84	4.9	2
L-22-1	EA102002-85	20.4	2
L-22-2	EA102002-86	ND	2
L-22-3	EA102002-87	ND	2
L-22-4	EA102002-88	ND	2
L-23-1	EA102002-89	43.2	2
L-23-2	EA102002-90	29.1	2
L-23-3	EA102002-91	85.2	2
L-23-4	EA102002-92	32.6	2

ND: Not Detected (at the specified limit).

02-11-2011

EPA 6010B (Total Lead)
Batch QA/QC Report

Client:	Earth Mechanics Inc.	Lab Job No:	EA102002
Project:	10-126		
Matrix:	Soil	Lab Sample ID:	LCS2
Batch No.:	0208-MS2	Date Analyzed:	02-08-2011

LCS/LCSD Report

Batch No.	MB Conc.	LCS %Rec.	LCSD %Rec.	% RPD	%RPD Accept. Limit	%Rec Accept. Limit
Lead (Pb)	ND	102.0	91.0	11.4	20	80-120

ND: Not Detected.

02-11-2011

EPA 6010B (Total Lead)
Batch QA/QC Report

Client:	Earth Mechanics Inc.	Lab Job No:	EA102002
Project:	10-126		
Matrix:	Soil	Lab Sample ID:	LCS3
Batch No.:	0208-MS3	Date Analyzed:	02-08-2011

LCS/LCSD Report

Batch No.	MB Conc.	LCS %Rec.	LCSD %Rec.	% RPD	%RPD Accept. Limit	%Rec Accept. Limit
Lead (Pb)	ND	114.9	112.7	1.9	20	80-120

ND: Not Detected.

02-11-2011

EPA 6010B (Total Lead)
Batch QA/QC Report

Client:	Earth Mechanics Inc.	Lab Job No:	EA102002
Project:	10-126		
Matrix:	Soil	Lab Sample ID:	LCS1
Batch No.:	0210-MS1	Date Analyzed:	02-10-2011

LCS/LCSD Report

Batch No.	MB Conc.	LCS %Rec.	LCSD %Rec.	% RPD	%RPD Accept. Limit	%Rec Accept. Limit
Lead (Pb)	ND	108.0	109.3	1.2	20	80-120

ND: Not Detected.

02-11-2011

EPA 6010B (Total Lead)
Batch QA/QC Report

Client:	Earth Mechanics Inc.	Lab Job No:	EA102002
Project:	10-126		
Matrix:	Soil	Lab Sample ID:	LCS2
Batch No.:	0210-MS2	Date Analyzed:	02-10-2011

LCS/LCSD Report

Batch No.	MB Conc.	LCS %Rec.	LCSD %Rec.	% RPD	%RPD Accept. Limit	%Rec Accept. Limit
Lead (Pb)	ND	105.8	94.7	11.1	20	80-120

ND: Not Detected.

02-11-2011

EPA 6010B (Total Lead)
Batch QA/QC Report

Client:	Earth Mechanics Inc.	Lab Job No:	EA102002
Project:	10-126		
Matrix:	Soil	Lab Sample ID:	LCS3
Batch No.:	0210-MS3	Date Analyzed:	02-10-2011

LCS/LCSD Report

Batch No.	MB Conc.	LCS %Rec.	LCSD %Rec.	% RPD	%RPD Accept. Limit	%Rec Accept. Limit
Lead (Pb)	ND	99.4	97.8	1.6	20	80-120

ND: Not Detected.

Alpha Scientific Corporation
Environmental Laboratories

02-22-2011

Mr. Lino Cheang
Earth Mechanics Inc.
17800 Newhope Street, Suite B
Fountain Valley, CA 92708

Project: 10-126
Project Site: W/B SR-91 Between I-5 and SR-57
Sample Date: 01-27/28/31-2011& 02-01-2011
Lab Job No.: EA102002A

Dear Mr. Cheang:

Enclosed please find the analytical report for the sample(s) received by Alpha Scientific Corporation on 02-01-2011 and analyzed by the following EPA methods:

EPA 9045 (pH)
EPA 6010B (Pb, STLC)
EPA 6010B (Pb, TCLP)
EPA 6010B (Pb, STLC, DI-Water Extraction)

All analyses have met the QA/QC criteria of this laboratory.

The sample(s) arrived in good conditions (i.e., chilled, intact) and with a chain of custody record attached.

Alpha Scientific Corporation is a CA DHS certified laboratory (Certificate Number 2633). Thank you for giving us the opportunity to serve you. Please feel free to call me at (562) 809-8880 if our laboratory can be of further service to you.

Sincerely,

Roger Wang, Ph.D.
Laboratory Director

Enclosures

This cover letter is an integral part of this analytical report.

Client:	Earth Mechanics Inc.	Lab Job No.:	EA102002A
Project:	10-126		
Project Site:	W/B SR-91 Between I-5 and SR-57	Date Sampled:	01-27,28,31/02-01-2011
Matrix:	Soil	Date Received:	02-01-2011
Batch No.:	0214-PH1	Date Analyzed:	02-14-2011
		Date Reported:	02-20-2011

EPA Method 9045 (Soil pH)
Reporting Units: pH Unit

Sample ID	Lab ID	pH	Reporting Limit
L-2-2	EA102002-6	6.92	---
L-2-3	EA102002-7	6.75	---
L-4-1	EA102002-13	7.12	---
L-6-1	EA102002-21	6.54	---
L-6-2	EA102002-22	7.26	---
L-6-3	EA102002-23	7.24	---
L-8-4	EA102002-32	7.48	---
L-10-1	EA102002-37	7.42	---
L-14-1	EA102002-53	7.23	---
L-17-3	EA102002-67	6.94	---
L-23-3	EA102002-91	7.11	---

ND: Not Detected (below RL)

Client: Earth Mechanics Inc.
Project: 10-126
Project Site: W/B SR-91 Between I-5 and SR-57
Matrix: Soil
Batch No. for 6010B: 0216-MS2

Lab Job No.: EA102002A

Date Sampled: 01-27,28,31/02-01-2011
Date Received: 02-01-2011
Date Analyzed: 02-16-2011
Date Reported: 02-20-2011

EPA 6010B (Pb, STLC)
Reporting Unit: mg/L (ppm)

Sample ID	Lab ID	Lead, STLC	MDL	PQL
Extraction Blank		ND	0.1	0.2
L-2-2	EA102002-6	3.2	0.1	0.2
L-2-3	EA102002-7	1.1	0.1	0.2
L-4-1	EA102002-13	2.7	0.1	0.2
L-5-2	EA102002-18	0.15 J	0.1	0.2
L-5-4	EA102002-20	1.9	0.1	0.2
L-6-1	EA102002-21	3.0	0.1	0.2
L-6-2	EA102002-22	8.3	0.1	0.2
L-6-3	EA102002-23	5.4	0.1	0.2
L-8-1	EA102002-29	2.5	0.1	0.2
L-8-4	EA102002-32	8.0	0.1	0.2
L-10-1	EA102002-37	3.7	0.1	0.2
L-13-1	EA102002-49	0.42	0.1	0.2
L-14-1	EA102002-53	1.8	0.1	0.2
L-14-2	EA102002-54	3.3	0.1	0.2
L-17-3	EA102002-67	15.5	0.1	0.2
L-20-3	EA102002-79	1.7	0.1	0.2
L-21-3	EA102002-83	1.4	0.1	0.2
L-23-1	EA102002-89	1.9	0.1	0.2
L-23-3	EA102002-91	1.5	0.1	0.2

Note: Sample Preparation: Extraction Procedures, STLC Metals, Title 22, Cal Wet 66700, 48 hours (02-14 to 01-16-2011).
MDL: Method Detection Limit;
PQL: Practical Quantitation Limit;
J: Trace concentration. The result is between MDL and PQL;
ND: Not Detected (at the specified limit).

Client:	Earth Mechanics Inc.	Lab Job No.:	EA102002A
Project:	10-126		
Project Site:	W/B SR-91 Between I-5 and SR-57	Date Sampled:	01-27,28,31/02-01-2011
Matrix:	Soil	Date Received:	02-01-2011
Batch No. for 6010B:	0216-MS1	Date Analyzed:	02-16-2011
		Date Reported:	02-20-2011

EPA 6010B (Pb, TCLP)
Reporting Unit: mg/L (ppm)

Sample ID	Lab ID	Lead, TCLP	MDL	PQL
Extraction Blank		ND	0.1	0.2
L-2-2	EA102002-6	ND	0.1	0.2
L-2-3	EA102002-7	ND	0.1	0.2
L-4-1	EA102002-13	0.17 J	0.1	0.2
L-6-1	EA102002-21	ND	0.1	0.2
L-6-2	EA102002-22	0.15 J	0.1	0.2
L-6-3	EA102002-23	0.10 J	0.1	0.2
L-8-4	EA102002-32	0.27	0.1	0.2
L-10-1	EA102002-37	ND	0.1	0.2
L-14-1	EA102002-53	ND	0.1	0.2
L-17-3	EA102002-67	0.39	0.1	0.2
L-23-3	EA102002-91	ND	0.1	0.2

Note: Sample Preparation: EPA 1311, 18 hours (02-14 to 02-15-2011).

MDL: Method Detection Limit;
PQL: Practical Quantitation Limit;
J: Trace concentration. The result is between MDL and PQL;
ND: Not Detected (at the specified limit).

Client: Earth Mechanics Inc.
Project: 10-126
Project Site: W/B SR-91 Between I-5 and SR-57
Matrix: Soil
Batch No. for 6010B: 0222-MS1

Lab Job No.: EA102002A

Date Sampled: 01-27,28,31/02-01-2011
Date Received: 02-01-2011
Date Analyzed: 02-22-2011
Date Reported: 02-22-2011

EPA 6010B (Pb, STLC-DI Water Extraction)
Reporting Unit: mg/L (ppm)

Sample ID	Lab ID	Lead, STLC	MDL	PQL
Extraction Blank		ND	0.1	0.2
L-2-2	EA102002-6	0.19 J	0.1	0.2
L-2-3	EA102002-7	ND	0.1	0.2
L-4-1	EA102002-13	0.20	0.1	0.2
L-6-1	EA102002-21	0.20	0.1	0.2
L-6-2	EA102002-22	0.41	0.1	0.2
L-6-3	EA102002-23	0.27	0.1	0.2
L-8-4	EA102002-32	0.24	0.1	0.2
L-10-1	EA102002-37	0.15 J	0.1	0.2
L-14-1	EA102002-53	ND	0.1	0.2
L-17-3	EA102002-67	0.63	0.1	0.2
L-23-3	EA102002-91	0.14 J	0.1	0.2

Note: Sample Preparation: Extraction Procedures, STLC Metals, Title 22, Cal Wet 66700, 48 hours (02-19 to 02-21-2011). DI water is used in the extraction instead of the normal STLC solution.

MDL: Method Detection Limit;
PQL: Practical Quantitation Limit;
J: Trace concentration. The result is between MDL and PQL;
ND: Not Detected (at the specified limit).

02-22-2011

EPA 6010B (Pb, STLC)
Batch QA/QC Report

Client:	Earth Mechanics Inc.	Lab Job No:	EA102002A
Project:	10-126		
Matrix:	Soil	Lab ID:	LCS
Batch No. for 6010B:	0216-MS2	Date Analyzed:	02-16-2011

LCS/LCSD Report

Analyte	EPA Method	MB Conc.	LCS %Rec.	LCSD %Rec.	% RPD	%RPD Accept. Limit	%Rec Accept. Limit
Pb	6010B	ND	102.7	96.0	6.7	20	80-120

ND: Not Detected

02-22-2011

EPA 6010B (Pb, TCLP)
Batch QA/QC Report

Client: Earth Mechanics Inc.
Project: 10-126
Matrix: Soil
Batch No. for 6010B: 0216-MS1

Lab Job No: EA102002A
Lab ID: LCS
Date Analyzed: 02-16-2011

LCS/LCSD Report

Analyte	EPA Method	MB Conc.	LCS %Rec.	LCSD %Rec.	% RPD	%RPD Accept. Limit	%Rec Accept. Limit
Pb	6010B	ND	98.1	99.6	1.5	20	80-120

ND: Not Detected

02-22-2011

EPA 6010B (Pb, STLC)
Batch QA/QC Report

Client: Earth Mechanics Inc.
Project: 10-126
Matrix: Soil
Batch No. for 6010B: 0222-MS1

Lab Job No: EA102002A
Lab ID: LCS
Date Analyzed: 02-22-2011

LCS/LCSD Report

Analyte	EPA Method	MB Conc.	LCS %Rec.	LCSD %Rec.	% RPD	%RPD Accept. Limit	%Rec Accept. Limit
Pb	6010B	ND	103.3	103.1	0.2	20	80-120

ND: Not Detected

ALPHA SCIENTIFIC CORPORATION
CHAIN OF CUSTODY RECORD

Lab Job Number EA102002

Client: EARTH MECHANICS, INC.

Address: 17800 NEWHOPE ST., Suite B, FOUNTAIN VALLEY, CA 92708

Report Attention: LING CHEANG | Phone: 714 751-3920 | Fax: 714 751-3928 | Sampled by: R.J.

Project Name/No.: 10-126 | Project Site: W/B SR-91 Between I-5 and SR-57

T.A.T. Requested: ☐ 8 hrs ☐ 24 hrs ☐ 48 hrs ☐ 3 days ☑ Normal

Sample Condition: ☐ Chilled ☒ Intact ☐ Sample seals

Client Sample ID	Lab Sample ID	Sample Collection Date	Sample Collection Time	Matrix Type	Sample Preserv	No..type* & size of container	TPH-Gasoline	TPH-Diesel	8260B (BTEX, Oxygenates)	8260B (VOCs)	8270C (SVOCs)	CAM Metals	8082 (PCBs)	Total Lead EPA - 6010B	PH, EPA 9045C	STLC (DI-WET) 6010B-DI WET	STLC (CITRATE) 6010B-STLC	TCLP - 6010B, TCLP	Remark
L-1-1	EA102002-1	2-1-11	1330	Soil	N/A	4oz jar								✓					Additional Tests
L-1-2	-2		1340											✓					Maybe assigned
L-1-3	-3		1350											✓					in future, please
L-1-4	-4		1415											✓					Keep Samples
L-2-1	-5		1155											✓					Refrigerated.
L-2-2	-6		1205											✓					
L-2-3	-7		1220											✓					
L-2-4	-8		1240											✓					
L-3-1	-9		1025											✓					
L-3-2	-10		1035											✓					
L-3-3	-11		1050											✓					
L-3-4	-12		1115											✓					
L-4-1	-13		0915											✓					
L-4-2	-14		0925											✓					
L-4-3	-15		0940											✓					
L-4-4	-16		1000											✓					

Relinquished by	Company	Date	Time	Received by	Company	Date	Time
[signature]	E.M.I.	2-1-11	1500	[signature]	ASC	2-1-11	15:50
Relinquished by	Company	Date	Time	Received by	Company	Date	Time

Container types: M=Metal Tube, A=Air Bag, P=Plastic bottle, G=Glass bottle, V=VOA vial

Alpha Scientific Corporation
16760 Gridley Road
Cerritos, CA 90703

Email: ascorp@verizon.net
Tel: (562) 809-8880
Fax: (562) 809-8801

Note: Samples are discarded 30 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client's expense.
Distribution: WHITE with report, PINK to courier.

ALPHA SCIENTIFIC CORPORATION
CHAIN OF CUSTODY RECORD

Lab Job Number EA102002

Client: EARTH MECHANICS, INC.

Address: 17800 NEWHOPE ST., Suite B, FOUNTAIN VALLEY, CA 92708

Report Attention: LINO CHEANG | Phone: 714 751-3826 | Fax: 714 751-3928 | Sampled by: R. J.

Project Name/No.: 10-126 | Project Site: W/B SR-91 Between I-5 and SR-57

T.A.T. Requested: ☐ 8 hrs ☐ 24 hrs ☐ 48 hrs ☐ 3 days ☒ Normal

Sample Condition: ☐ Chilled ☒ Intact ☐ Sample seals

Client Sample ID	Lab Sample ID	Sample Collection Date	Sample Collection Time	Matrix Type	Sample Preserv	No..type* & size of container	TPH-Gasoline	TPH-Diesel	8260B (BTEX, Oxygenates)	8260B (VOCs)	8270C (SVOCs)	CAM Metals	8082 (PCBs)	Total Lead EPA-6010B	pH, EPA 9045C	STLC (DI-WET) 6010B-DI WET	STLC (CITRATE) 6010B-STLC	TCLP, 6010B-TCLP	Remark
L-5-1	EA102002-17	2-1-11	0740	Soil	N/A	4 oz jar								✓					Additional tests
L-5-2	-18	↓	0750	↓	↓	↓								✓					may be assigned
L-5-3	-19		0815											✓					in future, please
L-6-1	-21	1-31-11	1230											✓					keep samples
L-6-2	-22		1240											✓					refrigerated.
L-6-3	-23		1255											✓					
L-6-4	-24		1310											✓					
L-7-1	-25		1000											✓					
L-7-2	-26		1010											✓					
L-7-3	-27		1025											✓					
L-7-4	-28		1040											✓					
L-8-1	-29		1105											✓					
L-8-2	-30		1115											✓					
L-8-3	-31		1130											✓					
L-8-4	-32	↓	1145	↓	↓	↓								✓					
L-5 dup	-20	2-1-11	0845	"	"	"								✓					

Relinquished by	Company	Date	Time	Received by	Company	Date	Time
[signature]	E.M.I.	2-1-11	1500	[signature]	ABC	2-1-11	15:00
Relinquished by	Company	Date	Time	Received by	Company	Date	Time

Container types: M=Metal Tube, A=Air Bag, P=Plastic bottle, G=Glass bottle, V=VOA vial

Alpha Scientific Corporation
16760 Gridley Road
Cerritos, CA 90703

Email: ascorp@verizon.net
Tel: (562) 809-8880
Fax: (562) 809-8801

Note: Samples are discarded 30 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client's expense.
Distribution: WHITE with report, PINK to courier.

ALPHA SCIENTIFIC CORPORATION
CHAIN OF CUSTODY RECORD

Lab Job Number EA102002

Client: EARTH MECHANICS, INC.

Address: 17800 NEWHOPE st., Suite B, FOUNTAIN VALLEY, CA 92708

Report Attention | Phone 714 751-3826 | Fax 714 751-3920 | Sampled by R.J.

Project Name/No.: 10-126 | Project Site: W/B SR-91 Between I-5 and SR-57

T.A.T. Requested: ☐ 8 hrs ☐ 24 hrs ☐ 48 hrs ☐ 3 days ☑ Normal

Sample Condition: ☐ Chilled ☒ Intact ☐ Sample seals

Client Sample ID	Lab Sample ID	Sample Collection Date	Sample Collection Time	Matrix Type	Sample Preserv	No..type* & size of container	TPH-Gasoline	TPH-Diesel	8260B (BTEX, Oxygenates)	8260B (VOCs)	8270C (SVOCs)	CAM Metals	8082 (PCBs)	Total Lead EPA-6010B	PH, EPA-9045C	STLC (DI-WET) 6010B, DI WET	STLC (citrate) 6010B-STLC	TCLP, 6010B-TCLP	Remark
L-9-1	EA102002-33	1-31-11	0850	Soil	N/A	4oz jar								✓					Additional Tests
L-9-2	-34		0900											✓					May be assigned
L-9-3	-35		0915											✓					in future, please
L-9-4	-36		0930											✓					Keep samples
L-10-1	-37		0745											✓					refrigerated.
L-10-2	-38		0755											✓					
L-10-3	-39		0810											✓					
L-10-4	-40	↓	0825											✓					
L-11-1	-41	1-28-11	1325											✓					
L-11-2	-42		1335											✓					
L-11-3	-43		1350											✓					
L-11-4	-44	↓	1410											✓					
L-12-1	-45	1-28-11	1225											✓					
L-12-2	-46		1235											✓					
L-12-3	-47		1250											✓					
L-12-4	-48	↓	1305	↓	↓	↓								✓					

Relinquished by	Company	Date	Time	Received by	Company	Date	Time
Reinquished by	E.M.I.	2-1-11	1500		ASC	2-11-11	1500
Relinquished by	Company	Date	Time	Received by	Company	Date	Time

Container types: M=Metal Tube, P=Plastic bottle, A=Air Bag, G=Glass bottle, V=VOA vial

Alpha Scientific Corporation
16760 Gridley Road
Cerritos, CA 90703

Email: ascorp@verizon.net
Tel: (562) 809-8880
Fax: (562) 809-8801

Note: Samples are discarded 30 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client's expense.
Distribution: WHITE with report, PINK to courier.

ALPHA SCIENTIFIC CORPORATION

CHAIN OF CUSTODY RECORD

Lab Job Number EA102002

Client: EARTH MECHANICS, INC.

Address: 17800 NEWHOPE St. Suite B, FOUNTAIN VALLEY CA 92708

Report Attention | Phone 714 751-3826 | Fax 714 751-3928 | Sampled by R.J.

Project Name/No.: 10-126 | Project Site: W/B SR-91 Between I-5 and SR-57

T.A.T. Requested: ☐ 8 hrs ☐ 24 hrs ☐ 48 hrs ☐ 3 days ☑ Normal

Sample Condition: ☐ Chilled ☒ Intact ☐ Sample seals

Analyses Requested: TPH-Gasoline; TPH-Diesel; 8260B (BTEX, Oxygenates); 8260B (VOCs); 8270C (SVOCs); CAM Metals; 8082 (PCBs); Total Lead EPA-6010B; pH, EPA-9045C; STLC CDI-WET 6010B, DIWET; STLC 6010B-STLC (CITRATE); TCLP, 6010B-TCLP

Client Sample ID	Lab Sample ID	Sample Collection Date	Sample Collection Time	Matrix Type	Sample Preserv	No.,type* & size of container	Total Lead EPA-6010B	Remark
L-13-1	EA102002-49	1-28-11	1430	Soil	N/A	4 oz. jar	✓	Additional tests may be assigned in future. please keep samples refrigerated.
L-13-2	-50		1440				✓	
L-13-3	-51		1455				✓	
L-13-4	-52		1510				✓	
L-14-1	-53		1050				✓	
L-14-2	-54		1100				✓	
L-14-3	-55		1115				✓	
L-14-4	-56		1135				✓	
L-15-1	-57		0950				✓	
L-15-2	-58		1000				✓	
L-15-3	-59		1015				✓	
L-15-4	-60		1030				✓	
L-16-1	-61		0850				✓	
L-16-2	-62		0900				✓	
L-16-3	-63		0915				✓	
L-16-4	-64	↓	0935	↓	↓	↓	✓	

Relinquished by	Company	Date	Time	Received by	Company	Date	Time
[signature]	E.M.I.	2-1-11	1500	[signature]	ASC	2-1-11	15:00
Relinquished by	Company	Date	Time	Received by	Company	Date	Time

Container types: M=Metal Tube, A=Air Bag, P=Plastic bottle, G=Glass bottle, V=VOA vial

Alpha Scientific Corporation
16760 Gridley Road
Cerritos, CA 90703

Email: ascorp@verizon.net
Tel: (562) 809-8880
Fax: (562) 809-8801

Note: Samples are discarded 30 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client's expense.
Distribution: WHITE with report. PINK to courier.

ALPHA SCIENTIFIC CORPORATION
CHAIN OF CUSTODY RECORD

Lab Job Number EA102002

Client: EARTH MECHANICS, INC

Address: 17800 NEWHOPE ST., SUITE B, FOUNTAIN VALLEY, CA 92708

Report Attention: LINO CHEANG | Phone: 714 751-3826 | Fax: 714 751-3928 | Sampled by: R. JIE

Project Name/No.: 10-126 | Project Site: W/B SR-91, Between I-5 and SR-57

T.A.T. Requested: ☐ 8 hrs ☐ 24 hrs ☐ 48 hrs ☐ 3 days ☑ Normal

Sample Condition: ☐ Chilled ☒ Intact ☐ Sample seals

Client Sample ID	Lab Sample ID	Sample Collection Date	Sample Collection Time	Matrix Type	Sample Preserv	No..type* & size of container	TPH-Gasoline	TPH-Diesel	8260B (BTEX, Oxygenates)	8260B (VOCs)	8270C (SVOCs)	CAM Metals	8082 (PCBs)	Total Lead EPA- 6010 B	PH- EPA 9045C	STLC (DI-WET) 6010B-DI WET	STLC (CITRATE) 6010 B-STLC	TCLP, 6010B-TCLP	Remark
L-17-1	EA102002-65	1-28-11	0740	Soil	N/A	4oz. jar								✓					Additional Tests
L-17-2	-66		0750											✓					May be assigned
L-17-3	-67		0805											✓					in future, please
L-17-4	-68	↓	0825											✓					keep samples
L-18-1	-69	1-27-11	1420											✓					refrigerated
L-18-2	-70		1430											✓					
L-18-3	-71		1445											✓					
L-18-4	-72		1505											✓					
L-19-1	-73		1310											✓					
L-19-2	-74		1320											✓					
L-19-3	-75		1335											✓					
L-19-4	-76		1450											✓					
L-20-1	-77		1110											✓					
L-20-2	-78		1120											✓					
L-20-3	-79		1135											✓					
L-20-4	-80	↓	1155	↓	↓	↓								✓					

Relinquished by	Company	Date	Time	Received by	Company	Date	Time
Reynold Jie	E.M.I.	2-1-11	1500	[illegible]	ASC	2-1-11	15:00
Relinquished by	Company	Date	Time	Received by	Company	Date	Time

Container types: M=Metal Tube, A=Air Bag, P=Plastic bottle, G=Glass bottle, V=VOA vial

Alpha Scientific Corporation
16760 Gridley Road
Cerritos, CA 90703

Email: ascorp@verizon.net
Tel: (562) 809-8880
Fax: (562) 809-8801

Note: Samples are discarded 30 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client's expense.
Distribution: WHITE with report, PINK to courier.

ALPHA SCIENTIFIC CORPORATION
CHAIN OF CUSTODY RECORD

Lab Job Number EA102002

Client:	EARTH MECHANICS, INC.
Address	17800 NEWHOPE ST., SUITE B, FOUNTAIN VALLEY, CA 92708
Report Attention	LINO CHEANG
Phone	714 751-3826
Fax	714 751-3928
Sampled by	R. JIE
Project Name/No.	10-126
Project Site	W/B SR-91, Between I-5 and SR-57
T.A.T. Requested	☐ 8 hrs ☐ 24 hrs ☐ 48 hrs ☐ 3 days ☑ Normal
Sample Condition	☐ Chilled ☒ Intact ☐ Sample seals

Analyses Requested: TPH-Gasoline; TPH-Diesel; 8260B (BTEX, Oxygenates); 8260B (VOCs); 8270C (SVOCs); CAM Metals; 8082 (PCBs); Total Lead EPA 6010B; PH - EPA 9045C; STLC (DI-WET) 6010B-DI WET; STLC (Citrate) 6010B-STLC; TCLP, 6010B TCLP

Client Sample ID	Lab Sample ID	Date	Time	Matrix Type	Sample Preserv	No., type* & size of container	TPH-Gasoline	TPH-Diesel	8260B (BTEX, Oxygenates)	8260B (VOCs)	8270C (SVOCs)	CAM Metals	8082 (PCBs)	Total Lead EPA 6010B	PH - EPA 9045C	STLC (DI-WET) 6010B-DI WET	STLC (Citrate) 6010B-STLC	TCLP, 6010B TCLP	Remark
L-21-1	EA102002-81	1-27-11	0950	Soil	N/A	4oz jar								✓					Additional tests
L-21-2	-82	↓	1000	↓	↓	↓								✓					May be assigned
L-21-3	-83	↓	1010	↓	↓	↓								✓					in future, please
L-21-4	-84	↓	1025	↓	↓	↓								✓					Keep samples
L-22-1	-85	↓	0840	↓	↓	↓								✓					refrigerated
L-22-2	-86	↓	0850	↓	↓	↓								✓					
L-22-3	-87	↓	0900	↓	↓	↓								✓					
L-22-4	-88	↓	0915	↓	↓	↓								✓					
L-23-1	-89	↓	0740	↓	↓	↓								✓					
L-23-2	-90	↓	0750	↓	↓	↓								✓					
L-23-3	-91	↓	0800	↓	↓	↓								✓					
L-23-4	-92	↓	0810	↓	↓	↓													

Relinquished by	Company	Date	Time	Received by	Company	Date	Time
Raymond Jie	E.M.I.	2-1-11	1500	[signature]	ASC	2-1-11	15:00
Relinquished by	Company	Date	Time	Received by	Company	Date	Time

Container types: A=Air Bag, G=Glass bottle, M=Metal Tube, P=Plastic bottle, V=VOA vial

Alpha Scientific Corporation
16760 Gridley Road
Cerritos, CA 90703

Email: ascorp@verizon.net
Tel: (562) 809-8880
Fax: (562) 809-8801

Note: Samples are discarded 30 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client's expense. Distribution: WHITE with report, PINK to courier.

Alpha Scientific Corporation
Environmental Laboratories

02-03-2011

Mr. Lino Cheang
Earth Mechanics Inc.
17800 Newhope Street, Suite B
Fountain Valley, CA 92708

Project: 10-126
Project Site: W/B SR-91 Widening
Sample Date: 01-26-2011
Lab Job No.: EA101134

Dear Mr. Cheang:

Enclosed please find the analytical report for the sample(s) received by Alpha Scientific Corporation on 01-28-2011 and analyzed by the following EPA methods:

EPA 6010B (Total Lead)

All analyses have met the QA/QC criteria of this laboratory.

The sample(s) arrived in good conditions (i.e., chilled, intact) and with a chain of custody record attached.

Alpha Scientific Corporation is a CA DHS certified laboratory (Certificate Number 2633). Thank you for giving us the opportunity to serve you. Please feel free to call me at (562) 809-8880 if our laboratory can be of further service to you.

Sincerely,

Roger Wang, Ph.D.
Laboratory Director

Enclosures

This cover letter is an integral part of this analytical report.

Client:	Earth Mechanics Inc.	Lab Job No.:	EA101134
Project:	10-126		
Project Site:	W/B SR-91 Widening	Date Sampled:	01-26-2011
Matrix:	Paint	Date Received:	01-28-2011
Digestion Method:	EPA 3050B	Date Digested:	01-31-2011
Batch No.:	0202-MS1	Date Analyzed:	02-02-2011
		Date Reported:	02-03-2011

EPA 6010B for Total Lead
Reporting Units: mg/kg (ppm)

Sample ID	Lab ID	Total Lead	Reporting Limit
Method Blank		ND	2
L-S-1	EA101134-1	61.0	2
L-R-1	EA101134-2	401	2
L-E-1	EA101134-3	516	2
L-B-1	EA101134-4	12.3	2

ND: Not Detected (at the specified limit).

02-03-2011

EPA 6010B (Total Lead)
Batch QA/QC Report

Client:	Earth Mechanics Inc.	Lab Job No:	EA101134
Project:	10-126		
Matrix:	Paint	Lab Sample ID:	LCS
Batch No.:	0202-MS1	Date Analyzed:	02-02-2011

LCS/LCSD Report

Batch No.	MB Conc.	LCS %Rec.	LCSD %Rec.	% RPD	%RPD Accept. Limit	%Rec Accept. Limit
Lead (Pb)	ND	92.9	95.5	2.8	20	80-120

ND: Not Detected.

Alpha Scientific Corporation
Environmental Laboratories

Client: Earth Mechanics Inc.
Project: 10-126
Project Site: W/B SR-91 Widening
Matrix: Paint
Batch No. for 6010B: 0210-MS3

Lab Job No.: EA101134A

Date Sampled: 01-26-2011
Date Received: 01-28-2011
Date Analyzed: 02-10-2011
Date Reported: 03-04-2011

EPA 6010B (Pb, STLC)
Reporting Unit: mg/L (ppm)

Sample ID	Lab ID	Lead, STLC		
Method Detection Limit		0.1		
Practical Quantitation Limit.		0.2		
Extraction Blank		ND		
L-S-1	EA101134-1	0.96		
L-R-1	EA101134-2	2.2		
L-E-1	EA101134-3	2.8		
L-B-1	EA101134-4	0.10		

Note: Sample Preparation: Extraction Procedures, STLC Metals, Title 22, Cal Wet 66700, 48 hours (02-07 to 02-09-2011).

ND: Not Detected (at the specified limit).

Checked & approved by:

Roger Wang, Ph.D.
Laboratory Director

03-04-2011

EPA 6010B (Pb)
Batch QA/QC Report

Client: Earth Mechanics Inc.
Project: 10-126
Matrix: Solid
Batch No. for 6010B: 0210-MS3

Lab Job No.: EA101134A
Lab ID: LCS
Date Analyzed: 02-10-2011

LCS/LCSD Report

Analyte	EPA Method	MB Conc.	LCS %Rec.	LCSD %Rec.	% RPD	%RPD Accept. Limit	%Rec Accept. Limit
Pb	6010B	ND	99.4	97.8	1.6	20	80-120

ND: Not Detected.

ALPHA SCIENTIFIC CORPORATION
CHAIN OF CUSTODY RECORD

Lab Job Number EA#11134

Client:	Analyses Requested	T.A.T. Requested
EARTH MECHANICS INC. (L.CHEANG@EARTHMECH.COM)		☐ 8 hrs ☐ 24 hrs ☐ 48 hrs ☐ 3 days ☑ Normal
Address: 17800 NEWHOPE ST., SUITE B, FOUNTAIN VALLEY, CA 92708		Sample Condition: ☐ Chilled ☐ Intact ☐ Sample seals
Report Attention: LINO CHEANG / Phone: 714 751-3826 / Fax: 714 751-3928 / Sampled by: R. JUE		
Project Name/No.: 10-126 / Project Site: W/B SR-91 WIDening		

Client Sample ID	Lab Sample ID	Sample Collection Date	Sample Collection Time	Matrix Type	Sample Preserv	No..type* & size of container	TPH-Gasoline	TPH-Diesel	8260B (BTEX, Oxygenates)	8260B (VOCs)	8270C (SVOCs)	CAM Metals	8082 (PCBs)	EPA 3050 B/7420 Lead by AAS or 6010 B				Remark
L-S-1	EA#11341	11-26-11	1415	Paint	N/A	4 oz. jar								✓				
L-R-1	-2	↓	1430	↓	↓	↓								✓				
L-E-1	-3		1450											✓				
L-B-1	-4		1520											✓				

Relinquished by	Company	Date	Time	Received by	Company	Date	Time
[signature]	E.M.I.	11-28-11	1600	[signature]	ASC	11/28/11	16:00
Relinquished by	Company	Date	Time	Received by	Company	Date	Time

Container types: M=Metal Tube, P=Plastic bottle, A=Air Bag, V=VOA vial, G=Glass bottle

Alpha Scientific Corporation
16760 Gridley Road
Cerritos, CA 90703

Email: ascorp@verizon.net
Tel: (562) 809-8880
Fax: (562) 809-8801

Note: Samples are discarded 30 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client's expense.
Distribution: WHITE with report, PINK to courier.

Alpha Scientific Corporation
Environmental Laboratories

05-19-2011

Mr. Lino Cheang
Earth Mechanics Inc.
17800 Newhope Street, Suite B
Fountain Valley, CA 92708

Project: 10-126
Project Site: West Bound SR-91, Harbor Blvd. on-Ramp
Sample Date: 05-16-2011
Lab Job No.: EA105069

Dear Mr. Cheang:

Enclosed please find the analytical report for the sample(s) received by Alpha Scientific Corporation on 05-16-2011 and analyzed by the following EPA methods:

EPA 6010B (Total Lead)

All analyses have met the QA/QC criteria of this laboratory.

The sample(s) arrived in good conditions (i.e., chilled, intact) and with a chain of custody record attached.

Alpha Scientific Corporation is a CA DHS certified laboratory (Certificate Number 2633). Thank you for giving us the opportunity to serve you. Please feel free to call me at (562) 809-8880 if our laboratory can be of further service to you.

Sincerely,

Roger Wang, Ph.D.
Laboratory Director

Enclosures

This cover letter is an integral part of this analytical report.

Client:	Earth Mechanics Inc.	Lab Job No.:	EA105069
Project:	10-126		
Project Site:	West Bound SR-91, Harbor Blvd. on-Ramp	Date Sampled:	05-16-2011
Matrix:	Solid	Date Received:	05-16-2011
Digestion Method:	EPA 3050B	Date Digested:	05-17-2011
Batch No.:	0518-MS1	Date Analyzed:	05-18-2011
		Date Reported:	05-19-2011

EPA 6010B for Total Lead
Reporting Units: mg/kg (ppm)

Sample ID	Lab ID	Total Lead	Reporting Limit
Method Blank		ND	2
L-24-1	EA105069-1	40.3	2
L-24-2	EA105069-2	140	2
L-24-3	EA105069-3	75.4	2
L-24-4	EA105069-4	65.8	2
L-25-1	EA105069-5	55.3	2
L-25-2	EA105069-6	6.5	2
L-25-3	EA105069-7	ND	2
L-25-4	EA105069-8	ND	2
L-26-1	EA105069-9	7.9	2
L-26-2	EA105069-10	4.3	2
L-26-3	EA105069-11	3.3	2
L-26-4	EA105069-12	ND	2
L-27-1	EA105069-13	18.5	2
L-27-2	EA105069-14	13.6	2
L-27-3	EA105069-15	6.4	2
L-27-4	EA105069-16	3.8	2
L-1-1 (Paint)	EA105069-17	98.4	2

ND: Not Detected (at the specified limit).

05-19-2011

EPA 6010B (Total Lead)
Batch QA/QC Report

Client:	Earth Mechanics Inc.	Lab Job No:	EA105069
Project:	10-126		
Matrix:	Solid	Lab Sample ID:	LCS
Batch No.:	0518-MS1	Date Analyzed:	05-18-2011

LCS/LCSD Report

Batch No.	MB Conc.	LCS %Rec.	LCSD %Rec.	% RPD	%RPD Accept. Limit	%Rec Accept. Limit
Lead (Pb)	ND	95.1	92.5	2.8	20	80-120

ND: Not Detected.

Alpha Scientific Corporation
Environmental Laboratories

05-26-2011

Mr. Lino Cheang
Earth Mechanics Inc.
17800 Newhope Street, Suite B
Fountain Valley, CA 92708

Project: 10-126
Project Site: West Bound SR-91, Harbor Blvd. on-Ramp
Sample Date: 05-16-2011
Lab Job No.: EA105069A

Dear Mr. Cheang:

Enclosed please find the analytical report for the sample(s) received by Alpha Scientific Corporation on 05-16-2011 and analyzed by the following EPA methods:

EPA 9045 (pH)
EPA 6010B (Pb, STLC)

All analyses have met the QA/QC criteria of this laboratory.

The sample(s) arrived in good conditions (i.e., chilled, intact) and with a chain of custody record attached.

Alpha Scientific Corporation is a CA DHS certified laboratory (Certificate Number 2633). Thank you for giving us the opportunity to serve you. Please feel free to call me at (562) 809-8880 if our laboratory can be of further service to you.

Sincerely,

Roger Wang, Ph.D.
Laboratory Director

Enclosures

This cover letter is an integral part of this analytical report.

Client:	Earth Mechanics Inc.	Lab Job No.:	EA105069A
Project:	10-126		
Project Site:	West Bound SR-91, Harbor Blvd. on-Ramp	Date Sampled:	05-16-2011
Matrix:	Soil	Date Received:	05-16-2011
Batch No.:	0519-PH1	Date Analyzed:	05-19-2011
		Date Reported:	05-26-2011

EPA Method 9045 (Soil pH)
Reporting Units: pH Unit

Sample ID	Lab ID	pH	Reporting Limit
L-24-2	EA105069-2	7.83	---
L-25-1	EA105069-5	7.30	---
L-27-4	EA105069-16	7.29	---

ND: Not Detected (below RL)

Client:	Earth Mechanics Inc.	Lab Job No.:	EA105069A
Project:	10-126		
Project Site:	West Bound SR-91, Harbor Blvd. on-Ramp	Date Sampled:	05-16-2011
Matrix:	Soil	Date Received:	05-16-2011
Batch No. for 6010B:	0523-MS1	Date Analyzed:	05-23-2011
		Date Reported:	05-26-2011

EPA 6010B (Pb, STLC)
Reporting Unit: mg/L (ppm)

Sample ID	Lab ID	Lead, STLC	MDL	PQL
Extraction Blank		ND	0.1	0.2
L-24-2	EA105069-2	6.5	0.1	0.2
L-24-3	EA105069-3	3.1	0.1	0.2
L-24-4	EA105069-4	4.3	0.1	0.2
L-25-1	EA105069-5	2.8	0.1	0.2
L-1-1 (Paint)	EA105069-17	1.0	0.1	0.2

Note: Sample Preparation: Extraction Procedures, STLC Metals, Title 22, Cal Wet 66700, 48 hours (05-20 to 05-22-2011).
MDL: Method Detection Limit;
PQL: Practical Quantitation Limit;
J: Trace concentration. The result is between MDL and PQL;
ND: Not Detected (at the specified limit).

05-26-2011

EPA 6010B (Pb, STLC)
Batch QA/QC Report

Client: Earth Mechanics Inc.
Project: 10-126
Matrix: Soil
Batch No. for 6010B: 0523-MS1

Lab Job No: EA105069A
Lab ID: LCS
Date Analyzed: 05-23-2011

LCS/LCSD Report

Analyte	EPA Method	MB Conc.	LCS %Rec.	LCSD %Rec.	% RPD	%RPD Accept. Limit	%Rec Accept. Limit
Pb	6010B	ND	90.9	88.3	2.9	20	80-120

ND: Not Detected

Alpha Scientific Corporation
Environmental Laboratories

06-06-2011

Mr. Lino Cheang
Earth Mechanics Inc.
17800 Newhope Street, Suite B
Fountain Valley, CA 92708

Project: 10-126
Project Site: West Bound SR-91, Harbor Blvd. on-Ramp
Sample Date: 05-16-2011
Lab Job No.: EA105069B

Dear Mr. Cheang:

Enclosed please find the analytical report for the sample(s) received by Alpha Scientific Corporation on 05-16-2011 and analyzed by the following EPA methods:

EPA 6010B (Lead, DI Water STLC)
EPA 6010B (Lead, TCLP)

All analyses have met the QA/QC criteria of this laboratory.

The sample(s) arrived in good conditions (i.e., chilled, intact) and with a chain of custody record attached.

Alpha Scientific Corporation is a CA DHS certified laboratory (Certificate Number 2633). Thank you for giving us the opportunity to serve you. Please feel free to call me at (562) 809-8880 if our laboratory can be of further service to you.

Sincerely,

Roger Wang, Ph.D.
Laboratory Director

Enclosures

This cover letter is an integral part of this analytical report.

06-06-2011

EPA 6010B (Pb)
Batch QA/QC Report

Client: Earth Mechanics Inc.
Project: 10-126
Matrix: Soil
Batch No. for 6010B: 0531-MS1

Lab Job No: EA105069B
Lab Sample ID: LCS
Date Analyzed: 05-31-2011

LCS/LCSD Report

Analyte	EPA Method	MB Conc.	LCS %Rec.	LCSD %Rec.	% RPD	%RPD Accept. Limit	%Rec Accept. Limit
Pb	6010B	ND	111.5	105.5	5.5	20	80-120

ND: Not Detected

Client:	Earth Mechanics Inc.	Lab Job No.:	EA105069B
Project:	10-126		
Project Site:	West Bound SR-91, Harbor Blvd. on-Ramp	Date Sampled:	05-16-2011
Matrix:	Soil	Date Received:	05-16-2011
Batch No. for 6010B:	0531-MS1	Date Analyzed:	05-31-2011
		Date Reported:	06-06-2011

EPA 6010B (Lead, TCLP)
Reporting Unit: mg/L (ppm)

Sample ID	Lab ID	Lead, TCLP		
Method Detection Limit		0.1		
PQL		0.2		
Extraction Blank		ND		
L-24-2	EA105069-2	0.23		

Note: Sample Preparation: EPA 1311, 18 hours (05-29 to 05-30-2011).

MDL: Method Detection Limit;
PQL: Practical Quantitation Limit;
J: Trace concentration. The result is between MDL and PQL;
ND: Not Detected (below MDL).

Client:	Earth Mechanics Inc.	Lab Job No.:	EA105069B
Project:	10-126		
Project Site:	West Bound SR-91, Harbor Blvd. on-Ramp	Date Sampled:	05-16-2011
Matrix:	Soil	Date Received:	05-16-2011
Batch No. for 6010B:	0606-MS1	Date Analyzed:	06-06-2011
		Date Reported:	06-06-2011

EPA 6010B (Lead, DI Water STLC)
Reporting Unit: mg/L (ppm)

Sample ID	Lab ID	Lead, DI Water STLC		
Method Detection Limit		0.1		
PQL		0.2		
Extraction Blank		ND		
L-24-2	EA105069-2	ND		

Note: Sample Preparation: Extraction Procedures, STLC Metals, Title 22, Cal Wet 66700, 48 hours (05-28 to 05-30-2011). DI water is used as extraction fluid.

MDL: Method Detection Limit;
PQL: Practical Quantitation Limit;
J: Trace concentration. The result is between MDL and PQL;
ND: Not Detected (below MDL).

ALPHA SCIENTIFIC CORPORATION

CHAIN OF CUSTODY RECORD

Lab Job Number EA105069

Client: EARTH MECHANICS, INC.			
Address: 17800 Newhope st. Suite B, Fountain Valley, CA			
Report Attention: LINO CHEANG	Phone: 714 751-3826	Fax: 714 751-3928	Sampled by: R. JIE
Project Name/No.: 10-126	Project Site: West Bound SR-91, Harbor Blvd. on-ramp		

Client Sample ID	Lab Sample ID	Sample Collection Date	Sample Collection Time	Matrix Type	Sample Preserv	No..type* & size of container	TPH-Gasoline	TPH-Diesel	8260B (BTEX, Oxygenates)	8260B (VOCs)	8270C (SVOCs)	CAM Metals	8082 (PCBs)	Total Lead	STLC (CITRATE) 6010B	PH (EPA 9045)	TCLP (EPA 6010B)	STLC (DI-WET) (6010B)	Remark
L-24-1	EA105069-1	5-16-11	1550	Soil	N/A	4oz. jar								V					pls. keep samples refrigerated. more tests may be assigned w/ future
L-24-2	-2		1600											V	V	V	V	V	
L-24-3	-3		1615											V	V				
L-24-4	-4		1630											V	V				
L-25-1	-5		1450											V	V	V			
L-25-2	-6		1500											V					
L-25-3	-7		1515											V					
L-25-4	-8		1530											V					
L-26-1	-9		1340											V					
L-26-2	-10		1350											V					
L-26-3	-11		1400											V					
L-26-4	-12		1415											V					
L-27-1	-13		1200											V					
L-27-2	-14		1210											V					
L-27-3	-15		1220											V					
L-27-4	-16		1230											V		V			
L-H1	-17	V	1300	paint	V	V								V	V				

Relinquished by	Company	Date	Time	Received by	Company	Date	Time
Raymond R. Jie Jr.	E.M.I	5-16-11	1725	[signature]	ASC	5/16/11	17:25
Relinquished by	Company	Date	Time	Received by	Company	Date	Time

Container types: M=Metal Tube, P=Plastic bottle, A=Air Bag, G=Glass bottle, V=VOA vial

T.A.T. Requested: ☐ 8 hrs ☐ 24 hrs ☐ 48 hrs ☐ 3 days ☒ Normal

Sample Condition: ☐ Chilled ☒ Intact ☐ Sample seals

Alpha Scientific Corporation
16760 Gridley Road
Cerritos, CA 90703
Email ascorp@verizon.net
Tel. (562) 809-8880
Fax (562) 809-8801

Note. Samples are discarded 30 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client's expense.
Distribution: White - with report; Pink - to courier

APPENDIX D

STATISTIC CALCULATIONS

From File: WorkSheet.wst

Summary Statistics for Raw Full Data Sets

Variable		NumObs	Minimum	Maximum	Mean	Median	Variance	SD	MAD/0.675	Skewness	Kurtosis	CV
Region I	ML-I	29	2	70	22.76	22	327.8	18.1	21.94	0.713	-0.0816	0.796
Region II	ML-II	29	3.9	100	30.68	27	586.2	24.21	19.27	1.409	1.745	0.789
Region III	ML-III	43	3.4	100	31.98	27.1	673.4	25.95	24.31	1.031	0.457	0.811
Region IV	ML-IV	50	2	190	35.52	20.5	1878	43.33	20.09	2.472	6.331	1.22
Region V	ML-V	21	3.4	52	17.97	14	182.8	13.52	12.01	1.093	0.552	0.753
	Ramps	76	2	179	19.73	7.45	769.6	27.74	7.487	3.263	14.48	1.406

SR-91 Mainline

General UCL Statistics for Full Data Sets

SR-91 MAINLINE - REGION I
(Between Sta. 102+00 and Sta. 136+00)

User Selected Options	
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

ML-I

General Statistics

Number of Valid Observations	29	Number of Distinct Observations	27

Raw Statistics		Log-transformed Statistics	
Minimum	2	Minimum of Log Data	0.693
Maximum	70	Maximum of Log Data	4.248
Mean	22.76	Mean of log Data	2.688
Median	22	SD of log Data	1.073
SD	18.1		
Coefficient of Variation	0.796		
Skewness	0.713		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.913	Shapiro Wilk Test Statistic	0.914
Shapiro Wilk Critical Value	0.926	Shapiro Wilk Critical Value	0.926
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	28.48	95% H-UCL	43.75
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	51.07
95% Adjusted-CLT UCL	28.76	97.5% Chebyshev (MVUE) UCL	62.17
95% Modified-t UCL	28.55	99% Chebyshev (MVUE) UCL	83.99

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.176	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	19.35		
nu star	68.21		
Approximate Chi Square Value (.05)	50.2	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0407	95% CLT UCL	28.29
Adjusted Chi Square Value	49.28	95% Jackknife UCL	28.48
		95% Standard Bootstrap UCL	28.17
Anderson-Darling Test Statistic	0.616	95% Bootstrap-t UCL	28.75
Anderson-Darling 5% Critical Value	0.768	95% Hall's Bootstrap UCL	28.97
Kolmogorov-Smirnov Test Statistic	0.137	95% Percentile Bootstrap UCL	28.21
Kolmogorov-Smirnov 5% Critical Value	0.166	95% BCA Bootstrap UCL	28.87
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	37.41
		97.5% Chebyshev(Mean, Sd) UCL	43.75
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	56.21
95% Approximate Gamma UCL	30.92		
95% Adjusted Gamma UCL	31.5		

Potential UCL to Use	Use 95% Approximate Gamma UCL	30.92

General UCL Statistics for Full Data Sets

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

SR-91 MAINLINE - REGION II
(Between Sta. 136+00 and Sta. 157+50)

ML-II

General Statistics

Number of Valid Observations	29	Number of Distinct Observations	24

Raw Statistics		Log-transformed Statistics	
Minimum	3.9	Minimum of Log Data	1.361
Maximum	100	Maximum of Log Data	4.605
Mean	30.68	Mean of log Data	3.12
Median	27	SD of log Data	0.831
SD	24.21		
Coefficient of Variation	0.789		
Skewness	1.409		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.859	Shapiro Wilk Test Statistic	0.975
Shapiro Wilk Critical Value	0.926	Shapiro Wilk Critical Value	0.926
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	38.33	95% H-UCL	45.55
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	54.98
95% Adjusted-CLT UCL	39.33	97.5% Chebyshev (MVUE) UCL	65.14
95% Modified-t UCL	38.52	99% Chebyshev (MVUE) UCL	85.11

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.632	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	18.8		
nu star	94.67		
Approximate Chi Square Value (.05)	73.23	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0407	95% CLT UCL	38.07
Adjusted Chi Square Value	72.11	95% Jackknife UCL	38.33
		95% Standard Bootstrap UCL	38.08
Anderson-Darling Test Statistic	0.257	95% Bootstrap-t UCL	40.09
Anderson-Darling 5% Critical Value	0.759	95% Hall's Bootstrap UCL	40.12
Kolmogorov-Smirnov Test Statistic	0.0878	95% Percentile Bootstrap UCL	38.01
Kolmogorov-Smirnov 5% Critical Value	0.165	95% BCA Bootstrap UCL	38.83
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	50.28
		97.5% Chebyshev(Mean, Sd) UCL	58.76
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	75.41
95% Approximate Gamma UCL	39.66		
95% Adjusted Gamma UCL	40.28		

Potential UCL to Use		Use 95% Approximate Gamma UCL	39.66

General UCL Statistics for Full Data Sets

SR-91 MAINLINE - REGION III
(Between Sta. 157+50 and Sta. 275+00)

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

ML-III

General Statistics

Number of Valid Observations	43	Number of Distinct Observations	40

Raw Statistics

Minimum	3.4
Maximum	100
Mean	31.98
Median	27.1
SD	25.95
Coefficient of Variation	0.811
Skewness	1.031

Log-transformed Statistics

Minimum of Log Data	1.224
Maximum of Log Data	4.605
Mean of log Data	3.081
SD of log Data	0.963

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.885
Shapiro Wilk Critical Value	0.943

Data not Normal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	38.64

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL	39.16
95% Modified-t UCL	38.74

Gamma Distribution Test

k star (bias corrected)	1.359
Theta Star	23.54
nu star	116.8
Approximate Chi Square Value (.05)	92.89
Adjusted Level of Significance	0.0444
Adjusted Chi Square Value	92.15
Anderson-Darling Test Statistic	0.411
Anderson-Darling 5% Critical Value	0.768
Kolmogorov-Smirnov Test Statistic	0.0897
Kolmogorov-Smirnov 5% Critical Value	0.137

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	40.23
95% Adjusted Gamma UCL	40.55

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.943
Shapiro Wilk Critical Value	0.943

Data not Lognormal at 5% Significance Level

Assuming Lognormal Distribution

95% H-UCL	48.72
95% Chebyshev (MVUE) UCL	59.35
97.5% Chebyshev (MVUE) UCL	70.29
99% Chebyshev (MVUE) UCL	91.77

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	38.49
95% Jackknife UCL	38.64
95% Standard Bootstrap UCL	38.5
95% Bootstrap-t UCL	39.25
95% Hall's Bootstrap UCL	39.3
95% Percentile Bootstrap UCL	38.42
95% BCA Bootstrap UCL	39.14
95% Chebyshev(Mean, Sd) UCL	49.23
97.5% Chebyshev(Mean, Sd) UCL	56.7
99% Chebyshev(Mean, Sd) UCL	71.36

Potential UCL to Use	Use 95% Approximate Gamma UCL	40.23

General UCL Statistics for Full Data Sets

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

SR-91 MAINLINE - REGION IV
(Between Sta. 275+00 and Sta. 321+75)

ML-IV

General Statistics

Number of Valid Observations	50	Number of Distinct Observations	45

Raw Statistics		Log-transformed Statistics	
Minimum	2	Minimum of Log Data	0.693
Maximum	190	Maximum of Log Data	5.247
Mean	35.52	Mean of log Data	2.978
Median	20.5	SD of log Data	1.146
SD	43.33		
Coefficient of Variation	1.22		
Skewness	2.472		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.684	Shapiro Wilk Test Statistic	0.964
Shapiro Wilk Critical Value	0.947	Shapiro Wilk Critical Value	0.947
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	45.79	95% H-UCL	56.78
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	69.12
95% Adjusted-CLT UCL	47.89	97.5% Chebyshev (MVUE) UCL	82.96
95% Modified-t UCL	46.15	99% Chebyshev (MVUE) UCL	110.2

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.933	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	38.08		
nu star	93.27		
Approximate Chi Square Value (.05)	72	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0452	95% CLT UCL	45.6
Adjusted Chi Square Value	71.44	95% Jackknife UCL	45.79
		95% Standard Bootstrap UCL	45.47
Anderson-Darling Test Statistic	0.724	95% Bootstrap-t UCL	48.47
Anderson-Darling 5% Critical Value	0.781	95% Hall's Bootstrap UCL	49.04
Kolmogorov-Smirnov Test Statistic	0.115	95% Percentile Bootstrap UCL	45.69
Kolmogorov-Smirnov 5% Critical Value	0.129	95% BCA Bootstrap UCL	48
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	62.23
		97.5% Chebyshev(Mean, Sd) UCL	73.79
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	96.49
95% Approximate Gamma UCL	46.01		
95% Adjusted Gamma UCL	46.37		

Potential UCL to Use	Use 95% Approximate Gamma UCL	46.01

General UCL Statistics for Full Data Sets

User Selected Options

From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

SR-91 MAINLINE - REGION V
(Between Sta. 321+75 and Sta. 342+00)

ML-V

General Statistics

Number of Valid Observations	21	Number of Distinct Observations	21

Raw Statistics		Log-transformed Statistics	
Minimum	3.4	Minimum of Log Data	1.224
Maximum	52	Maximum of Log Data	3.951
Mean	17.97	Mean of log Data	2.608
Median	14	SD of log Data	0.792
SD	13.52		
Coefficient of Variation	0.753		
Skewness	1.093		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.89	Shapiro Wilk Test Statistic	0.971
Shapiro Wilk Critical Value	0.908	Shapiro Wilk Critical Value	0.908
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	23.06	95% H-UCL	27.89
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	33.11
95% Adjusted-CLT UCL	23.57	97.5% Chebyshev (MVUE) UCL	39.56
95% Modified-t UCL	23.17	99% Chebyshev (MVUE) UCL	52.21
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.689	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	10.64		
nu star	70.94		
Approximate Chi Square Value (.05)	52.55	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0383	95% CLT UCL	22.82
Adjusted Chi Square Value	51.33	95% Jackknife UCL	23.06
		95% Standard Bootstrap UCL	22.79
Anderson-Darling Test Statistic	0.252	95% Bootstrap-t UCL	23.94
Anderson-Darling 5% Critical Value	0.754	95% Hall's Bootstrap UCL	24.08
Kolmogorov-Smirnov Test Statistic	0.117	95% Percentile Bootstrap UCL	22.78
Kolmogorov-Smirnov 5% Critical Value	0.192	95% BCA Bootstrap UCL	23.37
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	30.83
		97.5% Chebyshev(Mean, Sd) UCL	36.39
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	47.33
95% Approximate Gamma UCL	24.25		
95% Adjusted Gamma UCL	24.83		

Potential UCL to Use		Use 95% Approximate Gamma UCL	24.25

General UCL Statistics for Full Data Sets

User Selected Options

From File	X:\Projects\2010\10-126 - RBF, SR 91 Westbound Widening\ADL\Preliminary Analyses - Ranjan\SR-91.w
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

ALL RAMPS LOCATED BETWEEN STA 102+00 AND STA. 342+00 (SR-91 LINE)

Ramps

General Statistics

Number of Valid Observations	92	Number of Distinct Observations	69

Raw Statistics

Minimum	2
Maximum	179
Mean	21.15
Median	7.45
SD	29.86
Coefficient of Variation	1.412
Skewness	2.855

Log-transformed Statistics

Minimum of Log Data	0.693
Maximum of Log Data	5.187
Mean of log Data	2.326
SD of log Data	1.188

Relevant UCL Statistics

Normal Distribution Test

Lilliefors Test Statistic	0.261
Lilliefors Critical Value	0.0924

Data not Normal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	26.33

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL	27.27
95% Modified-t UCL	26.48

Gamma Distribution Test

k star (bias corrected)	0.796
Theta Star	26.58
nu star	146.5
Approximate Chi Square Value (.05)	119.5
Adjusted Level of Significance	0.0474
Adjusted Chi Square Value	119.1
Anderson-Darling Test Statistic	3.402
Anderson-Darling 5% Critical Value	0.791
Kolmogorov-Smirnov Test Statistic	0.178
Kolmogorov-Smirnov 5% Critical Value	0.0967

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	25.93
95% Adjusted Gamma UCL	26.01

Lognormal Distribution Test

Lilliefors Test Statistic	0.128
Lilliefors Critical Value	0.0924

Data not Lognormal at 5% Significance Level

Assuming Lognormal Distribution

95% H-UCL	27.95
95% Chebyshev (MVUE) UCL	34.43
97.5% Chebyshev (MVUE) UCL	40.47
99% Chebyshev (MVUE) UCL	52.34

Data Distribution

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

95% CLT UCL	26.28
95% Jackknife UCL	26.33
95% Standard Bootstrap UCL	26.22
95% Bootstrap-t UCL	27.57
95% Hall's Bootstrap UCL	28.06
95% Percentile Bootstrap UCL	26.49
95% BCA Bootstrap UCL	27.26
95% Chebyshev(Mean, Sd) UCL	34.72
97.5% Chebyshev(Mean, Sd) UCL	40.6
99% Chebyshev(Mean, Sd) UCL	52.13

Potential UCL to Use	Use 97.5% Chebyshev (Mean, Sd) UCL	40.6

APPENDIX E

CALTRANS APPROVAL MEMORANDUM OF

ADL ADDENDUM REPORT

State of California Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: Andrew Oshrin, Chief
Design Branch "D"
Attention: Naser Saleh

Date: June 22, 2011

File: 12-ORA-91 PM: 0.9/5.4
WB widening from SR-57 to
West of I-5, E.A. 0C5700
Project ID: 1200000079

From: **DEPARTMENT OF TRANSPORTATION**
DISTRICT 12 DIVISION OF PROJECT DELIVERY
ENVIRONEMNTAL ENGINEERING BRANCH

Subject: 65% Plans and Aerially Deposited Lead (ADL) Addendum Report
SR-91 from State College to Brookhurst Widening Project

Environmental Engineering Branch reviewed the above referenced submittals dated May 31, 2011 and has no comment. Please submit the Special Provision for handling the ADL soil for our review. Even though the soil is not considered as hazardous waste and can be used at the project site, applicable Special Provision is required.

If you have any questions, please call Mr. Paul Chang of my staff at Ext. 7814.

R. Aurasteh

REZA AURASTEH, Chief
Environmental Engineering Branch

APPENDIX F

CALTRANS MEMORANDUM, DATED NOVEMBER 3, 2011,

REGARDING AERIALLY DEPOSITED LEAD SOIL IN REGION IV

State of California Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: Andrew Oshrin, Chief
Design Branch "D"
Attention: Naser Saleh

Date: November 3, 2011

File: 12-ORA-91 PM: 0.9/5.4
WB widening from SR-57 to
West of I-5, E.A. 0C5700
E-FIS ID: 12-0000-0079

From: **DEPARTMENT OF TRANSPORTATION**
DISTRICT 12 DIVISION OF PROJECT DELIVERY
ENVIRONEMNTAL ENGINEERING BRANCH

Subject: 95% Plans Specifications & Estimates (PS&E) Regarding Aerially Deposited Lead (ADL) Soil SR-91 from State College to Brookhurst Widening Project

Environmental Engineering Branch reviewed the above referenced PS&E dated September 26, 2011, provided comments on October 18, and had a follow-up meeting with RBF Consulting, the Design Consultant of the project, on October 25. In the meeting we explained how Caltrans classifies Type "Y1" soil to be re-used at the project site, and what ADL containing soil is not considered as hazardous after excavated from the ground.

Additionally, we communicated with Mr. Lino Cheang, Earth Mechanics, Inc., who prepared the ADL Addendum Report on November 1, 2011 to reach the conclusion of defining Type "Y1" soil. We've learned that there are expansive soil to be excavated and cannot be reused. To classify the entire 4 feet depth of soil in Region IV (from Sta. 275+00 to Sta. 321+75) as Type "Y1" is not realistic, and will generate unnecessary costs.

From the test data of the ADL Addendum Report, the only questionable area are identified at Borings ADL-17 and ADL-46, where the STLC WET Citric Acid are above 5.0 mg/L. At Boring ADL-17, the amount of soil to be excavated for Structure Excavation will obviously dilute the ADL containing soil to non-hazardous level. Similarly, at Boring ADL-46, according to the Typical Section X-5, the proposed earthwork also indicates that the ADL containing soil will be diluted and become non-hazardous. Therefore, all excavated soil at this project should be considered as Type "X", which would be non-hazardous. Since the soil contains lead, it should be handled according to State requirements.

If you have any questions, please call Mr. Paul Chang of my staff at Ext. 7814.

R. Aurasteh

REZA AURASTEH, Chief
Environmental Engineering Branch

Cc: K. Dove, Environmental Planning B

FINAL GEOTECHNICAL DESIGN REPORT (GDR)

Earth Mechanics, Inc.

January 1, 2012

FINAL GEOTECHNICAL DESIGN REPORT

State Route 91 Westbound Widening Project
Orange County, California
12-ORA-91, PM 0.9/5.4
Caltrans Project No. 12000000791 (EA 12-0C5701)
EMI Project No. 10-126
Date: January 10, 2012

EARTH MECHANICS, INC.

Geotechnical and Earthquake Engineering

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

January 10, 2012

EMI Project No. 10-126

RBF Consulting
14725 Alton Parkway
Irvine, California 92618

Attention: Mr. Steve Huff, P.E.

Subject: Final Geotechnical Design Report
State Route 91 Westbound Widening Project
Orange County, California
12-ORA-91, PM 0.9/5.4
Caltrans Project No. 12000000791 (EA 12-0C5701)

Dear Mr. Huff:

Attached please find the Final Geotechnical Design Report (GDR) for the State Route 91 Westbound Widening Project. This GDR describes the geotechnical conditions at the project site based on information obtained from our field investigation and laboratory soil testing. This report also contains our recommendations for the design and construction of the roadway embankments and Caltrans standard retaining walls.

An earlier version of this report dated July 15, 2011 was submitted to Caltrans for review. Caltrans provided their comments in a memorandum dated August 19, 2011. We developed responses to the Caltrans review comments and submitted them in a letter dated September 9, 2011. These responses were reviewed and concurred by Caltrans reviewer. Caltrans approval email along with review comments and our responses are included in Appendix D. Our responses to all the review comments have been incorporated into this report.

We appreciate the opportunity to provide geotechnical design services for this project. If you have any questions, please call us.

Sincerely,

EARTH MECHANICS, INC.

1-10-12

(Raja) S. Pirathiviraj, PE 71662
Senior Staff Engineer

1-10-2012

Lino Cheang, GE 2345
Project Manager

SP/sp,lcc

17800 Newhope Street, Suite B, Fountain Valley, California 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

FINAL GEOTECHNICAL DESIGN REPORT

STATE ROUTE 91 WESTBOUND WIDENING PROJECT
ORANGE COUNTY, CALIFORNIA
12-ORA-91, PM 0.9/5.4
CALTRANS PROJECT NO. 12000000791 (EA 12-0C5701)

Prepared for:

RBF Consulting
14725 Alton Parkway
Irvine, California 92618

Prepared By:

Earth Mechanics, Inc.
17800 Newhope Street, Suite B
Fountain Valley, California 92708

EMI Project No. 10-126

January 10, 2012

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Appendix D. Caltrans Review Comments and EMI Responses

1.0 INTRODUCTION

This Geotechnical Design Report (GDR) presents the findings and conclusions of a geotechnical study conducted by Earth Mechanics, Inc. (EMI) for the State Route (SR) 91 Westbound (WB) Widening Project located in County of Orange, California. The project location is shown on the Site Location Map in Figure 1-1. The purpose of the geotechnical study was to obtain subsurface information and develop design and construction recommendations to assist RBF Consulting in preparing the Project Plans, Specifications, and Estimates.

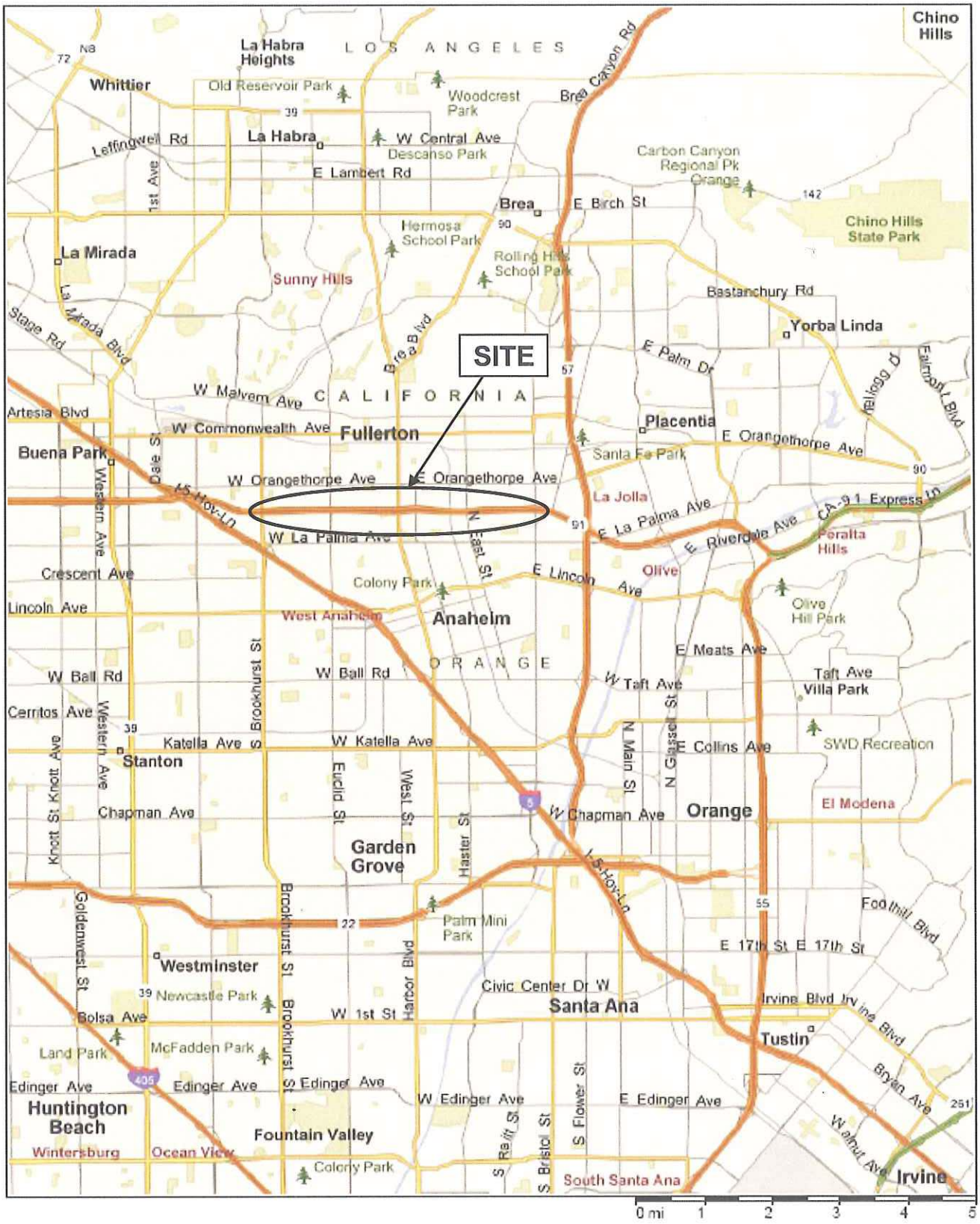
EMI's scope of work included preparing this GDR per Topic 113 of the Caltrans Highway Design Manual (HDM, 2008). This report was prepared in accordance with the "Guidelines for Preparing Geotechnical Design Reports" (2006). Recommendations for pavement structural sections and corrosion issues are addressed in the Materials Report (EMI, 2012b) for this project.

The geotechnical scope of work for preparing this GDR included the following tasks:

- Performance of geotechnical field exploration including drilling and logging of 72 exploratory borings;
- Laboratory testing of selected subsurface soil samples;
- Evaluation of slope stability, settlement, and liquefaction potential of subsurface soils;
- Performance of engineering calculations and analysis to develop foundation design and construction recommendations for Caltrans Standard Type 1 retaining walls, culvert and channel;
- Development of recommendations for earthwork; and
- Preparation of this report presenting our findings, conclusions and recommendations.

The purpose of this report is to document subsurface geotechnical conditions, provide analyses of anticipated site conditions as they pertain to the project described herein, and recommend design and construction criteria for the roadway portions of the project. This report also establishes a geotechnical baseline to be used in assessing the existence and scope of changed site conditions.

This report is intended for use by the project roadway design engineer, construction personnel, bidders, and contractors.



SR-91 WB Widening Project

Earth Mechanics, Inc.
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SITE LOCATION MAP

Figure 1-1

Project No. 10-126

Date: 06-23-11

2.0 EXISTING FACILITIES AND PROPOSED IMPROVEMENTS

2.1 EXISTING FACILITIES

SR-91 is a major east-west freeway facility that begins at the eastern junction with SR-60 in the city of Riverside in Riverside County, and continues west through Orange County to its terminus at the junction with Pacific Coast Highway 1 near the city of Hermosa Beach in Los Angeles County.

The proposed project is located in Orange County, on SR-91 between SR- 57 (to the east) and Interstate 5 (to the west) and traverses through the City of Anaheim and the City of Fullerton. Within the limits of the proposed project, SR-91 has a varying number of existing general purpose lanes, auxiliary lanes, and HOV lanes.

The proposed project alignment is generally elevated on an embankment, at or near the elevations of the surrounding land, and crosses:

- State College Boulevard (Bridge No. 55-0852)
- Acacia Street (Bridge No. 55-0218)
- East Street (Bridge No. 55-0245)
- The OCTA/Metrolink rail line at the North Anaheim Overhead (Bridge No. 55-0216)
- Lemon Street (Bridge No. 55-0858)
- Harbor Boulevard (Bridge No. 55-0857)
- Euclid Street (Bridge No. 55-0279)
- Brookhurst Street (Bridge No. 55-0280)

At the diverge with mainline SR-91, all interchanges are diamond interchanges with single lane on- and off-ramps, and off-ramps terminating at signalized intersections at the crossing arterial streets. However, Lemon Street and Harbor Boulevard have been reconfigured as a split diamond interchange, and at Acacia Street there is no interchange.

There are five segments of existing sound walls and retaining walls along the proposed alignment of the project. They are located as follows (from east to west):

- Beginning at the terminus of the State College Boulevard on-ramp to WB SR-91 (south of North Baxter Street) and ending at WB SR-91 immediately south of Manhattan Avenue.
- Beginning at the Lemon Street overcrossing and ending at the Harbor Boulevard overcrossing.
- Beginning approximately 450 feet east of the terminus of the Harbor Boulevard on-ramp to WB SR-91 and ending at the off-ramp at South Euclid Street.
- Beginning at the WB SR-91 on-ramp at Euclid Street and ending at the off-ramp at South Brookhurst Street.
- Beginning at the on-ramp at Brookhurst Street to WB SR-91 and ending at the northbound I-5 and WB SR-91 connector at Magnolia Avenue.

Existing drainage facilities located in the proposed study area include:

- Storm-drain systems and inlets along the shoulders of the existing through lanes and along the on- and off-ramps.
- Under-highway cross culverts.
- Houston Storm Channel which is primarily a concrete open channel running along the north side of the freeway. However, between the Euclid Street and Brookhurst Street segment of SR-91, it becomes a reinforced concrete box culvert.
- Carbon Creek Channel which traverses along the north side of the freeway west of East Burton Street and crosses SR-91 at Raymond Avenue as a reinforced concrete box culvert.

2.2 PROPOSED IMPROVEMENTS

The California Department of Transportation (Caltrans), in cooperation with the Orange County Transportation Authority (OCTA) and the cities of Anaheim and Fullerton, proposes to widen the SR-91 WB from SR-57 to I-5. The proposed project limits cover a distance of 4.5 miles; however, actual improvements are limited to a total of about 4.0 miles within the project area.

The proposed project consists of the westbound mainline widening that connects the existing lanes through each interchange and the addition of two-lane exit ramps and associated auxiliary lanes at the westbound exit ramps to Raymond Avenue, Lemon Street and Brookhurst Street.

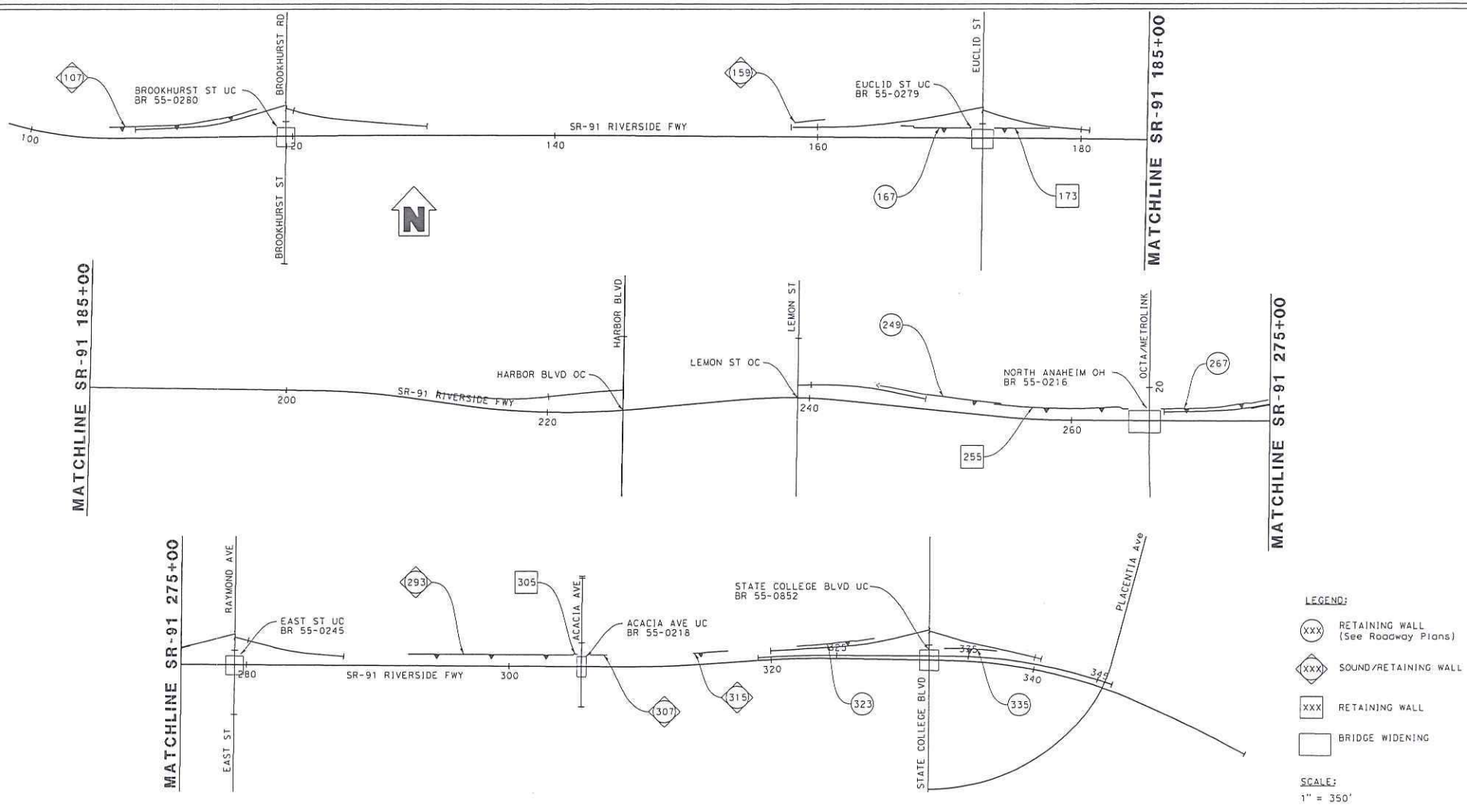
To accommodate the proposed improvements, bridge widening and new walls are required. Locations of the bridge widening and new walls are presented in Figure 2-1. As shown in Figure 2-1, bridge widening will be located at:

- State College Boulevard Undercrossing (Bridge No. 55-0852)
- Acacia Street Undercrossing (Bridge No. 55-0218)
- East Street Undercrossing (Bridge No. 55-0245)
- North Anaheim Overhead (Bridge No. 55-0216)
- Euclid Street Undercrossing (Bridge No. 55-0279)
- Brookhurst Street Undercrossing (Bridge No. 55-0280)

A total of 3 non-standard retaining walls, 4 soundwall on retaining walls, 1 soundwall and 5 Caltrans Standard Type 1 retaining walls are proposed for the project.

Drainage work involves construction of various sized Reinforced Concrete Pipe (RCP) culverts and drainage inlets throughout the length of the project. Modifications to the Houston Storm Channel include construction of a Reinforced Concrete Box (RCB) culvert and an open-concrete rectangular channel between Stations 157+00 and 161+00.

A total of 12 Caltrans standard and non-standard overhead sign structures are proposed within the project limits. The proposed overhead sign structures consist of nine "cantilever" type single-post structures, two "bridge" type double-post structures and one "unbalanced butterfly" type single-post structure.



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STATE ROUTE 91 WESTBOUND WIDENING PROJECT

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BRIDGES AND WALLS KEY MAP

Figure 2-1

3.0 PERTINENT REPORTS AND INVESTIGATIONS

3.1 PERTINENT PREVIOUS REPORTS AND INVESTIGATIONS

No previous geotechnical studies were performed specifically for the improvements addressed in this report.

3.2 RELATED REPORTS PREPARED FOR THE PROPOSED IMPROVEMENTS

Separate Foundation Reports have been prepared for the bridges, non-standard walls and sign structures (EMI, 2011a through 2011g, and 2012a):

- State College Boulevard Undercrossing (Bridge No. 55-0852),
- Acacia Street Undercrossing (Bridge No. 55-0218),
- East Street Undercrossing (Bridge No. 55-0245),
- North Anaheim Overhead (Bridge No. 55-0216),
- Euclid Street Undercrossing (Bridge No. 55-0279),
- Brookhurst Street Undercrossing (Bridge No. 55-0280),
- Non-Standard Walls, and
- Overhead Sign Structures

A Materials Report (EMI, 2012b) has also been prepared for this project, which addresses pavement structural section design and soil corrosion issues for buried drainage devices.

4.0 PHYSICAL SETTING

4.1 CLIMATE

Weather in the Los Angeles region is a Mediterranean-type, semi-arid, climate characterized by warm dry summers and mild winters. A dominating factor in the weather is the semi-permanent north Pacific high pressure system that migrates northward in summer, holding storm tracks well to the north, and as a result southern California receives little or no precipitation during the summers. In winter, the north Pacific high migrates southward permitting storm centers to swing across southern California. These storms generate moderate, but occasionally severe, precipitation events. When changes in the circulation pattern permit storms to approach from a southwesterly direction, the colder northern air masses merge with subtropical air masses and bring copious amounts of moisture with the northeastward streaming air. This results in heavy rains and often produces widespread flooding, especially in the spring when it coincides with runoff from melting snow in the mountains.

Summer is a dry period over most of the area. With the northward migration of the Pacific high most storm tracks are deflected far to the north during summer, and southern California seldom receives precipitation from Pacific storms during this time of year. Occasionally, during the summer months, moist air drifts northward from the Gulf of Mexico or the Gulf of California creating monsoonal conditions. At such times, scattered, locally heavy thunder showers occur, mostly in the desert and inland mountain areas.

The average annual high temperature is about 78 degrees (F) and the average low about 50 degrees. The hottest months are July, August, and September when high temperatures average in the high 80s, and low temperatures average in the high 50s. The coolest temperatures are in the winter months of December, January, and February when average highs are in the high 60s and average lows are in the low 40 degrees.

The extreme high temperatures can reach about 110 degrees in July, August, and September with the record high of 114 degrees in September. These high temperatures are commonly associated with adiabatic heating associated with winds called Santa Ana winds. The extreme low temperatures average about 30 degrees in December through February with a record low of 22 degrees. Freezing occurs occasionally on the winter nights, but is generally of short duration (a couple hours) and does not commonly result in a "hard" freeze.

Annual precipitation averages about 14 inches. The wettest months are November through March with an average of 3.5 inches in January and 3.0 inches in February. Although snow is common in the surrounding high mountains and results in snow-capped peaks for several months, snow fall is extremely rare in the lowlands such as the site area. However, snowfall events have been recorded. For example in January of 1949 about 1.5 inches of snow fell. Such snow generally melts the same day that it falls.

4.2 MAN-MADE AND NATURAL FEATURES OF ENGINEERING AND CONSTRUCTION SIGNIFICANCE

4.2.1 Man Made Features

4.2.1.1 Utilities

Based on the project utility plans, many utilities lie within the project area. The existing utilities crossing or running parallel to SR-91 and surface-streets include water, sewer, gas, cable, telephone, and fiber optic lines. It is our understanding that some of these utilities could be impacted by the proposed construction. If so, they will either be protected in-place, abandoned, or relocated.

4.2.1.2 Drainage

Based on the project drainage plans, the existing drainage facilities include storm drain systems and inlets, under-highway cross culverts, Houston Storm Channel and Carbon Creek Channel. The majority of the water within the project limits is routed through cross culverts and concrete ditches to Houston Channel and Carbon Creek Channel.

Based on current plans, fills are proposed throughout the project area; impact of fills at least 5 feet in height should be evaluated for utilities and drainage structures that fall within a 45-degree projection below the footprint of fills.

4.2.1.3 Fill

The SR-91 mainline and ramps are constructed on top of earthen embankments of varying heights. Documentation regarding placement of existing fills was not available for our review.

4.2.2 Natural Features

No natural features are present that affect the project design or construction. Moderate to dense low-growth vegetation is present on existing unpaved ground and slopes, which must be removed prior to placing compacted fill. Loose, soft, dry, wet, unstable, or otherwise unsuitable materials should be removed from areas to receive fill. Excavation bottoms should be firm and unyielding prior to placement of new fill.

4.3 REGIONAL GEOLOGY AND SEISMICITY

4.3.1 Topography

The project area extends in an east-west direction for a distance of about 4½ miles across the east-central part of the Los Angeles Basin. The project corridor is on a flat plain that descends gently to the west at a gradient of about 20 to 25 feet per mile. Elevation at the eastern end of the project corridor near Placentia Avenue is about 195 feet above sea level. Elevation decreases westerly to about 110 feet above sea level at Brookhurst Street. The plain is bordered by the Coyote Hills which lie about 2 miles north of the site and rise to as much as 400-500 feet elevation.

Major rivers within the Los Angeles basin are the Los Angeles, San Gabriel, and Santa Ana Rivers. The rivers enter the basin through gaps in the surrounding mountains and drain southerly across the basin floor. The site area is near the Santa Ana River which originates in the San

Bernardino Mountains to the west. Santiago Creek, a major tributary to the Santa Ana River flows westerly from the foothills of the Santa Ana Mountains and together with the Santa Ana River flows southerly to the ocean near Costa Mesa.

4.3.2 Physiography

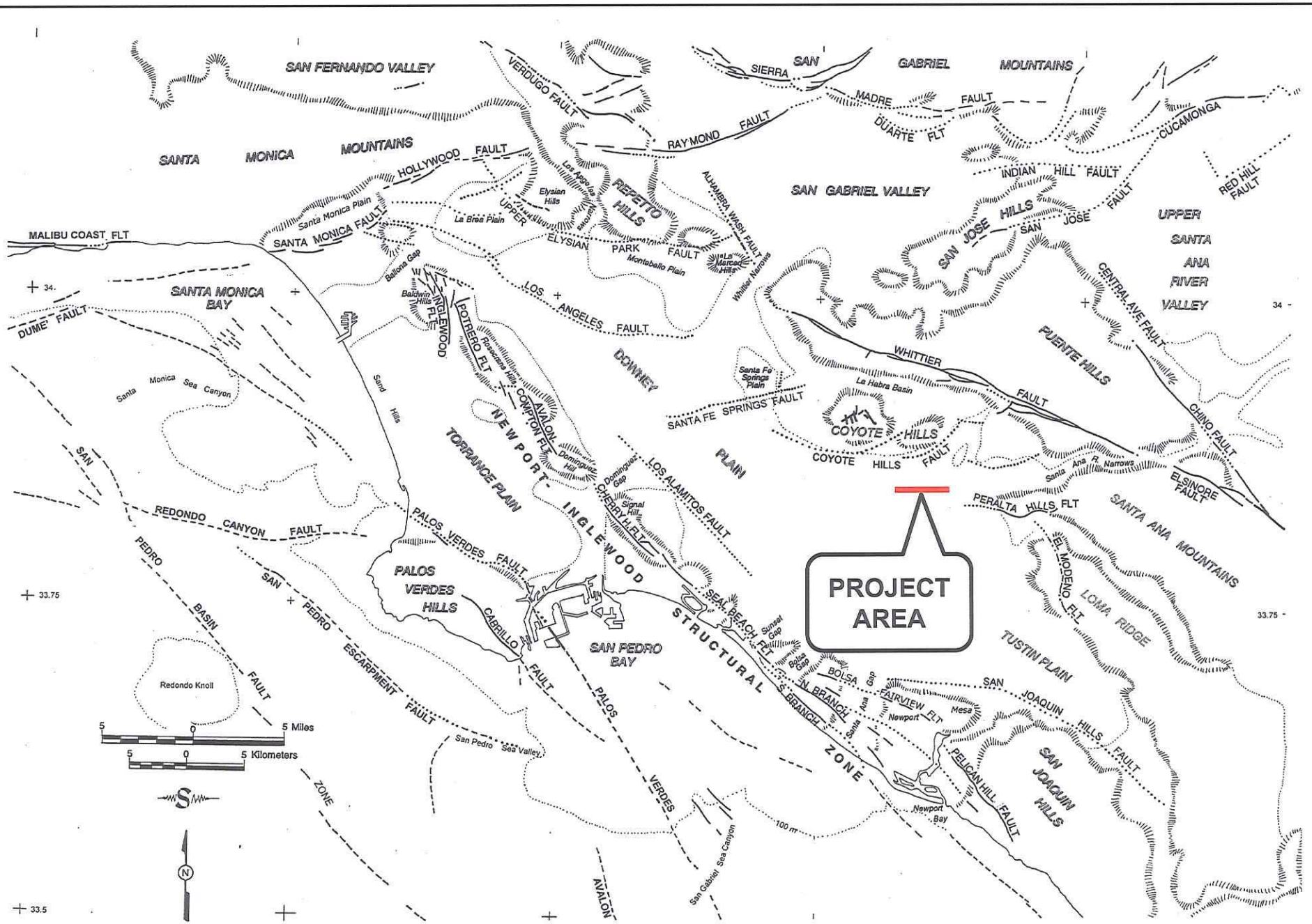
The project area is in the east-central part of the Los Angeles Basin as shown in Figure 4-1 which comprises a transition zone between the Peninsular Ranges physiographic province on the east, and the Transverse Ranges physiographic province to the north. The Peninsular Ranges physiographic province comprises a northwest-southeast trending group of fault-bounded ranges such as Santa Ana Mountains, Puente Hills and San Joaquin Hills between the Salton Trough and the Pacific Ocean. The Transverse Ranges physiographic province comprises east-west trending ranges and valleys such as the Santa Monica Mountains, San Fernando Valley and San Gabriel Mountains. Valleys such as the Los Angeles Basin, the San Gabriel Valley and the Upper Santa Ana River Valley have characteristics compatible with both physiographic provinces and form a transition zone between the two provinces.

The Los Angeles Basin is essentially a large, relatively flat, low-lying and coastal plain surrounded by mountains on the north, east and southeast which rise abruptly to a few thousand feet above the plains. The western margin of the basin is bordered by the sea, the Palos Verdes Hills and the San Joaquin Hills. The floor of the basin gradually rises inland to a series of uplifted terrain along the margins of the surrounding mountains. This elevated marginal terrain includes the Santa Monica, La Brea, Montebello, Santa Fe Springs plains, and the Coyote Hills. The generally flat-lying nature and gradual inland rise of the Basin floor is disrupted by an alignment of northwest-southeast trending, low-elevation hills along the Newport-Inglewood Structural Zone (NISZ). The areas on either side of the NISZ are essentially flat and comprise the Downey-Tustin plain on the northeast and the Torrance Plain on the southwest. The site area is near the transition between the Downey and the Tustin plains.

4.3.3 Stratigraphy

The proposed project alignment is generally elevated on an embankment, at or near the elevations of the surrounding land. The subsurface condition is predominantly sand and silty sand native sediments with traces of fine gravelly sands, and thin silt and clay beds. These materials are typical of late Quaternary-age sediments deposited in a river flood plain and/or a distal alluvial fan environment. Individual beds within these materials are poorly developed, lenticular, and discontinuous.

Based on regional geological maps these materials are up to about 300 feet thick and are underlain by older Quaternary-age alluvium of the La Habra and Coyote Hills formations. The combined thickness is on the order of 1,000 feet. These formations are underlain by Tertiary-age marine formations of the San Pedro, Fernando, and Puente formations to depths on the order of 11,000 feet which in turn are underlain by early Tertiary formations. Mesozoic-age crystalline basement rocks are at depths of about 15,000 feet (Yerkes et al., 1965).



SR-91 WB Widening Project

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

REGIONAL MAP OF ACTIVE FAULTS AND PHYSIOGRAPHY

Figure 4-1

Project No. 10-126

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4.3.4 Geologic Structure

The Los Angeles Basin is a deep structural basin comprising two major downward folds (synclines) separated by the NISZ uplift; the Paramount syncline is east of the NISZ under the Downey-Tustin Plain, and the Gardena syncline is west of the NISZ under the Torrance Plain. The Paramount syncline is the larger and deeper syncline with basement rocks as deep as about 30,000 feet (Yerkes et al, 1965). As described in the physiography section, the basin is rimmed by marginal elevated plains that rise about a hundred feet to as much as a couple hundred feet above the general level of the basin floor. These elevated plains and the Coyote Hills are underlain by fault-bounded, upward folds (anticlines) that are prolific oil fields. Most of the major faults associated with these folds are blind thrust faults and are shown on Figure 4-1 as dotted lines. The nearest faults to the project area are the blind thrust faults of the Puente Hills Blind Thrust Fault System and Compton-Los Alamitos Blind Fault System. Larger surface faults, such as the NISZ and the Elsinore Fault Zone (Whittier Section) lie to the southwest and northeast of the project site, respectively.

4.3.5 Geologic Hazards

The only significant geological hazard at the site is earthquake shaking and perhaps local liquefaction. There are no known active surface faults within the project area so ground rupture is not a factor. The flat-lying nature of the area is not susceptible to landsliding. The site is too far from the ocean to be affected by tsunamis, and there are no large bodies of water within the site area that could generate a seiche. There are no volcanoes in the region.

The project site may be susceptible to liquefaction during a large earthquake. As presented in Figure 4-2, the California Geological Survey (1997, 1998) has designated the area between Brookhurst Street and Euclid Street as having a potential for liquefaction. The potential for liquefaction is discussed in detail in Section 8.1.2.1.

4.3.6 Seismicity

The project is in seismically active Southern California. The present-day seismotectonic stress field in the Los Angeles region is one of north-northeasterly compression. This is indicated by the geologic structures, by earthquake focal-mechanism solutions and by geodetic measurements. These data suggest crustal shortening of between 0.2 and 0.35 inches per year across the greater Los Angeles area (Argus et al., 1999).

Historical earthquake epicenter maps show widespread seismicity throughout the Los Angeles region. Earthquakes occur primarily as loose clusters along the NISZ, the southern margin of the Santa Monica Mountains, the margin between the Santa Susana-San Fernando Valley and the southern margin of the San Gabriel Mountains, and in the Coyote Hills-Puente Hills area.

The largest historical earthquakes within the Los Angeles Basin were the 1933 Long Beach (moment magnitude (M_W) of about 6.4), 1994 Northridge (M_W = 6.7), 1971 San Fernando (M_W = 6.7), 1987 Whittier (M_W = 5.9), and 2008 Chino Hills (M_W = 5.4). There have been no significant historical earthquakes in the immediate site area. There may have been a few random small events (M_W < 3.0). The nearest concentrated earthquake activity has been within the Puente Hills about 5 or 6 miles to the north of the site.

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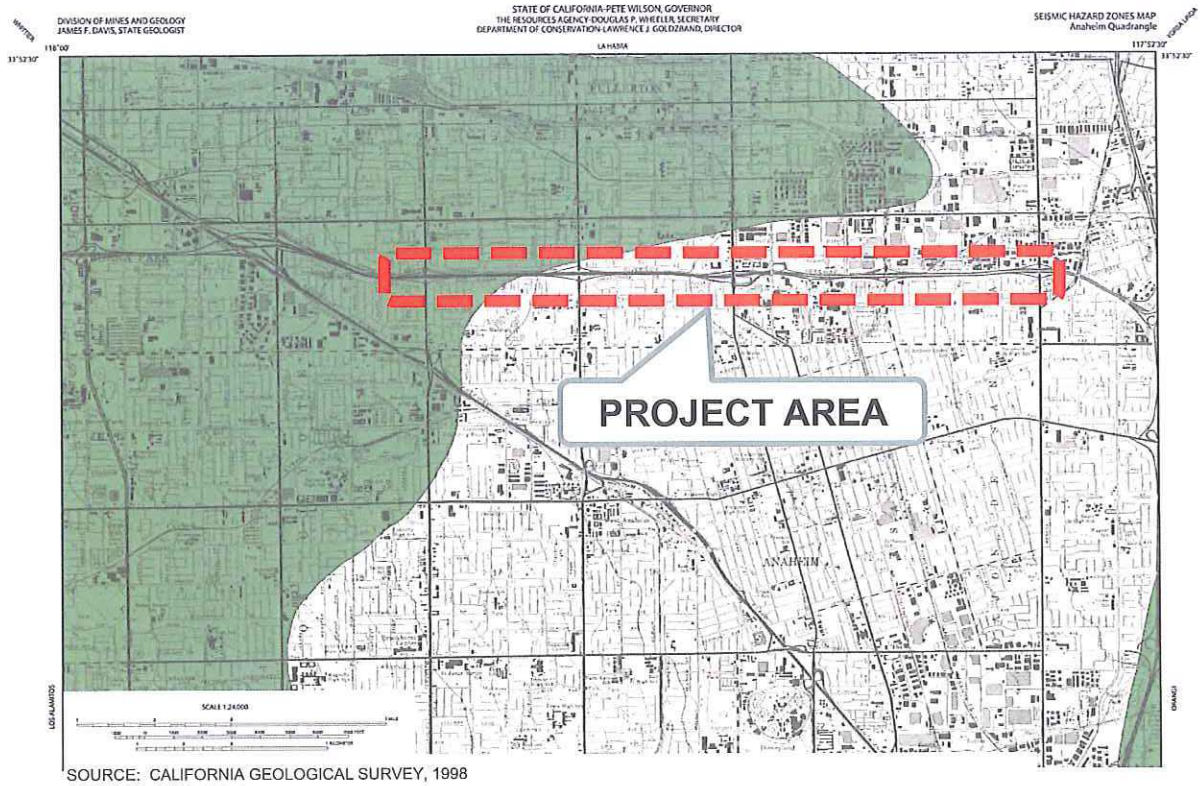


SOURCE: CALIFORNIA GEOLOGICAL SURVEY, 1998

MAP EXPLANATION

Zones of Required Investigation:

Liquefaction

Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

SR-91 WB Widening Project	MAP OF LIQUEFACTION POTENTIAL	
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering		Figure 4-2
	Project No. 10-126	Date: 06-23-11

The 1933 Long Beach earthquake did not rupture the surface but is believed to have been associated with the NISZ (Benioff, 1938). Reevaluation of the seismic data by Hauksson and Gross (1991) relocated the 1933 earthquake hypocenter to a depth of about 6 miles below the Huntington Beach-Newport Beach city boundary.

The 1994 Northridge earthquake occurred on a southerly dipping subsurface fault which was unknown prior to the earthquake. The main shock occurred at a depth of about 12 miles. Earthquake aftershocks clearly defined the rupture surface dipping about 35 degrees southerly from a depth of about 1 or 2 miles to 14 miles. The causative fault was never identified with certainty.

The 1971 San Fernando earthquake involves surface rupture. The 1971 event occurred on a northerly dipping thrust fault that dips from the northern side of the San Fernando Valley to a depth of about 9 miles under the San Gabriel Mountains, and considered part of the Sierra Madre Fault System.

4.4 SOIL SURVEY MAPPING

No soil survey mapping was undertaken for this project.

5.0 EXPLORATION

5.1 DRILLING AND SAMPLING

A geotechnical field investigation was conducted between December 6, 2010 and February 1, 2011, and on May 16 and December 16, 2011. Seventy three exploratory borings were accomplished under the supervision of EMI. Approximate locations of borings are shown on Figure 5-1 through Figure 5-19. Soil exploration information is summarized in Table 5-1 and boring logs and Log of Test Boring (LOTB) sheets are presented in Appendix A.

Table 5-1. Soil Exploration Information

Boring	Station [1]	Offset [1] (feet)	Top of Boring Elevation (feet)	Bottom of Boring Elevation (feet)	Groundwater Elevation (feet)	Drilling Method
HA-10-001	102+95	73 Lt	+108.0	+106.0	NE	HA
A-10-002	109+44	78 Lt	+112.0	+80.5	NE	HSA
A-10-003	112+86	101 Lt	+112.0	+80.5	NE	HSA
HA-10-004	114+02	62 Lt	+121.0	+119.0	NE	HA
A-10-005	116+24	176 Lt	+114.3	+62.8	+70.9	HSA
A-10-006	118+55	76 Lt	+130.0	+43.5	+73.5	HSA
A-10-007	119+36	63 Lt	+112.4	+30.9	+68.4	HSA
A-10-008	120+42	55 Lt	+130.0	+49.2	+71.6	HSA
HA-10-009	120+28	244 Lt	+112.5	+109.5	NE	HA
HA-10-010	125+09	138 Lt	+115.8	+112.8	NE	HA
HA-10-011	126+00	61 Lt	+119.0	+117.0	NE	HA
A-10-012	131+14	91 Lt	+119.0	+87.5	NE	HSA
HA-10-013	137+00	81 Lt	+120.8	+118.8	NE	HA
HA-10-014	142+00	82 Lt	+123.0	+121.0	NE	HA
HA-10-015	146+98	84 Lt	+125.0	+123.0	NE	HA
A-10-016	150+46	86 Lt	+126.2	+94.7	NE	HSA
A-10-017	155+04	87 Lt	+128.7	+122.2	NE	HSA
A-10-018	159+18	95 Lt	+130.0	+98.5	NE	HSA
A-10-019	160+55	106 Lt	+131.0	+99.5	NE	HSA
A-10-020	165+00	63 Lt	+138.0	+106.5	NE	HSA
A-10-021	168+00	58 Lt	+146.8	+115.3	NE	HSA
CPT-10-022	171+67	61 Lt	+153.0	+90.0	NM	CPT
A-10-023	172+55	77 Lt	+135.0	+53.5	+65.0	HSA
A-10-024	173+76	62 Lt	+152.6	+66.1	+80.4	HSA
HA-10-025	173+28	232 Lt	+134.2	+132.2	NE	HSA

Boring	Station [1]	Offset [1] (feet)	Top of Boring Elevation (feet)	Bottom of Boring Elevation (feet)	Groundwater Elevation (feet)	Drilling Method
CPT-10-026	176+21	60 Lt	+148.0	+137.3	NM	CPT
A-10-027	176+59	93 Lt	+141.0	+134.5	NE	HSA
A-10-028	181+00	67 Lt	+140.0	+133.5	NE	HSA
A-10-029	184+45	85 Lt	+139.0	+107.5	NE	HSA
A-10-030	186+48	67 Lt	+142.0	+110.5	NE	HSA
CPT-10-031	189+61	67 Lt	+144.0	+83.5	NM	CPT
A-10-032	193+48	90 Lt	+144.0	+112.5	NE	HSA
A-10-033	196+46	73 Lt	+146.0	+114.5	NE	HSA
A-10-034	244+48	145 Lt	+164.6	+160.6	NE	HSA
A-10-035	249+78	89 Lt	+166.0	+134.5	NE	HSA
A-10-036	253+33	89 Lt	+168.0	+116.5	NE	HSA
A-10-037	256+96	79 Lt	+178.0	+146.5	NE	HSA
A-10-038	260+40	79 Lt	+188.0	+156.5	NE	HSA
A-10-039	264+14	88 Lt	+198.4	+96.9	NE	HSA
A-10-040	267+05	74 Lt	+201.2	+100.7	NE	HSA
CPT-10-041	270+54	87 Lt	+198.0	+181.1	NM	CPT
HA-10-042	273+10	61 Lt	+196.5	+194.5	NE	HA
A-10-043	273+55	138 Lt	+192.5	+141.0	NE	HSA
A-10-044	278+00	77 Lt	+193.0	+111.5	+113.3	HSA
A-10-045	279+05	77 Lt	+174.0	+92.6	+120.5	HSA
CPT-10-046	279+92	64 Lt	+189.5	+103.2	NM	CPT
A-10-047	280+88	211 Lt	+175.0	+168.5	NE	HSA
A-10-048	284+98	64 Lt	+177.9	+171.4	NE	HSA
A-10-049	288+71	77 Lt	+178.0	+146.5	NE	HSA
A-10-050	293+06	77 Lt	+180.0	+148.5	NE	HSA
CPT-10-051	296+68	80 Lt	+180.0	+122.6	NM	CPT
A-10-052	300+05	82 Lt	+192.0	+160.5	NE	HSA
CPT-10-053	304+43	73 Lt	+200.0	+140.6	NM	CPT
A-10-054	305+43	95 Lt	+181.0	+99.5	+128.2	HSA
A-10-055	306+48	76 Lt	+200.5	+129.3	NE	HSA
A-10-056	310+10	80 Lt	+194.0	+162.5	NE	HSA
A-10-057	313+75	82 Lt	+188.0	+156.5	NE	HSA
A-10-058	316+80	84 Lt	+185.9	+154.5	NE	HSA
A-10-059	323+05	94 Lt	+194.0	+162.5	NE	HSA

Boring	Station [1]	Offset [1] (feet)	Top of Boring Elevation (feet)	Bottom of Boring Elevation (feet)	Groundwater Elevation (feet)	Drilling Method
HA-10-060	326+00	73 Lt	+199.0	+197.0	NE	HA
A-10-061	327+09	139 Lt	+196.8	+145.3	+153.7	HSA
CPT-10-062	330+80	69 Lt	+208.7	+162.6	NM	CPT
A-10-063	332+01	90 Lt	+190.2	+109.7	NE	HSA
A-10-064	333+13	76 Lt	+210.0	+128.7	NE	HSA
HA-10-065	332+93	244 Lt	+191.0	+189.0	NE	HA
HA-10-066	335+13	172 Lt	+196.0	+194.0	NE	HA
A-10-067	336+96	83 Lt	+204.0	+172.5	NE	HSA
HA-10-068	341+16	102 Lt	+202.0	+200.0	NE	HA
HA-11-069	208+12	93 Lt	+156.0	+152.0	NE	HA
HA-11-070	212+85	91 Lt	+155.7	+151.7	NE	HA
HA-11-071	217+91	207 Lt	+152.0	+148.0	NE	HA
HA-11-072	223+07	249 Lt	+156.0	+152.0	NE	HA
A-11-073	106+21	91 Lt	+108.5	+72.0	NE	HSA

Notes:
1. Stations and offsets are measured relative to "A Line" Stations and are approximate.
2. A Line = SR-91 Centerline.
3. NE = Not Encountered; NM = Not Measured.
4. CPT = Cone Penetration Test boring; HA = Hand Auger boring; HSA = Hollow-Stem Auger boring;

Hollow-stem auger borings except A-11-073 were drilled using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers. The boring A-11-073 was drilled using a tripod with hydraulic power unit drill system equipped with 6-inch diameter solid-fly augers. Sampling was performed by alternating the Modified California Drive (MCD) sampler and Standard Penetration Test (SPT) sampler. The soil sampling interval is generally 5 feet.

Relatively undisturbed soil samples were obtained using a 3.25-inch outer diameter MCD sampler lined with brass rings. Each of these brass rings is 1-inch long with a 2.5-inch outside diameter. The SPT sampler (1.4-inch inside diameter) was also used to obtain soil samples. The MCD and SPT samplers were driven 18 inches into the ground or until refusal was encountered using a 140-lb hammer free falling from a height of 30 inches. Automatic hammer and rope hammer were used to drive samplers in the truck-mounted drill rig and tripod drill system, respectively. The numbers of blows to advance the sampler each 6 inches of penetration were recorded. The number of blows for the final 12 inches or shorter of driving was recorded on the boring logs and LOTB sheets. Charts published by Winterkorn and Fang (1975) can be used to determine a reduction factor used to convert blowcounts recorded using the California Drive sampler into SPT blowcounts. Using those charts, we obtained a reduction factor of 0.5 which was used for this project.

Hand-auger borings were drilled using a 3-inch diameter stainless steel hand-auger. Bulk samples were collected from the hand-auger borings.

The CPT sounding was performed using an electronic cone penetrometer in general accordance with current ASTM Standards (ASTM D5778 and ASTM D3441). The CPT equipment consisted of a cone penetrometer assembly mounted at the end of a series of hollow sounding rods. The cone penetrometer assembly consisted of a conical tip with a 60° apex angle and a projected cross sectional area of 1.55 in² (10 cm²) and a cylindrical friction sleeve with a surface area of 23.25 in² (150 cm²). The interior of the cone penetrometer is instrumented with strain gauges that allow simultaneous measurements of cone tip and friction sleeve resistance during penetration. The cone penetrometer assembly is continuously pushed into the soil by a set of hydraulic rams at a standard rate of 0.79 inch per second (20 mm per second) while the cone tip resistance and sleeve friction resistance are recorded every 1.967 inches (50 mm) and stored in digital form. A specially designed all-wheel drive 25-ton truck provides the required reaction weight for pushing the cone assembly and is also used to transport and house the testing equipment. The computer generated graphical logs include tip resistance, friction resistance, and friction ratio. Soil behavior type interpretations are based on guidelines by Robertson and Campanella (1989).

5.2 GEOLOGIC MAPPING

Geologic mapping was not necessary and therefore was not performed for the project.

5.3 GEOPHYSICAL STUDIES

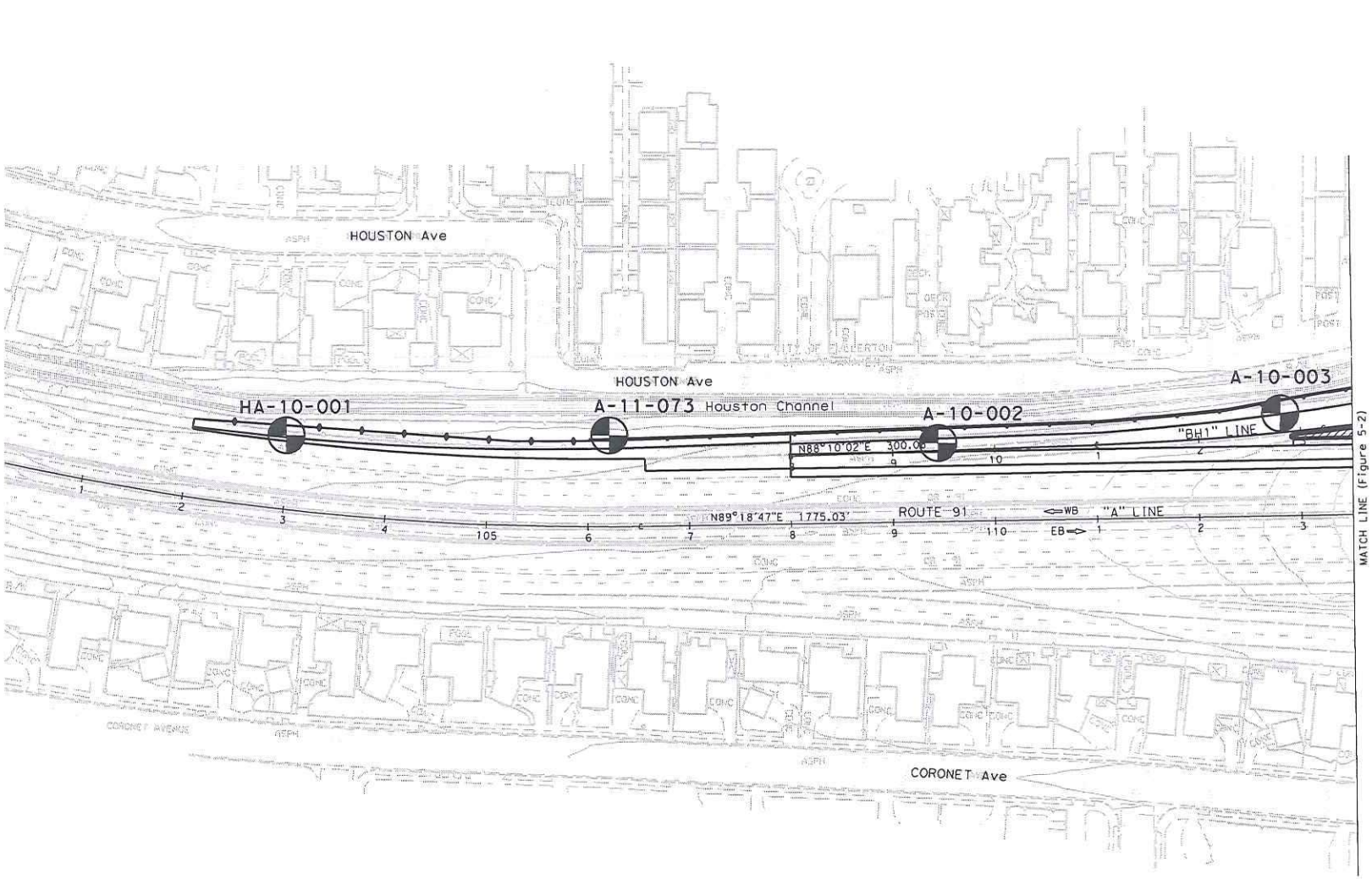
Geophysical studies were not necessary and therefore were not performed for the project.

5.4 INSTRUMENTATION

Instrumentation was not necessary and therefore not installed as part of the field investigation program.

5.5 EXPLORATION NOTES

No unique conditions were encountered or observed during the field exploration.



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STATE ROUTE 91 WESTBOUND WIDENING PROJECT

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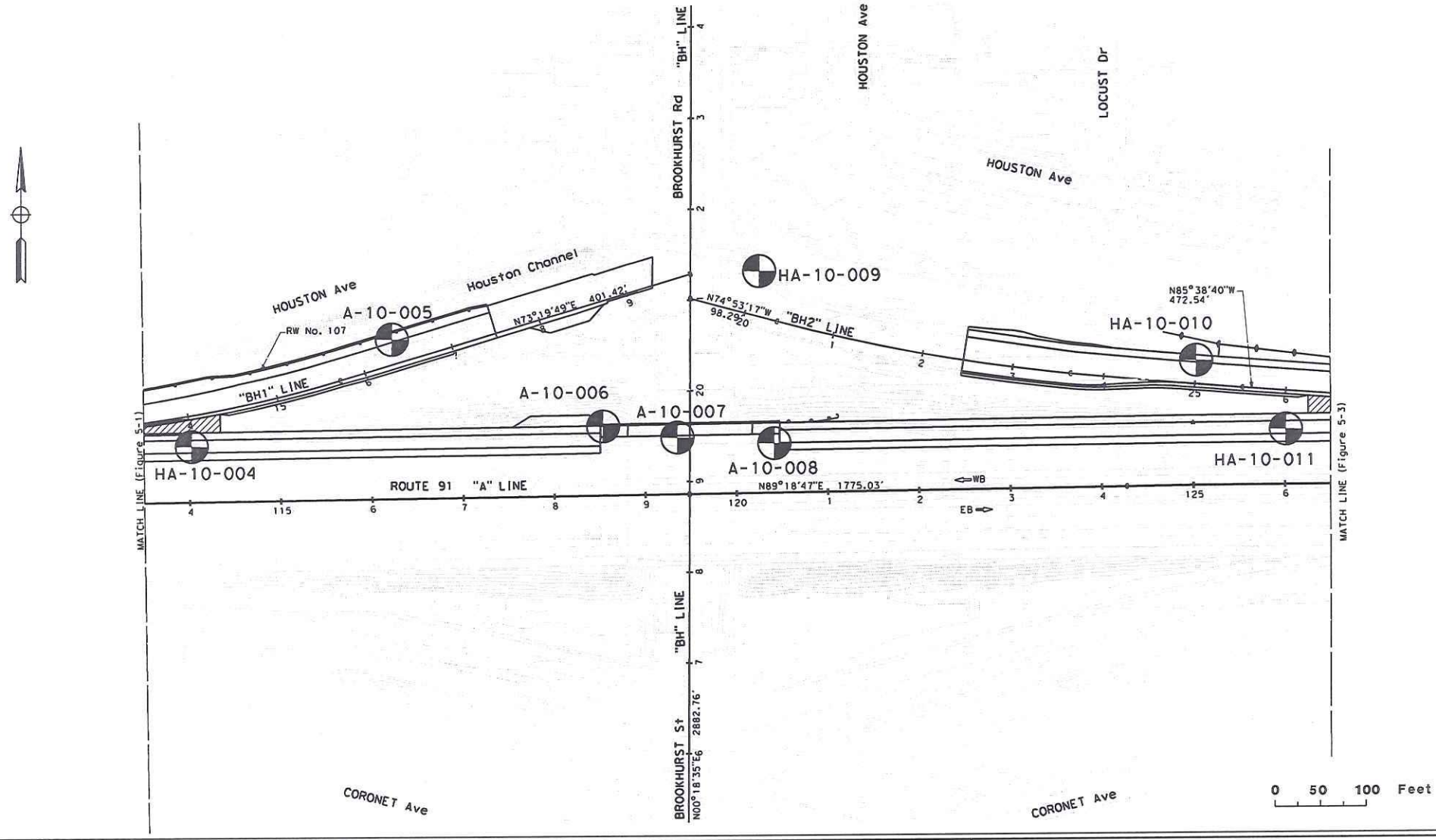
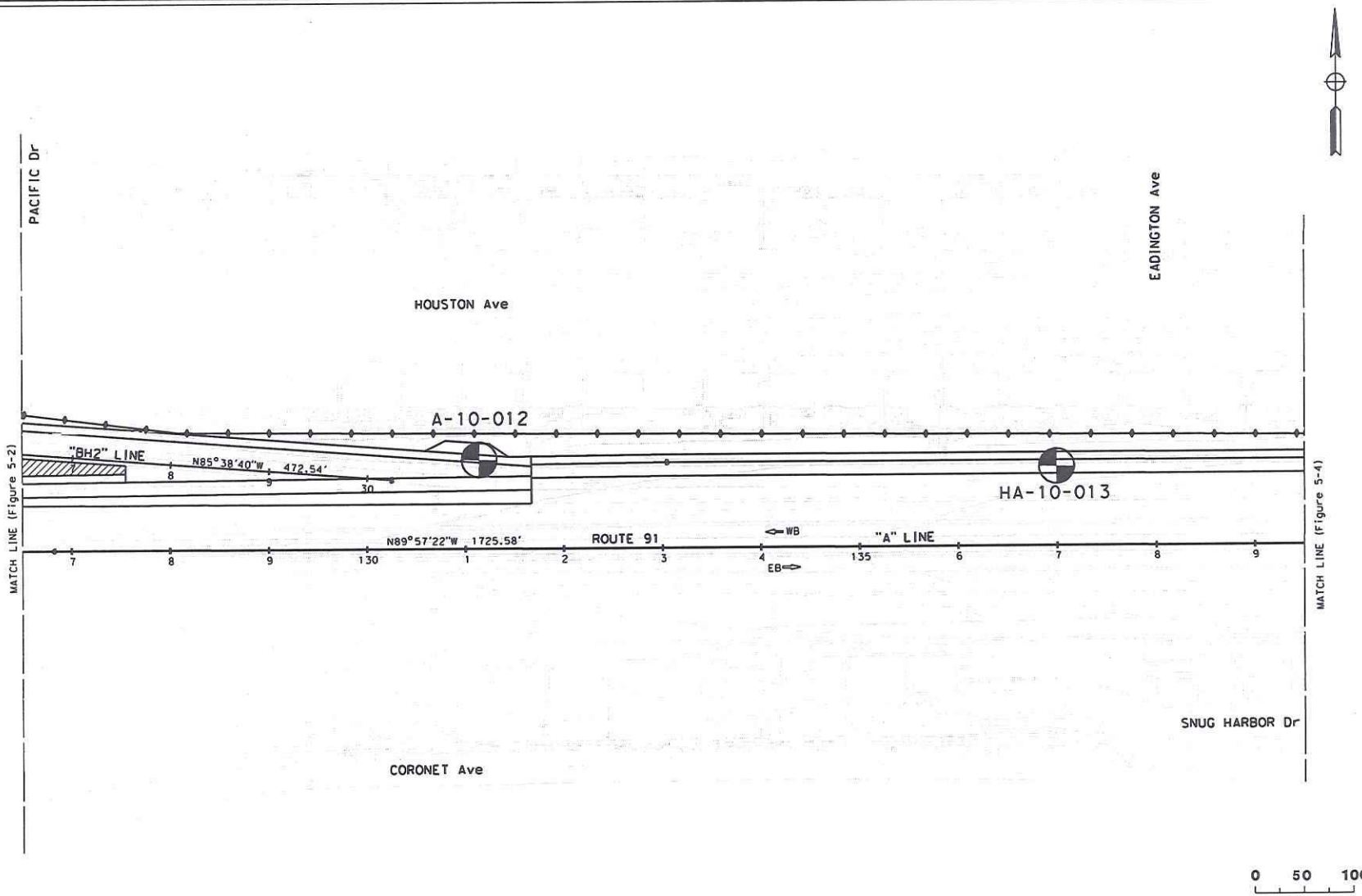
Exploratory Boring Location Map (1 of 19)

Figure 5-1



Earth Mechanics, Inc. Geotechnical & Earthquake Engineering	**STATE ROUTE 91 WESTBOUND WIDENING PROJECT** **Project No.: 10-126** **Date: 06-23-2011**	**Exploratory Boring Location Map (2 of 19)** **Figure 5-2**



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STATE ROUTE 91 WESTBOUND WIDENING PROJECT

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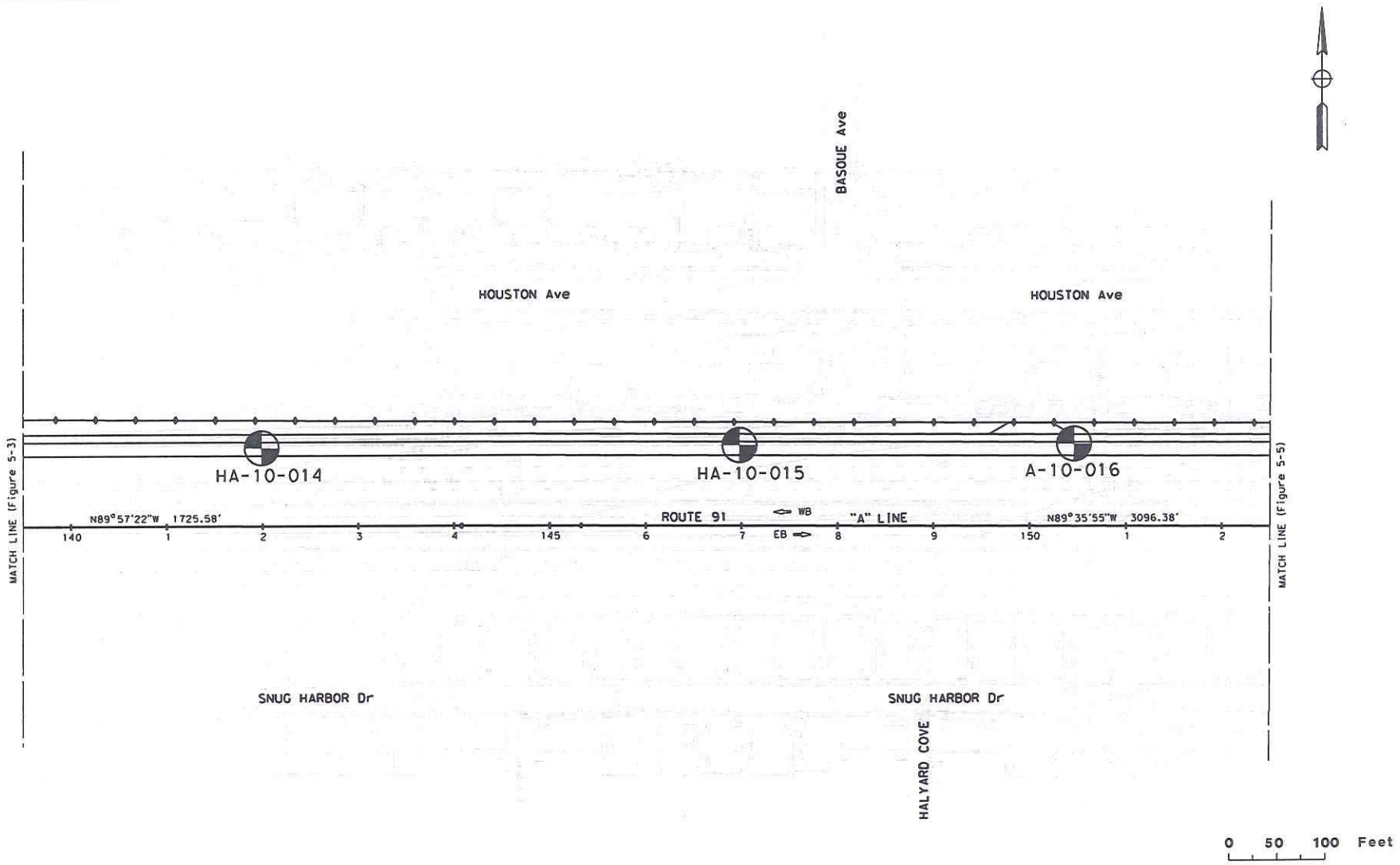
Exploratory Boring Location Map (3 of 19)

Figure 5-3



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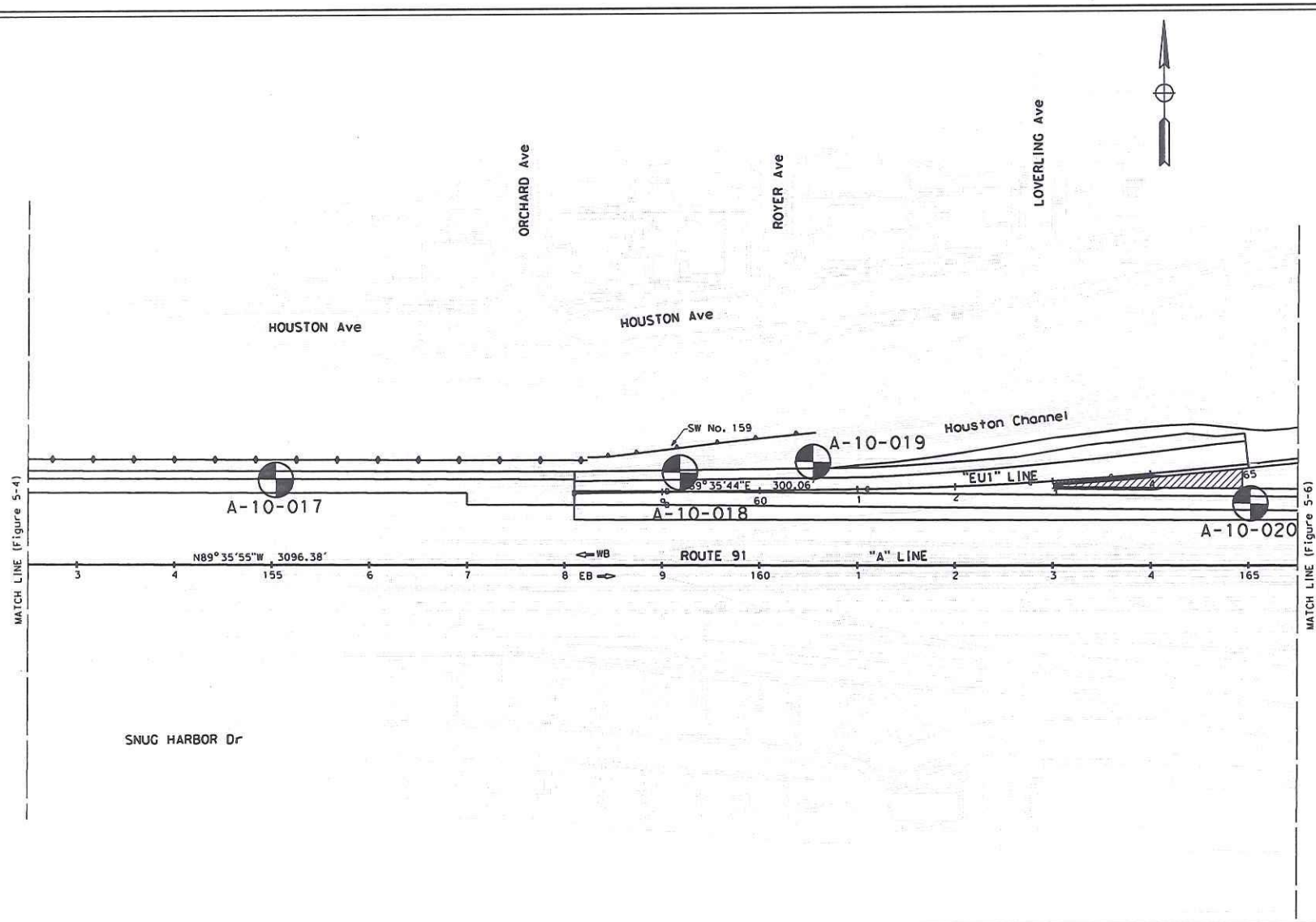
Exploratory Boring Location Map (4 of 19)

Figure 5-4



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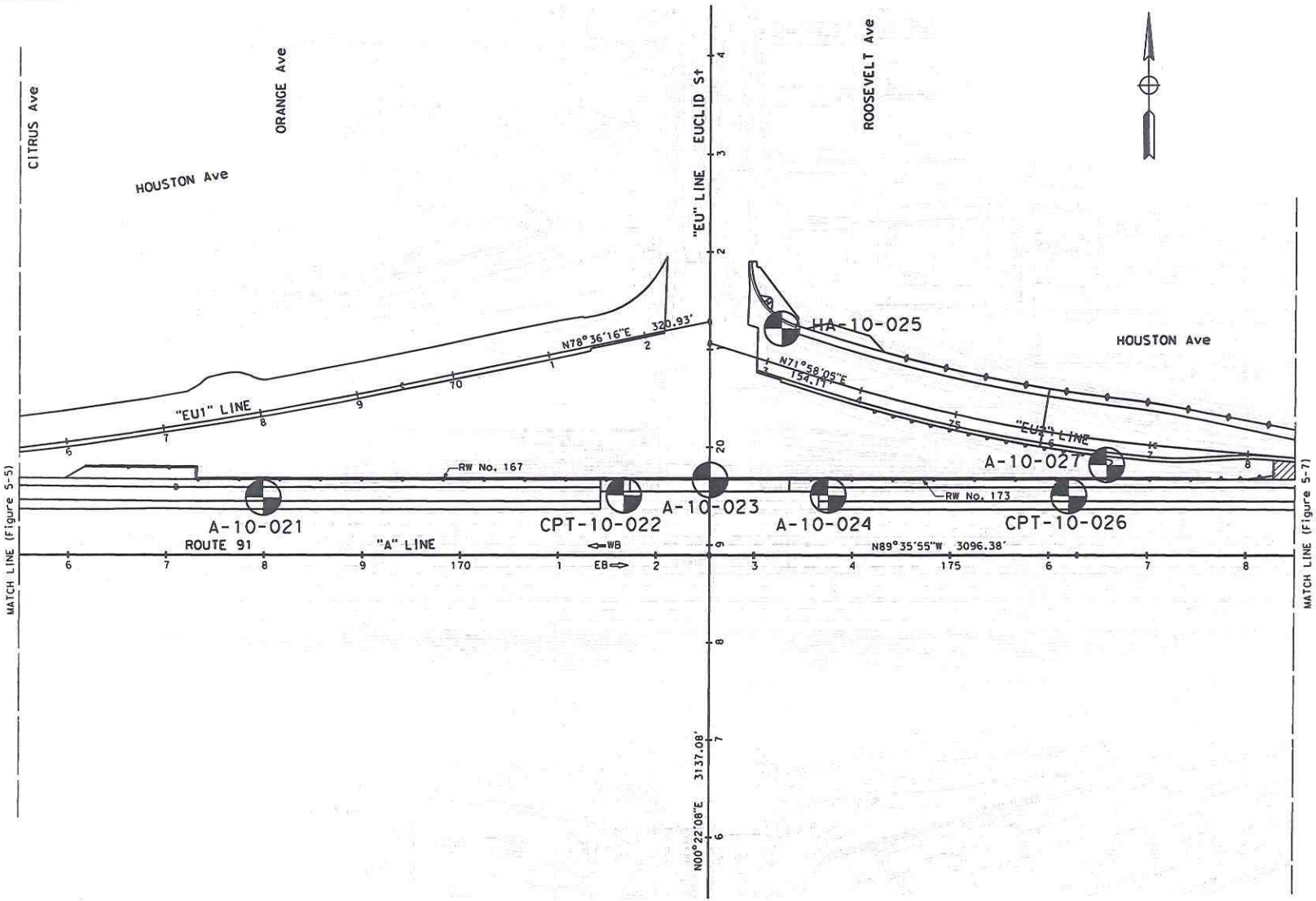
Exploratory Boring Location Map (5 of 19)

Figure 5-5



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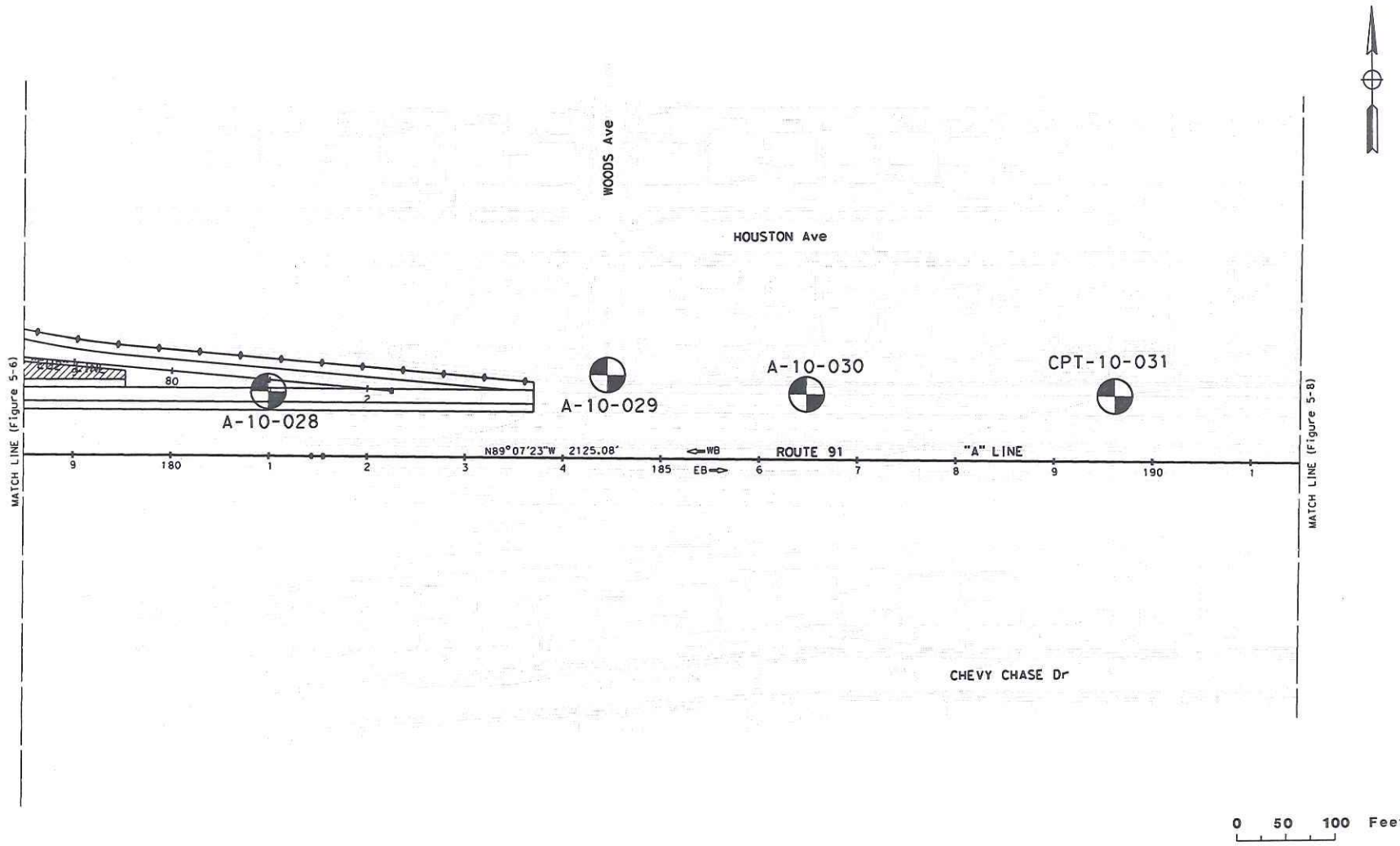
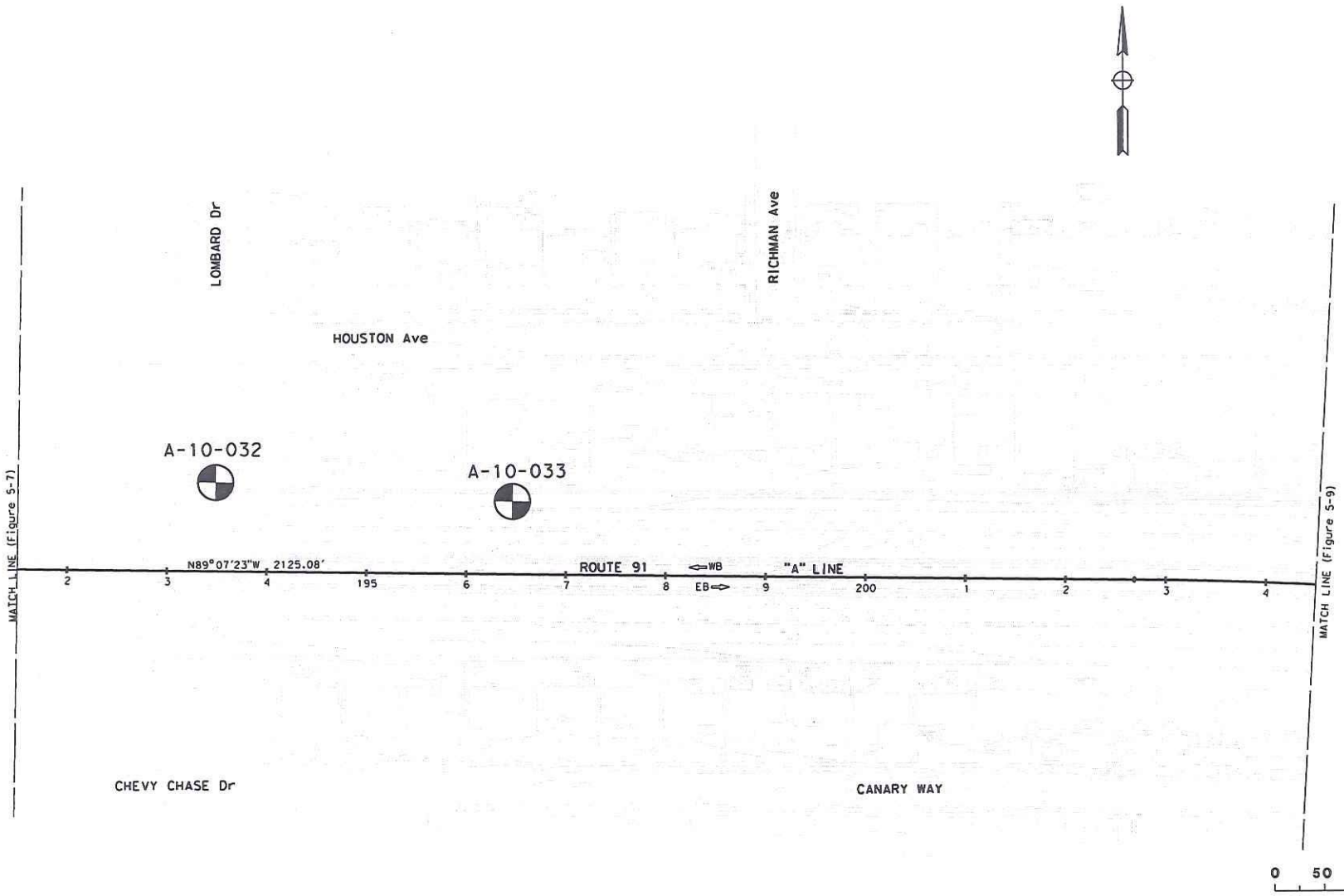
Exploratory Boring Location Map (6 of 19)

Figure 5-6



Earth Mechanics, Inc. Geotechnical & Earthquake Engineering	**STATE ROUTE 91 WESTBOUND WIDENING PROJECT**	**Exploratory Boring Location Map (7 of 19)**
	Project No.: 10-126 / **Date: 06-23-2011**	**Figure 5-7**



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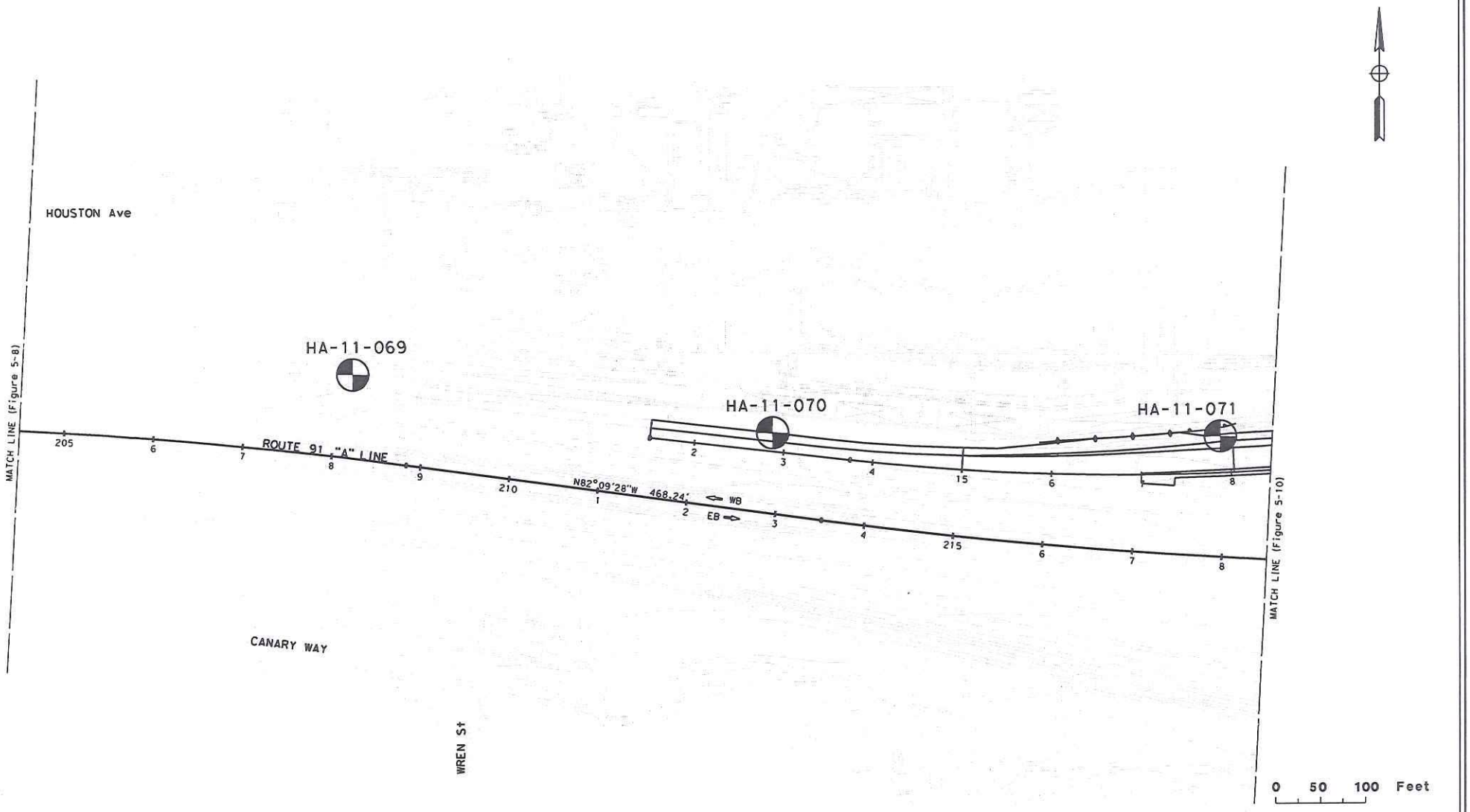
Exploratory Boring Location Map (8 of 19)

Figure 5-8



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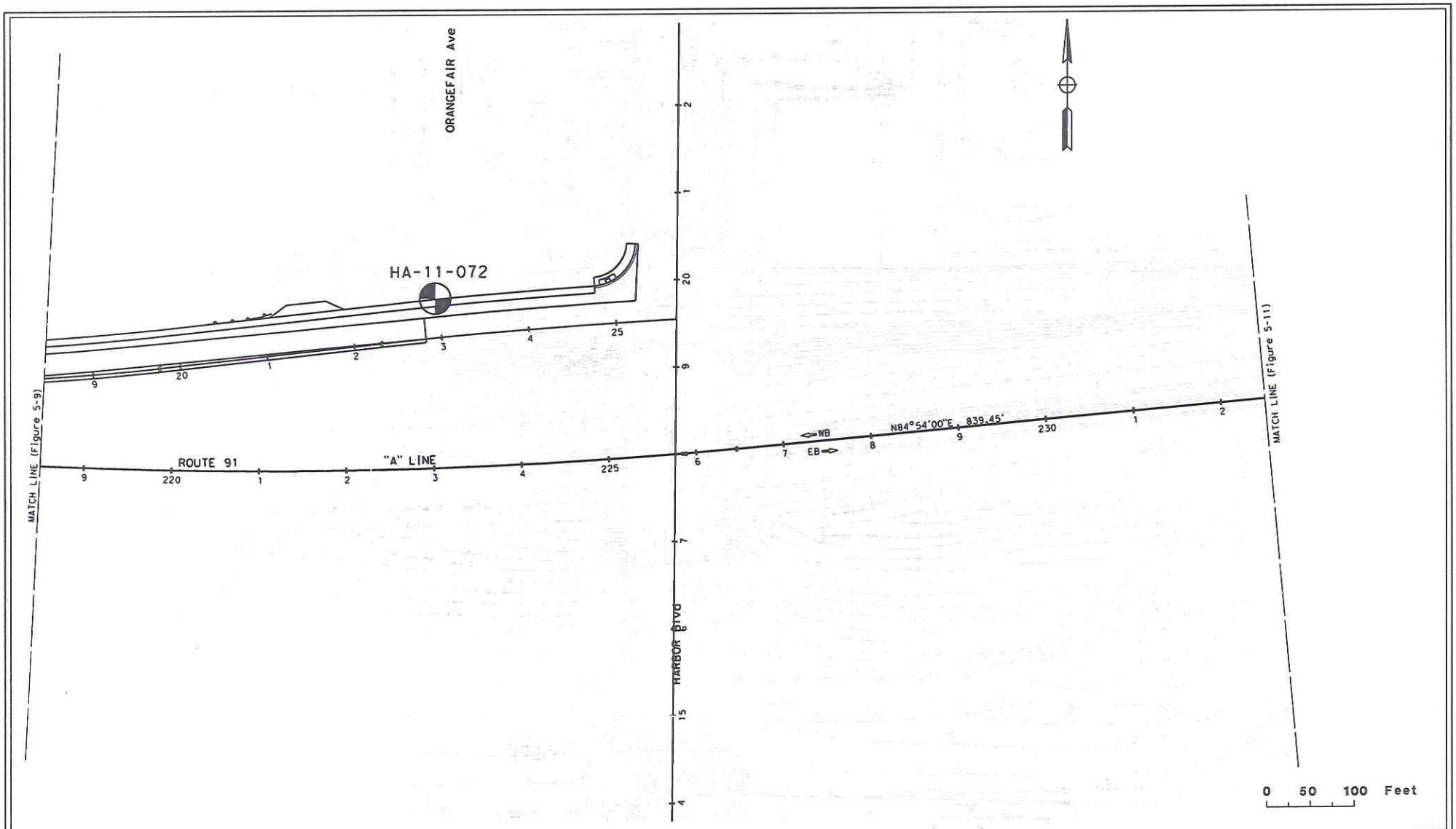
Exploratory Boring Location Map (9 of 19)

Figure 5-9



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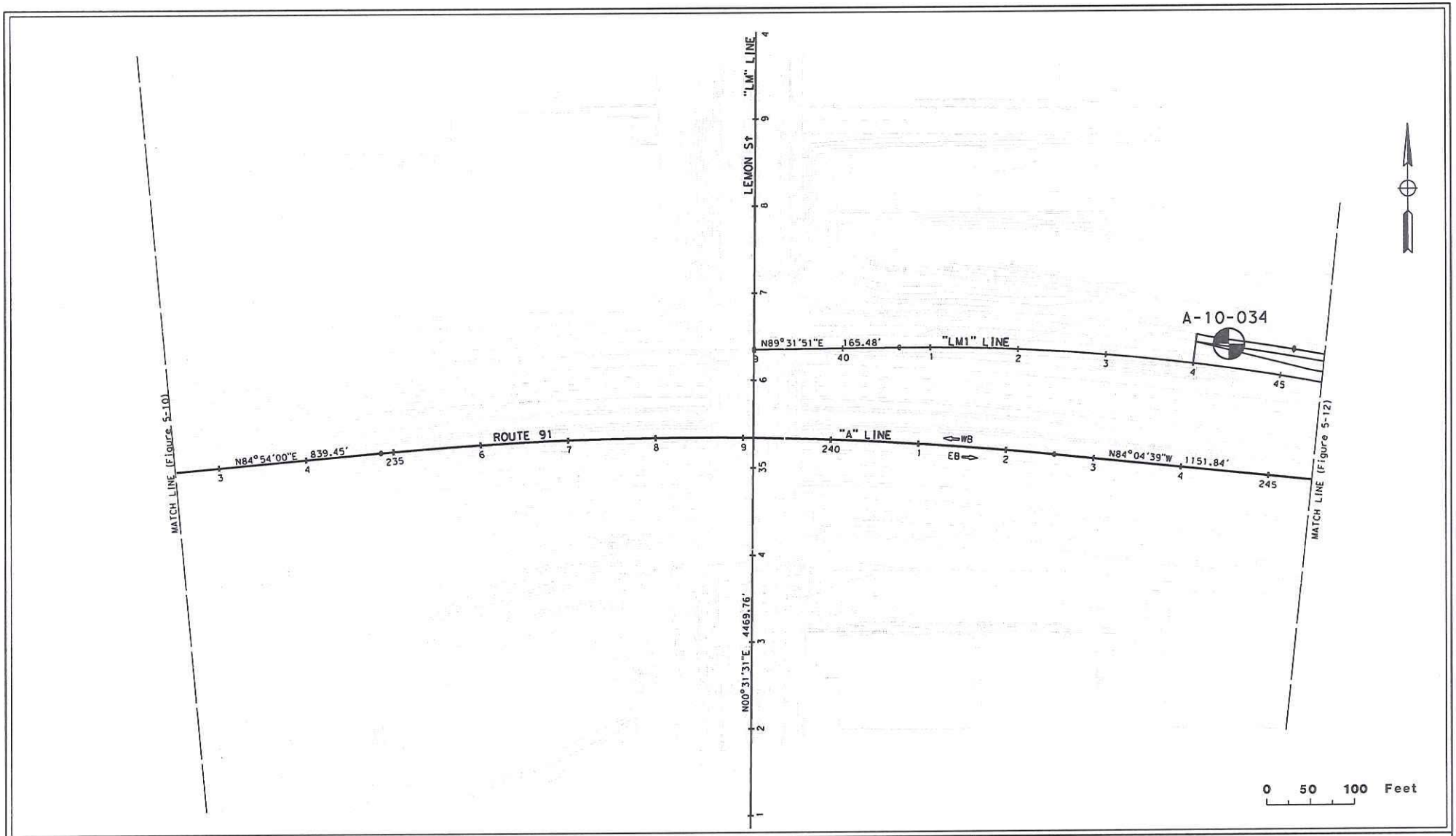
Exploratory Boring Location Map (10 of 19)

Figure 5-10



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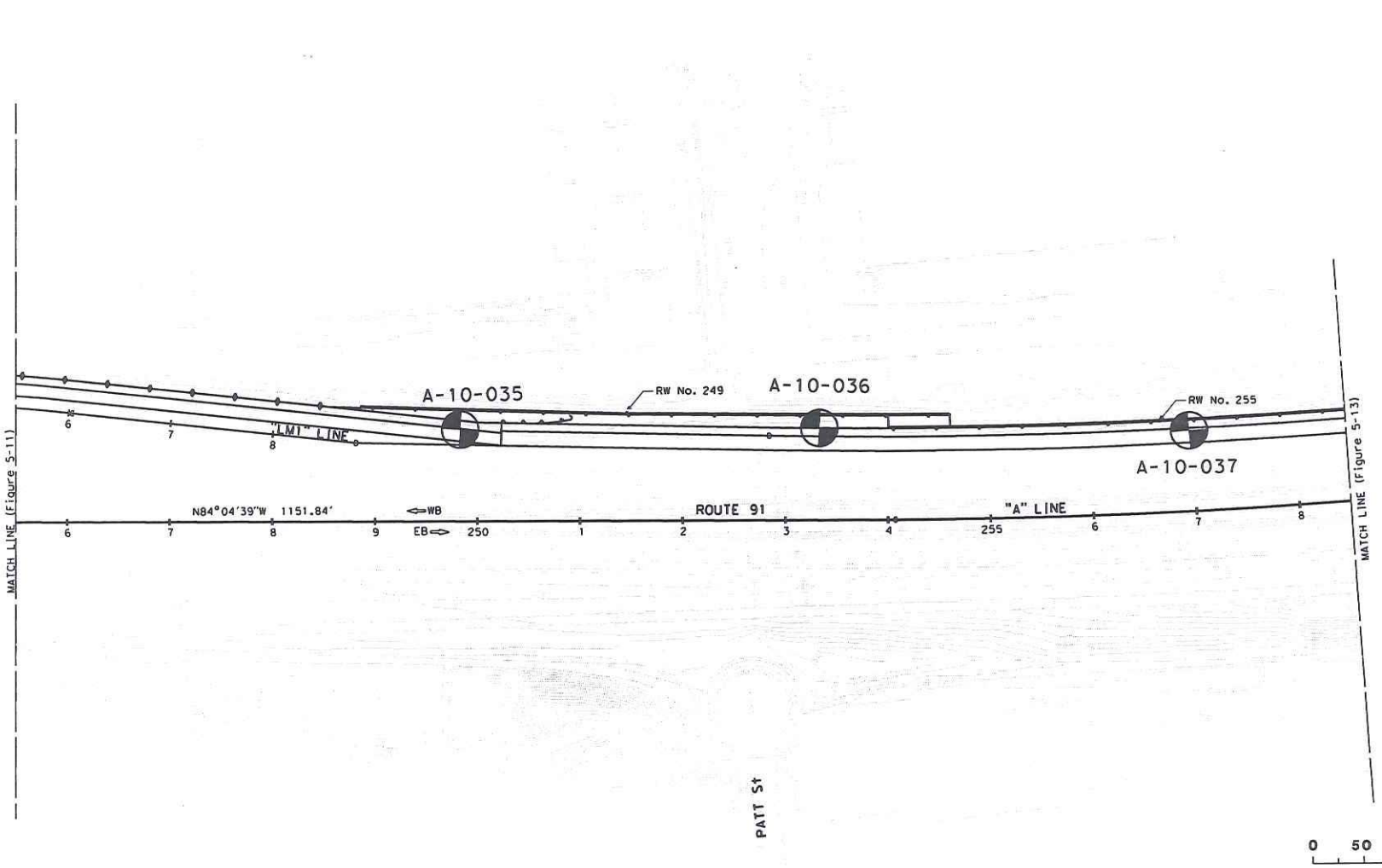
Exploratory Boring Location Map (11 of 19)

Figure 5-11



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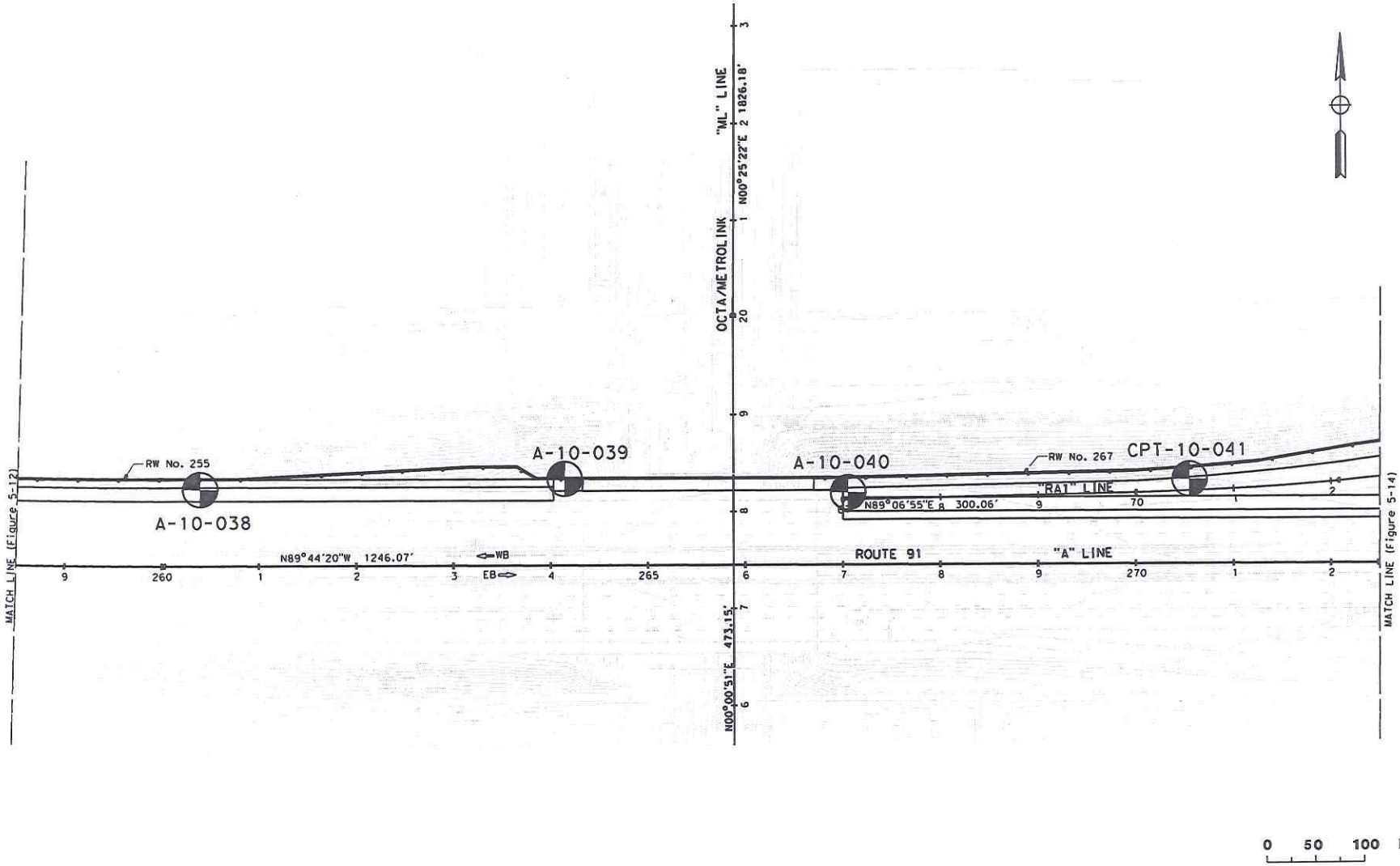
Exploratory Boring Location Map (12 of 19)

Figure 5-12



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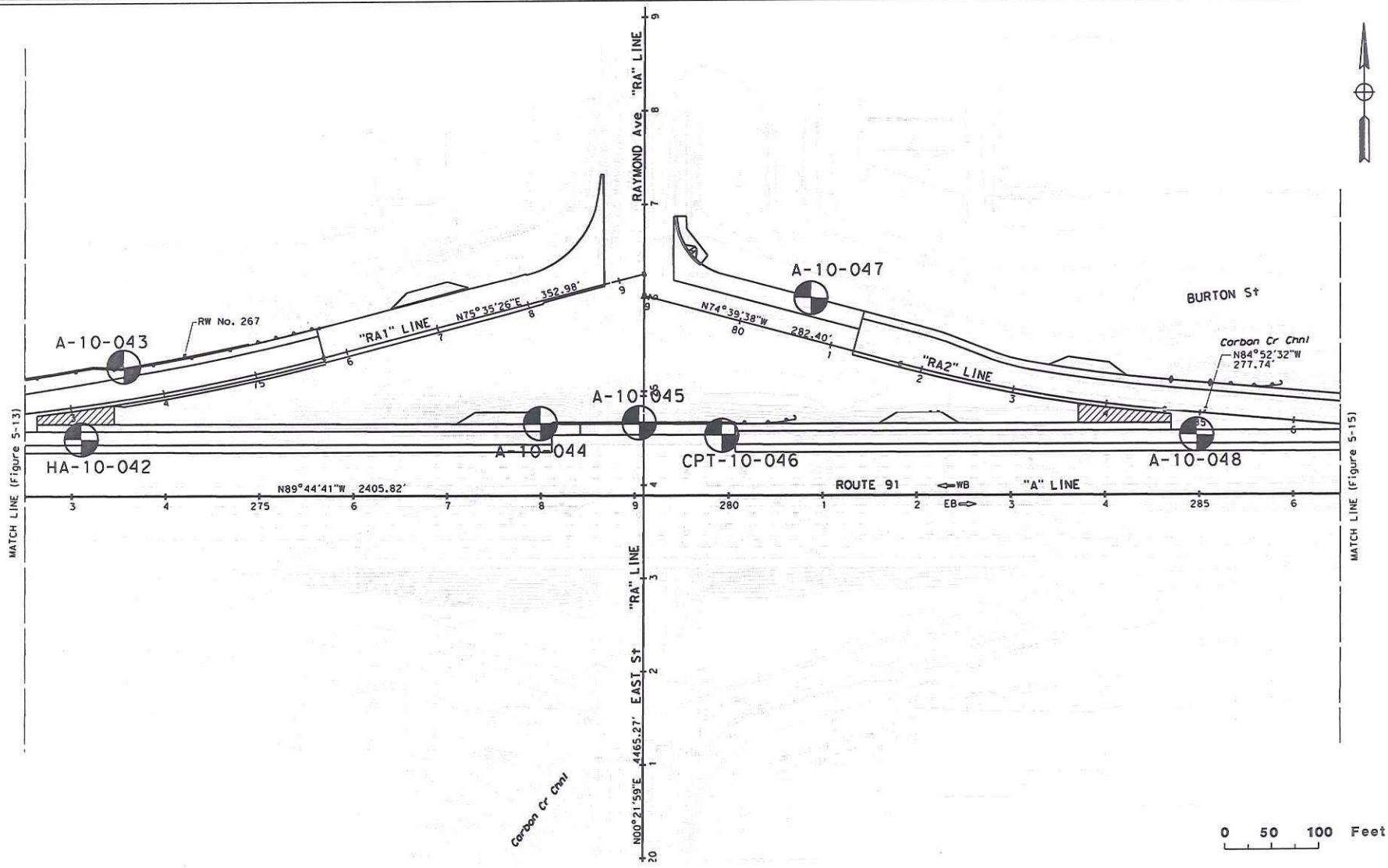
Exploratory Boring Location Map (13 of 19)

Figure 5-13



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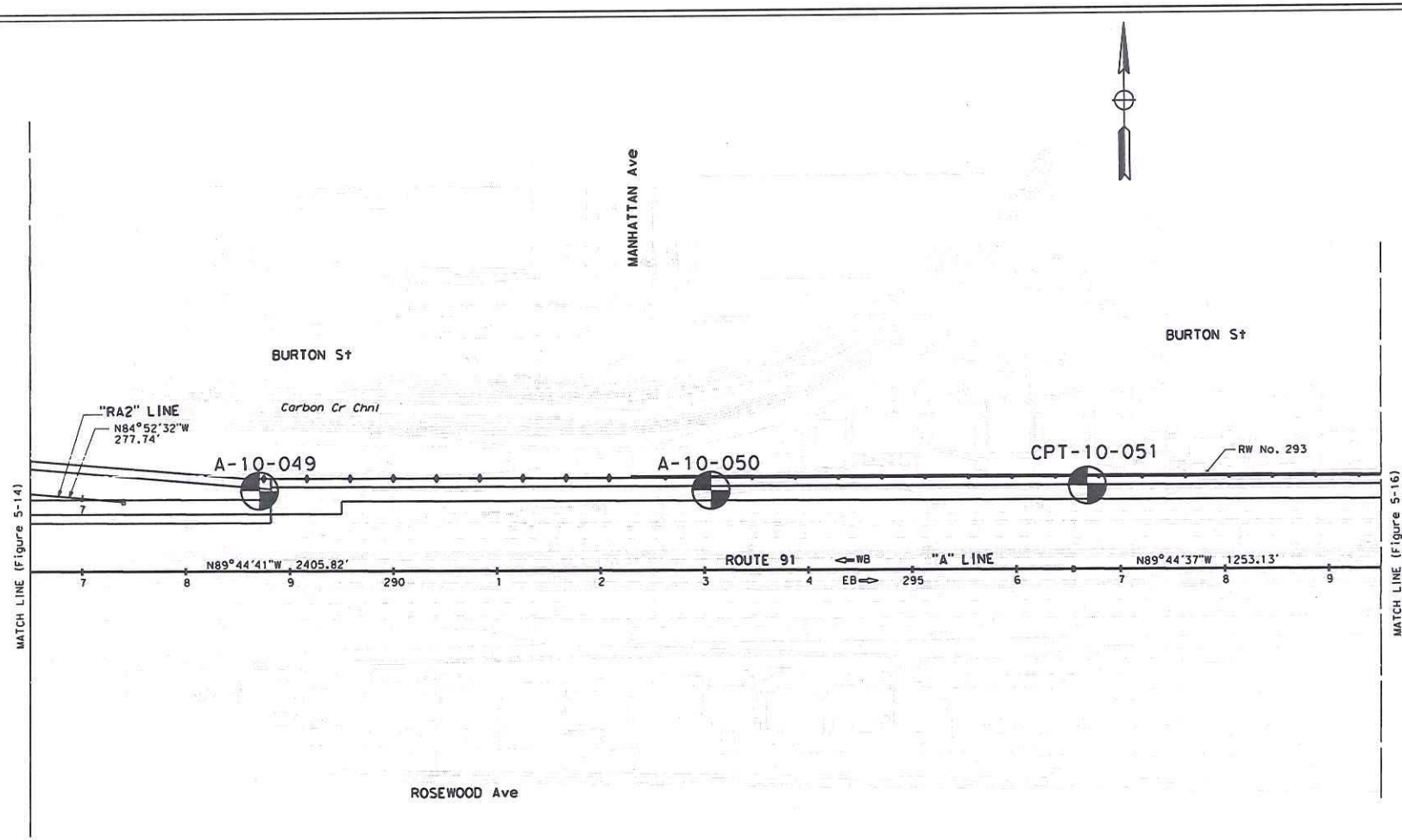
Exploratory Boring Location Map (14 of 19)

Figure 5-14



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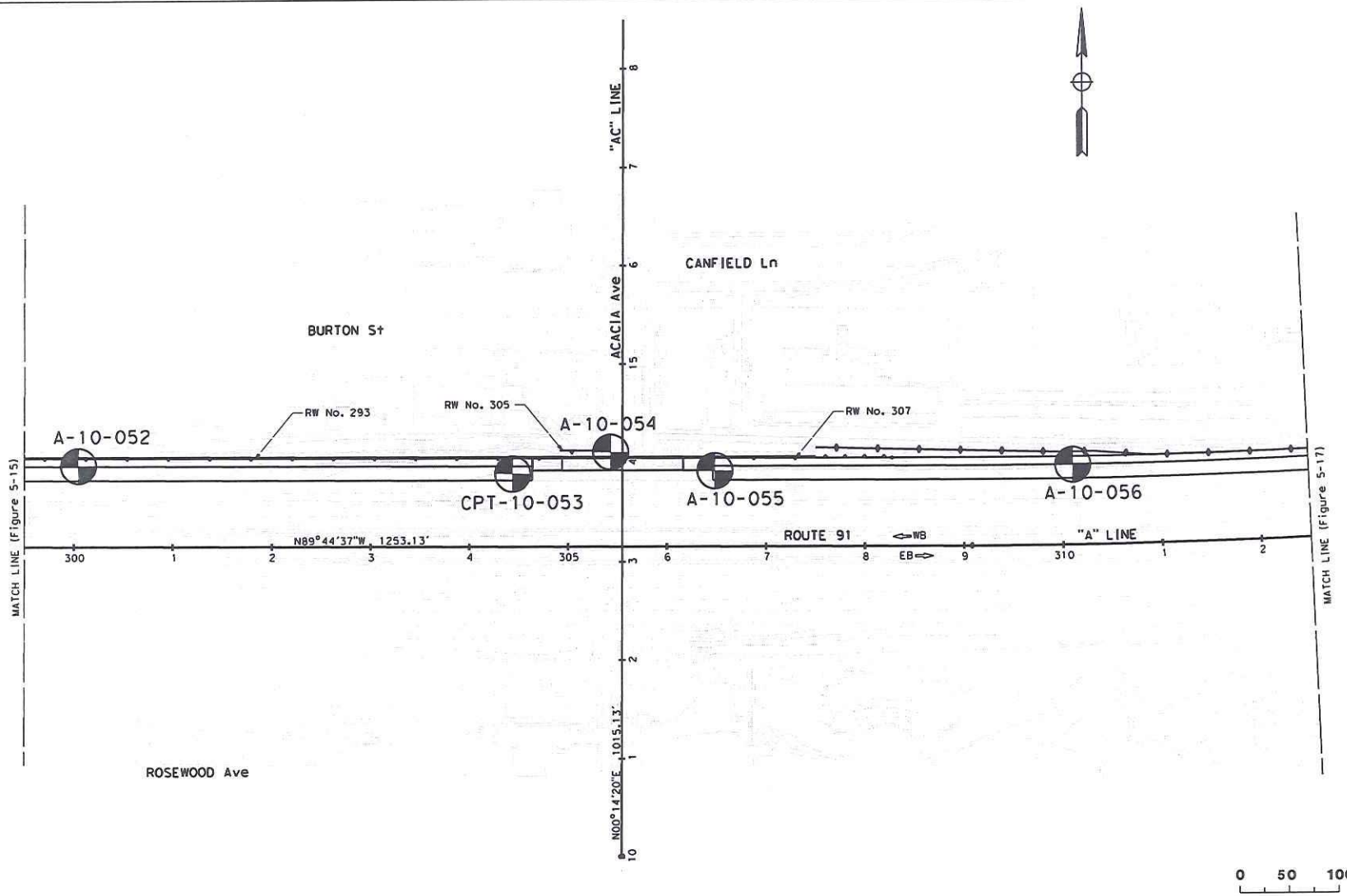
Exploratory Boring Location Map (15 of 19)

Figure 5-15



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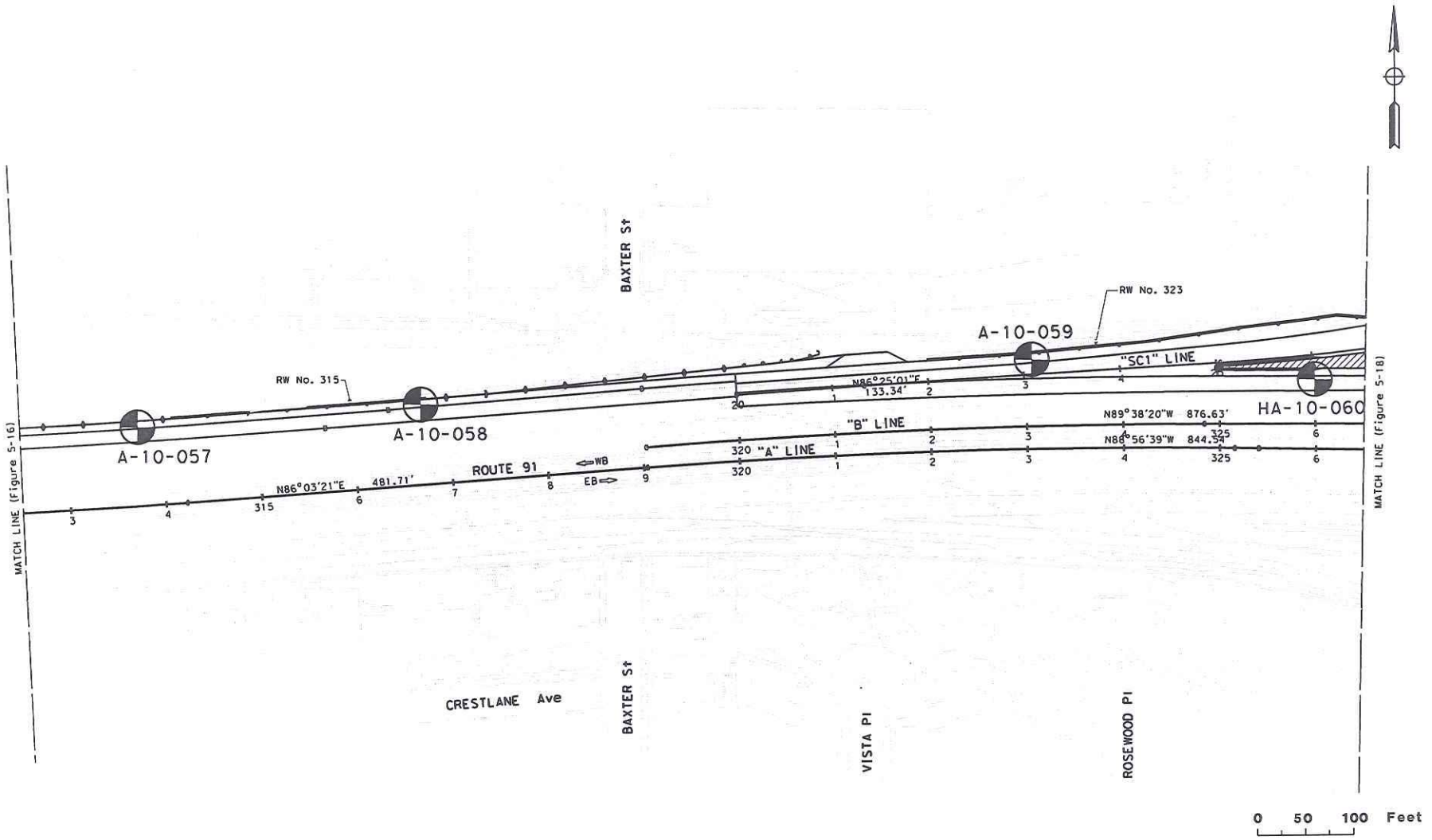
Exploratory Boring Location Map (16 of 19)

Figure 5-16



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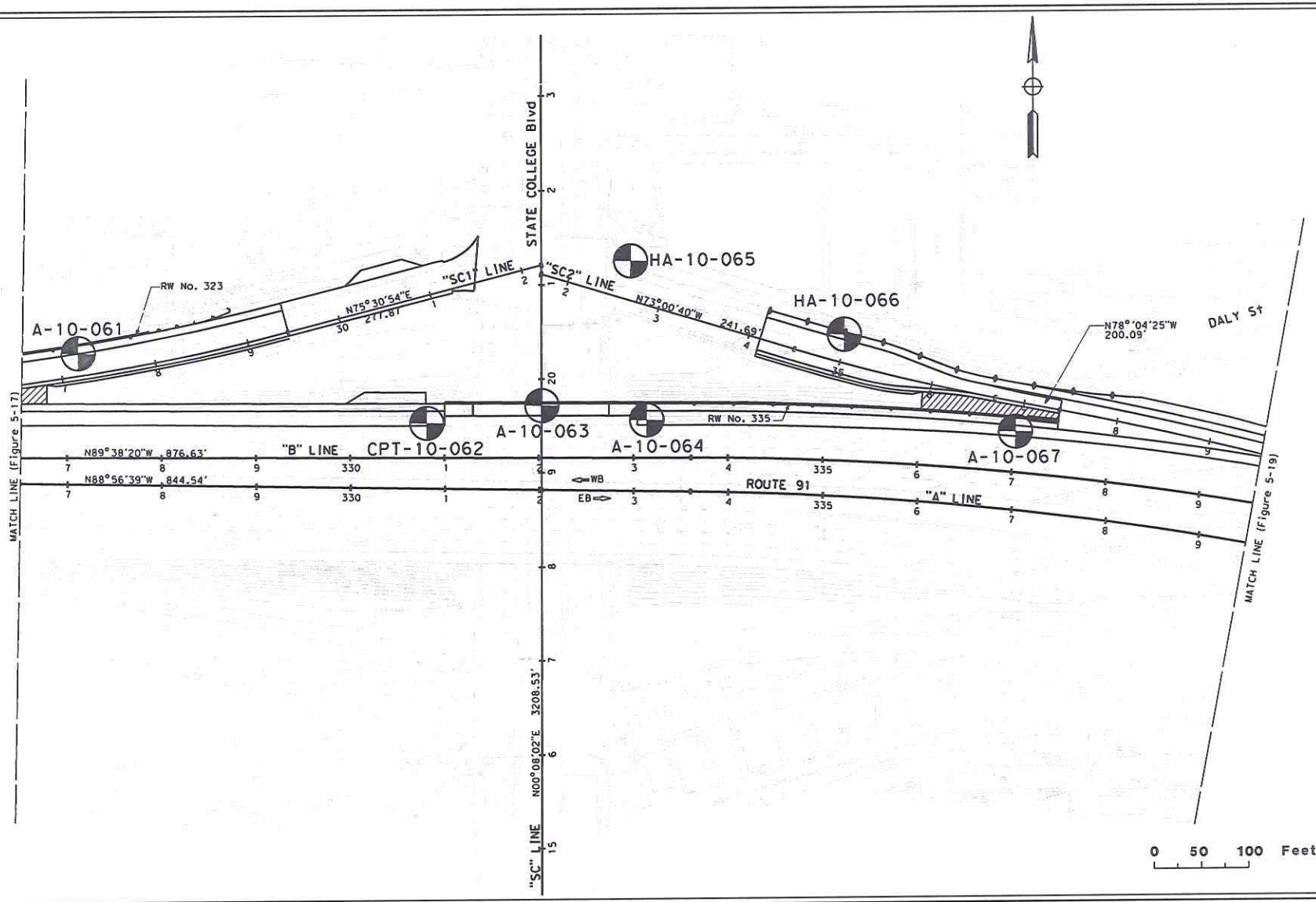
Exploratory Boring Location Map (17 of 19)

Figure 5-17



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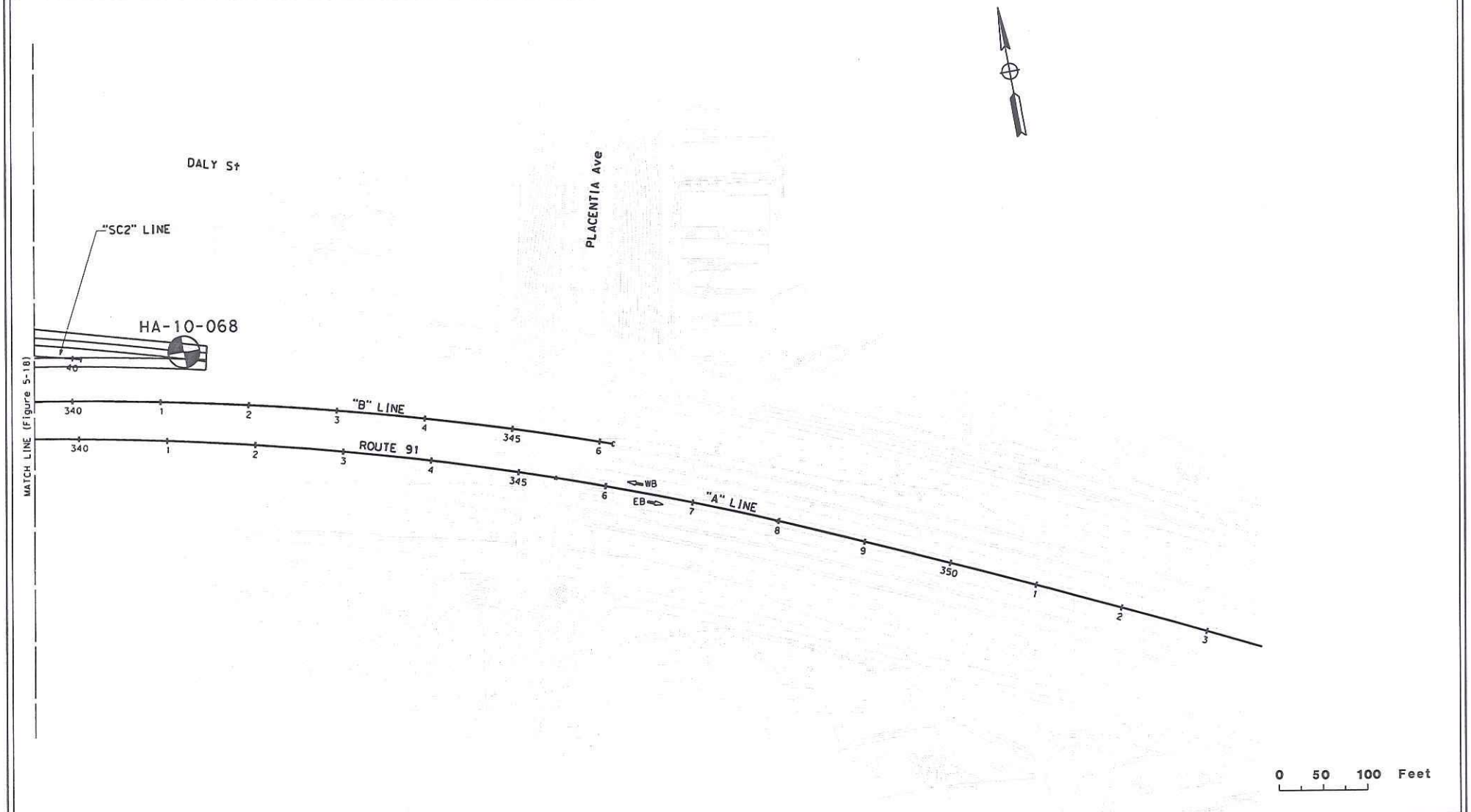
Exploratory Boring Location Map (18 of 19)

Figure 5-18



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Exploratory Boring Location Map (19 of 19)

Figure 5-19

6.0 GEOTECHNICAL TESTING

6.1 IN-SITU TESTING

Blowcounts from the SPT and MCD samplers were recorded during the exploration. The blowcounts are shown on the borings logs and LOTB sheets in Appendix A.

6.2 LABORATORY SOIL TESTING

Soil samples considered representative of the subsurface conditions were tested to obtain or derive relevant physical and engineering soil properties. The following laboratory tests were conducted to supplement the observations recorded during the field investigation.

- In-situ Moisture Content and Unit Weight
- Percent Passing No. 200 Sieve
- Grain Size Analysis
- Atterberg Limits
- Direct Shear
- Unconsolidated Undrained Triaxial
- Consolidation
- Pocket Penetrometer
- Minimum Resistivity, pH, Sulfate Content and Chloride Content
- Maximum Density and Optimum Moisture Content
- Sand Equivalent
- R-Value

The laboratory soil tests were conducted in general accordance with California Test methods or American Society for Testing and Materials standards. Laboratory test results are presented in Appendix B.

R-value tests noted on the boring logs and LOTB sheets in Appendix A were conducted for preparation of the Materials Report (EMI, 2012b). The R-value test results were not used in preparation of the recommendations included in this report and therefore, they were omitted from Appendix B.

7.0 GEOTECHNICAL CONDITIONS

7.1 SITE GEOLOGY

7.1.1 Lithology

The project area is underlain predominantly by non-indurated sand and silty sand sediments with traces of fine gravelly sands, and thin silt and clay beds.

7.1.2 Geologic Structure

The geologic structure of the site was described in Section 4.3.4.

7.1.3 Natural Slope Stability

There are no natural slopes within the project limits that require stability evaluation.

7.2 SUBSURFACE SOIL CONDITIONS

7.2.1 Material Strength Parameters

Materials encountered during the field investigation consist of fill and alluvium. Based on the SPT blowcounts and laboratory test results, shear strength parameters for various soil types were selected and are summarized in Table 7-1.

Table 7-1. Soil Strength Parameters

Predominant Soil Type	Equivalent SPT Blowcount (blows/foot)*	Total Unit Weight (pcf)	Friction Angle (degree)	Cohesion (psf)
Sand, Silty Sand and Sand with Silt	4 to >100 Average = 24	120	30 – 36 Average = 32	50 – 150 Average = 100
Sandy Silt and Lean Clay with Sand	(7) to 39 Average = 19	115	-	1300 – 2500 Average = 2500
Sand	11 to >100 Average = 51	125	38	0
Sandy Silt	(7) to 14 Average = 10	115	-	1000 – 1700 Average = 1300

* Values in ( ) are converted SPT blowcounts corrected for sampler size; correction factor from California sampler blowcounts to SPT blowcounts is 0.5.

7.2.2 Expansion Potential

The sands and silty sands encountered in boreholes are not expansive. The occasional sandy silt layers are anticipated to have a low expansion potential. Lean clay with sand layers which were encountered in some of the borings have a low to medium expansion potential. However, these clayey soils were encountered at relatively deeper depths and are not anticipated to impact the proposed improvements. On-site native soils and existing fill materials within the project area are considered suitable for use as compacted fill. Fine-grained native soils and fine-grained existing

fill materials should not be placed behind retaining walls. Additional laboratory tests may be required during earthwork operations to verify the expansion potential of soils used in specific areas.

7.2.3 Settlement Potential

On-site soils are predominantly sandy soils with occasional layers of fine-grained soils. Ground settlement due to fill placement can be expected and the settlement rate should be relatively quick. Settlement due to embankment construction is discussed in detail in Section 8.3.

7.3 WATER

7.3.1 Surface Water

The only natural surface drainage at the site is Carbon Creek which crosses the site near Raymond Avenue. This drainage is now confined within a concrete-lined aqueduct as are most of the natural drainages. Flow within the Carbon Creek aqueduct has been reduced primarily to local urban drainage because the bulk of natural runoff from Carbon Canyon is now diverted to the Santa Ana River via the Carbon Creek Diversion Channel which passes east of the project area.

Standing surface water was not observed within the project area during EMI's field investigation. The majority of the water within the project limits is routed through cross culverts and concrete ditches to Houston Channel and Carbon Creek Channel.

7.3.1.1 Scour

This site is located within an area that is presently improved; roadway surfaces are paved and drainage is controlled by engineered facilities. Therefore, scour is not considered a design issue.

7.3.1.2 Erosion

Surficial soils on slopes are mostly sandy soils (with little to no cohesive fines) and are susceptible to piping and accelerated erosion. Presently, there is minor to moderate vegetation covering the slopes adjacent to the SR-91 mainline, and on- and off-ramps. Erosion of the existing slope faces was observed to be minimal.

In general, the erosion potential of soils within the project area is considered to be moderate; provisions for site drainage, slope planting and other measures in accordance with Caltrans requirements should be fulfilled to provide adequate protection against erosion. To minimize erosion of slopes, surface water should not be directed to flow over slope faces. Faces of finished slopes should be planted as soon as possible, after grading is completed, to minimize erosion.

7.3.2 Groundwater

Groundwater was encountered between elevations +65.0 feet near SR-91 Mainline Station 172+55 and +153.7 feet near SR-91 Mainline Station 327+09. Groundwater was also encountered between elevations +59.5 feet near Brookhurst Street Undercrossing (UC) and +128 feet near Acacia Street UC in 1993 and between elevations +72.2 and +73.5 feet near Brookhurst Street UC in 1955. Based on California Geological Survey (Division of Mines and Geology, 1997 and 1998), the recorded highest historical groundwater at the project site is between 40 and

50 feet below the existing ground surface. The existing ground surface elevations vary from +108 to +210 feet between the western and eastern end of the project, respectively. Therefore, using a historical high groundwater depth of 40 feet, the historical high groundwater elevations vary from +68 to +170 feet between the western and eastern end of the project, respectively.

Groundwater encountered during construction may be higher or lower than those encountered above due to seasonal rainfall fluctuation and runoff amount, local irrigation practices, extraction and recharge of local and regional aquifers, and other manmade conditions.

7.4 PROJECT SITE SEISMICITY

The regional seismicity was discussed in Section 4.3.6.

7.4.1 Maximum Earthquakes

The principal faults, which might generate earthquakes affecting the project design, are listed in Table 7-2 along with their maximum earthquake magnitude. Fault data is obtained from the Caltrans 2007 Fault Database (Caltrans, 2007a and 2007b), and the distance to the fault is measured from the Caltrans 2007 Deterministic PGA Map (Shantz and Merriam, 2007). Other known faults in the region were also analyzed but were found not to be capable of generating ground motion at the site in excess of the faults listed on Table 7-2.

Table 7-2. Nearby Earthquake Faults

Fault Name	Fault ID	Maximum Magnitude M_{Max}	Distance (Direction) from Site (miles)	Fault Type*
Puente Hills Blind Thrust	240	7.3	8.0 (North)	R
Elsinore Fault Zone (Whittier Section)	241	7.6	10.0 (Northeast)	RLSS
Compton – Los Alamitos Blind Thrust	291	6.8	10.5 (Southwest)	R
Peralta Hills Fault	146	6.2	3.5 (East)	R

*R = Reverse, RLSS = Right Lateral Strike Slip

7.4.2 Ground Rupture

There are no active faults through the project area, therefore the potential for ground rupture is remote to nil.

7.4.3 Earthquake-Induced Landslides

Earthquake-induced landslides in the vicinity of the site were described in Section 7.1.3.

8.0 GEOTECHNICAL ANALYSES AND DESIGN

8.1 DYNAMIC ANALYSES

8.1.1 Parameter Selection

We determined the design ARS curve based on the 2009 Caltrans Seismic Design Criteria (SDC) procedures (2009a and 2009c). The peak ground acceleration (PGA) is the zero-period spectral acceleration in the ARS curve. A PGA of 0.52g is obtained from the design ARS curve.

For analyzing global slope stability, Section 3.10 of the Caltrans Guidelines for Structures Foundation Reports (Caltrans, 2009b) recommends using a horizontal seismic coefficient equal to one-third of the peak acceleration but not exceeding 0.2. Therefore, a horizontal seismic coefficient of 0.173 was used in the slope stability analysis.

8.1.2 Evaluation

Liquefaction potential and seismically-induced settlement are discussed below.

8.1.2.1 Liquefaction

Liquefaction analysis was performed using the available site-specific subsurface information and the historical high groundwater elevations varying from +68 to +170 feet near the western and eastern end of the project, respectively.

The liquefaction potential of the saturated, granular materials below the historical high groundwater table was evaluated using the procedures outlined by Seed et al. (1983), Seed and Harder (1990), and updated by NCEER (1997). Results of the liquefaction analysis are included in Appendix C. Based on the analysis, relatively thin layers of granular materials susceptible to liquefaction were encountered in some of the borings below the historical high groundwater table. These liquefiable layers, which are relatively deep and isolated, are not anticipated to impact the proposed improvements. Therefore, the liquefaction potential is anticipated to be low.

8.1.2.2 Seismically-Induced Settlement

Since the liquefaction potential is low, the seismically-induced settlement is not expected to adversely impact the SR-91 WB Widening project.

8.2 CUTS AND EXCAVATIONS

Based on the Profile Sheets and crosss sections provided by RBF, most of the excavations are relatively minor (less than about 5 feet).

Per Caltrans HDM Topic 304 (Caltrans, 2008), side slopes should be constructed no steeper than 4H:1V where possible. Design exception will be required for side slopes with gradients steeper than 4H:1V.

8.2.1 Slope Stability

We do not anticipate any slope stability issues for minor cuts and excavations. Per Caltrans HDM Topic 304 (Caltrans, 2008), side slopes with a steepness of 4H:1V or flatter will be

globally and surficially stable. Side slopes with a 2H:1V gradient and a maximum height of 5 feet are globally stable.

Surficial stability analysis was performed using the infinite slope method. Based on laboratory strength test results of the onsite soils, the calculated factor of safety is at least 1.5 provided the slope gradient is 2H:1V or flatter. Proper maintenance with erosion protection and drainage control in accordance with Section 21 of Caltrans Standard Specifications (2010b) are also recommended.

8.2.2 Rippability

Minor excavations are anticipated to be performed within existing fill and alluvium. These on-site materials can be excavated using conventional heavy-duty earth-moving equipment and the materials are not expected to pose a rippability problem.

8.2.3 Earthwork Factors

The volume change of on-site materials upon excavation and compaction will vary with soil type and soil density. Although accurate grading factors cannot be determined, the volume change of on-site sandy soils after compaction is estimated to be on the order of +5 percent to -9 percent for determining preliminary earthwork quantities. Excavated materials may be assumed to bulk 3 to 10 percent for hauling purposes.

8.3 EMBANKMENTS

8.3.1 Description

Based on the Profile Sheets and cross-sections provided by RBF, fill will need to be placed to construct the approaches to each bridge widening. About 30 feet of sliver fill at North Anaheim Overhead and about 20 feet of sliver fill at other bridge locations will be placed to construct the abutment approaches. Most of the other embankment fills are relatively minor (5 feet or less). Thickness of the backfill varies from a few feet to about 18 feet for the retaining walls.

Per Caltrans HDM Topic 304 (Caltrans, 2008), side slopes should be constructed no steeper than 4H:1V where possible. Design exception will be required for side slopes with gradients steeper than 4H:1V.

8.3.2 Stability and Settlement

Stability and settlement of the bridge approach fill embankments and non-standard retaining wall backfills are addressed in the foundation reports (EMI, 2011a through 2011g). The stability and settlement of the Caltrans Standard Type 1 retaining wall backfill are addressed in Section 8.4.

Fill embankments at locations other than retaining walls and bridges are globally stable for a maximum slope gradient of 2H:1V and a maximum height of 5 feet.

Surficial stability analysis was performed using the infinite slope method. The results indicates that the factor of safety is greater than 1.5 for 2H:1V slopes provided the outer 4 feet of the slope face is composed of soil possessing a minimum internal friction angle of 34 degrees and a minimum cohesion of 170 psf. This select material should be properly keyed and benched into

the sloping ground. In all cases, proper maintenance with erosion protection and drainage control in accordance with Section 21 of Caltrans Standard Specifications (2010b) are also recommended.

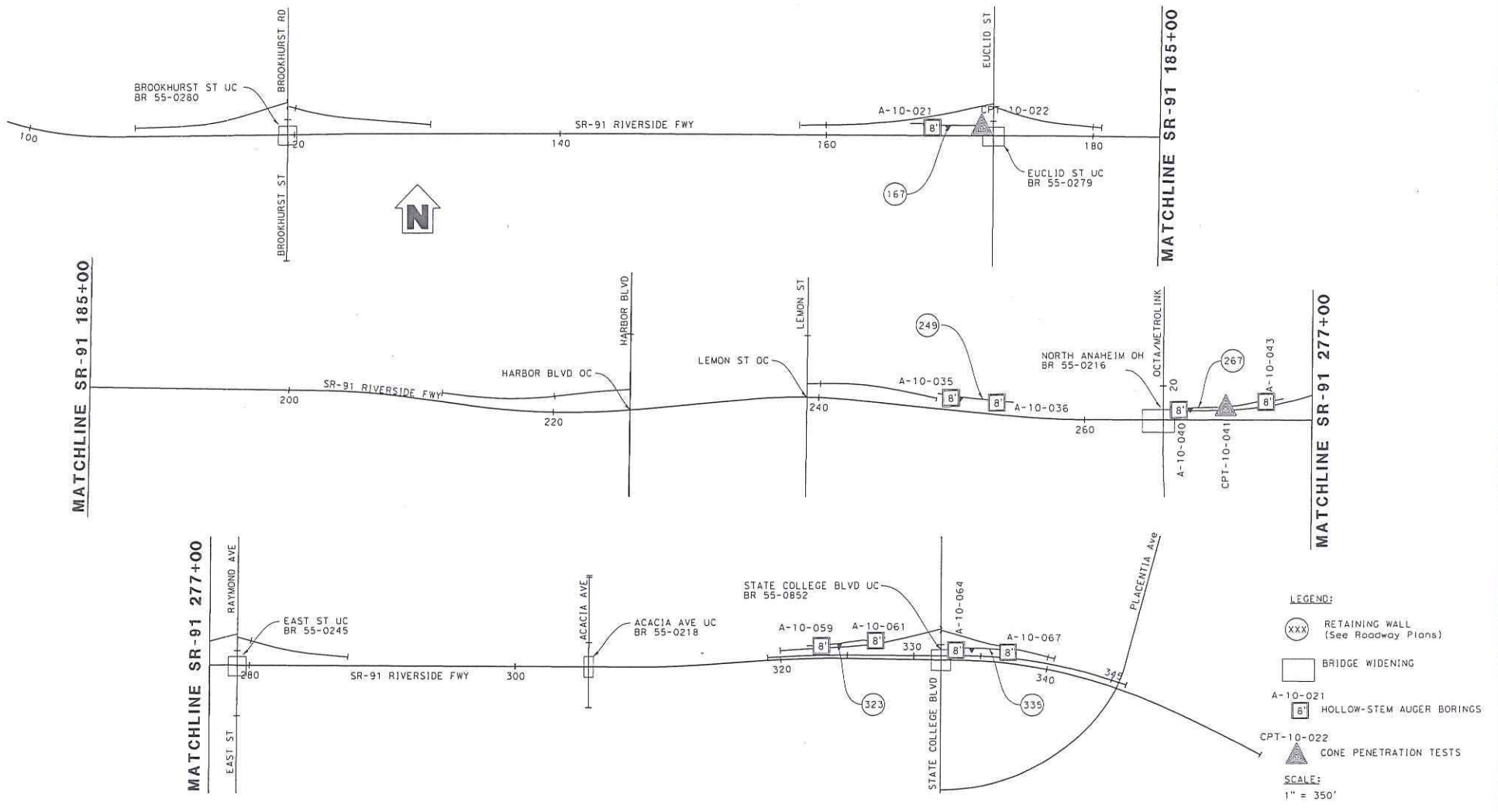
8.4 EARTH RETAINING STRUCTURES

Thirteen walls are proposed for the SR-91 WB Widening Project. Eight are non-standard walls and five are Caltrans Standard Type 1 cantilevered retaining walls. Separate foundation reports have been prepared for the non-standard walls (EMI, 2011g). Locations of the standard cantilevered walls are described in Section 2.2 and shown in Figure 8-1. Pertinent wall data is presented in Table 8-1.

Table 8-1. Proposed Caltrans Standard Type 1 Walls

Retaining Wall	Location		Length (feet)	Height (feet)	Bottom of Footing Elevation (feet)	Backfill Slope Condition	Pertinent Borings
	Begin Wall	End Wall					
167	167+31.52 91.19 Lt	171+70.16 78.50 Lt	551	6 to 12	+133.67 to +139.67	Level	A-10-021 CPT-10-022
249	248+85.42 112.14 Lt	254+60.86 103.00 Lt	575	4 to 8	+157.00 to +161.66	Level	A-10-035 A-10-036
267	266+74.46 90.50 Lt	75+00 33.50 Lt (RA1 Line)	820	6 to 12	+181.67 to +189.67	Level	A-10-040 CPT-10-041 A-10-043
323	22+00 23.50 Lt (SC1 Line)	28+00 33.50 Lt (SC1 Line)	545	4 to 10	+186.17 to +190.17	Level	A-10-059 A-10-061
335	333+97.99 95.94 Lt	337+19.60 99.69 Lt	330	8 to 10	+196.67 to +198.67	Level	A-10-064 A-10-067

Notes:
1. All the stations and offsets are based on A Line unless noted otherwise.
2. A Line = SR-91 Mainline; RA1 Line = Westbound Raymond Avenue On-Ramp; SC1 Line = Westbound State College Blvd On-Ramp.



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STATE ROUTE 91 WESTBOUND WIDENING PROJECT

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STANDARD WALLS AND BORINGS MAP

Figure 8-1

Based on the recent field investigation, the retaining walls will be underlain by fill and alluvium. The fill and alluvial soils are predominately sandy soils including silty sand, sand, sand with silt and clayey sand. The idealized soil profiles and design strength parameters for retaining wall foundation design are presented in Table 8-2.

Table 8-2. Idealized Soil Profiles and Soil Strength Parameters for Caltrans Standard Type 1 Retaining Walls

Approximate Elevation (feet)	Predominant Soil Type	Equivalent SPT Blowcounts* (blows/foot)	Total Unit Weight (pcf)	Friction Angle (degree)	Cohesion (psf)
Retaining Wall 167					
+153 to +133	Silty Sand and Sand with Silt	17 to 30 Average = 24	120	32	100
+133 to +115	Silty Sand	8 to (20) Average = 14	115	31	100
Retaining Wall 249					
+166 to +156	Clayey Sand and Sand with Silt	6 to (16) Average = 10	120	30	100
+156 to +150	Fat Clay	9 to (14) Average = 12	115	0	1,500
+150 to +125	Silty Sand and Sand with Silt	14 to (28) Average = 17	120	32	100
Retaining Wall 267					
+201 to +170	Sand with Silt, Silty Sand and Clayey Sand	14 to (53) Average = 30	120	34	100
+170 to +140	Sand, Silty Sand and Sand with Silt	14 to (42) Average = 24	120	32	100
Retaining Wall 323					
+196 to +175	Sand and Sand with Silt	8 to (27) Average = 14	120	31	100
+175 to +145	Sand with Silt	19 to (57) Average = 32	120	34	100
Retaining Wall 335					
+210 to +190	Silty Sand and Sand with Silt	27 to 38 Average = 33	120	34	100
+190 to +180	Sand with Silt	9 to 18 Average = 13	120	30	100
+180 to +140	Sand and Sand with Silt	16 to (53) Average = 37	120	38	50

* Values in ( ) are converted SPT blowcounts corrected for sampler size; correction factor from California sampler blowcounts to SPT blowcounts is 0.5.

Material shear strength parameters were selected based on the correlations with SPT blowcounts (Lam and Martin, 1986) and laboratory test results. Direct shear and triaxial test results were used where available and SPT blowcount correlations were used in all other idealized soil layers. The available direct shear and triaxial test results are presented in Appendix B. It should be

pointed out that the shear strength parameters obtained from the laboratory strength tests are lower than those obtained from SPT blowcount correlation for the same idealized soil layer.

Allowable bearing capacity calculations for retaining walls are provided in Appendix C for a total footing settlement of one inch or less. Based on the calculations, the allowable bearing capacity for retaining walls exceeds the maximum bearing stresses shown on the Caltrans Standard Plan (2010a). To limit the total settlement to approximately one inch, one foot of remedial overexcavation below the footing bottom is recommended for all the walls except Retaining Wall 249. After the remedial overexcavation has been performed, the excavated soils can be reused to backfill the overexcavations.

Near the bottom of footing elevation of Retaining Wall 249, either fat clay or loose sand with silt is encountered. Therefore, at least 1.5 feet of remedial overexcation below the footing bottom is recommended for Retaining Wall 249. After the remedial overexcavation has been performed, Caltrans Structure backfill should be used to backfill the overexcavation.

A sign structure is proposed at "A Line" Station 250+25 with Retaining Wall 249. The retaining wall height is 8 feet and the footing width with the sign structure is 11 feet. Foundation loads for retaining wall with sign structure were provided by the structural designers: 1.9 ksf for Service I Limit State; 2.7 ksf for Strength Limit State; and 2.2 ksf for Extreme Event Limit State. Based on the calculations provided in Appendix C, the bearing capacity exceeds the values presented above by the structural engineers for each load case, provided 2 feet of overexcavation and recompaction is performed below the sign structure/retaining wall bottom of footing. After the remedial overexcavation has been performed, the excavated soils can be reused to backfill the overexcavations

The horizontal limits of the overexcavation should begin one foot from each edge of the footing bottom and extending downward at a 45-degree imaginary plane until the plane intersects the recommended minimum excavation depth. In some areas, the 45-degree imaginary plane could intersect temporary shoring. In this case only, the horizontal limit of the overexcavation should begin from the edge of the footing bottom and extending out a minimum of 1 foot and down until the plane intersects the recommended excavation depths. On-site soils or Caltrans Structure Backfill should be used for backfilling with a minimum relative compaction of 95% of maximum density as determined by Caltrans Test Method 216. The overexcavation bottom should be proof rolled prior to backfilling. Further, the overexcavation bottom should be inspected by a qualified geotechnical engineer or technician to confirm the presence of an unyielding and competent surface.

Minimum footing embedment for all retaining walls should conform to Section 4.4.5.1 of the Caltrans Bridge Design Specifications (2003a).

Global stability analyses were performed for each wall using cross-sections where the wall height is maximum. The soil strength parameters in Table 8-2 were used in the static and pseudo-static analysis and the results are presented in Appendix C. The factor-of-safety for a deep-seated failure is greater than 1.5 under the static condition with a 2-foot soil surcharge to represent traffic loading. Stability analysis for the pseudo-static condition was performed using a seismic coefficient equal to 0.173. Analysis indicates that the factor-of-safety is greater than 1.1 under the pseudo-static condition.

8.5 CULVERT AND CHANNEL FOUNDATIONS

Based on current plans, RCP culverts with diameters up to 24 inches are proposed at various locations. There are no special foundation preparation and design requirements for the proposed RCP culverts. The foundation and bedding requirements presented in the Caltrans Standard Plans (2010a) and Standard Specifications (2010b) are sufficient for these proposed culverts.

Also, based on current plans, fills are proposed throughout the project area; impact of fills at least 5 feet in height should be evaluated for drainage structures that fall within a 45-degree projection below the footprint of fills. In addition, the existing culverts that will remain in-place should be inspected, then rehabilitated or replaced (if necessary).

The existing Houston Storm Channel is to be modified between "A" Line Stations 157+00 and 161+00. A Rectangular Channel and a RCB are proposed between these stations to connect the existing trapezoidal channel into the existing RCB. Recommendations for bearing capacity, backfill and earth pressures for design of the rectangular channel and RCB are presented below.

8.5.1 Bearing Capacity

Calculations were performed to determine the relationship between allowable bearing capacity and settlement at the invert elevations of the rectangular channel and RCB. Based on the information provided by RBF, a bearing pressure of 6,000 psf is required for the design of the channel and RCB. Based on our calculations, the bearing pressure of 6,000 psf will result in a total settlement of less than 2 inches.

In order to provide a uniform and firm bottom to support the rectangular channel and RCB, a minimum of two feet of overexcavation and recompaction is recommended below the bottom slab. The horizontal limits of the removal should begin one-foot from each edge of the bottom slab and extending downward at a 45-degree imaginary plane until the plane intersects the recommended minimum excavation depth of two feet. The excavated onsite soils or Caltrans Structure Backfill is recommended for backfilling with a minimum relative compaction of 95% of maximum density as determined by Caltrans Test Method 216. The overexcavation bottom should be proof rolled prior to backfilling. Further, the overexcavation bottom should be inspected by a qualified geotechnical engineer or technician to confirm the presence of an unyielding and competent surface.

For the foundation soils, an unadjusted vertical subgrade modulus of 45 tons per cubic feet (tcf) is recommended. The estimated subgrade modulus given above is based on a 1-foot by 1-foot plate load test; therefore, the subgrade modulus should be adjusted considering the size of the tributary area. Based on the predominant soil type below the base slab, the adjustment factor is $\left(\frac{B+1}{2B}\right)^2$ where B is the width of the tributary area in feet.

8.5.2 Earth Pressure

Lateral earth pressures for the RCB should be based on the equivalent fluid pressures presented in Section 6.2.1 of Caltrans Bridge Design Specifications (2000). The incremental seismic lateral earth pressures can be calculated using the inverted triangular distribution with the maximum

pressure of 46H pounds per foot at the ground level and zero at the invert elevation, and "H" is the depth below the ground surface to the invert elevation of the RCB.

Lateral earth pressures for rectangular concrete channel are presented in Figure 8-2. Lateral active earth pressure for drained or saturated and level backfill can be used for the static conditions. Combination of active earth pressure for drained or saturated and level backfill, incremental seismic earth pressure, and pile surcharge loads can be used for seismic design of the channel.

The above lateral earth pressure values for static and seismic conditions do not include surcharge loads resulting from structures and traffic. Any surcharges that are set back behind the RCB or rectangular channel wall a horizontal distance greater than the depth to the invert elevation do not need to be added to the design pressures; otherwise, earth pressures from uniform vertical surcharge behind the RCB or rectangular channel wall should be added as a horizontal uniform pressure and can be calculated using a lateral earth pressure coefficient of 0.3.

8.5.3 Backfill

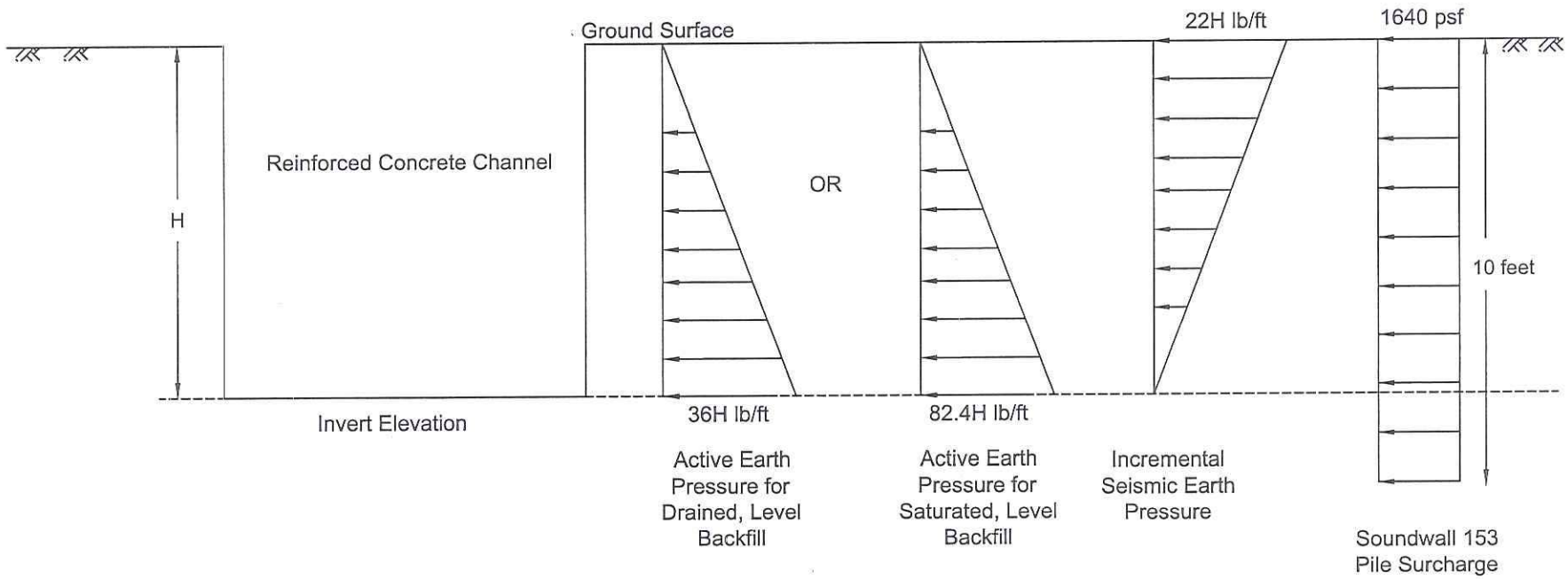
For an open-cut construction, onsite soils or Caltrans Structure backfill can be used as backfill materials behind the rectangular channel and RCB. The horizontal limits of the backfill should begin one-foot from edge of the bottom slab and extending upward at a 45-degree imaginary plane until the plane intersects an imaginary horizontal line which coincides with the top of the rectangular channel or RCB. Backfill should be placed in loose lifts not exceeding 8 inches in thickness, moisture-conditioned to near optimum moisture content, and compacted to at least 90 percent relative compaction. The relative compaction should be based on the maximum density determined by Caltrans Test Method 216. Jetting or flooding to compact backfill is not recommended.

If shoring is used, then the open space between the shoring and box should be backfilled with self-compacting materials such as clean sand or pea gravel.

Each of the above backfill configurations is supplemental to the Structure Backfill requirement as described in the Caltrans Standard Plans (2010a). Heavy compaction equipment, such as vibratory rollers, dozers, or loaders, should not be used adjacent to the rectangular channel and RCB in order to avoid damaging the walls due to large lateral earth pressures.

8.6 SOIL CORROSIVITY

Twenty seven soil samples were tested to determine minimum resistivity, pH, soluble sulfate content, and soluble chloride content using procedures described in California Test Methods 417, 422, and 643, respectively. The test results are presented in Table 8-3. Minimum resistivities ranged from 750 to 29,000 ohm-cm. The pH ranged from 6.9 to 8.7. The soluble sulfate measurements ranged from 10 to 600 parts per million (ppm), and the soluble chloride ranged from 83 to 375 ppm.



Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	SR-91 WB Widening	LATERAL EARTH PRESSURES REINFORCED CONCRETE CHANNEL
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Table 8-3. Summary of Soil Corrosion Test Results

Boring	A Line Station (Offset)	Sample Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Soluble Sulfate Content (ppm)	Soluble Chloride Content (ppm)
A-10-002	109+44 (73 Lt)	2.5	SC	3200	7.9	70	95
A-10-003	112+86 (78 Lt)	5	SM	5700	8.5	80	97
A-10-005	116+24 (176 Lt)	1.5	SC	2000	8.6	130	149
A-10-006	118+55 (76 Lt)	5	SC	2600	8.5	10	83
A-10-008	120+42 (55 Lt)	45	ML	2200	8.0	60	161
HA-10-013	137+00 (81 Lt)	2	SC	860	6.9	110	124
A-10-016	150+46 (86 Lt)	15	ML	2200	8.7	70	94
A-10-019	160+55 (106 Lt)	10	ML	2200	8.5	110	118
A-10-024	173+76 (62 Lt)	25	SM	750	7.8	40	332
A-10-029	184+45 (85 Lt)	20	SM	770	7.7	300	375
A-10-032	193+48 (90 Lt)	5	ML	3800	8.1	50	142
A-10-035	249+78 (89 Lt)	10	CL	790	7.5	60	239
A-10-037	256+96 (79 Lt)	2	SC	1200	7.2	10	114
A-10-039	264+14 (88 Lt)	5	SM	4800	8.0	120	191
A-10-039	264+14 (88 Lt)	75	CL-ML	760	7.9	40	253
A-10-043	273+55 (138 Lt)	5	SC	2400	7.9	60	142
A-10-044	278+00 (77 Lt)	3	SC	1100	7.6	600	109
A-10-044	278+00 (77 Lt)	45	CL-ML	760	7.6	130	322
A-10-044	278+00 (77 Lt)	70	CL	810	7.8	70	255
A-10-045	279+05 (77 Lt)	10	SP-SM	17000	8.0	60	153
A-10-052	300+05 (82 Lt)	10	SM	5400	7.8	100	139
A-10-054	305+43 (95 Lt)	5	SP	29000	7.7	60	108
A-10-054	305+43 (95 Lt)	25	SP-SC	3500	7.8	110	189
A-10-054	305+43 (95 Lt)	65	CL	2100	7.2	70	293
A-10-056	310+10 (80 Lt)	15	SP-SM	11000	7.3	10	130
A-10-063	332+01 (90 Lt)	35	SP-SM	13000	7.8	10	158
A-10-064	333+13 (76 Lt)	5	SM	2000	7.8	10	217

Based on the Caltrans Corrosion Guidelines (2003b), soils are considered corrosive if the pH is 5.5 or less, or the chloride concentration is 500 ppm or greater, or the sulfate concentration is 2,000 ppm or greater. Based on the test results and the Caltrans criteria, the on-site soils are considered to be non-corrosive to bare metals and concrete.

9.0 MATERIAL SOURCES

The Materials Report (EMI, 2012b) provides a list of potential commercial suppliers for sand, gravel, aggregate base, and concrete. Pulverizing existing pavement, during construction, might be performed. Pulverized AC material (or Reclaimed Asphalt Pavement – RAP) can be used as aggregate base (AB) provided the material meets the quality requirements of AB specified in Section 26 (Aggregate Bases) of the Caltrans Standard Specifications (2010b). Pulverized AC material may also be used within certain Hot Mix Asphalt (HMA) mixes, such as HMA Type A, if pulverized AC material and its processing complies with Section 39 (Hot Mix Asphalt) of Caltrans Standard Specifications (2010b).

10.0 MATERIAL DISPOSAL

Based on information provided by the civil designer, the project requires import material to achieve proposed grades. Therefore, no soil or only minor amounts of on-site soil are anticipated to require disposal.

11.0 CONSTRUCTION CONSIDERATIONS

11.1 CONSTRUCTION ADVISORIES

All work should be performed in accordance with the Caltrans Standard Specifications (2010b) except as indicated in the Special Provisions prepared for the project improvements.

11.2 CONSTRUCTION CONSIDERATIONS THAT INFLUENCE DESIGN

No construction considerations influenced the analyses or design of proposed improvements described in this report.

11.3 CONSTRUCTION CONSIDERATIONS THAT INFLUENCE SPECIFICATIONS

Special Provisions that are influenced by geotechnical factors include shoring requirements, dewatering requirements, and corrosion protection specifications. Temporary construction slopes, bracing, and shoring should be made the contractor's responsibility. Also, specific activities for dewatering including preparing a dewatering plan are the responsibility of the contractor; however, dewatering is not expected to be necessary for the project.

Complete removal of compressible surficial materials including topsoil, loose or soft alluvium, and unsuitable fill is required prior to fill placement. A minimum overexcavation and recompaction of 18 inches is recommended within all areas to receive compacted fill, and the overexcavation depth is measured from the existing grade. The overexcavation should extend horizontally a minimum distance of 18 inches from edges of new fills. In cut areas, the minimum overexcavation and recompaction depth is 12 inches below finish grade if the difference between the finished and existing grade is 2 feet or less, and overexcavation is not required if the difference between the finished and existing grade is greater than 2 feet. Unless specified on the contract plans or specifications, the excavated soils (in both fill and cut areas) may be reused as compacted fill.

Overexcavations should be performed beneath all new embankments and structures. Bottoms of overexcavations should be firm and unyielding prior to placing compacted fill. Remedial excavations, in areas where new pavement is proposed, are addressed in the Materials report (EMI, 2012b).

11.4 CONSTRUCTION MONITORING AND INSTRUMENTATION

Qualified geotechnical personnel should perform inspections and materials testing during the following stages of construction:

- Grading operations, including excavations and placement of compacted fill.
- Excavations for footings.
- Excavations for drainage structures and utility trenches.
- Removal or support of buried structures or utilities.
- Shoring installation, if necessary.
- When any unusual conditions are encountered.

Temporary backcuts and shoring, if used during earthwork or construction, should be monitored by the contractor and qualified geotechnical personnel.

11.5 HAZARDOUS WASTE CONSIDERATIONS

Evaluating the presence and concentration of hazardous contaminants is beyond EMI's scope of work and therefore is not addressed herein. EMI has assumed that no hazardous or contaminated materials exist within the project area; therefore, no hazardous waste considerations are provided. If for any reason hazardous or toxic materials are believed to exist within the project area, an environmental consultant should be retained.

11.6 DIFFERING SITE CONDITIONS

The analyses and recommendations contained in this report are based on the data obtained from the review of available geologic references, our site reconnaissance, soil borings, and laboratory testing. The soil boring logs indicate subsurface conditions only at specific locations and times drilled, and only to the depths penetrated. Borings do not necessarily reflect subsurface variations that may exist between such locations. If variations in subsurface conditions from those described in this report are noted during construction, the recommendations presented in this report must be re-evaluated. In the event that any changes in the nature, design, or location of the proposed facilities occur, the conclusions and recommendations in this report should not be considered valid unless the changes are reviewed and conclusions of this report are verified in writing by the designer. Therefore, upon encountering any site conditions that are perceived to differ materially from those conditions anticipated in this report, the resident engineer should contact the geotechnical designer immediately.

12.0 RECOMMENDATIONS AND SPECIFICATIONS

Below are recommendations for the proposed widening project. If designers have questions or disagree with the recommendations, or, if variations in subsurface conditions from those described herein are observed during construction, the geotechnical designer should be contacted to verify the applicability of the recommendations. Recommendations in this report may require modification based on actual subsurface conditions encountered during construction.

- Minor to significant amounts of earthwork, depending on the area of improvement, are expected. In areas where compacted fill will be placed, complete removal of compressible surficial materials including topsoil, loose or soft alluvium or fill soil, dry or saturated soil, or otherwise unsuitable material is required prior to fill placement. A minimum overexcavation and recompaction of 18 inches is recommended within all areas to receive compacted fill, and the overexcavation depth is measured from the existing grade. The overexcavation should extend horizontally a minimum distance of 18 inches from edges of new fills. In cut areas, the minimum overexcavation and recompaction depth is 12 inches if the difference between the finished and existing grade is 2 feet or less, and overexcavation is not required if the difference between the finished and existing grade is greater than 2 feet. In cut areas, the overexcavation depth is measured from the finished grade. Unless specified on the contract plans or specifications, the excavated soils (in both fill and cut areas) may be reused as compacted fill. Actual depths and extent of remedial removals should be determined in the field by qualified geotechnical personnel during earthwork activities. Remedial excavations, in areas where new pavement is proposed are addressed in the Materials report (EMI, 2012b).

- All overexcavations should be observed by qualified geotechnical personnel to verify that firm and unyielding bottoms are exposed. Overexcavated areas should be cleaned of loose soils and debris and should be observed to be firm and unyielding before receiving fill.

- Fills placed against sloping ground shall be keyed and benched into the sloping ground and placed as specified in Section 19-6 of the Caltrans Standard Specifications (Caltrans, 2010b).

- The maximum calculated settlement due to the approach embankment construction is presented in foundation reports for the bridge structures (EMI, 2011a through 2011f). In areas where ground movement may impact proposed structures, the structures should not be constructed until settlement period is complete.

- On-site soils affected by the proposed construction are expected to have very low to medium expansion potential. On-site native soil and existing fill material within the project area are considered suitable for use as compacted fill for embankments. However, fine-grained soils should not be placed behind retaining walls. Additional laboratory tests may be required during earthwork operations to verify the expansion potential of soils used in specific areas.

- To mitigate possible uneven movements of buried drainage devices, we recommend surrounding the bottom of these drainage lines using Sand Bedding. Limits and configurations of the Sand Bedding should conform to Caltrans Standard Plan Sheet A62D

(2010a). Material properties of the Sand Bedding should conform to Caltrans Standard Specifications, Section 19-3.02E(2) (2010b).

- The outer 4 feet of the proposed 2H:1V embankment slope face should compose of soil possessing a minimum friction angle of 34 degrees and a minimum cohesion of 170 psf. This select material should be properly keyed and benched into the sloping ground.

- In general, the erosion potential at this site is expected to be minor considering the provisions for site drainage, slope planting and other measures required by Caltrans. In order to minimize potential erosion, all finish slopes should be planted as soon as practical after grading. Local areas may require additional measures at the discretion of the geotechnical personnel present on-site during construction.

- Design of temporary construction slopes and shoring is the contractor's responsibility during construction.

- It shall be made the contractor's responsibility to control subsurface and surface water. The contractor should dewater the site as necessary, if groundwater is encountered. Water should not be allowed to stand in any excavations. If excavations become flooded, at least the bottom 8 inches of soil should be removed and replaced, and re-compacted to a minimum 95 percent relative compaction. Additional removals may be required at the discretion of the resident engineer or geotechnical personnel.

13.0 LIMITATIONS

This report is intended for the use of OCTA, RBF and Caltrans for design and construction of the SR-91 WB Widening. This report is based on the project as described and the information obtained from the exploratory borings at the approximate locations indicated on the attached plans. The findings and recommendations contained in this report are based on the results of the field investigation, laboratory tests, and engineering analyses. In addition, soils and subsurface conditions encountered in the exploratory borings are presumed to be representative of the project site. However, subsurface conditions and characteristics of soils between exploratory borings can vary. The findings reflect an interpretation of the direct evidence obtained. The recommendations presented in this report are based on the assumption that an appropriate level of quality control and quality assurance (inspections and tests) will be provided during construction. EMI should be notified of any pertinent changes in the project plans or if subsurface conditions are found to vary from those described herein. Such changes or variations may require a re-evaluation of the recommendations contained in this report.

The data, opinions, and recommendations contained herein are applicable to the specific design elements and locations which are the subject of this report. Data, opinions, and recommendations herein have no applicability to any other design elements or to any other locations, and any and all subsequent users accept any and all liability resulting from any use or reuse of the data, opinions, and recommendations without the prior written consent of EMI.

EMI is not responsible for construction means, methods, techniques, sequences, or procedures, or for safety precautions or programs in connection with the construction. EMI is not responsible for the acts or omissions of the Contractor, or any other person performing any construction, or for the failure of any worker to carry out construction in accordance with the Final construction drawings and specifications.

Services performed by EMI were conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, expressed or implied, and no warranty or guarantee is included or intended.

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EMI, 2011f, Final Foundation Report, State College Boulevard Undercrossing (Widen), Bridge No. 55-0852, Orange County, California, 12-ORA-91, PM 5.3, EA 12-0C5701, September 16.

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Appendix A

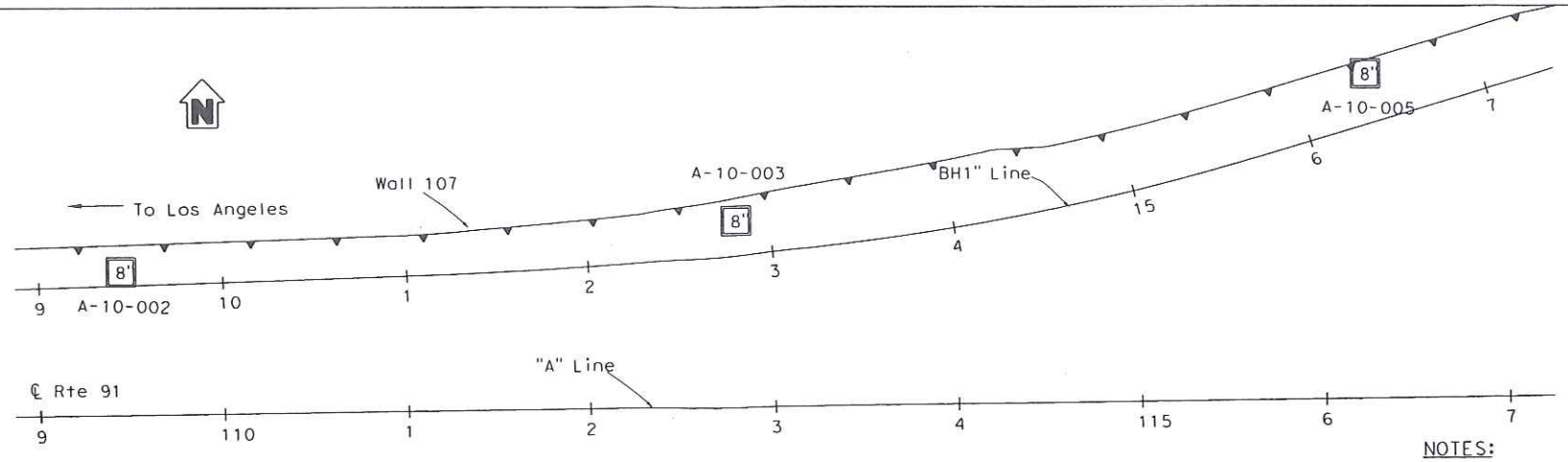
Log of Test Boring Sheets

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).

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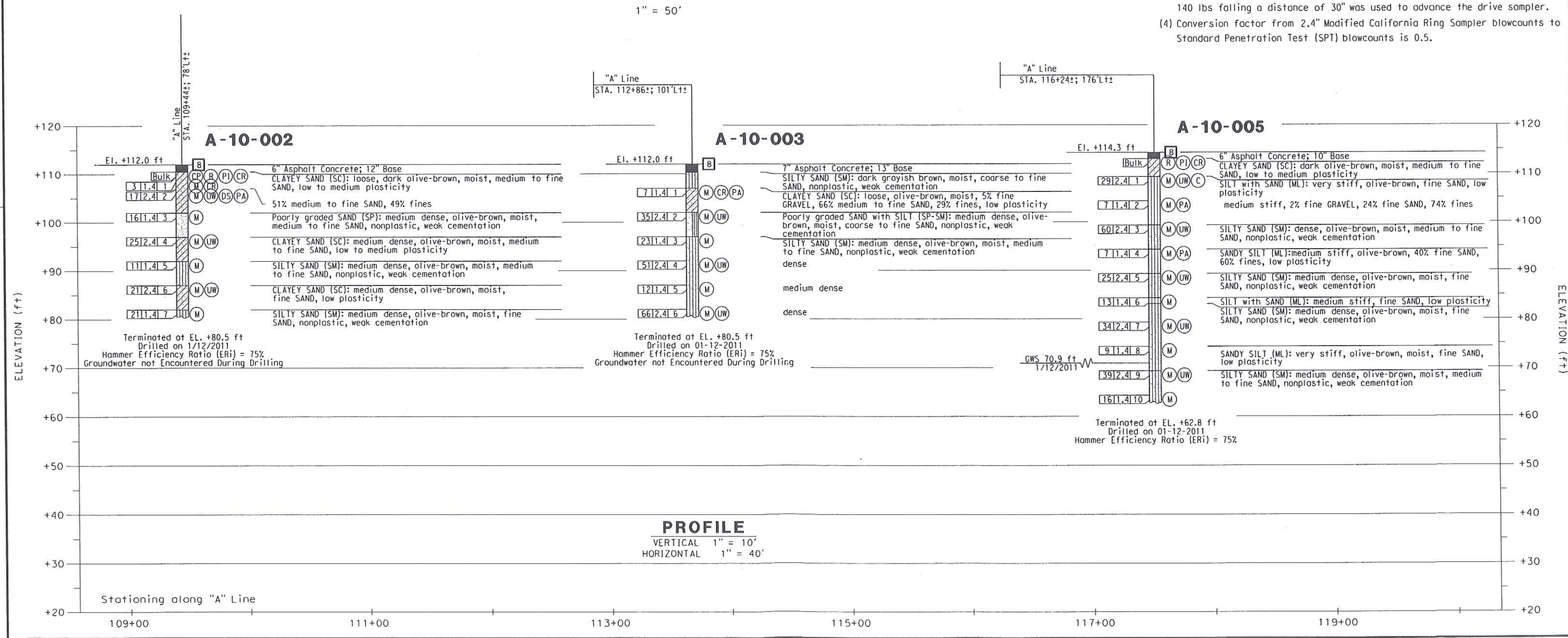
(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.

PLAN

1" = 50'

To Corona



PROFILE

VERTICAL 1" = 10'
HORIZONTAL 1" = 40'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. -
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 1/12/2011				POST MILES -

WALL 107

LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

USERNAME => #USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
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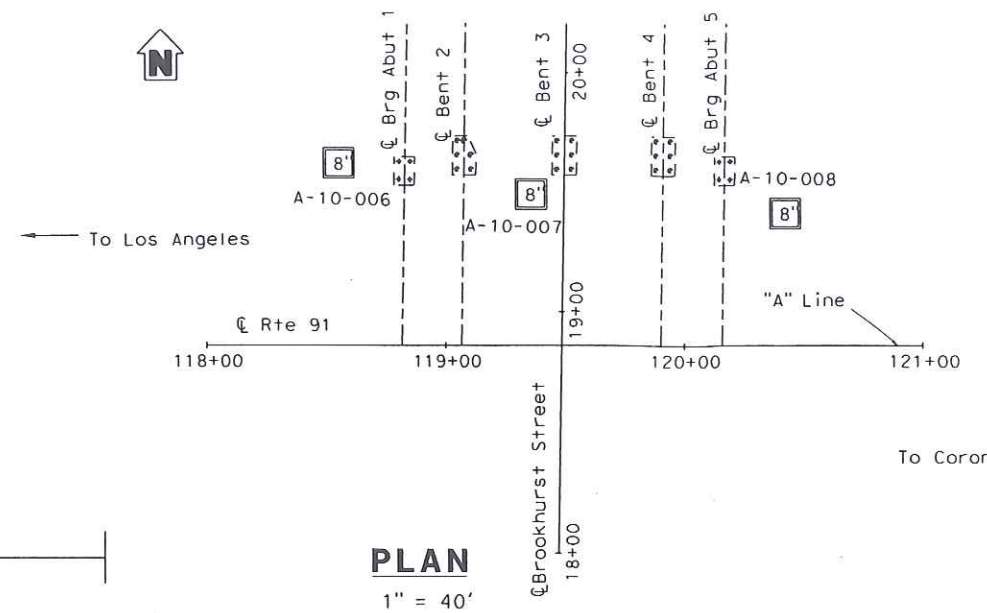

PLAN
1" = 40'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

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ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

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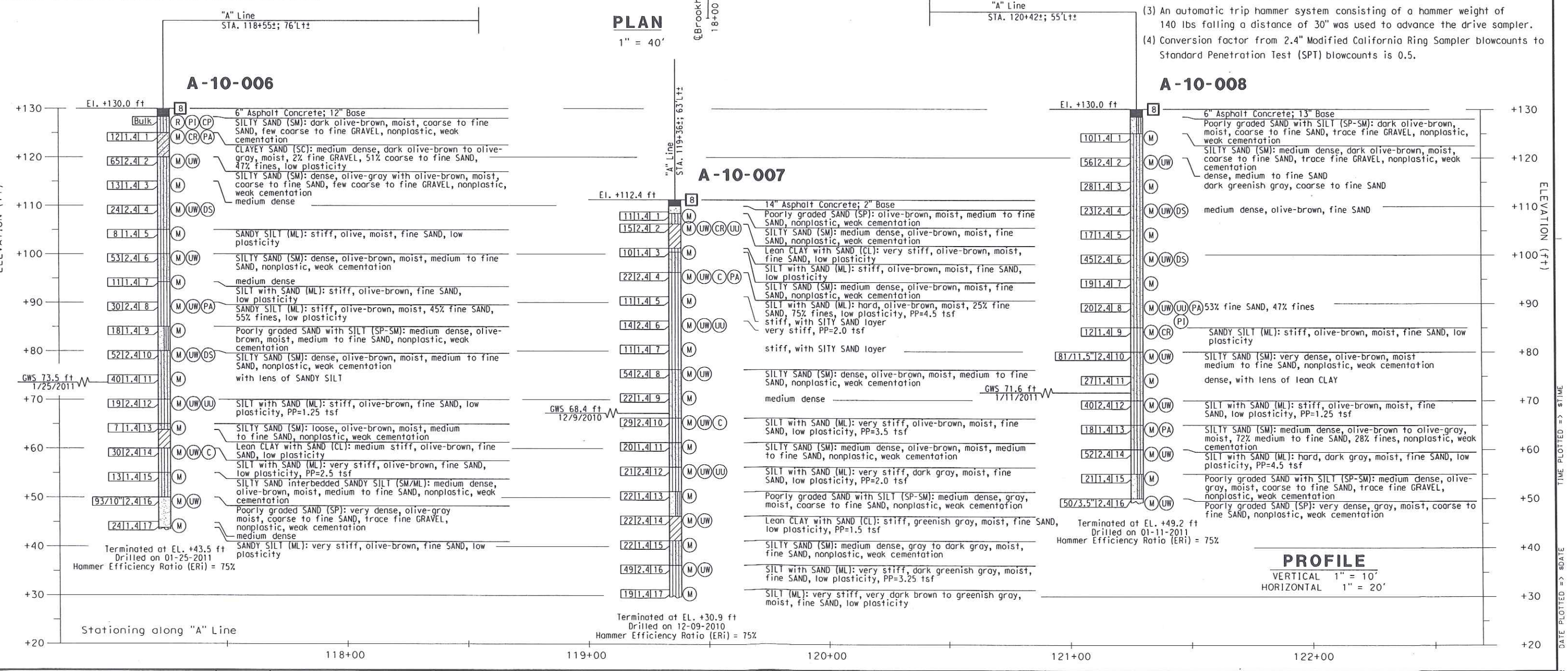

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj, PROJECT ENGINEER
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011		

BRIDGE NO. 55-0280 | POST MILES 1.2

BROOKHURST STREET UC (WIDEN)
LOG OF TEST BORINGS 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
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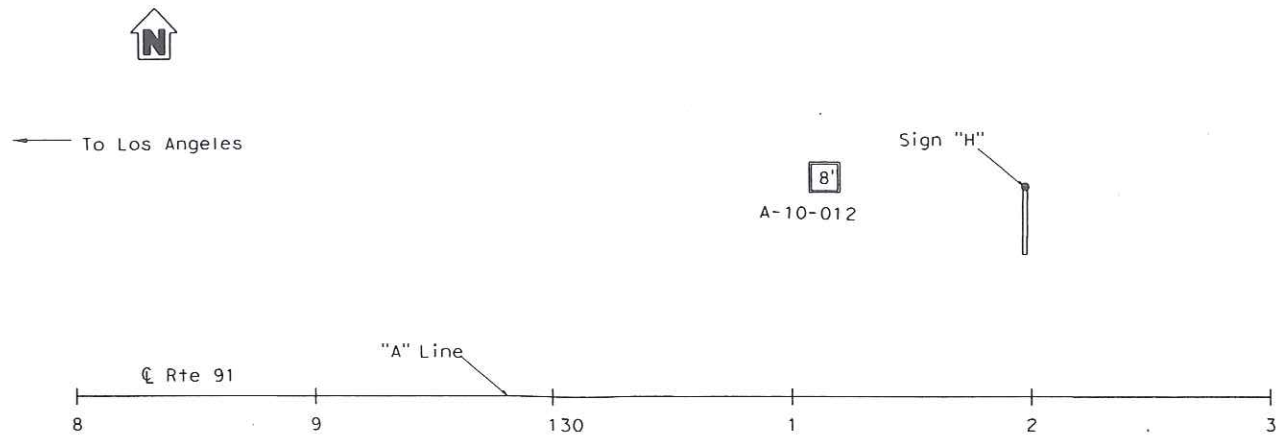

PLAN
1" = 40'

To Corona

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER _____ DATE _____

PLANS APPROVAL DATE _____

REGISTERED PROFESSIONAL ENGINEER
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NO. C71662
EXP. 12/31/11
CIVIL
STATE OF CALIFORNIA

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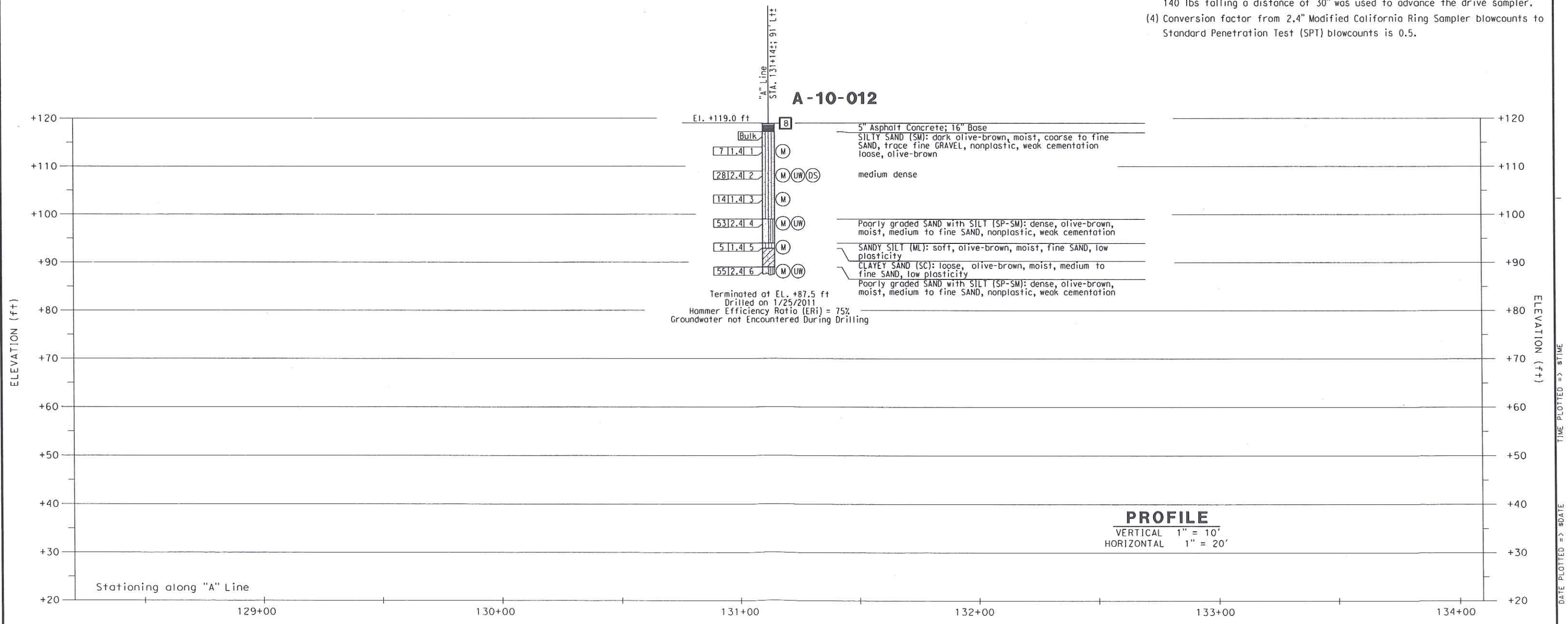

PROFILE
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SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/25/2011			PROJECT ENGINEER	POST MILES -	LOG OF TEST BORINGS 1 OF 3

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES										SHEET	OF

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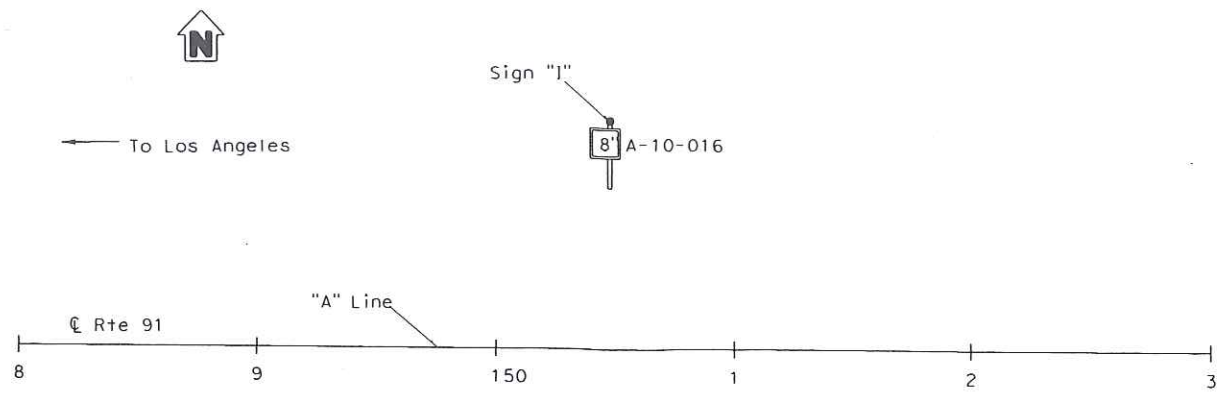

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12	ORA	91	0.9/5.4		

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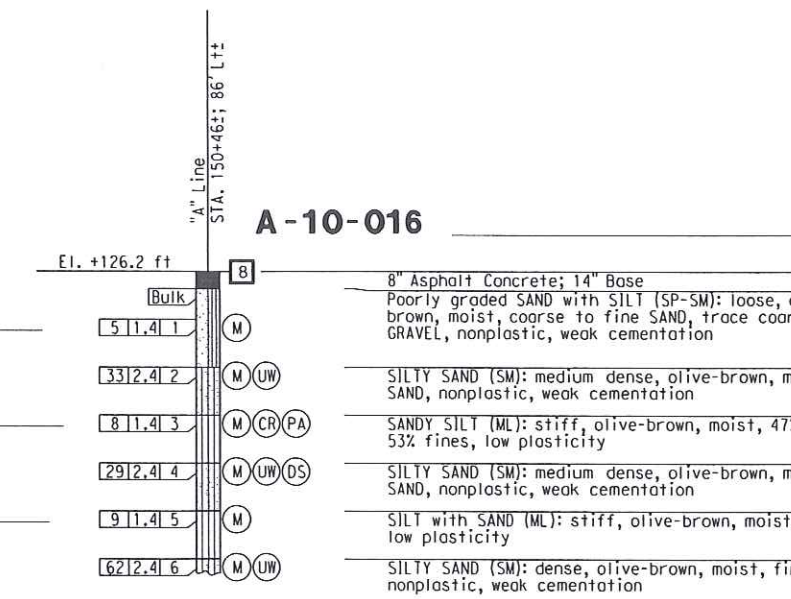

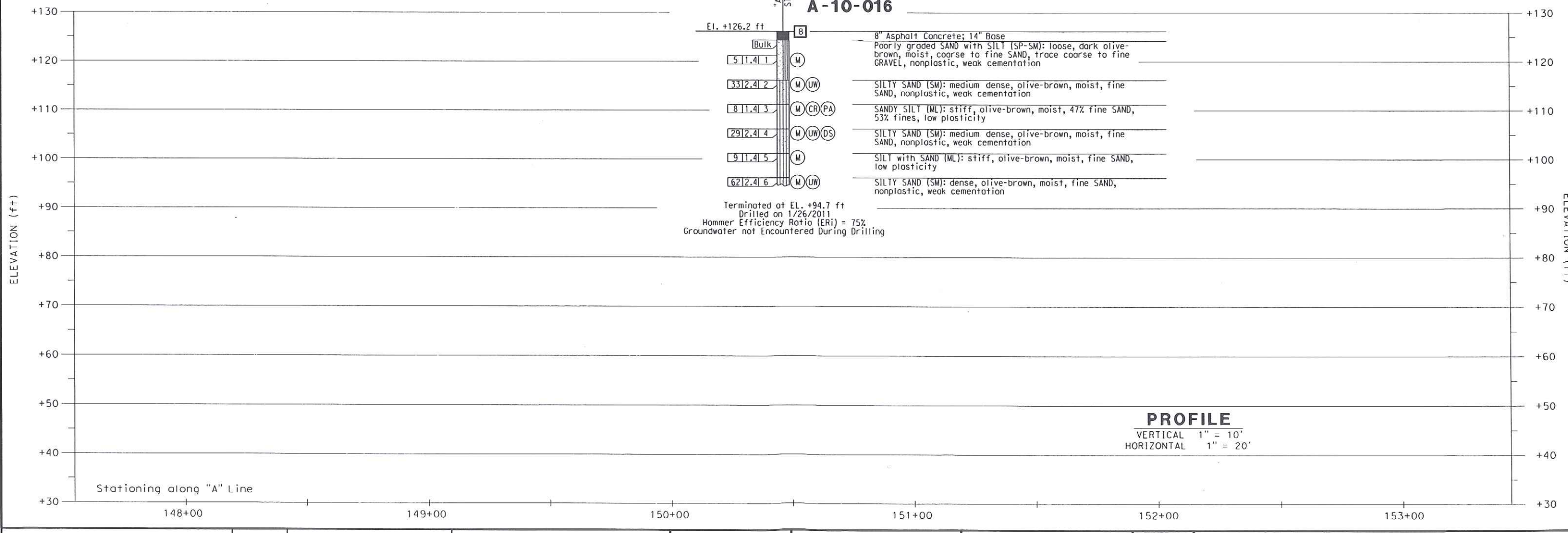

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj, PROJECT ENGINEER	BRIDGE NO. -	OVERHEAD SIGN STRUCTURES
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/26/2011			POST MILES -	LOG OF TEST BORINGS 2 OF 3

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

TIME PLOTTED => $TIME
DATE PLOTTED => $DATE
USERNAME => $USER

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
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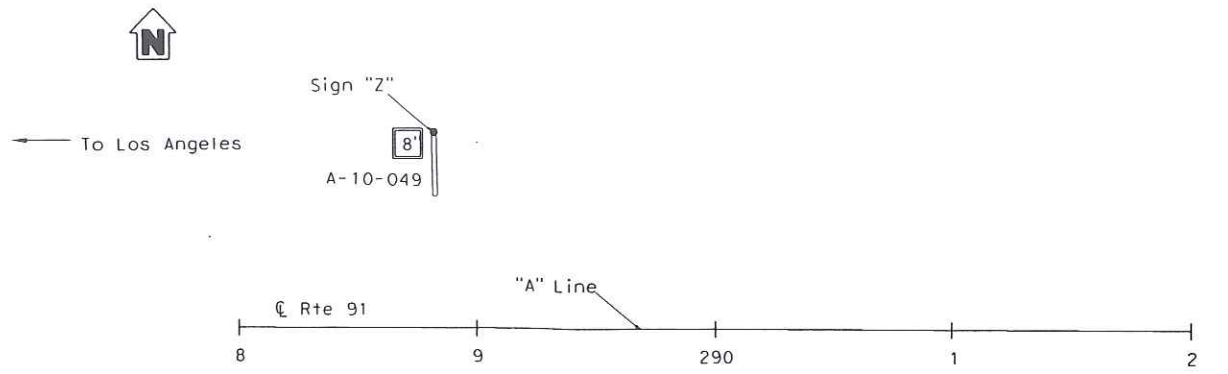

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

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PLAN

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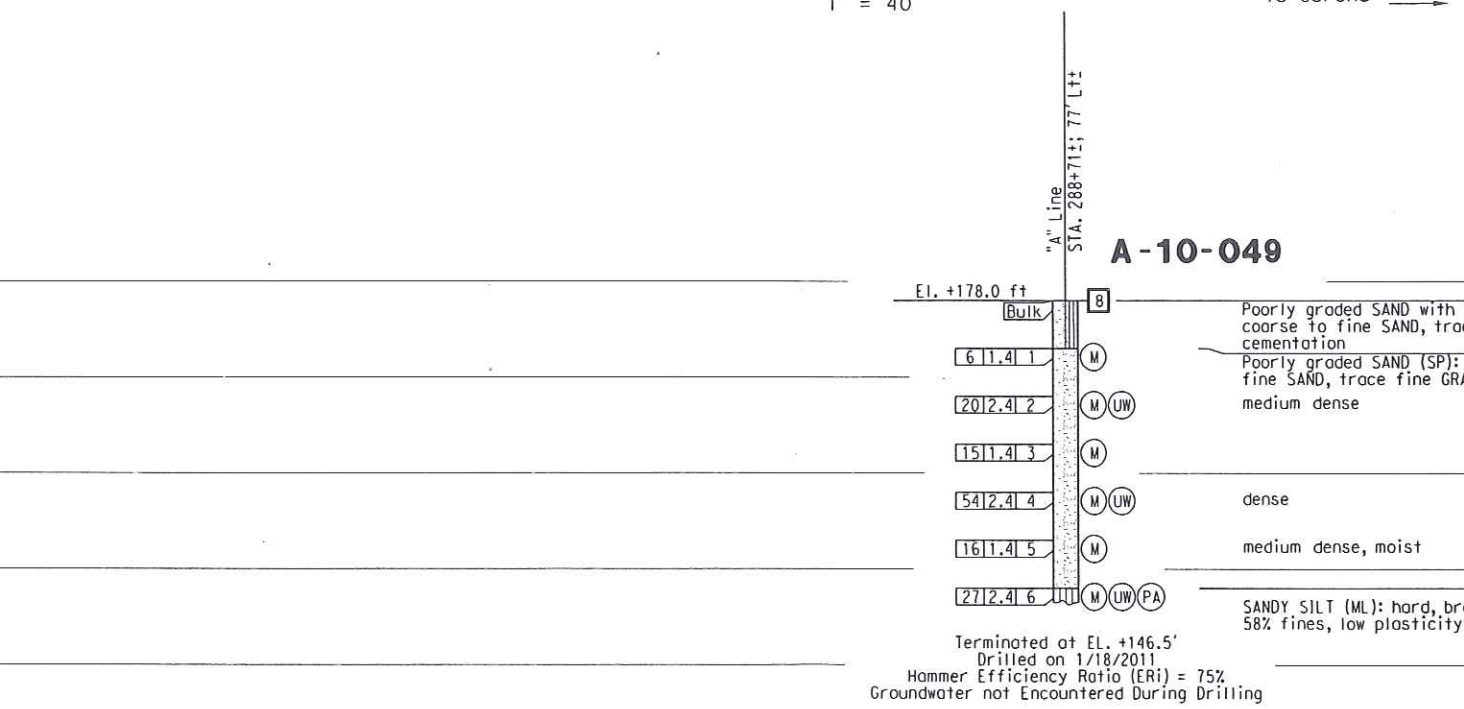

PROFILE

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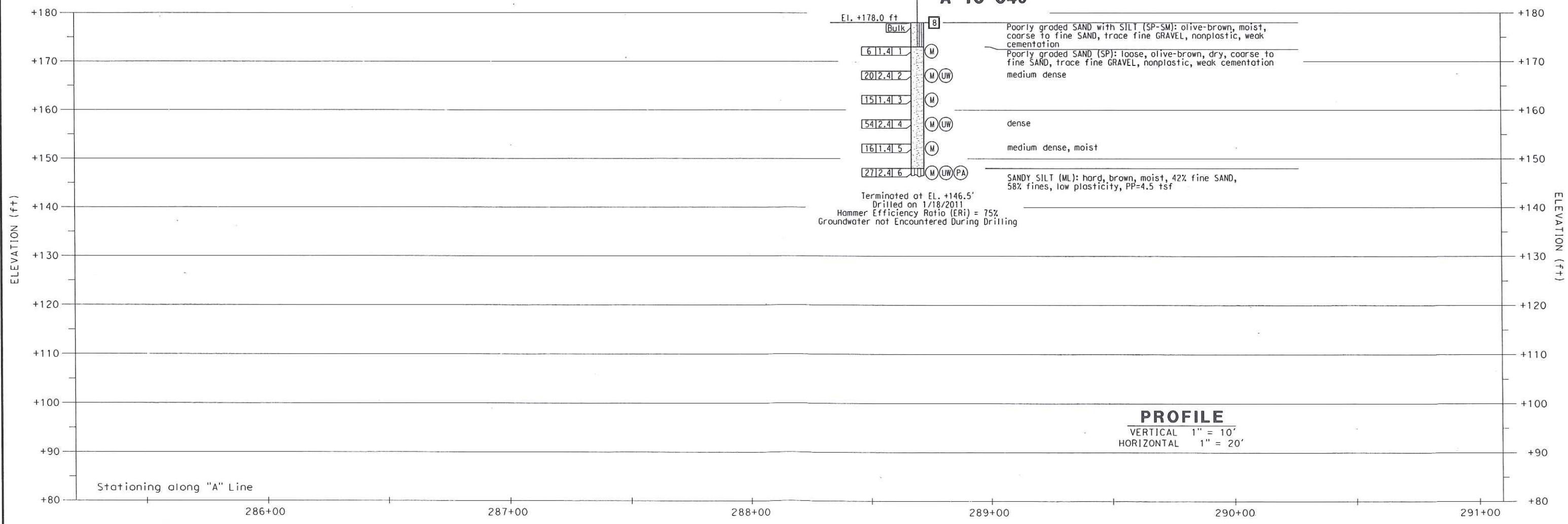

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -	OVERHEAD SIGN STRUCTURES
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/18/2010		PROJECT ENGINEER	POST MILES -	LOG OF TEST BORINGS 3 OF 3

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

TIME PLOTTED => $TIME
DATE PLOTTED => $DATE
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BENCH MARK

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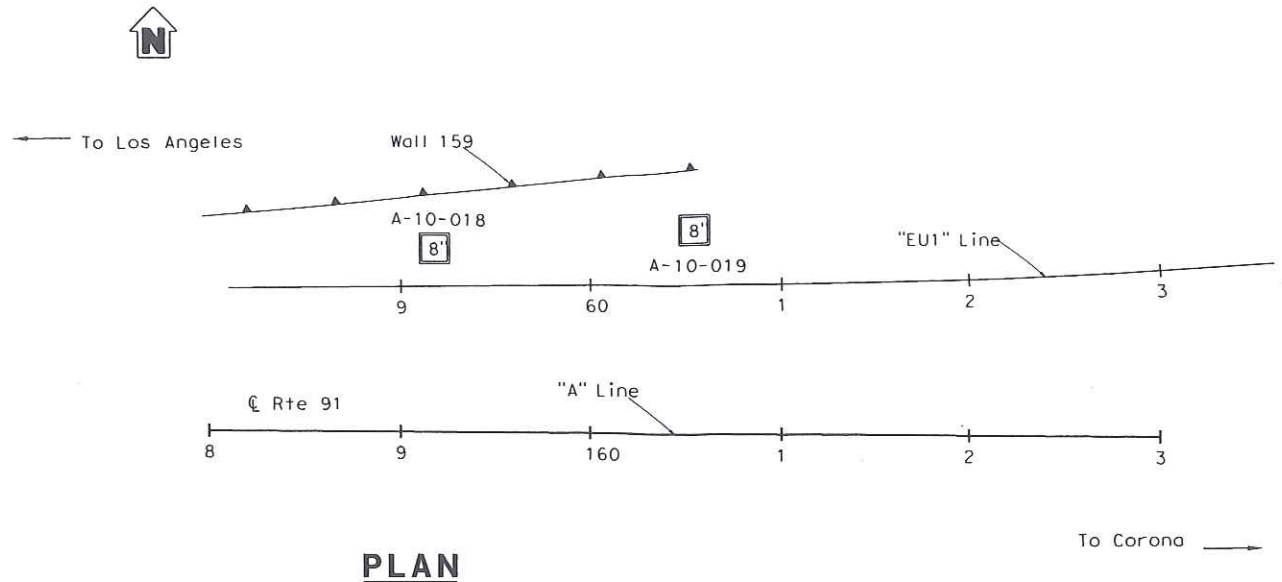

PLAN
1" = 50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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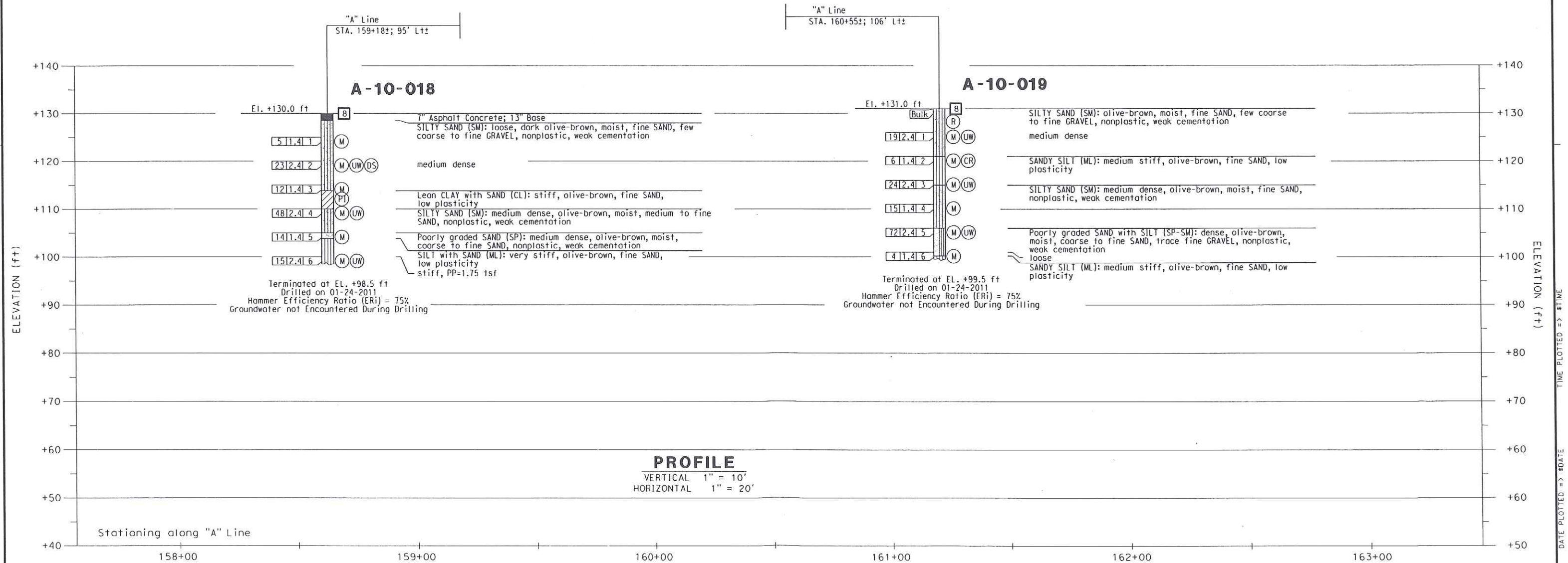
ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).
(2) 2.4" samples were taken using a California Modified Sampler.
(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.
(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.



PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. -	WALL 159
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 1/24/2011				POST MILES -	LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

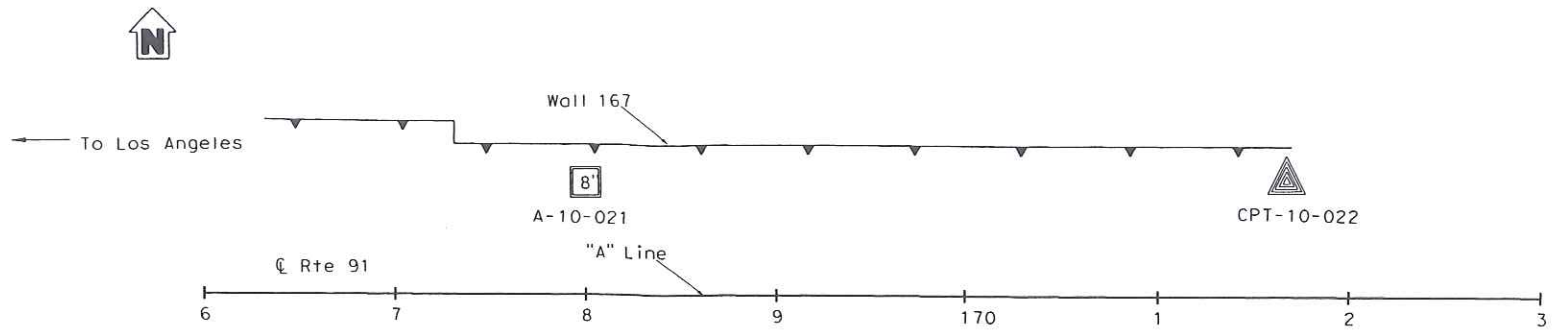
USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 50'

To Corona

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

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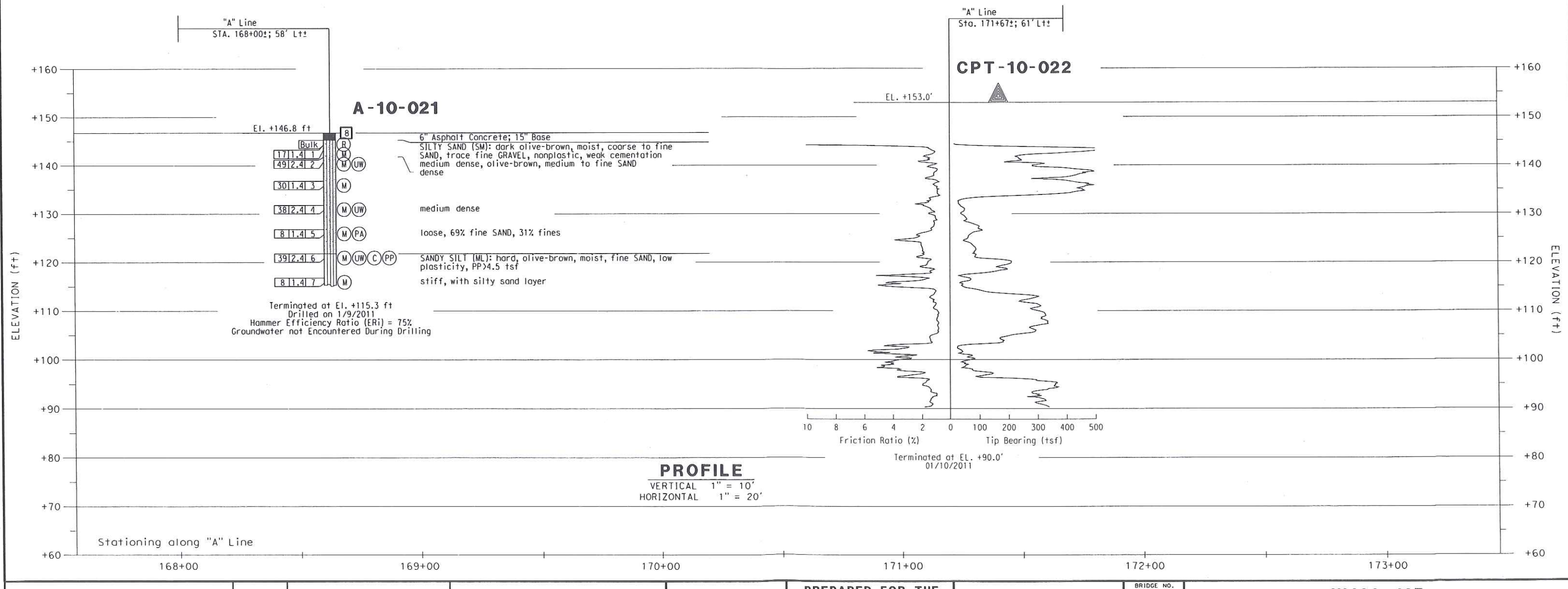

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -	WALL 167
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 1/24/2011			PROJECT ENGINEER	POST MILES -	LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARK

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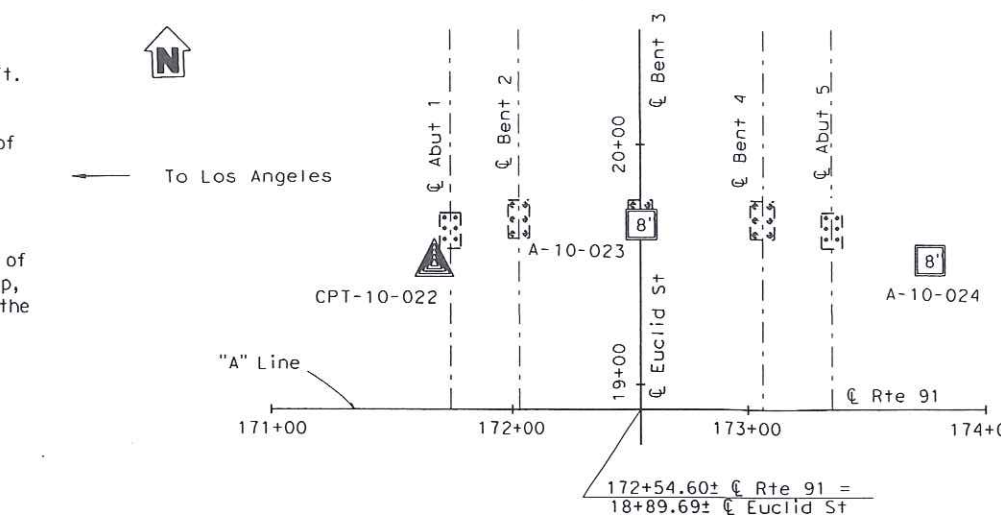

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

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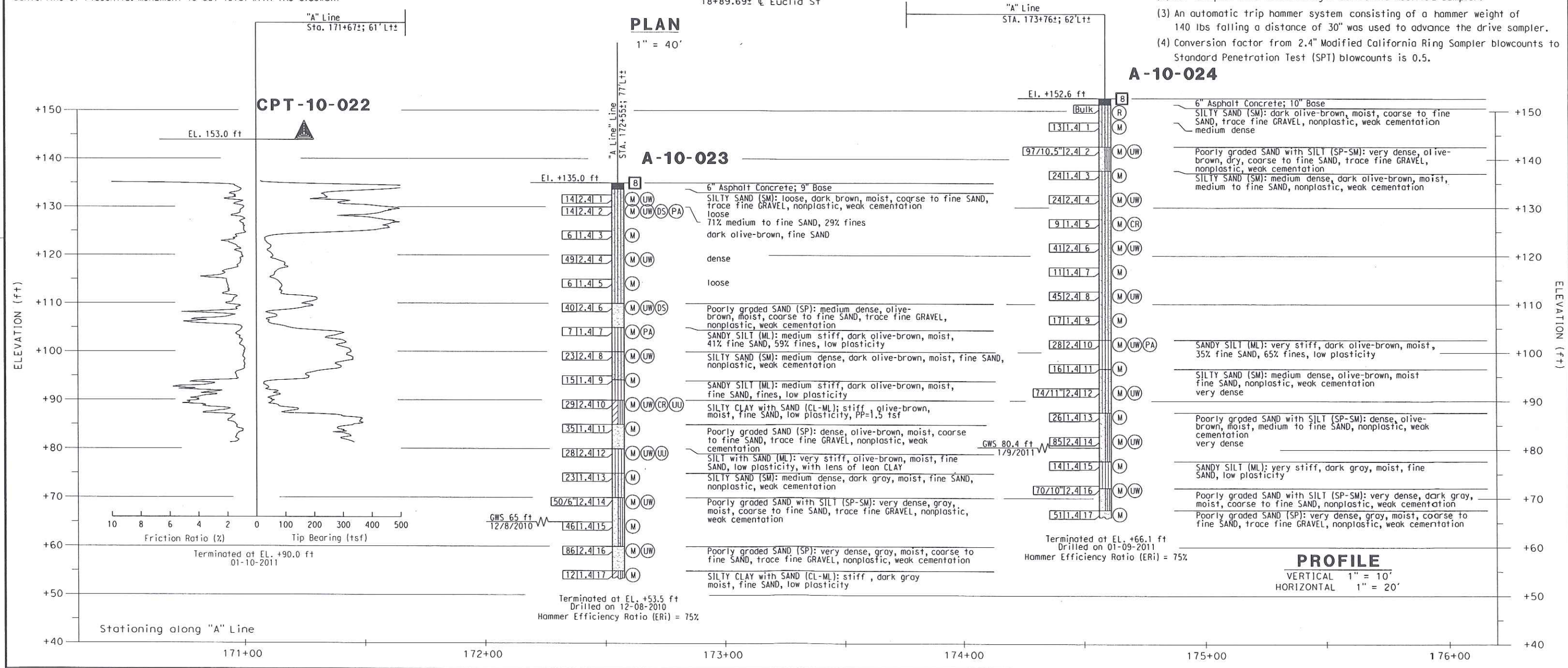
PLAN

1" = 40'



A-10-024

6" Asphalt Concrete; 10" Base
SILTY SAND (SM): dark olive-brown, moist, coarse to fine SAND, trace fine GRAVEL, nonplastic, weak cementation
medium dense
Poorly graded SAND with SILT (SP-SM): very dense, olive-brown, dry, coarse to fine SAND, trace fine GRAVEL, nonplastic, weak cementation
SILTY SAND (SM): medium dense, dark olive-brown, moist, medium to fine SAND, nonplastic, weak cementation
SANDY SILT (ML): very stiff, dark olive-brown, moist, 35% fine SAND, 65% fines, low plasticity
SILTY SAND (SM): medium dense, olive-brown, moist fine SAND, nonplastic, weak cementation
very dense
Poorly graded SAND with SILT (SP-SM): dense, olive-brown, moist, medium to fine SAND, nonplastic, weak cementation
very dense
SANDY SILT (ML): very stiff, dark gray, moist, fine SAND, low plasticity
Poorly graded SAND with SILT (SP-SM): very dense, dark gray, moist, coarse to fine SAND, nonplastic, weak cementation
Poorly graded SAND (SP): very dense, gray, moist, coarse to fine SAND, trace fine GRAVEL, nonplastic, weak cementation

PROFILE

VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011		S. Pirathiviraj PROJECT ENGINEER

BRIDGE NO. 55-0279 | POST MILES 2.2

EUCLID STREET UC (WIDEN)

LOG OF TEST BORINGS 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
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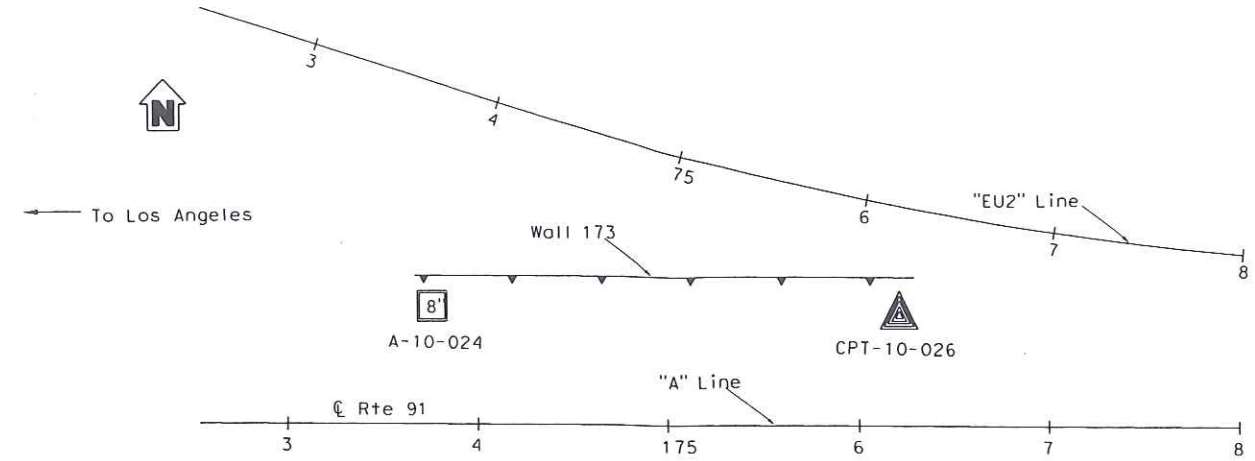

PLAN
1" = 50'

To Corona

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

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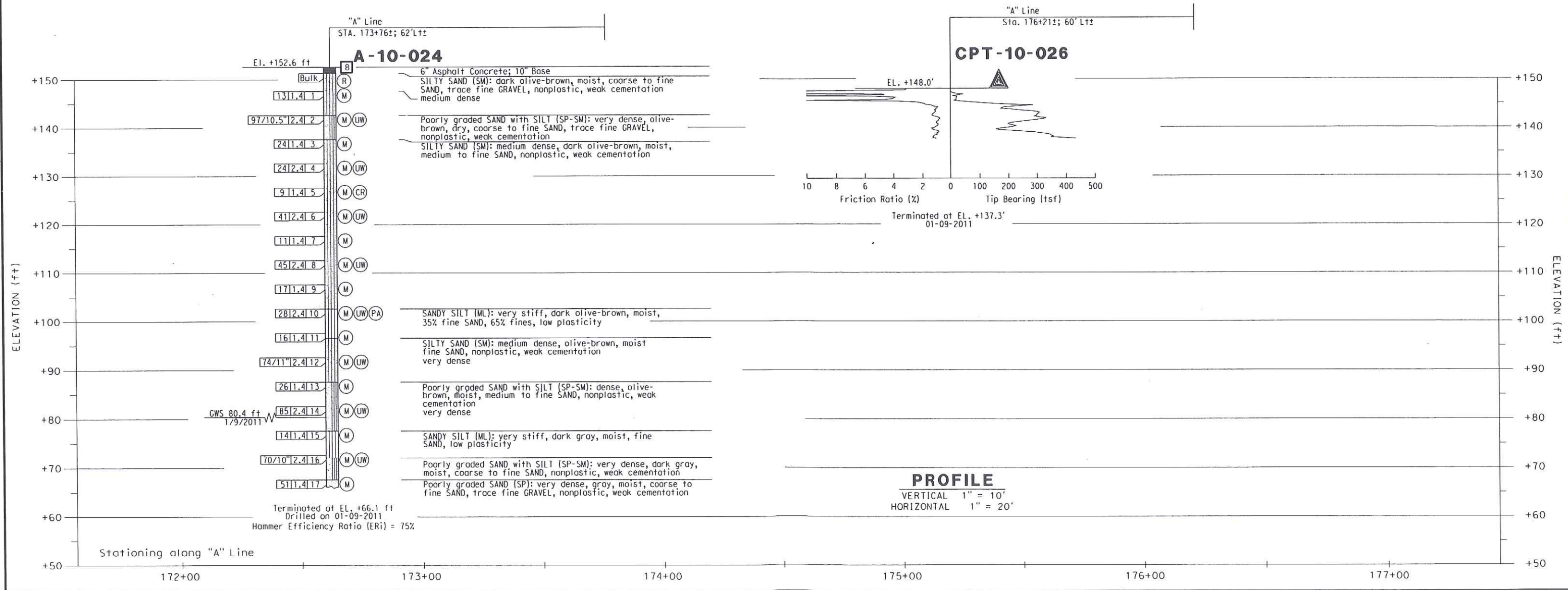

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. -	WALL 173
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 1/9/2011				POST MILES -	LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
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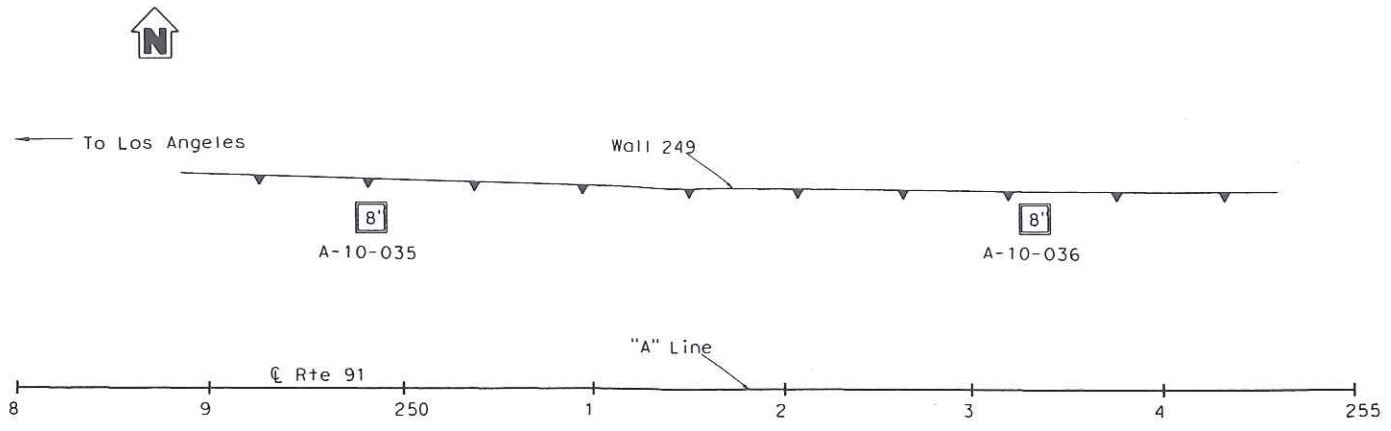

PLAN
1" = 50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER _____ DATE _____

PLANS APPROVAL DATE _____

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

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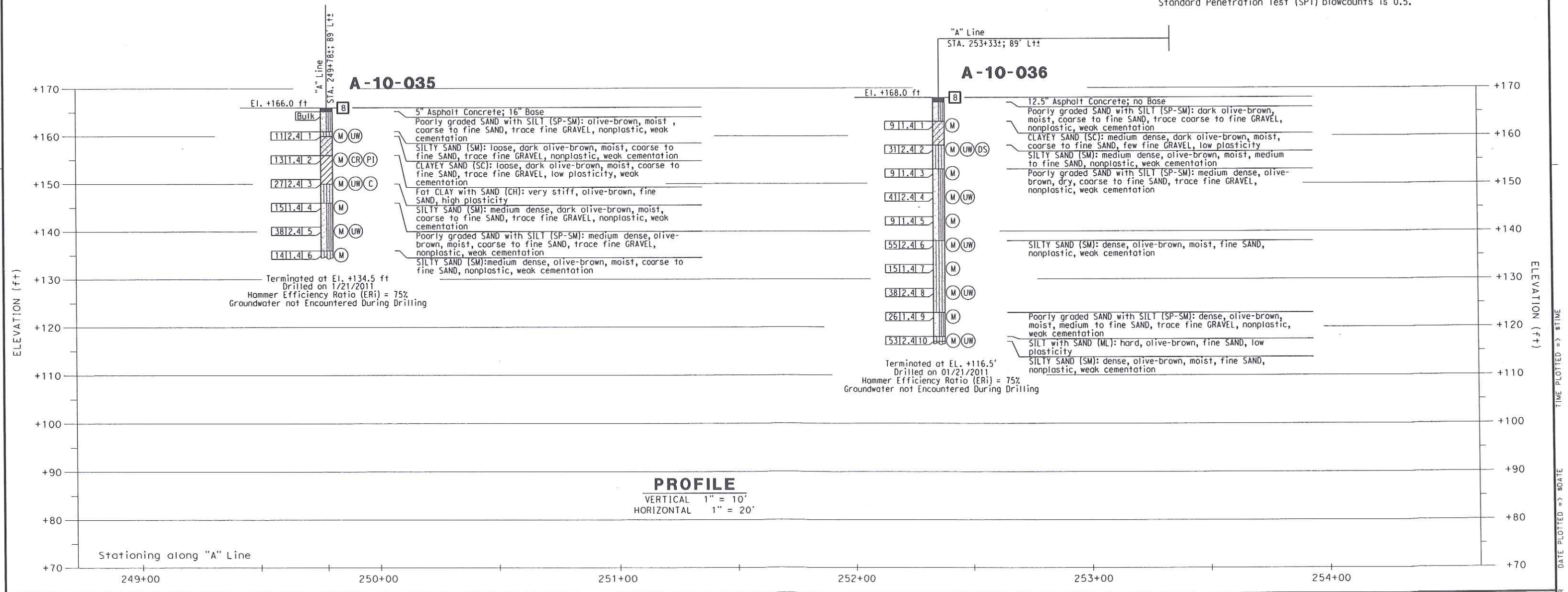

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

TIME PLOTTED => $TIME
DATE PLOTTED => $DATE
USERNAME => $USER

DESIGN OVERSIGHT	DRAWN BY	J. Fong	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. -	WALL 249
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 1/24/2011				POST MILES -	LOG OF TEST BORING 1 OF 1
GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)				ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3		UNIT: 2295 PROJECT NUMBER & PHASE: 12000000791	DISREGARD PRINTS BEARING EARLIER REVISION DATES →	REVISION DATES / SHEET / OF

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
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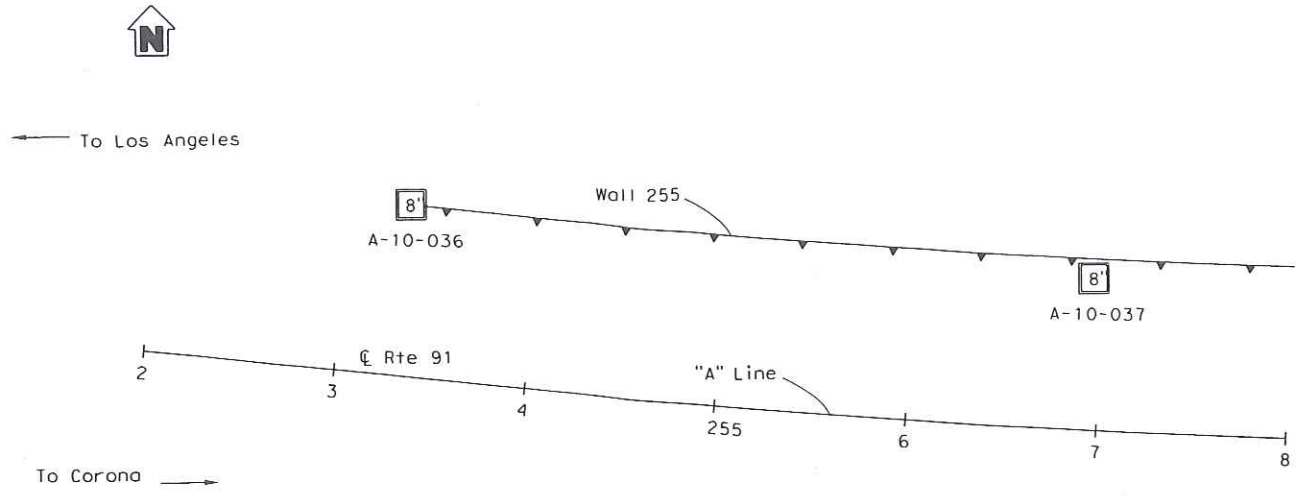

PLAN
1" = 50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
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REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
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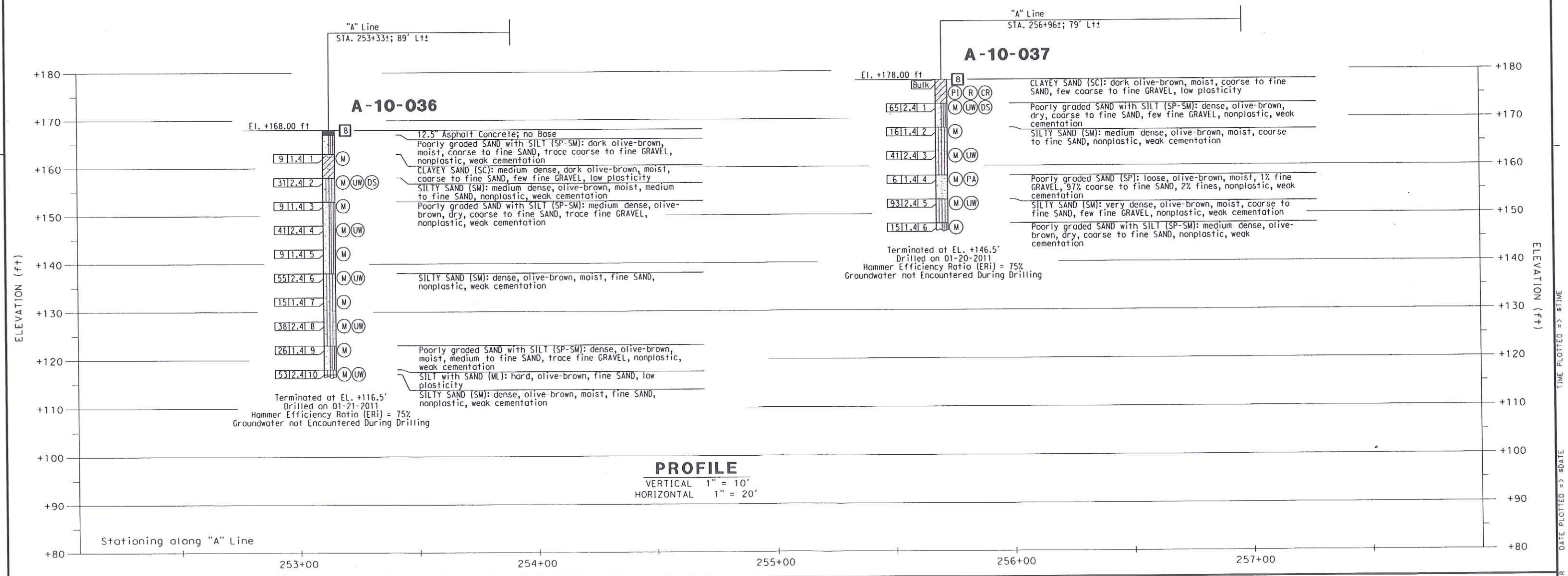

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. PIRATHIVIRAJ PROJECT ENGINEER	BRIDGE NO. -	WALL 255
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/2011			POST MILES -	LOG OF TEST BORINGS 1 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARK

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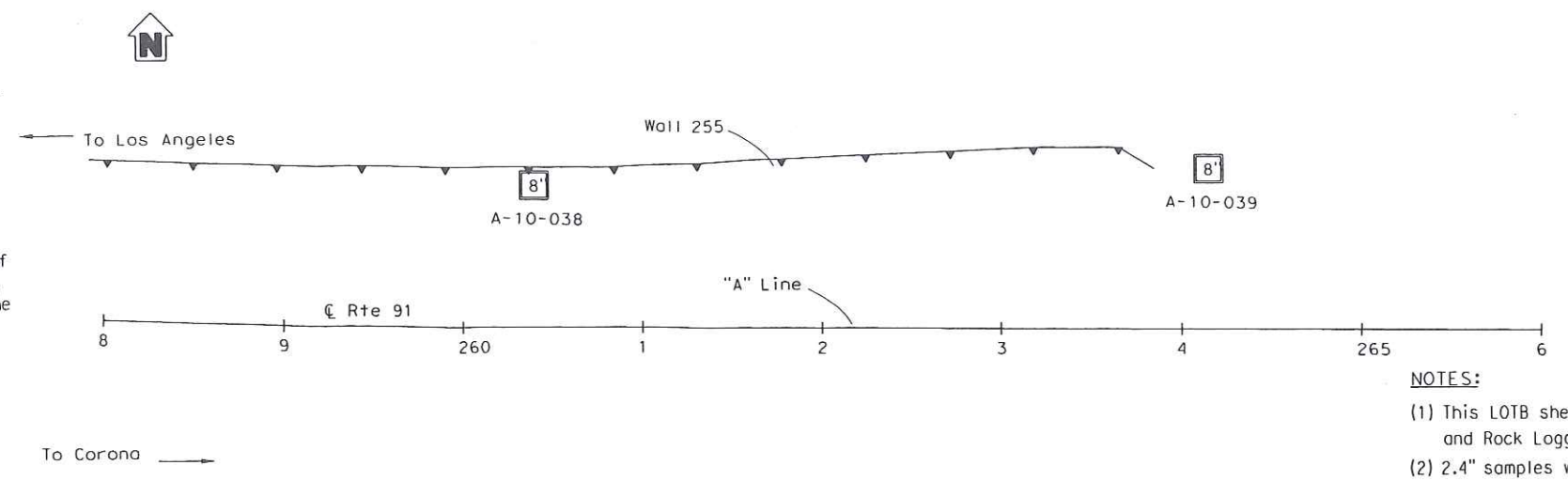


DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010)

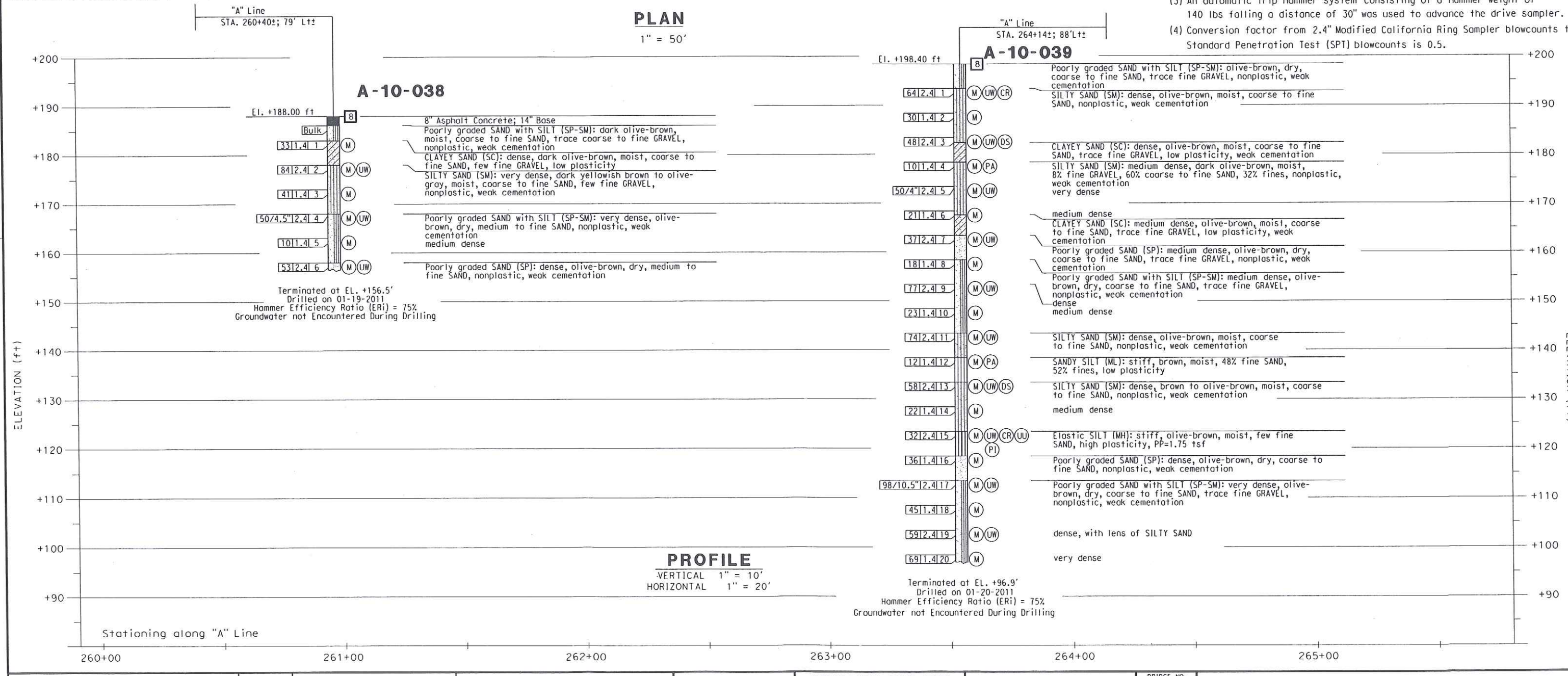
(2) 2.4" samples were taken using a California Modified Sampler.

(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.

PLAN

1" = 50'



PROFILE

VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -	WALL 255
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/2011			PROJECT ENGINEER	POST MILES -	LOG OF TEST BORINGS 2 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295 PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk
Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

BENCH MARK

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER · S. PIRATHIVIRAJ · NO. C71662 · EXP. 12/31/11 · CIVIL · STATE OF CALIFORNIA

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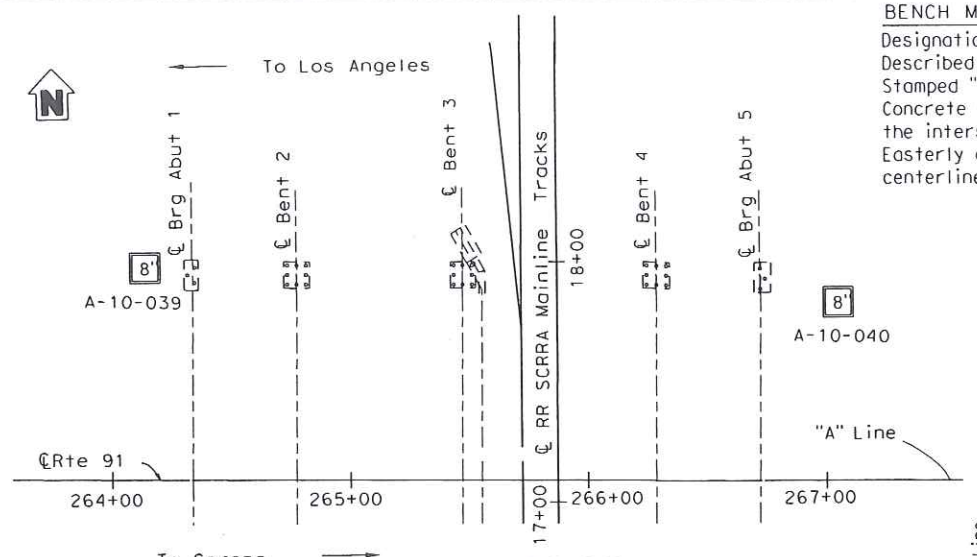
ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708



PLAN
1" = 40'

NOTES:

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A-10-039

"A" Line STA. 264+14; 88'Lt±

El. +198.40 ft

Blows/ft | Dry Density (pcf) | Sample No.	Sample Type	Lab Tests	Description
	B		Poorly graded SAND with SILT (SP-SM): olive-brown, dry, coarse to fine SAND, trace fine GRAVEL, nonplastic, weak cementation
64 | 2.4 | 1	M	UW, CR	SILTY SAND (SM): dense, olive-brown, moist, coarse to fine SAND, nonplastic, weak cementation
30 | 1.4 | 2	M		
48 | 2.4 | 3	M	UW, DS	CLAYEY SAND (SC): dense, olive-brown, moist, coarse to fine SAND, trace fine GRAVEL, low plasticity, weak cementation
10 | 1.4 | 4	M	PA	SILTY SAND (SM): medium dense, dark olive-brown, moist, 8% fine GRAVEL, 60% coarse to fine SAND, 32% fines, nonplastic, weak cementation
50/4" | 2.4 | 5	M	UW	very dense
21 | 1.4 | 6	M		medium dense
37 | 2.4 | 7	M	UW	CLAYEY SAND (SC): medium dense, olive-brown, moist, coarse to fine SAND, trace fine GRAVEL, low plasticity, weak cementation
18 | 1.4 | 8	M		Poorly graded SAND (SP): medium dense, olive-brown, dry, coarse to fine SAND, trace fine GRAVEL, nonplastic, weak cementation
77 | 2.4 | 9	M	UW	Poorly graded SAND with SILT (SP-SM): medium dense, olive-brown, dry, coarse to fine SAND, trace fine GRAVEL, nonplastic, weak cementation
23 | 1.4 | 10	M		dense medium dense
74 | 2.4 | 11	M	UW	SILTY SAND (SM): dense, olive-brown, moist, coarse to fine SAND, nonplastic, weak cementation
12 | 1.4 | 12	M	PA	SANDY SILT (ML): stiff, brown, moist, 48% fine SAND, 52% fines, low plasticity
58 | 2.4 | 13	M	UW, DS	SILTY SAND (SM): dense, brown to olive-brown, moist, coarse to fine SAND, nonplastic, weak cementation
22 | 1.4 | 14	M		medium dense
32 | 2.4 | 15	M	UW, CR, UU, PI	Elastic SILT (MH): stiff, olive-brown, moist, few fine SAND, high plasticity, PP=1.75 tsf
36 | 1.4 | 16	M		Poorly graded SAND (SP): dense, olive-brown, dry, coarse to fine SAND, nonplastic, weak cementation
98/10.5" | 2.4 | 17	M	UW	Poorly graded SAND with SILT (SP-SM): very dense, olive-brown, dry, coarse to fine SAND, trace fine GRAVEL, nonplastic, weak cementation
45 | 1.4 | 18	M		
59 | 2.4 | 19	M	UW	dense, with lens of SILTY SAND
69 | 1.4 | 20	M		very dense

Terminated at EL. +96.9'
Drilled on 01-20-2011
Hammer Efficiency Ratio (ERi) = 75%
Groundwater not Encountered During Drilling

A-10-040

"A" Line STA. 267+05±; 74'Lt±

El. +201.20 ft

Blows/ft | Dry Density (pcf) | Sample No.	Sample Type	Lab Tests	Description
	B		9" Asphalt Concrete; 12" Base
Bulk	R		Poorly graded SAND with SILT (SP-SM): dark olive-brown, moist, coarse to fine SAND, trace fine GRAVEL, nonplastic, weak cementation
20 | 1.4 | 1	M		SILTY SAND with GRAVEL (SM): medium dense, dark olive-brown, moist, little coarse to fine GRAVL, coarse to fine SAND, nonplastic, weak cementation
63 | 2.4 | 2	M	UW	Poorly graded SAND with SILT (SP-SM): dense, olive-brown, moist, coarse to fine SAND, nonplastic, weak cementation
43 | 1.4 | 3	M		very dense
106 | 2.4 | 4	M	UW	SILTY SAND (SM): very dense, dark olive-brown, moist, medium to fine SAND, nonplastic, weak cementation
39 | 1.4 | 5	M		dense
63 | 2.4 | 6	M	UW	
14 | 1.4 | 7	M		Poorly graded SAND with SILT (SP-SM): medium dense, olive-brown, dry, coarse to fine SAND, nonplastic, weak cementation
31 | 2.4 | 8	M	UW, DS	Poorly graded SAND (SP): medium dense, olive-brown, dry, coarse to fine SAND, nonplastic, weak cementation
28 | 1.4 | 9	M		dense
84 | 2.4 | 10	M	UW	very dense
18 | 1.4 | 11	M		SILTY SAND (SM): medium dense, dark olive-brown, moist, medium to fine SAND, nonplastic, weak cementation
81 | 2.4 | 12	M	UW	Poorly graded SAND with SILT (SP-SM): very dense, olive-brown, moist, coarse to fine SAND, nonplastic, weak cementation
26 | 1.4 | 13	M		dense
75 | 2.4 | 14	M	UW	Poorly graded SAND (SP): dense, olive-brown, dry, coarse to fine SAND, nonplastic, weak cementation
41 | 1.4 | 15	M		very dense
69 | 2.4 | 16	M	UW	Poorly graded SAND with SILT (SP-SM): dense, olive-brown, dry, medium to fine SAND, nonplastic, weak cementation
61 | 1.4 | 17	M		very dense
53 | 2.4 | 18	M	UW	dense
29 | 1.4 | 19	M		SILT with SAND (ML): hard, olive-brown, moist, fine SAND, low plasticity
REF | 2.4 | 20	M	UW	Poorly graded SAND with SILT (SP-SM): dense, olive-brown, moist, coarse to fine SAND, nonplastic, weak cementation very dense

Terminated at EL. +100.7'
Drilled on 01-06-2011
Hammer Efficiency Ratio (ERi) = 75%
Groundwater not Encountered During Drilling

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

ELEVATION (ft): +200, +190, +180, +170, +160, +150, +140, +130, +120, +110, +100, +90

Stationing along "A" Line
264+00 265+00 266+00 267+00 268+00 269+00

TIME PLOTTED => $TIME
DATE PLOTTED => $DATE
USERNAME => $USER

DESIGN OVERSIGHT	DRAWN BY	J. Fong	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. 55-0216
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011				POST MILES 4.0

NORTH ANAHEIM OH (WIDEN)
LOG OF TEST BORINGS 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

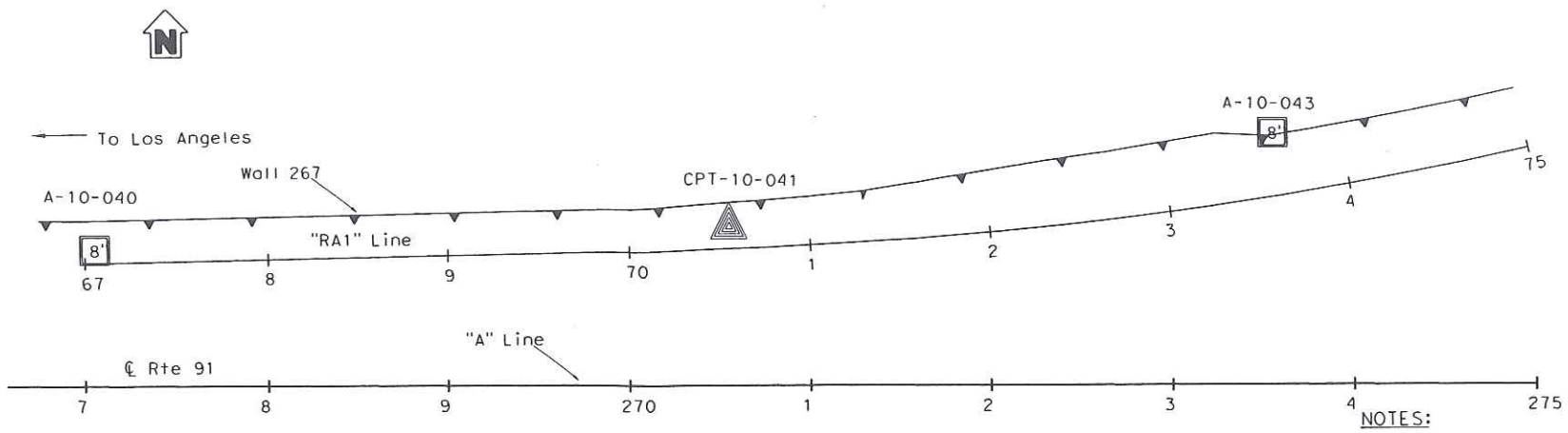
EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



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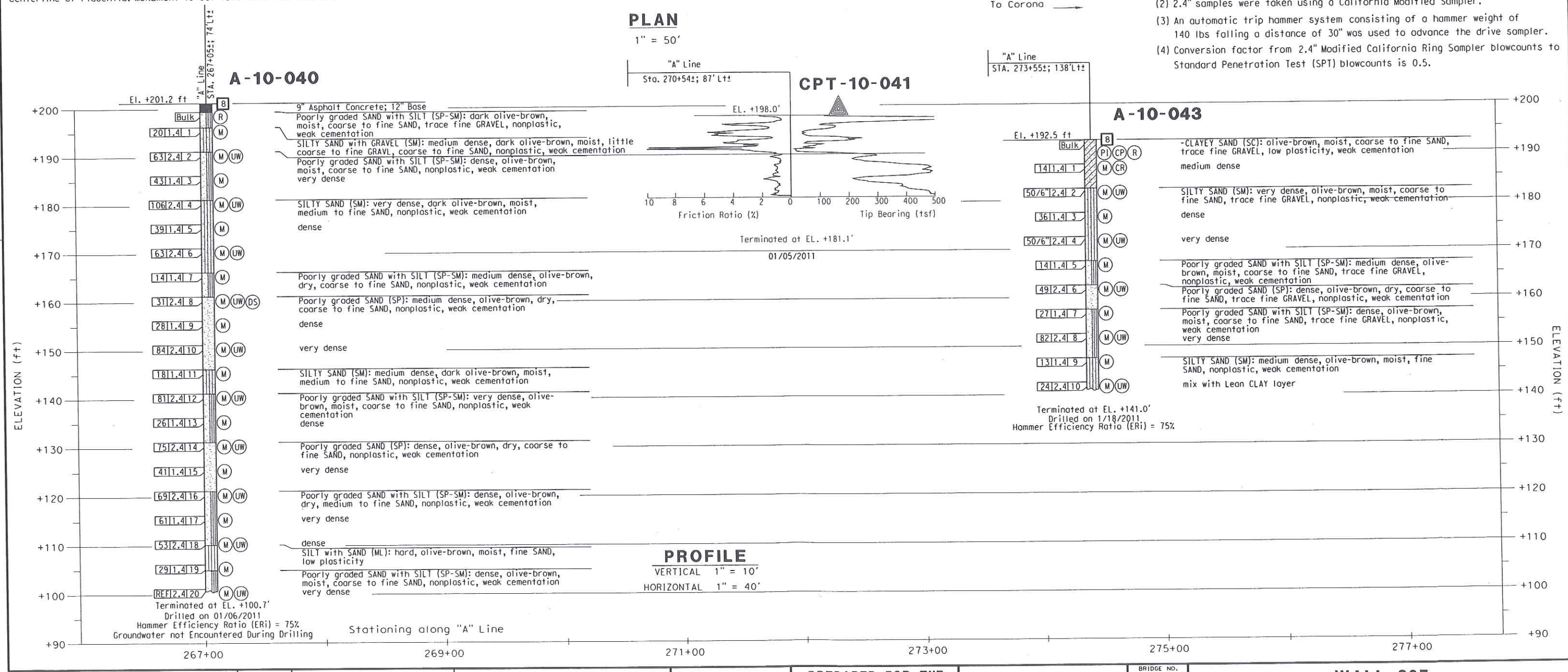
PLAN

1" = 50'



PROFILE

VERTICAL 1" = 10'
HORIZONTAL 1" = 40'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -	WALL 267
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 1/24/2011		PROJECT ENGINEER	POST MILES -	LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

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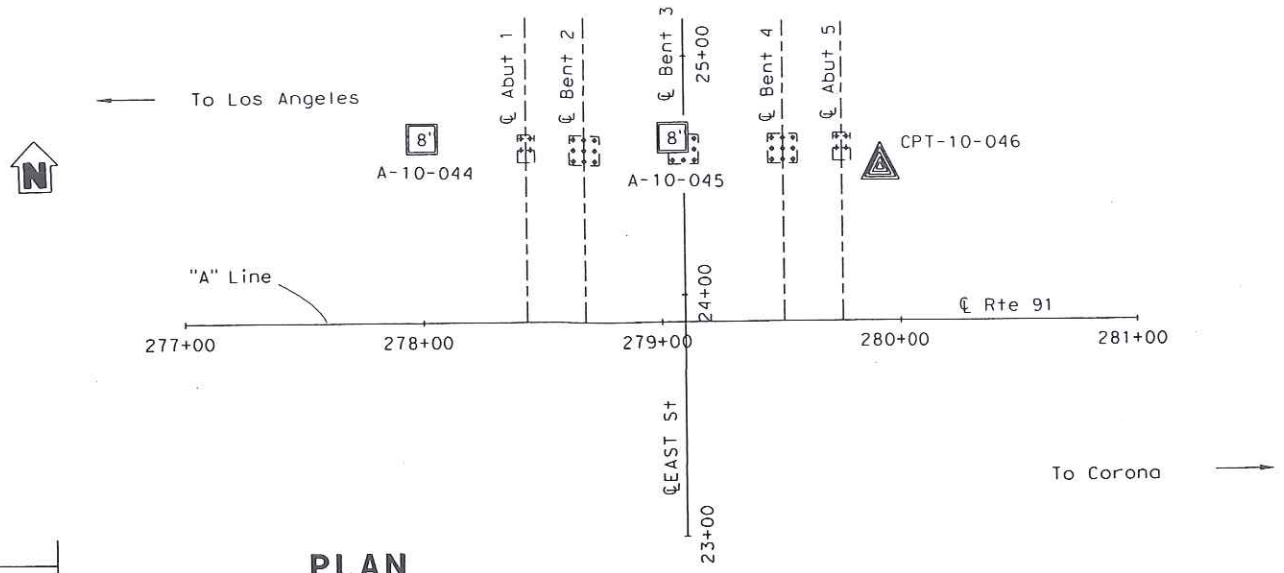
Described by OCS 2003 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

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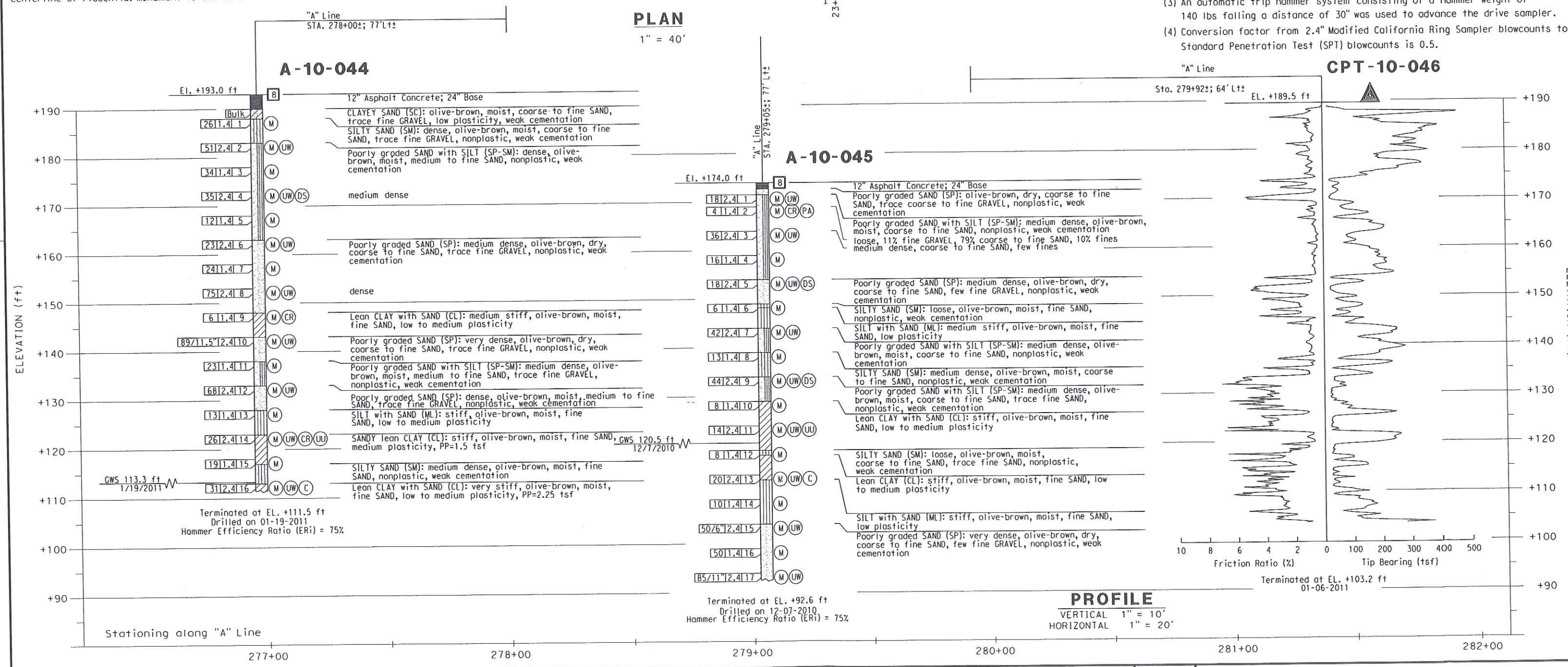
PLAN

1" = 40'



PROFILE

VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. 55-0245	EAST STREET UC (WIDEN)
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011			POST MILES 4.3	LOG OF TEST BORINGS 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295 PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
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REGISTERED ENGINEER — DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

BENCH MARK

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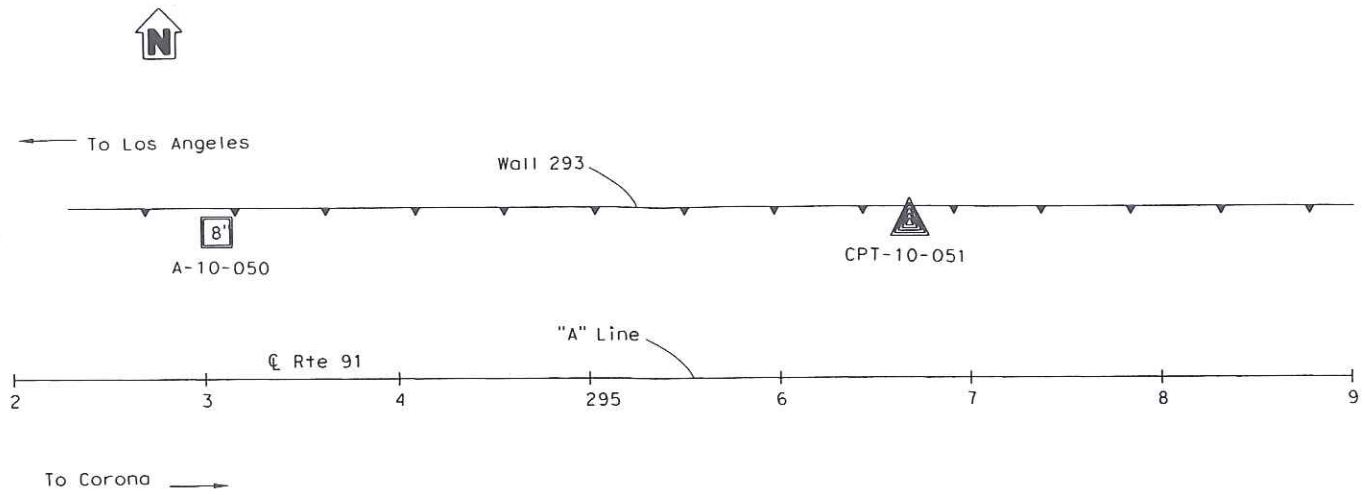

PLAN
1" = 50'

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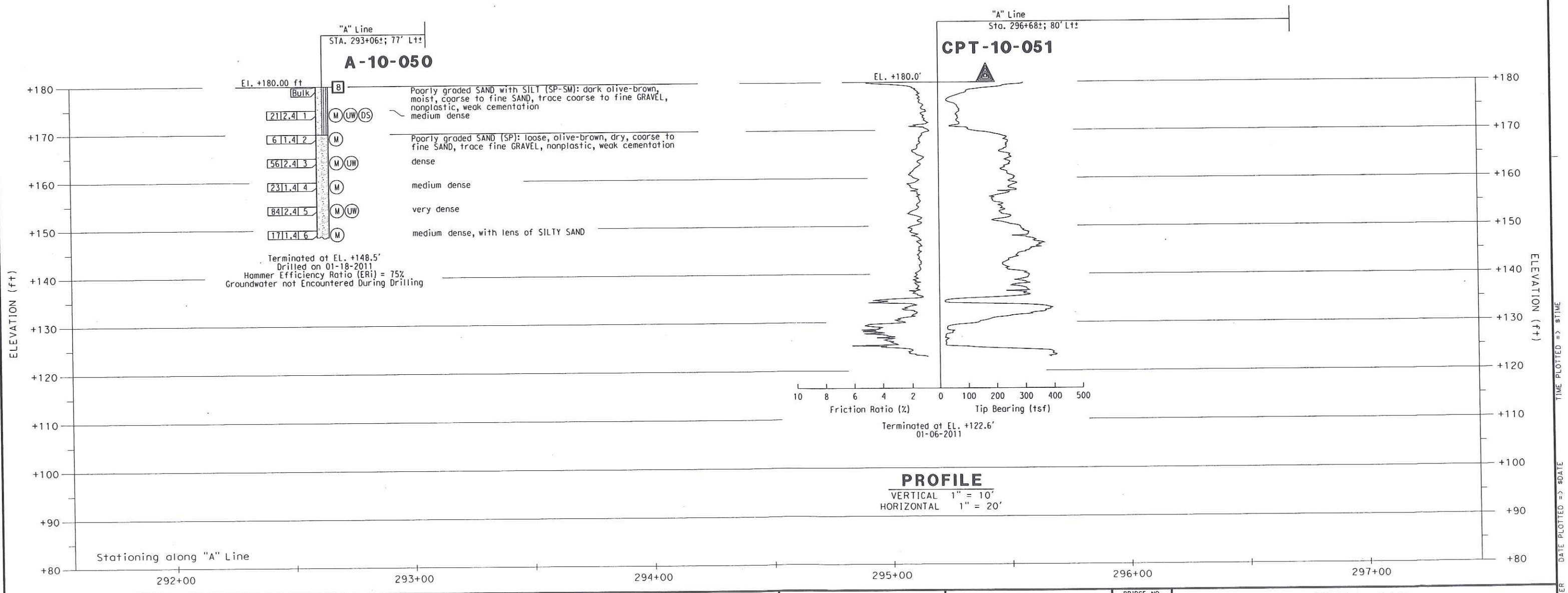

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/2011		PROJECT ENGINEER	POST MILES -

WALL 293
LOG OF TEST BORINGS 1 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER _____ DATE _____

PLANS APPROVAL DATE _____

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REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
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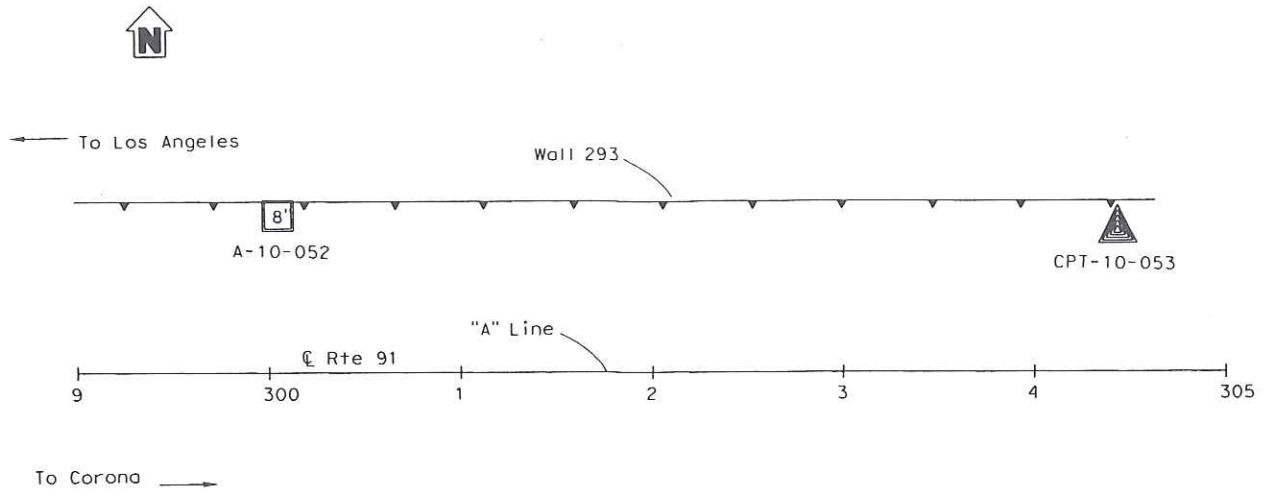
Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 50'

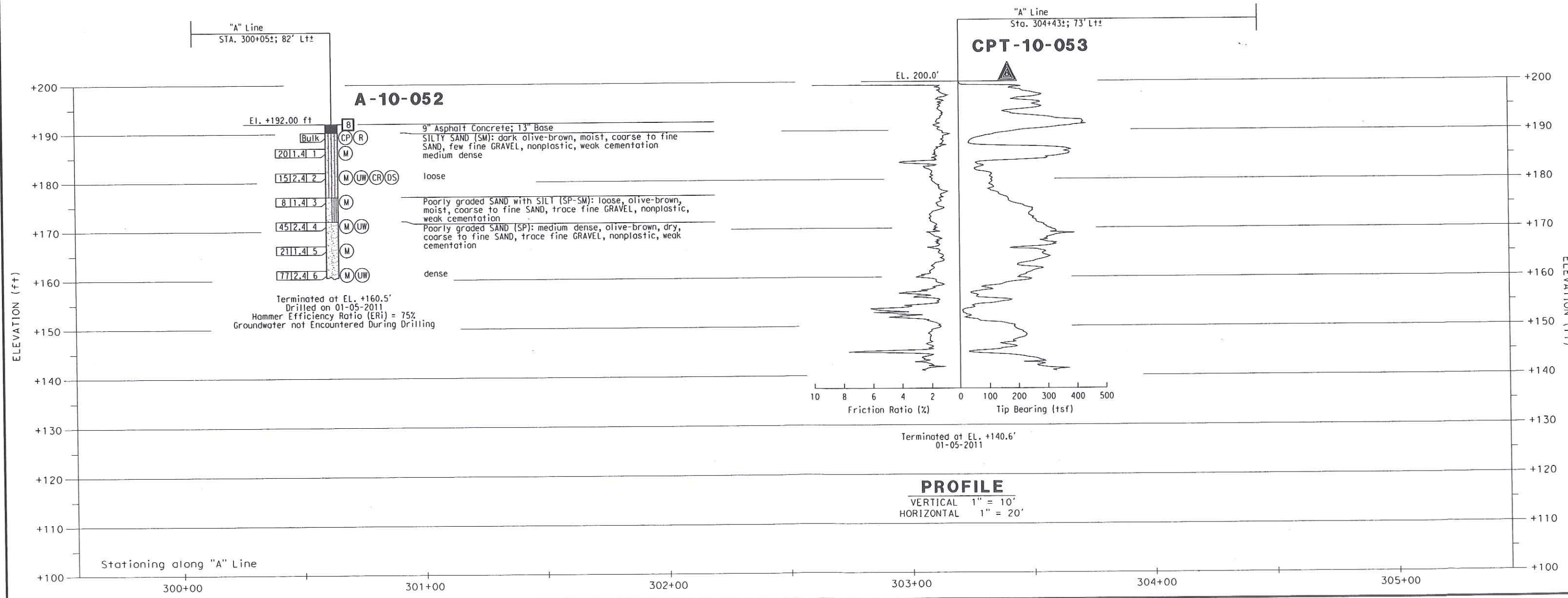
NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).

(2) 2.4" samples were taken using a California Modified Sampler.

(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.



PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/2011		PROJECT ENGINEER	POST MILES -

WALL 293

LOG OF TEST BORINGS 2 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

USERNAME => %USER
DATE PLOTTED => %DATE
TIME PLOTTED => %TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER _____ DATE _____

PLANS APPROVAL DATE _____

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

REGISTERED PROFESSIONAL ENGINEER
S. PIRATHIVIRAJ
NO. C71662
EXP. 12/31/11
CIVIL
STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

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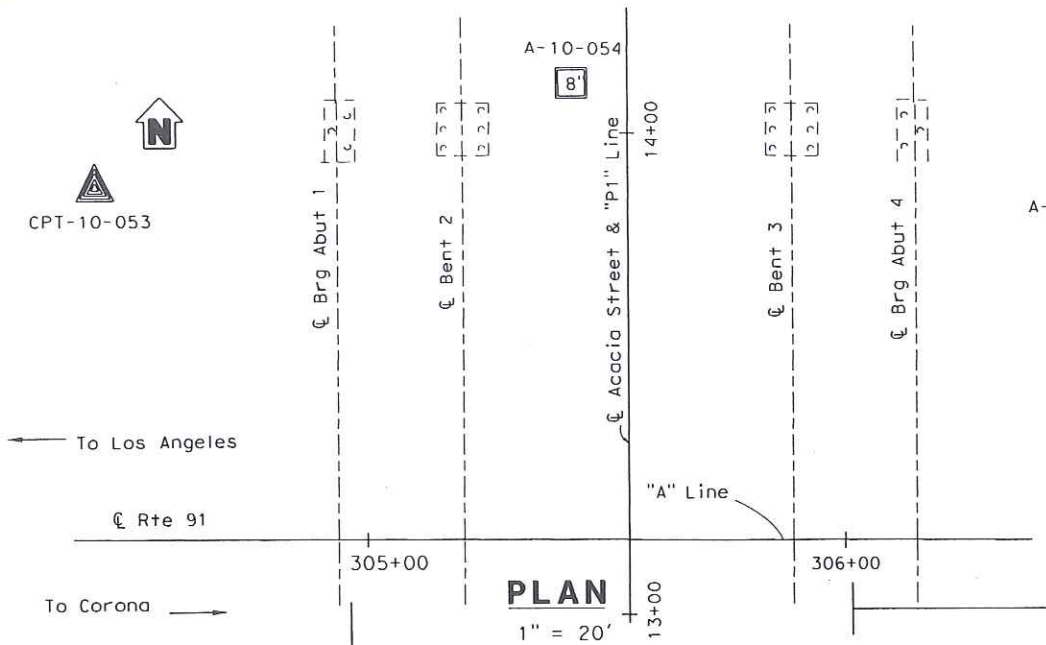

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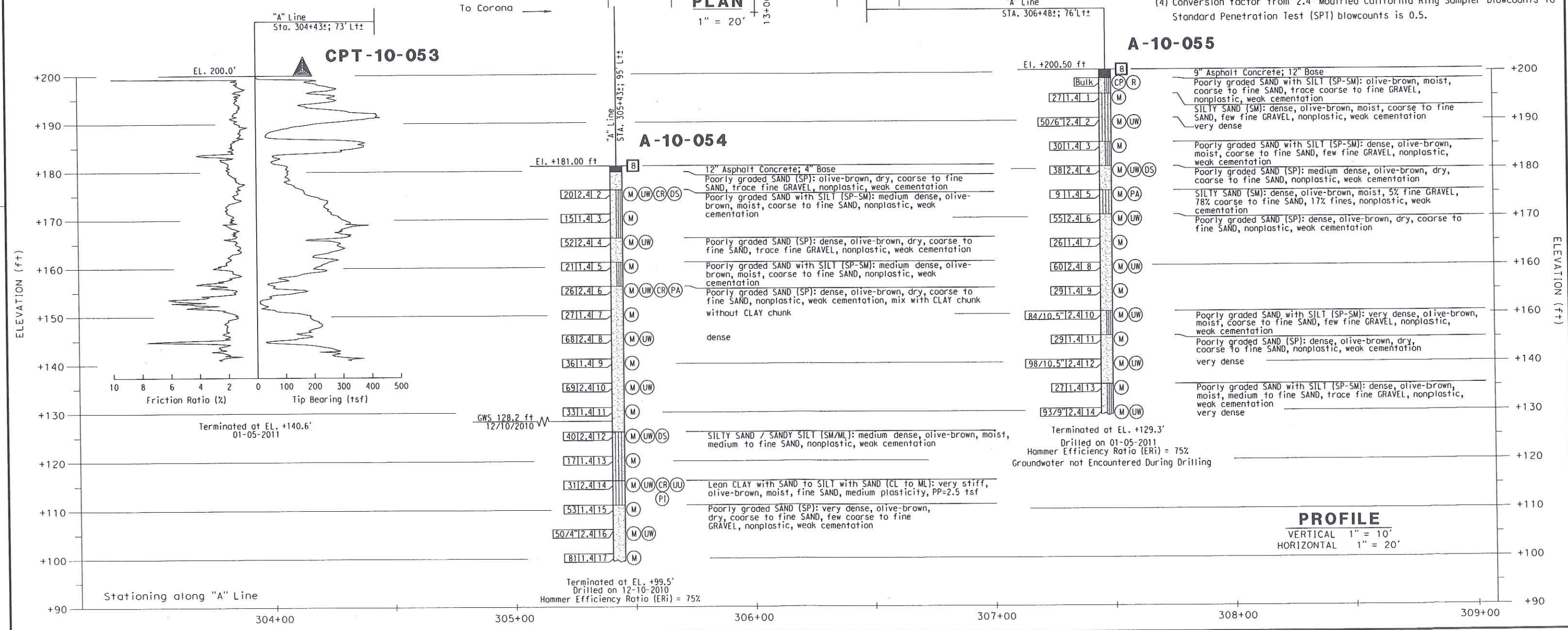

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. 55-0218
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011			PROJECT ENGINEER	POST MILES 4.8

ACACIA STREET UC (WIDEN)

LOG OF TEST BORINGS 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

USERNAME => #USER DATE PLOTTED => #DATE TIME PLOTTED => #TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER _____ DATE _____

PLANS APPROVAL DATE _____

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REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

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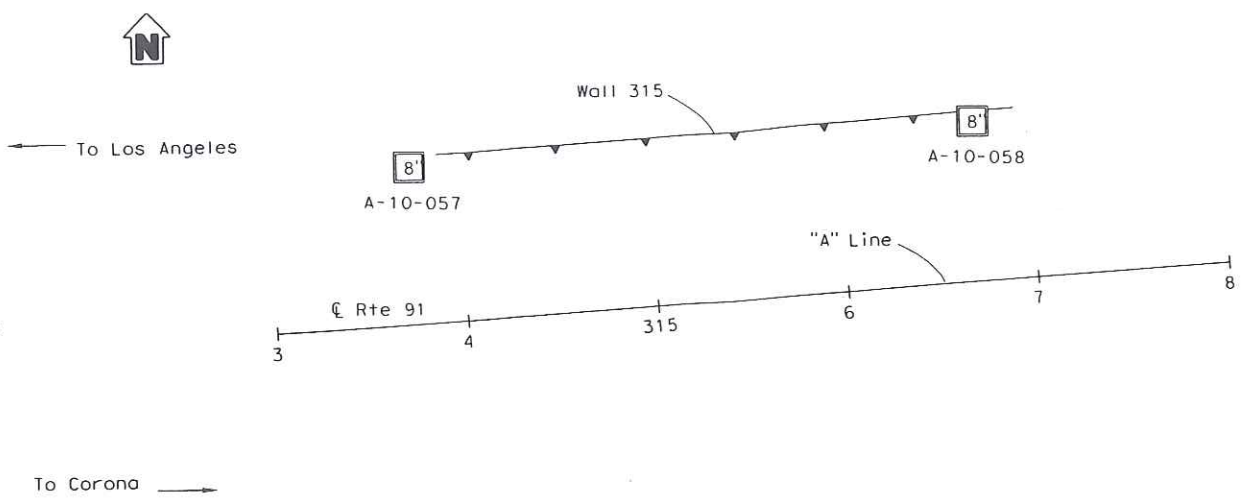

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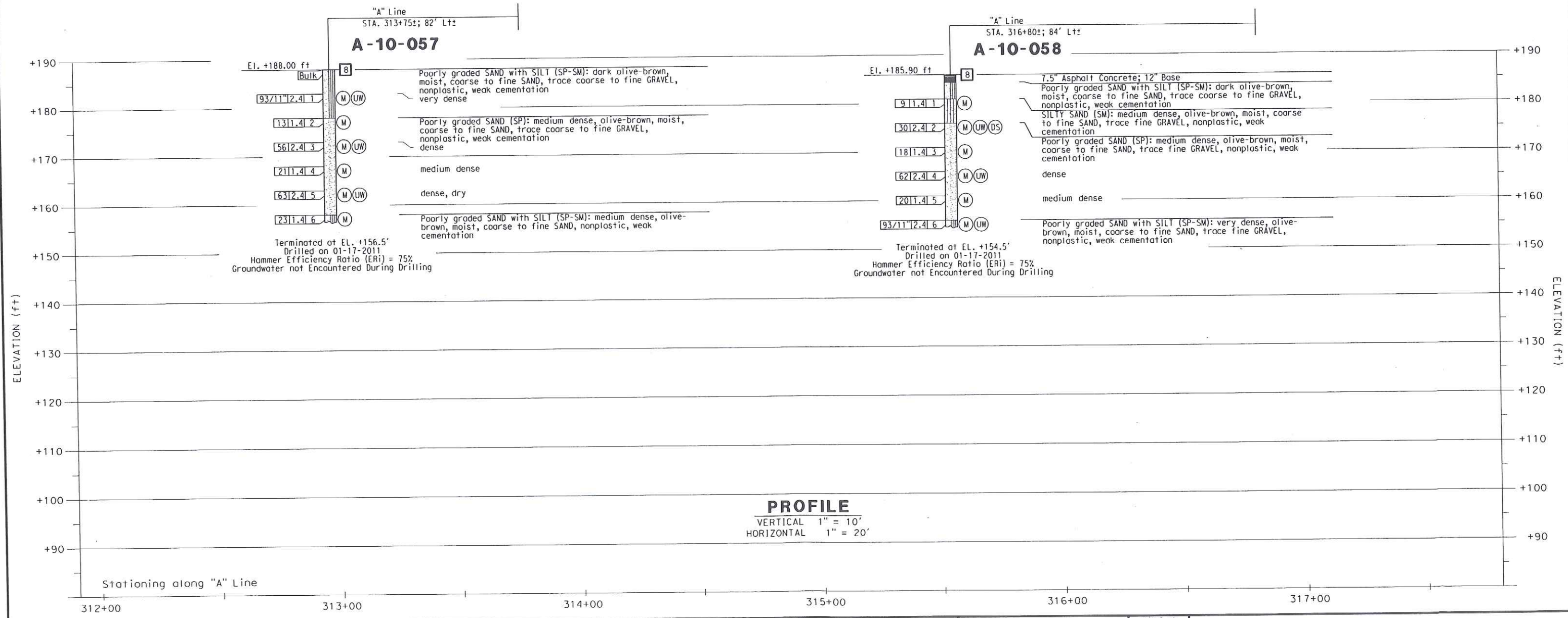
(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.

PLAN

1" = 50'



PROFILE

VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviroj	BRIDGE NO. -	WALL 315
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/2011		PROJECT ENGINEER	POST MILES -	LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

FILENAME => $FILER
DATE PLOTTED => $DATE
TIME PLOTTED => $TIME

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

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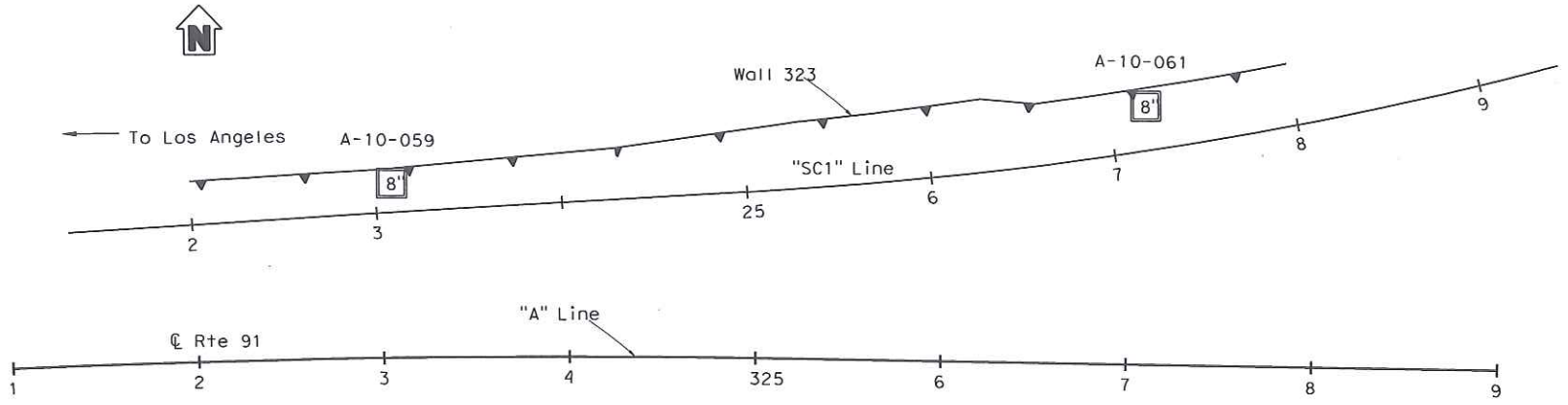

PLAN
1" = 50'

To Corona →

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

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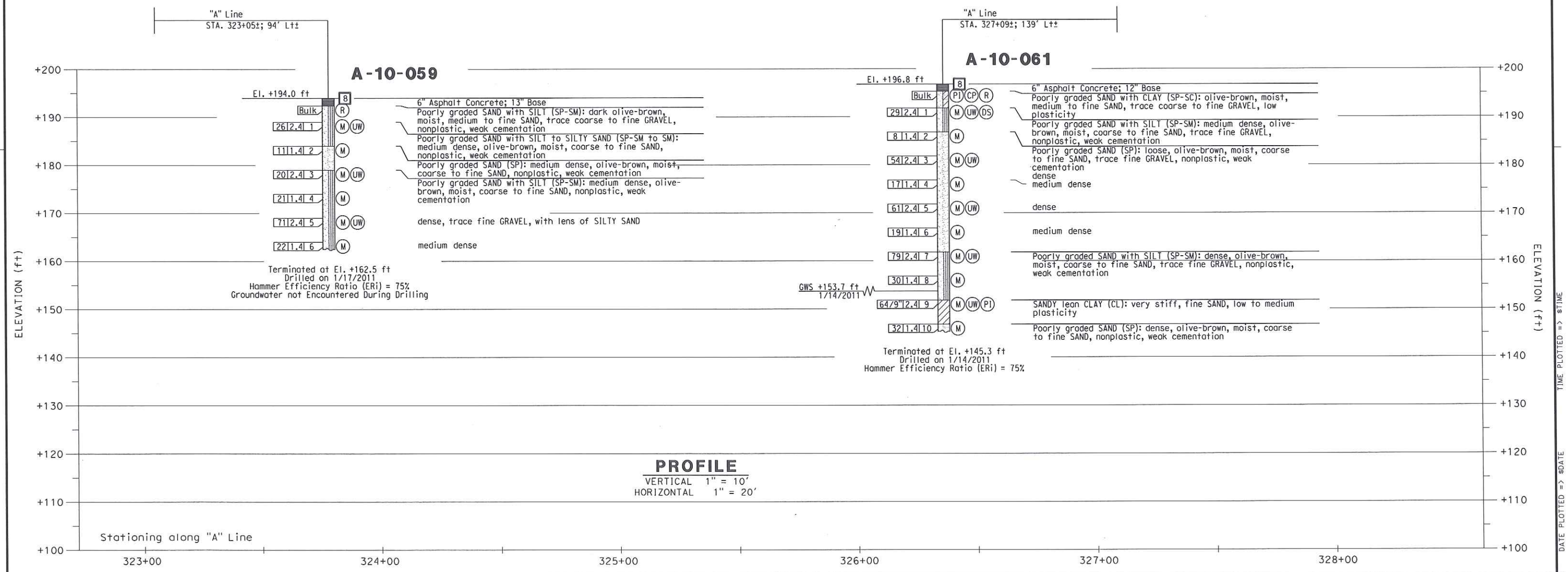

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 1/14/2011,1/17/2011			PROJECT ENGINEER

BRIDGE NO. -
POST MILES -

WALL 323

LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER
S. PIRATHIVIRAJ
NO. C71662
EXP. 12/31/11
CIVIL
STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

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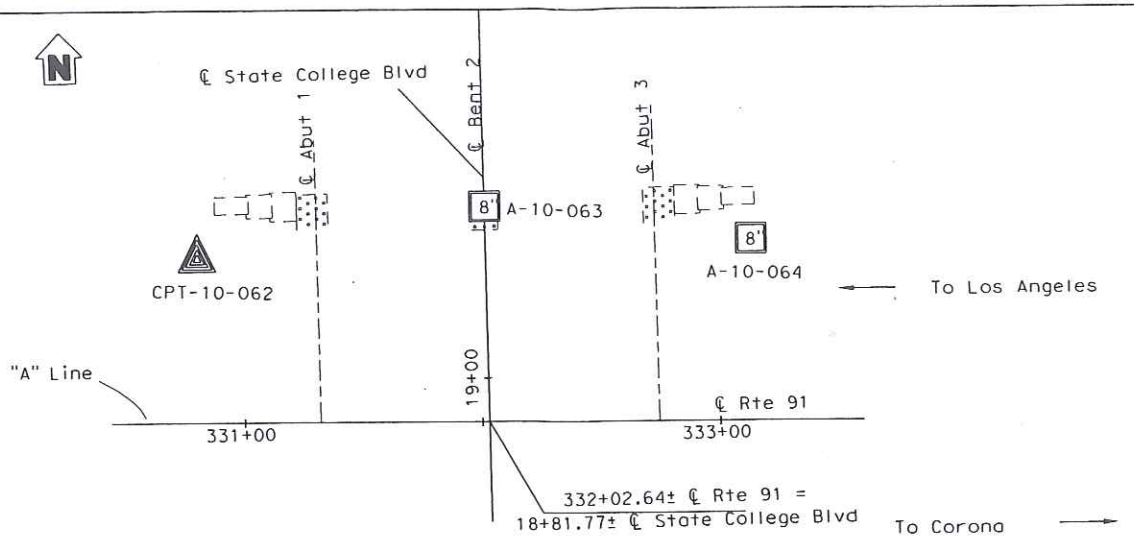

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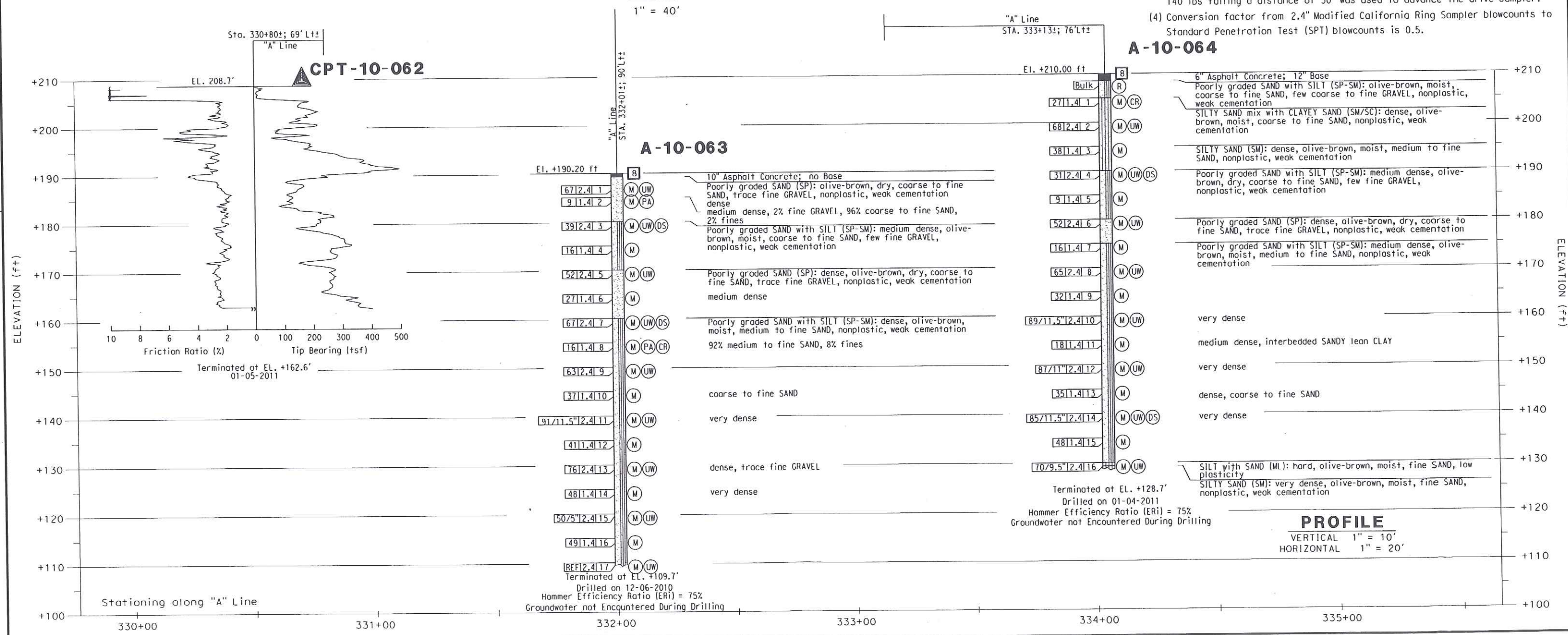
PLAN

1" = 40'



PROFILE

VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. 55-0852	STATE COLLEGE BOULEVARD UC (WIDEN)
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011			PROJECT ENGINEER	POST MILES 5.3	LOG OF TEST BORINGS 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295 PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
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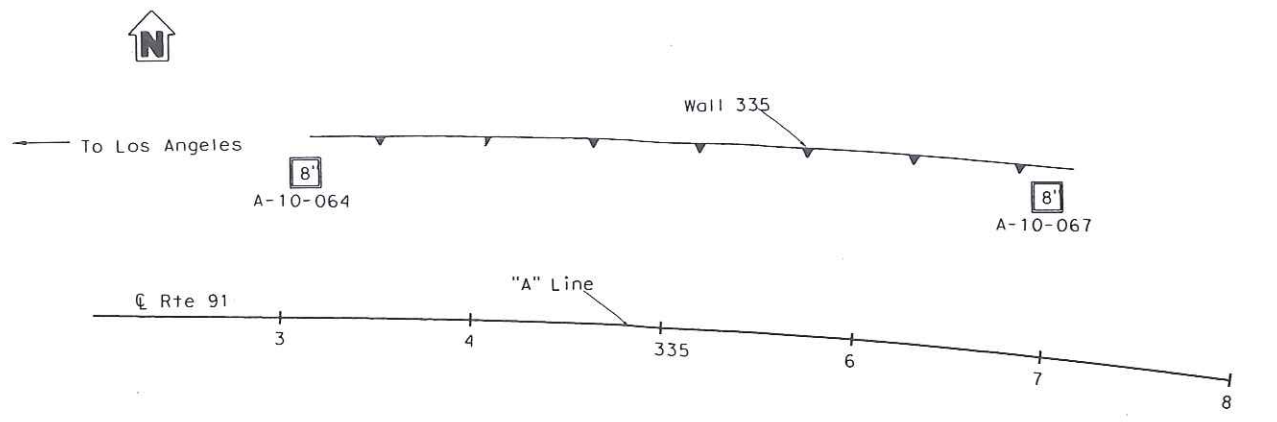

PLAN
1" = 50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

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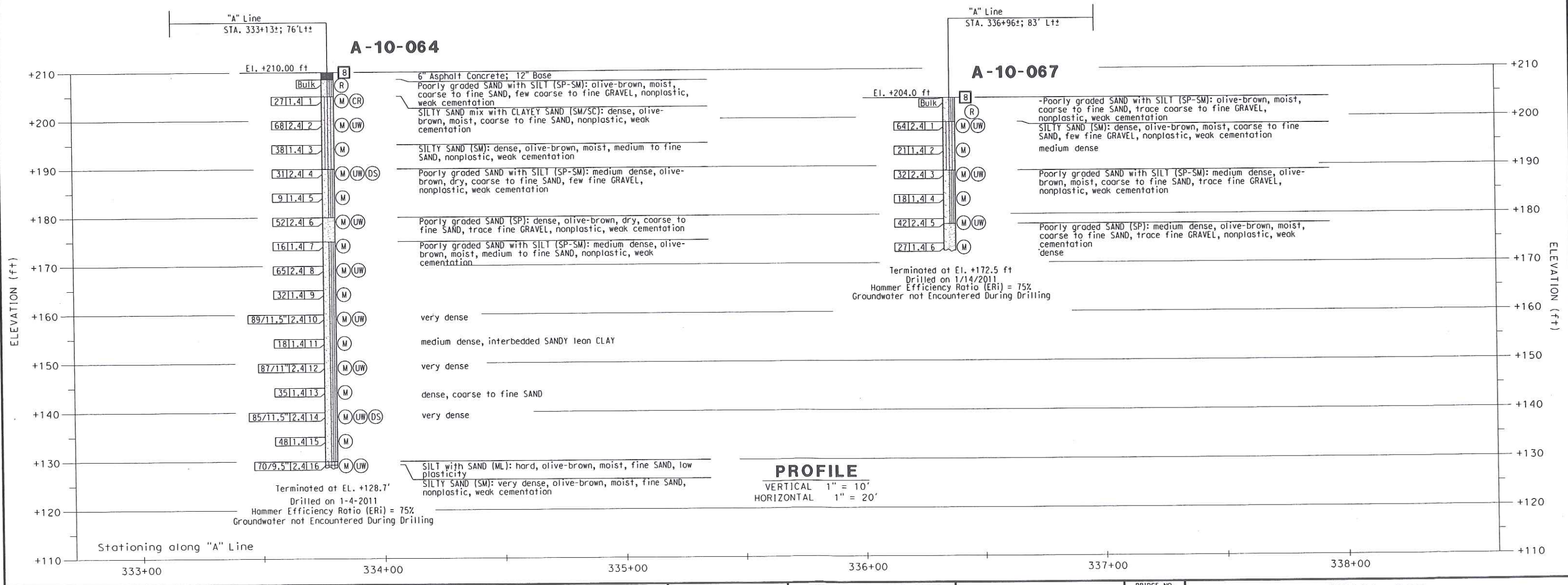

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fong	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. -	WALL 335
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 1/14/2011,1/4/2011				POST MILES -	LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER _____ DATE _____

PLANS APPROVAL DATE _____

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

CEMENTATION

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

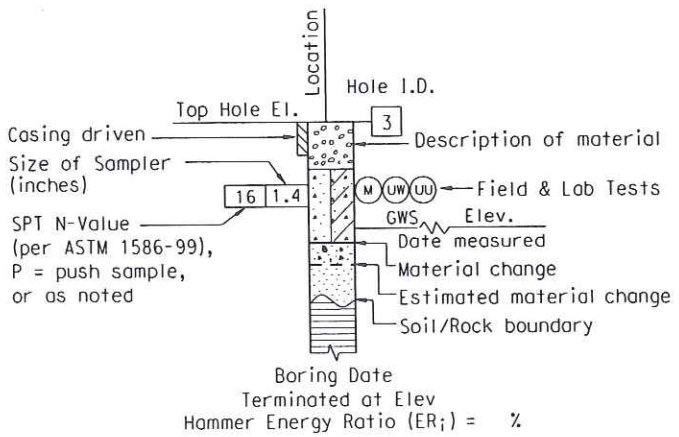
BOREHOLE IDENTIFICATION

Symbol	Hole Type	Description
Size	A	Auger Boring (hollow or solid stem bucket)
Size	R RW RC P	Rotary drilled boring (conventional) Rotary drilled with self-casing wire-line Rotary core with continuously-sampled, self-casing wire-line Rotary percussion boring (air)
Size	R	Rotary drilled diamond core
Size	HD HA	Hand driven (1-inch soil tube) Hand Auger
●	D	Dynamic Cone Penetration Boring
▲	CPT	Cone Penetration Test (ASTM D 5778)
[ ]	O	Other (note on LOTB)

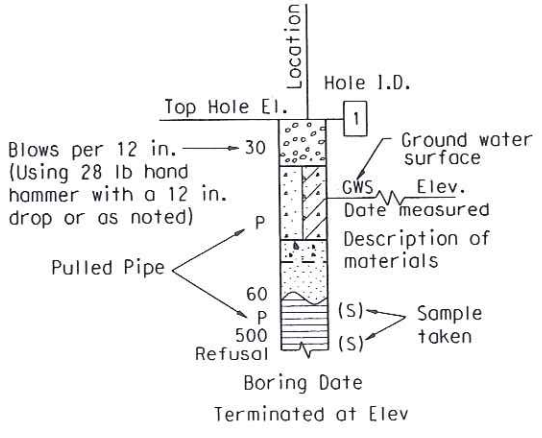
Note: Size in inches.

CONSISTENCY OF COHESIVE SOILS

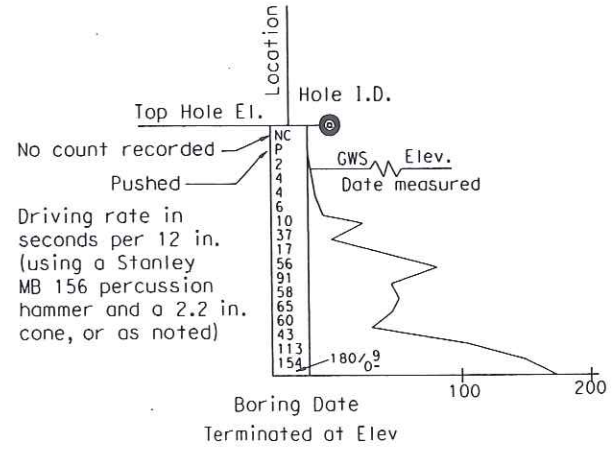
Description	Shear Strength (tsf)	Pocket Penetrometer Measurement, PP, (tsf)	Torvane Measurement, TV, (tsf)	Vane Shear Measurement, VS, (tsf)
Very Soft	Less than 0.12	Less than 0.25	Less than 0.12	Less than 0.12
Soft	0.12 - 0.25	0.25 - 0.5	0.12 - 0.25	0.12 - 0.25
Medium Stiff	0.25 - 0.5	0.5 - 1	0.25 - 0.5	0.25 - 0.5
Stiff	0.5 - 1	1 - 2	0.5 - 1	0.5 - 1
Very Stiff	1 - 2	2 - 4	1 - 2	1 - 2
Hard	Greater than 2	Greater than 4	Greater than 2	Greater than 2



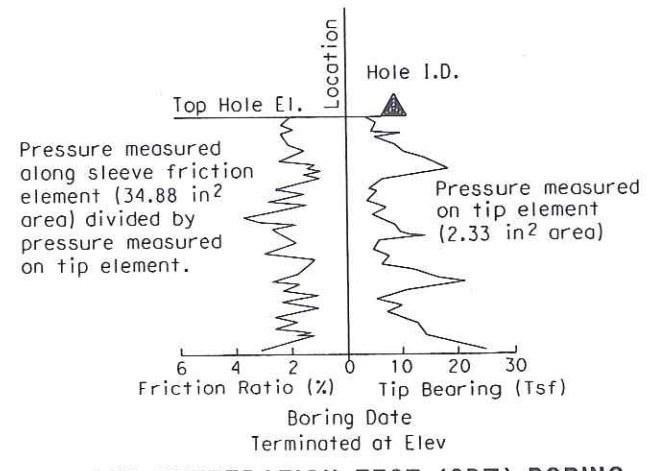
ROTARY BORING



HAND BORING



DYNAMIC CONE PENETRATION BORING



CONE PENETRATION TEST (CPT) BORING

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. -	SOIL LEGEND
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011			POST MILES -	LOG OF TEST BORINGS 1 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295 PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

USERNAME => %USER DATE PLOTTED => %DATE TIME PLOTTED => %TIME

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

GROUP SYMBOLS AND NAMES

Graphic/Symbol	Group Names	Graphic/Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND	CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
GP	Poorly-graded GRAVEL Poorly-graded GRAVEL with SAND		
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND	CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GP-GM	Poorly-graded GRAVEL with SILT Poorly-graded GRAVEL with SILT and SAND	ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
GP-GC	Poorly-graded GRAVEL with CLAY (or SILTY CLAY) Poorly-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GM	SILTY GRAVEL SILTY GRAVEL with SAND	OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND		
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND	OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL		
SP	Poorly-graded SAND Poorly-graded SAND with GRAVEL	CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL		
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
SP-SM	Poorly-graded SAND with SILT Poorly-graded SAND with SILT and GRAVEL		
SP-SC	Poorly-graded SAND with CLAY (or SILTY CLAY) Poorly-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
SM	SILTY SAND SILTY SAND with GRAVEL		
SC	CLAYEY SAND CLAYEY SAND with GRAVEL	OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY ORGANIC elastic SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL		
PT	PEAT	OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND
	COBBLES COBBLES and BOULDERS BOULDERS		

FIELD AND LABORATORY TESTING

- (C) Consolidation (ASTM D 2435)
- (CL) Collapse Potential (ASTM D 5333)
- (CP) Compaction Curve (CTM 216)
- (CR) Corrosivity Testing (CTM 643, CTM 422, CTM 417)
- (CU) Consolidated Undrained Triaxial (ASTM D 4767)
- (DS) Direct Shear (ASTM D 3080)
- (EI) Expansion Index (ASTM D 4829)
- (M) Moisture Content (ASTM D 2216)
- (OC) Organic Content-% (ASTM D 2974)
- (P) Permeability (CTM 220)
- (PA) Particle Size Analysis (ASTM D 422)
- (PI) Plasticity Index (AASHTO T 90)
Liquid Limit (AASHTO T 89)
- (PL) Point Load Index (ASTM D 5731)
- (PM) Pressure Meter
- (R) R-Value (CTM 301)
- (SE) Sand Equivalent (CTM 217)
- (SG) Specific Gravity (AASHTO T 100)
- (SL) Shrinkage Limit (ASTM D 427)
- (SW) Swell Potential (ASTM D 4546)
- (UC) Unconfined Compression-Soil (ASTM D 2166)
Unconfined Compression-Rock (ASTM D 2938)
- (UU) Unconsolidated Undrained Triaxial (ASTM D 2850)
- (UW) Unit Weight (ASTM D 4767)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER — DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER · S. PIRATHIVIRAJ · NO. C71662 · EXP. 12/31/11 · CIVIL · STATE OF CALIFORNIA

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

APPARENT DENSITY OF COHESIONLESS SOILS

Description	SPT N_{60} (Blows / 12 in.)
Very Loose	0 - 5
Loose	5 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Greater than 50

MOISTURE

Description	Criteria
Dry	No discernable moisture
Moist	Moisture present, but no free water
Wet	Visible free water

PERCENT OR PROPORTION OF SOILS

Description	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5% - 10%
Little	15% - 25%
Some	30% - 45%
Mostly	50% - 100%

PARTICLE SIZE

Description		Size (in.)
Boulder		Greater than 12
Cobble		3 - 12
Gravel	Coarse	3/4 - 3
	Fine	1/5 - 3/4
Sand	Coarse	1/16 - 1/5
	Medium	1/64 - 1/16
	Fine	1/300 - 1/64
Silt and Clay		Less than 1/300

DESIGN OVERSIGHT — SIGN OFF DATE

DRAWN BY: J. Fang — CHECKED BY: S. Pirathiviraj

FIELD INVESTIGATION BY: R. Jie — DATE: 12/2010,1/2011

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

S. Pirathiviraj — PROJECT ENGINEER

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

BRIDGE NO. -
POST MILES -

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

SOIL LEGEND
LOG OF TEST BORINGS 2 OF 2

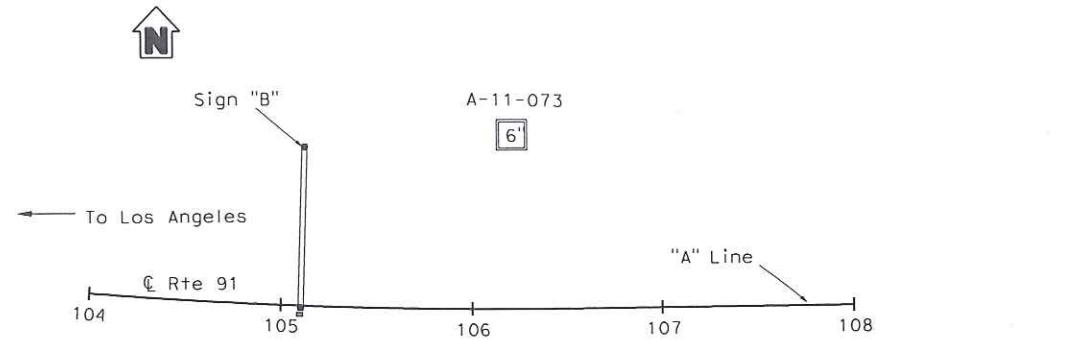
USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¾" OCS Aluminum Benchmark Disk
Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft.
Concrete Catch Basin. Monument is located in the Southeasterly Corner of
the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ±
from the centerline of Buckingham and 47 ft. Easterly of the centerline of
Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¾" OCS Aluminum Benchmark Disk
Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5
ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of
the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp,
39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the
centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¾" OCS Aluminum Benchmark Disk
Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft.
Concrete Catch Basin. Monument is located in the Southeasterly Corner of
the intersection of Placentia Avenue and State College Boulevard, 38 ft.
Easterly of the centerline of State College and 70.5 ft. Southerly of the
centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER S. PIRATHIVIRAJ NO. C71662 EXP. 12/31/13 CIVIL STATE OF CALIFORNIA

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

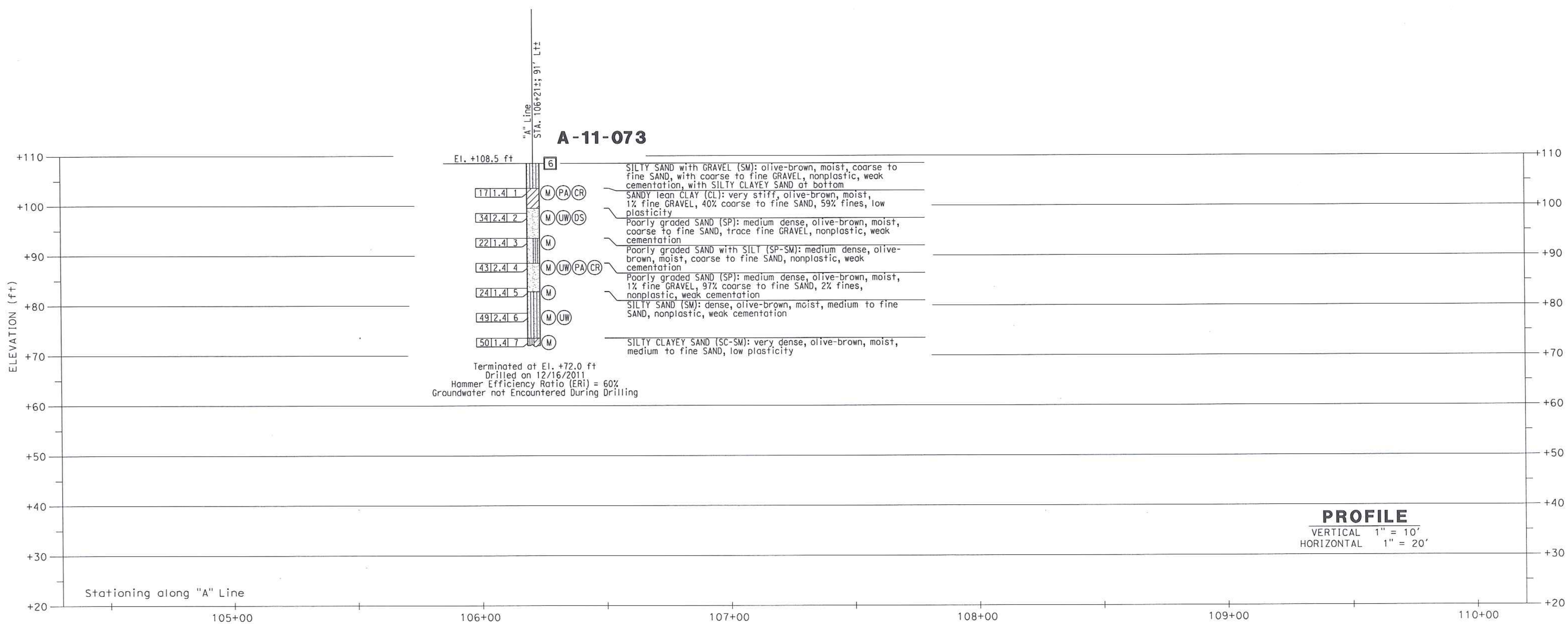
EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).

(2) 2.4" samples were taken using a California Modified Sampler.

(3) A rope hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.



PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie FIELD INVESTIGATION BY:
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	DATE: 12/16/2011

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

S. Pirathiviraj
PROJECT ENGINEER

BRIDGE NO. -
POST MILES -

OVERHEAD SIGN STRUCTURES
LOG OF TEST BORING 5 OF 11

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

SHEET OF

FILE => $REQUEST

CONTRACT NO.: 12-0C5701 PROJECT ID:

LOG OF BORING NO. HA-10-001

Grade Elevation:	+108.0 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-12-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, medium to fine SAND, trace coarse SAND, nonplastic			R
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
5								
10								
15								
20								
25								
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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

Project No. 11-102 Date: 7-15-11

LOG OF BORING NO. HA-10-004

Grade Elevation:	+121.0 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-26-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): olive-brown, moist, medium to fine SAND, trace coarse SAND, few coarse to fine GRAVEL, nonplastic			
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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Earth Mechanics, Inc.
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RBF/SR-91 WB Widening

Project No. 11-102 Date: 7-15-11

LOG OF BORING NO. HA-10-009

Grade Elevation:	+112.5 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-26-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): dark olive-brown, moist, medium to fine SAND, trace coarse SAND, few coarse to fine GRAVEL, nonplastic			
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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Earth Mechanics, Inc.
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RBF/SR-91 WB Widening

Project No. 11-102 Date: 7-15-11

LOG OF BORING NO. HA-10-010

Grade Elevation:	+115.8 ft		
Boring Depth:	3.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-26-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): dark grayish brown, moist, medium to fine SAND, trace coarse SAND, few coarse to fine GRAVEL, nonplastic			R
					Terminated Boring at 3.0 ft depth. Groundwater not encountered.			
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Earth Mechanics, Inc.
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RBF/SR-91 WB Widening

Project No. 11-102 Date: 7-15-11

LOG OF BORING NO. HA-10-011

Grade Elevation:	+119.0 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-11-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, nonplastic			R,CP
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

Project No. 11-102 Date: 7-15-11

LOG OF BORING NO. HA-10-013

Grade Elevation:	+120.8 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	2-1-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			CLAYEY SAND (SC): olive-brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, low to medium plasticity			R,PI,CR
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

Project No. 11-102 Date: 7-15-11

LOG OF BORING NO. HA-10-014

Grade Elevation:	+123.0 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	2-1-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, nonplastic			
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

Project No. 11-102 Date: 7-15-11

LOG OF BORING NO. HA-10-015

Grade Elevation:	+125.0 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-31-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): dark olive-brown, moist, medium to fine SAND, trace coarse SAND, few coarse to fine GRAVEL, nonplastic			PI,R
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

Project No. 11-102 Date: 7-15-11

LOG OF BORING NO. A-10-017

Grade Elevation:	+128.7 ft		
Boring Depth:	6.5 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig: Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler
Date Drilled:	1-26-11	Drive Wt. (lbs): 140	
Logged By:	RJ	Drop (inches): 30	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): dark gray to dark brown, moist, medium to fine SAND, trace coarse SAND, few coarse to fine GRAVEL, nonplastic			
	S	1	25		dense	-	-	
5	D	2	17		medium dense	-	-	
					Terminated Boring at 6.5 ft depth. Groundwater not encountered.			
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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. A-10-020

Grade Elevation:	+138.0 ft		
Boring Depth:	31.5 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig: Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler
Date Drilled:	1-24-11	Drive Wt. (lbs): 140	
Logged By:	RJ	Drop (inches): 30	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0					4" Asphalt Concrete; 18" Base			
	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, GRAVEL size up to 1.25" dia., nonplastic			
5	S	1	9		SILTY SAND (SM): medium dense, olive-brown, moist, medium to fine SAND, trace coarse SAND, nonplastic	9	-	
10	D	2	26			7	119	DS
15	S	3	8			16	-	
20	D	4	37			14	132	
25	S	5	25		Poorly graded SAND (SP): dense, olive-brown, moist, coarse to fine SAND, nonplastic	4	-	
30	D	6	78		dry	2	-	
					Terminated Boring at 31.5 ft depth. Groundwater not encountered.			
35								

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. HA-10-025

Grade Elevation:	+134.2 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-31-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND/SANDY SILT (SM/ML): olive-brown, moist, fine SAND, trace medium SAND, few coarse to fine GRAVEL, nonplastic			
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

Project No. 11-102 Date: 7-15-11

LOG OF BORING NO. A-10-027

Grade Elevation:	+141.0 ft		
Boring Depth:	6.5 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig: Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler
Date Drilled:	1-21-11	Drive Wt. (lbs): 140	
Logged By:	RJ	Drop (inches): 30	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, GRAVEL size up to 1.5" dia., nonplastic			R
	S	1	5		loose	-	-	
5	D	2	28		medium dense SILTY SAND (SM): medium dense, olive-brown, moist, fine SAND, trace mica, nonplastic	-	-	
					Terminated Boring at 6.5 ft depth. Groundwater not encountered.			
10								
15								
20								
25								
30								
35								

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RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. A-10-028

Grade Elevation: +140.0 ft			
Boring Depth: 6.5 feet	Driller: 2R Drilling		SHEET 1 OF 1
Borehole Diameter: 8 inches	Type of Rig: Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler	
Date Drilled: 1-21-11	Drive Wt. (lbs): 140		
Logged By: RJ	Drop (inches): 30		

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0					5.5" Asphalt Concrete; 12" Base			
	B	0			Poorly graded SAND with SILT (SP-SM): medium dense, olive-brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, GRAVEL size up to 1" dia., nonplastic	-	-	CP,R
	D	1	34					
5	S	2	4		SILTY SAND (SM): medium dense, olive-brown, moist, fine SAND, trace mica, nonplastic	-	-	
					Terminated Boring at 6.5 ft depth. Groundwater not encountered.			
10								
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20								
25								
30								
35								

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Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. A-10-029

Grade Elevation:	+139.0 ft		
Boring Depth:	31.5 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig: Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler
Date Drilled:	12-6-11	Drive Wt. (lbs): 140	
Logged By:	RJ	Drop (inches): 30	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0					3" Asphalt Concrete; 5" Base			
					SILTY SAND (SM): olive-brown, moist, fine SAND, trace medium SAND, nonplastic			
5	D	1	24		medium dense	5	119	
10	S	2	13		Poorly graded SAND with SILT (SP-SM): medium dense, olive-brown, moist, coarse to fine SAND, trace fine GRAVEL, nonplastic	3	-	
15	D	3	30		SILTY SAND (SM): medium dense, brown to dark brown, moist, fine SAND, trace medium SAND, nonplastic	10	130	
20	S	4	11			24	-	CR
					SANDY SILT (ML): stiff, olive-brown, moist, medium to fine SAND, low plasticity			
25	D	5	51		SILTY SAND (SM): dense, brown to dark brown, moist, fine SAND, trace medium SAND, nonplastic	11	129	
30	S	6	10		SANDY SILT (ML): stiff, dark olive-brown, moist, fine SAND, low plasticity	17	-	
					Terminated Boring at 31.5 ft depth. Groundwater not encountered.			
35								

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RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. A-10-030

Grade Elevation:	+142.0 ft			
Boring Depth:	31.5 feet	Driller: 2R Drilling		SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig: Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler	
Date Drilled:	01-10-11	Drive Wt. (lbs): 140		
Logged By:	RJ	Drop (inches): 30		

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0					10" Asphalt Concrete; 11" Base			
	B	0			SILTY SAND (SM): dark olive-brown, moist, coarse to fine SAND, nonplastic fines, trace mica			R
5	S	1	5		Loose	10	-	
10	D	2	27		Medium dense	9	127	DS
15	S	3	9		SILT with SAND (ML): medium stiff, olive-brown, dry to moist, about 23% fine SAND, about 77% nonplastic fines	22	-	
20	D	4	62		SILTY SAND (SM): dense, olive-brown, moist, fine SAND, nonplastic fines, trace mica.	12	129	
25	S	5	17		Medium dense	10	-	
30	D	6	41			7	128	
35					Terminated Boring at 31.5 ft depth. Groundwater not encountered.			

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RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. A-10-032

Grade Elevation:	+144.0 ft	Driller: 2R Drilling	SHEET 1 OF 1
Boring Depth:	31.5 feet	Type of Rig: Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler
Borehole Diameter:	8 inches	Drive Wt. (lbs): 140	
Date Drilled:	12-6-11	Drop (inches): 30	
Logged By:	RJ		

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0					3" Asphalt Concrete; 3" Base			
					SILTY SAND (SM): dark olive-brown, moist, fine SAND, nonplastic, trace mica			
5	S	1	6		SANDY SILT (ML): medium stiff, olive-brown, moist, fine SAND, nonplastic	12	-	CR
10	D	2	24		SILTY SAND (SM): medium dense, olive-brown, moist, medium to fine SAND, nonplastic, trace mica.	4	106	
15	S	3	7		Loose	8	-	
20	D	4	26		Medium dense	11	133	
25	S	5	16		Poorly graded SAND with SILT (SP-SM): medium dense, olive-brown, dry, medium to fine SAND, nonplastic, trace mica	3	-	
30	D	6	23		SILTY SAND (SM): medium dense, olive-brown, moist, fine SAND, nonplastic fines, trace mica.	16	117	
					Terminated Boring at 31.5 ft depth. Groundwater not encountered.			
35								

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Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. A-10-033

Grade Elevation:	+146.0 ft		
Boring Depth:	31.5 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig: Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler
Date Drilled:	01-10-11	Drive Wt. (lbs): 140	
Logged By:	RJ	Drop (inches): 30	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0					10" Asphalt Concrete; 11" Base			
	B	0			SILTY SAND (SM): dark olive-brown, moist, coarse to fine SAND, nonplastic fines, trace mica			R
5	D	1	9		Loose	12	115	DS
10	S	2	6		Medium dense	13	-	
15	D	3	27		SILT with SAND (ML): medium stiff, olive-brown, moist, 27% fine SAND, 73% nonplastic fines	18	122	
20	S	4	8		SILTY SAND (SM): medium dense, olive-brown, moist, medium to fine SAND, nonplastic, trace mica.	12	-	
25	D	5	27			10	135	
30	S	6	14		with SP layer	14	-	
					Terminated Boring at 31.5 ft depth. Groundwater not encountered.			
35								

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RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. A-10-034

Grade Elevation:	+164.6 ft	Driller: 2R Drilling	SHEET 1 OF 1
Boring Depth:	4.0 feet	Type of Rig: Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler
Borehole Diameter:	8 inches	Drive Wt. (lbs): 140	
Date Drilled:	1-20-11	Drop (inches): 30	
Logged By:	RJ		

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): dark olive-brown, moist, medium to fine SAND, trace coarse SAND, few coarse to fine GRAVEL, nonplastic	-	-	CP,R
	S	1	14		Medium dense			
					Terminated Boring at 4.0 ft depth.			
5					Groundwater not encountered.			
10								
15								
20								
25								
30								
35								

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RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. HA-10-042

Grade Elevation:	+196.5 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-19-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, trace coarse to fine GRAVEL, nonplastic			
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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RBF/SR-91 WB Widening

Project No. 11-102 Date: 7-15-11

LOG OF BORING NO. A-10-047

Grade Elevation:	+175.0 ft		
Boring Depth:	6.5 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig: Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler
Date Drilled:	1-18-11	Drive Wt. (lbs): 140	
Logged By:	RJ	Drop (inches): 30	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, GRAVEL size up to 1.5" dia., nonplastic			R
	S	1	11		medium dense	-	-	
5	D	2	21			-	-	
					Terminated Boring at 6.5 ft depth. Groundwater not encountered.			
10								
15								
20								
25								
30								
35								

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RBF/SR-91 WB Widening

Project No. 10-126 | Date: 7-15-11

LOG OF BORING NO. A-10-048

Grade Elevation:	+175.0 ft		
Boring Depth:	6.5 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig: Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler
Date Drilled:	1-18-11	Drive Wt. (lbs): 140	
Logged By:	RJ	Drop (inches): 30	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, GRAVEL size up to 0.5" dia., nonplastic			
	D	1	25		SILTY SAND (SM): medium dense, dark olive-brown, moist, fine SAND, trace mica, nonplastic	-	-	
5	S	2	11		Poorly graded SAND (SP): medium dense, olive-brown, moist, coarse to fine SAND, trace mica, nonplastic	-	-	
					Terminated Boring at 6.5 ft depth. Groundwater not encountered.			
10								
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25								
30								
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RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. A-10-056

Grade Elevation:	+194.0 ft			
Boring Depth:	31.5 feet	Driller:	2R Drilling	SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig:	Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler
Date Drilled:	01-17-11	Drive Wt. (lbs):	140	
Logged By:	RJ	Drop (inches):	30	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0					13" Asphalt Concrete; 13" Base			
					Poorly graded SAND with SILT (SP-SM): dark olive-brown, moist, coarse to fine SAND, trace coarse to fine GRAVEL, nonplastic			
5	S	1	32		SILTY SAND (SM): dense, dark olive-brown, moist, coarse to fine SAND, trace fine GRAVEL, nonplastic, trace mica	6	-	
10	D	2	74			6	127	
15	S	3	17		Poorly graded SAND with SILT (SP-SM): medium dense, olive-brown, moist, coarse to fine SAND, trace mica, nonplastic	4	-	CR
20	D	4	55		Dense	9	112	
25	S	5	22		Poorly graded SAND (SP): medium dense, olive-brown, moist, coarse to fine SAND, trace fine GRAVEL and mica, nonplastic	4	-	
30	D	6	73		Dense	5	114	
					Terminated Boring at 31.5 ft depth. Groundwater not encountered.			
35								

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RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. HA-10-060

Grade Elevation:	+197.0 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-17-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, trace coarse to fine GRAVEL, nonplastic			
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
5								
10								
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RBF/SR-91 WB Widening

Project No. 11-102 Date: 7-15-11

LOG OF BORING NO. HA-10-065

Grade Elevation:	+191.0 ft	Driller: 2R Drilling	SHEET 1 OF 1
Boring Depth:	2.0 feet	Type of Rig: Bulk only	
Borehole Diameter:	-	Drive Wt. (lbs): -	
Date Drilled:	1-31-11	Drop (inches): -	
Logged By:	RJ		

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): olive-brown, moist, fine SAND, trace medium SAND, few coarse to fine GRAVEL, nonplastic, trace mica			
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
5								
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25								
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RBF/SR-91 WB Widening

Project No. 11-102 Date: 7-15-11

LOG OF BORING NO. HA-10-066

Grade Elevation:	+196.0 ft	Driller: 2R Drilling	SHEET 1 OF 1
Boring Depth:	2.0 feet	Type of Rig: Bulk only	
Borehole Diameter:	-	Drive Wt. (lbs): -	
Date Drilled:	1-27-11	Drop (inches): -	
Logged By:	RJ		

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, nonplastic			R
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
5								
10								
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RBF/SR-91 WB Widening

Project No. 11-102 Date: 7-15-11

LOG OF BORING NO. HA-10-068

Grade Elevation:	+202.0 ft	Driller: 2R Drilling	SHEET 1 OF 1
Boring Depth:	2.0 feet	Type of Rig: Bulk only	
Borehole Diameter:	-	Drive Wt. (lbs): -	
Date Drilled:	1-14-11	Drop (inches): -	
Logged By:	RJ		

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, trace coarse to fine GRAVEL, nonplastic			R
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
5								
10								
15								
20								
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RBF/SR-91 WB Widening

Project No. 11-102 Date: 7-15-11

LOG OF BORING NO. HA-10-069

Grade Elevation:	+156.0 ft		
Boring Depth:	4.0 feet	Driller: EMI	SHEET 1 OF 1
Borehole Diameter:	3"	Type of Rig: Hand Auger	
Date Drilled:	5-16-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): dark yellowish brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, nonplastic, trace mica			
					Poorly graded SAND (SP): olive-brown, moist, medium to fine SAND, trace coarse SAND, nonplastic			
					Terminated Boring at 4.0 ft depth.			
5					Groundwater not encountered.			
10								
15								
20								
25								
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35								

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RBF/SR-91 WB Widening

Project No. 11-102 Date: 7-15-11

LOG OF BORING NO. HA-10-070

Grade Elevation:	+155.7 ft	Driller: EMI	SHEET 1 OF 1
Boring Depth:	4.0 feet	Type of Rig: Hand Auger	
Borehole Diameter:	3"	Drive Wt. (lbs): -	
Date Drilled:	5-16-11	Drop (inches): -	
Logged By:	RJ		

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): dark yellowish brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, nonplastic, trace mica			
					Terminated Boring at 4.0 ft depth. Groundwater not encountered.			
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RBF/SR-91 WB Widening

Project No. 11-102 Date: 7-15-11

LOG OF BORING NO. HA-10-071

Grade Elevation:	+152.0 ft	Driller: EMI	SHEET 1 OF 1
Boring Depth:	4.0 feet	Type of Rig: Hand Auger	
Borehole Diameter:	3"	Drive Wt. (lbs): -	
Date Drilled:	5-16-11	Drop (inches): -	
Logged By:	RJ		

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): dark yellowish brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, nonplastic, trace mica			
					Terminated Boring at 4.0 ft depth. Groundwater not encountered.			
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15								
20								
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Earth Mechanics, Inc.
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RBF/SR-91 WB Widening

Project No. 11-102 Date: 7-15-11

LOG OF BORING NO. HA-10-072

Grade Elevation:	+156.0 ft	Driller: EMI	SHEET 1 OF 1
Boring Depth:	4.0 feet	Type of Rig: Hand Auger	
Borehole Diameter:	3"	Drive Wt. (lbs): -	
Date Drilled:	5-16-11	Drop (inches): -	
Logged By:	RJ		

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): dark yellowish brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, nonplastic, trace mica			
					Terminated Boring at 4.0 ft depth. Groundwater not encountered.			
5								
10								
15								
20								
25								
30								
35								

Earth Mechanics, Inc.
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RBF/SR-91 WB Widening

Project No. 11-102 Date: 7-15-11

Grade Elevation	+27.3 ft				
Boring Depth	25.0 ft	Driller	SoCal Drilling	SHEET 1 OF	1
Borehole Diameter	8 inches	Type of Rig	Mud Rotary	Comments	
Date Drilled	04-21-10	Drive Wt.	140-lb		
Logged By	P. F. Chan	Drop	30 inches		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	1			SILTY SAND (SM): dark olive-brown, moist, mostly medium to fine, little fines			R,CP
5	D	2	20		Poorly graded SAND (SP): loose, light olive-gray, moist, mostly coarse to fine SAND, slightly compact when handled	14	106	DS
	S	3	20		Poorly graded SAND with SILT and GRAVEL (SP-SM): light olive-gray, moist, little GRAVEL, mostly coarse to fine SAND, few fines, compact	35	-	PA
10								
15	D	4	40			24	108	

1. 'Sample Type' – Graphical representation of sample type as shown below.
   - S: Split Spoon – Standard Penetration Test Sample (SPT)
   - D: Drive Sample – California Drive Sampler
   - B: Bulk Sample – Obtained by collecting cuttings in a plastic bag
   - T: Tube Sample – Thin-walled Tube Sample
   - P: Thin-walled Pitcher Core Sample

2. 'Sample' – Sample Number

3. 'Blows/foot' – Number of blows required to advance sampler one foot (unless a distance is specified). Samplers in general were driven into the soil at the bottom of the hole with a 140-lb automatic trip hammer falling a standard 30 inches (as specified in header).

   'REC/RQD' – Sample Core Recovery (REC) in percent (%) and Rock Quality Designation (RQD) in percent (%). RQD is defined as the percentage of core in each run in which the spacing between natural fractures is greater than 4 inches. Mechanical breaks of the core are not considered.

4. 'Graphic Log' – Standard symbols for soil and rock types, as shown in Note B opposite

5. ▼ Groundwater elevation while drilling.

6. 'Geotechnical Description' (See also Note A, opposite).
   Soil – Soil classifications are in general accordance with the American Society for Testing and Materials (ASTM) D2488.84. Designations include consistency, moisture, and color. Field description have been modified to reflect results of laboratory analyses where deemed appropriate.

   Rock – Rock classifications generally include a rock type, color, moisture, mineral constituents, degree of weathering, alteration and the mechanical properties of the rock.

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RBF/SR-91 WB Widening

EMI Project No.: 11-102 | Date: 6-22-11

LEGEND FOR LETTER-SIZE GEOTECHNICAL BORING LOGS (SHEET 1 OF 2)

7. 'Moisture Content' and 'Total Unit Weight' determined by laboratory testing.

8. 'Tests/Results' – Identify types of laboratory tests performed on samples collected from the field investigation. Abbreviations of tests are provided below:

C	Consolidation (ASTM D 2435)	P	Permeability (CTM 220)	SG	Specific Gravity (AASHTO T 100)
CL	Collapse Potential (ASTM D 5333)	PA	Particle Size Analysis (ASTM D 422)	SL	Shrinkage Limit (ASTM D 427)
CP	Compaction Curve (CTM 216)	PI	Plasticity Index (AASHTO T 90) Liquid Limit (AASHTO T 89)	SW	Swell Potential (ASTM D 4546)
CR	Corrosivity Testing (CTM 643, CTM 422, CTM 417)	PL	Point Load Index (ASTM D 5731)	TV	Pocket Torvane
CU	Consolidated Undrained Triaxial (ASTM D 4767)	PM	Pressure Meter	UC	Unconfined Compression–Soil (ASTM D 2166) Unconfined Compression–Rock (ASTM D 2938)
DS	Direct Shear (ASTM D 3080)	PP	Pocket Penetrometer	UU	Unconsolidated Undrained Triaxial (ASTM D 2850)
EI	Expansion Index (ASTM D 4829)	R	R–Value (CTM 301)	UW	Unit Weight (ASTM D 4767)
M	Moisture Content (ASTM D 2216)	SE	Sand Equivalent (CTM 217)	VS	Vane Shear (AASHTO T 223)
OC	Organic Content–% (ASTM D 2974)				

Criteria for Describing Moisture Condition

Description	Criteria (After ASTM D 2488)
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

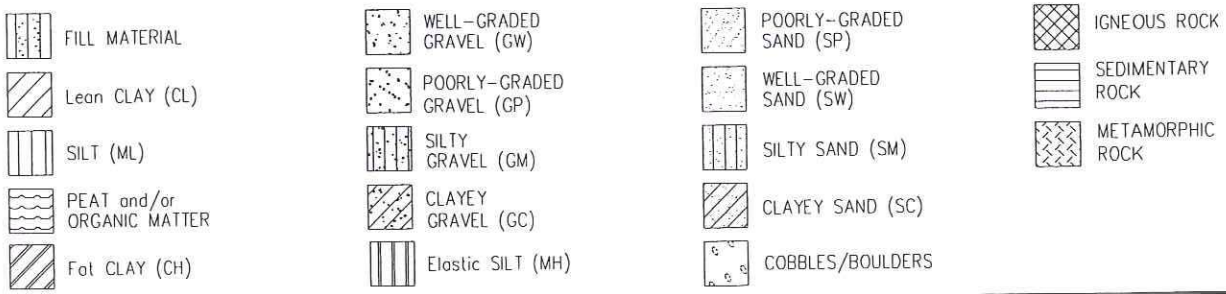
Relative Density of Coarse–Grained Soil

Blows/foot	Relative Density	Field Test (After Sowers, 1979)
0 – 4	Very Loose	Easily penetrated 12" with 0.5–inch steel rod pushed by hand
5 – 10	Loose	Easily penetrated with 0.5–inch steel rod pushed by hand
11 – 30	Medium Dense	Easily penetrated with 0.5–inch steel rod driven by 5–lb hammer
31 – 50	Dense	Penetrated a foot with 0.5–inch steel rod driven by 5–lb hammer
> 50	Very Dense	Penetrated a few inches with 0.5–inch steel rod driven by 5–lb hammer

Consistency of Cohesive Soils

Description	Unconfined Compressive Strength (tsf)	Pocket Penetrometer Measurement (tsf)	Torvane Measurement (tsf)	Field Approximation
Very Soft	< 0.25	< 0.25	< 0.12	Easily penetrated several inches by fist
Soft	0.25 to 0.50	0.25 to 0.50	0.12 to 0.25	Easily penetrated several inches by thumb
Medium Stiff	0.50 to 1.0	0.50 to 1.0	0.25 to 0.50	Penetrated several inches by thumb with moderate effort
Stiff	1 to 2	1 to 2	0.50 to 1.0	Readily indented by thumb but penetrated only with great effort
Very Stiff	2 to 4	2 to 4	1.0 to 2.0	Readily indented by thumbnail
Hard	> 4.0	> 4.0	> 2.0	Indented by thumbnail with difficulty

Legend of Earth Materials



Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR–91 WB Widening

EMI Project No.: 11–102 | Date: 6–22–11

LEGEND FOR LETTER–SIZE GEOTECHNICAL BORING LOGS (SHEET 2 OF 2)

Appendix B

Laboratory Test Results

TABLE B-1 SUMMARY OF LABORATORY TEST RESULTS

Project No. : 10-126 Project Name : SR-91 WB Widening

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-002	S-1	2.5	SC	15.4							3200	7.9	70	95
A-10-002	D-2	5	SC	17.8	128.8			0:51:49						
A-10-002	S-3	10	SP	5.5										
A-10-002	D-4	15	SC	7.1	132.1									
A-10-002	S-5	20	SM	17.4										
A-10-002	D-6	25	ML	19.3	125.5	3.5								
A-10-002	S-7	30	SM	13.1										
A-10-003	S-1	5	SC	12.0				5:66:29			5700	8.5	80	97
A-10-003	D-2	10	SP-SM	2.6	106.5									
A-10-003	S-3	15	SM	8.5										
A-10-003	D-4	20	SM	6.5	124.6									
A-10-003	S-5	25	SM	14.8										
A-10-003	D-6	30	SM	7.9	115.2									
A-10-005	B-0	1.5~5	SC								2000	8.6	130	149
A-10-005	D-1	5	ML	16.3	129.9	4.5								
A-10-005	S-2	10	ML	20.7				2:24:74						
A-10-005	D-3	15	SM	7.2	132.9									
A-10-005	S-4	20	ML	22.5				0:40:60						
A-10-005	D-5	25	SM	13.4	130.2									
A-10-005	S-6	30	SM	18.6										
A-10-005	D-7	35	SM/ML	19.4	126.0									
A-10-005	S-8	40	SM/ML	21.2										
A-10-005	D-9	45	SM	24.6	121.6									
A-10-005	S-10	50	SM	20.5										
A-10-006	S-1	5	SC	15.3				2:51:47			2600	8.5	10	83
A-10-006	D-2	10	SM	11.7	134.0									
A-10-006	S-3	15	SM	12.9										
A-10-006	D-4	20	SM	8.3	122.8									
A-10-006	S-5	25	ML	15.3										
A-10-006	D-6	30	SM	6.1	129.3									
A-10-006	S-7	35	SM to ML	28.9										
A-10-006	D-8	40	ML	15.3	130.3			0:45:55						
A-10-006	S-9	45	SP-SM	4.0										
A-10-006	D-10	50	SM	23.5	119.9									
A-10-006	S-11	55	SM	22.5										
A-10-006	D-12	60	ML	34.1	123.1	1.25								
A-10-006	S-13	65	SM to CL	22.9										
A-10-006	D-14	70	ML	32.0	120.7	2.5								
A-10-006	S-15	75	SM/ML	19.7										

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-006	D-16	80	SP	14.6	137.2									
A-10-006	S-17	85	SP-SM to ML	15.4										
A-10-007	S-1	2.5	SP to SM	11.1										
A-10-007	D-2	5	CL	18.6	125.4	3.75								
A-10-007	S-3	10	ML to SM	10.9										
A-10-007	D-4	15	ML	18.6	118.5	4.5		0:25:75						
A-10-007	S-5	20	ML	5.9										
A-10-007	D-6	25	ML	19.9	126.7	2.0								
A-10-007	S-7	30	ML	15.0										
A-10-007	D-8	35	SM	12.1	126.8									
A-10-007	S-9	40	SM	22.3										
A-10-007	D-10	45	ML	26.7	129.7	3.5								
A-10-007	S-11	50	SM	19.0										
A-10-007	D-12	55	ML	27.1	115.1	2.0								
A-10-007	S-13	60	SP-SM	21.1										
A-10-007	D-14	65	CL	30.2	121.2	1.5								
A-10-007	S-15	70	SM	29.4										
A-10-007	D-16	75	ML	22.8	124.5	3.25								
A-10-007	S-17	80	ML	29.2										
A-10-008	S-1	5	SM	10.3										
A-10-008	D-2	10	SM	10.5	127.0									
A-10-008	S-3	15	SM	10.4										
A-10-008	D-4	20	SM	11.1	131.0									
A-10-008	S-5	25	SM	17.7										
A-10-008	D-6	30	SM	8.1	125.8									
A-10-008	S-7	35	SM	15.9										
A-10-008	D-8	40	SM	18.5	131.6			0:53:47		20/17/3				
A-10-008	S-9	45	ML	16.0							2200	8.0	60	161
A-10-008	D-10	50	SM	9.7	115.1									
A-10-008	S-11	55	SM	21.9										
A-10-008	D-12	60	ML	25.0	123.6	1.25								
A-10-008	S-13	65	SM	24.1				0:72:28						
A-10-008	D-14	70	ML	26.5	119.6	4.5								
A-10-008	S-15	75	SP-SM	23.0										
A-10-008	D-16	80	SP	17.4	132.6									
A-10-012	S-1	5	SM	11.6										
A-10-012	D-2	10	SM	11.2	121.7									
A-10-012	S-3	15	SM	9.9										
A-10-012	D-4	20	SP-SM	5.4	113.5									
A-10-012	S-5	25	ML	20.4										
A-10-012	D-6	30	SP-SM	2.3	106.1									

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-013	*B-0*	2	CL								860	6.9	110	124
A-10-016	*S-1*	5	SM to SP-SM	9.5										
A-10-016	*D-2*	10	SM	8.5	123.2									
A-10-016	*S-3*	15	ML	15.2				0:47:53			2200	8.7	70	94
A-10-016	*D-4*	20	SM	16.5	132.4									
A-10-016	*S-5*	25	ML	29.5										
A-10-016	*D-6*	30	SM	9.7	117.9									
A-10-018	*S-1*	5	SM	17.8										
A-10-018	*D-2*	10	SM	15.8	127.1									
A-10-018	*S-3*	15	SM to CL	21.3					0.0					
A-10-018	*D-4*	20	SM	7.6	124.6									
A-10-018	*S-5*	25	SP to ML	6.5										
A-10-018	*D-6*	30	CL	23.2	117.4	1.75								
A-10-019	*D-1*	5	SM	10.1	124.9									
A-10-019	*S-2*	10	SM	14.8							2200	8.5	110	118
A-10-019	*D-3*	15	SM	16.8	125.7									
A-10-019	*S-4*	20	SM	12.3										
A-10-019	*D-5*	25	SP-SM	3.7	113.7									
A-10-019	*S-6*	30	SP-SM to CL	24.3										
A-10-020	*S-1*	5	SM	9.3										
A-10-020	*D-2*	10	SM	6.8	119.3									
A-10-020	*S-3*	15	SM	15.8										
A-10-020	*D-4*	20	SM	13.6	131.6									
A-10-020	*S-5*	25	SP	3.5										
A-10-020	*D-6*	30	SP	2.1	111.1									
A-10-021	*S-1*	2.5	SM	6.0										
A-10-021	*D-2*	5	SM	9.9	127.9									
A-10-021	*S-3*	10	SM	9.5										
A-10-021	*D-4*	15	SM	9.9	128.3									
A-10-021	*S-5*	20	SM	9.4				0:69:31						
A-10-021	*D-6*	25	ML	10.6	118.4	>4.5								
A-10-021	*S-7*	30	SM to ML	14.4										
A-10-023	*D-1*	2.5	SM	15.3	126.8									
A-10-023	*D-2*	5	SM	11.2	125.6			0:71:29						
A-10-023	*S-3*	10	SM	15.0										
A-10-023	*D-4*	15	SM	8.4	130.2									
A-10-023	*S-5*	20	SM	19.1										
A-10-023	*D-6*	25	SP	3.1	107.0									
A-10-023	*S-7*	30	ML	19.4				0:41:59						
A-10-023	*D-8*	35	SM	17.3	129.7									
A-10-023	*S-9*	40	SM to ML	6.6										

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-023	*D-10*	45	CL-ML	27.5	114.9	1.5								
A-10-023	*S-11*	50	SP	4.0										
A-10-023	*D-12*	55	ML	25.4	113.9	2.5								
A-10-023	*S-13*	60	SM	22.5										
A-10-023	*D-14*	65	SP-SM	4.7	110.7									
A-10-023	*S-15*	70	SP-SM	8.9										
A-10-023	*D-16*	75	SP	13.4	131.9									
A-10-023	*S-17*	80	CL-ML	22.9										
A-10-024	*S-1*	5	SM	8.3										
A-10-024	*D-2*	10	SP-SM	2.3	118.6									
A-10-024	*S-3*	15	SM	10.5										
A-10-024	*D-4*	20	SM	8.9	118.5									
A-10-024	*S-5*	25	SM	11.2							750	7.8	40	332
A-10-024	*D-6*	30	SM	6.4	113.1									
A-10-024	*S-7*	35	SM	13.1										
A-10-024	*D-8*	40	SM	11.1	128.3									
A-10-024	*S-9*	45	SM	12.2										
A-10-024	*D-10*	50	ML	17.7	126.6			0:35:65						
A-10-024	*S-11*	55	ML to SM	22.6										
A-10-024	*D-12*	60	SM	26.5	120.0									
A-10-024	*S-13*	65	SP-SM	6.5										
A-10-024	*D-14*	70	SP-SM	14.5	125.9									
A-10-024	*S-15*	75	ML	26.5										
A-10-024	*D-16*	80	SP-SM	11.5	126.0									
A-10-024	*S-17*	85	SP	3.9										
A-10-029	*D-1*	5	SM	4.7	118.7									
A-10-029	*S-2*	10	SP-SM	3.4										
A-10-029	*D-3*	15	SM	10.0	129.7									
A-10-029	*S-4*	20	SM to ML	23.9							770	7.7	300	375
A-10-029	*D-5*	25	SM	11.1	128.7									
A-10-029	*S-6*	30	ML	16.8										
A-10-030	*S-1*	5	SM	10.1										
A-10-030	*D-2*	10	SM	9.1	126.5									
A-10-030	*S-3*	15	ML	22.1				0:23:77						
A-10-030	*D-4*	20	SM	12.4	129.0									
A-10-030	*S-5*	25	SM	10.0										
A-10-030	*D-6*	30	SM	6.7	128.2									
A-10-032	*S-1*	5	ML	11.9							3800	8.1	50	142
A-10-032	*D-2*	10	SM	3.6	106.4									
A-10-032	*S-3*	15	SM	8.0										
A-10-032	*D-4*	20	SM	11.2	133.3									

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-032	S-5	25	SP-SM	3.0										
A-10-032	D-6	30	SM	16.4	117.1									
A-10-033	D-1	5	SM	11.7	115.1									
A-10-033	S-2	10	SM	13.3										
A-10-033	D-3	15	ML	17.6	121.5			0:27:73						
A-10-033	S-4	20	SM	12.1										
A-10-033	D-5	25	SM	10.4	134.5									
A-10-033	S-6	30	SP to SM	13.7										
A-10-035	D-1	5	SM to SC	9.2	123.8									
A-10-035	S-2	10	CH	28.8						64/21/43	790	7.5	60	239
A-10-035	D-3	15	CH to SM	29.3	118.1	4.5								
A-10-035	S-4	20	SP-SM	1.2										
A-10-035	D-5	25	SP-SM	1.9	109.8									
A-10-035	S-6	30	SM	11.3										
A-10-036	S-1	5	SC	15.0										
A-10-036	D-2	10	SM	3.3	108.9									
A-10-036	S-3	15	SP-SM	2.1										
A-10-036	D-4	20	SP-SM	2.5	118.0									
A-10-036	S-5	25	SP-SM	7.1										
A-10-036	D-6	30	SM	9.5	129.4									
A-10-036	S-7	35	SM	7.2										
A-10-036	D-8	40	SM	17.9	130.0									
A-10-036	S-9	45	SP-SM	4.3										
A-10-036	D-10	50	ML to SM	16.1	125.9									
A-10-037	B-0	0~3	CL								1200	7.2	10	114
A-10-037	D-1	5	SP-SM	8.9	129.2									
A-10-037	S-2	10	SM	9.2										
A-10-037	D-3	15	SM	3.3	113.6									
A-10-037	S-4	20	SP	1.8				1:97:2						
A-10-037	D-5	25	SM	2.2	126.1									
A-10-037	S-6	30	SP-SM	1.1										
A-10-038	S-1	5	SC	12.8										
A-10-038	D-2	10	SM	12.9	128.1									
A-10-038	S-3	15	SM	6.6										
A-10-038	D-4	20	SP-SM	3.3	115.3									
A-10-038	S-5	25	SP-SM	4.3										
A-10-038	D-6	30	SP	1.6	111.1									
A-10-039	D-1	5	SM	8.3	139.2						4800	8.0	120	191
A-10-039	S-2	10	SM	16.4										
A-10-039	D-3	15	SP-SM to SC	10.9	136.0									
A-10-039	S-4	20	SM	13.1				8:60:32						

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-039	D-5	25	SM	3.1	115.0									
A-10-039	S-6	30	SM to SC	3.4										
A-10-039	D-7	35	SP	0.8	110.7									
A-10-039	S-8	40	SP-SM	3.6										
A-10-039	D-9	45	SP-SM	4.1	113.1									
A-10-039	S-10	50	SP-SM	6.3										
A-10-039	D-11	55	SM	5.6	113.6									
A-10-039	S-12	60	ML	15.1				0:48:52						
A-10-039	D-13	65	SM	10.5	134.4									
A-10-039	S-14	70	SM	12.3										
A-10-039	D-15	75	MH	28.7	120.9	1.75				67/34/33	760	7.9	40	253
A-10-039	S-16	80	SP	3.6										
A-10-039	D-17	85	SP-SM	2.3	114.5									
A-10-039	S-18	90	SP-SM	3.5										
A-10-039	D-19	85	SM to SP-SM	8.8	130.9									
A-10-039	S-20	100	SP-SM	3.5										
A-10-040	S-1	5	SM	8.3										
A-10-040	D-2	10	SP-SM	4.6	115.6									
A-10-040	S-3	15	SP-SM	4.4										
A-10-040	D-4	20	SM	8.4	130.1									
A-10-040	S-5	25	SM	7.8										
A-10-040	D-6	30	SM	11.7	134.4									
A-10-040	S-7	35	SP-SM	4.5										
A-10-040	D-8	40	SP	3.1	106.7									
A-10-040	S-9	45	SP	2.5										
A-10-040	D-10	50	SP	2.0	105.2									
A-10-040	S-11	55	SM	16.5										
A-10-040	D-12	60	SP-SM	1.9	107.2									
A-10-040	S-13	65	SP-SM	6.0										
A-10-040	D-14	70	SP	2.1	110.5									
A-10-040	S-15	75	SP	3.1										
A-10-040	D-16	80	SM to SP-SM	2.9	116.6									
A-10-040	S-17	85	SP-SM	5.1										
A-10-040	D-18	90	SP-SM to ML	15.9	124.6									
A-10-040	S-19	95	ML to SP-SM	19.3										
A-10-040	D-20	100	SP-SM	4.9	106.6									
A-10-043	S-1	5	SC	15.7							2400	7.9	60	142
A-10-043	D-2	10	SM	7.4	137.7									
A-10-043	S-3	15	SM	3.9										
A-10-043	D-4	20	SM	3.8	121.5									
A-10-043	S-5	25	SP-SM	3.5										

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-043	D-6	30	SP	2.3	112.1									
A-10-043	S-7	35	SP-SM	4.5										
A-10-043	D-8	40	SP-SM	4.6	110.8									
A-10-043	S-9	45	SM	17.2										
A-10-043	S-10	50	CL	18.8										
A-10-044	B-0	3~5	SC								1100	7.6	600	109
A-10-044	S-1	5	SM	11.6										
A-10-044	D-2	10	SP-SM	6.1	131.8									
A-10-044	S-3	15	SP-SM	6.8										
A-10-044	D-4	20	SP-SM	2.0	109.3									
A-10-044	S-5	25	SP-SM	2.1										
A-10-044	D-6	30	SP	1.1	104.4									
A-10-044	S-7	35	SP	4.2										
A-10-044	D-8	40	SP	1.7	111.1									
A-10-044	S-9	45	CL	30.0						36/22/14	760	7.6	130	322
A-10-044	D-10	50	SP	3.1	110.9									
A-10-044	S-11	55	SP-SM	5.0										
A-10-044	D-12	60	SP	3.6	117.6									
A-10-044	S-13	65	ML	31.0										
A-10-044	D-14	70	CL	19.6	126.7	1.5					810	7.8	70	255
A-10-044	S-15	75	CL to SM	23.6										
A-10-044	D-16	80	CL	34.1	119.2	2.25								
A-10-045	D-1	5	SP-SM	3.0	109.3									
A-10-045	S-2	10	SP-SM	5.3				11:79:10			17000	8.0	60	153
A-10-045	D-3	15	SP-SM	1.9	109.2									
A-10-045	S-4	15	SP-SM	4.8										
A-10-045	D-5	20	SP	1.8	103.2									
A-10-045	S-6	25	SM to ML	33.9										
A-10-045	D-7	30	SP-SM	17.0	115.7									
A-10-045	S-8	35	SM	12.5										
A-10-045	D-9	40	SP-SM	5.7	111.3									
A-10-045	S-10	45	CL	29.7										
A-10-045	D-11	50	CL	29.8	121.1									
A-10-045	S-12	55	SM to CL	19.2										
A-10-045	D-13	60	CL	31.8	118.6									
A-10-045	S-14	65	ML	28.2										
A-10-045	D-15	70	SP	2.9	109.2									
A-10-045	S-16	75	SP	3.8										
A-10-045	D-17	80	SP	12.4	121.7									
A-10-049	S-1	5	SP	3.9										
A-10-049	D-2	10	SP	2.3	105.9									

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-049	S-3	15	SP	3.6										
A-10-049	D-4	20	SP	2.9	113.4									
A-10-049	S-5	25	SP	8.2										
A-10-049	D-6	30	ML	16.5	129.9	4.5		0:42:58						
A-10-050	D-1	5	SP-SM	5.7	107.9									
A-10-050	S-2	10	SP	3.4										
A-10-050	D-3	15	SP	2.4	113.9									
A-10-050	S-4	20	SP	3.7										
A-10-050	D-5	25	SP	3.3	116.3									
A-10-050	S-6	30	SM to SP	10.5										
A-10-052	S-1	5	SM	7.5										
A-10-052	D-2	10	SM	6.4	123.3						5400	7.8	100	139
A-10-052	S-3	15	SP-SM	5.5										
A-10-052	D-4	20	SP	2.8	107.8									
A-10-052	S-5	25	SP	3.3										
A-10-052	D-6	10	SP	2.3	115.0									
A-10-054	D-2	5	SP-SM	2.6	104.3						29000	7.7	60	108
A-10-054	S-3	10	SP-SM	4.2										
A-10-054	D-4	15	SP	1.9	111.4									
A-10-054	S-5	20	SP-SM	3.6										
A-10-054	D-6	25	SP/CL	12.8	126.4			0:71:29			3500	7.8	110	189
A-10-054	S-7	30	SP	1.8										
A-10-054	D-8	35	SP	1.6	106.0									
A-10-054	S-9	40	SP	4.7										
A-10-054	D-10	45	SP	2.5	109.1									
A-10-054	S-11	50	SP	6.0										
A-10-054	D-12	55	SM/ML	24.4	120.5									
A-10-054	S-13	60	SM	17.7										
A-10-054	D-14	65	ML	30.0	118.3	2.5				48/34/14	2100	7.2	70	293
A-10-054	S-15	70	SP	5.1										
A-10-054	D-16	75	SP	3.9										
A-10-054	S-17	80	SP	3.4	114.3									
A-10-055	S-1	5	SM	9.9										
A-10-055	D-2	10	SM	5.1	123.6									
A-10-055	S-3	15	SP-SM	2.5										
A-10-055	D-4	20	SP	2.2	113.4									
A-10-055	S-5	25	SM	6.4				5:78:17						
A-10-055	D-6	30	SP	2.4	105.9									
A-10-055	S-7	35	SP	2.3										
A-10-055	D-8	40	SP	2.6	109.8									
A-10-055	S-9	45	SP	4.1										

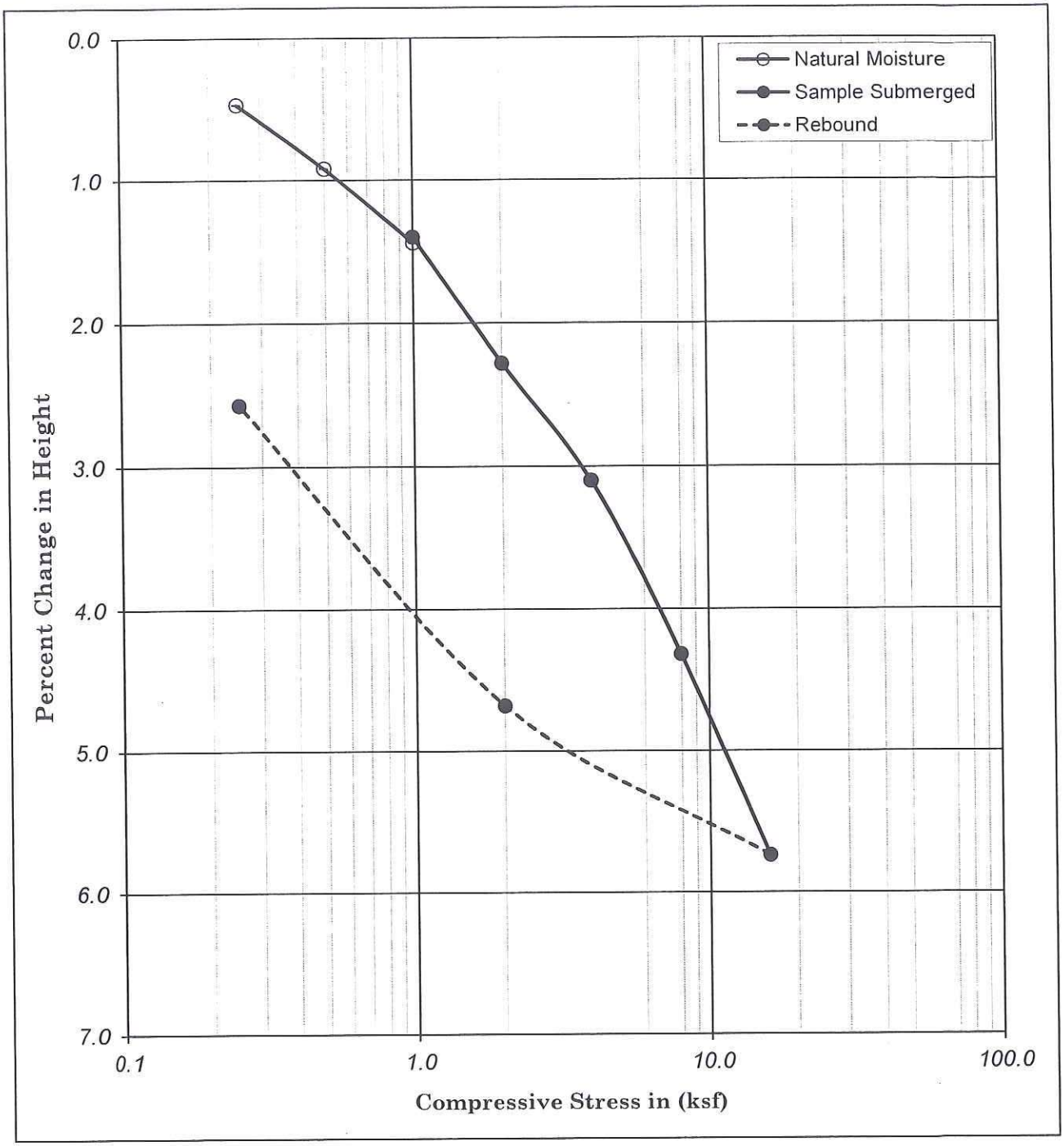
Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-055	*D-10*	50	SP-SM	3.6	112.1									
A-10-055	*S-11*	55	SP	2.9										
A-10-055	*D-12*	60	SP	1.9	114.4									
A-10-055	*S-13*	65	SP-SM	6.4										
A-10-055	*D-14*	70	SP-SM	3.6	113.0									
A-10-056	*S-1*	5	SM	6.4										
A-10-056	*D-2*	10	SM	5.9	126.8									
A-10-056	*S-3*	15	SP-SM	3.6							11000	7.3	10	130
A-10-056	*D-4*	20	SP-SM	9.2	111.8									
A-10-056	*S-5*	25	SP	4.0										
A-10-056	*D-6*	30	SP	5.4	114.3									
A-10-057	*D-1*	5	SP-SM	6.3	126.1									
A-10-057	*S-2*	10	SP	3.6										
A-10-057	*D-3*	15	SP	6.6	111.4									
A-10-057	*S-4*	20	SP	4.9										
A-10-057	*D-5*	25	SP	7.8	121.6									
A-10-057	*S-6*	30	SP-SM	10.7										
A-10-058	*S-1*	5	SM	8.3										
A-10-058	*D-2*	10	SP	2.0	111.5									
A-10-058	*S-3*	15	SP	4.2										
A-10-058	*D-4*	20	SP	3.2	114.8									
A-10-058	*S-5*	25	SP	5.9										
A-10-058	*D-6*	30	SP-SM	4.5	129.9									
A-10-059	*D-1*	5	SP-SM to SM	1.5	115.1									
A-10-059	*S-2*	10	SP	1.9										
A-10-059	*D-3*	15	SP-SM	6.5	110.8									
A-10-059	*S-4*	20	SP	1.8										
A-10-059	*D-5*	25	SM to SP-SM	10.6	117.8									
A-10-059	*S-6*	30	SP-SM	3.9										
A-10-061	*D-1*	5	SP-SM	3.0	115.4									
A-10-061	*S-2*	10	SP	1.9										
A-10-061	*D-3*	15	SP	2.1	111.6									
A-10-061	*S-4*	20	SP	3.4										
A-10-061	*D-5*	25	SP	2.9	113.7									
A-10-061	*S-6*	30	SP	4.1										
A-10-061	*D-7*	35	SP-SM	4.0	112.8									
A-10-061	*S-8*	40	SP-SM	3.8										
A-10-061	*D-9*	45	CL	24.7	123.1	2.25				36/20/16				
A-10-061	*S-10*	50	SP	5.7										
A-10-063	*D-1*	2.5	SP-SM	2.6	114.9									
A-10-063	*S-2*	5	SP	1.7				2:96:2						

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-063	*D-3*	10	SP-SM	1.8	113.3									
A-10-063	*S-4*	15	SP-SM	2.6										
A-10-063	*D-5*	20	SP	3.4	108.1									
A-10-063	*S-6*	25	SP-SM	2.8										
A-10-063	*D-7*	30	SP-SM	4.8	112.4									
A-10-063	*S-8*	35	SP-SM	5.2				0:92:8			13000	7.8	10	158
A-10-063	*D-9*	40	SP-SM	2.6	109.4									
A-10-063	*S-10*	45	SP-SM	2.0										
A-10-063	*D-11*	50	SP-SM	2.7	117.4									
A-10-063	*S-12*	55	SP-SM	3.2										
A-10-063	*D-13*	60	SP-SM	1.8	115.7									
A-10-063	*S-14*	65	SP-SM	2.9										
A-10-063	*D-15*	70	SP-SM	3.1	103.7									
A-10-063	*S-16*	75	SP-SM	4.0										
A-10-063	*D-17*	80	SP-SM	3.5	108.0									
A-10-064	*S-1*	5	SM/SC	8.0							2000	7.8	10	217
A-10-064	*D-2*	10	SC to SM	13.1	134.3									
A-10-064	*S-3*	15	SM	6.5										
A-10-064	*D-4*	20	SP-SM	2.7	111.8									
A-10-064	*S-5*	25	SP-SM	2.8										
A-10-064	*D-6*	30	SP	1.3	110.0									
A-10-064	*S-7*	35	SP-SM	5.0										
A-10-064	*D-8*	40	SP-SM	3.7	105.6									
A-10-064	*S-9*	45	SP-SM	5.2										
A-10-064	*D-10*	50	SP-SM	4.4	113.5									
A-10-064	*S-11*	55	SP-SM	8.2										
A-10-064	*D-12*	60	SP-SM	1.7	105.1									
A-10-064	*S-13*	65	SP-SM	4.4										
A-10-064	*D-14*	70	SP-SM	3.0	105.9									
A-10-064	*S-15*	75	SP-SM	3.6										
A-10-064	*D-16*	80	ML to SM	15.7	121.4									
A-10-067	*D-1*	5	SM	4.6	121.0									
A-10-067	*S-2*	10	SM	10.7										
A-10-067	*D-3*	15	SP-SM	6.4	107.2									
A-10-067	*S-4*	20	SP-SM	2.4										
A-10-067	*D-5*	25	SP-SM	3.0	111.3									
A-10-067	*S-6*	30	SP	2.9										

TABLE B1 SUMMARY OF LABORATORY TEST RESULTS FOR SIGN STRUCTURES

Project No. : *10-126* **Project Name :** SR-91 WB Widening - Overhead Sign Structures

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-11-073	*S-1*	5	CL	14.4				1:40:59			1200	8.6	150	204
A-11-073	*D-2*	10	SP	6.0	106.6									
A-11-073	*S-3*	15	SP-SM	7.9										
A-11-073	*D-4*	20	SP	3.0	102.5			1:97:2			14000	7.47	20.0	10
A-11-073	*S-5*	25	SP-SM to SM	14.1										
A-11-073	*D-6*	30	SM	12.6	114.4									
A-11-073	*S-7*	35	SC-SM	19.6										



Boring No. : A-10-005			Liquid Limit :	-		Moisture Content (%)	Dry Density (pcf)	Dry Density (kN/m³)	Percent Saturation	Void Ratio
Sample No. : D-1			Plastic Limit :	-						
Depth	(ft) : 5.0	6.5	Plastic Index :	-	Initial	16.48	114.20	17.98	93.47	0.48
	(m) : 1.53	1.98	Specific Gravity :	2.70	Final	18.45	117.24	18.45	113.80	0.44
Description : Olive-brown, SANDY SILT (ML)										

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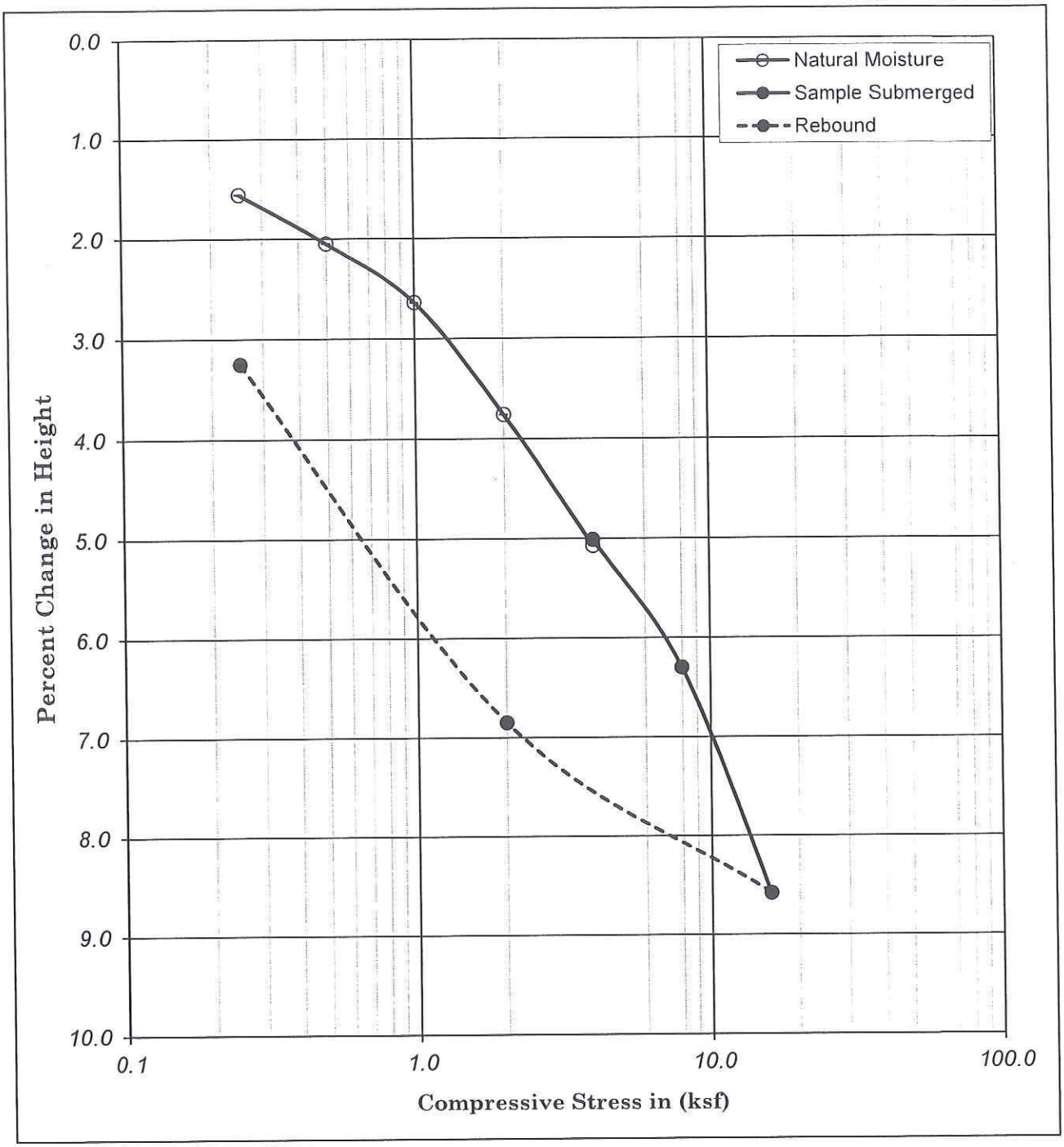
RBF/ SR-91 WB Widening

Project No. : 10-126 02/24/11

CONSOLIDATION TEST
(ASTM D-2435 / CT-219)



Boring No. : A-10-006			Liquid Limit :	-		Moisture Content (%)	Dry Density (pcf)	Dry Density (kN/m³)	Percent Saturation	Void Ratio
Sample No. : D-14			Plastic Limit :	-						
Depth	(ft) : 70.0	71.5	Plastic Index :	-	Initial	33.19	89.62	14.11	101.73	0.88
	(m) : 21.35	21.81	Specific Gravity :	2.70	Final	32.46	92.73	14.60	107.15	0.82
Description : Olive-brown, SILT with SAND										

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CONSOLIDATION TEST
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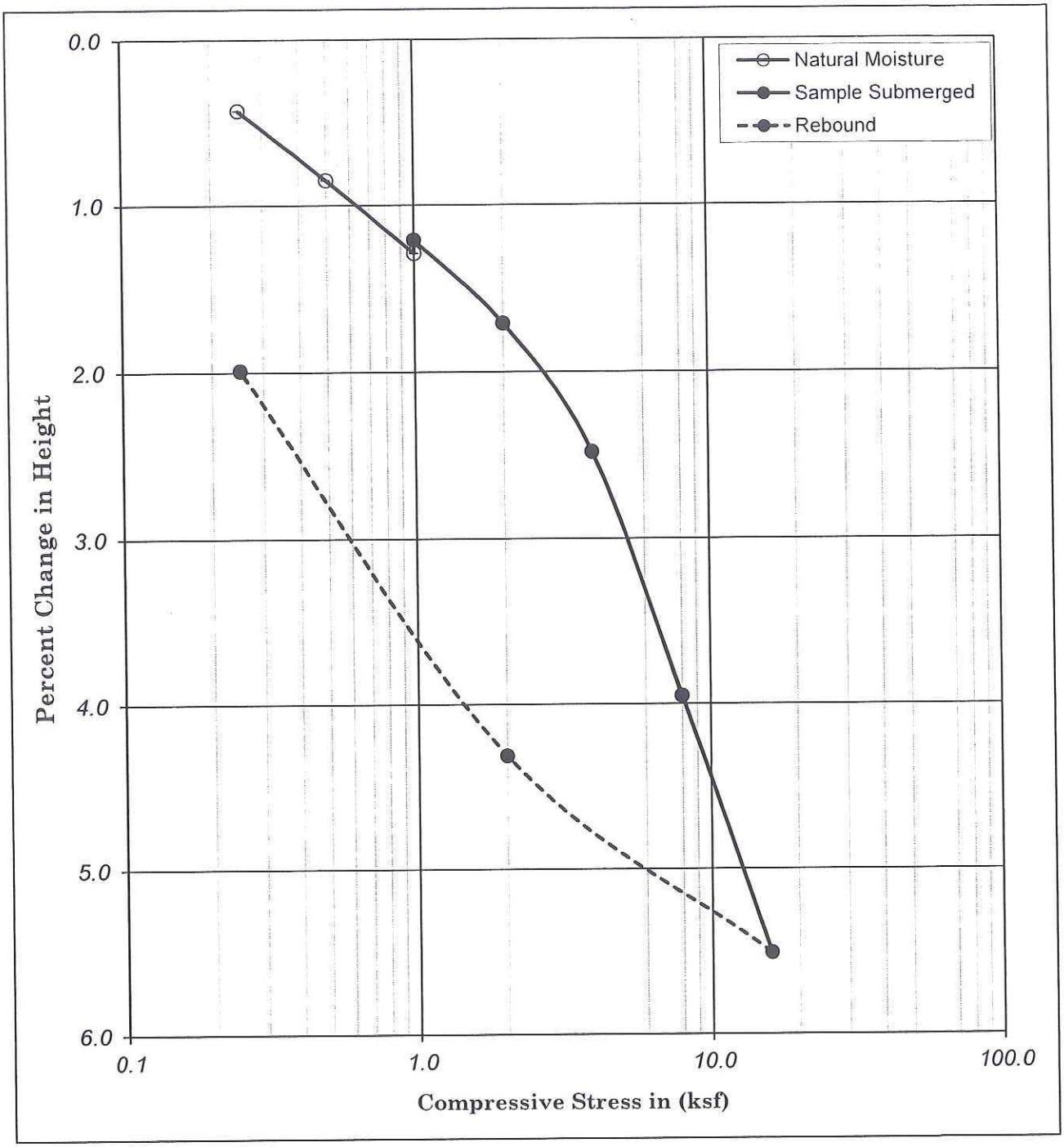

Boring No. : A-10-007			Liquid Limit :	-		Moisture Content (%)	Dry Density (pcf)	Dry Density (kN/m³)	Percent Saturation	Void Ratio
Sample No. : D-4			Plastic Limit :	-						
Depth	(ft) : 15.0	16.5	Plastic Index :	-	Initial	23.57	99.57	15.67	91.83	0.69
	(m) : 4.58	5.03	Specific Gravity :	2.70	Final	26.34	101.60	15.99	107.89	0.66
Description : Olive-brown, SILT with SAND (ML)										

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CONSOLIDATION TEST
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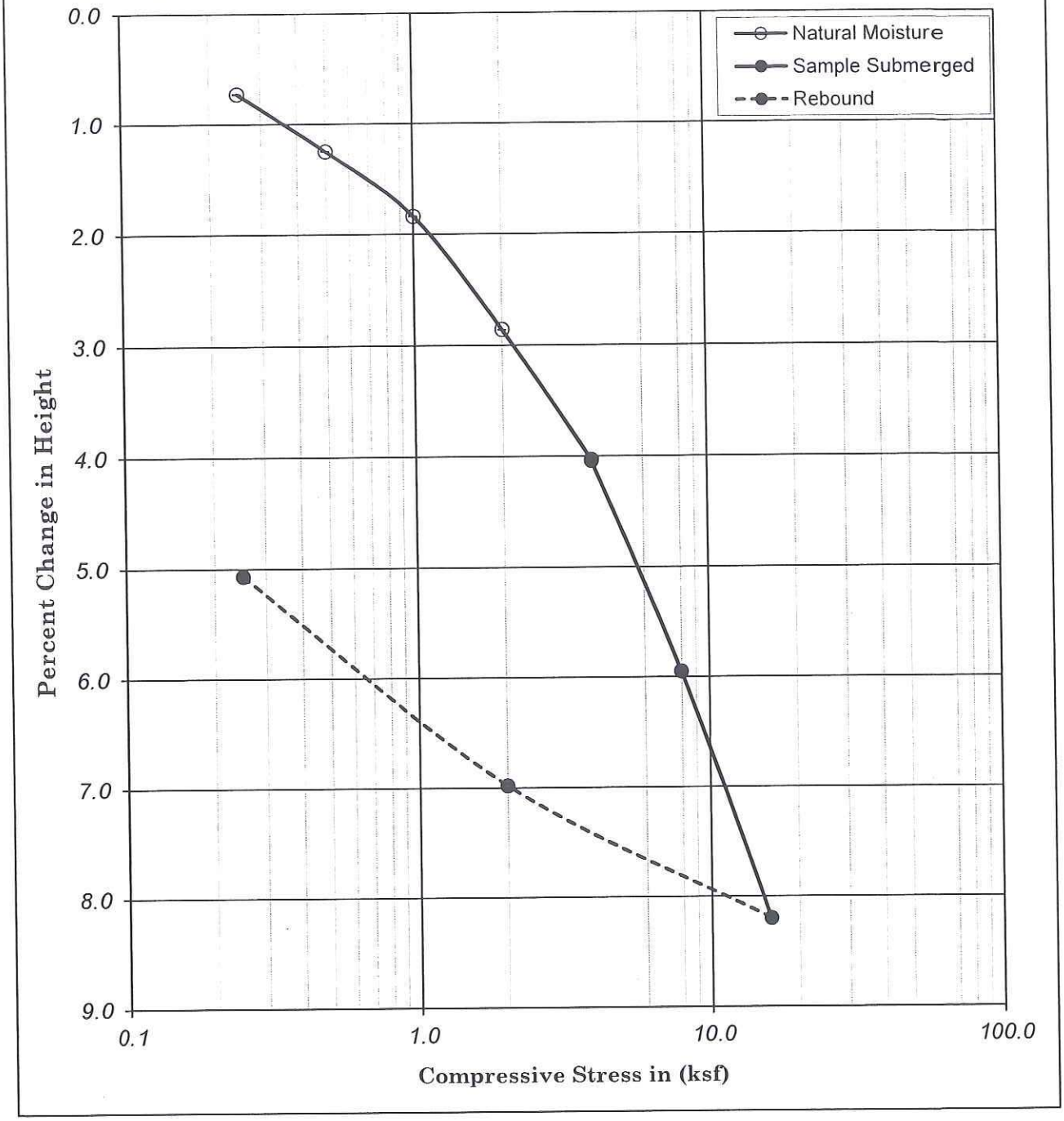

Boring No. : A-10-007			Liquid Limit :	-		Moisture Content (%)	Dry Density (pcf)	Dry Density (kN/m³)	Percent Saturation	Void Ratio
Sample No. : D-10			Plastic Limit :	-						
Depth	(ft) : 45.0	46.5	Plastic Index :	-	Initial	23.29	103.75	16.33	100.65	0.62
	(m) : 13.73	14.18	Specific Gravity :	2.70	Final	21.85	109.41	17.22	109.11	0.54
Description : Olive-brown, SILT with SAND (ML)										

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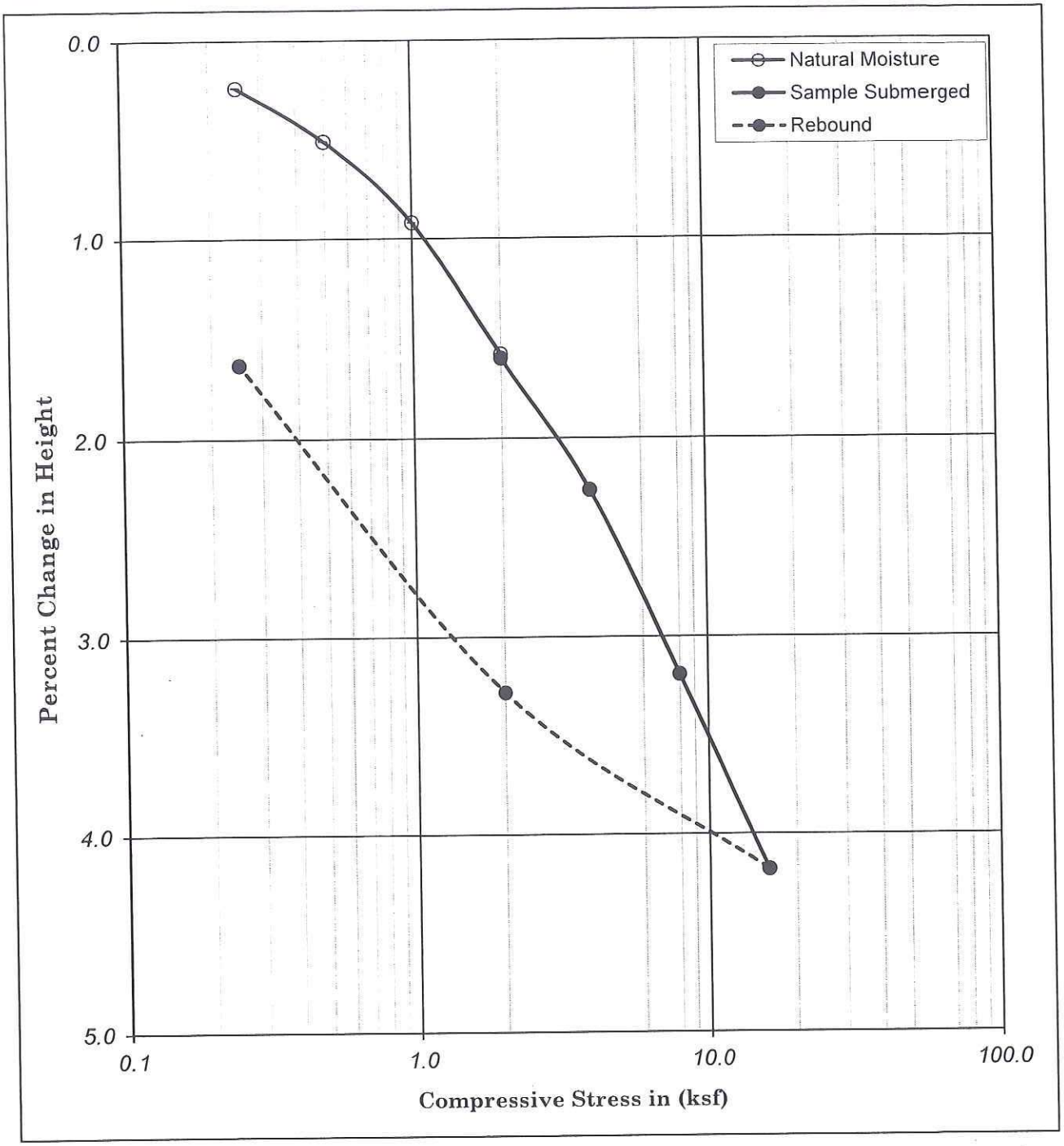
CONSOLIDATION TEST
(ASTM D-2435 / CT-219)



Boring No. : A-10-021			Liquid Limit :	-		Moisture Content (%)	Dry Density (pcf)	Dry Density (kN/m³)	Percent Saturation	Void Ratio
Sample No. : D-6			Plastic Limit :	-						
Depth	(ft) : 25.0	26.5	Plastic Index :	-	Initial	10.45	108.46	17.07	50.94	0.55
	(m) : 7.63	8.08	Specific Gravity :	2.70	Final	23.67	110.27	17.36	120.91	0.53
Description : Olive-brown, SANDY SILT (ML)										

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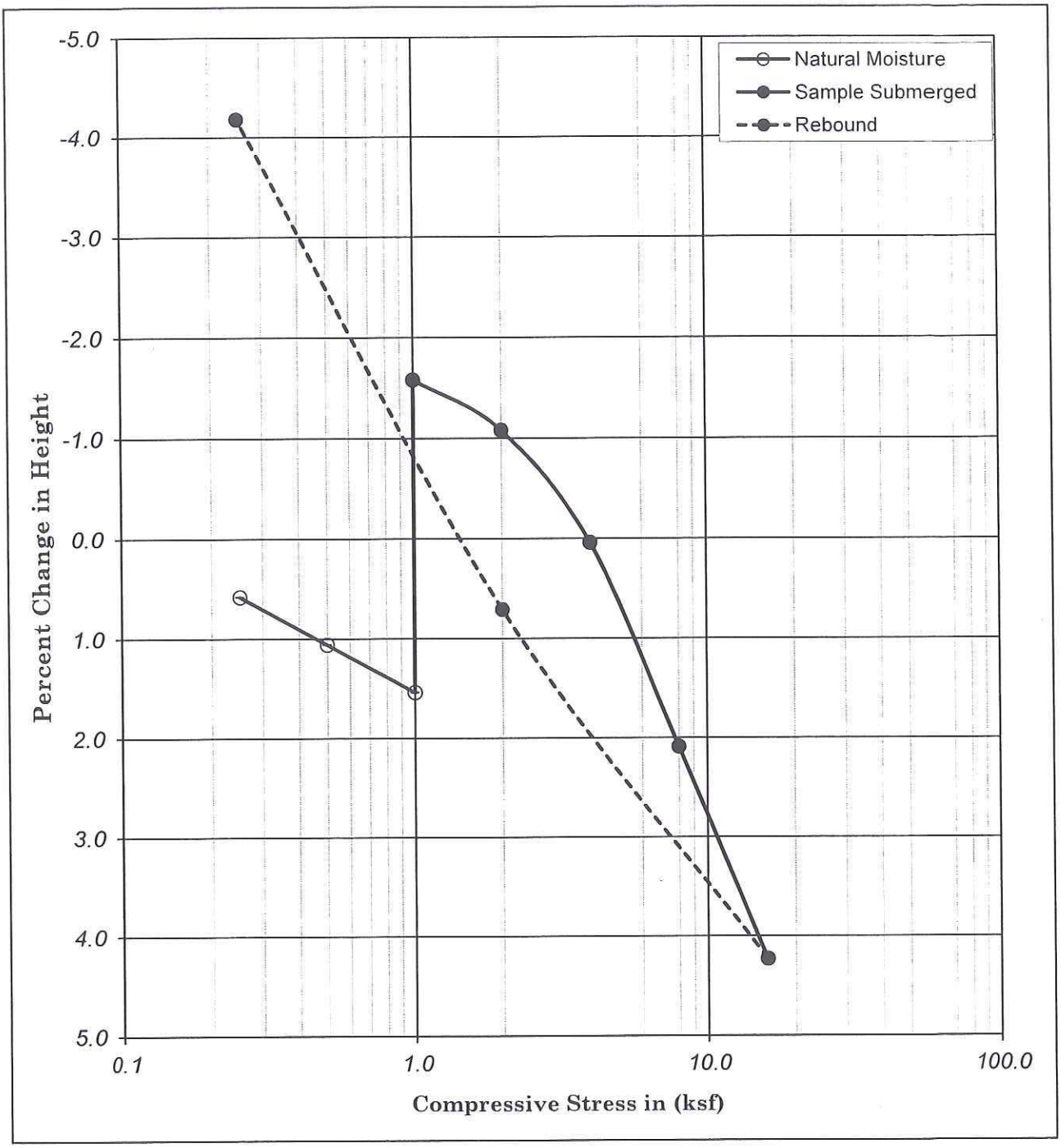
CONSOLIDATION TEST
(ASTM D-2435 / CT-219)



Boring No. : A-10-035			Liquid Limit :	-		Moisture Content (%)	Dry Density (pcf)	Dry Density (kN/m³)	Percent Saturation	Void Ratio
Sample No. : D-3			Plastic Limit :	-						
Depth	(ft) : 15.0	16.5	Plastic Index :	-	Initial	26.62	94.41	14.86	91.50	0.79
	(m) : 4.58	5.03	Specific Gravity :	2.70	Final	32.26	90.63	14.27	101.29	0.86
Description : Very dark brown, Fat CLAY (CH)										

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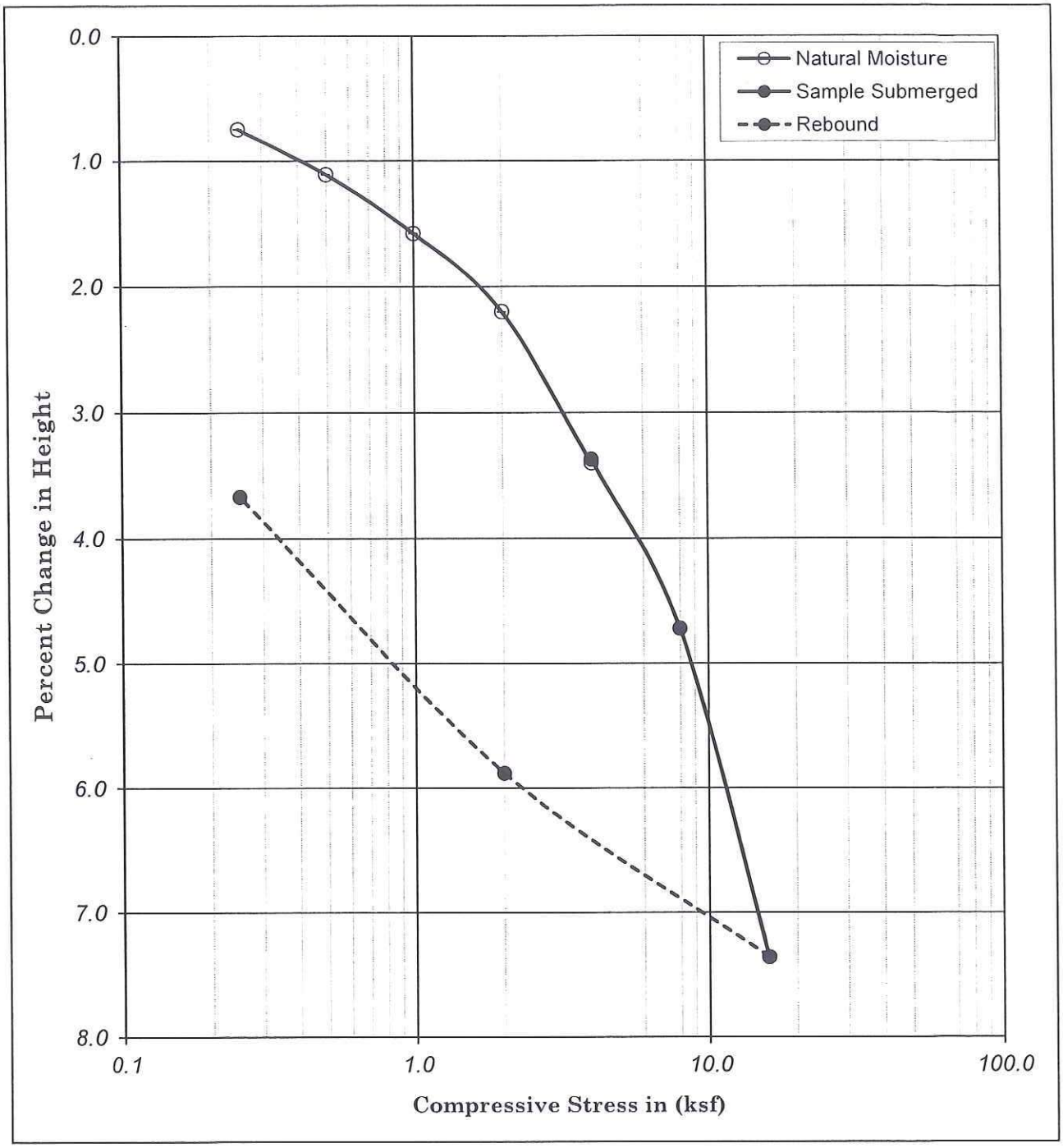
CONSOLIDATION TEST
(ASTM D-2435 / CT-219)



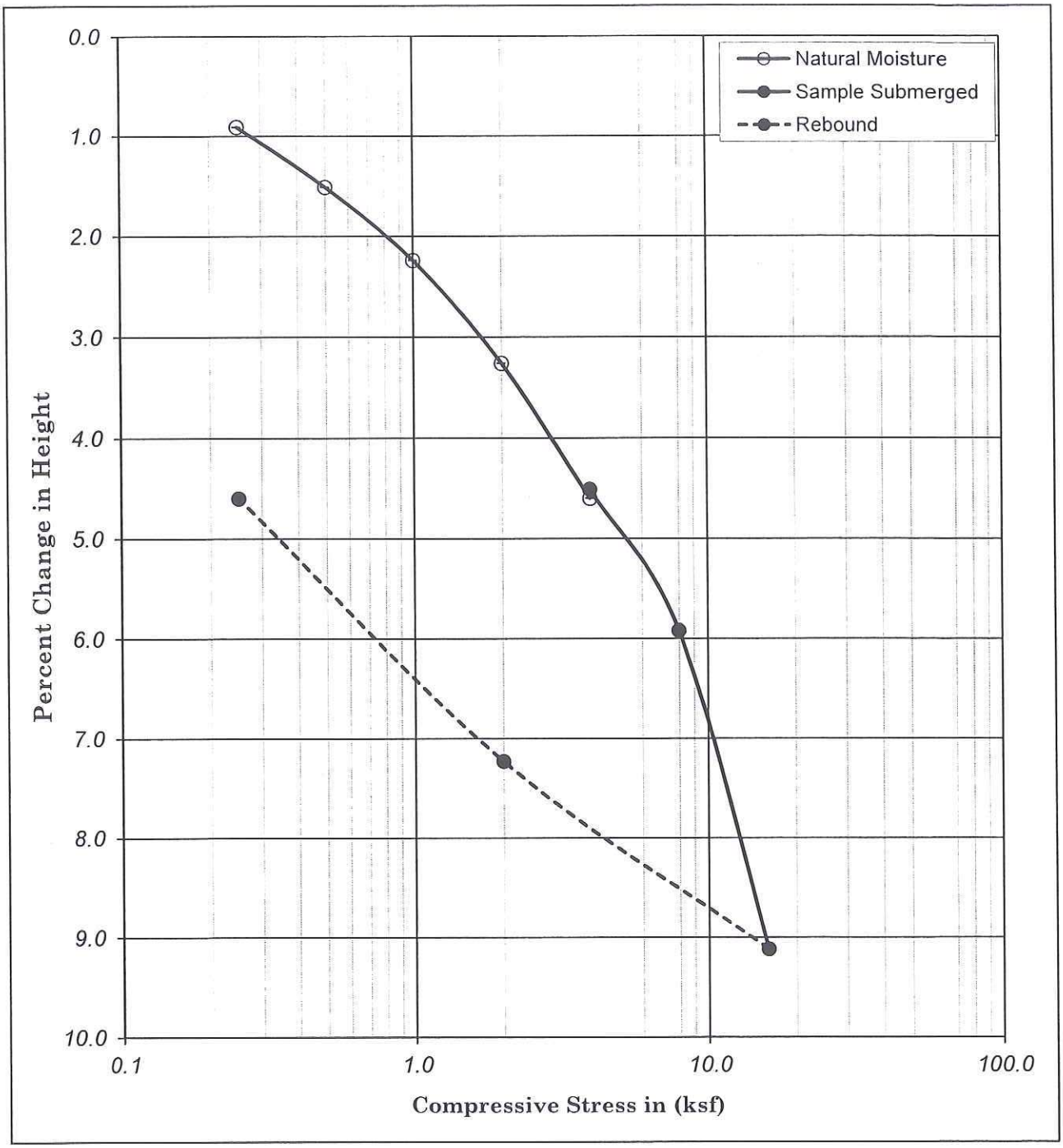
Boring No. : A-10-044			Liquid Limit :	-		Moisture Content (%)	Dry Density (pcf)	Dry Density (kN/m³)	Percent Saturation	Void Ratio
Sample No. : D-16			Plastic Limit :	-						
Depth	(ft) : 80.0	81.5	Plastic Index :	-	Initial	32.32	91.58	14.41	103.82	0.84
	(m) : 24.40	24.86	Specific Gravity :	2.70	Final	31.66	95.09	14.97	110.63	0.77
Description : Olive-brown, Lean CLAY with SAND (CL)										

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

East Street UC (Widen)

Project No. : 10-126 02/24/11

CONSOLIDATION TEST
(ASTM D-2435 / CT-219)



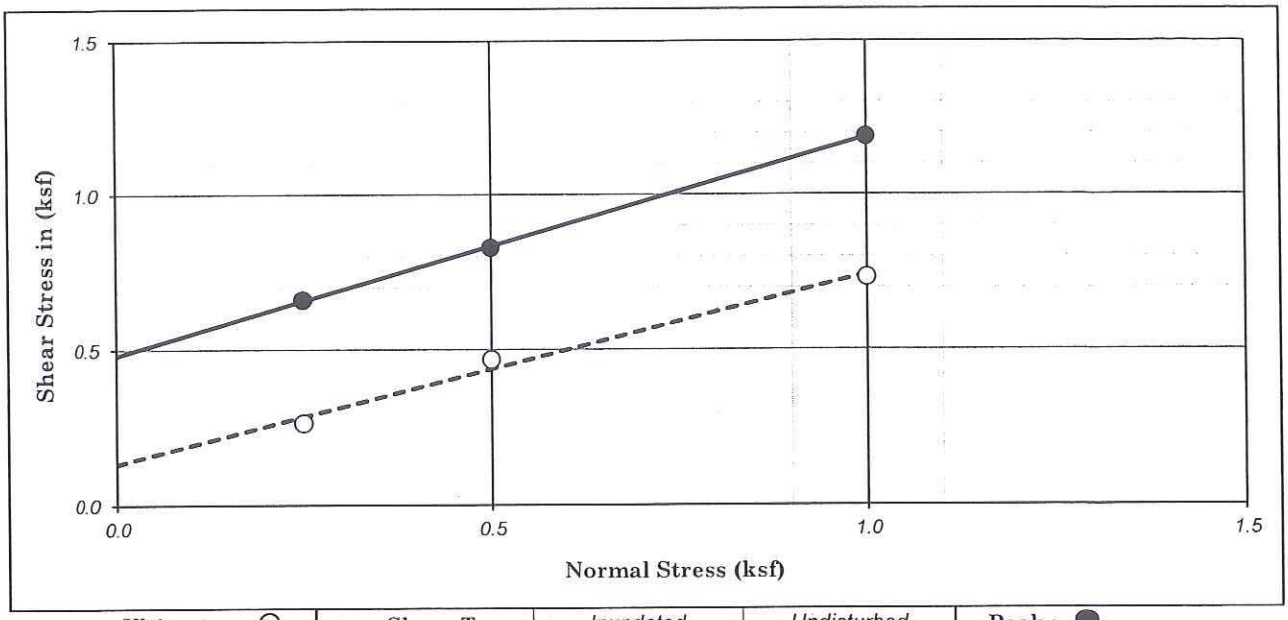
Boring No. : A-10-045			Liquid Limit :	-		Moisture Content (%)	Dry Density (pcf)	Dry Density (kN/m³)	Percent Saturation	Void Ratio
Sample No. : D-13			Plastic Limit :	-						
Depth	(ft) : 60.0	61.5	Plastic Index :	-	Initial	32.22	91.36	14.38	102.95	0.84
	(m) : 18.30	18.76	Specific Gravity :	2.70	Final	30.48	95.78	15.08	108.29	0.76
Description : Olive-brown, Lean CLAY (CL)										

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

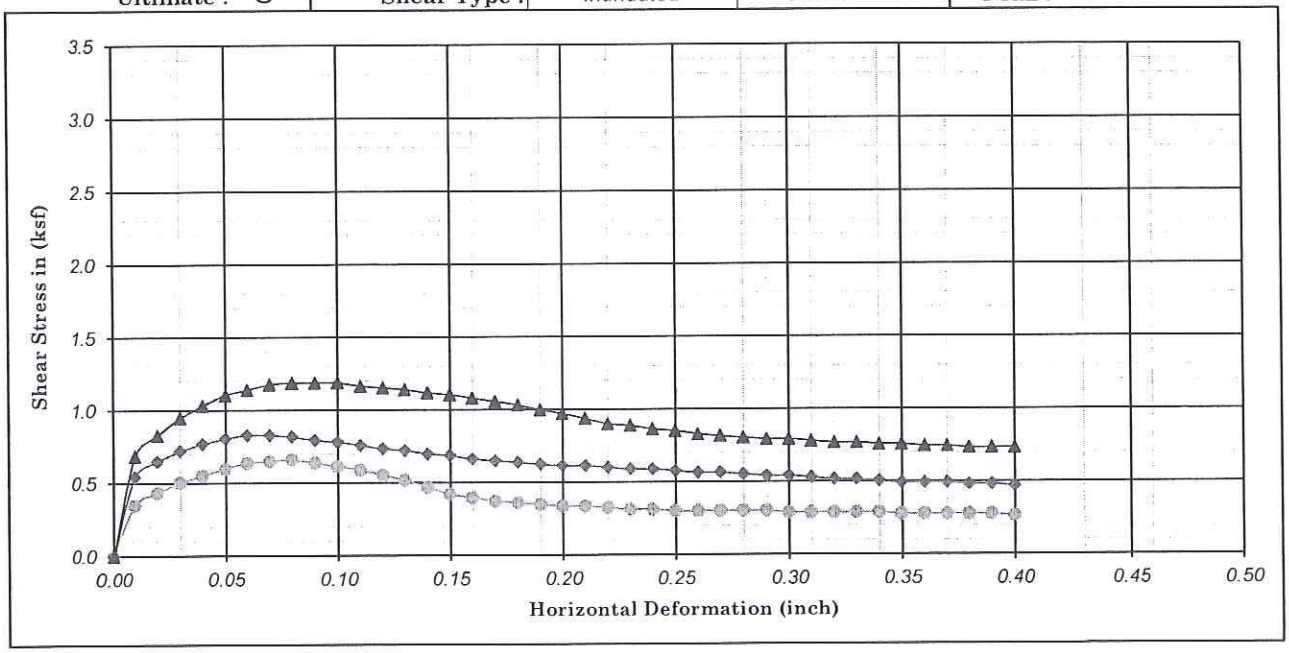
East Street UC (Widen)

Project No. : 10-126 02/24/11

CONSOLIDATION TEST
(ASTM D-2435 / CT-219)



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-002		Strength Intercept (C) :	0.48	(ksf)	Peak	0.13	(ksf)	Ultimate	
Sample No. : D-2			22.98	(kPa)		6.32	(kPa)		
Depth (ft/m) : 5.0	0.00	Friction Angle (ϕ) :	35.23	Degree		31.40	Degree		
Description : Dark grayish brown, CLAYEY SAND (SC)					Shear Rate (inch/minute) :			0.02	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	22.04	103.71	16.32	0.63	0.25	11.97	0.66	31.60	0.26	12.64
◆	22.51	106.36	16.74	0.58	0.50	23.94	0.83	39.64	0.47	22.41
▲	21.80	106.54	16.77	0.58	1.00	47.88	1.19	56.88	0.73	35.05

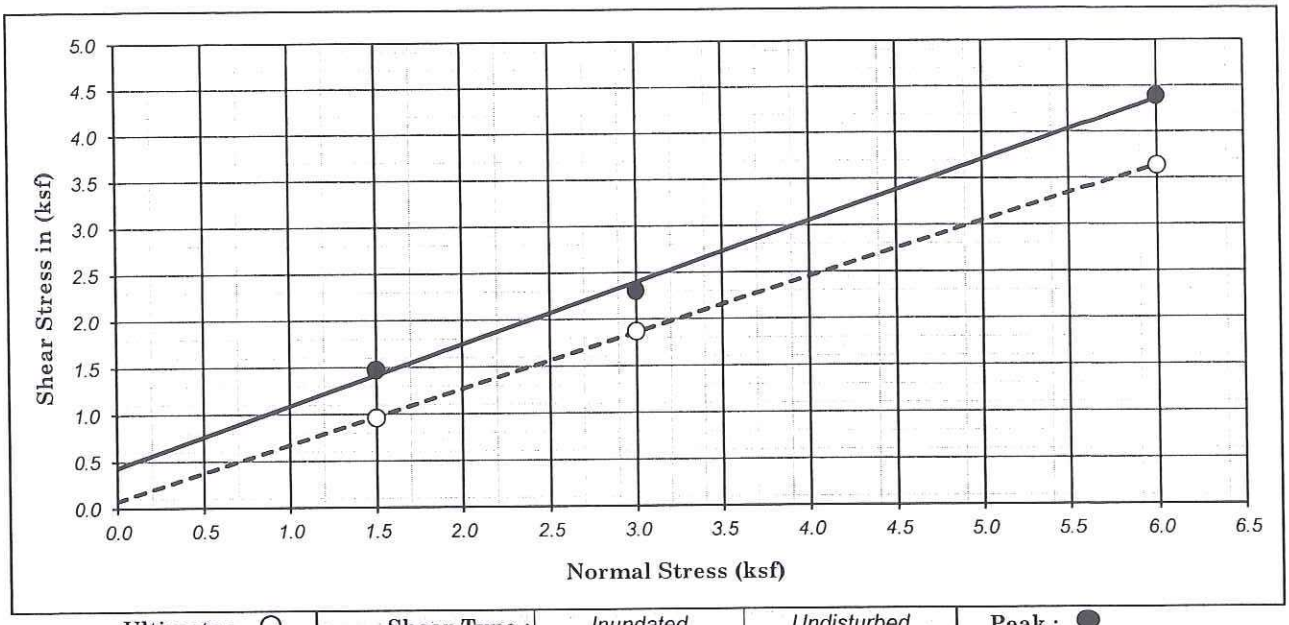
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

RBF/SR-91 WB Widening

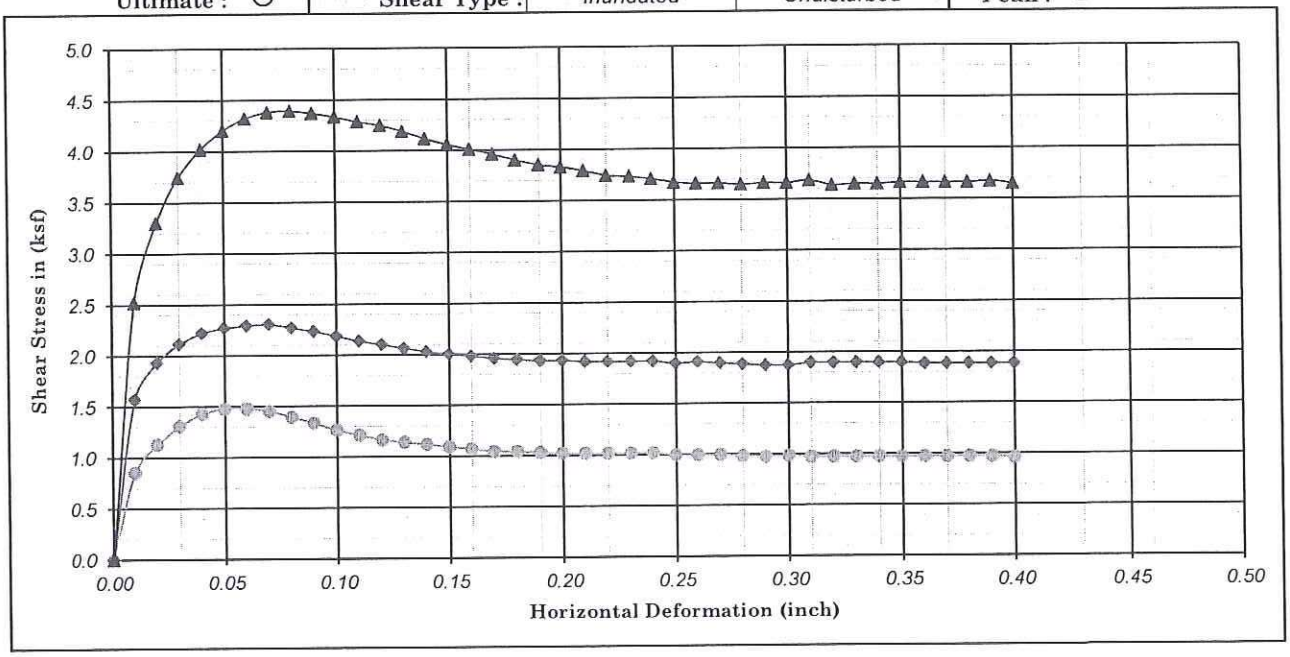
DIRECT SHEAR TEST

(ASTM D-3080)

Project No. : 10-126 | Date : 02/08/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-006		Strength Intercept (C) :	0.43	(ksf)	Peak	0.08	(ksf)	Ultimate	
Sample No. : D-4			20.68	(kPa)		3.73	(kPa)		
Depth (ft/m) : 20.0	0.00	Friction Angle (ϕ) :	33.22	Degree		30.70	Degree		
Description : Olive-gray with olive-brown, SILTY SAND (SM)						Shear Rate (inch/minute) :		0.02	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	15.76	102.81	16.18	0.64	1.50	71.82	1.48	70.67	0.96	45.96
◆	15.71	102.38	16.11	0.65	3.00	143.64	2.30	110.32	1.87	89.63
▲	16.43	106.14	16.71	0.59	6.00	287.28	4.39	210.29	3.64	174.09

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

SR-91 WB Widening Project

Project No. : 10-126

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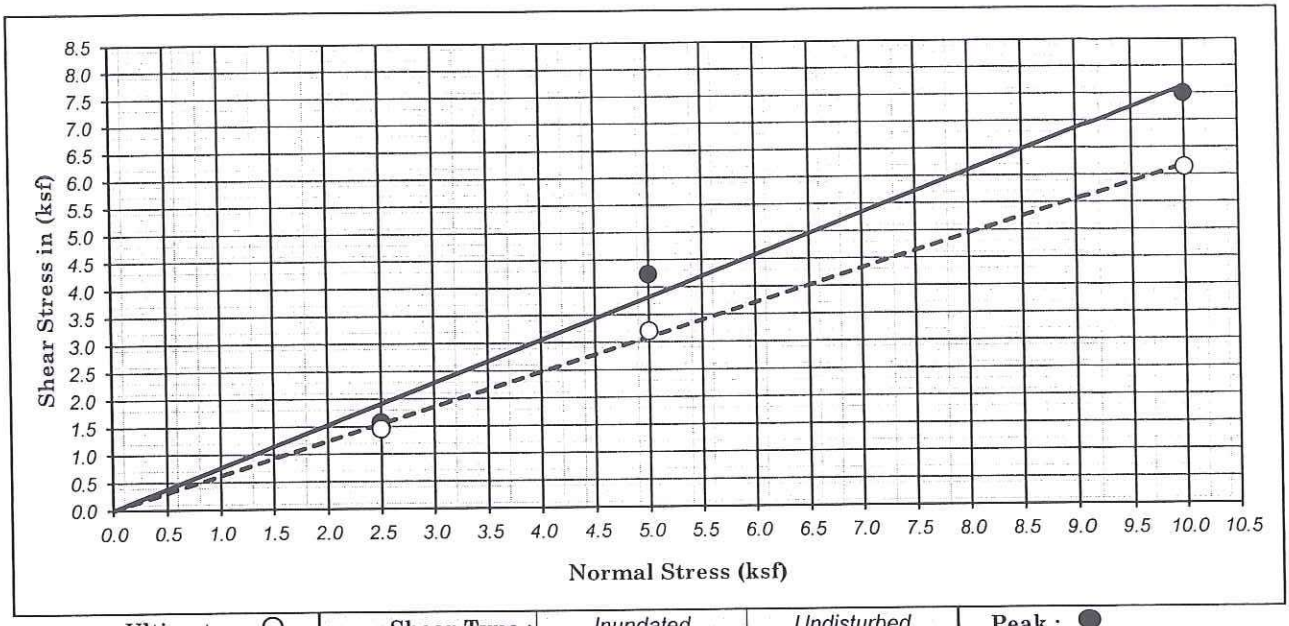
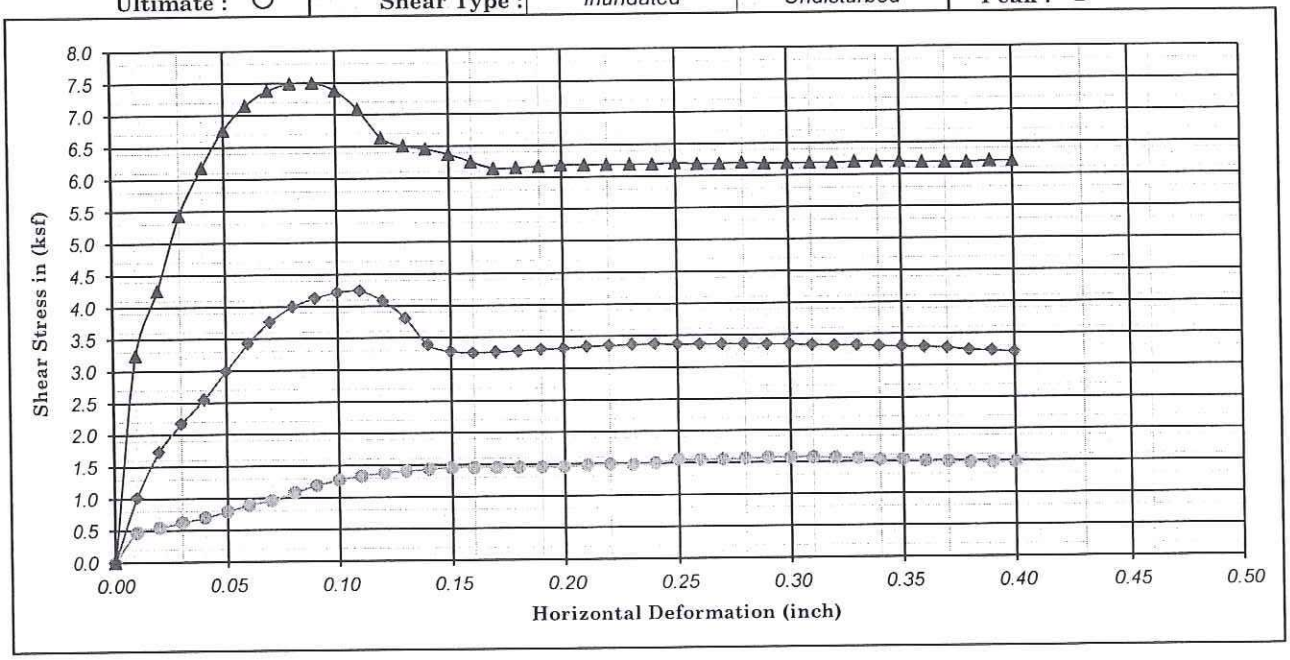
DIRECT SHEAR TEST (ASTM D-3080)

Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-006		Strength Intercept (C) :	0.00	(ksf)	Peak	0.00	(ksf)	Ultimate
Sample No. : D-10			0.00	(kPa)		0.00	(kPa)	
Depth (ft/m) : 50.0	0.00	Friction Angle (ϕ) :	37.33	Degree		31.71	Degree	
Description : Olive-brown, SILTY SAND (SM)					Shear Rate (inch/minute) :			0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	26.42	92.24	14.52	0.83	2.50	119.70	1.57	75.27	1.45	69.52
◆	23.82	97.69	15.38	0.73	5.00	239.40	4.24	202.82	3.20	153.41
▲	24.64	103.58	16.30	0.63	10.00	478.80	7.50	359.05	6.14	294.13

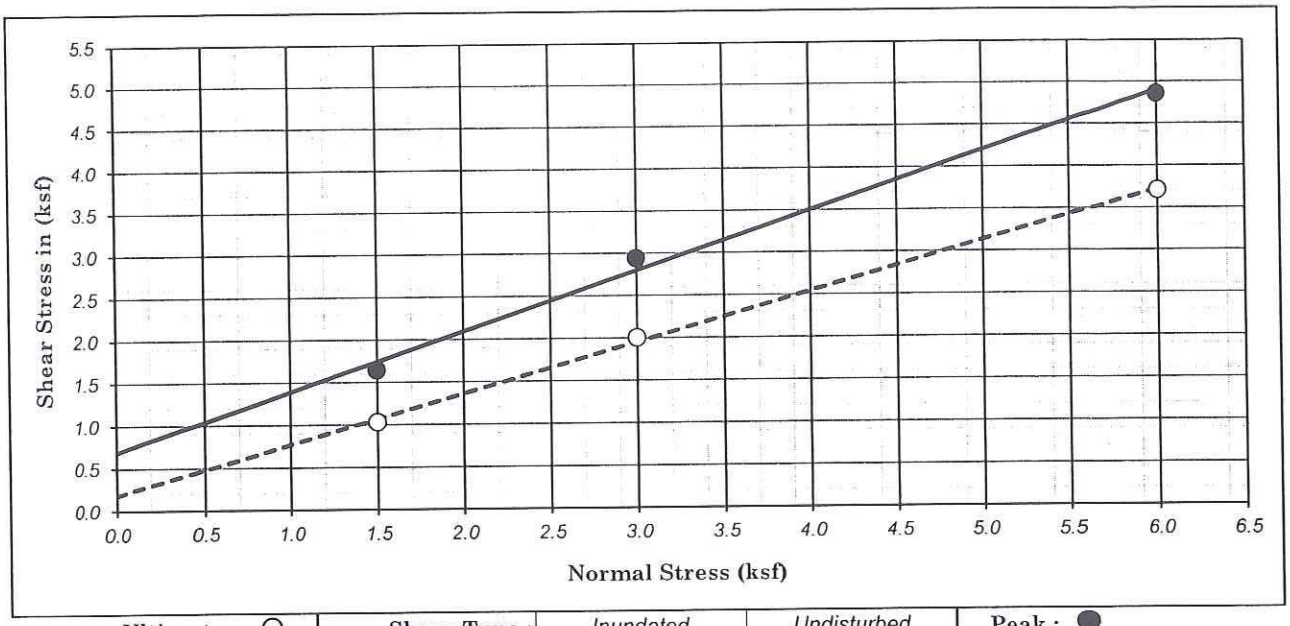
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Brookhurst Street UC (Widen)

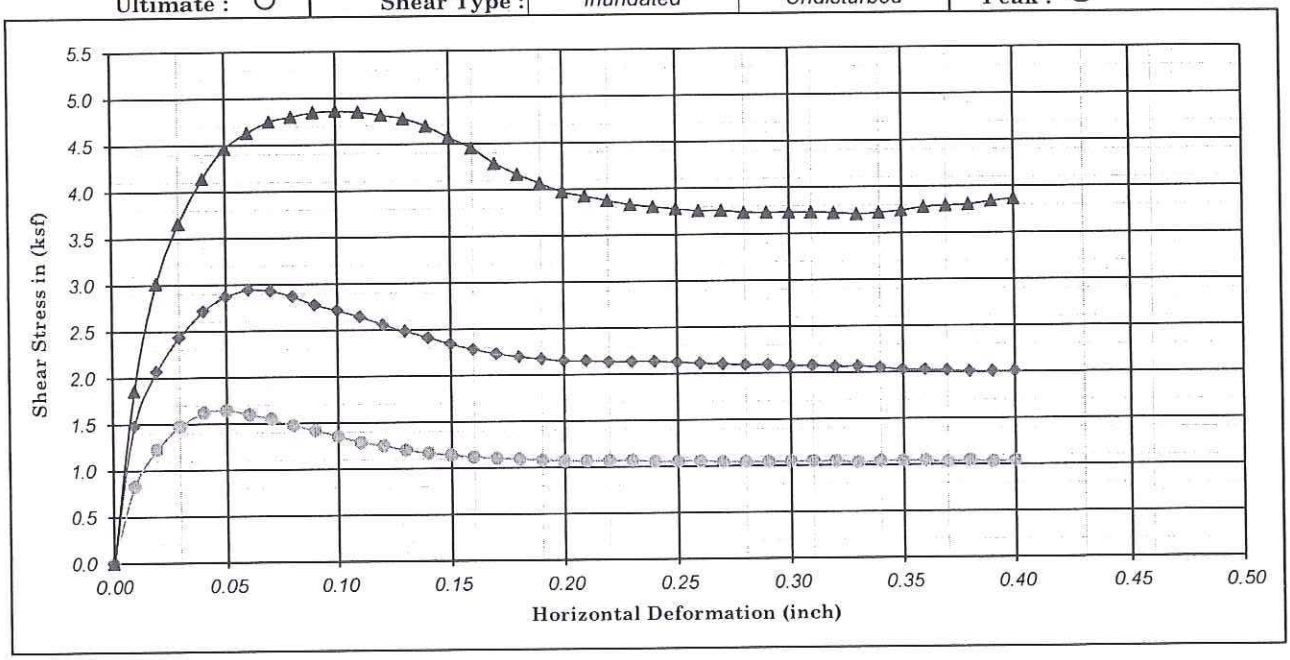
SR-91 WB Widening Project

DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126 | Date : 02/08/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-008		Strength Intercept (C) :	0.68	(ksf)	Peak	0.18	(ksf)	Ultimate	
Sample No. : D-4			32.75	(kPa)		8.62	(kPa)		
Depth (ft/m) : 20.0	0.00	Friction Angle (ϕ) :	35.15	Degree		30.58	Degree		
Description : Olive-brown, SILTY SAND (SM)					Shear Rate (inch/minute) :			0.02	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	16.11	114.74	18.06	0.47	1.50	71.82	1.64	78.71	1.03	49.41
◆	16.12	114.74	18.06	0.47	3.00	143.64	2.94	140.77	2.00	95.95
▲	15.97	114.45	18.01	0.47	6.00	287.28	4.86	232.70	3.71	177.54

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Brookhurst Street UC (Widen)

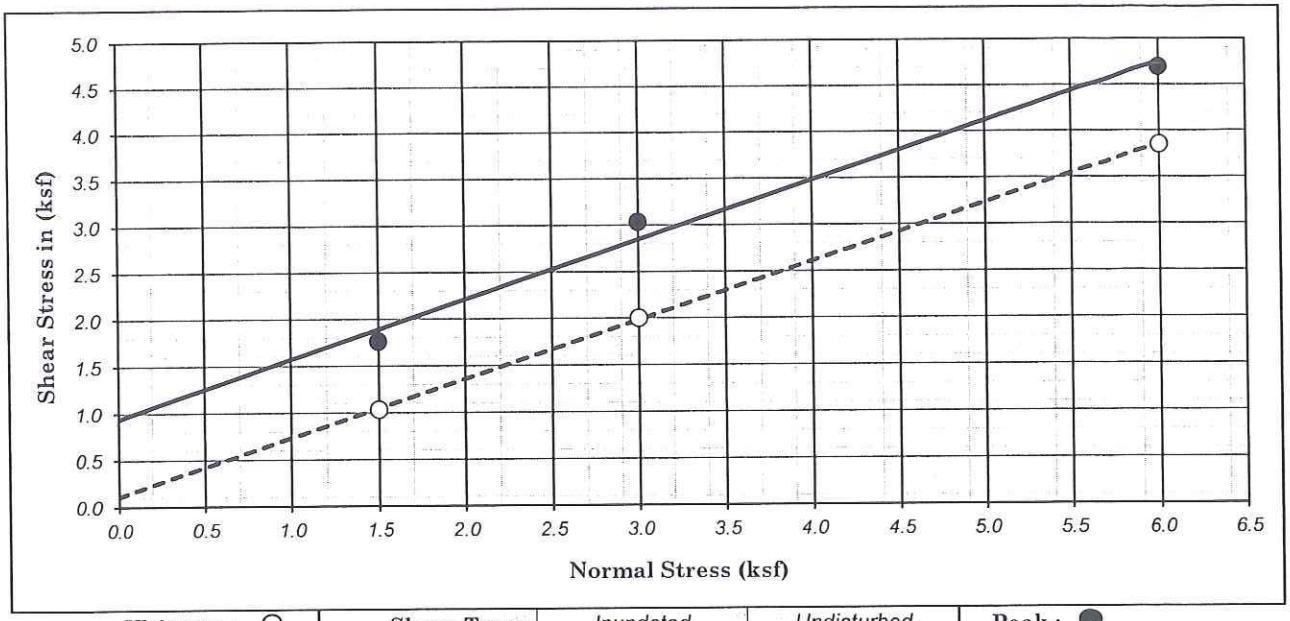
SR-91 WB Widening Project

DIRECT SHEAR TEST (ASTM D-3080)

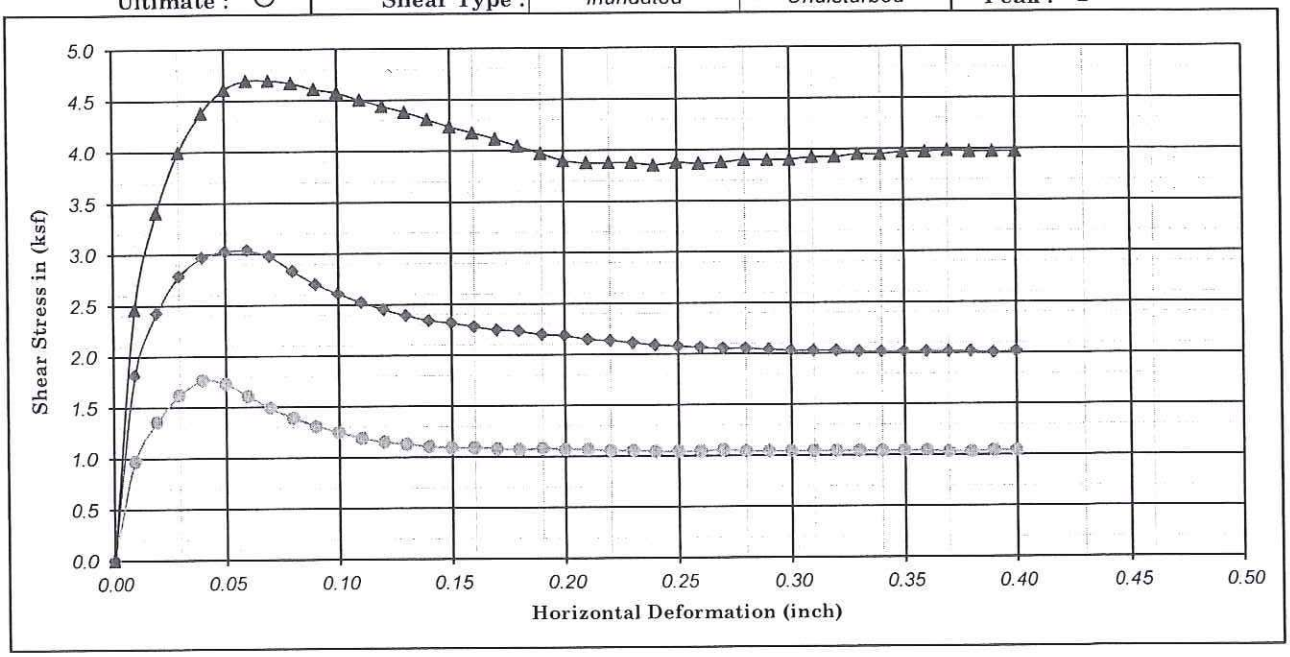
Project No. : 10-126

Date : 02/08/11

Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-008	Strength Intercept (C) :	0.94	(ksf)	Peak	0.11	(ksf)	Ultimate
Sample No. : D-6		44.82	(kPa)		5.17	(kPa)	
Depth (ft/m) : 30.0 / 0.00	Friction Angle (ϕ) :	32.48	Degree		32.01	Degree	

Description : Olive-brown, SILTY SAND (SM)

Shear Rate (inch/minute) : 0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	15.49	109.54	17.24	0.54	1.50	71.82	1.76	84.46	1.03	49.41
◆	15.96	110.16	17.34	0.53	3.00	143.64	3.04	145.36	2.00	95.95
▲	16.89	108.35	17.05	0.56	6.00	287.28	4.69	224.65	3.85	184.43

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Brookhurst Street UC (Widen)

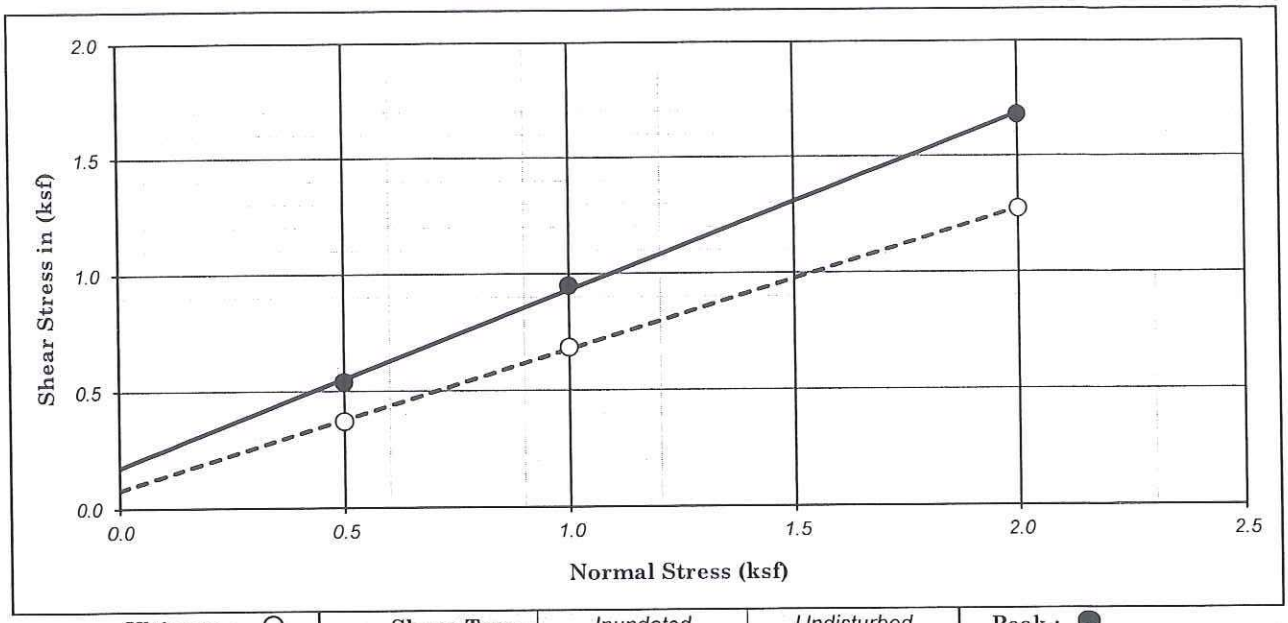
SR-91 WB Widening Project

DIRECT SHEAR TEST (ASTM D-3080)

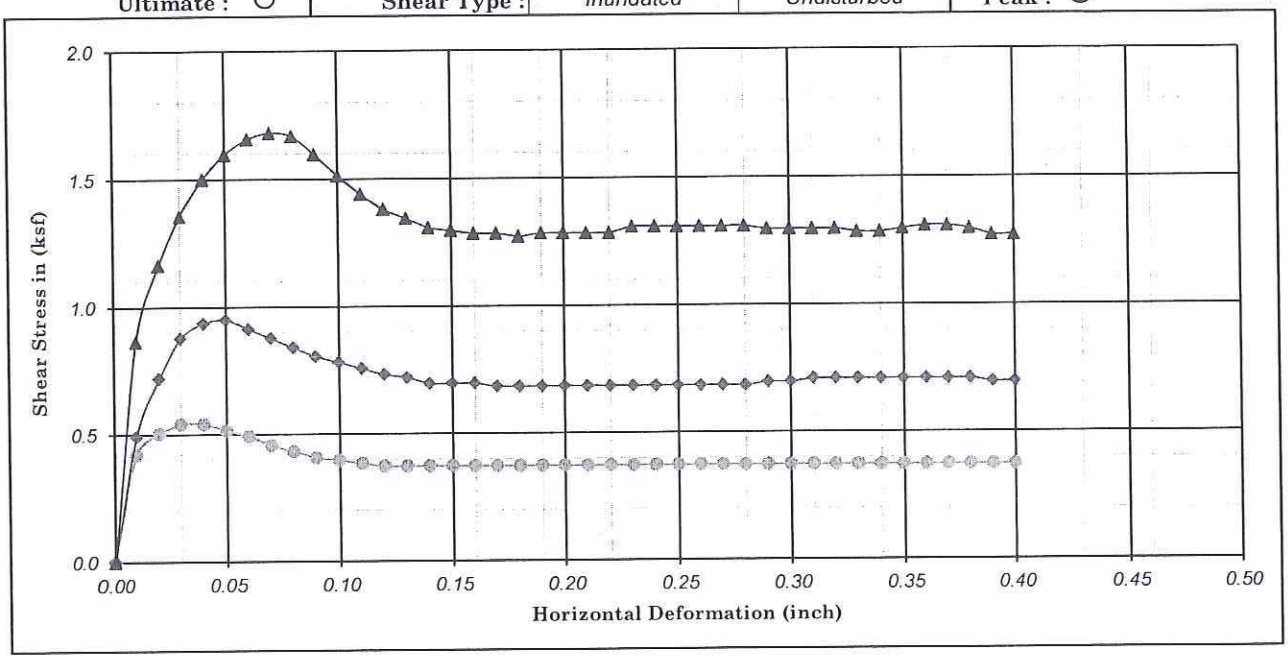
Project No. : 10-126

Date : 02/09/11

Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-012		Strength Intercept (C) :	0.17	(ksf)	Peak	0.08	(ksf)	Ultimate
Sample No. : D-2			8.33	(kPa)		3.73	(kPa)	
Depth (ft/m) : 10.0	0.00	Friction Angle (ϕ) :	37.09	Degree		30.89	Degree	
Description : Dark olive-brown, SILTY SAND (SM)					Shear Rate (inch/minute) :		0.02	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	20.70	92.84	14.61	0.82	0.50	23.94	0.54	25.86	0.37	17.81
◆	20.96	92.02	14.48	0.83	1.00	47.88	0.95	45.39	0.68	32.75
▲	20.35	90.20	14.20	0.87	2.00	95.76	1.68	80.44	1.27	60.90

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

RBF/SR-91 WB Widening

DIRECT SHEAR TEST

(ASTM D-3080)

Project No. : 10-126

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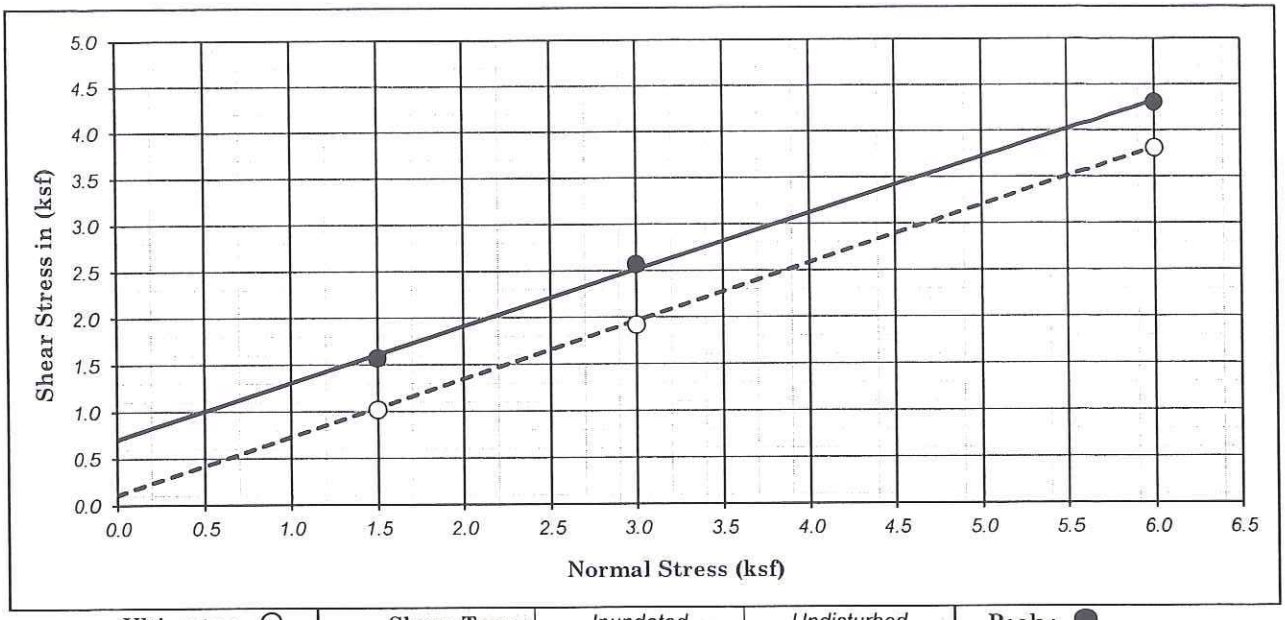
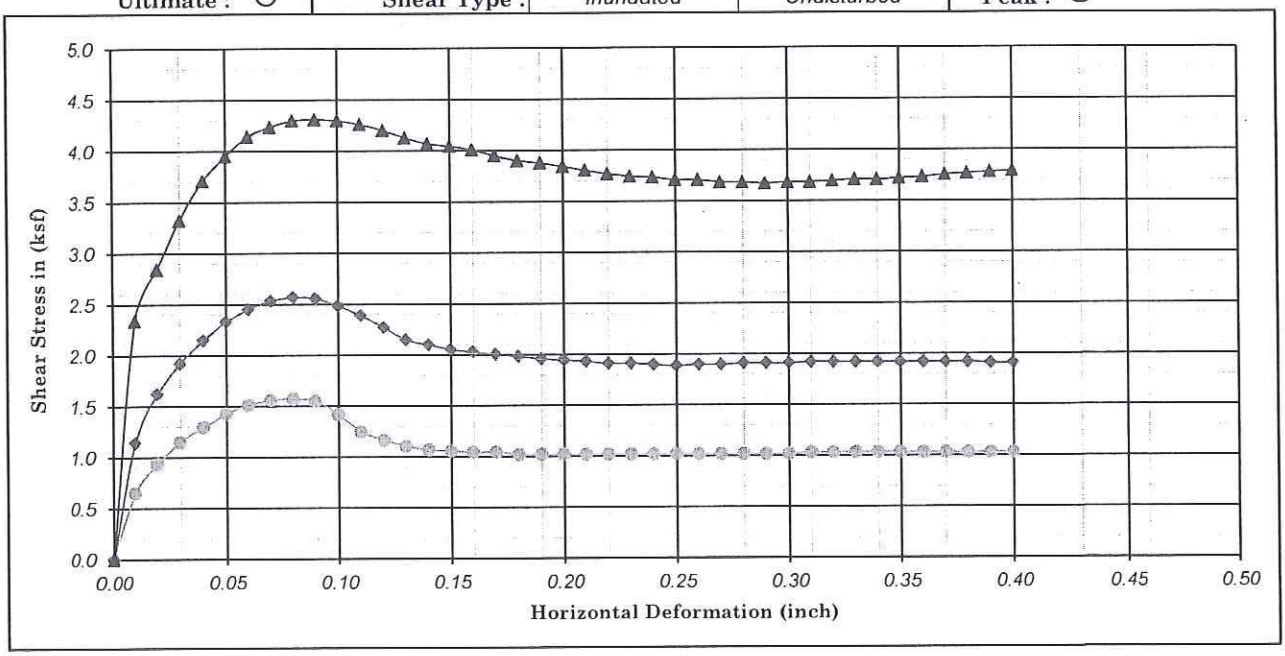
Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-016		Strength Intercept (C) :	0.70	(ksf)	Peak	0.08	(ksf)	Ultimate	
Sample No. : D-4			33.61	(kPa)		3.59	(kPa)		
Depth (ft/m) : 20.0	0.00	Friction Angle (ϕ) :	31.13	Degree		31.73	Degree		
Description : Olive-brown, SILTY SAND (SM)						Shear Rate (inch/minute) :		0.02	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	18.37	110.34	17.37	0.53	1.50	71.82	1.57	75.27	1.02	48.84
◆	17.76	111.65	17.57	0.51	3.00	143.64	2.57	122.96	1.92	91.93
▲	17.81	113.74	17.90	0.48	6.00	287.28	4.31	206.27	3.81	182.42

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

RBF/SR-91 WB Widening

DIRECT SHEAR TEST

(ASTM D-3080)

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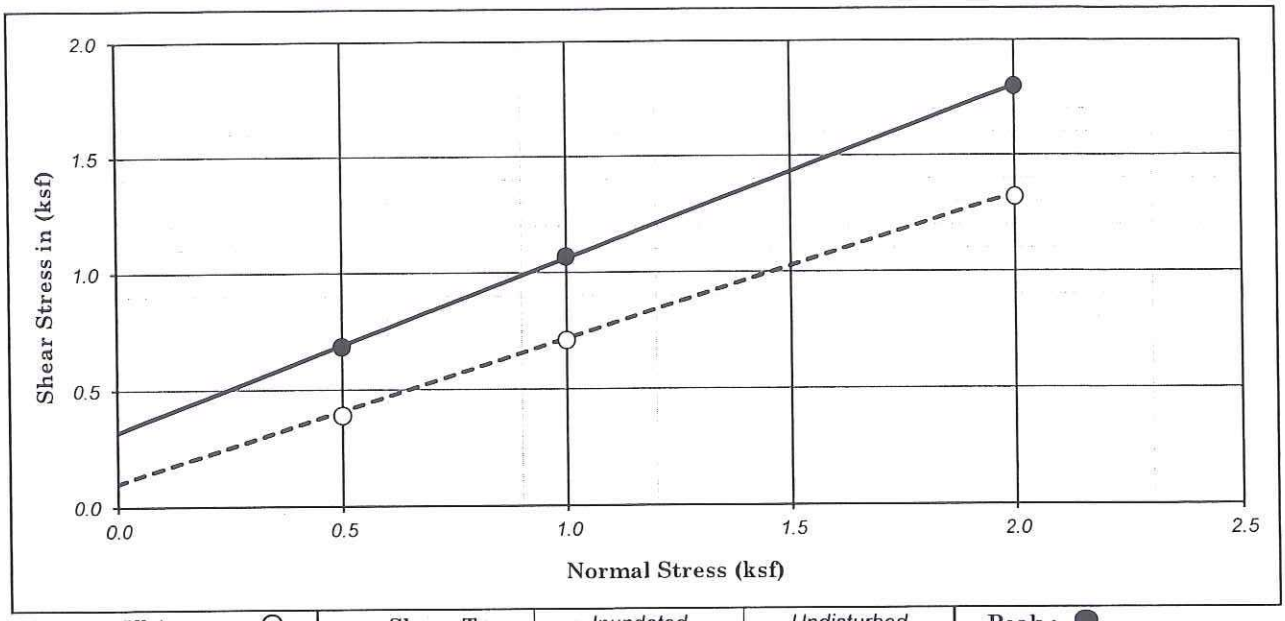
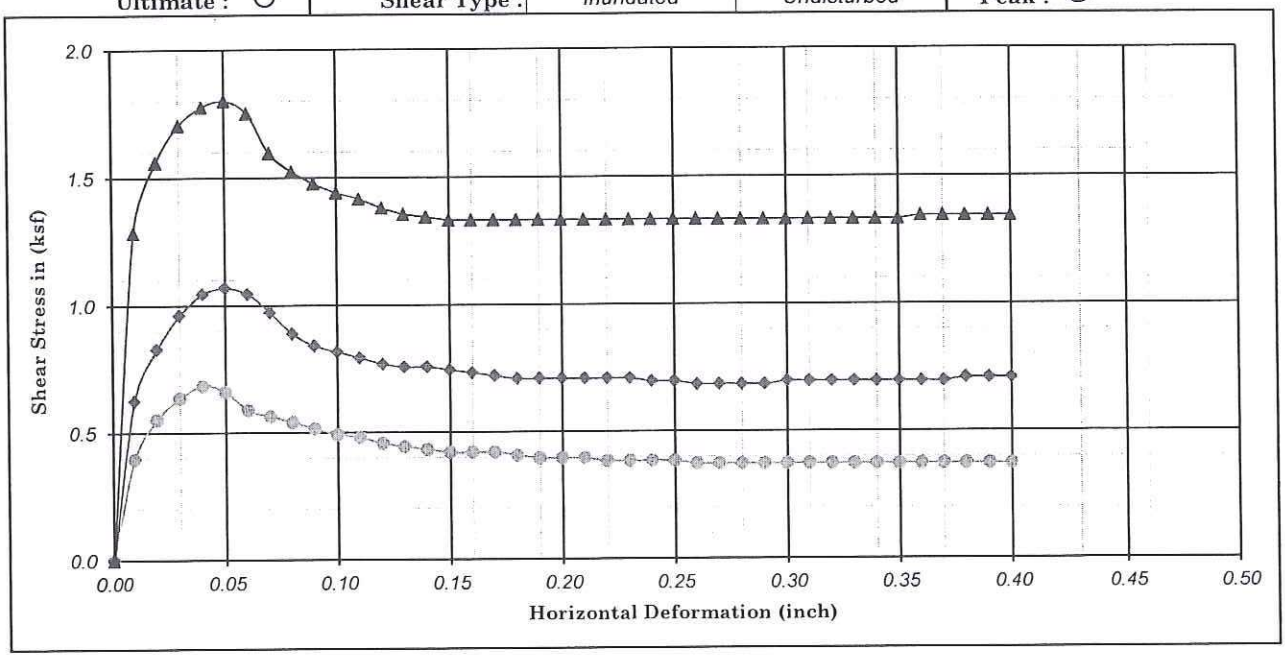
Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-018		Strength Intercept (C) :	0.32	(ksf)	Peak	0.10	(ksf)	Ultimate
Sample No. : D-2			15.23	(kPa)		4.79	(kPa)	
Depth (ft/m) : 10.0	0.00	Friction Angle (ϕ) :	36.59	Degree		31.68	Degree	
Description : Olive-brown, SILTY SAND (SM)						Shear Rate (inch/minute) :		0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	19.75	107.09	16.86	0.57	0.50	23.94	0.68	32.75	0.39	18.67
◆	20.01	108.27	17.04	0.56	1.00	47.88	1.07	51.14	0.71	33.99
▲	20.28	107.37	16.90	0.57	2.00	95.76	1.80	86.18	1.32	63.20

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

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DIRECT SHEAR TEST

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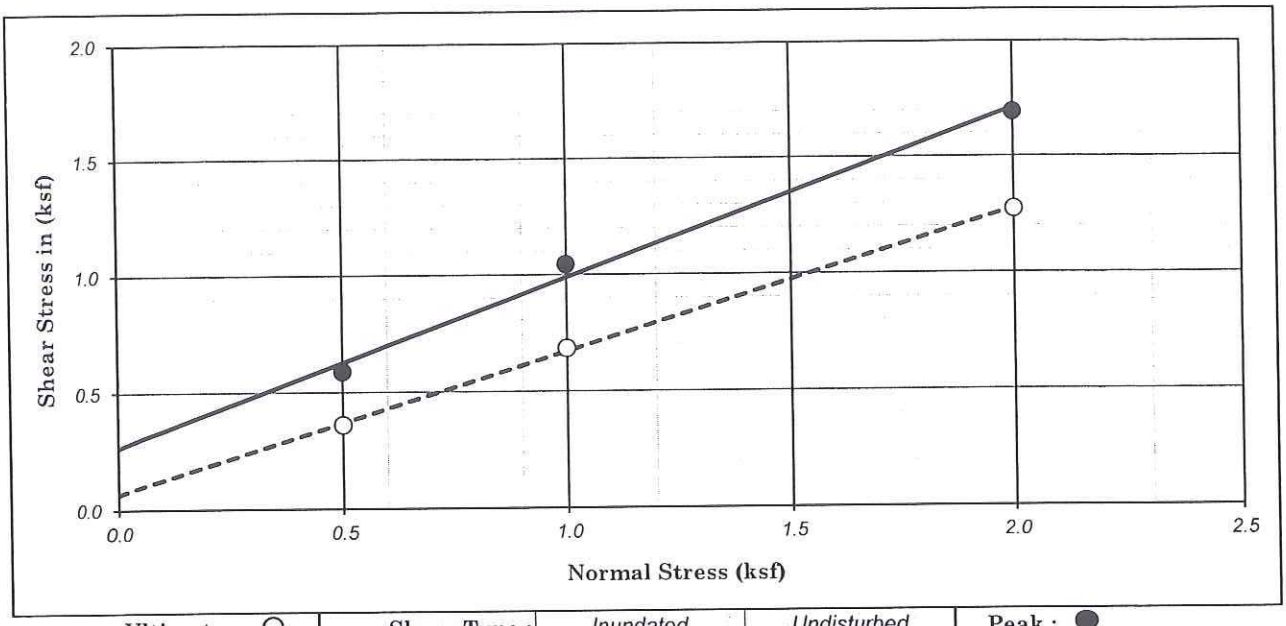
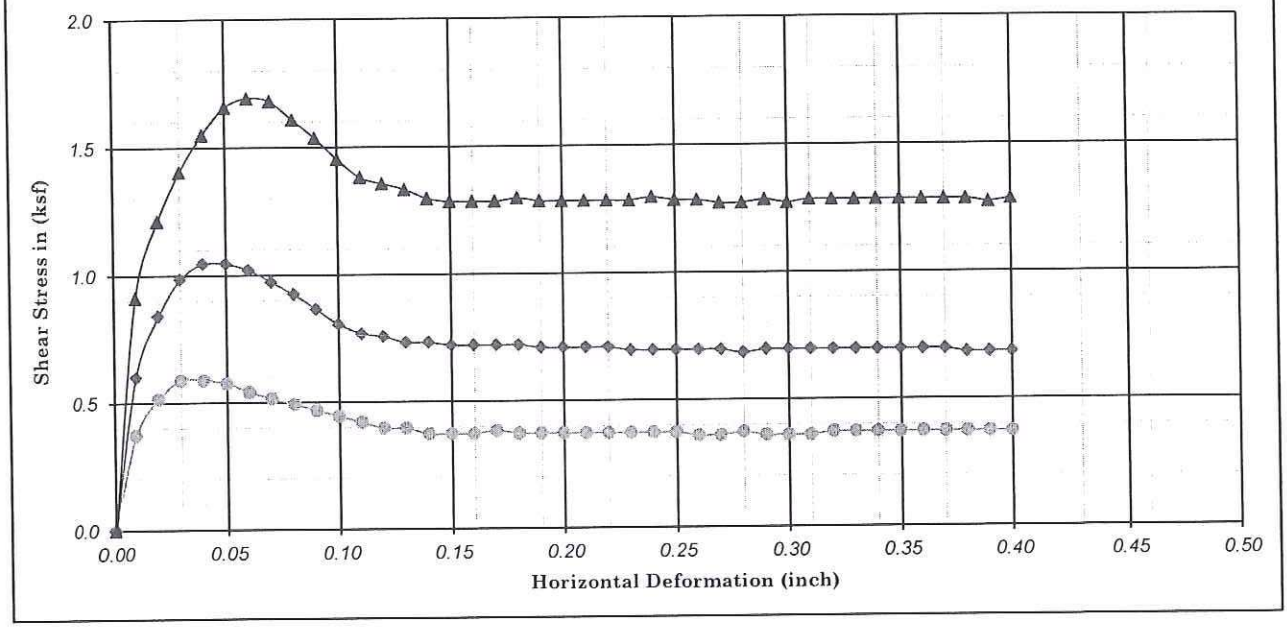
Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-020		Strength Intercept (C) :	0.26	(ksf)	Peak	0.07	(ksf)	Ultimate	
Sample No. : D-2			12.64	(kPa)		3.16	(kPa)		
Depth (ft/m) : 10.0	0.00	Friction Angle (ϕ) :	35.88	Degree		31.18	Degree		
Description : Olive-brown, SILTY SAND (SM)						Shear Rate (inch/minute) :		0.02	

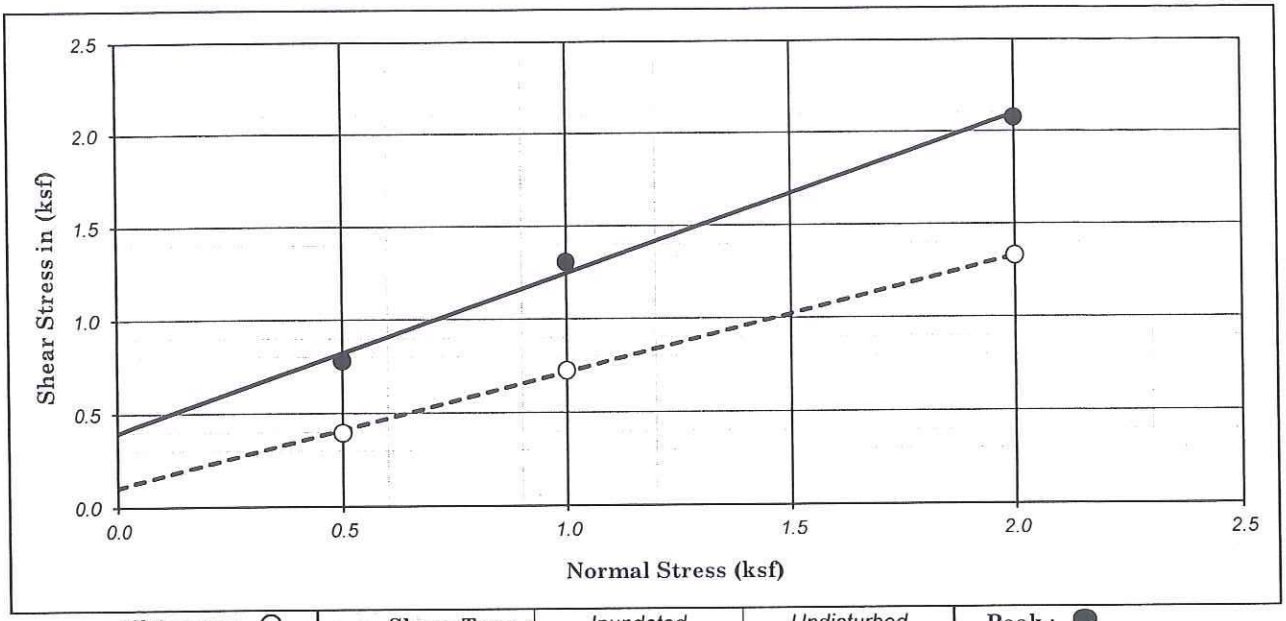
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	18.32	101.91	16.04	0.65	0.50	23.94	0.59	28.15	0.36	17.24
◆	18.31	100.61	15.84	0.68	1.00	47.88	1.04	49.99	0.68	32.75
▲	18.65	99.16	15.61	0.70	2.00	95.76	1.69	81.01	1.27	60.90

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

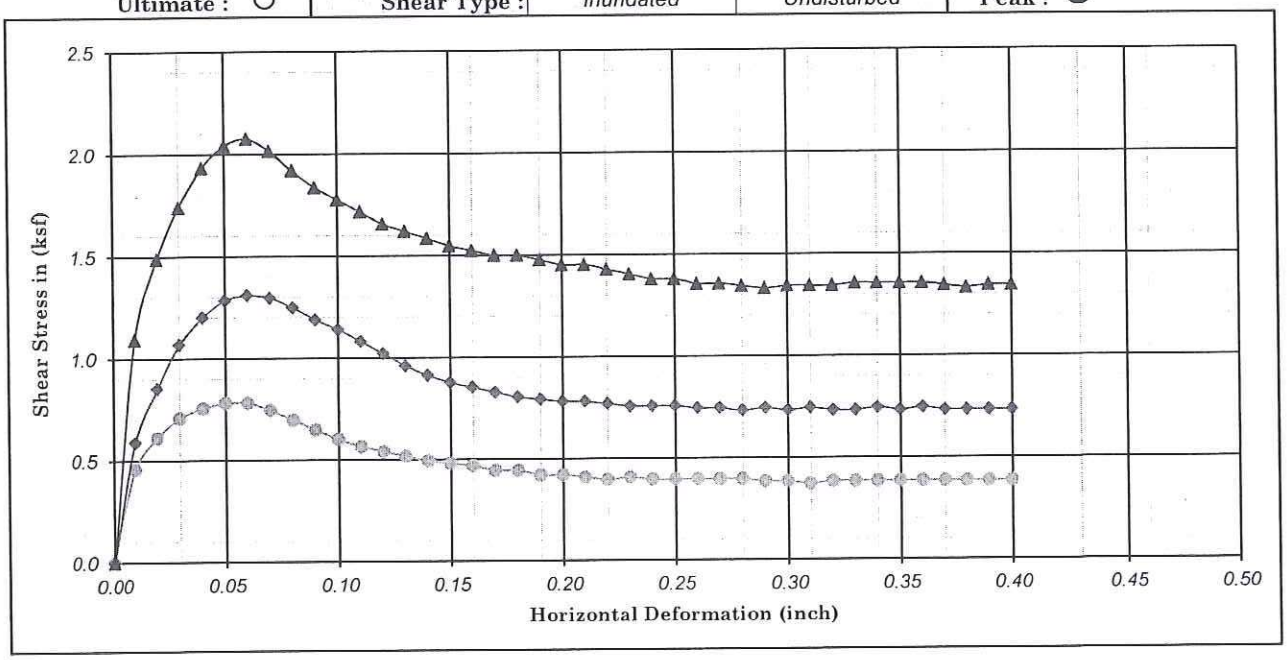
RBF/SR-91 WB Widening

DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126 | Date : 02/10/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-023		Strength Intercept (C) :	0.40	(ksf)	Peak	0.10	(ksf)	Ultimate
Sample No. : D-2			18.96	(kPa)		4.98	(kPa)	
Depth (ft/m) : 10.0	0.00	Friction Angle (ϕ) :	40.37	Degree		31.48	Degree	
Description : Dark -brown, SILTY SAND (SM)					Shear Rate (inch/minute) :		0.02	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	17.66	107.73	16.96	0.56	0.50	23.94	0.78	37.35	0.40	18.91
◆	16.52	109.98	17.31	0.53	1.00	47.88	1.31	62.63	0.73	34.71
▲	16.37	110.15	17.34	0.53	2.00	95.76	2.08	99.40	1.33	63.68

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Euclid Street UC (Widen)

SR-91 WB Widening Project

DIRECT SHEAR TEST (ASTM D-3080)

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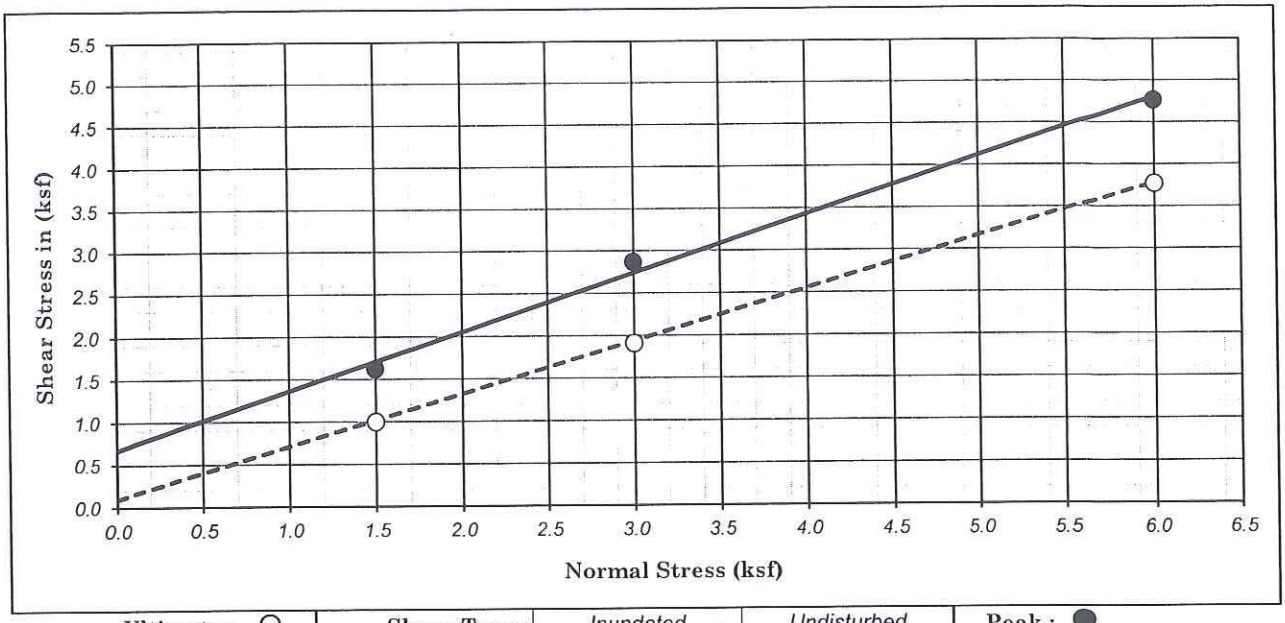
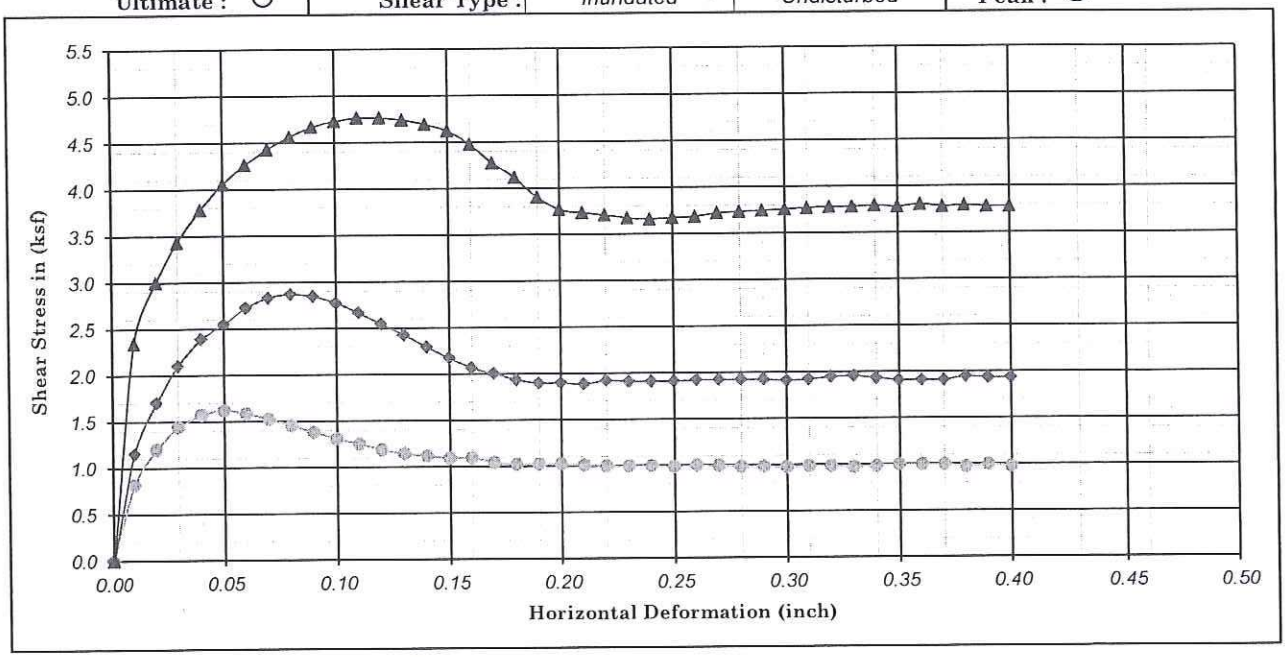
Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-023		Strength Intercept (C) :	0.67	(ksf)	Peak	0.10	(ksf)	Ultimate
Sample No. : D-6			32.18	(kPa)		4.62	(kPa)	
Depth (ft/m) : 25.0	0.00	Friction Angle (ϕ) :	34.57	Degree		31.55	Degree	
Description : Olive-brown, Poorly graded SAND (SP)					Shear Rate (inch/minute) :		0.02	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	20.66	90.03	14.17	0.87	1.50	71.82	1.62	77.57	1.00	47.88
◆	21.36	89.16	14.03	0.89	3.00	143.64	2.87	137.32	1.91	91.45
▲	23.30	85.48	13.45	0.97	6.00	287.28	4.76	228.10	3.77	180.51

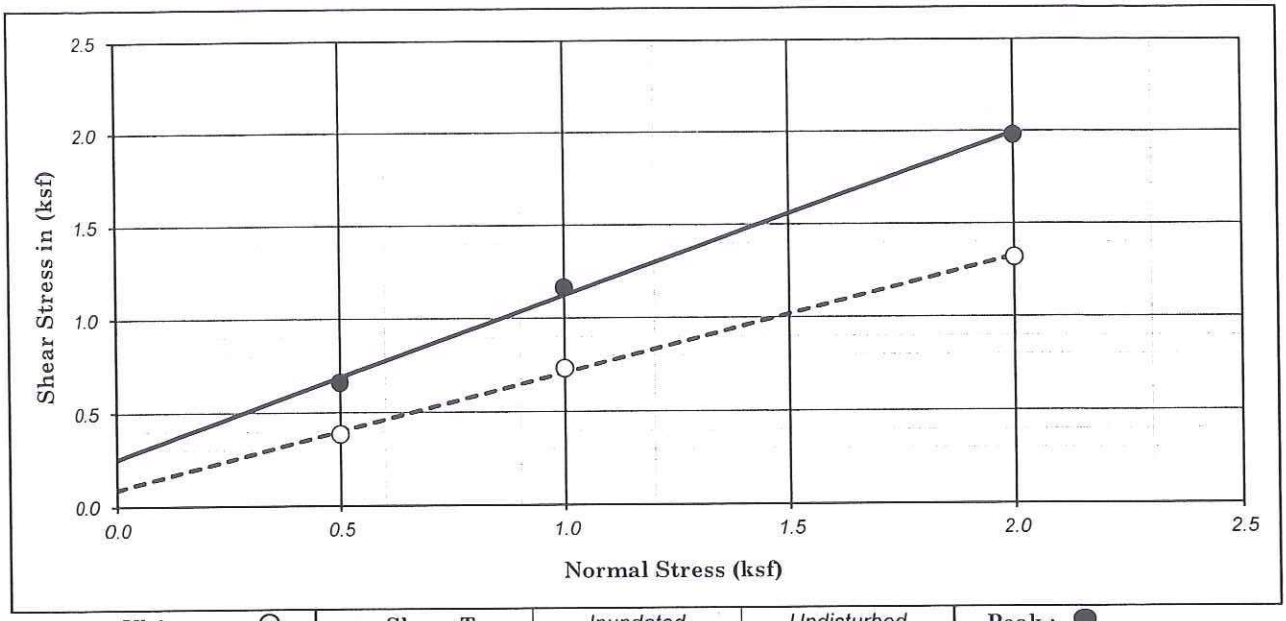
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Euclid Street UC (Widen)

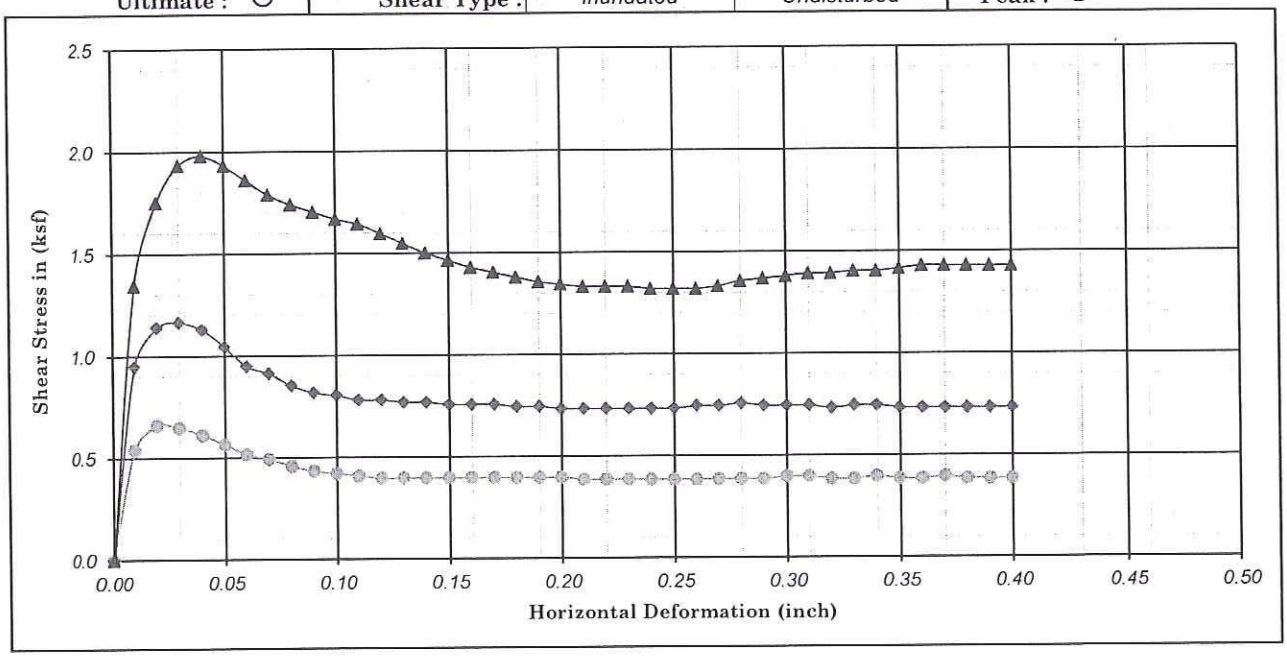
SR-91 WB Widening Project

DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126 | Date : 02/11/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-030		Strength Intercept (C) :	0.25	(ksf)	Peak	0.09	(ksf)	Ultimate
Sample No. : D-2			12.07	(kPa)		4.31	(kPa)	
Depth (ft/m) : 10.0	0.00	Friction Angle (ϕ) :	41.05	Degree		31.75	Degree	
Description : Olive-brown, SILTY SAND (SM)						Shear Rate (inch/minute) :		0.02

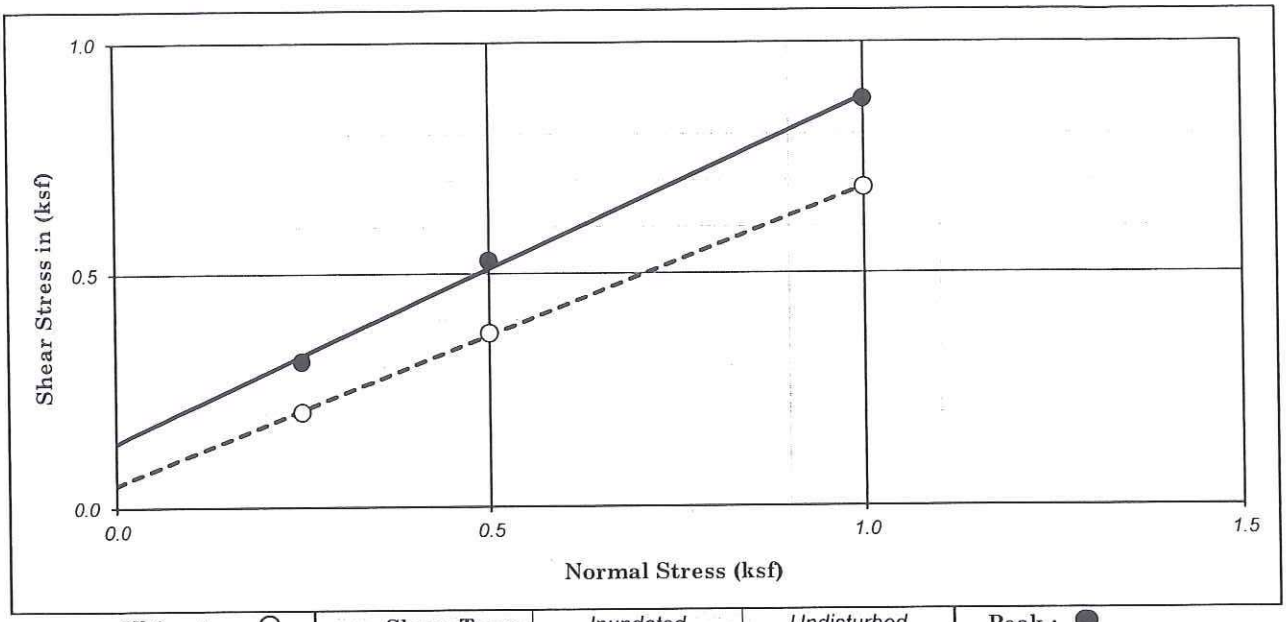
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	15.88	112.41	17.69	0.50	0.50	23.94	0.66	31.60	0.38	18.39
◆	15.74	111.04	17.48	0.52	1.00	47.88	1.16	55.73	0.73	35.05
▲	16.11	112.63	17.73	0.50	2.00	95.76	1.98	94.80	1.32	63.20

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

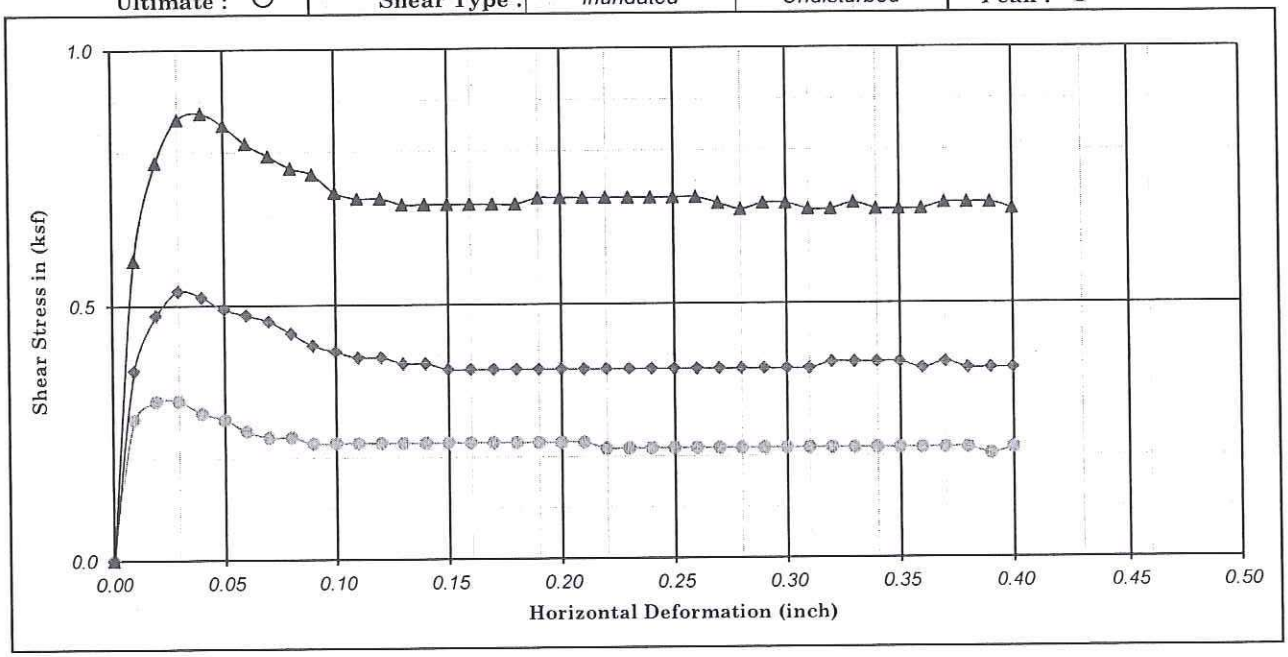
RBF/SR-91 WB Widening

DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126 | Date : 02/09/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-033		Strength Intercept (C) :	0.14	(ksf)	Peak	0.05	(ksf)	Ultimate
Sample No. : D-6			6.61	(kPa)		2.30	(kPa)	
Depth (ft/m) : 25.0	0.00	Friction Angle (ϕ) :	36.65	Degree		32.53	Degree	

Description : Light yellowish brown, Poorly graded SAND with SILT (SP-SM) — Shear Rate (inch/minute) : 0.02

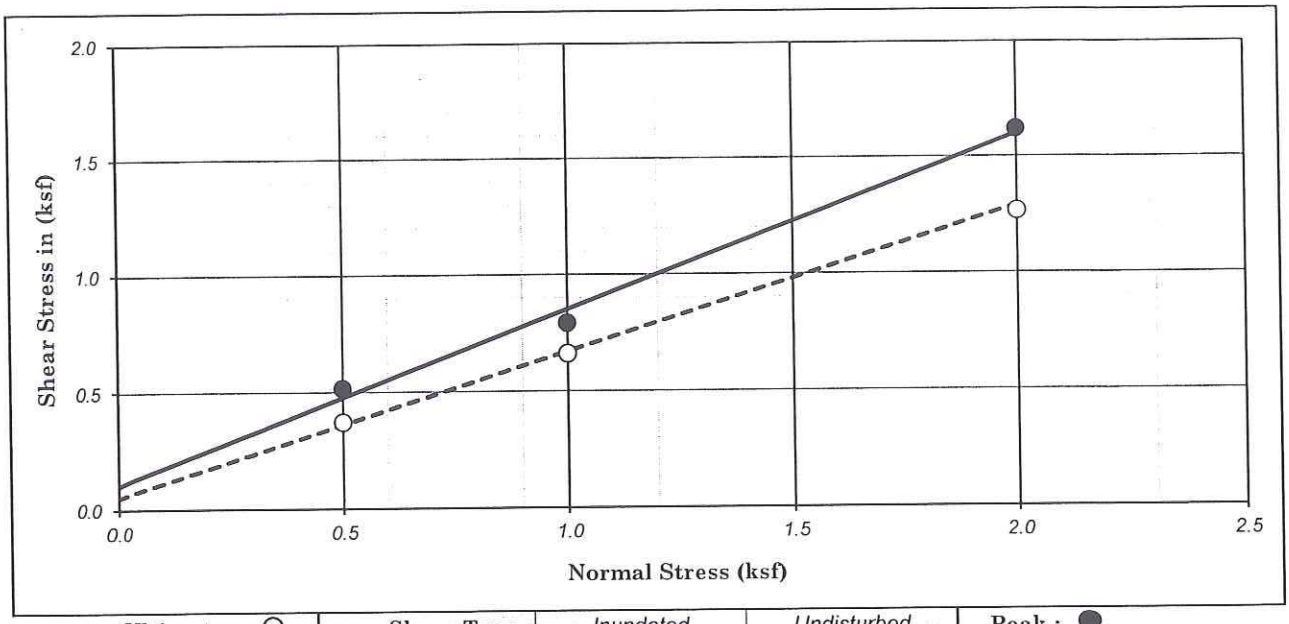
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	20.98	97.02	15.27	0.74	0.25	11.97	0.31	14.94	0.20	9.77
◆	21.16	99.33	15.63	0.70	0.50	23.94	0.53	25.28	0.37	17.81
▲	21.97	97.94	15.42	0.72	1.00	47.88	0.88	41.94	0.68	32.75

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

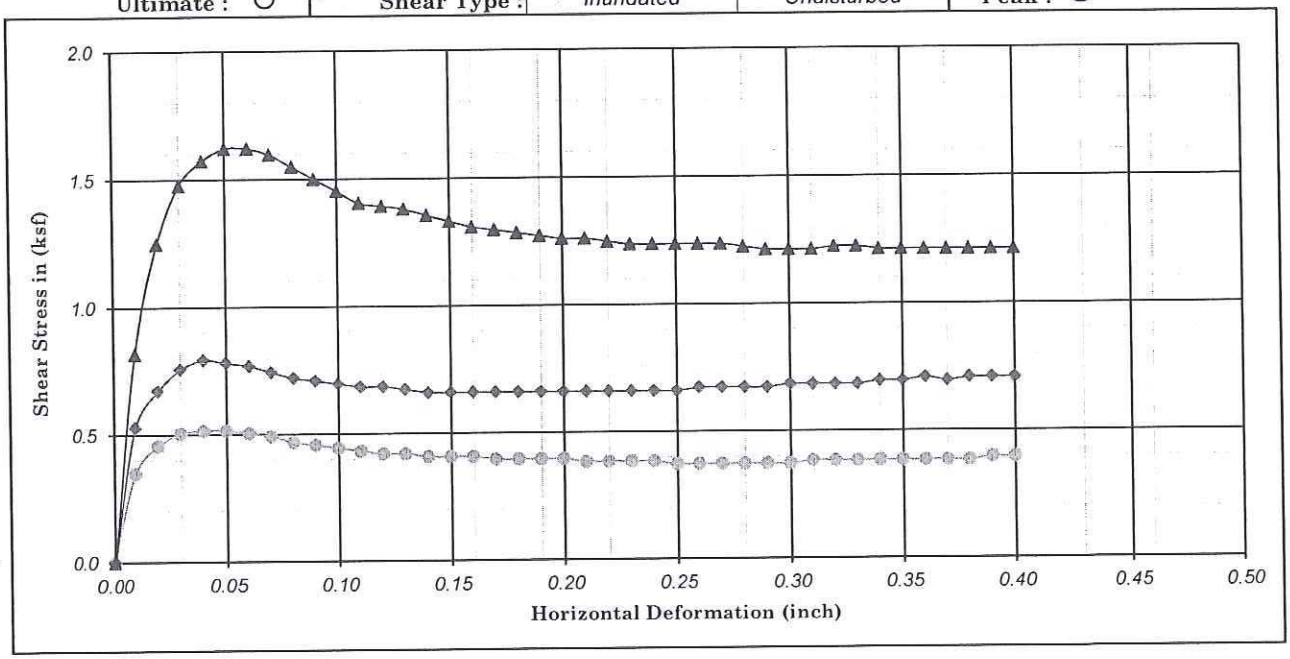
RBF/SR-91 WB Widening

DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126 | Date : 02/11/11 | Figure No. :



Ultimate : ○ | Shear Type : *Inundated* | *Undisturbed* | Peak : ●



Boring No. : *A-10-036*		Strength Intercept (C) :	*0.10*	(ksf)	Peak	*0.07*	(ksf)	Ultimate
Sample No. : *D-2*			*4.88*	(kPa)		*3.33*	(kPa)	
Depth (ft/m) : *10.0*	*0.00*	Friction Angle (ϕ) :	*36.84*	Degree		*31.80*	Degree	
Description : *Olive-brown, SILTY SAND (SM)*					Shear Rate (inch/minute) :		*0.02*	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	*20.00*	*90.34*	*14.22*	*0.87*	*0.50*	*23.94*	*0.52*	*24.71*	*0.37*	*17.81*
◆	*21.22*	*89.86*	*14.14*	*0.88*	*1.00*	*47.88*	*0.79*	*37.92*	*0.66*	*31.60*
▲	*20.41*	*92.34*	*14.53*	*0.83*	*2.00*	*95.76*	*1.62*	*77.57*	*1.27*	*60.57*

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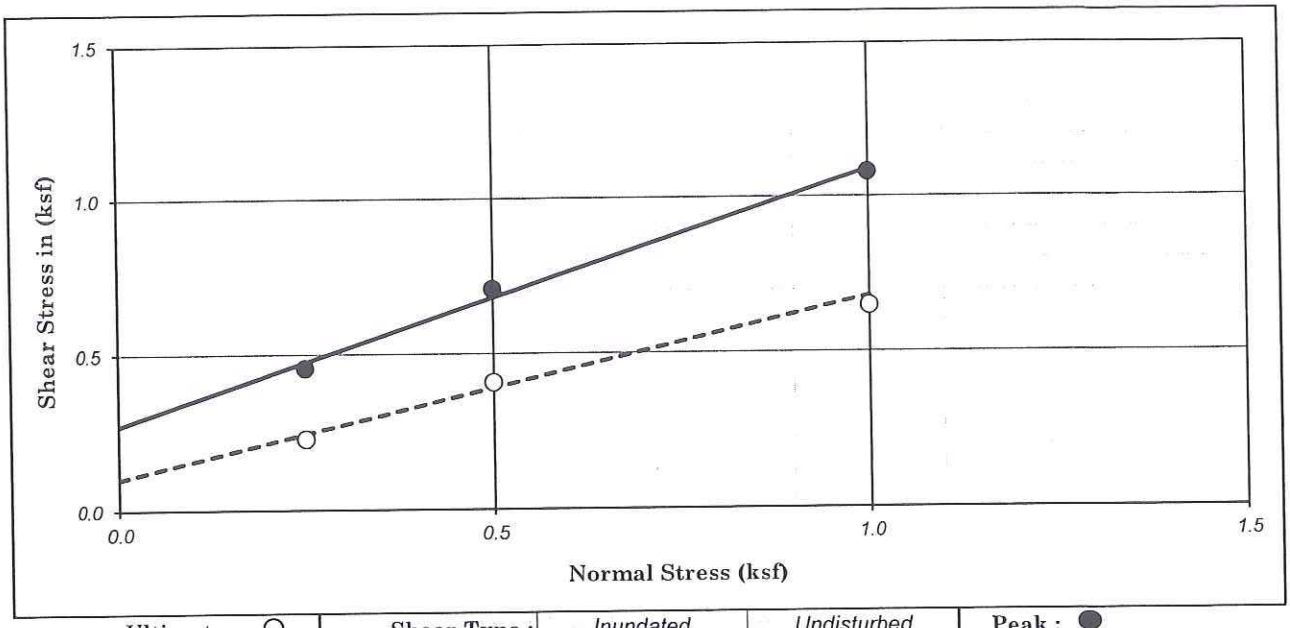
RBF/SR-91 WB Widening

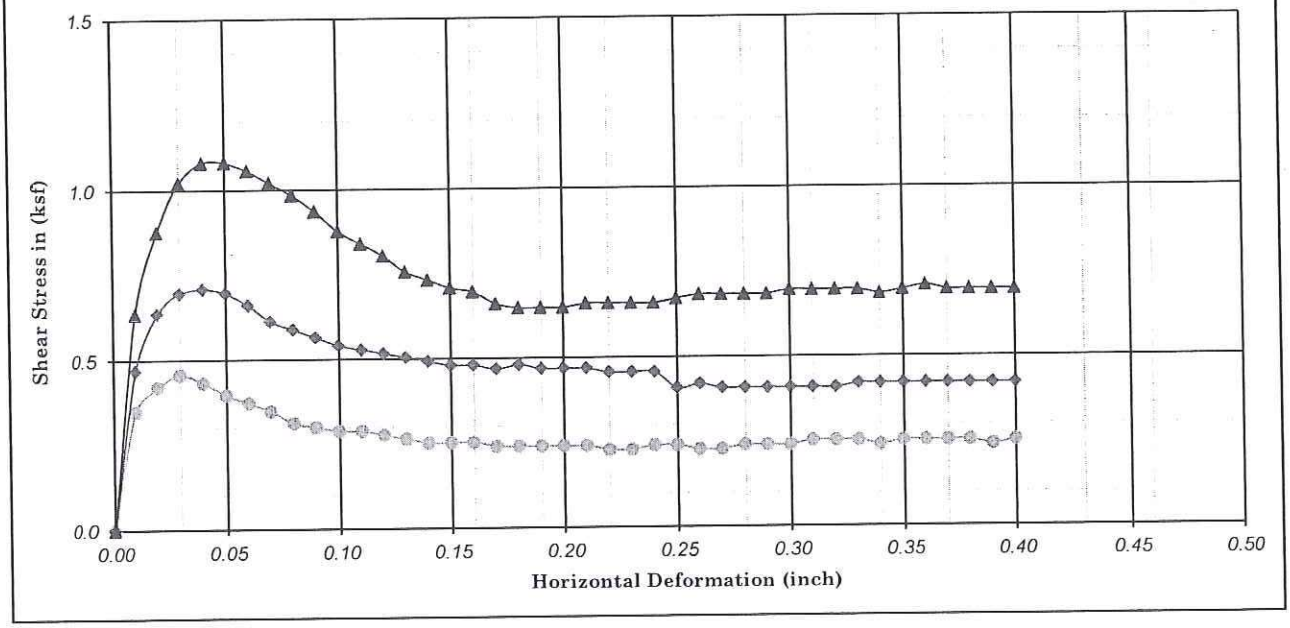
DIRECT SHEAR TEST

(ASTM D-3080)

Project No. : *10-126* | Date : *02/09/11* | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-037		Strength Intercept (C) :	0.27	(ksf)	Peak	0.11	(ksf)	Ultimate
Sample No. : D-1			12.93	(kPa)		5.17	(kPa)	
Depth (ft/m) : 5.0	0.00	Friction Angle (ϕ) :	39.33	Degree		30.11	Degree	
Description : Olive-brown, Poorly graded SAND with SILT (SP-SM)						Shear Rate (inch/minute) :		0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	13.04	110.32	17.36	0.53	0.25	11.97	0.46	21.83	0.23	10.92
◆	13.04	111.06	17.48	0.52	0.50	23.94	0.71	33.90	0.41	19.54
▲	13.18	110.26	17.36	0.53	1.00	47.88	1.08	51.71	0.65	31.03

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

RBF/SR-91 WB Widening

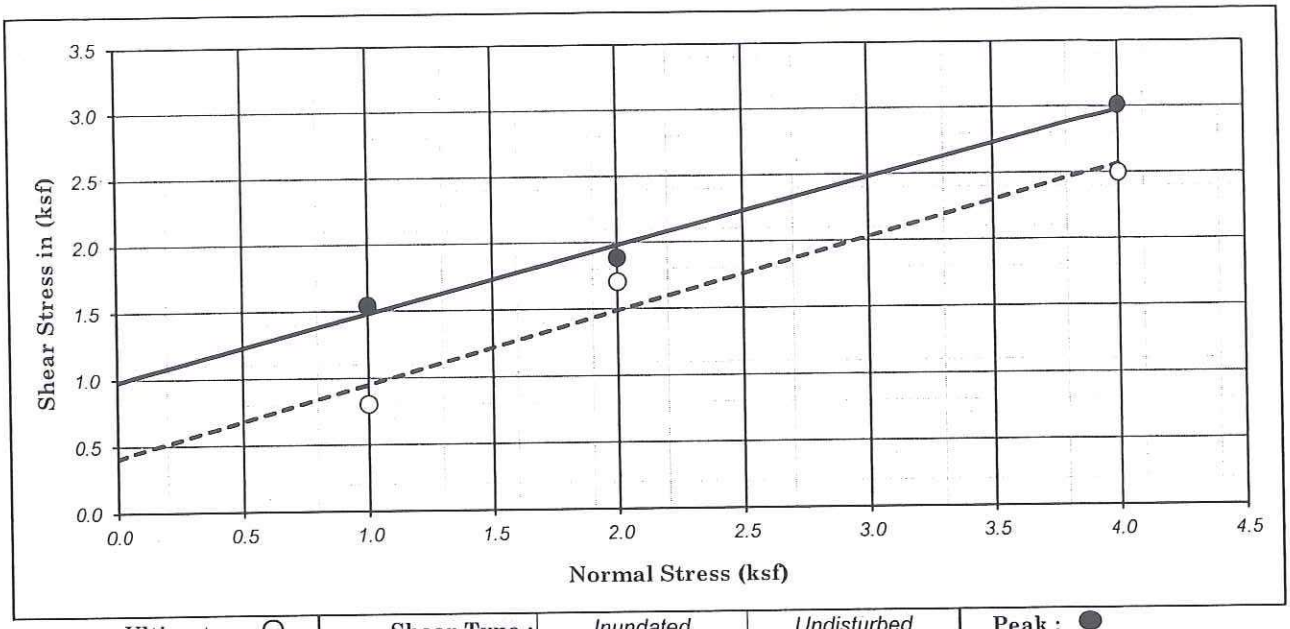
DIRECT SHEAR TEST

(ASTM D-3080)

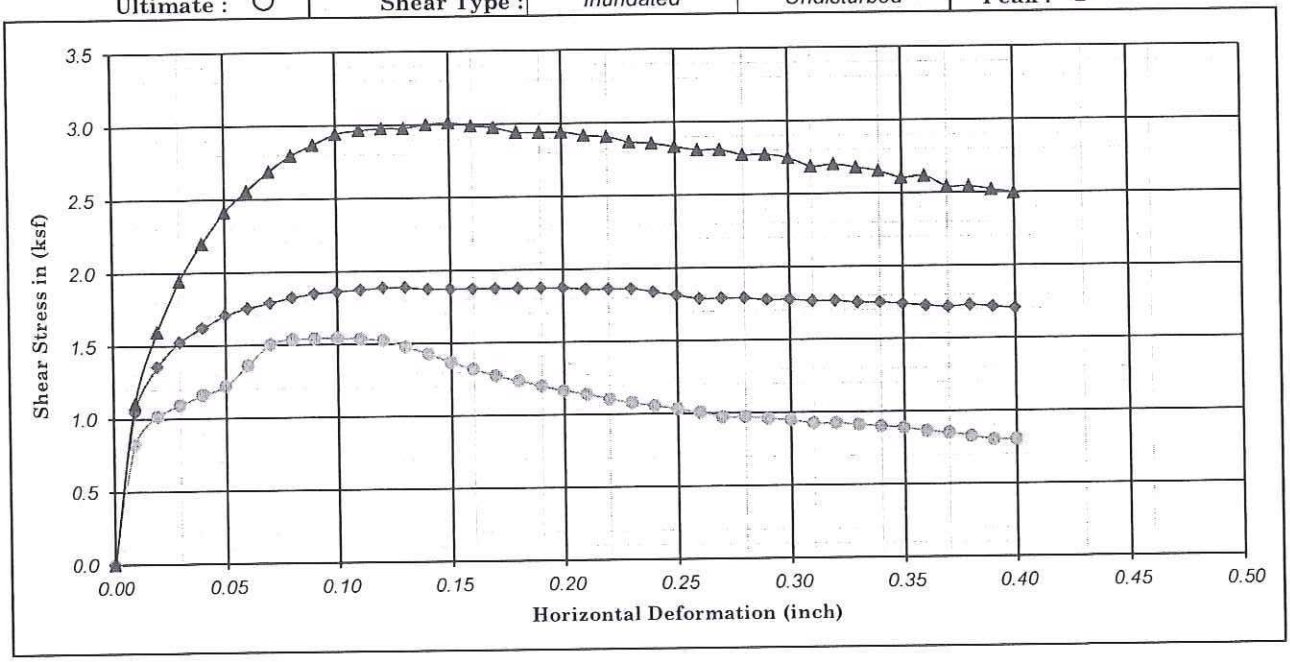
Project No. : 10-126

Date : 02/12/11

Figure No. :



Ultimate : ○ | Shear Type : Inundated | Undisturbed | Peak : ●



Boring No. : A-10-039	Strength Intercept (C) :	0.98	(ksf)	Peak	0.41	(ksf)	Ultimate
Sample No. : D-3		46.92	(kPa)		19.54	(kPa)	
Depth (ft/m) : 15.0 | 0.00	Friction Angle (ϕ) :	26.57	Degree		28.37	Degree	

Description : Dark brown, CLAYEY SAND (SC) — Shear Rate (inch/minute) : 0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	18.16	117.85	18.55	0.43	1.00	47.88	1.54	73.93	0.80	38.50
◆	20.18	114.11	17.96	0.48	2.00	95.76	1.88	90.21	1.70	81.59
▲	17.41	114.75	18.06	0.47	4.00	191.52	3.01	144.21	2.50	119.51

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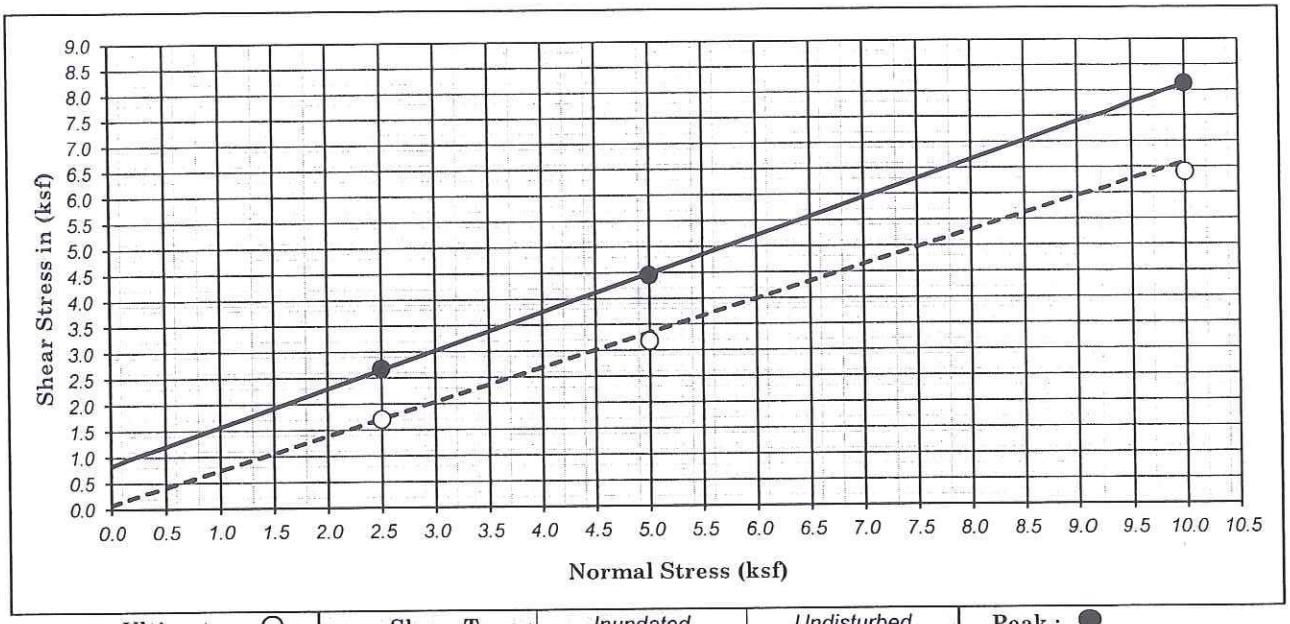
Geotechnical and Earthquake Engineering

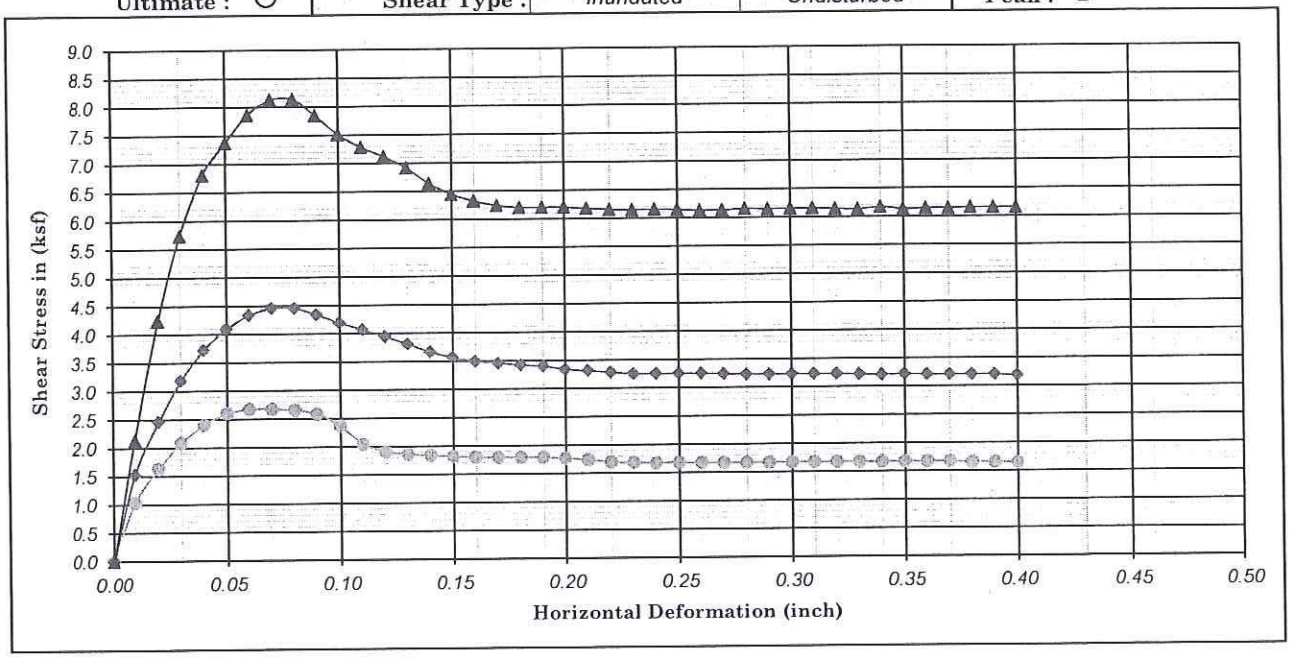
RBF/SR-91 WB Widening

DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126 | Date : 02/09/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-039		Strength Intercept (C) :	0.83	(ksf)	Peak	0.09	(ksf)	Ultimate
Sample No. : D-13			39.96	(kPa)		4.31	(kPa)	
Depth (ft/m) : 65.0	0.00	Friction Angle (ϕ) :	36.10	Degree		33.10	Degree	
Description : Olive-brown, SILTY SAND (SM)					Shear Rate (inch/minute) :		0.02	

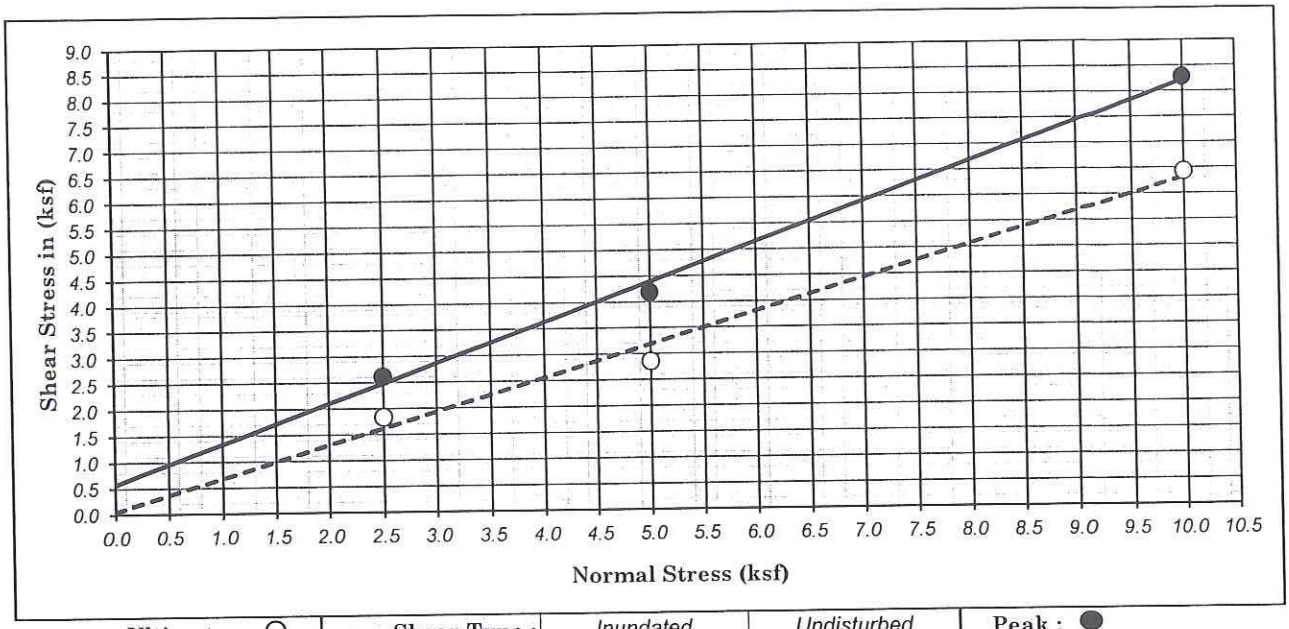
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	17.49	116.61	18.35	0.45	2.50	119.70	2.68	128.13	1.70	81.40
◆	17.58	117.17	18.44	0.44	5.00	239.40	4.45	213.16	3.18	152.26
▲	16.23	117.59	18.51	0.43	10.00	478.80	8.14	389.50	6.40	306.43

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

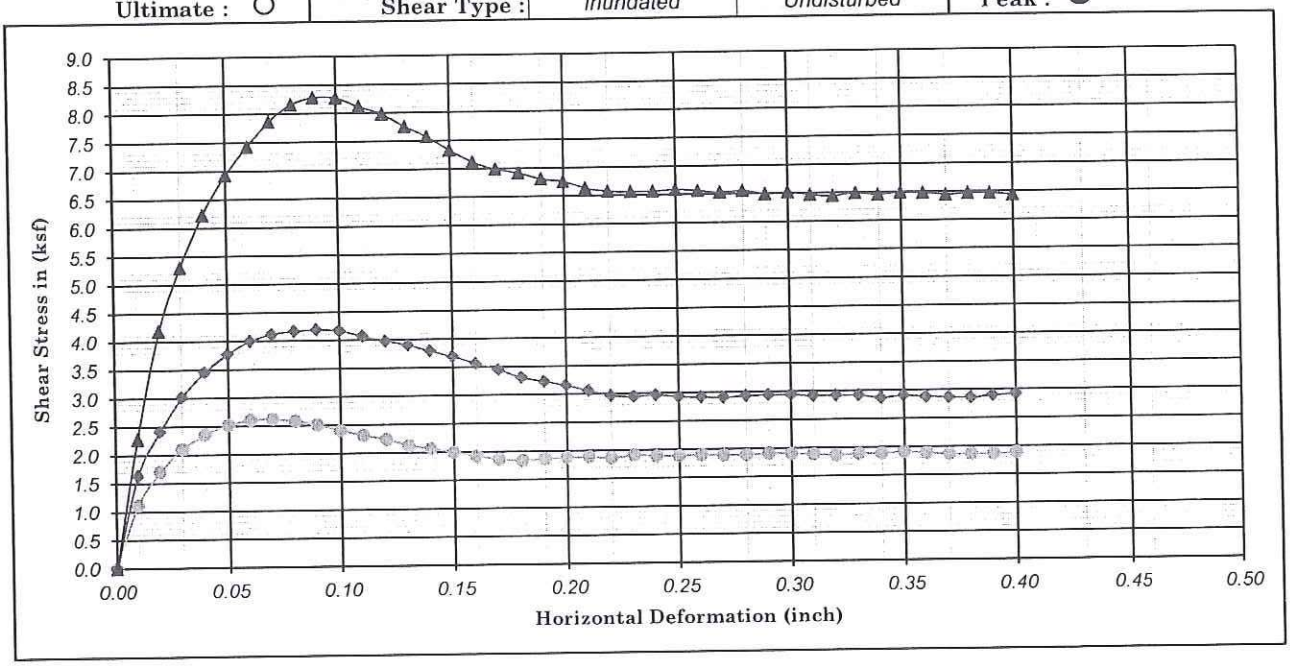
RBF/SR-91 WB Widening

DIRECT SHEAR TEST
(ASTM D-3080)

Project No. : 10-126 | Date : 02/12/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-040	Strength Intercept (C) :	0.57	(ksf)	Peak	0.05	(ksf)	Ultimate
Sample No. : D-8		27.32	(kPa)		2.32	(kPa)	
Depth (ft/m) : 40.0 | 0.00	Friction Angle (ϕ) :	37.38	Degree		32.10	Degree	
Description : Olive-brown, Poorly graded SAND (SP)				Shear Rate (inch/minute) :		0.02	

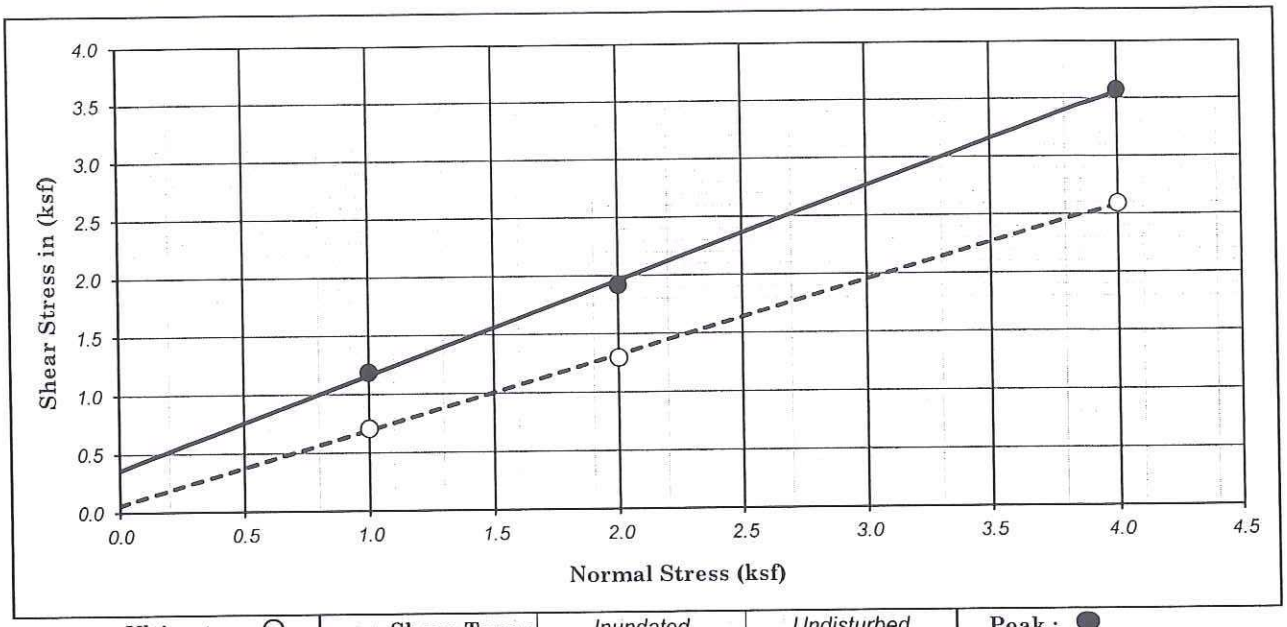
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	23.68	84.15	13.24	1.00	2.50	119.70	2.62	125.25	1.84	87.91
◆	23.44	86.93	13.68	0.94	5.00	239.40	4.19	200.52	2.86	136.75
▲	18.91	91.97	14.48	0.83	10.00	478.80	8.28	396.40	6.43	307.92

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

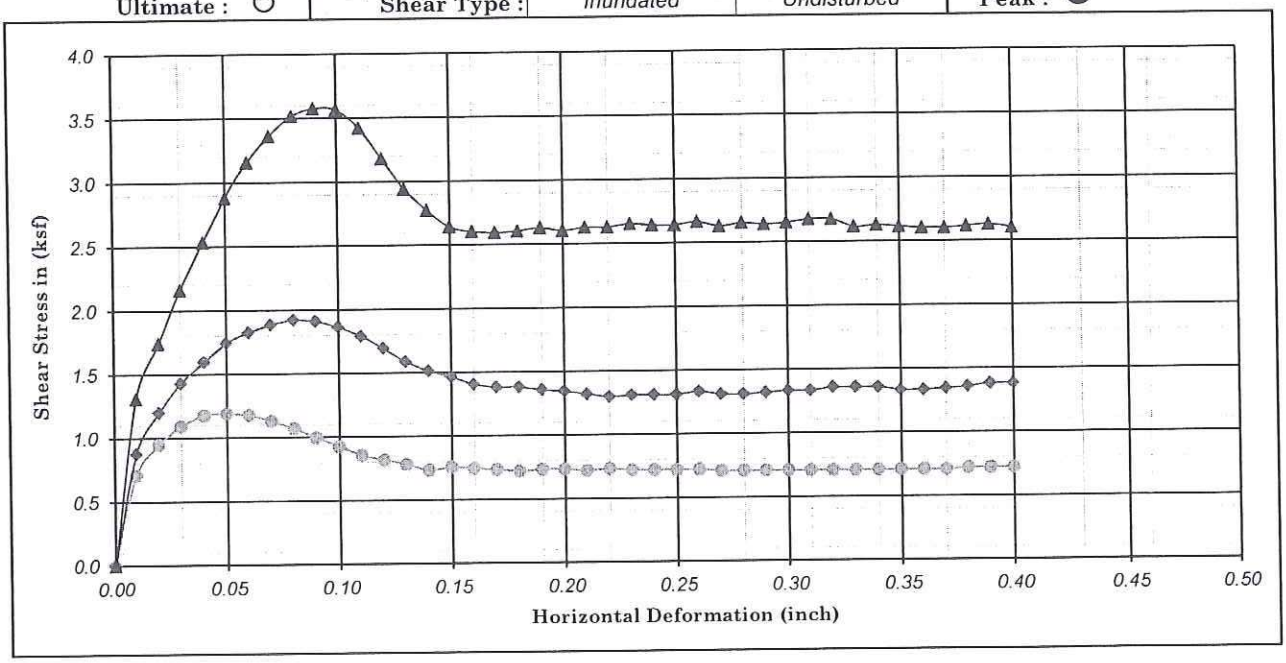
RBF/SR-91 WB Widening

DIRECT SHEAR TEST
(ASTM D-3080)

Project No. : 10-126 | Date : 02/12/11 | Figure No. :



Ultimate : ○ | Shear Type : Inundated | Undisturbed | Peak : ●



Boring No. : A-10-044		Strength Intercept (C) :	0.36	(ksf)	Peak	0.06	(ksf)	Ultimate
Sample No. : D-4			17.24	(kPa)		2.87	(kPa)	
Depth (ft/m) : 20.0	0.00	Friction Angle (ϕ) :	38.68	Degree		32.25	Degree	

Description : Olive-brown, Poorly graded SAND with SILT (SP-SM) — Shear Rate (inch/minute) : 0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	17.67	96.23	15.15	0.75	1.00	47.88	1.19	56.88	0.71	33.90
◆	17.31	97.48	15.34	0.73	2.00	95.76	1.92	91.93	1.30	62.05
▲	18.82	93.50	14.72	0.80	4.00	191.52	3.58	171.22	2.59	124.10

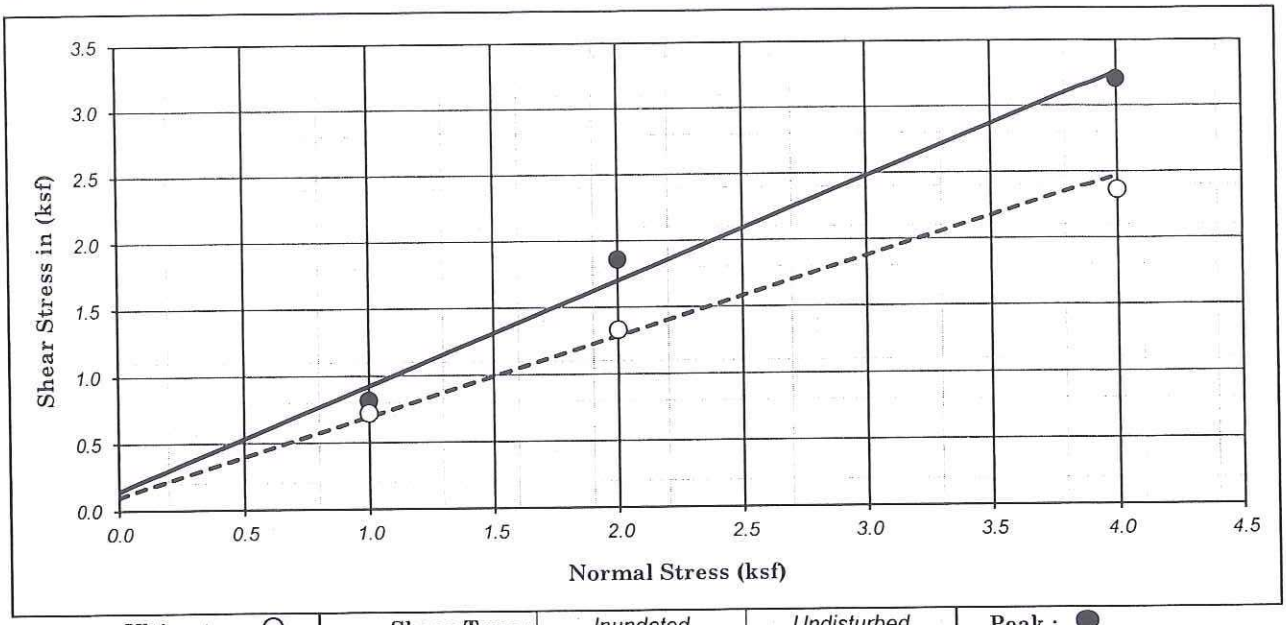
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

East Street UC (Widen)

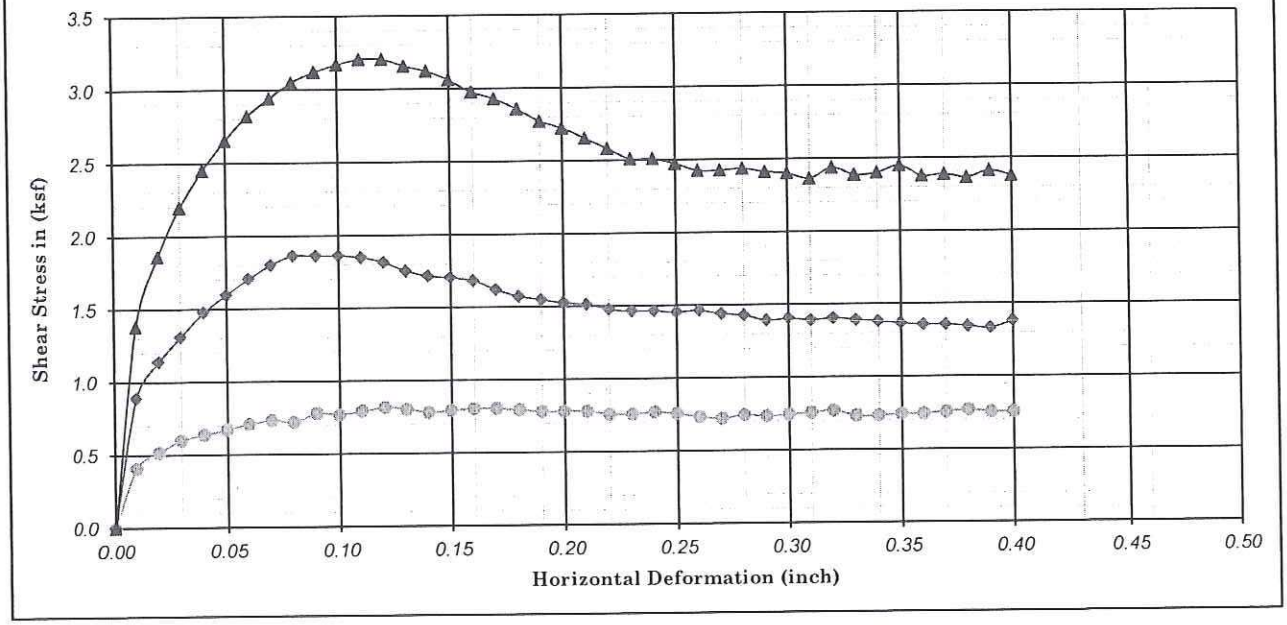
SR-91 WB Widening Project

DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126 | Date : 02/14/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-045		Strength Intercept (C) :	0.14	(ksf)	Peak	0.10	(ksf)	Ultimate
Sample No. : D-5			6.89	(kPa)		4.79	(kPa)	
Depth (ft/m) : 20.0	0.00	Friction Angle (ϕ) :	37.89	Degree		30.65	Degree	
Description : Olive-brown, Poorly graded SAND (SP)						Shear Rate (inch/minute) :		0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	20.92	86.79	13.66	0.94	1.00	47.88	0.82	39.07	0.72	34.47
◆	20.76	85.34	13.43	0.98	2.00	95.76	1.86	89.06	1.33	63.78
▲	21.14	86.77	13.66	0.94	4.00	191.52	3.20	153.41	2.36	113.19

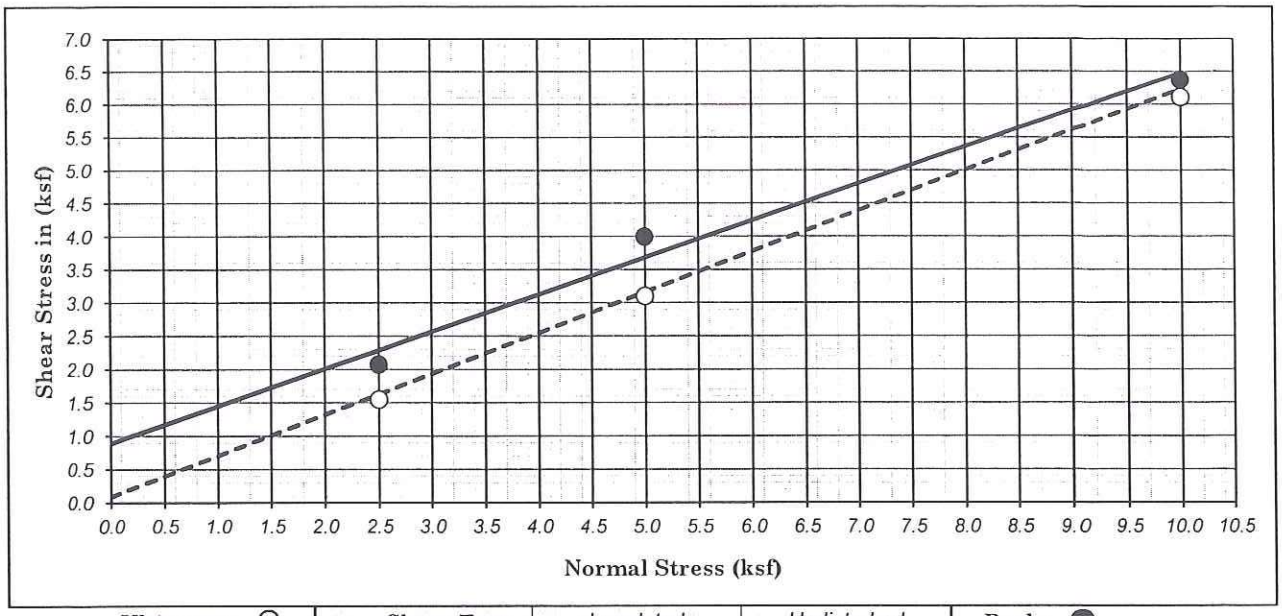
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

East Street UC (Widen)

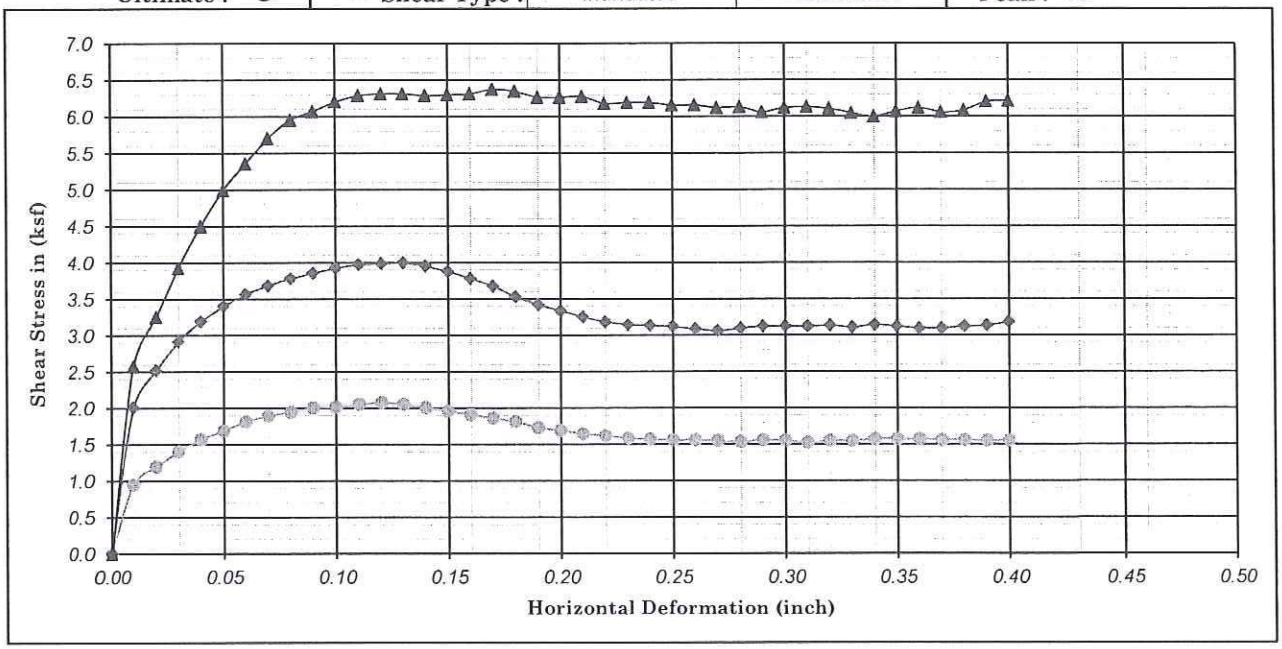
SR-91 WB Widening Project

DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126 | Date : 02/14/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-045		Strength Intercept (C) :	0.89	(ksf)	Peak	0.05	(ksf)	Ultimate
Sample No. : D-9			42.54	(kPa)		2.15	(kPa)	
Depth (ft/m) : 40.0	0.00	Friction Angle (ϕ) :	29.19	Degree		31.26	Degree	
Description : Olive-brown, Poorly graded SAND with SILT (SP-SM)					Shear Rate (inch/minute) :		0.02	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	23.28	82.92	13.05	1.03	2.50	119.70	2.08	99.40	1.55	74.21
◆	21.94	84.66	13.33	0.99	5.00	239.40	4.00	191.33	3.10	148.43
▲	21.88	88.41	13.92	0.91	10.00	478.80	6.37	305.04	6.11	292.55

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

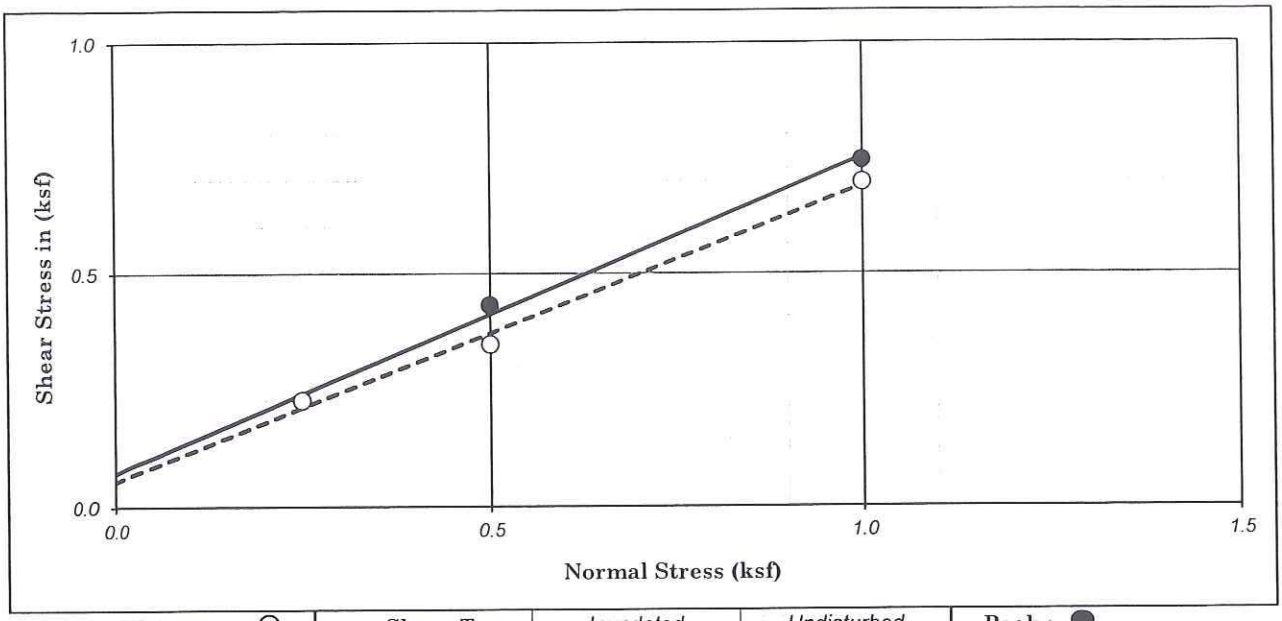
East Street UC (Widen)

SR-91 WB Widening Project

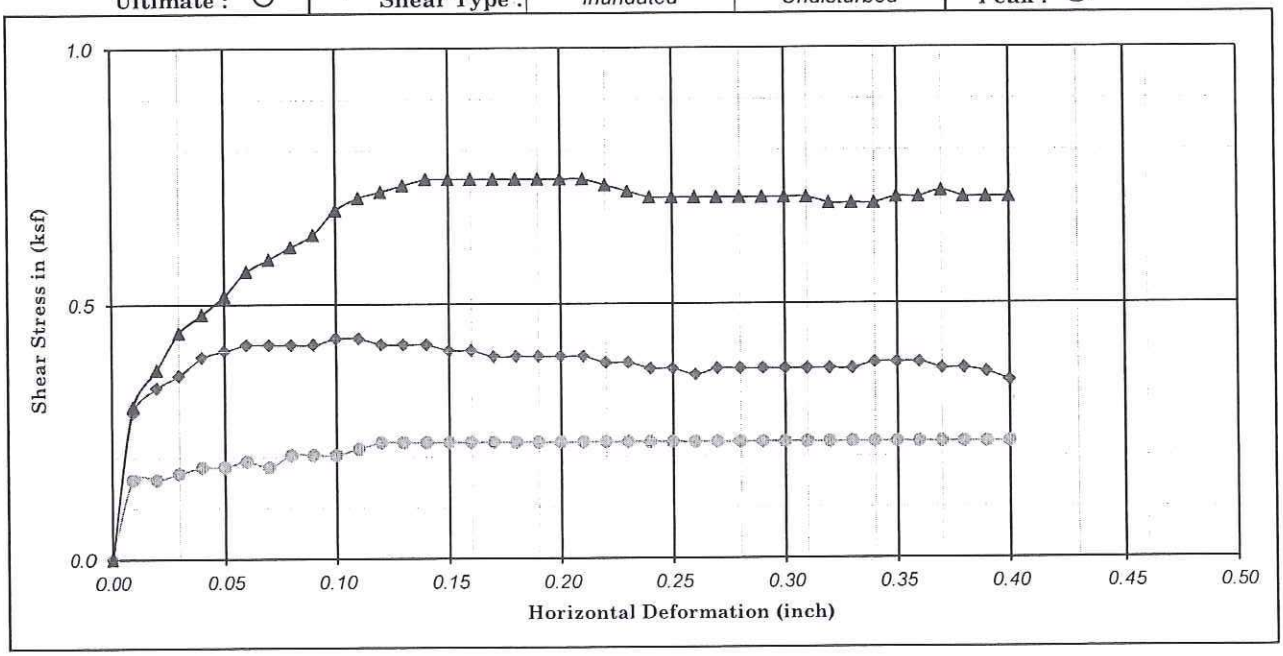
DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126 | Date : 02/14/11

Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-050		Strength Intercept (C) :	0.07	(ksf)	Peak	0.05	(ksf)	Ultimate	
Sample No. : D-1			3.45	(kPa)		2.59	(kPa)		
Depth (ft/m) : 5.0	0.00	Friction Angle (ϕ) :	34.17	Degree		32.39	Degree		
Description : Light yellowish brown, Poorly graded SAND (SP)						Shear Rate (inch/minute) :		0.02	

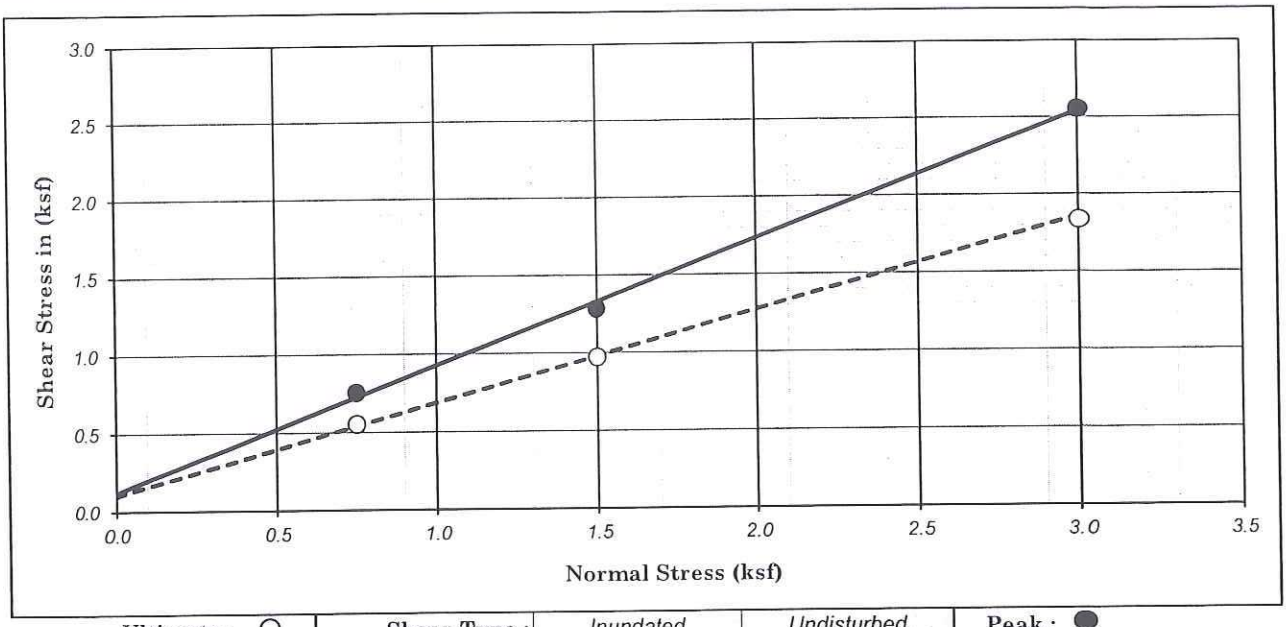
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	19.02	89.83	14.14	0.88	0.25	11.97	0.23	10.92	0.23	10.92
◆	19.83	90.04	14.17	0.87	0.50	23.94	0.43	20.68	0.35	16.66
▲	20.44	90.93	14.31	0.85	1.00	47.88	0.74	35.62	0.70	33.32

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

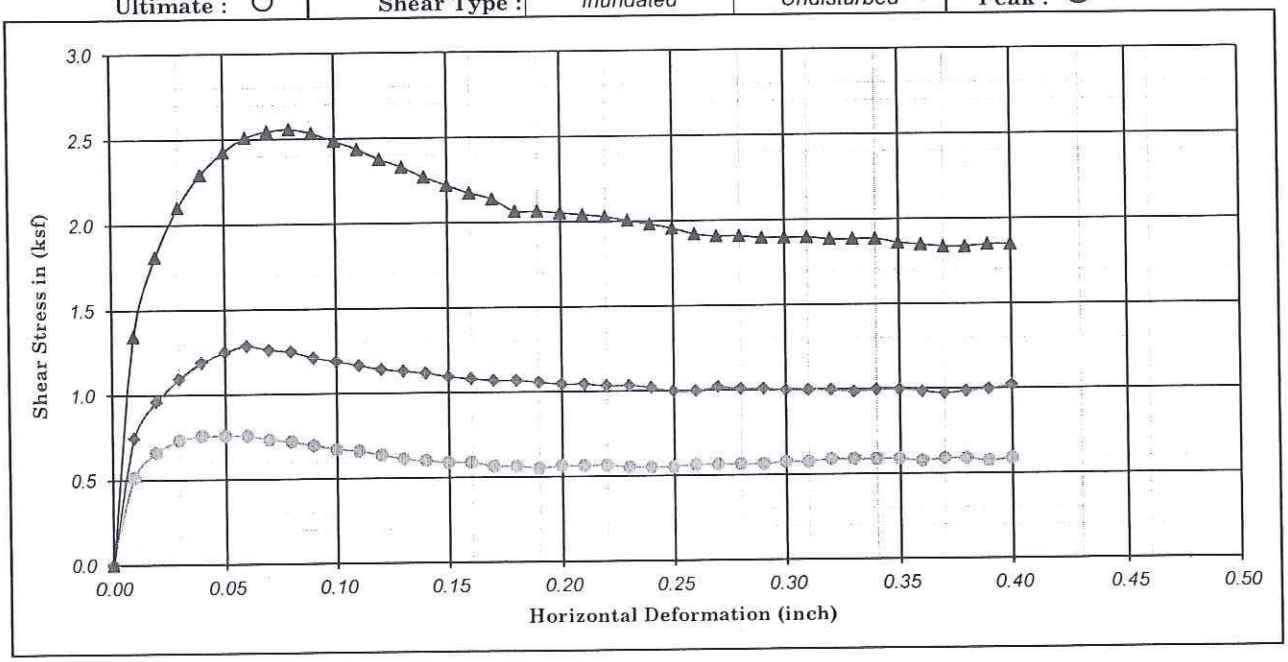
RBF/SR-91 WB Widening

DIRECT SHEAR TEST
(ASTM D-3080)

Project No. : 10-126 | Date : 02/14/11 | Figure No. :



Ultimate : ○ | Shear Type : *Inundated* | *Undisturbed* | Peak : ●



Boring No. : *A-10-052*	Strength Intercept (C) :	*0.12*	(ksf)	Peak	*0.12*	(ksf)	Ultimate
Sample No. : *D-2*		*5.75*	(kPa)		*5.75*	(kPa)	
Depth (ft/m) : *10.0* *0.00*	Friction Angle (ϕ) :	*38.90*	Degree		*30.40*	Degree	

Description : *Light yellowish brown, Poorly graded SAND with SILT (SP-SM)* — Shear Rate (inch/minute) : *0.02*

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	*14.63*	*111.32*	*17.52*	*0.51*	*0.75*	*35.91*	*0.76*	*36.20*	*0.55*	*26.43*
◆	*15.29*	*110.40*	*17.38*	*0.53*	*1.50*	*71.82*	*1.28*	*61.48*	*0.97*	*46.54*
▲	*13.78*	*110.44*	*17.38*	*0.53*	*3.00*	*143.64*	*2.56*	*122.38*	*1.84*	*87.91*

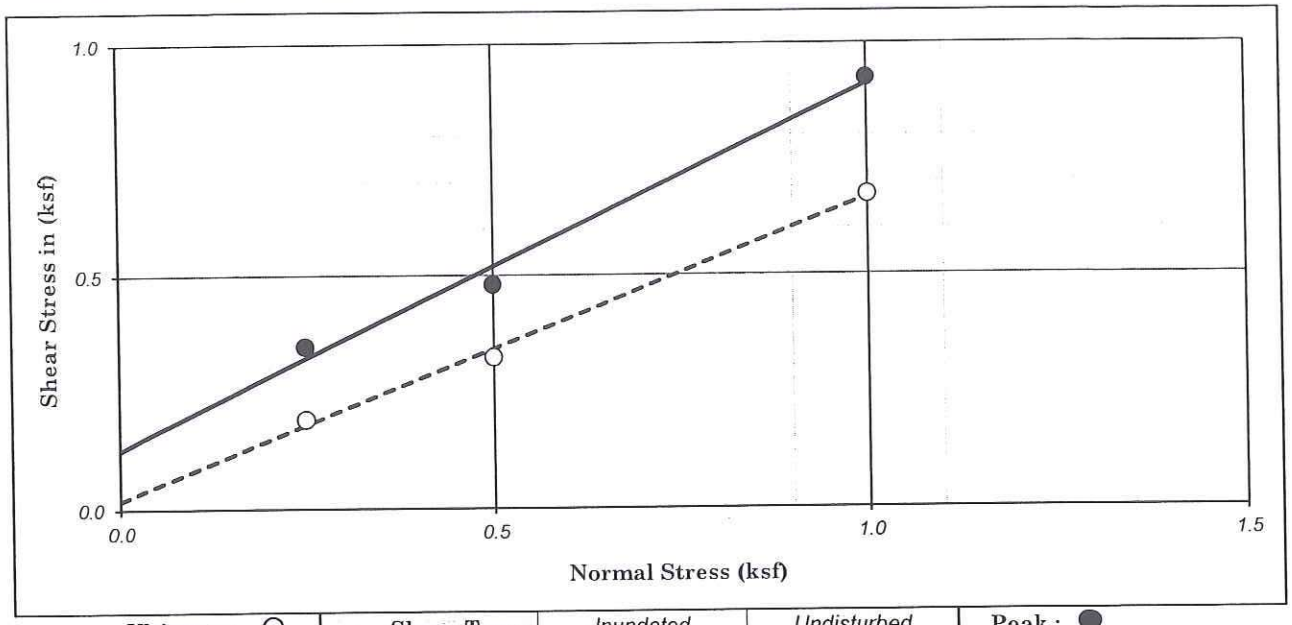
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

RBF/SR-91 WB Widening

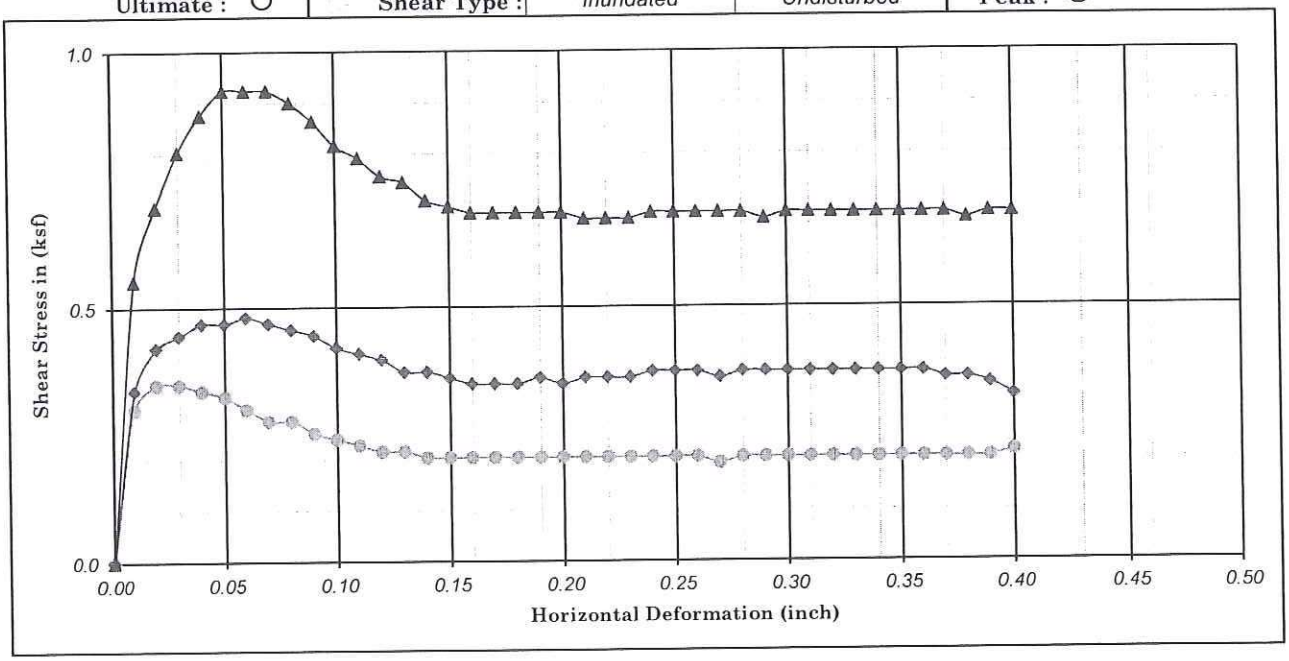
DIRECT SHEAR TEST

(ASTM D-3080)

Project No. : *10-126* | Date : *02/14/11* | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-054		Strength Intercept (C) :	0.13	(ksf)	Peak	0.02	(ksf)	Ultimate
Sample No. : D-2			6.03	(kPa)		0.86	(kPa)	
Depth (ft/m) : 5.0	0.00	Friction Angle (ϕ) :	38.14	Degree		32.94	Degree	
Description : Light olive-brown, Poorly graded SAND with SILT (SP-SM)					Shear Rate (inch/minute) :		0.02	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	22.48	83.52	13.15	1.02	0.25	11.97	0.35	16.66	0.19	9.19
◆	22.46	83.31	13.11	1.02	0.50	23.94	0.48	22.98	0.32	15.51
▲	22.83	82.50	12.99	1.04	1.00	47.88	0.92	44.24	0.67	32.18

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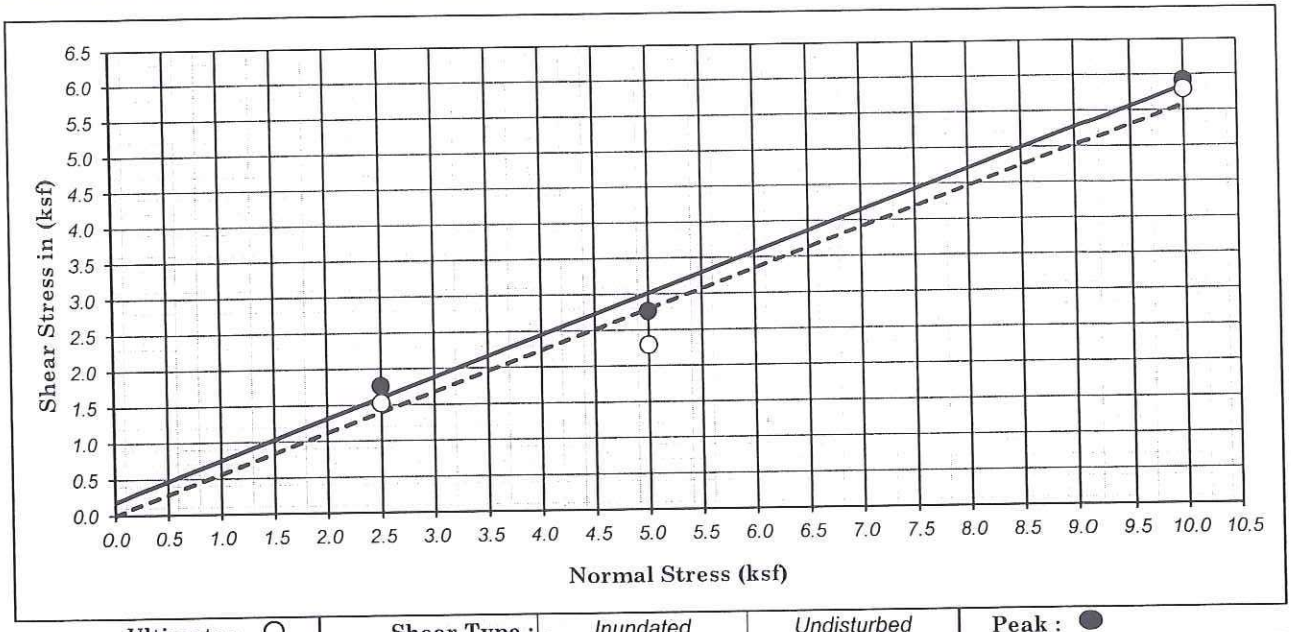
Geotechnical and Earthquake Engineering

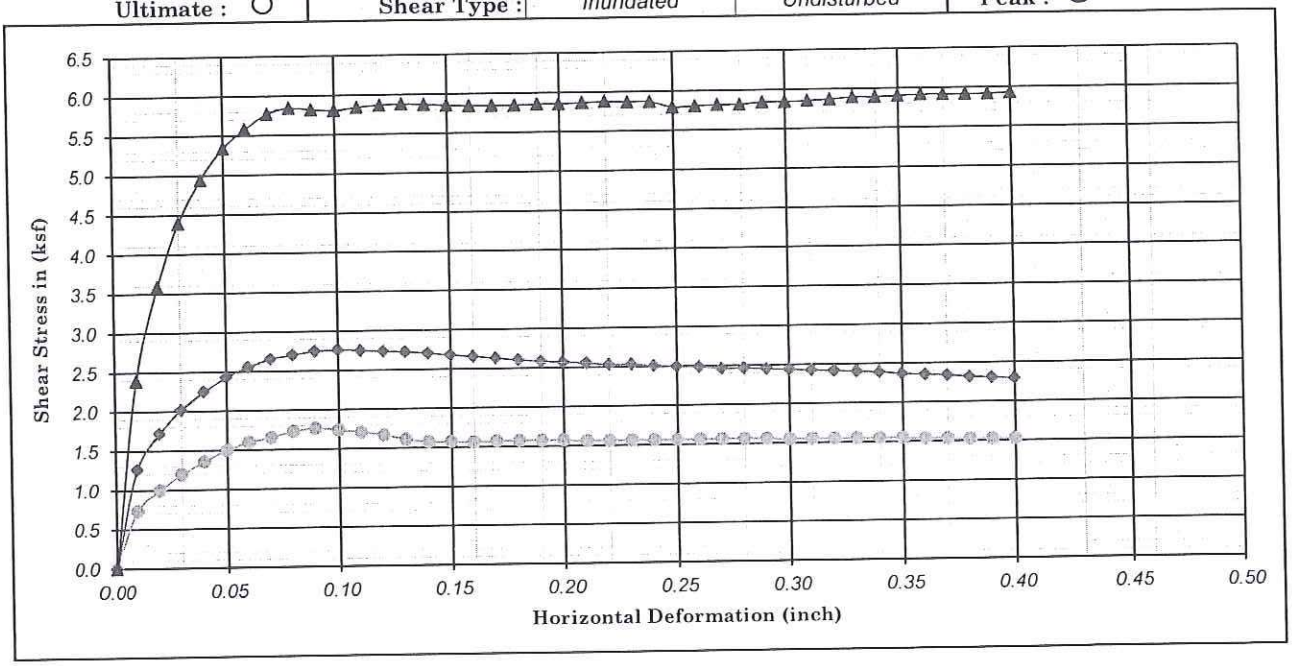
RBF/SR-91 WB Widening

DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126 | Date : 02/15/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-054		Strength Intercept (C) :	0.18	(ksf)	Peak	0.00	(ksf)	Ultimate	
Sample No. : D-12			8.64	(kPa)		0.00	(kPa)		
Depth (ft/m) : 55.0	0.00	Friction Angle (ϕ) :	29.52	Degree		29.16	Degree		
Description : Dark olive-brown, SILTY SAND / SANDY SILT (SM/ML)						Shear Rate (inch/minute) :		0.02	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	34.48	89.57	14.10	0.88	2.50	119.70	1.76	84.46	1.52	72.97
◆	36.46	88.46	13.92	0.91	5.00	239.40	2.76	132.15	2.29	109.74
▲	28.04	97.56	15.36	0.73	10.00	478.80	5.93	283.78	5.80	277.46

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

RBF/SR-91 WB Widening

DIRECT SHEAR TEST

(ASTM D-3080)

Project No. : 10-126

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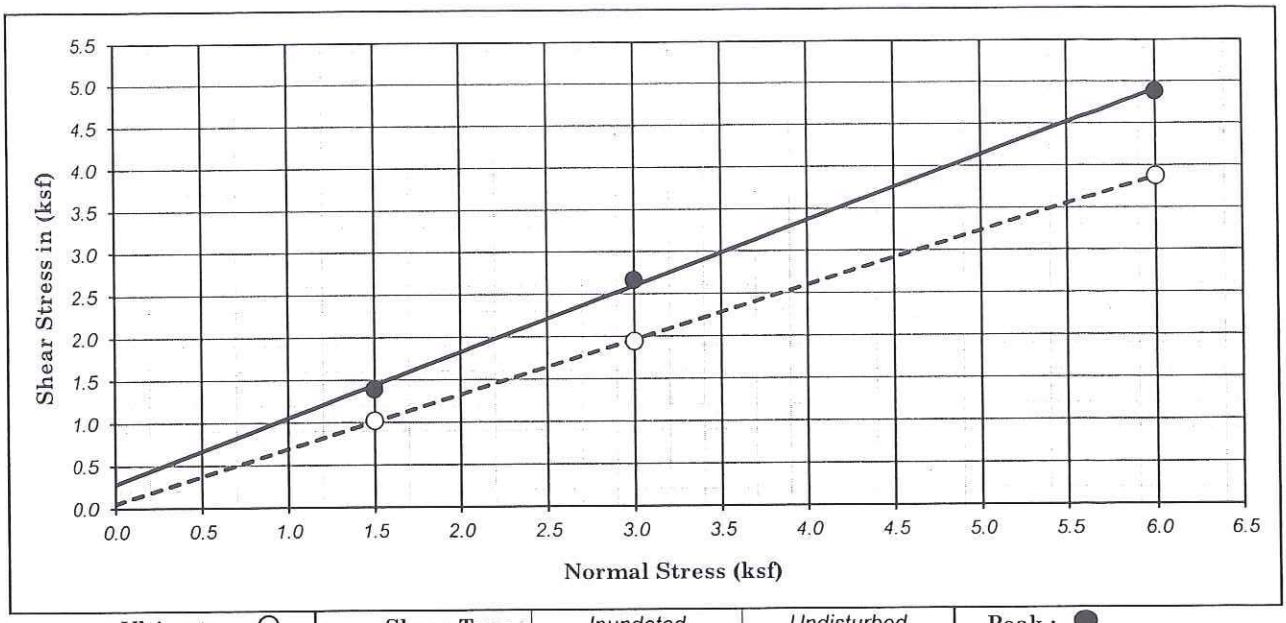
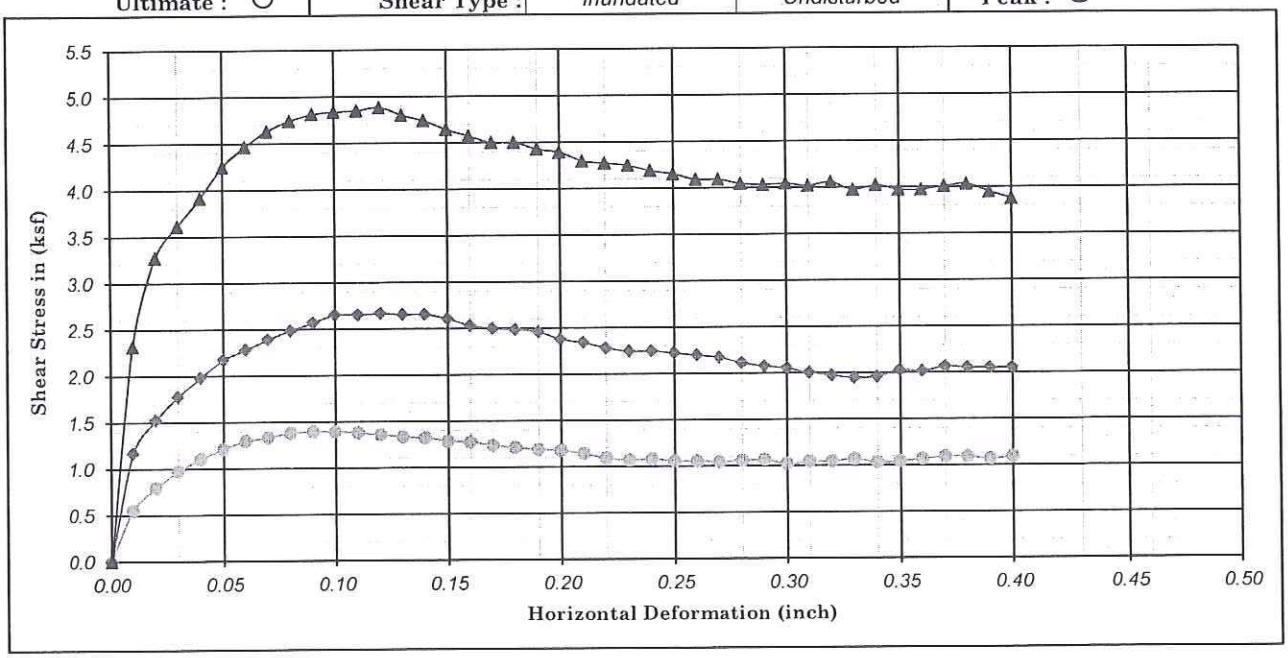
Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-055		Strength Intercept (C) :	0.28	(ksf)	Peak	0.05	(ksf)	Ultimate
Sample No. : D-4			13.50	(kPa)		2.59	(kPa)	
Depth (ft/m) : 20.0	0.00	Friction Angle (ϕ) :	37.63	Degree		32.46	Degree	
Description : Light yellowish brown, Poorly graded SAND (SP)					Shear Rate (inch/minute) :			0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m³)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	17.03	94.93	14.94	0.78	1.50	71.82	1.39	66.65	1.02	48.84
◆	16.41	97.96	15.42	0.72	3.00	143.64	2.66	127.55	1.94	93.08
▲	11.19	101.59	15.99	0.66	6.00	287.28	4.88	233.85	3.88	185.58

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Geotechnical and Earthquake Engineering

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DIRECT SHEAR TEST

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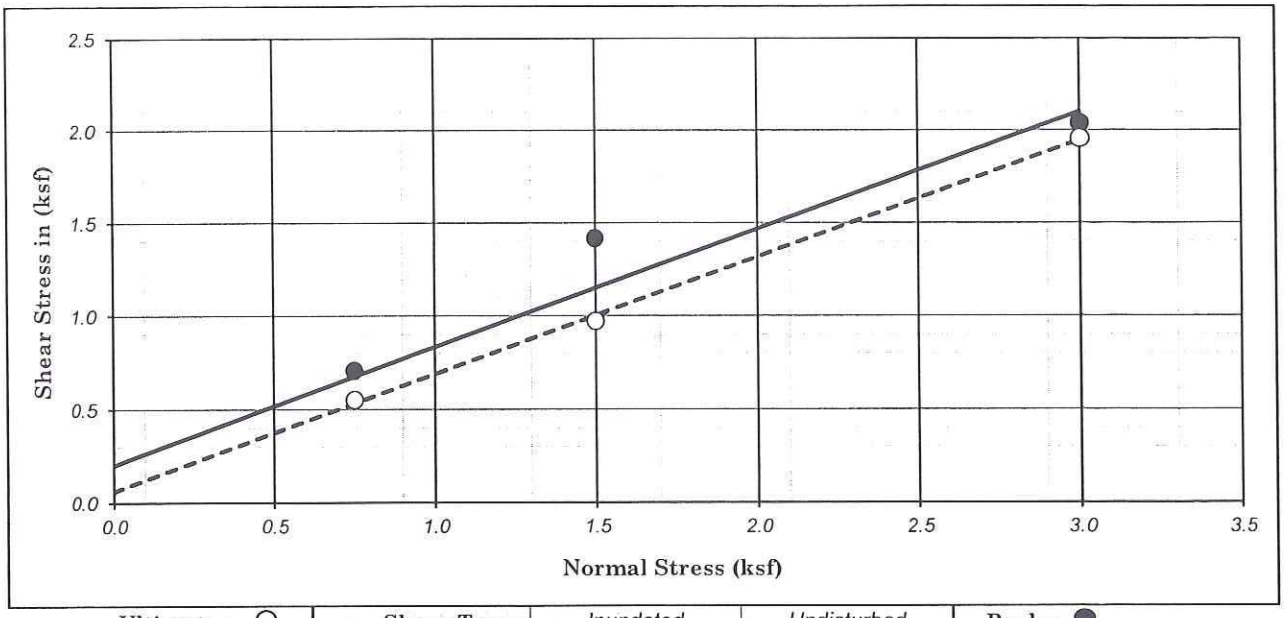
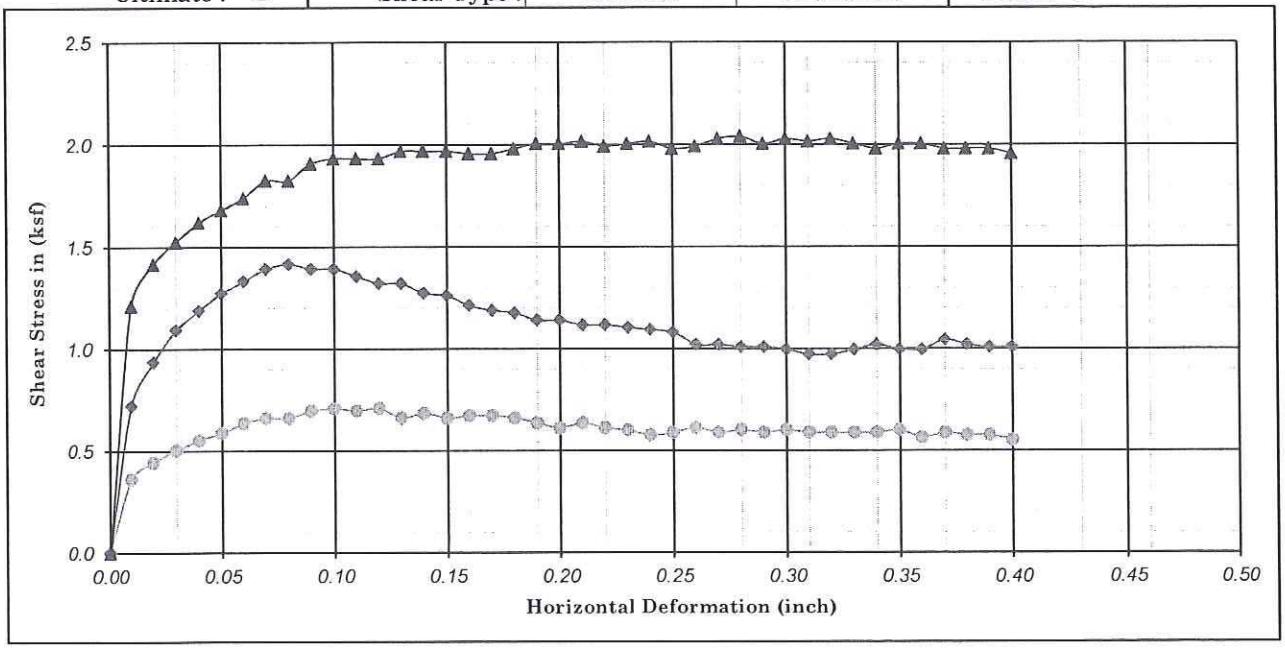
Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-058		Strength Intercept (C) :	0.40	(ksf)	Peak	0.06	(ksf)	Ultimate	
Sample No. : D-2			18.96	(kPa)		2.87	(kPa)		
Depth (ft/m) : 10.0	0.00	Friction Angle (ϕ) :	32.35	Degree		32.15	Degree		
Description : Light yellowish brown, Poorly graded SAND with SILT (SP-SM)						Shear Rate (inch/minute) :		0.02	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	17.05	100.78	15.86	0.67	0.75	35.91	0.71	33.90	0.55	26.43
◆	17.94	92.99	14.64	0.81	1.50	71.82	1.42	67.80	0.97	46.54
▲	19.82	91.78	14.45	0.84	3.00	143.64	2.04	97.68	1.96	93.65

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

RBF/SR-91 WB Widening

DIRECT SHEAR TEST

(ASTM D-3080)

Project No. : 10-126

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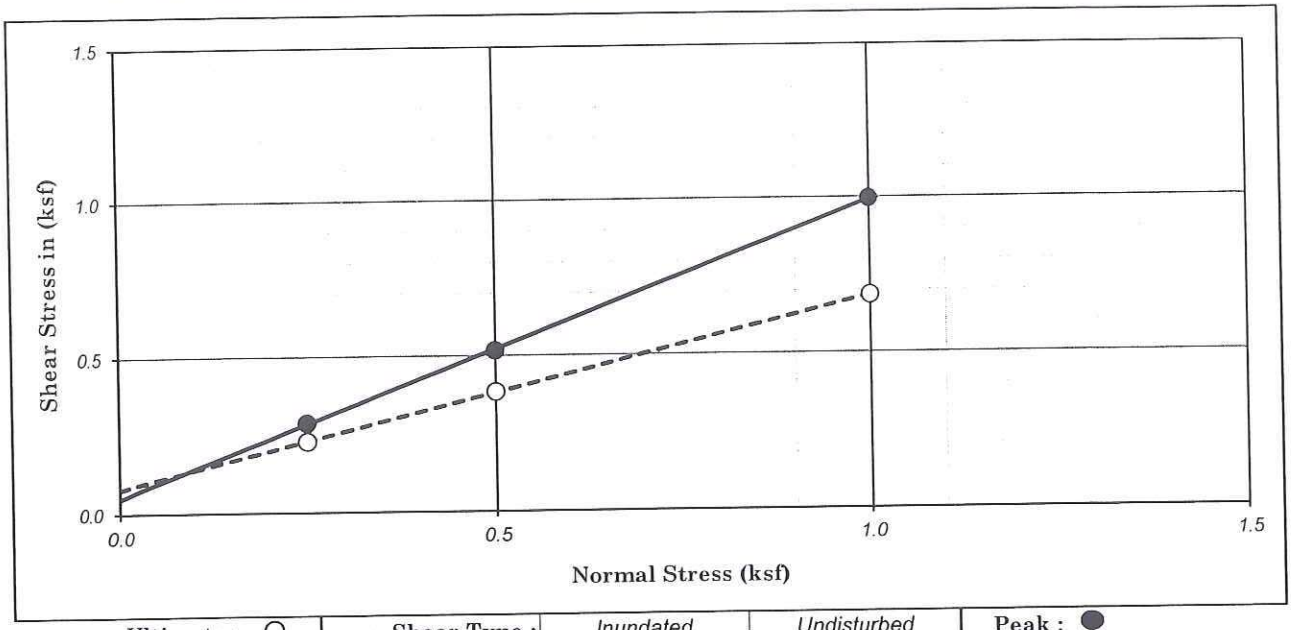
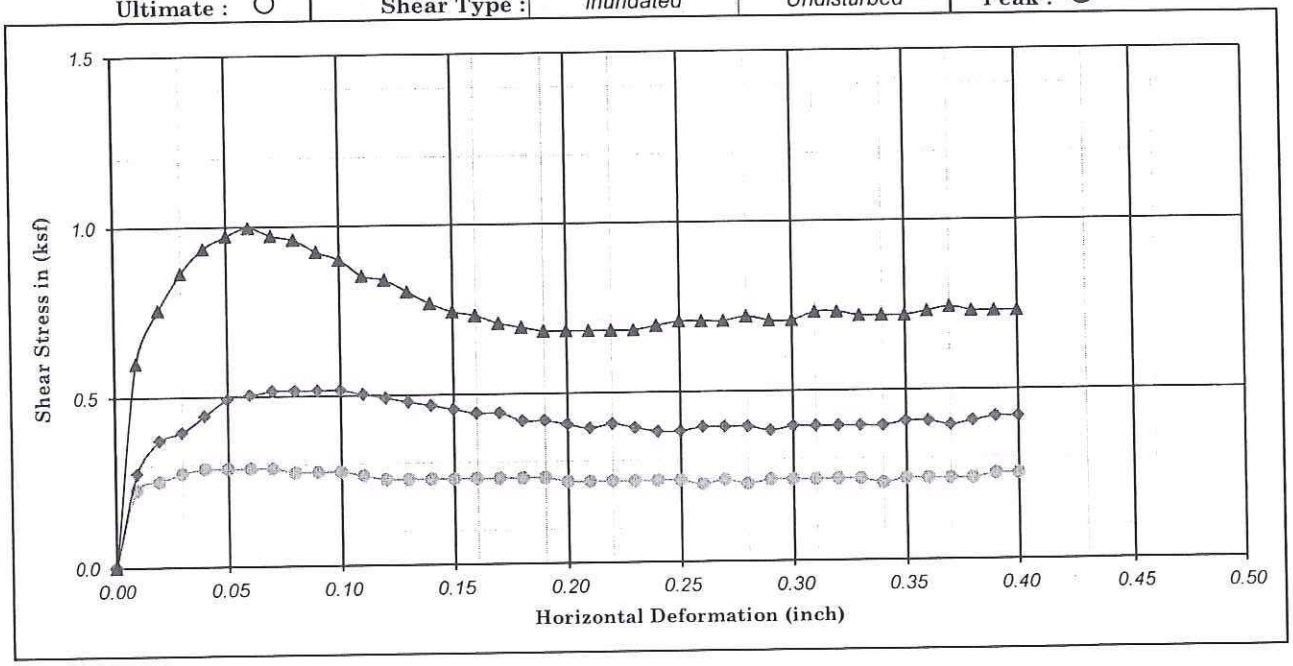
Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-061		Strength Intercept (C) :	0.05	(ksf)	Peak	0.08	(ksf)	Ultimate
Sample No. : D-1			2.30	(kPa)		3.73	(kPa)	
Depth (ft/m) : 5.0	0.00	Friction Angle (ϕ) :	43.42	Degree		31.25	Degree	
Description : Light yellowish brown, Poorly graded SAND with SILT (SP-SM)						Shear Rate (inch/minute) :		0.02

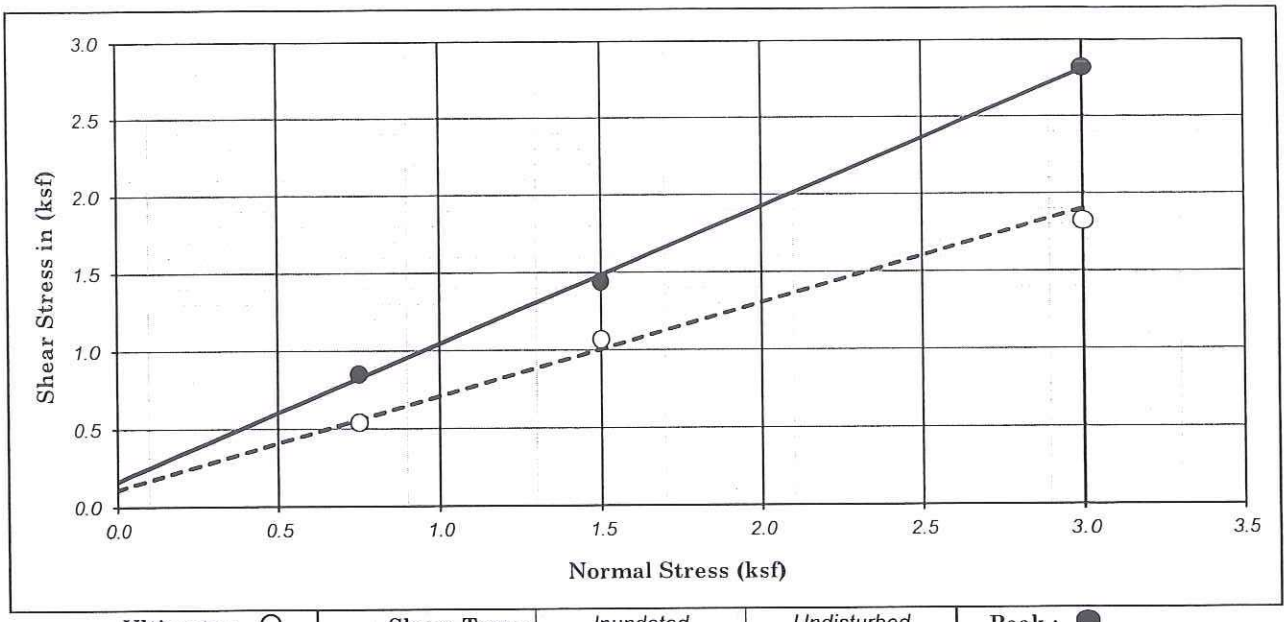
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	17.16	98.38	15.48	0.71	0.25	11.97	0.29	13.79	0.23	10.92
◆	17.23	97.56	15.36	0.73	0.50	23.94	0.52	24.71	0.38	18.39
▲	16.41	94.06	14.80	0.79	1.00	47.88	1.00	47.69	0.68	32.75

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

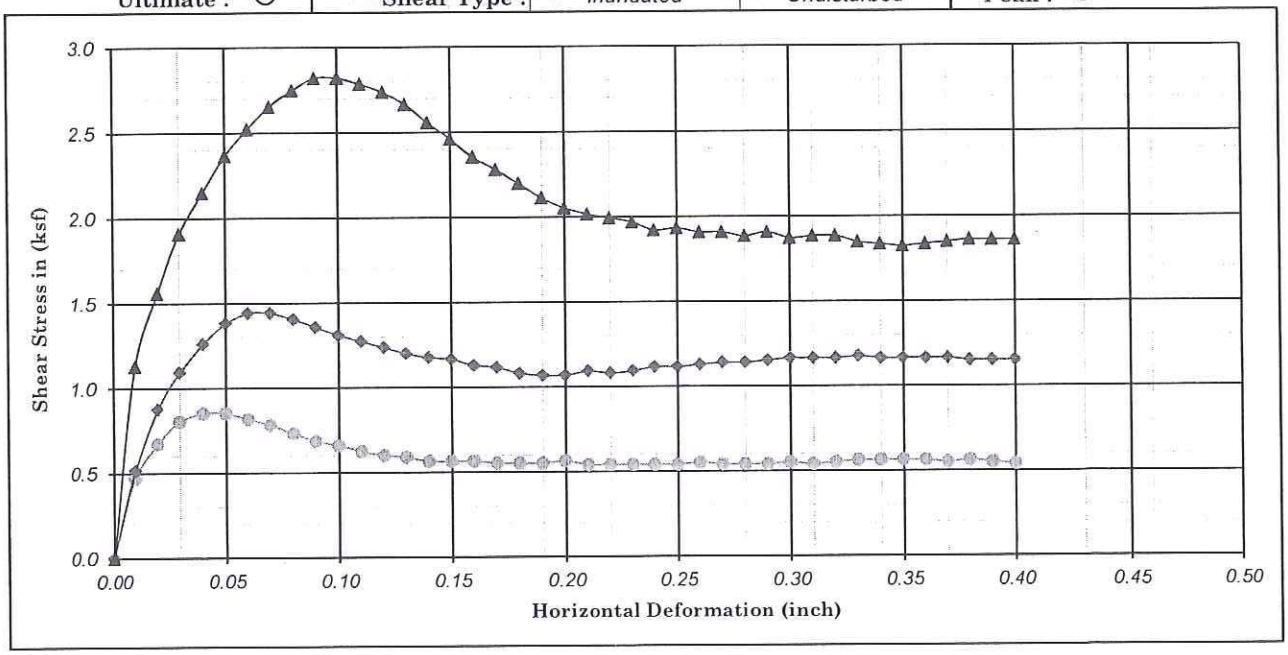
RBF/SR-91 WB Widening

DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126 | Date : 02/15/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-063		Strength Intercept (C) :	0.16	(ksf)	Peak	0.16	(ksf)	Ultimate	
Sample No. : D-3			7.76	(kPa)		7.76	(kPa)		
Depth (ft/m) : 10.0	0.00	Friction Angle (ϕ) :	41.38	Degree		30.82	Degree		
Description : Light yellowish brown, Poorly graded SAND with SILT (SP-SM)						Shear Rate (inch/minute) :		0.02	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	17.41	95.73	15.07	0.76	0.75	35.91	0.85	40.79	0.54	25.86
◆	19.31	94.89	14.93	0.78	1.50	71.82	1.44	68.95	1.07	51.14
▲	18.90	93.74	14.75	0.80	3.00	143.64	2.82	135.02	1.82	87.33
					0.00	0.00	0.16	7.76	0.11	
					3.0	143.64	2.81	134.32	1.90	

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

RBF/SR-91 WB Widening

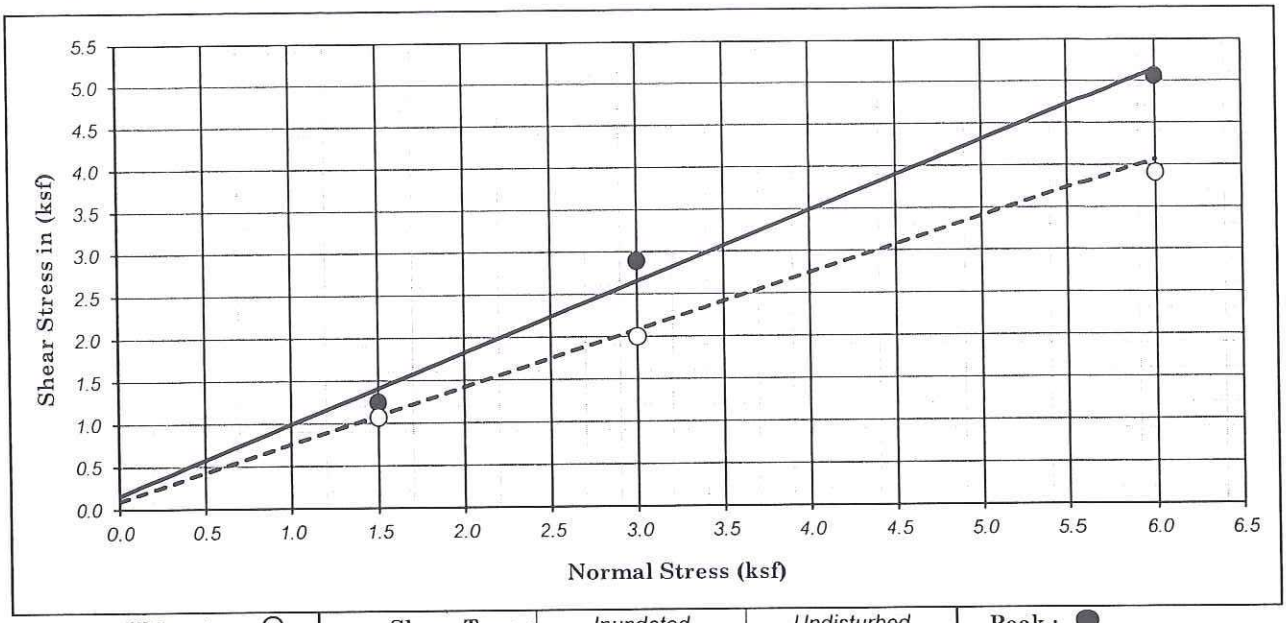
DIRECT SHEAR TEST

(ASTM D-3080)

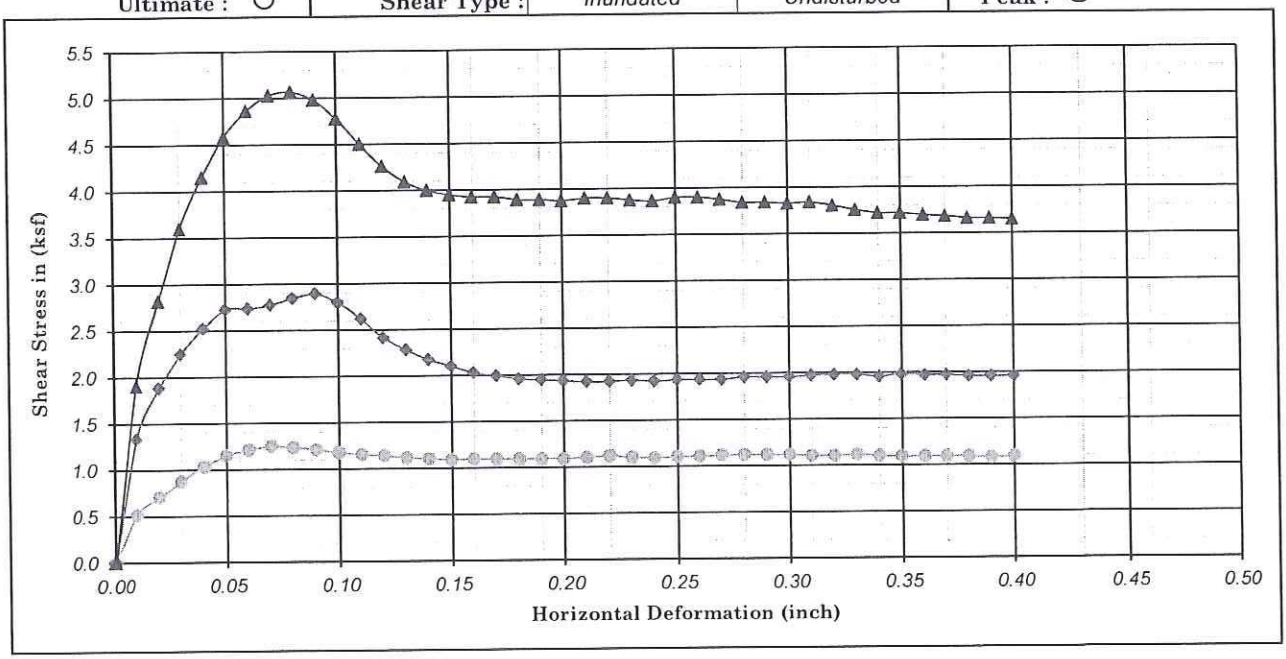
Project No. : 10-126

Date : 02/16/11

Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-063		Strength Intercept (C) :	0.16	(ksf)	Peak	0.10	(ksf)	Ultimate
Sample No. : D-7			7.76	(kPa)		4.57	(kPa)	
Depth (ft/m) : 30.0	0.00	Friction Angle (ϕ) :	39.70	Degree		33.51	Degree	

Description : *Light yellowish brown, Poorly graded SAND with SILT (SP-SM)* — Shear Rate (inch/minute) : 0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	22.18	91.04	14.33	0.85	1.50	71.82	1.25	59.75	1.07	51.23
◆	20.89	93.74	14.75	0.80	3.00	143.64	2.89	138.47	2.00	95.76
▲	20.21	93.57	14.73	0.80	6.00	287.28	5.06	242.46	3.91	187.21

Earth Mechanics, Inc.
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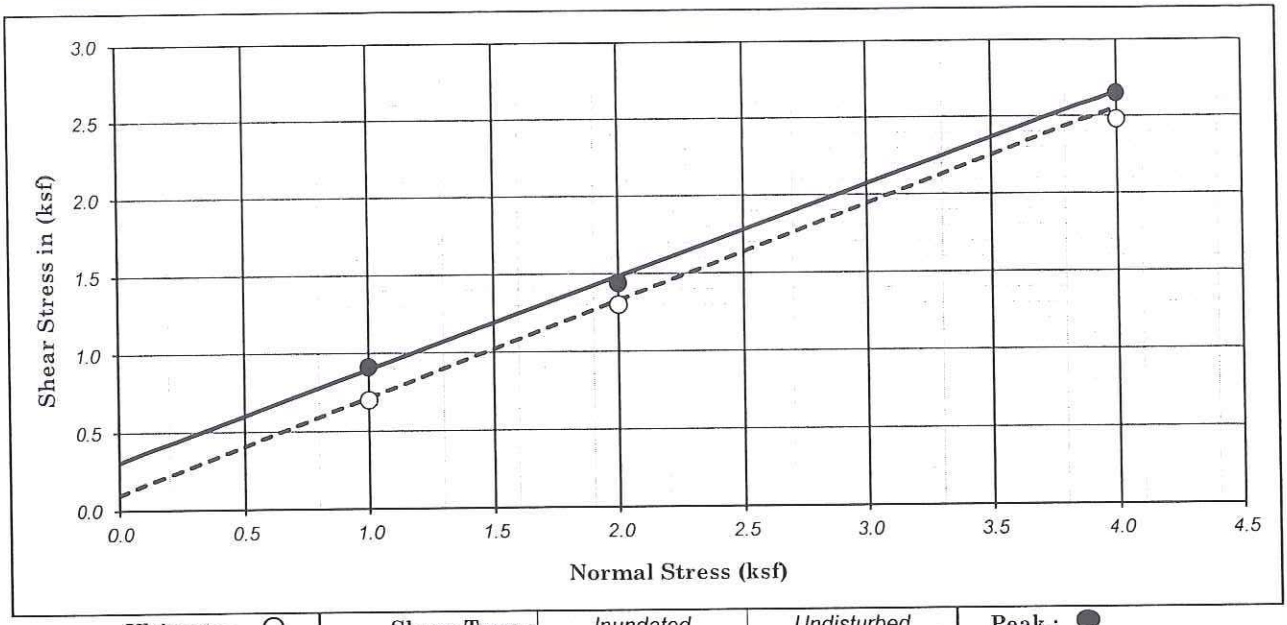
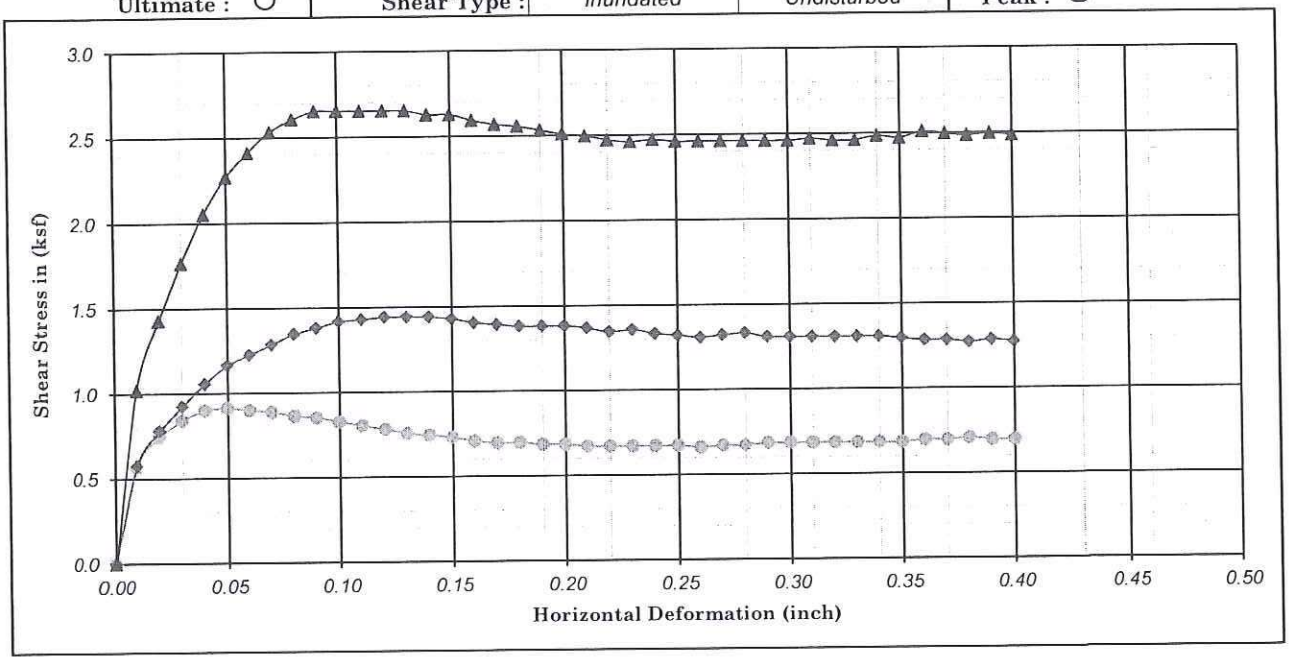
DIRECT SHEAR TEST

(ASTM D-3080)

Project No. : 10-126 | Date : 02/15/11 | Figure No. :



Ultimate : ○ | Shear Type : *Inundated* | *Undisturbed* | Peak : ●



Boring No. : *A-10-064*	Strength Intercept (C) :	*0.31*	(ksf)	Peak	*0.10*	(ksf)	Ultimate
Sample No. : *D-4*		*14.65*	(kPa)		*4.69*	(kPa)	
Depth (ft/m) : *20.0* / *0.00*	Friction Angle (ϕ) :	*30.48*	Degree		*31.61*	Degree	
Description : *Olive-brown, Poorly graded SAND with SILT (SP-SM)*				Shear Rate (inch/minute) :		*0.02*	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	*16.83*	*101.45*	*15.97*	*0.66*	*1.00*	*47.88*	*0.91*	*43.67*	*0.70*	*33.52*
◆	*17.68*	*100.03*	*15.75*	*0.69*	*2.00*	*95.76*	*1.44*	*68.95*	*1.30*	*62.24*
▲	*17.91*	*97.44*	*15.34*	*0.73*	*4.00*	*191.52*	*2.65*	*126.98*	*2.48*	*118.74*

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

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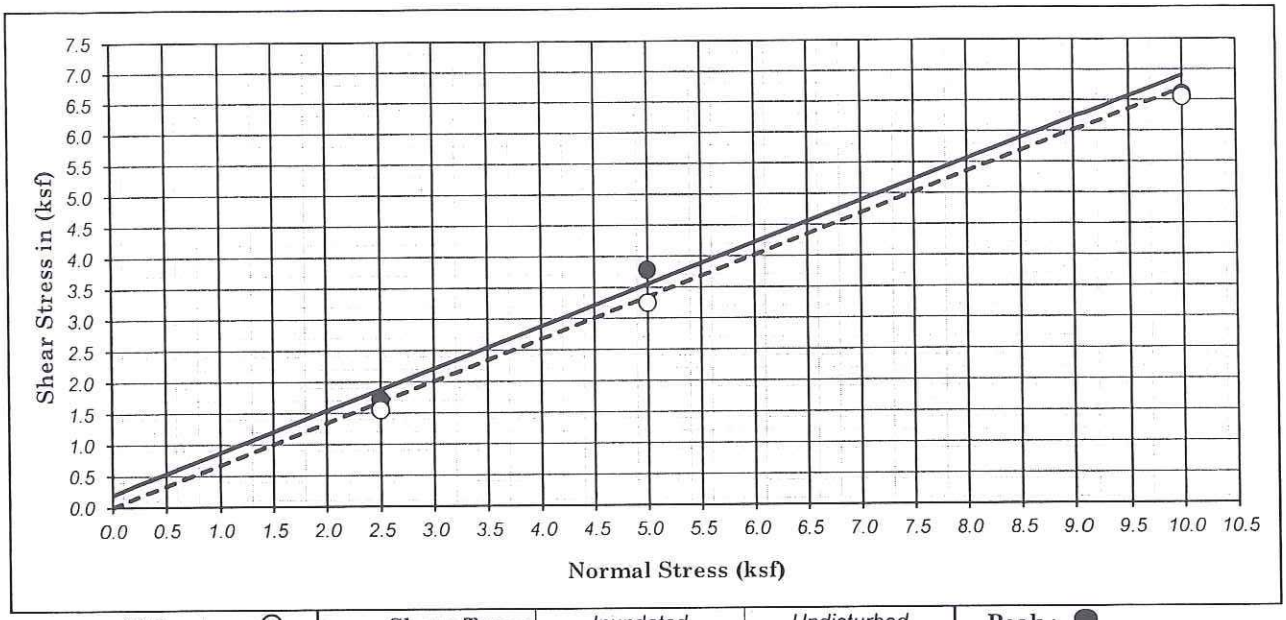
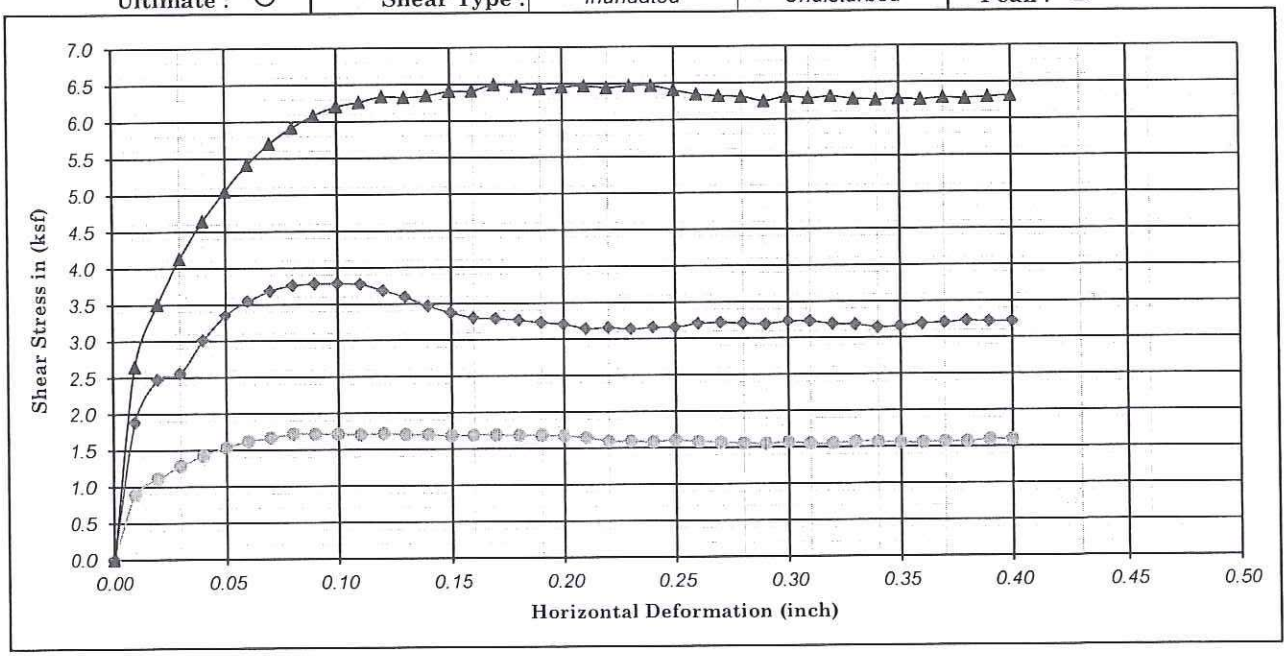
DIRECT SHEAR TEST

(ASTM D-3080)

Project No. : *10-126* | Date : *02/16/11* | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-064	Strength Intercept (C) :	0.31	(ksf)	Peak	0.00	(ksf)	Ultimate
Sample No. : D-14		14.65	(kPa)		0.00	(kPa)	
Depth (ft/m) : 70.0 | 0.00	Friction Angle (ϕ) :	33.82	Degree		33.78	Degree	

Description : *Light yellowish brown, Poorly graded SAND with SILT (SP-SM)* Shear Rate (inch/minute) : 0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
◌	22.86	89.10	14.02	0.89	2.50	119.70	1.72	82.16	1.55	74.12
◆	21.87	90.06	14.18	0.87	5.00	239.40	3.78	180.99	3.25	155.61
▲	22.40	87.19	13.72	0.93	10.00	478.80	6.60	316.01	6.55	313.61

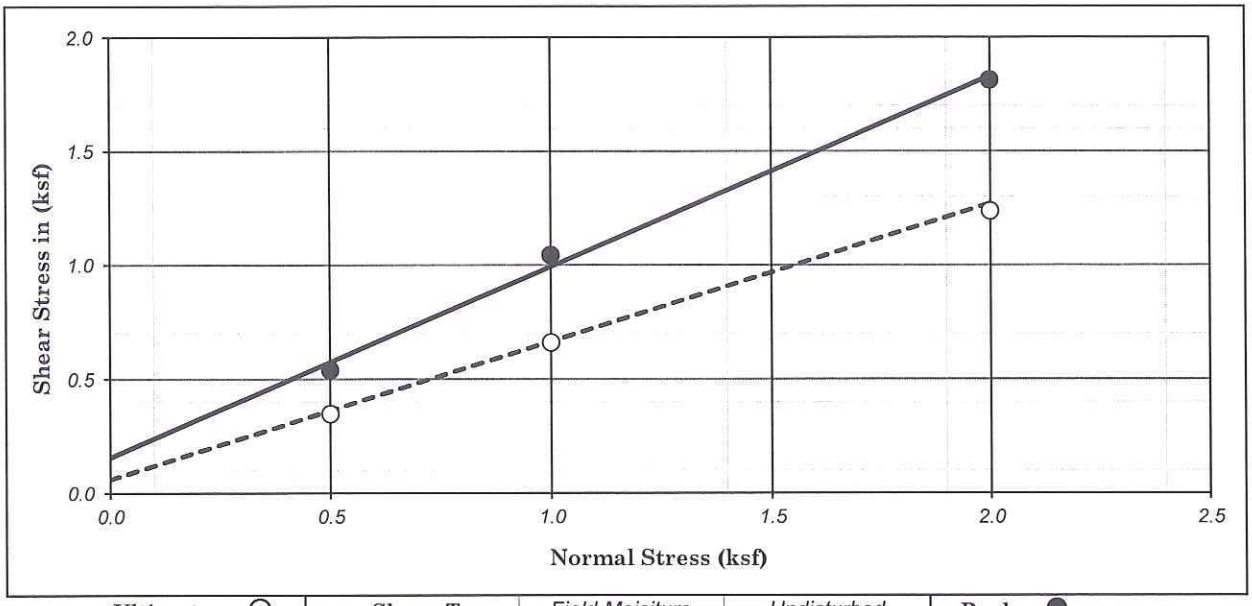
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

RBF/SR-91 WB Widening

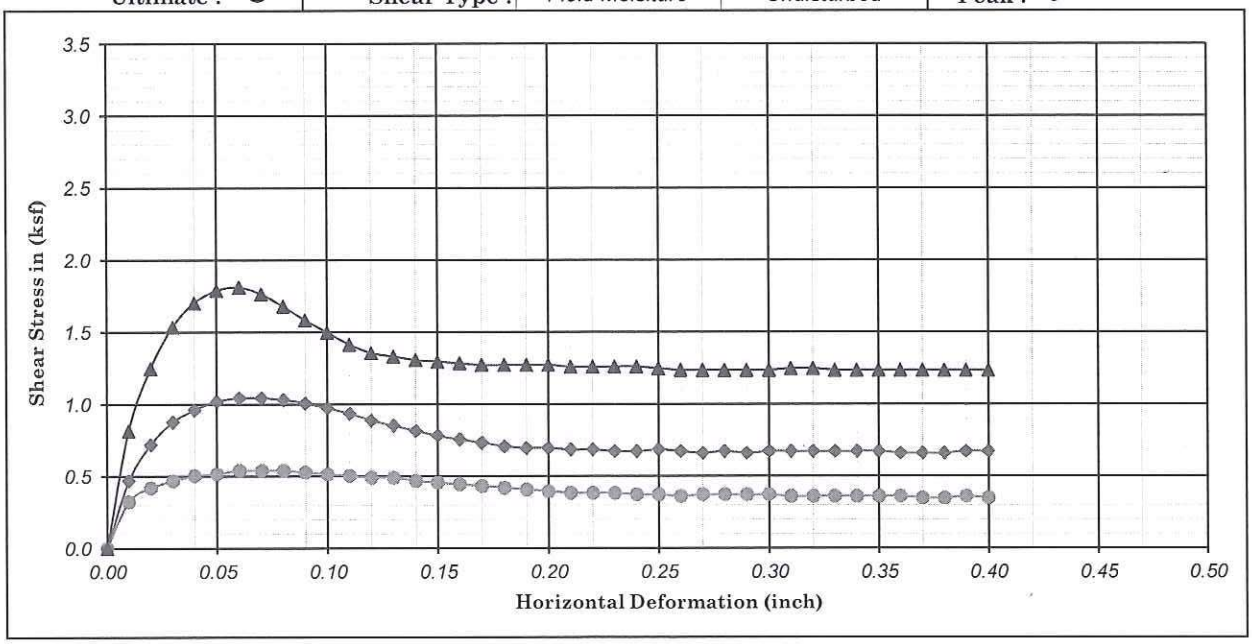
DIRECT SHEAR TEST

(ASTM D-3080)

Project No. : 10-126 | Date : 02/15/11 | Figure No. :



Ultimate : ○	Shear Type :	Field Moisiture	Undisturbed	Peak : ●



Boring No. : A-11-073	Strength Intercept (C) :	0.16	(ksf)	Peak	0.06	(ksf)	Ultimate
Sample No. : D-2		7.47	(kPa)		2.87	(kPa)	
Depth (ft/m) : 10.0 | 0.00	Friction Angle (ϕ) :	39.91	Degree		31.17	Degree	
Description : Olive-brown, Poorly graded SAND (SP)					Shear Rate (inch/minute) :		0.02

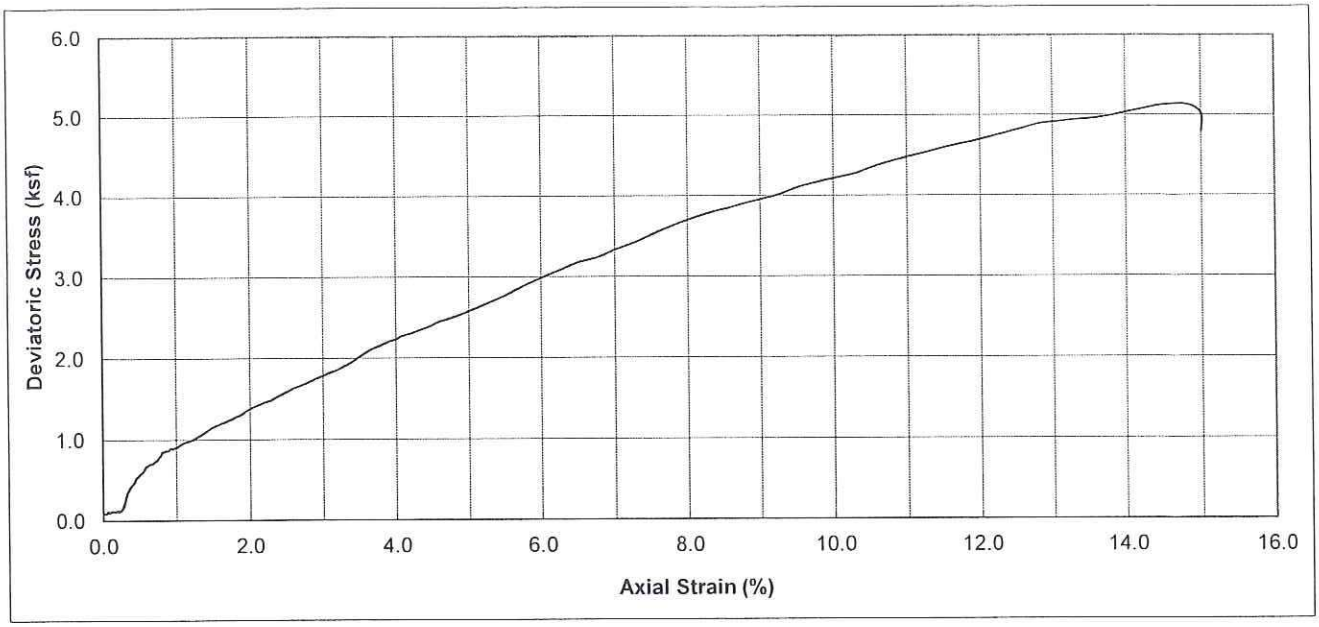
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	3.16	103.36	16.27	0.63	0.50	23.94	0.54	25.86	0.35	16.66
◆	5.80	102.54	16.14	0.64	1.00	47.88	1.04	49.99	0.66	31.60
▲	9.20	100.62	15.84	0.68	2.00	95.76	1.81	86.76	1.24	59.18

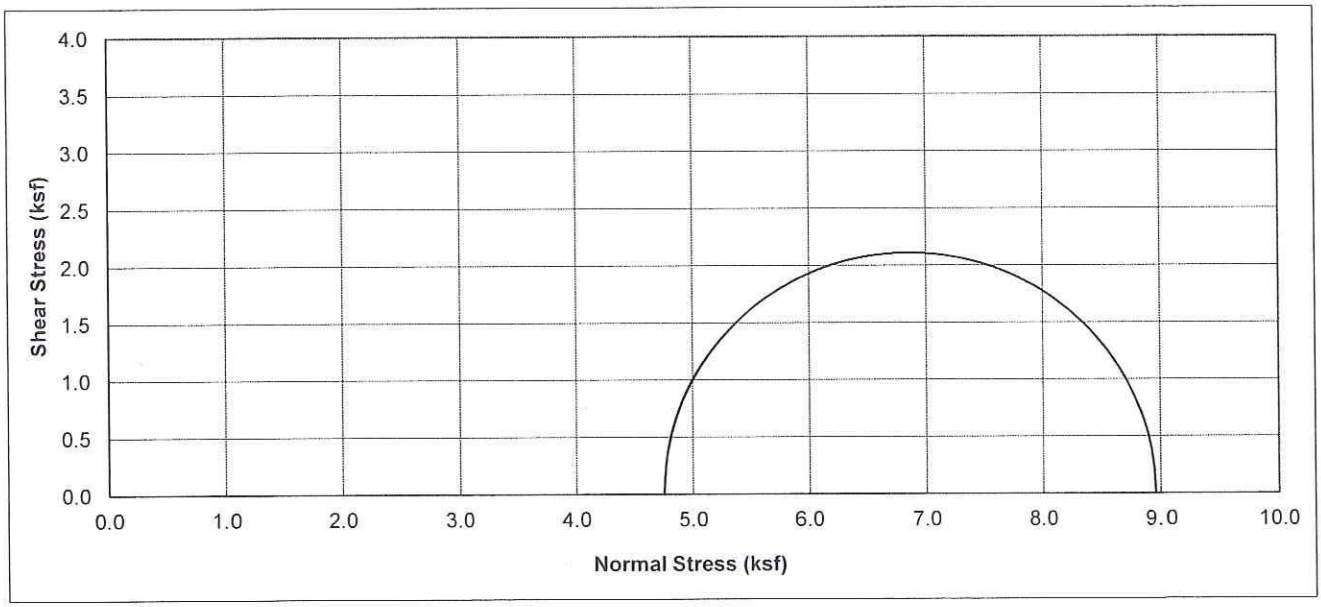
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

RBF/SR-91 WB Widening

DIRECT SHEAR TEST
(ASTM D-3080)

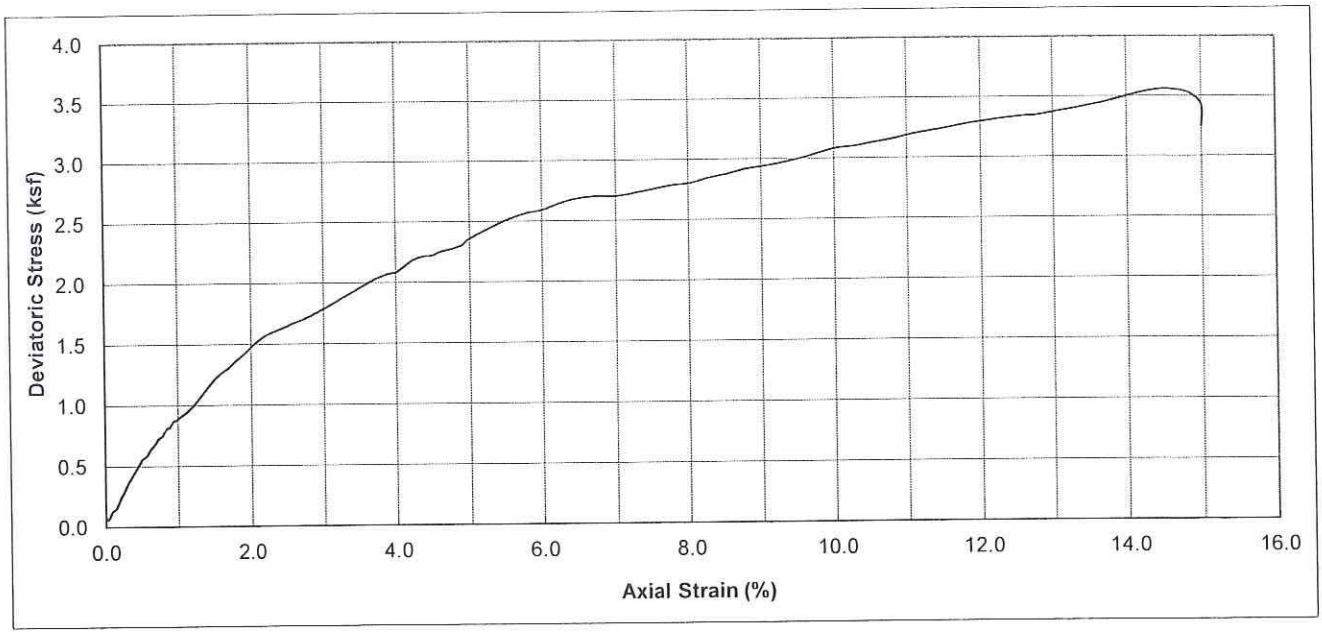
Project No. : 10-126 | Date : 12/19/11 | Figure No. :

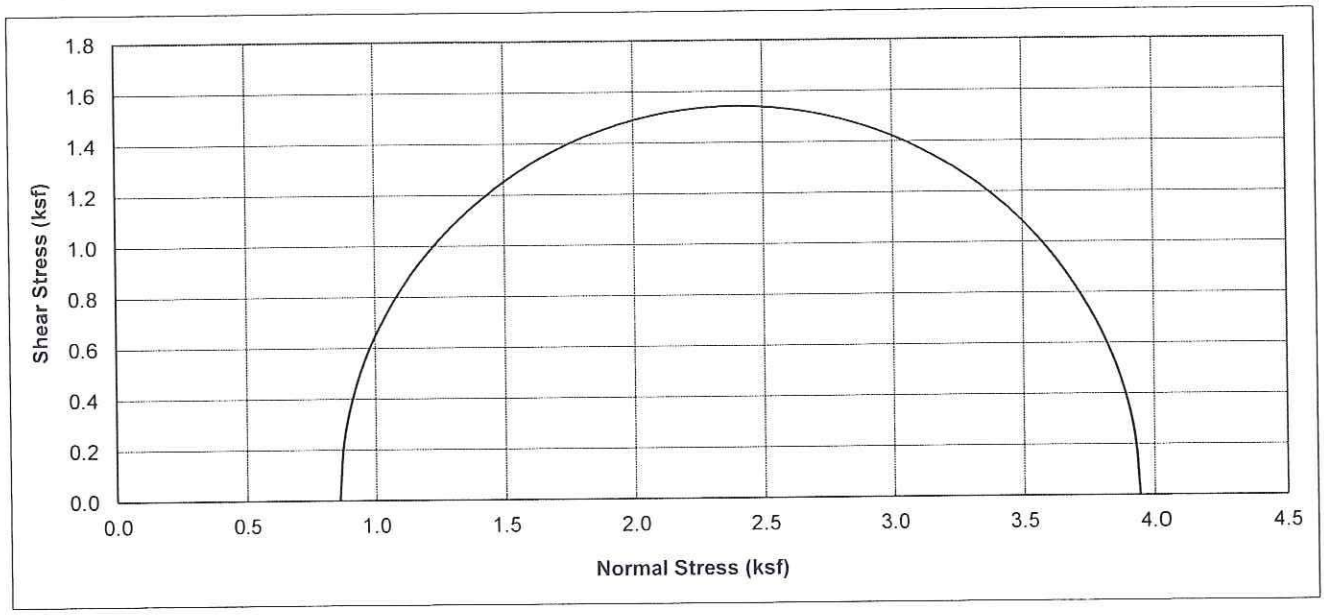




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-006	D-12	60	Olive-brown , SILT with SAND (ML)	92.5	34.07	4.75	4.22	112.0

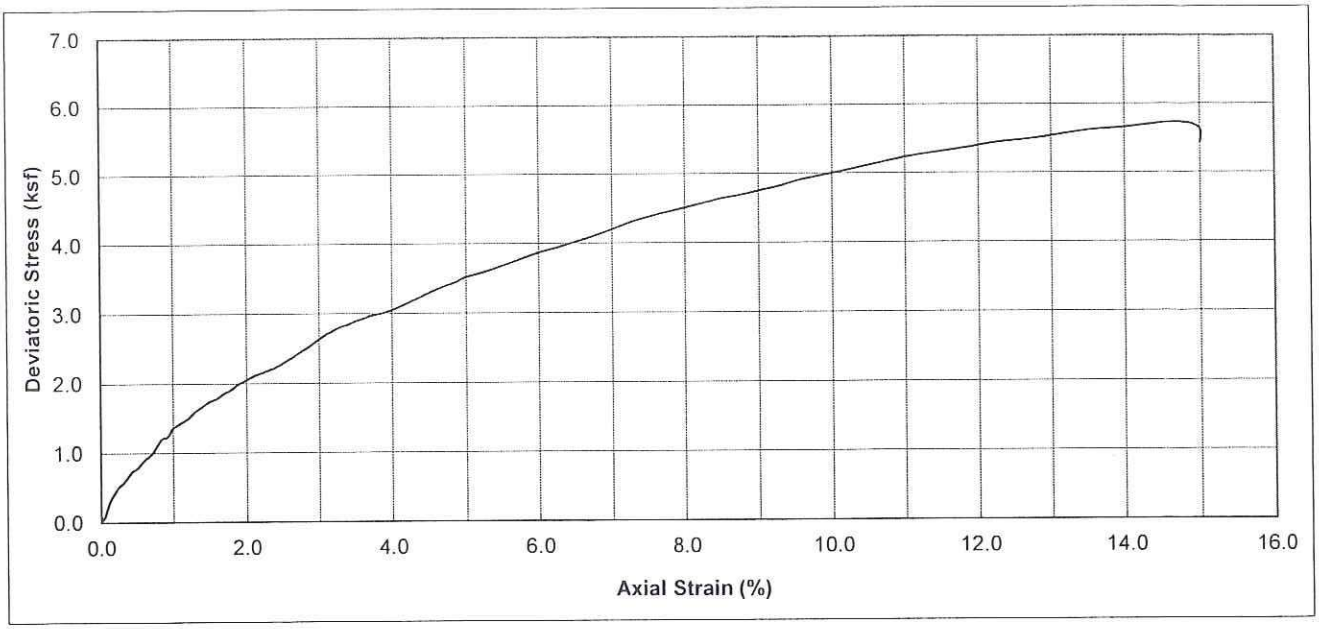
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	**Brookhurst Street UC (Widen)**
	UNCONSOLIDATED UNDRAINED TEST
Project No. : 10-126 **Date :** 02/07/11	**(ASTM D2850)** Figure No. :

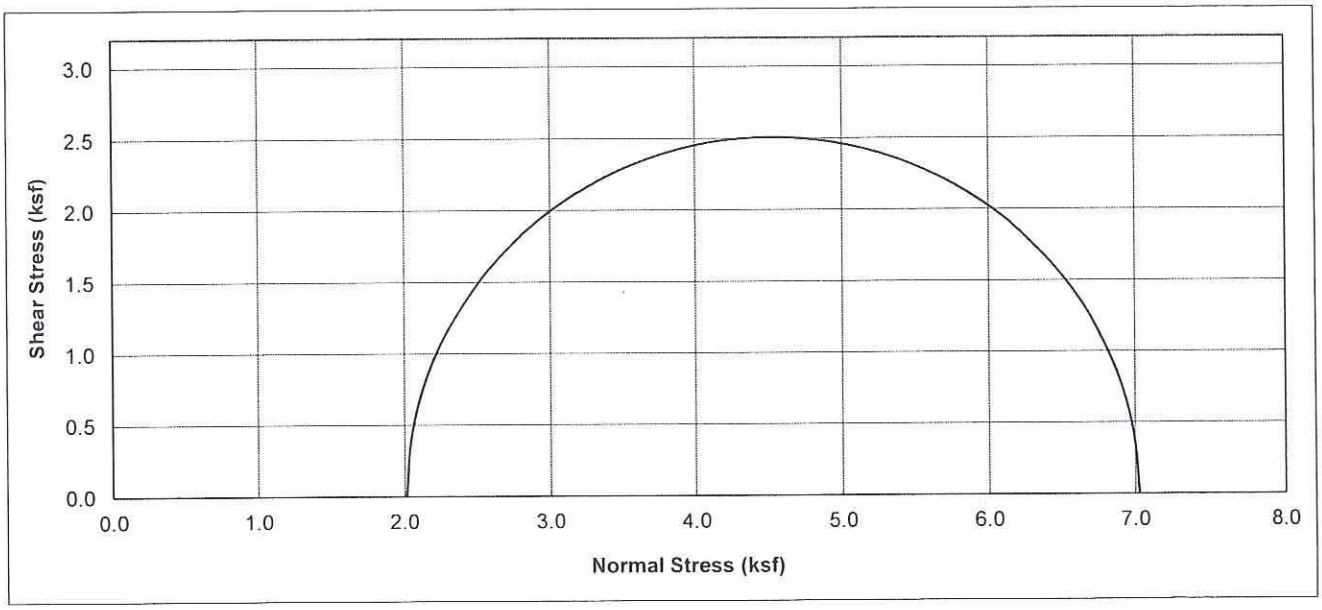




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-007	D-2	5	Olive-brown , Lean CLAY with SAND(CL)	106.1	18.61	0.86	3.09	85.4

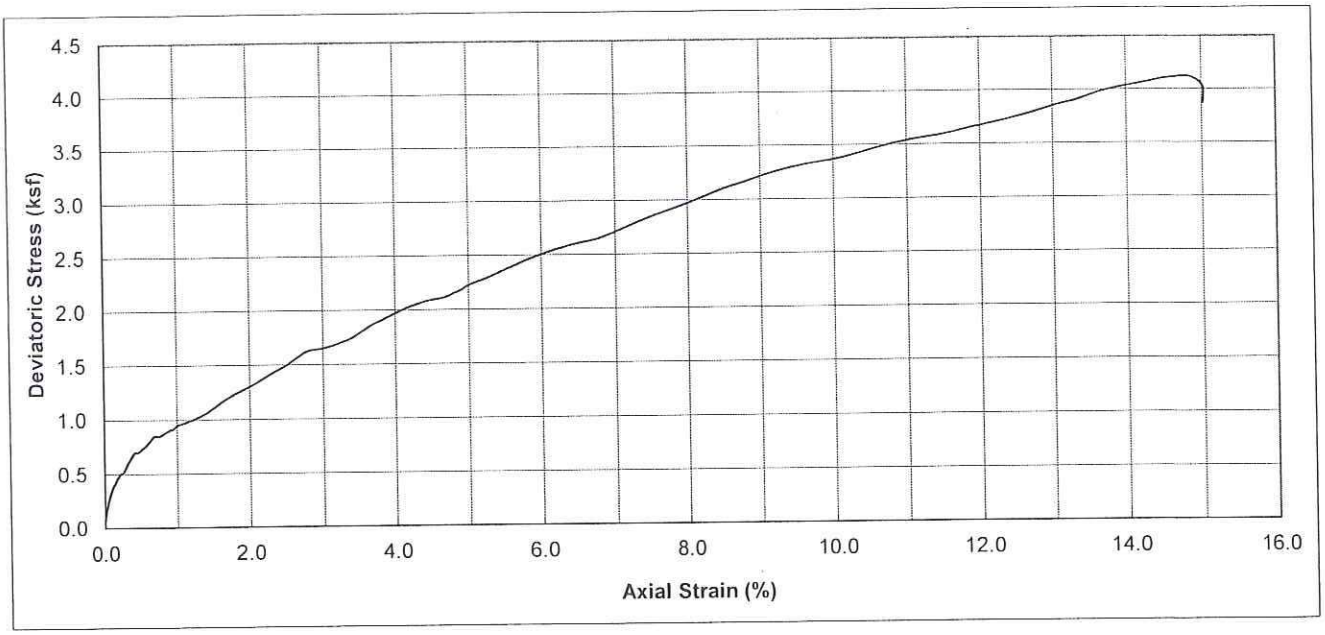
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	**Brookhurst Street UC (Widen)**
Project No. : 10-126 **Date :** 02/07/11	**UNCONSOLIDATED UNDRAINED TEST** **(ASTM D2850)** Figure No. :

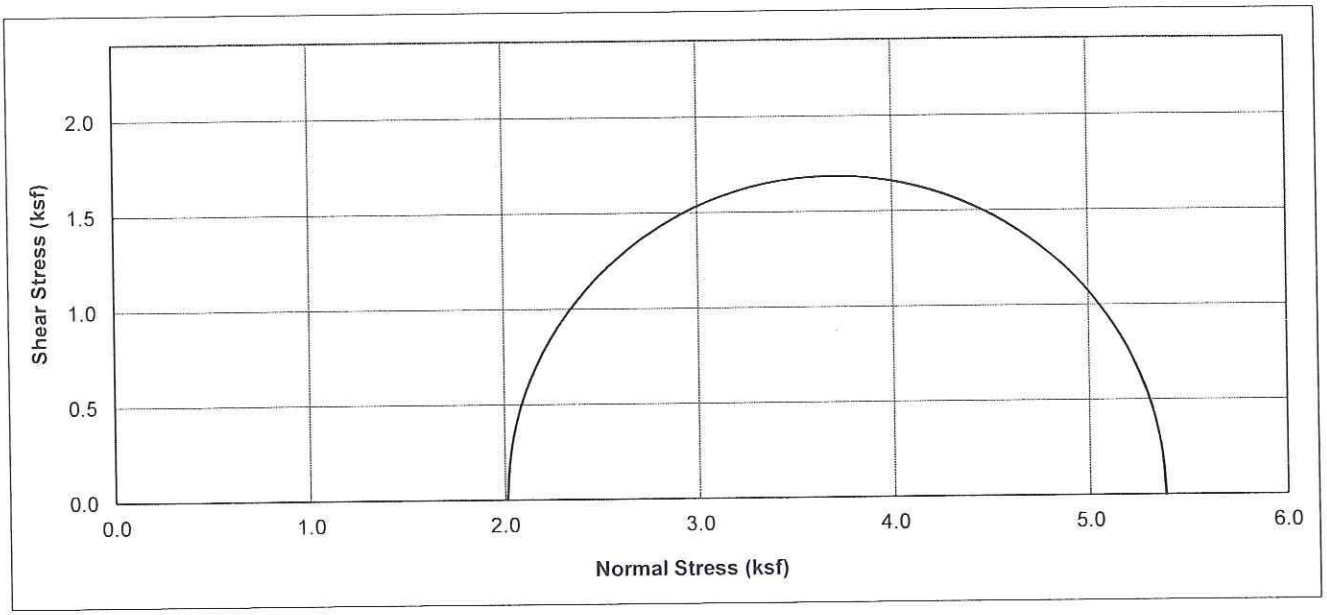




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-007	D-6	25	Olive-brown , SILT with SAND (ML)	106.8	19.88	2.01	5.01	92.8

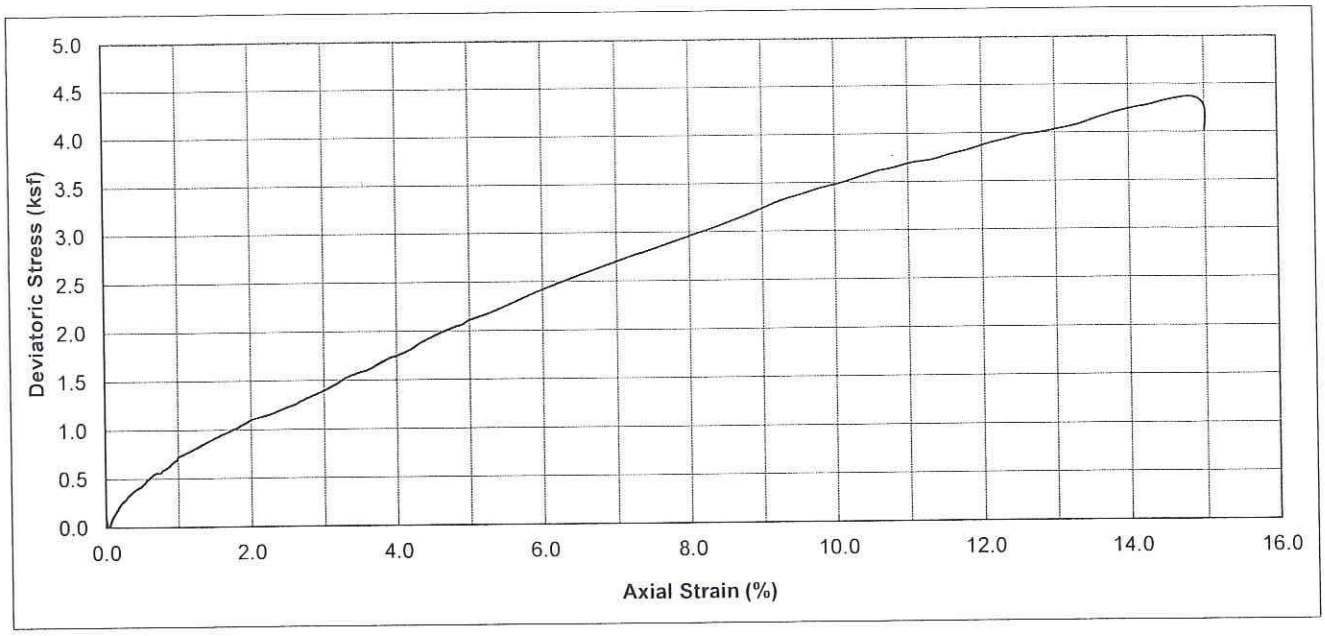
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering		Brookhurst Street UC (Widen)
		UNCONSOLIDATED UNDRAINED TEST
Project No. : 10-126	Date : 02/07/11	(ASTM D2850) Figure No. :

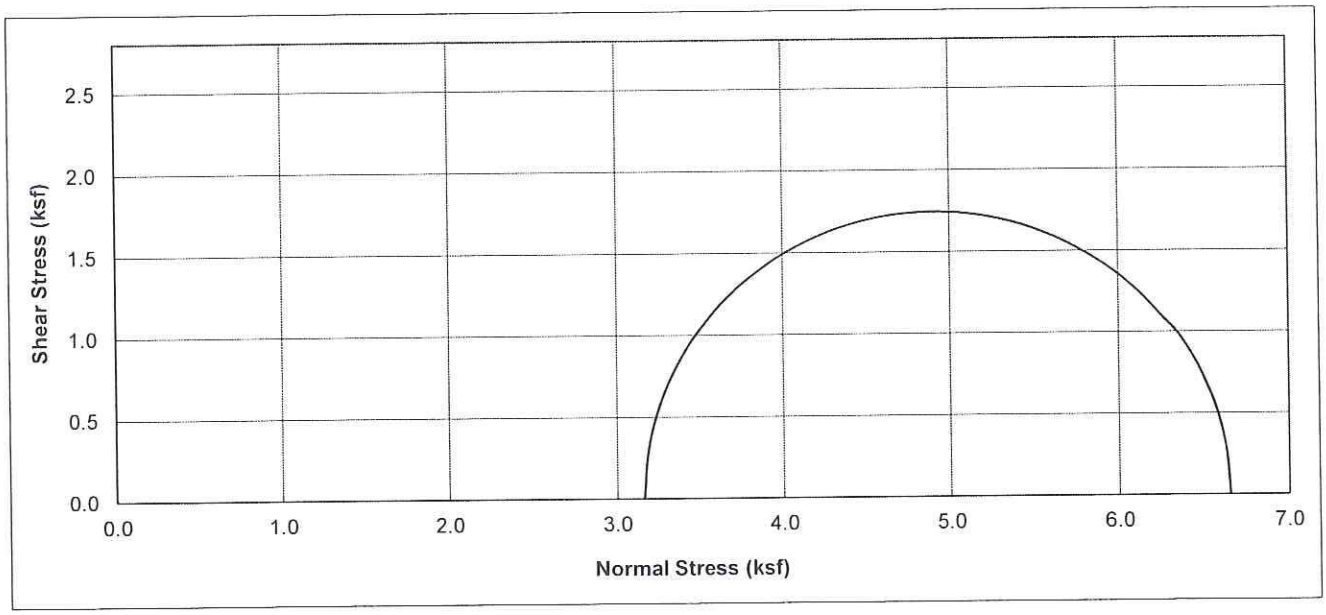




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-007	D-12	55	Dark gray , SILT with SAND (ML)	89.3	27.07	2.01	3.37	82.5

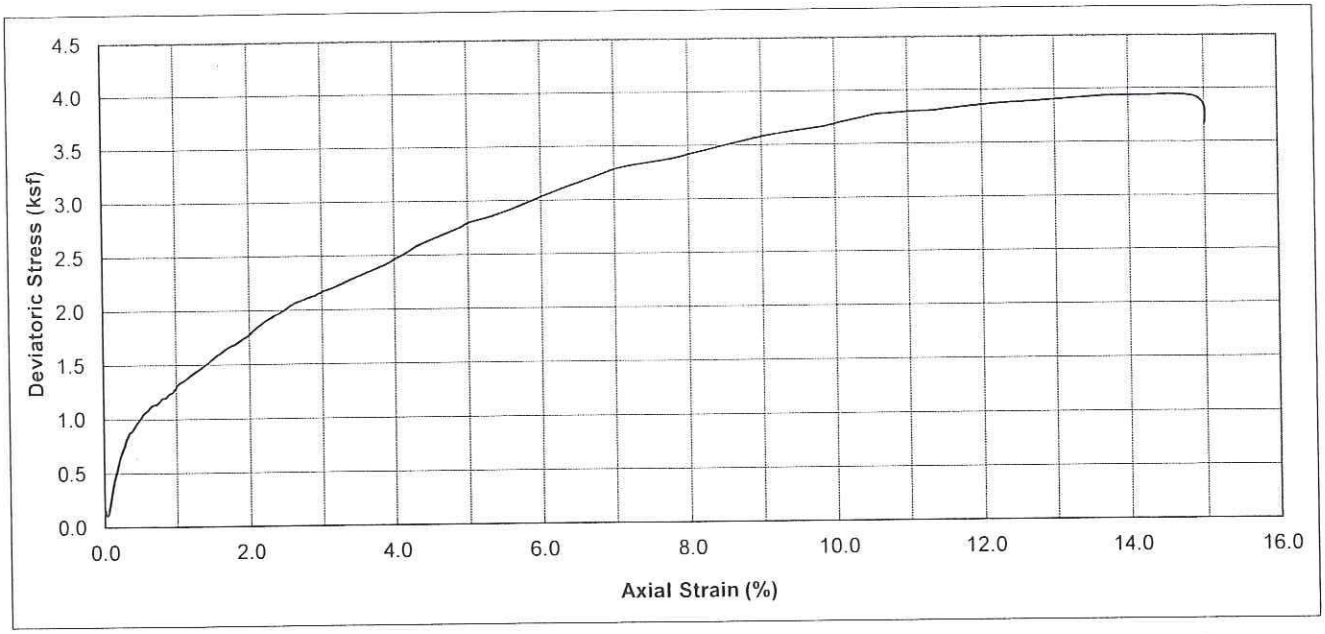
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	**Brookhurst Steet UC (Widen)**
	UNCONSOLIDATED UNDRAINED TEST
Project No. : 10-126 **Date :** 02/08/11	**(ASTM D2850)** Figure No. :

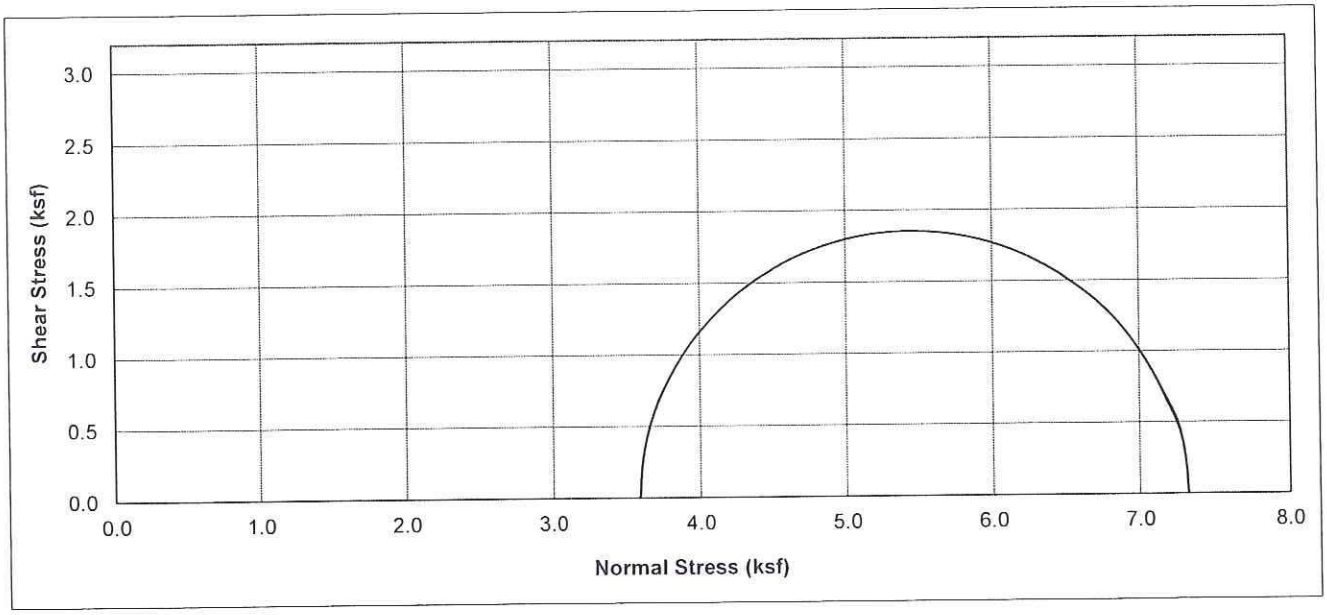




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-008	D-8	40	Olive-brown SILTY SAND	112.3	18.55	3.16	3.49	100.0

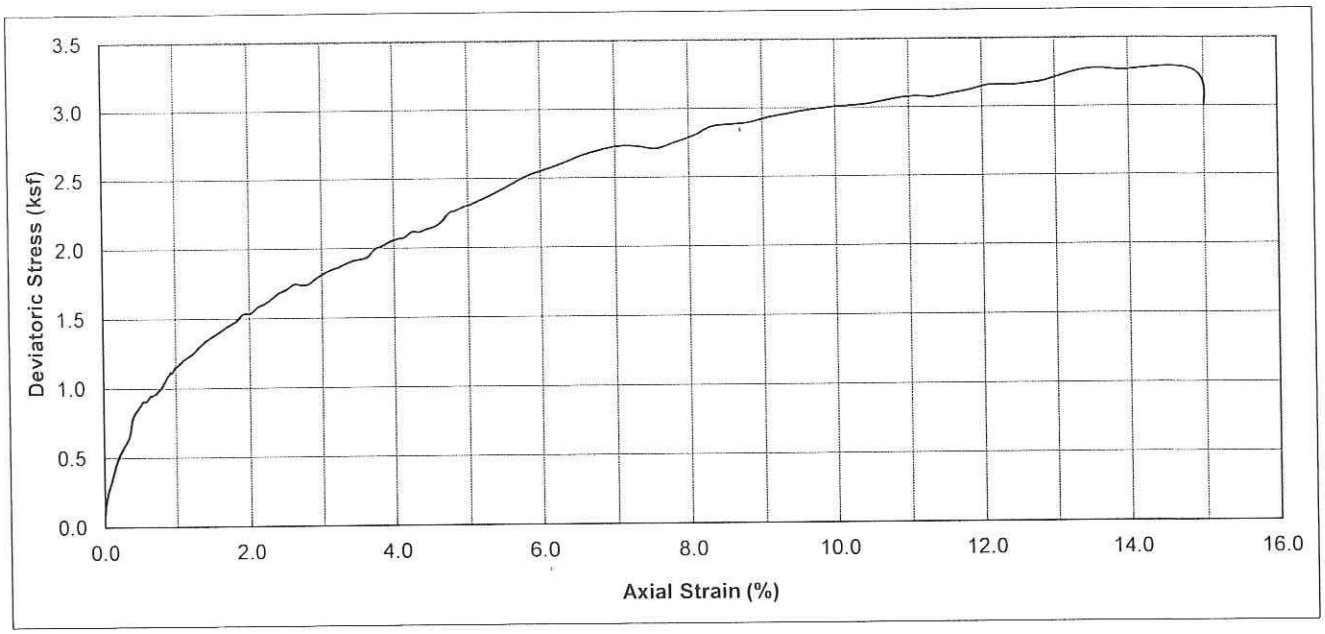
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Brookhurst Street UC (Widen)
Project No. : 10-126 Date : 02/08/11	UNCONSOLIDATED UNDRAINED TEST (ASTM D2850) Figure No. :

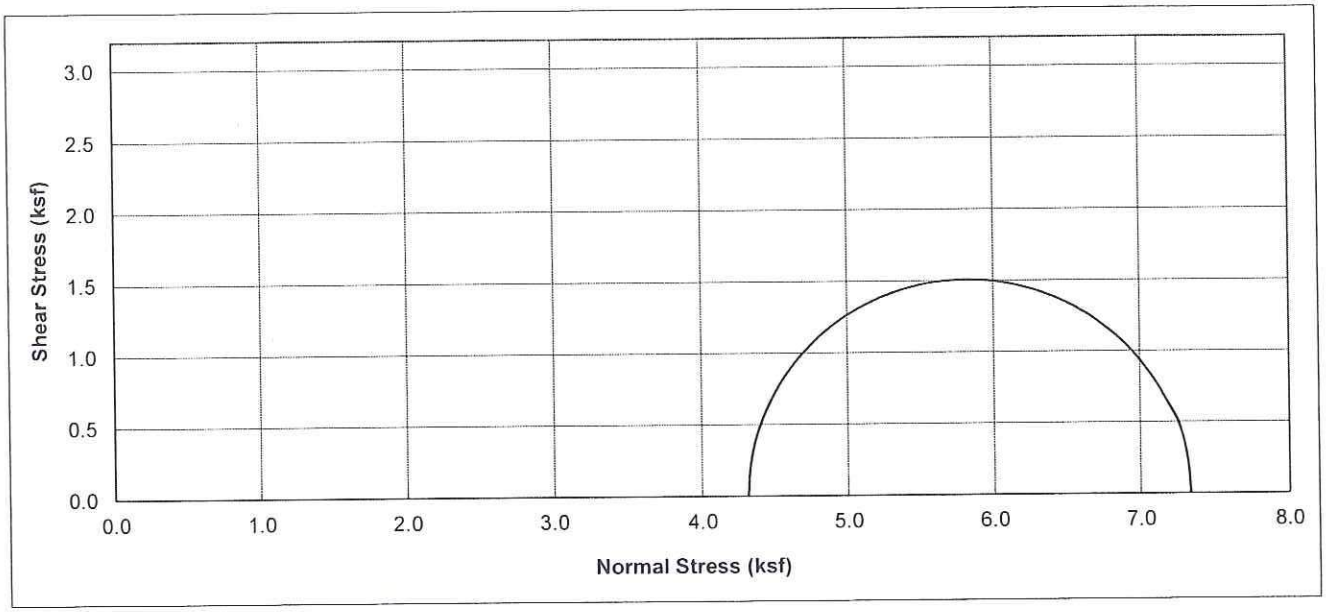




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-023	D-10	45	Olive-brown, SILTY CLAY with SAND (CL-ML)	89.9	27.55	3.59	3.71	85.2

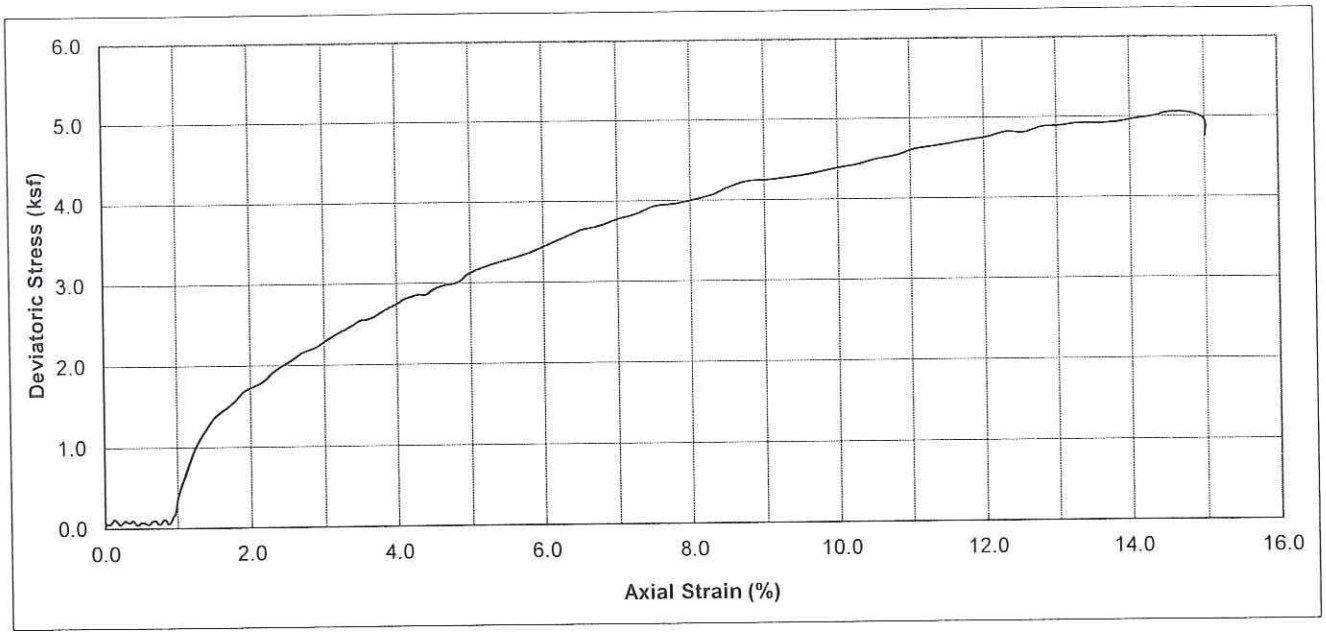
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Euclid Street UC (Widen)
	UNCONSOLIDATED UNDRAINED TEST (ASTM D2850) Figure No.:
Project No.: 10-126	Date: 02/08/11

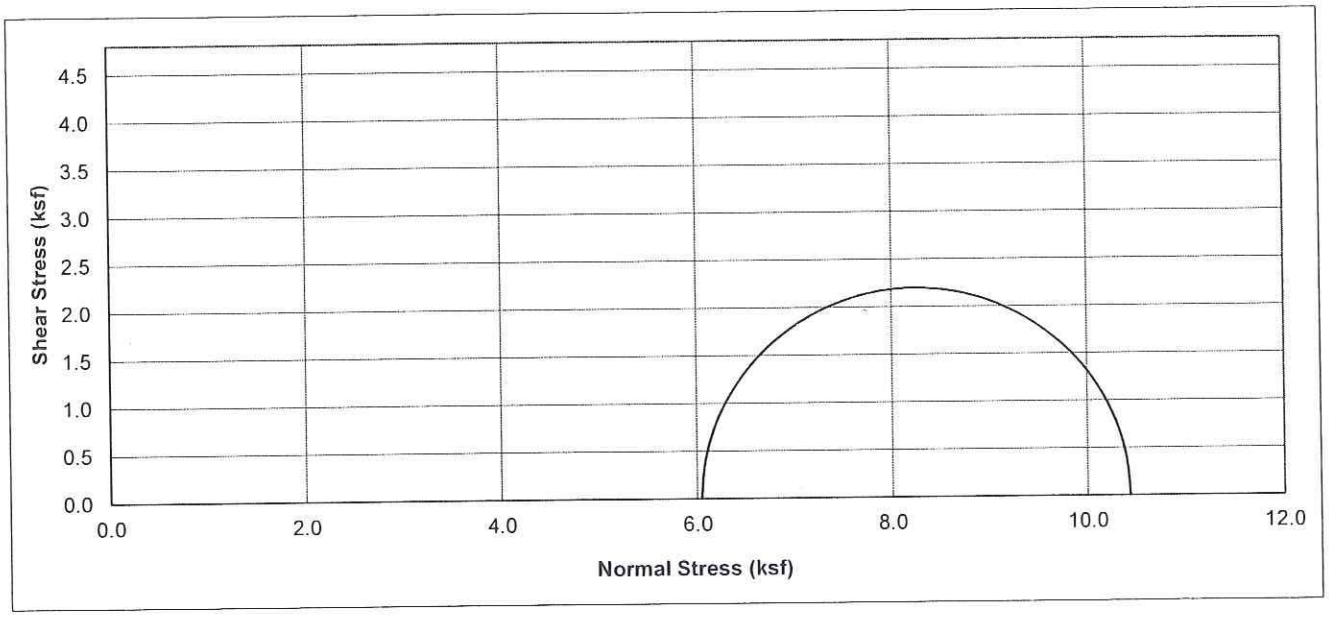




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-023	D-12	55	Olive-brown, SILT with SAND (ML)	89.8	25.37	4.31	3.01	78.3

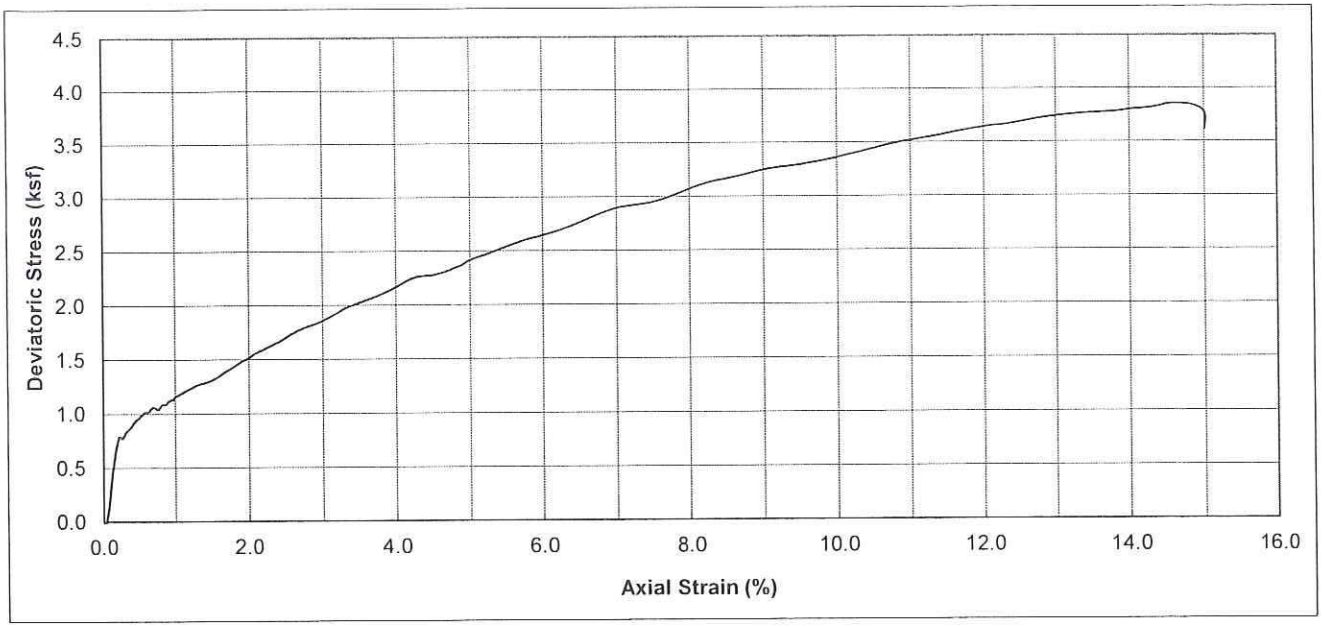
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	**Euclid Street UC (Widen)**
	UNCONSOLIDATED UNDRAINED TEST
Project No. : 10-126 **Date :** 02/08/11	**(ASTM D2850)** Figure No. :

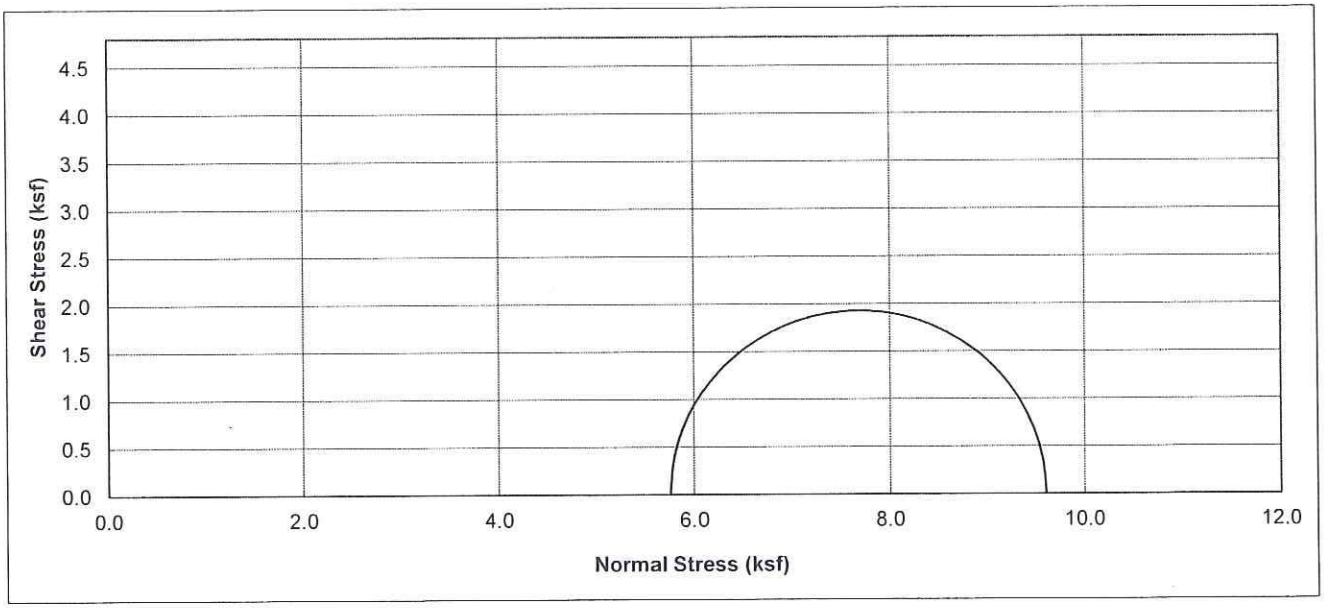




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-039	D-15	75	Olive Brown, Elastic SILT (MH)	92.9	28.75	6.04	4.39	95.5

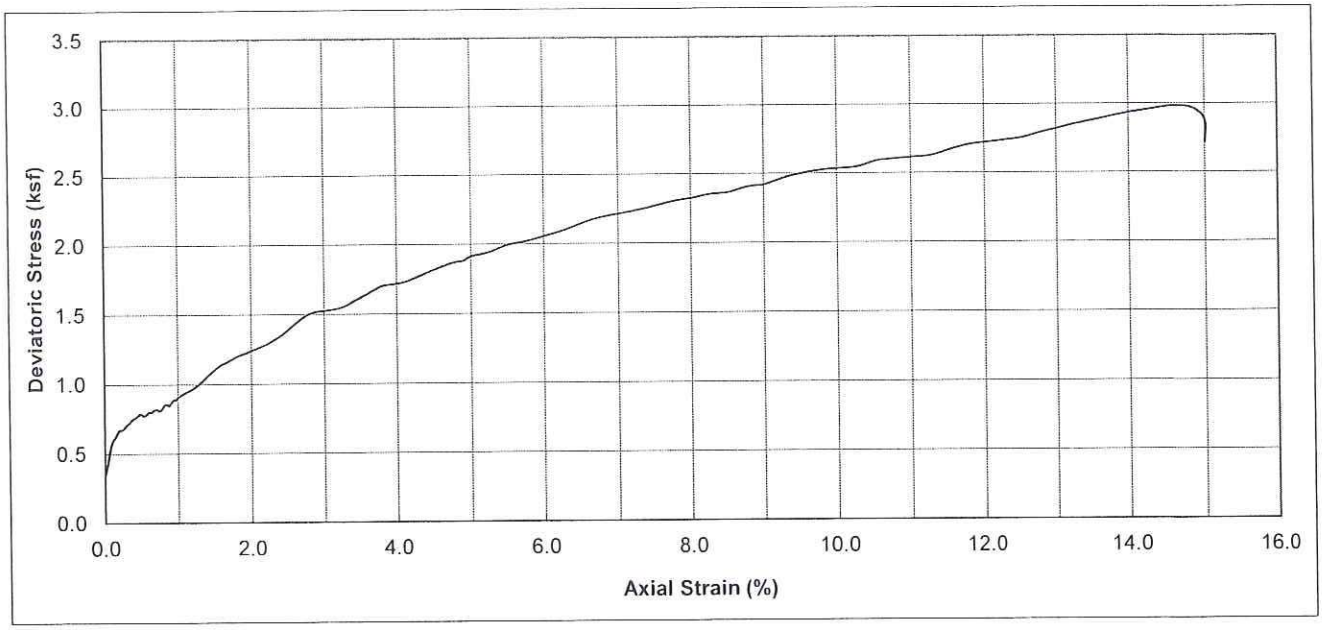
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	**RBF/SR-91 WB Widening**
Project No. : 10-126 **Date :** 02/08/11	**UNCONSOLIDATED UNDRAINED TEST** **(ASTM D2850)** Figure No. :

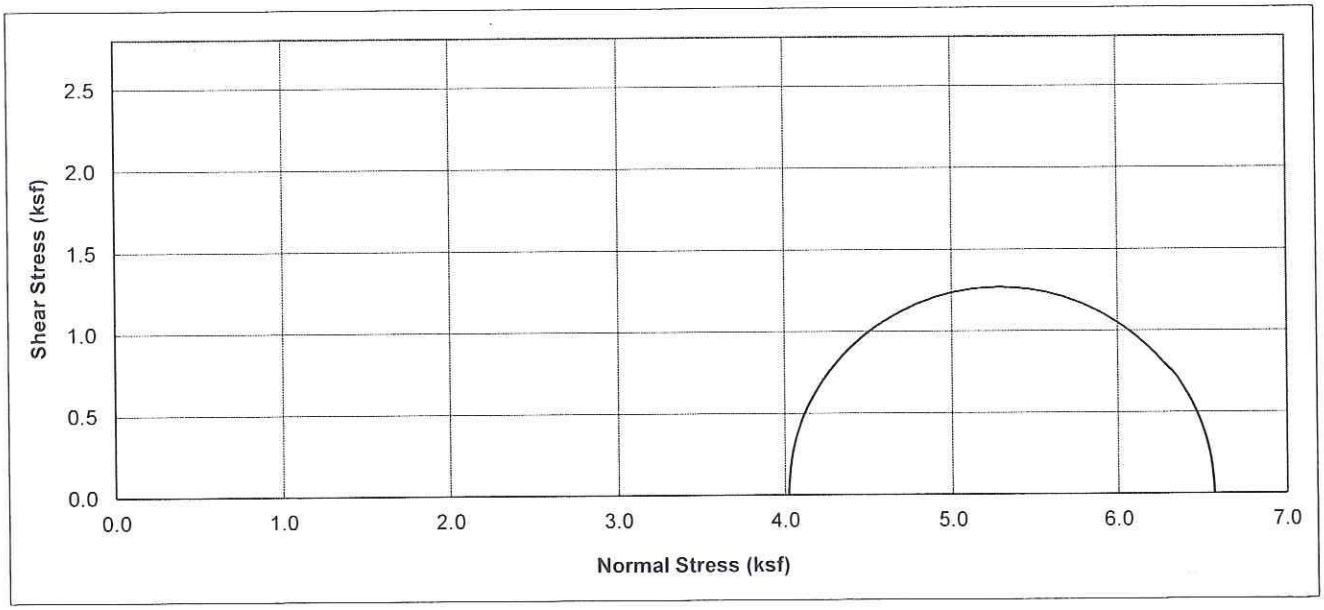




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-044	D-14	70	Olive-brown , SANDY Lean CLAY (CL)	105.9	19.56	5.75	3.36	89.4

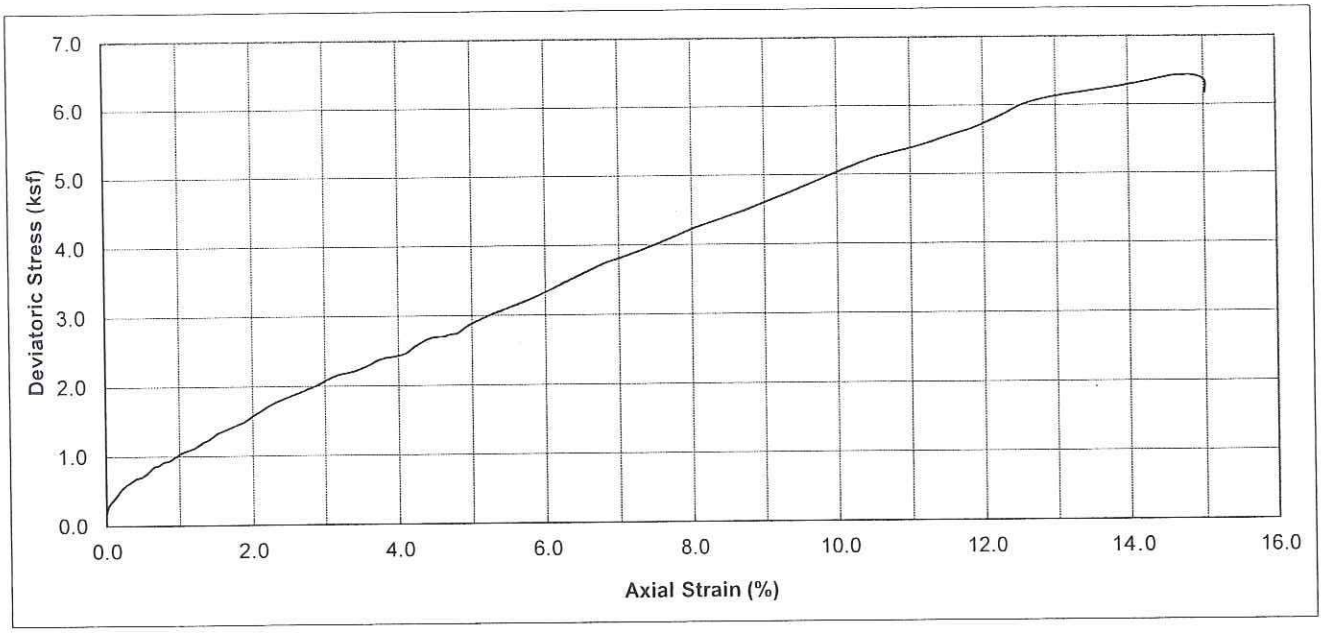
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	East Street UC (Widen)
Project No. : 10-126 Date : 02/08/11	UNCONSOLIDATED UNDRAINED TEST (ASTM D2850) Figure No. :

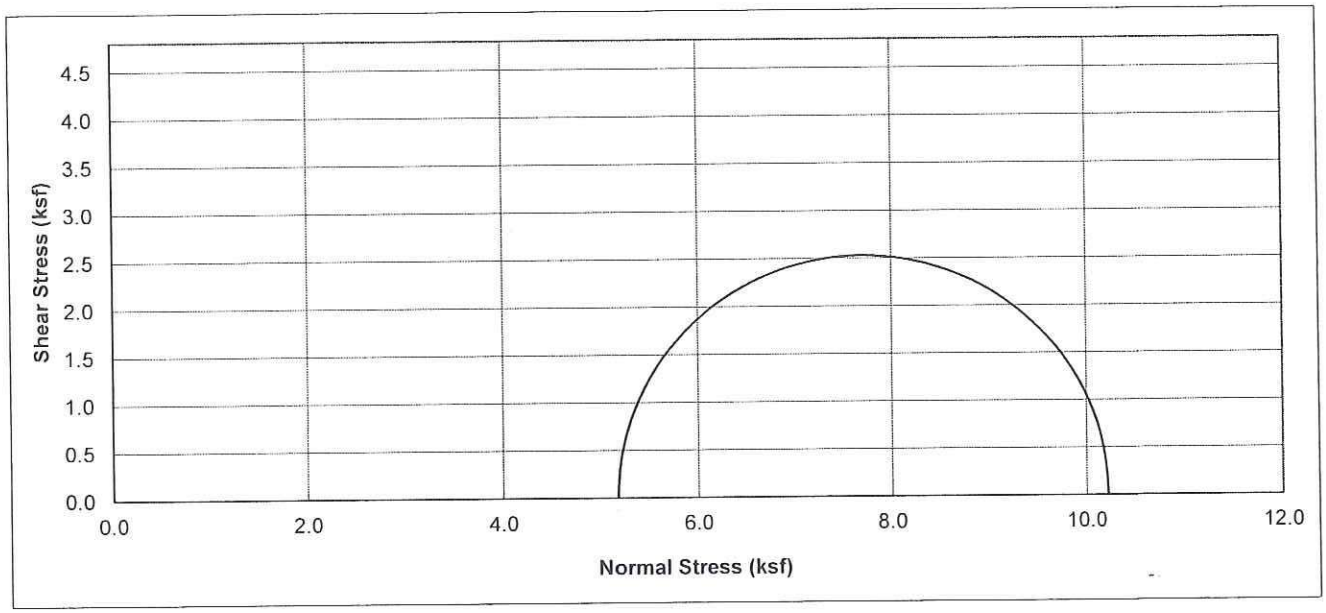




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-045	D-11	50	Olive-brown , Lean CLAY with SAND (CL)	93.9	29.79	4.02	2.54	101.4

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	East Street UC (Widen)
	UNCONSOLIDATED UNDRAINED TEST (ASTM D2850) Figure No. :
Project No. : 10-126	Date : 02/08/11





Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-054	D-14	65	Olive Br. , LEAN CLAY to SILT with SAND (CL to ML)	90.0	30.04	5.17	5.O6	92.9

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	**RBF/SR-91 WB Widening**
Project No. : 10-126 **Date :** 02/09/11	**UNCONSOLIDATED UNDRAINED TEST** **(ASTM D2850)** Figure No. :

AP Engineering & Testing, Inc.

CAL 216 PART 2

LABORATORY COMPACTED TEST MAXIMUM WET DENSITY

Client: Earth Mechanics, Inc.
Project Name: SR-91 WB Widening
Project No. : 10126
Boring No.: A10-002
Sample No. : B-0
Visual Sample Description: Clayey Sand w/gravel

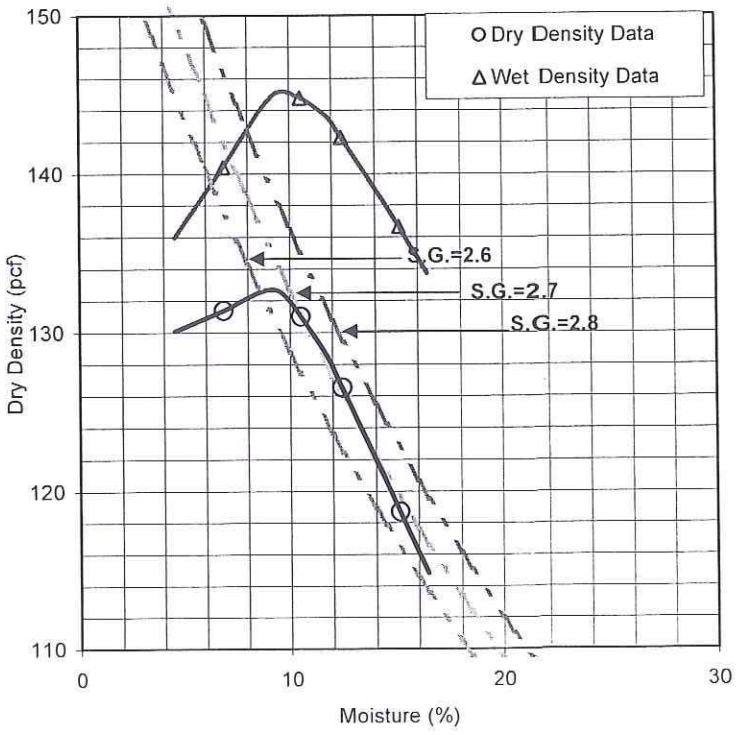
AP Number: 11-0210
Tested By: KM Date: 02/08/11
Calculated By: KM Date: 02/18/11
Checked By: AP Date: 02/21/11
Depth (ft): 1.5-5

IMPACT TEST DATA

I	Initial Wet Weight of Test Specimen (Grams)	2450					
	Increment No.	1	2	3	4	5	6
	Water Adjustment (grams)	-98	-49	0	-165		
J	Tamper Reading	10.0	10.2	10.6	10.3		
K	Wet Density (gm/cc) from Table 1	2.32	2.28	2.19	2.25		
	Dry Density (gm/cc)	2.10	2.03	1.90	2.11		
	Dry Density (pcf)	**131.0**	**126.5**	**118.7**	**131.4**		
	Wt. of Container (gm.)	105.80	104.80	105.50	103.90		
	Wet Wt. of Soil + Cont. (gm.)	901.00	944.60	943.00	833.60		
	Dry Wt. of Soil + Cont. (gm.)	825.30	851.69	832.93	786.76		
	Moisture Content (%)	**10.52**	**12.44**	**15.13**	**6.86**		

ROCK CORRECTION			
L	Total Sample Weight	(grams)	10636.5
M	+19 mm (¾") Weight in Air	(grams)	20
N	+19 mm (¾") Weight in Water	(grams)	12.59
O	+19 mm (¾") Volume	(M-N)	7.41
P	% +19 mm (¾") 100*	(M/L)	0.19
Q	% -19 mm (¾")	(100-P)	99.81
R	Density of +19 mm (¾")	(M/O)	2.70
S	(%+19 mm)/Density of +19 mm	(P/RY)	0.07
T	(%-19 mm)/Density of -19 mm	(Q/K)	43.02
U	Sum of S and T	(S+T)	43.09
V	Average Adjusted Density	(100/U)	2.32
Percent Relative* Compaction	Spec	Failed	or less
		Passed	
*(H/K) for 10% or less +19 mm; (H/V) for > 10% +19 mm			
Note: 62.4 x (gm/cc) = P.C.F.			

Maximum Dry Density (pcf)	**132.5**
Optimum Moisture Content (%)	**9.5**
Maximum Wet Density (pcf)	**145.1**



AP Engineering & Testing, Inc.

CAL 216 PART 2

LABORATORY COMPACTED TEST MAXIMUM WET DENSITY

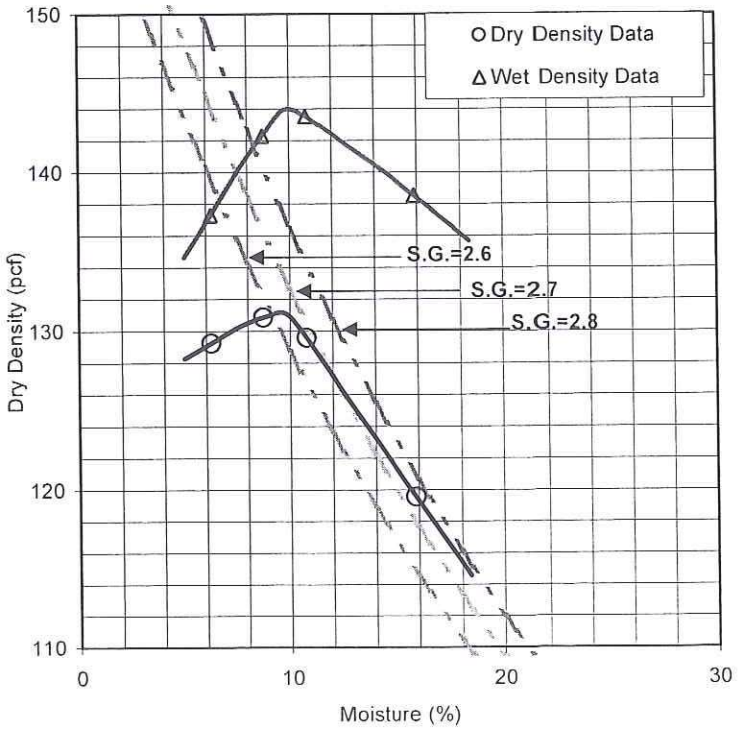
Client: Earth Mechanics, Inc.
Project Name: SR-91 WB Widening
Project No. : 10126
Boring No.: A10-006
Sample No. : B-0
Visual Sample Description: Silty Sand

AP Number: 11-0210
Tested By: KM Date: 02/18/11
Calculated By: KM Date: 02/21/11
Checked By: AP Date: 02/24/11
Depth (ft): 2-5

IMPACT TEST DATA

I	Initial Wet Weight of Test Specimen (Grams)	2550					
	Increment No.	1	2	3	4	5	6
	Water Adjustment (grams)	-102	-151	0	-122		
J	Tamper Reading	10.5	11.0	10.9	10.6		
K	Wet Density (gm/cc) from Table 1	2.30	2.20	2.22	2.28		
	Dry Density (gm/cc)	2.08	2.07	1.92	2.10		
	Dry Density (pcf)	**129.6**	**129.2**	**119.5**	**130.8**		
	Wt. of Container (gm.)	105.30	105.80	105.30	105.30		
	Wet Wt. of Soil + Cont. (gm.)	560.20	646.60	700.90	528.30		
	Dry Wt. of Soil + Cont. (gm.)	515.97	614.88	619.28	494.33		
	Moisture Content (%)	**10.77**	**6.23**	**15.88**	**8.73**		

ROCK CORRECTION			
L	Total Sample Weight (grams)		13668
M	+19 mm (¾") Weight in Air (grams)		0
N	+19 mm (¾") Weight in Water (grams)		0
O	+19 mm (¾") Volume (M-N)		0
P	% +19 mm (¾") 100* (M/L)		0.00
Q	% -19 mm (¾") (100-P)		100.00
R	Density of +19 mm (¾") (M/O)		0.00
S	(%+19 mm)/Density of +19 mm (P/RY)		0.00
T	(%-19 mm)/Density of -19 mm (Q/K)		43.48
U	Sum of S and T (S+T)		43.48
V	Average Adjusted Density (100/U)		2.30
Percent Relative* Compaction	Spec	Failed	or less
		Passed	
*(H/K) for 10% or less +19 mm; (H/V) for > 10% +19 mm			
Note: 62.4 x (gm/cc) = P.C.F.			



Maximum Dry Density (pcf)	**131.0**
Optimum Moisture Content (%)	**9.9**
Maximum Wet Density (pcf)	**144.0**

AP Engineering & Testing, Inc.

CAL 216 PART 2

LABORATORY COMPACTED TEST MAXIMUM WET DENSITY

Client: Earth Mechanics, Inc.
Project Name: SR-91 WB Widening
Project No. : 10126
Boring No.: A10-011
Sample No. : B-0
Visual Sample Description: Poorly-Graded Sand w/silt & gravel

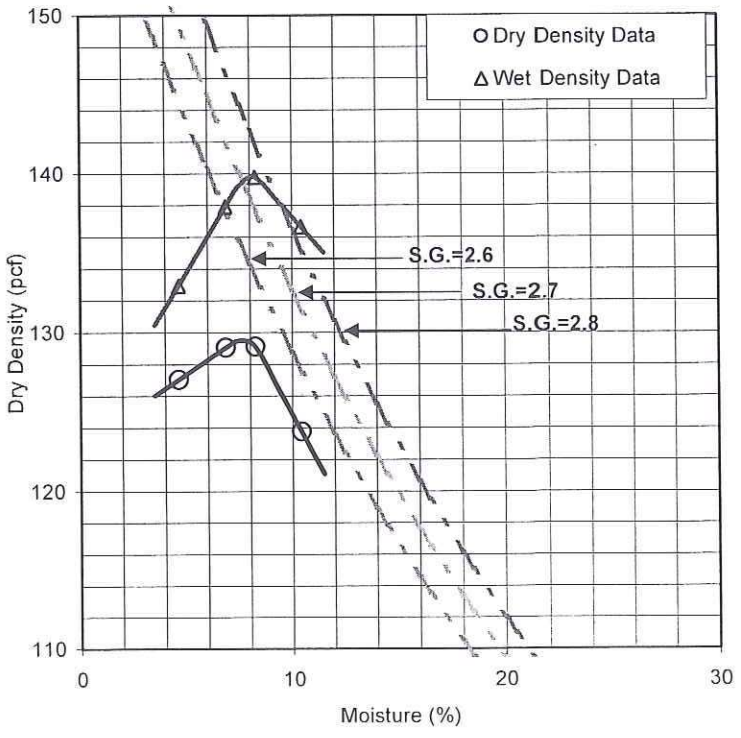
AP Number: 11-0210
Tested By: CP — Date: 02/16/11
Calculated By: KM — Date: 02/18/11
Checked By: AP — Date: 02/21/11
Depth (ft): 0-2

IMPACT TEST DATA

I	Initial Wet Weight of Test Specimen (Grams)	2500					
	Increment No.	1	2	3	4	5	6
	Water Adjustment (grams)	0	50	100	150		
J	Tamper Reading	11.1	10.7	10.6	10.8		
K	Wet Density (gm/cc) from Table 1	2.13	2.21	2.24	2.19		
	Dry Density (gm/cc)	2.04	2.07	2.07	1.98		
	Dry Density (pcf)	**127.0**	**129.1**	**129.1**	**123.8**		
	Wt. of Container (gm.)	105.40	105.50	104.70	105.60		
	Wet Wt. of Soil + Cont. (gm.)	558.40	740.20	1107.30	868.30		
	Dry Wt. of Soil + Cont. (gm.)	538.36	699.46	1030.82	796.28		
	Moisture Content (%)	**4.63**	**6.86**	**8.26**	**10.43**		

ROCK CORRECTION				
L	Total Sample Weight		(grams)	22284.5
M	+19 mm (¾") Weight in Air		(grams)	3376
N	+19 mm (¾") Weight in Water		(grams)	2125
O	+19 mm (¾") Volume		(M-N)	1251
P	% +19 mm (¾")	100*	(M/L)	15.15
Q	% -19 mm (¾")		(100-P)	84.85
R	Density of +19 mm (¾")		(M/O)	2.70
S	(%+19 mm)/Density of +19 mm		(P/RY)	5.61
T	(%-19 mm)/Density of -19 mm		(Q/K)	37.88
U	Sum of S and T		(S+T)	43.49
V	Average Adjusted Density		(100/U)	2.30
Percent Relative* Compaction		Spec	Failed	or less
			Passed	
*(H/K) for 10% or less +19 mm; (H/V) for > 10% +19 mm				
Note: 62.4 x (gm/cc) = P.C.F.				

Maximum Dry Density (pcf)	**129.5**
Optimum Moisture Content (%)	**8.0**
Maximum Wet Density (pcf)	**139.9**



AP Engineering & Testing, Inc.

CAL 216 PART 2

LABORATORY COMPACTED TEST MAXIMUM WET DENSITY

Client: Earth Mechanics, Inc.
Project Name: SR-91 WB Widening
Project No. : 10126
Boring No.: A10-028
Sample No. : B-0
Visual Sample Description: Poorly-Graded Sand w/silt

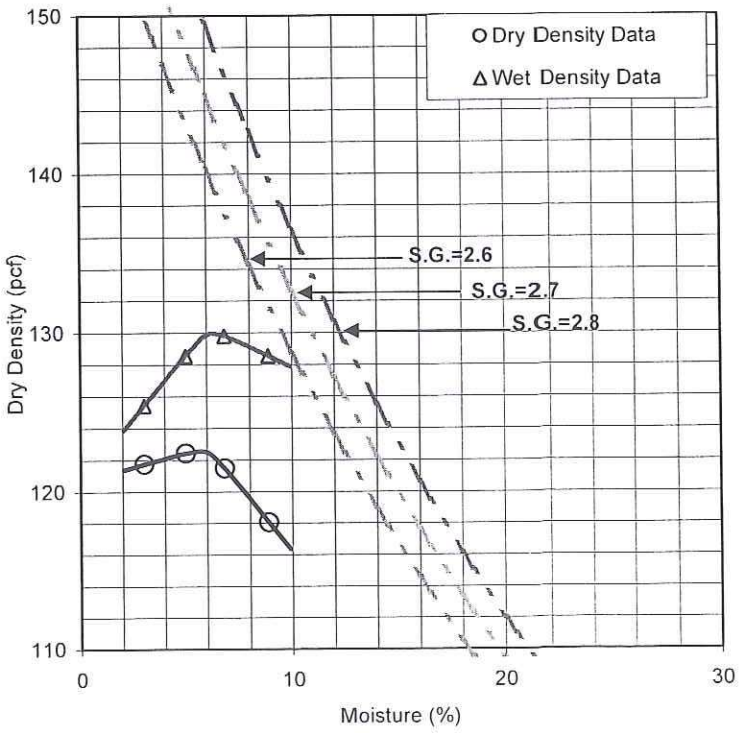
AP Number: 11-0210
Tested By: KM Date: 02/18/11
Calculated By: KM Date: 02/21/11
Checked By: AP Date: 02/24/11
Depth (ft): 1.5-5

IMPACT TEST DATA

I	Initial Wet Weight of Test Specimen (Grams)	2500					
	Increment No.	1	2	3	4	5	6
	Water Adjustment (grams)	0	50	100	150		
J	Tamper Reading	11.8	11.5	11.4	11.5		
K	Wet Density (gm/cc) from Table 1	2.01	2.06	2.08	2.06		
	Dry Density (gm/cc)	1.95	1.96	1.95	1.89		
	Dry Density (pcf)	**121.7**	**122.4**	**121.5**	**118.0**		
	Wt. of Container (gm.)	104.60	105.60	104.90	104.90		
	Wet Wt. of Soil + Cont. (gm.)	612.20	625.90	537.90	625.00		
	Dry Wt. of Soil + Cont. (gm.)	597.23	601.12	510.16	582.54		
	Moisture Content (%)	**3.04**	**5.00**	**6.84**	**8.89**		

ROCK CORRECTION				
L	Total Sample Weight		(grams)	11446
M	+19 mm (¾") Weight in Air		(grams)	185
N	+19 mm (¾") Weight in Water		(grams)	116.5
O	+19 mm (¾") Volume		(M-N)	68.5
P	% +19 mm (¾")	100*	(M/L)	1.62
Q	% -19 mm (¾")		(100-P)	98.38
R	Density of +19 mm (¾")		(M/O)	2.70
S	(%+19 mm)/Density of +19 mm		(P/RY)	0.60
T	(%-19 mm)/Density of -19 mm		(Q/K)	47.30
U	Sum of S and T		(S+T)	47.90
V	Average Adjusted Density		(100/U)	2.09
Percent Relative* Compaction		Spec	Failed	or less
			Passed	
*(H/K) for 10% or less +19 mm; (H/V) for > 10% +19 mm				
Note: 62.4 x (gm/cc) = P.C.F.				

Maximum Dry Density (pcf)	**122.6**
Optimum Moisture Content (%)	**6.0**
Maximum Wet Density (pcf)	**130.0**



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CAL 216 PART 2

LABORATORY COMPACTED TEST MAXIMUM WET DENSITY

Client: Earth Mechanics, Inc.
Project Name: SR-91 WB Widening
Project No. : 10126
Boring No.: A10-034
Sample No. : B-0
Visual Sample Description: Silty Sand with gravel

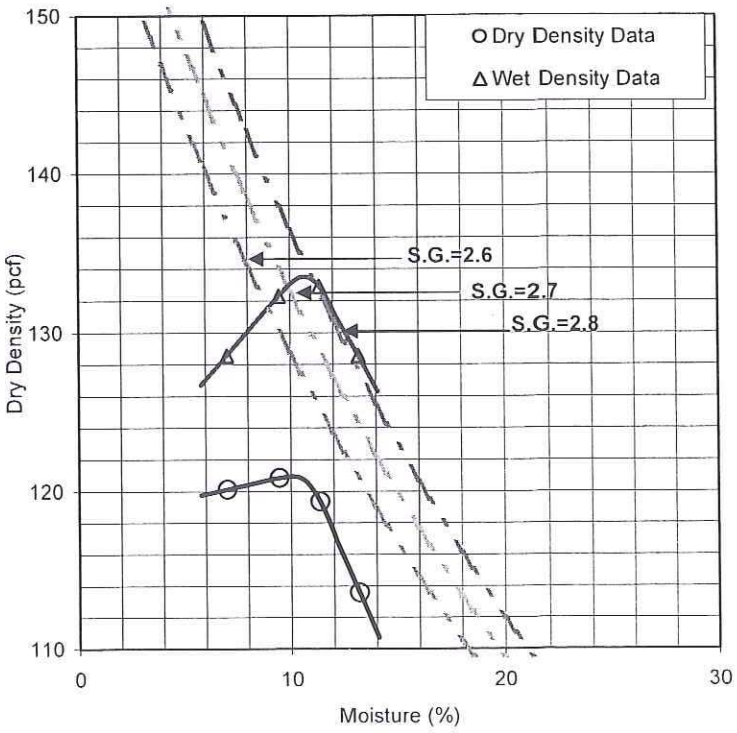
AP Number: 11-0210
Tested By: KM Date: 02/18/11
Calculated By: KM Date: 02/21/11
Checked By: AP Date: 02/24/11
Depth (ft): 0-2

IMPACT TEST DATA

I	Initial Wet Weight of Test Specimen (Grams)	2500					
	Increment No.	1	2	3	4	5	6
	Water Adjustment (grams)	0	50	100	150		
J	Tamper Reading	11.5	11.2	11.1	11.5		
K	Wet Density (gm/cc) from Table 1	2.06	2.12	2.13	2.06		
	Dry Density (gm/cc)	1.92	1.94	1.91	1.82		
	Dry Density (pcf)	**120.1**	**120.8**	**119.4**	**113.6**		
	Wt. of Container (gm.)	102.70	105.10	105.20	104.10		
	Wet Wt. of Soil + Cont. (gm.)	611.80	637.10	626.90	655.80		
	Dry Wt. of Soil + Cont. (gm.)	578.43	591.08	573.68	591.55		
	Moisture Content (%)	**7.01**	**9.47**	**11.36**	**13.18**		

ROCK CORRECTION				
L	Total Sample Weight		(grams)	13216
M	+19 mm (¾") Weight in Air		(grams)	111.5
N	+19 mm (¾") Weight in Water		(grams)	62
O	+19 mm (¾") Volume		(M-N)	49.5
P	% +19 mm (¾")	100*	(M/L)	0.84
Q	% -19 mm (¾")		(100-P)	99.16
R	Density of +19 mm (¾")		(M/O)	2.25
S	(%+19 mm)/Density of +19 mm		(P/RY)	0.37
T	(%-19 mm)/Density of -19 mm		(Q/K)	46.55
U	Sum of S and T		(S+T)	46.93
V	Average Adjusted Density		(100/U)	2.13
Percent Relative* Compaction		Spec	Failed	or less
			Passed	
*(H/K) for 10% or less +19 mm; (H/V) for > 10% +19 mm				
Note: 62.4 x (gm/cc) = P.C.F.				

Maximum Dry Density (pcf)	**120.8**
Optimum Moisture Content (%)	**10.5**
Maximum Wet Density (pcf)	**133.5**



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CAL 216 PART 2

LABORATORY COMPACTED TEST MAXIMUM WET DENSITY

Client: Earth Mechanics, Inc.
Project Name: SR-91 WB Widening
Project No. : 10126
Boring No.: A10-043
Sample No. : B-0
Visual Sample Description: Clayey Sand

Tested By: JT
Calculated By: KM
Checked By: AP
Depth (ft): 0-5

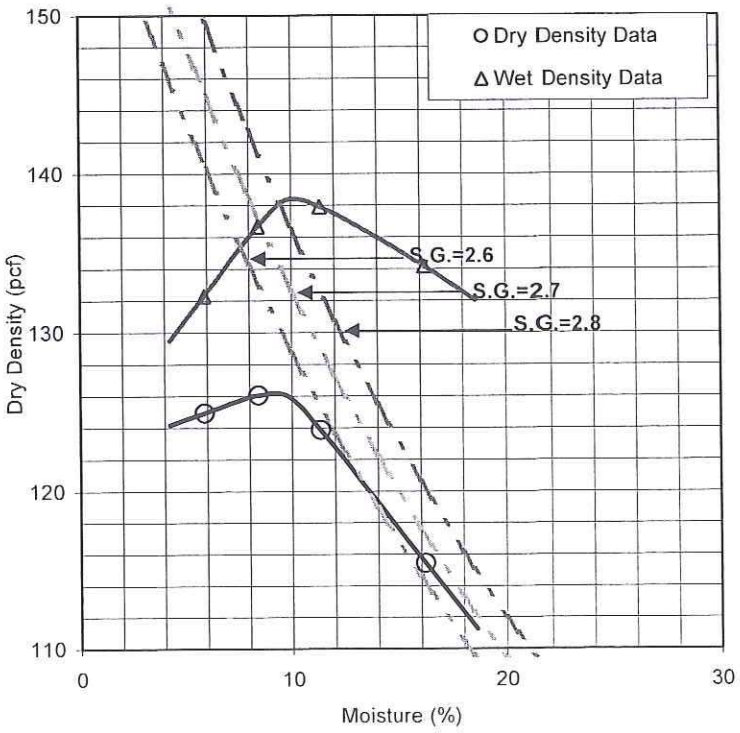
AP Number: 11-0210
Date: 02/22/11
Date: 03/03/11
Date: 03/06/11

IMPACT TEST DATA

I	Initial Wet Weight of Test Specimen (Grams)	2500					
	Increment No.	1	2	3	4	5	6
	Water Adjustment (grams)	0	-200	-100	-158		
J	Tamper Reading	11.0	11.2	10.7	10.8		
K	Wet Density (gm/cc) from Table 1	2.15	2.12	2.21	2.19		
	Dry Density (gm/cc)	1.85	2.00	1.98	2.02		
	Dry Density (pcf)	**115.4**	**124.9**	**123.9**	**126.1**		
	Wt. of Container (gm.)	191.79	192.05	181.64	193.86		
	Wet Wt. of Soil + Cont. (gm.)	697.22	669.05	622.78	645.46		
	Dry Wt. of Soil + Cont. (gm.)	626.68	642.56	577.84	610.42		
	Moisture Content (%)	**16.22**	**5.88**	**11.34**	**8.41**		

ROCK CORRECTION			
L	Total Sample Weight (grams)		13034
M	+19 mm (¾") Weight in Air (grams)		262
N	+19 mm (¾") Weight in Water (grams)		154
O	+19 mm (¾") Volume (M-N)		108
P	% +19 mm (¾") 100* (M/L)		2.01
Q	% -19 mm (¾") (100-P)		97.99
R	Density of +19 mm (¾") (M/O)		2.43
S	(%+19 mm)/Density of +19 mm (P/RY)		0.83
T	(%-19 mm)/Density of -19 mm (Q/K)		44.34
U	Sum of S and T (S+T)		45.17
V	Average Adjusted Density (100/U)		2.21
Percent Relative* Compaction	Spec	Failed	or less
		Passed	
*(H/K) for 10% or less +19 mm; (H/V) for > 10% +19 mm			
Note: 62.4 x (gm/cc) = P.C.F.			

Maximum Dry Density (pcf)	**126.0**
Optimum Moisture Content (%)	**10.0**
Maximum Wet Density (pcf)	**138.6**



AP Engineering & Testing, Inc.

CAL 216 PART 2

LABORATORY COMPACTED TEST MAXIMUM WET DENSITY

Client: Earth Mechanics, Inc.
Project Name: SR-91 WB Widening
Project No. : 10126
Boring No.: A10-052
Sample No. : B-0
Visual Sample Description: Poorly-Graded Sand w/silt

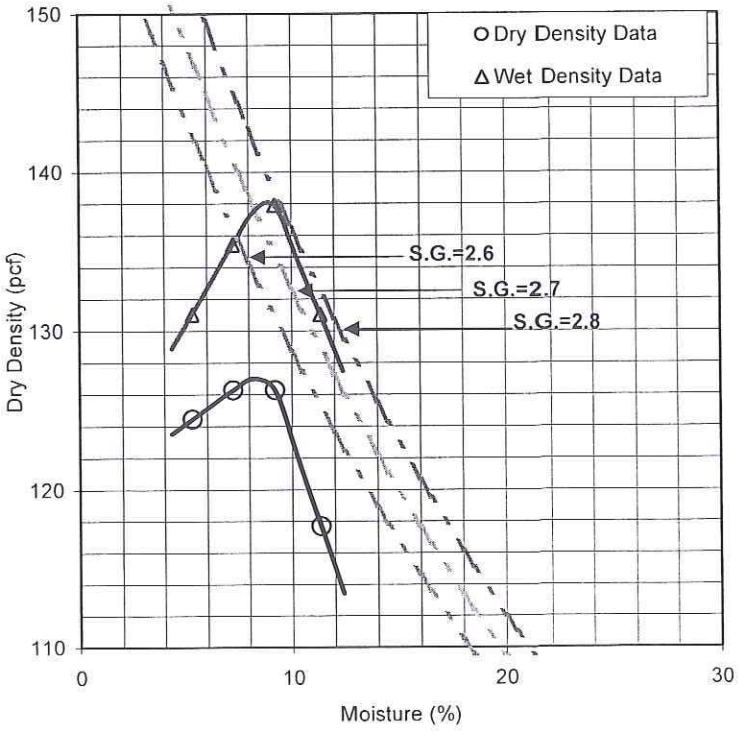
Tested By: JT
Calculated By: KM
Checked By: AP
Depth (ft): 2-5

AP Number: 11-0210
Date: 02/21/11
Date: 02/22/11
Date: 02/25/11

IMPACT TEST DATA

I	Initial Wet Weight of Test Specimen (Grams)	2500					
	Increment No.	1	2	3	4	5	6
	Water Adjustment (grams)	0	50	100	150		
J	Tamper Reading	11.3	10.9	10.7	11.3		
K	Wet Density (gm/cc) from Table 1	2.10	2.17	2.21	2.10		
	Dry Density (gm/cc)	1.99	2.02	2.02	1.89		
	Dry Density (pcf)	**124.4**	**126.3**	**126.3**	**117.7**		
	Wt. of Container (gm.)	155.29	194.93	158.17	155.01		
	Wet Wt. of Soil + Cont. (gm.)	695.61	639.82	829.34	736.23		
	Dry Wt. of Soil + Cont. (gm.)	668.39	609.78	772.70	677.01		
	Moisture Content (%)	**5.31**	**7.24**	**9.22**	**11.34**		

ROCK CORRECTION				
L	Total Sample Weight		(grams)	13124
M	+19 mm (¾") Weight in Air		(grams)	44
N	+19 mm (¾") Weight in Water		(grams)	29
O	+19 mm (¾") Volume		(M-N)	15
P	% +19 mm (¾")	100*	(M/L)	0.34
Q	% -19 mm (¾")		(100-P)	99.66
R	Density of +19 mm (¾")		(M/O)	2.93
S	(%+19 mm)/Density of +19 mm		(P/RY)	0.11
T	(%-19 mm)/Density of -19 mm		(Q/K)	45.10
U	Sum of S and T		(S+T)	45.21
V	Average Adjusted Density		(100/U)	2.21
Percent Relative* Compaction		Spec	Failed	or less
			Passed	
*(H/K) for 10% or less +19 mm; (H/V) for > 10% +19 mm				
Note: 62.4 x (gm/cc) = P.C.F.				



Maximum Dry Density (pcf)	**127.0**
Optimum Moisture Content (%)	**8.7**
Maximum Wet Density (pcf)	**138.0**

AP Engineering & Testing, Inc.

CAL 216 PART 2

LABORATORY COMPACTED TEST MAXIMUM WET DENSITY

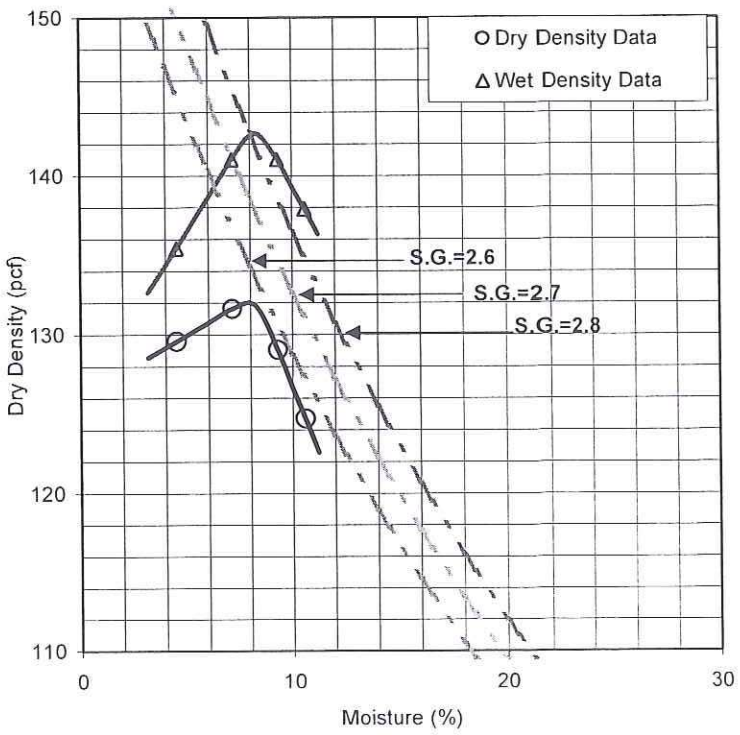
Client: Earth Mechanics, Inc.
Project Name: SR-91 WB Widening
Project No. : 10126
Boring No.: A10-055
Sample No. : B-0
Visual Sample Description: Poorly-Graded Sand w/silt

AP Number: 11-0210
Tested By: JT — Date: 02/22/11
Calculated By: KM — Date: 03/03/11
Checked By: AP — Date: 03/06/11
Depth (ft): 2-5

IMPACT TEST DATA

I	Initial Wet Weight of Test Specimen (Grams)	2500					
	Increment No.	1	2	3	4	5	6
	Water Adjustment (grams)	0	50	100	-60		
J	Tamper Reading	10.5	10.5	10.7	10.9		
K	Wet Density (gm/cc) from Table 1	2.26	2.26	2.21	2.17		
	Dry Density (gm/cc)	2.11	2.07	2.00	2.08		
	Dry Density (pcf)	**131.6**	**129.0**	**124.7**	**129.6**		
	Wt. of Container (gm.)	190.00	154.76	186.30	192.82		
	Wet Wt. of Soil + Cont. (gm.)	700.04	816.71	800.76	845.59		
	Dry Wt. of Soil + Cont. (gm.)	666.03	760.39	742.00	817.46		
	Moisture Content (%)	**7.14**	**9.30**	**10.57**	**4.50**		

ROCK CORRECTION			
L	Total Sample Weight (grams)		13002
M	+19 mm (¾") Weight in Air (grams)		242
N	+19 mm (¾") Weight in Water (grams)		147
O	+19 mm (¾") Volume (M-N)		95
P	% +19 mm (¾") 100* (M/L)		1.86
Q	% -19 mm (¾") (100-P)		98.14
R	Density of +19 mm (¾") (M/O)		2.55
S	(%+19 mm)/Density of +19 mm (P/RY)		0.73
T	(%-19 mm)/Density of -19 mm (Q/K)		43.42
U	Sum of S and T (S+T)		44.15
V	Average Adjusted Density (100/U)		2.26
Percent Relative* Compaction	Spec	Failed	or less
		Passed	
*(H/K) for 10% or less +19 mm; (H/V) for > 10% +19 mm			
Note: 62.4 x (gm/cc) = P.C.F.			



Maximum Dry Density (pcf)	**132.0**
Optimum Moisture Content (%)	**8.0**
Maximum Wet Density (pcf)	**142.6**

AP Engineering & Testing, Inc.

CAL 216 PART 2

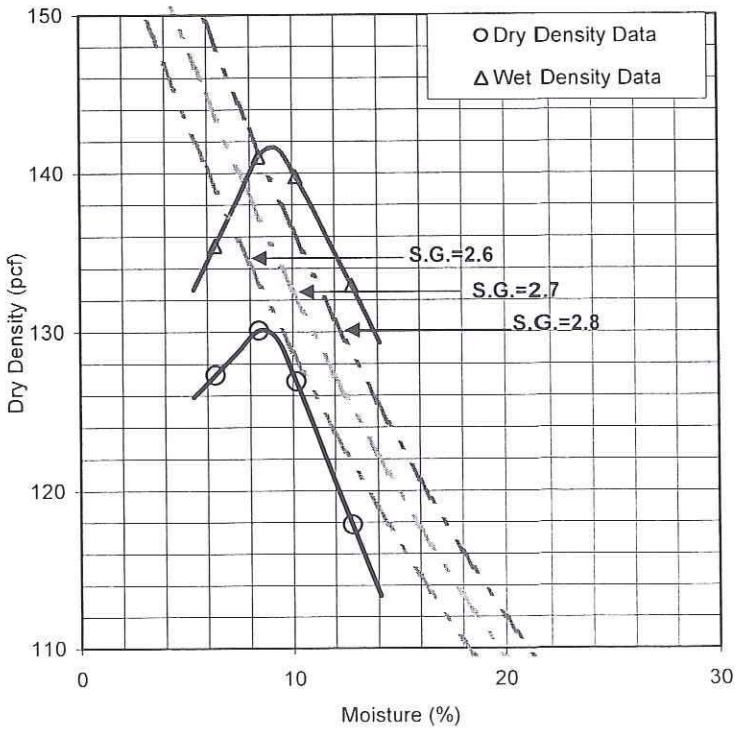
LABORATORY COMPACTED TEST MAXIMUM WET DENSITY

Client: Earth Mechanics, Inc.
Project Name: SR-91 WB Widening
Project No. : 10126
Boring No.: A10-061
Sample No. : B-0
Visual Sample Description: Poorly-Graded Sand with silt

AP Number: 11-0210
Tested By: JT Date: 02/22/11
Calculated By: KM Date: 03/03/11
Checked By: AP Date: 03/06/11
Depth (ft): 1.5-5

IMPACT TEST DATA							
I	Initial Wet Weight of Test Specimen (Grams)	2500					
	Increment No.	1	2	3	4	5	6
	Water Adjustment (grams)	0	50	100	-50		
J	Tamper Reading	10.5	10.6	11.1	10.9		
K	Wet Density (gm/cc) from Table 1	2.26	2.24	2.13	2.17		
	Dry Density (gm/cc)	2.08	2.03	1.89	2.04		
	Dry Density (pcf)	**130.1**	**126.9**	**117.8**	**127.3**		
	Wt. of Container (gm.)	148.39	152.63	154.75	156.48		
	Wet Wt. of Soil + Cont. (gm.)	573.10	601.82	716.59	557.65		
	Dry Wt. of Soil + Cont. (gm.)	540.14	560.40	652.85	533.59		
	Moisture Content (%)	**8.41**	**10.16**	**12.80**	**6.38**		

ROCK CORRECTION			
L	Total Sample Weight (grams)		13022
M	+19 mm (¾") Weight in Air (grams)		260
N	+19 mm (¾") Weight in Water (grams)		157
O	+19 mm (¾") Volume (M-N)		103
P	% +19 mm (¾") 100* (M/L)		2.00
Q	% -19 mm (¾") (100-P)		98.00
R	Density of +19 mm (¾") (M/O)		2.52
S	(%+19 mm)/Density of +19 mm (P/RY)		0.79
T	(%-19 mm)/Density of -19 mm (Q/K)		43.36
U	Sum of S and T (S+T)		44.16
V	Average Adjusted Density (100/U)		2.26
Percent Relative* Compaction	Spec	Failed	or less
		Passed	
*(H/K) for 10% or less +19 mm; (H/V) for > 10% +19 mm			
Note: 62.4 x (gm/cc) = P.C.F.			



Maximum Dry Density (pcf)	**130.0**
Optimum Moisture Content (%)	**9.0**
Maximum Wet Density (pcf)	**141.7**

AP Engineering & Testing, Inc.

COMPACTION TEST

Client: Earth Mechanics, Inc.
Project Name: RBF/WB SR-91 Widening
Project No. : 10-126
Boring No.: A-11-070
Sample No. : B-0
Visual Sample Description: Sand with silt

AP Number: 11-0543
Tested By: EM — Date: 05/18/11
Calculated By: KM — Date: 06/06/11
Checked By: AP — Date: 06/08/11
Depth (ft.): 0-4

Compaction Method: [X] ASTM D1557 [ ] ASTM D698
Preparation Method: [ ] Moist [X] Dry

METHOD: A
MOLD VOLUME (CU.FT): 0.0333

Trial No.	1	2	3	4	5	6
Wt. Comp. Soil + Mold (gm.)	3643	3686	3581	3694		
Wt. of Mold (gm.)	1739	1739	1739	1739		
Net Wt. of Soil (gm.)	1904	1947	1842	1955		
Container No.						
Wt. of Container (gm.)	162.16	162.67	151.55	148.18		
Wet Wt. of Soil + Cont. (gm.)	417.48	402.44	480.89	497.01		
Dry Wt. of Soil + Cont. (gm.)	405.07	385.36	472.49	465.50		
Moisture Content (%)	5.11	7.67	2.62	9.93		
Wet Density (pcf)	125.89	128.77	121.83	129.28		
Dry Density (pcf)	119.77	119.60	118.72	117.60		

Maximum Dry Density (pcf): **120.0**
Maximum Dry Density w/ Rock Correction (pcf): **N/A**
Optimum Moisture Content (%): **6.5**
Optimum Moisture Content w/ Rock Correction (%): **N/A**

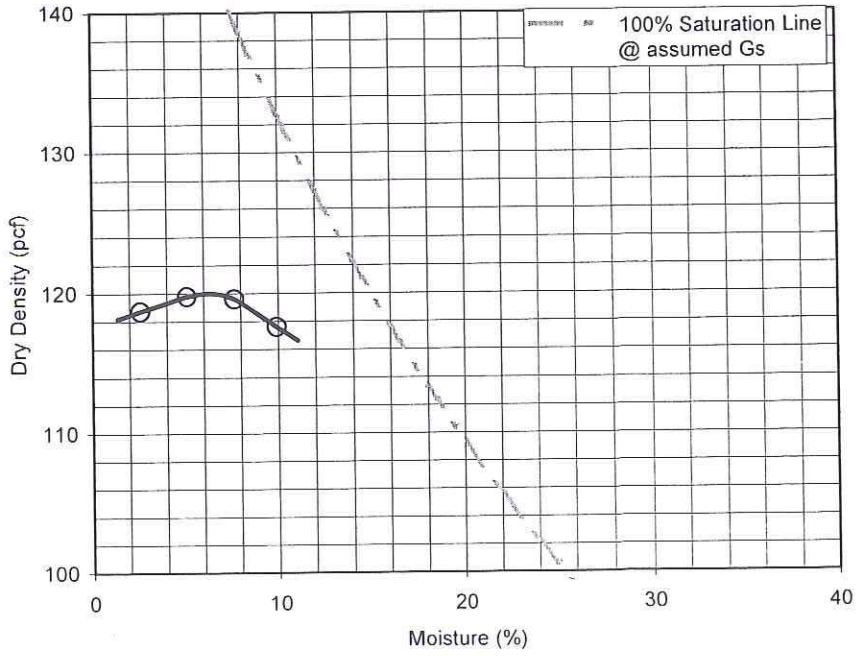
Assumed Specific Gravity = 2.7

PROCEDURE USED

[X] *METHOD A: Percent of Oversize:* NA
Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
May be used if No.4 retained < 25%

[ ] *METHOD B: Percent of Oversize:* NA
Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
Use if + No.4 > 25% and + 3/8 in < 25%

[ ] *METHOD C: Percent of Oversize:* NA
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)
Use if + 3/8 in >25% and +3/4 in <30%



Appendix C

Design Calculations

Retaining Wall 107 SP 10-126

LIQUEFACTION ANALYSIS: ACC. = 0.52 g 27-Jun-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
$^{1}C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-002

Emean (%) 75 Sur.= psf 112 =top of ground el. Borehole Diamete 8 73.5 =water table El. acc. max = 0.52 g Earthq. M= 7.3
C_E 1.25 C_B 1.15 Cm= 1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD.	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
-	-	-	-	-	-	-				-	-	-	-	-	-	-	-	-	-	-		-	-
109.5	112	2.5	0.15	0.15	2.50	2.00	0.75	1.20	1.00	120	1	1	3	0.99	0.34	8	30.0	14	1.00	0.15	0.16	0.48	AboveWT
107	109.5	2.5	0.30	0.30	5.00	1.87	0.75	1.00	0.60	120	2	2	17	0.99	0.33	21	30.0	29	1.00	0.41	0.44	1.32	AboveWT
102	107	5	0.60	0.60	10.00	1.32	0.75	1.20	1.00	120	1	1	16	0.98	0.33	28	4.0	28	1.00	0.37	0.40	1.20	AboveWT
97	102	5	0.90	0.90	15.00	1.08	0.85	1.00	0.60	120	2	2	25	0.97	0.33	20	30.0	28	1.00	0.37	0.40	1.21	AboveWT
92	97	5	1.20	1.20	20.00	0.93	0.85	1.20	1.00	120	1	1	11	0.95	0.32	16	35.0	25	0.97	0.29	0.30	0.94	AboveWT
87	92	5	1.50	1.50	25.00	0.83	0.95	1.00	0.60	120	2	2	21	0.94	0.32	15	30.0	23	0.93	0.26	0.26	0.80	AboveWT
82	87	5	1.80	1.80	30.00	0.76	0.95	1.20	1.00	120	1	1	21	0.93	0.31	27	25.0	35	0.89	high N	high N	LARGE	AboveWT

Retaining Wall 107 SP 10-126

LIQUEFACTION ANALYSIS; ACC. = 0.52 g 27-Jun-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
^1C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-003

Emean (%)	75	Sur.=	psf	112	=top of ground el.	Borehole Diamete	8							73.5	=water table El.			acc. max =	0.52	g		Earthq. M=	7.3
C_E	1.25					C_B	1.15															Cm=	1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD.	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
-	-	-	-	-	-	-				-	-		-	-	-	-	-	-	-	-	-	-	-
107	112	5	0.30	0.30	5.00	1.87	0.75	1.20	1.00	120	1	1	7	0.99	0.33	17	25.0	24	1.00	0.27	0.29	0.88	AboveWT
102	107	5	0.60	0.60	10.00	1.32	0.75	1.00	0.60	120	2	2	35	0.98	0.33	30	6.0	31	1.00	high N	high N	LARGE	AboveWT
97	102	5	0.90	0.90	15.00	1.08	0.85	1.20	1.00	120	1	1	23	0.97	0.33	37	15.0	42	1.00	high N	high N	LARGE	AboveWT
92	97	5	1.20	1.20	20.00	0.93	0.85	1.00	0.60	120	2	2	51	0.95	0.32	35	15.0	40	0.97	high N	high N	LARGE	AboveWT
87	92	5	1.50	1.50	25.00	0.83	0.95	1.20	1.00	120	1	1	12	0.94	0.32	17	40.0	26	0.93	0.31	0.31	0.98	AboveWT
82	87	5	1.80	1.80	30.00	0.76	0.95	1.00	0.60	120	2	2	66	0.93	0.31	42	15.0	47	0.89	high N	high N	LARGE	AboveWT

Retaining Wall 107 SP 10-126

LIQUEFACTION ANALYSIS; ACC. = 0.52 g 27-Jun-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
^1C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-005

Emean (%)	75	Sur.=	psf	114.3	=top of ground el.		Borehole Diamete	8						73.5	=water table El.			acc. max =	0.52	g		Earthq. M=	7.3
C_E	1.25						C_B	1.15														Cm=	1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD.	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
-	-	-	-	-	-	-				-	-	-	-	-	-	-	-	-	-	-		-	-
109.3	114.3	5	0.30	0.30	5.00	1.87	0.75	1.00	0.60	120	2	2	29	0.99	0.33	35	55.0	47	1.00	high N	high N	LARGE	AboveWT
104.3	109.3	5	0.60	0.60	10.00	1.32	0.75	1.20	1.00	120	1	1	7	0.98	0.33	12	25.0	18	1.00	0.19	0.21	0.62	AboveWT
99.3	104.3	5	0.90	0.90	15.00	1.08	0.85	1.00	0.60	120	2	2	60	0.97	0.33	48	20.0	56	1.00	high N	high N	LARGE	AboveWT
94.3	99.3	5	1.20	1.20	20.00	0.93	0.85	1.20	1.00	120	1	1	7	0.95	0.32	10	85.0	17	0.97	0.18	0.19	0.58	AboveWT
89.3	94.3	5	1.50	1.50	25.00	0.83	0.95	1.00	0.60	120	2	2	25	0.94	0.32	18	35.0	27	0.93	0.34	0.34	1.06	AboveWT
84.3	89.3	5	1.80	1.80	30.00	0.76	0.95	1.20	1.00	120	1	1	13	0.93	0.31	17	75.0	26	0.89	0.31	0.30	0.95	AboveWT
79.3	84.3	5	2.10	2.10	35.00	0.71	1.00	1.00	0.60	120	2	2	34	0.89	0.30	21	40.0	31	0.87	high N	high N	LARGE	AboveWT
74.3	79.3	5	2.40	2.40	40.00	0.66	1.00	1.20	1.00	120	1	1	9	0.85	0.29	11	65.0	19	0.85	0.20	0.18	0.64	AboveWT
73.5	74.3	0.8	2.45	2.45	40.80	0.65	1.00	1.00	0.60	120	2	2	39	0.84	0.28	22	35.0	32	0.84	high N	high N	LARGE	high N
68.5	73.5	5	2.75	2.59	45.80	0.63	1.00	1.00	0.60	120	2	2	39	0.80	0.29	22	35.0	32	0.83	high N	high N	LARGE	high N
63.5	68.5	5	3.05	2.74	50.80	0.62	1.00	1.20	1.00	120	1	1	16	0.76	0.29	18	35.0	27	0.82	0.34	0.30	1.04	no

Brookhurst Street Undercrossing (Widen) SP 10-126

LIQUEFACTION ANALYSIS; ACC. = 0.52 g 27-Jun-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
$^{1}C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-006

Emean (%) 75 Sur.= psf 130 =top of ground el. Borehole Diamete 8 73.5 =water table El. acc. max = 0.52 g Earthq. M= 7.3
C_E 1.25 C_B 1.15 Cm= 1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD.	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
125	130	5	0.30	0.30	5.00	1.87	0.75	1.20	1.00	120	1	1	12	0.99	0.33	29	20.0	35	1.00	high N	high N	LARGE	AboveWT
120	125	5	0.60	0.60	10.00	1.32	0.75	1.00	0.60	120	2	2	65	0.98	0.33	56	20.0	65	1.00	high N	high N	LARGE	AboveWT
115	120	5	0.90	0.90	15.00	1.08	0.85	1.20	1.00	120	1	1	13	0.97	0.33	21	30.0	29	1.00	0.41	0.44	1.35	AboveWT
110	115	5	1.20	1.20	20.00	0.93	0.85	1.00	0.60	120	2	2	24	0.95	0.32	17	30.0	25	0.97	0.29	0.30	0.94	AboveWT
105	110	5	1.50	1.50	25.00	0.83	0.95	1.20	1.00	120	1	1	8	0.94	0.32	11	70.0	19	0.93	0.20	0.20	0.64	AboveWT
100	105	5	1.79	1.79	30.00	0.76	0.95	1.00	0.60	115	2	2	53	0.93	0.31	34	25.0	43	0.89	high N	high N	LARGE	AboveWT
95	100	5	2.09	2.09	35.00	0.71	1.00	1.20	1.00	120	1	1	11	0.89	0.30	14	35.0	22	0.87	0.24	0.23	0.75	AboveWT
90	95	5	2.38	2.38	40.00	0.66	1.00	1.00	0.60	115	2	2	30	0.85	0.29	18	65.0	27	0.85	0.34	0.31	1.07	AboveWT
85	90	5	2.66	2.66	45.00	0.63	1.00	1.20	1.00	115	1	1	18	0.81	0.27	20	7.0	21	0.83	0.23	0.20	0.74	AboveWT
80	85	5	2.96	2.96	50.00	0.59	1.00	1.00	0.60	120	2	2	52	0.77	0.26	27	20.0	33	0.80	high N	high N	LARGE	AboveWT
75	80	5	3.26	3.26	55.00	0.57	1.00	1.20	1.00	120	1	1	40	0.73	0.25	40	15.0	45	0.77	high N	high N	LARGE	AboveWT
73.5	75	1.5	3.35	3.35	56.50	0.56	1.00	1.00	0.60	120	2	2	19	0.71	0.24	10	90.0	17	0.76	0.18	0.15	0.61	fines
70	73.5	3.5	3.56	3.45	60.00	0.55	1.00	1.00	0.60	120	2	2	19	0.69	0.24	10	90.0	17	0.76	0.18	0.15	0.61	fines
65	70	5	3.85	3.58	65.00	0.54	1.00	1.20	1.00	115	1	1	7	0.64	0.23	7	90.0	14	0.75	0.15	0.12	0.51	fines
60	65	5	4.14	3.72	70.00	0.53	1.00	1.00	0.60	115	2	2	30	0.60	0.23	14	80.0	22	0.74	0.24	0.19	0.84	fines
55	60	5	4.43	3.85	75.00	0.52	1.00	1.20	1.00	115	1	1	13	0.56	0.22	12	51.0	20	0.73	0.22	0.17	0.77	fines
50	55	5	4.73	3.99	80.00	0.51	1.00	1.00	0.60	120	2	2	100	0.55	0.22	45	4.0	45	0.73	high N	high N	LARGE	high N
45	50	5	5.03	4.14	85.00	0.50	1.00	1.20	1.00	120	1	1	24	0.54	0.22	21	30.0	29	0.72	0.41	0.32	1.43	no

Brookhurst Street Undercrossing (Widen) SP 10-126
LIQUEFACTION ANALYSIS; ACC. = 0.52 g 27-Jun-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
$^{1}C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-007

Emean (%)	75	Sur.=	psf	112.4	=top of ground el.	Borehole Diamete	8							73.5	=water table El.			acc. max =	0.52	g		Earthq. M=	7.3
C_E	1.25					C_B	1.15															Cm=	1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD.	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
109.9	112.4	2.5	0.15	0.15	2.50	2.00	0.75	1.20	1.00	120	1	1	11	0.99	0.34	29	4.0	29	1.00	0.41	0.44	1.31	AboveWT
107.4	109.9	2.5	0.30	0.30	5.00	1.87	0.75	1.00	0.60	120	2	2	15	0.99	0.33	19	80.0	28	1.00	0.37	0.40	1.19	AboveWT
102.4	107.4	5	0.59	0.59	10.00	1.33	0.75	1.20	1.00	115	1	1	10	0.98	0.33	18	80.0	27	1.00	0.34	0.36	1.10	AboveWT
97.4	102.4	5	0.88	0.88	15.00	1.09	0.85	1.00	0.60	115	2	2	22	0.97	0.33	18	65.0	27	1.00	0.34	0.36	1.11	AboveWT
92.4	97.4	5	1.16	1.16	20.00	0.95	0.85	1.20	1.00	115	1	1	11	0.95	0.32	16	35.0	25	0.98	0.29	0.31	0.95	AboveWT
87.4	92.4	5	1.45	1.45	25.00	0.85	0.95	1.00	0.60	115	2	2	14	0.94	0.32	10	70.0	17	0.94	0.18	0.18	0.57	AboveWT
82.4	87.4	5	1.74	1.74	30.00	0.78	0.95	1.20	1.00	115	1	1	11	0.93	0.31	14	20.0	19	0.90	0.20	0.20	0.62	AboveWT
77.4	82.4	5	2.04	2.04	35.00	0.72	1.00	1.00	0.60	120	2	2	54	0.89	0.30	34	30.0	44	0.88	high N	high N	LARGE	AboveWT
73.5	77.4	3.9	2.27	2.27	38.90	0.68	1.00	1.20	1.00	120	1	1	22	0.86	0.29	26	25.0	34	0.86	high N	high N	LARGE	high N
72.4	73.5	1.1	2.34	2.30	40.00	0.67	1.00	1.20	1.00	120	1	1	22	0.85	0.29	26	25.0	34	0.86	high N	high N	LARGE	high N
67.4	72.4	5	2.64	2.45	45.00	0.65	1.00	1.00	0.60	120	2	2	29	0.81	0.29	17	85.0	26	0.84	0.31	0.28	0.96	fines
62.4	67.4	5	2.93	2.58	50.00	0.64	1.00	1.20	1.00	115	1	1	20	0.77	0.29	22	25.0	29	0.83	0.41	0.37	1.25	no
57.4	62.4	5	3.21	2.71	55.00	0.62	1.00	1.00	0.60	115	2	2	21	0.73	0.29	12	75.0	20	0.82	0.22	0.19	0.65	fines
52.4	57.4	5	3.50	2.84	60.00	0.61	1.00	1.20	1.00	115	1	1	22	0.69	0.29	24	12.0	27	0.81	0.34	0.29	1.03	no
47.4	52.4	5	3.80	2.99	65.00	0.59	1.00	1.00	0.60	120	2	2	22	0.64	0.28	12	85.0	20	0.80	0.22	0.18	0.67	fines
42.4	47.4	5	4.10	3.13	70.00	0.58	1.00	1.20	1.00	120	1	1	22	0.60	0.27	22	30.0	31	0.77	high N	high N	LARGE	high N
37.4	42.4	5	4.40	3.27	75.00	0.56	1.00	1.00	0.60	120	2	2	49	0.56	0.26	24	75.0	34	0.76	high N	high N	LARGE	high N/fines
32.4	37.4	5	4.70	3.42	80.00	0.55	1.00	1.20	1.00	120	1	1	19	0.55	0.26	19	85.0	28	0.76	0.37	0.30	1.17	fines

Brookhurst Street Undercrossing (Widen) SP 10-126

LIQUEFACTION ANALYSIS; ACC. = 0.52 g 27-Jun-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
^1C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-008

Emean (%)	75	Sur.=	psf	130	=top of ground el.	Borehole Diamete	8									73.5	=water table El.		acc. max =	0.52	g		Earthq. M=	7.3
C_E	1.25					C_B	1.15																Cm=	1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD.	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
125	130	5	0.30	0.30	5.00	1.87	0.75	1.20	1.00	120	1	1	10	0.99	0.33	25	30.0	34	1.00	high N	high N	LARGE	AboveWT
120	125	5	0.60	0.60	10.00	1.32	0.75	1.00	0.60	120	2	2	56	0.98	0.33	48	30.0	61	1.00	high N	high N	LARGE	AboveWT
115	120	5	0.90	0.90	15.00	1.08	0.85	1.20	1.00	120	1	1	28	0.97	0.33	45	30.0	57	1.00	high N	high N	LARGE	AboveWT
110	115	5	1.20	1.20	20.00	0.93	0.85	1.00	0.60	120	2	2	23	0.95	0.32	16	35.0	25	0.97	0.29	0.30	0.94	AboveWT
105	110	5	1.50	1.50	25.00	0.83	0.95	1.20	1.00	120	1	1	17	0.94	0.32	24	35.0	34	0.93	high N	high N	LARGE	AboveWT
100	105	5	1.79	1.79	30.00	0.76	0.95	1.00	0.60	115	2	2	45	0.93	0.31	29	15.0	33	0.89	high N	high N	LARGE	AboveWT
95	100	5	2.09	2.09	35.00	0.71	1.00	1.20	1.00	120	1	1	19	0.89	0.30	24	45.0	34	0.87	high N	high N	LARGE	AboveWT
90	95	5	2.38	2.38	40.00	0.66	1.00	1.00	0.60	115	2	2	20	0.85	0.29	12	60.0	20	0.85	0.22	0.20	0.68	AboveWT
85	90	5	2.66	2.66	45.00	0.63	1.00	1.20	1.00	115	1	1	12	0.81	0.27	13	55.0	21	0.83	0.23	0.20	0.74	AboveWT
80	85	5	2.96	2.96	50.00	0.59	1.00	1.00	0.60	120	2	2	100	0.77	0.26	52	20.0	60	0.80	high N	high N	LARGE	AboveWT
75	80	5	3.26	3.26	55.00	0.57	1.00	1.20	1.00	120	1	1	27	0.73	0.25	27	20.0	33	0.77	high N	high N	LARGE	AboveWT
73.5	75	1.5	3.35	3.35	56.50	0.56	1.00	1.00	0.60	120	2	2	40	0.71	0.24	20	80.0	29	0.76	0.41	0.33	1.38	fines
70	73.5	3.5	3.56	3.45	60.00	0.55	1.00	1.00	0.60	120	2	2	40	0.69	0.24	19	80.0	28	0.76	0.37	0.30	1.25	fines
65	70	5	3.85	3.58	65.00	0.54	1.00	1.20	1.00	115	1	1	18	0.64	0.23	18	28.0	26	0.75	0.31	0.25	1.07	no
60	65	5	4.14	3.72	70.00	0.53	1.00	1.00	0.60	115	2	2	52	0.60	0.23	24	80.0	34	0.74	high N	high N	LARGE	high N/fines
55	60	5	4.43	3.85	75.00	0.52	1.00	1.20	1.00	115	1	1	21	0.56	0.22	19	30.0	27	0.73	0.34	0.27	1.21	no
50	55	5	4.73	3.99	80.00	0.51	1.00	1.00	0.60	120	2	2	100	0.55	0.22	45	4.0	45	0.73	high N	high N	LARGE	high N

Euclid St UC (Widen)

Sounding: CPT-10-022

PGA: 0.52 Mag 7.3 Gwdepth 72 Ground EL 153

Note: Units are tons/cf, tons/sf, and feet

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	CQ2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
7.55	145.5	11.68	1.048	0.06	0.45	0.45	24.78	9.33	3.02	Clay	Clay	Clay	Clay	Clay	Clay	24.78	3.02	6.94	172.00	0.55	0.33	0.98	FALSE	0.00	Above WT
7.71	145.3	11.61	0.930	0.06	0.46	0.46	24.10	8.34	2.99	Clay	Clay	Clay	Clay	Clay	Clay	24.10	2.99	6.64	160.06	0.46	0.33	0.98	FALSE	0.00	Above WT
7.87	145.1	11.11	1.021	0.06	0.47	0.47	22.53	9.60	3.06	Clay	Clay	Clay	Clay	Clay	Clay	22.53	3.06	7.38	166.20	0.51	0.33	0.98	FALSE	0.00	Above WT
8.04	145.0	12.35	1.233	0.06	0.48	0.48	24.60	10.39	3.05	Clay	Clay	Clay	Clay	Clay	Clay	24.60	3.05	7.36	181.08	0.63	0.33	0.98	FALSE	0.00	Above WT
8.20	144.8	14.32	1.442	0.06	0.49	0.49	28.11	10.43	3.02	Clay	Clay	Clay	Clay	Clay	Clay	28.11	3.02	6.92	194.53	0.76	0.33	0.98	FALSE	0.00	Above WT
8.37	144.6	16.92	1.503	0.06	0.50	0.50	32.69	9.15	2.93	Clay	Clay	Clay	Clay	Clay	Clay	32.69	2.93	6.00	196.01	0.78	0.33	0.98	FALSE	0.00	Above WT
8.53	144.5	16.00	1.858	0.06	0.51	0.51	30.26	11.99	3.04	Clay	Clay	Clay	Clay	Clay	Clay	30.26	3.04	7.20	217.91	1.04	0.33	0.98	FALSE	0.00	Above WT
8.69	144.3	19.25	2.843	0.06	0.52	0.52	35.92	15.18	3.07	Clay	Clay	Clay	Clay	Clay	Clay	35.92	3.07	7.57	271.94	1.95	0.33	0.98	FALSE	0.00	Above WT
8.86	144.1	67.30	4.456	0.06	0.53	0.53	125.60	6.67	2.46	1.40	90.51	2.54	Sand	Sand	Sand	90.51	2.54	3.00	271.38	1.94	0.33	0.98	FALSE	0.00	Above WT
9.02	144.0	159.80	6.066	0.06	0.54	0.54	294.27	3.81	2.06	1.39	213.00	2.13	Sand	Sand	Sand	213.00	2.13	1.52	322.92	3.21	0.33	0.98	FALSE	0.00	Above WT
9.19	143.8	308.56	5.833	0.06	0.55	0.55	558.59	1.89	1.66	1.37	407.46	1.73	Sand	Sand	Sand	407.46	1.73	1.06	430.20	7.48	0.33	0.98	FALSE	0.00	Above WT
9.35	143.7	437.33	6.398	0.06	0.56	0.56	778.55	1.46	1.50	1.36	572.55	1.56	Sand	Sand	Sand	572.55	1.56	1.00	572.55	17.53	0.33	0.98	FALSE	0.00	Above WT
9.51	143.5	549.24	8.107	0.06	0.57	0.57	961.57	1.48	1.47	1.35	712.98	1.52	Sand	Sand	Sand	712.98	1.52	1.00	712.98	33.79	0.33	0.98	FALSE	0.00	Above WT
9.68	143.3	608.58	7.978	0.06	0.58	0.58	1046.83	1.31	1.41	1.34	783.05	1.46	Sand	Sand	Sand	783.05	1.46	1.00	783.05	44.73	0.33	0.98	FALSE	0.00	Above WT
9.84	143.2	531.16	6.594	0.06	0.59	0.59	898.66	1.24	1.41	1.33	677.85	1.46	Sand	Sand	Sand	677.85	1.46	1.00	677.85	29.05	0.33	0.98	FALSE	0.00	Above WT
10.01	143.0	490.80	5.251	0.06	0.60	0.60	816.18	1.07	1.37	1.32	621.01	1.42	Sand	Sand	Sand	621.01	1.42	1.00	621.01	22.35	0.33	0.98	FALSE	0.00	Above WT
10.17	142.8	459.84	4.528	0.06	0.61	0.61	752.59	0.99	1.35	1.31	577.24	1.41	Sand	Sand	Sand	577.24	1.41	1.00	577.24	17.97	0.33	0.98	FALSE	0.00	Above WT
10.33	142.7	412.48	4.275	0.06	0.62	0.62	664.51	1.04	1.40	1.30	513.76	1.45	Sand	Sand	Sand	513.76	1.45	1.00	513.76	12.69	0.33	0.98	FALSE	0.00	Above WT
10.50	142.5	359.65	3.977	0.06	0.63	0.63	569.87	1.11	1.45	1.28	444.32	1.51	Sand	Sand	Sand	444.32	1.51	1.00	444.32	8.24	0.33	0.98	FALSE	0.00	Above WT
10.66	142.3	295.66	3.526	0.06	0.64	0.64	461.26	1.20	1.53	1.28	362.51	1.59	Sand	Sand	Sand	362.51	1.59	1.00	362.51	4.51	0.33	0.98	FALSE	0.00	Above WT
10.83	142.2	253.74	3.661	0.06	0.65	0.65	389.49	1.45	1.64	1.27	308.66	1.69	Sand	Sand	Sand	308.66	1.69	1.03	318.91	3.10	0.33	0.97	FALSE	0.00	Above WT
10.99	142.0	234.51	4.194	0.06	0.66	0.66	354.64	1.79	1.74	1.26	283.18	1.79	Sand	Sand	Sand	283.18	1.79	1.10	311.57	2.89	0.33	0.97	FALSE	0.00	Above WT
11.15	141.9	224.08	4.132	0.06	0.67	0.67	333.95	1.85	1.76	1.25	268.64	1.82	Sand	Sand	Sand	268.64	1.82	1.12	300.30	2.60	0.33	0.97	FALSE	0.00	Above WT
11.32	141.7	234.38	3.616	0.06	0.68	0.68	344.06	1.55	1.69	1.24	278.87	1.74	Sand	Sand	Sand	278.87	1.74	1.07	297.43	2.53	0.33	0.97	FALSE	0.00	Above WT
11.48	141.5	237.33	3.285	0.06	0.69	0.69	343.56	1.39	1.65	1.23	280.41	1.70	Sand	Sand	Sand	280.41	1.70	1.04	291.64	2.39	0.33	0.97	FALSE	0.00	Above WT
11.65	141.4	238.15	3.615	0.06	0.70	0.70	339.70	1.52	1.69	1.22	279.32	1.74	Sand	Sand	Sand	279.32	1.74	1.06	296.77	2.51	0.33	0.97	FALSE	0.00	Above WT
11.81	141.2	246.00	3.339	0.06	0.71	0.71	346.16	1.36	1.64	1.21	286.56	1.69	Sand	Sand	Sand	286.56	1.69	1.03	295.62	2.48	0.33	0.97	FALSE	0.00	Above WT
11.98	141.0	246.21	4.105	0.06	0.72	0.72	341.53	1.67	1.72	1.20	284.76	1.76	Sand	Sand	Sand	284.76	1.76	1.08	308.02	2.80	0.33	0.97	FALSE	0.00	Above WT
12.14	140.9	203.70	4.484	0.06	0.73	0.73	278.65	2.21	1.87	1.19	234.04	1.91	Sand	Sand	Sand	234.04	1.91	1.20	281.09	2.15	0.33	0.97	FALSE	0.00	Above WT
12.30	140.7	186.72	4.033	0.06	0.74	0.74	252.01	2.17	1.89	1.19	213.13	1.93	Sand	Sand	Sand	213.13	1.93	1.22	259.65	1.71	0.33	0.97	FALSE	0.00	Above WT
12.47	140.5	307.51	3.984	0.06	0.75	0.75	410.00	1.30	1.59	1.18	348.61	1.62	Sand	Sand	Sand	348.61	1.62	1.00	348.61	4.02	0.33	0.97	FALSE	0.00	Above WT
12.63	140.4	326.26	2.859	0.06	0.76	0.76	429.54	0.88	1.43	1.17	367.51	1.47	Sand	Sand	Sand	367.51	1.47	1.00	367.51	4.70	0.33	0.97	FALSE	0.00	Above WT
12.80	140.2	303.58	2.974	0.06	0.77	0.77	394.29	0.98	1.49	1.16	339.68	1.53	Sand	Sand	Sand	339.68	1.53	1.00	339.68	3.73	0.33	0.97	FALSE	0.00	Above WT
12.96	140.0	283.18	3.498	0.06	0.78	0.78	363.17	1.24	1.60	1.16	314.90	1.63	Sand	Sand	Sand	314.90	1.63	1.00	314.90	2.98	0.33	0.97	FALSE	0.00	Above WT
13.12	139.9	282.99	4.114	0.06	0.79	0.79	358.49	1.46	1.66	1.15	312.76	1.69	Sand	Sand	Sand	312.76	1.69	1.03	323.02	3.21	0.33	0.97	FALSE	0.00	Above WT
13.29	139.7	301.76	4.684	0.06	0.80	0.80	377.43	1.56	1.67	1.14	331.37	1.70	Sand	Sand	Sand	331.37	1.70	1.04	344.31	3.88	0.33	0.97	FALSE	0.00	Above WT
13.45	139.6	380.59	4.833	0.06	0.81	0.81	470.61	1.27	1.55	1.14	415.44	1.57	Sand	Sand	Sand	415.44	1.57	1.00	415.44	6.75	0.33	0.97	FALSE	0.00	Above WT
13.62	139.4	409.27	3.880	0.06	0.82	0.82	499.82	0.95	1.42	1.13	443.94	1.45	Sand	Sand	Sand	443.94	1.45	1.00	443.94	8.22	0.33	0.97	FALSE	0.00	Above WT
13.78	139.2	432.83	3.576	0.06	0.83	0.83	522.50	0.83	1.36	1.12	466.77	1.39	Sand	Sand	Sand	466.77	1.39	1.00	466.77	9.54	0.33	0.97	FALSE	0.00	Above WT
13.94	139.1	472.28	3.978	0.06	0.84	0.84	563.66	0.84	1.35	1.12	506.38	1.38	Sand	Sand	Sand	506.38	1.38	1.00	506.38	12.16	0.33	0.97	FALSE	0.00	Above WT
14.11	138.9	491.79	4.390	0.06	0.85	0.85	579.90	0.89	1.37	1.11	524.11	1.39	Sand	Sand	Sand	524.11	1.39	1.00	524.11	13.47	0.33	0.97	FALSE	0.00	Above WT
14.27	138.7	497.43	4.712	0.06	0.86	0.86	579.97	0.95	1.39	1.10	527.14	1.41	Sand	Sand	Sand	527.14	1.41	1.00	527.14	13.70	0.33	0.97	FALSE	0.00	Above WT
14.44	138.6	456.62	4.843	0.06	0.87	0.87	526.03	1.06	1.45	1.10	481.04	1.47	Sand	Sand	Sand	481.04	1.47	1.00	481.04	10.43	0.33	0.97	FALSE	0.00	Above WT
14.60	138.4	468.55	5.045	0.06	0.88	0.88	533.87	1.08	1.46	1.09	490.89	1.48	Sand	Sand	Sand	490.89	1.48	1.00	490.89	11.08	0.33	0.97	FALSE	0.00	Above WT
14.76	138.2	447.29	4.914	0.06	0.89	0.89	504.07	1.10	1.48	1.08	466.07	1.49	Sand	Sand	Sand	466.07	1.49	1.00	466.07	9.50	0.33	0.97	FALSE	0.00	Above WT
14.93	138.1	439.92	4.797	0.06	0.90	0.90	490.09	1.09	1.48	1.08	455.78	1.50	Sand	Sand	Sand	455.78	1.50	1.00	455.78	8.89	0.33	0.97	FALSE	0.00	Above WT
15.09	137.9	428.57	4.564	0.06	0.91	0.91	472.35	1.07	1.48	1.07	441.66	1.50	Sand	Sand	Sand	441.66	1.50	1.00	441.66	8.09	0.33	0.96	FALSE	0.00	Above WT
15.26	137.7	413.44	5.015	0.06	0.92	0.92	450.55	1.22	1.54	1.07	423.68	1.55	Sand	Sand	Sand	423.68	1.55	1.00	423.68	7.15	0.33	0.96	FALSE	0.00	Above WT
15.42	137.6	392.88	5.541	0.06	0.93	0.93	423.64	1.41	1.61	1.06	400.52	1.62	Sand	Sand	Sand	400.52	1.62	1.00	400.52	6.06	0.33	0.96	FALSE	0.00	Above WT
15.58	137.4	326.62	5.589	0.06	0.93	0.93	348.40	1.72	1.73	1.05	331.26	1.74	Sand	Sand	Sand	331.26	1.74	1.06	352.10	4.14	0.33	0.96	FALSE	0.00	Above WT
15.75	137.3	280.42	4.784	0.06	0.95	0.95	295.74	1.71	1.76	1.05	282.86	1.77	Sand	Sand	Sand	282.86	1.77	1.09	307.95	2.80	0.33	0.96	FALSE	0.00	Above WT
15.91	137.1	361.17	3.896	0.06	0.95	0.95	377.35	1.08	1.54	1.04	362.48	1.55	Sand	Sand	Sand	362.48	1.55	1.00	362.48	4.51	0.33	0.96	FALSE	0.00	Above WT
16.08	136.9	394.93	3.524	0.06	0.96	0.96	408.34	0.89	1.45	1.04	394.26	1.46	Sand	Sand	Sand	394.26	1.46	1.00	394.26	5.78	0.33	0.96	FALSE	0.00	Above WT
16.24	136.8	412.23	3.430	0.06	0.97	0.97	422.06	0.83	1.42	1.03	409.50	1.43	Sand	Sand	Sand	409.50	1.43	1.00	409.50	6.47	0.33	0.96	FALSE	0.00	Above WT
16.40	136.6	427.49	3.092	0.06	0.98	0.98	433.44	0.72	1.36	1.03	422.58	1.37	Sand	Sand	Sand	422.58	1.37	1.00	422.58	7.10	0.33	0.96	FALSE	0.00	Above WT
16.57	136.4	446.80	4.175	0.06	0.99	0.99	448.41	0.94	1.45	1.02	439.40	1.45	Sand	Sand	Sand	439.40	1.45	1.00	439.40	7.97	0.32	0.96	FALSE	0.00	Above WT
16.73	136.3	479.27	4.954	0.06	1.00	1.00	476.46	1.04	1.47	1.02	469.07	1.47	Sand	Sand	Sand	469.07	1.47	1.00	469.07	9.68	0.32	0.96	FALSE	0.00	Above WT
16.90	136.1	473.18	5.401	0.06	1.01	1.01	465.65	1.14	1.51	1.01	460.78	1.51	Sand	Sand	Sand	460.78	1.51	1.00	460.78	9.18	0.32	0.96	FALSE	0.00	Above WT
17.06	135.9	497.35	5.300	0.06	1.02	1.02	484.88	1.07	1.47	1.01	482.04	1.48	Sand	Sand	Sand	482.04	1.48	1.00	482.04	10.50	0.32	0.96	FALSE	0.00	Above WT
17.22	135.8	468.32	4.700	0.06	1.03	1.03	452.27	1.01	1.47	1.00	451.79	1.47	Sand	Sand	Sand	451.79	1.47	1.00	451.79	8.66	0.32	0.96	FALSE	0.00	Above WT
17.39	135.6	463.82	3.890	0.06	1.04	1.04	443.53	0.84	1.41	1.00	445.25	1.41	Sand	Sand	Sand	445.25	1.41	1.00	445.25	8.29	0.32	0.96	FALSE	0.00	Above WT
17.55	135.5	450.26	4.010	0.06	1.05	1.05	426.60	0.89	1.44	0.99	430.26	1.44	Sand	Sand	Sand	430.26	1.44	1.00	430.26	7.49	0.32	0.96	FALSE	0.00	Above WT
17.72	135.3	437.56	3.922	0.06	1.06	1.06	410.55	0.90	1.45	0.99	416.12	1.45	Sand	Sand	Sand	416.12	1.45	1.00	416.12	6.78	0.32	0.96	FALSE	0.00	Above WT
17.88	135.1	456.28	3.435	0.06	1.07	1.07	424.32	0.75	1.38	0.98	431.97	1.38	Sand	Sand	Sand	431.97	1.38	1.00	431.97	7.58	0.32	0.96	FALSE	0.00	Above WT
18.04	135.0	457.94	3.936	0.06	1.08	1.08	422.08	0.86	1.43	0.98	431.62	1.43	Sand	Sand	Sand	431.62	1.43	1.00	431.62	7.56	0.32	0.96	FALSE	0.00	Above WT
18.21	134.8	463.46	3.964	0.06	1.09	1.09	423.18	0.86	1.43	0.98	434.78	1.42	Sand	Sand	Sand	434.78	1.42	1.00	434.78	7.72	0.32	0.96	FALSE	0.00	Above WT
18.37	134.6	438.46	3.618	0.06	1.10	1.10	396.80	0.83	1.43	0.97	409.53	1.42	Sand	Sand	Sand	409.53	1.42	1.00	409.53	6.47	0.32	0.96	FALSE	0.00	Above WT
18.54	134.5	422.57	3.626	0.06	1.11	1.11	378.87	0.86	1.46	0.97	392.87	1.45	Sand	Sand	Sand	392.87	1.45	1.00	392.87	5.72	0.32	0.96	FALSE	0.00	Above WT

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	CQ2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
18.70	134.3	412.44	3.508	0.06	1.12	1.12	366.59	0.85	1.46	0.96	381.81	1.45	Sand	Sand	Sand	381.81	1.45	1.00	381.81	5.26	0.32	0.96	FALSE	0.00	Above WT
18.86	134.1	375.78	3.104	0.06	1.13	1.13	331.08	0.83	1.48	0.96	346.39	1.47	Sand	Sand	Sand	346.39	1.47	1.00	346.39	3.95	0.32	0.96	FALSE	0.00	Above WT
19.03	134.0	323.39	2.518	0.06	1.14	1.14	282.23	0.78	1.51	0.95	296.77	1.49	Sand	Sand	Sand	296.77	1.49	1.00	296.77	2.51	0.32	0.96	FALSE	0.00	Above WT
19.19	133.8	253.16	1.703	0.06	1.15	1.15	218.87	0.68	1.54	0.95	231.35	1.52	Sand	Sand	Sand	231.35	1.52	1.00	231.35	1.23	0.32	0.96	FALSE	0.00	Above WT
19.36	133.6	177.94	1.451	0.06	1.16	1.16	152.19	0.82	1.72	0.95	161.89	1.70	Sand	Sand	Sand	161.89	1.70	1.04	167.57	0.52	0.32	0.95	FALSE	0.00	Above WT
19.52	133.5	109.28	1.257	0.06	1.17	1.17	92.31	1.16	1.98	0.94	99.02	1.96	Sand	Sand	Sand	99.02	1.96	1.25	123.44	0.25	0.32	0.95	FALSE	0.00	Above WT
19.69	133.3	77.04	1.100	0.06	1.18	1.18	64.21	1.45	2.16	0.94	69.50	2.14	Sand	Sand	Sand	69.50	2.14	1.52	105.77	0.19	0.32	0.95	FALSE	0.00	Above WT
19.85	133.2	54.80	0.767	0.06	1.19	1.19	45.01	1.43	2.28	0.93	49.24	2.25	Sand	Sand	Sand	49.24	2.25	1.79	88.22	0.14	0.32	0.95	FALSE	0.00	Above WT
20.01	133.0	41.28	0.541	0.06	1.20	1.20	33.38	1.35	2.37	0.93	36.94	2.33	Sand	Sand	Sand	36.94	2.33	2.06	76.07	0.12	0.32	0.95	FALSE	0.00	Above WT
20.18	132.8	33.87	0.447	0.06	1.21	1.21	26.97	1.37	2.45	0.93	30.18	2.41	Sand	Sand	Sand	30.18	2.41	2.35	70.82	0.11	0.32	0.95	FALSE	0.00	Above WT
20.34	132.7	29.16	0.460	0.06	1.22	1.22	22.89	1.65	2.55	0.92	25.88	2.51	Sand	Sand	Sand	25.88	2.51	2.81	72.86	0.12	0.32	0.95	FALSE	0.00	Above WT
20.51	132.5	30.22	0.438	0.06	1.23	1.23	23.56	1.51	2.52	0.92	26.71	2.48	Sand	Sand	Sand	26.71	2.48	2.65	70.81	0.11	0.32	0.95	FALSE	0.00	Above WT
20.67	132.3	30.60	0.472	0.06	1.24	1.24	23.67	1.61	2.53	0.92	26.94	2.49	Sand	Sand	Sand	26.94	2.49	2.71	73.05	0.12	0.32	0.95	FALSE	0.00	Above WT
20.83	132.2	30.01	0.624	0.06	1.25	1.25	23.01	2.17	2.62	Clay	Clay	Clay	Clay	Clay	Clay	23.01	2.62	3.45	79.44	0.13	0.32	0.95	FALSE	0.00	Above WT
21.00	132.0	31.99	0.779	0.06	1.26	1.26	24.39	2.54	2.64	Clay	Clay	Clay	Clay	Clay	Clay	24.39	2.64	3.59	87.51	0.14	0.32	0.95	FALSE	0.00	Above WT
21.16	131.8	35.75	0.665	0.06	1.27	1.27	27.16	1.93	2.53	0.91	31.11	2.48	Sand	Sand	Sand	31.11	2.48	2.69	83.78	0.13	0.32	0.95	FALSE	0.00	Above WT
21.33	131.7	36.47	0.688	0.06	1.28	1.28	27.50	1.96	2.53	0.90	31.61	2.48	Sand	Sand	Sand	31.61	2.48	2.68	84.86	0.14	0.32	0.95	FALSE	0.00	Above WT
21.49	131.5	40.25	0.674	0.06	1.29	1.29	30.22	1.73	2.47	0.90	34.76	2.42	Sand	Sand	Sand	34.76	2.42	2.39	83.00	0.13	0.32	0.95	FALSE	0.00	Above WT
21.65	131.4	44.72	0.689	0.06	1.30	1.30	33.43	1.59	2.41	0.89	38.48	2.36	Sand	Sand	Sand	38.48	2.36	2.16	82.99	0.13	0.32	0.95	FALSE	0.00	Above WT
21.82	131.2	49.54	0.689	0.06	1.31	1.31	36.84	1.43	2.35	0.89	42.46	2.30	Sand	Sand	Sand	42.46	2.30	1.94	82.53	0.13	0.32	0.95	FALSE	0.00	Above WT
21.98	131.0	52.06	0.681	0.06	1.32	1.32	38.48	1.34	2.32	0.89	44.45	2.27	Sand	Sand	Sand	44.45	2.27	1.84	82.01	0.13	0.32	0.95	FALSE	0.00	Above WT
22.15	130.9	50.86	0.662	0.06	1.33	1.33	37.27	1.34	2.33	0.88	43.26	2.27	Sand	Sand	Sand	43.26	2.27	1.87	80.94	0.13	0.32	0.95	FALSE	0.00	Above WT
22.31	130.7	50.26	0.615	0.06	1.34	1.34	36.55	1.26	2.32	0.88	42.60	2.26	Sand	Sand	Sand	42.60	2.26	1.84	78.39	0.12	0.32	0.95	FALSE	0.00	Above WT
22.47	130.5	47.75	0.511	0.06	1.35	1.35	34.42	1.10	2.31	0.88	40.33	2.25	Sand	Sand	Sand	40.33	2.25	1.80	72.64	0.12	0.32	0.95	FALSE	0.00	Above WT
22.64	130.4	43.28	0.442	0.06	1.36	1.36	30.86	1.05	2.34	0.87	36.41	2.28	Sand	Sand	Sand	36.41	2.28	1.88	68.42	0.11	0.32	0.95	FALSE	0.00	Above WT
22.80	130.2	38.11	0.549	0.06	1.37	1.37	26.86	1.49	2.47	0.87	31.95	2.41	Sand	Sand	Sand	31.95	2.41	2.35	75.20	0.12	0.32	0.95	FALSE	0.00	Above WT
22.97	130.0	37.99	0.564	0.06	1.38	1.38	26.56	1.54	2.48	0.87	31.73	2.42	Sand	Sand	Sand	31.73	2.42	2.40	76.05	0.12	0.32	0.95	FALSE	0.00	Above WT
23.13	129.9	42.53	0.546	0.06	1.39	1.39	29.65	1.33	2.41	0.87	35.40	2.34	Sand	Sand	Sand	35.40	2.34	2.10	74.25	0.12	0.32	0.95	FALSE	0.00	Above WT
23.29	129.7	47.34	0.522	0.06	1.40	1.40	32.88	1.14	2.33	0.86	39.27	2.27	Sand	Sand	Sand	39.27	2.27	1.85	72.72	0.12	0.32	0.95	FALSE	0.00	Above WT
23.46	129.5	51.10	0.505	0.06	1.41	1.41	35.30	1.02	2.28	0.86	42.23	2.22	Sand	Sand	Sand	42.23	2.22	1.71	72.02	0.11	0.32	0.95	FALSE	0.00	Above WT
23.62	129.4	52.95	0.529	0.06	1.42	1.42	36.36	1.03	2.27	0.86	43.61	2.21	Sand	Sand	Sand	43.61	2.21	1.68	73.36	0.12	0.32	0.94	FALSE	0.00	Above WT
23.79	129.2	55.33	0.548	0.06	1.43	1.43	37.76	1.02	2.26	0.85	45.41	2.19	Sand	Sand	Sand	45.41	2.19	1.64	74.51	0.12	0.32	0.94	FALSE	0.00	Above WT
23.95	129.1	57.50	0.550	0.06	1.44	1.44	39.01	0.98	2.24	0.85	47.04	2.17	Sand	Sand	Sand	47.04	2.17	1.59	74.84	0.12	0.32	0.94	FALSE	0.00	Above WT
24.11	128.9	59.36	0.560	0.06	1.45	1.45	40.03	0.97	2.22	0.85	48.40	2.15	Sand	Sand	Sand	48.40	2.15	1.56	75.55	0.12	0.32	0.94	FALSE	0.00	Above WT
24.28	128.7	55.31	0.478	0.06	1.46	1.46	36.97	0.89	2.23	0.84	44.94	2.16	Sand	Sand	Sand	44.94	2.16	1.58	70.79	0.11	0.32	0.94	FALSE	0.00	Above WT
24.44	128.6	49.09	0.540	0.06	1.47	1.47	32.48	1.13	2.34	0.84	39.75	2.26	Sand	Sand	Sand	39.75	2.26	1.84	73.01	0.12	0.32	0.94	FALSE	0.00	Above WT
24.61	128.4	54.73	0.603	0.06	1.48	1.48	36.06	1.13	2.30	0.84	44.16	2.23	Sand	Sand	Sand	44.16	2.23	1.73	76.48	0.12	0.32	0.94	FALSE	0.00	Above WT
24.77	128.2	66.79	0.709	0.06	1.49	1.49	43.94	1.09	2.22	0.84	53.72	2.15	Sand	Sand	Sand	53.72	2.15	1.54	82.94	0.13	0.32	0.94	FALSE	0.00	Above WT
24.93	128.1	74.97	0.787	0.06	1.50	1.50	49.12	1.07	2.17	0.83	60.11	2.10	Sand	Sand	Sand	60.11	2.10	1.46	87.76	0.14	0.32	0.94	FALSE	0.00	Above WT
25.10	127.9	81.77	0.853	0.06	1.51	1.51	53.30	1.06	2.14	0.83	65.34	2.07	Sand	Sand	Sand	65.34	2.07	1.41	91.85	0.15	0.32	0.94	FALSE	0.00	Above WT
25.26	127.7	89.12	0.966	0.06	1.52	1.52	57.80	1.10	2.12	0.83	70.98	2.05	Sand	Sand	Sand	70.98	2.05	1.38	97.64	0.17	0.32	0.94	FALSE	0.00	Above WT
25.43	127.6	97.37	1.062	0.06	1.53	1.53	62.82	1.11	2.10	0.83	77.30	2.03	Sand	Sand	Sand	77.30	2.03	1.33	103.13	0.18	0.32	0.94	FALSE	0.00	Above WT
25.59	127.4	100.30	1.101	0.06	1.54	1.54	64.32	1.11	2.09	0.82	79.37	2.02	Sand	Sand	Sand	79.37	2.02	1.32	105.10	0.19	0.32	0.94	FALSE	0.00	Above WT
25.75	127.3	98.98	1.178	0.06	1.55	1.55	63.06	1.21	2.12	0.82	78.08	2.05	Sand	Sand	Sand	78.08	2.05	1.36	106.53	0.19	0.32	0.94	FALSE	0.00	Above WT
25.92	127.1	95.97	1.232	0.06	1.56	1.56	60.71	1.30	2.15	0.82	75.46	2.08	Sand	Sand	Sand	75.46	2.08	1.42	106.89	0.19	0.32	0.94	FALSE	0.00	Above WT
26.08	126.9	97.30	1.282	0.06	1.56	1.56	61.18	1.34	2.16	0.82	76.27	2.08	Sand	Sand	Sand	76.27	2.08	1.42	108.52	0.20	0.32	0.94	FALSE	0.00	Above WT
26.25	126.8	108.40	1.349	0.06	1.58	1.58	67.83	1.26	2.10	0.81	84.70	2.03	Sand	Sand	Sand	84.70	2.03	1.34	113.69	0.22	0.32	0.94	FALSE	0.00	Above WT
26.41	126.6	111.07	1.381	0.06	1.58	1.58	69.09	1.26	2.10	0.81	86.52	2.02	Sand	Sand	Sand	86.52	2.02	1.33	115.23	0.22	0.32	0.94	FALSE	0.00	Above WT
26.57	126.4	95.65	1.371	0.06	1.59	1.59	59.00	1.46	2.19	0.81	74.28	2.11	Sand	Sand	Sand	74.28	2.11	1.48	110.07	0.20	0.32	0.94	FALSE	0.00	Above WT
26.74	126.3	81.52	1.356	0.06	1.60	1.60	49.81	1.70	2.29	0.81	63.11	2.21	Sand	Sand	Sand	63.11	2.21	1.70	106.98	0.19	0.32	0.94	FALSE	0.00	Above WT
26.90	126.1	77.20	1.499	0.06	1.61	1.61	46.83	1.98	2.35	0.80	59.59	2.27	Sand	Sand	Sand	59.59	2.27	1.87	111.45	0.21	0.32	0.94	FALSE	0.00	Above WT
27.07	125.9	72.66	1.568	0.06	1.62	1.62	43.74	2.21	2.41	0.80	55.91	2.33	Sand	Sand	Sand	55.91	2.33	2.04	113.88	0.22	0.32	0.94	FALSE	0.00	Above WT
27.23	125.8	69.51	1.606	0.06	1.63	1.63	41.54	2.37	2.44	0.80	53.33	2.36	Sand	Sand	Sand	53.33	2.36	2.16	115.41	0.22	0.32	0.94	FALSE	0.00	Above WT
27.40	125.6	65.85	1.548	0.06	1.64	1.64	39.05	2.41	2.47	0.80	50.36	2.39	Sand	Sand	Sand	50.36	2.39	2.26	113.60	0.22	0.32	0.94	FALSE	0.00	Above WT
27.56	125.4	63.58	1.354	0.06	1.65	1.65	37.45	2.19	2.46	0.79	48.48	2.37	Sand	Sand	Sand	48.48	2.37	2.19	106.39	0.19	0.32	0.94	FALSE	0.00	Above WT
27.72	125.3	63.48	1.396	0.06	1.66	1.66	37.17	2.26	2.47	0.79	48.27	2.38	Sand	Sand	Sand	48.27	2.38	2.24	107.89	0.20	0.32	0.94	FALSE	0.00	Above WT
27.89	125.1	62.61	1.464	0.06	1.67	1.67	36.41	2.40	2.49	0.79	47.46	2.40	Sand	Sand	Sand	47.46	2.40	2.33	110.54	0.21	0.32	0.93	FALSE	0.00	Above WT
28.05	125.0	61.53	1.557	0.06	1.68	1.68	35.56	2.60	2.52	0.79	46.51	2.43	Sand	Sand	Sand	46.51	2.43	2.46	114.18	0.22	0.32	0.93	FALSE	0.00	Above WT
28.22	124.8	56.92	1.754	0.06	1.69	1.69	32.62	3.18	2.61	Clay	Clay	Clay	Clay	Clay	Clay	32.62	2.61	3.37	109.78	0.20	0.32	0.93	FALSE	0.00	Above WT
28.38	124.6	47.93	1.846	0.06	1.70	1.70	27.15	3.99	2.73	Clay	Clay	Clay	Clay	Clay	Clay	27.15	2.73	4.23	114.96	0.22	0.32	0.93	FALSE	0.00	Above WT
28.54	124.5	46.81	1.600	0.06	1.71	1.71	26.34	3.55	2.71	Clay	Clay	Clay	Clay	Clay	Clay	26.34	2.71	4.05	106.76	0.19	0.32	0.93	FALSE	0.00	Above WT
28.71	124.3	56.08	1.396	0.06	1.72	1.72	31.56	2.57	2.56	0.78	41.90	2.46	Sand	Sand	Sand	41.90	2.46	2.59	108.60	0.20	0.32	0.93	FALSE	0.00	Above WT
28.87	124.1	64.99	1.347	0.06	1.73	1.73	36.52	2.13	2.46	0.77	48.42	2.36	Sand	Sand	Sand	48.42	2.36	2.17	104.92	0.19	0.32	0.93	FALSE	0.00	Above WT
29.04	124.0	70.79	1.454	0.06	1.74	1.74	39.63	2.11	2.43	0.77	52.59	2.33	Sand	Sand	Sand	52.59	2.33	2.06	108.22	0.20	0.32	0.93	FALSE	0.00	Above WT
29.20	123.8	74.68	1.537	0.06	1.75	1.75	41.63	2.11	2.41	0.77	55.32	2.32	Sand	Sand	Sand	55.32	2.32	2.00	110.80	0.21	0.31	0.93	FALSE	0.00	Above WT
29.36	123.6	77.07	1.575	0.06	1.76	1.76	42.75	2.09	2.40	0.77	56.94	2.30	Sand	Sand	Sand	56.94	2.30	1.96	111.88	0.21	0.31	0.93	FALSE	0.00	Above WT
29.53	123.5	79.58	1.628	0.06	1.77	1.77	43.91	2.09	2.39	0.77	58.62	2.30	Sand	Sand	Sand	58.62	2.30	1.94	113.44	0.22	0.31	0.93	FALSE	0.00	Above WT
29.69	123.3	82.47	1.661	0.06	1.78	1.78	45.30	2.06	2.38	0.76	60.59	2.28	Sand	Sand	Sand	60.59	2.28	1.89	114.34	0.22	0.31	0.93	FALSE	0.00	Above WT
29.86	123.1	85.46	1.698	0.06	1.79	1.79	46.70	2.03	2.36	0.76	62.61	2.27	Sand	Sand	Sand	62.61	2.27	1.84	115.39	0.22	0.31	0.93	FALSE	0.00	Above WT
30.02	123.0	87.28	1.727	0.06	1.80	1.80	47.46	2.02	2.35	0.76	63.77	2.26	Sand	Sand	Sand	63.77	2.26	1.82	116.21	0.23	0.31	0.93	FALSE	0.00	Above WT
30.18	122.8	88.31	1.724	0.06	1.81	1.81	47.77	1.99	2.35	0.76	64.35	2.25	Sand	Sand	Sand	64.35	2.25	1.80	116.00	0.23	0.31	0.93	FALSE	0.00	Above WT
30.35	122.7	88.80	1.713	0.06	1.82	1.82	47.76	1.97	2.35	0.76	64.53	2.25	Sand	Sand	Sand	64.53	2.25	1.79	115.52	0.22	0.31	0.93	FALSE	0.00	Above WT

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	CQ2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
30.51	122.5	87.76	1.706	0.06	1.83	1.83	46.94	1.99	2.35	0.75	63.60	2.25	Sand	Sand	Sand	63.60	2.25	1.81	115.12	0.22	0.31	0.93	FALSE	0.00	Above WT
30.68	122.3	84.74	1.668	0.06	1.84	1.84	45.03	2.01	2.37	0.75	61.24	2.27	Sand	Sand	Sand	61.24	2.27	1.86	113.70	0.22	0.31	0.92	FALSE	0.00	Above WT
30.84	122.2	82.15	1.542	0.06	1.85	1.85	43.40	1.92	2.37	0.75	59.22	2.27	Sand	Sand	Sand	59.22	2.27	1.85	109.50	0.20	0.31	0.92	FALSE	0.00	Above WT
31.00	122.0	83.62	1.527	0.06	1.86	1.86	43.96	1.87	2.36	0.75	60.12	2.25	Sand	Sand	Sand	60.12	2.25	1.81	108.90	0.20	0.31	0.92	FALSE	0.00	Above WT
31.17	121.8	78.99	1.547	0.06	1.87	1.87	41.24	2.01	2.40	0.75	56.64	2.29	Sand	Sand	Sand	56.64	2.29	1.93	109.41	0.20	0.31	0.92	FALSE	0.00	Above WT
31.33	121.7	89.25	1.636	0.06	1.88	1.88	46.48	1.87	2.34	0.74	63.83	2.24	Sand	Sand	Sand	63.83	2.24	1.76	112.30	0.21	0.31	0.92	FALSE	0.00	Above WT
31.50	121.5	88.60	1.696	0.06	1.89	1.89	45.88	1.96	2.36	0.74	63.20	2.25	Sand	Sand	Sand	63.20	2.25	1.80	113.98	0.22	0.31	0.92	FALSE	0.00	Above WT
31.66	121.3	86.08	1.801	0.06	1.90	1.90	44.31	2.14	2.39	0.74	61.24	2.29	Sand	Sand	Sand	61.24	2.29	1.91	117.05	0.23	0.31	0.92	FALSE	0.00	Above WT
31.82	121.2	84.57	1.975	0.06	1.91	1.91	43.30	2.39	2.43	0.74	60.02	2.33	Sand	Sand	Sand	60.02	2.33	2.04	122.39	0.25	0.31	0.91	FALSE	0.00	Above WT
31.99	121.0	86.54	2.012	0.06	1.92	1.92	44.09	2.38	2.43	0.74	61.25	2.32	Sand	Sand	Sand	61.25	2.32	2.01	123.27	0.25	0.31	0.91	FALSE	0.00	Above WT
32.15	120.9	106.46	2.003	0.06	1.93	1.93	54.19	1.92	2.30	0.73	75.16	2.19	Sand	Sand	Sand	75.16	2.19	1.64	123.56	0.26	0.31	0.91	FALSE	0.00	Above WT
32.32	120.7	154.25	2.049	0.06	1.94	1.94	78.54	1.35	2.07	0.73	108.62	1.97	Sand	Sand	Sand	108.62	1.97	1.26	136.99	0.32	0.31	0.91	FALSE	0.00	Above WT
32.48	120.5	185.36	2.382	0.06	1.95	1.95	94.11	1.30	2.00	0.73	130.20	1.90	Sand	Sand	Sand	130.20	1.90	1.19	154.96	0.43	0.31	0.91	FALSE	0.00	Above WT
32.64	120.4	204.10	2.908	0.06	1.96	1.96	103.22	1.44	2.00	0.73	143.01	1.90	Sand	Sand	Sand	143.01	1.90	1.19	170.62	0.54	0.31	0.91	FALSE	0.00	Above WT
32.81	120.2	210.14	3.231	0.06	1.97	1.97	105.75	1.55	2.02	0.73	146.86	1.92	Sand	Sand	Sand	146.86	1.92	1.21	177.54	0.60	0.31	0.91	FALSE	0.00	Above WT
32.97	120.0	209.97	3.282	0.06	1.98	1.98	105.14	1.58	2.03	0.73	146.39	1.93	Sand	Sand	Sand	146.39	1.93	1.22	177.88	0.60	0.31	0.91	FALSE	0.00	Above WT
33.14	119.9	208.87	3.279	0.06	1.99	1.99	104.04	1.59	2.03	0.72	145.25	1.93	Sand	Sand	Sand	145.25	1.93	1.22	177.07	0.60	0.31	0.90	FALSE	0.00	Above WT
33.30	119.7	202.63	3.289	0.06	2.00	2.00	100.42	1.64	2.05	0.72	140.57	1.95	Sand	Sand	Sand	140.57	1.95	1.24	174.44	0.57	0.31	0.90	FALSE	0.00	Above WT
33.46	119.5	193.52	3.146	0.06	2.01	2.01	95.39	1.64	2.07	0.72	133.93	1.97	Sand	Sand	Sand	133.93	1.97	1.26	168.47	0.52	0.30	0.90	FALSE	0.00	Above WT
33.63	119.4	178.14	3.048	0.06	2.02	2.02	87.28	1.73	2.11	0.72	122.97	2.01	Sand	Sand	Sand	122.97	2.01	1.31	161.14	0.47	0.30	0.90	FALSE	0.00	Above WT
33.79	119.2	165.61	3.481	0.06	2.03	2.03	80.69	2.13	2.20	0.72	114.05	2.10	Sand	Sand	Sand	114.05	2.10	1.45	165.06	0.50	0.30	0.90	FALSE	0.00	Above WT
33.96	119.0	156.59	3.308	0.06	2.04	2.04	75.85	2.14	2.22	0.71	107.57	2.11	Sand	Sand	Sand	107.57	2.11	1.48	159.45	0.46	0.30	0.90	FALSE	0.00	Above WT
34.12	118.9	179.06	3.078	0.06	2.05	2.05	86.47	1.74	2.12	0.71	122.72	2.01	Sand	Sand	Sand	122.72	2.01	1.31	161.15	0.47	0.30	0.90	FALSE	0.00	Above WT
34.28	118.7	195.01	2.223	0.06	2.06	2.06	93.81	1.15	1.97	0.71	133.34	1.86	Sand	Sand	Sand	133.34	1.86	1.15	153.54	0.42	0.30	0.89	FALSE	0.00	Above WT
34.45	118.6	196.15	2.054	0.06	2.07	2.07	93.90	1.06	1.95	0.71	133.78	1.83	Sand	Sand	Sand	133.78	1.83	1.13	151.22	0.40	0.30	0.89	FALSE	0.00	Above WT
34.61	118.4	171.83	2.174	0.06	2.08	2.08	81.75	1.28	2.05	0.71	116.92	1.93	Sand	Sand	Sand	116.92	1.93	1.22	142.56	0.35	0.30	0.89	FALSE	0.00	Above WT
34.78	118.2	159.44	2.216	0.06	2.09	2.09	75.40	1.41	2.10	0.71	108.23	1.98	Sand	Sand	Sand	108.23	1.98	1.28	138.44	0.33	0.30	0.89	FALSE	0.00	Above WT
34.94	118.1	144.84	2.038	0.06	2.10	2.10	68.09	1.43	2.14	0.70	98.09	2.02	Sand	Sand	Sand	98.09	2.02	1.33	129.99	0.28	0.30	0.89	FALSE	0.00	Above WT
35.10	117.9	125.14	1.588	0.06	2.11	2.11	58.42	1.29	2.16	0.70	84.56	2.04	Sand	Sand	Sand	84.56	2.04	1.35	114.33	0.22	0.30	0.89	FALSE	0.00	Above WT
35.27	117.7	96.37	1.354	0.06	2.12	2.12	44.54	1.44	2.28	0.70	64.96	2.15	Sand	Sand	Sand	64.96	2.15	1.56	101.56	0.18	0.30	0.89	FALSE	0.00	Above WT
35.43	117.6	64.96	1.677	0.06	2.13	2.13	29.56	2.67	2.59	0.70	43.69	2.46	Sand	Sand	Sand	43.69	2.46	2.58	112.72	0.21	0.30	0.89	FALSE	0.00	Above WT
35.60	117.4	43.54	1.618	0.06	2.14	2.14	19.38	3.91	2.84	Clay	Clay	Clay	Clay	Clay	Clay	19.38	2.84	5.10	98.94	0.17	0.30	0.88	FALSE	0.00	Above WT
35.76	117.2	31.67	1.631	0.06	2.15	2.15	13.76	5.52	3.05	Clay	Clay	Clay	Clay	Clay	Clay	13.76	3.05	7.28	100.24	0.17	0.30	0.88	FALSE	0.00	Above WT
35.93	117.1	39.65	1.284	0.06	2.16	2.16	17.39	3.43	2.84	Clay	Clay	Clay	Clay	Clay	Clay	17.39	2.84	5.11	88.88	0.15	0.30	0.88	FALSE	0.00	Above WT
36.09	116.9	55.03	1.177	0.06	2.17	2.17	24.41	2.23	2.61	Clay	Clay	Clay	Clay	Clay	Clay	24.41	2.61	3.37	82.18	0.13	0.30	0.88	FALSE	0.00	Above WT
36.25	116.8	68.08	0.955	0.06	2.18	2.18	30.30	1.45	2.42	0.69	45.27	2.28	Sand	Sand	Sand	45.27	2.28	1.89	85.39	0.14	0.30	0.88	FALSE	0.00	Above WT
36.42	116.6	71.83	1.212	0.06	2.19	2.19	31.87	1.74	2.45	0.69	47.65	2.31	Sand	Sand	Sand	47.65	2.31	1.99	94.68	0.16	0.30	0.88	FALSE	0.00	Above WT
36.58	116.4	71.40	1.352	0.06	2.19	2.19	31.53	1.95	2.48	0.69	47.26	2.35	Sand	Sand	Sand	47.26	2.35	2.11	99.59	0.17	0.30	0.88	FALSE	0.00	Above WT
36.75	116.3	66.41	1.448	0.06	2.21	2.21	29.12	2.26	2.55	0.69	43.85	2.41	Sand	Sand	Sand	43.85	2.41	2.36	103.54	0.18	0.30	0.87	FALSE	0.00	Above WT
36.91	116.1	51.34	1.490	0.06	2.21	2.21	22.18	3.03	2.72	Clay	Clay	Clay	Clay	Clay	Clay	22.18	2.72	4.16	92.22	0.15	0.30	0.87	FALSE	0.00	Above WT
37.07	115.9	36.66	1.554	0.06	2.22	2.22	15.48	4.51	2.95	Clay	Clay	Clay	Clay	Clay	Clay	15.48	2.95	6.22	96.35	0.16	0.29	0.87	FALSE	0.00	Above WT
37.24	115.8	33.95	1.521	0.06	2.23	2.23	14.19	4.80	3.00	Clay	Clay	Clay	Clay	Clay	Clay	14.19	3.00	6.72	95.35	0.16	0.29	0.87	FALSE	0.00	Above WT
37.40	115.6	44.46	1.512	0.06	2.24	2.24	18.81	3.58	2.82	Clay	Clay	Clay	Clay	Clay	Clay	18.81	2.82	4.98	93.71	0.16	0.29	0.87	FALSE	0.00	Above WT
37.57	115.4	44.08	1.861	0.06	2.25	2.25	18.55	4.45	2.89	Clay	Clay	Clay	Clay	Clay	Clay	18.55	2.89	5.58	103.46	0.18	0.29	0.87	FALSE	0.00	Above WT
37.73	115.3	39.34	1.979	0.06	2.26	2.26	16.38	5.34	2.98	Clay	Clay	Clay	Clay	Clay	Clay	16.38	2.98	6.52	106.85	0.19	0.29	0.87	FALSE	0.00	Above WT
37.89	115.1	42.82	1.970	0.06	2.27	2.27	17.84	4.86	2.93	Clay	Clay	Clay	Clay	Clay	Clay	17.84	2.93	5.95	106.12	0.19	0.29	0.87	FALSE	0.00	Above WT
38.06	114.9	47.08	1.824	0.06	2.28	2.28	19.62	4.07	2.84	Clay	Clay	Clay	Clay	Clay	Clay	19.62	2.84	5.17	101.46	0.18	0.29	0.86	FALSE	0.00	Above WT
38.22	114.8	54.82	1.450	0.06	2.29	2.29	22.91	2.76	2.69	Clay	Clay	Clay	Clay	Clay	Clay	22.91	2.69	3.89	89.13	0.15	0.29	0.86	FALSE	0.00	Above WT
38.39	114.6	73.91	1.060	0.06	2.30	2.30	31.09	1.48	2.42	0.67	47.75	2.27	Sand	Sand	Sand	47.75	2.27	1.85	88.25	0.14	0.29	0.86	FALSE	0.00	Above WT
38.55	114.5	89.60	0.974	0.06	2.31	2.31	37.74	1.12	2.28	0.67	57.77	2.13	Sand	Sand	Sand	57.77	2.13	1.51	87.02	0.14	0.29	0.86	FALSE	0.00	Above WT
38.71	114.3	100.95	1.041	0.06	2.32	2.32	42.46	1.05	2.22	0.67	64.95	2.07	Sand	Sand	Sand	64.95	2.07	1.41	91.32	0.15	0.29	0.86	FALSE	0.00	Above WT
38.88	114.1	111.38	1.058	0.06	2.33	2.33	46.75	0.97	2.17	0.67	71.51	2.02	Sand	Sand	Sand	71.51	2.02	1.32	94.56	0.16	0.29	0.86	FALSE	0.00	Above WT
39.04	114.0	123.47	1.217	0.06	2.34	2.34	51.71	1.00	2.14	0.67	79.11	1.99	Sand	Sand	Sand	79.11	1.99	1.29	101.91	0.18	0.29	0.86	FALSE	0.00	Above WT
39.21	113.8	143.33	1.493	0.06	2.35	2.35	59.92	1.06	2.10	0.66	91.63	1.96	Sand	Sand	Sand	91.63	1.96	1.25	114.16	0.22	0.29	0.85	FALSE	0.00	Above WT
39.37	113.6	175.07	1.865	0.06	2.36	2.36	73.11	1.08	2.04	0.66	111.70	1.90	Sand	Sand	Sand	111.70	1.90	1.18	132.32	0.30	0.29	0.85	FALSE	0.00	Above WT
39.53	113.5	217.92	2.400	0.06	2.37	2.37	90.88	1.11	1.97	0.66	138.75	1.84	Sand	Sand	Sand	138.75	1.84	1.13	157.23	0.44	0.29	0.85	FALSE	0.00	Above WT
39.70	113.3	266.41	3.081	0.06	2.38	2.38	110.84	1.17	1.92	0.66	169.26	1.79	Sand	Sand	Sand	169.26	1.79	1.10	185.88	0.68	0.29	0.85	FALSE	0.00	Above WT
39.86	113.1	290.88	3.760	0.06	2.39	2.39	120.63	1.30	1.93	0.66	184.44	1.80	Sand	Sand	Sand	184.44	1.80	1.11	203.82	0.87	0.29	0.85	FALSE	0.00	Above WT
40.03	113.0	304.99	4.193	0.06	2.40	2.40	125.98	1.39	1.93	0.66	192.97	1.80	Sand	Sand	Sand	192.97	1.80	1.11	214.23	0.99	0.29	0.85	FALSE	0.00	Above WT
40.19	112.8	293.93	4.212	0.06	2.41	2.41	120.89	1.44	1.96	0.66	185.61	1.83	Sand	Sand	Sand	185.61	1.83	1.13	209.52	0.94	0.29	0.85	FALSE	0.00	Above WT
40.35	112.7	282.61	3.828	0.06	2.42	2.42	115.73	1.37	1.95	0.66	178.10	1.82	Sand	Sand	Sand	178.10	1.82	1.12	200.19	0.83	0.29	0.85	FALSE	0.00	Above WT
40.52	112.5	273.04	3.384	0.06	2.43	2.43	111.31	1.25	1.94	0.65	171.71	1.81	Sand	Sand	Sand	171.71	1.81	1.11	190.73	0.73	0.29	0.84	FALSE	0.00	Above WT
40.68	112.3	256.33	2.781	0.06	2.44	2.44	104.02	1.10	1.92	0.65	160.89	1.78	Sand	Sand	Sand	160.89	1.78	1.10	176.20	0.59	0.28	0.84	FALSE	0.00	Above WT
40.85	112.2	241.34	2.824	0.06	2.45	2.45	97.47	1.18	1.97	0.65	151.16	1.83	Sand	Sand	Sand	151.16	1.83	1.13	170.30	0.54	0.28	0.84	FALSE	0.00	Above WT
41.01	112.0	237.16	2.672	0.06	2.46	2.46	95.38	1.14	1.96	0.65	148.25	1.82	Sand	Sand	Sand	148.25	1.82	1.12	166.40	0.51	0.28	0.84	FALSE	0.00	Above WT
41.17	111.8	247.69	2.895	0.06	2.47	2.47	99.27	1.18	1.96	0.65	154.53	1.82	Sand	Sand	Sand	154.53	1.82	1.12	173.24	0.56	0.28	0.84	FALSE	0.00	Above WT
41.34	111.7	275.15	2.678	0.06	2.48	2.48	109.93	0.98	1.87	0.65	171.31	1.73	Sand	Sand	Sand	171.31	1.73	1.06	181.41	0.64	0.28	0.84	FALSE	0.00	Above WT
41.50	111.5	297.07	2.857	0.06	2.49	2.49	118.31	0.97	1.85	0.65	184.60	1.70	Sand	Sand	Sand	184.60	1.70	1.04	192.15	0.74	0.28	0.84	FALSE	0.00	Above WT
41.67	111.3	302.35	2.946	0.06	2.50	2.50	119.93	0.98	1.85	0.64	187.50	1.70	Sand	Sand	Sand	187.50	1.70	1.04	195.06	0.77	0.28	0.83	FALSE	0.00	Above WT
41.83	111.2	307.50	3.161	0.06	2.51	2.51	121.52	1.04	1.86	0.64	190.33	1.72	Sand	Sand	Sand	190.33	1.72	1.05	199.56	0.82	0.28	0.83	FALSE	0.00	Above WT
41.99	111.0	311.77	3.275	0.06	2.52	2.52	122.75	1.06	1.86	0.64	192.61	1.72	Sand	Sand	Sand	192.61	1.72	1.05	202.36	0.85	0.28	0.83	FALSE	0.00	Above WT
42.16	110.8	303.94	3.407	0.06	2.53	2.53	119.15	1.13	1.89	0.64	187.39	1.75	Sand	Sand	Sand	187.39	1.75	1.07	200.52	0.83	0.28	0.83	FALSE	0.00	Above WT

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	CQ2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
42.32	110.7	287.26	3.312	0.06	2.54	2.54	112.13	1.16	1.92	0.64	176.77	1.77	Sand	Sand	Sand	176.77	1.77	1.09	192.37	0.74	0.28	0.83	FALSE	0.00	Above WT
42.49	110.5	275.78	3.121	0.06	2.55	2.55	107.17	1.14	1.93	0.64	169.37	1.78	Sand	Sand	Sand	169.37	1.78	1.09	185.16	0.67	0.28	0.83	FALSE	0.00	Above WT
42.65	110.4	278.67	2.922	0.06	2.56	2.56	107.90	1.06	1.90	0.64	170.82	1.76	Sand	Sand	Sand	170.82	1.76	1.08	183.65	0.66	0.28	0.83	FALSE	0.00	Above WT
42.81	110.2	291.66	2.625	0.06	2.57	2.57	112.55	0.91	1.84	0.64	178.45	1.69	Sand	Sand	Sand	178.45	1.69	1.03	184.56	0.66	0.28	0.83	FALSE	0.00	Above WT
42.98	110.0	302.43	2.615	0.06	2.58	2.58	116.28	0.87	1.82	0.64	184.67	1.67	Sand	Sand	Sand	184.67	1.67	1.02	188.13	0.70	0.28	0.82	FALSE	0.00	Above WT
43.14	109.9	313.48	2.601	0.06	2.59	2.59	120.11	0.84	1.80	0.63	191.06	1.65	Sand	Sand	Sand	191.06	1.65	1.00	191.54	0.73	0.28	0.82	FALSE	0.00	Above WT
43.31	109.7	321.71	2.497	0.06	2.60	2.60	122.80	0.78	1.77	0.63	195.69	1.62	Sand	Sand	Sand	195.69	1.62	1.00	195.69	0.78	0.28	0.82	FALSE	0.00	Above WT
43.47	109.5	323.87	2.521	0.06	2.61	2.61	123.17	0.78	1.77	0.63	196.65	1.62	Sand	Sand	Sand	196.65	1.62	1.00	196.65	0.79	0.28	0.82	FALSE	0.00	Above WT
43.64	109.4	325.93	2.653	0.06	2.62	2.62	123.48	0.82	1.78	0.63	197.51	1.63	Sand	Sand	Sand	197.51	1.63	1.00	197.51	0.80	0.28	0.82	FALSE	0.00	Above WT
43.80	109.2	326.77	2.840	0.06	2.63	2.63	123.34	0.88	1.80	0.63	197.66	1.65	Sand	Sand	Sand	197.66	1.65	1.00	198.64	0.81	0.28	0.82	FALSE	0.00	Above WT
43.96	109.0	328.25	2.689	0.06	2.64	2.64	123.45	0.83	1.79	0.63	198.19	1.63	Sand	Sand	Sand	198.19	1.63	1.00	198.19	0.80	0.28	0.82	FALSE	0.00	Above WT
44.13	108.9	321.92	2.699	0.06	2.65	2.65	120.58	0.85	1.80	0.63	193.99	1.65	Sand	Sand	Sand	193.99	1.65	1.00	194.25	0.76	0.28	0.81	FALSE	0.00	Above WT
44.29	108.7	312.46	2.713	0.06	2.66	2.66	116.58	0.88	1.82	0.63	187.95	1.67	Sand	Sand	Sand	187.95	1.67	1.02	190.92	0.73	0.27	0.81	FALSE	0.00	Above WT
44.46	108.5	313.85	2.814	0.06	2.67	2.67	116.65	0.90	1.83	0.62	188.43	1.68	Sand	Sand	Sand	188.43	1.68	1.02	192.57	0.74	0.27	0.81	FALSE	0.00	Above WT
44.62	108.4	311.45	2.856	0.06	2.68	2.68	115.33	0.93	1.84	0.62	186.65	1.69	Sand	Sand	Sand	186.65	1.69	1.03	192.02	0.74	0.27	0.81	FALSE	0.00	Above WT
44.78	108.2	322.82	2.989	0.06	2.69	2.69	119.15	0.93	1.83	0.62	193.12	1.68	Sand	Sand	Sand	193.12	1.68	1.02	197.66	0.80	0.27	0.81	FALSE	0.00	Above WT
44.95	108.1	330.44	3.020	0.06	2.70	2.70	121.52	0.92	1.82	0.62	197.30	1.67	Sand	Sand	Sand	197.30	1.67	1.02	200.50	0.83	0.27	0.81	FALSE	0.00	Above WT
45.11	107.9	334.96	2.888	0.06	2.71	2.71	122.76	0.87	1.80	0.62	199.65	1.65	Sand	Sand	Sand	199.65	1.65	1.00	199.85	0.82	0.27	0.81	FALSE	0.00	Above WT
45.28	107.7	333.25	2.697	0.06	2.72	2.72	121.66	0.82	1.79	0.62	198.26	1.63	Sand	Sand	Sand	198.26	1.63	1.00	198.26	0.80	0.27	0.81	FALSE	0.00	Above WT
45.44	107.6	333.34	2.610	0.06	2.73	2.73	121.26	0.79	1.78	0.62	197.96	1.62	Sand	Sand	Sand	197.96	1.62	1.00	197.96	0.80	0.27	0.80	FALSE	0.00	Above WT
45.60	107.4	335.55	2.650	0.06	2.74	2.74	121.64	0.80	1.78	0.62	198.92	1.62	Sand	Sand	Sand	198.92	1.62	1.00	198.92	0.81	0.27	0.80	FALSE	0.00	Above WT
45.77	107.2	317.01	2.705	0.06	2.75	2.75	114.44	0.86	1.82	0.62	187.58	1.66	Sand	Sand	Sand	187.58	1.66	1.01	189.94	0.72	0.27	0.80	FALSE	0.00	Above WT
45.93	107.1	302.19	2.632	0.06	2.76	2.76	108.66	0.88	1.85	0.61	178.50	1.68	Sand	Sand	Sand	178.50	1.68	1.03	183.44	0.65	0.27	0.80	FALSE	0.00	Above WT
46.10	106.9	285.68	2.470	0.06	2.77	2.77	102.28	0.87	1.87	0.61	168.44	1.70	Sand	Sand	Sand	168.44	1.70	1.04	174.97	0.58	0.27	0.80	FALSE	0.00	Above WT
46.26	106.7	273.86	2.235	0.06	2.78	2.78	97.67	0.82	1.87	0.61	161.19	1.70	Sand	Sand	Sand	161.19	1.70	1.04	167.14	0.51	0.27	0.80	FALSE	0.00	Above WT
46.42	106.6	271.67	2.197	0.06	2.79	2.79	96.54	0.82	1.87	0.61	159.62	1.70	Sand	Sand	Sand	159.62	1.70	1.04	165.57	0.50	0.27	0.80	FALSE	0.00	Above WT
46.59	106.4	278.50	2.173	0.06	2.80	2.80	98.63	0.79	1.85	0.61	163.34	1.68	Sand	Sand	Sand	163.34	1.68	1.03	167.44	0.52	0.27	0.79	FALSE	0.00	Above WT
46.75	106.3	286.00	2.319	0.06	2.81	2.81	100.96	0.82	1.85	0.61	167.45	1.68	Sand	Sand	Sand	167.45	1.68	1.03	172.00	0.55	0.27	0.79	FALSE	0.00	Above WT
46.92	106.1	293.66	2.455	0.06	2.82	2.82	103.31	0.84	1.85	0.61	171.62	1.69	Sand	Sand	Sand	171.62	1.69	1.03	176.42	0.59	0.27	0.79	FALSE	0.00	Above WT
47.08	105.9	293.19	2.507	0.06	2.82	2.82	102.79	0.86	1.86	0.61	171.06	1.69	Sand	Sand	Sand	171.06	1.69	1.03	176.74	0.59	0.27	0.79	FALSE	0.00	Above WT
47.24	105.8	290.06	2.279	0.06	2.83	2.83	101.34	0.79	1.84	0.61	168.94	1.67	Sand	Sand	Sand	168.94	1.67	1.02	172.14	0.55	0.27	0.79	FALSE	0.00	Above WT
47.41	105.6	280.17	2.345	0.06	2.84	2.84	97.49	0.85	1.87	0.60	162.89	1.70	Sand	Sand	Sand	162.89	1.70	1.04	169.34	0.53	0.27	0.79	FALSE	0.00	Above WT
47.57	105.4	257.14	2.241	0.06	2.85	2.85	89.09	0.88	1.92	0.60	149.25	1.74	Sand	Sand	Sand	149.25	1.74	1.07	159.20	0.46	0.27	0.79	FALSE	0.00	Above WT
47.74	105.3	229.16	2.396	0.06	2.86	2.86	79.00	1.06	2.01	0.60	132.77	1.83	Sand	Sand	Sand	132.77	1.83	1.13	150.34	0.40	0.27	0.79	FALSE	0.00	Above WT
47.90	105.1	211.96	2.580	0.06	2.87	2.87	72.75	1.23	2.08	0.60	122.60	1.90	Sand	Sand	Sand	122.60	1.90	1.19	146.31	0.37	0.27	0.78	FALSE	0.00	Above WT
48.06	104.9	201.64	2.757	0.06	2.88	2.88	68.93	1.39	2.13	0.60	116.44	1.96	Sand	Sand	Sand	116.44	1.96	1.25	145.16	0.36	0.26	0.78	FALSE	0.00	Above WT
48.23	104.8	188.79	2.679	0.06	2.89	2.89	64.24	1.44	2.16	0.60	108.82	1.99	Sand	Sand	Sand	108.82	1.99	1.29	139.90	0.33	0.26	0.78	FALSE	0.00	Above WT
48.39	104.6	173.37	2.526	0.06	2.90	2.90	58.71	1.48	2.20	0.60	99.77	2.02	Sand	Sand	Sand	99.77	2.02	1.33	133.02	0.30	0.26	0.78	FALSE	0.00	Above WT
48.56	104.4	168.92	2.375	0.06	2.91	2.91	56.98	1.43	2.20	0.60	97.04	2.02	Sand	Sand	Sand	97.04	2.02	1.33	129.15	0.28	0.26	0.78	FALSE	0.00	Above WT
48.72	104.3	169.72	2.379	0.06	2.92	2.92	57.06	1.43	2.20	0.60	97.34	2.02	Sand	Sand	Sand	97.34	2.02	1.33	129.29	0.28	0.26	0.78	FALSE	0.00	Above WT
48.88	104.1	175.80	2.387	0.06	2.93	2.93	58.94	1.38	2.18	0.60	100.66	2.00	Sand	Sand	Sand	100.66	2.00	1.30	130.94	0.29	0.26	0.78	FALSE	0.00	Above WT
49.05	104.0	183.88	2.513	0.06	2.94	2.94	61.48	1.39	2.16	0.59	105.10	1.99	Sand	Sand	Sand	105.10	1.99	1.29	135.10	0.31	0.26	0.77	FALSE	0.00	Above WT
49.21	103.8	179.33	2.449	0.06	2.95	2.95	59.74	1.39	2.17	0.59	102.34	2.00	Sand	Sand	Sand	102.34	2.00	1.30	132.64	0.30	0.26	0.77	FALSE	0.00	Above WT
49.38	103.6	180.41	2.248	0.06	2.96	2.96	59.89	1.27	2.15	0.59	102.78	1.97	Sand	Sand	Sand	102.78	1.97	1.26	129.61	0.28	0.26	0.77	FALSE	0.00	Above WT
49.54	103.5	165.97	2.054	0.06	2.97	2.97	54.84	1.26	2.18	0.59	94.40	1.99	Sand	Sand	Sand	94.40	1.99	1.29	122.06	0.25	0.26	0.77	FALSE	0.00	Above WT
49.70	103.3	123.93	2.115	0.06	2.98	2.98	40.56	1.75	2.37	0.59	70.37	2.18	Sand	Sand	Sand	70.37	2.18	1.63	114.70	0.22	0.26	0.77	FALSE	0.00	Above WT
49.87	103.1	66.71	2.303	0.06	2.99	2.99	21.29	3.61	2.78	Clay	Clay	Clay	Clay	Clay	Clay	21.29	2.78	4.65	98.94	0.17	0.26	0.77	FALSE	0.00	Above WT
50.03	103.0	40.55	1.767	0.06	3.00	3.00	12.51	4.71	3.04	Clay	Clay	Clay	Clay	Clay	Clay	12.51	3.04	7.14	89.37	0.15	0.26	0.77	FALSE	0.00	Above WT
50.20	102.8	27.97	1.290	0.06	3.01	3.01	8.29	5.17	3.20	Clay	Clay	Clay	Clay	Clay	Clay	8.29	3.20	9.27	76.80	0.12	0.26	0.77	FALSE	0.00	Above WT
50.36	102.6	25.33	0.730	0.06	3.02	3.02	7.38	3.27	3.13	Clay	Clay	Clay	Clay	Clay	Clay	7.38	3.13	8.27	61.08	0.10	0.26	0.76	FALSE	0.00	Above WT
50.52	102.5	24.94	0.724	0.06	3.03	3.03	7.23	3.30	3.14	Clay	Clay	Clay	Clay	Clay	Clay	7.23	3.14	8.40	60.72	0.10	0.26	0.76	FALSE	0.00	Above WT
50.69	102.3	26.03	0.859	0.06	3.04	3.04	7.56	3.74	3.15	Clay	Clay	Clay	Clay	Clay	Clay	7.56	3.15	8.58	64.88	0.11	0.26	0.76	FALSE	0.00	Above WT
50.85	102.2	32.71	1.204	0.06	3.05	3.05	9.72	4.06	3.08	Clay	Clay	Clay	Clay	Clay	Clay	9.72	3.08	7.72	75.01	0.12	0.26	0.76	FALSE	0.00	Above WT
51.02	102.0	38.27	2.051	0.06	3.06	3.06	11.50	5.82	3.12	Clay	Clay	Clay	Clay	Clay	Clay	11.50	3.12	8.20	94.34	0.16	0.26	0.76	FALSE	0.00	Above WT
51.18	101.8	41.15	2.378	0.06	3.07	3.07	12.40	6.25	3.12	Clay	Clay	Clay	Clay	Clay	Clay	12.40	3.12	8.13	100.82	0.18	0.26	0.76	FALSE	0.00	Above WT
51.35	101.7	43.76	2.286	0.06	3.08	3.08	13.20	5.62	3.07	Clay	Clay	Clay	Clay	Clay	Clay	13.20	3.07	7.51	99.10	0.17	0.26	0.76	FALSE	0.00	Above WT
51.51	101.5	38.73	1.625	0.06	3.09	3.09	11.53	4.56	3.05	Clay	Clay	Clay	Clay	Clay	Clay	11.53	3.05	7.37	84.98	0.14	0.26	0.75	FALSE	0.00	Above WT
51.67	101.3	30.98	1.666	0.06	3.10	3.10	8.99	5.98	3.21	Clay	Clay	Clay	Clay	Clay	Clay	8.99	3.21	9.42	84.68	0.14	0.25	0.75	FALSE	0.00	Above WT
51.84	101.2	44.29	1.605	0.06	3.11	3.11	13.24	3.90	2.97	Clay	Clay	Clay	Clay	Clay	Clay	13.24	2.97	6.36	84.26	0.14	0.25	0.75	FALSE	0.00	Above WT
52.00	101.0	73.75	1.743	0.06	3.12	3.12	22.64	2.47	2.66	Clay	Clay	Clay	Clay	Clay	Clay	22.64	2.66	3.71	84.01	0.14	0.25	0.75	FALSE	0.00	Above WT
52.17	100.8	75.78	1.978	0.06	3.13	3.13	23.21	2.72	2.68	Clay	Clay	Clay	Clay	Clay	Clay	23.21	2.68	3.83	88.97	0.15	0.25	0.75	FALSE	0.00	Above WT
52.33	100.7	64.07	2.229	0.06	3.14	3.14	19.41	3.66	2.82	Clay	Clay	Clay	Clay	Clay	Clay	19.41	2.82	4.94	95.86	0.16	0.25	0.75	FALSE	0.00	Above WT
52.49	100.5	57.79	2.221	0.06	3.15	3.15	17.35	4.07	2.88	Clay	Clay	Clay	Clay	Clay	Clay	17.35	2.88	5.55	96.29	0.16	0.25	0.75	FALSE	0.00	Above WT
52.66	100.3	81.66	2.220	0.06	3.16	3.16	24.85	2.83	2.66	Clay	Clay	Clay	Clay	Clay	Clay	24.85	2.66	3.74	93.01	0.15	0.25	0.75	FALSE	0.00	Above WT
52.82	100.2	83.71	2.316	0.06	3.17	3.17	25.41	2.88	2.66	Clay	Clay	Clay	Clay	Clay	Clay	25.41	2.66	3.72	94.61	0.16	0.25	0.74	FALSE	0.00	Above WT
52.99	100.0	67.94	2.422	0.06	3.18	3.18	20.37	3.74	2.81	Clay	Clay	Clay	Clay	Clay	Clay	20.37	2.81	4.85	98.84	0.17	0.25	0.74	FALSE	0.00	Above WT
53.15	99.9	56.74	2.183	0.06	3.19	3.19	16.79	4.08	2.90	Clay	Clay	Clay	Clay	Clay	Clay	16.79	2.90	5.66	95.11	0.16	0.25	0.74	FALSE	0.00	Above WT
53.31	99.7	43.16	1.752	0.06	3.20	3.20	12.49	4.38	3.02	Clay	Clay	Clay	Clay	Clay	Clay	12.49	3.02	6.93	86.56	0.14	0.25	0.74	FALSE	0.00	Above WT
53.48	99.5	38.63	1.764	0.06	3.21	3.21	11.04	4.98	3.09	Clay	Clay	Clay	Clay	Clay	Clay	11.04	3.09	7.84	86.53	0.14	0.25	0.74	FALSE	0.00	Above WT
53.64	99.4	51.90	2.049	0.06	3.22	3.22	15.13	4.21	2.94	Clay	Clay	Clay	Clay	Clay	Clay	15.13	2.94	6.11	92.34	0.15	0.25	0.74	FALSE	0.00	Above WT
53.81	99.2	49.20	2.021	0.06	3.23	3.23	14.24	4.40	2.97	Clay	Clay	Clay	Clay	Clay	Clay	14.24	2.97	6.45	91.77	0.15	0.25	0.74	FALSE	0.00	Above WT
53.97	99.0	63.73	2.509	0.06	3.24	3.24	18.68	4.15	2.87	Clay	Clay	Clay	Clay	Clay	Clay	18.68	2.87	5.37	100.28	0.17	0.25	0.73	FALSE	0.00	Above WT

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	CQ2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
54.13	98.9	52.89	2.550	0.06	3.25	3.25	15.28	5.14	2.99	Clay	Clay	Clay	Clay	Clay	Clay	15.28	2.99	6.66	101.74	0.18	0.25	0.73	FALSE	0.00	Above WT
54.30	98.7	52.69	2.413	0.06	3.26	3.26	15.17	4.88	2.98	Clay	Clay	Clay	Clay	Clay	Clay	15.17	2.98	6.53	99.02	0.17	0.25	0.73	FALSE	0.00	Above WT
54.46	98.5	47.28	2.191	0.06	3.27	3.27	13.47	4.98	3.03	Clay	Clay	Clay	Clay	Clay	Clay	13.47	3.03	7.03	94.72	0.16	0.25	0.73	FALSE	0.00	Above WT
54.63	98.4	41.12	2.109	0.06	3.28	3.28	11.54	5.57	3.11	Clay	Clay	Clay	Clay	Clay	Clay	11.54	3.11	8.03	92.73	0.15	0.25	0.73	FALSE	0.00	Above WT
54.79	98.2	65.46	2.376	0.06	3.29	3.29	18.91	3.82	2.84	Clay	Clay	Clay	Clay	Clay	Clay	18.91	2.84	5.12	96.89	0.16	0.25	0.73	FALSE	0.00	Above WT
54.95	98.1	75.65	2.632	0.06	3.30	3.30	21.95	3.64	2.78	Clay	Clay	Clay	Clay	Clay	Clay	21.95	2.78	4.58	100.47	0.17	0.25	0.73	FALSE	0.00	Above WT
55.12	97.9	75.58	2.821	0.06	3.31	3.31	21.85	3.90	2.80	Clay	Clay	Clay	Clay	Clay	Clay	21.85	2.80	4.75	103.90	0.18	0.25	0.73	FALSE	0.00	Above WT
55.28	97.7	81.90	2.701	0.06	3.32	3.32	23.69	3.44	2.73	Clay	Clay	Clay	Clay	Clay	Clay	23.69	2.73	4.25	100.70	0.17	0.24	0.72	FALSE	0.00	Above WT
55.45	97.6	112.54	2.502	0.06	3.33	3.33	32.83	2.29	2.51	0.56	60.50	2.31	Sand	Sand	Sand	60.50	2.31	1.99	120.32	0.24	0.24	0.72	FALSE	0.00	Above WT
55.61	97.4	140.72	2.506	0.06	3.34	3.34	41.17	1.82	2.37	0.56	75.54	2.17	Sand	Sand	Sand	75.54	2.17	1.61	121.33	0.25	0.24	0.72	FALSE	0.00	Above WT
55.77	97.2	145.82	2.719	0.06	3.35	3.35	42.58	1.91	2.38	0.56	78.17	2.18	Sand	Sand	Sand	78.17	2.18	1.61	126.01	0.27	0.24	0.72	FALSE	0.00	Above WT
55.94	97.1	140.51	3.075	0.06	3.36	3.36	40.86	2.24	2.43	0.56	75.21	2.24	Sand	Sand	Sand	75.21	2.24	1.76	132.65	0.30	0.24	0.72	FALSE	0.00	Above WT
56.10	96.9	121.50	3.230	0.06	3.37	3.37	35.10	2.73	2.54	0.56	64.94	2.34	Sand	Sand	Sand	64.94	2.34	2.10	136.14	0.31	0.24	0.72	FALSE	0.00	Above WT
56.27	96.7	105.56	3.197	0.06	3.38	3.38	30.27	3.13	2.63	Clay	Clay	Clay	Clay	Clay	Clay	30.27	2.63	3.49	105.72	0.19	0.24	0.72	FALSE	0.00	Above WT
56.43	96.6	86.06	3.173	0.06	3.39	3.39	24.42	3.84	2.76	Clay	Clay	Clay	Clay	Clay	Clay	24.42	2.76	4.42	107.81	0.20	0.24	0.71	FALSE	0.00	Above WT
56.59	96.4	98.56	3.633	0.06	3.40	3.40	28.03	3.82	2.71	Clay	Clay	Clay	Clay	Clay	Clay	28.03	2.71	4.06	113.77	0.22	0.24	0.71	FALSE	0.00	Above WT
56.76	96.2	212.50	4.403	0.06	3.41	3.41	61.40	2.11	2.28	0.55	112.91	2.10	Sand	Sand	Sand	112.91	2.10	1.45	163.33	0.49	0.24	0.71	FALSE	0.00	Above WT
56.92	96.1	272.21	4.008	0.06	3.42	3.42	78.71	1.49	2.10	0.55	144.44	1.91	Sand	Sand	Sand	144.44	1.91	1.20	173.49	0.57	0.24	0.71	FALSE	0.00	Above WT
57.09	95.9	295.35	4.334	0.06	3.43	3.43	85.22	1.48	2.08	0.55	156.48	1.89	Sand	Sand	Sand	156.48	1.89	1.18	184.26	0.66	0.24	0.71	FALSE	0.00	Above WT
57.25	95.8	294.45	4.920	0.06	3.44	3.44	84.72	1.69	2.12	0.55	155.79	1.93	Sand	Sand	Sand	155.79	1.93	1.22	189.99	0.72	0.24	0.71	FALSE	0.00	Above WT
57.41	95.6	336.41	5.674	0.06	3.44	3.44	96.66	1.70	2.08	0.55	177.74	1.90	Sand	Sand	Sand	177.74	1.90	1.19	210.68	0.95	0.24	0.71	FALSE	0.00	Above WT
57.58	95.4	364.73	6.279	0.06	3.45	3.45	104.57	1.74	2.06	0.55	192.42	1.88	Sand	Sand	Sand	192.42	1.88	1.17	225.39	1.14	0.24	0.71	FALSE	0.00	Above WT
57.74	95.3	366.94	6.653	0.06	3.46	3.46	104.92	1.83	2.07	0.55	193.31	1.90	Sand	Sand	Sand	193.31	1.90	1.19	229.31	1.20	0.24	0.70	FALSE	0.00	Above WT
57.91	95.1	359.77	7.069	0.06	3.47	3.47	102.54	1.98	2.11	0.55	189.26	1.93	Sand	Sand	Sand	189.26	1.93	1.22	230.66	1.22	0.24	0.70	FALSE	0.00	Above WT
58.07	94.9	360.85	7.128	0.06	3.48	3.48	102.57	1.99	2.11	0.55	189.57	1.93	Sand	Sand	Sand	189.57	1.93	1.22	231.31	1.23	0.24	0.70	FALSE	0.00	Above WT
58.23	94.8	356.35	7.093	0.06	3.49	3.49	100.99	2.01	2.11	0.55	186.94	1.94	Sand	Sand	Sand	186.94	1.94	1.23	229.37	1.20	0.24	0.70	FALSE	0.00	Above WT
58.40	94.6	355.75	5.920	0.06	3.50	3.50	100.53	1.68	2.06	0.54	186.36	1.88	Sand	Sand	Sand	186.36	1.88	1.17	217.89	1.04	0.24	0.70	FALSE	0.00	Above WT
58.56	94.4	369.71	5.616	0.06	3.51	3.51	104.22	1.53	2.02	0.54	193.41	1.84	Sand	Sand	Sand	193.41	1.84	1.14	219.54	1.06	0.24	0.70	FALSE	0.00	Above WT
58.73	94.3	363.80	5.216	0.06	3.52	3.52	102.24	1.45	2.01	0.54	190.04	1.82	Sand	Sand	Sand	190.04	1.82	1.12	213.64	0.99	0.24	0.70	FALSE	0.00	Above WT
58.89	94.1	335.01	4.751	0.06	3.53	3.53	93.81	1.43	2.03	0.54	174.76	1.84	Sand	Sand	Sand	174.76	1.84	1.14	199.30	0.82	0.23	0.69	FALSE	0.00	Above WT
59.06	93.9	334.08	4.489	0.06	3.54	3.54	93.28	1.36	2.02	0.54	174.02	1.83	Sand	Sand	Sand	174.02	1.83	1.13	196.25	0.78	0.23	0.69	FALSE	0.00	Above WT
59.22	93.8	308.57	4.047	0.06	3.55	3.55	85.84	1.33	2.04	0.54	160.52	1.84	Sand	Sand	Sand	160.52	1.84	1.14	183.09	0.65	0.23	0.69	FALSE	0.00	Above WT
59.38	93.6	289.77	3.986	0.06	3.56	3.56	80.33	1.39	2.08	0.54	150.54	1.88	Sand	Sand	Sand	150.54	1.88	1.17	176.07	0.59	0.23	0.69	FALSE	0.00	Above WT
59.55	93.5	279.00	3.795	0.06	3.57	3.57	77.09	1.38	2.09	0.54	144.73	1.89	Sand	Sand	Sand	144.73	1.89	1.18	170.37	0.54	0.23	0.69	FALSE	0.00	Above WT
59.71	93.3	278.81	3.389	0.06	3.58	3.58	76.82	1.23	2.06	0.54	144.44	1.85	Sand	Sand	Sand	144.44	1.85	1.15	165.77	0.50	0.23	0.69	FALSE	0.00	Above WT
59.88	93.1	283.13	2.624	0.06	3.59	3.59	77.80	0.94	1.98	0.54	146.47	1.77	Sand	Sand	Sand	146.47	1.77	1.08	158.70	0.45	0.23	0.69	FALSE	0.00	Above WT
60.04	93.0	303.53	2.728	0.06	3.60	3.60	83.26	0.91	1.95	0.54	156.82	1.74	Sand	Sand	Sand	156.82	1.74	1.06	166.57	0.51	0.23	0.69	FALSE	0.00	Above WT
60.20	92.8	298.79	2.895	0.06	3.61	3.61	81.72	0.98	1.97	0.54	154.16	1.76	Sand	Sand	Sand	154.16	1.76	1.08	166.67	0.51	0.23	0.68	FALSE	0.00	Above WT
60.37	92.6	312.59	2.881	0.06	3.62	3.62	85.30	0.93	1.95	0.54	161.05	1.74	Sand	Sand	Sand	161.05	1.74	1.06	170.95	0.54	0.23	0.68	FALSE	0.00	Above WT
60.53	92.5	262.92	3.206	0.06	3.63	3.63	71.39	1.24	2.08	0.54	135.28	1.87	Sand	Sand	Sand	135.28	1.87	1.17	157.71	0.44	0.23	0.68	FALSE	0.00	Above WT
60.70	92.3	301.96	3.679	0.06	3.64	3.64	81.91	1.23	2.04	0.53	155.15	1.83	Sand	Sand	Sand	155.15	1.83	1.13	175.41	0.58	0.23	0.68	FALSE	0.00	Above WT
60.86	92.1	309.28	4.091	0.06	3.65	3.65	83.70	1.34	2.05	0.53	158.71	1.85	Sand	Sand	Sand	158.71	1.85	1.15	181.81	0.64	0.23	0.68	FALSE	0.00	Above WT
61.02	92.0	321.67	4.297	0.06	3.66	3.66	86.86	1.35	2.04	0.53	164.85	1.84	Sand	Sand	Sand	164.85	1.84	1.14	187.75	0.70	0.23	0.68	FALSE	0.00	Above WT
61.19	91.8	325.08	4.477	0.06	3.67	3.67	87.54	1.39	2.05	0.53	166.36	1.85	Sand	Sand	Sand	166.36	1.85	1.14	190.41	0.72	0.23	0.68	FALSE	0.00	Above WT
61.35	91.7	328.17	4.487	0.06	3.68	3.68	88.15	1.38	2.04	0.53	167.73	1.84	Sand	Sand	Sand	167.73	1.84	1.14	191.33	0.73	0.23	0.67	FALSE	0.00	Above WT
61.52	91.5	305.98	4.441	0.06	3.69	3.69	81.89	1.47	2.09	0.53	156.17	1.88	Sand	Sand	Sand	156.17	1.88	1.17	183.50	0.65	0.23	0.67	FALSE	0.00	Above WT
61.68	91.3	289.92	4.143	0.06	3.70	3.70	77.34	1.45	2.10	0.53	147.78	1.90	Sand	Sand	Sand	147.78	1.90	1.19	175.22	0.58	0.23	0.67	FALSE	0.00	Above WT
61.84	91.2	293.14	3.857	0.06	3.71	3.71	78.00	1.33	2.07	0.53	149.23	1.87	Sand	Sand	Sand	149.23	1.87	1.16	173.08	0.56	0.23	0.67	FALSE	0.00	Above WT
62.01	91.0	307.57	3.693	0.06	3.72	3.72	81.67	1.22	2.03	0.53	156.36	1.82	Sand	Sand	Sand	156.36	1.82	1.13	175.93	0.59	0.23	0.67	FALSE	0.00	Above WT
62.17	90.8	316.28	3.840	0.06	3.73	3.73	83.79	1.23	2.03	0.53	160.58	1.82	Sand	Sand	Sand	160.58	1.82	1.12	180.11	0.62	0.23	0.67	FALSE	0.00	Above WT
62.34	90.7	328.05	4.345	0.06	3.74	3.74	86.70	1.34	2.04	0.53	166.33	1.84	Sand	Sand	Sand	166.33	1.84	1.13	188.73	0.71	0.23	0.67	FALSE	0.00	Above WT
62.50	90.5	333.13	4.461	0.06	3.75	3.75	87.83	1.35	2.04	0.53	168.69	1.84	Sand	Sand	Sand	168.69	1.84	1.13	191.31	0.73	0.22	0.67	FALSE	0.00	Above WT
62.66	90.3	338.92	6.213	0.06	3.76	3.76	89.15	1.85	2.13	0.53	171.40	1.93	Sand	Sand	Sand	171.40	1.93	1.22	209.63	0.94	0.22	0.66	FALSE	0.00	Above WT

Euclid Street Undercrossing (Widen) SP 10-126

LIQUEFACTION ANALYSIS; ACC. = 0.52 g 27-Jun-11 08:39

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
$^{1}C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-023

Emean (%) 75 Sur.= psf 135 =top of ground el. Borehole Diamete 8 81 =water table El. acc. max = 0.52 g Earthq. M= 7.3
C_E 1.25 C_B 1.15 Cm= 1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD.	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
132.5	135	2.5	0.15	0.15	2.50	2.00	0.75	1.00	0.60	120	2	2	14	0.99	0.34	18	29.0	25	1.00	0.29	0.31	0.92	AboveWT
130	132.5	2.5	0.30	0.30	5.00	1.83	0.75	1.00	0.60	120	2	2	14	0.99	0.33	17	30.0	24	1.00	0.26	0.28	0.85	AboveWT
125	130	5	0.60	0.60	10.00	1.29	0.75	1.20	1.00	120	1	1	6	0.98	0.33	10	30.0	16	1.00	0.18	0.19	0.57	AboveWT
120	125	5	0.90	0.90	15.00	1.05	0.85	1.00	0.60	120	2	2	49	0.97	0.33	38	30.0	48	1.00	high N	high N	LARGE	AboveWT
115	120	5	1.20	1.20	20.00	0.91	0.85	1.20	1.00	120	1	1	6	0.95	0.32	8	30.0	14	0.97	0.15	0.16	0.49	AboveWT
110	115	5	1.50	1.50	25.00	0.82	0.95	1.00	0.60	120	2	2	40	0.94	0.32	27	4.0	27	0.93	0.31	0.31	0.98	AboveWT
105	110	5	1.80	1.80	30.00	0.75	0.95	1.20	1.00	120	1	1	7	0.93	0.31	9	59.0	15	0.89	0.16	0.16	0.50	AboveWT
100	105	5	2.10	2.10	35.00	0.69	1.00	1.00	0.60	120	2	2	23	0.89	0.30	14	40.0	21	0.87	0.23	0.22	0.72	AboveWT
95	100	5	2.40	2.40	40.00	0.65	1.00	1.20	1.00	120	1	1	15	0.85	0.29	17	20.0	22	0.85	0.24	0.21	0.75	AboveWT
90	95	5	2.70	2.70	45.00	0.61	1.00	1.00	0.60	120	2	2	29	0.81	0.27	15	90.0	23	0.82	0.26	0.23	0.83	AboveWT
85	90	5	3.00	3.00	50.00	0.58	1.00	1.20	1.00	120	1	1	35	0.77	0.26	35	4.0	35	0.78	high N	high N	LARGE	AboveWT
80	85	5	3.30	3.14	55.00	0.56	1.00	1.00	0.60	120	2	2	28	0.73	0.26	14	90.0	21	0.77	0.23	0.19	0.74	fines
75	80	5	3.60	3.29	60.00	0.55	1.00	1.20	1.00	120	1	1	23	0.69	0.25	22	25.0	29	0.76	0.36	0.30	1.17	no
70	75	5	3.90	3.43	65.00	0.54	1.00	1.00	0.60	120	2	2	100	0.64	0.25	47	5.0	47	0.76	high N	high N	LARGE	high N
65	70	5	4.20	3.58	70.00	0.53	1.00	1.20	1.00	120	1	1	46	0.60	0.24	42	6.0	42	0.75	high N	high N	LARGE	high N
60	65	5	4.50	3.72	75.00	0.52	1.00	1.00	0.60	120	2	2	86	0.56	0.23	38	3.0	38	0.74	high N	high N	LARGE	high N
55	60	5	4.80	3.86	80.00	0.51	1.00	1.20	1.00	120	1	1	12	0.55	0.23	11	90.0	18	0.73	0.19	0.15	0.65	fines

Euclid Street Undercrossing (Widen) SP 10-126

LIQUEFACTION ANALYSIS; ACC. = 0.52 g 27-Jun-11 08:39

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc, max = maximum peak acceleration at the ground surface (g's)
$^{1}C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc, max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-024

Emean (%)	75	Sur.=	psf	152.6	=top of ground el.	Borehole Diamete	8							81	=water table El.			acc, max =	0.52	g		Earthq, M=	7.3
C_E	1.25					C_B	1.15															Cm=	1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA,MOD.	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
147.6	152.6	5	0.30	0.30	5.00	1.83	0.75	1.20	1.00	120	1	1	13	0.99	0.33	31	30.0	40	1.00	high N	high N	LARGE	AboveWT
142.6	147.6	5	0.60	0.60	10.00	1.29	0.75	1.00	0.60	120	2	2	100	0.98	0.33	84	6.0	84	1.00	high N	high N	LARGE	AboveWT
137.6	142.6	5	0.90	0.90	15.00	1.05	0.85	1.20	1.00	120	1	1	24	0.97	0.33	37	25.0	46	1.00	high N	high N	LARGE	AboveWT
132.6	137.6	5	1.20	1.20	20.00	0.91	0.85	1.00	0.60	120	2	2	24	0.95	0.32	16	25.0	22	0.97	0.24	0.25	0.78	AboveWT
127.6	132.6	5	1.50	1.50	25.00	0.82	0.95	1.20	1.00	120	1	1	9	0.94	0.32	12	35.0	19	0.93	0.21	0.21	0.66	AboveWT
122.6	127.6	5	1.80	1.80	30.00	0.75	0.95	1.00	0.60	120	2	2	41	0.93	0.31	25	25.0	32	0.89	high N	high N	LARGE	AboveWT
117.6	122.6	5	2.10	2.10	35.00	0.69	1.00	1.20	1.00	120	1	1	11	0.89	0.30	13	25.0	19	0.87	0.20	0.19	0.63	AboveWT
112.6	117.6	5	2.40	2.40	40.00	0.65	1.00	1.00	0.60	120	2	2	45	0.85	0.29	25	25.0	32	0.85	high N	high N	LARGE	AboveWT
107.6	112.6	5	2.70	2.70	45.00	0.61	1.00	1.20	1.00	120	1	1	17	0.81	0.27	18	25.0	24	0.82	0.27	0.24	0.87	AboveWT
102.6	107.6	5	3.00	3.00	50.00	0.58	1.00	1.00	0.60	120	2	2	28	0.77	0.26	14	65.0	22	0.78	0.24	0.20	0.76	AboveWT
97.6	102.6	5	3.30	3.30	55.00	0.55	1.00	1.20	1.00	120	1	1	16	0.73	0.25	15	80.0	23	0.76	0.26	0.21	0.85	AboveWT
92.6	97.6	5	3.60	3.60	60.00	0.53	1.00	1.00	0.60	120	2	2	100	0.69	0.23	45	70.0	60	0.75	high N	high N	LARGE	AboveWT
87.6	92.6	5	3.90	3.90	65.00	0.51	1.00	1.20	1.00	120	1	1	26	0.64	0.22	23	7.0	23	0.73	0.25	0.20	0.91	AboveWT
82.6	87.6	5	4.20	4.20	70.00	0.49	1.00	1.00	0.60	120	2	2	85	0.60	0.20	36	10.0	37	0.71	high N	high N	LARGE	AboveWT
77.6	82.6	5	4.50	4.34	75.00	0.48	1.00	1.20	1.00	120	1	1	14	0.56	0.20	12	70.0	19	0.71	0.20	0.15	0.78	fines
72.6	77.6	5	4.80	4.49	80.00	0.47	1.00	1.00	0.60	120	2	2	100	0.55	0.20	41	10.0	42	0.70	high N	high N	LARGE	high N
67.6	72.6	5	5.10	4.63	85.00	0.46	1.00	1.20	1.00	120	1	1	51	0.54	0.20	41	4.0	41	0.69	high N	high N	LARGE	high N

Cf

Retaining Wall 173 — **Sounding: CPT-10-026**

PGA: 0.52 Mag 7.3 Gwdepth 67 Ground EL 148

Note: Units are tons/cf, tons/sf, and feet

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	CQ2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
1.15	146.9	43.54	2.068	0.06	0.07	0.07	630.01	4.76	2.01	3.88	162.54	2.28	Sand	Sand	Sand	162.54	2.28	1.88	305.13	2.72	0.34	1.00	FALSE	0.00	Above WT
1.31	146.7	27.97	1.294	0.06	0.08	0.08	354.85	4.64	2.10	3.64	97.83	2.40	Sand	Sand	Sand	97.83	2.40	2.30	225.21	1.14	0.34	1.00	FALSE	0.00	Above WT
1.48	146.5	8.98	1.236	0.06	0.09	0.09	100.13	13.90	2.78	Clay	Clay	Clay	Clay	Clay	Clay	100.13	2.78	4.64	464.48	9.40	0.34	1.00	FALSE	0.00	Above WT
1.64	146.4	22.45	1.191	0.06	0.10	0.10	227.15	5.33	2.24	3.25	70.18	2.53	Sand	Sand	Sand	70.18	2.53	2.95	207.08	0.91	0.34	1.00	FALSE	0.00	Above WT
1.80	146.2	21.74	0.839	0.06	0.11	0.11	200.30	3.88	2.15	3.10	64.87	2.45	Sand	Sand	Sand	64.87	2.45	2.55	165.10	0.50	0.34	1.00	FALSE	0.00	Above WT
1.97	146.0	20.21	0.800	0.06	0.12	0.12	169.98	3.98	2.20	2.97	57.64	2.50	Sand	Sand	Sand	57.64	2.50	2.75	158.71	0.45	0.34	1.00	FALSE	0.00	Above WT
2.13	145.9	20.30	0.823	0.06	0.13	0.13	157.84	4.08	2.23	2.85	55.68	2.51	Sand	Sand	Sand	55.68	2.51	2.84	158.37	0.45	0.34	1.00	FALSE	0.00	Above WT
2.30	145.7	19.19	0.885	0.06	0.14	0.14	138.06	4.64	2.31	2.75	50.65	2.58	Sand	Sand	Sand	50.65	2.58	3.23	163.59	0.49	0.34	0.99	FALSE	0.00	Above WT
2.46	145.5	11.97	1.240	0.06	0.15	0.15	80.10	10.49	2.73	Clay	Clay	Clay	Clay	Clay	Clay	80.10	2.73	4.25	340.40	3.75	0.34	0.99	FALSE	0.00	Above WT
2.62	145.4	36.06	1.336	0.06	0.16	0.16	228.39	3.72	2.11	2.57	89.18	2.35	Sand	Sand	Sand	89.18	2.35	2.11	188.57	0.70	0.34	0.99	FALSE	0.00	Above WT
2.79	145.2	73.30	1.766	0.06	0.17	0.17	436.87	2.41	1.80	2.49	175.67	2.02	Sand	Sand	Sand	175.67	2.02	1.32	232.51	1.25	0.34	0.99	FALSE	0.00	Above WT
2.95	145.1	106.80	2.277	0.06	0.18	0.18	602.39	2.14	1.70	2.42	248.92	1.89	Sand	Sand	Sand	248.92	1.89	1.18	292.55	2.41	0.34	0.99	FALSE	0.00	Above WT
3.12	144.9	150.97	2.848	0.06	0.19	0.19	805.46	1.89	1.60	2.36	342.15	1.76	Sand	Sand	Sand	342.15	1.76	1.08	370.12	4.80	0.34	0.99	FALSE	0.00	Above WT
3.28	144.7	216.15	3.880	0.06	0.20	0.20	1097.32	1.80	1.54	2.30	477.78	1.67	Sand	Sand	Sand	477.78	1.67	1.02	487.12	10.83	0.34	0.99	FALSE	0.00	Above WT
3.44	144.6	285.74	3.775	0.06	0.21	0.21	1383.40	1.32	1.38	2.24	616.74	1.50	Sand	Sand	Sand	616.74	1.50	1.00	616.74	21.90	0.34	0.99	FALSE	0.00	Above WT
3.61	144.4	236.45	2.953	0.06	0.22	0.22	1090.64	1.25	1.39	2.19	498.19	1.53	Sand	Sand	Sand	498.19	1.53	1.00	498.19	11.58	0.34	0.99	FALSE	0.00	Above WT
3.77	144.2	192.56	1.697	0.06	0.23	0.23	850.28	0.88	1.28	2.14	397.01	1.46	Sand	Sand	Sand	397.01	1.46	1.00	397.01	5.90	0.34	0.99	FALSE	0.00	Above WT
3.94	144.1	177.25	1.604	0.06	0.24	0.24	748.79	0.91	1.32	2.10	357.48	1.49	Sand	Sand	Sand	357.48	1.49	1.00	357.48	4.33	0.33	0.99	FALSE	0.00	Above WT
4.10	143.9	174.04	1.773	0.06	0.25	0.25	706.48	1.02	1.38	2.06	344.08	1.54	Sand	Sand	Sand	344.08	1.54	1.00	344.08	3.87	0.33	0.99	FALSE	0.00	Above WT
4.27	143.7	207.48	2.076	0.06	0.26	0.26	808.84	1.00	1.34	2.01	401.95	1.50	Sand	Sand	Sand	401.95	1.50	1.00	401.95	6.12	0.33	0.99	FALSE	0.00	Above WT
4.43	143.6	231.58	2.591	0.06	0.27	0.27	870.26	1.12	1.38	1.98	440.46	1.51	Sand	Sand	Sand	440.46	1.51	1.00	440.46	8.03	0.33	0.99	FALSE	0.00	Above WT
4.59	143.4	267.09	2.825	0.06	0.28	0.28	968.83	1.06	1.34	1.94	499.07	1.46	Sand	Sand	Sand	499.07	1.46	1.00	499.07	11.64	0.33	0.99	FALSE	0.00	Above WT
4.76	143.2	297.21	3.066	0.06	0.29	0.29	1039.65	1.03	1.31	1.91	545.34	1.44	Sand	Sand	Sand	545.34	1.44	1.00	545.34	15.16	0.33	0.99	FALSE	0.00	Above WT
4.92	143.1	308.15	3.395	0.06	0.30	0.30	1042.87	1.10	1.34	1.88	556.14	1.46	Sand	Sand	Sand	556.14	1.46	1.00	556.14	16.08	0.33	0.99	FALSE	0.00	Above WT
5.09	142.9	307.03	3.612	0.06	0.31	0.31	1004.34	1.18	1.37	1.85	544.79	1.48	Sand	Sand	Sand	544.79	1.48	1.00	544.79	15.12	0.33	0.99	FALSE	0.00	Above WT
5.25	142.8	302.02	3.742	0.06	0.32	0.32	957.79	1.24	1.40	1.82	527.67	1.51	Sand	Sand	Sand	527.67	1.51	1.00	527.67	13.74	0.33	0.99	FALSE	0.00	Above WT
5.41	142.6	299.00	3.895	0.06	0.32	0.32	920.13	1.30	1.43	1.79	514.61	1.54	Sand	Sand	Sand	514.61	1.54	1.00	514.61	12.75	0.33	0.99	FALSE	0.00	Above WT
5.58	142.4	297.99	3.819	0.06	0.33	0.33	889.05	1.28	1.43	1.76	505.00	1.53	Sand	Sand	Sand	505.00	1.53	1.00	505.00	12.06	0.33	0.99	FALSE	0.00	Above WT
5.74	142.3	291.37	3.171	0.06	0.34	0.34	845.02	1.09	1.37	1.74	486.85	1.48	Sand	Sand	Sand	486.85	1.48	1.00	486.85	10.81	0.33	0.99	FALSE	0.00	Above WT
5.91	142.1	306.05	2.658	0.06	0.35	0.35	862.09	0.87	1.28	1.71	503.97	1.39	Sand	Sand	Sand	503.97	1.39	1.00	503.97	11.98	0.33	0.99	FALSE	0.00	Above WT
6.07	141.9	332.38	2.486	0.06	0.36	0.36	911.63	0.75	1.21	1.69	540.07	1.32	Sand	Sand	Sand	540.07	1.32	1.00	540.07	14.73	0.33	0.99	FALSE	0.00	Above WT
6.23	141.8	324.94	2.403	0.06	0.37	0.37	868.29	0.74	1.21	1.67	521.15	1.32	Sand	Sand	Sand	521.15	1.32	1.00	521.15	13.24	0.33	0.99	FALSE	0.00	Above WT
6.40	141.6	302.62	2.486	0.06	0.38	0.38	787.07	0.82	1.27	1.65	478.87	1.38	Sand	Sand	Sand	478.87	1.38	1.00	478.87	10.29	0.33	0.99	FALSE	0.00	Above WT
6.56	141.4	281.49	2.320	0.06	0.39	0.39	714.17	0.83	1.29	1.63	439.97	1.41	Sand	Sand	Sand	439.97	1.41	1.00	439.97	8.00	0.33	0.98	FALSE	0.00	Above WT
6.73	141.3	252.72	2.284	0.06	0.40	0.40	624.85	0.91	1.36	1.60	389.98	1.47	Sand	Sand	Sand	389.98	1.47	1.00	389.98	5.60	0.33	0.98	FALSE	0.00	Above WT
6.89	141.1	228.91	2.245	0.06	0.41	0.41	552.73	0.98	1.41	1.59	349.11	1.53	Sand	Sand	Sand	349.11	1.53	1.00	349.11	4.04	0.33	0.98	FALSE	0.00	Above WT
7.05	141.0	208.10	2.056	0.06	0.42	0.42	490.96	0.99	1.44	1.57	313.75	1.56	Sand	Sand	Sand	313.75	1.56	1.00	313.75	2.95	0.33	0.98	FALSE	0.00	Above WT
7.22	140.8	199.37	1.856	0.06	0.43	0.43	459.23	0.93	1.44	1.55	297.03	1.55	Sand	Sand	Sand	297.03	1.55	1.00	297.03	2.52	0.33	0.98	FALSE	0.00	Above WT
7.38	140.6	202.75	1.697	0.06	0.44	0.44	456.88	0.84	1.40	1.53	298.77	1.52	Sand	Sand	Sand	298.77	1.52	1.00	298.77	2.56	0.33	0.98	FALSE	0.00	Above WT
7.55	140.5	216.90	1.919	0.06	0.45	0.45	477.81	0.89	1.41	1.52	316.00	1.52	Sand	Sand	Sand	316.00	1.52	1.00	316.00	3.01	0.33	0.98	FALSE	0.00	Above WT
7.71	140.3	225.97	2.067	0.06	0.46	0.46	487.48	0.92	1.42	1.50	325.79	1.52	Sand	Sand	Sand	325.79	1.52	1.00	325.79	3.30	0.33	0.98	FALSE	0.00	Above WT
7.87	140.1	216.25	2.243	0.06	0.47	0.47	456.96	1.04	1.48	1.48	308.59	1.58	Sand	Sand	Sand	308.59	1.58	1.00	308.59	2.81	0.33	0.98	FALSE	0.00	Above WT
8.04	140.0	199.23	2.168	0.06	0.48	0.48	412.00	1.09	1.52	1.47	281.28	1.62	Sand	Sand	Sand	281.28	1.62	1.00	281.28	2.15	0.33	0.98	FALSE	0.00	Above WT
8.20	139.8	173.77	2.292	0.06	0.49	0.49	352.19	1.32	1.63	1.45	242.93	1.72	Sand	Sand	Sand	242.93	1.72	1.05	256.21	1.64	0.33	0.98	FALSE	0.00	Above WT
8.37	139.6	156.32	1.914	0.06	0.50	0.50	310.27	1.23	1.63	1.44	216.30	1.73	Sand	Sand	Sand	216.30	1.73	1.06	229.27	1.20	0.33	0.98	FALSE	0.00	Above WT
8.53	139.5	167.66	2.037	0.06	0.51	0.51	326.59	1.22	1.62	1.43	229.81	1.71	Sand	Sand	Sand	229.81	1.71	1.05	240.53	1.37	0.33	0.98	FALSE	0.00	Above WT
8.69	139.3	216.69	1.972	0.06	0.52	0.52	414.59	0.91	1.46	1.41	294.26	1.55	Sand	Sand	Sand	294.26	1.55	1.00	294.26	2.45	0.33	0.98	FALSE	0.00	Above WT
8.86	139.1	254.24	2.020	0.06	0.53	0.53	477.25	0.80	1.37	1.40	341.93	1.46	Sand	Sand	Sand	341.93	1.46	1.00	341.93	3.80	0.33	0.98	FALSE	0.00	Above WT
9.02	139.0	293.56	2.427	0.06	0.54	0.54	541.42	0.83	1.36	1.39	391.29	1.44	Sand	Sand	Sand	391.29	1.44	1.00	391.29	5.65	0.33	0.98	FALSE	0.00	Above WT
9.19	138.8	310.40	2.941	0.06	0.55	0.55	561.93	0.95	1.40	1.37	409.89	1.47	Sand	Sand	Sand	409.89	1.47	1.00	409.89	6.48	0.33	0.98	FALSE	0.00	Above WT
9.35	138.7	336.76	3.223	0.06	0.56	0.56	599.29	0.96	1.39	1.36	440.88	1.46	Sand	Sand	Sand	440.88	1.46	1.00	440.88	8.05	0.33	0.98	FALSE	0.00	Above WT
9.51	138.5	346.26	3.212	0.06	0.57	0.57	605.83	0.93	1.37	1.35	449.49	1.44	Sand	Sand	Sand	449.49	1.44	1.00	449.49	8.53	0.33	0.98	FALSE	0.00	Above WT
9.68	138.3	349.48	4.016	0.06	0.58	0.58	600.72	1.15	1.46	1.34	449.67	1.52	Sand	Sand	Sand	449.67	1.52	1.00	449.67	8.54	0.33	0.98	FALSE	0.00	Above WT
9.84	138.2	356.69	4.162	0.06	0.59	0.59	603.15	1.17	1.46	1.33	455.20	1.52	Sand	Sand	Sand	455.20	1.52	1.00	455.20	8.85	0.33	0.98	FALSE	0.00	Above WT
10.01	138.0	348.87	4.319	0.06	0.60	0.60	579.87	1.24	1.49	1.32	441.42	1.55	Sand	Sand	Sand	441.42	1.55	1.00	441.42	8.08	0.33	0.98	FALSE	0.00	Above WT
10.17	137.8	386.18	4.720	0.06	0.61	0.61	631.87	1.22	1.47	1.31	484.77	1.53	Sand	Sand	Sand	484.77	1.53	1.00	484.77	10.67	0.33	0.98	FALSE	0.00	Above WT
10.33	137.7	433.02	4.266	0.06	0.62	0.62	697.64	0.99	1.37	1.30	539.34	1.42	Sand	Sand	Sand	539.34	1.42	1.00	539.34	14.67	0.33	0.98	FALSE	0.00	Above WT

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
$CRR\ r = CRR_{7.5} \times Cm \times K\ sigma$

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines (Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

$F_L = CRR\ r / CSR\ i$

A-10-036

Emean (%)	75		Present Ground El.	168	Borehole Dia. (in)	8	Tot. Unit Wt. (pcf)	48.0	=Design Water Table Depth	48.0	=Field Water Table Depth	Acc. max =	0.520	g							Earthq. M=	7.3
C_E	1.25		Future Ground El.	168	C_B	1.15	120	120	=Design Water El.	120	=Field Water El.										Cm=	1.07

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
-	-	-	-	-	-	-	-				-	-	-	-	-	-	-	-	-	-	-	-
5	163	9	SC	23.0	0.30	0.30	1.70	0.80	1.20	1.00	1	1	0.99	0.30	0.33	21	27	1.00	0.35	0.37	1.11	AboveWT
10	158	31	SM	25.0	0.60	0.60	1.32	0.85	1.00	0.67	2	2	0.98	0.60	0.33	33	41	1.00	High N	0.00	LARGE	AboveWT
15	153	9	SP-SM	5.0	0.90	0.90	1.08	0.85	1.20	1.00	1	1	0.97	0.90	0.33	14	14	1.00	0.15	0.16	0.50	AboveWT
20	148	41	SP-SM	5.0	1.20	1.20	0.93	0.95	1.00	0.67	2	2	0.95	1.20	0.32	35	35	0.97	High N	0.00	LARGE	AboveWT
25	143	9	SP-SM	5.0	1.50	1.50	0.83	0.95	1.20	1.00	1	1	0.94	1.50	0.32	12	12	0.93	0.13	0.13	0.42	AboveWT
30	138	55	SM	30.0	1.80	1.80	0.76	1.00	1.00	0.67	2	2	0.93	1.80	0.31	40	51	0.89	High N	0.00	LARGE	AboveWT
35	133	15	SM	30.0	2.10	2.10	0.71	1.00	1.20	1.00	1	1	0.89	2.10	0.30	18	26	0.87	0.31	0.29	0.96	AboveWT
40	128	38	SM	30.0	2.40	2.40	0.66	1.00	1.00	0.67	2	2	0.85	2.40	0.29	24	32	0.85	High N	0.00	LARGE	AboveWT
45	123	26	SP-SM	10.0	2.70	2.70	0.62	1.00	1.20	1.00	1	1	0.81	2.70	0.27	28	29	0.82	0.43	0.38	1.39	AboveWT
50	118	53	ML/SM	40.0	3.00	2.94	0.60	1.00	1.00	0.67	2	2	0.77	2.94	0.26	30	41	0.80	High N	0.00	LARGE	high N

SR-91 Westbound Widening - N. Anaheim OH **EMI Project No. 10-126** Version - 12/05

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines (Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

F_L = CRR r / CSR i

A-10-039

Emean (%)	75			Present Ground El.	198.4	Borehole Dia. (in)	8	Tot. Unit Wt. (pcf)	78.4	=Design Water Table Depth	78.4	=Field Water Table Depth	Acc. max =	0.520 g				Earthq. M=	7.3			
C_E	1.25			Future Ground El.	198.4	C_B	1.15	120	120	=Design Water El.	120	=Field Water El.						Cm=	1.07			

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
-		-		-	-	-	-				-		-	-	-	-		-	-		-	-
5	193	64	SM	20.0	0.30	0.30	1.70	0.80	1.00	0.67	2	2	0.99	0.30	0.33	83	94	1.00	High N	0.00	LARGE	AboveWT
10	188	30	SM	15.0	0.60	0.60	1.32	0.85	1.20	1.00	1	1	0.98	0.60	0.33	58	63	1.00	High N	0.00	LARGE	AboveWT
15	183	48	SP-SM/SC	20.0	0.90	0.90	1.08	0.85	1.00	0.67	2	2	0.97	0.90	0.33	42	49	1.00	High N	0.00	LARGE	AboveWT
20	178	10	SM	32.0	1.20	1.20	0.93	0.95	1.20	1.00	1	1	0.95	1.20	0.32	15	23	0.97	0.25	0.26	0.82	AboveWT
25	173	80	SP-SM	10.0	1.50	1.50	0.83	0.95	1.00	0.67	2	2	0.94	1.50	0.32	61	63	0.93	High N	0.00	LARGE	AboveWT
30	168	21	SM/SC	25.0	1.80	1.80	0.76	1.00	1.20	1.00	1	1	0.93	1.80	0.31	28	35	0.89	High N	0.00	LARGE	AboveWT
35	163	37	SP	3.0	2.10	2.10	0.71	1.00	1.00	0.67	2	2	0.89	2.10	0.30	25	25	0.87	0.29	0.27	0.91	AboveWT
40	158	18	SP-SM	5.0	2.40	2.40	0.66	1.00	1.20	1.00	1	1	0.85	2.40	0.29	20	20	0.85	0.22	0.20	0.70	AboveWT
45	153	77	SP-SM	5.0	2.70	2.70	0.62	1.00	1.00	0.67	2	2	0.81	2.70	0.27	46	46	0.82	High N	0.00	LARGE	AboveWT
50	148	23	SP-SM	6.0	3.00	3.00	0.59	1.00	1.20	1.00	1	1	0.77	3.00	0.26	23	24	0.78	0.27	0.22	0.86	AboveWT
55	143	74	SM	15.0	3.30	3.30	0.56	1.00	1.00	0.67	2	2	0.73	3.30	0.25	40	44	0.76	High N	0.00	LARGE	AboveWT
60	138	12	ML	52.0	3.60	3.60	0.54	1.00	1.20	1.00	1	1	0.69	3.60	0.23	11	18	0.75	0.20	0.16	0.68	AboveWT
65	133	58	SM	30.0	3.90	3.90	0.52	1.00	1.00	0.67	2	2	0.64	3.90	0.22	29	38	0.73	High N	0.00	LARGE	AboveWT
70	128	22	MH	85.0	4.20	4.20	0.50	1.00	1.20	1.00	1	1	0.60	4.20	0.20	19	28	0.71	0.36	0.28	1.35	AboveWT
75	123	32	SP	4.0	4.50	4.50	0.48	1.00	1.00	0.67	2	2	0.56	4.50	0.19	15	15	0.70	0.16	0.12	0.62	AboveWT
80	118	36	SP-SM	6.0	4.80	4.75	0.47	1.00	1.20	1.00	1	1	0.55	4.75	0.19	29	29	0.68	0.42	0.31	1.66	no
85	113	98	SP-SM	6.0	5.10	4.89	0.46	1.00	1.00	0.67	2	2	0.54	4.89	0.19	43	44	0.68	High N	0.00	LARGE	high N
90	108	45	SP-SM	6.0	5.40	5.04	0.46	1.00	1.20	1.00	1	1	0.52	5.04	0.19	35	36	0.67	High N	0.00	LARGE	high N
95	103	59	SM/SP-SM	5.0	5.70	5.18	0.45	1.00	1.00	0.67	2	2	0.51	5.18	0.19	25	25	0.67	0.30	0.21	1.12	no
100	98.4	69	SP-SM	5.0	6.00	5.33	0.44	0.95	1.20	1.00	1	1	0.50	5.33	0.19	50	50	0.66	High N	0.00	LARGE	high N

SR-91 Westbound Widening - N. Anaheim OH **EMI Project No. 10-126** Version - 12/05

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

$$CSR\ i = 0.65 \times acc\ max. \times total\ normal\ stress \times rd\ /\ (effective\ normal\ stress \times g)$$

The resisting cyclic stress ratio (CRR r) is equal to:
$CRR\ r = CRR_{7.5} \times Cm \times K\ sigma$

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines (Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

$$F_L = CRR\ r\ /\ CSR\ i$$

A-10-040

Emean (%) 75 | Present Ground El. 201.2 | Borehole Dia. (in) 8 | Tot. Unit Wt. (pcf) 120 | 81.2 =Design Water Table Depth | 81.2 =Field Water Table Depth | Acc. max = 0.520 g | Earthq. M= 7.3
C_E 1.25 | Future Ground El. 201.2 | C_B 1.15 | 120 =Design Water El. | 120 =Field Water El. | Cm= 1.07

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	196	20	SM	20.0	0.30	0.30	1.70	0.80	1.20	1.00	1	1	0.99	0.30	0.33	47	54	1.00	High N	0.00	LARGE	AboveWT
10	191	63	SP-SM	10.0	0.60	0.60	1.32	0.85	1.00	0.67	2	2	0.98	0.60	0.33	68	70	1.00	High N	0.00	LARGE	AboveWT
15	186	43	SP-SM	10.0	0.90	0.90	1.08	0.85	1.20	1.00	1	1	0.97	0.90	0.33	68	70	1.00	High N	0.00	LARGE	AboveWT
20	181	81	SM	20.0	1.20	1.20	0.93	0.95	1.00	0.67	2	2	0.95	1.20	0.32	69	78	0.97	High N	0.00	LARGE	AboveWT
25	176	39	SM	20.0	1.50	1.50	0.83	0.95	1.20	1.00	1	1	0.94	1.50	0.32	53	61	0.93	High N	0.00	LARGE	AboveWT
30	171	63	SM	25.0	1.80	1.80	0.76	1.00	1.00	0.67	2	2	0.93	1.80	0.31	46	56	0.89	High N	0.00	LARGE	AboveWT
35	166	14	SP-SM	5.0	2.10	2.10	0.71	1.00	1.20	1.00	1	1	0.89	2.10	0.30	17	17	0.87	0.18	0.17	0.56	AboveWT
40	161	31	SP-SM	5.0	2.40	2.40	0.66	1.00	1.00	0.67	2	2	0.85	2.40	0.29	20	20	0.85	0.21	0.19	0.67	AboveWT
45	156	28	SP	3.0	2.70	2.70	0.62	1.00	1.20	1.00	1	1	0.81	2.70	0.27	30	30	0.82	High N	0.00	LARGE	AboveWT
50	151	84	SP	3.0	3.00	3.00	0.59	1.00	1.00	0.67	2	2	0.77	3.00	0.26	47	47	0.78	High N	0.00	LARGE	AboveWT
55	146	18	SM	20.0	3.30	3.30	0.56	1.00	1.20	1.00	1	1	0.73	3.30	0.25	17	22	0.76	0.25	0.20	0.83	AboveWT
60	141	81	SP-SM	5.0	3.60	3.60	0.54	1.00	1.00	0.67	2	2	0.69	3.60	0.23	42	42	0.75	High N	0.00	LARGE	AboveWT
65	136	26	SP-SM	7.0	3.90	3.90	0.52	1.00	1.20	1.00	1	1	0.64	3.90	0.22	23	24	0.73	0.27	0.21	0.95	AboveWT
70	131	75	SP	4.0	4.20	4.20	0.50	1.00	1.00	0.67	2	2	0.60	4.20	0.20	36	36	0.71	High N	0.00	LARGE	AboveWT
75	126	41	SP	3.0	4.50	4.50	0.48	1.00	1.20	1.00	1	1	0.56	4.50	0.19	34	34	0.70	High N	0.00	LARGE	AboveWT
80	121	69	SM/SP-SM	10.0	4.80	4.80	0.47	1.00	1.00	0.67	2	2	0.55	4.80	0.19	31	32	0.68	High N	0.00	LARGE	AboveWT
85	116	61	SP-SM	7.0	5.10	4.98	0.46	1.00	1.20	1.00	1	1	0.54	4.98	0.19	48	49	0.67	High N	0.00	LARGE	high N
90	111	53	SP-SM	10.0	5.40	5.13	0.45	1.00	1.00	0.67	2	2	0.52	5.13	0.19	23	24	0.67	0.28	0.20	1.06	no
96.2	105	42	SP-SM	4.0	5.77	5.30	0.44	0.95	1.20	1.00	1	1	0.51	5.30	0.19	31	31	0.66	High N	0.00	LARGE	high N
100	101	80	SP-SM	4.0	6.00	5.41	0.44	0.95	1.00	0.67	2	2	0.50	5.41	0.19	32	32	0.66	High N	0.00	LARGE	high N

East Street Undercrossing (Widen)
LIQUEFACTION ANALYSIS; ACC. = 0.52 g

SP 10-126
27-Jun-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
$^{1}C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-044

Emean (%)	75	Sur.=	psf	193	=top of ground el.	Borehole Diamete	8								121	=water table El.			acc. max =	0.52	g		Earthq. M=	7.3
C_E	1.25					C_B	1.15																Cm=	1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD.	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
-	-	-	-	-	-	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-
188	193	5	0.30	0.30	5.00	1.83	0.75	1.20	1.00	120	1	1	26	0.99	0.33	61	20.0	70	1.00	high N	high N	LARGE	AboveWT
183	188	5	0.60	0.60	10.00	1.29	0.75	1.00	0.60	120	2	2	51	0.98	0.33	43	7.0	43	1.00	high N	high N	LARGE	AboveWT
178	183	5	0.90	0.90	15.00	1.05	0.85	1.20	1.00	120	1	1	34	0.97	0.33	53	8.0	54	1.00	high N	high N	LARGE	AboveWT
173	178	5	1.20	1.20	20.00	0.91	0.85	1.00	0.60	120	2	2	35	0.95	0.32	23	5.0	23	0.97	0.26	0.27	0.84	AboveWT
168	173	5	1.50	1.50	25.00	0.82	0.95	1.20	1.00	120	1	1	12	0.94	0.32	16	5.0	16	0.93	0.17	0.17	0.54	AboveWT
163	168	5	1.80	1.80	30.00	0.75	0.95	1.00	0.60	120	2	2	23	0.93	0.31	14	3.0	14	0.89	0.15	0.14	0.46	AboveWT
158	163	5	2.10	2.10	35.00	0.69	1.00	1.20	1.00	120	1	1	24	0.89	0.30	29	3.0	29	0.87	0.36	0.34	1.12	AboveWT
153	158	5	2.40	2.40	40.00	0.65	1.00	1.00	0.60	120	2	2	75	0.85	0.29	42	3.0	42	0.85	high N	high N	LARGE	AboveWT
148	153	5	2.70	2.70	45.00	0.61	1.00	1.20	1.00	120	1	1	6	0.81	0.27	6	80.0	13	0.82	0.14	0.12	0.44	AboveWT
143	148	5	3.00	3.00	50.00	0.58	1.00	1.00	0.60	120	2	2	100	0.77	0.26	50	3.0	50	0.78	high N	high N	LARGE	AboveWT
138	143	5	3.30	3.30	55.00	0.55	1.00	1.20	1.00	120	1	1	23	0.73	0.25	22	5.0	22	0.76	0.24	0.19	0.79	AboveWT
133	138	5	3.60	3.60	60.00	0.53	1.00	1.00	0.60	120	2	2	68	0.69	0.23	31	4.0	31	0.75	high N	high N	LARGE	AboveWT
128	133	5	3.90	3.90	65.00	0.51	1.00	1.20	1.00	120	1	1	13	0.64	0.22	11	80.0	19	0.73	0.20	0.16	0.72	AboveWT
123	128	5	4.20	4.20	70.00	0.49	1.00	1.00	0.60	120	2	2	26	0.60	0.20	11	70.0	18	0.71	0.20	0.15	0.73	AboveWT
118	123	5	4.50	4.34	75.00	0.48	1.00	1.20	1.00	120	1	1	19	0.56	0.20	16	65.0	24	0.71	0.27	0.20	1.02	fines
113	118	5	4.80	4.49	80.00	0.47	1.00	1.00	0.60	120	2	2	31	0.55	0.20	13	65.0	20	0.70	0.22	0.16	0.82	fines

East Street Undercrossing (Widen) SP 10-126

LIQUEFACTION ANALYSIS: ACC. = 0.52 g 27-Jun-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
^1C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-045

Emean (%)	75	Sur.=	psf	174	=top of ground el.	Borehole Diamete	8							121	=water table El.		acc. max =	0.52	g		Earthq. M=	7.3	
C_E	1.25					C_B	1.15														Cm=	1.07	

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD.	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
171.5	174	2.5	0.15	0.15	2.50	2.00	0.75	1.20	1.00	120	1	1	18	0.99	0.34	47	4.0	47	1.00	high N	high N	LARGE	AboveWT
169	171.5	2.5	0.30	0.30	5.00	1.83	0.75	1.00	0.60	120	2	2	4	0.99	0.33	5	10.0	6	1.00	0.07	0.07	0.22	AboveWT
164	169	5	0.60	0.60	10.00	1.29	0.75	1.20	1.00	120	1	1	36	0.98	0.33	60	10.0	62	1.00	high N	high N	LARGE	AboveWT
159	164	5	0.90	0.90	15.00	1.05	0.85	1.00	0.60	120	2	2	16	0.97	0.33	12	10.0	14	1.00	0.15	0.16	0.48	AboveWT
154	159	5	1.20	1.20	20.00	0.91	0.85	1.20	1.00	120	1	1	18	0.95	0.32	24	3.0	24	0.97	0.27	0.28	0.87	AboveWT
149	154	5	1.50	1.50	25.00	0.82	0.95	1.00	0.60	120	2	2	6	0.94	0.32	4	20.0	8	0.93	0.09	0.09	0.28	AboveWT
144	149	5	1.80	1.80	30.00	0.75	0.95	1.20	1.00	120	1	1	42	0.93	0.31	51	4.0	51	0.89	high N	high N	LARGE	AboveWT
139	144	5	2.10	2.10	35.00	0.69	1.00	1.00	0.60	120	2	2	13	0.89	0.30	8	30.0	14	0.87	0.15	0.14	0.46	AboveWT
134	139	5	2.40	2.40	40.00	0.65	1.00	1.20	1.00	120	1	1	44	0.85	0.29	49	3.0	49	0.85	high N	high N	LARGE	AboveWT
129	134	5	2.70	2.70	45.00	0.61	1.00	1.00	0.60	120	2	2	8	0.81	0.27	4	85.0	10	0.82	0.11	0.10	0.35	AboveWT
124	129	5	3.00	3.00	50.00	0.58	1.00	1.20	1.00	120	1	1	14	0.77	0.26	14	75.0	22	0.78	0.24	0.20	0.76	AboveWT
119	124	5	3.30	3.14	55.00	0.56	1.00	1.00	0.60	120	2	2	8	0.73	0.26	4	18.0	7	0.77	0.08	0.07	0.27	yes
114	119	5	3.60	3.29	60.00	0.55	1.00	1.20	1.00	120	1	1	20	0.69	0.25	19	90.0	28	0.76	0.34	0.28	1.09	fines
109	114	5	3.90	3.43	65.00	0.54	1.00	1.00	0.60	120	2	2	10	0.64	0.25	5	80.0	11	0.76	0.11	0.09	0.38	fines
104	109	5	4.20	3.58	70.00	0.53	1.00	1.20	1.00	120	1	1	100	0.60	0.24	91	4.0	91	0.75	high N	high N	LARGE	high N
99	104	5	4.50	3.72	75.00	0.52	1.00	1.00	0.60	120	2	2	50	0.56	0.23	22	4.0	22	0.74	0.24	0.19	0.84	yes
94	99	5	4.80	3.86	80.00	0.51	1.00	1.20	1.00	120	1	1	100	0.55	0.23	88	4.0	88	0.73	high N	high N	LARGE	high N

CF East St UC (Widen) Sounding: CPT-10-046

PGA: 0.52 Mag 7.3 Gwdepth 68.5 Ground EL 189.5 Note: Units are tons/cf, tons/sf, and feet

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	CQ2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
0.66	188.8	18.76	0.005	0.06	0.04	0.04	472.74	0.02	0.89	5.12	92.44	1.55	Sand	Sand	Sand	92.44	1.55	1.00	92.44	0.15	0.34	1.00	FALSE	0.00	Above WT
0.82	188.7	16.33	0.018	0.06	0.05	0.05	330.91	0.11	0.99	4.60	72.19	1.63	Sand	Sand	Sand	72.19	1.63	1.00	72.19	0.11	0.34	1.00	FALSE	0.00	Above WT
0.98	188.5	36.94	0.045	0.06	0.06	0.06	627.23	0.12	0.74	4.21	149.38	1.33	Sand	Sand	Sand	149.38	1.33	1.00	149.38	0.39	0.34	1.00	FALSE	0.00	Above WT
1.15	188.4	58.88	0.404	0.06	0.07	0.07	852.33	0.69	1.19	3.88	219.80	1.55	Sand	Sand	Sand	219.80	1.55	1.00	219.80	1.07	0.34	1.00	FALSE	0.00	Above WT
1.31	188.2	68.59	0.739	0.06	0.08	0.08	871.65	1.08	1.36	3.64	239.90	1.66	Sand	Sand	Sand	239.90	1.66	1.01	242.53	1.41	0.34	1.00	FALSE	0.00	Above WT
1.48	188.0	80.54	0.866	0.06	0.09	0.09	905.98	1.08	1.35	3.42	265.03	1.63	Sand	Sand	Sand	265.03	1.63	1.00	265.03	1.81	0.34	1.00	FALSE	0.00	Above WT
1.64	187.9	319.29	2.453	0.06	0.10	0.10	3243.82	0.77	1.11	3.25	998.09	1.20	Sand	Sand	Sand	998.09	1.20	1.00	998.09	92.55	0.34	1.00	FALSE	0.00	Above WT
1.80	187.7	458.55	3.764	0.06	0.11	0.11	4244.83	0.82	1.15	3.10	1368.23	1.18	Sand	Sand	Sand	1368.23	1.18	1.00	1368.23	238.29	0.34	1.00	FALSE	0.00	Above WT
1.97	187.5	451.36	4.510	0.06	0.12	0.12	3817.61	1.00	1.22	2.97	1287.35	1.27	Sand	Sand	Sand	1287.35	1.27	1.00	1287.35	198.50	0.34	1.00	FALSE	0.00	Above WT
2.13	187.4	345.14	3.835	0.06	0.13	0.13	2699.63	1.11	1.27	2.85	946.70	1.36	Sand	Sand	Sand	946.70	1.36	1.00	946.70	78.99	0.34	1.00	FALSE	0.00	Above WT
2.30	187.2	325.20	4.040	0.06	0.14	0.14	2355.52	1.24	1.32	2.75	858.41	1.42	Sand	Sand	Sand	858.41	1.42	1.00	858.41	58.91	0.34	0.99	FALSE	0.00	Above WT
2.46	187.0	255.89	4.447	0.06	0.15	0.15	1732.67	1.74	1.48	2.65	653.12	1.60	Sand	Sand	Sand	653.12	1.60	1.00	653.12	25.99	0.34	0.99	FALSE	0.00	Above WT
2.62	186.9	194.09	3.664	0.06	0.16	0.16	1233.67	1.89	1.54	2.57	480.02	1.69	Sand	Sand	Sand	480.02	1.69	1.03	495.42	11.39	0.34	0.99	FALSE	0.00	Above WT
2.79	186.7	155.13	4.017	0.06	0.17	0.17	925.70	2.59	1.71	2.49	371.79	1.87	Sand	Sand	Sand	371.79	1.87	1.16	430.37	7.49	0.34	0.99	FALSE	0.00	Above WT
2.95	186.6	107.76	3.849	0.06	0.18	0.18	607.81	3.58	1.90	2.42	251.16	2.07	Sand	Sand	Sand	251.16	2.07	1.41	352.94	4.17	0.34	0.99	FALSE	0.00	Above WT
3.12	186.4	123.32	2.181	0.06	0.19	0.19	657.76	1.77	1.61	2.36	279.49	1.79	Sand	Sand	Sand	279.49	1.79	1.10	307.26	2.78	0.34	0.99	FALSE	0.00	Above WT
3.28	186.2	176.77	1.737	0.06	0.20	0.20	897.22	0.98	1.32	2.30	390.73	1.50	Sand	Sand	Sand	390.73	1.50	1.00	390.73	5.63	0.34	0.99	FALSE	0.00	Above WT
3.44	186.1	200.02	1.780	0.06	0.21	0.21	968.09	0.89	1.27	2.24	431.72	1.44	Sand	Sand	Sand	431.72	1.44	1.00	431.72	7.56	0.34	0.99	FALSE	0.00	Above WT
3.61	185.9	175.91	1.773	0.06	0.22	0.22	811.14	1.01	1.35	2.19	370.63	1.52	Sand	Sand	Sand	370.63	1.52	1.00	370.63	4.81	0.34	0.99	FALSE	0.00	Above WT
3.77	185.7	189.90	1.679	0.06	0.23	0.23	838.52	0.89	1.29	2.14	391.53	1.46	Sand	Sand	Sand	391.53	1.46	1.00	391.53	5.66	0.34	0.99	FALSE	0.00	Above WT
3.94	185.6	197.52	1.609	0.06	0.24	0.24	834.53	0.82	1.26	2.10	398.36	1.43	Sand	Sand	Sand	398.36	1.43	1.00	398.36	5.96	0.33	0.99	FALSE	0.00	Above WT
4.10	185.4	203.40	1.735	0.06	0.25	0.25	825.83	0.85	1.28	2.06	402.13	1.44	Sand	Sand	Sand	402.13	1.44	1.00	402.13	6.13	0.33	0.99	FALSE	0.00	Above WT
4.27	185.2	279.50	3.668	0.06	0.26	0.26	1089.94	1.31	1.41	2.01	541.47	1.53	Sand	Sand	Sand	541.47	1.53	1.00	541.47	14.84	0.33	0.99	FALSE	0.00	Above WT
4.43	185.1	361.07	3.867	0.06	0.27	0.27	1357.43	1.07	1.29	1.98	686.75	1.40	Sand	Sand	Sand	686.75	1.40	1.00	686.75	30.20	0.33	0.99	FALSE	0.00	Above WT
4.59	184.9	394.32	4.597	0.06	0.28	0.28	1430.81	1.17	1.32	1.94	736.80	1.42	Sand	Sand	Sand	736.80	1.42	1.00	736.80	37.28	0.33	0.99	FALSE	0.00	Above WT
4.76	184.7	391.94	3.629	0.06	0.29	0.29	1371.34	0.93	1.23	1.91	719.16	1.34	Sand	Sand	Sand	719.16	1.34	1.00	719.16	34.67	0.33	0.99	FALSE	0.00	Above WT
4.92	184.6	352.08	4.184	0.06	0.30	0.30	1191.68	1.19	1.35	1.88	635.43	1.46	Sand	Sand	Sand	635.43	1.46	1.00	635.43	23.94	0.33	0.99	FALSE	0.00	Above WT
5.09	184.4	356.02	4.024	0.06	0.31	0.31	1164.75	1.13	1.34	1.85	631.72	1.44	Sand	Sand	Sand	631.72	1.44	1.00	631.72	23.53	0.33	0.99	FALSE	0.00	Above WT
5.25	184.3	344.00	3.362	0.06	0.32	0.32	1091.06	0.98	1.29	1.82	601.02	1.39	Sand	Sand	Sand	601.02	1.39	1.00	601.02	20.27	0.33	0.99	FALSE	0.00	Above WT
5.41	184.1	333.77	3.405	0.06	0.32	0.32	1027.25	1.02	1.31	1.79	574.46	1.42	Sand	Sand	Sand	574.46	1.42	1.00	574.46	17.71	0.33	0.99	FALSE	0.00	Above WT
5.58	183.9	341.04	3.467	0.06	0.33	0.33	1017.64	1.02	1.31	1.76	577.96	1.42	Sand	Sand	Sand	577.96	1.42	1.00	577.96	18.03	0.33	0.99	FALSE	0.00	Above WT
5.74	183.8	345.27	3.543	0.06	0.34	0.34	1001.53	1.03	1.32	1.74	576.91	1.42	Sand	Sand	Sand	576.91	1.42	1.00	576.91	17.94	0.33	0.99	FALSE	0.00	Above WT
5.91	183.6	345.38	3.326	0.06	0.35	0.35	973.00	0.96	1.30	1.71	568.74	1.40	Sand	Sand	Sand	568.74	1.40	1.00	568.74	17.19	0.33	0.99	FALSE	0.00	Above WT
6.07	183.4	322.60	2.876	0.06	0.36	0.36	884.78	0.89	1.28	1.69	524.18	1.39	Sand	Sand	Sand	524.18	1.39	1.00	524.18	13.47	0.33	0.99	FALSE	0.00	Above WT
6.23	183.3	322.27	2.411	0.06	0.37	0.37	861.15	0.75	1.22	1.67	516.87	1.33	Sand	Sand	Sand	516.87	1.33	1.00	516.87	12.92	0.33	0.99	FALSE	0.00	Above WT
6.40	183.1	316.00	2.156	0.06	0.38	0.38	821.92	0.68	1.19	1.65	500.04	1.31	Sand	Sand	Sand	500.04	1.31	1.00	500.04	11.71	0.33	0.99	FALSE	0.00	Above WT
6.56	182.9	287.66	1.798	0.06	0.39	0.39	729.84	0.63	1.18	1.63	449.61	1.30	Sand	Sand	Sand	449.61	1.30	1.00	449.61	8.53	0.33	0.98	FALSE	0.00	Above WT
6.73	182.8	275.57	1.689	0.06	0.40	0.40	681.44	0.61	1.19	1.60	425.24	1.31	Sand	Sand	Sand	425.24	1.31	1.00	425.24	7.23	0.33	0.98	FALSE	0.00	Above WT
6.89	182.6	256.82	1.663	0.06	0.41	0.41	620.24	0.65	1.23	1.59	391.68	1.35	Sand	Sand	Sand	391.68	1.35	1.00	391.68	5.67	0.33	0.98	FALSE	0.00	Above WT
7.05	182.5	242.92	1.799	0.06	0.42	0.42	573.28	0.74	1.30	1.57	366.25	1.42	Sand	Sand	Sand	366.25	1.42	1.00	366.25	4.65	0.33	0.98	FALSE	0.00	Above WT
7.22	182.3	263.27	2.001	0.06	0.43	0.43	606.73	0.76	1.30	1.55	392.23	1.41	Sand	Sand	Sand	392.23	1.41	1.00	392.23	5.69	0.33	0.98	FALSE	0.00	Above WT
7.38	182.1	306.83	2.315	0.06	0.44	0.44	691.93	0.76	1.27	1.53	452.14	1.37	Sand	Sand	Sand	452.14	1.37	1.00	452.14	8.68	0.33	0.98	FALSE	0.00	Above WT
7.55	182.0	322.31	2.514	0.06	0.45	0.45	710.50	0.78	1.27	1.52	469.58	1.37	Sand	Sand	Sand	469.58	1.37	1.00	469.58	9.71	0.33	0.98	FALSE	0.00	Above WT
7.71	181.8	316.92	2.158	0.06	0.46	0.46	684.08	0.68	1.23	1.50	456.91	1.33	Sand	Sand	Sand	456.91	1.33	1.00	456.91	8.95	0.33	0.98	FALSE	0.00	Above WT
7.87	181.6	305.31	2.241	0.06	0.47	0.47	645.57	0.73	1.27	1.48	435.67	1.37	Sand	Sand	Sand	435.67	1.37	1.00	435.67	7.77	0.33	0.98	FALSE	0.00	Above WT
8.04	181.5	282.00	2.205	0.06	0.48	0.48	583.58	0.78	1.32	1.47	398.13	1.41	Sand	Sand	Sand	398.13	1.41	1.00	398.13	5.95	0.33	0.98	FALSE	0.00	Above WT
8.20	181.3	279.98	3.333	0.06	0.49	0.49	568.07	1.19	1.48	1.45	391.41	1.57	Sand	Sand	Sand	391.41	1.57	1.00	391.41	5.66	0.33	0.98	FALSE	0.00	Above WT
8.37	181.1	287.67	7.106	0.06	0.50	0.50	571.82	2.47	1.76	1.44	398.05	1.83	Sand	Sand	Sand	398.05	1.83	1.13	450.43	8.58	0.33	0.98	FALSE	0.00	Above WT
8.53	181.0	323.27	6.292	0.06	0.51	0.51	630.63	1.95	1.65	1.43	443.10	1.72	Sand	Sand	Sand	443.10	1.72	1.05	465.81	9.48	0.33	0.98	FALSE	0.00	Above WT
8.69	180.8	234.79	4.356	0.06	0.52	0.52	449.31	1.86	1.70	1.41	318.84	1.78	Sand	Sand	Sand	318.84	1.78	1.09	347.26	3.97	0.33	0.98	FALSE	0.00	Above WT
8.86	180.6	250.73	2.727	0.06	0.53	0.53	470.65	1.09	1.49	1.40	337.21	1.57	Sand	Sand	Sand	337.21	1.57	1.00	337.21	3.65	0.33	0.98	FALSE	0.00	Above WT
9.02	180.5	295.89	2.958	0.06	0.54	0.54	545.73	1.00	1.42	1.39	394.40	1.50	Sand	Sand	Sand	394.40	1.50	1.00	394.40	5.79	0.33	0.98	FALSE	0.00	Above WT
9.19	180.3	312.14	3.205	0.06	0.55	0.55	565.09	1.03	1.43	1.37	412.19	1.50	Sand	Sand	Sand	412.19	1.50	1.00	412.19	6.59	0.33	0.98	FALSE	0.00	Above WT
9.35	180.2	326.48	3.112	0.06	0.56	0.56	580.96	0.95	1.39	1.36	427.42	1.46	Sand	Sand	Sand	427.42	1.46	1.00	427.42	7.34	0.33	0.98	FALSE	0.00	Above WT
9.51	180.0	347.38	3.114	0.06	0.57	0.57	607.80	0.90	1.36	1.35	450.94	1.43	Sand	Sand	Sand	450.94	1.43	1.00	450.94	8.61	0.33	0.98	FALSE	0.00	Above WT
9.68	179.8	363.16	3.065	0.06	0.58	0.58	624.28	0.85	1.33	1.34	467.27	1.40	Sand	Sand	Sand	467.27	1.40	1.00	467.27	9.57	0.33	0.98	FALSE	0.00	Above WT
9.84	179.7	341.04	2.967	0.06	0.59	0.59	576.64	0.87	1.36	1.33	435.23	1.43	Sand	Sand	Sand	435.23	1.43	1.00	435.23	7.75	0.33	0.98	FALSE	0.00	Above WT
10.01	179.5	290.19	3.380	0.06	0.60	0.60	482.17	1.17	1.51	1.32	367.18	1.57	Sand	Sand	Sand	367.18	1.57	1.00	367.18	4.68	0.33	0.98	FALSE	0.00	Above WT
10.17	179.3	226.88	3.420	0.06	0.61	0.61	370.81	1.51	1.66	1.31	284.80	1.73	Sand	Sand	Sand	284.80	1.73	1.06	301.15	2.62	0.33	0.98	FALSE	0.00	Above WT
10.33	179.2	205.70	3.379	0.06	0.62	0.62	330.88	1.65	1.72	1.30	256.21	1.79	Sand	Sand	Sand	256.21	1.79	1.10	281.02	2.14	0.33	0.98	FALSE	0.00	Above WT
10.50	179.0	198.38	3.511	0.06	0.63	0.63	313.89	1.78	1.76	1.28	245.08	1.82	Sand	Sand	Sand	245.08	1.82	1.12	275.60	2.03	0.33	0.98	FALSE	0.00	Above WT
10.66	178.8	177.46	2.971	0.06	0.64	0.64	276.45	1.68	1.77	1.28	217.59	1.84	Sand	Sand	Sand	217.59	1.84	1.13	246.73	1.48	0.33	0.98	FALSE	0.00	Above WT
10.83	178.7	193.28	2.615	0.06	0.65	0.65	296.45	1.36	1.68	1.27	235.12	1.74	Sand	Sand	Sand	235.12	1.74	1.07	250.78	1.55	0.33	0.97	FALSE	0.00	Above WT
10.99	178.5	189.59	1.840	0.06	0.66	0.66	286.52	0.97	1.58	1.26	228.94	1.64	Sand	Sand	Sand	228.94	1.64	1.00	228.25	1.19	0.33	0.97	FALSE	0.00	Above WT
11.15	178.4	184.07	1.630	0.06	0.67	0.67	274.14	0.89	1.56	1.25	220.68	1.62	Sand	Sand	Sand	220.68	1.62	1.00	220.68	1.08	0.33	0.97	FALSE	0.00	Above WT
11.32	178.2	192.91	1.852	0.06	0.68	0.68	283.03	0.96	1.58	1.24	229.53	1.64	Sand	Sand	Sand	229.53	1.64	1.00	229.53	1.20	0.33	0.97	FALSE	0.00	Above WT
11.48	178.0	191.93	1.882	0.06	0.69	0.69	277.64	0.98	1.59	1.23	226.77	1.65	Sand	Sand	Sand	226.77	1.65	1.00	227.06	1.17	0.33	0.97	FALSE	0.00	Above WT
11.65	177.9	244.02	2.533	0.06	0.70	0.70	348.10	1.04	1.55	1.22	286.20	1.60	Sand	Sand	Sand	286.20	1.60	1.00	286.20	2.26	0.33	0.97	FALSE	0.00	Above WT

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Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
11.81	177.7	296.53	2.650	0.06	0.71	0.71	417.47	0.90	1.45	1.21	345.42	1.50	Sand	Sand	Sand	345.42	1.50	1.00	345.42	3.91	0.33	0.97	FALSE	0.00	Above WT
11.98	177.5	323.48	2.654	0.06	0.72	0.72	449.03	0.82	1.40	1.20	374.13	1.45	Sand	Sand	Sand	374.13	1.45	1.00	374.13	4.95	0.33	0.97	FALSE	0.00	Above WT
12.14	177.4	333.49	2.259	0.06	0.73	0.73	456.84	0.68	1.33	1.19	383.16	1.38	Sand	Sand	Sand	383.16	1.38	1.00	383.16	5.31	0.33	0.97	FALSE	0.00	Above WT
12.30	177.2	338.69	2.530	0.06	0.74	0.74	457.93	0.75	1.36	1.19	386.60	1.41	Sand	Sand	Sand	386.60	1.41	1.00	386.60	5.45	0.33	0.97	FALSE	0.00	Above WT
12.47	177.0	340.29	2.794	0.06	0.75	0.75	453.81	0.82	1.40	1.18	385.77	1.44	Sand	Sand	Sand	385.77	1.44	1.00	385.77	5.42	0.33	0.97	FALSE	0.00	Above WT
12.63	176.9	303.59	2.893	0.06	0.76	0.76	399.62	0.96	1.48	1.17	341.97	1.52	Sand	Sand	Sand	341.97	1.52	1.00	341.97	3.80	0.33	0.97	FALSE	0.00	Above WT
12.80	176.7	284.00	3.064	0.06	0.77	0.77	368.79	1.08	1.55	1.16	317.78	1.58	Sand	Sand	Sand	317.78	1.58	1.00	317.78	3.06	0.33	0.97	FALSE	0.00	Above WT
12.96	176.5	266.91	3.044	0.06	0.78	0.78	342.25	1.14	1.58	1.16	296.80	1.62	Sand	Sand	Sand	296.80	1.62	1.00	296.80	2.51	0.33	0.97	FALSE	0.00	Above WT
13.12	176.4	256.97	2.803	0.06	0.79	0.79	325.44	1.09	1.58	1.15	284.00	1.62	Sand	Sand	Sand	284.00	1.62	1.00	284.00	2.21	0.33	0.97	FALSE	0.00	Above WT
13.29	176.2	261.38	2.512	0.06	0.80	0.80	326.79	0.96	1.54	1.14	287.02	1.57	Sand	Sand	Sand	287.02	1.57	1.00	287.02	2.28	0.33	0.97	FALSE	0.00	Above WT
13.45	176.1	261.51	1.881	0.06	0.81	0.81	323.05	0.72	1.44	1.14	285.45	1.48	Sand	Sand	Sand	285.45	1.48	1.00	285.45	2.24	0.33	0.97	FALSE	0.00	Above WT
13.62	175.9	249.67	2.011	0.06	0.82	0.82	304.52	0.81	1.50	1.13	270.82	1.53	Sand	Sand	Sand	270.82	1.53	1.00	270.82	1.93	0.33	0.97	FALSE	0.00	Above WT
13.78	175.7	208.72	1.556	0.06	0.83	0.83	251.44	0.75	1.53	1.12	225.09	1.56	Sand	Sand	Sand	225.09	1.56	1.00	225.09	1.14	0.33	0.97	FALSE	0.00	Above WT
13.94	175.6	181.08	1.627	0.06	0.84	0.84	215.50	0.90	1.64	1.12	194.15	1.67	Sand	Sand	Sand	194.15	1.67	1.02	197.12	0.79	0.33	0.97	FALSE	0.00	Above WT
14.11	175.4	176.03	1.503	0.06	0.85	0.85	206.93	0.86	1.63	1.11	187.60	1.66	Sand	Sand	Sand	187.60	1.66	1.01	189.84	0.72	0.33	0.97	FALSE	0.00	Above WT
14.27	175.2	145.24	1.306	0.06	0.86	0.86	168.63	0.90	1.71	1.10	153.92	1.74	Sand	Sand	Sand	153.92	1.74	1.07	163.95	0.49	0.33	0.97	FALSE	0.00	Above WT
14.44	175.1	128.39	1.490	0.06	0.87	0.87	147.19	1.17	1.83	1.10	135.26	1.86	Sand	Sand	Sand	135.26	1.86	1.15	155.71	0.43	0.33	0.97	FALSE	0.00	Above WT
14.60	174.9	131.29	1.615	0.06	0.88	0.88	148.87	1.24	1.85	1.09	137.55	1.87	Sand	Sand	Sand	137.55	1.87	1.16	159.81	0.46	0.33	0.97	FALSE	0.00	Above WT
14.76	174.7	149.26	1.426	0.06	0.89	0.89	167.54	0.96	1.73	1.08	155.53	1.76	Sand	Sand	Sand	155.53	1.76	1.08	167.21	0.51	0.33	0.97	FALSE	0.00	Above WT
14.93	174.6	153.95	1.014	0.06	0.90	0.90	170.86	0.66	1.62	1.08	159.50	1.64	Sand	Sand	Sand	159.50	1.64	1.00	158.90	0.45	0.33	0.97	FALSE	0.00	Above WT
15.09	174.4	117.44	0.695	0.06	0.91	0.91	128.71	0.60	1.69	1.07	121.03	1.71	Sand	Sand	Sand	121.03	1.71	1.04	126.22	0.27	0.33	0.96	FALSE	0.00	Above WT
15.26	174.2	110.54	0.564	0.06	0.92	0.92	119.73	0.51	1.67	1.07	113.28	1.69	Sand	Sand	Sand	113.28	1.69	1.03	117.16	0.23	0.33	0.96	FALSE	0.00	Above WT
15.42	174.1	72.52	0.538	0.06	0.93	0.93	77.38	0.75	1.92	1.06	73.93	1.94	Sand	Sand	Sand	73.93	1.94	1.23	90.87	0.15	0.33	0.96	FALSE	0.00	Above WT
15.58	173.9	39.14	0.582	0.06	0.93	0.93	40.87	1.52	2.33	1.05	39.70	2.34	Sand	Sand	Sand	39.70	2.34	2.08	82.54	0.13	0.33	0.96	FALSE	0.00	Above WT
15.75	173.8	25.31	0.705	0.06	0.95	0.95	25.78	2.89	2.66	Clay	Clay	Clay	Clay	Clay	Clay	25.78	2.66	3.70	95.41	0.16	0.33	0.96	FALSE	0.00	Above WT
15.91	173.6	21.52	0.914	0.06	0.95	0.95	21.54	4.44	2.84	Clay	Clay	Clay	Clay	Clay	Clay	21.54	2.84	5.12	110.22	0.20	0.33	0.96	FALSE	0.00	Above WT
16.08	173.4	23.93	0.994	0.06	0.96	0.96	23.80	4.33	2.80	Clay	Clay	Clay	Clay	Clay	Clay	23.80	2.80	4.77	113.43	0.22	0.33	0.96	FALSE	0.00	Above WT
16.24	173.3	37.79	0.881	0.06	0.97	0.97	37.78	2.39	2.48	1.03	37.54	2.48	Sand	Sand	Sand	37.54	2.48	2.67	100.16	0.17	0.33	0.96	FALSE	0.00	Above WT
16.40	173.1	52.60	0.787	0.06	0.98	0.98	52.46	1.52	2.24	1.03	52.00	2.25	Sand	Sand	Sand	52.00	2.25	1.79	92.94	0.15	0.33	0.96	FALSE	0.00	Above WT
16.57	172.9	56.81	0.602	0.06	0.99	0.99	56.14	1.08	2.13	1.02	55.87	2.13	Sand	Sand	Sand	55.87	2.13	1.51	84.50	0.14	0.32	0.96	FALSE	0.00	Above WT
16.73	172.8	55.34	0.604	0.06	1.00	1.00	54.13	1.11	2.15	1.02	54.16	2.15	Sand	Sand	Sand	54.16	2.15	1.55	83.96	0.14	0.32	0.96	FALSE	0.00	Above WT
16.90	172.6	47.89	0.604	0.06	1.01	1.01	46.23	1.29	2.24	1.01	46.63	2.24	Sand	Sand	Sand	46.63	2.24	1.77	82.48	0.13	0.32	0.96	FALSE	0.00	Above WT
17.06	172.4	39.70	0.713	0.06	1.02	1.02	37.78	1.84	2.41	1.01	38.48	2.40	Sand	Sand	Sand	38.48	2.40	2.31	88.96	0.15	0.32	0.96	FALSE	0.00	Above WT
17.22	172.3	34.03	0.940	0.06	1.03	1.03	31.94	2.85	2.58	1.00	32.83	2.57	Sand	Sand	Sand	32.83	2.57	3.17	103.98	0.18	0.32	0.96	FALSE	0.00	Above WT
17.39	172.1	34.36	0.996	0.06	1.04	1.04	31.93	2.99	2.60	1.00	32.98	2.59	Sand	Sand	Sand	32.98	2.59	3.24	106.83	0.19	0.32	0.96	FALSE	0.00	Above WT
17.55	172.0	41.57	0.863	0.06	1.05	1.05	38.48	2.13	2.44	0.99	39.72	2.43	Sand	Sand	Sand	39.72	2.43	2.43	96.65	0.16	0.32	0.96	FALSE	0.00	Above WT
17.72	171.8	48.35	0.402	0.06	1.06	1.06	44.48	0.85	2.15	0.99	45.98	2.14	Sand	Sand	Sand	45.98	2.14	1.54	70.61	0.11	0.32	0.96	FALSE	0.00	Above WT
17.88	171.6	52.88	0.249	0.06	1.07	1.07	48.29	0.48	2.00	0.98	50.06	1.99	Sand	Sand	Sand	50.06	1.99	1.28	64.26	0.10	0.32	0.96	FALSE	0.00	Above WT
18.04	171.5	53.02	0.285	0.06	1.08	1.08	47.98	0.55	2.03	0.98	49.97	2.01	Sand	Sand	Sand	49.97	2.01	1.32	65.95	0.11	0.32	0.96	FALSE	0.00	Above WT
18.21	171.3	49.24	0.288	0.06	1.09	1.09	44.07	0.60	2.08	0.98	46.19	2.06	Sand	Sand	Sand	46.19	2.06	1.39	64.21	0.10	0.32	0.96	FALSE	0.00	Above WT
18.37	171.1	45.42	0.285	0.06	1.10	1.10	40.21	0.64	2.13	0.97	42.42	2.11	Sand	Sand	Sand	42.42	2.11	1.47	62.50	0.10	0.32	0.96	FALSE	0.00	Above WT
18.54	171.0	41.29	0.385	0.06	1.11	1.11	36.12	0.96	2.26	0.97	38.39	2.24	Sand	Sand	Sand	38.39	2.24	1.76	67.53	0.11	0.32	0.96	FALSE	0.00	Above WT
18.70	170.8	34.90	0.528	0.06	1.12	1.12	30.11	1.56	2.44	0.96	32.31	2.42	Sand	Sand	Sand	32.31	2.42	2.38	77.01	0.12	0.32	0.96	FALSE	0.00	Above WT
18.86	170.6	30.49	0.851	0.06	1.13	1.13	25.94	2.90	2.66	Clay	Clay	Clay	Clay	Clay	Clay	25.94	2.66	3.69	95.73	0.16	0.32	0.96	FALSE	0.00	Above WT
19.03	170.5	26.55	1.017	0.06	1.14	1.14	22.25	4.00	2.80	Clay	Clay	Clay	Clay	Clay	Clay	22.25	2.80	4.76	106.02	0.19	0.32	0.96	FALSE	0.00	Above WT
19.19	170.3	24.95	1.055	0.06	1.15	1.15	20.67	4.43	2.85	Clay	Clay	Clay	Clay	Clay	Clay	20.67	2.85	5.23	108.14	0.20	0.32	0.96	FALSE	0.00	Above WT
19.36	170.1	21.48	1.144	0.06	1.16	1.16	17.49	5.63	2.97	Clay	Clay	Clay	Clay	Clay	Clay	17.49	2.97	6.46	112.94	0.21	0.32	0.95	FALSE	0.00	Above WT
19.52	170.0	22.58	1.161	0.06	1.17	1.17	18.28	5.42	2.95	Clay	Clay	Clay	Clay	Clay	Clay	18.28	2.95	6.19	113.14	0.21	0.32	0.95	FALSE	0.00	Above WT
19.69	169.8	23.35	1.206	0.06	1.18	1.18	18.76	5.44	2.94	Clay	Clay	Clay	Clay	Clay	Clay	18.76	2.94	6.11	114.68	0.22	0.32	0.95	FALSE	0.00	Above WT
19.85	169.7	28.73	1.122	0.06	1.19	1.19	23.12	4.07	2.79	Clay	Clay	Clay	Clay	Clay	Clay	23.12	2.79	4.70	108.67	0.20	0.32	0.95	FALSE	0.00	Above WT
20.01	169.5	42.53	0.978	0.06	1.20	1.20	34.42	2.37	2.51	0.93	38.06	2.47	Sand	Sand	Sand	38.06	2.47	2.63	100.13	0.17	0.32	0.95	FALSE	0.00	Above WT
20.18	169.3	73.57	0.622	0.06	1.21	1.21	59.76	0.86	2.05	0.93	65.56	2.02	Sand	Sand	Sand	65.56	2.02	1.32	86.66	0.14	0.32	0.95	FALSE	0.00	Above WT
20.34	169.2	93.47	0.559	0.06	1.22	1.22	75.59	0.61	1.88	0.92	82.97	1.85	Sand	Sand	Sand	82.97	1.85	1.14	94.79	0.16	0.32	0.95	FALSE	0.00	Above WT
20.51	169.0	107.00	0.518	0.06	1.23	1.23	85.95	0.49	1.78	0.92	94.58	1.75	Sand	Sand	Sand	94.58	1.75	1.07	101.31	0.18	0.32	0.95	FALSE	0.00	Above WT
20.67	168.8	104.53	0.459	0.06	1.24	1.24	83.28	0.44	1.78	0.92	92.04	1.74	Sand	Sand	Sand	92.04	1.74	1.06	97.88	0.17	0.32	0.95	FALSE	0.00	Above WT
20.83	168.7	92.05	0.393	0.06	1.25	1.25	72.65	0.43	1.82	0.91	80.74	1.78	Sand	Sand	Sand	80.74	1.78	1.09	88.32	0.14	0.32	0.95	FALSE	0.00	Above WT
21.00	168.5	77.18	0.376	0.06	1.26	1.26	60.25	0.50	1.92	0.91	67.42	1.88	Sand	Sand	Sand	67.42	1.88	1.17	78.86	0.13	0.32	0.95	FALSE	0.00	Above WT
21.16	168.3	64.64	0.386	0.06	1.27	1.27	49.91	0.61	2.04	0.91	56.25	1.99	Sand	Sand	Sand	56.25	1.99	1.29	72.52	0.12	0.32	0.95	FALSE	0.00	Above WT
21.33	168.2	59.64	0.602	0.06	1.28	1.28	45.60	1.03	2.19	0.90	51.70	2.15	Sand	Sand	Sand	51.70	2.15	1.55	79.89	0.13	0.32	0.95	FALSE	0.00	Above WT
21.49	168.0	62.38	0.528	0.06	1.29	1.29	47.38	0.86	2.14	0.90	53.87	2.09	Sand	Sand	Sand	53.87	2.09	1.43	77.26	0.12	0.32	0.95	FALSE	0.00	Above WT
21.65	167.9	65.85	0.462	0.06	1.30	1.30	49.69	0.72	2.07	0.89	56.65	2.03	Sand	Sand	Sand	56.65	2.03	1.33	75.60	0.12	0.32	0.95	FALSE	0.00	Above WT
21.82	167.7	71.47	0.475	0.06	1.31	1.31	53.59	0.68	2.03	0.89	61.25	1.98	Sand	Sand	Sand	61.25	1.98	1.28	78.37	0.12	0.32	0.95	FALSE	0.00	Above WT
21.98	167.5	84.78	0.929	0.06	1.32	1.32	63.29	1.11	2.09	0.89	72.39	2.05	Sand	Sand	Sand	72.39	2.05	1.37	99.12	0.17	0.32	0.95	FALSE	0.00	Above WT
22.15	167.4	119.67	1.160	0.06	1.33	1.33	89.05	0.98	1.94	0.88	101.79	1.90	Sand	Sand	Sand	101.79	1.90	1.19	120.91	0.24	0.32	0.95	FALSE	0.00	Above WT
22.31	167.2	127.58	1.193	0.06	1.34	1.34	94.31	0.95	1.91	0.88	108.13	1.87	Sand	Sand	Sand	108.13	1.87	1.16	125.49	0.26	0.32	0.95	FALSE	0.00	Above WT
22.47	167.0	153.06	0.926	0.06	1.35	1.35	112.53	0.61	1.74	0.88	129.26	1.69	Sand	Sand	Sand	129.26	1.69	1.03	133.29	0.30	0.32	0.95	FALSE	0.00	Above WT
22.64	166.9	157.03	0.879	0.06	1.36	1.36	114.60	0.56	1.71	0.87	132.11	1.66	Sand	Sand	Sand	132.11	1.66	1.01	133.74	0.30	0.32	0.95	FALSE	0.00	Above WT
22.80	166.7	145.23	0.862	0.06	1.37	1.37	105.16	0.60	1.76	0.87	121.76	1.71	Sand	Sand	Sand	121.76	1.71	1.04	126.91	0.27	0.32	0.95	FALSE	0.00	Above WT
22.97	166.5	124.91	0.780	0.06	1.38	1.38	89.63	0.63	1.83	0.87	104.33	1.77	Sand	Sand	Sand	104.33	1.77	1.09	113.54	0.22	0.32	0.95	FALSE	0.00	Above WT
23.13	166.4	93.69	0.547	0.06	1.39	1.39	66.51	0.59	1.92	0.87	77.99	1.86	Sand	Sand	Sand	77.99	1.86	1.16	90.24	0.15	0.32	0.95	FALSE	0.00	Above WT
23.29	166.2	65.33	0.431	0.06	1.40	1.40	45.75	0.67	2.09	0.86	54.19	2.03	Sand	Sand	Sand	54.19	2.03	1.34	72.55	0.12	0.32	0.95	FALSE	0.00	Above WT
23.46	166.0	43.10	0.573	0.06	1.41	1.41	29.62	1.37	2.42	0.86	35.62	2.35	Sand	Sand	Sand	35.62	2.35	2.12	75.57	0.12	0.32	0.95	FALSE	0.00	Above WT

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	CPT-100046	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
23.62	165.9	38.06	0.663	0.06	1.42	1.42	25.86	1.81	2.53	0.86	31.35	2.47	Sand	Sand	Sand	31.35	2.47	2.60	81.50	0.13	0.32	0.94	FALSE	0.00	Above WT
23.79	165.7	57.21	0.731	0.06	1.43	1.43	39.08	1.31	2.31	0.85	46.96	2.24	Sand	Sand	Sand	46.96	2.24	1.77	83.27	0.13	0.32	0.94	FALSE	0.00	Above WT
23.95	165.6	115.25	0.706	0.06	1.44	1.44	79.20	0.62	1.87	0.85	94.27	1.81	Sand	Sand	Sand	94.27	1.81	1.11	104.76	0.19	0.32	0.94	FALSE	0.00	Above WT
24.11	165.4	150.71	0.726	0.06	1.45	1.45	103.18	0.49	1.72	0.85	122.87	1.65	Sand	Sand	Sand	122.87	1.65	1.00	123.45	0.25	0.32	0.94	FALSE	0.00	Above WT
24.28	165.2	167.22	0.908	0.06	1.46	1.46	113.79	0.55	1.71	0.84	135.85	1.65	Sand	Sand	Sand	135.85	1.65	1.00	135.83	0.31	0.32	0.94	FALSE	0.00	Above WT
24.44	165.1	170.47	1.030	0.06	1.47	1.47	115.25	0.61	1.73	0.84	138.04	1.67	Sand	Sand	Sand	138.04	1.67	1.02	140.15	0.34	0.32	0.94	FALSE	0.00	Above WT
24.61	164.9	158.11	1.060	0.06	1.48	1.48	106.08	0.68	1.79	0.84	127.59	1.72	Sand	Sand	Sand	127.59	1.72	1.05	134.28	0.31	0.32	0.94	FALSE	0.00	Above WT
24.77	164.7	162.13	1.059	0.06	1.49	1.49	108.09	0.66	1.77	0.84	130.41	1.71	Sand	Sand	Sand	130.41	1.71	1.04	135.98	0.31	0.32	0.94	FALSE	0.00	Above WT
24.93	164.6	180.73	1.386	0.06	1.50	1.50	119.82	0.77	1.78	0.83	144.90	1.72	Sand	Sand	Sand	144.90	1.72	1.05	151.86	0.41	0.32	0.94	FALSE	0.00	Above WT
25.10	164.4	195.74	1.484	0.06	1.51	1.51	128.97	0.76	1.75	0.83	156.40	1.69	Sand	Sand	Sand	156.40	1.69	1.03	160.90	0.47	0.32	0.94	FALSE	0.00	Above WT
25.26	164.2	209.57	1.377	0.06	1.52	1.52	137.28	0.66	1.69	0.83	166.92	1.62	Sand	Sand	Sand	166.92	1.62	1.00	166.92	0.51	0.32	0.94	FALSE	0.00	Above WT
25.43	164.1	208.96	1.311	0.06	1.53	1.53	135.95	0.63	1.68	0.83	165.88	1.61	Sand	Sand	Sand	165.88	1.61	1.00	165.88	0.50	0.32	0.94	FALSE	0.00	Above WT
25.59	163.9	208.74	1.229	0.06	1.54	1.54	134.95	0.59	1.67	0.82	165.19	1.60	Sand	Sand	Sand	165.19	1.60	1.00	165.19	0.50	0.32	0.94	FALSE	0.00	Above WT
25.75	163.8	205.08	1.159	0.06	1.55	1.55	131.74	0.57	1.67	0.82	161.79	1.59	Sand	Sand	Sand	161.79	1.59	1.00	161.79	0.47	0.32	0.94	FALSE	0.00	Above WT
25.92	163.6	200.65	1.109	0.06	1.56	1.56	128.02	0.56	1.67	0.82	157.77	1.60	Sand	Sand	Sand	157.77	1.60	1.00	157.77	0.45	0.32	0.94	FALSE	0.00	Above WT
26.08	163.4	190.08	1.015	0.06	1.56	1.56	120.47	0.54	1.68	0.82	149.00	1.61	Sand	Sand	Sand	149.00	1.61	1.00	149.00	0.39	0.32	0.94	FALSE	0.00	Above WT
26.25	163.3	176.00	0.947	0.06	1.58	1.58	110.75	0.54	1.72	0.81	137.52	1.64	Sand	Sand	Sand	137.52	1.64	1.00	137.52	0.32	0.32	0.94	FALSE	0.00	Above WT
26.41	163.1	147.22	0.798	0.06	1.58	1.58	91.91	0.55	1.79	0.81	114.68	1.71	Sand	Sand	Sand	114.68	1.71	1.04	119.46	0.24	0.32	0.94	FALSE	0.00	Above WT
26.57	162.9	123.70	0.632	0.06	1.59	1.59	76.59	0.52	1.84	0.81	96.07	1.76	Sand	Sand	Sand	96.07	1.76	1.08	103.36	0.18	0.32	0.94	FALSE	0.00	Above WT
26.74	162.8	107.15	0.503	0.06	1.60	1.60	65.79	0.48	1.88	0.81	82.95	1.79	Sand	Sand	Sand	82.95	1.79	1.10	91.35	0.15	0.32	0.94	FALSE	0.00	Above WT
26.90	162.6	96.09	0.396	0.06	1.61	1.61	58.54	0.42	1.90	0.80	74.17	1.81	Sand	Sand	Sand	74.17	1.81	1.11	82.52	0.13	0.32	0.94	FALSE	0.00	Above WT
27.07	162.4	86.95	0.302	0.06	1.62	1.62	52.53	0.35	1.91	0.80	66.90	1.82	Sand	Sand	Sand	66.90	1.82	1.12	74.79	0.12	0.32	0.94	FALSE	0.00	Above WT
27.23	162.3	79.48	0.341	0.06	1.63	1.63	47.65	0.44	1.99	0.80	60.97	1.89	Sand	Sand	Sand	60.97	1.89	1.18	72.06	0.11	0.32	0.94	FALSE	0.00	Above WT
27.40	162.1	81.39	0.402	0.06	1.64	1.64	48.51	0.50	2.01	0.80	62.24	1.91	Sand	Sand	Sand	62.24	1.91	1.20	74.79	0.12	0.32	0.94	FALSE	0.00	Above WT
27.56	161.9	83.43	0.442	0.06	1.65	1.65	49.45	0.54	2.02	0.79	63.62	1.92	Sand	Sand	Sand	63.62	1.92	1.21	76.83	0.12	0.32	0.94	FALSE	0.00	Above WT
27.72	161.8	88.01	0.412	0.06	1.66	1.66	51.92	0.48	1.97	0.79	66.92	1.87	Sand	Sand	Sand	66.92	1.87	1.17	77.99	0.12	0.32	0.94	FALSE	0.00	Above WT
27.89	161.6	97.83	0.481	0.06	1.67	1.67	57.46	0.50	1.94	0.79	74.16	1.84	Sand	Sand	Sand	74.16	1.84	1.14	84.61	0.14	0.32	0.93	FALSE	0.00	Above WT
28.05	161.5	107.07	0.535	0.06	1.68	1.68	62.62	0.51	1.91	0.79	80.93	1.82	Sand	Sand	Sand	80.93	1.82	1.12	90.50	0.15	0.32	0.93	FALSE	0.00	Above WT
28.22	161.3	113.26	0.432	0.06	1.69	1.69	65.89	0.39	1.84	0.78	85.35	1.74	Sand	Sand	Sand	85.35	1.74	1.06	90.75	0.15	0.32	0.93	FALSE	0.00	Above WT
28.38	161.1	110.23	0.439	0.06	1.70	1.70	63.73	0.40	1.86	0.78	82.83	1.76	Sand	Sand	Sand	82.83	1.76	1.08	89.23	0.15	0.32	0.93	FALSE	0.00	Above WT
28.54	161.0	96.96	0.514	0.06	1.71	1.71	55.62	0.54	1.97	0.78	72.66	1.87	Sand	Sand	Sand	72.66	1.87	1.16	84.37	0.14	0.32	0.93	FALSE	0.00	Above WT
28.71	160.8	80.57	0.641	0.06	1.72	1.72	45.77	0.81	2.13	0.78	60.20	2.03	Sand	Sand	Sand	60.20	2.03	1.35	81.04	0.13	0.32	0.93	FALSE	0.00	Above WT
28.87	160.6	69.91	0.753	0.06	1.73	1.73	39.36	1.10	2.26	0.77	52.09	2.16	Sand	Sand	Sand	52.09	2.16	1.58	82.10	0.13	0.32	0.93	FALSE	0.00	Above WT
29.04	160.5	93.68	0.789	0.06	1.74	1.74	52.76	0.86	2.09	0.77	69.59	1.99	Sand	Sand	Sand	69.59	1.99	1.29	90.00	0.15	0.32	0.93	FALSE	0.00	Above WT
29.20	160.3	117.72	0.610	0.06	1.75	1.75	66.19	0.53	1.90	0.77	87.21	1.80	Sand	Sand	Sand	87.21	1.80	1.10	96.23	0.16	0.31	0.93	FALSE	0.00	Above WT
29.36	160.1	129.65	0.555	0.06	1.76	1.76	72.60	0.43	1.82	0.77	95.79	1.72	Sand	Sand	Sand	95.79	1.72	1.05	100.57	0.17	0.31	0.93	FALSE	0.00	Above WT
29.53	160.0	145.83	0.649	0.06	1.77	1.77	81.31	0.45	1.79	0.77	107.43	1.68	Sand	Sand	Sand	107.43	1.68	1.03	110.28	0.20	0.31	0.93	FALSE	0.00	Above WT
29.69	159.8	160.35	0.693	0.06	1.78	1.78	89.01	0.44	1.75	0.76	117.81	1.64	Sand	Sand	Sand	117.81	1.64	1.00	117.55	0.23	0.31	0.93	FALSE	0.00	Above WT
29.86	159.6	157.54	0.735	0.06	1.79	1.79	86.93	0.47	1.77	0.76	115.41	1.67	Sand	Sand	Sand	115.41	1.67	1.02	117.23	0.23	0.31	0.93	FALSE	0.00	Above WT
30.02	159.5	160.29	0.655	0.06	1.80	1.80	87.99	0.54	1.80	0.76	117.11	1.69	Sand	Sand	Sand	117.11	1.69	1.03	121.07	0.25	0.31	0.93	FALSE	0.00	Above WT
30.18	159.3	173.30	0.998	0.06	1.81	1.81	94.70	0.58	1.79	0.76	126.28	1.69	Sand	Sand	Sand	126.28	1.69	1.03	129.88	0.28	0.31	0.93	FALSE	0.00	Above WT
30.35	159.2	190.14	1.161	0.06	1.82	1.82	103.42	0.62	1.77	0.76	138.17	1.67	Sand	Sand	Sand	138.17	1.67	1.02	140.53	0.34	0.31	0.93	FALSE	0.00	Above WT
30.51	159.0	192.78	1.189	0.06	1.83	1.83	104.31	0.62	1.77	0.75	139.72	1.67	Sand	Sand	Sand	139.72	1.67	1.02	141.99	0.35	0.31	0.93	FALSE	0.00	Above WT
30.68	158.8	188.79	1.184	0.06	1.84	1.84	101.56	0.63	1.78	0.75	136.45	1.68	Sand	Sand	Sand	136.45	1.68	1.02	139.86	0.33	0.31	0.92	FALSE	0.00	Above WT
30.84	158.7	177.30	1.278	0.06	1.85	1.85	94.82	0.73	1.84	0.75	127.81	1.74	Sand	Sand	Sand	127.81	1.74	1.07	136.17	0.31	0.31	0.92	FALSE	0.00	Above WT
31.00	158.5	186.72	1.448	0.06	1.86	1.86	99.39	0.78	1.85	0.75	134.25	1.74	Sand	Sand	Sand	134.25	1.74	1.07	143.33	0.35	0.31	0.92	FALSE	0.00	Above WT
31.17	158.3	194.41	1.546	0.06	1.87	1.87	102.95	0.80	1.84	0.75	139.40	1.74	Sand	Sand	Sand	139.40	1.74	1.06	148.29	0.38	0.31	0.92	FALSE	0.00	Above WT
31.33	158.2	195.99	1.393	0.06	1.88	1.88	103.26	0.72	1.81	0.74	140.17	1.71	Sand	Sand	Sand	140.17	1.71	1.04	146.01	0.37	0.31	0.92	FALSE	0.00	Above WT
31.50	158.0	185.69	0.981	0.06	1.89	1.89	97.25	0.53	1.76	0.74	132.45	1.65	Sand	Sand	Sand	132.45	1.65	1.00	132.66	0.30	0.31	0.92	FALSE	0.00	Above WT
31.66	157.8	184.10	1.179	0.06	1.90	1.90	95.92	0.65	1.81	0.74	130.98	1.70	Sand	Sand	Sand	130.98	1.70	1.04	136.02	0.31	0.31	0.92	FALSE	0.00	Above WT
31.82	157.7	194.72	1.307	0.06	1.91	1.91	100.99	0.68	1.80	0.74	138.19	1.69	Sand	Sand	Sand	138.19	1.69	1.03	142.93	0.35	0.31	0.91	FALSE	0.00	Above WT
31.99	157.5	217.25	1.478	0.06	1.92	1.92	112.19	0.69	1.77	0.74	153.77	1.66	Sand	Sand	Sand	153.77	1.66	1.01	155.60	0.43	0.31	0.91	FALSE	0.00	Above WT
32.15	157.4	212.02	1.392	0.06	1.93	1.93	108.91	0.66	1.77	0.73	149.69	1.66	Sand	Sand	Sand	149.69	1.66	1.01	151.40	0.40	0.31	0.91	FALSE	0.00	Above WT
32.32	157.2	208.66	1.419	0.06	1.94	1.94	106.60	0.69	1.79	0.73	146.93	1.68	Sand	Sand	Sand	146.93	1.68	1.02	150.25	0.40	0.31	0.91	FALSE	0.00	Above WT
32.48	157.0	211.24	1.354	0.06	1.95	1.95	107.39	0.65	1.77	0.73	148.38	1.66	Sand	Sand	Sand	148.38	1.66	1.01	149.71	0.39	0.31	0.91	FALSE	0.00	Above WT
32.64	156.9	212.45	1.306	0.06	1.96	1.96	107.48	0.62	1.76	0.73	148.86	1.65	Sand	Sand	Sand	148.86	1.65	1.00	148.91	0.39	0.31	0.91	FALSE	0.00	Above WT
32.81	156.7	218.76	1.300	0.06	1.97	1.97	110.12	0.60	1.74	0.73	152.89	1.63	Sand	Sand	Sand	152.89	1.63	1.00	152.89	0.41	0.31	0.91	FALSE	0.00	Above WT
32.97	156.5	216.65	1.305	0.06	1.98	1.98	108.52	0.61	1.75	0.73	151.05	1.64	Sand	Sand	Sand	151.05	1.64	1.00	151.05	0.40	0.31	0.91	FALSE	0.00	Above WT
33.14	156.4	203.81	1.316	0.06	1.99	1.99	101.50	0.65	1.79	0.72	141.73	1.68	Sand	Sand	Sand	141.73	1.68	1.02	144.75	0.36	0.31	0.90	FALSE	0.00	Above WT
33.30	156.2	182.35	1.336	0.06	2.00	2.00	90.27	0.74	1.87	0.72	126.50	1.75	Sand	Sand	Sand	126.50	1.75	1.07	135.47	0.31	0.31	0.90	FALSE	0.00	Above WT
33.46	156.0	171.83	1.326	0.06	2.01	2.01	84.59	0.78	1.90	0.72	118.92	1.78	Sand	Sand	Sand	118.92	1.78	1.10	130.24	0.29	0.30	0.90	FALSE	0.00	Above WT
33.63	155.9	173.05	1.310	0.06	2.02	2.02	84.76	0.77	1.90	0.72	119.46	1.78	Sand	Sand	Sand	119.46	1.78	1.09	130.27	0.29	0.30	0.90	FALSE	0.00	Above WT
33.79	155.7	179.05	1.224	0.06	2.03	2.03	87.32	0.69	1.86	0.72	123.31	1.74	Sand	Sand	Sand	123.31	1.74	1.06	131.24	0.29	0.30	0.90	FALSE	0.00	Above WT
33.96	155.5	182.84	1.169	0.06	2.04	2.04	88.73	0.65	1.84	0.71	125.60	1.72	Sand	Sand	Sand	125.60	1.72	1.05	131.64	0.29	0.30	0.90	FALSE	0.00	Above WT
34.12	155.4	187.23	1.128	0.06	2.05	2.05	90.46	0.61	1.82	0.71	128.32	1.69	Sand	Sand	Sand	128.32	1.69	1.03	132.50	0.30	0.30	0.90	FALSE	0.00	Above WT
34.28	155.2	196.73	1.209	0.06	2.06	2.06	94.65	0.62	1.81	0.71	134.51	1.68	Sand	Sand	Sand	134.51	1.68	1.02	137.86	0.32	0.30	0.89	FALSE	0.00	Above WT
34.45	155.1	219.62	1.309	0.06	2.07	2.07	105.25	0.60	1.76	0.71	149.79	1.64	Sand	Sand	Sand	149.79	1.64	1.00	149.79	0.39	0.30	0.89	FALSE	0.00	Above WT
34.61	154.9	239.94	1.441	0.06	2.08	2.08	114.54	0.61	1.73	0.71	163.27	1.61	Sand	Sand	Sand	163.27	1.61	1.00	163.27	0.48	0.30	0.89	FALSE	0.00	Above WT
34.78	154.7	242.84	1.325	0.06	2.09	2.09	115.37	0.55	1.70	0.71	164.84	1.58	Sand	Sand	Sand	164.84	1.58	1.00	164.84	0.50	0.30	0.89	FALSE	0.00	Above WT
34.94	154.6	235.52	1.350	0.06	2.10	2.10	111.34	0.58	1.73	0.70	159.50	1.60	Sand	Sand	Sand	159.50	1.60	1.00	159.50	0.46	0.30	0.89	FALSE	0.00	Above WT
35.10	154.4	216.06	1.161	0.06	2.11	2.11	101.59	0.54	1.75	0.70	145.99	1.62	Sand	Sand	Sand	145.99	1.62	1.00	145.99	0.37	0.30	0.89	FALSE	0.00	Above WT
35.27	154.2	173.02	1.011	0.06	2.12	2.12	80.76	0.59	1.85	0.70	116.63	1.72	Sand	Sand	Sand	116.63	1.72	1.05	122.49	0.25	0.30	0.89	FALSE	0.00	Above WT

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	CPT-100046	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
35.43	154.1	115.14	0.870	0.06	2.13	2.13	53.16	0.77	2.07	0.70	77.44	1.93	Sand	Sand	Sand	77.44	1.93	1.22	94.32	0.16	0.30	0.89	FALSE	0.00	Above WT
35.60	153.9	62.64	1.041	0.06	2.14	2.14	28.33	1.72	2.49	0.70	42.03	2.35	Sand	Sand	Sand	42.03	2.35	2.12	89.26	0.15	0.30	0.88	FALSE	0.00	Above WT
35.76	153.7	37.59	1.172	0.06	2.15	2.15	16.52	3.31	2.85	Clay	Clay	Clay	Clay	Clay	Clay	16.52	2.85	5.19	85.66	0.14	0.30	0.88	FALSE	0.00	Above WT
35.93	153.6	25.47	1.039	0.06	2.16	2.16	10.81	4.46	3.07	Clay	Clay	Clay	Clay	Clay	Clay	10.81	3.07	7.56	81.79	0.13	0.30	0.88	FALSE	0.00	Above WT
36.09	153.4	28.55	0.890	0.06	2.17	2.17	12.18	3.37	2.96	Clay	Clay	Clay	Clay	Clay	Clay	12.18	2.96	6.27	76.42	0.12	0.30	0.88	FALSE	0.00	Above WT
36.25	153.3	73.04	1.050	0.06	2.18	2.18	32.58	1.48	2.40	0.69	48.56	2.26	Sand	Sand	Sand	48.56	2.26	1.83	88.95	0.15	0.30	0.88	FALSE	0.00	Above WT
36.42	153.1	116.43	1.043	0.06	2.19	2.19	52.28	0.91	2.11	0.69	77.23	1.97	Sand	Sand	Sand	77.23	1.97	1.27	97.89	0.17	0.30	0.88	FALSE	0.00	Above WT
36.58	152.9	129.01	1.021	0.06	2.19	2.19	57.78	0.80	2.05	0.69	85.39	1.91	Sand	Sand	Sand	85.39	1.91	1.19	102.04	0.18	0.30	0.88	FALSE	0.00	Above WT
36.75	152.8	137.70	1.120	0.06	2.21	2.21	61.45	0.83	2.03	0.69	90.93	1.89	Sand	Sand	Sand	90.93	1.89	1.18	107.38	0.20	0.30	0.87	FALSE	0.00	Above WT
36.91	152.6	130.05	1.044	0.06	2.21	2.21	57.72	0.82	2.05	0.69	85.69	1.91	Sand	Sand	Sand	85.69	1.91	1.20	102.61	0.18	0.30	0.87	FALSE	0.00	Above WT
37.07	152.4	102.61	1.043	0.06	2.22	2.22	45.13	1.04	2.20	0.68	67.47	2.05	Sand	Sand	Sand	67.47	2.05	1.38	93.00	0.15	0.29	0.87	FALSE	0.00	Above WT
37.24	152.3	69.95	1.119	0.06	2.23	2.23	30.31	1.65	2.45	0.68	45.89	2.31	Sand	Sand	Sand	45.89	2.31	1.98	90.98	0.15	0.29	0.87	FALSE	0.00	Above WT
37.40	152.1	50.15	1.382	0.06	2.24	2.24	21.35	2.88	2.72	Clay	Clay	Clay	Clay	Clay	Clay	21.35	2.72	4.15	88.66	0.14	0.29	0.87	FALSE	0.00	Above WT
37.57	151.9	36.99	1.429	0.06	2.25	2.25	15.41	4.11	2.93	Clay	Clay	Clay	Clay	Clay	Clay	15.41	2.93	5.98	92.10	0.15	0.29	0.87	FALSE	0.00	Above WT
37.73	151.8	27.34	1.294	0.06	2.26	2.26	11.08	5.16	3.10	Clay	Clay	Clay	Clay	Clay	Clay	11.08	3.10	7.94	87.98	0.14	0.29	0.87	FALSE	0.00	Above WT
37.89	151.6	23.53	1.074	0.06	2.27	2.27	9.35	5.05	3.15	Clay	Clay	Clay	Clay	Clay	Clay	9.35	3.15	8.62	80.59	0.13	0.29	0.87	FALSE	0.00	Above WT
38.06	151.4	22.15	1.071	0.06	2.28	2.28	8.70	5.39	3.20	Clay	Clay	Clay	Clay	Clay	Clay	8.70	3.20	9.19	79.94	0.13	0.29	0.86	FALSE	0.00	Above WT
38.22	151.3	23.44	1.033	0.06	2.29	2.29	9.22	4.88	3.15	Clay	Clay	Clay	Clay	Clay	Clay	9.22	3.15	8.56	78.96	0.13	0.29	0.86	FALSE	0.00	Above WT
38.39	151.1	23.34	1.161	0.06	2.30	2.30	9.13	5.52	3.19	Clay	Clay	Clay	Clay	Clay	Clay	9.13	3.19	9.05	82.62	0.13	0.29	0.86	FALSE	0.00	Above WT
38.55	151.0	25.18	1.253	0.06	2.31	2.31	9.89	5.48	3.16	Clay	Clay	Clay	Clay	Clay	Clay	9.89	3.16	8.65	85.56	0.14	0.29	0.86	FALSE	0.00	Above WT
38.71	150.8	31.39	1.301	0.06	2.32	2.32	12.52	4.48	3.02	Clay	Clay	Clay	Clay	Clay	Clay	12.52	3.02	6.99	87.43	0.14	0.29	0.86	FALSE	0.00	Above WT
38.88	150.6	36.99	1.435	0.06	2.33	2.33	14.86	4.14	2.94	Clay	Clay	Clay	Clay	Clay	Clay	14.86	2.94	6.12	90.95	0.15	0.29	0.86	FALSE	0.00	Above WT
39.04	150.5	42.59	1.406	0.06	2.34	2.34	17.18	3.49	2.85	Clay	Clay	Clay	Clay	Clay	Clay	17.18	2.85	5.20	89.28	0.15	0.29	0.86	FALSE	0.00	Above WT
39.21	150.3	53.71	1.190	0.06	2.35	2.35	21.83	2.32	2.66	Clay	Clay	Clay	Clay	Clay	Clay	21.83	2.66	3.69	80.45	0.13	0.29	0.85	FALSE	0.00	Above WT
39.37	150.1	72.13	1.031	0.06	2.36	2.36	29.54	1.48	2.44	0.66	46.02	2.28	Sand	Sand	Sand	46.02	2.28	1.89	86.76	0.14	0.29	0.85	FALSE	0.00	Above WT
39.53	150.0	96.12	1.023	0.06	2.37	2.37	39.53	1.09	2.26	0.66	61.20	2.10	Sand	Sand	Sand	61.20	2.10	1.46	89.17	0.15	0.29	0.85	FALSE	0.00	Above WT
39.70	149.8	112.50	1.319	0.06	2.38	2.38	46.23	1.20	2.22	0.66	71.48	2.07	Sand	Sand	Sand	71.48	2.07	1.41	100.61	0.17	0.29	0.85	FALSE	0.00	Above WT
39.86	149.6	113.35	1.446	0.06	2.39	2.39	46.40	1.30	2.24	0.66	71.87	2.09	Sand	Sand	Sand	71.87	2.09	1.44	103.80	0.18	0.29	0.85	FALSE	0.00	Above WT
40.03	149.5	86.19	1.858	0.06	2.40	2.40	34.89	2.22	2.48	0.66	54.53	2.34	Sand	Sand	Sand	54.53	2.34	2.07	112.85	0.21	0.29	0.85	FALSE	0.00	Above WT
40.19	149.3	47.64	1.954	0.06	2.41	2.41	18.76	4.32	2.88	Clay	Clay	Clay	Clay	Clay	Clay	18.76	2.88	5.46	102.47	0.18	0.29	0.85	FALSE	0.00	Above WT
40.35	149.2	41.25	1.737	0.06	2.42	2.42	16.04	4.47	2.94	Clay	Clay	Clay	Clay	Clay	Clay	16.04	2.94	6.07	97.43	0.17	0.29	0.85	FALSE	0.00	Above WT
40.52	149.0	52.39	1.711	0.06	2.43	2.43	20.55	3.43	2.78	Clay	Clay	Clay	Clay	Clay	Clay	20.55	2.78	4.62	95.00	0.16	0.29	0.84	FALSE	0.00	Above WT
40.68	148.8	59.37	1.640	0.06	2.44	2.44	23.32	2.88	2.69	Clay	Clay	Clay	Clay	Clay	Clay	23.32	2.69	3.93	91.63	0.15	0.28	0.84	FALSE	0.00	Above WT
40.85	148.7	68.10	1.667	0.06	2.45	2.45	26.78	2.54	2.61	Clay	Clay	Clay	Clay	Clay	Clay	26.78	2.61	3.39	90.69	0.15	0.28	0.84	FALSE	0.00	Above WT
41.01	148.5	90.06	1.861	0.06	2.46	2.46	35.60	2.12	2.46	0.65	56.30	2.31	Sand	Sand	Sand	56.30	2.31	1.99	112.14	0.21	0.28	0.84	FALSE	0.00	Above WT
41.17	148.3	119.21	2.042	0.06	2.47	2.47	47.26	1.75	2.32	0.65	74.38	2.17	Sand	Sand	Sand	74.38	2.17	1.59	118.20	0.23	0.28	0.84	FALSE	0.00	Above WT
41.34	148.2	131.32	2.175	0.06	2.48	2.48	51.94	1.69	2.27	0.65	81.76	2.13	Sand	Sand	Sand	81.76	2.13	1.50	122.98	0.25	0.28	0.84	FALSE	0.00	Above WT
41.50	148.0	134.09	2.302	0.06	2.49	2.49	52.85	1.75	2.28	0.65	83.33	2.13	Sand	Sand	Sand	83.33	2.13	1.51	126.08	0.27	0.28	0.84	FALSE	0.00	Above WT
41.67	147.8	131.35	2.156	0.06	2.50	2.50	51.54	1.67	2.27	0.64	81.46	2.12	Sand	Sand	Sand	81.46	2.12	1.50	122.31	0.25	0.28	0.83	FALSE	0.00	Above WT
41.83	147.7	120.95	1.978	0.06	2.51	2.51	47.19	1.67	2.30	0.64	74.86	2.15	Sand	Sand	Sand	74.86	2.15	1.56	116.45	0.23	0.28	0.83	FALSE	0.00	Above WT
41.99	147.5	112.12	1.700	0.06	2.52	2.52	43.50	1.55	2.31	0.64	69.27	2.16	Sand	Sand	Sand	69.27	2.16	1.56	108.32	0.20	0.28	0.83	FALSE	0.00	Above WT
42.16	147.3	88.20	1.702	0.06	2.53	2.53	33.87	1.99	2.46	0.64	54.38	2.31	Sand	Sand	Sand	54.38	2.31	1.97	106.87	0.19	0.28	0.83	FALSE	0.00	Above WT
42.32	147.2	61.47	1.856	0.06	2.54	2.54	23.21	3.15	2.72	Clay	Clay	Clay	Clay	Clay	Clay	23.21	2.72	4.12	95.61	0.16	0.28	0.83	FALSE	0.00	Above WT
42.49	147.0	43.99	1.602	0.06	2.55	2.55	16.26	3.87	2.89	Clay	Clay	Clay	Clay	Clay	Clay	16.26	2.89	5.63	91.51	0.15	0.28	0.83	FALSE	0.00	Above WT
42.65	146.9	45.10	1.433	0.06	2.56	2.56	16.62	3.37	2.85	Clay	Clay	Clay	Clay	Clay	Clay	16.62	2.85	5.21	86.61	0.14	0.28	0.83	FALSE	0.00	Above WT
42.81	146.7	78.67	1.402	0.06	2.57	2.57	29.63	1.84	2.49	0.64	48.13	2.32	Sand	Sand	Sand	48.13	2.32	2.03	97.64	0.17	0.28	0.83	FALSE	0.00	Above WT
42.98	146.5	88.69	1.370	0.06	2.58	2.58	33.39	1.59	2.41	0.64	54.16	2.24	Sand	Sand	Sand	54.16	2.24	1.78	96.49	0.16	0.28	0.82	FALSE	0.00	Above WT
43.14	146.4	91.21	1.416	0.06	2.59	2.59	34.24	1.60	2.40	0.63	55.59	2.24	Sand	Sand	Sand	55.59	2.24	1.76	97.91	0.17	0.28	0.82	FALSE	0.00	Above WT
43.31	146.2	81.54	1.360	0.06	2.60	2.60	30.38	1.72	2.46	0.63	49.60	2.30	Sand	Sand	Sand	49.60	2.30	1.93	95.94	0.16	0.28	0.82	FALSE	0.00	Above WT
43.47	146.0	74.85	1.555	0.06	2.61	2.61	27.70	2.15	2.55	0.63	45.45	2.39	Sand	Sand	Sand	45.45	2.39	2.26	102.69	0.18	0.28	0.82	FALSE	0.00	Above WT
43.64	145.9	54.81	1.837	0.06	2.62	2.62	19.93	3.52	2.80	Clay	Clay	Clay	Clay	Clay	Clay	19.93	2.80	4.77	95.09	0.16	0.28	0.82	FALSE	0.00	Above WT
43.80	145.7	30.37	1.345	0.06	2.63	2.63	10.56	4.85	3.10	Clay	Clay	Clay	Clay	Clay	Clay	10.56	3.10	7.94	83.82	0.13	0.28	0.82	FALSE	0.00	Above WT
43.96	145.5	29.02	1.039	0.06	2.64	2.64	10.00	3.94	3.07	Clay	Clay	Clay	Clay	Clay	Clay	10.00	3.07	7.50	75.01	0.12	0.28	0.82	FALSE	0.00	Above WT
44.13	145.4	133.57	0.966	0.06	2.65	2.65	49.45	0.74	2.08	0.63	80.49	1.91	Sand	Sand	Sand	80.49	1.91	1.19	96.11	0.16	0.28	0.81	FALSE	0.00	Above WT
44.29	145.2	136.13	0.825	0.06	2.66	2.66	50.23	0.62	2.04	0.63	81.89	1.86	Sand	Sand	Sand	81.89	1.86	1.15	94.19	0.16	0.27	0.81	FALSE	0.00	Above WT
44.46	145.0	109.83	1.069	0.06	2.67	2.67	40.17	1.00	2.23	0.62	65.94	2.05	Sand	Sand	Sand	65.94	2.05	1.37	90.62	0.15	0.27	0.81	FALSE	0.00	Above WT
44.62	144.9	103.40	1.056	0.06	2.68	2.68	37.62	1.05	2.26	0.62	61.97	2.09	Sand	Sand	Sand	61.97	2.09	1.43	88.68	0.14	0.27	0.81	FALSE	0.00	Above WT
44.78	144.7	101.07	1.179	0.06	2.69	2.69	36.62	1.20	2.31	0.62	60.46	2.13	Sand	Sand	Sand	60.46	2.13	1.51	91.42	0.15	0.27	0.81	FALSE	0.00	Above WT
44.95	144.6	90.75	0.965	0.06	2.70	2.70	32.65	1.10	2.33	0.62	54.19	2.14	Sand	Sand	Sand	54.19	2.14	1.54	83.57	0.13	0.27	0.81	FALSE	0.00	Above WT
45.11	144.4	82.58	1.540	0.06	2.71	2.71	29.51	1.93	2.50	0.62	49.22	2.33	Sand	Sand	Sand	49.22	2.33	2.05	100.73	0.18	0.27	0.81	FALSE	0.00	Above WT
45.28	144.2	72.27	1.819	0.06	2.72	2.72	25.60	2.61	2.63	Clay	Clay	Clay	Clay	Clay	Clay	25.60	2.63	3.53	90.47	0.15	0.27	0.81	FALSE	0.00	Above WT
45.44	144.1	86.09	1.905	0.06	2.73	2.73	30.58	2.28	2.54	0.62	51.13	2.37	Sand	Sand	Sand	51.13	2.37	2.18	111.28	0.21	0.27	0.80	FALSE	0.00	Above WT
45.60	143.9	144.30	1.880	0.06	2.74	2.74	51.74	1.33	2.21	0.62	85.54	2.04	Sand	Sand	Sand	85.54	2.04	1.36	116.22	0.23	0.27	0.80	FALSE	0.00	Above WT
45.77	143.7	177.64	1.551	0.06	2.75	2.75	63.69	0.89	2.03	0.62	105.11	1.86	Sand	Sand	Sand	105.11	1.86	1.15	121.27	0.25	0.27	0.80	FALSE	0.00	Above WT
45.93	143.6	204.50	1.817	0.06	2.76	2.76	73.21	0.90	1.99	0.61	120.80	1.82	Sand	Sand	Sand	120.80	1.82	1.12	135.31	0.31	0.27	0.80	FALSE	0.00	Above WT
46.10	143.4	222.79	2.092	0.06	2.77	2.77	79.55	0.95	1.97	0.61	131.36	1.81	Sand	Sand	Sand	131.36	1.81	1.11	145.96	0.37	0.27	0.80	FALSE	0.00	Above WT
46.26	143.2	248.86	2.316	0.06	2.78	2.78	88.66	0.94	1.93	0.61	146.47	1.77	Sand	Sand	Sand	146.47	1.77	1.08	158.77	0.45	0.27	0.80	FALSE	0.00	Above WT
46.42	143.1	251.05	2.311	0.06	2.79	2.79	89.14	0.93	1.93	0.61	147.51	1.76	Sand	Sand	Sand	147.51	1.76	1.08	159.33	0.46	0.27	0.80	FALSE	0.00	Above WT
46.59	142.9	246.96	2.293	0.06	2.80	2.80	87.35	0.94	1.94	0.61	144.84	1.77	Sand	Sand	Sand	144.84	1.77	1.09	157.30	0.44	0.27	0.79	FALSE	0.00	Above WT
46.75	142.8	250.04	2.303	0.06	2.81	2.81	88.14	0.93	1.93	0.61	146.40	1.77	Sand	Sand	Sand	146.40	1.77	1.08	158.39	0.45	0.27	0.79	FALSE	0.00	Above WT
46.92	142.6	237.36	2.330	0.06	2.82	2.82	83.31	0.99	1.97	0.61	138.72	1.80	Sand	Sand	Sand	138.72	1.80	1.11	153.65	0.42	0.27	0.79	FALSE	0.00	Above WT
47.08	142.4	230.56	2.421	0.06	2.82	2.82	80.62	1.06	2.00	0.61	134.52	1.83	Sand	Sand	Sand	134.52	1.83	1.13	152.01	0.41	0.27	0.79	FALSE	0.00	Above WT

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	CPT-[illegible]046	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
47.24	142.3	236.26	2.408	0.06	2.83	2.83	82.35	1.03	1.98	0.61	137.61	1.81	Sand	Sand	Sand	137.61	1.81	1.12	153.81	0.42	0.27	0.79	FALSE	0.00	Above WT
47.41	142.1	232.93	2.365	0.06	2.84	2.84	80.88	1.03	1.99	0.60	135.42	1.82	Sand	Sand	Sand	135.42	1.82	1.12	151.78	0.41	0.27	0.79	FALSE	0.00	Above WT
47.57	141.9	215.45	2.088	0.06	2.85	2.85	74.49	0.98	2.01	0.60	125.05	1.83	Sand	Sand	Sand	125.05	1.83	1.13	141.34	0.34	0.27	0.79	FALSE	0.00	Above WT
47.74	141.8	185.71	1.520	0.06	2.86	2.86	63.83	0.83	2.02	0.60	107.60	1.84	Sand	Sand	Sand	107.60	1.84	1.13	121.93	0.25	0.27	0.79	FALSE	0.00	Above WT
47.90	141.6	150.96	1.111	0.06	2.87	2.87	51.53	0.75	2.07	0.60	87.32	1.88	Sand	Sand	Sand	87.32	1.88	1.17	102.27	0.18	0.27	0.78	FALSE	0.00	Above WT
48.06	141.4	125.64	0.876	0.06	2.88	2.88	42.57	0.71	2.13	0.60	72.55	1.93	Sand	Sand	Sand	72.55	1.93	1.22	88.74	0.14	0.26	0.78	FALSE	0.00	Above WT
48.23	141.3	115.08	0.868	0.06	2.89	2.89	38.77	0.77	2.18	0.60	66.34	1.99	Sand	Sand	Sand	66.34	1.99	1.28	85.09	0.14	0.26	0.78	FALSE	0.00	Above WT
48.39	141.1	132.43	1.070	0.06	2.90	2.90	44.61	0.83	2.15	0.60	76.21	1.95	Sand	Sand	Sand	76.21	1.95	1.24	94.75	0.16	0.26	0.78	FALSE	0.00	Above WT
48.56	140.9	163.36	1.534	0.06	2.91	2.91	55.07	0.96	2.10	0.60	93.85	1.92	Sand	Sand	Sand	93.85	1.92	1.21	113.33	0.22	0.26	0.78	FALSE	0.00	Above WT
48.72	140.8	193.46	1.860	0.06	2.92	2.92	65.18	0.98	2.05	0.60	110.95	1.87	Sand	Sand	Sand	110.95	1.87	1.16	128.81	0.28	0.26	0.78	FALSE	0.00	Above WT
48.88	140.6	196.44	1.991	0.06	2.93	2.93	65.98	1.03	2.06	0.60	112.48	1.88	Sand	Sand	Sand	112.48	1.88	1.17	131.61	0.29	0.26	0.78	FALSE	0.00	Above WT
49.05	140.5	185.48	2.238	0.06	2.94	2.94	62.02	1.23	2.13	0.59	106.02	1.95	Sand	Sand	Sand	106.02	1.95	1.24	131.34	0.29	0.26	0.77	FALSE	0.00	Above WT
49.21	140.3	205.21	2.488	0.06	2.95	2.95	68.50	1.23	2.09	0.59	117.11	1.92	Sand	Sand	Sand	117.11	1.92	1.21	141.29	0.34	0.26	0.77	FALSE	0.00	Above WT
49.38	140.1	220.18	2.710	0.06	2.96	2.96	73.31	1.25	2.08	0.59	125.43	1.90	Sand	Sand	Sand	125.43	1.90	1.19	149.23	0.39	0.26	0.77	FALSE	0.00	Above WT
49.54	140.0	238.45	2.431	0.06	2.97	2.97	79.22	1.03	2.00	0.59	135.62	1.82	Sand	Sand	Sand	135.62	1.82	1.12	152.08	0.41	0.26	0.77	FALSE	0.00	Above WT
49.70	139.8	247.12	2.434	0.06	2.98	2.98	81.87	1.00	1.98	0.59	140.33	1.80	Sand	Sand	Sand	140.33	1.80	1.11	155.15	0.43	0.26	0.77	FALSE	0.00	Above WT
49.87	139.6	264.68	2.351	0.06	2.99	2.99	87.46	0.90	1.93	0.59	150.04	1.75	Sand	Sand	Sand	150.04	1.75	1.07	160.45	0.46	0.26	0.77	FALSE	0.00	Above WT
50.03	139.5	277.97	2.370	0.06	3.00	3.00	91.60	0.86	1.90	0.59	157.32	1.72	Sand	Sand	Sand	157.32	1.72	1.05	165.33	0.50	0.26	0.77	FALSE	0.00	Above WT
50.20	139.3	271.20	2.422	0.06	3.01	3.01	89.04	0.90	1.92	0.59	153.23	1.74	Sand	Sand	Sand	153.23	1.74	1.07	163.31	0.49	0.26	0.77	FALSE	0.00	Above WT
50.36	139.1	257.01	2.250	0.06	3.02	3.02	84.06	0.89	1.94	0.59	144.98	1.75	Sand	Sand	Sand	144.98	1.75	1.07	155.73	0.43	0.26	0.76	FALSE	0.00	Above WT
50.52	139.0	236.66	2.014	0.06	3.03	3.03	77.07	0.86	1.96	0.59	133.29	1.77	Sand	Sand	Sand	133.29	1.77	1.09	144.97	0.36	0.26	0.76	FALSE	0.00	Above WT
50.69	138.8	217.90	1.947	0.06	3.04	3.04	70.64	0.91	2.00	0.58	122.52	1.82	Sand	Sand	Sand	122.52	1.82	1.12	136.97	0.32	0.26	0.76	FALSE	0.00	Above WT
50.85	138.7	199.66	1.838	0.06	3.05	3.05	64.44	0.94	2.04	0.58	112.09	1.85	Sand	Sand	Sand	112.09	1.85	1.15	128.68	0.28	0.26	0.76	FALSE	0.00	Above WT
51.02	138.5	189.03	1.860	0.06	3.06	3.06	60.75	1.00	2.08	0.58	105.94	1.89	Sand	Sand	Sand	105.94	1.89	1.18	125.08	0.26	0.26	0.76	FALSE	0.00	Above WT
51.18	138.3	188.57	1.961	0.06	3.07	3.07	60.41	1.06	2.10	0.58	105.52	1.91	Sand	Sand	Sand	105.52	1.91	1.20	126.26	0.27	0.26	0.76	FALSE	0.00	Above WT
51.35	138.2	192.55	1.764	0.06	3.08	3.08	61.50	0.93	2.06	0.58	107.57	1.87	Sand	Sand	Sand	107.57	1.87	1.16	124.62	0.26	0.26	0.76	FALSE	0.00	Above WT
51.51	138.0	186.15	1.437	0.06	3.09	3.09	59.23	0.79	2.03	0.58	103.83	1.83	Sand	Sand	Sand	103.83	1.83	1.13	117.41	0.23	0.26	0.75	FALSE	0.00	Above WT
51.67	137.8	174.51	1.275	0.06	3.10	3.10	55.29	0.74	2.04	0.58	97.19	1.84	Sand	Sand	Sand	97.19	1.84	1.14	110.57	0.21	0.25	0.75	FALSE	0.00	Above WT
51.84	137.7	155.44	1.097	0.06	3.11	3.11	48.97	0.72	2.08	0.58	86.42	1.87	Sand	Sand	Sand	86.42	1.87	1.17	100.71	0.17	0.25	0.75	FALSE	0.00	Above WT
52.00	137.5	117.30	1.234	0.06	3.12	3.12	36.60	1.08	2.28	0.58	65.12	2.08	Sand	Sand	Sand	65.12	2.08	1.42	92.16	0.15	0.25	0.75	FALSE	0.00	Above WT
52.17	137.3	86.92	1.378	0.06	3.13	3.13	26.77	1.64	2.50	0.58	48.17	2.29	Sand	Sand	Sand	48.17	2.29	1.93	92.76	0.15	0.25	0.75	FALSE	0.00	Above WT
52.33	137.2	66.80	1.511	0.06	3.14	3.14	20.28	2.37	2.69	Clay	Clay	Clay	Clay	Clay	Clay	20.28	2.69	3.91	79.22	0.13	0.25	0.75	FALSE	0.00	Above WT
52.49	137.0	57.93	1.793	0.06	3.15	3.15	17.39	3.27	2.83	Clay	Clay	Clay	Clay	Clay	Clay	17.39	2.83	5.00	87.01	0.14	0.25	0.75	FALSE	0.00	Above WT
52.66	136.8	46.29	1.464	0.06	3.16	3.16	13.65	3.39	2.92	Clay	Clay	Clay	Clay	Clay	Clay	13.65	2.92	5.88	80.27	0.13	0.25	0.75	FALSE	0.00	Above WT
52.82	136.7	77.14	1.344	0.06	3.17	3.17	23.34	1.82	2.57	0.57	42.49	2.36	Sand	Sand	Sand	42.49	2.36	2.16	91.97	0.15	0.25	0.74	FALSE	0.00	Above WT
52.99	136.5	187.47	1.359	0.06	3.18	3.18	57.96	0.74	2.02	0.57	103.10	1.82	Sand	Sand	Sand	103.10	1.82	1.12	115.46	0.22	0.25	0.74	FALSE	0.00	Above WT
53.15	136.4	231.89	1.540	0.06	3.19	3.19	71.72	0.67	1.92	0.57	127.33	1.72	Sand	Sand	Sand	127.33	1.72	1.05	133.96	0.30	0.25	0.74	FALSE	0.00	Above WT
53.31	136.2	233.72	1.869	0.06	3.20	3.20	72.07	0.81	1.97	0.57	128.14	1.77	Sand	Sand	Sand	128.14	1.77	1.08	139.02	0.33	0.25	0.74	FALSE	0.00	Above WT
53.48	136.0	223.59	2.050	0.06	3.21	3.21	68.68	0.93	2.02	0.57	122.40	1.82	Sand	Sand	Sand	122.40	1.82	1.12	137.54	0.32	0.25	0.74	FALSE	0.00	Above WT
53.64	135.9	212.75	1.774	0.06	3.22	3.22	65.10	0.85	2.02	0.57	116.29	1.81	Sand	Sand	Sand	116.29	1.81	1.12	129.87	0.28	0.25	0.74	FALSE	0.00	Above WT
53.81	135.7	187.86	1.485	0.06	3.23	3.23	57.19	0.80	2.05	0.57	102.52	1.84	Sand	Sand	Sand	102.52	1.84	1.14	116.79	0.23	0.25	0.74	FALSE	0.00	Above WT
53.97	135.5	151.47	1.160	0.06	3.24	3.24	45.78	0.78	2.12	0.57	82.54	1.91	Sand	Sand	Sand	82.54	1.91	1.20	99.01	0.17	0.25	0.73	FALSE	0.00	Above WT
54.13	135.4	113.67	1.204	0.06	3.25	3.25	34.00	1.09	2.31	0.57	61.85	2.10	Sand	Sand	Sand	61.85	2.10	1.45	89.70	0.15	0.25	0.73	FALSE	0.00	Above WT
54.30	135.2	67.91	1.618	0.06	3.26	3.26	19.84	2.50	2.71	Clay	Clay	Clay	Clay	Clay	Clay	19.84	2.71	4.06	80.60	0.13	0.25	0.73	FALSE	0.00	Above WT
54.46	135.0	36.77	1.543	0.06	3.27	3.27	10.25	4.61	3.10	Clay	Clay	Clay	Clay	Clay	Clay	10.25	3.10	7.89	80.94	0.13	0.25	0.73	FALSE	0.00	Above WT
54.63	134.9	27.57	1.024	0.06	3.28	3.28	7.41	4.22	3.19	Clay	Clay	Clay	Clay	Clay	Clay	7.41	3.19	9.09	67.34	0.11	0.25	0.73	FALSE	0.00	Above WT
54.79	134.7	57.21	1.147	0.06	3.29	3.29	16.40	2.13	2.74	Clay	Clay	Clay	Clay	Clay	Clay	16.40	2.74	4.26	69.85	0.11	0.25	0.73	FALSE	0.00	Above WT
54.95	134.6	93.26	1.351	0.06	3.30	3.30	27.29	1.50	2.47	0.56	50.36	2.25	Sand	Sand	Sand	50.36	2.25	1.81	90.98	0.15	0.25	0.73	FALSE	0.00	Above WT
55.12	134.4	109.03	1.172	0.06	3.31	3.31	31.97	1.11	2.34	0.56	58.79	2.12	Sand	Sand	Sand	58.79	2.12	1.49	87.66	0.14	0.25	0.73	FALSE	0.00	Above WT
55.28	134.2	123.00	1.357	0.06	3.32	3.32	36.08	1.13	2.30	0.56	66.23	2.08	Sand	Sand	Sand	66.23	2.08	1.43	94.48	0.16	0.24	0.72	FALSE	0.00	Above WT
55.45	134.1	151.11	1.507	0.06	3.33	3.33	44.42	1.02	2.20	0.56	81.24	1.99	Sand	Sand	Sand	81.24	1.99	1.26	104.14	0.19	0.24	0.72	FALSE	0.00	Above WT
55.61	133.9	165.95	1.755	0.06	3.34	3.34	48.74	1.08	2.18	0.56	89.09	1.97	Sand	Sand	Sand	89.09	1.97	1.26	112.50	0.21	0.24	0.72	FALSE	0.00	Above WT
55.77	133.7	162.43	1.630	0.06	3.35	3.35	47.54	1.02	2.17	0.56	87.07	1.96	Sand	Sand	Sand	87.07	1.96	1.26	109.30	0.20	0.24	0.72	FALSE	0.00	Above WT
55.94	133.6	134.35	1.799	0.06	3.36	3.36	39.03	1.37	2.32	0.56	71.91	2.11	Sand	Sand	Sand	71.91	2.11	1.47	105.75	0.19	0.24	0.72	FALSE	0.00	Above WT
56.10	133.4	88.19	2.382	0.06	3.37	3.37	25.20	2.81	2.66	Clay	Clay	Clay	Clay	Clay	Clay	25.20	2.66	3.70	93.19	0.16	0.24	0.72	FALSE	0.00	Above WT
56.27	133.2	46.37	2.411	0.06	3.38	3.38	12.73	5.61	3.08	Clay	Clay	Clay	Clay	Clay	Clay	12.73	3.08	7.65	97.36	0.17	0.24	0.72	FALSE	0.00	Above WT
56.43	133.1	34.63	1.942	0.06	3.39	3.39	9.23	6.22	3.21	Clay	Clay	Clay	Clay	Clay	Clay	9.23	3.21	9.44	87.15	0.14	0.24	0.71	FALSE	0.00	Above WT
56.59	132.9	33.16	1.846	0.06	3.40	3.40	8.77	6.20	3.23	Clay	Clay	Clay	Clay	Clay	Clay	8.77	3.23	9.68	84.88	0.14	0.24	0.71	FALSE	0.00	Above WT
56.76	132.7	35.01	1.763	0.06	3.41	3.41	9.28	5.58	3.18	Clay	Clay	Clay	Clay	Clay	Clay	9.28	3.18	9.01	83.61	0.13	0.24	0.71	FALSE	0.00	Above WT
56.92	132.6	34.49	1.729	0.06	3.42	3.42	9.10	5.56	3.19	Clay	Clay	Clay	Clay	Clay	Clay	9.10	3.19	9.09	82.74	0.13	0.24	0.71	FALSE	0.00	Above WT
57.09	132.4	32.44	1.887	0.06	3.43	3.43	8.47	6.50	3.26	Clay	Clay	Clay	Clay	Clay	Clay	8.47	3.26	10.04	85.04	0.14	0.24	0.71	FALSE	0.00	Above WT
57.25	132.3	39.83	2.438	0.06	3.44	3.44	10.60	6.70	3.19	Clay	Clay	Clay	Clay	Clay	Clay	10.60	3.19	9.08	96.24	0.16	0.24	0.71	FALSE	0.00	Above WT
57.41	132.1	61.51	3.605	0.06	3.44	3.44	16.86	6.21	3.01	Clay	Clay	Clay	Clay	Clay	Clay	16.86	3.01	6.90	116.34	0.23	0.24	0.71	FALSE	0.00	Above WT
57.58	131.9	71.02	4.370	0.06	3.45	3.45	19.56	6.47	2.98	Clay	Clay	Clay	Clay	Clay	Clay	19.56	2.98	6.51	127.24	0.27	0.24	0.71	FALSE	0.00	Above WT
57.74	131.8	53.75	3.777	0.06	3.46	3.46	14.51	7.51	3.12	Clay	Clay	Clay	Clay	Clay	Clay	14.51	3.12	8.15	118.28	0.23	0.24	0.70	FALSE	0.00	Above WT
57.91	131.6	52.66	2.317	0.06	3.47	3.47	14.16	4.71	2.99	Clay	Clay	Clay	Clay	Clay	Clay	14.16	2.99	6.67	94.47	0.16	0.24	0.70	FALSE	0.00	Above WT
58.07	131.4	67.63	2.389	0.06	3.48	3.48	18.41	3.72	2.84	Clay	Clay	Clay	Clay	Clay	Clay	18.41	2.84	5.14	94.65	0.16	0.24	0.70	FALSE	0.00	Above WT
58.23	131.3	75.03	2.200	0.06	3.49	3.49	20.48	3.07	2.75	Clay	Clay	Clay	Clay	Clay	Clay	20.48	2.75	4.40	90.00	0.15	0.24	0.70	FALSE	0.00	Above WT
58.40	131.1	55.95	2.174	0.06	3.50	3.50	14.97	4.14	2.94	Clay	Clay	Clay	Clay	Clay	Clay	14.97	2.94	6.10	91.28	0.15	0.24	0.70	FALSE	0.00	Above WT
58.56	130.9	33.95	1.839	0.06	3.51	3.51	8.66	6.04	3.23	Clay	Clay	Clay	Clay	Clay	Clay	8.66	3.23	9.64	83.51	0.13	0.24	0.70	FALSE	0.00	Above WT
58.73	130.8	25.26	1.171	0.06	3.52	3.52	6.17	5.39	3.32	Clay	Clay	Clay	Clay	Clay	Clay	6.17	3.32	10.95	67.54	0.11	0.24	0.70	FALSE	0.00	Above WT
58.89	130.6	23.27	0.986	0.06	3.53	3.53	5.59	5.00	3.33	Clay	Clay	Clay	Clay	Clay	Clay	5.59	3.33	11.20	62.56	0.10	0.23	0.69	FALSE	0.00	Above WT

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
59.06	130.4	24.26	0.954	0.06	3.54	3.54	5.85	4.60	3.29	Clay	Clay	Clay	Clay	Clay	Clay	5.85	3.29	10.63	62.15	0.10	0.23	0.69	FALSE	0.00	Above WT
59.22	130.3	26.73	0.916	0.06	3.55	3.55	6.52	3.95	3.22	Clay	Clay	Clay	Clay	Clay	Clay	6.52	3.22	9.50	61.94	0.10	0.23	0.69	FALSE	0.00	Above WT
59.38	130.1	22.35	0.839	0.06	3.56	3.56	5.27	4.46	3.32	Clay	Clay	Clay	Clay	Clay	Clay	5.27	3.32	11.08	58.45	0.10	0.23	0.69	FALSE	0.00	Above WT
59.55	130.0	21.46	0.736	0.06	3.57	3.57	5.01	4.12	3.32	Clay	Clay	Clay	Clay	Clay	Clay	5.01	3.32	11.07	55.42	0.10	0.23	0.69	FALSE	0.00	Above WT
59.71	129.8	24.16	0.751	0.06	3.58	3.58	5.74	3.65	3.24	Clay	Clay	Clay	Clay	Clay	Clay	5.74	3.24	9.88	56.74	0.10	0.23	0.69	FALSE	0.00	Above WT
59.88	129.6	25.23	1.007	0.06	3.59	3.59	6.02	4.65	3.29	Clay	Clay	Clay	Clay	Clay	Clay	6.02	3.29	10.51	63.29	0.10	0.23	0.69	FALSE	0.00	Above WT
60.04	129.5	29.24	1.100	0.06	3.60	3.60	7.12	4.29	3.21	Clay	Clay	Clay	Clay	Clay	Clay	7.12	3.21	9.35	66.52	0.11	0.23	0.69	FALSE	0.00	Above WT
60.20	129.3	24.91	0.914	0.06	3.61	3.61	5.90	4.29	3.27	Clay	Clay	Clay	Clay	Clay	Clay	5.90	3.27	10.32	60.84	0.10	0.23	0.68	FALSE	0.00	Above WT
60.37	129.1	21.97	0.772	0.06	3.62	3.62	5.07	4.21	3.32	Clay	Clay	Clay	Clay	Clay	Clay	5.07	3.32	11.09	56.15	0.10	0.23	0.68	FALSE	0.00	Above WT
60.53	129.0	21.04	1.110	0.06	3.63	3.63	4.79	5.38	3.45	Clay	Clay	Clay	Clay	Clay	Clay	4.79	3.45	13.13	62.95	0.10	0.23	0.68	FALSE	0.00	Above WT
60.70	128.8	28.96	1.336	0.06	3.64	3.64	6.95	5.28	3.27	Clay	Clay	Clay	Clay	Clay	Clay	6.95	3.27	10.23	71.11	0.11	0.23	0.68	FALSE	0.00	Above WT
60.86	128.6	40.41	1.234	0.06	3.65	3.65	10.07	3.36	3.02	Clay	Clay	Clay	Clay	Clay	Clay	10.07	3.02	7.00	70.43	0.11	0.23	0.68	FALSE	0.00	Above WT
61.02	128.5	38.75	1.651	0.06	3.66	3.66	9.58	4.70	3.13	Clay	Clay	Clay	Clay	Clay	Clay	9.58	3.13	8.26	79.18	0.13	0.23	0.68	FALSE	0.00	Above WT
61.19	128.3	33.38	2.181	0.06	3.67	3.67	8.09	7.34	3.30	Clay	Clay	Clay	Clay	Clay	Clay	8.09	3.30	10.77	87.17	0.14	0.23	0.68	FALSE	0.00	Above WT
61.35	128.2	61.87	2.630	0.06	3.68	3.68	15.81	4.52	2.95	Clay	Clay	Clay	Clay	Clay	Clay	15.81	2.95	6.15	97.28	0.17	0.23	0.67	FALSE	0.00	Above WT
61.52	128.0	78.20	3.259	0.06	3.69	3.69	20.19	4.37	2.85	Clay	Clay	Clay	Clay	Clay	Clay	20.19	2.85	5.27	106.36	0.19	0.23	0.67	FALSE	0.00	Above WT
61.68	127.8	71.70	3.420	0.06	3.70	3.70	18.37	5.03	2.93	Clay	Clay	Clay	Clay	Clay	Clay	18.37	2.93	5.95	109.33	0.20	0.23	0.67	FALSE	0.00	Above WT
61.84	127.7	57.25	3.379	0.06	3.71	3.71	14.43	6.31	3.07	Clay	Clay	Clay	Clay	Clay	Clay	14.43	3.07	7.55	108.91	0.20	0.23	0.67	FALSE	0.00	Above WT
62.01	127.5	62.44	3.005	0.06	3.72	3.72	15.78	5.12	2.98	Clay	Clay	Clay	Clay	Clay	Clay	15.78	2.98	6.53	103.02	0.18	0.23	0.67	FALSE	0.00	Above WT
62.17	127.3	86.99	2.812	0.06	3.73	3.73	22.32	3.38	2.75	Clay	Clay	Clay	Clay	Clay	Clay	22.32	2.75	4.37	97.48	0.17	0.23	0.67	FALSE	0.00	Above WT
62.34	127.2	93.67	2.606	0.06	3.74	3.74	24.04	2.90	2.68	Clay	Clay	Clay	Clay	Clay	Clay	24.04	2.68	3.87	92.98	0.15	0.23	0.67	FALSE	0.00	Above WT
62.50	127.0	88.82	3.085	0.06	3.75	3.75	22.69	3.63	2.76	Clay	Clay	Clay	Clay	Clay	Clay	22.69	2.76	4.48	101.68	0.18	0.22	0.67	FALSE	0.00	Above WT
62.66	126.8	81.98	3.696	0.06	3.76	3.76	20.81	4.73	2.87	Clay	Clay	Clay	Clay	Clay	Clay	20.81	2.87	5.38	111.97	0.21	0.22	0.66	FALSE	0.00	Above WT
62.83	126.7	79.29	4.261	0.06	3.77	3.77	20.03	5.64	2.93	Clay	Clay	Clay	Clay	Clay	Clay	20.03	2.93	6.00	120.27	0.24	0.22	0.66	FALSE	0.00	Above WT
62.99	126.5	126.40	4.172	0.06	3.78	3.78	32.44	3.40	2.63	Clay	Clay	Clay	Clay	Clay	Clay	32.44	2.63	3.50	113.62	0.22	0.22	0.66	FALSE	0.00	Above WT
63.16	126.3	176.08	3.668	0.06	3.79	3.79	45.46	2.13	2.38	0.52	88.69	2.17	Sand	Sand	Sand	88.69	2.17	1.60	141.81	0.35	0.22	0.66	FALSE	0.00	Above WT
63.32	126.2	220.18	2.920	0.06	3.80	3.80	56.95	1.35	2.18	0.52	110.77	1.96	Sand	Sand	Sand	110.77	1.96	1.26	139.02	0.33	0.22	0.66	FALSE	0.00	Above WT
63.48	126.0	247.25	2.654	0.06	3.81	3.81	63.92	1.09	2.09	0.52	124.23	1.86	Sand	Sand	Sand	124.23	1.86	1.16	143.69	0.36	0.22	0.66	FALSE	0.00	Above WT
63.65	125.9	234.73	2.567	0.06	3.82	3.82	60.46	1.11	2.11	0.52	117.78	1.89	Sand	Sand	Sand	117.78	1.89	1.18	138.58	0.33	0.22	0.66	FALSE	0.00	Above WT
63.81	125.7	203.17	2.551	0.06	3.83	3.83	52.07	1.28	2.20	0.52	101.82	1.97	Sand	Sand	Sand	101.82	1.97	1.27	129.13	0.28	0.22	0.65	FALSE	0.00	Above WT
63.98	125.5	162.49	2.406	0.06	3.84	3.84	41.33	1.52	2.32	0.52	81.32	2.10	Sand	Sand	Sand	81.32	2.10	1.45	117.80	0.23	0.22	0.65	FALSE	0.00	Above WT
64.14	125.4	92.19	2.163	0.06	3.85	3.85	22.96	2.45	2.65	Clay	Clay	Clay	Clay	Clay	Clay	22.96	2.65	3.67	84.14	0.14	0.22	0.65	FALSE	0.00	Above WT
64.30	125.2	39.91	1.737	0.06	3.86	3.86	9.34	4.82	3.14	Clay	Clay	Clay	Clay	Clay	Clay	9.34	3.14	8.46	79.01	0.13	0.22	0.65	FALSE	0.00	Above WT
64.47	125.0	32.19	1.378	0.06	3.87	3.87	7.32	4.86	3.23	Clay	Clay	Clay	Clay	Clay	Clay	7.32	3.23	9.66	70.70	0.11	0.22	0.65	FALSE	0.00	Above WT
64.63	124.9	26.13	1.087	0.06	3.88	3.88	5.74	4.89	3.32	Clay	Clay	Clay	Clay	Clay	Clay	5.74	3.32	10.96	62.90	0.10	0.22	0.65	FALSE	0.00	Above WT
64.80	124.7	26.30	0.869	0.06	3.89	3.89	5.76	3.88	3.26	Clay	Clay	Clay	Clay	Clay	Clay	5.76	3.26	10.07	58.06	0.10	0.22	0.65	FALSE	0.00	Above WT
64.96	124.5	26.30	0.850	0.06	3.90	3.90	5.75	3.79	3.25	Clay	Clay	Clay	Clay	Clay	Clay	5.75	3.25	10.01	57.55	0.10	0.22	0.65	FALSE	0.00	Above WT
65.12	124.4	25.39	0.801	0.06	3.91	3.91	5.50	3.73	3.27	Clay	Clay	Clay	Clay	Clay	Clay	5.50	3.27	10.19	56.03	0.10	0.22	0.64	FALSE	0.00	Above WT
65.29	124.2	24.42	0.823	0.06	3.92	3.92	5.23	4.01	3.30	Clay	Clay	Clay	Clay	Clay	Clay	5.23	3.30	10.73	56.14	0.10	0.22	0.64	FALSE	0.00	Above WT
65.45	124.1	24.86	0.977	0.06	3.93	3.93	5.33	4.67	3.33	Clay	Clay	Clay	Clay	Clay	Clay	5.33	3.33	11.20	59.69	0.10	0.22	0.64	FALSE	0.00	Above WT
65.62	123.9	28.49	1.073	0.06	3.94	3.94	6.24	4.37	3.26	Clay	Clay	Clay	Clay	Clay	Clay	6.24	3.26	10.09	62.91	0.10	0.22	0.64	FALSE	0.00	Above WT
65.78	123.7	29.06	1.044	0.06	3.95	3.95	6.36	4.16	3.24	Clay	Clay	Clay	Clay	Clay	Clay	6.36	3.24	9.80	62.36	0.10	0.22	0.64	FALSE	0.00	Above WT
65.94	123.6	25.31	0.970	0.06	3.96	3.96	5.40	4.54	3.32	Clay	Clay	Clay	Clay	Clay	Clay	5.40	3.32	11.02	59.49	0.10	0.22	0.64	FALSE	0.00	Above WT
66.11	123.4	23.70	0.891	0.06	3.97	3.97	4.97	4.51	3.35	Clay	Clay	Clay	Clay	Clay	Clay	4.97	3.35	11.46	57.01	0.10	0.21	0.64	FALSE	0.00	Above WT
66.27	123.2	23.49	0.828	0.06	3.98	3.98	4.91	4.24	3.34	Clay	Clay	Clay	Clay	Clay	Clay	4.91	3.34	11.30	55.46	0.10	0.21	0.63	FALSE	0.00	Above WT
66.44	123.1	23.23	1.026	0.06	3.99	3.99	4.83	5.33	3.40	Clay	Clay	Clay	Clay	Clay	Clay	4.83	3.40	12.31	59.43	0.10	0.21	0.63	FALSE	0.00	Above WT
66.60	122.9	23.54	1.575	0.06	4.00	4.00	4.89	8.06	3.50	Clay	Clay	Clay	Clay	Clay	Clay	4.89	3.50	14.10	68.94	0.11	0.21	0.63	FALSE	0.00	Above WT
66.77	122.7	40.32	2.211	0.06	4.01	4.01	9.06	6.09	3.21	Clay	Clay	Clay	Clay	Clay	Clay	9.06	3.21	9.45	85.66	0.14	0.21	0.63	FALSE	0.00	Above WT
66.93	122.6	46.32	2.211	0.06	4.02	4.02	10.53	5.23	3.12	Clay	Clay	Clay	Clay	Clay	Clay	10.53	3.12	8.20	86.43	0.14	0.21	0.63	FALSE	0.00	Above WT
67.09	122.4	33.68	1.075	0.06	4.03	4.03	7.37	3.63	3.15	Clay	Clay	Clay	Clay	Clay	Clay	7.37	3.15	8.61	63.41	0.10	0.21	0.63	FALSE	0.00	Above WT
67.26	122.2	23.53	1.621	0.06	4.04	4.04	4.83	8.32	3.51	Clay	Clay	Clay	Clay	Clay	Clay	4.83	3.51	14.33	69.21	0.11	0.21	0.63	FALSE	0.00	Above WT
67.42	122.1	73.84	1.854	0.06	4.05	4.05	17.25	2.66	2.77	Clay	Clay	Clay	Clay	Clay	Clay	17.25	2.77	4.56	78.69	0.13	0.21	0.63	FALSE	0.00	Above WT
67.59	121.9	177.97	2.304	0.06	4.06	4.06	42.88	1.32	2.28	0.51	86.66	2.04	Sand	Sand	Sand	86.66	2.04	1.35	117.09	0.23	0.21	0.62	FALSE	0.00	Above WT
67.75	121.8	234.83	1.888	0.06	4.07	4.07	56.77	0.82	2.06	0.51	114.21	1.81	Sand	Sand	Sand	114.21	1.81	1.11	127.28	0.27	0.21	0.62	FALSE	0.00	Above WT
67.91	121.6	261.51	1.982	0.06	4.07	4.07	63.18	0.77	2.00	0.51	127.04	1.76	Sand	Sand	Sand	127.04	1.76	1.08	136.82	0.32	0.21	0.62	FALSE	0.00	Above WT
68.08	121.4	260.87	2.094	0.06	4.08	4.08	62.86	0.82	2.02	0.50	126.57	1.77	Sand	Sand	Sand	126.57	1.77	1.09	137.81	0.32	0.21	0.62	FALSE	0.00	Above WT
68.24	121.3	254.34	2.329	0.06	4.09	4.09	61.12	0.93	2.06	0.50	123.25	1.82	Sand	Sand	Sand	123.25	1.82	1.12	138.31	0.33	0.21	0.62	FALSE	0.00	Above WT
68.41	121.1	245.16	2.652	0.06	4.10	4.10	58.73	1.10	2.12	0.50	118.66	1.88	Sand	Sand	Sand	118.66	1.88	1.17	139.03	0.33	0.21	0.62	FALSE	0.00	Above WT
68.57	120.9	238.30	2.904	0.06	4.11	4.11	56.95	1.24	2.16	0.50	115.23	1.93	Sand	Sand	Sand	115.23	1.93	1.21	139.91	0.33	0.21	0.62	FALSE	0.00	liq
68.73	120.8	237.38	2.866	0.06	4.12	4.12	56.66	1.23	2.16	0.50	114.72	1.92	Sand	Sand	Sand	114.72	1.92	1.21	139.14	0.33	0.21	0.61	FALSE	0.00	liq
68.90	120.6	244.73	2.479	0.06	4.13	4.12	58.37	1.03	2.10	0.50	118.21	1.86	Sand	Sand	Sand	118.21	1.86	1.16	136.69	0.32	0.21	0.61	FALSE	0.00	liq
69.06	120.4	243.48	2.006	0.06	4.14	4.13	58.00	0.84	2.05	0.50	117.54	1.81	Sand	Sand	Sand	117.54	1.81	1.11	130.71	0.29	0.21	0.61	FALSE	0.00	liq
69.23	120.3	234.36	1.745	0.06	4.15	4.13	55.72	0.76	2.04	0.50	113.07	1.79	Sand	Sand	Sand	113.07	1.79	1.10	124.58	0.26	0.21	0.61	FALSE	0.00	liq
69.39	120.1	215.01	1.525	0.06	4.16	4.14	50.98	0.72	2.07	0.50	103.67	1.81	Sand	Sand	Sand	103.67	1.81	1.11	115.57	0.22	0.21	0.61	FALSE	0.00	liq
69.55	120.0	193.60	1.330	0.06	4.17	4.14	45.75	0.70	2.10	0.50	93.30	1.84	Sand	Sand	Sand	93.30	1.84	1.14	106.12	0.19	0.21	0.61	FALSE	0.00	liq
69.72	119.8	161.15	1.637	0.06	4.18	4.15	37.87	1.04	2.26	0.50	77.61	2.01	Sand	Sand	Sand	77.61	2.01	1.31	101.67	0.18	0.21	0.61	FALSE	0.00	liq
69.88	119.6	94.17	1.946	0.06	4.19	4.15	21.68	2.16	2.64	Clay	Clay	Clay	Clay	Clay	Clay	21.68	2.64	3.58	77.70	0.12	0.21	0.61	FALSE	0.00	Clay
70.05	119.5	47.29	1.421	0.06	4.20	4.15	10.37	3.30	3.01	Clay	Clay	Clay	Clay	Clay	Clay	10.37	3.01	6.83	70.80	0.11	0.21	0.60	FALSE	0.00	Clay
70.21	119.3	32.89	0.751	0.06	4.21	4.16	6.89	2.62	3.10	Clay	Clay	Clay	Clay	Clay	Clay	6.89	3.10	7.92	54.61	0.10	0.21	0.60	FALSE	0.00	Clay
70.37	119.1	32.21	0.358	0.06	4.22	4.16	6.72	1.28	2.96	Clay	Clay	Clay	Clay	Clay	Clay	6.72	2.96	6.28	42.20	0.09	0.21	0.60	FALSE	0.00	Clay
70.54	119.0	31.79	0.335	0.06	4.23	4.17	6.61	1.22	2.95	Clay	Clay	Clay	Clay	Clay	Clay	6.61	2.95	6.24	41.27	0.08	0.21	0.60	FALSE	0.00	Clay
70.70	118.8	30.13	0.336	0.06	4.24	4.17	6.20	1.30	2.99	Clay	Clay	Clay	Clay	Clay	Clay	6.20	2.99	6.65	41.22	0.08	0.21	0.60	FALSE	0.00	Clay

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
70.87	118.6	27.95	0.365	0.06	4.25	4.18	5.67	1.54	3.06	Clay	Clay	Clay	Clay	Clay	5.67	3.06	7.43	42.11	0.09	0.21	0.60	FALSE	0.00	Clay
71.03	118.5	27.84	0.679	0.06	4.26	4.18	5.64	2.88	3.20	Clay	Clay	Clay	Clay	Clay	5.64	3.20	9.19	51.80	0.09	0.21	0.60	FALSE	0.00	Clay
71.19	118.3	33.99	0.569	0.06	4.27	4.19	7.10	1.92	3.02	Clay	Clay	Clay	Clay	Clay	7.10	3.02	6.96	49.40	0.09	0.20	0.59	FALSE	0.00	Clay
71.36	118.1	28.66	0.692	0.06	4.28	4.19	5.81	2.84	3.18	Clay	Clay	Clay	Clay	Clay	5.81	3.18	8.99	52.26	0.09	0.20	0.59	FALSE	0.00	Clay
71.52	118.0	29.45	0.692	0.06	4.29	4.20	5.99	2.75	3.16	Clay	Clay	Clay	Clay	Clay	5.99	3.16	8.74	52.38	0.09	0.20	0.59	FALSE	0.00	Clay
71.69	117.8	28.26	0.667	0.06	4.30	4.20	5.70	2.78	3.18	Clay	Clay	Clay	Clay	Clay	5.70	3.18	9.03	51.47	0.09	0.20	0.59	FALSE	0.00	Clay
71.85	117.7	25.61	0.795	0.06	4.31	4.21	5.06	3.73	3.30	Clay	Clay	Clay	Clay	Clay	5.06	3.30	10.65	53.90	0.09	0.20	0.59	FALSE	0.00	Clay
72.01	117.5	24.61	1.635	0.06	4.32	4.21	4.82	8.06	3.51	Clay	Clay	Clay	Clay	Clay	4.82	3.51	14.19	68.37	0.11	0.20	0.59	FALSE	0.00	Clay
72.18	117.3	49.57	2.131	0.06	4.33	4.22	10.73	4.71	3.09	Clay	Clay	Clay	Clay	Clay	10.73	3.09	7.77	83.41	0.13	0.20	0.59	FALSE	0.00	Clay
72.34	117.2	82.71	2.622	0.06	4.34	4.22	18.57	3.35	2.81	Clay	Clay	Clay	Clay	Clay	18.57	2.81	4.86	90.21	0.15	0.20	0.59	FALSE	0.00	Clay
72.51	117.0	98.40	2.704	0.06	4.35	4.23	22.25	2.88	2.71	Clay	Clay	Clay	Clay	Clay	22.25	2.71	4.04	89.93	0.15	0.20	0.58	FALSE	0.00	Clay
72.67	116.8	97.27	2.791	0.06	4.36	4.23	21.96	3.00	2.72	Clay	Clay	Clay	Clay	Clay	21.96	2.72	4.16	91.42	0.15	0.20	0.58	FALSE	0.00	Clay
72.83	116.7	97.33	2.849	0.06	4.37	4.24	21.95	3.06	2.73	Clay	Clay	Clay	Clay	Clay	21.95	2.73	4.21	92.31	0.15	0.20	0.58	FALSE	0.00	Clay
73.00	116.5	71.32	2.763	0.06	4.38	4.24	15.79	4.13	2.92	Clay	Clay	Clay	Clay	Clay	15.79	2.92	5.90	93.19	0.16	0.20	0.58	FALSE	0.00	Clay
73.16	116.3	43.04	1.989	0.06	4.39	4.25	9.10	5.15	3.17	Clay	Clay	Clay	Clay	Clay	9.10	3.17	8.81	80.18	0.13	0.20	0.58	FALSE	0.00	Clay
73.33	116.2	29.75	1.961	0.06	4.40	4.25	5.96	7.73	3.42	Clay	Clay	Clay	Clay	Clay	5.96	3.42	12.69	75.70	0.12	0.20	0.58	FALSE	0.00	Clay
73.49	116.0	59.64	2.476	0.06	4.41	4.25	12.98	4.48	3.01	Clay	Clay	Clay	Clay	Clay	12.98	3.01	6.85	88.92	0.15	0.20	0.58	FALSE	0.00	Clay
73.65	115.9	111.36	3.100	0.06	4.42	4.26	25.11	2.90	2.67	Clay	Clay	Clay	Clay	Clay	25.11	2.67	3.77	94.55	0.16	0.20	0.57	FALSE	0.00	Clay
73.82	115.7	138.00	3.281	0.06	4.43	4.26	31.32	2.46	2.55	0.49	65.53	2.31	Sand	Sand	65.53	2.31	1.97	129.41	0.28	0.20	0.57	FALSE	0.00	liq
73.98	115.5	144.09	3.484	0.06	4.44	4.27	32.71	2.49	2.54	0.49	68.38	2.30	Sand	Sand	68.38	2.30	1.95	133.17	0.30	0.20	0.57	FALSE	0.00	liq
74.15	115.4	146.01	3.218	0.06	4.45	4.27	33.12	2.27	2.51	0.49	69.26	2.27	Sand	Sand	69.26	2.27	1.85	128.02	0.28	0.20	0.57	FALSE	0.00	liq
74.31	115.2	146.48	2.880	0.06	4.46	4.28	33.19	2.03	2.48	0.49	69.44	2.23	Sand	Sand	69.44	2.23	1.75	121.51	0.25	0.20	0.57	FALSE	0.00	liq
74.48	115.0	117.94	2.848	0.06	4.47	4.28	26.49	2.51	2.61	Clay	Clay	Clay	Clay	Clay	26.49	2.61	3.39	89.80	0.15	0.20	0.57	FALSE	0.00	Clay
74.64	114.9	65.46	2.888	0.06	4.48	4.29	14.22	4.74	2.99	Clay	Clay	Clay	Clay	Clay	14.22	2.99	6.67	94.88	0.16	0.20	0.57	FALSE	0.00	Clay
74.80	114.7	38.66	2.214	0.06	4.49	4.29	7.96	6.48	3.28	Clay	Clay	Clay	Clay	Clay	7.96	3.28	10.34	82.30	0.13	0.20	0.57	FALSE	0.00	Clay
74.97	114.5	28.09	1.552	0.06	4.50	4.30	5.49	6.58	3.41	Clay	Clay	Clay	Clay	Clay	5.49	3.41	12.45	68.35	0.11	0.20	0.56	FALSE	0.00	Clay
75.13	114.4	26.56	1.266	0.06	4.51	4.30	5.13	5.74	3.40	Clay	Clay	Clay	Clay	Clay	5.13	3.40	12.27	62.87	0.10	0.20	0.56	FALSE	0.00	Clay
75.30	114.2	25.34	1.357	0.06	4.52	4.31	4.83	6.52	3.45	Clay	Clay	Clay	Clay	Clay	4.83	3.45	13.18	63.70	0.10	0.20	0.56	FALSE	0.00	Clay
75.46	114.0	27.46	1.420	0.06	4.53	4.31	5.32	6.19	3.40	Clay	Clay	Clay	Clay	Clay	5.32	3.40	12.37	65.81	0.11	0.20	0.56	FALSE	0.00	Clay
75.62	113.9	38.56	0.800	0.06	4.54	4.32	7.88	2.35	3.03	Clay	Clay	Clay	Clay	Clay	7.88	3.03	7.03	55.45	0.10	0.20	0.56	FALSE	0.00	Clay
75.79	113.7	46.38	1.020	0.06	4.55	4.32	9.68	2.44	2.96	Clay	Clay	Clay	Clay	Clay	9.68	2.96	6.29	60.93	0.10	0.20	0.56	FALSE	0.00	Clay
75.95	113.6	32.18	1.298	0.06	4.56	4.33	6.39	4.70	3.27	Clay	Clay	Clay	Clay	Clay	6.39	3.27	10.23	65.33	0.11	0.20	0.56	FALSE	0.00	Clay
76.12	113.4	26.37	1.125	0.06	4.57	4.33	5.03	5.16	3.38	Clay	Clay	Clay	Clay	Clay	5.03	3.38	11.93	60.04	0.10	0.20	0.56	FALSE	0.00	Clay
76.28	113.2	24.77	0.926	0.06	4.58	4.34	4.66	4.59	3.37	Clay	Clay	Clay	Clay	Clay	4.66	3.37	11.91	55.47	0.10	0.20	0.56	FALSE	0.00	Clay
76.44	113.1	24.96	1.425	0.06	4.59	4.34	4.69	6.99	3.48	Clay	Clay	Clay	Clay	Clay	4.69	3.48	13.68	64.23	0.10	0.20	0.56	FALSE	0.00	Clay
76.61	112.9	50.58	1.778	0.06	4.60	4.35	10.58	3.87	3.04	Clay	Clay	Clay	Clay	Clay	10.58	3.04	7.21	76.30	0.12	0.20	0.56	FALSE	0.00	Clay
76.77	112.7	101.80	2.531	0.06	4.61	4.35	22.34	2.60	2.68	Clay	Clay	Clay	Clay	Clay	22.34	2.68	3.84	85.82	0.14	0.20	0.56	FALSE	0.00	Clay
76.94	112.6	55.25	2.030	0.06	4.62	4.35	11.63	4.01	3.02	Clay	Clay	Clay	Clay	Clay	11.63	3.02	6.94	80.70	0.13	0.20	0.56	FALSE	0.00	Clay
77.10	112.4	33.14	1.315	0.06	4.63	4.36	6.54	4.61	3.25	Clay	Clay	Clay	Clay	Clay	6.54	3.25	10.04	65.65	0.11	0.20	0.56	FALSE	0.00	Clay
77.26	112.2	29.67	0.845	0.06	4.64	4.36	5.74	3.38	3.23	Clay	Clay	Clay	Clay	Clay	5.74	3.23	9.62	55.18	0.10	0.20	0.56	FALSE	0.00	Clay
77.43	112.1	31.21	1.225	0.06	4.65	4.37	6.08	4.61	3.28	Clay	Clay	Clay	Clay	Clay	6.08	3.28	10.43	63.39	0.10	0.20	0.56	FALSE	0.00	Clay
77.59	111.9	39.96	1.896	0.06	4.66	4.37	8.07	5.37	3.22	Clay	Clay	Clay	Clay	Clay	8.07	3.22	9.54	76.99	0.12	0.20	0.55	FALSE	0.00	Clay
77.76	111.7	47.22	2.010	0.06	4.67	4.38	9.72	4.72	3.12	Clay	Clay	Clay	Clay	Clay	9.72	3.12	8.21	79.82	0.13	0.20	0.55	FALSE	0.00	Clay
77.92	111.6	50.14	1.592	0.06	4.68	4.38	10.37	3.50	3.02	Clay	Clay	Clay	Clay	Clay	10.37	3.02	7.00	72.59	0.12	0.20	0.55	FALSE	0.00	Clay
78.08	111.4	37.38	1.345	0.06	4.68	4.39	7.45	4.11	3.18	Clay	Clay	Clay	Clay	Clay	7.45	3.18	8.97	66.87	0.11	0.20	0.55	FALSE	0.00	Clay
78.25	111.3	29.44	1.213	0.06	4.70	4.39	5.63	4.90	3.32	Clay	Clay	Clay	Clay	Clay	5.63	3.32	11.08	62.40	0.10	0.20	0.55	FALSE	0.00	Clay
78.41	111.1	26.07	1.072	0.06	4.70	4.40	4.86	5.02	3.38	Clay	Clay	Clay	Clay	Clay	4.86	3.38	12.02	58.42	0.10	0.20	0.55	FALSE	0.00	Clay
78.58	110.9	26.07	1.023	0.06	4.71	4.40	4.85	4.79	3.37	Clay	Clay	Clay	Clay	Clay	4.85	3.37	11.85	57.46	0.10	0.20	0.55	FALSE	0.00	Clay
78.74	110.8	33.56	1.882	0.06	4.72	4.41	6.54	6.53	3.34	Clay	Clay	Clay	Clay	Clay	6.54	3.34	11.41	74.68	0.12	0.20	0.55	FALSE	0.00	Clay
78.90	110.6	55.78	2.717	0.06	4.73	4.41	11.57	5.32	3.10	Clay	Clay	Clay	Clay	Clay	11.57	3.10	7.86	90.99	0.15	0.20	0.55	FALSE	0.00	Clay
79.07	110.4	89.64	3.059	0.06	4.74	4.42	19.22	3.60	2.82	Clay	Clay	Clay	Clay	Clay	19.22	2.82	4.93	94.80	0.16	0.20	0.55	FALSE	0.00	Clay
79.23	110.3	99.98	3.443	0.06	4.75	4.42	21.54	3.62	2.78	Clay	Clay	Clay	Clay	Clay	21.54	2.78	4.62	99.42	0.17	0.20	0.55	FALSE	0.00	Clay
79.40	110.1	116.36	3.814	0.06	4.76	4.43	25.21	3.42	2.71	Clay	Clay	Clay	Clay	Clay	25.21	2.71	4.08	102.93	0.18	0.20	0.55	FALSE	0.00	Clay
79.56	109.9	149.95	3.965	0.06	4.77	4.43	32.77	2.73	2.56	0.48	69.85	2.32	Sand	Sand	69.85	2.32	2.02	140.95	0.34	0.20	0.55	FALSE	0.00	liq
79.72	109.8	116.23	3.893	0.06	4.78	4.44	25.13	3.49	2.72	Clay	Clay	Clay	Clay	Clay	25.13	2.72	4.14	103.94	0.18	0.20	0.55	FALSE	0.00	Clay
79.89	109.6	57.79	3.306	0.06	4.79	4.44	11.94	6.24	3.13	Clay	Clay	Clay	Clay	Clay	11.94	3.13	8.29	98.94	0.17	0.20	0.55	FALSE	0.00	Clay
80.05	109.5	39.76	2.023	0.06	4.80	4.44	7.86	5.79	3.25	Clay	Clay	Clay	Clay	Clay	7.86	3.25	9.95	78.27	0.12	0.20	0.55	FALSE	0.00	Clay
80.22	109.3	28.08	1.781	0.06	4.81	4.45	5.23	7.66	3.46	Clay	Clay	Clay	Clay	Clay	5.23	3.46	13.43	70.24	0.11	0.20	0.55	FALSE	0.00	Clay
80.38	109.1	40.31	2.421	0.06	4.82	4.45	7.97	6.82	3.29	Clay	Clay	Clay	Clay	Clay	7.97	3.29	10.55	84.02	0.14	0.20	0.55	FALSE	0.00	Clay
80.54	109.0	82.13	3.192	0.06	4.83	4.46	17.33	4.13	2.89	Clay	Clay	Clay	Clay	Clay	17.33	2.89	5.59	96.99	0.16	0.20	0.55	FALSE	0.00	Clay
80.71	108.8	119.31	3.515	0.06	4.84	4.46	25.64	3.07	2.68	Clay	Clay	Clay	Clay	Clay	25.64	2.68	3.83	98.14	0.17	0.20	0.55	FALSE	0.00	Clay
80.87	108.6	111.98	3.436	0.06	4.85	4.47	23.97	3.21	2.71	Clay	Clay	Clay	Clay	Clay	23.97	2.71	4.08	97.72	0.17	0.20	0.55	FALSE	0.00	Clay
81.04	108.5	111.40	3.225	0.06	4.86	4.47	23.81	3.03	2.70	Clay	Clay	Clay	Clay	Clay	23.81	2.70	3.98	94.67	0.16	0.20	0.55	FALSE	0.00	Clay
81.20	108.3	111.15	3.255	0.06	4.87	4.48	23.73	3.06	2.70	Clay	Clay	Clay	Clay	Clay	23.73	2.70	4.01	95.10	0.16	0.20	0.55	FALSE	0.00	Clay
81.36	108.1	128.17	3.762	0.06	4.88	4.48	27.50	3.05	2.65	Clay	Clay	Clay	Clay	Clay	27.50	2.65	3.65	100.51	0.17	0.20	0.55	FALSE	0.00	Clay
81.53	108.0	148.30	4.130	0.06	4.89	4.49	31.95	2.88	2.59	0.48	68.64	2.34	Sand	Sand	68.64	2.34	2.09	143.70	0.36	0.20	0.55	FALSE	0.00	liq
81.69	107.8	162.86	4.089	0.06	4.90	4.49	35.16	2.59	2.52	0.48	75.34	2.28	Sand	Sand	75.34	2.28	1.89	142.42	0.35	0.20	0.54	FALSE	0.00	liq
81.86	107.6	157.90	4.164	0.06	4.91	4.50	34.02	2.72	2.55	0.48	73.01	2.31	Sand	Sand	73.01	2.31	1.97	143.80	0.36	0.20	0.54	FALSE	0.00	liq
82.02	107.5	163.26	4.519	0.06	4.92	4.50	35.17	2.85	2.55	0.48	75.45	2.31	Sand	Sand	75.45	2.31	1.99	149.83	0.39	0.20	0.54	FALSE	0.00	liq
82.19	107.3	177.12	4.794	0.06	4.93	4.51	38.20	2.78	2.52	0.48	81.81	2.28	Sand	Sand	81.81	2.28	1.88	154.18	0.42	0.20	0.54	FALSE	0.00	liq
82.35	107.2	172.56	4.677	0.06	4.94	4.51	37.15	2.79	2.53	0.48	79.66	2.29	Sand	Sand	79.66	2.29	1.91	152.24	0.41	0.20	0.54	FALSE	0.00	liq
82.51	107.0	157.42	4.551	0.06	4.95	4.52	33.76	2.99	2.58	0.48	72.64	2.34	Sand	Sand	72.64	2.34	2.07	150.57	0.40	0.20	0.54	FALSE	0.00	liq

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	CPT-100246	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
82.68	106.8	143.63	4.044	0.06	4.96	4.52	30.67	2.92	2.60	Clay	Clay	Clay	Clay	Clay	Clay	30.67	2.60	3.34	102.47	0.18	0.20	0.54	FALSE	0.00	Clay
82.84	106.7	137.96	3.674	0.06	4.97	4.53	29.38	2.76	2.60	Clay	Clay	Clay	Clay	Clay	Clay	29.38	2.60	3.34	98.01	0.17	0.20	0.54	FALSE	0.00	Clay
83.01	106.5	133.76	3.386	0.06	4.98	4.53	28.42	2.63	2.60	0.48	61.62	2.35	Sand	Sand	Sand	61.62	2.35	2.11	130.13	0.28	0.20	0.54	FALSE	0.00	liq
83.17	106.3	133.30	3.297	0.06	4.99	4.54	28.29	2.57	2.59	0.48	61.38	2.34	Sand	Sand	Sand	61.38	2.34	2.09	128.35	0.28	0.20	0.54	FALSE	0.00	liq
83.33	106.2	125.13	3.548	0.06	5.00	4.54	26.46	2.95	2.66	Clay	Clay	Clay	Clay	Clay	Clay	26.46	2.66	3.68	97.39	0.17	0.20	0.54	FALSE	0.00	Clay
83.50	106.0	85.19	3.715	0.06	5.01	4.55	17.64	4.63	2.92	Clay	Clay	Clay	Clay	Clay	Clay	17.64	2.92	5.85	103.23	0.18	0.20	0.54	FALSE	0.00	Clay
83.66	105.8	59.34	3.129	0.06	5.02	4.55	11.94	5.76	3.11	Clay	Clay	Clay	Clay	Clay	Clay	11.94	3.11	8.00	95.57	0.16	0.20	0.54	FALSE	0.00	Clay
83.83	105.7	75.72	3.295	0.06	5.03	4.55	15.52	4.66	2.96	Clay	Clay	Clay	Clay	Clay	Clay	15.52	2.96	6.31	97.90	0.17	0.20	0.54	FALSE	0.00	Clay
83.99	105.5	101.82	3.490	0.06	5.04	4.56	21.23	3.61	2.78	Clay	Clay	Clay	Clay	Clay	Clay	21.23	2.78	4.65	98.70	0.17	0.20	0.54	FALSE	0.00	Clay
84.15	105.4	147.87	3.790	0.06	5.05	4.56	31.29	2.65	2.57	0.48	67.87	2.32	Sand	Sand	Sand	67.87	2.32	2.02	136.92	0.32	0.20	0.54	FALSE	0.00	liq
84.32	105.2	188.59	3.686	0.06	5.06	4.57	40.17	2.01	2.41	0.48	86.52	2.16	Sand	Sand	Sand	86.52	2.16	1.58	136.34	0.32	0.20	0.54	FALSE	0.00	liq
84.48	105.0	164.85	3.271	0.06	5.07	4.57	34.94	2.05	2.46	0.48	75.59	2.21	Sand	Sand	Sand	75.59	2.21	1.69	127.57	0.27	0.20	0.54	FALSE	0.00	liq
84.65	104.9	123.46	3.226	0.06	5.08	4.58	25.86	2.73	2.64	Clay	Clay	Clay	Clay	Clay	Clay	25.86	2.64	3.59	92.70	0.15	0.20	0.54	FALSE	0.00	Clay
84.81	104.7	106.91	3.587	0.06	5.09	4.58	22.22	3.52	2.76	Clay	Clay	Clay	Clay	Clay	Clay	22.22	2.76	4.47	99.37	0.17	0.20	0.54	FALSE	0.00	Clay
84.97	104.5	123.62	3.554	0.06	5.10	4.59	25.84	3.00	2.67	Clay	Clay	Clay	Clay	Clay	Clay	25.84	2.67	3.76	97.24	0.17	0.20	0.54	FALSE	0.00	Clay
85.14	104.4	122.31	3.922	0.06	5.11	4.59	25.52	3.35	2.70	Clay	Clay	Clay	Clay	Clay	Clay	25.52	2.70	4.01	102.33	0.18	0.20	0.54	FALSE	0.00	Clay
85.30	104.2	132.09	4.529	0.06	5.12	4.60	27.62	3.57	2.69	Clay	Clay	Clay	Clay	Clay	Clay	27.62	2.69	3.95	109.14	0.20	0.20	0.54	FALSE	0.00	Clay
85.47	104.0	203.33	5.057	0.06	5.13	4.60	43.07	2.55	2.45	0.48	92.94	2.21	Sand	Sand	Sand	92.94	2.21	1.70	158.16	0.45	0.20	0.54	FALSE	0.00	liq
85.63	103.9	321.56	5.330	0.06	5.14	4.61	68.69	1.68	2.18	0.48	146.91	1.95	Sand	Sand	Sand	146.91	1.95	1.24	181.63	0.64	0.20	0.54	FALSE	0.00	liq
85.79	103.7	375.13	3.424	0.06	5.15	4.61	80.23	0.93	1.96	0.47	171.30	1.71	Sand	Sand	Sand	171.30	1.71	1.05	179.33	0.62	0.20	0.53	FALSE	0.00	liq
85.96	103.5	279.93	3.557	0.06	5.16	4.62	59.52	1.29	2.16	0.47	127.76	1.91	Sand	Sand	Sand	127.76	1.91	1.19	152.65	0.41	0.20	0.53	FALSE	0.00	liq

SR-91 Westbound Widening - RW No. 293 | EMI Project No. 10-126 | Sounding: CPT-10-051

PGA (g) 0.52 | Mag 7.3 | GW depth (ft) 50.0 | Ground EL. (ft MLLW) 180.0 | Note: Units are tons/cf, tons/sf, and feet

Depth (ft)	El. (ft MLLW)	$q_{c,tip}$ (tsf)	f_s (tsf)	Unit Wt (tcf)	Total OB (tsf)	Eff OB (tsf)	Q_1	F (%)	I_{c1}	C_{Q2}	Q_2	I_{c2}	C_{Q3}	Q_3	I_{c3}	q_{c1N}	I_c	K_c	$(q_{c1n})_{CS}$	$CRR_{7.5}$	CSR	r_d	MSF	FOS	Liquefaction
0.33	179.7	288.4	12.5	0.06	0.02	0.02	14564.7	4.33	1.98	7.25	2009.63	1.86	Sand	Sand	Sand	2009.77	1.86	1.16	2325.45	1169.60	0.34	1.00	1.07	3705.42	Above WT
0.82	179.2	222.4	4.7	0.06	0.05	0.05	4519.33	2.11	1.56	4.60	982.97	1.62	Sand	Sand	Sand	983.19	1.62	1.00	983.19	88.47	0.34	1.00	1.07	280.60	Above WT
1.31	178.7	134.1	2.2	0.06	0.08	0.08	1705.11	1.64	1.45	3.64	468.76	1.64	Sand	Sand	Sand	469.03	1.64	1.00	468.14	9.62	0.34	1.00	1.07	30.55	Above WT
1.80	178.2	96.8	1.5	0.06	0.11	0.11	895.30	1.55	1.50	3.10	288.51	1.73	Sand	Sand	Sand	288.83	1.73	1.06	306.56	2.76	0.34	1.00	1.07	8.77	Above WT
2.30	177.7	79.1	1.1	0.06	0.14	0.14	572.19	1.39	1.54	2.75	208.43	1.78	Sand	Sand	Sand	208.80	1.78	1.10	228.78	1.19	0.34	0.99	1.07	3.80	Above WT
2.79	177.2	56.8	0.8	0.06	0.17	0.17	338.31	1.41	1.66	2.49	135.73	1.91	Sand	Sand	Sand	136.13	1.91	1.20	163.74	0.49	0.34	0.99	1.07	1.56	Above WT
3.28	176.7	35.4	0.5	0.06	0.20	0.20	178.88	1.42	1.83	2.30	77.81	2.09	Sand	Sand	Sand	78.25	2.09	1.44	112.71	0.21	0.34	0.99	1.07	0.68	Above WT
3.77	176.2	28.5	0.4	0.06	0.23	0.23	124.99	1.41	1.94	2.14	58.29	2.19	Sand	Sand	Sand	58.76	2.19	1.64	96.12	0.16	0.34	0.99	1.07	0.52	Above WT
4.27	175.7	52.6	0.7	0.06	0.26	0.26	204.31	1.34	1.78	2.01	101.40	1.99	Sand	Sand	Sand	101.90	1.99	1.29	131.01	0.29	0.33	0.99	1.07	0.92	Above WT
4.76	175.2	66.3	0.7	0.06	0.29	0.29	231.14	1.06	1.67	1.91	121.13	1.86	Sand	Sand	Sand	121.65	1.86	1.16	140.71	0.34	0.33	0.99	1.07	1.09	Above WT
5.25	174.8	69.6	0.9	0.06	0.32	0.32	219.95	1.30	1.75	1.82	121.05	1.92	Sand	Sand	Sand	121.60	1.92	1.21	147.44	0.38	0.33	0.99	1.07	1.21	Above WT
5.74	174.3	72.9	0.6	0.06	0.34	0.34	210.67	0.83	1.61	1.74	121.23	1.79	Sand	Sand	Sand	121.81	1.79	1.10	134.21	0.30	0.33	0.99	1.07	0.98	Above WT
6.23	173.8	66.9	0.8	0.06	0.37	0.37	177.97	1.20	1.78	1.67	106.70	1.94	Sand	Sand	Sand	107.30	1.94	1.23	132.03	0.29	0.33	0.99	1.07	0.94	Above WT
6.73	173.3	62.7	0.7	0.06	0.40	0.40	154.27	1.12	1.80	1.60	96.13	1.96	Sand	Sand	Sand	96.75	1.96	1.25	120.61	0.24	0.33	0.98	1.07	0.78	Above WT
7.22	172.8	68.5	0.8	0.06	0.43	0.43	157.13	1.18	1.81	1.55	101.41	1.95	Sand	Sand	Sand	102.05	1.95	1.24	126.68	0.27	0.33	0.98	1.07	0.87	Above WT
7.71	172.3	64.6	0.6	0.06	0.46	0.46	138.65	0.94	1.78	1.50	92.47	1.92	Sand	Sand	Sand	93.14	1.92	1.21	112.39	0.21	0.33	0.98	1.07	0.68	Above WT
8.20	171.8	69.3	0.6	0.06	0.49	0.49	139.85	0.87	1.76	1.45	96.19	1.89	Sand	Sand	Sand	96.88	1.89	1.18	113.94	0.22	0.33	0.98	1.07	0.70	Above WT
8.69	171.3	74.7	0.7	0.06	0.52	0.52	142.27	0.94	1.78	1.41	100.73	1.89	Sand	Sand	Sand	101.44	1.89	1.18	119.83	0.24	0.33	0.98	1.07	0.78	Above WT
9.19	170.8	40.2	0.8	0.06	0.55	0.55	71.91	2.02	2.22	1.37	52.36	2.32	Sand	Sand	Sand	53.09	2.32	2.02	107.29	0.19	0.33	0.98	1.07	0.63	Above WT
9.68	170.3	100.6	0.8	0.06	0.58	0.58	172.21	0.80	1.67	1.34	128.69	1.76	Sand	Sand	Sand	129.44	1.76	1.08	139.96	0.33	0.33	0.98	1.07	1.08	Above WT
10.17	169.8	136.9	0.9	0.06	0.61	0.61	223.35	0.66	1.53	1.31	171.08	1.62	Sand	Sand	Sand	171.85	1.62	1.00	171.85	0.55	0.33	0.98	1.07	1.79	Above WT
10.66	169.3	192.7	2.3	0.06	0.64	0.64	300.28	1.20	1.63	1.28	235.49	1.70	Sand	Sand	Sand	236.27	1.70	1.04	245.27	1.45	0.33	0.98	1.07	4.71	Above WT
11.16	168.8	226.5	2.9	0.06	0.67	0.67	337.26	1.28	1.63	1.25	270.62	1.69	Sand	Sand	Sand	271.42	1.69	1.03	279.08	2.10	0.33	0.97	1.07	6.83	Above WT
11.65	168.4	233.4	3.3	0.06	0.70	0.70	332.91	1.42	1.67	1.22	272.92	1.72	Sand	Sand	Sand	273.74	1.72	1.05	287.38	2.29	0.33	0.97	1.07	7.44	Above WT
12.14	167.9	243.3	3.4	0.06	0.73	0.73	333.02	1.40	1.66	1.19	278.70	1.71	Sand	Sand	Sand	279.54	1.71	1.04	291.67	2.39	0.33	0.97	1.07	7.78	Above WT
12.63	167.4	238.0	3.1	0.06	0.76	0.76	313.07	1.31	1.65	1.17	267.24	1.70	Sand	Sand	Sand	268.09	1.70	1.03	277.35	2.06	0.33	0.97	1.07	6.73	Above WT
13.12	166.9	235.7	3.7	0.06	0.79	0.79	298.42	1.58	1.73	1.15	259.63	1.77	Sand	Sand	Sand	260.50	1.77	1.08	282.23	2.17	0.33	0.97	1.07	7.09	Above WT
13.62	166.4	237.0	3.6	0.06	0.82	0.82	289.01	1.52	1.73	1.13	256.19	1.76	Sand	Sand	Sand	257.08	1.76	1.08	277.12	2.06	0.33	0.97	1.07	6.73	Above WT
14.11	165.9	215.8	4.1	0.06	0.85	0.85	253.90	1.91	1.84	1.11	229.08	1.87	Sand	Sand	Sand	229.98	1.87	1.16	266.49	1.84	0.33	0.97	1.07	6.02	Above WT
14.60	165.4	225.5	4.1	0.06	0.88	0.88	256.42	1.83	1.82	1.09	235.34	1.84	Sand	Sand	Sand	236.25	1.84	1.14	269.40	1.90	0.33	0.97	1.07	6.22	Above WT
15.09	164.9	248.2	3.9	0.06	0.91	0.91	273.13	1.58	1.75	1.07	254.85	1.77	Sand	Sand	Sand	255.78	1.77	1.09	278.06	2.08	0.33	0.96	1.07	6.82	Above WT
15.58	164.4	255.0	2.6	0.06	0.93	0.93	271.79	1.02	1.61	1.05	257.67	1.62	Sand	Sand	Sand	258.62	1.62	1.00	258.62	1.69	0.33	0.96	1.07	5.55	Above WT
16.08	163.9	231.5	2.9	0.06	0.96	0.96	238.95	1.26	1.71	1.04	230.15	1.72	Sand	Sand	Sand	231.11	1.72	1.05	243.46	1.42	0.33	0.96	1.07	4.68	Above WT
16.57	163.4	251.5	3.9	0.06	0.99	0.99	251.97	1.56	1.77	1.02	246.36	1.78	Sand	Sand	Sand	247.33	1.78	1.09	269.64	1.90	0.32	0.96	1.07	6.27	Above WT
17.06	162.9	248.4	3.2	0.06	1.02	1.02	241.67	1.29	1.72	1.01	239.76	1.72	Sand	Sand	Sand	240.75	1.72	1.05	253.29	1.59	0.32	0.96	1.07	5.25	Above WT
17.55	162.5	231.5	3.5	0.06	1.05	1.05	218.85	1.52	1.80	0.99	220.21	1.80	Sand	Sand	Sand	221.22	1.80	1.11	244.58	1.44	0.32	0.96	1.07	4.76	Above WT
18.05	162.0	216.8	3.8	0.06	1.08	1.08	199.18	1.76	1.88	0.98	203.26	1.87	Sand	Sand	Sand	204.28	1.87	1.16	237.44	1.32	0.32	0.96	1.07	4.38	Above WT
18.54	161.5	239.3	4.5	0.06	1.11	1.11	214.12	1.89	1.88	0.97	221.45	1.87	Sand	Sand	Sand	222.48	1.87	1.16	258.85	1.69	0.32	0.96	1.07	5.60	Above WT
19.03	161.0	240.3	4.8	0.06	1.14	1.14	209.46	2.01	1.91	0.95	219.47	1.90	Sand	Sand	Sand	220.52	1.90	1.18	261.18	1.74	0.32	0.96	1.07	5.75	Above WT
19.52	160.5	262.6	5.2	0.06	1.17	1.17	223.21	1.99	1.89	0.94	236.88	1.87	Sand	Sand	Sand	237.94	1.87	1.16	276.96	2.06	0.32	0.95	1.07	6.82	Above WT
20.01	160.0	263.0	4.5	0.06	1.20	1.20	218.06	1.72	1.84	0.93	234.29	1.82	Sand	Sand	Sand	235.36	1.82	1.12	264.74	1.81	0.32	0.95	1.07	6.00	Above WT
20.51	159.5	243.5	3.8	0.06	1.23	1.23	196.87	1.57	1.84	0.92	214.15	1.82	Sand	Sand	Sand	215.24	1.82	1.12	240.91	1.38	0.32	0.95	1.07	4.59	Above WT

Depth (ft)	El. (ft MLLW)	$q_{c,tip}$ (tsf)	f_s (tsf)	Unit Wt (tcf)	Total OB (tsf)	Eff OB (tsf)	Q_1	F (%)	I_{c1}	C_{Q2}	Q_2	I_{c2}	C_{Q3}	Q_3	I_{c3}	q_{c1N}	I_c	K_c	$(q_{c1n})_{CS}$	$CRR_{7.5}$	CSR	r_d	MSF	FOS	Liquefaction
21.00	159.0	274.8	5.3	0.06	1.26	1.26	217.10	1.94	1.89	0.91	238.96	1.86	Sand	Sand	Sand	240.06	1.86	1.15	277.08	2.06	0.32	0.95	1.07	6.85	Above WT
21.49	158.5	252.2	5.2	0.06	1.29	1.29	194.59	2.07	1.94	0.90	216.67	1.91	Sand	Sand	Sand	217.79	1.91	1.20	260.95	1.73	0.32	0.95	1.07	5.77	Above WT
21.98	158.0	246.2	4.9	0.06	1.32	1.32	185.68	2.00	1.94	0.89	209.10	1.91	Sand	Sand	Sand	210.22	1.91	1.20	251.28	1.56	0.32	0.95	1.07	5.19	Above WT
22.47	157.5	271.0	4.3	0.06	1.35	1.35	200.01	1.59	1.84	0.88	227.72	1.81	Sand	Sand	Sand	228.86	1.81	1.11	254.29	1.61	0.32	0.95	1.07	5.38	Above WT
22.97	157.0	246.0	3.8	0.06	1.38	1.38	177.49	1.55	1.87	0.87	204.33	1.83	Sand	Sand	Sand	205.48	1.83	1.13	231.49	1.23	0.32	0.95	1.07	4.13	Above WT
23.46	156.5	204.5	2.7	0.06	1.41	1.41	144.28	1.33	1.88	0.86	167.86	1.83	Sand	Sand	Sand	169.02	2.60	3.33	562.28	16.61	0.32	0.95	1.07	55.63	Above WT
23.95	156.1	195.6	2.8	0.06	1.44	1.44	135.12	1.44	1.92	0.85	158.83	1.87	Sand	Sand	Sand	160.00	2.60	3.33	532.28	14.11	0.32	0.94	1.07	47.29	Above WT
24.44	155.6	189.9	2.7	0.06	1.47	1.47	128.50	1.43	1.94	0.84	152.59	1.88	Sand	Sand	Sand	153.77	2.60	3.33	511.56	12.53	0.32	0.94	1.07	42.06	Above WT
24.94	155.1	194.9	2.7	0.06	1.50	1.50	129.25	1.40	1.93	0.83	155.03	1.87	Sand	Sand	Sand	156.23	2.60	3.33	519.74	13.14	0.32	0.94	1.07	44.16	Above WT
25.43	154.6	220.7	3.5	0.06	1.53	1.53	143.65	1.60	1.94	0.83	173.99	1.88	Sand	Sand	Sand	175.20	2.60	3.33	582.85	18.49	0.32	0.94	1.07	62.24	Above WT
25.92	154.1	221.9	3.2	0.06	1.56	1.56	141.68	1.45	1.91	0.82	173.26	1.85	Sand	Sand	Sand	174.48	2.60	3.33	580.45	18.27	0.32	0.94	1.07	61.55	Above WT
26.41	153.6	231.9	3.7	0.06	1.58	1.58	145.35	1.61	1.93	0.81	179.41	1.87	Sand	Sand	Sand	180.64	2.60	3.33	600.95	20.26	0.32	0.94	1.07	68.36	Above WT
26.90	153.1	210.9	4.2	0.06	1.61	1.61	129.67	2.01	2.04	0.80	161.54	1.98	Sand	Sand	Sand	162.78	2.60	3.33	541.53	14.85	0.32	0.94	1.07	50.15	Above WT
27.40	152.6	219.0	4.9	0.06	1.64	1.64	132.21	2.25	2.07	0.80	166.23	2.01	Sand	Sand	Sand	167.49	2.60	3.33	557.18	16.17	0.32	0.94	1.07	54.67	Above WT
27.89	152.1	252.7	4.0	0.06	1.67	1.67	150.01	1.59	1.92	0.79	190.28	1.85	Sand	Sand	Sand	191.55	2.60	3.33	637.24	24.15	0.32	0.93	1.07	81.76	Above WT
28.38	151.6	220.5	2.8	0.06	1.70	1.70	128.49	1.28	1.90	0.78	164.42	1.83	Sand	Sand	Sand	165.70	2.60	3.33	551.22	15.66	0.32	0.93	1.07	53.08	Above WT
28.87	151.1	195.1	3.1	0.06	1.73	1.73	111.63	1.60	2.01	0.77	144.07	1.94	Sand	Sand	Sand	145.36	2.60	3.33	483.57	10.60	0.32	0.93	1.07	35.97	Above WT
29.36	150.6	240.4	3.0	0.06	1.76	1.76	135.47	1.26	1.88	0.77	176.31	1.80	Sand	Sand	Sand	177.61	2.60	3.33	590.85	19.26	0.31	0.93	1.07	65.46	Above WT
29.86	150.1	280.3	5.2	0.06	1.79	1.79	155.45	1.87	1.96	0.76	204.03	1.89	Sand	Sand	Sand	205.35	2.60	3.33	683.13	29.73	0.31	0.93	1.07	101.15	Above WT
30.35	149.7	287.2	6.3	0.06	1.82	1.82	156.72	2.21	2.02	0.76	207.37	1.94	Sand	Sand	Sand	208.70	2.60	3.33	694.27	31.20	0.31	0.93	1.07	106.56	Above WT
30.84	149.2	292.8	5.8	0.06	1.85	1.85	157.24	1.99	1.98	0.75	209.73	1.90	Sand	Sand	Sand	211.07	1.90	1.19	251.87	1.57	0.31	0.92	1.07	5.37	Above WT
31.33	148.7	312.8	6.3	0.06	1.88	1.88	165.40	2.03	1.97	0.74	222.37	1.90	Sand	Sand	Sand	223.71	1.90	1.18	264.96	1.81	0.31	0.92	1.07	6.23	Above WT
31.83	148.2	308.6	5.3	0.06	1.91	1.91	160.59	1.73	1.93	0.74	217.62	1.85	Sand	Sand	Sand	218.97	2.60	3.33	728.45	36.03	0.31	0.91	1.07	124.67	Above WT
32.32	147.7	306.9	4.7	0.06	1.94	1.94	157.26	1.54	1.90	0.73	214.74	1.81	Sand	Sand	Sand	216.11	2.60	3.33	718.93	34.64	0.31	0.91	1.07	120.38	Above WT
32.81	147.2	339.4	4.4	0.06	1.97	1.97	171.41	1.30	1.82	0.73	235.83	1.73	Sand	Sand	Sand	237.20	1.73	1.06	250.71	1.55	0.31	0.91	1.07	5.39	Above WT
33.30	146.7	360.5	5.8	0.06	2.00	2.00	179.43	1.62	1.88	0.72	248.70	1.79	Sand	Sand	Sand	250.09	2.60	3.33	831.97	53.64	0.31	0.90	1.07	188.05	Above WT
33.79	146.2	355.3	4.7	0.06	2.03	2.03	174.25	1.33	1.82	0.72	243.29	1.73	Sand	Sand	Sand	244.69	1.73	1.06	258.33	1.68	0.30	0.90	1.07	5.93	Above WT
34.29	145.7	358.4	5.2	0.06	2.06	2.06	173.20	1.46	1.85	0.71	243.61	1.76	Sand	Sand	Sand	245.01	1.76	1.08	263.84	1.79	0.30	0.89	1.07	6.33	Above WT
34.78	145.2	316.6	4.7	0.06	2.09	2.09	150.72	1.49	1.90	0.71	213.49	1.80	Sand	Sand	Sand	214.91	1.80	1.11	238.07	1.33	0.30	0.89	1.07	4.74	Above WT
35.27	144.7	304.0	3.8	0.06	2.12	2.12	142.65	1.26	1.86	0.70	203.49	1.76	Sand	Sand	Sand	204.92	1.76	1.08	220.74	1.08	0.30	0.89	1.07	3.86	Above WT
35.76	144.2	273.9	4.0	0.06	2.15	2.15	126.66	1.47	1.95	0.70	181.92	1.84	Sand	Sand	Sand	183.36	1.84	1.14	208.68	0.93	0.30	0.88	1.07	3.32	Above WT
36.26	143.7	277.5	4.1	0.06	2.18	2.18	126.55	1.49	1.95	0.69	183.04	1.84	Sand	Sand	Sand	184.48	1.84	1.14	210.27	0.94	0.30	0.88	1.07	3.40	Above WT
36.75	143.3	243.0	3.7	0.06	2.21	2.21	109.20	1.54	2.01	0.69	159.01	1.89	Sand	Sand	Sand	160.47	1.89	1.18	189.89	0.72	0.30	0.87	1.07	2.59	Above WT
37.24	142.8	235.7	3.2	0.06	2.23	2.23	104.49	1.37	1.99	0.68	153.15	1.87	Sand	Sand	Sand	154.62	1.87	1.16	179.47	0.62	0.29	0.87	1.07	2.25	Above WT
37.73	142.3	220.9	2.8	0.06	2.26	2.26	96.58	1.28	1.99	0.68	142.49	1.87	Sand	Sand	Sand	143.97	1.87	1.16	167.19	0.51	0.29	0.87	1.07	1.88	Above WT
38.22	141.8	229.3	3.3	0.06	2.29	2.29	98.99	1.45	2.02	0.67	146.99	1.90	Sand	Sand	Sand	148.48	1.90	1.19	176.45	0.59	0.29	0.86	1.07	2.17	Above WT
38.72	141.3	233.9	3.2	0.06	2.32	2.32	99.68	1.38	2.00	0.67	148.98	1.88	Sand	Sand	Sand	150.48	1.88	1.17	176.08	0.59	0.29	0.86	1.07	2.17	Above WT
39.21	140.8	267.4	3.7	0.06	2.35	2.35	112.66	1.40	1.97	0.66	169.45	1.84	Sand	Sand	Sand	170.95	1.84	1.14	195.02	0.77	0.29	0.85	1.07	2.85	Above WT
39.70	140.3	298.8	5.2	0.06	2.38	2.38	124.44	1.75	2.01	0.66	188.33	1.89	Sand	Sand	Sand	189.84	1.89	1.18	223.92	1.12	0.29	0.85	1.07	4.18	Above WT
40.19	139.8	315.2	5.2	0.06	2.41	2.41	129.71	1.66	1.98	0.66	197.51	1.86	Sand	Sand	Sand	199.04	1.86	1.15	229.35	1.20	0.29	0.85	1.07	4.49	Above WT
40.68	139.3	309.2	5.1	0.06	2.44	2.44	125.68	1.66	1.99	0.65	192.54	1.87	Sand	Sand	Sand	194.07	1.87	1.16	224.78	1.14	0.28	0.84	1.07	4.27	Above WT
41.18	138.8	262.2	5.1	0.06	2.47	2.47	105.12	1.96	2.09	0.65	162.03	1.97	Sand	Sand	Sand	163.57	1.97	1.26	206.40	0.90	0.28	0.84	1.07	3.39	Above WT
41.67	138.3	305.7	4.0	0.06	2.50	2.50	121.27	1.32	1.93	0.64	188.03	1.80	Sand	Sand	Sand	189.58	1.80	1.10	209.28	0.93	0.28	0.83	1.07	3.54	Above WT
42.16	137.8	255.6	4.3	0.06	2.53	2.53	100.04	1.70	2.06	0.64	156.03	1.93	Sand	Sand	Sand	157.59	2.61	3.39	533.98	14.24	0.28	0.83	1.07	54.26	Above WT
42.65	137.4	293.4	4.7	0.06	2.56	2.56	113.65	1.62	2.01	0.64	178.28	1.88	Sand	Sand	Sand	179.85	1.88	1.17	210.18	0.94	0.28	0.83	1.07	3.61	Above WT
43.15	136.9	309.7	4.7	0.06	2.59	2.59	118.62	1.53	1.98	0.63	187.16	1.85	Sand	Sand	Sand	188.74	1.85	1.14	215.53	1.01	0.28	0.82	1.07	3.89	Above WT

Depth (ft)	El. (ft MLLW)	$q_{c,tip}$ (tsf)	f_s (tsf)	Unit Wt (tcf)	Total OB (tsf)	Eff OB (tsf)	Q_1	F (%)	I_{c1}	C_{Q2}	Q_2	I_{c2}	C_{Q3}	Q_3	I_{c3}	q_{c1N}	I_c	K_c	$(q_{c1n})_{CS}$	$CRR_{7.5}$	CSR	r_d	MSF	FOS	Liquefaction
43.64	136.4	306.3	5.2	0.06	2.62	2.62	115.98	1.71	2.02	0.63	184.03	1.89	Sand	Sand	Sand	185.61	1.89	1.18	218.64	1.05	0.28	0.82	1.07	4.07	Above WT
44.13	135.9	317.6	5.1	0.06	2.65	2.65	118.95	1.62	2.00	0.63	189.80	1.86	Sand	Sand	Sand	191.39	2.61	3.39	648.53	25.45	0.28	0.81	1.07	98.87	Above WT
44.62	135.4	245.0	2.9	0.06	2.68	2.68	90.51	1.20	1.99	0.62	145.22	1.84	Sand	Sand	Sand	146.83	1.84	1.14	167.27	0.52	0.27	0.81	1.07	2.01	Above WT
45.11	134.9	52.1	1.7	0.06	2.71	2.71	18.25	3.44	2.82	Clay	Clay	Clay	Clay	Clay	Clay	19.25	2.82	4.98	95.79	0.16	0.27	0.81	1.07	0.63	Above WT
45.61	134.4	18.0	0.7	0.06	2.74	2.74	5.58	4.59	3.31	Clay	Clay	Clay	Clay	Clay	Clay	6.58	3.31	10.87	71.53	0.11	0.27	0.80	1.07	0.45	Above WT
46.10	133.9	178.4	3.8	0.06	2.77	2.77	63.50	2.16	2.28	0.61	103.55	2.13	Sand	Sand	Sand	105.18	2.13	1.51	158.93	0.45	0.27	0.80	1.07	1.80	Above WT
46.59	133.4	371.5	7.7	0.06	2.80	2.80	131.90	2.09	2.05	0.61	216.24	1.91	Sand	Sand	Sand	217.88	1.91	1.20	261.74	1.75	0.27	0.79	1.07	6.96	Above WT
47.08	132.9	387.2	9.0	0.06	2.82	2.82	136.07	2.34	2.08	0.61	224.26	1.94	Sand	Sand	Sand	225.90	1.94	1.23	278.61	2.09	0.27	0.79	1.07	8.37	Above WT
47.57	132.4	372.0	6.8	0.06	2.85	2.85	129.33	1.84	2.01	0.60	214.26	1.87	Sand	Sand	Sand	215.92	1.87	1.16	251.19	1.55	0.27	0.79	1.07	6.25	Above WT
48.07	131.9	320.2	5.3	0.06	2.88	2.88	110.02	1.67	2.03	0.60	183.22	1.88	Sand	Sand	Sand	184.88	1.88	1.17	216.60	1.03	0.26	0.78	1.07	4.15	Above WT
48.56	131.4	252.8	5.1	0.06	2.91	2.91	85.77	2.04	2.17	0.60	143.55	2.02	Sand	Sand	Sand	145.23	2.02	1.32	191.91	0.74	0.26	0.78	1.07	3.00	Above WT
49.05	131.0	187.0	5.0	0.06	2.94	2.94	62.54	2.72	2.35	0.59	105.21	2.20	Sand	Sand	Sand	106.89	2.20	1.66	177.70	0.60	0.26	0.77	1.07	2.46	Above WT
49.54	130.5	157.5	4.9	0.06	2.97	2.97	51.99	3.17	2.46	0.59	87.89	2.30	Sand	Sand	Sand	89.58	2.30	1.95	174.65	0.58	0.26	0.77	1.07	2.36	Above WT
50.04	130.0	134.2	3.3	0.06	3.00	3.00	43.72	2.52	2.44	0.59	74.26	2.28	Sand	Sand	Sand	75.96	2.28	1.88	142.54	0.35	0.26	0.77	1.07	1.44	Nonliq
50.53	129.5	50.0	2.5	0.06	3.03	3.02	15.58	5.32	3.00	Clay	Clay	Clay	Clay	Clay	Clay	16.58	3.00	6.70	111.05	0.21	0.26	0.76	1.07	0.86	Clay
51.02	129.0	27.4	1.1	0.06	3.06	3.03	8.03	4.52	3.18	Clay	Clay	Clay	Clay	Clay	Clay	9.04	3.18	8.94	80.83	0.13	0.26	0.76	1.07	0.53	Clay
51.51	128.5	28.1	1.5	0.06	3.09	3.04	8.22	6.00	3.24	Clay	Clay	Clay	Clay	Clay	Clay	9.23	3.24	9.87	91.14	0.15	0.26	0.75	1.07	0.62	Clay
52.00	128.0	46.1	2.0	0.06	3.12	3.06	14.05	4.65	2.99	Clay	Clay	Clay	Clay	Clay	Clay	15.08	2.99	6.66	100.44	0.17	0.26	0.75	1.07	0.72	Clay
52.50	127.5	21.9	0.9	0.06	3.15	3.07	6.10	4.80	3.29	Clay	Clay	Clay	Clay	Clay	Clay	7.13	3.29	10.56	75.24	0.12	0.26	0.75	1.07	0.49	Clay
52.99	127.0	19.7	0.6	0.06	3.18	3.09	5.35	3.63	3.27	Clay	Clay	Clay	Clay	Clay	Clay	6.38	3.27	10.24	65.36	0.11	0.26	0.74	1.07	0.44	Clay
53.48	126.5	27.3	1.0	0.06	3.21	3.10	7.77	4.15	3.17	Clay	Clay	Clay	Clay	Clay	Clay	8.80	3.17	8.80	77.51	0.12	0.26	0.74	1.07	0.51	Clay
53.97	126.0	20.8	0.7	0.06	3.24	3.12	5.64	3.99	3.27	Clay	Clay	Clay	Clay	Clay	Clay	6.68	3.27	10.29	68.72	0.11	0.26	0.73	1.07	0.46	Clay
54.46	125.5	21.4	0.7	0.06	3.27	3.13	5.79	3.86	3.25	Clay	Clay	Clay	Clay	Clay	Clay	6.84	3.25	10.03	68.60	0.11	0.26	0.73	1.07	0.46	Clay
54.96	125.0	100.0	3.7	0.06	3.30	3.14	30.76	3.83	2.68	Clay	Clay	Clay	Clay	Clay	Clay	31.81	2.68	3.85	122.39	0.25	0.26	0.73	1.07	1.04	Clay
55.45	124.6	276.0	6.2	0.06	3.33	3.16	86.34	2.27	2.20	0.57	150.46	2.04	Sand	Sand	Sand	152.29	2.04	1.35	206.23	0.90	0.26	0.72	1.07	3.72	Nonliq
55.94	124.1	394.7	8.2	0.06	3.36	3.17	123.36	2.10	2.07	0.57	215.46	1.92	Sand	Sand	Sand	217.30	1.92	1.20	261.49	1.74	0.26	0.72	1.07	7.26	Nonliq
56.43	123.6	394.9	8.7	0.06	3.39	3.19	122.87	2.22	2.09	0.57	215.07	1.94	Sand	Sand	Sand	216.93	1.94	1.22	265.70	1.82	0.26	0.71	1.07	7.61	Nonliq
56.93	123.1	383.5	3.8	0.06	3.42	3.20	118.74	1.00	1.85	0.57	208.32	1.68	Sand	Sand	Sand	210.19	1.68	1.02	214.91	1.00	0.26	0.71	1.07	4.19	Nonliq
57.09	122.9	388.7	3.2	0.06	3.43	3.21	120.19	0.83	1.80	0.57	211.01	1.62	Sand	Sand	Sand	212.88	1.62	1.00	212.88	0.98	0.26	0.71	1.07	4.08	Nonliq

SR-91 Westbound Widening - Acacia Street UC EMI Project No. 10-126 Sounding: CPT-10-053

PGA (g) 0.52 Mag 7.3 GW depth (ft) 70.0 Ground EL. (ft MLLW) 200.0 Note: Units are tons/cf, tons/sf, and feet

Depth (ft)	El. (ft MLLW)	$q_{c,tip}$ (tsf)	f_s (tsf)	Unit Wt (tcf)	Total OB (tsf)	Eff OB (tsf)	Q_1	F (%)	I_{c1}	C_{Q2}	Q_2	I_{c2}	C_{Q3}	Q_3	I_{c3}	q_{c1N}	I_c	K_c	$(q_{c1n})_{CS}$	$CRR_{7.5}$	CSR	r_d	MSF	FOS	Liquefaction
0.33	199.7	3.5	0.8	0.06	0.02	0.02	175.77	22.99	2.86	Clay	Clay	Clay	Clay	Clay	Clay	176.77	2.86	5.29	935.69	76.27	0.34	1.00	1.07	241.62	Above WT
0.82	199.2	194.4	2.5	0.06	0.05	0.05	3950.22	1.29	1.34	4.60	859.19	1.43	Sand	Sand	Sand	859.40	1.43	1.00	859.40	59.11	0.34	1.00	1.07	187.48	Above WT
1.31	198.7	171.9	2.2	0.06	0.08	0.08	2186.02	1.28	1.33	3.64	600.97	1.50	Sand	Sand	Sand	601.24	1.50	1.00	601.24	20.29	0.34	1.00	1.07	64.44	Above WT
1.80	198.2	213.3	3.2	0.06	0.11	0.11	1974.00	1.50	1.41	3.10	636.12	1.55	Sand	Sand	Sand	636.45	1.55	1.00	636.45	24.06	0.34	1.00	1.07	76.47	Above WT
2.30	197.7	253.2	3.1	0.06	0.14	0.14	1833.78	1.22	1.32	2.75	667.99	1.46	Sand	Sand	Sand	668.36	1.46	1.00	668.36	27.85	0.34	0.99	1.07	88.63	Above WT
2.79	197.2	279.7	2.1	0.06	0.17	0.17	1669.85	0.75	1.12	2.49	669.94	1.27	Sand	Sand	Sand	670.34	1.27	1.00	670.34	28.09	0.34	0.99	1.07	89.52	Above WT
3.28	196.7	203.8	2.9	0.06	0.20	0.20	1034.57	1.42	1.45	2.30	450.04	1.60	Sand	Sand	Sand	450.48	1.60	1.00	450.48	8.58	0.34	0.99	1.07	27.38	Above WT
3.77	196.2	208.2	2.3	0.06	0.23	0.23	919.42	1.11	1.36	2.14	428.79	1.52	Sand	Sand	Sand	429.26	1.52	1.00	429.26	7.44	0.34	0.99	1.07	23.75	Above WT
4.27	195.7	276.8	4.1	0.06	0.26	0.26	1079.41	1.48	1.46	2.01	535.74	1.58	Sand	Sand	Sand	536.24	1.58	1.00	536.24	14.42	0.33	0.99	1.07	46.11	Above WT
4.76	195.2	260.1	3.7	0.06	0.29	0.29	909.71	1.42	1.47	1.91	476.72	1.59	Sand	Sand	Sand	477.25	1.59	1.00	477.25	10.19	0.33	0.99	1.07	32.62	Above WT
5.25	194.8	274.4	3.9	0.06	0.32	0.32	870.11	1.42	1.47	1.82	478.87	1.58	Sand	Sand	Sand	479.42	1.58	1.00	479.42	10.33	0.33	0.99	1.07	33.10	Above WT
5.74	194.3	199.2	2.8	0.06	0.34	0.34	577.40	1.41	1.54	1.74	332.27	1.67	Sand	Sand	Sand	332.84	1.67	1.01	337.51	3.66	0.33	0.99	1.07	11.73	Above WT
6.23	193.8	157.2	1.9	0.06	0.37	0.37	419.55	1.21	1.55	1.67	251.53	1.69	Sand	Sand	Sand	252.13	1.69	1.03	259.26	1.70	0.33	0.99	1.07	5.46	Above WT
6.73	193.3	203.4	2.2	0.06	0.40	0.40	502.71	1.08	1.47	1.60	313.25	1.59	Sand	Sand	Sand	313.87	1.59	1.00	313.87	2.96	0.33	0.98	1.07	9.51	Above WT
7.22	192.8	303.4	3.9	0.06	0.43	0.43	699.37	1.29	1.47	1.55	451.37	1.56	Sand	Sand	Sand	452.02	1.56	1.00	452.02	8.67	0.33	0.98	1.07	27.91	Above WT
7.71	192.3	371.7	5.5	0.06	0.46	0.46	802.50	1.48	1.50	1.50	535.22	1.58	Sand	Sand	Sand	535.89	1.58	1.00	535.89	14.39	0.33	0.98	1.07	46.39	Above WT
8.20	191.8	424.9	6.8	0.06	0.49	0.49	862.62	1.60	1.52	1.45	593.31	1.59	Sand	Sand	Sand	594.00	1.59	1.00	594.00	19.57	0.33	0.98	1.07	63.17	Above WT
8.69	191.3	434.9	6.6	0.06	0.52	0.52	833.10	1.52	1.51	1.41	589.88	1.57	Sand	Sand	Sand	590.59	1.57	1.00	590.59	19.24	0.33	0.98	1.07	62.16	Above WT
9.19	190.8	342.2	5.2	0.06	0.55	0.55	619.60	1.52	1.56	1.37	451.16	1.62	Sand	Sand	Sand	451.89	1.62	1.00	451.89	8.66	0.33	0.98	1.07	28.02	Above WT
9.68	190.3	254.3	3.8	0.06	0.58	0.58	436.84	1.50	1.62	1.34	326.46	1.69	Sand	Sand	Sand	327.20	1.69	1.03	337.73	3.66	0.33	0.98	1.07	11.86	Above WT
10.17	189.8	184.4	2.0	0.06	0.61	0.61	301.20	1.09	1.60	1.31	230.71	1.67	Sand	Sand	Sand	231.48	1.67	1.02	236.25	1.31	0.33	0.98	1.07	4.24	Above WT
10.66	189.3	119.7	0.8	0.06	0.64	0.64	186.15	0.67	1.59	1.28	145.98	1.67	Sand	Sand	Sand	146.77	1.67	1.02	149.70	0.39	0.33	0.98	1.07	1.27	Above WT
11.16	188.8	81.5	0.9	0.06	0.67	0.67	120.71	1.11	1.88	1.25	96.86	1.95	Sand	Sand	Sand	97.66	1.95	1.24	121.19	0.25	0.33	0.97	1.07	0.80	Above WT
11.65	188.4	47.1	0.5	0.06	0.70	0.70	66.38	1.08	2.07	1.22	54.42	2.14	Sand	Sand	Sand	55.24	2.14	1.53	84.54	0.14	0.33	0.97	1.07	0.44	Above WT
12.14	187.9	36.1	0.4	0.06	0.73	0.73	48.56	1.13	2.19	1.19	40.64	2.26	Sand	Sand	Sand	41.48	2.26	1.81	75.17	0.12	0.33	0.97	1.07	0.39	Above WT
12.63	187.4	34.1	0.4	0.06	0.76	0.76	44.00	1.20	2.24	1.17	37.56	2.30	Sand	Sand	Sand	38.41	2.30	1.94	74.58	0.12	0.33	0.97	1.07	0.39	Above WT
13.12	186.9	146.4	1.8	0.06	0.79	0.79	184.98	1.24	1.78	1.15	160.93	1.82	Sand	Sand	Sand	161.80	1.82	1.12	181.64	0.64	0.33	0.97	1.07	2.08	Above WT
13.62	186.4	359.9	5.2	0.06	0.82	0.82	439.41	1.45	1.61	1.13	389.51	1.64	Sand	Sand	Sand	390.39	1.64	1.00	390.39	5.61	0.33	0.97	1.07	18.35	Above WT
14.11	185.9	366.3	6.4	0.06	0.85	0.85	431.67	1.75	1.68	1.11	389.47	1.71	Sand	Sand	Sand	390.37	1.71	1.04	407.08	6.35	0.33	0.97	1.07	20.80	Above WT
14.60	185.4	377.1	6.5	0.06	0.88	0.88	429.48	1.73	1.68	1.09	394.16	1.70	Sand	Sand	Sand	395.08	1.70	1.04	409.93	6.49	0.33	0.97	1.07	21.26	Above WT
15.09	184.9	345.7	5.5	0.06	0.91	0.91	380.82	1.60	1.68	1.07	355.32	1.69	Sand	Sand	Sand	356.26	1.69	1.03	368.30	4.73	0.33	0.96	1.07	15.51	Above WT
15.58	184.4	301.1	5.8	0.06	0.93	0.93	321.10	1.93	1.79	1.05	304.43	1.80	Sand	Sand	Sand	305.38	1.80	1.11	338.04	3.67	0.33	0.96	1.07	12.06	Above WT
16.08	183.9	178.4	2.7	0.06	0.96	0.96	183.91	1.52	1.85	1.04	177.14	1.86	Sand	Sand	Sand	178.10	1.86	1.15	205.39	0.89	0.33	0.96	1.07	2.91	Above WT
16.57	183.4	57.5	2.4	0.06	0.99	0.99	56.84	4.25	2.52	1.02	55.57	2.53	Sand	Sand	Sand	56.55	2.53	2.92	164.84	0.50	0.32	0.96	1.07	1.64	Above WT
17.06	182.9	82.3	1.3	0.06	1.02	1.02	79.40	1.60	2.12	1.01	78.77	2.12	Sand	Sand	Sand	79.77	2.12	1.50	119.37	0.24	0.32	0.96	1.07	0.79	Above WT
17.55	182.5	63.3	1.5	0.06	1.05	1.05	59.11	2.41	2.33	0.99	59.48	2.33	Sand	Sand	Sand	60.49	2.33	2.06	124.49	0.26	0.32	0.96	1.07	0.86	Above WT
18.05	182.0	56.5	1.2	0.06	1.08	1.08	51.17	2.17	2.35	0.98	52.22	2.34	Sand	Sand	Sand	53.24	2.34	2.09	111.51	0.21	0.32	0.96	1.07	0.69	Above WT
18.54	181.5	97.3	1.9	0.06	1.11	1.11	86.47	1.98	2.16	0.97	89.43	2.15	Sand	Sand	Sand	90.46	2.15	1.54	139.61	0.33	0.32	0.96	1.07	1.10	Above WT
19.03	181.0	109.2	2.2	0.06	1.14	1.14	94.64	2.04	2.14	0.95	99.16	2.12	Sand	Sand	Sand	100.21	2.12	1.50	150.19	0.40	0.32	0.96	1.07	1.31	Above WT
19.52	180.5	107.8	2.2	0.06	1.17	1.17	91.04	2.06	2.15	0.94	96.61	2.14	Sand	Sand	Sand	97.68	2.14	1.52	148.72	0.39	0.32	0.95	1.07	1.28	Above WT
20.01	180.0	107.5	2.1	0.06	1.20	1.20	88.54	1.98	2.15	0.93	95.13	2.13	Sand	Sand	Sand	96.20	2.13	1.51	144.79	0.36	0.32	0.95	1.07	1.20	Above WT
20.51	179.5	111.2	2.1	0.06	1.23	1.23	89.36	1.91	2.14	0.92	97.21	2.11	Sand	Sand	Sand	98.29	2.11	1.47	144.72	0.36	0.32	0.95	1.07	1.20	Above WT

Depth (ft)	El. (ft MLLW)	$q_{c,tip}$ (tsf)	f_s (tsf)	Unit Wt (tcf)	Total OB (tsf)	Eff OB (tsf)	Q_1	F (%)	I_{c1}	C_{Q2}	Q_2	I_{c2}	C_{Q3}	Q_3	I_{c3}	q_{c1N}	I_c	K_c	$(q_{c1n})_{cs}$	$CRR_{7.5}$	CSR	r_d	MSF	FOS	Liquefaction
21.00	179.0	102.2	1.6	0.06	1.26	1.26	80.11	1.59	2.11	0.91	88.18	2.08	Sand	Sand	Sand	89.28	2.08	1.43	127.28	0.27	0.32	0.95	1.07	0.90	Above WT
21.49	178.5	117.9	1.7	0.06	1.29	1.29	90.44	1.46	2.05	0.90	100.70	2.02	Sand	Sand	Sand	101.81	2.02	1.32	134.63	0.31	0.32	0.95	1.07	1.02	Above WT
21.98	178.0	98.3	1.4	0.06	1.32	1.32	73.54	1.44	2.12	0.89	82.81	2.08	Sand	Sand	Sand	83.94	2.08	1.41	118.64	0.24	0.32	0.95	1.07	0.79	Above WT
22.47	177.5	119.2	0.9	0.06	1.35	1.35	87.41	0.76	1.88	0.88	99.53	1.84	Sand	Sand	Sand	100.67	1.84	1.14	114.41	0.22	0.32	0.95	1.07	0.73	Above WT
22.97	177.0	133.1	1.6	0.06	1.38	1.38	95.58	1.21	1.98	0.87	110.02	1.93	Sand	Sand	Sand	111.17	1.93	1.22	135.98	0.31	0.32	0.95	1.07	1.05	Above WT
23.46	176.5	153.0	1.9	0.06	1.41	1.41	107.70	1.25	1.95	0.86	125.29	1.90	Sand	Sand	Sand	126.45	2.60	3.33	420.68	7.00	0.32	0.95	1.07	23.45	Above WT
23.95	176.1	167.1	2.3	0.06	1.44	1.44	115.28	1.39	1.96	0.85	135.51	1.91	Sand	Sand	Sand	136.69	2.60	3.33	454.72	8.82	0.32	0.94	1.07	29.59	Above WT
24.44	175.6	169.3	2.1	0.06	1.47	1.47	114.45	1.25	1.93	0.84	135.91	1.88	Sand	Sand	Sand	137.09	2.60	3.33	456.07	8.90	0.32	0.94	1.07	29.88	Above WT
24.94	175.1	192.0	3.1	0.06	1.50	1.50	127.31	1.63	1.98	0.83	152.71	1.92	Sand	Sand	Sand	153.91	2.60	3.33	512.01	12.56	0.32	0.94	1.07	42.23	Above WT
25.43	174.6	220.3	3.3	0.06	1.53	1.53	143.38	1.51	1.92	0.83	173.67	1.86	Sand	Sand	Sand	174.88	2.60	3.33	581.79	18.39	0.32	0.94	1.07	61.90	Above WT
25.92	174.1	250.9	2.6	0.06	1.56	1.56	160.33	1.04	1.77	0.82	196.06	1.71	Sand	Sand	Sand	197.28	2.60	3.33	656.31	26.37	0.32	0.94	1.07	88.85	Above WT
26.41	173.6	249.4	4.1	0.06	1.58	1.58	156.39	1.65	1.92	0.81	193.04	1.86	Sand	Sand	Sand	194.28	2.60	3.33	646.30	25.19	0.32	0.94	1.07	84.97	Above WT
26.90	173.1	237.6	4.7	0.06	1.61	1.61	146.21	1.99	2.00	0.80	182.15	1.94	Sand	Sand	Sand	183.39	2.60	3.33	610.09	21.20	0.32	0.94	1.07	71.60	Above WT
27.40	172.6	241.4	5.0	0.06	1.64	1.64	145.84	2.09	2.02	0.80	183.36	1.96	Sand	Sand	Sand	184.62	2.60	3.33	614.17	21.62	0.32	0.94	1.07	73.13	Above WT
27.89	172.1	248.8	5.3	0.06	1.67	1.67	147.68	2.14	2.02	0.79	187.33	1.96	Sand	Sand	Sand	188.60	2.60	3.33	627.41	23.05	0.32	0.93	1.07	78.04	Above WT
28.38	171.6	262.1	5.3	0.06	1.70	1.70	152.92	2.04	2.00	0.78	195.68	1.93	Sand	Sand	Sand	196.96	2.60	3.33	655.22	26.24	0.32	0.93	1.07	88.96	Above WT
28.87	171.1	268.4	5.0	0.06	1.73	1.73	153.95	1.87	1.97	0.77	198.68	1.90	Sand	Sand	Sand	199.97	2.60	3.33	665.25	27.46	0.32	0.93	1.07	93.21	Above WT
29.36	170.6	287.4	4.5	0.06	1.76	1.76	162.15	1.58	1.90	0.77	211.03	1.82	Sand	Sand	Sand	212.33	2.60	3.33	706.37	32.86	0.31	0.93	1.07	111.66	Above WT
29.86	170.1	301.6	4.7	0.06	1.79	1.79	167.34	1.57	1.89	0.76	219.64	1.81	Sand	Sand	Sand	220.95	2.60	3.33	735.04	37.01	0.31	0.93	1.07	125.94	Above WT
30.35	169.7	326.6	6.1	0.06	1.82	1.82	178.35	1.88	1.93	0.76	236.00	1.85	Sand	Sand	Sand	237.33	2.60	3.33	789.52	45.85	0.31	0.93	1.07	156.58	Above WT
30.84	169.2	310.5	7.2	0.06	1.85	1.85	166.80	2.33	2.02	0.75	222.49	1.94	Sand	Sand	Sand	223.83	1.94	1.23	276.21	2.04	0.31	0.92	1.07	7.00	Above WT
31.33	168.7	328.4	6.3	0.06	1.88	1.88	173.70	1.93	1.94	0.74	233.53	1.87	Sand	Sand	Sand	234.87	1.87	1.16	271.97	1.95	0.31	0.92	1.07	6.72	Above WT
31.83	168.2	296.7	4.3	0.06	1.91	1.91	154.36	1.46	1.89	0.74	209.17	1.80	Sand	Sand	Sand	210.53	2.60	3.33	700.36	32.03	0.31	0.91	1.07	110.82	Above WT
32.32	167.7	297.7	4.4	0.06	1.94	1.94	152.52	1.49	1.90	0.73	208.26	1.81	Sand	Sand	Sand	209.63	2.60	3.33	697.38	31.62	0.31	0.91	1.07	109.90	Above WT
32.81	167.2	299.2	4.9	0.06	1.97	1.97	150.99	1.65	1.93	0.73	207.73	1.84	Sand	Sand	Sand	209.11	1.84	1.14	238.12	1.34	0.31	0.91	1.07	4.66	Above WT
33.30	166.7	328.1	4.5	0.06	2.00	2.00	163.21	1.38	1.85	0.72	226.22	1.76	Sand	Sand	Sand	227.61	2.60	3.33	757.20	40.45	0.31	0.90	1.07	141.83	Above WT
33.79	166.2	241.5	4.1	0.06	2.03	2.03	118.12	1.71	2.02	0.72	164.92	1.92	Sand	Sand	Sand	166.31	1.92	1.21	200.77	0.83	0.30	0.90	1.07	2.93	Above WT
34.29	165.7	262.8	3.8	0.06	2.06	2.06	126.73	1.46	1.95	0.71	178.25	1.84	Sand	Sand	Sand	179.66	1.84	1.14	204.84	0.88	0.30	0.89	1.07	3.11	Above WT
34.78	165.2	293.9	4.2	0.06	2.09	2.09	139.84	1.44	1.91	0.71	198.08	1.81	Sand	Sand	Sand	199.50	1.81	1.11	222.22	1.10	0.30	0.89	1.07	3.91	Above WT
35.27	164.7	283.7	3.7	0.06	2.12	2.12	133.06	1.31	1.90	0.70	189.81	1.79	Sand	Sand	Sand	191.23	1.79	1.10	210.55	0.95	0.30	0.89	1.07	3.38	Above WT
35.76	164.2	308.6	3.4	0.06	2.15	2.15	142.83	1.11	1.82	0.70	205.15	1.72	Sand	Sand	Sand	206.59	1.72	1.05	216.50	1.02	0.30	0.88	1.07	3.67	Above WT
36.26	163.7	282.6	3.4	0.06	2.18	2.18	128.90	1.21	1.88	0.69	186.43	1.77	Sand	Sand	Sand	187.87	1.77	1.09	204.11	0.87	0.30	0.88	1.07	3.14	Above WT
36.75	163.3	252.6	2.9	0.06	2.21	2.21	113.56	1.16	1.91	0.69	165.35	1.79	Sand	Sand	Sand	166.81	1.79	1.10	183.74	0.66	0.30	0.87	1.07	2.38	Above WT
37.24	162.8	203.7	3.6	0.06	2.23	2.23	90.17	1.79	2.11	0.68	132.16	2.00	Sand	Sand	Sand	133.63	2.00	1.30	173.13	0.56	0.29	0.87	1.07	2.05	Above WT
37.73	162.3	208.6	4.2	0.06	2.26	2.26	91.15	2.04	2.15	0.68	134.47	2.03	Sand	Sand	Sand	135.95	2.03	1.35	183.08	0.65	0.29	0.87	1.07	2.38	Above WT
38.22	161.8	286.7	5.1	0.06	2.29	2.29	124.02	1.79	2.02	0.67	184.16	1.90	Sand	Sand	Sand	185.65	1.90	1.19	221.31	1.09	0.29	0.86	1.07	3.99	Above WT
38.72	161.3	248.4	5.2	0.06	2.32	2.32	105.92	2.11	2.12	0.67	158.31	2.00	Sand	Sand	Sand	159.81	2.00	1.30	207.80	0.91	0.29	0.86	1.07	3.37	Above WT
39.21	160.8	227.0	4.7	0.06	2.35	2.35	95.49	2.09	2.14	0.66	143.62	2.02	Sand	Sand	Sand	145.12	2.02	1.33	193.41	0.75	0.29	0.85	1.07	2.79	Above WT
39.70	160.3	207.7	5.2	0.06	2.38	2.38	86.20	2.53	2.23	0.66	130.45	2.11	Sand	Sand	Sand	131.96	2.11	1.48	195.50	0.77	0.29	0.85	1.07	2.88	Above WT
40.19	159.8	232.7	5.5	0.06	2.41	2.41	95.50	2.39	2.18	0.66	145.42	2.06	Sand	Sand	Sand	146.94	2.06	1.39	204.89	0.88	0.29	0.85	1.07	3.29	Above WT
40.68	159.3	218.0	3.6	0.06	2.44	2.44	88.31	1.67	2.10	0.65	135.30	1.97	Sand	Sand	Sand	136.83	1.97	1.26	172.48	0.56	0.28	0.84	1.07	2.09	Above WT
41.18	158.8	156.4	2.3	0.06	2.47	2.47	62.30	1.49	2.18	0.65	96.03	2.04	Sand	Sand	Sand	97.57	2.04	1.35	132.14	0.29	0.28	0.84	1.07	1.11	Above WT
41.67	158.3	115.0	1.4	0.06	2.50	2.50	45.00	1.24	2.24	0.64	69.77	2.09	Sand	Sand	Sand	71.32	2.09	1.44	102.66	0.18	0.28	0.83	1.07	0.68	Above WT
42.16	157.8	89.9	1.6	0.06	2.53	2.53	34.54	1.83	2.44	0.64	53.87	2.29	Sand	Sand	Sand	55.43	2.61	3.39	187.81	0.70	0.28	0.83	1.07	2.65	Above WT
42.65	157.4	79.6	2.1	0.06	2.56	2.56	30.11	2.73	2.59	0.64	47.22	2.44	Sand	Sand	Sand	48.79	2.44	2.49	121.70	0.25	0.28	0.83	1.07	0.95	Above WT
43.15	156.9	37.2	1.4	0.06	2.59	2.59	13.37	4.04	2.97	Clay	Clay	Clay	Clay	Clay	Clay	14.37	2.97	6.44	92.47	0.15	0.28	0.82	1.07	0.59	Above WT

Depth (ft)	El. (ft MLLW)	$q_{c,tip}$ (tsf)	f_s (tsf)	Unit Wt (tcf)	Total OB (tsf)	Eff OB (tsf)	Q_1	F (%)	I_{c1}	C_{Q2}	Q_2	I_{c2}	C_{Q3}	Q_3	I_{c3}	q_{c1N}	I_c	K_c	$(q_{c1n})_{CS}$	$CRR_{7.5}$	CSR	r_d	MSF	FOS	Liquefaction
43.64	156.4	63.0	1.5	0.06	2.62	2.62	23.06	2.48	2.65	Clay	Clay	Clay	Clay	Clay	Clay	24.06	2.65	3.68	88.55	0.14	0.28	0.82	1.07	0.56	Above WT
44.13	155.9	64.7	2.1	0.06	2.65	2.65	23.44	3.38	2.73	Clay	Clay	Clay	Clay	Clay	Clay	24.44	2.61	3.39	82.80	0.13	0.28	0.81	1.07	0.52	Above WT
44.62	155.4	177.5	2.5	0.06	2.68	2.68	65.30	1.43	2.15	0.62	104.77	2.00	Sand	Sand	Sand	106.38	2.00	1.30	138.06	0.32	0.27	0.81	1.07	1.27	Above WT
45.11	154.9	129.2	1.9	0.06	2.71	2.71	46.74	1.50	2.28	0.62	75.39	2.12	Sand	Sand	Sand	77.01	2.12	1.49	114.66	0.22	0.27	0.81	1.07	0.86	Above WT
45.61	154.4	50.8	1.4	0.06	2.74	2.74	17.56	2.91	2.79	Clay	Clay	Clay	Clay	Clay	Clay	18.56	2.79	4.71	87.39	0.14	0.27	0.80	1.07	0.56	Above WT
46.10	153.9	50.9	1.8	0.06	2.77	2.77	17.40	3.74	2.86	Clay	Clay	Clay	Clay	Clay	Clay	18.40	2.86	5.33	97.99	0.17	0.27	0.80	1.07	0.66	Above WT
46.59	153.4	13.0	0.8	0.06	2.80	2.80	3.65	7.84	3.60	Clay	Clay	Clay	Clay	Clay	Clay	4.65	3.60	15.90	73.93	0.12	0.27	0.79	1.07	0.47	Above WT
47.08	152.9	12.3	0.4	0.06	2.82	2.82	3.35	4.22	3.47	Clay	Clay	Clay	Clay	Clay	Clay	4.35	3.47	13.63	59.36	0.10	0.27	0.79	1.07	0.40	Above WT
47.57	152.4	21.8	0.9	0.06	2.85	2.85	6.64	4.75	3.26	Clay	Clay	Clay	Clay	Clay	Clay	7.64	3.26	10.07	76.92	0.12	0.27	0.79	1.07	0.49	Above WT
48.07	151.9	24.9	1.1	0.06	2.88	2.88	7.63	5.00	3.22	Clay	Clay	Clay	Clay	Clay	Clay	8.63	3.22	9.55	82.42	0.13	0.26	0.78	1.07	0.53	Above WT
48.56	151.4	59.7	1.6	0.06	2.91	2.91	19.49	2.82	2.75	Clay	Clay	Clay	Clay	Clay	Clay	20.49	2.75	4.35	89.03	0.15	0.26	0.78	1.07	0.59	Above WT
49.05	151.0	99.8	2.0	0.06	2.94	2.94	32.91	2.06	2.48	0.59	55.36	2.31	Sand	Sand	Sand	57.05	2.31	1.98	113.08	0.21	0.26	0.77	1.07	0.88	Above WT
49.54	150.5	165.6	2.5	0.06	2.97	2.97	54.71	1.54	2.23	0.59	92.50	2.06	Sand	Sand	Sand	94.19	2.06	1.39	130.50	0.29	0.26	0.77	1.07	1.18	Above WT
50.04	150.0	184.6	2.4	0.06	3.00	3.00	60.48	1.32	2.16	0.59	102.77	1.98	Sand	Sand	Sand	104.47	1.98	1.28	133.31	0.30	0.26	0.77	1.07	1.24	Above WT
50.53	149.5	192.7	3.4	0.06	3.03	3.03	62.56	1.79	2.23	0.59	106.81	2.06	Sand	Sand	Sand	108.52	2.06	1.39	150.70	0.40	0.26	0.76	1.07	1.65	Above WT
51.02	149.0	215.9	4.3	0.06	3.06	3.06	69.53	2.02	2.23	0.58	119.29	2.07	Sand	Sand	Sand	121.00	2.07	1.40	168.97	0.53	0.26	0.76	1.07	2.21	Above WT
51.51	148.5	225.5	5.1	0.06	3.09	3.09	71.96	2.29	2.26	0.58	124.06	2.10	Sand	Sand	Sand	125.78	2.10	1.45	182.02	0.64	0.26	0.75	1.07	2.69	Above WT
52.00	148.0	224.3	4.6	0.06	3.12	3.12	70.89	2.08	2.23	0.58	122.79	2.07	Sand	Sand	Sand	124.52	2.07	1.40	174.07	0.57	0.25	0.75	1.07	2.41	Above WT
52.50	147.5	198.7	4.2	0.06	3.15	3.15	62.08	2.15	2.28	0.57	108.04	2.11	Sand	Sand	Sand	109.78	2.11	1.48	162.70	0.48	0.25	0.75	1.07	2.04	Above WT
52.99	147.0	181.4	3.9	0.06	3.18	3.18	56.05	2.19	2.32	0.57	98.01	2.15	Sand	Sand	Sand	99.76	2.15	1.55	154.81	0.43	0.25	0.74	1.07	1.81	Above WT
53.48	146.5	136.4	3.2	0.06	3.21	3.21	41.51	2.40	2.45	0.57	72.91	2.27	Sand	Sand	Sand	74.67	2.27	1.85	138.22	0.33	0.25	0.74	1.07	1.40	Above WT
53.97	146.0	190.5	3.8	0.06	3.24	3.24	57.83	2.03	2.29	0.57	102.04	2.11	Sand	Sand	Sand	103.81	2.11	1.48	153.66	0.42	0.25	0.73	1.07	1.80	Above WT
54.46	145.5	141.1	3.2	0.06	3.27	3.27	42.18	2.32	2.43	0.56	74.77	2.25	Sand	Sand	Sand	76.54	2.25	1.80	137.66	0.32	0.25	0.73	1.07	1.40	Above WT
54.96	145.0	54.1	2.6	0.06	3.30	3.30	15.41	5.12	2.99	Clay	Clay	Clay	Clay	Clay	Clay	16.41	2.99	6.62	108.53	0.20	0.25	0.73	1.07	0.87	Above WT
55.45	144.6	69.7	2.8	0.06	3.33	3.33	19.95	4.22	2.85	Clay	Clay	Clay	Clay	Clay	Clay	20.95	2.85	5.21	109.17	0.20	0.24	0.72	1.07	0.88	Above WT
55.94	144.1	198.5	4.0	0.06	3.36	3.36	58.14	2.05	2.29	0.56	104.45	2.11	Sand	Sand	Sand	106.24	2.11	1.47	156.50	0.44	0.24	0.72	1.07	1.92	Above WT
56.43	143.6	254.6	6.8	0.06	3.39	3.39	74.20	2.71	2.30	0.55	133.87	2.13	Sand	Sand	Sand	135.68	2.13	1.51	205.00	0.88	0.24	0.71	1.07	3.90	Above WT
56.93	143.1	285.2	6.0	0.06	3.42	3.42	82.49	2.13	2.19	0.55	149.50	2.02	Sand	Sand	Sand	151.32	2.02	1.33	200.51	0.83	0.24	0.71	1.07	3.70	Above WT
57.42	142.6	268.7	6.5	0.06	3.45	3.45	76.99	2.45	2.26	0.55	140.13	2.08	Sand	Sand	Sand	141.95	2.08	1.43	202.39	0.85	0.24	0.71	1.07	3.81	Above WT
57.91	142.1	262.5	5.0	0.06	3.47	3.47	74.55	1.93	2.20	0.55	136.26	2.01	Sand	Sand	Sand	138.09	2.01	1.32	181.85	0.64	0.24	0.70	1.07	2.88	Above WT
58.40	141.6	305.2	6.1	0.06	3.50	3.50	86.10	2.02	2.16	0.54	158.04	1.99	Sand	Sand	Sand	159.88	1.99	1.28	204.97	0.88	0.24	0.70	1.07	3.99	Above WT
58.89	141.1	315.7	8.4	0.06	3.53	3.53	88.35	2.69	2.25	0.54	162.84	2.07	Sand	Sand	Sand	164.69	2.07	1.41	232.39	1.25	0.23	0.69	1.07	5.68	Above WT
59.06	140.9	328.7	8.1	0.06	3.54	3.54	91.76	2.49	2.21	0.54	169.38	2.04	Sand	Sand	Sand	171.22	2.04	1.35	231.63	1.24	0.23	0.69	1.07	5.64	Above WT

SR-91 Westbound Widening - Acacia Street UC

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

EMI Project No. 10-126

Version - 12/05

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
^1C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines (Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

F_L = CRR r / CSR i

A-10-054

Emean (%)	75		Present Ground El.	181	Borehole Dia. (in)	8	Tot. Unit Wt. (pcf)	51.0	=Design Water Table Depth	52.8	=Field Water Table Depth	Acc. max =	0.520 g									
C_E	1.25		Future Ground El.	181	C_B	1.15	120	130	=Design Water El.	128.2	=Field Water El.										Earthq. M=	7.3
																					Cm=	1.07

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
-		-		-	-	-	-				-		-	-	-	-		-	-		-	-
5	176	20	SP-SM	6.0	0.30	0.30	1.70	0.80	1.00	0.67	2	2	0.99	0.30	0.33	26	26	1.00	0.32	0.34	1.02	AboveWT
10	171	15	SP-SM	6.0	0.60	0.60	1.32	0.85	1.20	1.00	1	1	0.98	0.60	0.33	29	29	1.00	0.42	0.45	1.36	AboveWT
15	166	52	SP	4.0	0.90	0.90	1.08	0.85	1.00	0.67	2	2	0.97	0.90	0.33	46	46	1.00	High N	0.00	LARGE	AboveWT
20	161	21	SP-SM	6.0	1.20	1.20	0.93	0.95	1.20	1.00	1	1	0.95	1.20	0.32	32	32	0.97	High N	0.00	LARGE	AboveWT
25	156	26	SC	29.0	1.50	1.50	0.83	0.95	1.00	0.67	2	2	0.94	1.50	0.32	20	27	0.93	0.35	0.34	1.08	AboveWT
30	151	27	SP	4.0	1.80	1.80	0.76	1.00	1.20	1.00	1	1	0.93	1.80	0.31	35	35	0.89	High N	0.00	LARGE	AboveWT
35	146	68	SP	4.0	2.10	2.10	0.71	1.00	1.00	0.67	2	2	0.89	2.10	0.30	46	46	0.87	High N	0.00	LARGE	AboveWT
40	141	36	SP	4.0	2.40	2.40	0.66	1.00	1.20	1.00	1	1	0.85	2.40	0.29	41	41	0.85	High N	0.00	LARGE	AboveWT
45	136	69	SP	4.0	2.70	2.70	0.62	1.00	1.00	0.67	2	2	0.81	2.70	0.27	41	41	0.82	High N	0.00	LARGE	AboveWT
50	131	33	SP	4.0	3.00	3.00	0.59	1.00	1.20	1.00	1	1	0.77	3.00	0.26	34	34	0.78	High N	0.00	LARGE	AboveWT
55	126	40	SM/ML	50.0	3.30	3.23	0.57	1.00	1.00	0.67	2	2	0.73	3.18	0.26	22	31	0.77	High N	0.00	LARGE	AboveWT
60	121	17	SM	45.0	3.60	3.38	0.56	1.00	1.20	1.00	1	1	0.69	3.32	0.25	16	25	0.76	0.28	0.23	0.92	yes
65	116	31	CL/ML	75.0	3.90	3.52	0.54	1.00	1.00	0.67	2	2	0.64	3.46	0.25	16	24	0.75	0.28	0.23	0.92	fines
70	111	53	SP	4.0	4.20	3.66	0.53	1.00	1.20	1.00	1	1	0.60	3.61	0.24	49	49	0.75	High N	0.00	LARGE	high N
75	106	80	SP	4.0	4.50	3.81	0.52	1.00	1.00	0.67	2	2	0.56	3.75	0.23	40	40	0.74	High N	0.00	LARGE	high N
80	101	81	SP	4.0	4.80	3.95	0.51	1.00	1.20	1.00	1	1	0.55	3.90	0.23	72	72	0.73	High N	0.00	LARGE	high N

SR-91 Westbound Widening - Acacia Street UC

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

EMI Project No. 10-126

Version - 12/05

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
$^{1}C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines (Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

F_L = CRR r / CSR i

A-10-055

Emean (%) 75 | Present Ground El. 200.5 | Borehole Dia. (in) 8 | Tot. Unit Wt. (pcf) 120 | 70.5 =Design Water Table Depth | 130 =Design Water El. | 70.5 =Field Water Table Depth | 130 =Field Water El. | Acc. max = 0.520 g | Earthq. M= 7.3
C_E 1.25 | Future Ground El. 200.5 | C_B 1.15 | Cm= 1.07

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
-		-		-	-	-	-				-		-	-	-	-		-	-		-	-
5	196	27	SM	25.0	0.30	0.30	1.70	0.80	1.20	1.00	1	1	0.99	0.30	0.33	63	75	1.00	High N	0.00	LARGE	AboveWT
10	191	80	SM	25.0	0.60	0.60	1.32	0.85	1.00	0.67	2	2	0.98	0.60	0.33	86	100	1.00	High N	0.00	LARGE	AboveWT
15	186	30	SP-SM	10.0	0.90	0.90	1.08	0.85	1.20	1.00	1	1	0.97	0.90	0.33	47	49	1.00	High N	0.00	LARGE	AboveWT
20	181	38	SP	4.0	1.20	1.20	0.93	0.95	1.00	0.67	2	2	0.95	1.20	0.32	32	32	0.97	High N	0.00	LARGE	AboveWT
25	176	9	SM	17.0	1.50	1.50	0.83	0.95	1.20	1.00	1	1	0.94	1.50	0.32	12	16	0.93	0.17	0.17	0.53	AboveWT
30	171	55	SP	4.0	1.80	1.80	0.76	1.00	1.00	0.67	2	2	0.93	1.80	0.31	40	40	0.89	High N	0.00	LARGE	AboveWT
35	166	26	SP	4.0	2.10	2.10	0.71	1.00	1.20	1.00	1	1	0.89	2.10	0.30	32	32	0.87	High N	0.00	LARGE	AboveWT
40	161	60	SP	4.0	2.40	2.40	0.66	1.00	1.00	0.67	2	2	0.85	2.40	0.29	38	38	0.85	High N	0.00	LARGE	AboveWT
45	156	29	SP	4.0	2.70	2.70	0.62	1.00	1.20	1.00	1	1	0.81	2.70	0.27	31	31	0.82	High N	0.00	LARGE	AboveWT
50	151	85	SP-SM	6.0	3.00	3.00	0.59	1.00	1.00	0.67	2	2	0.77	3.00	0.26	48	48	0.78	High N	0.00	LARGE	AboveWT
55	146	29	SP	4.0	3.30	3.30	0.56	1.00	1.20	1.00	1	1	0.73	3.30	0.25	28	28	0.76	0.37	0.31	1.25	AboveWT
60	141	98	SP	4.0	3.60	3.60	0.54	1.00	1.00	0.67	2	2	0.69	3.60	0.23	51	51	0.75	High N	0.00	LARGE	AboveWT
65	136	27	SP-SM	6.0	3.90	3.90	0.52	1.00	1.20	1.00	1	1	0.64	3.90	0.22	24	24	0.73	0.28	0.22	1.00	AboveWT
70	131	93	SP-SM	6.0	4.20	4.20	0.50	1.00	1.00	0.67	2	2	0.60	4.20	0.20	44	45	0.71	High N	0.00	LARGE	AboveWT

SR-91 Westbound Widening - State College Blvd. UC

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

EMI Project No. 10-126

Version - 12/05

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
^1C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
$CRR\ r = CRR_{7.5} \times Cm \times K\ sigma$

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines (Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

$F_L = CRR\ r / CSR\ i$

A-10-063

Emean (%)	75			Present Ground El.	190.2	Borehole Dia. (in)	8	Tot. Unit Wt. (pcf)	52.2	=Design Water Table Depth	52.2	=Field Water Table Depth	Acc. max =	0.520 g						Earthq. M=	7.3
C_E	1.25			Future Ground El.	190.2	C_B	1.15	120	138	=Design Water El.	138	=Field Water El.								Cm=	1.07

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
2.5	188	67	SP-SM	7.0	0.15	0.15	1.70	0.75	1.00	0.67	2	2	0.99	0.15	0.34	82	83	1.00	High N	0.00	LARGE	AboveWT
5	185	9	SP	2.0	0.30	0.30	1.70	0.80	1.20	1.00	1	1	0.99	0.30	0.33	21	21	1.00	0.23	0.25	0.74	AboveWT
10	180	39	SP-SM	7.0	0.60	0.60	1.32	0.85	1.00	0.67	2	2	0.98	0.60	0.33	42	42	1.00	High N	0.00	LARGE	AboveWT
15	175	16	SP-SM	7.0	0.90	0.90	1.08	0.85	1.20	1.00	1	1	0.97	0.90	0.33	25	26	1.00	0.30	0.33	1.00	AboveWT
20	170	52	SP	4.0	1.20	1.20	0.93	0.95	1.00	0.67	2	2	0.95	1.20	0.32	44	44	0.97	High N	0.00	LARGE	AboveWT
25	165	27	SP-SM	7.0	1.50	1.50	0.83	0.95	1.20	1.00	1	1	0.94	1.50	0.32	37	37	0.93	High N	0.00	LARGE	AboveWT
30	160	67	SP-SM	7.0	1.80	1.80	0.76	1.00	1.00	0.67	2	2	0.93	1.80	0.31	49	49	0.89	High N	0.00	LARGE	AboveWT
35	155	16	SP-SM	7.0	2.10	2.10	0.71	1.00	1.20	1.00	1	1	0.89	2.10	0.30	19	20	0.87	0.21	0.20	0.66	AboveWT
40	150	63	SP-SM	7.0	2.40	2.40	0.66	1.00	1.00	0.67	2	2	0.85	2.40	0.29	40	40	0.85	High N	0.00	LARGE	AboveWT
45	145	37	SP-SM	7.0	2.70	2.70	0.62	1.00	1.20	1.00	1	1	0.81	2.70	0.27	40	40	0.82	High N	0.00	LARGE	AboveWT
50	140	91	SP-SM	7.0	3.00	3.00	0.59	1.00	1.00	0.67	2	2	0.77	3.00	0.26	51	52	0.78	High N	0.00	LARGE	AboveWT
55	135	41	SP-SM	7.0	3.30	3.21	0.57	1.00	1.20	1.00	1	1	0.73	3.21	0.25	40	41	0.77	High N	0.00	LARGE	AboveWT
60	130	76	SP-SM	7.0	3.60	3.36	0.56	1.00	1.00	0.67	2	2	0.69	3.36	0.25	41	41	0.76	High N	0.00	LARGE	high N
65	125	48	SP-SM	7.0	3.90	3.50	0.55	1.00	1.20	1.00	1	1	0.64	3.50	0.24	45	46	0.75	High N	0.00	LARGE	high N
70	120	80	SP-SM	7.0	4.20	3.64	0.54	1.00	1.00	0.67	2	2	0.60	3.64	0.24	41	41	0.74	High N	0.00	LARGE	high N
75	115	49	SP-SM	7.0	4.50	3.79	0.52	1.00	1.20	1.00	1	1	0.56	3.79	0.23	44	45	0.74	High N	0.00	LARGE	high N
80	110	80	SP-SM	7.0	4.80	3.93	0.52	1.00	1.00	0.67	2	2	0.55	3.93	0.23	39	40	0.73	High N	0.00	LARGE	high N

SR-91 Westbound Widening - State College Blvd. UC

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

EMI Project No. 10-126

Version - 12/05

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines (Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

F_L = CRR r / CSR i

A-10-064

Emean (%) 75 | C_E 1.25 | Present Ground El. 210 | Future Ground El. 210 | Borehole Dia. (in) 8 | C_B 1.15 | Tot. Unit Wt. (pcf) 120 | 72.0 =Design Water Table Depth | 138 =Design Water El. | 72.0 =Field Water Table Depth | 138 =Field Water El. | Acc. max : 0.520 g | Earthq. M= 7.3 | Cm= 1.07

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
-	-	-		-	-	-	-				-		-	-	-	-	-	-			-	-
5	205	27	SM/SC	25.0	0.30	0.30	1.70	0.80	1.20	1.00	1	1	0.99	0.30	0.33	63	75	1.00	High N	0.00	LARGE	AboveWT
10	200	68	SC/SM	25.0	0.60	0.60	1.32	0.85	1.00	0.67	2	2	0.98	0.60	0.33	73	86	1.00	High N	0.00	LARGE	AboveWT
15	195	38	SM	25.0	0.90	0.90	1.08	0.85	1.20	1.00	1	1	0.97	0.90	0.33	60	71	1.00	High N	0.00	LARGE	AboveWT
20	190	31	SP-SM	10.0	1.20	1.20	0.93	0.95	1.00	0.67	2	2	0.95	1.20	0.32	26	28	0.97	0.36	0.38	1.17	AboveWT
25	185	9	SP-SM	10.0	1.50	1.50	0.83	0.95	1.20	1.00	1	1	0.94	1.50	0.32	12	13	0.93	0.14	0.14	0.45	AboveWT
30	180	52	SP	4.0	1.80	1.80	0.76	1.00	1.00	0.67	2	2	0.93	1.80	0.31	38	38	0.89	High N	0.00	LARGE	AboveWT
35	175	16	SP-SM	6.0	2.10	2.10	0.71	1.00	1.20	1.00	1	1	0.89	2.10	0.30	19	20	0.87	0.21	0.20	0.65	AboveWT
40	170	65	SP-SM	6.0	2.40	2.40	0.66	1.00	1.00	0.67	2	2	0.85	2.40	0.29	41	41	0.85	High N	0.00	LARGE	AboveWT
45	165	32	SP-SM	6.0	2.70	2.70	0.62	1.00	1.20	1.00	1	1	0.81	2.70	0.27	34	35	0.82	High N	0.00	LARGE	AboveWT
50	160	89	SP-SM	9.0	3.00	3.00	0.59	1.00	1.00	0.67	2	2	0.77	3.00	0.26	50	52	0.78	High N	0.00	LARGE	AboveWT
55	155	18	SP-SM	9.0	3.30	3.30	0.56	1.00	1.20	1.00	1	1	0.73	3.30	0.25	17	18	0.76	0.20	0.16	0.65	AboveWT
60	150	87	SP-SM	6.0	3.60	3.60	0.54	1.00	1.00	0.67	2	2	0.69	3.60	0.23	45	45	0.75	High N	0.00	LARGE	AboveWT
65	145	35	SP-SM	6.0	3.90	3.90	0.52	1.00	1.20	1.00	1	1	0.64	3.90	0.22	31	31	0.73	High N	0.00	LARGE	AboveWT
70	140	85	SP-SM	6.0	4.20	4.20	0.50	1.00	1.00	0.67	2	2	0.60	4.20	0.20	41	41	0.71	High N	0.00	LARGE	AboveWT
75	135	48	SP-SM	6.0	4.50	4.41	0.49	1.00	1.20	1.00	1	1	0.56	4.41	0.19	40	41	0.70	High N	0.00	LARGE	high N
80	130	80	ML/SM	30.0	4.80	4.55	0.48	1.00	1.00	0.67	2	2	0.55	4.55	0.20	37	47	0.69	High N	0.00	LARGE	high N

Earth Mechanics, Inc.
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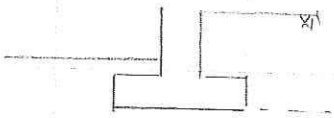
Project SP-91 WB Widening - Retaining wall 167 Project No. 10-126

By SP Date 06-27-11 Checked By LCC Date 6/30/11 Sheet ____ of ____

Retaining wall 167

Maximum wall weigrd = 12 ft.
width = 7.25 ft.
bottom of footing = +133.67 ft.



SM $\phi = 31$, $N_{corr} = 14$

Bearing capacity

$$q_u = c N_{cm} + \gamma D_f N_{qm} + \frac{1}{2} \gamma B N_{\gamma m}$$

$N_{cm} = N_c s_c i_c$; $N_{qm} = N_q s_q i_q d_q$; $N_{\gamma m} = N_\gamma s_\gamma i_\gamma$

load inclination factors $i_c = i_q = i_\gamma = 1$

shape factors $s_c = s_q = s_\gamma = 1$ for $B \ll L$

depth $D_f = 1.5 + 1.33 = 2.83$ ft

depth factor $d_q = 1.2$

for $\phi = 31$, $N_c = 32.7$, $N_q = 20.6$, $N_\gamma = 26$

$$q_u = 100 \times 32.7 + 120 \times 2.83 \times 20.6 \times 1.2 + \frac{1}{2} \times 115 \times 7.25 \times 26$$

$$= 22.5 \text{ ksf}$$

$q_{all} = 7.5$ ksf

Settlement

consider 2.8 ksf bearing pressure
perform 1 feet of over excavation & recompaction

$$\text{settlement} = 14 \times \frac{1}{55} \log\left(\frac{3.83 \times 0.12 + 7 \times 0.115 + 2.8 \times 0.5}{3.83 \times 0.12 + 7 \times 0.115}\right)$$

$$= 1''$$

SR-91 WB Widening - RW 167 Static Analysis

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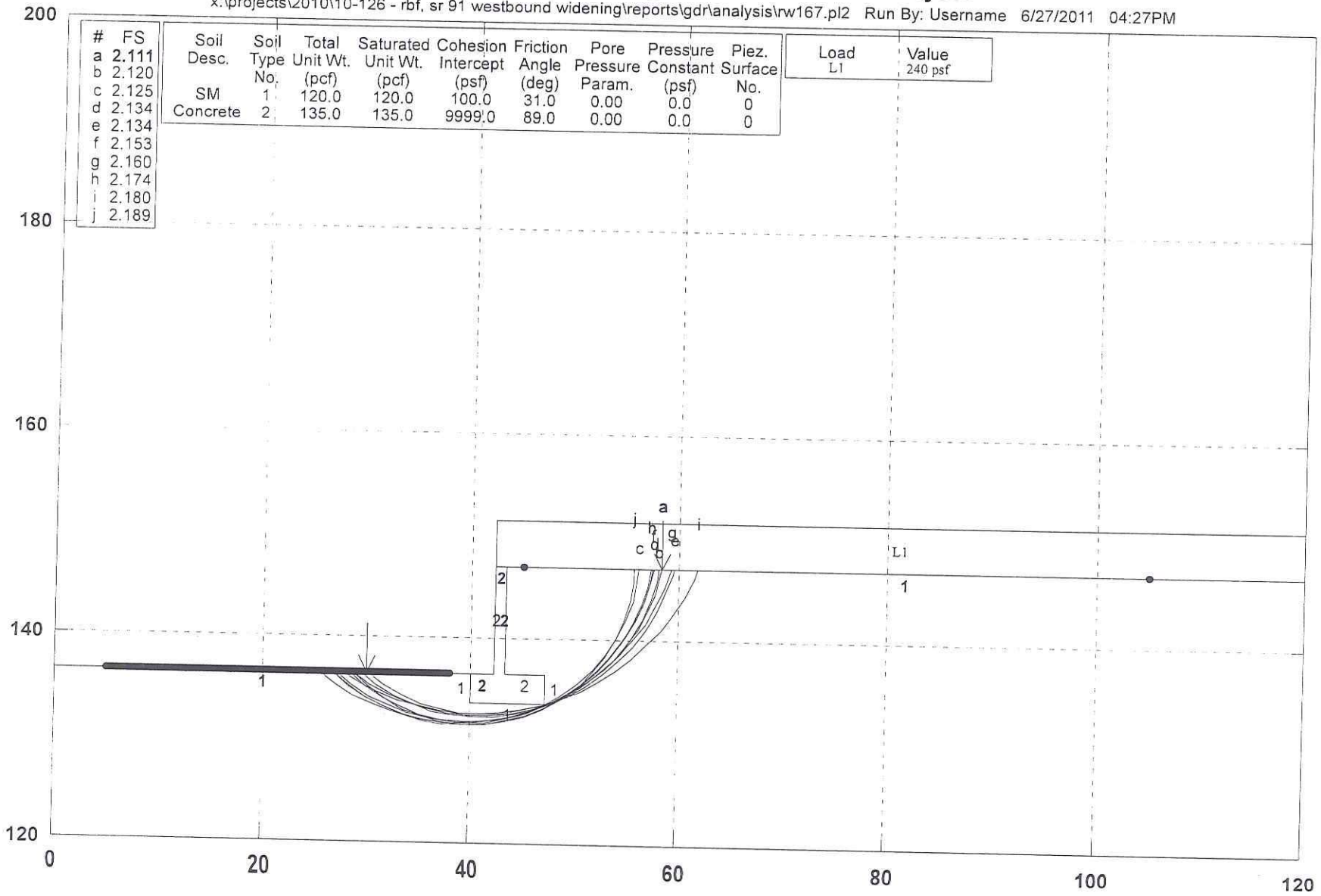

#	FS
a	2.111
b	2.120
c	2.125
d	2.134
e	2.134
f	2.153
g	2.160
h	2.174
i	2.180
j	2.189

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
SM	1	120.0	120.0	100.0	31.0	0.00	0.0	0
Concrete	2	135.0	135.0	9999.0	89.0	0.00	0.0	0

Load	Value
L1	240 psf

GSTABL7 v.2 FSmin=2.111

Safety Factors Are Calculated By The Modified Bishop Method

SR-91 WB Widening - RW 167 Pseudo Static Analysis

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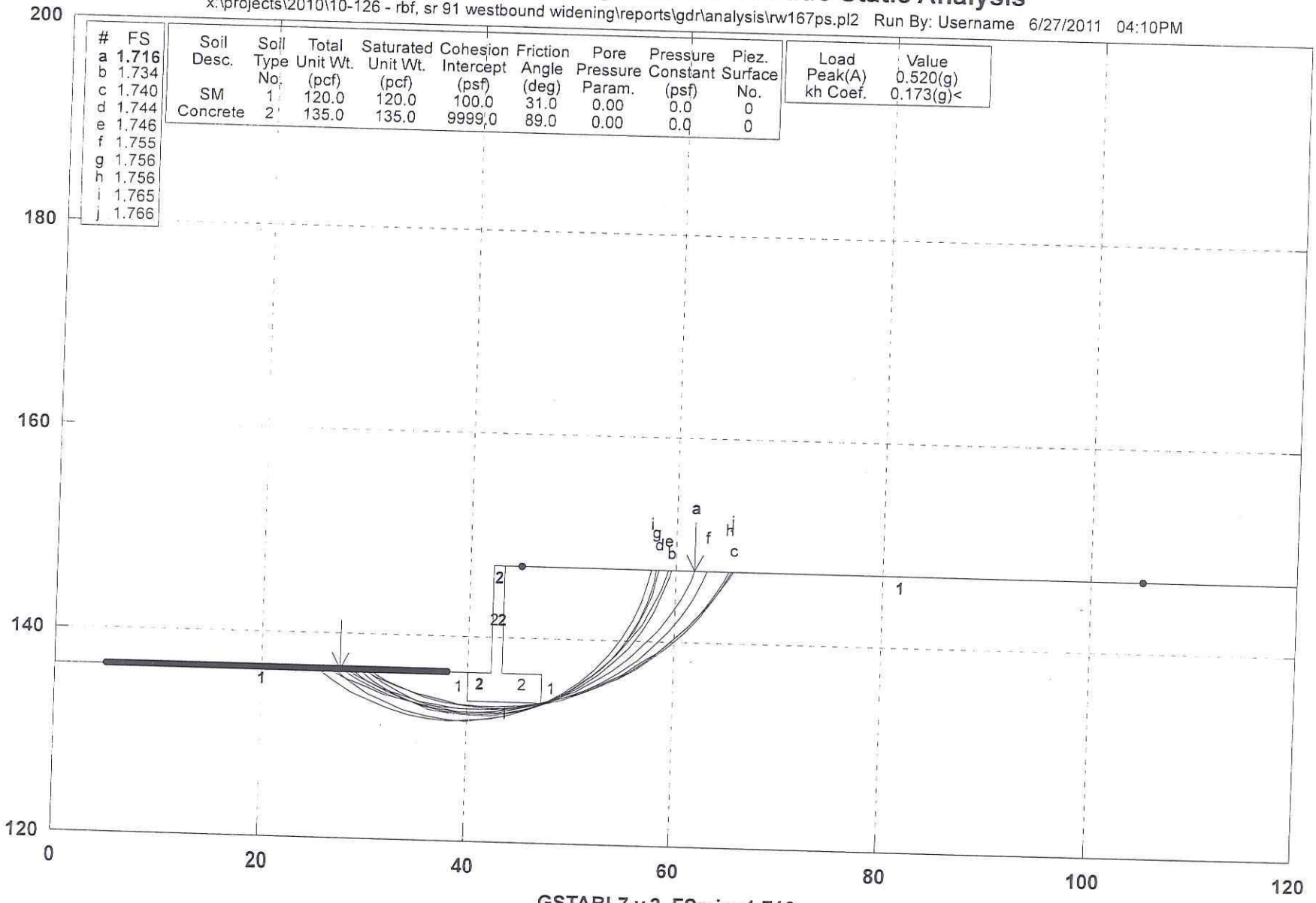

#	FS
a	1.716
b	1.734
c	1.740
d	1.744
e	1.746
f	1.755
g	1.756
h	1.756
i	1.765
j	1.766

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
SM	1	120.0	120.0	100.0	31.0	0.00	0.0	0
Concrete	2	135.0	135.0	9999.0	89.0	0.00	0.0	0

Load	Value
Peak(A)	0.520(g)
kh Coef.	0.173(g)<

GSTABL7 v.2 FSmin=1.716

Safety Factors Are Calculated By The Modified Bishop Method

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Project SR-91 WB widening – Retaining Wall 249 **Project No.** 10-126

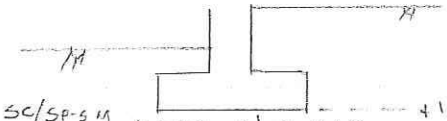
By SP **Date** 06-27-11 **Checked By** KC **Date** 6/30/11 **Sheet** ____ **of** ____

Retaining wall 249

Maximum wall height = 8 ft

width = 9.25 ft

bottom of footing = +157'



SC/SP-SM $\phi = 30$, $N_{ou} = 10$ — +157'

+154

① CH $S_u = 1.5$, $N_{ou} = 12$

+150

② SM/SP-SM

$\phi = 32$, $N_{qu} = 17$

bearing capacity

$q_u = cN_{cm} + \sigma D_f N_{qm} + \frac{1}{2}\gamma B N_{\gamma m}$

$N_{cm} = N_c s_c i_c$; $N_{qm} = N_q s_q i_q d_q$; $N_{\gamma m} = N_\gamma s_\gamma i_\gamma$

Load inclination factors $i_c = i_q = i_\gamma = 1$

Shape factors $s_c = s_q = s_\gamma = 1$

for footing on clay $N_c = 5.14$, $N_q = 1$, $N_\gamma = 1$

$D_f = 2.83$; $d_q = 1.2$

$q_u = 5.14 \times 1.5 + 0.115 \times 2.83 \times 1.2 = 8.1$ ksf

$q_{all} = 2.7$ ksf

settlement

consider 2.2 ksf bearing pressure.

perform 1.5 feet of overexcavation & recompaction

	σ_{vc}	$\Delta\sigma$	settlement
①	$7.1 \times 0.115 = 0.82$	$2.2 \times 0.65 = 1.43$	$5.5 \times \frac{1}{35} \log\left(\frac{0.82 + 1.43}{0.82}\right) = 0.82$
②	$14.8 \times 0.115 = 1.7$	$2.2 \times 0.25 = 0.55$	$10 \times \frac{1}{60} \log\left(\frac{1.7 + 0.55}{1.7}\right) = 0.23$

1.05"

Earth Mechanics, Inc.
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Project SR-91 WB Widening - Retaining Wall 249 **Project No.** 10-156

By SP **Date** 01/09/12 **Checked By** _____ **Date** _____ **Sheet** ____ **of** ____

Sign structure at station 250+25

footing width = 11'

bottom of footing = 157'

bearing pressure

service = 1.91 ksf

strength = 2.73 ksf

Extreme = 2.22 ksf

bearing capacity

$q_u = 5.14 \times 1.5 + 0.115 \times 2.83 \times 1.2 = 8.1$ ksf

strength limit state

$q = 0.95 \times 8.1 = 3.6 > 2.73$ ksf

Extreme event state

$q = 1.0 \times 8.1 = 8.1 > 2.22$ ksf

service limit state

Bearing pressure 1.9 ksf

perform 2' of overexcavation

	σ_{vo}	$\Delta\sigma$	Settlement
①	$7.3 \times 0.115 = 0.84$	$1.9 \times 0.7 = 1.33$	$5 \times \frac{1}{35} \log\left(\frac{0.84+1.33}{0.84}\right) = 0.7$
②	$17.3 \times 0.115 = 1.99$	$1.9 \times 0.3 = 0.57$	$15 \times \frac{1}{60} \log\left(\frac{1.99+0.57}{1.99}\right) = 0.33$
			1.03

SR-91 WB Widening - RW 249 Static Analysis

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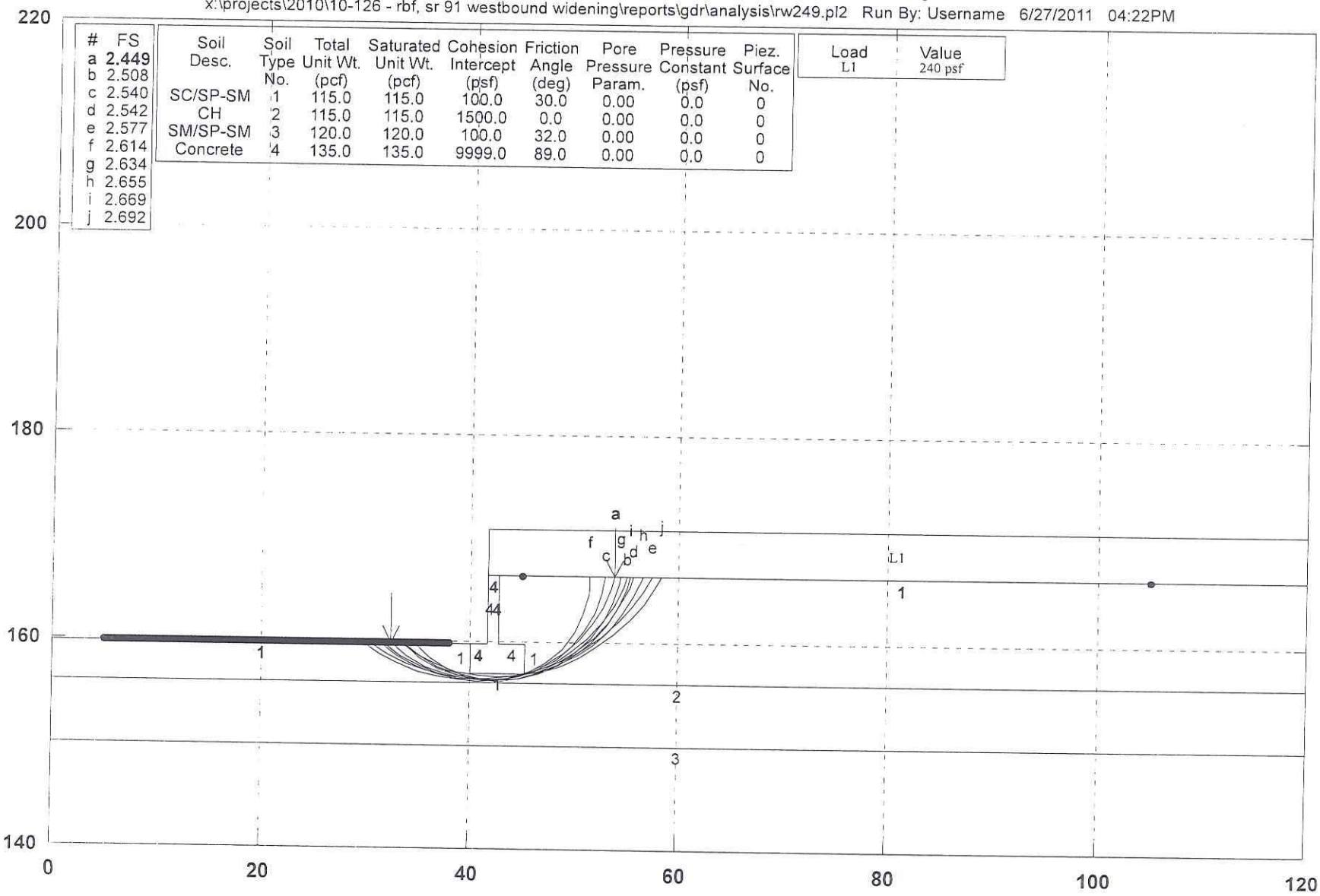
#	FS
a	2.449
b	2.508
c	2.540
d	2.542
e	2.577
f	2.614
g	2.634
h	2.655
i	2.669
j	2.692

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
SC/SP-SM	1	115.0	115.0	100.0	30.0	0.00	0.0	0
CH	2	115.0	115.0	1500.0	0.0	0.00	0.0	0
SM/SP-SM	3	120.0	120.0	100.0	32.0	0.00	0.0	0
Concrete	4	135.0	135.0	9999.0	89.0	0.00	0.0	0

Load	Value
L1	240 psf



GSTABL7 v.2 FSmin=2.449

Safety Factors Are Calculated By The Modified Bishop Method

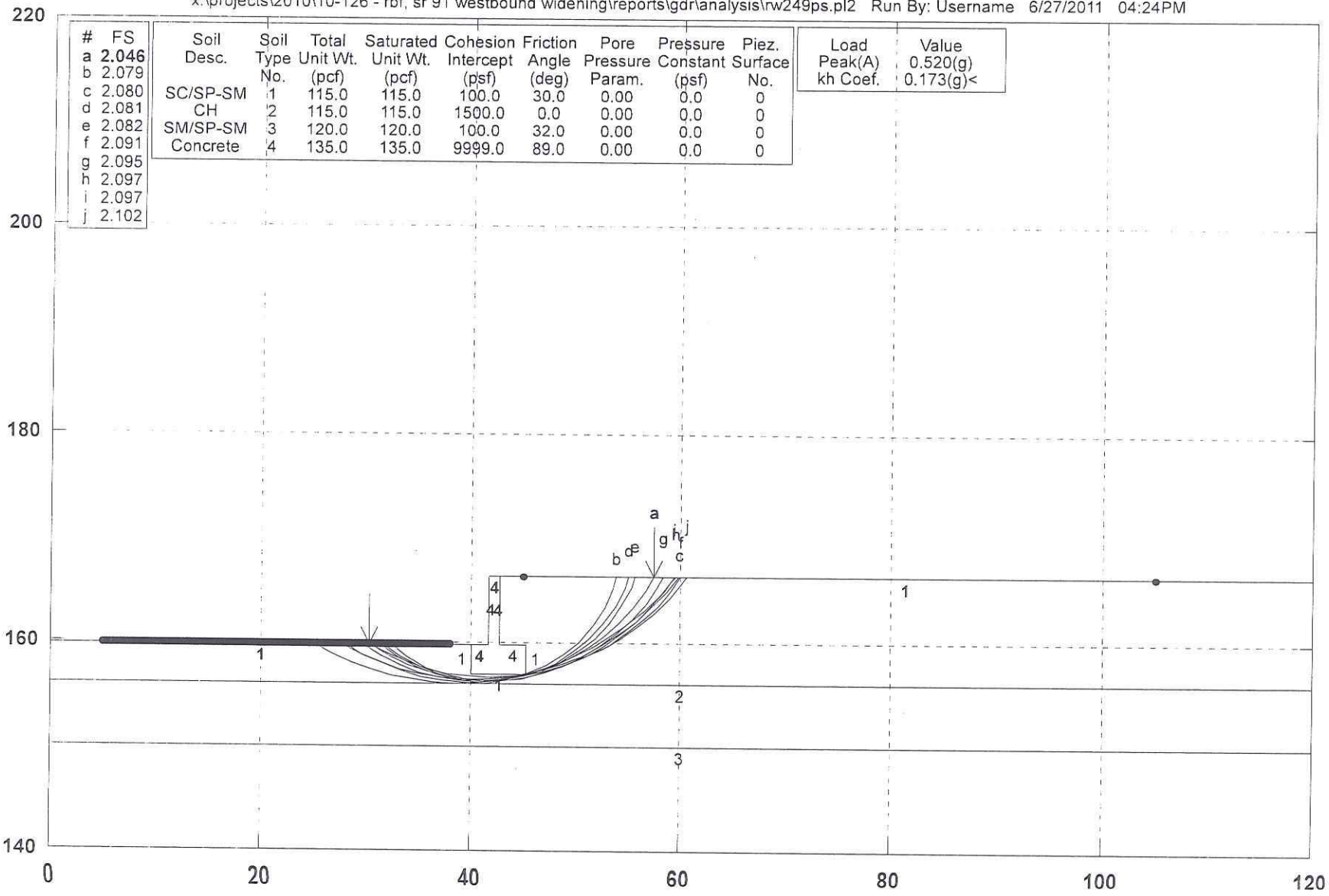
SR-91 WB Widening - RW 249 Pseudo Static Analysis

x:\projects\2010\10-126 - rbf, sr 91 westbound widening\reports\gdr\analysis\rw249ps.pl2 Run By: Username 6/27/2011 04:24PM

#	FS
a	**2.046**
b	2.079
c	2.080
d	2.081
e	2.082
f	2.091
g	2.095
h	2.097
i	2.097
j	2.102

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
SC/SP-SM	1	115.0	115.0	100.0	30.0	0.00	0.0	0
CH	2	115.0	115.0	1500.0	0.0	0.00	0.0	0
SM/SP-SM	3	120.0	120.0	100.0	32.0	0.00	0.0	0
Concrete	4	135.0	135.0	9999.0	89.0	0.00	0.0	0

Load	Value
Peak(A)	0.520(g)
kh Coef.	0.173(g)<



GSTABL7 v.2 FSmin=2.046

Safety Factors Are Calculated By The Modified Bishop Method

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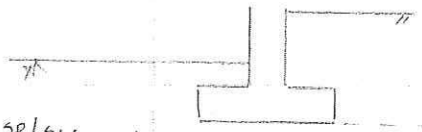
Project SR-91 WB Widening - Retaining Wall 267 **Project No.** 10-126

By SP **Date** 06-27-11 **Checked By** LCC **Date** 6/30/11 **Sheet** ____ **of** ____

Retaining Wall 267

Maximum wall height = 12 ft
width = 7.25 ft
bottom of footing = +181.67 ft



SP/SM $\phi = 34$ — +181.67'
(1) $N_{cor} = 50$ — +170'
SP/SM $\phi = 32$
(3) $N_{cor} = 24$

Bearing capacity

$q_{ult} = c N_{cm} + \gamma D_f N_{qm} + \frac{1}{2} \gamma B N_{\gamma m}$

for $\phi = 34$, $N_c = 42.2$, $N_q = 29.4$, $N_\gamma = 41.1$

$q_{ult} = 100 \times 42.2 + 120 \times 2.83 \times 29.4 \times 1.2 + \frac{1}{2} \times 120 \times 7.25 \times 41.1$
$= 34.1$ ksf

$q_{all} = 11.4$ ksf

Settlement

consider 2.8 ksf bearing pressure

	δ_{vc}	$\Delta\delta$	Settlement
(1)	$8.7 \times 0.12 = 1.04$	$2.8 \times 0.6 = 1.68$	$11.7 \times \frac{1}{85} \log\left(\frac{1.04+1.68}{1.04}\right) = 0.69$
(3)	$19.5 \times 0.12 = 2.34$	$2.8 \times 0.25 = 0.7$	$10 \times \frac{1}{70} \log\left(\frac{2.34+0.7}{2.34}\right) = 0.14$

0.83

SR-91 WB Widening - RW 267 Static Analysis

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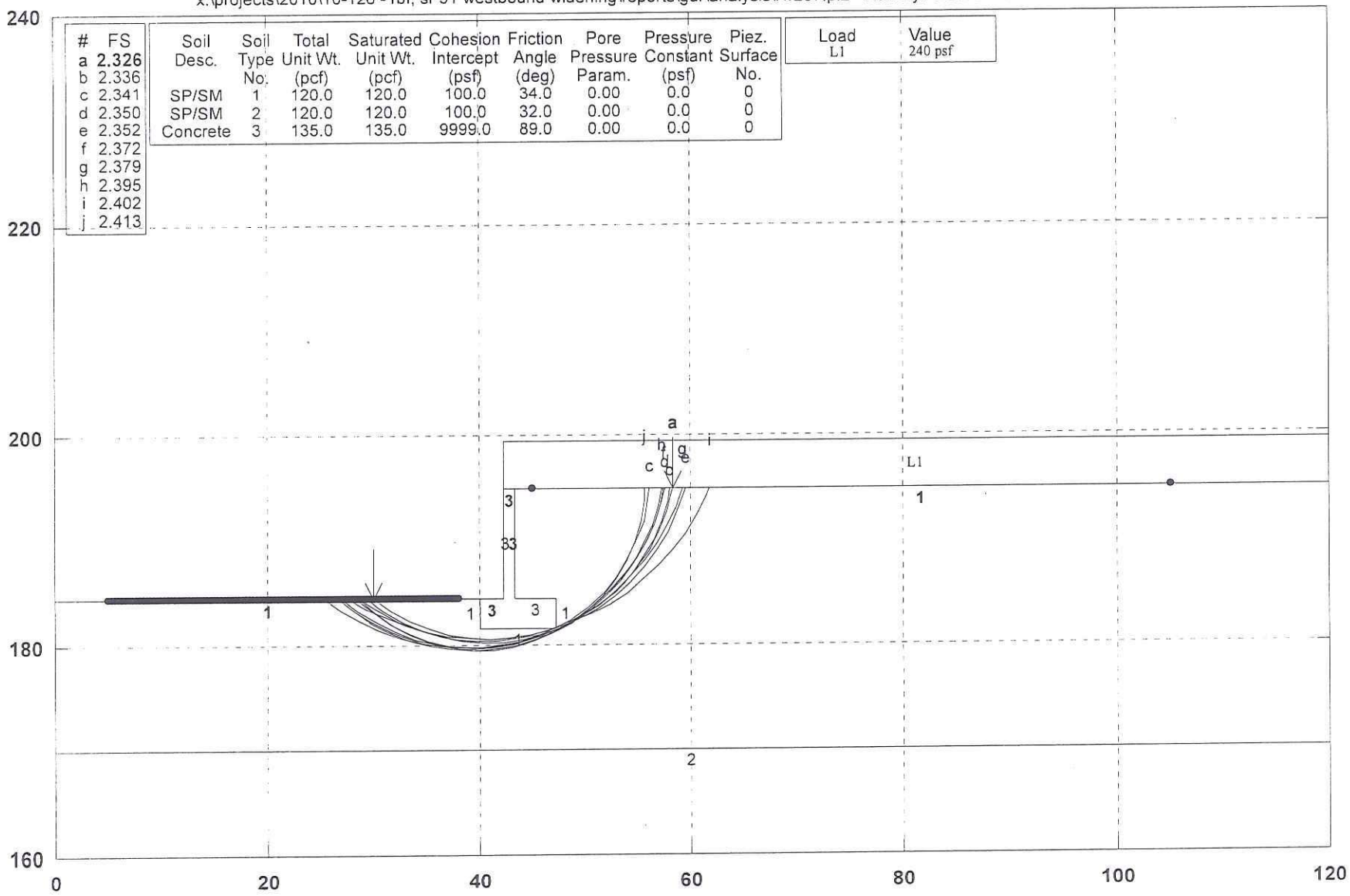


#	FS
a	2.326
b	2.336
c	2.341
d	2.350
e	2.352
f	2.372
g	2.379
h	2.395
i	2.402
j	2.413

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
SP/SM	1	120.0	120.0	100.0	34.0	0.00	0.0	0
SP/SM	2	120.0	120.0	100.0	32.0	0.00	0.0	0
Concrete	3	135.0	135.0	9999.0	89.0	0.00	0.0	0

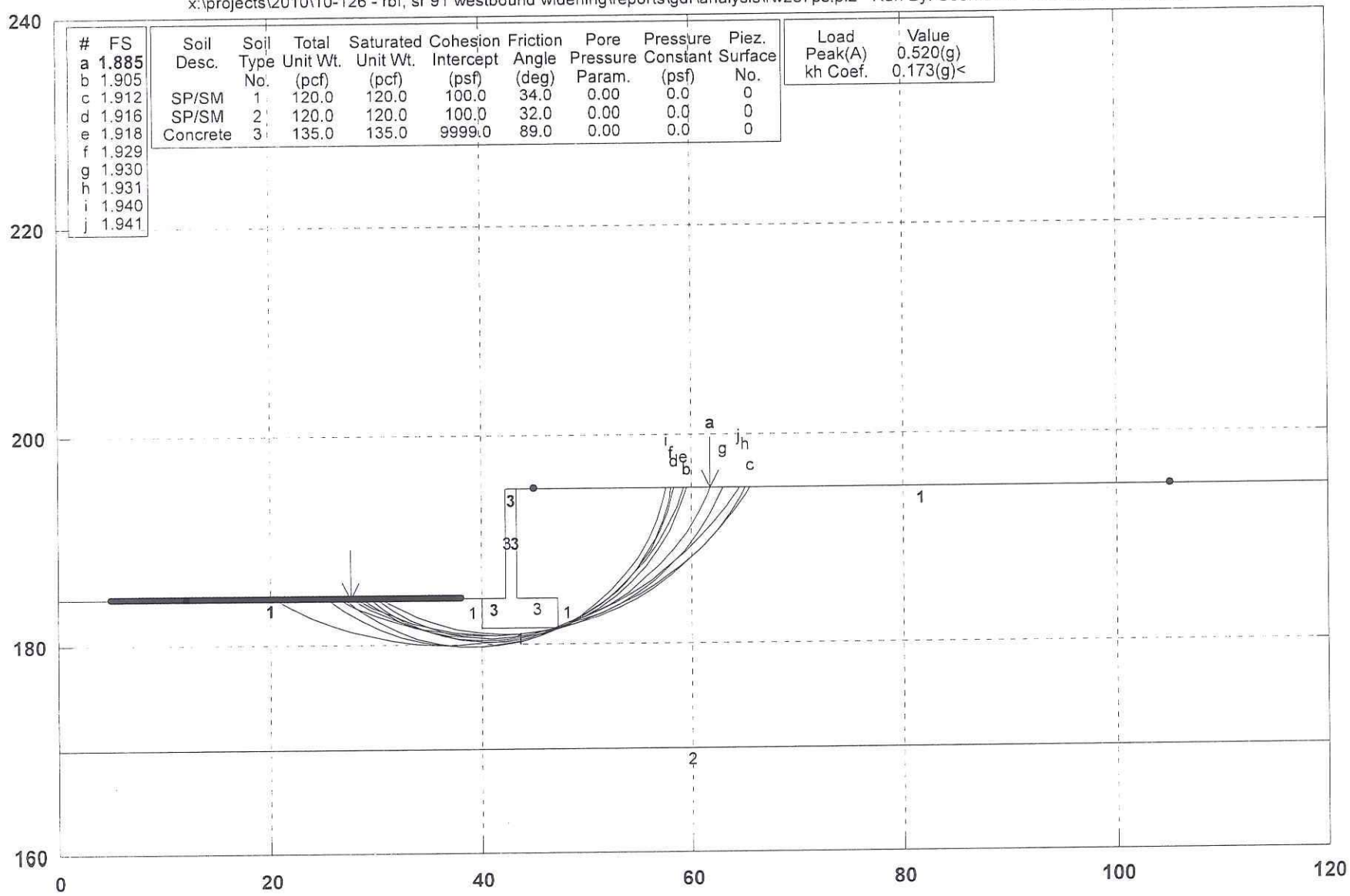
Load	Value
L1	240 psf

GSTABL7 v.2 FSmin=2.326

Safety Factors Are Calculated By The Modified Bishop Method

SR-91 WB Widening - RW 267 Pseudo Static Analysis

x:\projects\2010\10-126 - rbf, sr 91 westbound widening\reports\gdr\analysis\rw267ps.pl2 Run By: Username 6/27/2011 04:34PM



#	FS
a	1.885
b	1.905
c	1.912
d	1.916
e	1.918
f	1.929
g	1.930
h	1.931
i	1.940
j	1.941

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
SP/SM	1	120.0	120.0	100.0	34.0	0.00	0.0	0
SP/SM	2	120.0	120.0	100.0	32.0	0.00	0.0	0
Concrete	3	135.0	135.0	9999.0	89.0	0.00	0.0	0

Load	Value
Peak(A)	0.520(g)
kh Coef.	0.173(g)<

GSTABL7 v.2 FSmin=1.885

Safety Factors Are Calculated By The Modified Bishop Method

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
(714) 751-3826, Fax (714) 751-3928

Project SR91 - WB widening - Retaining Wall 323 **Project No.** 10-126

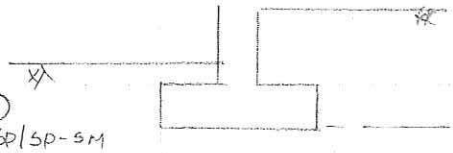
By SP **Date** 06-27-11 **Checked By** KLC **Date** 6/30/11 **Sheet** ____ **of** ____

Retaining Wall 323

Maximum wall ht = 10 ft

width = 6.25 ft

bottom of footing = +186.17 ft



① SP/SP-SM
$\phi = 31$, $N_{60} = 14$
+186.17'
+175'
SP-SM
② $\phi = 34$, $N_{60} = 32$

Bearing Capacity

$q_u = cN_{cm} + \gamma D_f N_{qm} + \frac{1}{2}\gamma B N_{\gamma m}$

for $\phi = 31$, $N_c = 32.7$, $N_q = 20.6$, $N_\gamma = 26$

$q_u = 100 \times 32.7 + 120 \times 2.83 \times 20.6 \times 1.2 + \frac{1}{2} \times 120 \times 6.25 \times 26$

$= 21.4$ ksf

$q_{all} = 7.1$ ksf

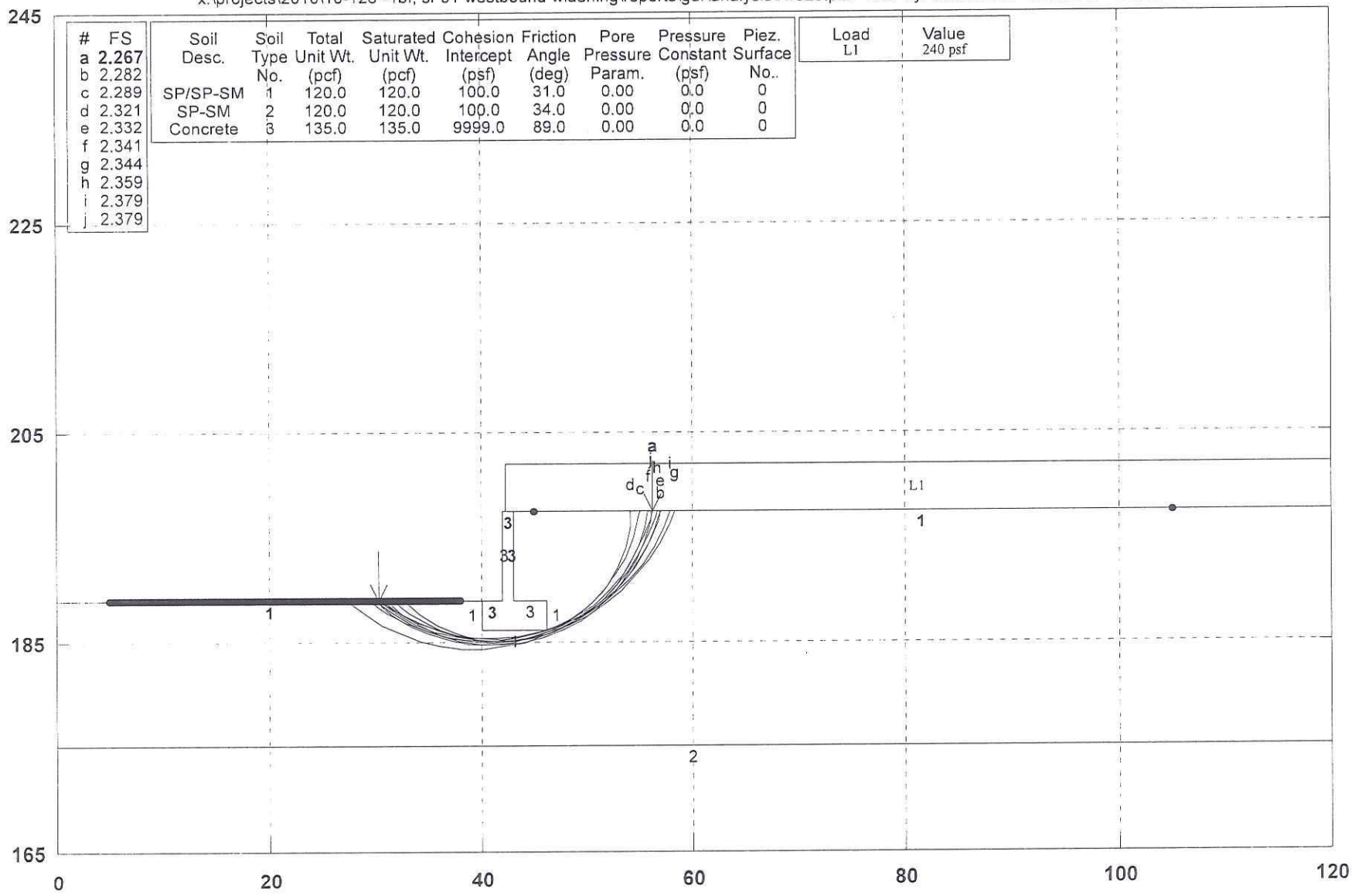
Settlement

consider 2.5 ksf bearing pressure
perform 1 ft of overexcavation & recompaction

	σ_{vo}	$\Delta\sigma$	settlement
①	$8.4 \times 0.12 = 1$	$2.5 \times 0.6 = 1.5$	$10.2 \times \frac{1}{55} \log\left(\frac{1+1.5}{1}\right) = 0.88$
②	$19 \times 0.12 = 2.28$	$2.5 \times 0.25 = 0.63$	$10 \times \frac{1}{85} \log\left(\frac{2.28+0.63}{2.28}\right) = 0.15$
			1.03"

SR-91 WB Widening - RW 323 Static Analysis

x:\projects\2010\10-126 - rbf, sr 91 westbound widening\reports\gdr\analysis\rw323.pl2 Run By: Username 6/27/2011 04:52PM

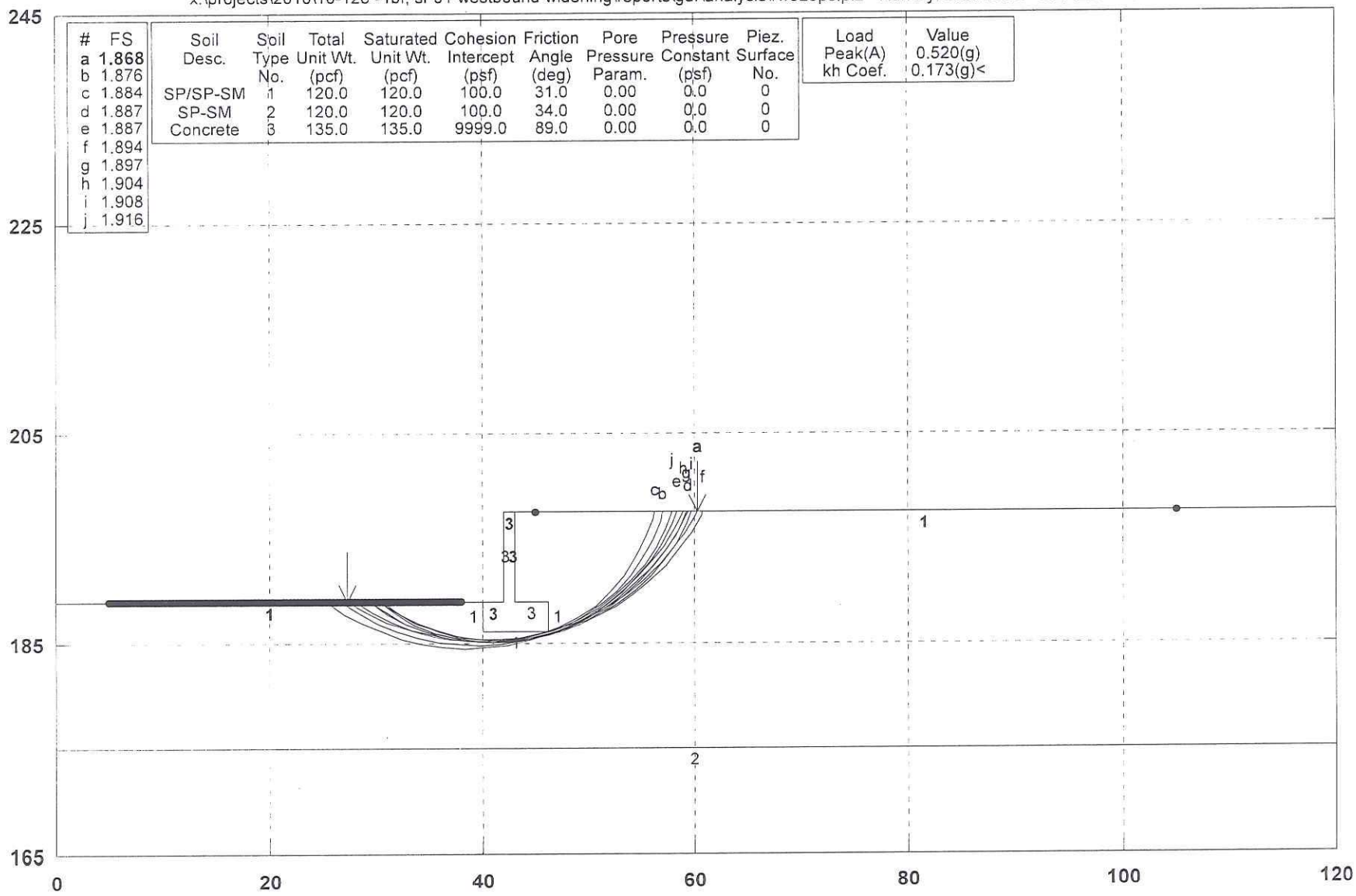


GSTABL7 v.2 FSmin=2.267

Safety Factors Are Calculated By The Modified Bishop Method

SR-91 WB Widening - RW 323 Pseudo Static Analysis

x:\projects\2010\10-126 - rbf, sr 91 westbound widening\reports\gdr\analysis\rw323ps.pl2 Run By: Username 6/27/2011 04:53PM



#	FS
a	1.868
b	1.876
c	1.884
d	1.887
e	1.887
f	1.894
g	1.897
h	1.904
i	1.908
j	1.916

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
SP/SP-SM	1	120.0	120.0	100.0	31.0	0.00	0.0	0
SP-SM	2	120.0	120.0	100.0	34.0	0.00	0.0	0
Concrete	3	135.0	135.0	9999.0	89.0	0.00	0.0	0

Load	Value
Peak(A)	0.520(g)
kh Coef.	0.173(g)<

GSTABL7 v.2 FSmin=1.868

Safety Factors Are Calculated By The Modified Bishop Method

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
(714) 751-3826, Fax (714) 751-3928

Project SR 91 WB Widening – Retaining Wall 335 **Project No.** 10-126

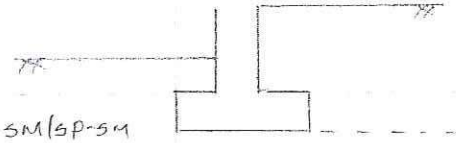
By SP **Date** 06-27-11 **Checked By** LLL **Date** 6/30/11 **Sheet** ___ **of** ___

Retaining wall 335

Maximum wall ht = 10 ft

width = 6.25 ft

bottom of footing = +196.67 ft



SM/SP-SM — +196.67'

① $\phi = 34$, $N_{av} = 33$

+190'

SP-SM

② $\phi = 30$, $N_{av} = 13$

+180'

SP/SP-SM

③ $\phi = 38$, $N_{av} = 37$

Bearing Capacity

$q_u = c N_{cm} + \sigma D_f N_{qm} + \frac{1}{2} \gamma B N_{\gamma m}$

for $\phi = 34$, $N_c = 42.2$, $N_q = 29.4$, $N_\gamma = 41.1$

$q_u = 100 \times 42.2 + 120 \times 2.83 \times 29.4 \times 1.2 + \frac{1}{2} \times 120 \times 6.25 \times 41.1$

$= 31.6$ ksf

$q_{all} = 10.5$ ksf

Settlement

consider 2.5 ksf bearing pressure.

	$\Delta\sigma_v$	$\Delta\sigma$	Settlement
①	$6.2 \times 0.12 = 0.74$	$2.5 \times 0.8 = 2$	$6.7 \times \frac{1}{85} \log\left(\frac{0.74+2}{0.74}\right) = 0.51$
⑤	$14.5 \times 0.12 = 1.74$	$2.5 \times 0.35 = 0.88$	$10 \times \frac{1}{55} \log\left(\frac{1.74+0.88}{1.74}\right) = 0.39$
			0.93

SR-91 WB Widening - RW 335 Static Analysis

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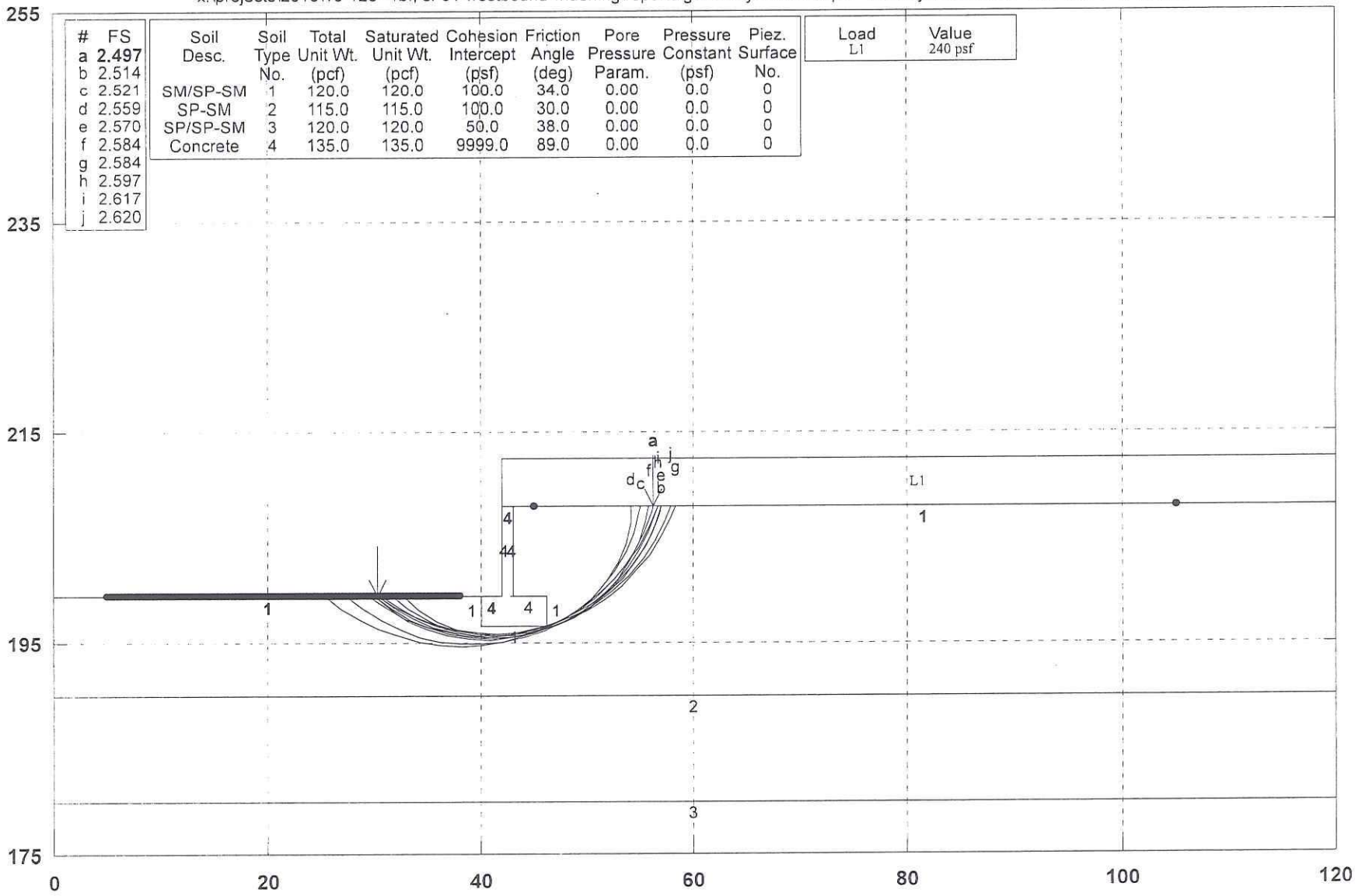


#	FS
a	2.497
b	2.514
c	2.521
d	2.559
e	2.570
f	2.584
g	2.584
h	2.597
i	2.617
j	2.620

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
SM/SP-SM	1	120.0	120.0	100.0	34.0	0.00	0.0	0
SP-SM	2	115.0	115.0	100.0	30.0	0.00	0.0	0
SP/SP-SM	3	120.0	120.0	50.0	38.0	0.00	0.0	0
Concrete	4	135.0	135.0	9999.0	89.0	0.00	0.0	0

Load	Value
L1	240 psf

GSTABL7 v.2 FSmin=2.497

Safety Factors Are Calculated By The Modified Bishop Method

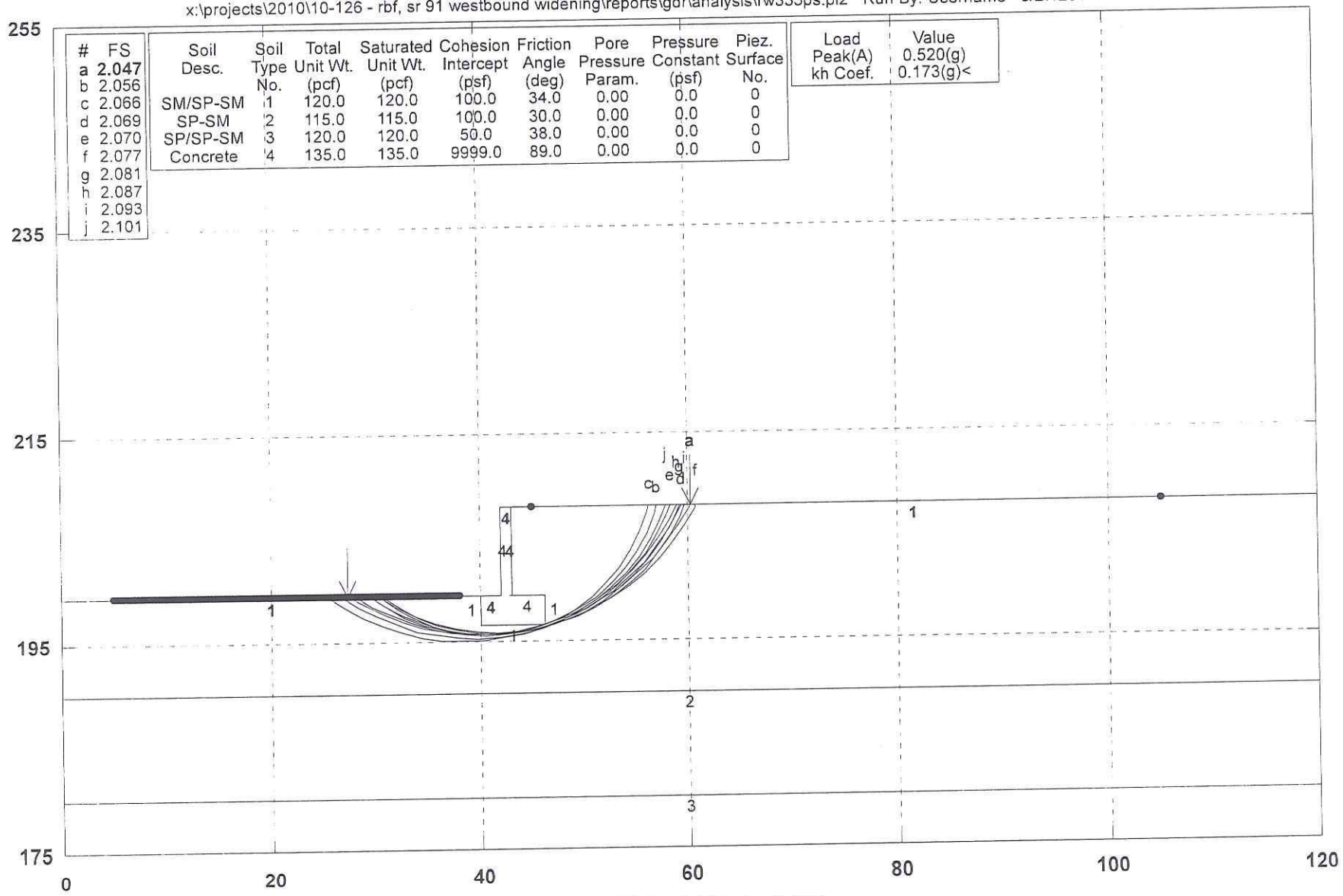
SR-91 WB Widening - RW 335 Pseudo Static Analysis

x:\projects\2010\10-126 - rbf, sr 91 westbound widening\reports\gdr\analysis\rw335ps.pl2 Run By: Username 6/27/2011 04:51PM

#	FS
a	**2.047**
b	2.056
c	2.066
d	2.069
e	2.070
f	2.077
g	2.081
h	2.087
i	2.093
j	2.101

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
SM/SP-SM	1	120.0	120.0	100.0	34.0	0.00	0.0	0
SP-SM	2	115.0	115.0	100.0	30.0	0.00	0.0	0
SP/SP-SM	3	120.0	120.0	50.0	38.0	0.00	0.0	0
Concrete	4	135.0	135.0	9999.0	89.0	0.00	0.0	0

Load	Value
Peak(A)	0.520(g)
kh Coef.	0.173(g)<



GSTABL7 v.2 FSmin=2.047

Safety Factors Are Calculated By The Modified Bishop Method

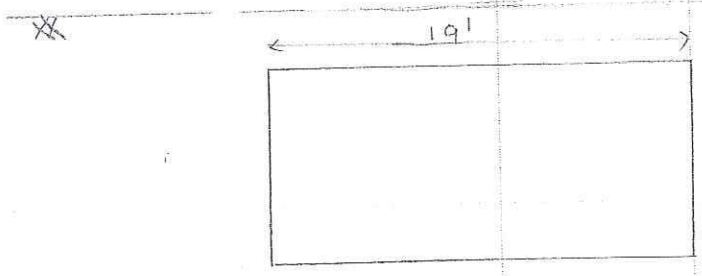
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
(714) 751-3826, Fax (714) 751-3928

Project SR-91 WB widening **Project No.** 10-126

By SP **Date** 06-28-11 **Checked By** LLC **Date** 6/30/11 **Sheet** ____ **of** ____

Reinforced concrete box and channel



① SM $N_{am} = 9$ $\phi = 31$ $N_{160} = 13$ — +115'

② ML $N_{am} = 12$ $S_u = 1.0$ $N_{160} = 15$ — +110

③ SM $N_{am} = 19$ $\phi = 33$ $N_{160} = 21$ — +103'

④ ML $N_{am} = 11$ $S_u = 1.0$ $N_{160} = 11$ — +98'

$N_{60} = C_N \left(\frac{ER}{60}\right) N_{am}$; $C_N = 0.77 \log\left(\frac{40}{\sigma v}\right)$; $ER = 75\%$

consider 6 ksf bearing pressure.

net bearing pressure for settlement calculation

$= 6 - 9 \times 0.12 = 4.92$ ksf

perform 2 ft of overexcavation below invert elevation

	σv_o	$\Delta\sigma$	settlement
①	$12 \times 0.12 = 1.44$	$4.92 \times 0.9 = 4.43$	$4 \times \frac{1}{45} \log\left(\frac{1.44 + 4.43}{1.44}\right) = 0.15$
②	$17.5 \times 0.12 = 2.1$	$4.92 \times 0.8 = 3.94$	$5 \times \frac{1}{60} \log\left(\frac{2.1 + 3.94}{2.1}\right) = 0.11$
③	$23.5 \times 0.12 = 2.82$	$4.92 \times 0.65 = 3.2$	$7 \times \frac{1}{75} \log\left(\frac{2.82 + 3.2}{2.82}\right) = 0.09$
④	$29.5 \times 0.12 = 3.54$	$4.92 \times 0.5 = 2.46$	$5 \times \frac{1}{90} \log\left(\frac{3.54 + 2.46}{3.54}\right) = 0.04$

$1.8''$

Appendix D

Caltrans Review Comments and EMI Responses

Sharid Amiri/D12/Caltrans/CAGov
10/29/2011 05:05 PM

To Luqi Yang/HQ/Caltrans/CAGov@DOT, Andrew Oshrin/D12/Caltrans/CAGov@DOT
cc Leo Chen/D12/Caltrans/CAGov@DOT
bcc
Subject SR 91, Project, project ID: 12000000791 Consultant Responses to Caltrans Review Comments on the Foundation Report for Overhead Sign Structures

I have reviewed the subject item and concur with it. I will review the Foundation Report once received by our office.

thanks

Sharid Khan Amiri,Ph.D.,P.E.

Senior Transportation Engineer
California Department of Transportation
Geotechnical Services, District 12 Oversight
3347 Michelson Dr., Suite 100
Irvine, Ca.92612-1699
Office (949)-724-2599

****

" For individuals with sensory disabilities , this document will be made available, upon request, in Braille, large print, audiocassette, or computer disk. To obtain a copy of one of these alternate formats, please call Della Moore at (916) 227-8185 or TTY (916) 227-8454 or write to Della Moore, Division of Engineering Services, P.O. Box 168041 Sacramento, CA 95816-8041"
****

—— Forwarded by Sharid Amiri/D12/Caltrans/CAGov on 10/29/2011 05:01 PM ——

Sharid Amiri/D12/Caltrans/CAGov
10/29/2011 04:55 PM

To Andrew Oshrin/D12/Caltrans/CAGov
cc Leo Chen/D12/Caltrans/CAGov@DOT
Subject SR 91, Project, project ID: 12000000791 Consultant Responses to Caltrans Review Comments on the Geotechnical Design Report

Andrew

I have reviewed the subject item and concur with it. I will review the revised Geotechnical Design Report once received by our office.

Thanks

Sharid Khan Amiri,Ph.D.,P.E.

Senior Transportation Engineer
California Department of Transportation
Geotechnical Services, District 12 Oversight
3347 Michelson Dr., Suite 100
Irvine, Ca.92612-1699
Office (949)-724-2599

September 9, 2011

EMI Project No. 10-126

RBF Consulting
14725 Alton Parkway
Irvine, California 92618

Attention: Mr. Steve Huff, P.E.

Subject: Responses to Caltrans Review Comments on the Geotechnical Design Report
State Route 91 Westbound Widening Project
Orange County, California
12-ORA-91, PM 0.9/5.4
Caltrans Project No. 12000000791 (EA 12-0C5701)

Dear Mr. Huff:

Earth Mechanics, Inc. (EMI) submitted the Geotechnical Design Report for the State Route 91 Westbound Widening Project, dated July15, 2011, to Caltrans for review and comments. Caltrans Office of Geotechnical Design South 1 reviewed the report and provided comments in a memorandum dated August 19, 2011. EMI has prepared responses to the Caltrans comments as documented in this letter. For convenience, Caltrans review comments are provided in italics followed by EMI responses. EMI will incorporate these responses into the Final Geotechnical Design Report after Caltrans approves our responses.

1. *Section 7.3.2: When indicating groundwater depth, use elevations in reference to established bench marks.*

   We will replace the first paragraph in Section 7.3.2 with the following.

   Groundwater was encountered between elevations +65.0 feet near SR-91 Mainline Station 172+55 and +153.7 feet near SR-91 Mainline Station 327+09. Groundwater was also encountered between elevations +59.5 feet near Brookhurst Street Undercrossing (UC) and +128 feet near Acacia Street UC in 1993 and between elevations +72.2 and +73.5 feet near Brookhurst Street UC in 1955. Based on California Geological Survey (Division of Mines and Geology, 1997 and 1998), the recorded highest historical groundwater at the project site is between 40 and 50 feet below the existing ground surface. The existing ground surface elevations vary from +108 to +210 feet between the western and eastern end of the project, respectively. Therefore, using a historical high groundwater depth of 40 feet, the historical high groundwater elevations vary from +68 to +170 feet between the western and eastern end of the project, respectively.

2. *Section 8.4: Add a key plan indicating retaining walls and reference soil borings used to determine idealize soil profiles.*

   The attached figure will be included in the final report.

3. *Section 8.4: Over excavated bottom of footing should be compacted to 90% density.*

   The settlement calculations were performed assuming there is no settlement within the overexcavation depth (i.e. the recompacted material will not settle under the foundation load). Therefore, we recommended a minimum of 95% relative compaction for backfilling of the overexcavation.

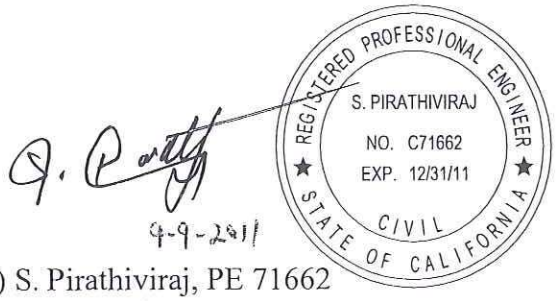
4. *Reference Soil & Rock Logging Manual Section 5.2.3.3 a): First LOTB sheet should show a plan view indicating all soil boring locations.*

   In the report, we presented the boring location plans in Figures 5-1 through 5-19. In addition, the wall or bridge location and the boring locations are indicated in the plan view of each LOTB sheet. If we combine all of this information on a plan view, it will be rather congested and difficult to read. Section 5.2.3.3 (a) in the Caltrans Soil and Rock Logging Manual is more appropriate for a long and complex bridge, such as a viaduct with merging and/or adjacent ramp structures. This is because the plan view only need to identify one structural element (in this case, the bridge supports) and the borehole locations, and the resulting drawing will not be as congested and will be legible. This SR-91 westbound widening project is about 4.5 miles long, with bridges, walls, and embankments. The boring location plans in Figures 5-1 through 5-19 identify all the design elements (bridges, walls and embankments) as well as the boring locations, and provide the same information as required in Section 5.2.3.3 (a) of the Caltrans Soil and Rock Logging Manual. We are requesting Caltrans to waive this requirement.

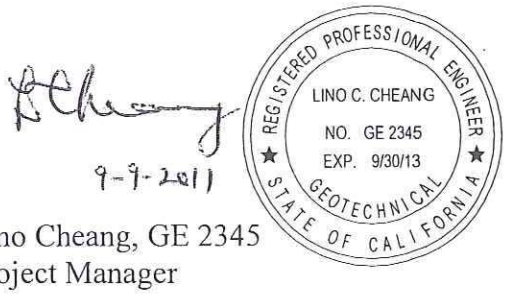
EMI will incorporate the above responses in the Final Geotechnical Design Report. Please submit this letter to Caltrans for their review of our responses.

Sincerely,

EARTH MECHANICS, INC.



(Raja) S. Pirathiviraj, PE 71662
Senior Staff Engineer



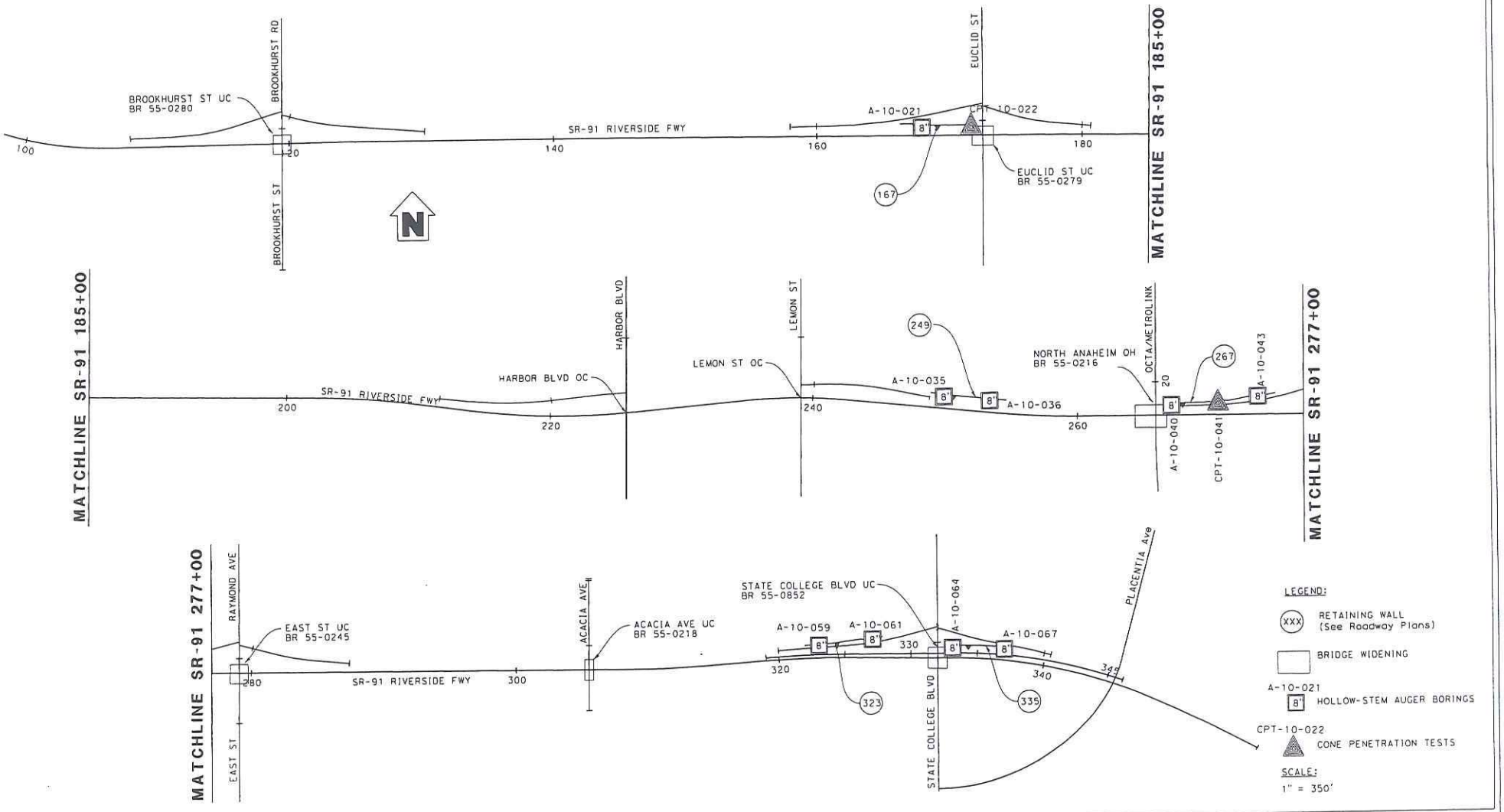
Lino Cheang, GE 2345
Project Manager

Attachment A - Figure 8-1 Standard Walls and Borings Map
- Review Comments on the Geotechnical Design Report for SR-91 Westbound Widening Project by Caltrans Office of Geotechnical South 1, Dated August 15, 2011

ATTACHMENT A

Figure 8-1 Standard Walls and Borings Map

Review Comments on the Geotechnical Design Report for SR-91 Westbound Widening Project by Caltrans Office of Geotechnical South 1 Dated August 10, 2011



Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

STATE ROUTE 91 WESTBOUND WIDENING PROJECT

Project No.: 10-126 | **Date: 06-23-2011**

STANDARD WALLS AND BORINGS MAP

Figure 8-1

State of California

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: ANDREW OSHRIN
STE – District 12

Date: August 19, 2011

File: 12-ORA-91 PM 0.9/5.4
EA 12-0C5701, 1200000079
GDR Review

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
Geotechnical Services
Office of Geotechnical Design – South 1

Subject: Geotechnical Design Report Review

Per your request, the Geotechnical Design South 1 - Branch B has reviewed the subject submittal, containing the following item:

1. Geotechnical Report for SR-91 Westbound Widening Project, Orange County, dated July 15, 2011.

Our office has following comments on above submitted item:

1. Section 7.3.2: When indicating groundwater depth, use elevations in reference to established bench marks.
2. Section 8.4: Add a key plan indicating retaining walls and reference soil borings used to determine idealized soil profiles.
3. Section 8.4: Over excavated bottom of footing should be compacted to 90% density.
4. Reference Soil & Rock Logging Manual Section 5.2.3.3 a): First LOTB sheet should show a plan view indicating all soil boring locations.

Should you have any questions, please contact Mushtaq Ahmed at (213) 620-2132.

Reviewed by: Date: 8/19/11

Mushtaq Ahmed, P.E.
Transportation Engineer-Civil
Office of Geotechnical Design – South 1
Branch B

Supervised by: Date: 8/19/11

Sam Sukiasian, G.E.
Chief Branch B
Office of Geotechnical Design – South 1

REGISTERED CIVIL ENGINEER
MOHAMMAD MUSHTAQ AHMED
No. C056390
Exp. 6-30-13
STATE OF CALIFORNIA

cc: OGDS1 – Ref. File, OGDS1- Author File, GS-Sac. File

"Caltrans improves mobility across California"

FINAL MATERIALS REPORT

Earth Mechanics, Inc.

February 1, 2012

FINAL MATERIALS REPORT

State Route 91 Westbound Widening Project
Orange County, California
12-ORA-91, PM 0.9/5.4
Caltrans Project No. 12000000791 (EA 12-0C5701)
EMI Project No. 10-126
Date: February 1, 2012

EARTH MECHANICS, INC.

Geotechnical and Earthquake Engineering

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

February 1, 2012

EMI Project No. 10-126

RBF Consulting
14725 Alton Parkway
Irvine, California 92618

Attention: Mr. Steve Huff, P.E.

Subject: Final Materials Report
State Route 91 Westbound Widening Project
Orange County, California
12-ORA-91, PM 0.9/5.4
Caltrans Project No. 12000000791 (EA 12-0C5701)

Dear Mr. Huff:

Attached please find the final Materials Report for the State Route 91 Westbound Widening Project. This report contains our findings, conclusions, and recommendations for the design and construction of the proposed widening. Specifically, this report addresses geotechnical and materials issues as described in Topic 114 of the California Department of Transportation (Caltrans) Highway Design Manual and Caltrans Test Method 130.

An earlier version of this report dated September 16, 2011 was submitted to Caltrans for their review. Caltrans Reviewer has minor comments and these comments were discussed and resolved in meetings and telephone conferences. This final report incorporates all the revisions agreed upon in those meetings and conferences.

We appreciate the opportunity to provide geotechnical design services for this project. If you have any questions, please call us.

Sincerely,

EARTH MECHANICS, INC.

2-1-2012

Lino Cheang, GE 2345
Project Manager

REGISTERED PROFESSIONAL ENGINEER
LINO C. CHEANG
NO. GE 2345
EXP. 9/30/13
GEOTECHNICAL
STATE OF CALIFORNIA

SP/sp,lcc

17800 Newhope Street, Suite B, Fountain Valley, California 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

FINAL MATERIALS REPORT

STATE ROUTE 91 WESTBOUND WIDENING PROJECT
ORANGE COUNTY, CALIFORNIA
12-ORA-91, PM 0.9/5.4
CALTRANS PROJECT NO. 12000000791 (EA 12-0C5701)

Prepared for:

RBF Consulting
14725 Alton Parkway
Irvine, California 92618

Prepared By:

Earth Mechanics, Inc.
17800 Newhope Street, Suite B
Fountain Valley, California 92708

EMI Project No. 10-126

February 1, 2012

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

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1.0 GENERAL

1.1 PURPOSE AND SCOPE OF WORK

This Materials Report presents findings and conclusions of a geotechnical investigation conducted by Earth Mechanics, Inc. (EMI) for the State Route (SR) 91 Westbound (WB) Widening Project located in County of Orange, California. The project location is shown on the Site Location Map in Figure 1. The purpose of the geotechnical investigation was to obtain subsurface information to develop design and construction recommendations to aid RBF Consulting in preparing the Project Plans, Specifications, and Estimates.

This report follows the requirements for a Materials Report in accordance with Topic 114 of the California Department of Transportation (Caltrans) Highway Design Manual (HDM, 2008a) and is organized in general accordance with California Test (CT) 130 (Caltrans, 2000). This report provides geotechnical information and recommendations for pavement structural sections, earthwork, and addresses soil corrosion issues at the site as required by the HDM.

The following geotechnical services were completed for this project:

- Geotechnical field exploration consisting of drilling and logging 72 exploratory borings.
- Laboratory testing of selected soil samples.
- Pavement structural section design.
- Soil corrosivity evaluation.
- Preparation of this report presenting our findings, conclusions, and recommendations.

1.2 PROJECT DESCRIPTION

The California Department of Transportation (Caltrans), in cooperation with the Orange County Transportation Authority (OCTA) and the cities of Anaheim and Fullerton, proposes to widen the SR-91 WB from SR-57 to I-5. The proposed project limits cover a distance of 4.5 miles; however, actual improvements are limited to a total of about 4.0 miles within the project area.

The proposed project consists of the westbound mainline widening that connects the existing lanes through each interchange and the addition of two-lane exit ramps and associated auxiliary lanes at the westbound exit ramps to Raymond Avenue, Lemon Street and Brookhurst Street.

To accommodate the proposed improvements, six bridge westbound widenings, 3 non-standard retaining walls, 4 soundwall on retaining walls, 1 soundwall, and 5 Caltrans Standard Type 1 retaining walls are proposed for the project. The bridge widening will be located at:

- State College Boulevard Undercrossing (Bridge No. 55-0852)
- Acacia Street Undercrossing (Bridge No. 55-0218)
- East Street Undercrossing (Bridge No. 55-0245)
- North Anaheim Overhead (Bridge No. 55-0216)
- Euclid Street Undercrossing (Bridge No. 55-0279)
- Brookhurst Street Undercrossing (Bridge No. 55-0280)

Drainage work involves construction of various sized Reinforced Concrete Pipe (RCP) culverts and drainage inlets throughout the length of the project. Modifications to the Houston Storm Channel include construction of a Reinforced Concrete Box (RCB) culvert and an open-concrete rectangular channel between Stations 157+00 and 161+00.

A total of 11 Caltrans standard and non-standard overhead sign structures are proposed within the project limits. The proposed overhead sign structures consist of nine "cantilever" type single-post structures and two "bridge" type double-post structures.

1.3 CLIMATIC CONDITIONS

Weather in the Los Angeles region is a Mediterranean-type, semi-arid, climate characterized by warm dry summers and mild winters. A dominating factor in the weather is the semi-permanent north Pacific high pressure system that migrates northward in summer, holding storm tracks well to the north, and as a result southern California receives little or no precipitation during the summers. In winter, the north Pacific high migrates southward permitting storm centers to swing across southern California. These storms generate moderate, but occasionally severe, precipitation events. When changes in the circulation pattern permit storms to approach from a southwesterly direction, the colder northern air masses merge with subtropical air masses and bring copious amounts of moisture with the northeastward streaming air. This results in heavy rains and often produces widespread flooding, especially in the spring when it coincides with runoff from melting snow in the mountains.

Summer is a dry period over most of the area. With the northward migration of the Pacific high most storm tracks are deflected far to the north during summer, and southern California seldom receives precipitation from Pacific storms during this time of year. Occasionally, during the summer months, moist air drifts northward from the Gulf of Mexico or the Gulf of California creating monsoonal conditions. At such times, scattered, locally heavy thunder showers occur, mostly in the desert and inland mountain areas.

The average annual high temperature is about 78 degrees (F) and the average low about 50 degrees. The hottest months are July, August, and September when high temperatures average in the high 80s, and low temperatures average in the high 50s. The coolest temperatures are in the winter months of December, January, and February when average highs are in the high 60s and average lows are in the low 40 degrees.

The extreme high temperatures can reach about 110 degrees in July, August, and September with the record high of 114 degrees in September. These high temperatures are commonly associated with adiabatic heating associated with winds called Santa Ana winds. The extreme low temperatures average about 30 degrees in December through February with a record low of 22 degrees. Freezing occurs occasionally on the winter nights, but is generally of short duration (a couple hours) and does not commonly result in a "hard" freeze.

Annual precipitation averages about 14 inches. The wettest months are November through March with an average of 3.5 inches in January and 3.0 inches in February. Although snow is common in the surrounding high mountains and results in snow-capped peaks for several months, snow fall is extremely rare in the lowlands such as the site area. However, snowfall

events have been recorded. For example in January of 1949 about 1.5 inches of snow fell. Such snow generally melts the same day that it falls.

1.4 TERRAIN, LAND USE, AND SURFACE DRAINAGE

The project area extends in an east-west direction for a distance of about 4½ miles across the east-central part of the Los Angeles Basin. The project corridor is on a flat plain that descends gently to the west at a gradient of about 20 to 25 feet per mile. Elevations at the eastern end of the project corridor near Placentia Avenue are about 195 feet above sea level. Elevation decreases westerly to about 110 feet above sea level at Brookhurst Street. The plain is bordered by the Coyote Hills which lie about 2 miles north of the site and rise to as much as 400-500 feet elevation.

The project area is a predominantly suburban/urban community characterized by a variety of land uses, which include residential, industrial, public facilities/institutional, and commercial uses. It is largely built out, with very few vacant lots. The northeastern portion of the project area contains predominantly industrial and commercial uses, particularly along the railroad corridor that runs parallel to and north of SR-91. A second railroad corridor branches off just east of Lemon Street and continues south toward the City of Anaheim where it crosses SR-91. Land uses in the southeastern, southwestern, and northwestern portions of the project area are predominantly residential and commercial. Commercial development in the project area includes strip malls and a few regional commercial centers. The commercial uses include supermarkets, home improvement stores, restaurants, gasoline stations, and hotels. Several office/business parks are also located in the vicinity of these commercial areas. Residential neighborhoods, with mostly single-family units and some multi-family complexes, are located throughout the project area but are concentrated along the western half of the project site. The neighborhoods include other typical uses and facilities such as schools, parks, community centers, and religious facilities.

Major rivers within the Los Angeles basin are the Los Angeles, San Gabriel, and Santa Ana Rivers. The rivers enter the basin through gaps in the surrounding mountains and drain southerly across the basin floor. The site area is near the Santa Ana River which originates in the San Bernardino Mountains to the west. Santiago Creek, a major tributary to the Santa Ana River flows westerly from the foothills of the Santa Ana Mountains and together with the Santa Ana River flows southerly to the ocean near Costa Mesa.

As presented in Project Report prepared in May 2010, the existing drainage facilities include storm drain systems and inlets, under-highway cross culverts, Houston Storm Channel and Carbon Creek Channel. The majority of the water within the project limits is routed through cross culverts and concrete ditches to Houston Channel and Carbon Creek Channel.

1.5 REGIONAL GEOLOGY

The project area is in the east-central part of the Los Angeles Basin which comprises a transition zone between the Peninsular Ranges physiographic province on the east, and the Transverse Ranges physiographic province to the north. The Peninsular Ranges physiographic province comprises a northwest-southeast trending group of fault-bounded ranges such as Santa Ana Mountains, Puente Hills and San Joaquin Hills between the Salton Trough and the Pacific Ocean.

The Transverse Ranges physiographic province comprises east-west trending ranges and valleys such as the Santa Monica Mountains, San Fernando Valley and San Gabriel Mountains. Valleys such as the Los Angeles Basin, the San Gabriel Valley and the Upper Santa Ana River Valley have characteristics compatible with both physiographic provinces and form a transition zone between the two provinces.

The Los Angeles Basin is essentially a large, relatively flat, low-lying and coastal plain surrounded by mountains on the north, east and southeast which rise abruptly to a few thousand feet above the plains. The western margin of the basin is bordered by the sea, the Palos Verdes Hills and the San Joaquin Hills. The floor of the basin gradually rises inland to a series of uplifted terrain along the margins of the surrounding mountains. This elevated marginal terrain includes the Santa Monica, La Brea, Montebello, Santa Fe Springs plains, and the Coyote Hills. The generally flat-lying nature and gradual inland rise of the Basin floor is disrupted by an alignment of northwest-southeast trending, low-elevation hills along the Newport-Inglewood Structural Zone (NISZ). The areas on either side of the NISZ are essentially flat and comprise the Downey-Tustin plain on the northeast and the Torrance Plain on the southwest. The site area is near the transition between the Downey and the Tustin plains.

1.6 PERTINENT REPORTS AND INVESTIGATIONS

No previous geotechnical studies were performed specifically for final design of the improvements addressed in this report.

1.7 RELATED REPORTS PREPARED FOR THE PROPOSED IMPROVEMENTS

A separate Geotechnical Design Report (GDR) (EMI, 2011i) has been prepared for the current geotechnical study to address geotechnical issues not included in this report. The Geotechnical Design Report may be referred to for additional geotechnical information.

Separate Foundation Reports have been prepared for the bridges, non-standard walls and overhead sign structures (EMI, 2011a through 2011h):

- State College Boulevard Undercrossing (Bridge No. 55-0852),
- Acacia Street Undercrossing (Bridge No. 55-0218),
- East Street Undercrossing (Bridge No. 55-0245),
- North Anaheim Overhead (Bridge No. 55-0216),
- Euclid Street Undercrossing (Bridge No. 55-0279),
- Brookhurst Street Undercrossing (Bridge No. 55-0280),
- Non-Standard Walls, and
- Overhead Sign Structures

1.8 LIMITATIONS

This report is intended for the use of OCTA, RBF and Caltrans for design and construction of the SR-91 WB Widening. This report is based on the project as described and the information obtained from the exploratory borings at the approximate locations indicated on the attached plans. The findings and recommendations contained in this report are based on the results of the field investigation, laboratory tests, and engineering analyses. In addition, soils and subsurface conditions encountered in the exploratory borings are presumed to be representative of the project site. However, subsurface conditions and characteristics of soils between exploratory borings can vary. The findings reflect an interpretation of the direct evidence obtained. The recommendations presented in this report are based on the assumption that an appropriate level of quality control and quality assurance (inspections and tests) will be provided during construction. EMI should be notified of any pertinent changes in the project plans or if subsurface conditions are found to vary from those described herein. Such changes or variations may require a re-evaluation of the recommendations contained in this report.

The data, opinions, and recommendations contained herein are applicable to the specific design elements and locations which are the subject of this report. Data, opinions, and recommendations herein have no applicability to any other design elements or to any other locations, and any and all subsequent users accept any and all liability resulting from any use or reuse of the data, opinions, and recommendations without the prior written consent of EMI.

EMI is not responsible for construction means, methods, techniques, sequences, or procedures, or for safety precautions or programs in connection with the construction. EMI is not responsible for the acts or omissions of the Contractor, or any other person performing any construction, or for the failure of any worker to carry out construction in accordance with the Final construction drawings and specifications.

Services performed by EMI were conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, expressed or implied, and no warranty or guarantee is included or intended.

2.0 EXISTING FACILITIES AND PROPOSED IMPROVEMENTS

2.1 EXISTING FACILITIES

State Route 91 is a major east-west freeway facility that begins at the eastern junction with SR-60 in the city of Riverside in Riverside County, and continues west through Orange County to its terminus just west of I-110 in Los Angeles County.

The proposed project is located in Orange County, on SR-91 generally between SR-57 (to the east) and Interstate 5 (to the west) and traverses through the City of Anaheim and the City of Fullerton. Within the limits of the proposed project, SR-91 has a varying number of existing general purpose lanes, auxiliary lanes, and HOV lanes.

The proposed project alignment is generally elevated on an embankment, at or near the elevations of the surrounding land, and crosses:

- State College Boulevard UC (Bridge No. 55-0852)
- Acacia Street UC (Bridge No. 55-0218)
- East Street UC (Bridge No. 55-0245)
- OCTA/Metrolink rail line at the North Anaheim Overhead (Bridge No. 55-0216)
- Lemon Street OC (Bridge No. 55-0858)
- Harbor Boulevard OC (Bridge No. 55-0857)
- Euclid Street UC (Bridge No. 55-0279)
- Brookhurst Street UC (Bridge No. 55-0280)

At the diverge with mainline SR-91, all interchanges are diamond interchanges with single lane on- and off-ramps, and off-ramps terminating at signalized intersections at the crossing arterial streets. However, Lemon Street and Harbor Boulevard have been reconfigured as a split diamond interchange, and there is no interchange at Acacia Street.

There are segments of existing sound walls and retaining walls located along the proposed alignment of the project.

The existing drainage facilities include storm drain systems and inlets, under-highway cross culverts, Houston Storm Channel and Carbon Creek Channel. The majority of the water within the project limits is routed through cross culverts and concrete ditches to Houston Channel and Carbon Creek Channel.

The existing pavement sections are presented in Typical Section sheets and summarized in Table 1.

Table 1. Existing Pavement Sections (Per As-Built Plans)

Locations[1]	Approximate Stations	As-Built Pavement Sections[2]
Inside Lanes		
Between West of Brookhurst Street and East of Euclid Street	102+00 to 183+70	0.67' PCC 0.67' UB 0.33' CTS 0.67' SM
Between East of Lemon Street and State College Boulevard	248+85 to 331+00	
East of State College Boulevard	333+00 to 341+50	0.65' AC 0.25' ATPB 0.75' Class 2 AB
Outside Lanes		
Between West of Brookhurst Street and East of Euclid Street	102+00 to 183+70	0.65' AC 0.25' ATPB 0.75' Class 2 AB
Between East of Lemon Street and State College Boulevard	248+85 to 331+00	0.65' AC 0.25' ATPB 2.20' Class 2 AB
East of State College Boulevard	333+00 to 341+50	0.75' AC 0.25' ATPB 0.95' Class 2 AB
Shoulders		
Between West of Brookhurst Street and East of Euclid Street	102+00 to 183+70	0.45' AC 0.80' Class 2 AB 0.40' Class 3 AS or 0.65' Class 4 AS
Between East of Lemon Street and State College Boulevard	248+85 to 331+00	0.65' AC 0.25' ATPB 0.85' Class 2 AB
East of State College Boulevard	333+00 to 341+50	0.45' AC 0.80' Class 2 AB
Ramps		
Brookhurst Street	Off- and On-Ramps	0.33' PMS 0.67' UB 1.00' SM
	Off- and On-Ramp Shoulders	0.50' AC 0.65' Class 2 AB
Euclid Street	Off- and On-Ramps	0.33' PMS 0.67' UB 1.00' SM
	Off-Ramp and On-Ramp Shoulders	0.50' AC 0.65' Class 2 AB
Harbor Boulevard	On-Ramp	0.65' AC 0.25' ATPB 1.10' Class 2 AB
Lemon Street	Off-Ramp	
Raymond Avenue	Off- and On-Ramps	
State College Boulevard	Off- and On-Ramps, and Off-Ramp Shoulder	0.50' AC 0.25' ATPB 0.60' Class 2 AB

Locations[1]	Approximate Stations	As-Built Pavement Sections[2]
	On-Ramp Shoulder	0.50' AC 0.95' Class 2 AB

Notes:
(1) No work is proposed on the Mainline between Stations 183+70 and 248+85
(2) PCC = Portland Cement Concrete; UB = Untreated Base; CTS = Cement Treated Subgrade; UB = Untreated Base; SM = Imported Subbase Material; AC = Asphalt Concrete; ATPB = Asphalt-Treated Permeable Base; AB = Aggregate Base; AS = Aggregate Subbase; PMS = Plant Mixed Surfacing.

2.2 PROPOSED IMPROVEMENTS

According to the Project Report prepared in May 2010, the Preferred Alternative consists of connecting the existing auxiliary lanes through each interchange. The Preferred Alternative would include:

- Construction of the proposed fourth continuous general purpose lane through the State College Boulevard interchange to the existing auxiliary lane between State College Boulevard and Raymond Avenue;
- Construction of the proposed fourth continuous general purpose lane through the Raymond Avenue interchange, connecting with the existing number four general purpose lane through the Lemon Street-Harbor Boulevard split diamond interchange segment;
- Construction of a new auxiliary lane between Raymond Avenue and Lemon Street where no auxiliary lane currently exists;
- Extension of the existing number four general purpose lane through the Euclid Street interchange to the existing auxiliary lane between Euclid Street and Brookhurst Street; and
- Construction of the proposed fourth continuous general purpose lane through the Brookhurst Street interchange, connecting with the existing auxiliary lane downstream of the Brookhurst Street On-ramp.

In addition to the fourth continuous general purpose through lane and auxiliary lanes, the Preferred Alternative would include improvements at the following ramps:

- State College Boulevard Off- and On-Ramps;
- Raymond Avenue Off- and On-Ramps;
- Lemon Street Off-Ramp;
- Harbor Boulevard On-Ramp;
- Euclid Street Off- and On-Ramps; and
- Brookhurst Street Off- and On-Ramps.

Recommended pavement structural sections for the auxiliary lanes, general purpose lanes, ramps, shoulders and maintenance vehicle pull-outs are presented in Section 7.3 of this report.

3.0 ROADWAY AND CULVERT FOUNDATIONS

3.1 GEOTECHNICAL INVESTIGATION

A geotechnical field investigation was conducted between December 6, 2010 and February 1, 2011, and on May 16 and December 16, 2011. Seventy three exploratory borings were accomplished under the supervision of EMI. Soil exploration information is summarized in Table 2. Approximate locations of borings drilled by EMI are shown on Figure 2 through Figure 20. Logs of borings are presented in Appendix A.

Table 2. Soil Exploration Information

Boring	Station	Offset (feet)	Top of Boring Elevation (feet)	Bottom of Boring Elevation (feet)	Groundwater Elevation (feet)	Drilling Method
HA-10-001	102+95	73 Lt	+108.0	+106.0	NE	HA
A-10-002	109+44	78 Lt	+112.0	+80.5	NE	HSA
A-10-003	112+86	101 Lt	+112.0	+80.5	NE	HSA
HA-10-004	114+02	62 Lt	+121.0	+119.0	NE	HA
A-10-005	116+24	176 Lt	+114.3	+62.8	+70.9	HSA
A-10-006	118+55	76 Lt	+130.0	+43.5	+73.5	HSA
A-10-007	119+36	63 Lt	+112.4	+30.9	+68.4	HSA
A-10-008	120+42	55 Lt	+130.0	+49.2	+71.6	HSA
HA-10-009	120+28	244 Lt	+112.5	+109.5	NE	HA
HA-10-010	125+09	138 Lt	+115.8	+112.8	NE	HA
HA-10-011	126+00	61 Lt	+119.0	+117.0	NE	HA
A-10-012	131+14	91 Lt	+119.0	+87.5	NE	HSA
HA-10-013	137+00	81 Lt	+120.8	+118.8	NE	HA
HA-10-014	142+00	82 Lt	+123.0	+121.0	NE	HA
HA-10-015	146+98	84 Lt	+125.0	+123.0	NE	HA
A-10-016	150+46	86 Lt	+126.2	+94.7	NE	HSA
A-10-017	155+04	87 Lt	+128.7	+122.2	NE	HSA
A-10-018	159+18	95 Lt	+130.0	+98.5	NE	HSA
A-10-019	160+55	106 Lt	+131.0	+99.5	NE	HSA
A-10-020	165+00	63 Lt	+138.0	+106.5	NE	HSA
A-10-021	168+00	58 Lt	+146.8	+115.3	NE	HSA
CPT-10-022	171+67	61 Lt	+153.0	+90.0	NE	CPT
A-10-023	172+55	77 Lt	+135.0	+53.5	+65.0	HSA
A-10-024	173+76	62 Lt	+152.6	+66.1	+80.4	HSA
HA-10-025	173+28	232 Lt	+134.2	+132.2	NE	HSA

Boring	Station	Offset (feet)	Top of Boring Elevation (feet)	Bottom of Boring Elevation (feet)	Groundwater Elevation (feet)	Drilling Method
CPT-10-026	176+21	60 Lt	+148.0	+137.3	NE	CPT
A-10-027	176+59	93 Lt	+141.0	+134.5	NE	HSA
A-10-028	181+00	67 Lt	+140.0	+133.5	NE	HSA
A-10-029	184+45	85 Lt	+139.0	+107.5	NE	HSA
A-10-030	186+48	67 Lt	+142.0	+110.5	NE	HSA
CPT-10-031	189+61	67 Lt	+144.0	+83.5	NE	CPT
A-10-032	193+48	90 Lt	+144.0	+112.5	NE	HSA
A-10-033	196+46	73 Lt	+146.0	+114.5	NE	HSA
A-10-034	244+48	145 Lt	+164.6	+160.6	NE	HSA
A-10-035	249+78	89 Lt	+166.0	+134.5	NE	HSA
A-10-036	253+33	89 Lt	+168.0	+116.5	NE	HSA
A-10-037	256+96	79 Lt	+178.0	+146.5	NE	HSA
A-10-038	260+40	79 Lt	+188.0	+156.5	NE	HSA
A-10-039	264+14	88 Lt	+198.4	+96.9	NE	HSA
A-10-040	267+05	74 Lt	+201.2	+100.7	NE	HSA
CPT-10-041	270+54	87 Lt	+198.0	+181.1	NE	CPT
HA-10-042	273+10	61 Lt	+196.5	+194.5	NE	HA
A-10-043	273+55	138 Lt	+192.5	+141.0	NE	HSA
A-10-044	278+00	77 Lt	+193.0	+111.5	+113.3	HSA
A-10-045	279+05	77 Lt	+174.0	+92.6	+120.5	HSA
CPT-10-046	279+92	64 Lt	+189.5	+103.2	NE	CPT
A-10-047	280+88	211 Lt	+175.0	+168.5	NE	HSA
A-10-048	284+98	64 Lt	+177.9	+171.4	NE	HSA
A-10-049	288+71	77 Lt	+178.0	+146.5	NE	HSA
A-10-050	293+06	77 Lt	+180.0	+148.5	NE	HSA
CPT-10-051	296+68	80 Lt	+180.0	+122.6	NE	CPT
A-10-052	300+05	82 Lt	+192.0	+160.5	NE	HSA
CPT-10-053	304+43	73 Lt	+200.0	+140.6	NE	CPT
A-10-054	305+43	95 Lt	+181.0	+99.5	+128.2	HSA
A-10-055	306+48	76 Lt	+200.5	+129.3	NE	HSA
A-10-056	310+10	80 Lt	+194.0	+162.5	NE	HSA
A-10-057	313+75	82 Lt	+188.0	+156.5	NE	HSA
A-10-058	316+80	84 Lt	+185.9	+154.5	NE	HSA
A-10-059	323+05	94 Lt	+194.0	+162.5	NE	HSA

Boring	Station	Offset (feet)	Top of Boring Elevation (feet)	Bottom of Boring Elevation (feet)	Groundwater Elevation (feet)	Drilling Method
HA-10-060	326+00	73 Lt	+199.0	+197.0	NE	HA
A-10-061	327+09	139 Lt	+196.8	+145.3	+153.7	HSA
CPT-10-062	330+80	69 Lt	+208.7	+162.6	NE	CPT
A-10-063	332+01	90 Lt	+190.2	+109.7	NE	HSA
A-10-064	333+13	76 Lt	+210.0	+128.7	NE	HSA
HA-10-065	332+93	244 Lt	+191.0	+189.0	NE	HA
HA-10-066	335+13	172 Lt	+196.0	+194.0	NE	HA
A-10-067	336+96	83 Lt	+204.0	+172.5	NE	HSA
HA-10-068	341+16	102 Lt	+202.0	+200.0	NE	HA
HA-11-069	208+12	93 Lt	+156.0	+152.0	NE	HA
HA-11-070	212+85	91 Lt	+155.7	+151.7	NE	HA
HA-11-071	217+91	207 Lt	+152.0	+148.0	NE	HA
HA-11-072	223+07	249 Lt	+156.0	+152.0	NE	HA
A-11-073	106+21	91 Lt	+108.5	+72.0	NE	HSA

Notes:
(1) Stations and offsets are measured relative to "A Line" (SR-91) Stations and are approximate.
(2) NE = Not Encountered.
(3) CPT = Cone Penetration Test boring; HA = Hand Auger boring; HSA = Hollow-Stem Auger boring.

Hollow-stem auger borings were drilled using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers. Boring A-11-073 was drilled using a tripod with hydraulic power unit drill system equipped with 6-inch diameter solid-fly augers. Sampling was performed by alternating the Modified California Drive (MCD) sampler and Standard Penetration Test (SPT) sampler. The soil sampling interval is generally 5 feet.

Relatively undisturbed soil samples were obtained using a 3.25-inch outer diameter MCD sampler lined with brass rings. Each of these brass rings is 1-inch long with a 2.5-inch outside diameter. The SPT sampler (1.4-inch inside diameter) was also used to obtain soil samples. The MCD and SPT samplers were driven 18 inches into the ground or until refusal was encountered using a 140-lb hammer free falling from a height of 30 inches. An automatic hammer and a rope hammer were used to drive samplers in the truck-mounted drill rig and tripod drill system, respectively. The numbers of blows to advance the sampler each 6 inches of penetration were recorded. The number of blows for the final 12 inches or shorter of driving was recorded on the boring logs and LOTB sheets. Charts published by Winterkorn and Fang (1975) can be used to determine a reduction factor used to convert blowcounts recorded using the California Drive sampler into SPT blowcounts. Using those charts, we obtained a reduction factor of 0.5 which was used for this project.

Hand-auger borings were drilled using a 3-inch diameter stainless steel hand-auger. Bulk samples were collected from the hand-auger borings.

The CPT sounding was performed using an electronic cone penetrometer in general accordance with current ASTM Standards (ASTM D5778 and ASTM D3441). The CPT equipment consisted of a cone penetrometer assembly mounted at the end of a series of hollow sounding rods. The cone penetrometer assembly consisted of a conical tip with a 60° apex angle and a projected cross sectional area of 1.55 in² (10 cm²) and a cylindrical friction sleeve with a surface area of 23.25 in² (150 cm²). The interior of the cone penetrometer is instrumented with strain gauges that allow simultaneous measurements of cone tip and friction sleeve resistance during penetration. The cone penetrometer assembly is continuously pushed into the soil by a set of hydraulic rams at a standard rate of 0.79 inch per second (20 mm per second) while the cone tip resistance and sleeve friction resistance are recorded every 1.967 inches (50 mm) and stored in digital form. A specially designed all-wheel drive 25-ton truck provides the required reaction weight for pushing the cone assembly and is also used to transport and house the testing equipment. The computer generated graphical logs include tip resistance, friction resistance, and friction ratio. Soil behavior type interpretations are based on guidelines by Robertson and Campanella (1989).

3.2 LABORATORY SOIL TESTING

Soil samples were tested to obtain or derive relevant physical and engineering properties. To perform analyses related to the Materials Report, the following laboratory soil tests were conducted to supplement the observations recorded during the field investigation:

- In-situ Moisture Content and Unit Weight
- Percent Passing No. 200 Sieve
- Atterberg Limits
- Direct Shear
- Unconsolidated-Undrained Triaxial
- Consolidation
- Pocket Penetrometer
- Minimum Resistivity, pH, Sulfate Content and Chloride Content (Soil Corrosivity)
- Maximum Density and Optimum Moisture Content
- R-Value

The laboratory tests were conducted in general accordance with California Test (CT) methods or American Society for Testing and Materials (ASTM, 2008) standards. Soil corrosivity test results are presented in Section 6.2. R-value and Atterberg Limits test results for near-surface bulk samples are presented in Section 7.2. Maximum Density and Optimum Moisture Content test results are presented in Section 10.0. The remaining laboratory test results are presented in Appendix B. Other laboratory tests such as Direct Shear, Unconsolidated-Undrained Triaxial, Pocket Penetrometer and Consolidation are noted on the boring logs and LOTBs in Appendix A. These strength tests were conducted for foundation design of the bridges, retaining walls, and drainage structures; these test results were not used in preparation of the recommendations included in this report and therefore, they were omitted from Appendix B.

3.3 GROUNDWATER

Groundwater was encountered between the depths of 43.4 and 72.2 feet during the recent field investigation for the SR-91 WB Widening Project. Groundwater was also encountered between the depths of 68.5 and 80 feet in 1993 and at a depth of 36 feet in 1955. However, groundwater level may be different during construction because it can fluctuate due to variations in seasonal precipitation, irrigation, groundwater injection or extraction, or numerous other man-made and natural influences.

3.4 FOUNDATION TREATMENT FOR GENERAL FILL AREAS

Vegetation on existing ground should be removed from the site prior to fill placement. Loose, soft, dry, wet, or otherwise unsuitable materials should be removed from areas to receive fill. After clearing and grubbing, a minimum overexcavation and recompaction of 18 inches should be accomplished within all areas to receive compacted fill. The overexcavation should extend horizontally a minimum distance of 18 inches from edges of new fills. The overexcavation bottoms should be scarified to a minimum depth of 6 inches, moisture conditioned to near optimum moisture content, and compacted to at least 90 percent relative compaction. All overexcavation bottoms should be observed to be firm and unyielding prior to fill placement. No special foundation treatment is recommended for proposed drainage structures at this site. Foundation treatment for pavement subgrade is discussed in Section 7.4.

3.5 DRAINAGE SYSTEMS

The existing drainage facilities located in the proposed study area include:

- Storm-drain systems and inlets along the shoulders of the existing through lanes and along the on- and off-ramps.
- Under-highway cross culverts.
- Houston Storm Channel which is primarily a concrete open channel running along the north side of the freeway. However, between the Euclid Street and Brookhurst Street segment of SR-91, it becomes a reinforced concrete box culvert.
- Carbon Creek Channel which traverses along the north side of the freeway west of East Burton Street and crosses SR-91 at Raymond Avenue as a reinforced concrete box culvert.

Based on current plans, fills are proposed throughout the project area; impact of fills at least 5 feet in height should be evaluated for utilities and drainage structures that fall within a 45-degree projection below the footprint of fills.

4.0 CUTS AND EXCAVATIONS

Based on the Profile Sheets and cross sections provided by RBF, most of the excavations are relatively minor (less than about 5 feet). We do not anticipate any slope stability issues for minor cuts and excavations.

5.0 EMBANKMENTS

Based on the Profile Sheets and cross-sections provided by RBF, fill will need to be placed to construct the approaches to each bridge widening. Also, backfill will be placed behind new retaining walls which are required for roadway embankment widening. About 30 feet of sliver fill at North Anaheim Overhead and about 20 feet of sliver fill at other bridge locations will be placed to construct the abutment approaches. Thickness of the backfill varies from a few feet to about 18 feet for the retaining walls. Most of the other embankment fills are relatively minor (5 feet or less).

Stability and settlement of the bridge approach fill embankments and non-standard retaining wall backfills are addressed in the foundation reports (EMI, 2011a through 2011g). Stability and settlement of the Caltrans Standard Type 1 retaining wall backfill and roadway embankments are addressed in GDR (EMI, 2011i).

6.0 CORROSION INVESTIGATIONS

6.1 SOIL CORROSION TESTING RESULTS

Twenty seven soil samples were tested to determine minimum resistivity, pH, soluble sulfate content, and soluble chloride content using procedures described in California Test Methods 417, 422, and 643, respectively. The test results are presented in Table 3. Minimum resistivities ranged from 750 to 29,000 ohm-cm. The pH ranged from 6.9 to 8.7. The soluble sulfate measurements ranged from 10 to 600 parts per million (ppm), and the soluble chloride ranged from 83 to 375 ppm.

6.2 SOIL CORROSIVITY

Based on the Caltrans Corrosion Guidelines (2003), soils are considered corrosive if the pH is 5.5 or less, or the chloride concentration is 500 ppm or greater, or the sulfate concentration is 2,000 ppm or greater. Based on the test results and the Caltrans criteria, the on-site soils are non-corrosive to bare metals and concrete. Corrosion protection requirements for various culvert materials are presented in Section 9.5.

Table 3. Soil Corrosion Test Results

Boring	"A Line" Station (Offset)	Sample Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Soluble Sulfate Content (ppm)	Soluble Chloride Content (ppm)
A-10-002	109+44 (73 Lt)	2.5	SC	3200	7.9	70	95
A-10-003	112+86 (78 Lt)	5	SM	5700	8.5	80	97
A-10-005	116+24 (176 Lt)	1.5	SC	2000	8.6	130	149
A-10-006	118+55 (76 Lt)	5	SC	2600	8.5	10	83
A-10-008	120+42 (55 Lt)	45	ML	2200	8.0	60	161
HA-10-013	137+00 (81 Lt)	2	SC	860	6.9	110	124
A-10-016	150+46 (86 Lt)	15	ML	2200	8.7	70	94
A-10-019	160+55 (106 Lt)	10	ML	2200	8.5	110	118
A-10-024	173+76 (62 Lt)	25	SM	750	7.8	40	332
A-10-029	184+45 (85 Lt)	20	SM	770	7.7	300	375
A-10-032	193+48 (90 Lt)	5	ML	3800	8.1	50	142
A-10-035	249+78 (89 Lt)	10	CL	790	7.5	60	239
A-10-037	256+96 (79 Lt)	2	SC	1200	7.2	10	114
A-10-039	264+14 (88 Lt)	5	SM	4800	8.0	120	191
A-10-039	264+14 (88 Lt)	75	CL-ML	760	7.9	40	253
A-10-043	273+55 (138 Lt)	5	SC	2400	7.9	60	142
A-10-044	278+00 (77 Lt)	3	SC	1100	7.6	600	109
A-10-044	278+00 (77 Lt)	45	CL-ML	760	7.6	130	322
A-10-044	278+00 (77 Lt)	70	CL	810	7.8	70	255
A-10-045	279+05 (77 Lt)	10	SP-SM	17000	8.0	60	153
A-10-052	300+05 (82 Lt)	10	SM	5400	7.8	100	139
A-10-054	305+43 (95 Lt)	5	SP	29000	7.7	60	108
A-10-054	305+43 (95 Lt)	25	SP-SC	3500	7.8	110	189
A-10-054	305+43 (95 Lt)	65	CL	2100	7.2	70	293
A-10-056	310+10 (80 Lt)	15	SP-SM	11000	7.3	10	130
A-10-063	332+01 (90 Lt)	35	SP-SM	13000	7.8	10	158
A-10-064	333+13 (76 Lt)	5	SM	2000	7.8	10	217

7.0 STRUCTURAL PAVEMENT DESIGN

7.1 EXISTING PAVEMENT SECTIONS

The as-built pavement sections along SR-91 WB mainline and ramps have been summarized in Table 1.

7.2 SUBGRADE R-VALUES

Thirty one samples of on-site, near-surface soils were tested to determine their R-values. The R-value and selected Plasticity Index (PI) test results are presented Table 4.

Table 4. R-Value and Plasticity Index Test Results

Boring	"A Line" Station (Offset)	Sample Depth (feet)	Soil Type	R-Value	PI (%)
HA-10-001	102+95 (73 Lt)	0 to 2	SP-SM	76	-
A-10-002	109+44 (78 Lt)	1.5 to 5	SC	28	9
A-10-005	116+24 (176 Lt)	1.5 to 5	SC	21	7
A-10-006	118+55 (76 Lt)	2 to 5	SC to SM	21	-
HA-10-010	125+09 (138 Lt)	0 to 3	SC	24	6
HA-10-011	126+00 (61 Lt)	0 to 2	SP-SM	79	-
HA-10-013	137+00 (81 Lt)	0 to 2	SC	16	20
HA-10-015	146+98 (84 Lt)	0 to 2	SM	51	5
A-10-019	160+55 (106 Lt)	0 to 5	SM	40	-
A-10-021	168+00 (58 Lt)	2 to 5	SM	68	-
A-10-024	173+76 (62 Lt)	1.5 to 5	SM	71	-
A-10-027	176+59 (93 Lt)	0 to 5	SP-SM	71	-
A-10-028	181+00 (67 Lt)	1.5 to 5	SP-SM	72	-
A-10-030	186+48 (67 Lt)	2 to 5	SM	72	-
A-10-033	196+46 (73 Lt)	2 to 5	SM	74	-
A-10-034	244+48 (145 Lt)	0 to 2	SM	75	-
A-10-037	256+96 (79 Lt)	0 to 3	SC	21	19
A-10-040	267+05 (74 Lt)	2 to 5	SP-SM	71	-
A-10-043	273+55 (138 Lt)	0 to 5	SC	16	12
A-10-044	278+00 (77 Lt)	3 to 5	SC	19	12
A-10-047	280+88 (211 Lt)	0 to 5	SP-SM	47	-
A-10-049	288+71 (77 Lt)	0 to 5	SP-SM	76	-
A-10-052	300+05 (82 Lt)	2 to 5	SM	72	-
A-10-055	306+48 (76 Lt)	2 to 5	SP-SM	78	-

Boring	"A Line" Station (Offset)	Sample Depth (feet)	Soil Type	R-Value	PI (%)
A-10-059	323+05 (94 Lt)	2 to 5	SP-SM	71	-
A-10-061	327+09 (139 Lt)	1.5 to 5	SP-SM	61	Non-Plastic
A-10-064	333+13 (76 Lt)	2 to 5	SP-SM	71	-
HA-10-066	335+13 (172 Lt)	0 to 2	SP-SM	73	-
HA-10-068	341+16 (102 Lt)	2 to 5	SP-SM	77	-
HA-11-069	208+12 (93 Lt)	0 to 4	SM	74	-
HA-11-071	217+91 (207 Lt)	0 to 4	SM	74	-

We have the following observations based on an examination of the data in Table 4.

- R-value ranges from 16 to 79 with an average of 57.
- Majority of the soils tested (23 out of 31) were either "SM" or "SP-SM" with R-values ranging from 40 to 79.
- Remaining eight soil samples were "SC" or "SC to SM" with R-values ranging from 16 to 28.
- PI ranges from 6 to 20%; two of the soil samples have PI greater than 12% which is considered to be "Expansive Soil" per Caltrans HDM Topic 614.4 (2008a).

The following R-Values are recommended for SR-91 WB mainline and ramps. These recommended R-Values (and Subgrade Type per Caltrans HDM, Table 623.1A) are also shown in Figure 21.

- R-Value of 20 (Subgrade Type II) for SR-91 WB mainline between "A Line" Stations 102+00 and 131+00, and 267+00 to 288+00, Brookhurst Street Off- and On- Ramps, Lemon Street Off-Ramp, and Raymond Avenue Off-Ramp;
- R-Values of 40 (Subgrade Type I) for SR-91 WB mainline between "A Line" Station 131+00 and 146+00, and 244+00 and 267+00 provided at least 2.5 feet of overexcavation and recompaction with select material is performed for the subgrade;
- R-Value of 40 (Subgrade Type I) for SR-91 WB mainline between "A Line" Stations 146+00 and 197+00 and 288+00 to 341+50, Euclid Street and State College Boulevard Off- and On-Ramps, and Harbor Boulevard On-Ramp;
- R-Value of 16 (Subgrade Type II) for Raymond Avenue On-Ramp.

In order to mitigate the onsite expansive subgrade, 2.5 feet of overexcavation is recommended between "A Line" Stations 131+00 and 146+00, and 244+00 and 267+00. The overexcavation should be backfilled with a select material. The select material should possess an R-value greater than 40, a Plasticity Index (PI) less than 12 and an Expansion Index (EI) less than 50. Compaction of the backfill should confirm to the requirements described in Section 19 of the Caltrans Standard Specifications (2010).

In a previous OCTA project completed in February 1999, the original concrete pavement along the mainline from about Stations 324+00 to 341+50 (in the vicinity of State College Boulevard interchange) was replaced with AC pavement. Caltrans requested EMI to investigate the subgrade properties at this location because they were concerned that a replacement AC-pavement was used due to poor subgrade condition. EMI drilled four soil borings (Borings HA-10-060, A-10-064, A-10-067 and HA-10-068) along this stretch of the mainline. Based on the boring logs included in Appendix A, the subgrade soils are classified as poorly graded sand with silt (SP-SM); R-value obtained from two of the subgrades were 71 and 77 (See Table 4). The above soil type and R-values represent a competent subgrade and selecting AC pavement to replace the original concrete pavement is not due to poor subgrade condition.

7.3 RECOMMENDED PAVEMENT STRUCTURAL SECTIONS

Rigid and flexible pavement sections were designed in accordance with Sections 620 and 630 of the Caltrans HDM (2008a), respectively. Calculations to determine the flexible pavement sections are included in Appendix C. Rapid-Strength Concrete (RSC) pavements are proposed for this project. Based on our discussions with Caltrans, a full-depth RSC section is not allowed.

There are new pavements that will be placed above reinforced concrete box (RCB) culverts. If there is sufficient vertical distance between the finished pavement surface and top of the RCB, then the entire designed pavement sections should be used; otherwise, the thickness of the designed pavement sections can be reduced to meet the actual site conditions. In both cases, the RCB must be designed to meet the Caltrans wheel loading requirements for the specific soil/pavement cover thickness.

7.3.1 Traffic Indices

Traffic Indices for a design life of 20-year were provided by Caltrans and summarized in Table 5.

Table 5. Summary of Traffic Indices

Location	Traffic Index
SR-91 WB Mainline Through Lane	16.0
SR-91 WB Mainline Auxiliary Lane	14.0
SR-91 WB Shoulder	9.5
Ramps	12.0
Maintenance Vehicle Pullouts	7.0

7.3.2 Drained Versus Undrained Pavement Sections

Mainline. Existing pavement type along the Mainline, adjacent to the proposed widening or remove-and-replace, is either an undrained Portland Cement Concrete (PCC) section or a drained asphaltic concrete (AC) section. There is no design issue for new pavements adjacent to the

existing undrained PCC section because the new pavements will be designed as undrained sections.

For new pavement sections placed adjacent to the existing drained AC pavements, we can design the thickness of the HMA or JPCP and the underlying permeable layer so that the water below the existing drainage layer can continue to flow via gravity, pass through the new pavement, and empty into the edge drains at the new shoulder area.

Ramps. Existing pavement type for the ramps consists of either undrained PCC, undrained AC, or drained AC section. There is no design issue for complete pavement replacement or new pavements placed adjacent to the existing undrained PCC section or undrained AC section because the new pavements will be designed as undrained sections. There is also no design issue for placing new HMA pavement adjacent to existing drained AC pavements because the thickness of the HMA and the underlying permeable layer can be designed so that the water below the existing drainage layer can continue to flow via gravity, pass through the new HMA pavement, and empty into the edge drains.

Maintenance Vehicle Pullout (MVP) Areas. MVPs are scattered throughout the entire project limits. EMI recommend using undrained sections for the MVP pavements because of the relatively small area occupied by the MVPs.

7.3.3 Coordination with SR-91 Safety Project and SR-91 CAPM Improvements

It is anticipated that a separate SR-91 Safety Project [12-0K5304] and a separate SR-91 Capital Preventive Maintenance (CPAM) Project [12-0H0294] will be scheduled to begin construction prior to this project. The Safety Project includes a 0.30-foot Rubberized Hot Mix Asphalt (RHMA) overlay consisting of 0.10-foot of RHMA-O (Open-Graded) over 0.20-foot of RHMA-G (Gap-Graded). The CAPM Project includes a 0.20-foot grind / RHMA-G overlay. This project will match the various RHMA overlays when the freeway is widened by implementing the following modifications to the calculated pavement sections in selected areas affected by the SR-91 Safety Project or SR-91 CAPM Project:

- For flexible pavement: add the 0.10' RHMA-O over 0.20' RHMA-G to the calculated sections, or change the thickness of the calculated HMA to accommodate the 0.20' RHMA-G (for example, if the calculated thickness of the HMA is 0.65', this HMA section is revised to 0.20' RHMA-G over 0.45' HMA), and

- For rigid pavement: add the 0.10' RHMA-O over 0.20' RHMA-G to the calculated sections.

7.3.4 Rigid Pavement

The recommended rigid pavement sections for the SR-91 WB mainline through lane, auxiliary lane and ramp termini are presented in Table 6.

Table 6. Recommended Rigid Pavement Structural Sections

Location	Traffic Index	Subgrade Type	Without Lateral Support (South Coast Climate Region)	
			Drained	Undrained
Through Lane	16	I	1.05' JPCP / 0.35' ATPB / 0.35' LCB	1.05' JPCP / 0.35' LCB or 1.05' RSC / 0.35' LCBRS
		II	-	1.05' JPCP / 0.35' LCB / 0.70' AS or 1.05' RSC / 0.35' LCBRS / 0.70' AS
Auxiliary Lane	14	I	-	0.95' JPCP / 0.35' LCB or 0.95' RSC / 0.35' LCBRS
		II	-	0.95' JPCP / 0.35' LCB / 0.70' AS or 0.95' RSC / 0.35' LCBRS / 0.70' AS
Ramp Termini and Gore Areas (See Caltrans HDM, Topic 626.1)	12	I	-	0.85' JPCP / 0.35' LCB or 0.85' RSC / 0.35' LCBRS
		II	-	0.85'JPCP / 0.35' LCB / 0.60' AS or 0.85' RSC / 0.35' LCBRS / 0.60' AS

Notes:
1. JPCP=Jointed Plain Concrete Pavement; RSC = Rapid Strength Concrete; ATPB = Asphalt Treated Permeable Base; LCB= Lean Concrete Base; LCBRS = Lean Concrete Base, Rapid Setting; AS = Class 2 Aggregate Subbase.
2. Bond Breaker between JPCP and LCB or RSC and LCBRS for undrained sections only. For drained sections, the ATPB becomes the Bond Breaker.

7.3.5 Flexible Pavement

The recommended drained and undrained flexible pavement sections for the SR-91 WB mainline auxiliary lane and shoulder, ramps and maintenance vehicle pullouts are presented in Table 7.

Table 7. Recommended Flexible Pavement Structural Sections

Location	Traffic Index	Design R-Value	Undrained Section	Drained Section
Auxiliary Lane	14	40	0.70' HMA-A / 1.40' AB	0.65' HMA-A / 0.25' ATPB / 1.15' AB or 0.75' HMA-A / 0.25' ATPB / 0.95' AB
		20	0.80' HMA-A / 2.00' AB	0.65' HMA-A / 0.25' ATPB / 2.00' AB or 0.75' HMA-A / 0.25' ATPB / 1.80' AB
Ramps	12	40	0.60' HMA-A / 1.15' AB	0.60' HMA-A / 0.25' ATPB / 0.85' AB or 0.65' HMA-A / 0.25' ATPB / 0.75' AB
		20	0.60' HMA-A / 1.85' AB	0.60' HMA-A / 0.25' ATPB / 1.55' AB or 0.65' HMA-A / 0.25' ATPB / 1.45' AB
		16	0.60' HMA-A / 1.00' AB / 1.10' AS	0.60' HMA-A / 0.25' ATPB / 0.70' AB / 1.10' AS or 0.65' HMA-A / 0.25' ATPB / 0.60' AB / 1.10' AS
Ramps	12	40	0.20' RHMA-G / 0.40' HMA-A / 1.15' AB	0.20' RHMA-G / 0.40' HMA-A / 0.25' ATPB / 0.85' AB or 0.20' RHMA-G / 0.45' HMA-A / 0.25' ATPB / 0.75' AB
		20	0.20' RHMA-G / 0.40' HMA-A / 1.85' AB	0.20' RHMA-G / 0.40' HMA-A / 0.25' ATPB / 1.55' AB or 0.20' RHMA-G / 0.45' HMA-A / 0.25' ATPB / 1.45' AB
		16	0.20' RHMA-G / 0.40' HMA-A / 1.00' AB / 1.10' AS	0.20' RHMA-G / 0.40' HMA-A / 0.25' ATPB / 0.70' AB / 1.10' AS or 0.20' RHMA-G / 0.45' HMA-A / 0.25' ATPB / 0.60' AB / 1.10' AS

Location	Traffic Index	Design R-Value	Undrained Section	Drained Section
Mainline Shoulder	9.5	40	0.90' HMA-A or 0.50' HMA-A / 0.80' AB	0.65' HMA-A / 0.25' ATPB / 0.35' AB or 0.75' HMA-A / 0.25' ATPB / 0.35' AB
		20	0.50' HMA-A / 1.35' AB	0.65' HMA-A / 0.25' ATPB / 0.75' AB or 0.75' HMA-A / 0.25' ATPB / 0.50' AB
Maintenance Vehicle Pullouts (Mainline and Ramps)	7	40	0.45' HMA-A / 0.35' AB	-
		20	0.65' HMA-A / 0.35' AB	-
		16	0.45' HMA-A / 0.35' AB / 0.55' AS	-

HMA-A=Hot Mix Asphalt-Type A; ATPB = Asphalt Treated Permeable Base; RHMA-G = Rubberized Hot Mix Asphalt – Gap Graded; AB= Class 2 Aggregate Base; AS = Class 2 Aggregate Subbase; Use PG 64-10 Asphalt Binder.

7.4 COMPACTION AND REMEDIAL GRADING

Compaction of the subgrade should conform to requirements described in Section 19 of the Caltrans Standard Specifications (2010). Special care is required when compaction subgrade above reinforced concrete box, buried utility lines and drainage devices, and other sensitive buried structures to avoid damaging these existing nearby facilities.

In paved area, the upper 2.5 feet of subgrade (measured from the grading plane) should possess the design R-values. The design R-values are presented in Section 7.2.

A design R-Value of 40 is recommended for SR-91 WB mainline between "A Line" Stations 131+00 and 146+00, and 244+00 and 267+00 provided at least 2.5 feet of overexcavation and recompaction with select material is performed for the subgrade. The select material should possess an R-value greater than 40, a Plasticity Index (PI) less than 12 and an Expansion Index (EI) less than 50. The compaction of the subgrade should confirm to requirement described in Section 19 of the Caltrans Standard Specifications (2010).

Compaction and remedial grading recommendations for unpaved areas are included in the Geotechnical Design Report (EMI, 2011i). Those recommendations are: a minimum overexcavation and recompaction of 18 inches is recommended within all areas to receive compacted fill, and the overexcavation depth is measured from the existing grade. The overexcavation should extend horizontally a minimum distance of 18 inches from edges of new fills. In cut areas, the minimum overexcavation and recompaction depth is 12 inches if the difference between the finished and existing grade is 2 feet or less, and overexcavation is not

required if the difference between the finished and existing grade is greater than 2 feet. In cut areas, the overexcavation depth is measured from the finished grade. Unless specified on the contract plans or specifications, the excavated soils (in both fill and cut areas) may be reused as compacted fill. The overexcavation bottom should be scarified a minimum depth of 6 inches and compacted in-place to the required minimum relative compaction.

All overexcavation bottoms should be firm and unyielding prior to fill placement. If not, additional remedial grading may be required.

8.0 MATERIALS AVAILABLE

Construction materials can be supplied by public or private sources. Private sources of construction materials (including sand, gravel, base, concrete, and asphalt concrete) were not investigated. However, materials are available from several commercial suppliers located in Orange, Riverside, and San Bernardino Counties. Table 8 provides the name, location, and telephone number for several commercial sources that can supply materials for the project. The suppliers listed in Table 8 are publicly known suppliers located in the vicinity of the project site; there may be other suppliers located closer to the project site.

Prior to submitting bids and scheduling construction, contractors should verify the availability of materials from the suppliers listed in Table 8.

A current listing of mining operations eligible to sell materials to the State can be found on the Internet at: http://www.consrv.ca.gov/omr/index.htm.

Table 8. Material Sources

Operator	Location/Telephone Number
Sand and Gravel	
Associated Building Materials	Torrance/310-325-1811
Chief Eagle Inc.	Santa Ana/714-540-7788
E.D.S. Sand & Gravel, Inc.	Orange/714-997-8365
El Toro Materials Company	Lake Forest/949-837-6677
Hanson Aggregates	Irwindale/626-856-6762
Sierra SWPPP & Erosion Control Services	Aliso Viejo /866-500-2110
Southeast Construction Products	Whittier/562-943-0201
West Coast Sand & Gravel, Inc.	Buena Park/714-522-0282
Portland Cement Concrete	
A & A Ready Mix Concrete Company	Gardena/310-515-0933
Associated Ready Mix, Inc.	Fountain Valley/714-966-0231
Bison Ready Mix	Anaheim/714-936-2757
K&G Concrete Pumping	Santa Ana/714-910-9473
Standard Concrete Products, Inc.	Santa Ana/800-266-2738
Standard Ready Mix Concrete	Westminster/714-901-2219
Taylor Ready Mix Concrete	Gardena/310-532-7500
United Concrete Companies, Inc.	South Gate, 323-564-1866

9.0 RECOMMENDED MATERIALS SPECIFICATIONS

9.1 REVIEW OF GRADING AND CONSTRUCTION PLANS

Recommendations contained herein are based on draft plans. Final grading and construction plans should be reviewed by EMI to confirm that geotechnical recommendations were applied to the design and that no additional recommendations are required. Recommendations contained herein may require revision or additional recommendations may be necessary based on the final design.

9.2 GENERAL EARTHWORK REQUIREMENTS

Earthwork should conform to requirements of Section 19 of the Caltrans Standard Specifications (2010). Compaction of soil should be conducted in accordance with Section 19-5 of the Caltrans Standard Specifications. Fills placed against existing embankments should be properly keyed and benched into the existing side slopes as described in Section 19-6.03 of the Caltrans Standard Specifications.

9.3 ADJACENT STRUCTURES

No excavation should be performed below an imaginary plane inclined at 45 degrees from the edge of any existing foundation without providing adequate support for the foundation. The contractor is responsible for worker safety in the field during construction. The contractor shall conform to all applicable occupational safety and health standards, rules, regulations, and orders established by the State of California. In addition, other State, County, or Municipal regulations may supersede the recommendations presented herein. If a trench shoring design and safety plan is required, the geotechnical consultant should review the plan to confirm that recommendations presented in this report have been applied to the design.

9.4 PAVEMENT

The design R-values are discussed in Section 7.3. If the R-value of subgrade exposed during construction comes into question, the exposed soils should be sampled and tested during grading to verify the R-value. Soils placed beneath pavement sections should be inspected, sampled, and tested to verify the minimum required relative compaction.

Construction may include pulverizing existing pavements. Outside Caltrans right-of-way, pulverized material can be used as aggregate base assuming the material meets requirements for crushed miscellaneous base as specified in the latest edition of the Standard Specifications for Public Works Construction (Greenbook). Within Caltrans right-of-way, any recycled materials used as aggregate base shall conform to Section 26 "Aggregate Bases" of the Caltrans Standard Specifications (2010).

9.5 CULVERT MATERIALS

Culvert material requirements were calculated using the Caltrans Alternative Pipe Culvert Selection Website (AltPipe) (Caltrans, 2008b) and the corrosion test results presented in Table 3. Using the corrosion test results of soil samples recovered above a depth equal to or shallower than 20 feet, the following worst-case scenario corrosion values were selected for determining minimum culvert material requirements:

- Minimum Resistivity = 750 ohm-cm
- pH = 6.9
- Soluble Sulfate = 600 ppm
- Soluble Chloride = 375 ppm

Based on the information provided by RBF, 18, 24, 30 and 36-inch alternate pipe culverts are proposed for the project. Based on these pipe diameters, an assumed soil cover of 10 feet and a design life of 50 years, the following information is provided:

- For all the pipe diameters, corrugated steel pipe helical corrugation $2^2/_3$" x $^1/_2$" corrugations with minimum steel thickness of 0.052 inch and steel coating of polymerized asphalt invert or polymeric sheet coating should be used to attain an estimated service life of 50 years under non-abrasive conditions.
- For all the pipe diameters, corrugated steel pipe $2^2/_3$" x $^1/_2$" annular corrugations with minimum steel thickness of 0.064 inch and steel coating of polymerized asphalt invert or polymeric sheet coating should be used to attain an estimated service life of 50 years under non-abrasive conditions.
- For pipe diameters of 24, 30 and 36 inches, steel spiral rib pipe $^3/_4$" x 1" ribs at $11^1/_2$" pitch with minimum steel thickness of 0.064 inch and coating of polymerized asphalt invert or polymeric sheet coating should be used to attain an estimated service life of 50 years under non-abrasive conditions
- Reinforced concrete pipe design should be suitable. The minimum concrete cover is 0.75-inch for 18-inch diameter pipe and 1-inch for 24, 30, 36-inch diameter pipes. The mix design should also include a cement content of 5 sacks per cubic yard and the quantity of water is 11.1% by volume.
- Corrugated PVC plastic pipe and Type-S corrugated HDPE pipes may be used; however, abrasion should be evaluated by the project civil engineer.
- Aluminum pipe or aluminized steel pipes are not allowed.

The above recommendations are applicable to Level-1 abrasion level only as defined by the AltPipe web based application and may require additional thickness for potential abrasion, higher flow velocities, strength and overfill requirements. The termini of any plastic pipes should be protected from potential physical or fire damage such as by constructing concrete headwalls, or by concrete or metal treatment.

9.6 INSPECTION AND TESTING

Qualified geotechnical personnel should perform inspections and testing during the following stages of construction:

- Grading operations, including excavations and placement of compacted fill.
- Removal of existing pavement structural sections, curb and gutter, and concrete sidewalk.
- Preparation of pavement subgrade.
- Placement of base and subbase.
- Excavations for utility trenches and drainage structures.
- Removal or support of buried utilities or structures.
- Shoring installation, if necessary.
- When any unusual conditions are encountered.

10.0 SOIL TESTING AND MATERIAL PROPERTIES SUMMARY

Relevant soil exploration logs and materials testing results prepared as part of this investigation are presented in Appendix A and Appendix B of this report, respectively. The summary of maximum density and optimum moisture content test results are presented in Table 9.

Table 9. Summary of Maximum Densities and Optimum Moisture Contents

Boring	"A Line" Station (Offset)	Sample Depth (feet)	Soil Type	Max Wet Density (pcf)	Max Dry Density (pcf)	Opt. Moist Content (%)
A-10-002	109+44 (78 Lt)	1.5 to 5	SC	145.1	132.5	9.5
A-10-006	118+55 (76 Lt)	2 to 5	SC to SM	144.0	131.0	9.9
HA-10-011	126+00 (61 Lt)	0 to 2	SP-SM	139.9	129.5	8.0
A-10-028	181+00 (67 Lt)	1.5 to 5	SP-SM	130.0	122.6	6.0
A-10-034	244+48 (145 Lt)	0 to 2	SM	133.5	120.8	10.5
A-10-043	273+55 (138 Lt)	0 to 5	SC	138.6	126.0	10.0
A-10-052	300+05 (82 Lt)	2 to 5	SM	138.0	127.0	8.7
A-10-055	306+48 (76 Lt)	2 to 5	SM	142.6	132.0	8.0
A-10-061	327+09 (139 Lt)	1.5 to 5	SP-SM	141.7	130.0	9.0
HA-11-070	217+91 (207 Lt)	0 to 4	SM	127.8	120.0	6.5

11.0 REFERENCES

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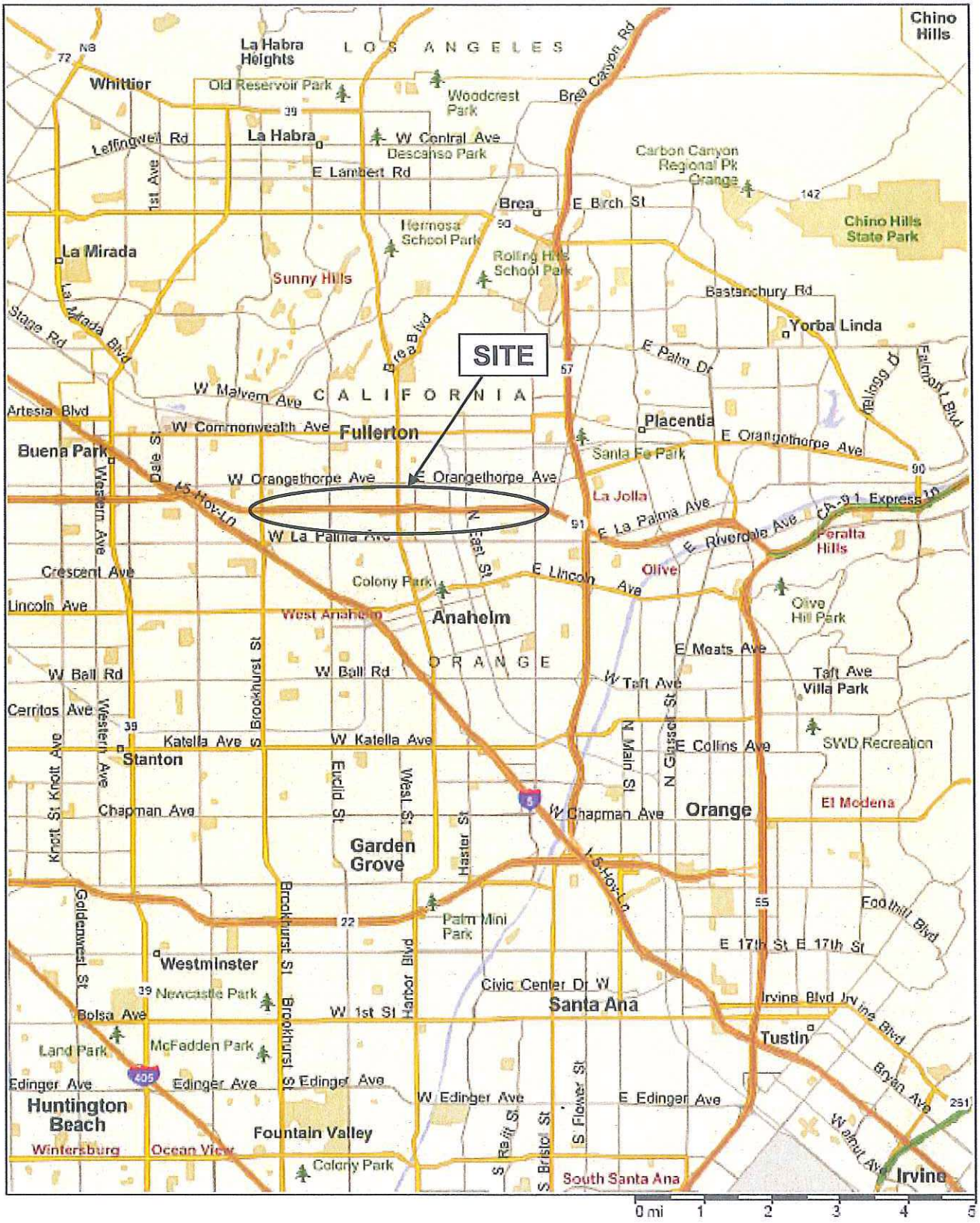

SR-91 WB Widening Project

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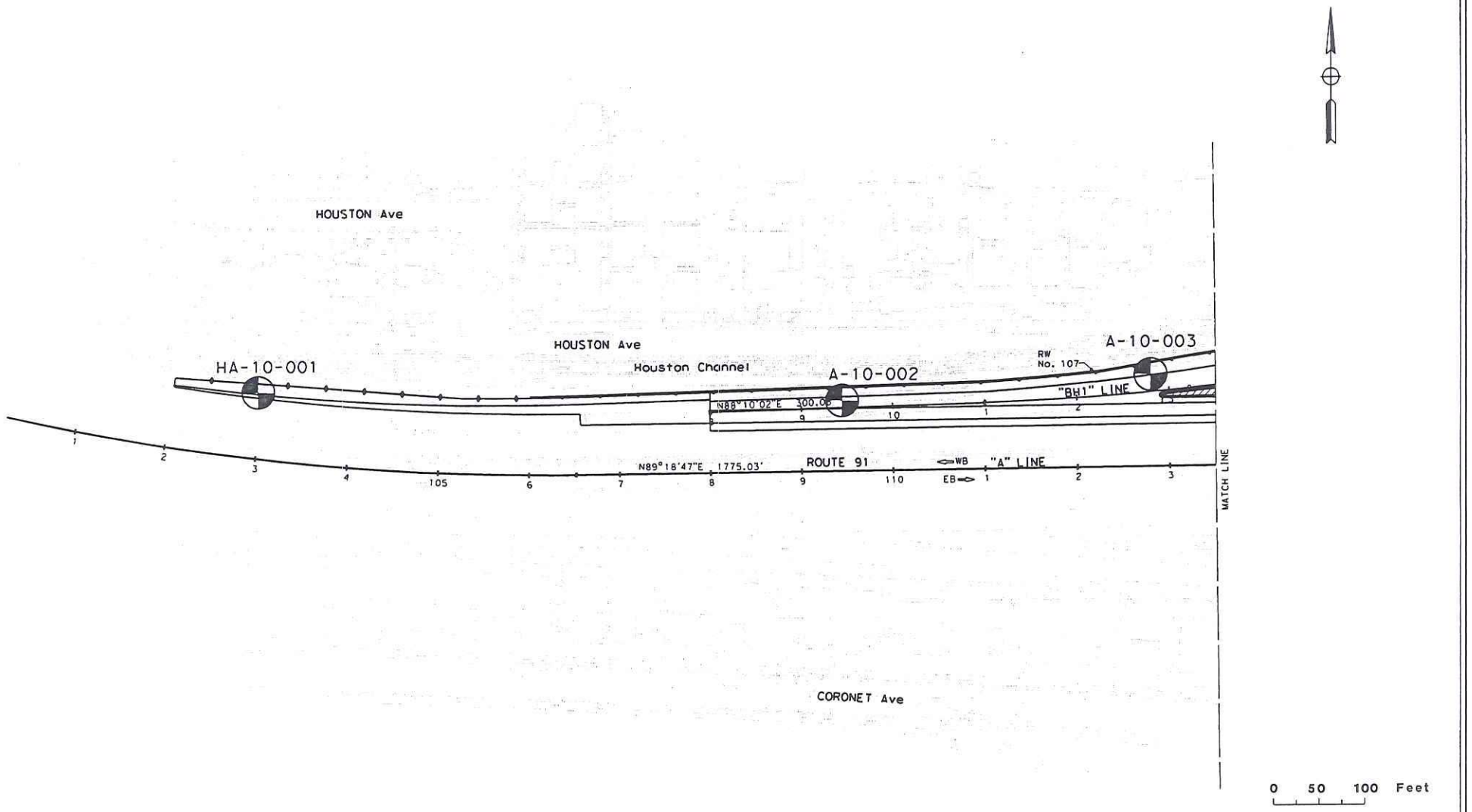
SITE LOCATION MAP

Figure 1

Project No. 10-126

Date: 06-23-11



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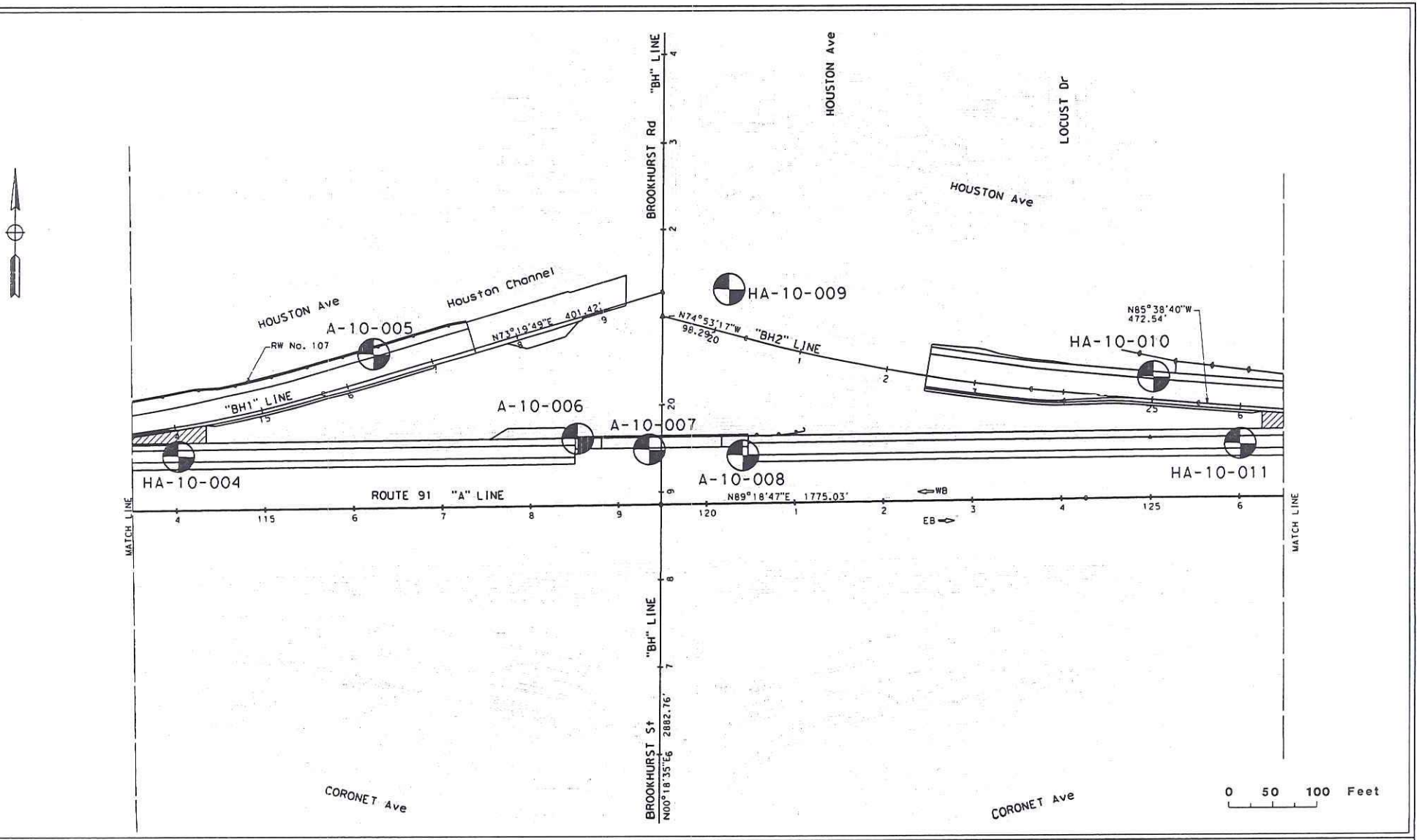
STATE ROUTE 91 WESTBOUND WIDENING PROJECT

Project No.: 10-126

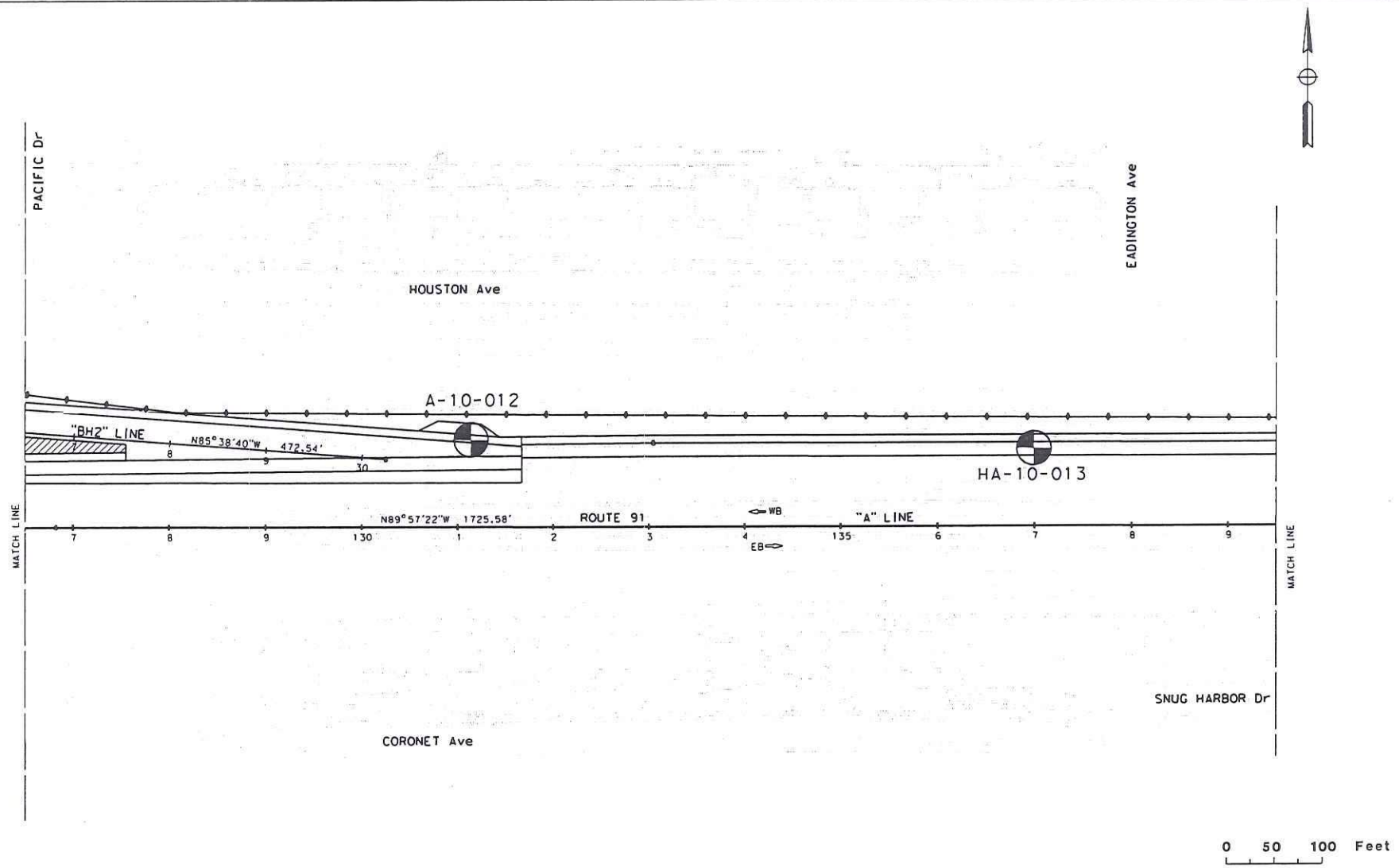
Date: 06-23-2011

Exploratory Boring Location Map (1 of 19)

Figure 2



Earth Mechanics, Inc. Geotechnical & Earthquake Engineering	**STATE ROUTE 91 WESTBOUND WIDENING PROJECT**	**Exploratory Boring Location Map (2 of 19)**
	Project No.: 10-126 / **Date: 06-23-2011**	Figure 3



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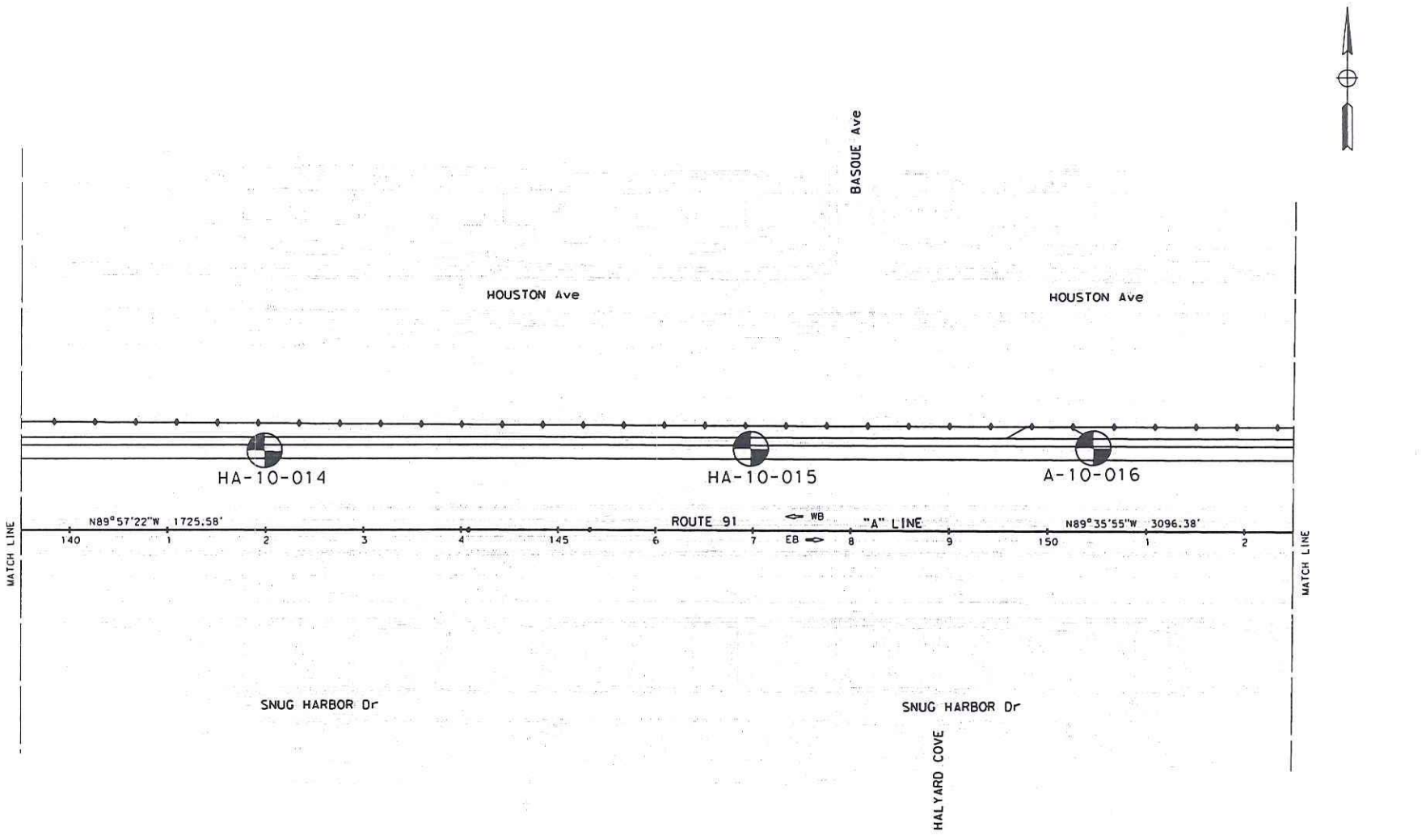
STATE ROUTE 91 WESTBOUND WIDENING PROJECT

Project No.: 10-126

Date: 06-23-2011

Exploratory Boring Location Map (3 of 19)

Figure 4



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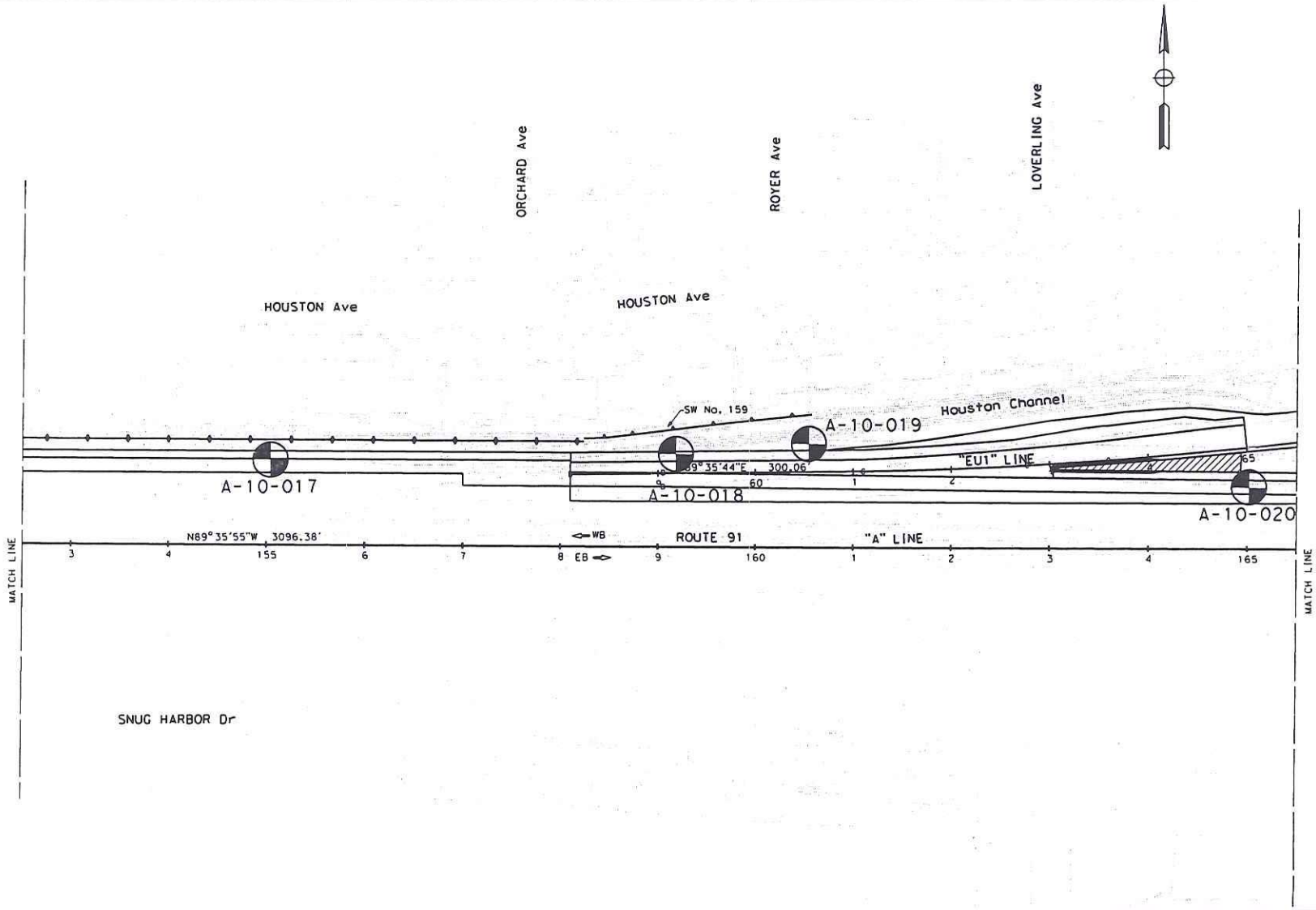
STATE ROUTE 91 WESTBOUND WIDENING PROJECT

Project No.: 10-126

Date: 06-23-2011

Exploratory Boring Location Map (4 of 19)

Figure 5



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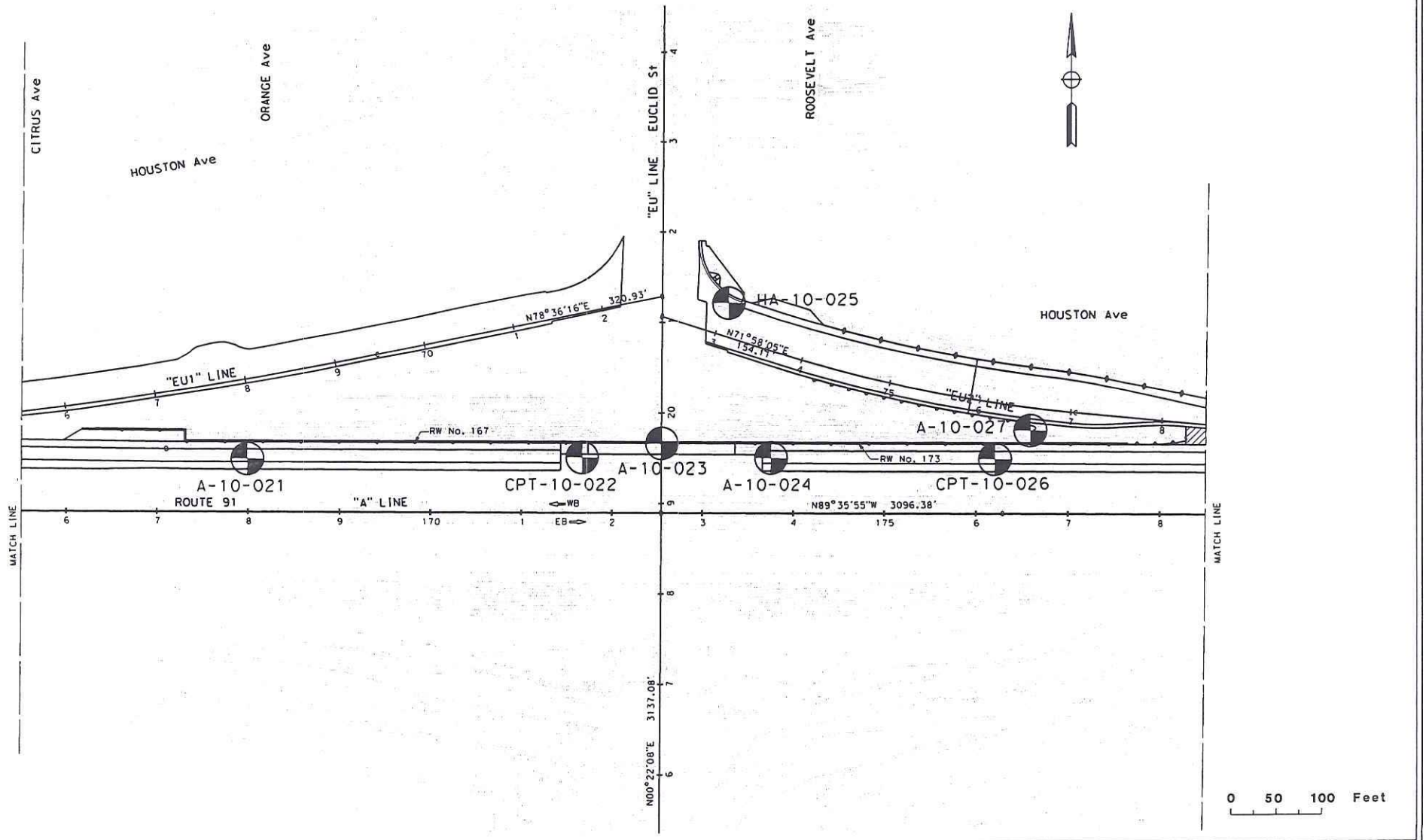
	Project No.: 10-126 / **Date: 06-23-2011**	Figure 6



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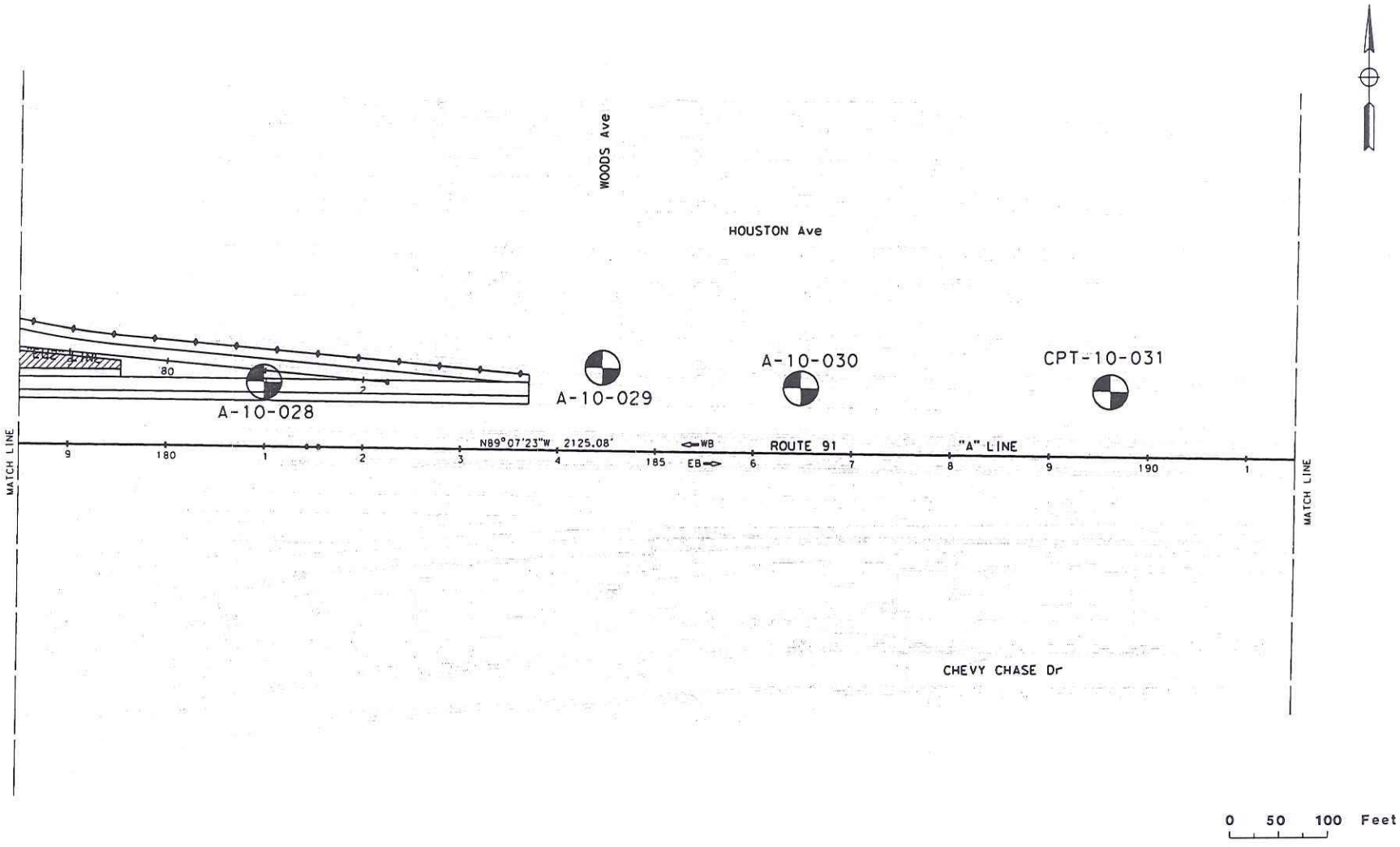
STATE ROUTE 91 WESTBOUND WIDENING PROJECT

Project No.: 10-126

Date: 06-23-2011

Exploratory Boring Location Map (6 of 19)

Figure 7



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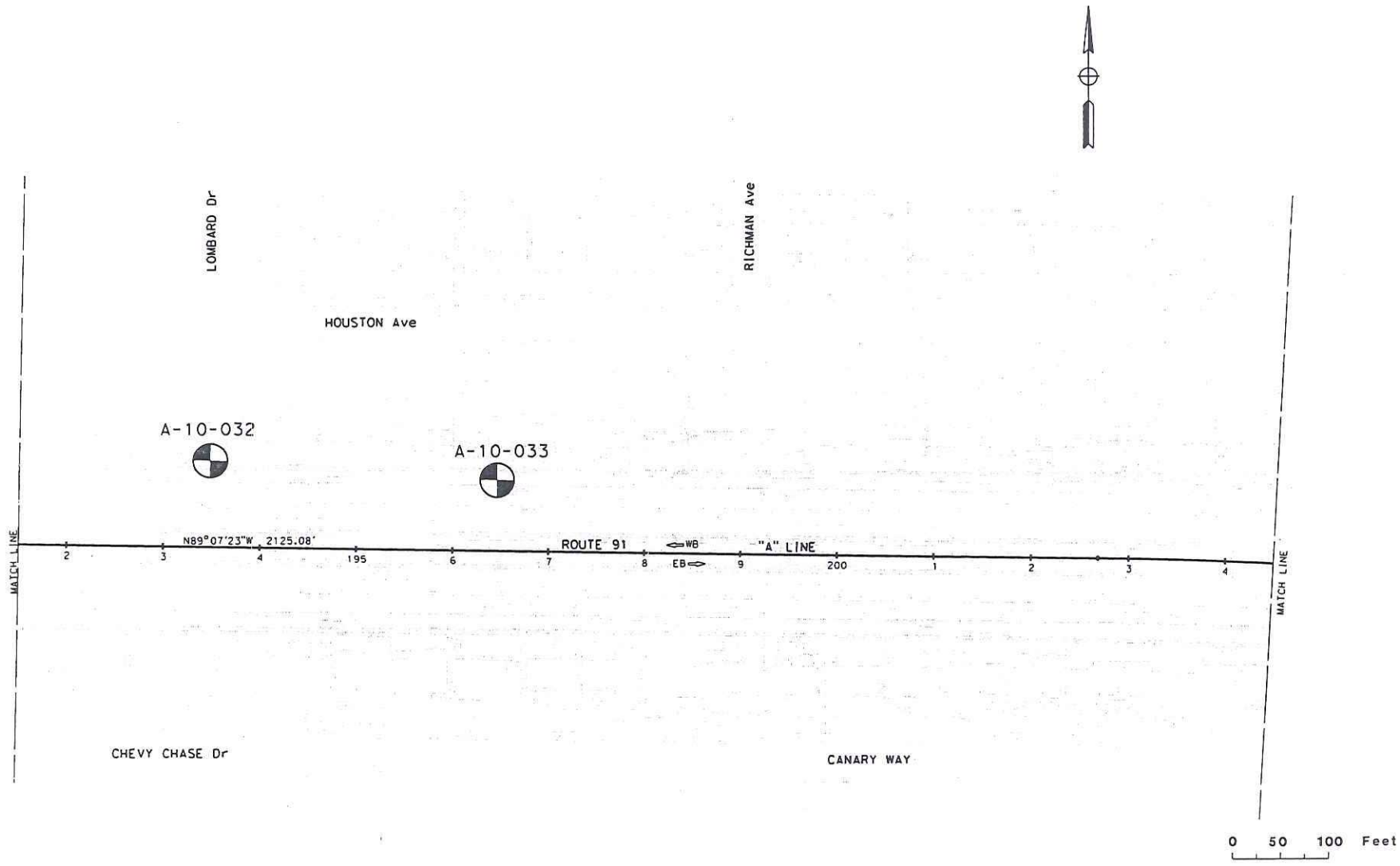
STATE ROUTE 91 WESTBOUND WIDENING PROJECT

Project No.: 10-126 | **Date: 06-23-2011**

Exploratory Boring Location Map (7 of 19)

Figure 8



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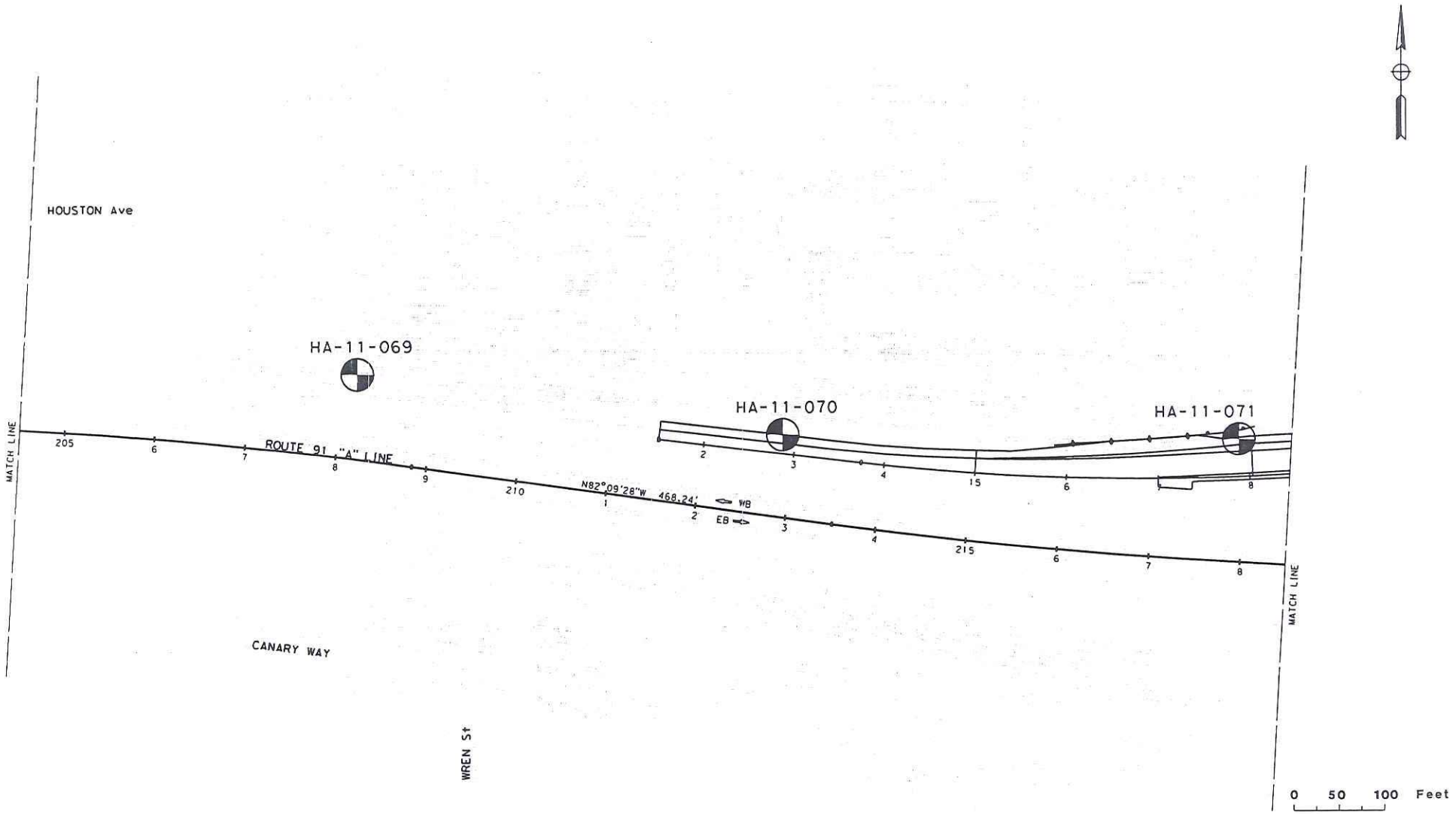
STATE ROUTE 91 WESTBOUND WIDENING PROJECT

Project No.: 10-126

Date: 06-23-2011

Exploratory Boring Location Map (8 of 19)

Figure 9



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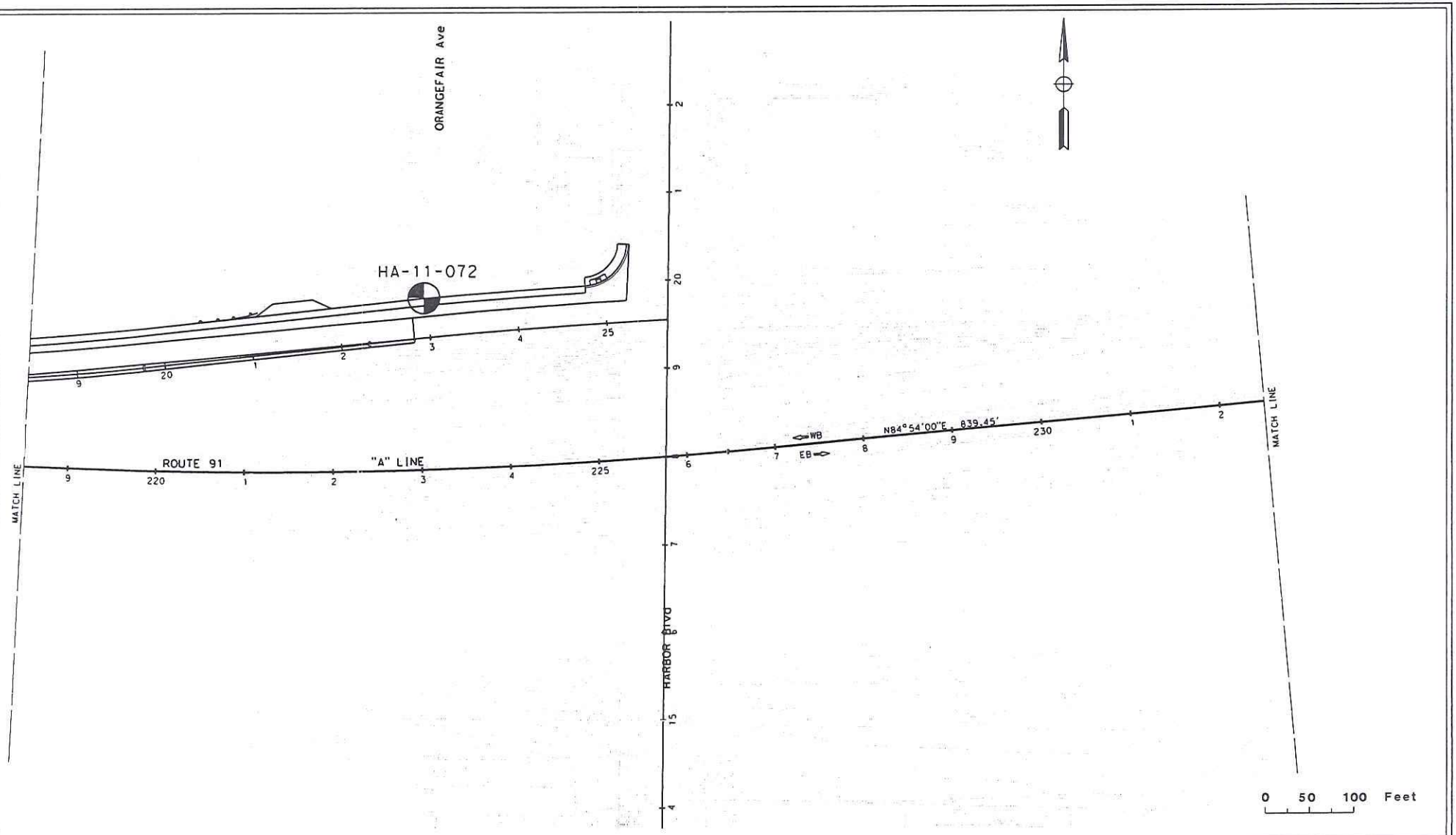
STATE ROUTE 91 WESTBOUND WIDENING PROJECT

Project No.: 10-126 | **Date: 06-23-2011**

Exploratory Boring Location Map (9 of 19)

Figure 10



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STATE ROUTE 91 WESTBOUND WIDENING PROJECT

Project No.: 10-126

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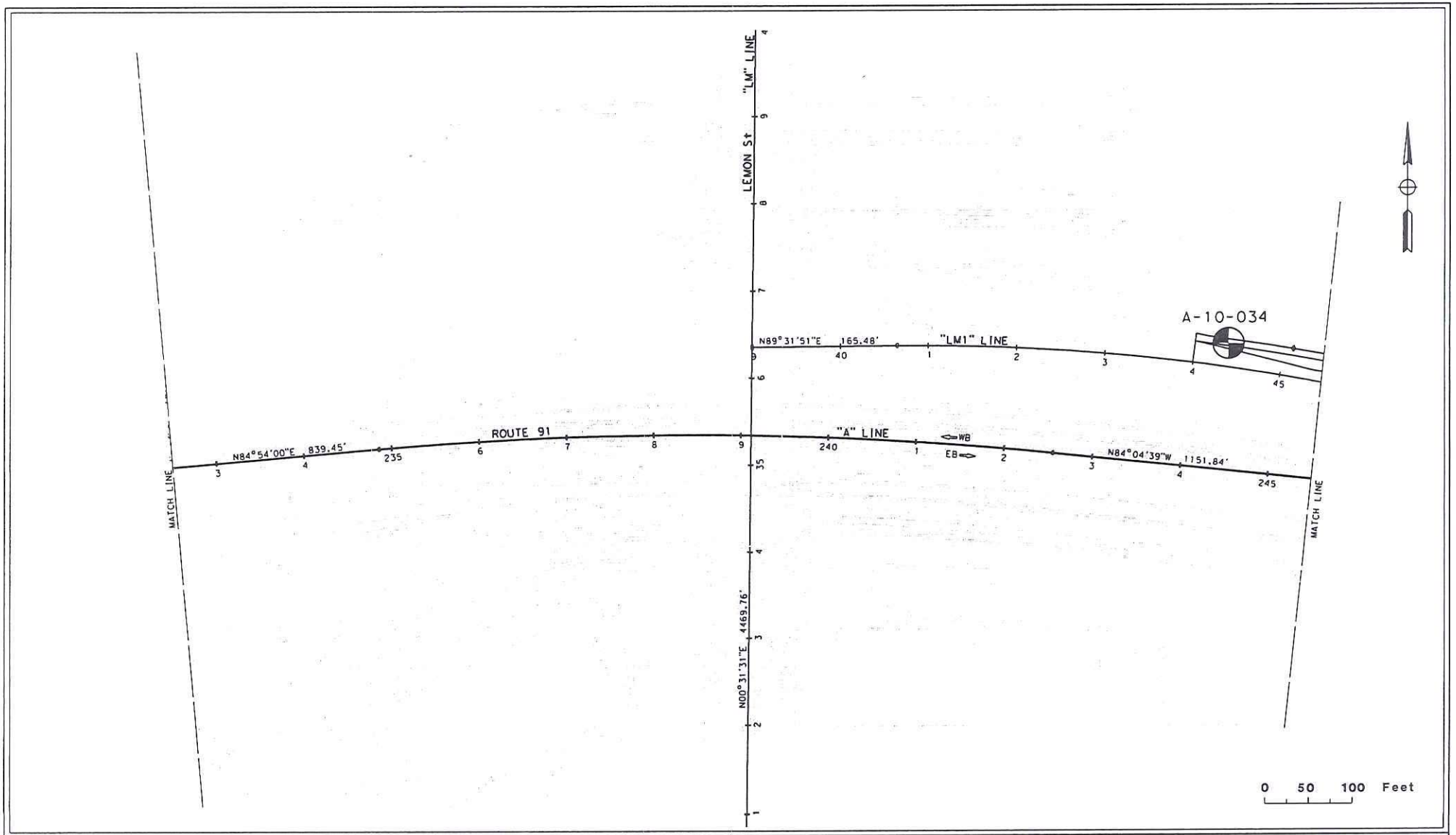
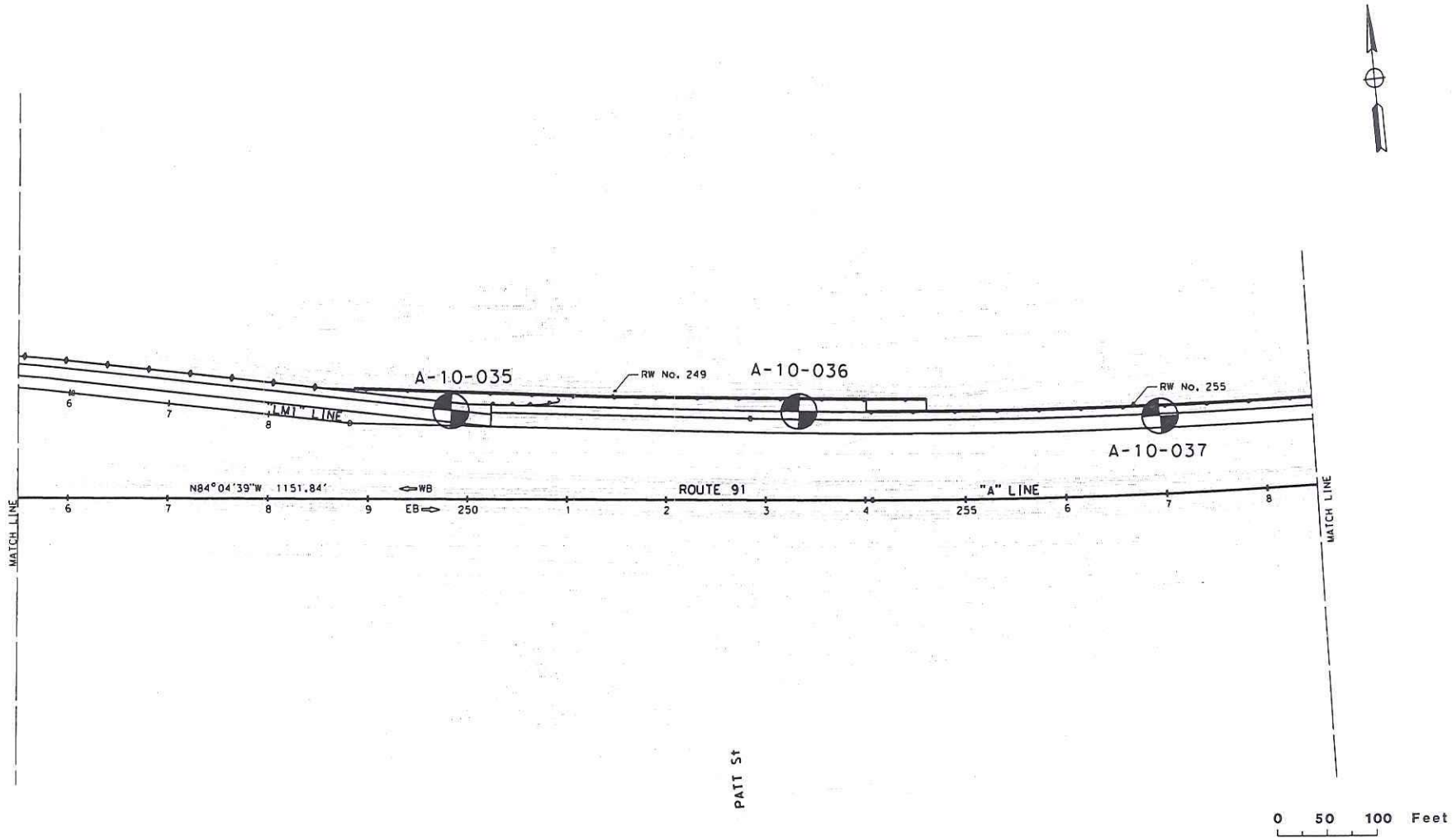
Exploratory Boring Location Map (10 of 19)

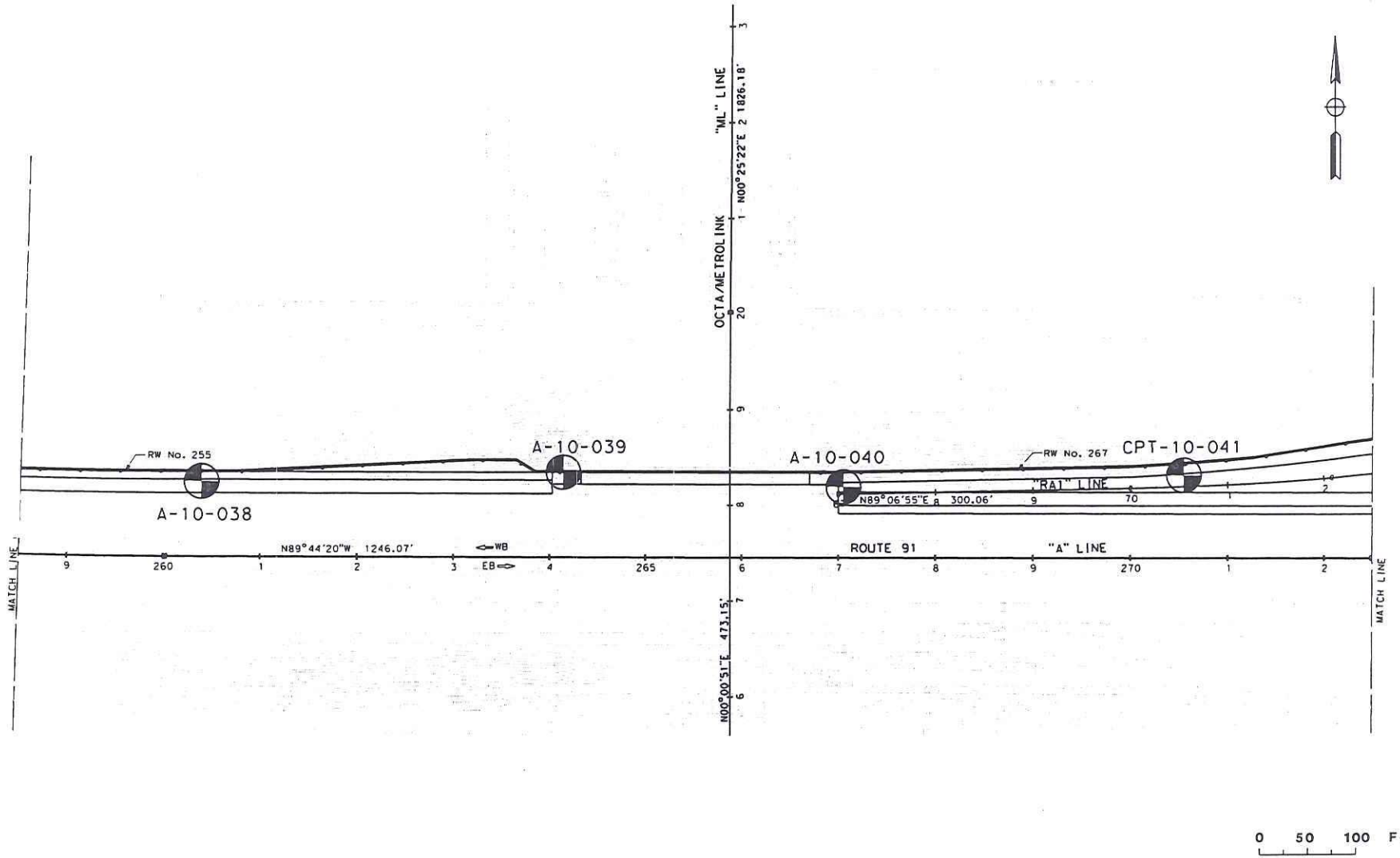
Figure 11



Earth Mechanics, Inc. Geotechnical & Earthquake Engineering	STATE ROUTE 91 WESTBOUND WIDENING PROJECT	Exploratory Boring Location Map (11 of 19)
	Project No.: 10-126 Date: 06-23-2011	Figure 12



Earth Mechanics, Inc. Geotechnical & Earthquake Engineering	**STATE ROUTE 91 WESTBOUND WIDENING PROJECT**	**Exploratory Boring Location Map (12 of 19)**
	Project No.: 10-126 / **Date: 06-23-2011**	Figure 13



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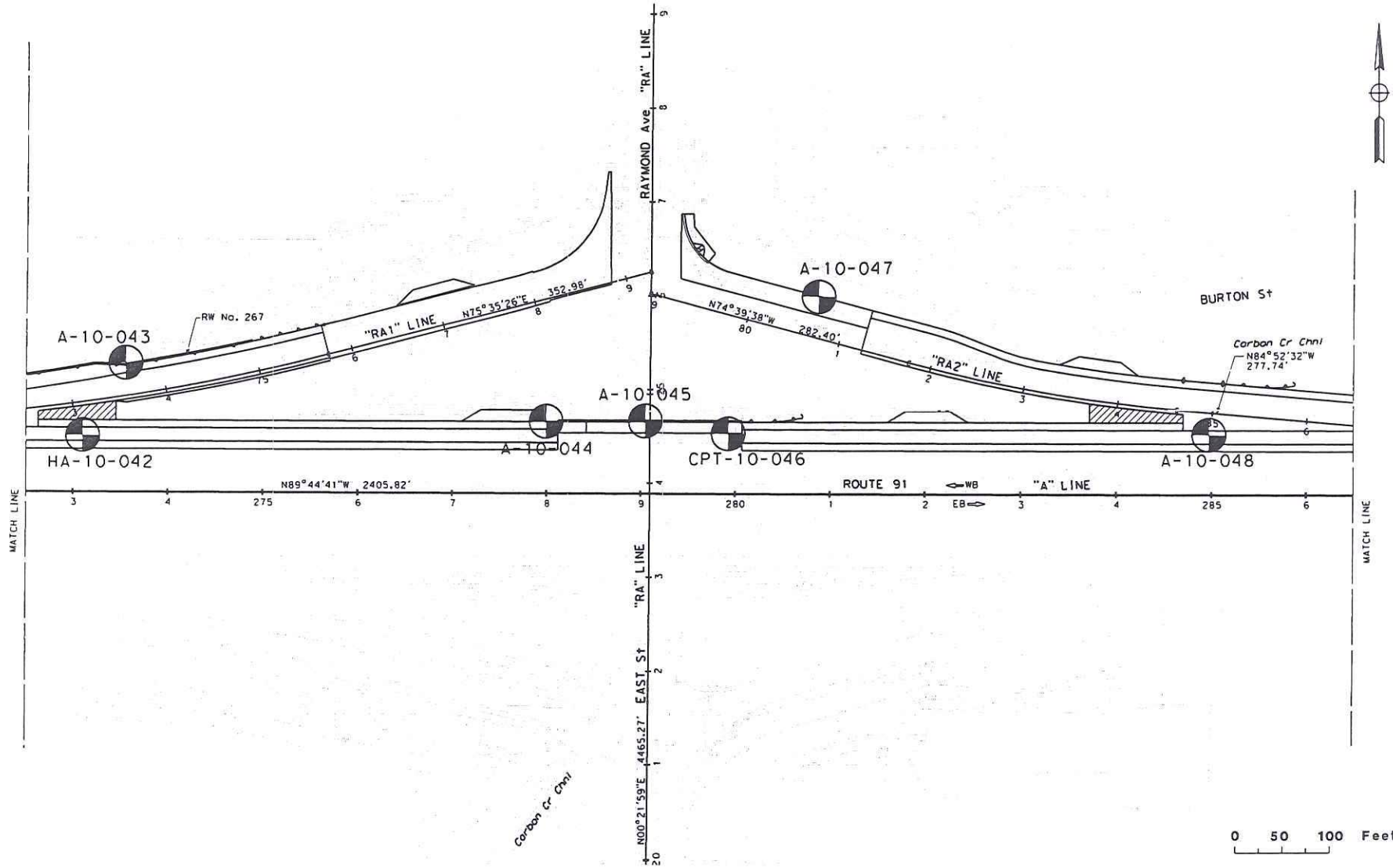
STATE ROUTE 91 WESTBOUND WIDENING PROJECT

Project No.: 10-126 | **Date: 06-23-2011**

Exploratory Boring Location Map (13 of 19)

Figure 14



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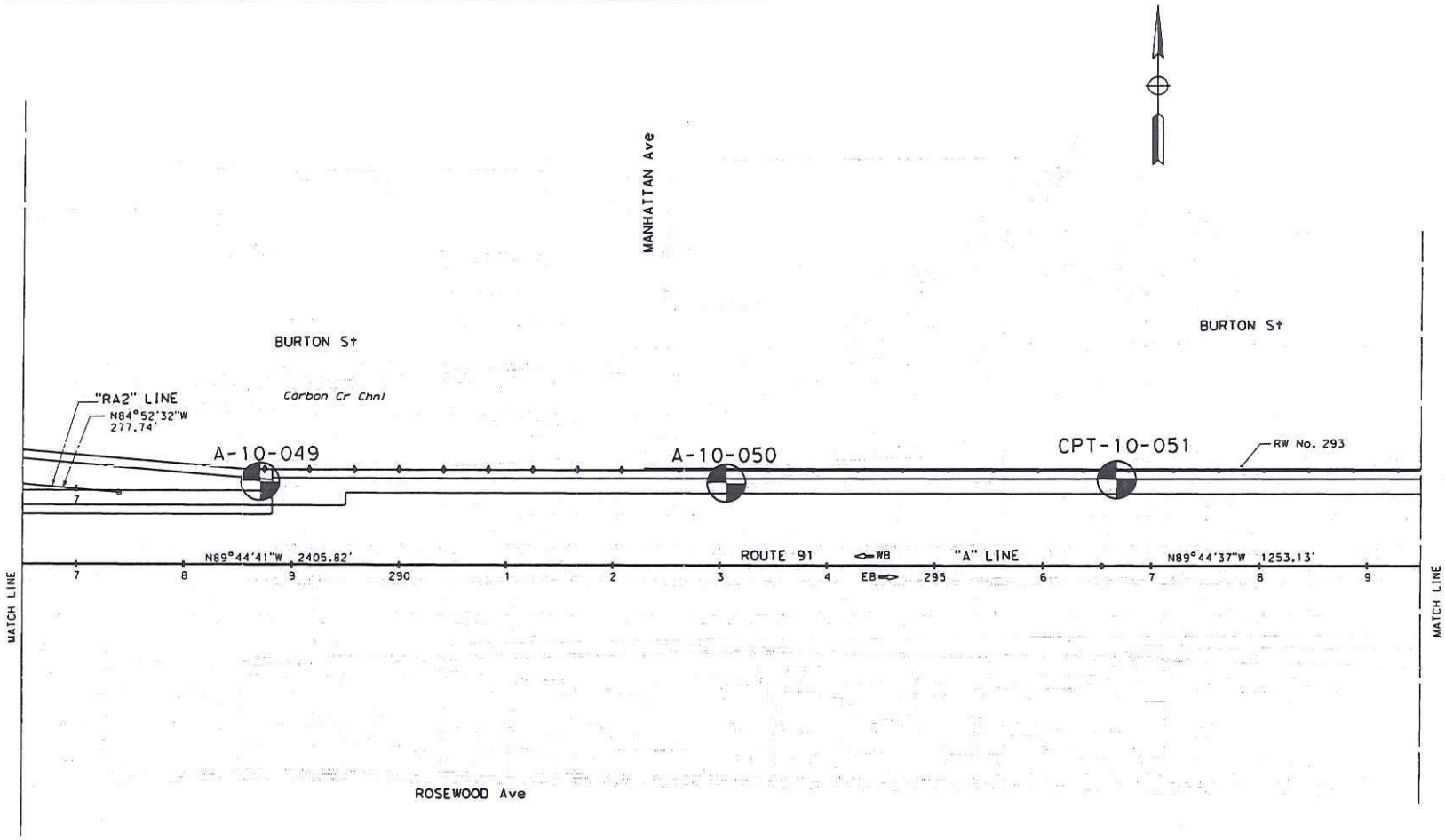
	Project No.: 10-126 / **Date: 06-23-2011**	Figure 15



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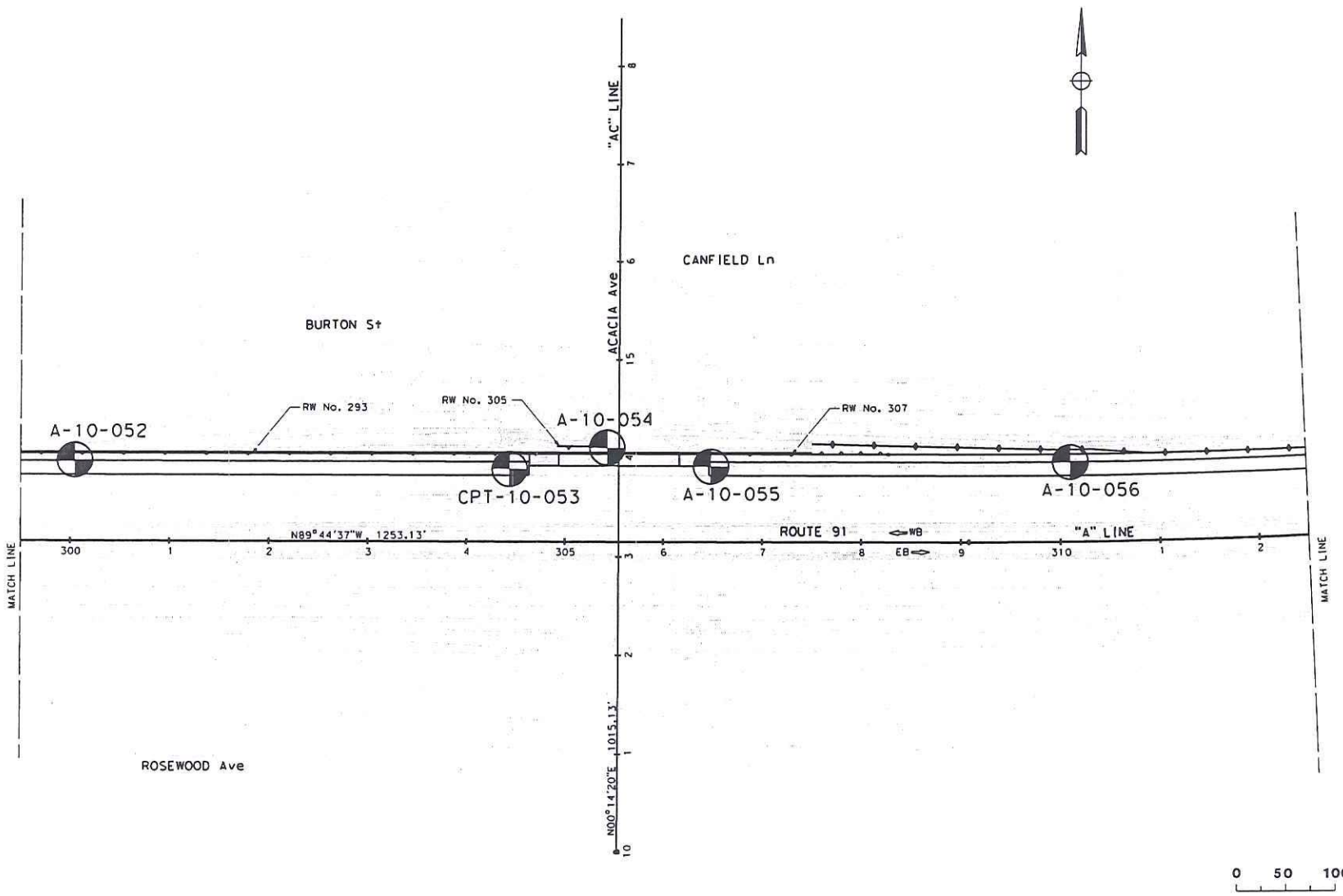
STATE ROUTE 91 WESTBOUND WIDENING PROJECT

Exploratory Boring Location Map (15 of 19)

Figure 16

Project No.: 10-126

Date: 06-23-2011



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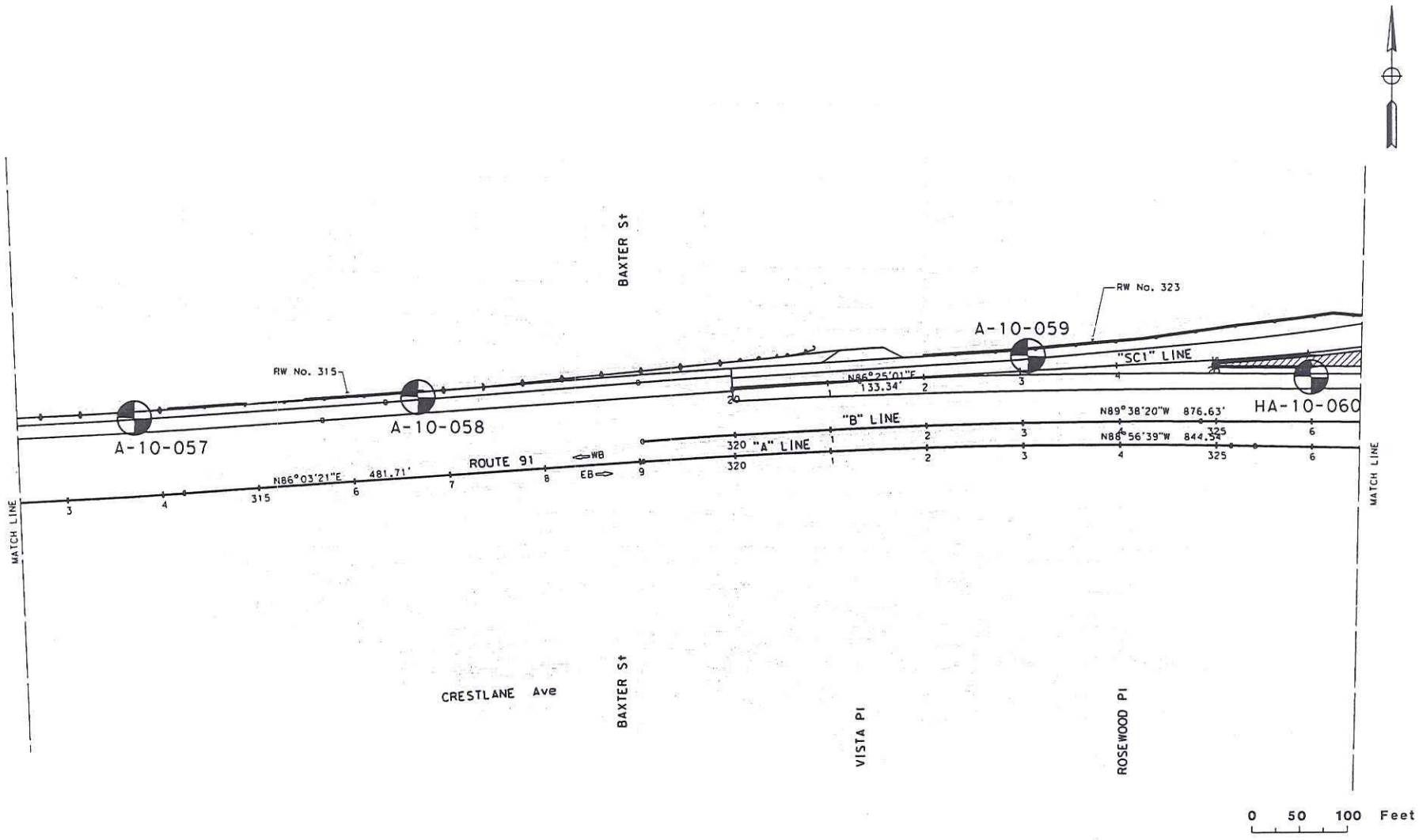
STATE ROUTE 91 WESTBOUND WIDENING PROJECT

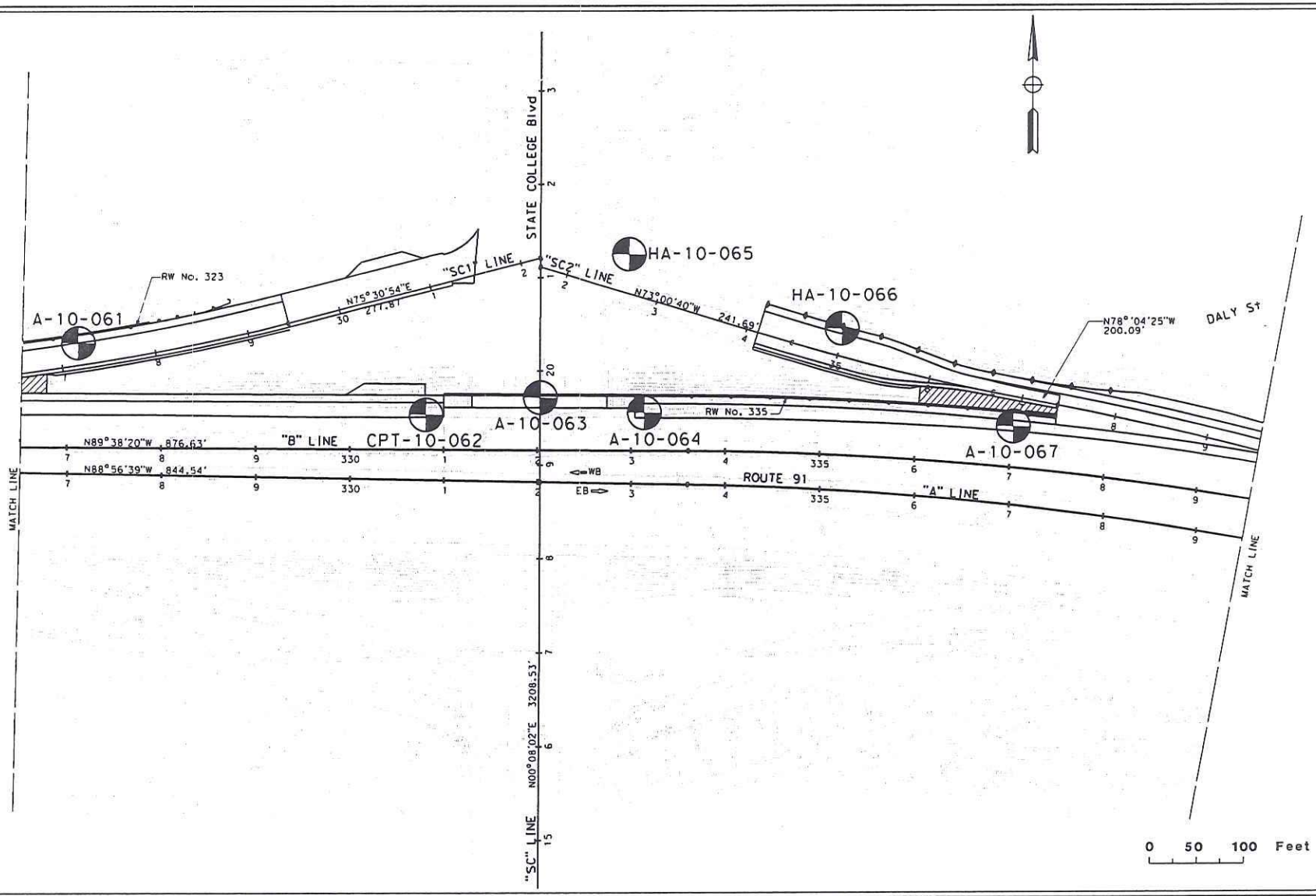
Project No.: 10-126 | **Date: 06-23-2011**

Exploratory Boring Location Map (16 of 19)

Figure 17



Earth Mechanics, Inc. Geotechnical & Earthquake Engineering	**STATE ROUTE 91 WESTBOUND WIDENING PROJECT**	**Exploratory Boring Location Map (17 of 19)**
	Project No.: 10-126 / **Date: 06-23-2011**	Figure 18



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STATE ROUTE 91 WESTBOUND WIDENING PROJECT

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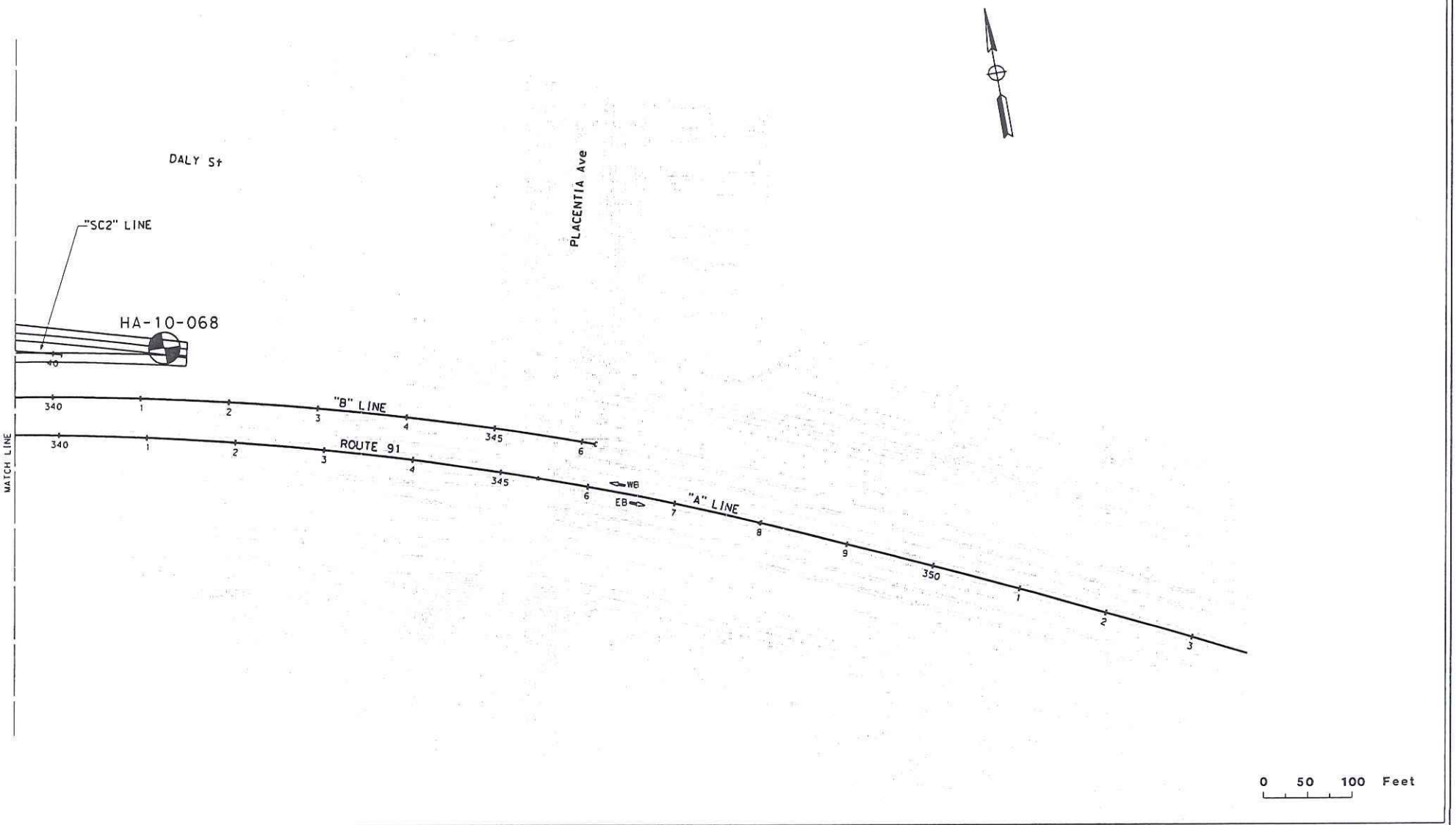
Exploratory Boring Location Map (18 of 19)

Figure 19



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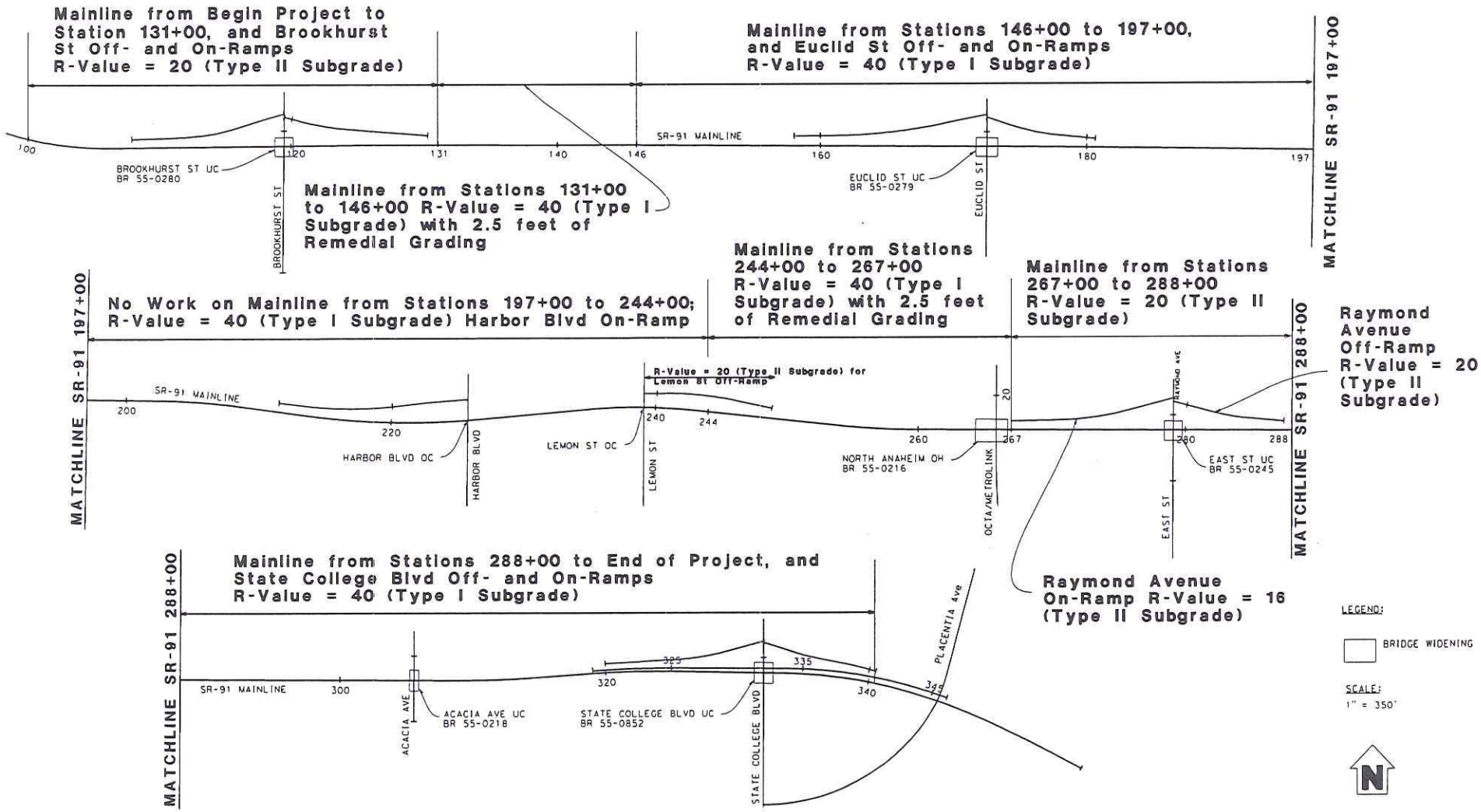
	Project No.: 10-126 / **Date: 06-23-2011**	Figure 20



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Geotechnical & Earthquake Engineering

STATE ROUTE 91 WESTBOUND WIDENING PROJECT

Project No.: 10-126 | **Date: 09-06-2011**

RECOMMENDED DESIGN R-VALUES AND SUBGRADES TYPES

Figure 21

Appendix A

LOG OF TEST BORINGS SHEETS

Grade Elevation	+27.3 ft				
Boring Depth	25.0 ft	Driller	SoCal Drilling		SHEET 1 OF 1
Borehole Diameter	8 inches	Type of Rig	Mud Rotary	Comments	
Date Drilled	04-21-10	Drive Wt.	140-lb		
Logged By	P. F. Chan	Drop	30 inches		

Depth (ft)	Sample Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	1			SILTY SAND (SM): dark olive-brown, moist, mostly medium to fine, little fines			R,CP
5	D	2	20		Poorly graded SAND (SP): loose, light olive-gray, moist, mostly coarse to fine SAND, slightly compact when handled	14	106	DS
	S	3	20		Poorly graded SAND with SILT and GRAVEL (SP-SM): light olive-gray, moist, little GRAVEL, mostly coarse to fine SAND, few fines, compact	35	-	PA
10								
15	D	4	40			24	108	

1. 'Sample Type' – Graphical representation of sample type as shown below.
   - S: Split Spoon – Standard Penetration Test Sample (SPT)
   - D: Drive Sample – California Drive Sampler
   - B: Bulk Sample – Obtained by collecting cuttings in a plastic bag
   - T: Tube Sample – Thin-walled Tube Sample
   - P: Thin-walled Pitcher Core Sample

2. 'Sample' – Sample Number

3. 'Blows/foot' – Number of blows required to advance sampler one foot (unless a distance is specified). Samplers in general were driven into the soil at the bottom of the hole with a 140-lb automatic trip hammer falling a standard 30 inches (as specified in header).

   'REC/RQD' – Sample Core Recovery (REC) in percent (%) and Rock Quality Designation (RQD) in percent (%). RQD is defined as the percentage of core in each run in which the spacing between natural fractures is greater than 4 inches. Mechanical breaks of the core are not considered.

4. 'Graphic Log' – Standard symbols for soil and rock types, as shown in Note B opposite

5. ▼ Groundwater elevation while drilling.

6. 'Geotechnical Description' (See also Note A, opposite).
   Soil – Soil classifications are in general accordance with the American Society for Testing and Materials (ASTM) D2488.84. Designations include consistency, moisture, and color. Field description have been modified to reflect results of laboratory analyses where deemed appropriate.

   Rock – Rock classifications generally include a rock type, color, moisture, mineral constituents, degree of weathering, alteration and the mechanical properties of the rock.

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

EMI Project No.: 10-126 Date: 6-22-11

LEGEND FOR LETTER-SIZE GEOTECHNICAL BORING LOGS (SHEET 1 OF 2)

7. 'Moisture Content' and 'Total Unit Weight' determined by laboratory testing.

8. 'Tests/Results' – Identify types of laboratory tests performed on samples collected from the field investigation. Abbreviations of tests are provided below:

C	Consolidation (ASTM D 2435)	P	Permeability (CTM 220)	SG	Specific Gravity (AASHTO T 100)
CL	Collapse Potential (ASTM D 5333)	PA	Particle Size Analysis (ASTM D 422)	SL	Shrinkage Limit (ASTM D 427)
CP	Compaction Curve (CTM 216)	PI	Plasticity Index (AASHTO T 90)	SW	Swell Potential (ASTM D 4546)
CR	Corrosivity Testing (CTM 643, CTM 422, CTM 417)		Liquid Limit (AASHTO T 89)	TV	Pocket Torvane
CU	Consolidated Undrained Triaxial (ASTM D 4767)	PL	Point Load Index (ASTM D 5731)	UC	Unconfined Compression–Soil (ASTM D 2166)
DS	Direct Shear (ASTM D 3080)	PM	Pressure Meter		Unconfined Compression–Rock (ASTM D 2938)
EI	Expansion Index (ASTM D 4829)	PP	Pocket Penetrometer	UU	Unconsolidated Undrained Triaxial (ASTM D 2850)
M	Moisture Content (ASTM D 2216)	R	R–Value (CTM 301)	UW	Unit Weight (ASTM D 4767)
OC	Organic Content–% (ASTM D 2974)	SE	Sand Equivalent (CTM 217)	VS	Vane Shear (AASHTO T 223)

Criteria for Describing Moisture Condition

Description	Criteria (After ASTM D 2488)
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

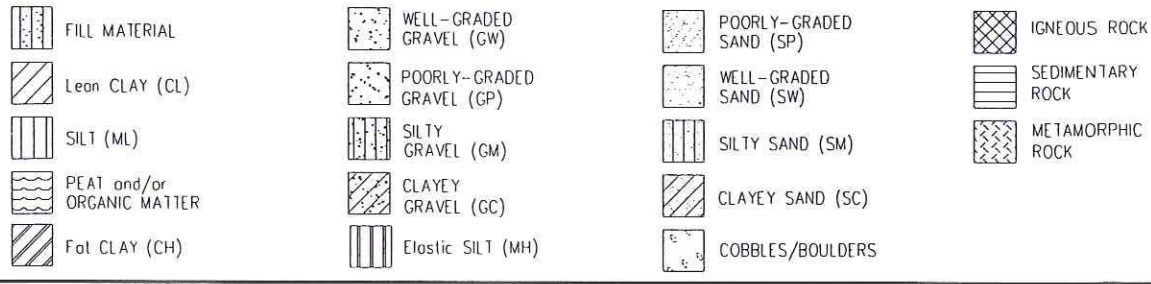
Relative Density of Coarse–Grained Soil

Blows/foot	Relative Density	Field Test (After Sowers, 1979)
0 – 4	Very Loose	Easily penetrated 12" with 0.5–inch steel rod pushed by hand
5 – 10	Loose	Easily penetrated with 0.5–inch steel rod pushed by hand
11 – 30	Medium Dense	Easily penetrated with 0.5–inch steel rod driven by 5–lb hammer
31 – 50	Dense	Penetrated a foot with 0.5–inch steel rod driven by 5–lb hammer
> 50	Very Dense	Penetrated a few inches with 0.5–inch steel rod driven by 5–lb hammer

Consistency of Cohesive Soils

Description	Unconfined Compressive Strength (tsf)	Pocket Penetrometer Measurement (tsf)	Torvane Measurement (tsf)	Field Approximation
Very Soft	< 0.25	< 0.25	< 0.12	Easily penetrated several inches by fist
Soft	0.25 to 0.50	0.25 to 0.50	0.12 to 0.25	Easily penetrated several inches by thumb
Medium Stiff	0.50 to 1.0	0.50 to 1.0	0.25 to 0.50	Penetrated several inches by thumb with moderate effort
Stiff	1 to 2	1 to 2	0.50 to 1.0	Readily indented by thumb but penetrated only with great effort
Very Stiff	2 to 4	2 to 4	1.0 to 2.0	Readily indented by thumbnail
Hard	> 4.0	> 4.0	> 2.0	Indented by thumbnail with difficulty

Legend of Earth Materials



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RBF/SR–91 WB Widening

EMI Project No.: 10–126 | Date: 6–22–11

LEGEND FOR LETTER–SIZE GEOTECHNICAL BORING LOGS (SHEET 2 OF 2)

LOG OF BORING NO. HA-10-001

Grade Elevation:	+108.0 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-12-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, medium to fine SAND, trace coarse SAND, nonplastic			R
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. HA-10-004

Grade Elevation:	+121.0 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-26-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): olive-brown, moist, medium to fine SAND, trace coarse SAND, few coarse to fine GRAVEL, nonplastic			
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. HA-10-009

Grade Elevation:	+112.5 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-26-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): dark olive-brown, moist, medium to fine SAND, trace coarse SAND, few coarse to fine GRAVEL, nonplastic			
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. HA-10-010

Grade Elevation:	+115.8 ft		
Boring Depth:	3.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-26-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			CLAYEY SAND (SC): dark grayish brown, moist, medium to fine SAND, trace coarse SAND, few coarse to fine GRAVEL, low plasticity			R
					Terminated Boring at 3.0 ft depth. Groundwater not encountered.			
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Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. HA-10-011

Grade Elevation:	+119.0 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-11-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, nonplastic			R,CP
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. HA-10-013

Grade Elevation:	+120.8 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	2-1-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			CLAYEY SAND (SC): olive-brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, low to medium plasticity			R,PI,CR
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. HA-10-014

Grade Elevation:	+123.0 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	2-1-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, nonplastic			
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. HA-10-015

Grade Elevation:	+125.0 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-31-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): dark olive-brown, moist, medium to fine SAND, trace coarse SAND, few coarse to fine GRAVEL, nonplastic			PI,R
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. A-10-017

Grade Elevation:	+128.7 ft		
Boring Depth:	6.5 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig: Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler
Date Drilled:	1-26-11	Drive Wt. (lbs): 140	
Logged By:	RJ	Drop (inches): 30	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): dark gray to dark brown, moist, medium to fine SAND, trace coarse SAND, few coarse to fine GRAVEL, nonplastic			
	S	1	25		dense	-	-	
5	D	2	17		medium dense	-	-	
					Terminated Boring at 6.5 ft depth. Groundwater not encountered.			
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Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. A-10-020

Grade Elevation:	+138.0 ft			
Boring Depth:	31.5 feet	Driller: 2R Drilling		SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig: Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler	
Date Drilled:	1-24-11	Drive Wt. (lbs): 140		
Logged By:	RJ	Drop (inches): 30		

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0					4" Asphalt Concrete; 18" Base			
	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, GRAVEL size up to 1.25" dia., nonplastic			
5	S	1	9		SILTY SAND (SM): medium dense, olive-brown, moist, medium to fine SAND, trace coarse SAND, nonplastic	9	-	
10	D	2	26			7	119	DS
15	S	3	8			16	-	
20	D	4	37			14	132	
25	S	5	25		Poorly graded SAND (SP): dense, olive-brown, moist, coarse to fine SAND, nonplastic	4	-	
30	D	6	78		dry	2	-	
					Terminated Boring at 31.5 ft depth. Groundwater not encountered.			
35								

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RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. HA-10-025

Grade Elevation:	+134.2 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-31-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND/SANDY SILT (SM/ML): olive-brown, moist, fine SAND, trace medium SAND, few coarse to fine GRAVEL, nonplastic			
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. A-10-027

Grade Elevation:	+141.0 ft			
Boring Depth:	6.5 feet	Driller:	2R Drilling	SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig:	Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler
Date Drilled:	1-21-11	Drive Wt. (lbs):	140	
Logged By:	RJ	Drop (inches):	30	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, GRAVEL size up to 1.5" dia., nonplastic			R
	S	1	5		loose	-	-	
5					medium dense			
	D	2	28		SILTY SAND (SM): medium dense, olive-brown, moist, fine SAND, trace mica, nonplastic	-	-	
					Terminated Boring at 6.5 ft depth. Groundwater not encountered.			
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Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. A-10-028

Grade Elevation:	+140.0 ft			
Boring Depth:	6.5 feet	Driller: 2R Drilling		SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig: Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler	
Date Drilled:	1-21-11	Drive Wt. (lbs): 140		
Logged By:	RJ	Drop (inches): 30		

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0					5.5" Asphalt Concrete; 12" Base			
	B	0			Poorly graded SAND with SILT (SP-SM): medium dense, olive-brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, GRAVEL size up to 1" dia., nonplastic	-	-	CP,R
	D	1	34					
5	S	2	4		SILTY SAND (SM): medium dense, olive-brown, moist, fine SAND, trace mica, nonplastic	-	-	
					Terminated Boring at 6.5 ft depth. Groundwater not encountered.			
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LOG OF BORING NO. A-10-029

Grade Elevation:	+139.0 ft			
Boring Depth:	31.5 feet	Driller: 2R Drilling		SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig: Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler	
Date Drilled:	12-6-11	Drive Wt. (lbs): 140		
Logged By:	RJ	Drop (inches): 30		

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0					3" Asphalt Concrete; 5" Base			
					SILTY SAND (SM): olive-brown, moist, fine SAND, trace medium SAND, nonplastic			
5	D	1	24		medium dense	5	119	
10	S	2	13		Poorly graded SAND with SILT (SP-SM): medium dense, olive-brown, moist, coarse to fine SAND, trace fine GRAVEL, nonplastic	3	-	
15	D	3	30		SILTY SAND (SM): medium dense, brown to dark brown, moist, fine SAND, trace medium SAND, nonplastic	10	130	
20	S	4	11			24	-	CR
					SANDY SILT (ML): stiff, olive-brown, moist, medium to fine SAND, low plasticity			
25	D	5	51		SILTY SAND (SM): dense, brown to dark brown, moist, fine SAND, trace medium SAND, nonplastic	11	129	
30	S	6	10		SANDY SILT (ML): stiff, dark olive-brown, moist, fine SAND, low plasticity	17	-	
					Terminated Boring at 31.5 ft depth. Groundwater not encountered.			
35								

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Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. A-10-030

Grade Elevation:	+142.0 ft			
Boring Depth:	31.5 feet	Driller: 2R Drilling		SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig: Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler	
Date Drilled:	01-10-11	Drive Wt. (lbs): 140		
Logged By:	RJ	Drop (inches): 30		

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0					10" Asphalt Concrete; 11" Base			
	B	0			SILTY SAND (SM): dark olive-brown, moist, coarse to fine SAND, nonplastic fines, trace mica			R
5	S	1	5		Loose	10	-	
10	D	2	27		Medium dense	9	127	DS
15	S	3	9		SILT with SAND (ML): medium stiff, olive-brown, dry to moist, about 23% fine SAND, about 77% nonplastic fines	22	-	
20	D	4	62		SILTY SAND (SM): dense, olive-brown, moist, fine SAND, nonplastic fines, trace mica.	12	129	
25	S	5	17		Medium dense	10	-	
30	D	6	41			7	128	
					Terminated Boring at 31.5 ft depth. Groundwater not encountered.			
35								

LOG OF BORING NO. A-10-032

Grade Elevation:	+144.0 ft			
Boring Depth:	31.5 feet	Driller: 2R Drilling		SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig: Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler	
Date Drilled:	12-6-11	Drive Wt. (lbs): 140		
Logged By:	RJ	Drop (inches): 30		

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0					3" Asphalt Concrete; 3" Base			
					SILTY SAND (SM): dark olive-brown, moist, fine SAND, nonplastic, trace mica			
5	S	1	6		SANDY SILT (ML): medium stiff, olive-brown, moist, fine SAND, nonplastic	12	-	CR
10	D	2	24		SILTY SAND (SM): medium dense, olive-brown, moist, medium to fine SAND, nonplastic, trace mica.	4	106	
15	S	3	7		Loose	8	-	
20	D	4	26		Medium dense	11	133	
25	S	5	16		Poorly graded SAND with SILT (SP-SM): medium dense, olive-brown, dry, medium to fine SAND, nonplastic, trace mica	3	-	
30	D	6	23		SILTY SAND (SM): medium dense, olive-brown, moist, fine SAND, nonplastic fines, trace mica.	16	117	
					Terminated Boring at 31.5 ft depth. Groundwater not encountered.			
35								

Earth Mechanics, Inc.
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RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. A-10-033

Grade Elevation:	+146.0 ft		
Boring Depth:	31.5 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig: Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler
Date Drilled:	01-10-11	Drive Wt. (lbs): 140	
Logged By:	RJ	Drop (inches): 30	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0					10" Asphalt Concrete; 11" Base			
	B	0			SILTY SAND (SM): dark olive-brown, moist, coarse to fine SAND, nonplastic fines, trace mica			R
5	D	1	9		Loose	12	115	DS
10	S	2	6		Medium dense	13	-	
15	D	3	27		SILT with SAND (ML): medium stiff, olive-brown, moist, 27% fine SAND, 73% nonplastic fines	18	122	
20	S	4	8		SILTY SAND (SM): medium dense, olive-brown, moist, medium to fine SAND, nonplastic, trace mica.	12	-	
25	D	5	27			10	135	
30	S	6	14		with SP layer	14	-	
					Terminated Boring at 31.5 ft depth. Groundwater not encountered.			
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LOG OF BORING NO. A-10-034

Grade Elevation:	+164.6 ft		
Boring Depth:	4.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig: Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler
Date Drilled:	1-20-11	Drive Wt. (lbs): 140	
Logged By:	RJ	Drop (inches): 30	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): dark olive-brown, moist, medium to fine SAND, trace coarse SAND, few coarse to fine GRAVEL, nonplastic			CP,R
	S	1	14		Medium dense	-	-	
					Terminated Boring at 4.0 ft depth.			
5					Groundwater not encountered.			
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LOG OF BORING NO. HA-10-042

Grade Elevation:	+196.5 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-19-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, trace coarse to fine GRAVEL, nonplastic			
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. A-10-047

Grade Elevation:	+175.0 ft			
Boring Depth:	6.5 feet	Driller:	2R Drilling	SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig:	Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler
Date Drilled:	1-18-11	Drive Wt. (lbs):	140	
Logged By:	RJ	Drop (inches):	30	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, GRAVEL size up to 1.5" dia., nonplastic			R
	S	1	11		medium dense	-	-	
5	D	2	21			-	-	
					Terminated Boring at 6.5 ft depth. Groundwater not encountered.			
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15								
20								
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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. A-10-048

Grade Elevation:	+175.0 ft			
Boring Depth:	6.5 feet	Driller:	2R Drilling	SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig:	Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler
Date Drilled:	1-18-11	Drive Wt. (lbs):	140	
Logged By:	RJ	Drop (inches):	30	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, GRAVEL size up to 0.5" dia., nonplastic			
	D	1	25		SILTY SAND (SM): medium dense, dark olive-brown, moist, fine SAND, trace mica, nonplastic	-	-	
5	S	2	11		Poorly graded SAND (SP): medium dense, olive-brown, moist, coarse to fine SAND, trace mica, nonplastic	-	-	
					Terminated Boring at 6.5 ft depth. Groundwater not encountered.			
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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. A-10-056

Grade Elevation:	+194.0 ft			
Boring Depth:	31.5 feet	Driller:	2R Drilling	SHEET 1 OF 1
Borehole Diameter:	8 inches	Type of Rig:	Hollow Stem	Comments: 1. CME 75 with automatic hammer 2. 3.25" O.D. ring sampler
Date Drilled:	01-17-11	Drive Wt. (lbs):	140	
Logged By:	RJ	Drop (inches):	30	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0					13" Asphalt Concrete; 13" Base			
					Poorly graded SAND with SILT (SP-SM): dark olive-brown, moist, coarse to fine SAND, trace coarse to fine GRAVEL, nonplastic			
5	S	1	32		SILTY SAND (SM): dense, dark olive-brown, moist, coarse to fine SAND, trace fine GRAVEL, nonplastic, trace mica	6	-	
10	D	2	74			6	127	
15	S	3	17		Poorly graded SAND with SILT (SP-SM): medium dense, olive-brown, moist, coarse to fine SAND, trace mica, nonplastic	4	-	CR
20	D	4	55		Dense	9	112	
25	S	5	22		Poorly graded SAND (SP): medium dense, olive-brown, moist, coarse to fine SAND, trace fine GRAVEL and mica, nonplastic	4	-	
30	D	6	73		Dense	5	114	
					Terminated Boring at 31.5 ft depth. Groundwater not encountered.			
35								

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. HA-10-060

Grade Elevation:	+197.0 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-17-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, trace coarse to fine GRAVEL, nonplastic			
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. HA-10-065

Grade Elevation:	+191.0 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-31-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): olive-brown, moist, fine SAND, trace medium SAND, few coarse to fine GRAVEL, nonplastic, trace mica			
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. HA-10-066

Grade Elevation:	+196.0 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-27-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, nonplastic			R
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. HA-10-068

Grade Elevation:	+202.0 ft		
Boring Depth:	2.0 feet	Driller: 2R Drilling	SHEET 1 OF 1
Borehole Diameter:	-	Type of Rig: Bulk only	
Date Drilled:	1-14-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			Poorly graded SAND with SILT (SP-SM): olive-brown, moist, coarse to fine SAND, trace coarse to fine GRAVEL, nonplastic			R
					Terminated Boring at 2.0 ft depth. Groundwater not encountered.			
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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. HA-10-069

Grade Elevation:	+156.0 ft		
Boring Depth:	4.0 feet	Driller: EMI	SHEET 1 OF 1
Borehole Diameter:	3"	Type of Rig: Hand Auger	
Date Drilled:	5-16-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): dark yellowish brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, nonplastic, trace mica			
					Poorly graded SAND (SP): olive-brown, moist, medium to fine SAND, trace coarse SAND, nonplastic			
5					Terminated Boring at 4.0 ft depth. Groundwater not encountered.			
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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. HA-10-070

Grade Elevation:	+155.7 ft		
Boring Depth:	4.0 feet	Driller: EMI	SHEET 1 OF 1
Borehole Diameter:	3"	Type of Rig: Hand Auger	
Date Drilled:	5-16-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): dark yellowish brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, nonplastic, trace mica			
					Terminated Boring at 4.0 ft depth. Groundwater not encountered.			
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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. HA-10-071

Grade Elevation:	+152.0 ft		
Boring Depth:	4.0 feet	Driller: EMI	SHEET 1 OF 1
Borehole Diameter:	3"	Type of Rig: Hand Auger	
Date Drilled:	5-16-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): dark yellowish brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, nonplastic, trace mica			
					Terminated Boring at 4.0 ft depth. Groundwater not encountered.			
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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

LOG OF BORING NO. HA-10-072

Grade Elevation:	+156.0 ft		
Boring Depth:	4.0 feet	Driller: EMI	SHEET 1 OF 1
Borehole Diameter:	3"	Type of Rig: Hand Auger	
Date Drilled:	5-16-11	Drive Wt. (lbs): -	
Logged By:	RJ	Drop (inches): -	

Depth (feet)	Sampler Type	Sample	Blows/foot	Graphic Log	GEOTECHNICAL DESCRIPTION	Moisture (%)	Total Unit Weight (pcf)	Tests/ Results
0	B	0			SILTY SAND (SM): dark yellowish brown, moist, coarse to fine SAND, few coarse to fine GRAVEL, nonplastic, trace mica			
					Terminated Boring at 4.0 ft depth. Groundwater not encountered.			
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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

RBF/SR-91 WB Widening

Project No. 10-126 Date: 7-15-11

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER _____ DATE _____

PLANS APPROVAL DATE _____

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

S. PIRATHIVIRAJ
NO. C71662
EXP. 12/31/11
REGISTERED PROFESSIONAL ENGINEER
CIVIL
STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

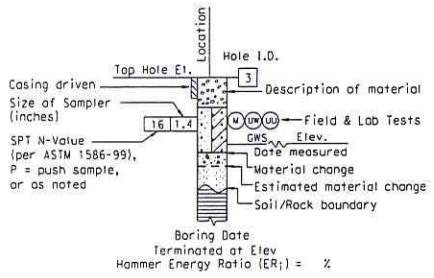
EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

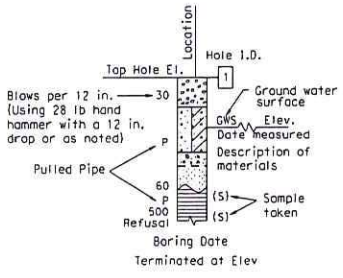
CEMENTATION	
Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

BOREHOLE IDENTIFICATION		
Symbol	Hole Type	Description
Size	A	Auger Boring (hollow or solid stem bucket)
Size	R RW RC P	Rotary drilled boring (conventional) Rotary drilled with self-casing wire-line Rotary core with continuously-sampled, self-casing wire-line Rotary percussion boring (air)
Size	R	Rotary drilled diamond core
Size	HD HA	Hand driven (1-inch soil tube) Hand Auger
●	D	Dynamic Cone Penetration Boring
▲	CPT	Cone Penetration Test (ASTM D 5778)
[ ]	O	Other (note on LOTB)
Note: Size in inches.		

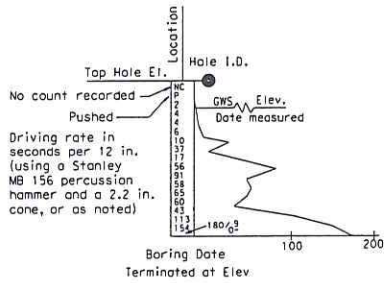
CONSISTENCY OF COHESIVE SOILS				
Description	Shear Strength (tsf)	Pocket Penetrometer Measurement, PP, (tsf)	Torvane Measurement, TV, (tsf)	Vane Shear Measurement, VS, (tsf)
Very Soft	Less than 0.12	Less than 0.25	Less than 0.12	Less than 0.12
Soft	0.12 - 0.25	0.25 - 0.5	0.12 - 0.25	0.12 - 0.25
Medium Stiff	0.25 - 0.5	0.5 - 1	0.25 - 0.5	0.25 - 0.5
Stiff	0.5 - 1	1 - 2	0.5 - 1	0.5 - 1
Very Stiff	1 - 2	2 - 4	1 - 2	1 - 2
Hard	Greater than 2	Greater than 4	Greater than 2	Greater than 2



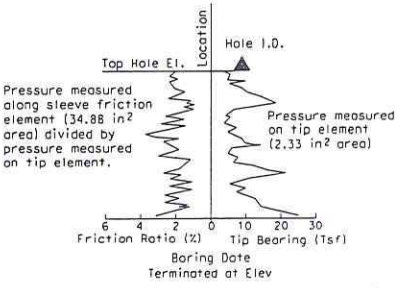
ROTARY BORING



HAND BORING



DYNAMIC CONE PENETRATION BORING



CONE PENETRATION TEST (CPT) BORING

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 12/2010, 1/2011		PROJECT ENGINEER	POST MILES -

SOIL LEGEND

LOG OF TEST BORINGS 1 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 1200000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

CONTRACT NO.: 12-0C5701 PROJECT ID:

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

GROUP SYMBOLS AND NAMES

Graphic/Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND
GP	Poorly-graded GRAVEL Poorly-graded GRAVEL with SAND
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)
GP-GM	Poorly-graded GRAVEL with SILT Poorly-graded GRAVEL with SILT and SAND
GP-GC	Poorly-graded GRAVEL with CLAY (or SILTY CLAY) Poorly-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)
GM	SILTY GRAVEL SILTY GRAVEL with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL
SP	Poorly-graded SAND Poorly-graded SAND with GRAVEL
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)
SP-SM	Poorly-graded SAND with SILT Poorly-graded SAND with SILT and GRAVEL
SP-SC	Poorly-graded SAND with CLAY (or SILTY CLAY) Poorly-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)
SM	SILTY SAND SILTY SAND with GRAVEL
SC	CLAYEY SAND CLAYEY SAND with GRAVEL
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL
PT	PEAT
	COBBLES COBBLES and BOULDERS BOULDERS

Graphic/Symbol	Group Names
CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY ORGANIC elastic SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND

FIELD AND LABORATORY TESTING

- (C) Consolidation (ASTM D 2435)
- (CL) Collapse Potential (ASTM D 5333)
- (CP) Compaction Curve (CTM 216)
- (CR) Corrosivity Testing (CTM 643, CTM 422, CTM 417)
- (CU) Consolidated Undrained Triaxial (ASTM D 4767)
- (DS) Direct Shear (ASTM D 3080)
- (EI) Expansion Index (ASTM D 4829)
- (M) Moisture Content (ASTM D 2216)
- (OC) Organic Content-% (ASTM D 2974)
- (P) Permeability (CTM 220)
- (PA) Particle Size Analysis (ASTM D 422)
- (PI) Plasticity Index (AASHTO T 90) Liquid Limit (AASHTO T 89)
- (PL) Point Load Index (ASTM D 5731)
- (PM) Pressure Meter
- (R) R-Value (CTM 301)
- (SE) Sand Equivalent (CTM 217)
- (SG) Specific Gravity (AASHTO T 100)
- (SL) Shrinkage Limit (ASTM D 427)
- (SW) Swell Potential (ASTM D 4546)
- (UC) Unconfined Compression-Soil (ASTM D 2166) Unconfined Compression-Rock (ASTM D 2938)
- (UU) Unconsolidated Undrained Triaxial (ASTM D 2850)
- (UW) Unit Weight (ASTM D 4767)

APPARENT DENSITY OF COHESIONLESS SOILS

Description	SPT N_{60} (Blows / 12 in.)
Very Loose	0 - 5
Loose	5 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Greater than 50

MOISTURE

Description	Criteria
Dry	No discernable moisture
Moist	Moisture present, but no free water
Wet	Visible free water

PERCENT OR PROPORTION OF SOILS

Description	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5% - 10%
Little	15% - 25%
Some	30% - 45%
Mostly	50% - 100%

PARTICLE SIZE

Description		Size (in.)
Boulder		Greater than 12
Cobble		3 - 12
Gravel	Coarse	3/4 - 3
	Fine	1/5 - 3/4
Sand	Coarse	1/16 - 1/5
	Medium	1/64 - 1/16
	Fine	1/300 - 1/64
Silt and Clay		Less than 1/300

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER — DATE

B. PIRATHIVIRAJ, NO. C71082, EXP. 12/31/11, REGISTERED PROFESSIONAL ENGINEER, CIVIL, STATE OF CALIFORNIA

PLANS APPROVAL DATE

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

DESIGN OVERSIGHT — SIGN OFF DATE

DRAWN BY: J. Fang
CHECKED BY: S. Pirathiviraj

R. Jie
FIELD INVESTIGATION BY
DATE: 12/2010,1/2011

PREPARED FOR THE STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

S. Pirathiviraj
PROJECT ENGINEER

BRIDGE NO. -
POST MILES -

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS: 0 1 2 3

FILE => $REQUEST

SOIL LEGEND
LOG OF TEST BORINGS 2 OF 2

REVISION DATES — SHEET — OF

CONTRACT NO.: 12-0C5701 — PROJECT ID:

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/18/10)

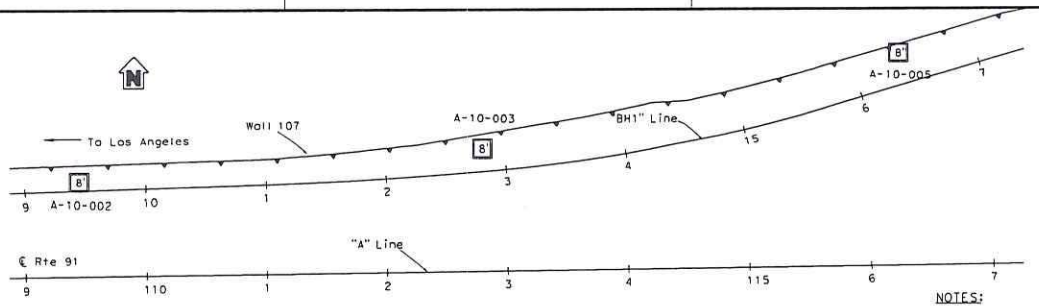
USERNAME => %USER — DATE PLOTTED => %DATE — TIME PLOTTED => %TIME

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

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S. PIRATHIVIRAJ NO. C71682 EXP. 12/31/11 CIVIL STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

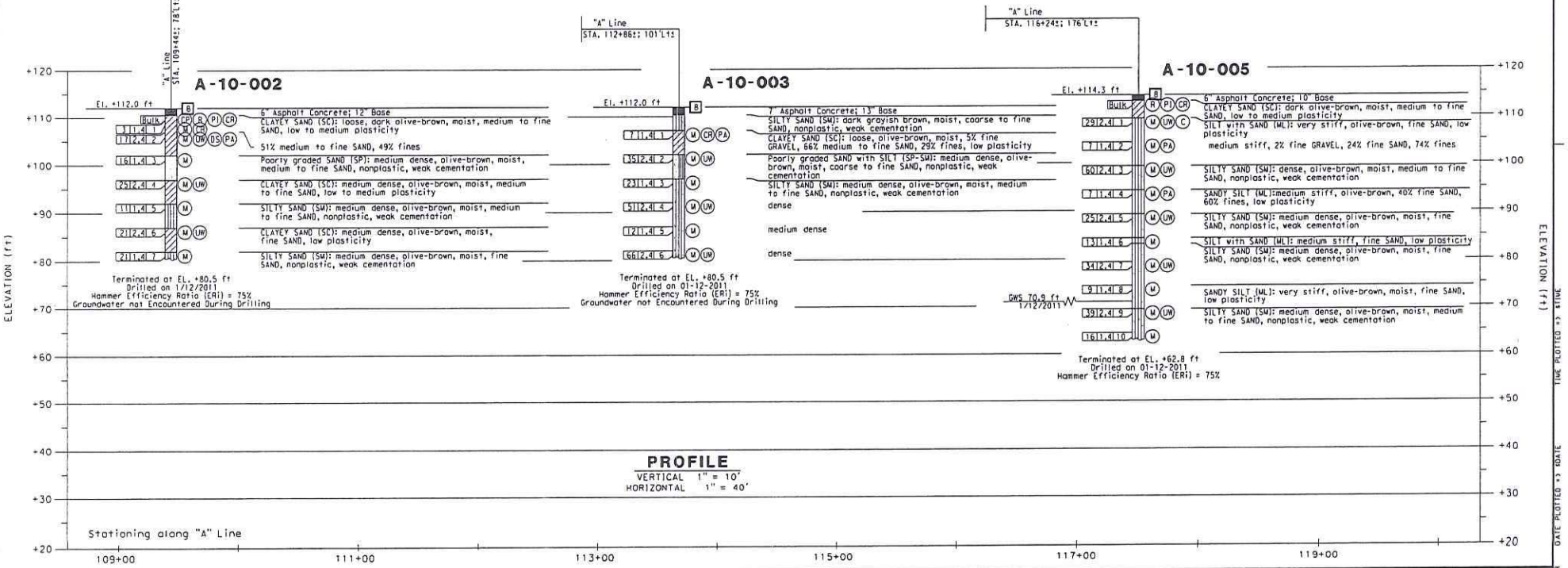
EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).
(2) 2.4" samples were taken using a California Modified Sampler.
(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.
(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.

PLAN
1" = 50'

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 40'



DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Piratniviraj	BRIDGE NO. -	WALL 107
SIGN OFF DATE	CHECKED BY	S. Piratniviraj	FIELD INVESTIGATION BY: DATE: 1/12/2011		PROJECT ENGINEER	POST MILES -	LOG OF TEST BORING 1 OF 1

05 GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 1200000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

CONTRACT NO.: 12-0C5701 PROJECT ID:

FILE => $REQUEST

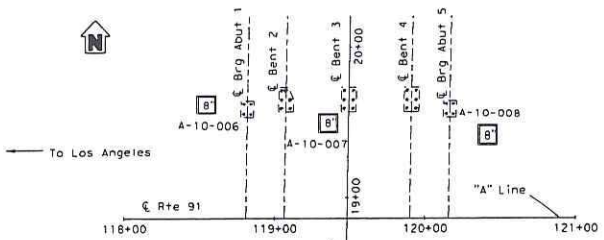
USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 40'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

REGISTERED PROFESSIONAL ENGINEER * S. PIRATHIVIRAJ * NO. C71682 EXP. 12/31/11 CIVIL * STATE OF CALIFORNIA *

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

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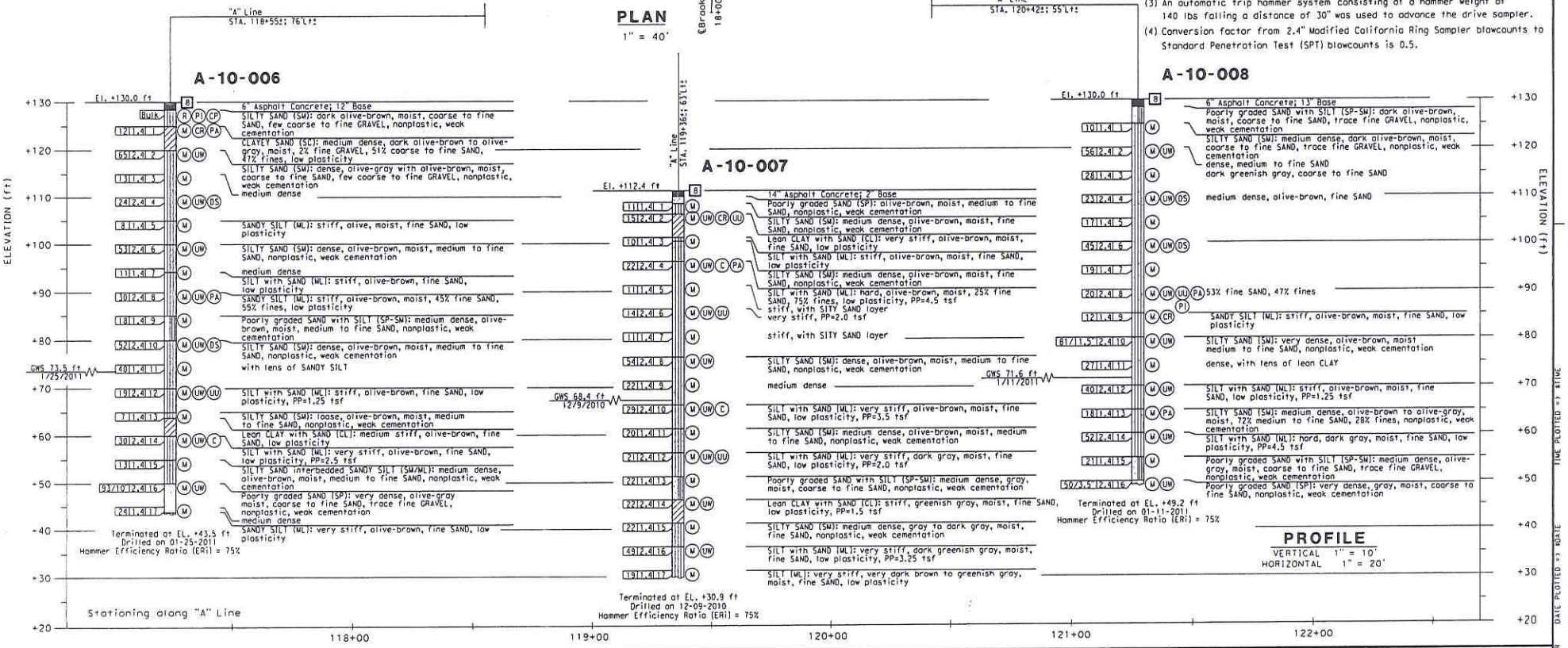


PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011		

BRIDGE NO. 55-0280
POST MILES 1.2

BROOKHURST STREET UC (WIDEN)
LOG OF TEST BORINGS 1 OF 1

UNIT: 2295
PROJECT NUMBER & PHASE: 1200000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

CONTRACT NO.: 12-0C5701 PROJECT ID:

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

FILE => $REQUEST

TIME PLOTTED => $TIME

DATE PLOTTED => $DATE

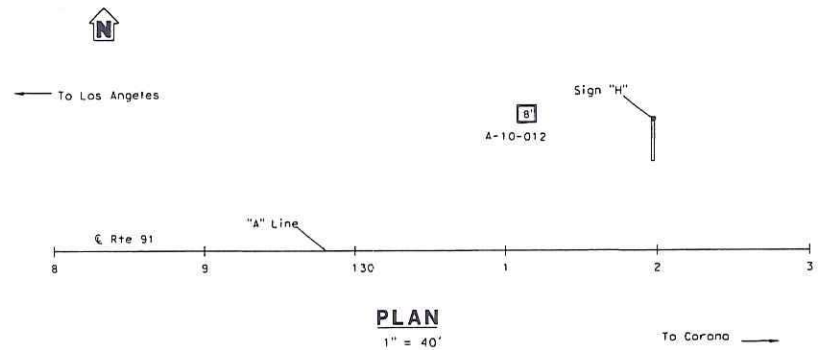
USERNAME => $USER

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 40'

To Corona

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER * S. PIRATHIVIRAJ NO. C71182 EXP. 12/31/11 CIVIL * STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

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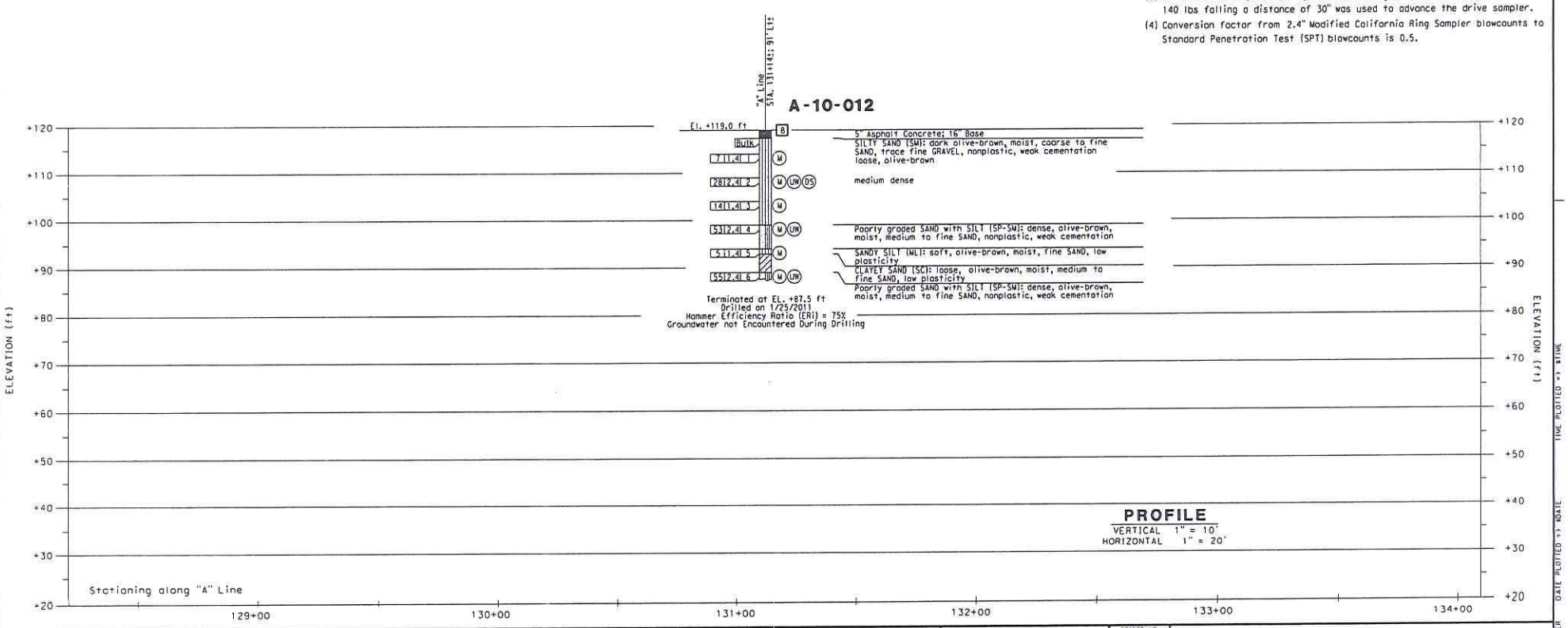

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fong	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. -	OVERHEAD SIGN STRUCTURES
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/25/2011				POST MILES -	LOG OF TEST BORINGS 1 OF 3

OS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/18/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

CONTRACT NO.: 12-0C5701 PROJECT ID:

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

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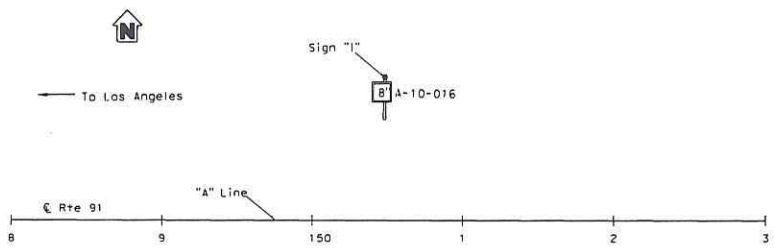
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 40'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER * S. PRATHIVIRAJ NO. C71662 EXP. 12/31/11 CIVIL * STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

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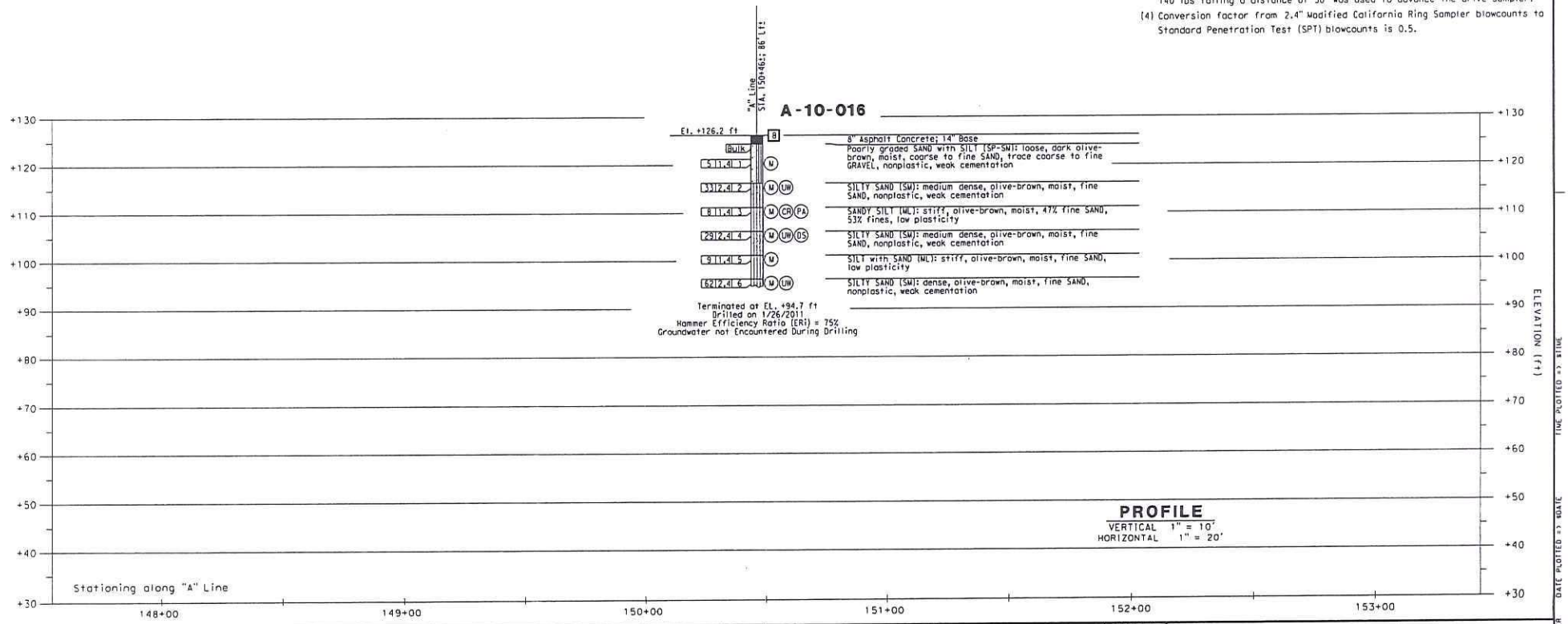

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -	OVERHEAD SIGN STRUCTURES
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/26/2011		PROJECT ENGINEER	POST MILES -	LOG OF TEST BORINGS 2 OF 3

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/18/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS: 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

CONTRACT NO.: 12-0C5701 PROJECT ID:

FILE => &REQUEST

USERNAME => %USER DATE PLOTTED => %DATE TIME PLOTTED => %TIME

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
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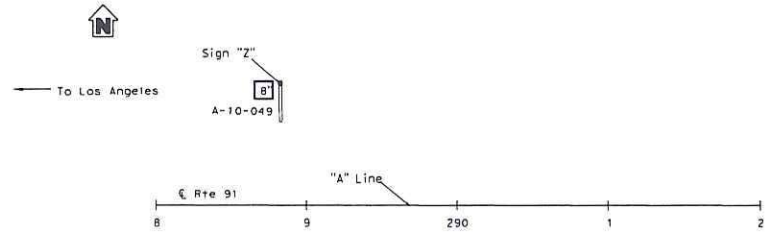
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER * S. PIRATHIVIRAJ NO. C71662 EXP. 12/31/11 CIVIL * STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

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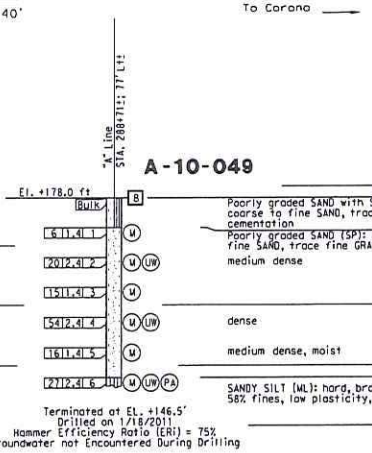
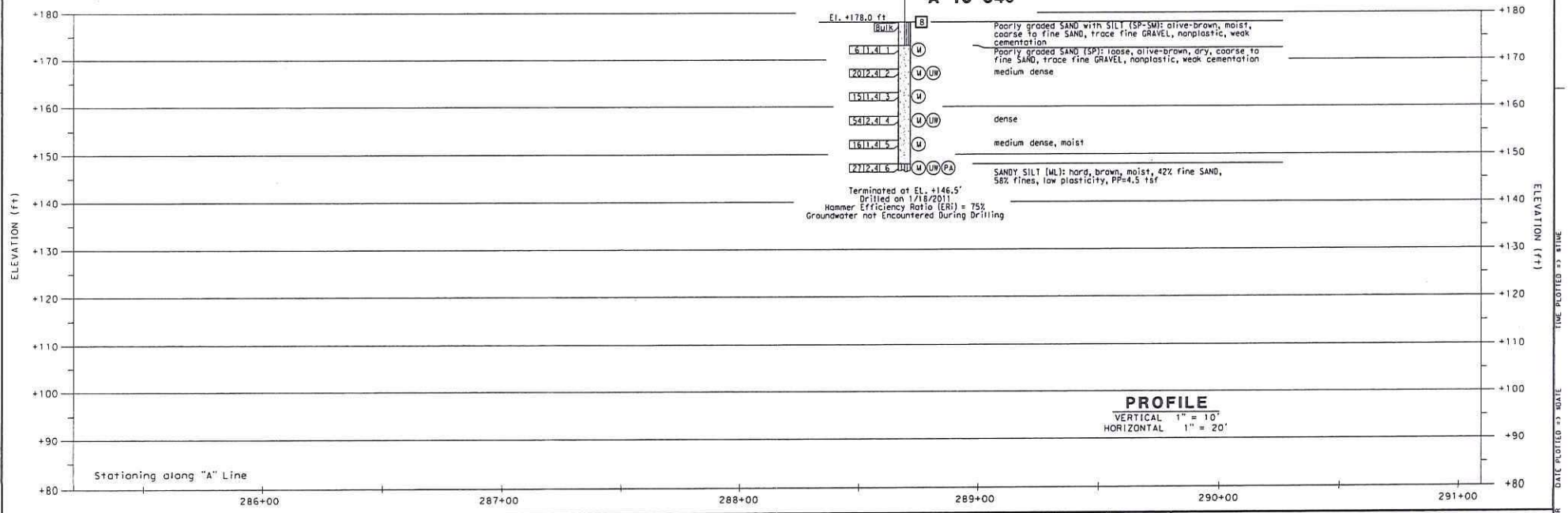
PLAN
1" = 40'





PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fong	R. Jie FIELD INVESTIGATION BY:	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. -
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	DATE: 1/18/2010			POST MILES -

OVERHEAD SIGN STRUCTURES
LOG OF TEST BORINGS 3 OF 3

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

FILE => $REQUEST

CONTRACT NO.: 12-0C5701 PROJECT ID:

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

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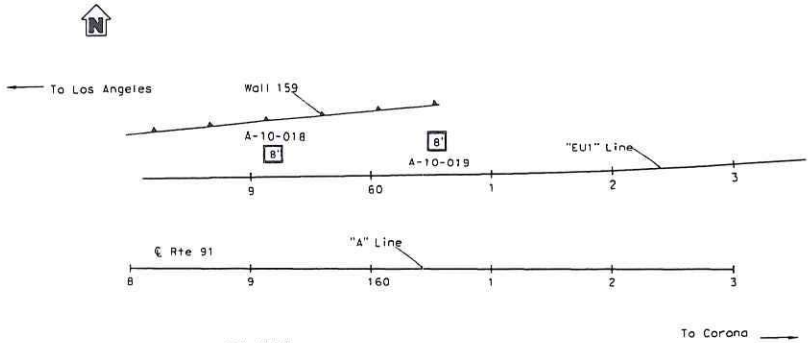
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71062 EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

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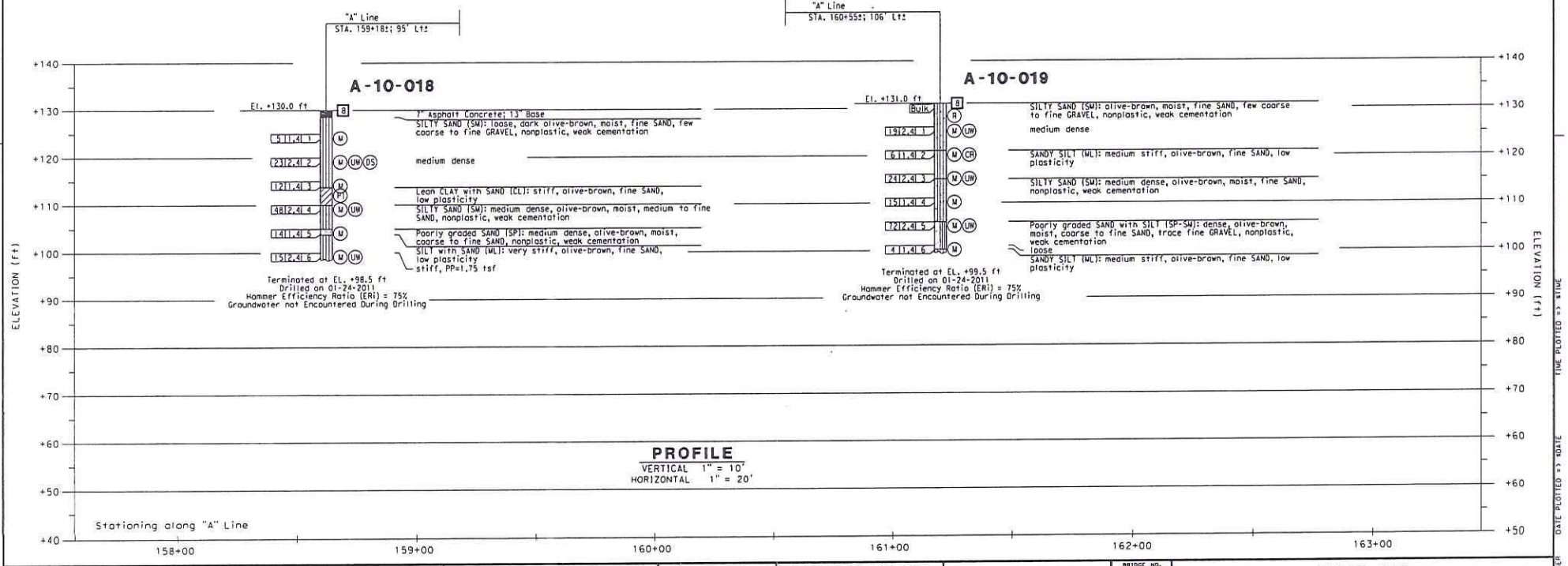

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -	WALL 159
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 1/24/2011		PROJECT ENGINEER	POST MILES -	LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

CONTRACT NO.: 12-0C5701 PROJECT ID:

FILE => $REQUEST

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BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
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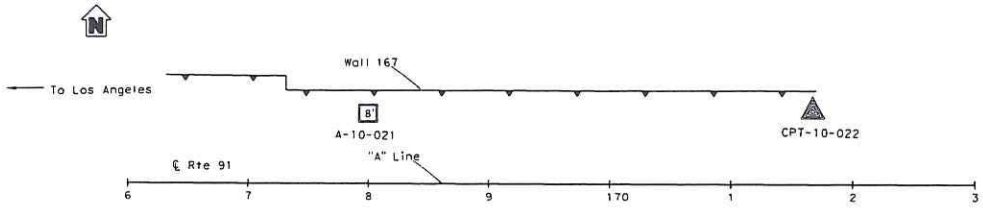

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER
S. PIRATHIVIRAJ
No. C71982
EXP. 12/31/11
CIVIL
STATE OF CALIFORNIA

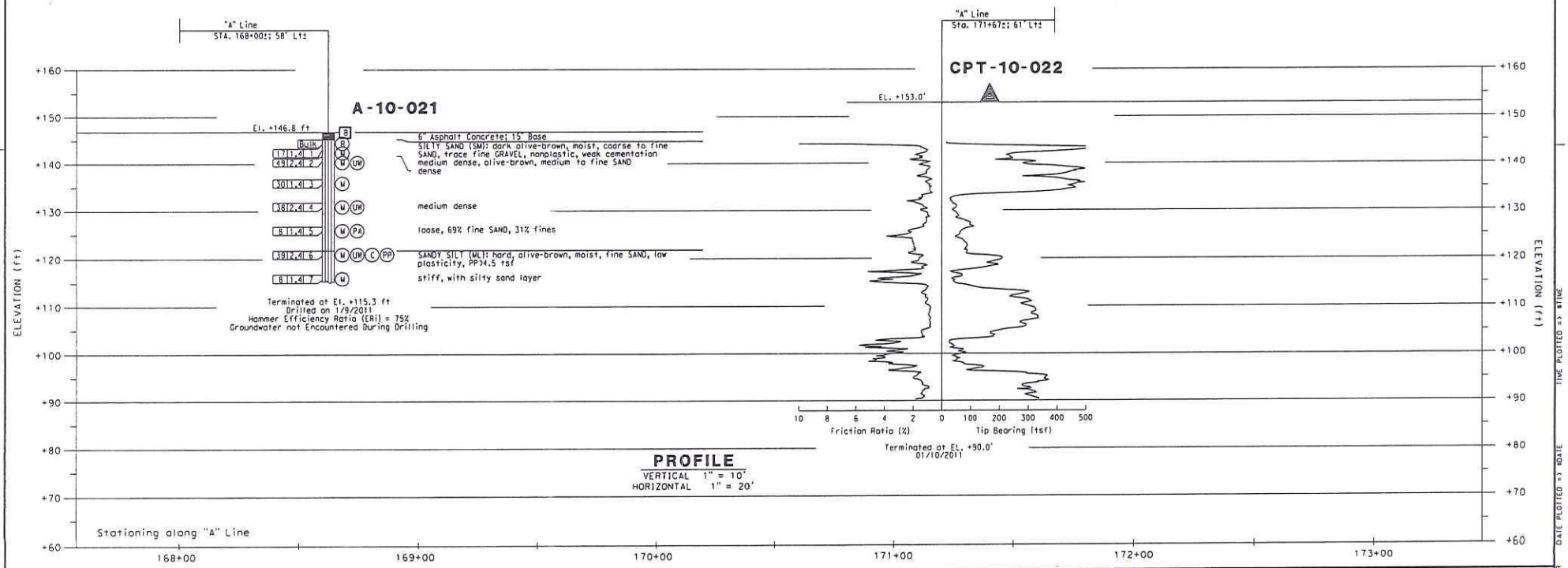
ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).
(2) 2.4" samples were taken using a California Modified Sampler.
(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.
(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.

PLAN
1" = 50'



PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT
SIGN OFF DATE
DRAWN BY J. Fang
CHECKED BY S. Pirathiviraj
R. Jie
FIELD INVESTIGATION BY
DATE: 1/24/2011

PREPARED FOR THE STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

S. Pirathiviraj
PROJECT ENGINEER

BRIDGE NO. -
POST MILES -

WALL 167
LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 1200000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

SHEET OF

FILE => REQUEST

CONTRACT NO.: 12-0C5701 PROJECT ID:

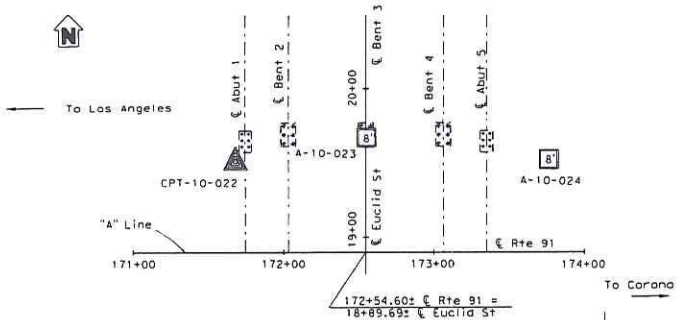
USERNAME => %USER DATE PLOTTED => %DATE TIME PLOTTED => %TIME

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnalia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnalia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 40'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

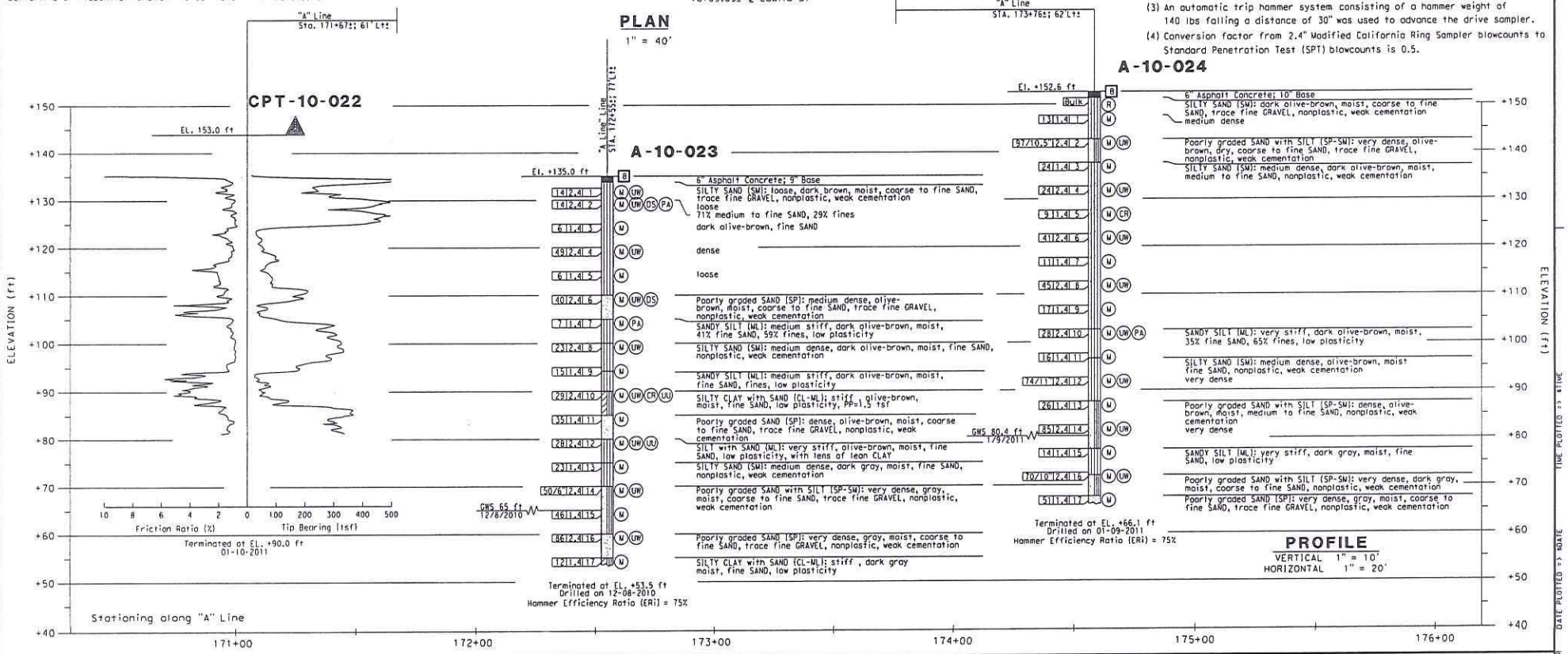
NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).

(2) 2.4" samples were taken using a California Modified Sampler.

(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.



PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. 55-0279	EUCLID STREET UC (WIDEN)
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011		PROJECT ENGINEER	POST MILES 2.2	LOG OF TEST BORINGS 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

CONTRACT NO.: 12-0C5701 PROJECT ID:

FILE => SREQUEST

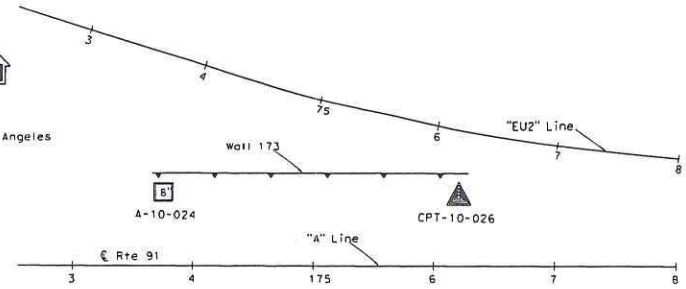
USERNAME => RUSER DATE PLOTTED => 8/JUE TIME PLOTTED => 8/TIME

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 20-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "20-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71862 EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

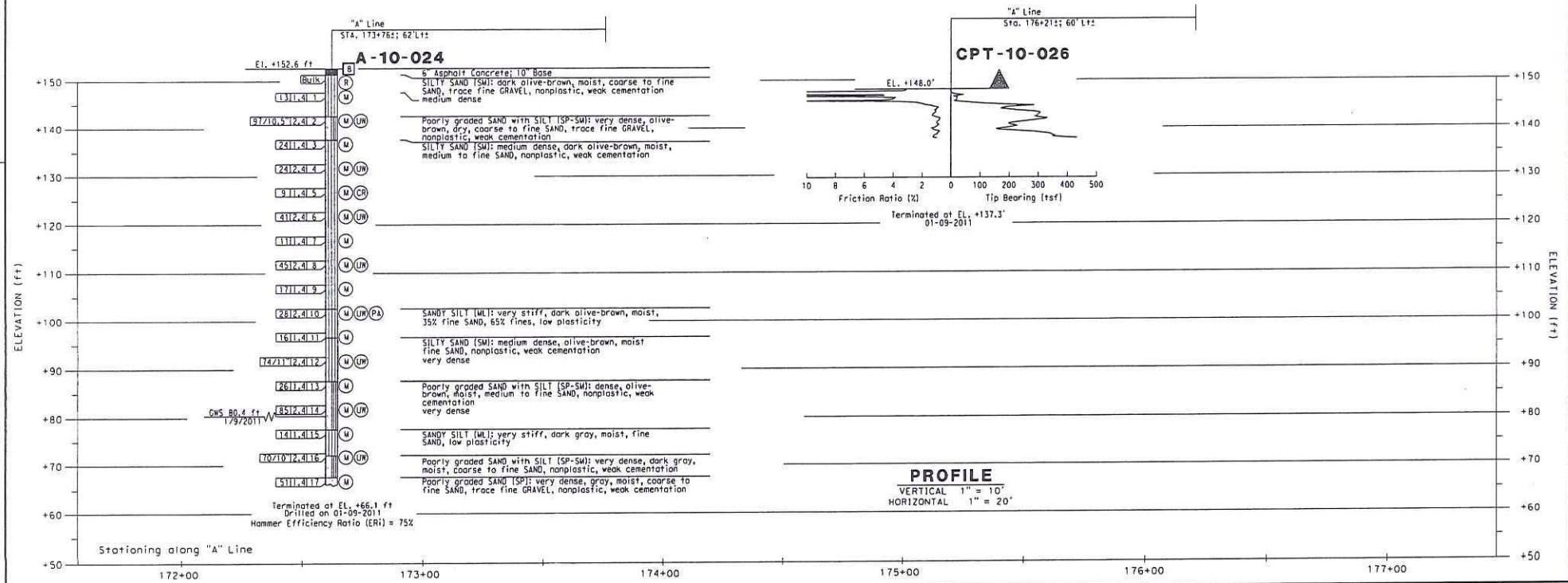
NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).

(2) 2.4" samples were taken using a California Modified Sampler.

(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.



PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -	WALL 173
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 1/9/2011		PROJECT ENGINEER	POST MILES -	LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/18/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

CONTRACT NO.: 12-0C5701 PROJECT ID:

FILE => %REQUEST

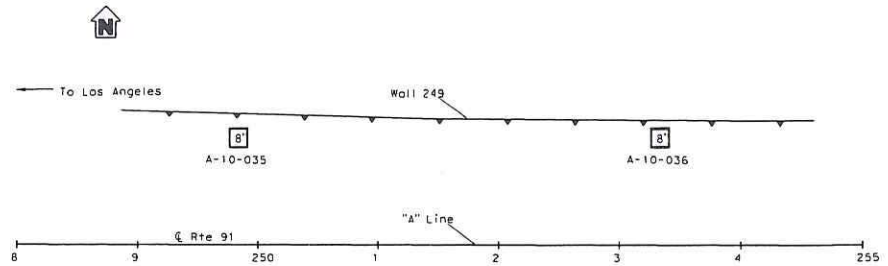
USERNAME => %USER DATE PLOTTED => %DATE TIME PLOTTED => %TIME

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-B6 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-B6", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 50'

To Corona

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

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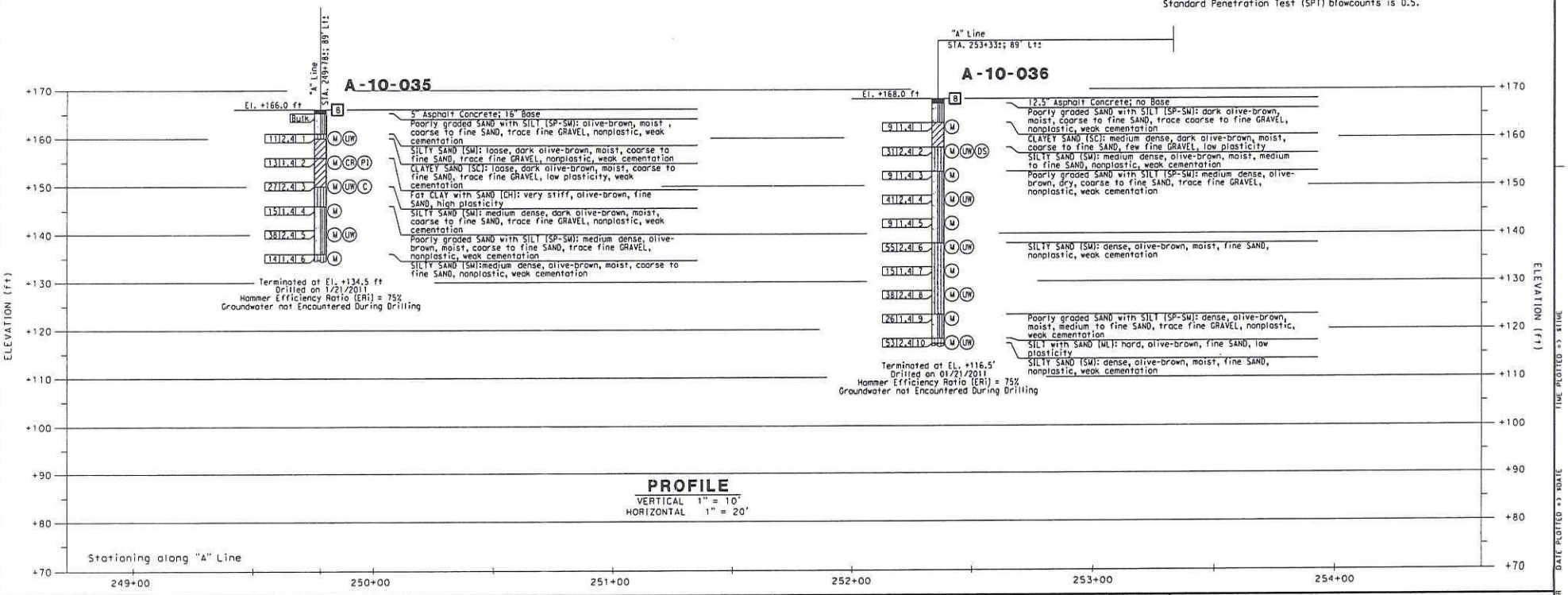

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -	WALL 249
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 1/24/2011		PROJECT ENGINEER	POST MILES -	LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

FILE => $REQUEST

CONTRACT NO.: 12-0C5701 PROJECT ID:

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

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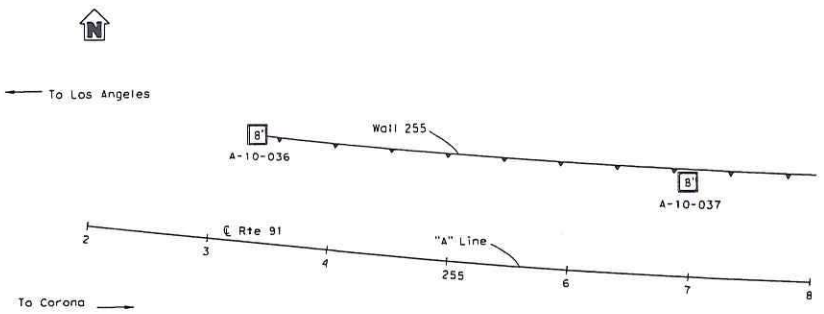
BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

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S. PIRATHIVIRAJ NO. C71662 EXP. 12/31/11 CIVIL — REGISTERED PROFESSIONAL ENGINEER — STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

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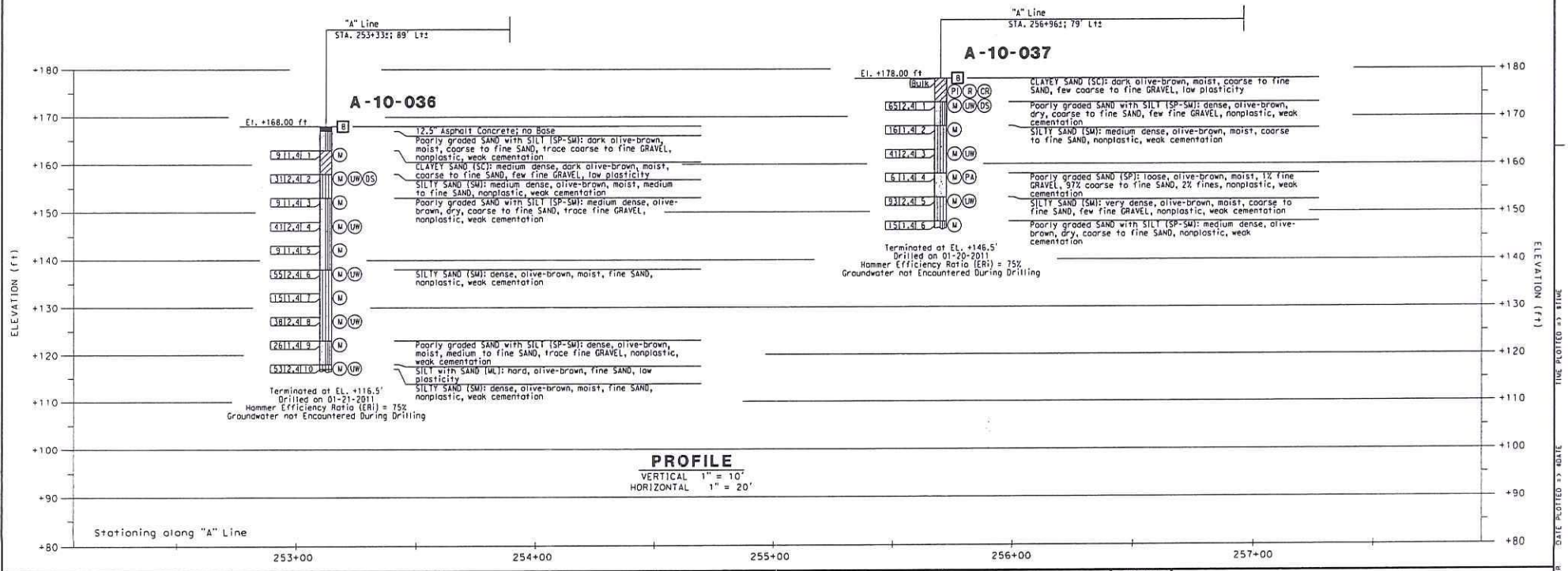

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. PIRATHIVIRAJ PROJECT ENGINEER	BRIDGE NO. -	WALL 255
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/2011			POST MILES -	LOG OF TEST BORINGS 1 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295 PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

FILE => $REQUEST

CONTRACT NO.: 12-0C5701 PROJECT ID:

DATE PLOTTED => $DATE TIME PLOTTED => $TIME USERNAME => $USER

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

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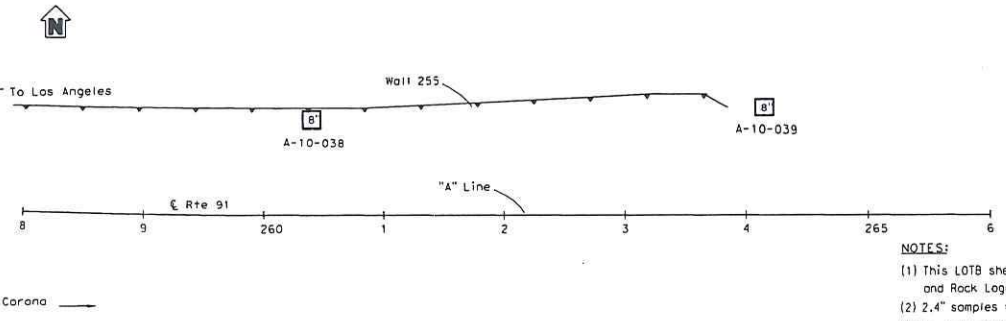
Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER
B. PIRATHIVIRAJ
NO. C71882
EXP. 12/31/11
CIVIL
STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

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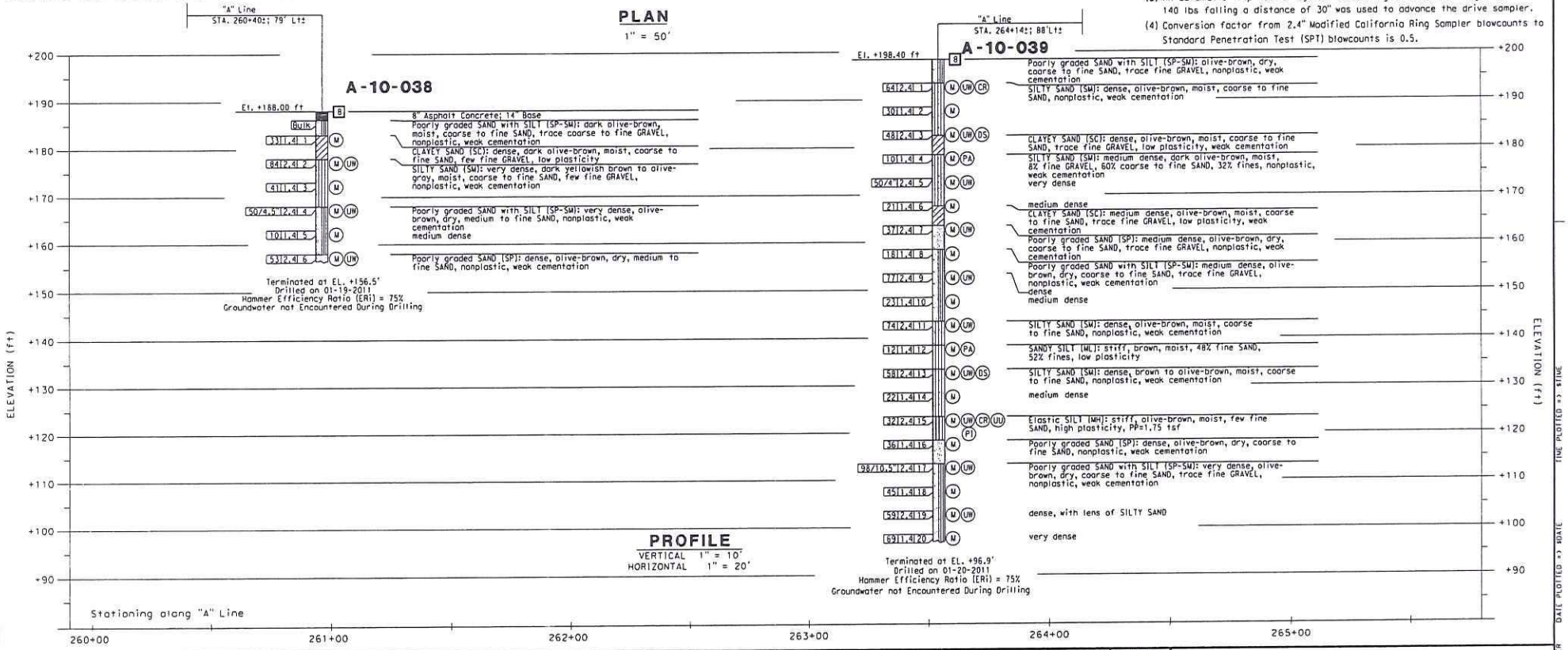
(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.

PLAN

1" = 50'



PROFILE

VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -	WALL 255
SIGN OFF DATE	CHECKED BY	G. J. Gunoranjan	FIELD INVESTIGATION BY: DATE: 1/2011		PROJECT ENGINEER	POST MILES -	LOG OF TEST BORINGS 2 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 1200000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

FILE => $REQUEST

CONTRACT NO.: 12-0C5701 PROJECT ID:

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
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BENCH MARK

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

S. PIRATHIVIRAJ No. C71862 EXP. 12/31/11 REGISTERED PROFESSIONAL ENGINEER CIVIL STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).
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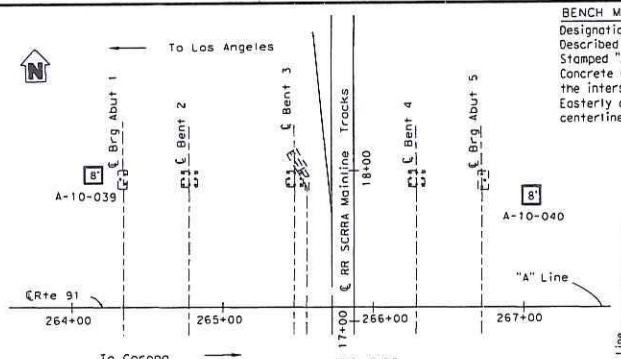
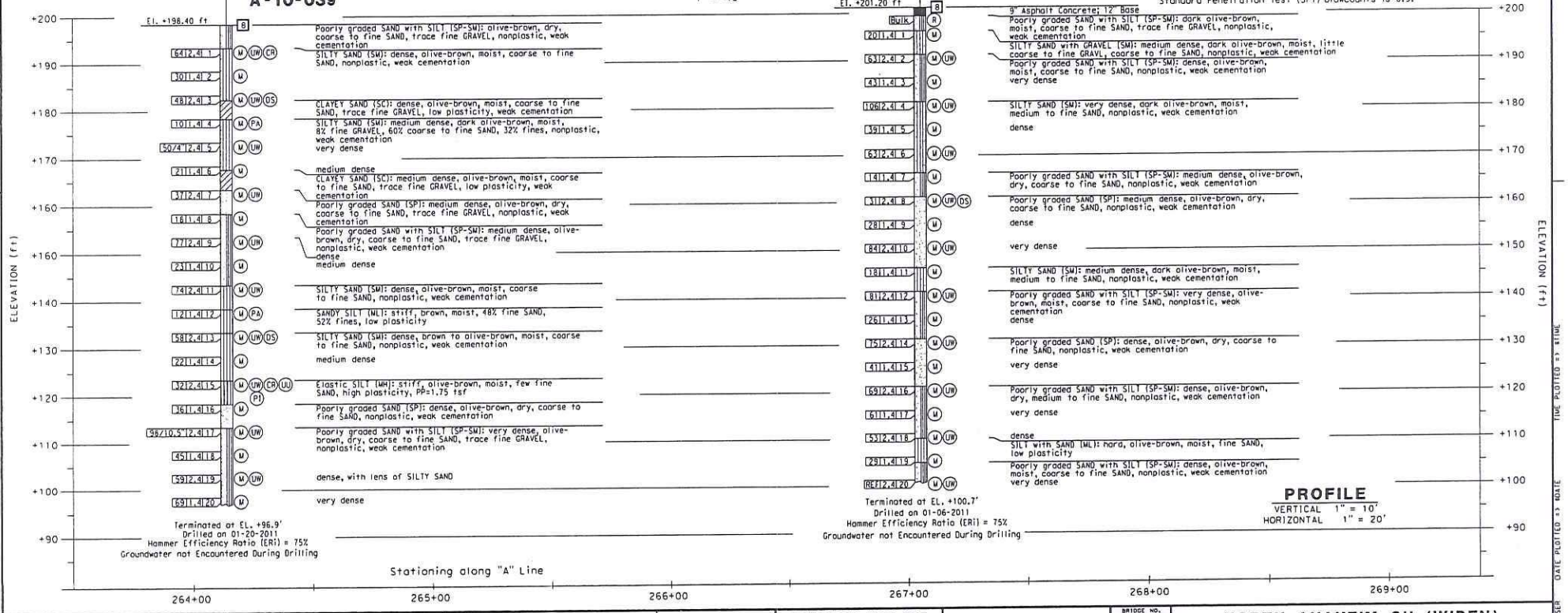
(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.



PLAN
1" = 40'



PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. 55-0216	NORTH ANAHEIM OH (WIDEN)
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011		PROJECT ENGINEER	POST MILES 4.0	LOG OF TEST BORINGS 1 OF 1
GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/18/10)			ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3		UNIT: 2295 PROJECT NUMBER & PHASE: 1200000791	DISREGARD PRINTS BEARING EARLIER REVISION DATES →	REVISION DATES SHEET OF
				FILE => $REQUEST		CONTRACT NO.: 12-0C5701	PROJECT ID:

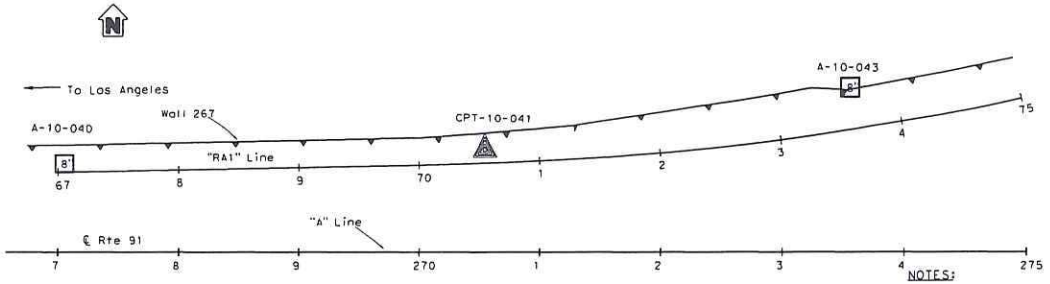
DATE PLOTTED => $DATE TIME PLOTTED => $TIME USERNAME => $USER

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Wagnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Wagnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

B. PIRATHIVIRAJ NO. C71862 EXP. 12/31/11 REGISTERED PROFESSIONAL ENGINEER CIVIL STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).

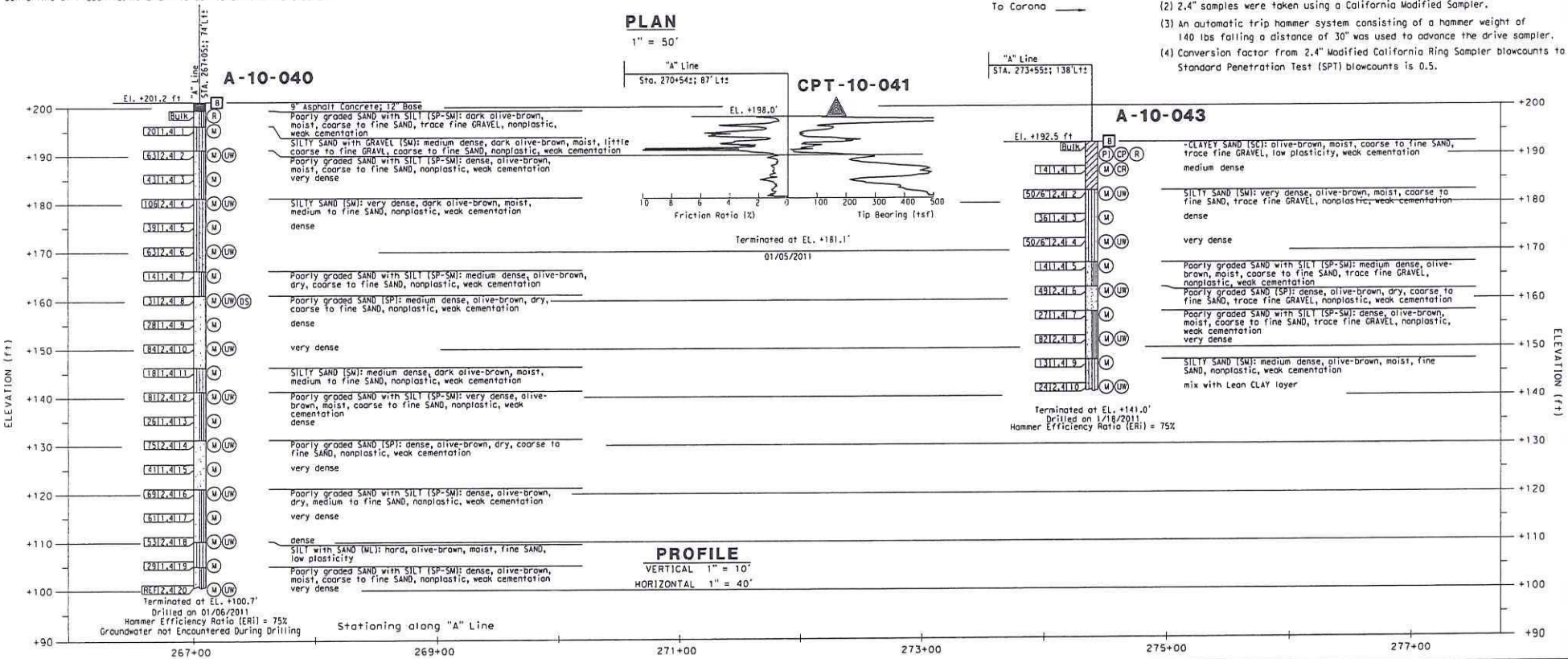
(2) 2.4" samples were taken using a California Modified Sampler.

(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.

PLAN

1" = 50'



PROFILE

VERTICAL 1" = 10'
HORIZONTAL 1" = 40'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. -	WALL 267
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 1/24/2011			POST MILES -	LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

FILE => $REQUEST

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

CONTRACT NO.: 12-0C5701 PROJECT ID:

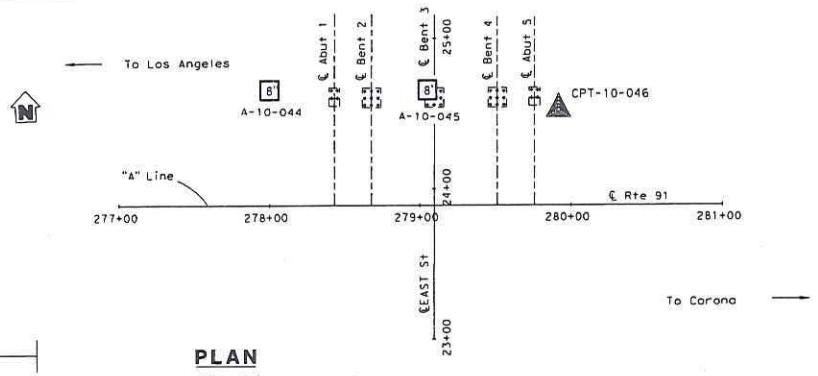
USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 20-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "20-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

R. PIRATHIVIRAJ NO. C71802 EXP. 12/31/11 CIVIL STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).

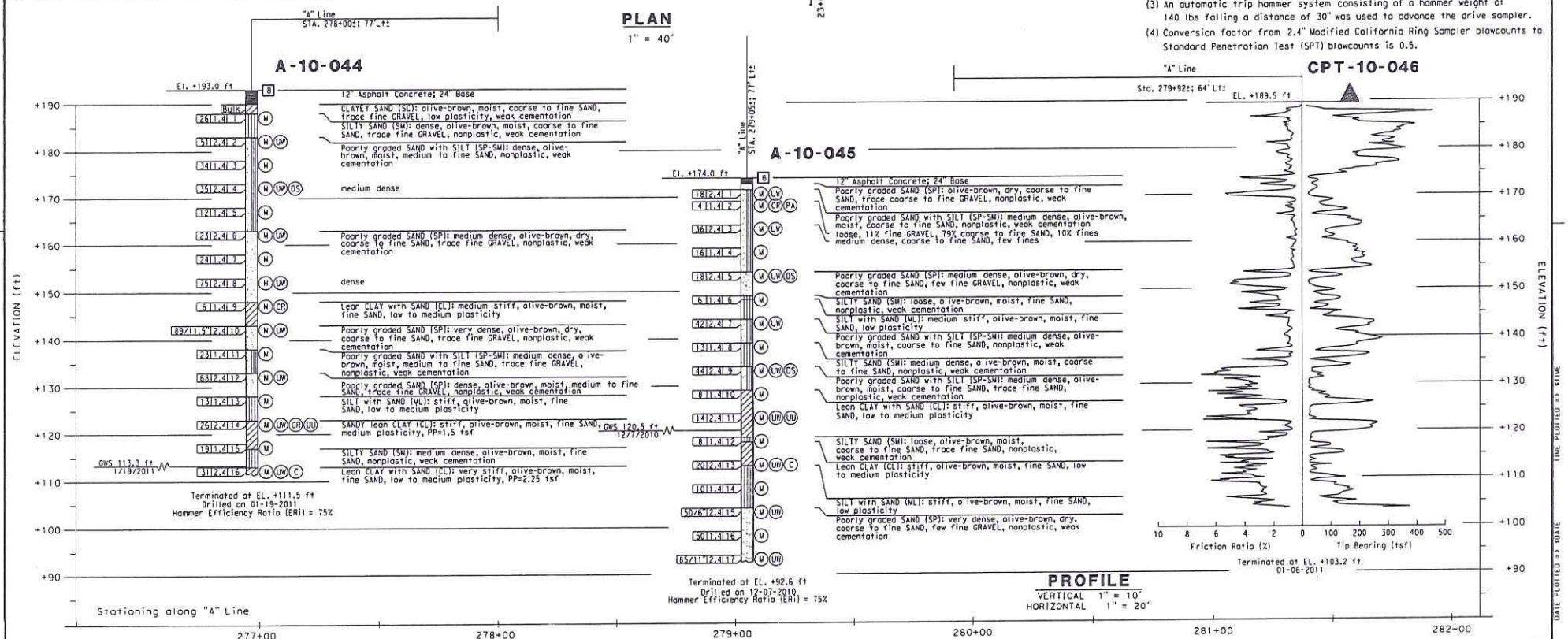
(2) 2.4" samples were taken using a California Modified Sampler.

(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.

PLAN

1" = 40'



PROFILE

VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. 55-0245	EAST STREET UC (WIDEN)
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 12/2010, 1/2011		PROJECT ENGINEER	POST MILES 4.3	LOG OF TEST BORINGS 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295 PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

CONTRACT NO.: 12-0C5701 PROJECT ID:

FILE => $REQUEST

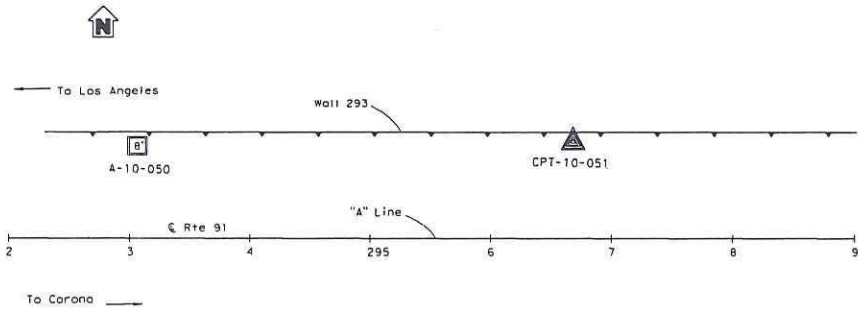
USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

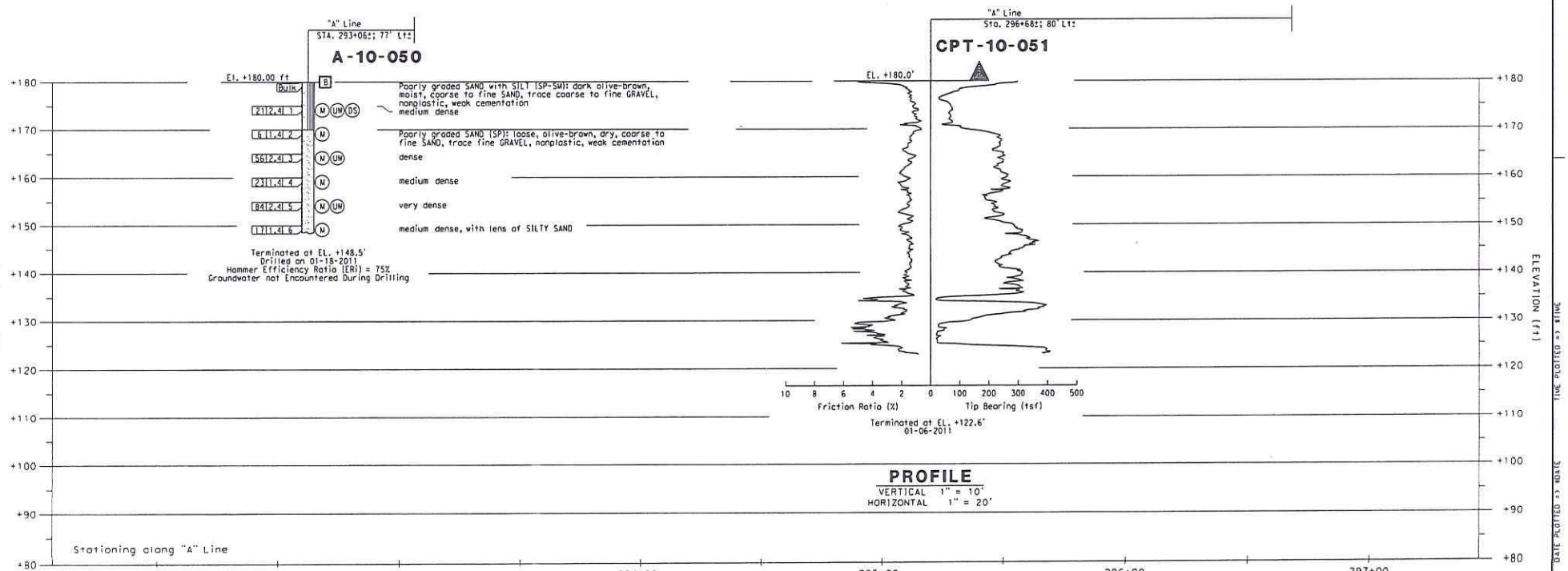
REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71682 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).
(2) 2.4" samples were taken using a California Modified Sampler.
(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.
(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.



PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fong	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. -	WALL 293
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/2011			POST MILES -	LOG OF TEST BORINGS 1 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

CONTRACT NO.: 12-0C5701 PROJECT ID:

FILE => $REQUEST

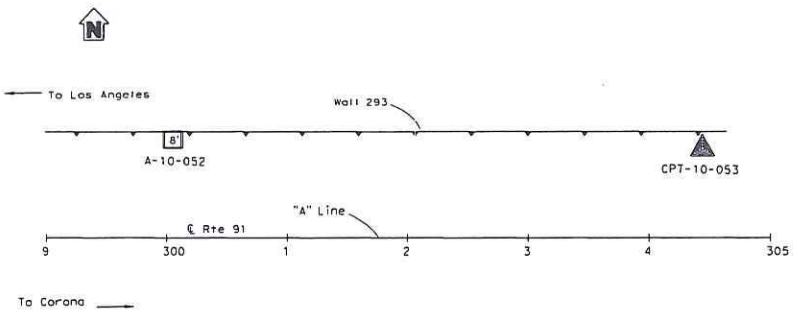
USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

S. PIRATHIVIRAJ NO. C71082 EXP: 12/31/11 REGISTERED PROFESSIONAL ENGINEER CIVIL STATE OF CALIFORNIA

PLANS APPROVAL DATE

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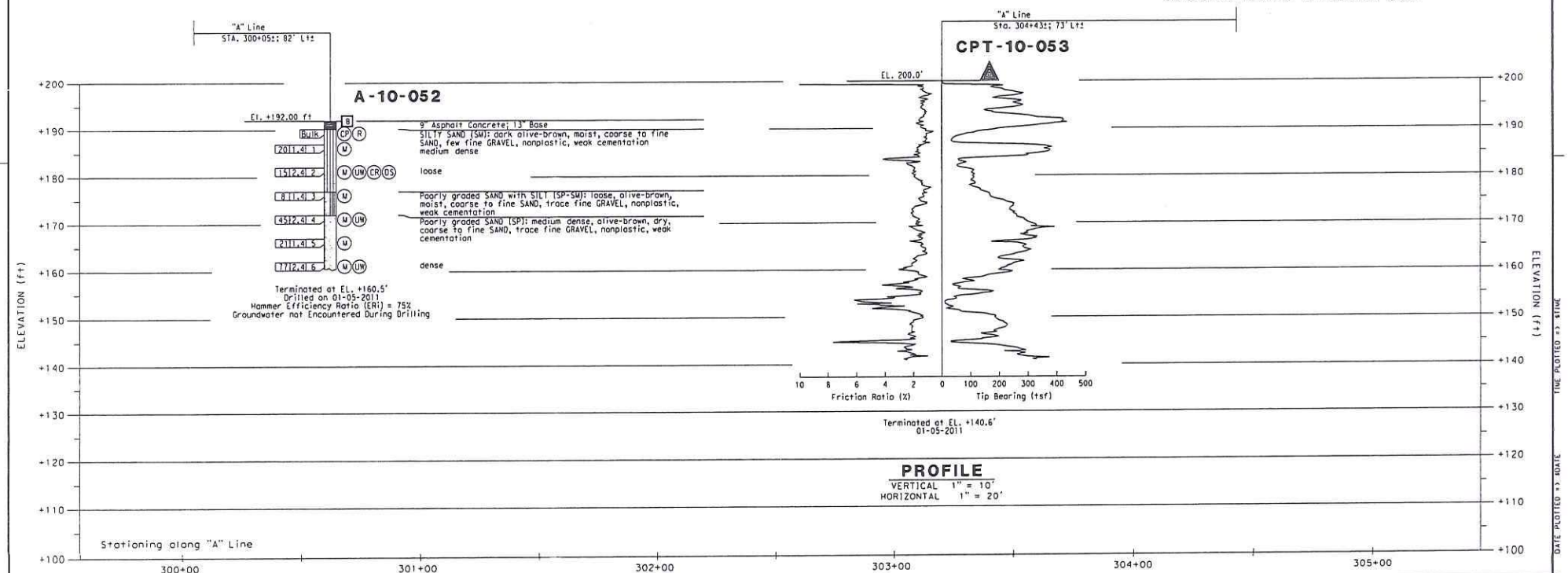
ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).
(2) 2.4" samples were taken using a California Modified Sampler.
(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.
(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.



PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -	WALL 293
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/2011		PROJECT ENGINEER	POST MILES -	LOG OF TEST BORINGS 2 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/18/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

CONTRACT NO.: 12-0C5701 PROJECT ID:

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 20-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "20-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

S. PIRATHIVIRAJ NO. C71652 EXP. 12/31/11 REGISTERED PROFESSIONAL ENGINEER CIVIL STATE OF CALIFORNIA

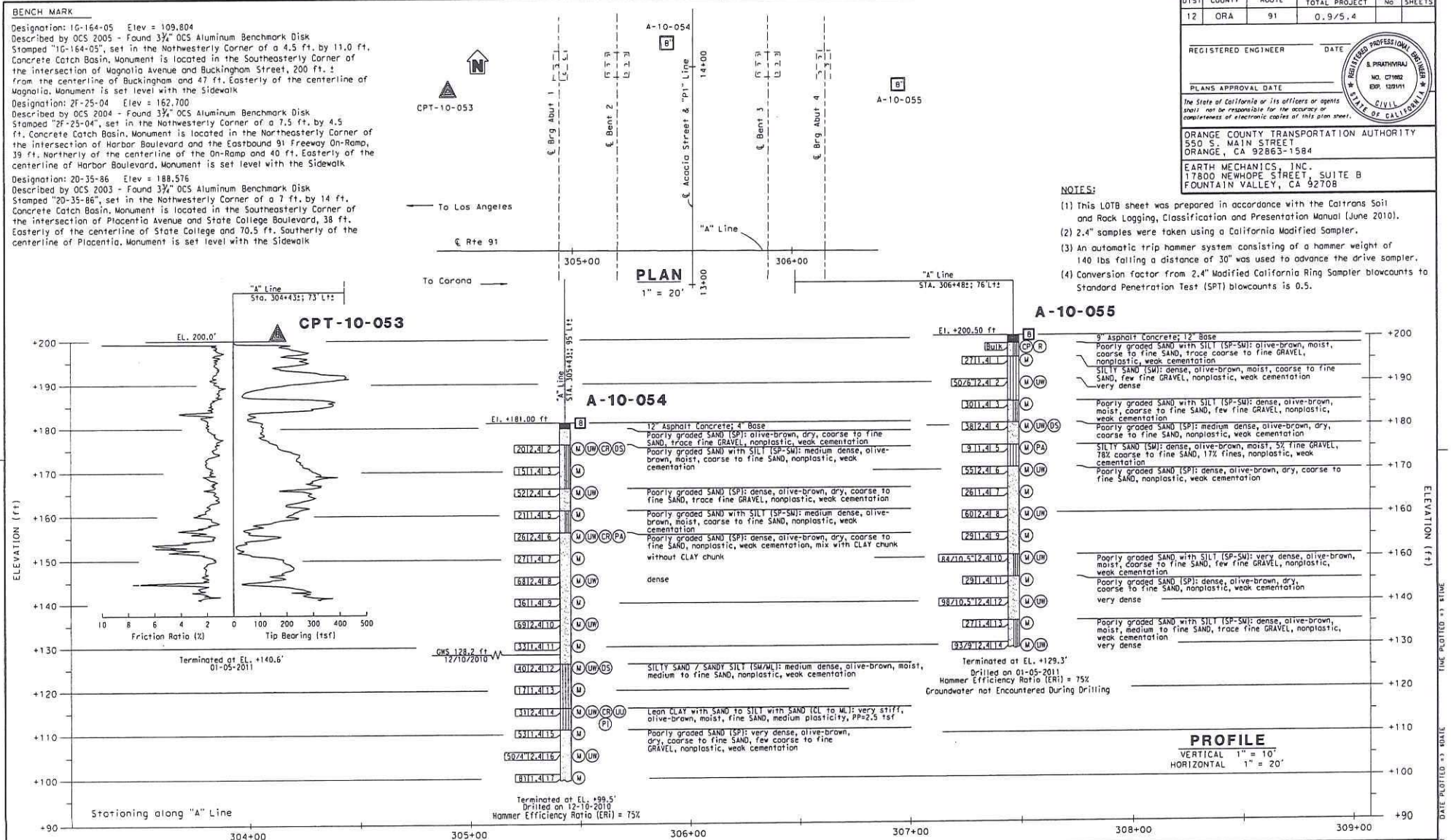
The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).
(2) 2.4" samples were taken using a California Modified Sampler.
(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.
(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.



DESIGN OVERSIGHT	DRAWN BY	J. Fang	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	BRIDGE NO.	ACACIA STREET UC (WIDEN)
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	R. Jie FIELD INVESTIGATION BY: DATE: 12/2010,1/2011	S. Pirathiviraj PROJECT ENGINEER	55-0218
				POST MILES	4.8
				UNIT: 2295 PROJECT NUMBER & PHASE: 12000000791	LOG OF TEST BORINGS 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

FILE => $REQUEST

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

CONTRACT NO.: 12-0C5701 PROJECT ID:

SHEET OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER — DATE

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

S. PIRATHIVIRAJ — No. C71882 — EXP. 12/31/11 — CIVIL — REGISTERED PROFESSIONAL ENGINEER — STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

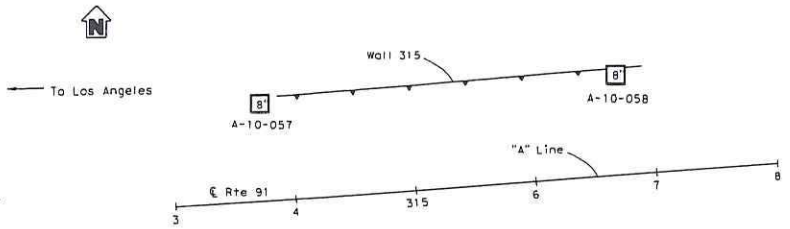
EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).

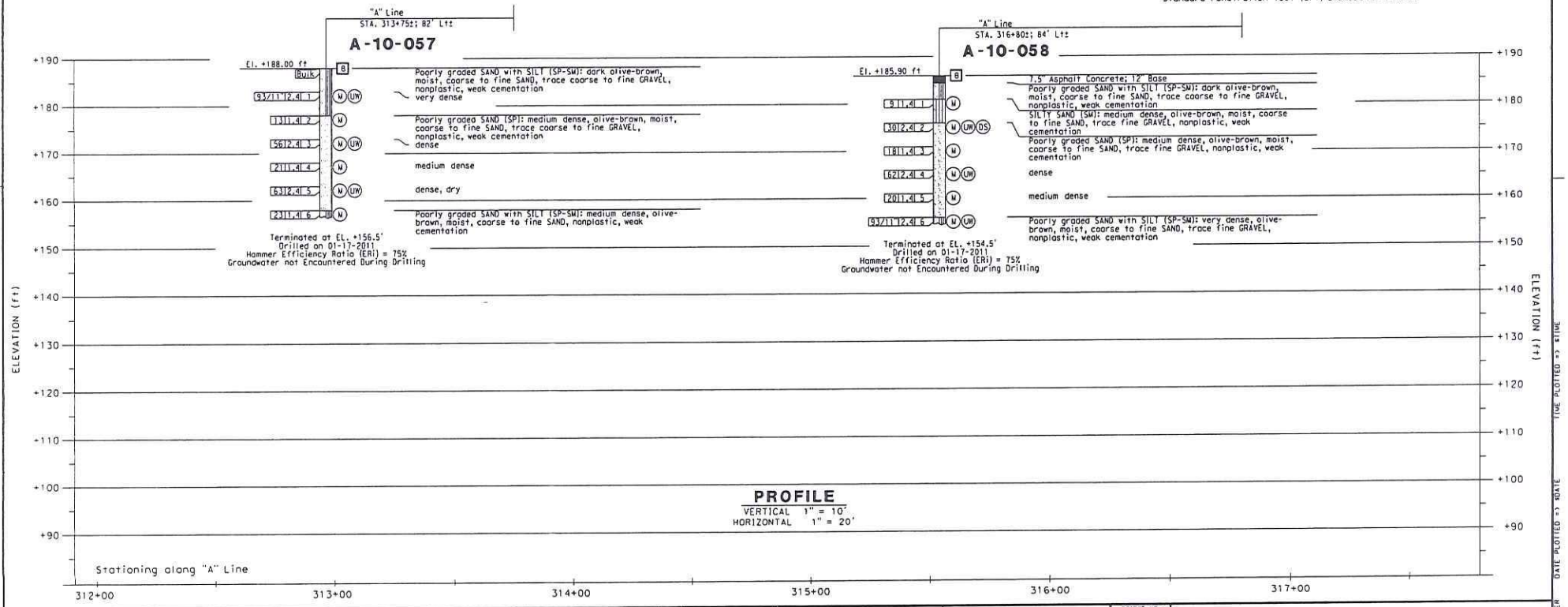
(2) 2.4" samples were taken using a California Modified Sampler.

(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.

PLAN

1" = 50'



PROFILE

VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. -	WALL 315
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/2011			POST MILES -	LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

FILE => $REQUEST

CONTRACT NO.: 12-0C5701 PROJECT ID:

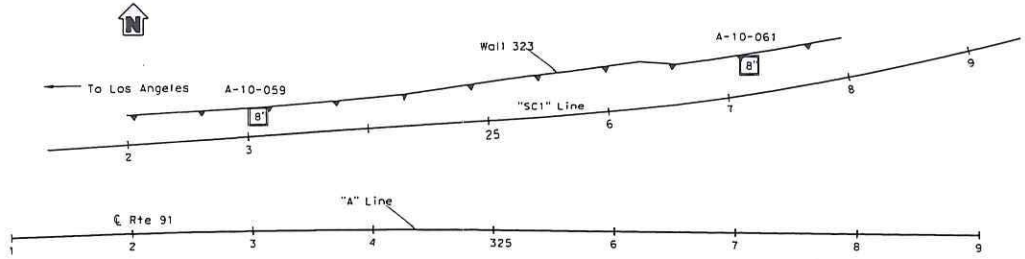
USERNAME => %USER% DATE PLOTTED => %DATE% TIME PLOTTED => %TIME%

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

S. PIRATHIVIRAJ No. C71892 EXP. 12/31/11 REGISTERED PROFESSIONAL ENGINEER CIVIL STATE OF CALIFORNIA

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

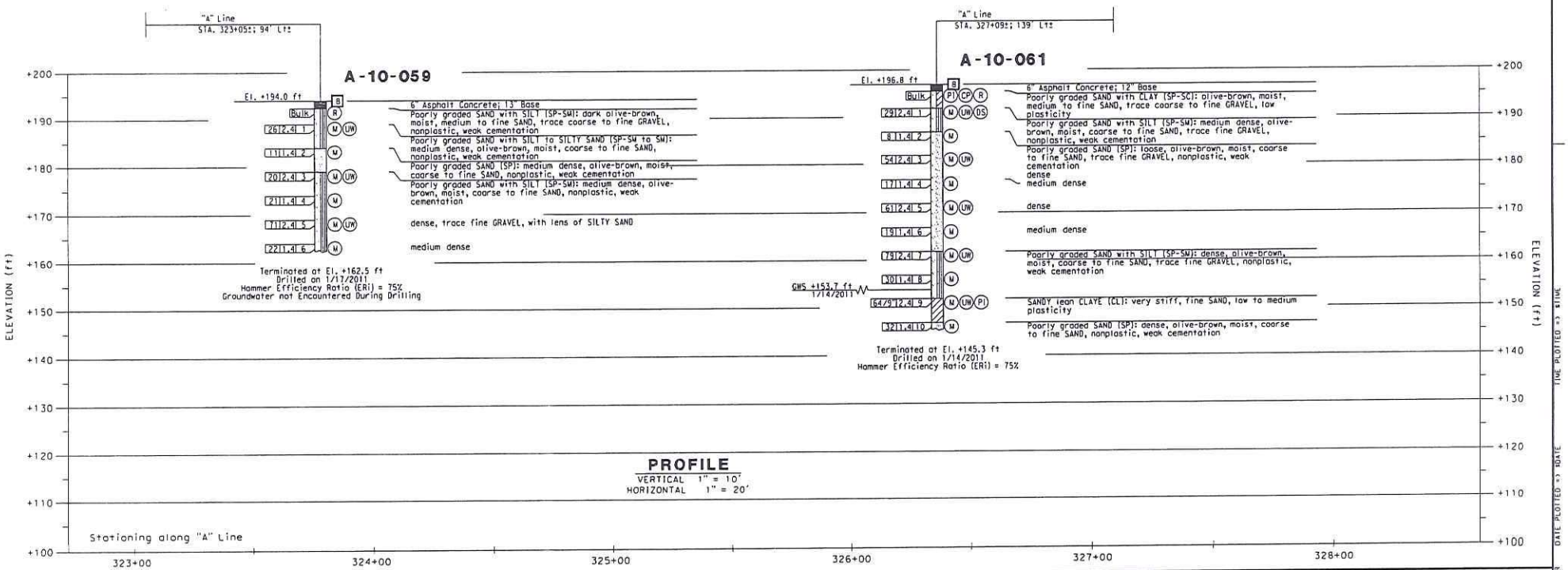
NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).

(2) 2.4" samples were taken using a California Modified Sampler.

(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.



PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -	WALL 323
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 1/14/2011,1/17/2011		PROJECT ENGINEER	POST MILES -	LOG OF TEST BORING 1 OF 1

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

SHEET OF

CONTRACT NO.: 12-0C5701 PROJECT ID:

FILE => $REQUEST

DS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/19/10)

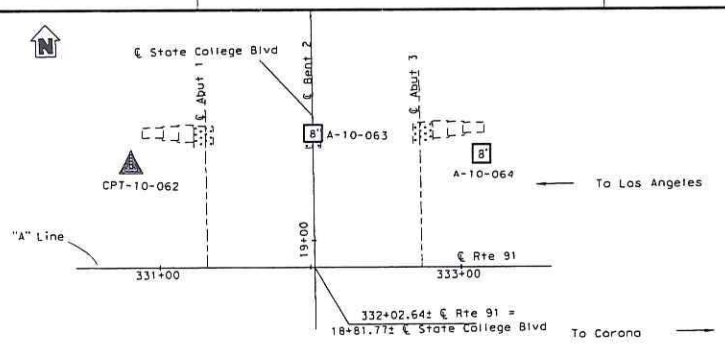
USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER * S. PRATHIVIRAJ * NO. C71652 EXP. 12/31/11 CIVIL STATE OF CALIFORNIA

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).

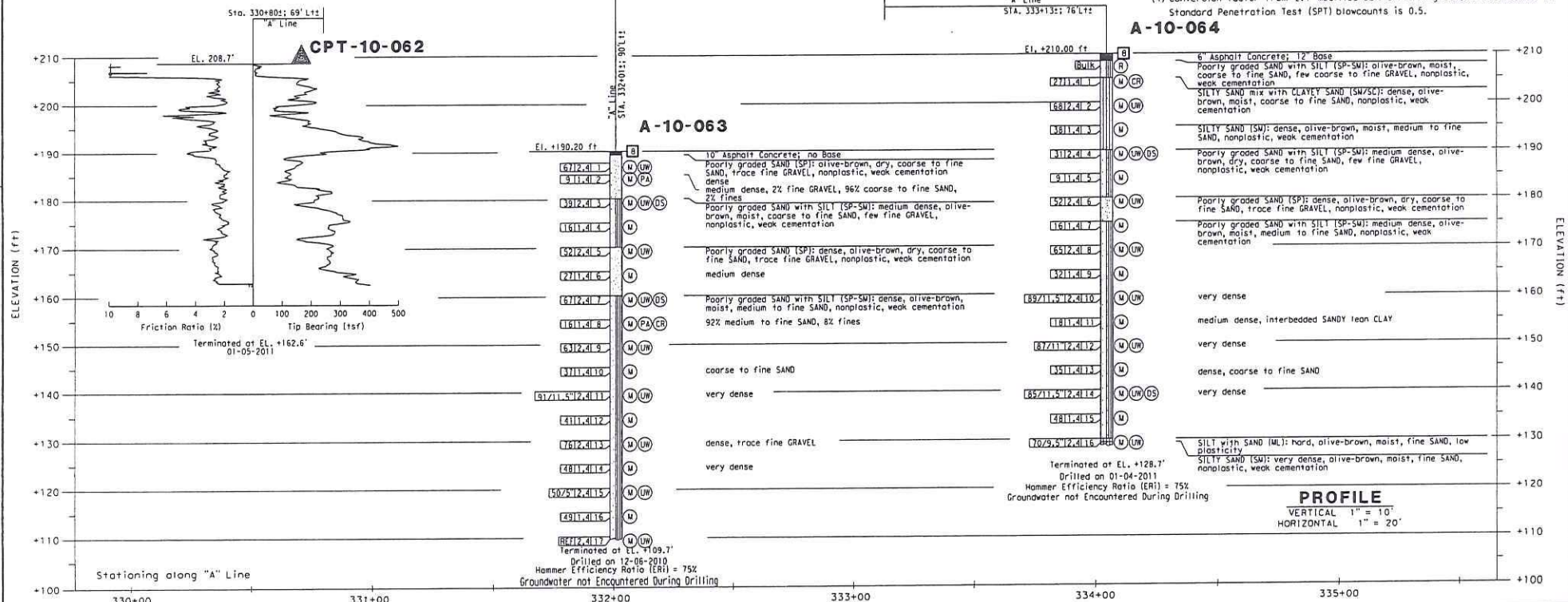
(2) 2.4" samples were taken using a California Modified Sampler.

(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.

PLAN

1" = 40'



PROFILE

VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Prathiviraj	BRIDGE NO. 55-0852	STATE COLLEGE BOULEVARD UC (WIDEN)
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 12/2010, 1/2011		PROJECT ENGINEER	POST MILES 5.3	LOG OF TEST BORINGS 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/18/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

CONTRACT NO.: 12-0C5701 PROJECT ID:

FILE => $REQUEST

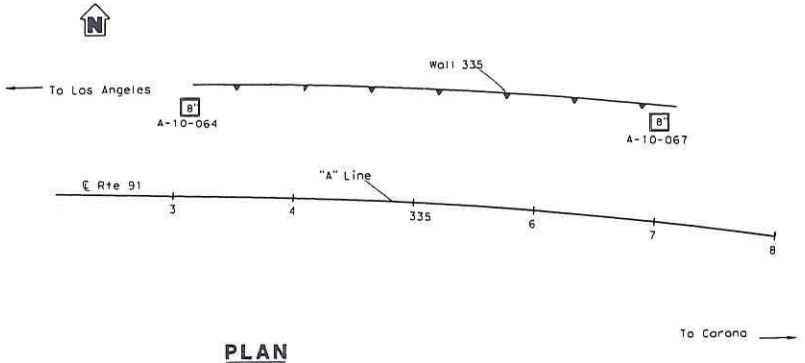
USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nathwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nathwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nathwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER
B. PIRATHIVIRAJ
NO. C71682
EXP. 12/31/11
CIVIL
STATE OF CALIFORNIA

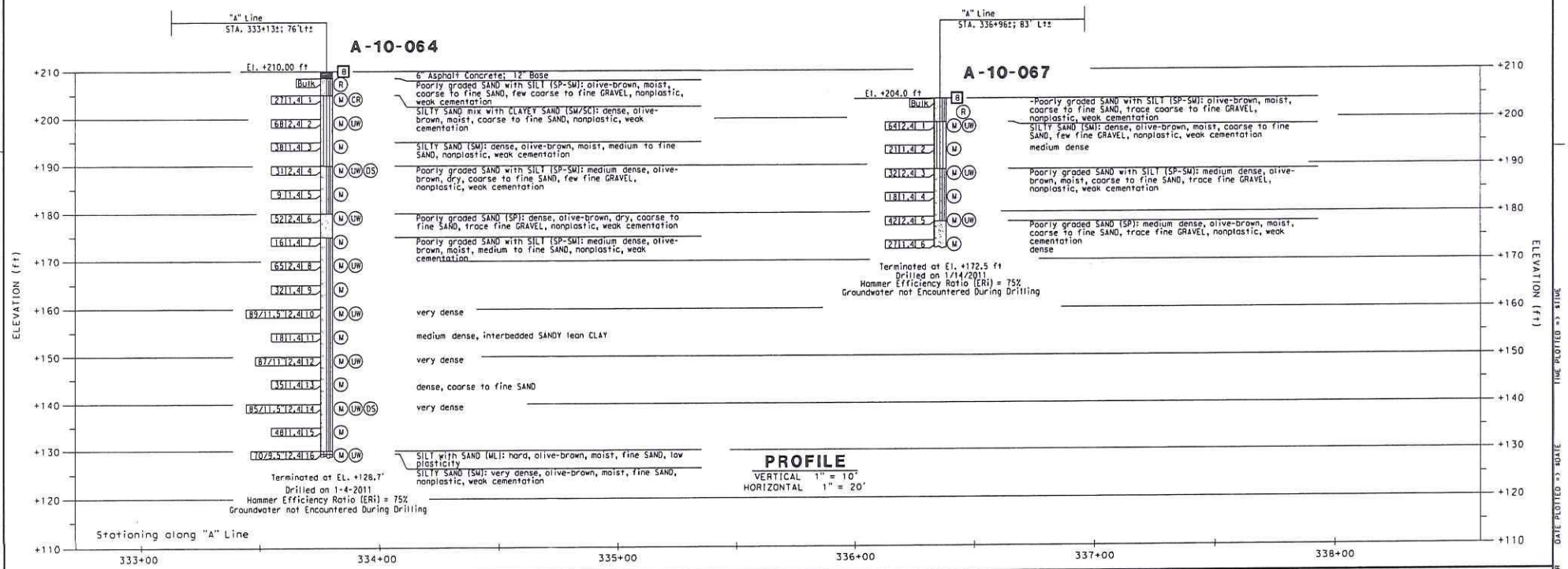
The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).
(2) 2.4" samples were taken using a California Modified Sampler.
(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.
(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.



PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie FIELD INVESTIGATION BY	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. -	WALL 335
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	DATE: 1/14/2011,1/4/2011			POST MILES -	LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/18/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

CONTRACT NO.:12-0C5701 PROJECT ID:

FILE => $REQUEST

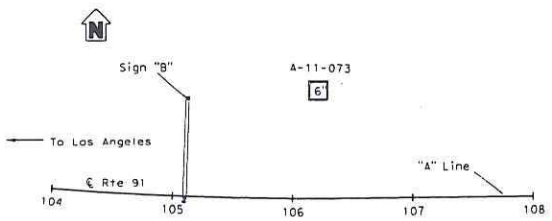
USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

REGISTERED PROFESSIONAL ENGINEER * S. PIRATHIVIRAJ NO. C71662 EXP. 12/31/13 CIVIL * STATE OF CALIFORNIA *

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

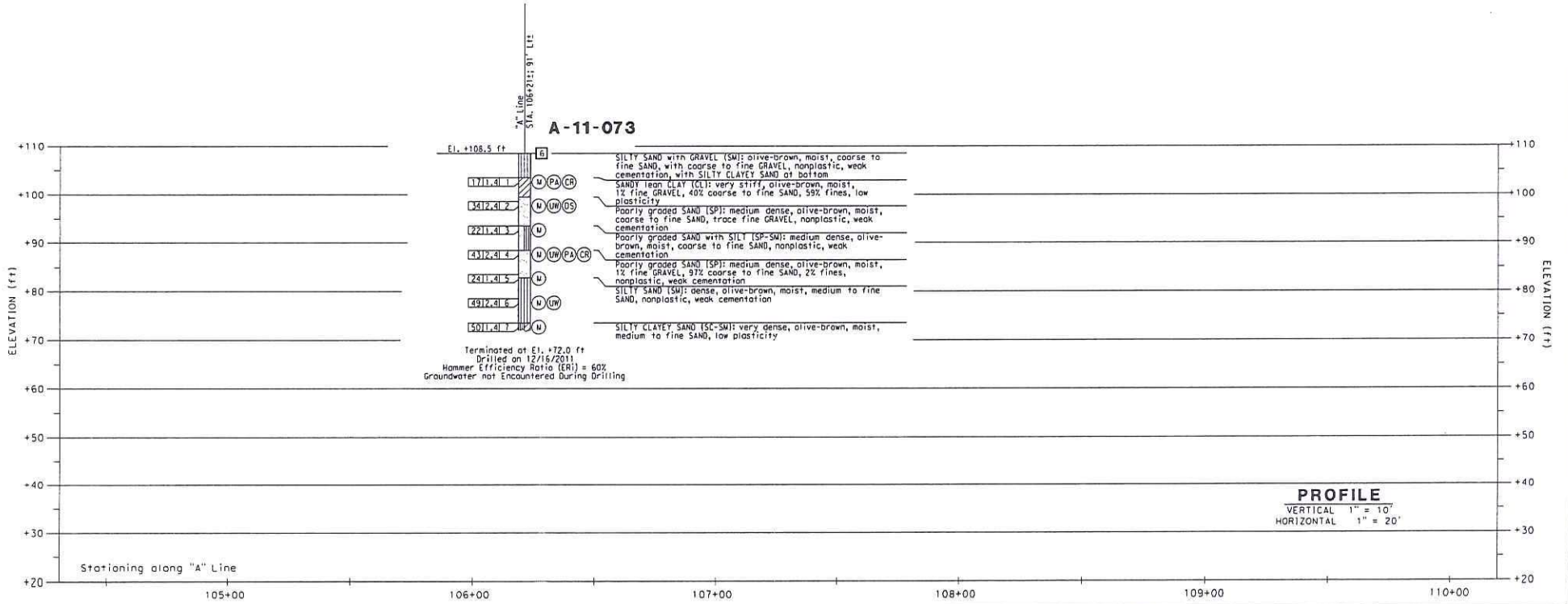
(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).

(2) 2.4" samples were taken using a California Modified Sampler.

(3) A rope hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

PLAN

1" = 50'



PROFILE

VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -	OVERHEAD SIGN STRUCTURES
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 12/16/2011		PROJECT ENGINEER	POST MILES -	LOG OF TEST BORINGS 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/18/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 1200000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

CONTRACT NO.: 12-0C5701 PROJECT ID:

FILE => $REQUEST

USERNAME => $USER$ DATE PLOTTED => $DATE$ TIME PLOTTED => $TIME

Appendix B

LABORATORY TEST RESULTS

TABLE B-1 SUMMARY OF LABORATORY TEST RESULTS

Project No. : *10-126* Project Name : SR-91 WB Widening

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/ D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-002	*B-0*	1.5~5	SC							27/18/9				
A-10-002	*S-1*	2.5	SC	15.4							3200	7.9	70	95
A-10-002	*D-2*	5	SC	17.8	128.8			0:51:49						
A-10-002	*S-3*	10	SP	5.5										
A-10-002	*D-4*	15	SC	7.1	132.1									
A-10-002	*S-5*	20	SM	17.4										
A-10-002	*D-6*	25	ML	19.3	125.5	3.5								
A-10-002	*S-7*	30	SM	13.1										
A-10-003	*S-1*	5	SC	12.0				5:66:29			5700	8.5	80	97
A-10-003	*D-2*	10	SP-SM	2.6	106.5									
A-10-003	*S-3*	15	SM	8.5										
A-10-003	*D-4*	20	SM	6.5	124.6									
A-10-003	*S-5*	25	SM	14.8										
A-10-003	*D-6*	30	SM	7.9	115.2									
A-10-005	*B-0*	1.5~5	SC							24/17/7	2000	8.6	130	149
A-10-005	*D-1*	5	ML	16.3	129.9	4.5								
A-10-005	*S-2*	10	ML	20.7				2:24:74						
A-10-005	*D-3*	15	SM	7.2	132.9									
A-10-005	*S-4*	20	ML	22.5				0:40:60						
A-10-005	*D-5*	25	SM	13.4	130.2									
A-10-005	*S-6*	30	SM	18.6										
A-10-005	*D-7*	35	SM/ML	19.4	126.0									
A-10-005	*S-8*	40	SM/ML	21.2										
A-10-005	*D-9*	45	SM	24.6	121.6									
A-10-005	*S-10*	50	SM	20.5										
A-10-006	*B-0*	2~5	SC to SM							26/20/6				
A-10-006	*S-1*	5	SC	15.3				2:51:47			2600	8.5	10	83
A-10-006	*D-2*	10	SM	11.7	134.0									
A-10-006	*S-3*	15	SM	12.9										
A-10-006	*D-4*	20	SM	8.3	122.8									
A-10-006	*S-5*	25	ML	15.3										
A-10-006	*D-6*	30	SM	6.1	129.3									
A-10-006	*S-7*	35	SM to ML	28.9										
A-10-006	*D-8*	40	ML	15.3	130.3			0:45:55						
A-10-006	*S-9*	45	SP-SM	4.0										
A-10-006	*D-10*	50	SM	23.5	119.9									
A-10-006	*S-11*	55	SM	22.5										
A-10-006	*D-12*	60	ML	34.1	123.1	1.25								
A-10-006	*S-13*	65	SM to CL	22.9										
A-10-006	*D-14*	70	ML	32.0	120.7	2.5								

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-006	S-15	75	SM/ML	19.7										
A-10-006	D-16	80	SP	14.6	137.2									
A-10-006	S-17	85	SP-SM to ML	15.4										
A-10-007	S-1	2.5	SP to SM	11.1										
A-10-007	D-2	5	CL	18.6	125.4	3.75								
A-10-007	S-3	10	ML to SM	10.9										
A-10-007	D-4	15	ML	18.6	118.5	4.5		0:25:75						
A-10-007	S-5	20	ML	5.9										
A-10-007	D-6	25	ML	19.9	126.7	2.0								
A-10-007	S-7	30	ML	15.0										
A-10-007	D-8	35	SM	12.1	126.8									
A-10-007	S-9	40	SM	22.3										
A-10-007	D-10	45	ML	26.7	129.7	3.5								
A-10-007	S-11	50	SM	19.0										
A-10-007	D-12	55	ML	27.1	115.1	2.0								
A-10-007	S-13	60	SP-SM	21.1										
A-10-007	D-14	65	CL	30.2	121.2	1.5								
A-10-007	S-15	70	SM	29.4										
A-10-007	D-16	75	ML	22.8	124.5	3.25								
A-10-007	S-17	80	ML	29.2										
A-10-008	S-1	5	SM	10.3										
A-10-008	D-2	10	SM	10.5	127.0									
A-10-008	S-3	15	SM	10.4										
A-10-008	D-4	20	SM	11.1	131.0									
A-10-008	S-5	25	SM	17.7										
A-10-008	D-6	30	SM	8.1	125.8									
A-10-008	S-7	35	SM	15.9										
A-10-008	D-8	40	SM	18.5	131.6			0:53:47		20/17/3				
A-10-008	S-9	45	ML	16.0							2200	8.0	60	161
A-10-008	D-10	50	SM	9.7	115.1									
A-10-008	S-11	55	SM	21.9										
A-10-008	D-12	60	ML	25.0	123.6	1.25								
A-10-008	S-13	65	SM	24.1				0:72:28						
A-10-008	D-14	70	ML	26.5	119.6	4.5								
A-10-008	S-15	75	SP-SM	23.0										
A-10-008	D-16	80	SP	17.4	132.6									
A-10-012	S-1	5	SM	11.6										
A-10-012	D-2	10	SM	11.2	121.7									
A-10-012	S-3	15	SM	9.9										
A-10-012	D-4	20	SP-SM	5.4	113.5									
A-10-012	S-5	25	ML	20.4										
A-10-012	D-6	30	SP-SM	2.3	106.1									

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
HA-10-013	*B-0*	2	CL							37/17/20	860	6.9	110	124
HA-10-015	*B-0*	0-3	SM							24/19/5	860	6.9	110	124
A-10-016	*S-1*	5	SM to SP-SM	9.5										
A-10-016	*D-2*	10	SM	8.5	123.2									
A-10-016	*S-3*	15	ML	15.2				0:47:53			2200	8.7	70	94
A-10-016	*D-4*	20	SM	16.5	132.4									
A-10-016	*S-5*	25	ML	29.5										
A-10-016	*D-6*	30	SM	9.7	117.9									
A-10-018	*S-1*	5	SM	17.8										
A-10-018	*D-2*	10	SM	15.8	127.1									
A-10-018	*S-3*	15	SM to CL	21.3					0.0					
A-10-018	*D-4*	20	SM	7.6	124.6									
A-10-018	*S-5*	25	SP to ML	6.5										
A-10-018	*D-6*	30	CL	23.2	117.4	1.75								
A-10-019	*D-1*	5	SM	10.1	124.9									
A-10-019	*S-2*	10	SM	14.8							2200	8.5	110	118
A-10-019	*D-3*	15	SM	16.8	125.7									
A-10-019	*S-4*	20	SM	12.3										
A-10-019	*D-5*	25	SP-SM	3.7	113.7									
A-10-019	*S-6*	30	SP-SM to CL	24.3										
A-10-020	*S-1*	5	SM	9.3										
A-10-020	*D-2*	10	SM	6.8	119.3									
A-10-020	*S-3*	15	SM	15.8										
A-10-020	*D-4*	20	SM	13.6	131.6									
A-10-020	*S-5*	25	SP	3.5										
A-10-020	*D-6*	30	SP	2.1	111.1									
A-10-021	*S-1*	2.5	SM	6.0										
A-10-021	*D-2*	5	SM	9.9	127.9									
A-10-021	*S-3*	10	SM	9.5										
A-10-021	*D-4*	15	SM	9.9	128.3									
A-10-021	*S-5*	20	SM	9.4				0:69:31						
A-10-021	*D-6*	25	ML	10.6	118.4	>4.5								
A-10-021	*S-7*	30	SM to ML	14.4										
A-10-023	*D-1*	2.5	SM	15.3	126.8									
A-10-023	*D-2*	5	SM	11.2	125.6			0:71:29						
A-10-023	*S-3*	10	SM	15.0										
A-10-023	*D-4*	15	SM	8.4	130.2									
A-10-023	*S-5*	20	SM	19.1										
A-10-023	*D-6*	25	SP	3.1	107.0									
A-10-023	*S-7*	30	ML	19.4				0:41:59						
A-10-023	*D-8*	35	SM	17.3	129.7									

Boring No .	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-023	*S-9*	40	SM to ML	6.6										
A-10-023	*D-10*	45	CL-ML	27.5	114.9	1.5								
A-10-023	*S-11*	50	SP	4.0										
A-10-023	*D-12*	55	ML	25.4	113.9	2.5								
A-10-023	*S-13*	60	SM	22.5										
A-10-023	*D-14*	65	SP-SM	4.7	110.7									
A-10-023	*S-15*	70	SP-SM	8.9										
A-10-023	*D-16*	75	SP	13.4	131.9									
A-10-023	*S-17*	80	CL-ML	22.9										
A-10-024	*S-1*	5	SM	8.3										
A-10-024	*D-2*	10	SP-SM	2.3	118.6									
A-10-024	*S-3*	15	SM	10.5										
A-10-024	*D-4*	20	SM	8.9	118.5									
A-10-024	*S-5*	25	SM	11.2							750	7.8	40	332
A-10-024	*D-6*	30	SM	6.4	113.1									
A-10-024	*S-7*	35	SM	13.1										
A-10-024	*D-8*	40	SM	11.1	128.3									
A-10-024	*S-9*	45	SM	12.2										
A-10-024	*D-10*	50	ML	17.7	126.6			0:35:65						
A-10-024	*S-11*	55	ML to SM	22.6										
A-10-024	*D-12*	60	SM	26.5	120.0									
A-10-024	*S-13*	65	SP-SM	6.5										
A-10-024	*D-14*	70	SP-SM	14.5	125.9									
A-10-024	*S-15*	75	ML	26.5										
A-10-024	*D-16*	80	SP-SM	11.5	126.0									
A-10-024	*S-17*	85	SP	3.9										
A-10-029	*D-1*	5	SM	4.7	118.7									
A-10-029	*S-2*	10	SP-SM	3.4										
A-10-029	*D-3*	15	SM	10.0	129.7									
A-10-029	*S-4*	20	SM to ML	23.9							770	7.7	300	375
A-10-029	*D-5*	25	SM	11.1	128.7									
A-10-029	*S-6*	30	ML	16.8										
A-10-030	*S-1*	5	SM	10.1										
A-10-030	*D-2*	10	SM	9.1	126.5									
A-10-030	*S-3*	15	ML	22.1				0:23:77						
A-10-030	*D-4*	20	SM	12.4	129.0									
A-10-030	*S-5*	25	SM	10.0										
A-10-030	*D-6*	30	SM	6.7	128.2									
A-10-032	*S-1*	5	ML	11.9							3800	8.1	50	142
A-10-032	*D-2*	10	SM	3.6	106.4									
A-10-032	*S-3*	15	SM	8.0										

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-032	*D-4*	20	SM	11.2	133.3									
A-10-032	*S-5*	25	SP-SM	3.0										
A-10-032	*D-6*	30	SM	16.4	117.1									
A-10-033	*D-1*	5	SM	11.7	115.1									
A-10-033	*S-2*	10	SM	13.3										
A-10-033	*D-3*	15	ML	17.6	121.5			0:27:73						
A-10-033	*S-4*	20	SM	12.1										
A-10-033	*D-5*	25	SM	10.4	134.5									
A-10-033	*S-6*	30	SP to SM	13.7										
A-10-035	*D-1*	5	SM to SC	9.2	123.8									
A-10-035	*S-2*	10	CH	28.8						64/21/43	790	7.5	60	239
A-10-035	*D-3*	15	CH to SM	29.3	118.1	4.5								
A-10-035	*S-4*	20	SP-SM	1.2										
A-10-035	*D-5*	25	SP-SM	1.9	109.8									
A-10-035	*S-6*	30	SM	11.3										
A-10-036	*S-1*	5	SC	15.0										
A-10-036	*D-2*	10	SM	3.3	108.9									
A-10-036	*S-3*	15	SP-SM	2.1										
A-10-036	*D-4*	20	SP-SM	2.5	118.0									
A-10-036	*S-5*	25	SP-SM	7.1										
A-10-036	*D-6*	30	SM	9.5	129.4									
A-10-036	*S-7*	35	SM	7.2										
A-10-036	*D-8*	40	SM	17.9	130.0									
A-10-036	*S-9*	45	SP-SM	4.3										
A-10-036	*D-10*	50	ML to SM	16.1	125.9									
A-10-037	*B-0*	0~3	CL							33/14/19	1200	7.2	10	114
A-10-037	*D-1*	5	SP-SM	8.9	129.2									
A-10-037	*S-2*	10	SM	9.2										
A-10-037	*D-3*	15	SM	3.3	113.6									
A-10-037	*S-4*	20	SP	1.8				1:97:2						
A-10-037	*D-5*	25	SM	2.2	126.1									
A-10-037	*S-6*	30	SP-SM	1.1										
A-10-038	*S-1*	5	SC	12.8										
A-10-038	*D-2*	10	SM	12.9	128.1									
A-10-038	*S-3*	15	SM	6.6										
A-10-038	*D-4*	20	SP-SM	3.3	115.3									
A-10-038	*S-5*	25	SP-SM	4.3										
A-10-038	*D-6*	30	SP	1.6	111.1									
A-10-039	*D-1*	5	SM	8.3	139.2						4800	8.0	120	191
A-10-039	*S-2*	10	SM	16.4										
A-10-039	*D-3*	15	SP-SM to SC	10.9	136.0									

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-039	*S-4*	20	SM	13.1				8:60:32						
A-10-039	*D-5*	25	SM	3.1	115.0									
A-10-039	*S-6*	30	SM to SC	3.4										
A-10-039	*D-7*	35	SP	0.8	110.7									
A-10-039	*S-8*	40	SP-SM	3.6										
A-10-039	*D-9*	45	SP-SM	4.1	113.1									
A-10-039	*S-10*	50	SP-SM	6.3										
A-10-039	*D-11*	55	SM	5.6	113.6									
A-10-039	*S-12*	60	ML	15.1				0:48:52						
A-10-039	*D-13*	65	SM	10.5	134.4									
A-10-039	*S-14*	70	SM	12.3										
A-10-039	*D-15*	75	MH	28.7	120.9	1.75				67/34/33	760	7.9	40	253
A-10-039	*S-16*	80	SP	3.6										
A-10-039	*D-17*	85	SP-SM	2.3	114.5									
A-10-039	*S-18*	90	SP-SM	3.5										
A-10-039	*D-19*	85	SM to SP-SM	8.8	130.9									
A-10-039	*S-20*	100	SP-SM	3.5										
A-10-040	*S-1*	5	SM	8.3										
A-10-040	*D-2*	10	SP-SM	4.6	115.6									
A-10-040	*S-3*	15	SP-SM	4.4										
A-10-040	*D-4*	20	SM	8.4	130.1									
A-10-040	*S-5*	25	SM	7.8										
A-10-040	*D-6*	30	SM	11.7	134.4									
A-10-040	*S-7*	35	SP-SM	4.5										
A-10-040	*D-8*	40	SP	3.1	106.7									
A-10-040	*S-9*	45	SP	2.5										
A-10-040	*D-10*	50	SP	2.0	105.2									
A-10-040	*S-11*	55	SM	16.5										
A-10-040	*D-12*	60	SP-SM	1.9	107.2									
A-10-040	*S-13*	65	SP-SM	6.0										
A-10-040	*D-14*	70	SP	2.1	110.5									
A-10-040	*S-15*	75	SP	3.1										
A-10-040	*D-16*	80	SM to SP-SM	2.9	116.6									
A-10-040	*S-17*	85	SP-SM	5.1										
A-10-040	*D-18*	90	SP-SM to ML	15.9	124.6									
A-10-040	*S-19*	95	ML to SP-SM	19.3										
A-10-040	*D-20*	100	SP-SM	4.9	106.6									
A-10-043	*B-0*	0-5	SC							36/24/12	2400	7.9	60	142
A-10-043	*S-1*	5	SC	15.7							2400	7.9	60	142
A-10-043	*D-2*	10	SM	7.4	137.7									
A-10-043	*S-3*	15	SM	3.9										

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-043	*D-4*	20	SM	3.8	121.5									
A-10-043	*S-5*	25	SP-SM	3.5										
A-10-043	*D-6*	30	SP	2.3	112.1									
A-10-043	*S-7*	35	SP-SM	4.5										
A-10-043	*D-8*	40	SP-SM	4.6	110.8									
A-10-043	*S-9*	45	SM	17.2										
A-10-043	*S-10*	50	CL	18.8										
A-10-044	*B-0*	3~5	SC							31/19/12	1100	7.6	600	109
A-10-044	*S-1*	5	SM	11.6										
A-10-044	*D-2*	10	SP-SM	6.1	131.8									
A-10-044	*S-3*	15	SP-SM	6.8										
A-10-044	*D-4*	20	SP-SM	2.0	109.3									
A-10-044	*S-5*	25	SP-SM	2.1										
A-10-044	*D-6*	30	SP	1.1	104.4									
A-10-044	*S-7*	35	SP	4.2										
A-10-044	*D-8*	40	SP	1.7	111.1									
A-10-044	*S-9*	45	CL	30.0						36/22/14	760	7.6	130	322
A-10-044	*D-10*	50	SP	3.1	110.9									
A-10-044	*S-11*	55	SP-SM	5.0										
A-10-044	*D-12*	60	SP	3.6	117.6									
A-10-044	*S-13*	65	ML	31.0										
A-10-044	*D-14*	70	CL	19.6	126.7	1.5					810	7.8	70	255
A-10-044	*S-15*	75	CL to SM	23.6										
A-10-044	*D-16*	80	CL	34.1	119.2	2.25								
A-10-045	*D-1*	5	SP-SM	3.0	109.3									
A-10-045	*S-2*	10	SP-SM	5.3				11:79:10			17000	8.0	60	153
A-10-045	*D-3*	15	SP-SM	1.9	109.2									
A-10-045	*S-4*	15	SP-SM	4.8										
A-10-045	*D-5*	20	SP	1.8	103.2									
A-10-045	*S-6*	25	SM to ML	33.9										
A-10-045	*D-7*	30	SP-SM	17.0	115.7									
A-10-045	*S-8*	35	SM	12.5										
A-10-045	*D-9*	40	SP-SM	5.7	111.3									
A-10-045	*S-10*	45	CL	29.7										
A-10-045	*D-11*	50	CL	29.8	121.1									
A-10-045	*S-12*	55	SM to CL	19.2										
A-10-045	*D-13*	60	CL	31.8	118.6									
A-10-045	*S-14*	65	ML	28.2										
A-10-045	*D-15*	70	SP	2.9	109.2									
A-10-045	*S-16*	75	SP	3.8										
A-10-045	*D-17*	80	SP	12.4	121.7									

Boring No .	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-049	*S-1*	5	SP	3.9										
A-10-049	*D-2*	10	SP	2.3	105.9									
A-10-049	*S-3*	15	SP	3.6										
A-10-049	*D-4*	20	SP	2.9	113.4									
A-10-049	*S-5*	25	SP	8.2										
A-10-049	*D-6*	30	ML	16.5	129.9	4.5		0:42:58						
A-10-050	*D-1*	5	SP-SM	5.7	107.9									
A-10-050	*S-2*	10	SP	3.4										
A-10-050	*D-3*	15	SP	2.4	113.9									
A-10-050	*S-4*	20	SP	3.7										
A-10-050	*D-5*	25	SP	3.3	116.3									
A-10-050	*S-6*	30	SM to SP	10.5										
A-10-052	*S-1*	5	SM	7.5										
A-10-052	*D-2*	10	SM	6.4	123.3						5400	7.8	100	139
A-10-052	*S-3*	15	SP-SM	5.5										
A-10-052	*D-4*	20	SP	2.8	107.8									
A-10-052	*S-5*	25	SP	3.3										
A-10-052	*D-6*	10	SP	2.3	115.0									
A-10-054	*D-2*	5	SP-SM	2.6	104.3						29000	7.7	60	108
A-10-054	*S-3*	10	SP-SM	4.2										
A-10-054	*D-4*	15	SP	1.9	111.4									
A-10-054	*S-5*	20	SP-SM	3.6										
A-10-054	*D-6*	25	SP/CL	12.8	126.4			0:71:29			3500	7.8	110	189
A-10-054	*S-7*	30	SP	1.8										
A-10-054	*D-8*	35	SP	1.6	106.0									
A-10-054	*S-9*	40	SP	4.7										
A-10-054	*D-10*	45	SP	2.5	109.1									
A-10-054	*S-11*	50	SP	6.0										
A-10-054	*D-12*	55	SM/ML	24.4	120.5									
A-10-054	*S-13*	60	SM	17.7										
A-10-054	*D-14*	65	ML	30.0	118.3	2.5				48/34/14	2100	7.2	70	293
A-10-054	*S-15*	70	SP	5.1										
A-10-054	*D-16*	75	SP	3.9										
A-10-054	*S-17*	80	SP	3.4	114.3									
A-10-055	*S-1*	5	SM	9.9										
A-10-055	*D-2*	10	SM	5.1	123.6									
A-10-055	*S-3*	15	SP-SM	2.5										
A-10-055	*D-4*	20	SP	2.2	113.4									
A-10-055	*S-5*	25	SM	6.4				5:78:17						
A-10-055	*D-6*	30	SP	2.4	105.9									
A-10-055	*S-7*	35	SP	2.3										

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-055	*D-8*	40	SP	2.6	109.8									
A-10-055	*S-9*	45	SP	4.1										
A-10-055	*D-10*	50	SP-SM	3.6	112.1									
A-10-055	*S-11*	55	SP	2.9										
A-10-055	*D-12*	60	SP	1.9	114.4									
A-10-055	*S-13*	65	SP-SM	6.4										
A-10-055	*D-14*	70	SP-SM	3.6	113.0									
A-10-056	*S-1*	5	SM	6.4										
A-10-056	*D-2*	10	SM	5.9	126.8									
A-10-056	*S-3*	15	SP-SM	3.6							11000	7.3	10	130
A-10-056	*D-4*	20	SP-SM	9.2	111.8									
A-10-056	*S-5*	25	SP	4.0										
A-10-056	*D-6*	30	SP	5.4	114.3									
A-10-057	*D-1*	5	SP-SM	6.3	126.1									
A-10-057	*S-2*	10	SP	3.6										
A-10-057	*D-3*	15	SP	6.6	111.4									
A-10-057	*S-4*	20	SP	4.9										
A-10-057	*D-5*	25	SP	7.8	121.6									
A-10-057	*S-6*	30	SP-SM	10.7										
A-10-058	*S-1*	5	SM	8.3										
A-10-058	*D-2*	10	SP	2.0	111.5									
A-10-058	*S-3*	15	SP	4.2										
A-10-058	*D-4*	20	SP	3.2	114.8									
A-10-058	*S-5*	25	SP	5.9										
A-10-058	*D-6*	30	SP-SM	4.5	129.9									
A-10-059	*D-1*	5	SP-SM to SM	1.5	115.1									
A-10-059	*S-2*	10	SP	1.9										
A-10-059	*D-3*	15	SP-SM	6.5	110.8									
A-10-059	*S-4*	20	SP	1.8										
A-10-059	*D-5*	25	SM to SP-SM	10.6	117.8									
A-10-059	*S-6*	30	SP-SM	3.9										
A-10-061	*B-0*	1.5~5	SP-SM							NP				
A-10-061	*D-1*	5	SP-SM	3.0	115.4									
A-10-061	*S-2*	10	SP	1.9										
A-10-061	*D-3*	15	SP	2.1	111.6									
A-10-061	*S-4*	20	SP	3.4										
A-10-061	*D-5*	25	SP	2.9	113.7									
A-10-061	*S-6*	30	SP	4.1										
A-10-061	*D-7*	35	SP-SM	4.0	112.8									
A-10-061	*S-8*	40	SP-SM	3.8										
A-10-061	*D-9*	45	CL	24.7	123.1	2.25				36/20/16				

Boring No .	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-061	*S-10*	50	SP	5.7										
A-10-063	*D-1*	2.5	SP-SM	2.6	114.9									
A-10-063	*S-2*	5	SP	1.7				2:96:2						
A-10-063	*D-3*	10	SP-SM	1.8	113.3									
A-10-063	*S-4*	15	SP-SM	2.6										
A-10-063	*D-5*	20	SP	3.4	108.1									
A-10-063	*S-6*	25	SP-SM	2.8										
A-10-063	*D-7*	30	SP-SM	4.8	112.4									
A-10-063	*S-8*	35	SP-SM	5.2				0:92:8			13000	7.8	10	158
A-10-063	*D-9*	40	SP-SM	2.6	109.4									
A-10-063	*S-10*	45	SP-SM	2.0										
A-10-063	*D-11*	50	SP-SM	2.7	117.4									
A-10-063	*S-12*	55	SP-SM	3.2										
A-10-063	*D-13*	60	SP-SM	1.8	115.7									
A-10-063	*S-14*	65	SP-SM	2.9										
A-10-063	*D-15*	70	SP-SM	3.1	103.7									
A-10-063	*S-16*	75	SP-SM	4.0										
A-10-063	*D-17*	80	SP-SM	3.5	108.0									
A-10-064	*S-1*	5	SM/SC	8.0							2000	7.8	10	217
A-10-064	*D-2*	10	SC to SM	13.1	134.3									
A-10-064	*S-3*	15	SM	6.5										
A-10-064	*D-4*	20	SP-SM	2.7	111.8									
A-10-064	*S-5*	25	SP-SM	2.8										
A-10-064	*D-6*	30	SP	1.3	110.0									
A-10-064	*S-7*	35	SP-SM	5.0										
A-10-064	*D-8*	40	SP-SM	3.7	105.6									
A-10-064	*S-9*	45	SP-SM	5.2										
A-10-064	*D-10*	50	SP-SM	4.4	113.5									
A-10-064	*S-11*	55	SP-SM	8.2										
A-10-064	*D-12*	60	SP-SM	1.7	105.1									
A-10-064	*S-13*	65	SP-SM	4.4										
A-10-064	*D-14*	70	SP-SM	3.0	105.9									
A-10-064	*S-15*	75	SP-SM	3.6										
A-10-064	*D-16*	80	ML to SM	15.7	121.4									
A-10-067	*D-1*	5	SM	4.6	121.0									
A-10-067	*S-2*	10	SM	10.7										
A-10-067	*D-3*	15	SP-SM	6.4	107.2									
A-10-067	*S-4*	20	SP-SM	2.4										
A-10-067	*D-5*	25	SP-SM	3.0	111.3									
A-10-067	*S-6*	30	SP	2.9										

TABLE B1 SUMMARY OF LABORATORY TEST RESULTS FOR SIGN STRUCTURES

Project No. : 10-126 Project Name : SR-91 WB Widening - Overhead Sign Structures

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-11-073	S-1	5	CL	14.4				1:40:59			1200	8.6	150	204
A-11-073	D-2	10	SP	6.0	106.6									
A-11-073	S-3	15	SP-SM	7.9										
A-11-073	D-4	20	SP	3.0	102.5			1:97:2			14000	7.47	20.0	10
A-11-073	S-5	25	SP-SM to SM	14.1										
A-11-073	D-6	30	SM	12.6	114.4									
A-11-073	S-7	35	SC-SM	19.6										

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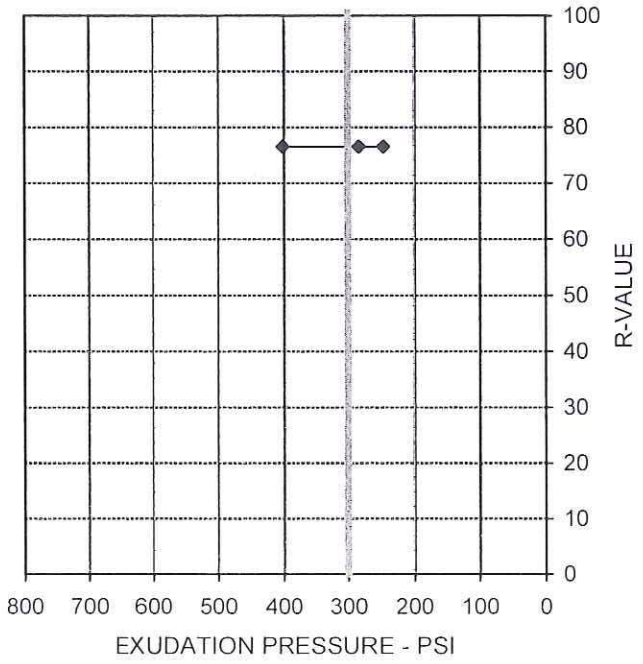
R-VALUE TEST DATA

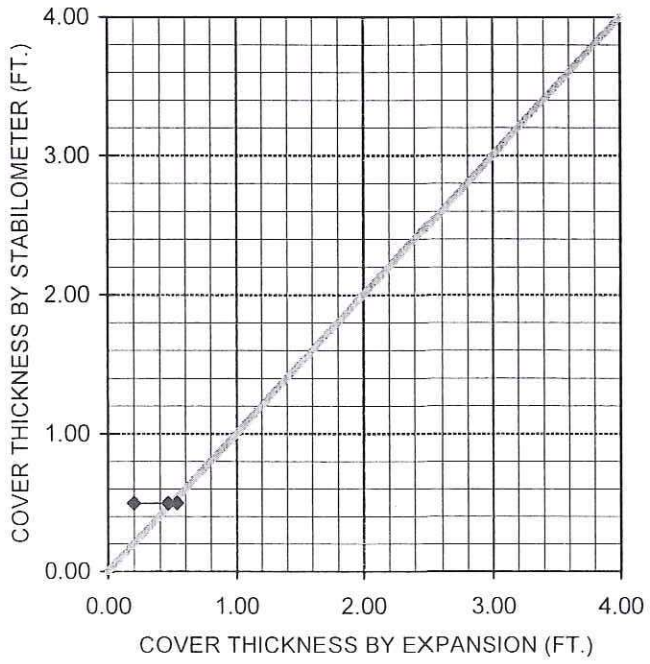
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/07/11
Project Number:	10126	Computed By:	KM	Date:	02/18/11
Boring No.:	A10-001	Checked By:	AP	Date:	03/07/11
Sample No.:	B0	Depth (ft.):	0-2		
Location:					
Soil Description:	Poorly-Graded Sand w/silt				

Mold Number	A	B	C	
Water Added, g	36	26	30	
Compact Moisture(%)	11.0	10.0	10.4	
Compaction Gage Pressure, psi	250	250	250	
Exudation Pressure, psi	247	401	284	
Sample Height, Inches	2.6	2.6	2.6	
Gross Weight Mold, g	3098	3084	3092	
Tare Weight Mold, g	1970	1967	1969	
Net Sample Weight, g	1129	1117	1124	
Expansion, inches$\times 10^{-4}$	6	16	14	
Stability 2,000 (160 psi)	15/26	15/25	15/25	
Turns Displacement	4.31	4.45	4.40	
R-Value Uncorrected	75	75	75	
R-Value Corrected	77	77	77	
Dry Density, pcf	118.5	118.3	118.6	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.50	0.50	0.50	
G.E. by Expansion	0.20	0.53	0.47	

R-VALUE		
	By Exudation:	76
	By Expansion:	76
	At Equilibrium: (by Expansion)	76
Remarks	Gf = 1.51, and 1.5 % Retained on the ¾	





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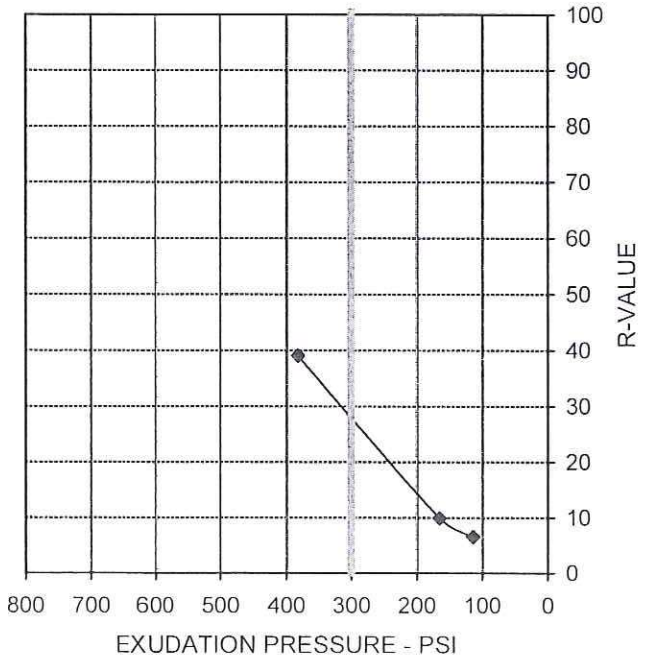
R-VALUE TEST DATA

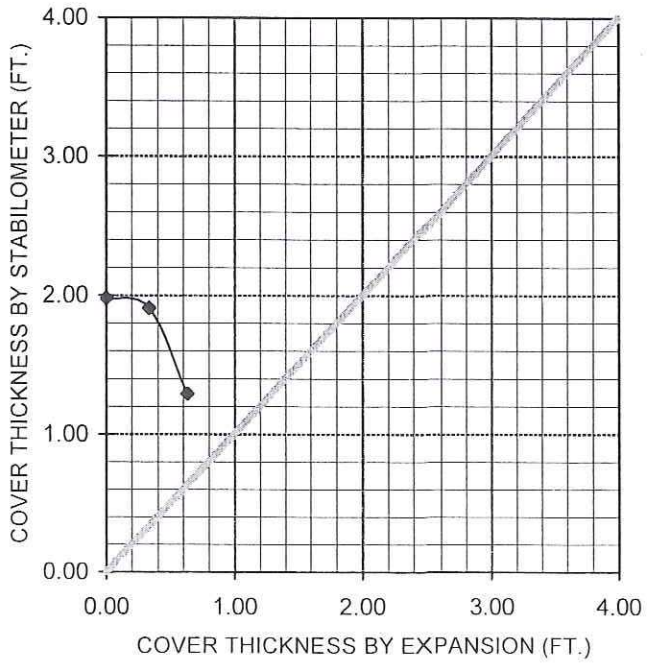
ASTM D2844

Project Name: SR-91 WB Widening — Tested By: ST — Date: 02/07/11
Project Number: 10126 — Computed By: KM — Date: 02/18/11
Boring No.: A10-002 — Checked By: AP — Date: 03/07/11
Sample No.: B0 — Depth (ft.): 1.5-5
Location:
Soil Description: Clayey Sand

Mold Number	D	E	F	
Water Added, g	0	-30	-50	
Compact Moisture(%)	17.8	14.2	11.9	
Compaction Gage Pressure, psi	50	50	100	
Exudation Pressure, psi	114	166	382	
Sample Height, Inches	2.4	2.3	2.3	
Gross Weight Mold, g	2959	2923	2818	
Tare Weight Mold, g	1971	1957	1871	
Net Sample Weight, g	989	966	947	
Expansion, inchesx10^{-4}	0	10	19	
Stability 2,000 (160 psi)	62/138	60/132	34/72	
Turns Displacement	5.09	4.24	3.91	
R-Value Uncorrected	7	11	44	
R-Value Corrected	7	10	39	
Dry Density, pcf	106.0	111.4	111.5	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	1.98	1.91	1.29	
G.E. by Expansion	0.00	0.33	0.63	

R-VALUE		
	By Exudation:	28
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	28
Remarks	Gf = 1.51, and 0.0 % Retained on the ¾	
	*Not Applicable	





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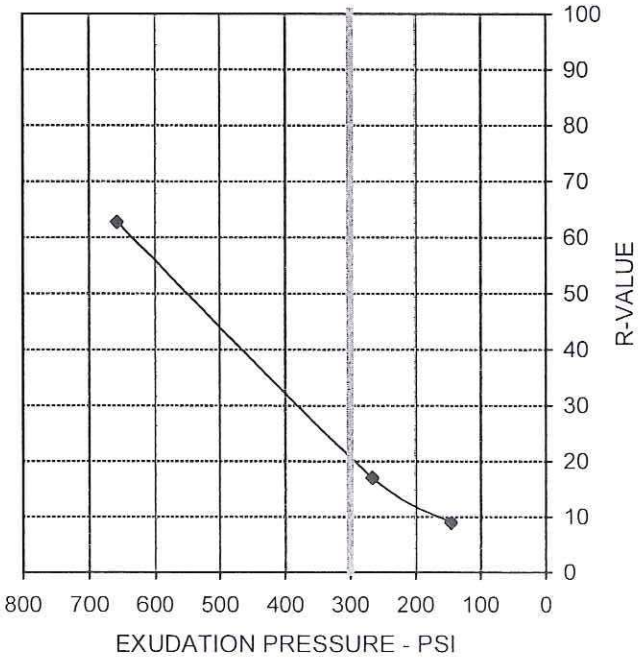
R-VALUE TEST DATA

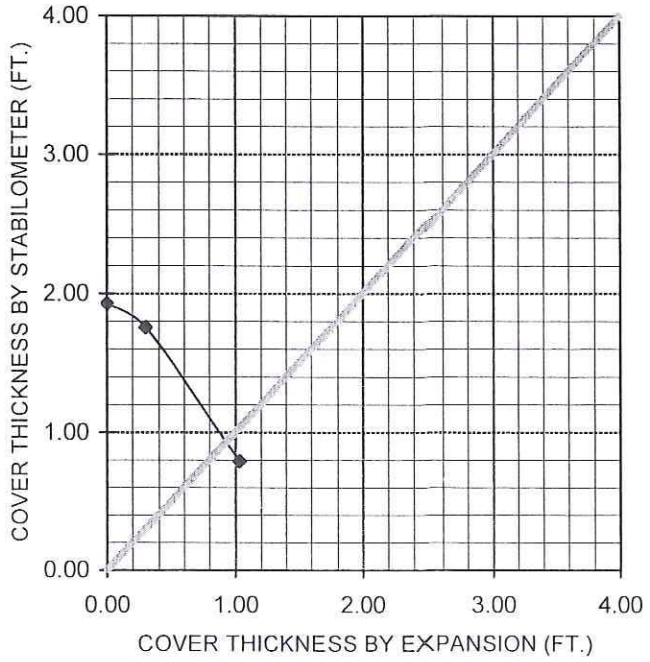
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/07/11
Project Number:	10126	Computed By:	KM	Date:	02/18/11
Boring No.:	A10-005	Checked By:	AP	Date:	03/07/11
Sample No.:	B0	Depth (ft.):	1.5-5		
Location:					
Soil Description:	Clayey Sand				

Mold Number	G	H	I	
Water Added, g	0	-30	-15	
Compact Moisture(%)	15.6	12.4	14.0	
Compaction Gage Pressure, psi	50	150	100	
Exudation Pressure, psi	145	658	266	
Sample Height, Inches	2.5	2.3	2.4	
Gross Weight Mold, g	2894	2860	2890	
Tare Weight Mold, g	1829	1820	1838	
Net Sample Weight, g	1065	1040	1052	
Expansion, inchesx10^{-4}	0	31	9	
Stability 2,000 (160 psi)	60/134	18/38	50/116	
Turns Displacement	4.98	3.97	4.24	
R-Value Uncorrected	9	67	18	
R-Value Corrected	9	63	17	
Dry Density, pcf	111.6	121.9	116.5	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	1.93	0.79	1.76	
G.E. by Expansion	0.00	1.03	0.30	

R-VALUE	By Exudation:	21
	By Expansion:	56
	At Equilibrium: (by Exudation)	21
Remarks	Gf = 1.51, and 0.0 % Retained on the ¾	





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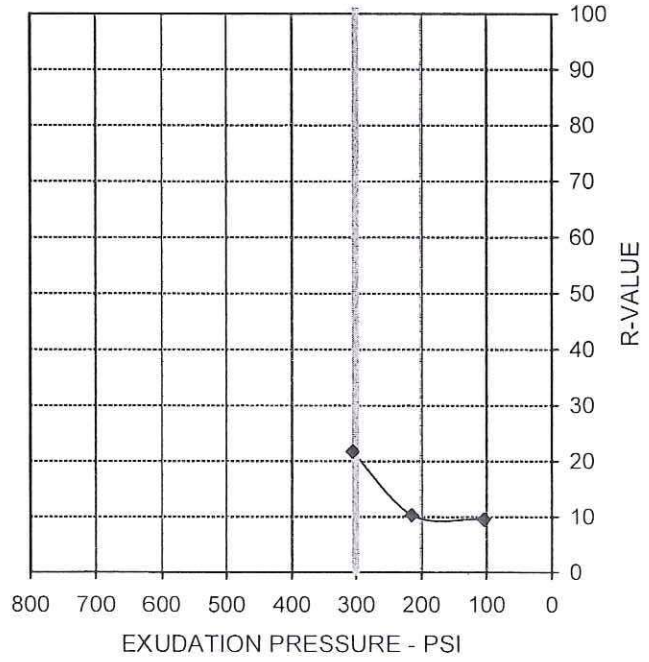
R-VALUE TEST DATA

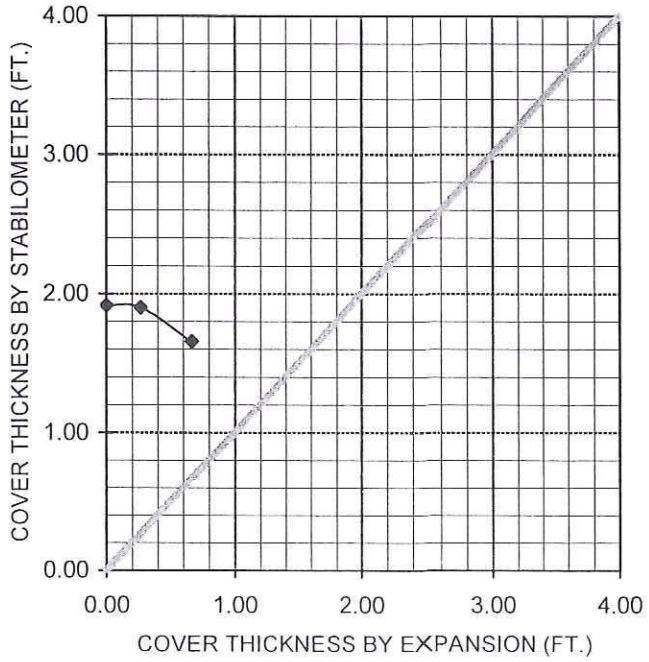
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/09/11
Project Number:	10126	Computed By:	KM	Date:	02/18/11
Boring No.:	A10-006	Checked By:	AP	Date:	03/07/11
Sample No.:	B0	Depth (ft.):	2-5		
Location:					
Soil Description:	Clayey to Silty Sand				

Mold Number	A	B	C	
Water Added, g	0	-30	-19	
Compact Moisture(%)	19.0	15.7	16.9	
Compaction Gage Pressure, psi	30	100	50	
Exudation Pressure, psi	104	305	214	
Sample Height, Inches	2.6	2.4	2.5	
Gross Weight Mold, g	3061	3042	3046	
Tare Weight Mold, g	1970	1967	1969	
Net Sample Weight, g	1091	1075	1078	
Expansion, inchesx10^{-4}	0	20	8	
Stability 2,000 (160 psi)	66/134	47/103	60/132	
Turns Displacement	5.17	4.55	4.63	
R-Value Uncorrected	9	23	10	
R-Value Corrected	10	22	10	
Dry Density, pcf	106.9	117.3	111.7	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	1.92	1.66	1.90	
G.E. by Expansion	0.00	0.67	0.27	

R-VALUE	By Exudation:	21
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	21
Remarks	Gf = 1.51, and 0.0 % Retained on the ¾	
	*Not Applicable	





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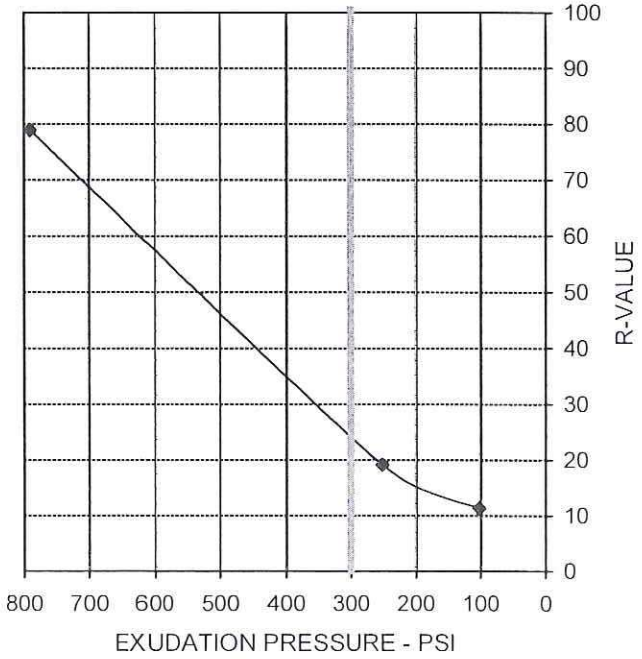
R-VALUE TEST DATA

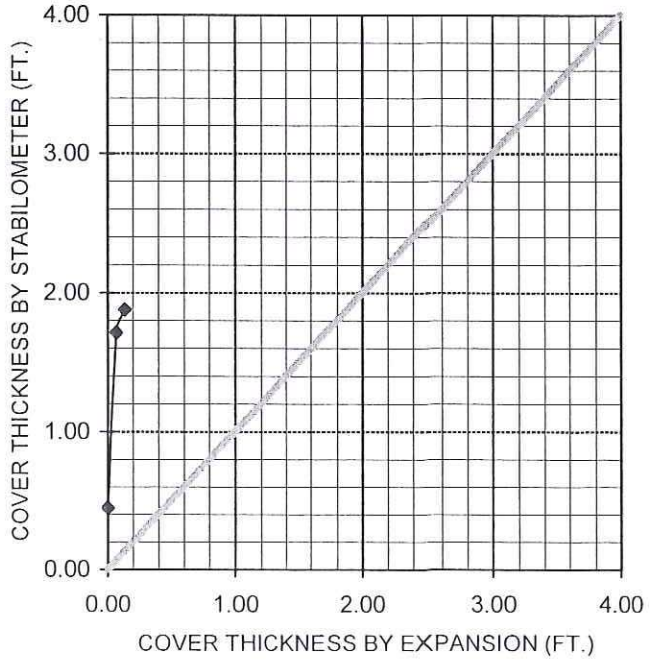
ASTM D2844

Project Name: SR-91 WB Widening — Tested By: ST — Date: 02/09/11
Project Number: 10126 — Computed By: KM — Date: 02/18/11
Boring No.: HA-10-010 — Checked By: AP — Date: 09/10/11
Sample No.: B0 — Depth (ft.): 0-3
Location:
Soil Description: Clayey Sand

Mold Number	G	H	I	
Water Added, g	0	30	15	
Compact Moisture(%)	9.1	12.1	10.6	
Compaction Gage Pressure, psi	250	50	100	
Exudation Pressure, psi	791	103	252	
Sample Height, Inches	2.5	2.5	2.5	
Gross Weight Mold, g	2929	2946	2954	
Tare Weight Mold, g	1829	1820	1839	
Net Sample Weight, g	1100	1126	1115	
Expansion, inchesx10^{-4}	0	4	2	
Stability 2,000 (160 psi)	14/22	57/128	50/112	
Turns Displacement	4.20	4.89	4.53	
R-Value Uncorrected	79	11	19	
R-Value Corrected	79	11	19	
Dry Density, pcf	122.2	121.8	122.2	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.45	1.88	1.71	
G.E. by Expansion	0.00	0.13	0.07	

R-VALUE		
	By Exudation:	24
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	24
Remarks	Gf = 1.51, and 1.4 % Retained on the ¾	
	*Not Applicable	





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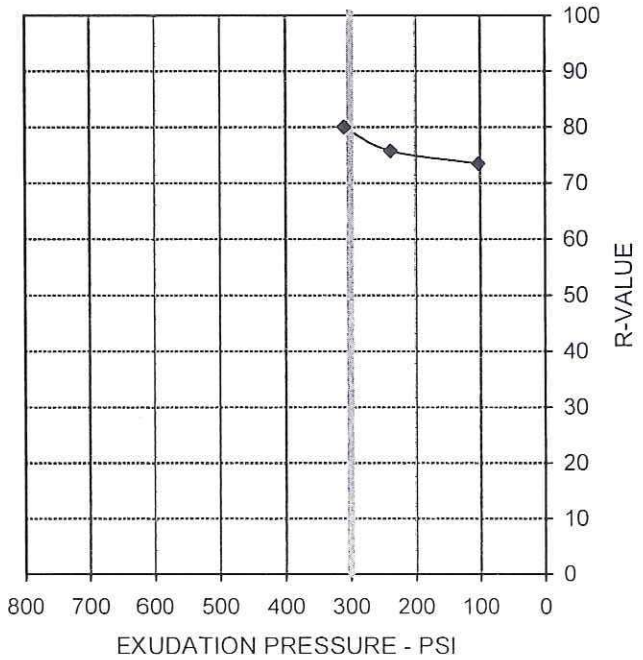
R-VALUE TEST DATA

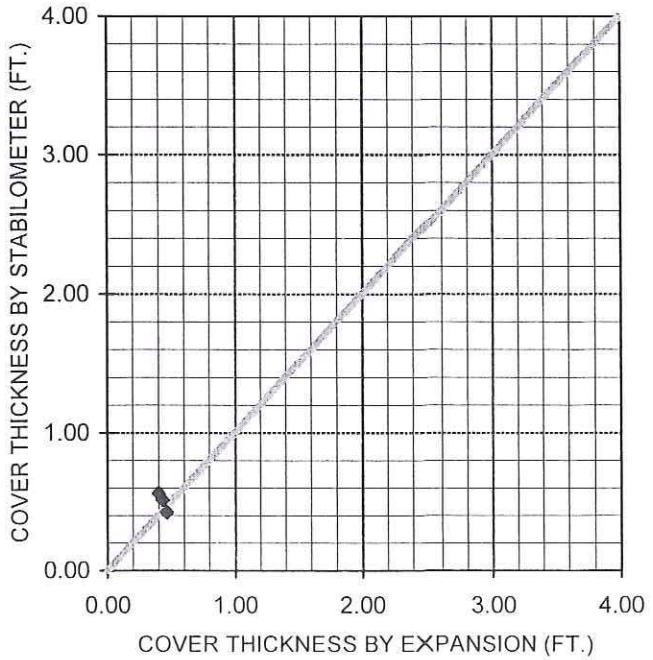
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/08/11
Project Number:	10126	Computed By:	KM	Date:	02/18/11
Boring No.:	A10-011	Checked By:	AP	Date:	03/07/11
Sample No.:	B0	Depth (ft.):	0-2		
Location:					
Soil Description:	Poorly-Graded Sand w/silt & gravel				

Mold Number	A	B	C	
Water Added, g	35	25	20	
Compact Moisture(%)	8.3	7.3	6.8	
Compaction Gage Pressure, psi	250	250	250	
Exudation Pressure, psi	103	238	310	
Sample Height, Inches	2.4	2.4	2.4	
Gross Weight Mold, g	3048	3044	3461	
Tare Weight Mold, g	1970	1967	1969	
Net Sample Weight, g	1079	1077	1492	
Expansion, inches$\times 10^{-4}$	12	13	14	
Stability 2,000 (160 psi)	14/24	13/21	12/17	
Turns Displacement	4.79	4.90	4.98	
R-Value Uncorrected	75	77	81	
R-Value Corrected	74	76	80	
Dry Density, pcf	125.7	126.7	176.4	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.56	0.51	0.42	
G.E. by Expansion	0.40	0.43	0.47	

R-VALUE	By Exudation:	79
	By Expansion:	79
	At Equilibrium: (by Expansion)	79
Remarks	Gf = 1.51, and 15.5 % Retained on the ¾	





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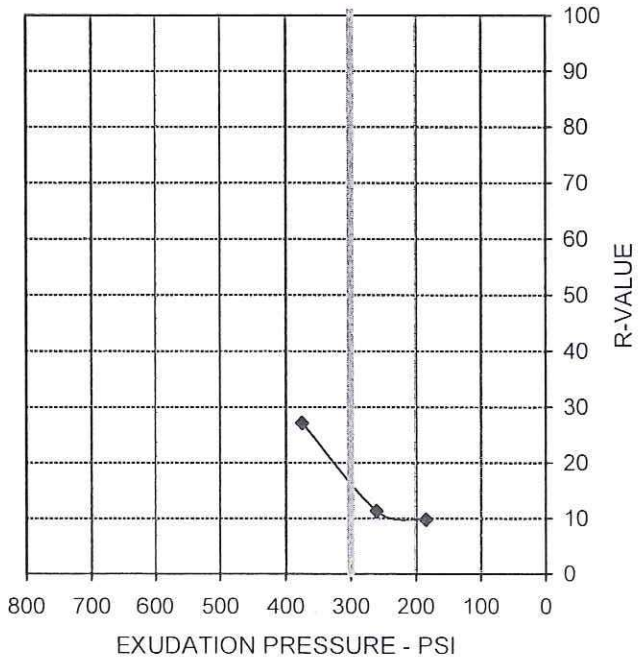
R-VALUE TEST DATA

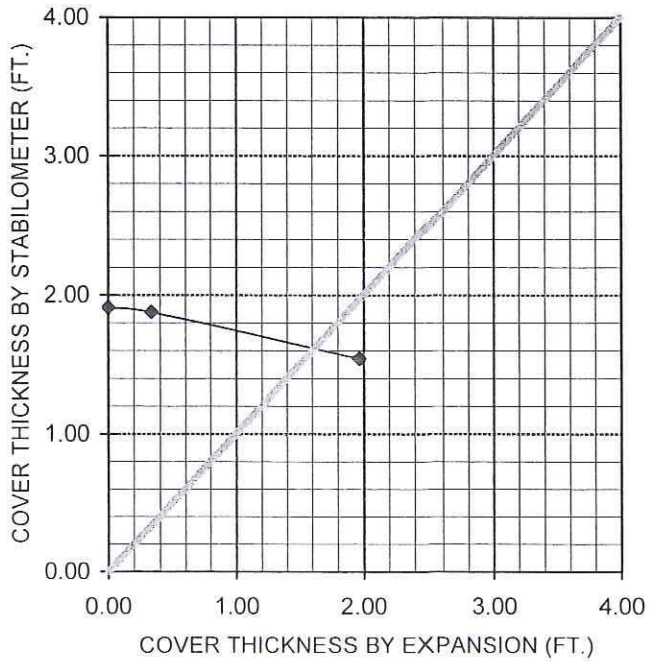
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/12/11
Project Number:	10126	Computed By:	KM	Date:	02/18/11
Boring No.:	A10-013	Checked By:	AP	Date:	03/07/11
Sample No.:	B0	Depth (ft.):	0-2		
Location:					
Soil Description:	Clayey Sand				

Mold Number	G	H	I	
Water Added, g	5	0	-15	
Compact Moisture(%)	18.1	17.6	15.9	
Compaction Gage Pressure, psi	50	90	120	
Exudation Pressure, psi	184	260	374	
Sample Height, Inches	2.5	2.4	2.4	
Gross Weight Mold, g	2883	2867	2869	
Tare Weight Mold, g	1829	1821	1839	
Net Sample Weight, g	1053	1046	1030	
Expansion, inches$\times 10^{-4}$	0	10	59	
Stability 2,000 (160 psi)	65/136	59/130	40/100	
Turns Displacement	4.08	4.07	3.67	
R-Value Uncorrected	10	12	29	
R-Value Corrected	10	11	27	
Dry Density, pcf	108.1	112.3	112.2	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	1.91	1.88	1.54	
G.E. by Expansion	0.00	0.33	1.97	

R-VALUE	By Exudation:	16
	By Expansion:	24
	At Equilibrium: (by Exudation)	16
Remarks	Gf = 1.51, and 0.7 % Retained on the ¾	





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AP Engineering & Testing, Inc.

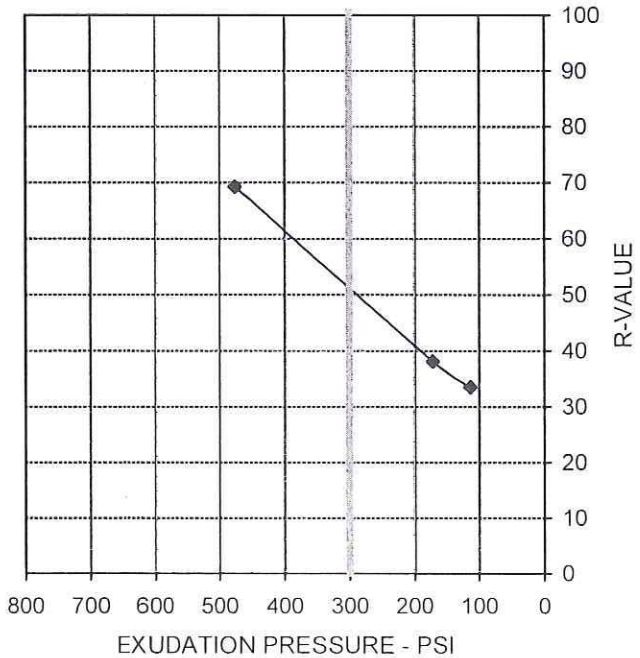
R-VALUE TEST DATA

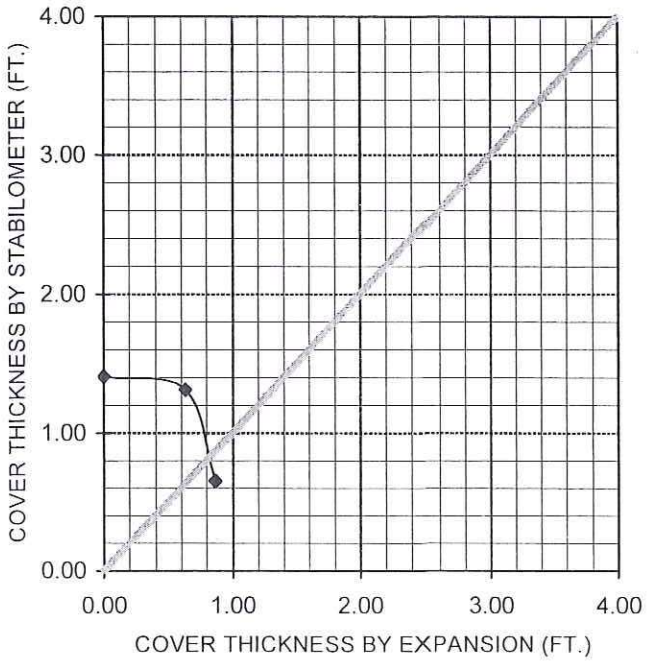
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/12/11
Project Number:	10126	Computed By:	KM	Date:	02/18/11
Boring No.:	A10-015	Checked By:	AP	Date:	03/07/11
Sample No.:	B0	Depth (ft.):	0-2		
Location:					
Soil Description:	Silty Sand				

Mold Number	F	E	D	
Water Added, g	15	0	-12	
Compact Moisture(%)	13.6	12.1	10.8	
Compaction Gage Pressure, psi	50	100	150	
Exudation Pressure, psi	114	171	476	
Sample Height, Inches	2.5	2.4	2.5	
Gross Weight Mold, g	3087	3053	3057	
Tare Weight Mold, g	1971	1957	1971	
Net Sample Weight, g	1116	1097	1086	
Expansion, inchesx10^{-4}	0	19	26	
Stability 2,000 (160 psi)	37/85	32/71	19/32	
Turns Displacement	4.38	4.42	4.45	
R-Value Uncorrected	33	41	69	
R-Value Corrected	33	38	69	
Dry Density, pcf	119.1	123.5	118.7	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	1.41	1.31	0.65	
G.E. by Expansion	0.00	0.63	0.87	

R-VALUE		
	By Exudation:	51
	By Expansion:	61
	At Equilibrium: (by Exudation)	51
Remarks	Gf = 1.51, and 3.9 % Retained on the ¾	





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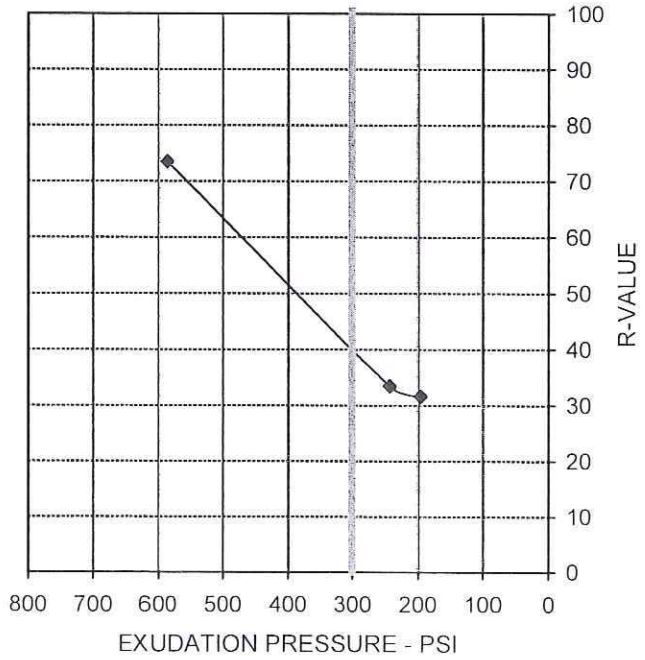
R-VALUE TEST DATA

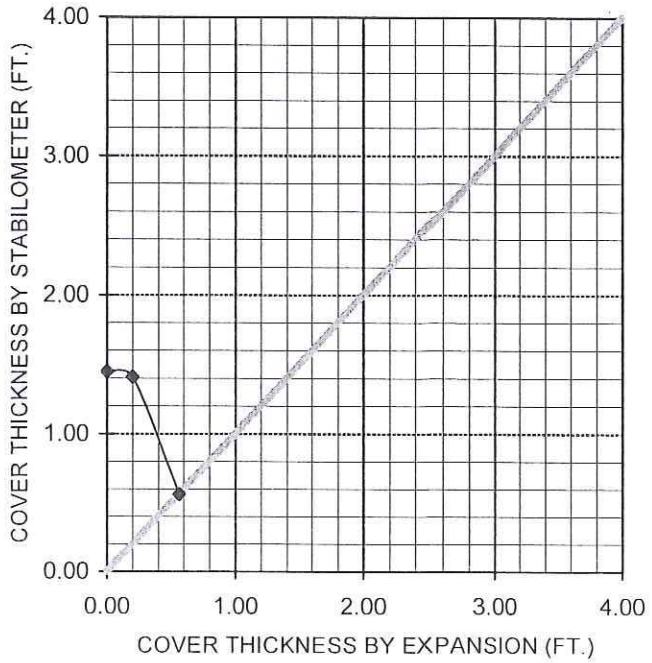
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/12/11
Project Number:	10126	Computed By:	KM	Date:	02/18/11
Boring No.:	A10-019	Checked By:	AP	Date:	03/07/11
Sample No.:	B0	Depth (ft.):	0-5		
Location:					
Soil Description:	Silty Sand				

Mold Number	A	B	C	
Water Added, g	30	10	20	
Compact Moisture(%)	11.3	9.2	10.3	
Compaction Gage Pressure, psi	100	250	150	
Exudation Pressure, psi	196	586	243	
Sample Height, Inches	2.4	2.4	2.4	
Gross Weight Mold, g	3067	3045	3056	
Tare Weight Mold, g	1970	1967	1971	
Net Sample Weight, g	1097	1078	1085	
Expansion, inchesx10^{-4}	0	17	6	
Stability 2,000 (160 psi)	40/82	15/26	39/80	
Turns Displacement	4.69	4.19	4.45	
R-Value Uncorrected	34	75	36	
R-Value Corrected	32	74	33	
Dry Density, pcf	124.5	124.6	124.2	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	1.45	0.56	1.41	
G.E. by Expansion	0.00	0.57	0.20	

R-VALUE	By Exudation:	40
	By Expansion:	73
	At Equilibrium: (by Exudation)	40
Remarks	Gf = 1.51, and 1.4 % Retained on the ¾	





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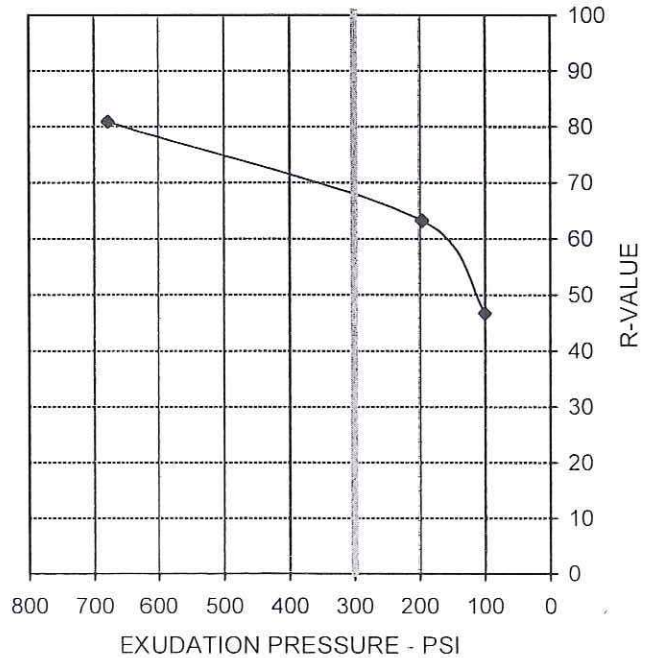
R-VALUE TEST DATA

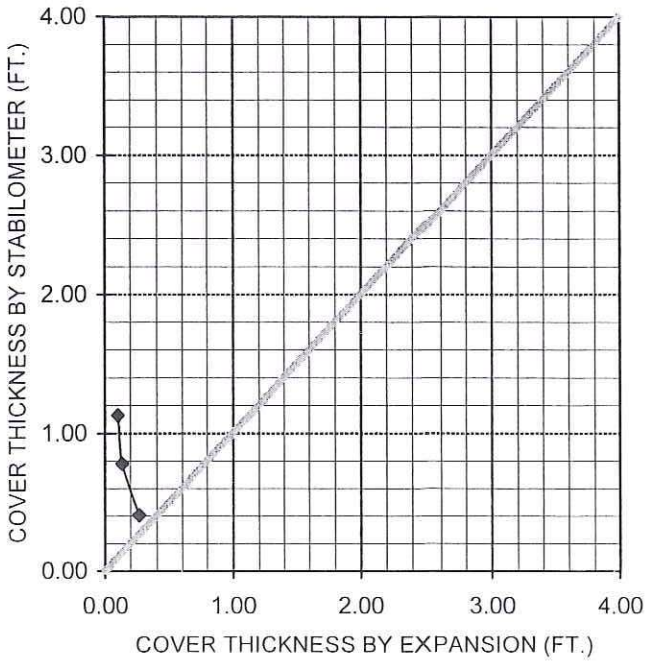
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/10/11
Project Number:	10126	Computed By:	KM	Date:	02/18/11
Boring No.:	A10-021	Checked By:	AP	Date:	03/07/11
Sample No.:	B0	Depth (ft.):	2-5		
Location:					
Soil Description:	Poorly-Graded Sand w/silt				

Mold Number	D	E	F	
Water Added, g	10	20	0	
Compact Moisture(%)	8.8	9.8	7.8	
Compaction Gage Pressure, psi	250	250	250	
Exudation Pressure, psi	196	100	679	
Sample Height, Inches	2.5	2.5	2.5	
Gross Weight Mold, g	3081	3068	2966	
Tare Weight Mold, g	1971	1957	1871	
Net Sample Weight, g	1110	1112	1095	
Expansion, inches$\times 10^{-4}$	4	3	8	
Stability 2,000 (160 psi)	25/42	30/58	11/18	
Turns Displacement	4.09	5.02	4.66	
R-Value Uncorrected	63	47	81	
R-Value Corrected	63	47	81	
Dry Density, pcf	123.6	122.7	123.1	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.78	1.13	0.40	
G.E. by Expansion	0.13	0.10	0.27	

R-VALUE		
	By Exudation:	68
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	68
Remarks	Gf = 1.51, and 2.5 % Retained on the ¾	
	*Not Applicable	





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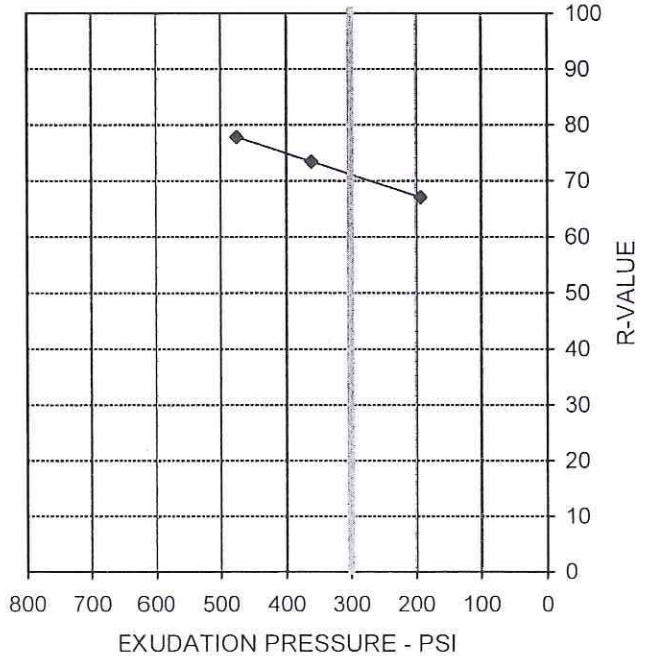
R-VALUE TEST DATA

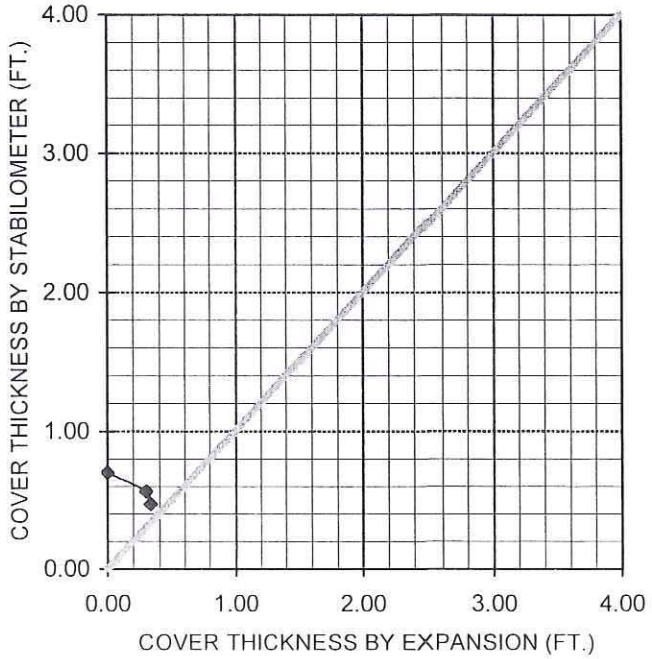
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/11/11
Project Number:	10126	Computed By:	KM	Date:	02/18/11
Boring No.:	A10-024	Checked By:	AP	Date:	03/07/11
Sample No.:	B0	Depth (ft.):	1.5-5		
Location:					
Soil Description:	Silty Sand w/gravel				

Mold Number	C	F	D	
Water Added, g	25	18	21	
Compact Moisture(%)	9.5	8.8	9.1	
Compaction Gage Pressure, psi	250	250	250	
Exudation Pressure, psi	193	475	361	
Sample Height, Inches	2.5	2.5	2.5	
Gross Weight Mold, g	3079	2975	3082	
Tare Weight Mold, g	1969	1871	1971	
Net Sample Weight, g	1110	1104	1111	
Expansion, inchesx10^{-4}	0	10	9	
Stability 2,000 (160 psi)	20/34	12/21	15/26	
Turns Displacement	4.56	4.72	4.66	
R-Value Uncorrected	67	78	73	
R-Value Corrected	67	78	73	
Dry Density, pcf	122.9	123.0	123.4	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.70	0.47	0.56	
G.E. by Expansion	0.00	0.33	0.30	

R-VALUE	By Exudation:	71
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	71
Remarks	Gf = 1.51, and 2.5 % Retained on the ¾	
	*Not Applicable	





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AP Engineering & Testing, Inc.

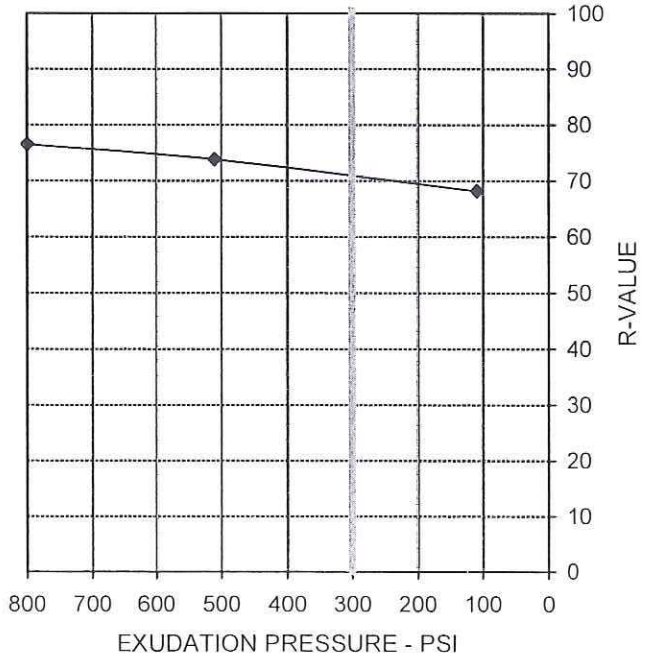
R-VALUE TEST DATA

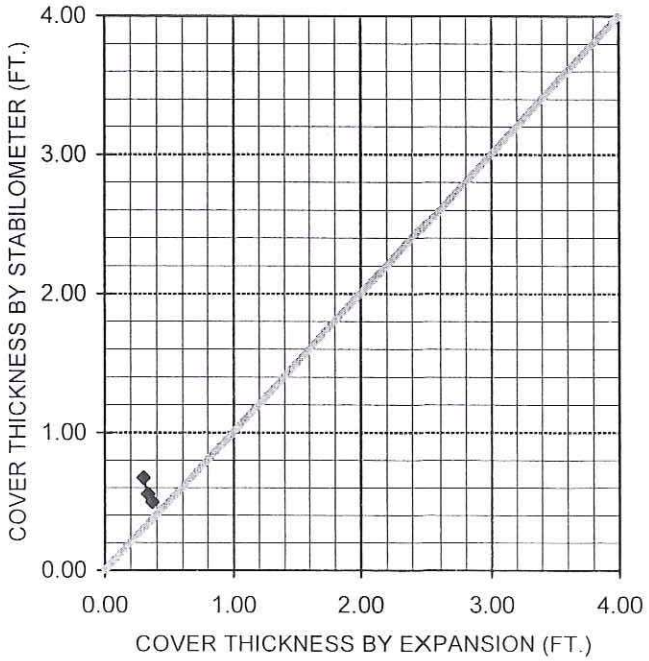
ASTM D2844

Project Name: SR-91 WB Widening — Tested By: ST — Date: 02/10/11
Project Number: 10126 — Computed By: KM — Date: 02/18/11
Boring No.: A10-027 — Checked By: AP — Date: 03/07/11
Sample No.: B0 — Depth (ft.): 0-5
Location:
Soil Description: Poorly-Graded Sand w/silt

Mold Number	A	B	C	
Water Added, g	65	40	75	
Compact Moisture(%)	11.4	9.0	12.4	
Compaction Gage Pressure, psi	250	250	250	
Exudation Pressure, psi	511	800	109	
Sample Height, Inches	2.6	2.6	2.6	
Gross Weight Mold, g	3085	3066	3085	
Tare Weight Mold, g	1970	1967	1969	
Net Sample Weight, g	1116	1099	1116	
Expansion, inchesx10^{-4}	10	11	9	
Stability 2,000 (160 psi)	13/23	13/20	18/30	
Turns Displacement	5.78	5.68	5.55	
R-Value Uncorrected	72	75	66	
R-Value Corrected	74	77	68	
Dry Density, pcf	116.6	117.5	115.7	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.55	0.50	0.67	
G.E. by Expansion	0.33	0.37	0.30	

R-VALUE		
	By Exudation:	71
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	71
Remarks	Gf = 1.51, and 0.0 % Retained on the ¾	
	*Not Applicable	





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AP Engineering & Testing, Inc.

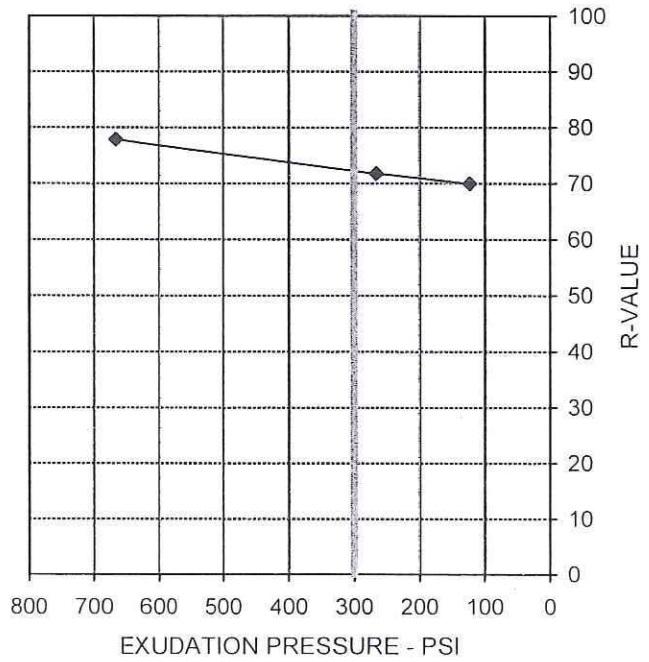
R-VALUE TEST DATA

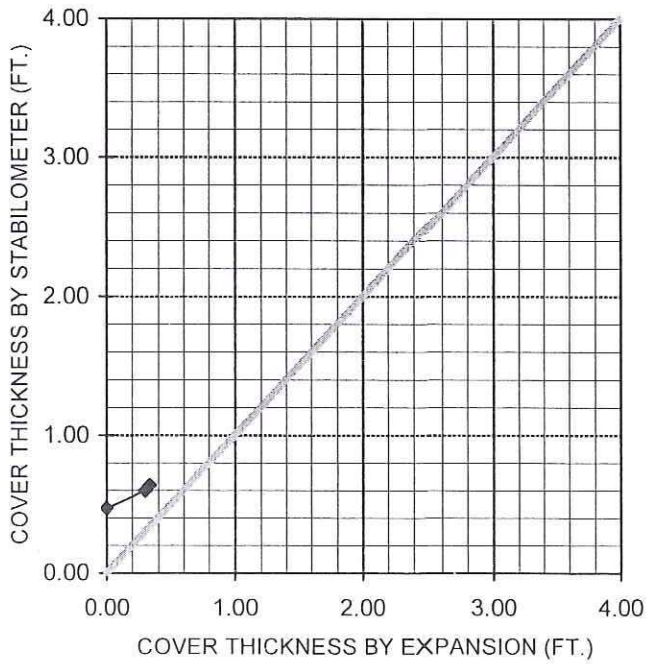
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/09/11
Project Number:	10126	Computed By:	KM	Date:	02/18/11
Boring No.:	A10-028	Checked By:	AP	Date:	03/07/11
Sample No.:	B0	Depth (ft.):	1.5-5		
Location:					
Soil Description:	Poorly-Graded Sand w/silt				

Mold Number	D	E	I	
Water Added, g	45	60	55	
Compact Moisture(%)	8.2	9.7	9.2	
Compaction Gage Pressure, psi	250	250	250	
Exudation Pressure, psi	667	123	266	
Sample Height, Inches	2.5	2.5	2.5	
Gross Weight Mold, g	3058	3077	2935	
Tare Weight Mold, g	1971	1967	1839	
Net Sample Weight, g	1088	1110	1096	
Expansion, inchesx10^{-4}	0	10	9	
Stability 2,000 (160 psi)	12/20	18/30	17/28	
Turns Displacement	4.98	4.65	4.64	
R-Value Uncorrected	78	70	72	
R-Value Corrected	78	70	72	
Dry Density, pcf	121.8	122.6	121.7	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.47	0.64	0.60	
G.E. by Expansion	0.00	0.33	0.30	

R-VALUE	By Exudation:	72
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	72
Remarks	Gf = 1.51, and 0.5 % Retained on the ¾	
	*Not Applicable	





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AP Engineering & Testing, Inc.

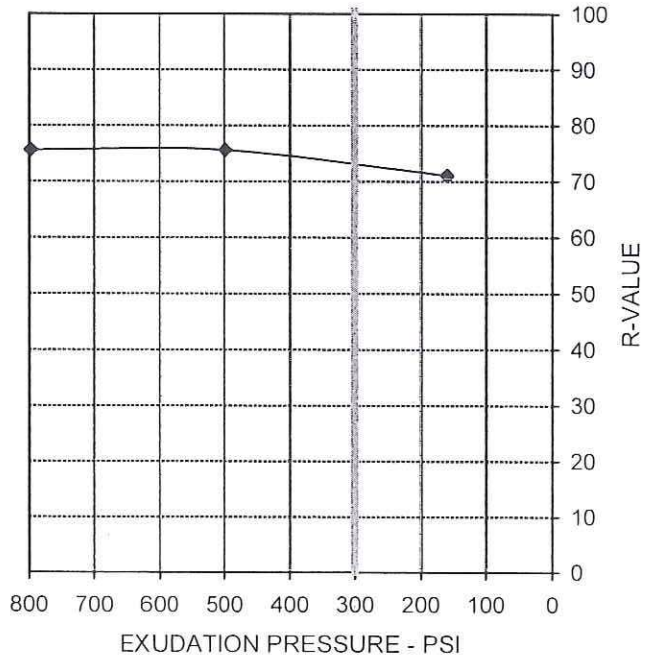
R-VALUE TEST DATA

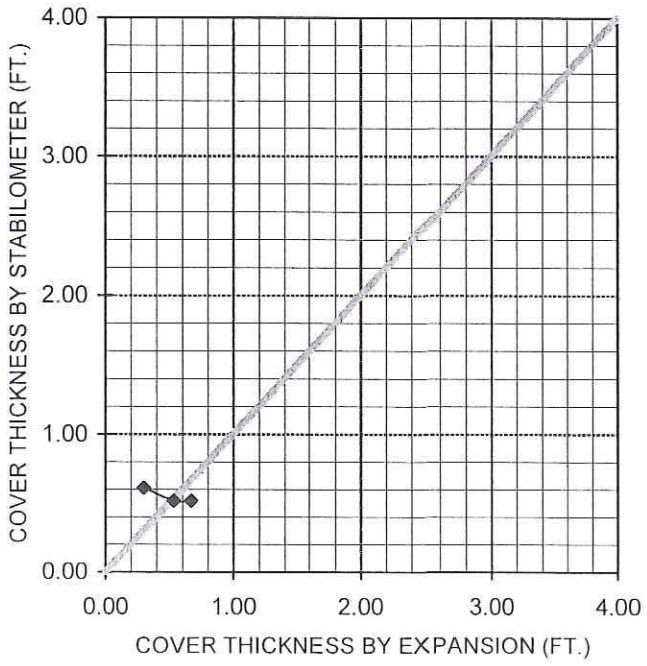
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/13/11
Project Number:	10126	Computed By:	KM	Date:	02/18/11
Boring No.:	A10-030	Checked By:	AP	Date:	03/07/11
Sample No.:	B0	Depth (ft.):	2-5		
Location:					
Soil Description:	Silty Sand				

Mold Number	D	E	I	
Water Added, g	24	37	30	
Compact Moisture(%)	10.2	11.5	10.8	
Compaction Gage Pressure, psi	150	150	150	
Exudation Pressure, psi	798	159	498	
Sample Height, Inches	2.6	2.6	2.6	
Gross Weight Mold, g	3082	3081	2987	
Tare Weight Mold, g	1971	1957	1871	
Net Sample Weight, g	1111	1124	1116	
Expansion, inches$\times 10^{-4}$	16	9	20	
Stability 2,000 (160 psi)	16/26	17/31	16/26	
Turns Displacement	4.50	4.70	4.44	
R-Value Uncorrected	74	69	74	
R-Value Corrected	76	71	76	
Dry Density, pcf	117.5	117.4	117.3	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.52	0.61	0.52	
G.E. by Expansion	0.53	0.30	0.67	

R-VALUE	By Exudation:	72
	By Expansion:	75
	At Equilibrium: (by Exudation)	72
Remarks	Gf = 1.51, and 0.0 % Retained on the ¾	





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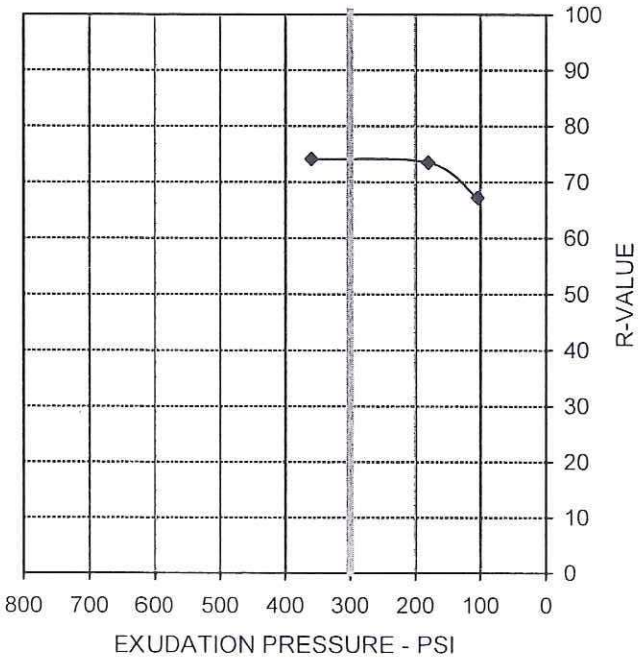
R-VALUE TEST DATA

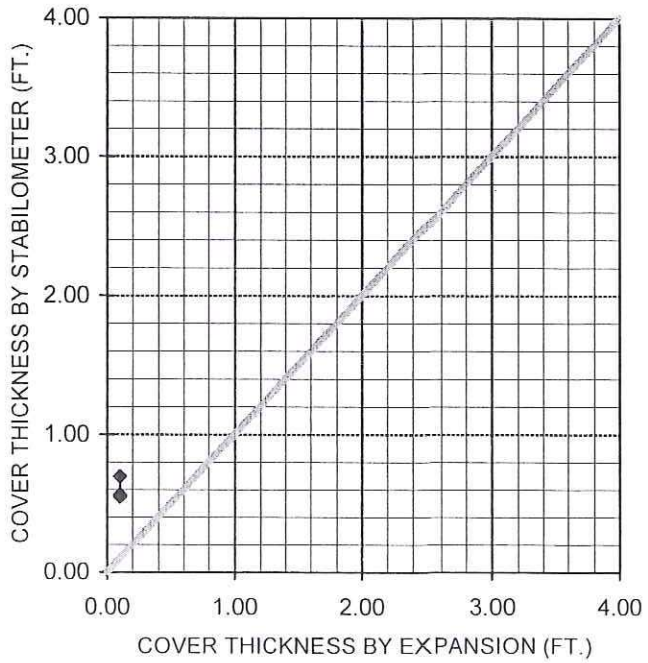
ASTM D2844

Project Name: SR-91 WB Widening — Tested By: ST — Date: 02/13/11
Project Number: 10126 — Computed By: KM — Date: 02/18/11
Boring No.: A10-033 — Checked By: AP — Date: 03/07/11
Sample No.: B0 — Depth (ft.): 2-5
Location:
Soil Description: Silty Sand

Mold Number	A	B	C	
Water Added, g	25	17	20	
Compact Moisture(%)	11.6	10.8	11.1	
Compaction Gage Pressure, psi	150	150	150	
Exudation Pressure, psi	104	359	181	
Sample Height, Inches	2.5	2.5	2.5	
Gross Weight Mold, g	3078	3070	3074	
Tare Weight Mold, g	1970	1967	1969	
Net Sample Weight, g	1109	1103	1105	
Expansion, inchesx10^{-4}	3	3	3	
Stability 2,000 (160 psi)	20/33	14/25	15/26	
Turns Displacement	4.70	4.72	4.65	
R-Value Uncorrected	67	74	73	
R-Value Corrected	67	74	73	
Dry Density, pcf	120.4	120.7	120.5	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.69	0.55	0.56	
G.E. by Expansion	0.10	0.10	0.10	

R-VALUE	By Exudation:	74
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	74
Remarks	Gf = 1.51, and 0.0 % Retained on the ¾	
	*Not Applicable	





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AP Engineering & Testing, Inc.

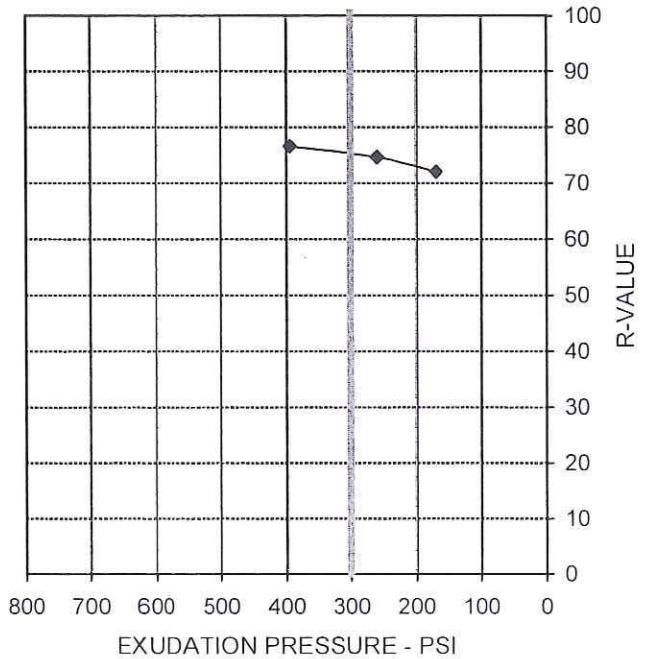
R-VALUE TEST DATA

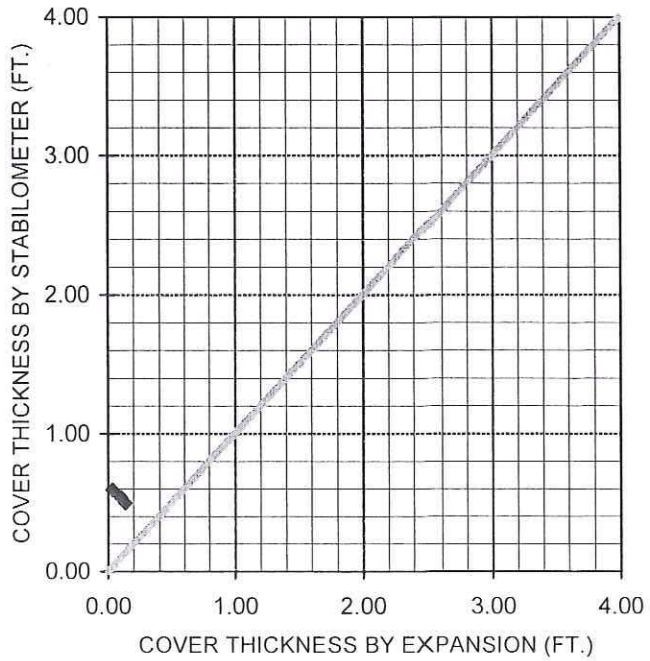
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/13/11
Project Number:	10126	Computed By:	KM	Date:	02/18/11
Boring No.:	A10-034	Checked By:	AP	Date:	03/07/11
Sample No.:	B0	Depth (ft.):	0-2		
Location:					
Soil Description:	Silty Sand with gravel				

Mold Number	G	H	I	
Water Added, g	25	30	28	
Compact Moisture(%)	10.7	11.2	11.0	
Compaction Gage Pressure, psi	150	140	150	
Exudation Pressure, psi	394	169	260	
Sample Height, Inches	2.5	2.5	2.5	
Gross Weight Mold, g	2922	2915	2937	
Tare Weight Mold, g	1829	1821	1839	
Net Sample Weight, g	1092	1094	1098	
Expansion, inches$x10^{-4}$	4	1	3	
Stability 2,000 (160 psi)	14/25	17/30	16/27	
Turns Displacement	4.13	4.20	4.18	
R-Value Uncorrected	77	72	75	
R-Value Corrected	77	72	75	
Dry Density, pcf	119.6	119.3	119.9	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.50	0.59	0.54	
G.E. by Expansion	0.13	0.03	0.10	

R-VALUE		
	By Exudation:	75
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	75
Remarks	Gf = 1.51, and 1.1 % Retained on the ¾	
	*Not Applicable	





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AP Engineering & Testing, Inc.

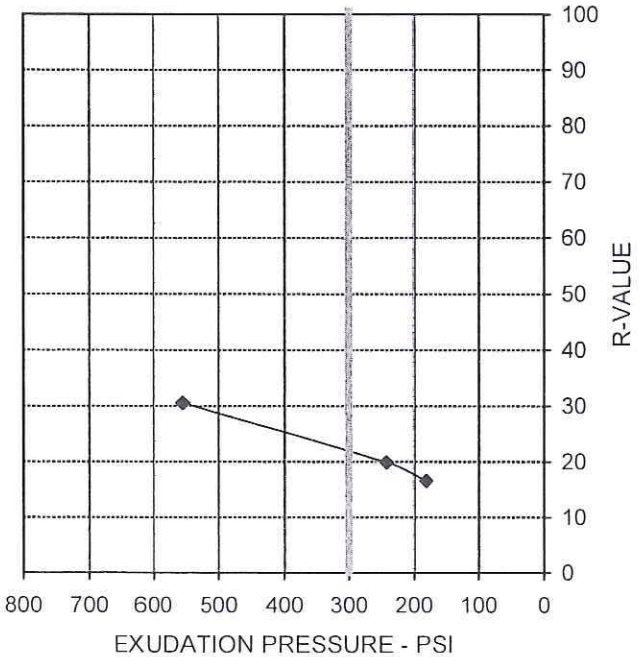
R-VALUE TEST DATA

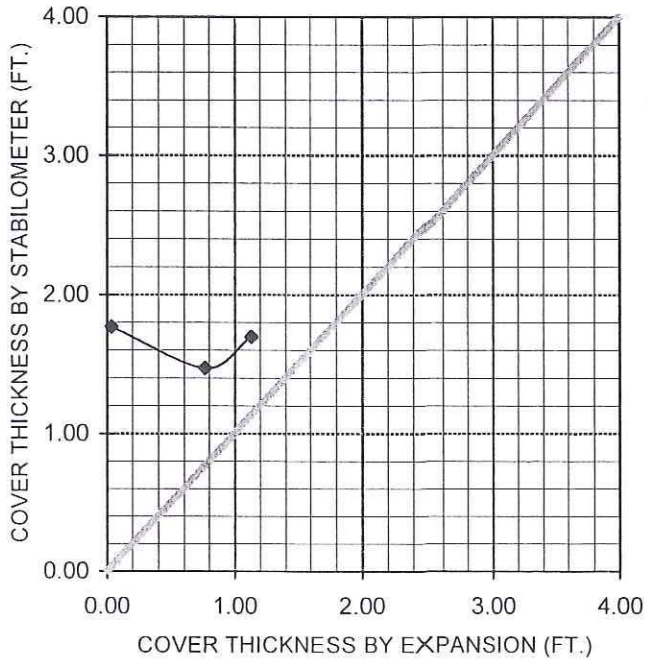
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/14/11
Project Number:	10126	Computed By:	KM	Date:	02/18/11
Boring No.:	A10-037	Checked By:	AP	Date:	03/07/11
Sample No.:	B0	Depth (ft.):	0-3		
Location:					
Soil Description:	Clayey Sand				

Mold Number	H	I	C	
Water Added, g	-13	0	-18	
Compact Moisture(%)	12.7	14.0	12.2	
Compaction Gage Pressure, psi	150	50	180	
Exudation Pressure, psi	243	181	555	
Sample Height, Inches	2.4	2.5	2.3	
Gross Weight Mold, g	2905	2936	3048	
Tare Weight Mold, g	1821	1839	1969	
Net Sample Weight, g	1085	1098	1079	
Expansion, inchesx10^{-4}	34	1	23	
Stability 2,000 (160 psi)	48/114	52/122	38/92	
Turns Displacement	3.88	3.93	3.47	
R-Value Uncorrected	21	17	35	
R-Value Corrected	20	17	31	
Dry Density, pcf	121.5	116.6	126.7	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	1.70	1.77	1.47	
G.E. by Expansion	1.13	0.03	0.77	

R-VALUE	By Exudation:	21
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	21
Remarks	Gf = 1.51, and 1.1 % Retained on the ¾	
	*Not Applicable	





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AP Engineering & Testing, Inc.

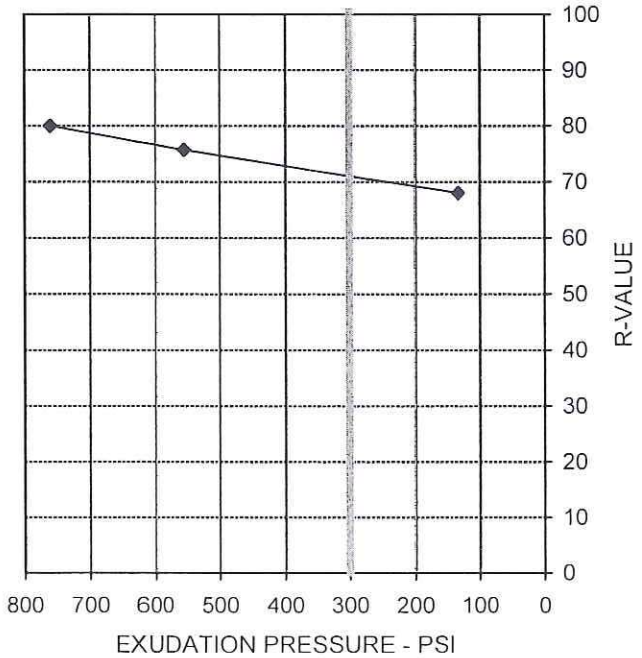
R-VALUE TEST DATA

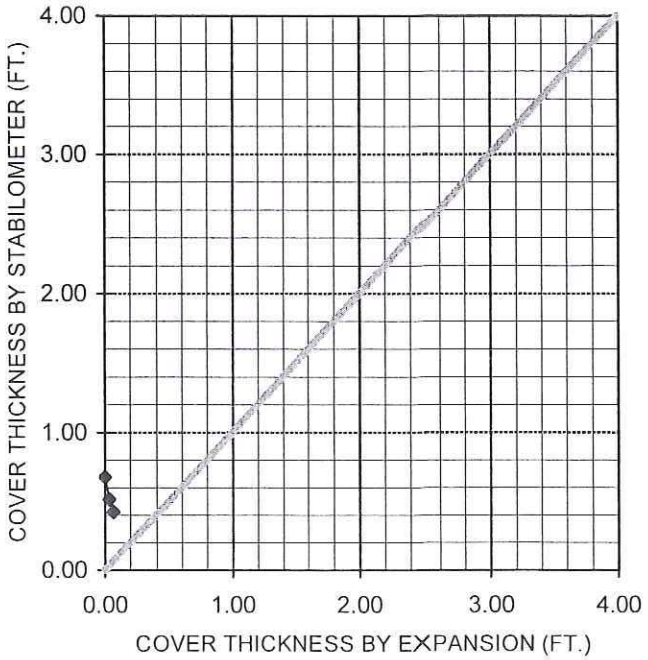
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/14/11
Project Number:	10126	Computed By:	KM	Date:	02/18/11
Boring No.:	A10-040	Checked By:	AP	Date:	03/07/11
Sample No.:	B0	Depth (ft.):	2-5		
Location:					
Soil Description:	Poorly-Graded Sand w/silt				

Mold Number	A	B	C	
Water Added, g	30	45	33	
Compact Moisture(%)	9.4	10.9	9.7	
Compaction Gage Pressure, psi	150	150	150	
Exudation Pressure, psi	759	133	555	
Sample Height, Inches	2.4	2.4	2.4	
Gross Weight Mold, g	3054	3062	3062	
Tare Weight Mold, g	1970	1967	1969	
Net Sample Weight, g	1084	1095	1093	
Expansion, inchesx10^{-4}	2	0	1	
Stability 2,000 (160 psi)	12/18	17/29	14/22	
Turns Displacement	4.61	4.81	4.71	
R-Value Uncorrected	81	70	77	
R-Value Corrected	80	68	76	
Dry Density, pcf	125.1	124.7	125.8	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.42	0.68	0.51	
G.E. by Expansion	0.07	0.00	0.03	

R-VALUE		
	By Exudation:	71
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	71
Remarks	Gf = 1.51, and 0.2 % Retained on the ¾	
	*Not Applicable	





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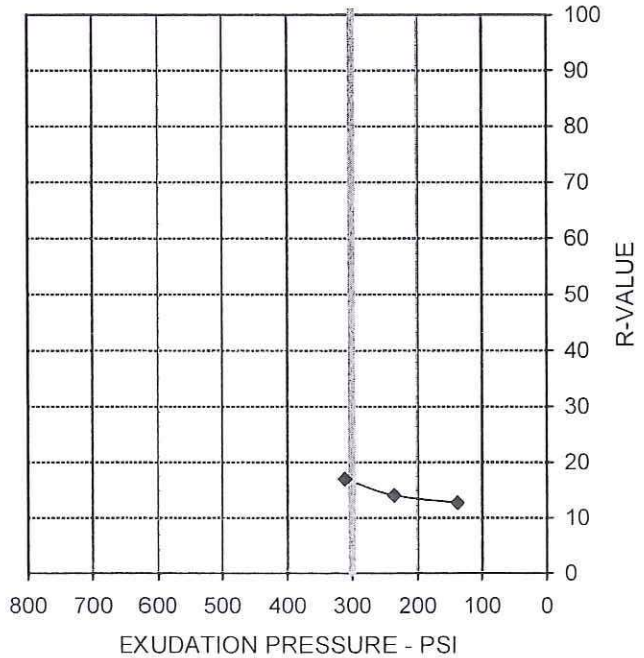
R-VALUE TEST DATA

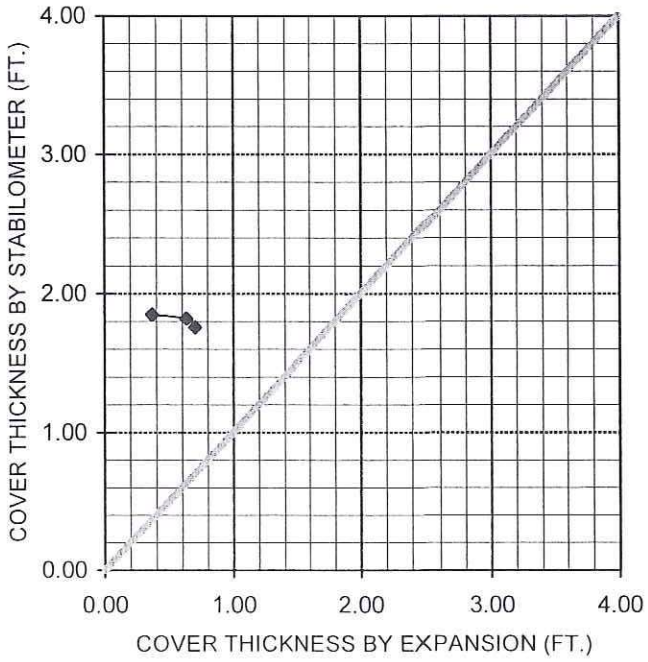
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/14/11
Project Number:	10126	Computed By:	KM	Date:	02/18/11
Boring No.:	A10-043	Checked By:	AP	Date:	03/07/11
Sample No.:	B0	Depth (ft.):	0-5		
Location:					
Soil Description:	Clayey Sand				

Mold Number	E	F	G	
Water Added, g	10	0	-10	
Compact Moisture(%)	18.3	17.2	16.1	
Compaction Gage Pressure, psi	100	100	100	
Exudation Pressure, psi	138	237	311	
Sample Height, Inches	2.6	2.5	2.5	
Gross Weight Mold, g	3019	2926	2879	
Tare Weight Mold, g	1957	1871	1829	
Net Sample Weight, g	1062	1056	1050	
Expansion, inchesx10^{-4}	11	19	21	
Stability 2,000 (160 psi)	58/128	50/124	44/119	
Turns Displacement	4.60	4.45	4.21	
R-Value Uncorrected	12	14	17	
R-Value Corrected	13	14	17	
Dry Density, pcf	104.6	109.2	109.6	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	1.85	1.82	1.76	
G.E. by Expansion	0.37	0.63	0.70	

R-VALUE		
	By Exudation:	16
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	16
Remarks	Gf = 1.51, and 0.2 % Retained on the ¾	
	*Not Applicable	





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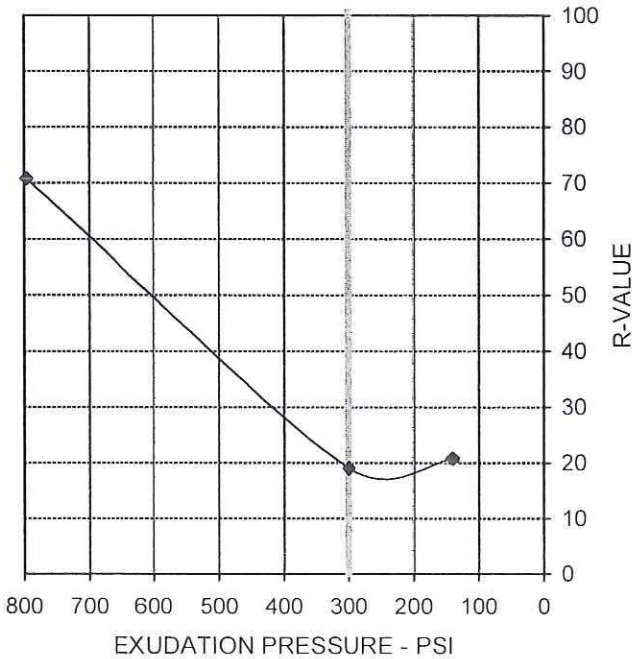
R-VALUE TEST DATA

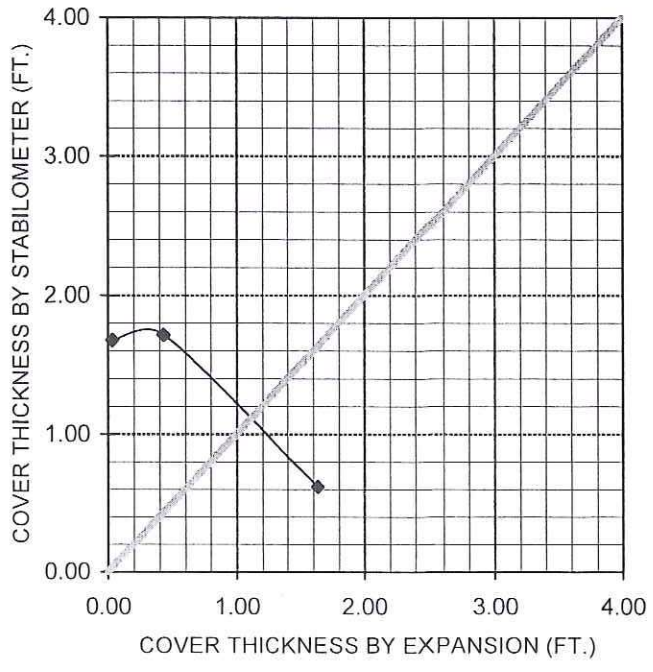
ASTM D2844

Project Name: SR-91 WB Widening | Tested By: ST | Date: 02/16/11
Project Number: 10126 | Computed By: KM | Date: 02/22/11
Boring No.: A10-044 | Checked By: AP | Date: 03/07/11
Sample No.: B-0 | Depth (ft.): 3-5
Location:
Soil Description: Clayey Sand

Mold Number	G	H	I	
Water Added, g	-20	0	-6	
Compact Moisture(%)	11.1	13.2	12.6	
Compaction Gage Pressure, psi	250	100	120	
Exudation Pressure, psi	796	140	299	
Sample Height, Inches	2.3	2.4	2.4	
Gross Weight Mold, g	2875	2888	2896	
Tare Weight Mold, g	1829	1820	1838	
Net Sample Weight, g	1046	1068	1058	
Expansion, inchesx10^{-4}	49	1	13	
Stability 2,000 (160 psi)	16/32	46/108	52/118	
Turns Displacement	3.57	4.22	3.64	
R-Value Uncorrected	74	22	20	
R-Value Corrected	71	21	19	
Dry Density, pcf	124.0	119.0	118.6	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.62	1.68	1.71	
G.E. by Expansion	1.63	0.03	0.43	

R-VALUE		
	By Exudation:	19
	By Expansion:	48
	At Equilibrium: (by Exudation)	19
Remarks	Gf = 1.51, and 0.2 % Retained on the ¾	





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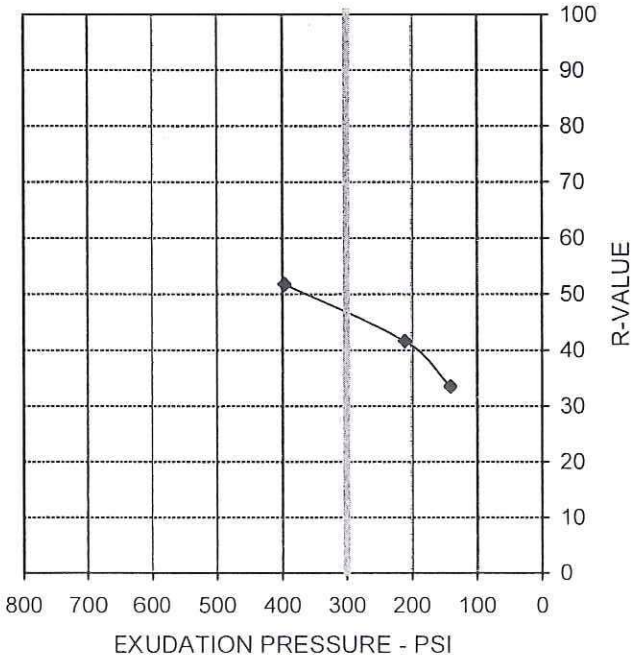
R-VALUE TEST DATA

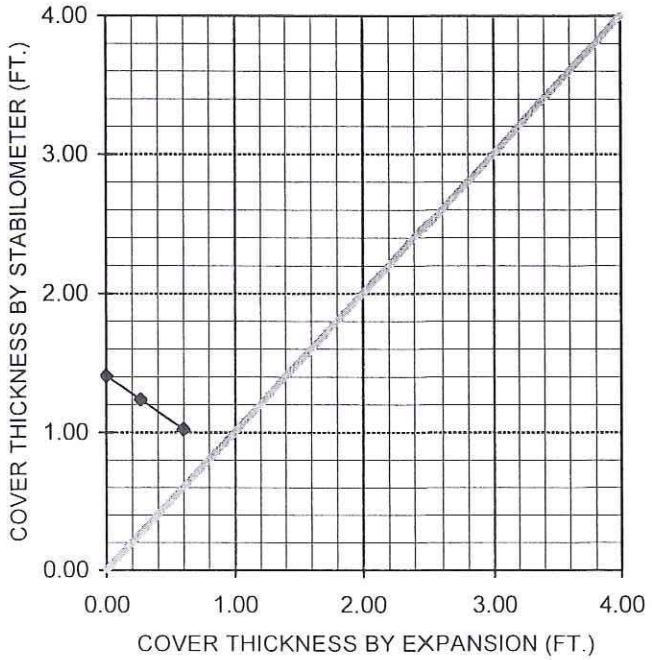
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/15/11
Project Number:	10126	Computed By:	KM	Date:	02/18/11
Boring No.:	A10-047	Checked By:	AP	Date:	03/07/11
Sample No.:	B0	Depth (ft.):	0-5		
Location:					
Soil Description:	Poorly-Graded Sand w/silt				

Mold Number	E	F	G	
Water Added, g	13	0	-20	
Compact Moisture(%)	13.3	12.0	9.9	
Compaction Gage Pressure, psi	150	250	250	
Exudation Pressure, psi	140	211	396	
Sample Height, Inches	2.5	2.5	2.5	
Gross Weight Mold, g	3030	2933	2874	
Tare Weight Mold, g	1957	1871	1829	
Net Sample Weight, g	1073	1062	1045	
Expansion, inchesx10^{-4}	0	8	18	
Stability 2,000 (160 psi)	37/85	32/71	23/55	
Turns Displacement	4.38	4.40	4.45	
R-Value Uncorrected	33	42	52	
R-Value Corrected	33	42	52	
Dry Density, pcf	114.7	115.0	115.3	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	1.41	1.24	1.02	
G.E. by Expansion	0.00	0.27	0.60	

R-VALUE	By Exudation:	47
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	47
Remarks	Gf = 1.51, and 0.0 % Retained on the ¾	
	*Not Applicable	





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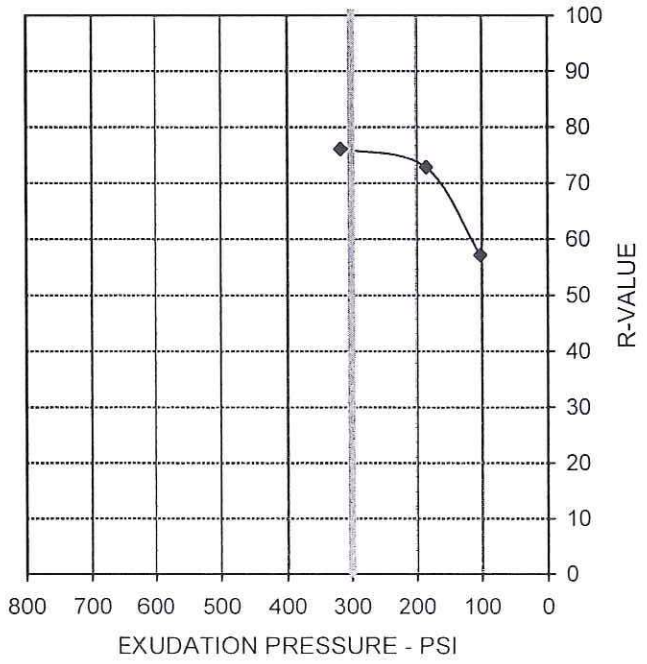
R-VALUE TEST DATA

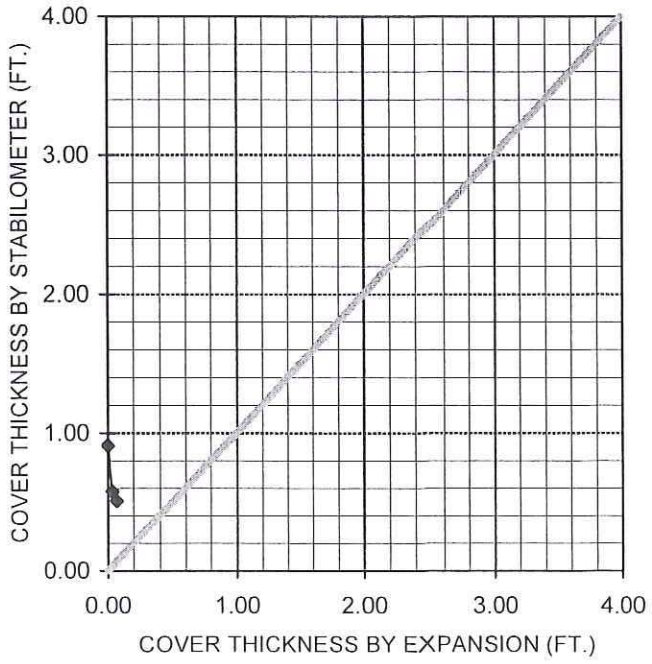
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/15/11
Project Number:	10126	Computed By:	KM	Date:	02/18/11
Boring No.:	A10-049	Checked By:	AP	Date:	03/07/11
Sample No.:	B-0	Depth (ft.):	0-5		
Location:					
Soil Description:	Poorly-Graded Sand w/silt				

Mold Number	A	B	C	
Water Added, g	0	-13	-18	
Compact Moisture(%)	12.2	10.8	10.3	
Compaction Gage Pressure, psi	250	250	250	
Exudation Pressure, psi	102	185	317	
Sample Height, Inches	2.5	2.5	2.5	
Gross Weight Mold, g	3063	3053	3051	
Tare Weight Mold, g	1970	1967	1969	
Net Sample Weight, g	1093	1086	1082	
Expansion, inchesx10^{-4}	0	1	2	
Stability 2,000 (160 psi)	26/48	16/28	13/25	
Turns Displacement	4.38	4.40	4.25	
R-Value Uncorrected	57	73	76	
R-Value Corrected	57	73	76	
Dry Density, pcf	118.1	118.7	118.9	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.91	0.58	0.51	
G.E. by Expansion	0.00	0.03	0.07	

R-VALUE	By Exudation:	76
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	76
Remarks	Gf = 1.51, and 1.0 % Retained on the ¾	
	*Not Applicable	





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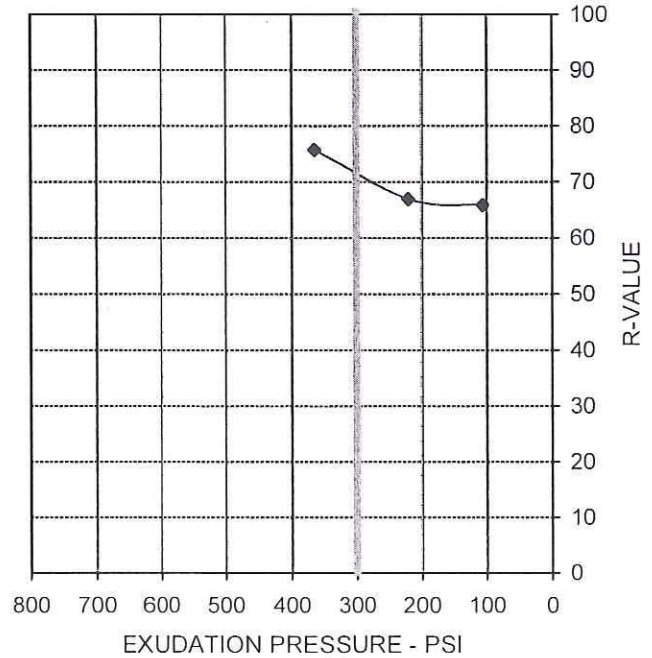
R-VALUE TEST DATA

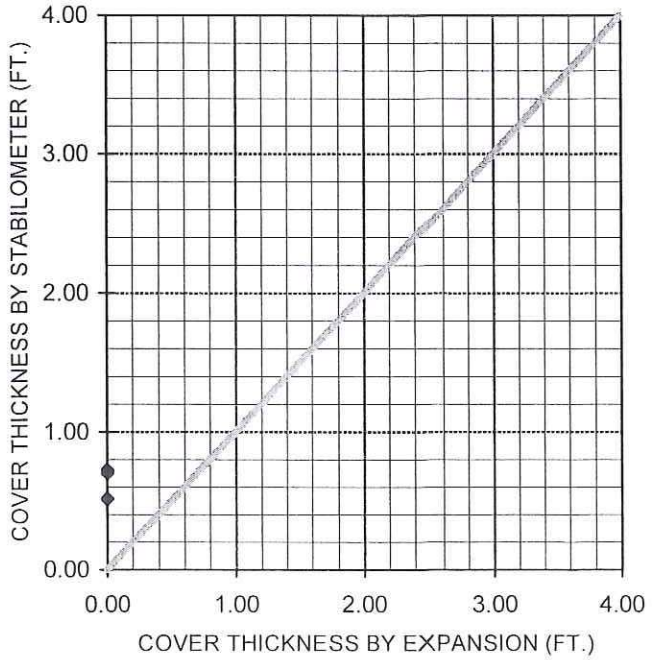
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/17/11
Project Number:	10126	Computed By:	KM	Date:	02/22/11
Boring No.:	A10-052	Checked By:	AP	Date:	03/07/11
Sample No.:	B-0	Depth (ft.):	2-5		
Location:					
Soil Description:	Poorly Graded Sand with silt				

Mold Number	A	B	C	
Water Added, g	36	40	38	
Compact Moisture(%)	9.4	9.8	9.6	
Compaction Gage Pressure, psi	250	250	250	
Exudation Pressure, psi	364	106	220	
Sample Height, Inches	2.4	2.4	2.4	
Gross Weight Mold, g	3069	3071	3076	
Tare Weight Mold, g	1969	1967	1968	
Net Sample Weight, g	1099	1105	1108	
Expansion, inchesx10^{-4}	0	0	0	
Stability 2,000 (160 psi)	14/23	20/34	18/33	
Turns Displacement	4.45	4.30	4.38	
R-Value Uncorrected	77	68	69	
R-Value Corrected	76	66	67	
Dry Density, pcf	126.8	127.0	127.6	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.51	0.72	0.70	
G.E. by Expansion	0.00	0.00	0.00	

R-VALUE		
	By Exudation:	72
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	72
Remarks	Gf = 1.51, and 1.0 % Retained on the ¾	
	*Not Applicable	





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R-VALUE TEST DATA

ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/18/11
Project Number:	10126	Computed By:	KM	Date:	02/22/11
Boring No.:	A10-055	Checked By:	AP	Date:	03/07/11
Sample No.:	B-0	Depth (ft.):	2-5		
Location:					
Soil Description:	Poorly-Graded Sand w/silt & gravel				

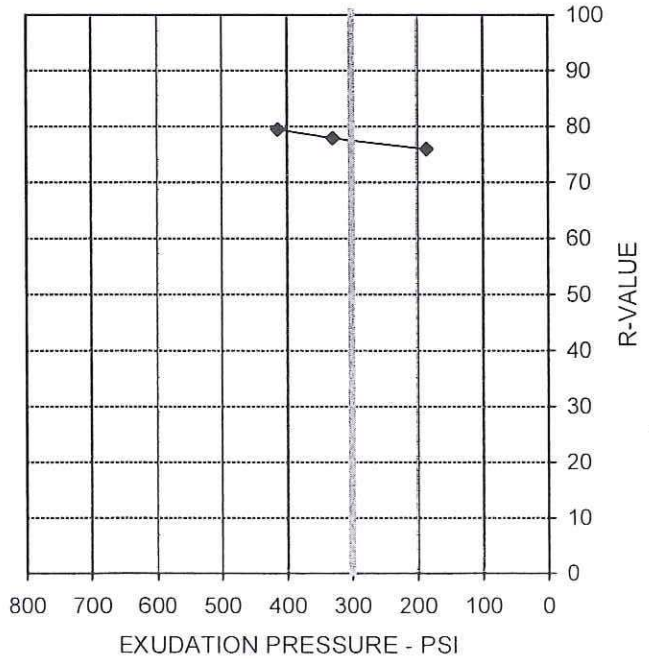
Mold Number	D	E	F	
Water Added, g	10	5	7	
Compact Moisture(%)	9.1	8.6	8.8	
Compaction Gage Pressure, psi	250	250	250	
Exudation Pressure, psi	186	414	329	
Sample Height, Inches	2.5	2.5	2.4	
Gross Weight Mold, g	3075	3059	2978	
Tare Weight Mold, g	1970	1957	1871	
Net Sample Weight, g	1105	1102	1107	
Expansion, inches$\times 10^{-4}$	0	2	1	
Stability 2,000 (160 psi)	16/26	13/21	14/22	
Turns Displacement	4.09	4.28	4.20	
R-Value Uncorrected	76	79	79	
R-Value Corrected	76	79	78	
Dry Density, pcf	122.7	123.0	128.4	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.51	0.43	0.47	
G.E. by Expansion	0.00	0.07	0.03	

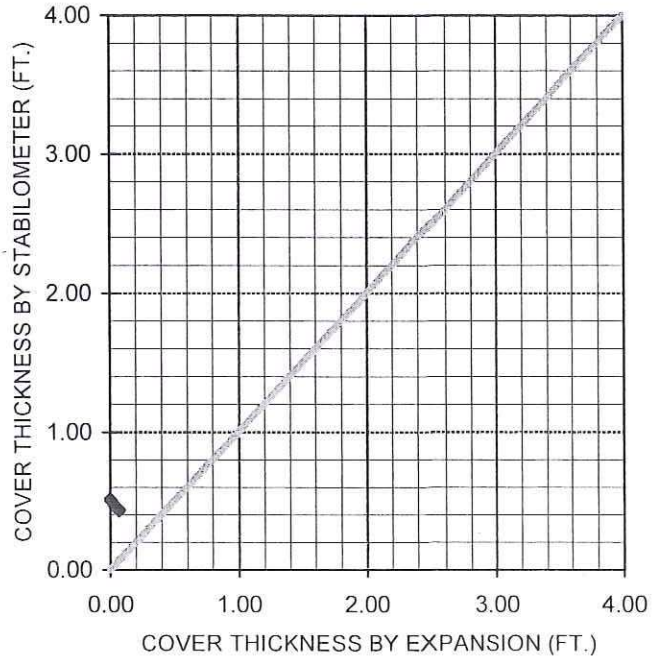
R-VALUE		
	By Exudation:	78
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	78

Remarks

Gf = 1.51, and 2.2 % Retained on the ¾

*Not Applicable





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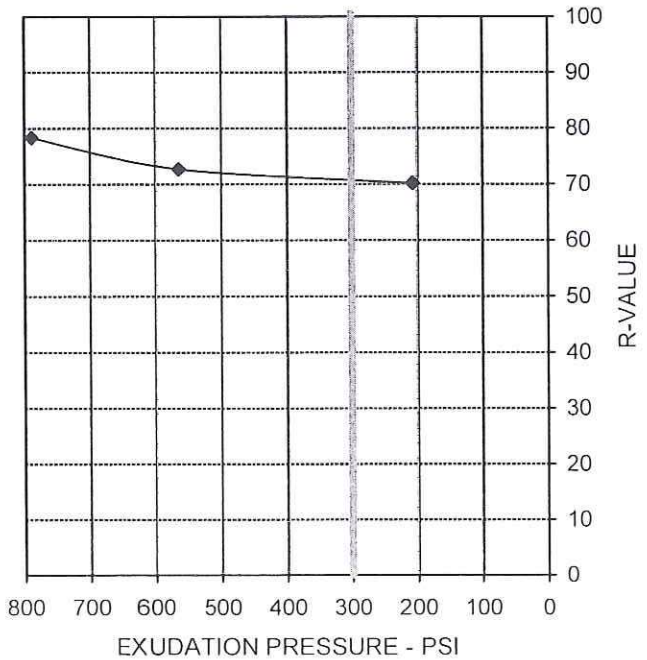
R-VALUE TEST DATA

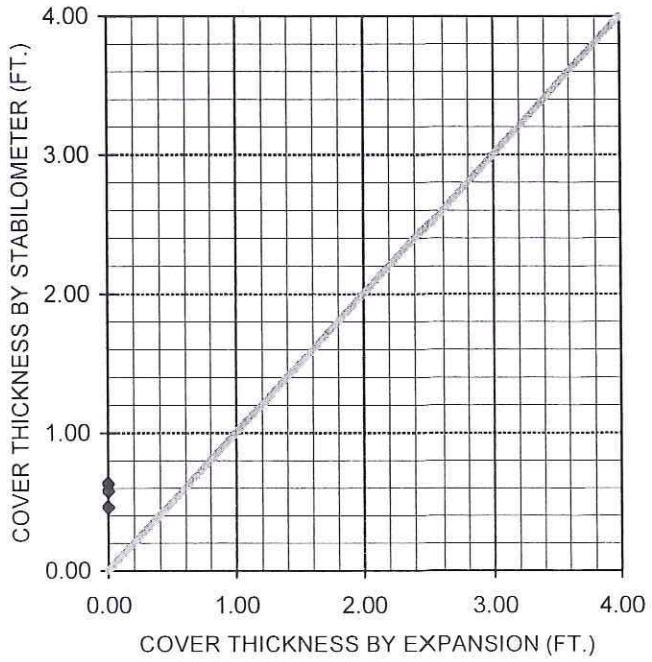
ASTM D2844

Project Name: SR-91 WB Widening — Tested By: ST — Date: 02/17/11
Project Number: 10126 — Computed By: KM — Date: 02/22/11
Boring No.: A10-059 — Checked By: AP — Date: 03/07/11
Sample No.: B-0 — Depth (ft.): 2-5
Location:
Soil Description: Poorly-Graded Sand w/silt

Mold Number	C	F	X	
Water Added, g	27	14	32	
Compact Moisture(%)	9.4	8.1	9.9	
Compaction Gage Pressure, psi	250	250	250	
Exudation Pressure, psi	564	789	207	
Sample Height, Inches	2.5	2.5	2.5	
Gross Weight Mold, g	3088	2978	3235	
Tare Weight Mold, g	1968	1871	2110	
Net Sample Weight, g	1120	1108	1125	
Expansion, inchesx10^{-4}	0	0	0	
Stability 2,000 (160 psi)	16/26	12/20	17/29	
Turns Displacement	4.85	4.86	4.80	
R-Value Uncorrected	73	78	70	
R-Value Corrected	73	78	70	
Dry Density, pcf	124.0	124.1	124.0	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.58	0.46	0.63	
G.E. by Expansion	0.00	0.00	0.00	

R-VALUE		
	By Exudation:	71
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	71
Remarks	Gf = 1.51, and 1.2 % Retained on the ¾	
	*Not Applicable	





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AP Engineering & Testing, Inc.

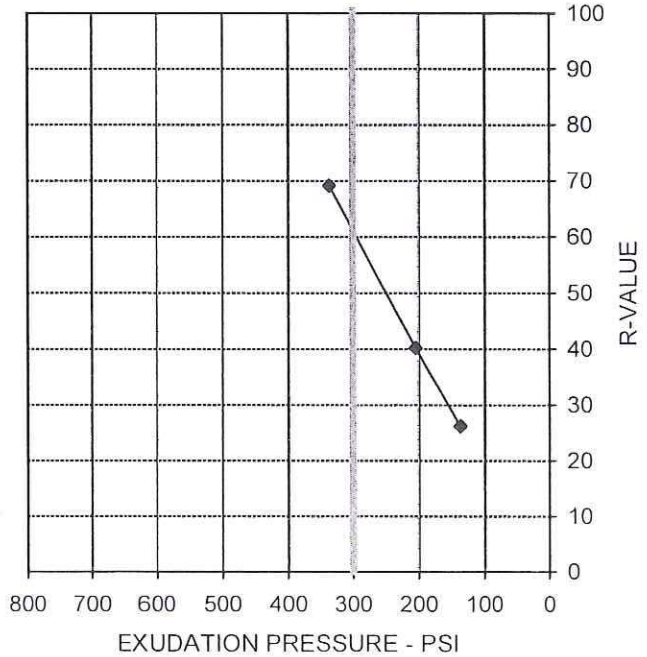
R-VALUE TEST DATA

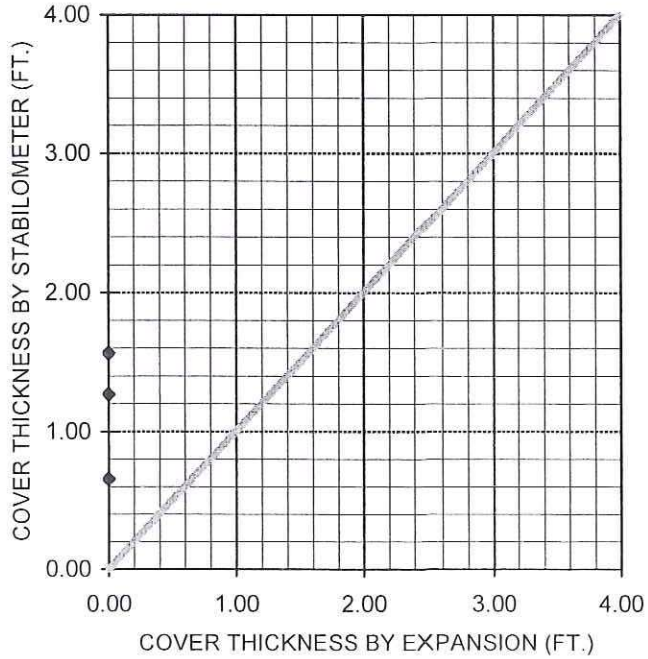
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/20/11
Project Number:	10126	Computed By:	KM	Date:	02/22/11
Boring No.:	A10-061	Checked By:	AP	Date:	03/07/11
Sample No.:	B-0	Depth (ft.):	1.5-5		
Location:					
Soil Description:	Poorly-Graded Sand with silt				

Mold Number	G	H	I	
Water Added, g	30	20	10	
Compact Moisture(%)	10.8	9.8	8.8	
Compaction Gage Pressure, psi	100	250	300	
Exudation Pressure, psi	136	205	336	
Sample Height, Inches	2.4	2.4	2.4	
Gross Weight Mold, g	2933	2917	2927	
Tare Weight Mold, g	1829	1821	1839	
Net Sample Weight, g	1104	1097	1088	
Expansion, inchesx10^{-4}	0	0	0	
Stability 2,000 (160 psi)	44/98	32/73	18/32	
Turns Displacement	4.14	4.00	4.04	
R-Value Uncorrected	28	43	71	
R-Value Corrected	26	40	69	
Dry Density, pcf	125.8	126.1	126.3	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	1.56	1.27	0.65	
G.E. by Expansion	0.00	0.00	0.00	

R-VALUE	By Exudation:	61
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	61
Remarks	Gf = 1.51, and 3.7 % Retained on the ¾ *Not Applicable	





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AP Engineering & Testing, Inc.

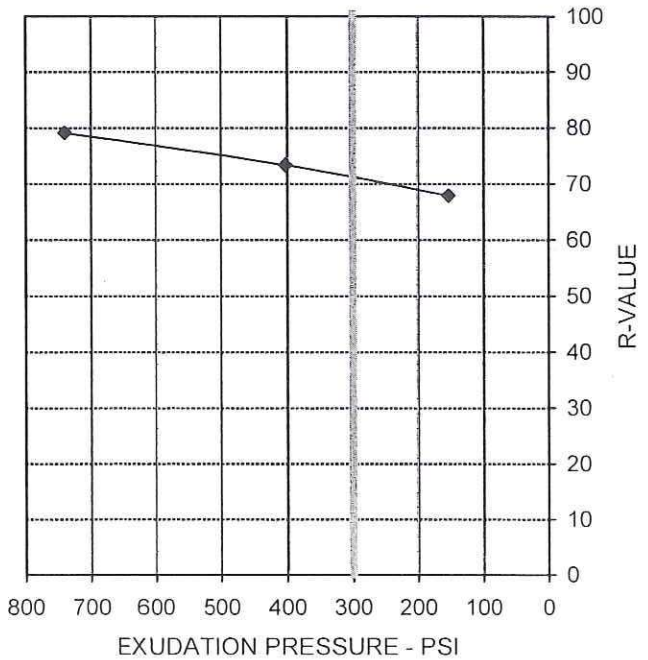
R-VALUE TEST DATA

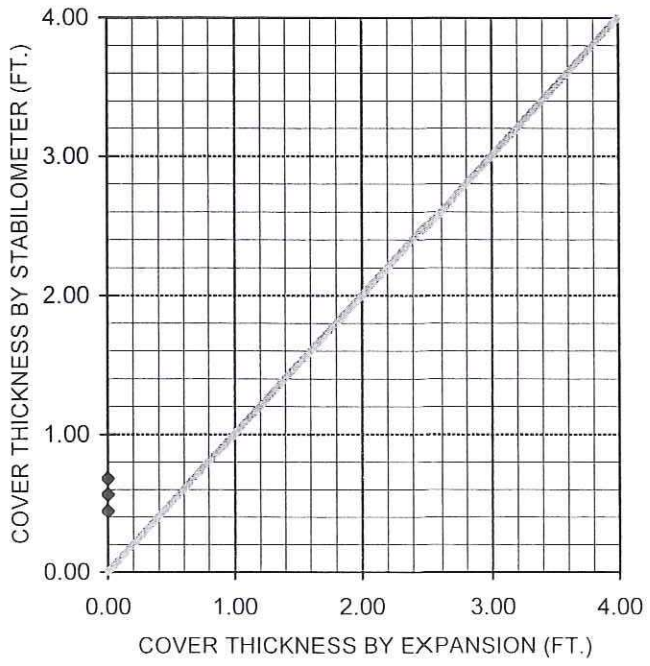
ASTM D2844

Project Name: SR-91 WB Widening Tested By: ST Date: 02/18/11
Project Number: 10126 Computed By: KM Date: 02/22/11
Boring No.: A10-064 Checked By: AP Date: 03/07/11
Sample No.: B-0 Depth (ft.): 2-5
Location:
Soil Description: Poorly-Graded Sand w/silt

Mold Number	A	B	C	
Water Added, g	25	37	45	
Compact Moisture(%)	8.3	9.5	10.3	
Compaction Gage Pressure, psi	250	250	250	
Exudation Pressure, psi	740	403	153	
Sample Height, Inches	2.5	2.5	2.5	
Gross Weight Mold, g	3060	3068	3075	
Tare Weight Mold, g	1970	1967	1969	
Net Sample Weight, g	1090	1101	1106	
Expansion, inches$x10^{-4}$	0	0	0	
Stability 2,000 (160 psi)	12/20	16/26	18/30	
Turns Displacement	4.62	4.68	5.12	
R-Value Uncorrected	79	73	68	
R-Value Corrected	79	73	68	
Dry Density, pcf	122.0	121.9	121.6	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.44	0.56	0.68	
G.E. by Expansion	0.00	0.00	0.00	

R-VALUE		
	By Exudation:	71
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	71
Remarks	Gf = 1.51, and 0.5 % Retained on the ¾ *Not Applicable	





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AP Engineering & Testing, Inc.

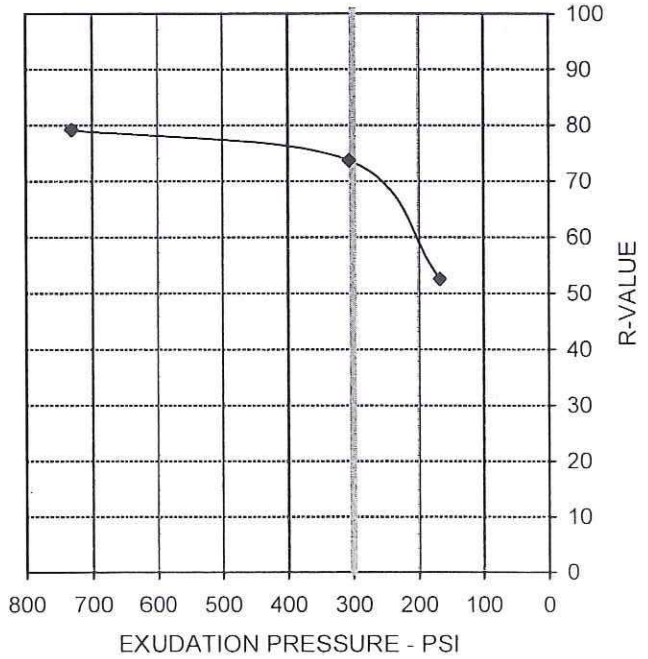
R-VALUE TEST DATA

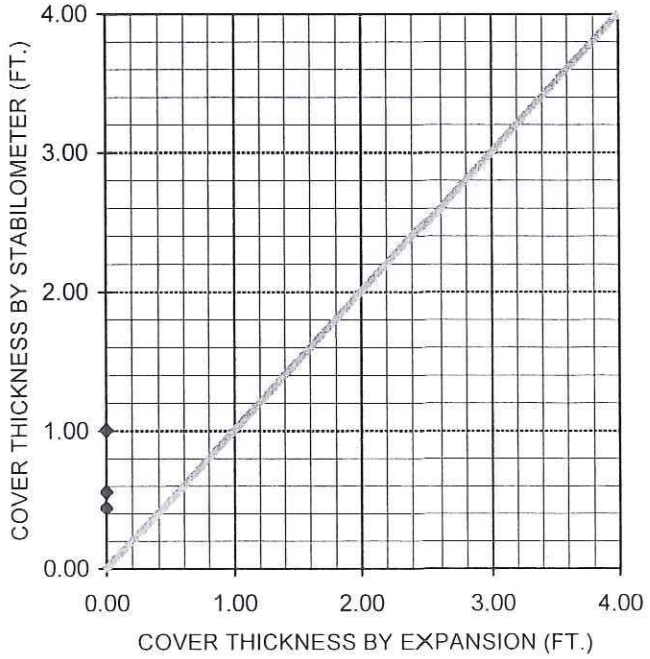
ASTM D2844

Project Name: SR-91 WB Widening — Tested By: ST — Date: 02/19/11
Project Number: 10126 — Computed By: KM — Date: 02/22/11
Boring No.: A10-066 — Checked By: AP — Date: 03/07/11
Sample No.: B-0 — Depth (ft.): 0-2
Location:
Soil Description: Poorly-Graded Sand w/silt

Mold Number	A	B	C	
Water Added, g	46	36	31	
Compact Moisture(%)	10.1	9.2	8.7	
Compaction Gage Pressure, psi	250	250	250	
Exudation Pressure, psi	167	306	730	
Sample Height, Inches	2.5	2.5	2.5	
Gross Weight Mold, g	3101	3091	3087	
Tare Weight Mold, g	1970	1967	1969	
Net Sample Weight, g	1131	1124	1118	
Expansion, inchesx10^{-4}	0	0	0	
Stability 2,000 (160 psi)	28/51	15/26	12/20	
Turns Displacement	4.83	4.60	4.60	
R-Value Uncorrected	53	74	79	
R-Value Corrected	53	74	79	
Dry Density, pcf	124.5	124.8	124.7	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	1.00	0.56	0.44	
G.E. by Expansion	0.00	0.00	0.00	

R-VALUE		
	By Exudation:	73
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	73
Remarks	Gf = 1.51, and 0.7 % Retained on the ¾ *Not Applicable	





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AP Engineering & Testing, Inc.

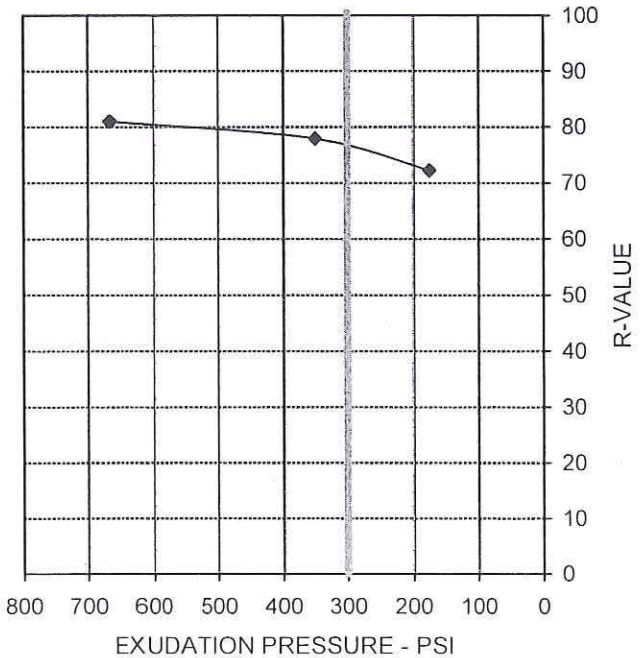
R-VALUE TEST DATA

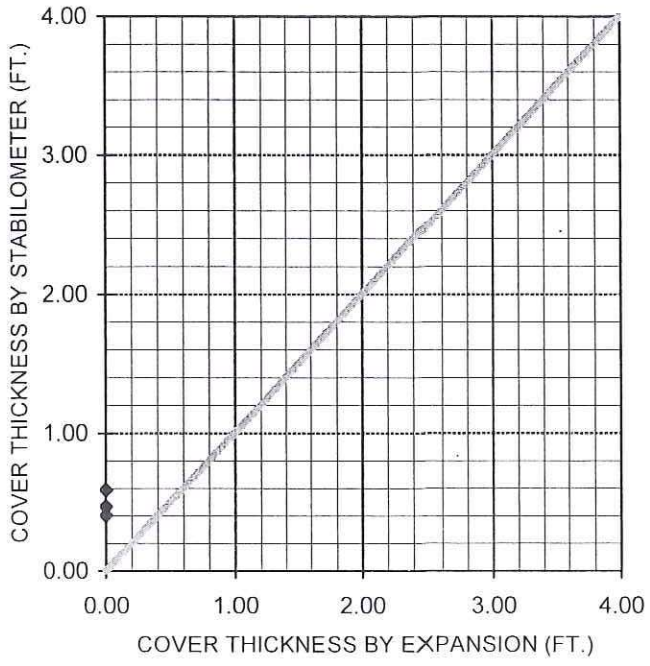
ASTM D2844

Project Name:	SR-91 WB Widening	Tested By:	ST	Date:	02/19/11
Project Number:	10126	Computed By:	KM	Date:	02/22/11
Boring No.:	A10-068	Checked By:	AP	Date:	03/07/11
Sample No.:	B-0	Depth (ft.):	2-5		
Location:					
Soil Description:	Poorly-Graded Sand w/silt				

Mold Number	D	E	F	
Water Added, g	25	35	30	
Compact Moisture(%)	7.5	8.5	8.0	
Compaction Gage Pressure, psi	250	250	250	
Exudation Pressure, psi	667	175	350	
Sample Height, Inches	2.4	2.5	2.4	
Gross Weight Mold, g	3061	3059	2966	
Tare Weight Mold, g	1971	1957	1871	
Net Sample Weight, g	1090	1102	1096	
Expansion, inches$\times 10^{-4}$	0	0	0	
Stability 2,000 (160 psi)	12/17	16/26	12/20	
Turns Displacement	4.75	4.96	4.78	
R-Value Uncorrected	82	72	79	
R-Value Corrected	81	72	78	
Dry Density, pcf	128.0	123.0	128.1	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.40	0.59	0.47	
G.E. by Expansion	0.00	0.00	0.00	

R-VALUE		
	By Exudation:	77
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	77
Remarks	Gf = 1.51, and 3.8 % Retained on the ¾	
	*Not Applicable	





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AP Engineering & Testing, Inc.

R-VALUE TEST DATA

ASTM D2844

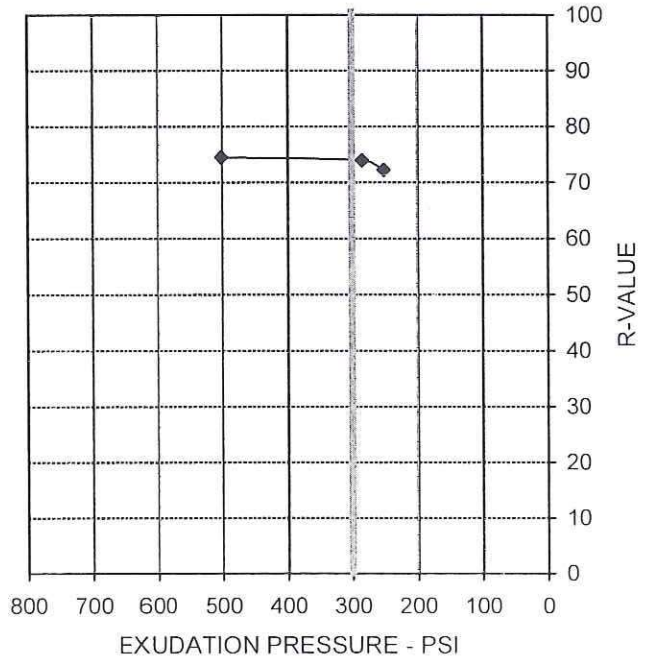
Project Name: RBF/W/B SR-91 Widening Tested By: ST Date: 05/18/11
Project Number: 10-126 Computed By: KM Date: 05/19/11
Boring No.: A-11-069 Checked By: AP Date: 06/08/11
Sample No.: B-0 Depth (ft.): 0-4
Location:
Soil Description: Silty Sand w/gravel

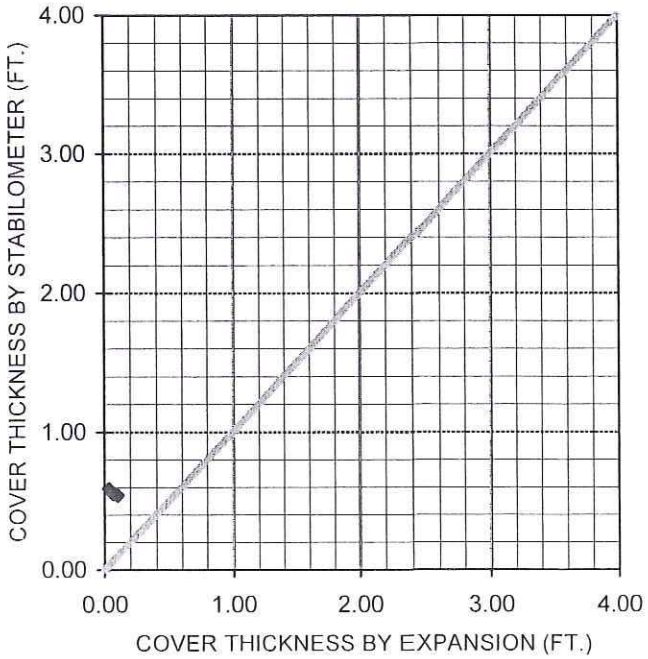
Mold Number	D	F	E	
Water Added, g	41	45	50	
Compact Moisture(%)	9.0	9.4	9.9	
Compaction Gage Pressure, psi	250	200	150	
Exudation Pressure, psi	501	284	251	
Sample Height, Inches	2.5	2.5	2.5	
Gross Weight Mold, g	3078	2963	3052	
Tare Weight Mold, g	1971	1871	1957	
Net Sample Weight, g	1108	1092	1095	
Expansion, inches$\times 10^{-4}$	3	2	1	
Stability 2,000 (160 psi)	18/28	17/27	16/29	
Turns Displacement	4.04	4.35	4.35	
R-Value Uncorrected	74	74	72	
R-Value Corrected	74	74	72	
Dry Density, pcf	123.2	121.0	120.8	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.54	0.55	0.59	
G.E. by Expansion	0.10	0.07	0.03	

R-VALUE		
	By Exudation:	74
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	74

Remarks: Gf = 1.51, and 3.9 % Retained on the ¾

*Not Applicable





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AP Engineering & Testing, Inc.

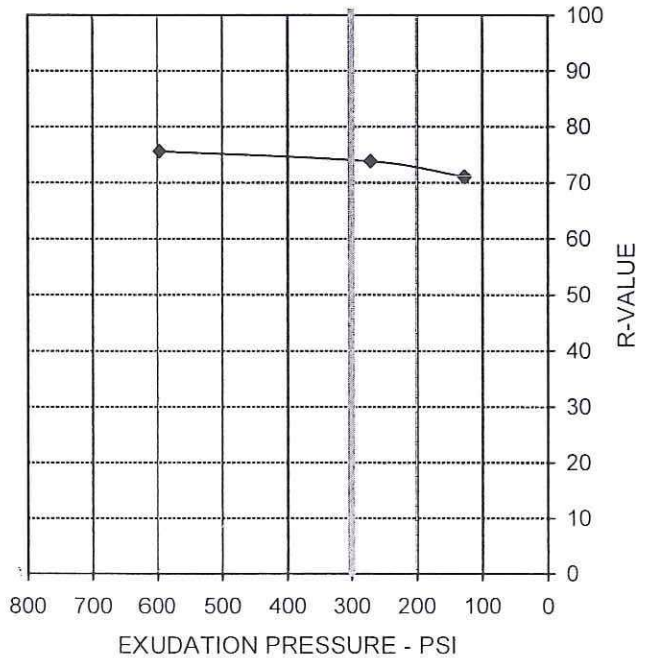
R-VALUE TEST DATA

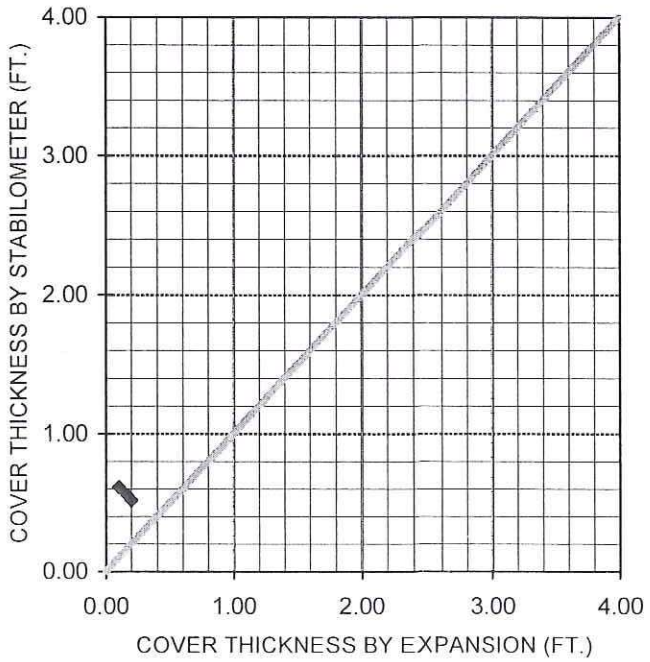
ASTM D2844

Project Name:	RBF/W/B SR-91 Widening	Tested By:	ST	Date:	05/18/11
Project Number:	10-126	Computed By:	KM	Date:	05/19/11
Boring No.:	A-11-071	Checked By:	AP	Date:	06/08/11
Sample No.:	B-0	Depth (ft.):	0-4		
Location:					
Soil Description:	Silty Sand				

Mold Number	G	I	H	
Water Added, g	62	55	50	
Compact Moisture(%)	11.4	10.7	10.2	
Compaction Gage Pressure, psi	150	150	150	
Exudation Pressure, psi	127	271	597	
Sample Height, Inches	2.6	2.6	2.6	
Gross Weight Mold, g	2934	2933	2915	
Tare Weight Mold, g	1829	1839	1821	
Net Sample Weight, g	1105	1095	1094	
Expansion, inches$\times 10^{-4}$	3	5	6	
Stability 2,000 (160 psi)	21/36	18/32	18/30	
Turns Displacement	3.88	3.97	3.83	
R-Value Uncorrected	69	72	74	
R-Value Corrected	71	74	76	
Dry Density, pcf	115.6	115.3	115.8	
Traffic Index	10.0	10.0	10.0	
G.E. by Stability	0.61	0.55	0.52	
G.E. by Expansion	0.10	0.17	0.20	

R-VALUE		
	By Exudation:	74
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	74
Remarks	Gf = 1.51, and 0.3 % Retained on the ¾ *Not Applicable	





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Appendix C

DESIGN CALCULATIONS

CALFP Ver. 1.1

Unit System = E

Title: SR-91 WB Mainline Aux Lane Undrained
Traffic Index (TI) = 14.0
R.Value of Subgrade (Native Soil) = 40
Required GE = 0002.69 ft

Base Type = AB-Class 2

Base Gravel Factor = 0001.10
Base R.Value = 0078.00
0.0032*TI*(100-R.VALUE) = 0000.99 ft
Base MAX. depth = 0002.00 ft
Base MIN. depth = 0000.35 ft

Depth (ft)	GF	GE (ft)	Depth (ft)	GF	GE (ft)
00.10	01.52	00.15	00.15	01.52	00.23
00.20	01.52	00.30	00.25	01.52	00.38
00.30	01.52	00.46	00.35	01.52	00.53
00.40	01.52	00.61	00.45	01.52	00.68
00.50	01.52	00.76	00.55	01.53	00.84
00.60	01.58	00.95	00.65	01.62	01.05
00.70	01.66	01.16	00.75	01.70	01.28
00.80	01.74	01.39	00.85	01.77	01.50
00.90	01.81	01.63	00.95	01.84	01.75
01.00	01.87	01.87	01.05	01.90	02.00
01.10	01.93	02.12	01.15	01.96	02.25
01.20	01.99	02.39	01.25	02.02	02.53
01.30	02.04	02.65	01.35	02.07	02.79
01.40	02.09	02.93	01.45	02.12	03.07
01.50	02.14	03.21	01.55	02.17	03.36
01.60	02.19	03.50	01.65	02.21	03.65
01.70	02.23	03.79	01.75	02.25	03.94
01.80	02.28	04.10	01.85	02.30	04.26
01.90	02.32	04.41	01.95	02.34	04.56
02.00	02.36	04.72	02.05	02.38	04.88

HMA Safety Factor (GE) = 0000.20 ft
HMA Ultimate Depth = 0002.00 ft
(HMA MAX. Depth shown in Table)

HMA MIN. Depth (from Base) = 0000.20 ft

HMA MIN. Depth (selected) = 0000.20 ft

Note: Positive Residual GE indicates over-design.
Note: Negative Safety Factor in Base

HMA ft	TPB ft	T-Base ft	B-Base ft	Subbase ft	Res-GE ft	Cost $/y^2	HMA-GF ft
00.70	00.00	01.40	00.00	00.00	00.01	0000.00	01.66
00.75	00.00	01.30	00.00	00.00	00.02	0000.00	01.70
00.80	00.00	01.20	00.00	00.00	00.02	0000.00	01.74
00.85	00.00	01.10	00.00	00.00	00.03	0000.00	01.77
00.90	00.00	00.95	00.00	00.00	-00.01	0000.00	01.81
00.95	00.00	00.85	00.00	00.00	-00.00	0000.00	01.84
01.00	00.00	00.75	00.00	00.00	00.01	0000.00	01.87
01.05	00.00	00.65	00.00	00.00	00.02	0000.00	01.90
01.10	00.00	00.50	00.00	00.00	-00.01	0000.00	01.93
01.15	00.00	00.40	00.00	00.00	00.01	0000.00	01.96
01.20	00.00	00.35	00.00	00.00	00.09	0000.00	01.99
01.25	00.00	00.35	00.00	00.00	00.22	0000.00	02.02
01.30	00.00	00.35	00.00	00.00	00.35	0000.00	02.04

***** FINISH *****

CALFP Ver. 1.1

Unit System = E

Title: SR-91 WB Mainline Aux Lane Undrained
Traffic Index (TI) = 14.0
R.Value of Subgrade (Native Soil) = 20
Required GE = 0003.58 ft

Base Type = AB-Class 2

Base Gravel Factor = 0001.10
Base R.Value = 0078.00
0.0032*TI*(100-R.VALUE) = 0000.99 ft
Base MAX. depth = 0002.00 ft
Base MIN. depth = 0000.35 ft

Depth (ft)	GF	GE (ft)	Depth (ft)	GF	GE (ft)
00.10	01.52	00.15	00.15	01.52	00.23
00.20	01.52	00.30	00.25	01.52	00.38
00.30	01.52	00.46	00.35	01.52	00.53
00.40	01.52	00.61	00.45	01.52	00.68
00.50	01.52	00.76	00.55	01.53	00.84
00.60	01.58	00.95	00.65	01.62	01.05
00.70	01.66	01.16	00.75	01.70	01.28
00.80	01.74	01.39	00.85	01.77	01.50
00.90	01.81	01.63	00.95	01.84	01.75
01.00	01.87	01.87	01.05	01.90	02.00
01.10	01.93	02.12	01.15	01.96	02.25
01.20	01.99	02.39	01.25	02.02	02.53
01.30	02.04	02.65	01.35	02.07	02.79
01.40	02.09	02.93	01.45	02.12	03.07
01.50	02.14	03.21	01.55	02.17	03.36

01.60	02.19	03.50	01.65	02.21	03.65
01.70	02.23	03.79	01.75	02.25	03.94
01.80	02.28	04.10	01.85	02.30	04.26
01.90	02.32	04.41	01.95	02.34	04.56
02.00	02.36	04.72	02.05	02.38	04.88

HMA Safety Factor (GE) = 0000.20 ft
HMA Ultimate Depth = 0002.00 ft
(HMA MAX. Depth shown in Table)

HMA MIN. Depth (from Base) = 0000.20 ft

HMA MIN. Depth (selected) = 0000.20 ft

Note: Positive Residual GE indicates over-design.
Note: Negative Safety Factor in Base

HMA ft	TPB ft	T-Base ft	B-Base ft	Subbase ft	Res-GE ft	Cost $/y^2	HMA-GF ft	ft
00.80	00.00	02.00	00.00	00.00	00.01	0000.00	01.74	
00.85	00.00	01.90	00.00	00.00	00.01	0000.00	01.77	
00.90	00.00	01.80	00.00	00.00	00.02	0000.00	01.81	
00.95	00.00	01.65	00.00	00.00	-00.02	0000.00	01.84	
01.00	00.00	01.55	00.00	00.00	-00.01	0000.00	01.87	
01.05	00.00	01.45	00.00	00.00	00.01	0000.00	01.90	
01.10	00.00	01.35	00.00	00.00	00.02	0000.00	01.93	
01.15	00.00	01.20	00.00	00.00	-00.01	0000.00	01.96	
01.20	00.00	01.10	00.00	00.00	00.01	0000.00	01.99	
01.25	00.00	00.95	00.00	00.00	-00.01	0000.00	02.02	
01.30	00.00	00.85	00.00	00.00	00.00	0000.00	02.04	
01.35	00.00	00.70	00.00	00.00	-00.02	0000.00	02.07	
01.40	00.00	00.60	00.00	00.00	00.00	0000.00	02.09	

***** FINISH *****

4/19

CALFP Ver. 1.1

Unit System = E

Mainline, Aux Lane, Drained

Title: SR-91 WB Widening
Traffic Index (TI) = 14.0
R.Value of Subgrade (Native Soil) = 40
Required GE = 0002.69 ft

Base Type = AB-Class 2

Base Gravel Factor = 0001.10
Base R.Value = 0078.00
0.0032*TI*(100-R.VALUE) = 0000.99 ft
Base MAX. depth = 0002.00 ft
Base MIN. depth = 0000.35 ft

TPB Type = ATPB

TPB Gravel Factor = 0001.40
TPB R.Value = 0100.00
0.0032*TI*(100-R.VALUE) = 0000.00 ft
TPB MAX. depth = 0000.25 ft
TPB MIN. depth = 0000.25 ft

Depth (ft)	GF	GE (ft)	Depth (ft)	GF	GE (ft)
00.10	01.52	00.15	00.15	01.52	00.23
00.20	01.52	00.30	00.25	01.52	00.38
00.30	01.52	00.46	00.35	01.52	00.53
00.40	01.52	00.61	00.45	01.52	00.68
00.50	01.52	00.76	00.55	01.53	00.84
00.60	01.58	00.95	00.65	01.62	01.05
00.70	01.66	01.16	00.75	01.70	01.28
00.80	01.74	01.39	00.85	01.77	01.50
00.90	01.81	01.63	00.95	01.84	01.75
01.00	01.87	01.87	01.05	01.90	02.00
01.10	01.93	02.12	01.15	01.96	02.25
01.20	01.99	02.39	01.25	02.02	02.53
01.30	02.04	02.65	01.35	02.07	02.79
01.40	02.09	02.93	01.45	02.12	03.07
01.50	02.14	03.21	01.55	02.17	03.36
01.60	02.19	03.50	01.65	02.21	03.65
01.70	02.23	03.79	01.75	02.25	03.94
01.80	02.28	04.10	01.85	02.30	04.26
01.90	02.32	04.41	01.95	02.34	04.56
02.00	02.36	04.72	02.05	02.38	04.88

HMA Safety Factor (GE) = 0000.20 ft
HMA Ultimate Depth = 0002.00 ft
(HMA MAX. Depth shown in Table)
HMA MIN. Depth (from TPB) = 0000.00 ft
HMA MIN. Depth (from Ratio) = 0000.00 ft

HMA MIN. Depth (selected) = 0000.65 ft

Note: To locate the TPB (Treated Permeable Base) as close as possible to the surface
(to facilitate drainage) you might want to 'sandwich' the TPB somewhere within the HMA.
If so, use the minimum HMA depth shown above for the top layer of the 'sandwich' ft 0.65
and then from the following table select an HMA depth of at least ft 0.8
which will provide a minimum depth of 0.15 ft for the bottom layer.

Note: Positive Residual GE indicates over-design.
Note: Negative Safety Factor in Base
Note: Layer Number and Minimum Layer Ratio (GE) 5 0.380803571428572

HMA ft	TPB ft	T-Base ft	B-Base ft	Subbase ft	Res-GE ft	Cost ft	HMA-GF ft	$/y^2
00.65	00.25	01.15	00.00	00.00	-00.02	0000.00	01.62	
00.70	00.25	01.05	00.00	00.00	-00.02	0000.00	01.66	
00.75	00.25	00.95	00.00	00.00	-00.02	0000.00	01.70	
00.80	00.25	00.85	00.00	00.00	-00.01	0000.00	01.74	
00.85	00.25	00.75	00.00	00.00	-00.01	0000.00	01.77	
00.90	00.25	00.65	00.00	00.00	00.01	0000.00	01.81	
00.95	00.25	00.55	00.00	00.00	00.02	0000.00	01.84	
01.00	00.25	00.45	00.00	00.00	00.03	0000.00	01.87	
01.05	00.25	00.35	00.00	00.00	00.04	0000.00	01.90	
01.10	00.25	00.35	00.00	00.00	00.17	0000.00	01.93	
01.15	00.25	00.35	00.00	00.00	00.30	0000.00	01.96	
01.20	00.25	00.35	00.00	00.00	00.44	0000.00	01.99	
01.25	00.25	00.35	00.00	00.00	00.57	0000.00	02.02	

***** FINISH *****

CALFP Ver. 1.1

Unit System = E

Title: SR-91 WB Widening
Traffic Index (TI) = 14.0
R.Value of Subgrade (Native Soil) = 20
Required GE = 0003.58 ft

Mainline, Aux Lane, Drained

Base Type = AB-Class 2

Base Gravel Factor = 0001.10
Base R.Value = 0078.00
0.0032*TI*(100-R.VALUE) = 0000.99 ft
Base MAX. depth = 0002.00 ft
Base MIN. depth = 0000.35 ft

TPB Type = ATPB

TPB Gravel Factor = 0001.40
TPB R.Value = 0100.00
0.0032*TI*(100-R.VALUE) = 0000.00 ft
TPB MAX. depth = 0000.25 ft
TPB MIN. depth = 0000.25 ft

Depth (ft)	GF	GE (ft)	Depth (ft)	GF	GE (ft)
00.10	01.52	00.15	00.15	01.52	00.23
00.20	01.52	00.30	00.25	01.52	00.38
00.30	01.52	00.46	00.35	01.52	00.53
00.40	01.52	00.61	00.45	01.52	00.68
00.50	01.52	00.76	00.55	01.53	00.84
00.60	01.58	00.95	00.65	01.62	01.05
00.70	01.66	01.16	00.75	01.70	01.28
00.80	01.74	01.39	00.85	01.77	01.50
00.90	01.81	01.63	00.95	01.84	01.75
01.00	01.87	01.87	01.05	01.90	02.00
01.10	01.93	02.12	01.15	01.96	02.25
01.20	01.99	02.39	01.25	02.02	02.53
01.30	02.04	02.65	01.35	02.07	02.79
01.40	02.09	02.93	01.45	02.12	03.07
01.50	02.14	03.21	01.55	02.17	03.36
01.60	02.19	03.50	01.65	02.21	03.65
01.70	02.23	03.79	01.75	02.25	03.94
01.80	02.28	04.10	01.85	02.30	04.26
01.90	02.32	04.41	01.95	02.34	04.56
02.00	02.36	04.72	02.05	02.38	04.88

HMA Safety Factor (GE) = 0000.20 ft
HMA Ultimate Depth = 0002.00 ft
(HMA MAX. Depth shown in Table)
HMA MIN. Depth (from TPB) = 0000.00 ft
HMA MIN. Depth (from Ratio) = 0000.00 ft

HMA MIN. Depth (selected) = 0000.65 ft

Note: To locate the TPB (Treated Permeable Base) as close as possible to the surface
(to facilitate drainage) you might want to 'sandwich' the TPB somewhere within the HMA.
If so, use the minimum HMA depth shown above for the top layer of the 'sandwich' ft 0.65
and then from the following table select an HMA depth of at least ft 0.8
which will provide a minimum depth of 0.15 ft for the bottom layer.

Note: Positive Residual GE indicates over-design.
Note: Negative Safety Factor in Base
Note: Layer Number and Minimum Layer Ratio (GE) 5 0.380803571428572

HMA ft	TPB ft	T-Base ft	B-Base ft	Subbase ft	Res-GE ft	Cost ft	HMA-GF ft	$/y^2
00.65	00.25	02.00	00.00	00.00	00.02	0000.00	01.62	
00.70	00.25	01.90	00.00	00.00	00.02	0000.00	01.66	
00.75	00.25	01.80	00.00	00.00	00.02	0000.00	01.70	
00.80	00.25	01.65	00.00	00.00	-00.03	0000.00	01.74	
00.85	00.25	01.55	00.00	00.00	-00.02	0000.00	01.77	
00.90	00.25	01.45	00.00	00.00	-00.01	0000.00	01.81	
00.95	00.25	01.35	00.00	00.00	-00.00	0000.00	01.84	
01.00	00.25	01.25	00.00	00.00	00.01	0000.00	01.87	
01.05	00.25	01.15	00.00	00.00	00.03	0000.00	01.90	
01.10	00.25	01.00	00.00	00.00	-00.01	0000.00	01.93	
01.15	00.25	00.90	00.00	00.00	00.01	0000.00	01.96	
01.20	00.25	00.75	00.00	00.00	-00.02	0000.00	01.99	
01.25	00.25	00.65	00.00	00.00	00.01	0000.00	02.02	

***** FINISH *****

CALFP Ver. 1.1

Unit System = E

Ramps, Undrained

Title: SR-91 WB Widening
Traffic Index (TI) = 12.0
R.Value of Subgrade (Native Soil) = 40
Required GE = 0002.30 ft

Base Type = AB-Class 2

Base Gravel Factor = 0001.10
Base R.Value = 0078.00
0.0032*TI*(100-R.VALUE) = 0000.84 ft
Base MAX. depth = 0002.00 ft
Base MIN. depth = 0000.35 ft

Depth (ft)	GF	GE (ft)	Depth (ft)	GF	GE (ft)
00.10	01.64	00.16	00.15	01.64	00.25
00.20	01.64	00.33	00.25	01.64	00.41
00.30	01.64	00.49	00.35	01.64	00.57
00.40	01.64	00.66	00.45	01.64	00.74
00.50	01.64	00.82	00.55	01.66	00.91
00.60	01.70	01.02	00.65	01.75	01.14
00.70	01.79	01.25	00.75	01.84	01.38
00.80	01.88	01.50	00.85	01.91	01.62
00.90	01.95	01.76	00.95	01.99	01.89
01.00	02.02	02.02	01.05	02.05	02.15
01.10	02.09	02.30	01.15	02.12	02.44
01.20	02.15	02.58	01.25	02.18	02.73
01.30	02.21	02.87	01.35	02.23	03.01
01.40	02.26	03.16	01.45	02.29	03.32
01.50	02.31	03.47	01.55	02.34	03.63
01.60	02.36	03.78	01.65	02.39	03.94

HMA Safety Factor (GE) = 0000.20 ft
HMA Ultimate Depth = 0001.65 ft
(HMA MAX. Depth shown in Table)

HMA MIN. Depth (from Base) = 0000.20 ft

HMA MIN. Depth (selected) = 0000.20 ft

Note: Positive Residual GE indicates over-design.
Note: Negative Safety Factor in Base

HMA ft	TPB ft	T-Base ft	B-Base ft	Subbase ft	Res-GE ft	Cost ft	HMA-GF ft	$/y^2
00.60	00.00	01.15	00.00	00.00	-00.02	0000.00	01.70	
00.65	00.00	01.05	00.00	00.00	-00.01	0000.00	01.75	
00.70	00.00	00.95	00.00	00.00	-00.01	0000.00	01.79	
00.75	00.00	00.85	00.00	00.00	00.01	0000.00	01.84	
00.80	00.00	00.75	00.00	00.00	00.02	0000.00	01.88	
00.85	00.00	00.60	00.00	00.00	-00.02	0000.00	01.91	
00.90	00.00	00.50	00.00	00.00	00.00	0000.00	01.95	
00.95	00.00	00.40	00.00	00.00	00.03	0000.00	01.99	
01.00	00.00	00.35	00.00	00.00	00.10	0000.00	02.02	
01.05	00.00	00.35	00.00	00.00	00.23	0000.00	02.05	
01.10	00.00	00.35	00.00	00.00	00.38	0000.00	02.09	
01.15	00.00	00.35	00.00	00.00	00.52	0000.00	02.12	

***** FINISH *****

SR91 TI=12.0 R=20 without ATPB.TXT

CALFP Ver. 1.1

Unit System = E

Ramps, Undrained

Title: SR-91 WB Widening
Traffic Index (TI) = 12.0
R.Value of Subgrade (Native Soil) = 20
Required GE = 0003.07 ft

Base Type = AB-Class 2

Base Gravel Factor = 0001.10
Base R.Value = 0078.00
0.0032*TI*(100-R.VALUE) = 0000.84 ft
Base MAX. depth = 0002.00 ft
Base MIN. depth = 0000.35 ft

Depth (ft)	GF	GE (ft)	Depth (ft)	GF	GE (ft)
00.10	01.64	00.16	00.15	01.64	00.25
00.20	01.64	00.33	00.25	01.64	00.41
00.30	01.64	00.49	00.35	01.64	00.57
00.40	01.64	00.66	00.45	01.64	00.74
00.50	01.64	00.82	00.55	01.66	00.91
00.60	01.70	01.02	00.65	01.75	01.14
00.70	01.79	01.25	00.75	01.84	01.38
00.80	01.88	01.50	00.85	01.91	01.62
00.90	01.95	01.76	00.95	01.99	01.89
01.00	02.02	02.02	01.05	02.05	02.15
01.10	02.09	02.30	01.15	02.12	02.44
01.20	02.15	02.58	01.25	02.18	02.73
01.30	02.21	02.87	01.35	02.23	03.01
01.40	02.26	03.16	01.45	02.29	03.32
01.50	02.31	03.47	01.55	02.34	03.63
01.60	02.36	03.78	01.65	02.39	03.94

HMA Safety Factor (GE) = 0000.20 ft
HMA Ultimate Depth = 0001.65 ft
(HMA MAX. Depth shown in Table)

HMA MIN. Depth (from Base) = 0000.20 ft

HMA MIN. Depth (selected) = 0000.20 ft

Note: Positive Residual GE indicates over-design.
Note: Negative Safety Factor in Base

HMA ft	TPB ft	T-Base ft	B-Base ft	Subbase ft	Res-GE ft	Cost ft	HMA-GF ft	$/y^2
00.60	00.00	01.85	00.00	00.00	-00.02	0000.00	01.70	
00.65	00.00	01.75	00.00	00.00	-00.01	0000.00	01.75	
00.70	00.00	01.65	00.00	00.00	-00.00	0000.00	01.79	
00.75	00.00	01.55	00.00	00.00	00.01	0000.00	01.84	
00.80	00.00	01.45	00.00	00.00	00.03	0000.00	01.88	
00.85	00.00	01.30	00.00	00.00	-00.02	0000.00	01.91	
00.90	00.00	01.20	00.00	00.00	00.00	0000.00	01.95	
00.95	00.00	01.05	00.00	00.00	-00.03	0000.00	01.99	
01.00	00.00	00.95	00.00	00.00	-00.01	0000.00	02.02	
01.05	00.00	00.85	00.00	00.00	00.02	0000.00	02.05	
01.10	00.00	00.70	00.00	00.00	-00.00	0000.00	02.09	
01.15	00.00	00.60	00.00	00.00	00.03	0000.00	02.12	
01.20	00.00	00.45	00.00	00.00	00.00	0000.00	02.15	

***** FINISH *****

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CALFP Ver. 1.1

Unit System = E

Ramps, Underground

Title: SR-91 WB Widening
Traffic Index (TI) = 12.0
R.Value of Subgrade (Native Soil) = 16
Required GE = 0003.23 ft

Subbase Type = AB-Class 2

Subbase Gravel Factor = 0001.00
Subbase R.Value = 0050.00
0.0032*TI*(100-R.VALUE) = 0001.92 ft
Subbase MAX. depth = 0005.00 ft
Subbase MIN. depth = 0000.35 ft

Base Type = AB-Class 2

Base Gravel Factor = 0001.10
Base R.Value = 0078.00
0.0032*TI*(100-R.VALUE) = 0000.84 ft
Base MAX. depth = 0002.00 ft
Base MIN. depth = 0000.35 ft

Depth (ft)	GF	GE (ft)	Depth (ft)	GF	GE (ft)
00.10	01.64	00.16	00.15	01.64	00.25
00.20	01.64	00.33	00.25	01.64	00.41
00.30	01.64	00.49	00.35	01.64	00.57
00.40	01.64	00.66	00.45	01.64	00.74
00.50	01.64	00.82	00.55	01.66	00.91
00.60	01.70	01.02	00.65	01.75	01.14
00.70	01.79	01.25	00.75	01.84	01.38
00.80	01.88	01.50	00.85	01.91	01.62
00.90	01.95	01.76	00.95	01.99	01.89
01.00	02.02	02.02	01.05	02.05	02.15
01.10	02.09	02.30	01.15	02.12	02.44
01.20	02.15	02.58	01.25	02.18	02.73
01.30	02.21	02.87	01.35	02.23	03.01
01.40	02.26	03.16	01.45	02.29	03.32
01.50	02.31	03.47	01.55	02.34	03.63
01.60	02.36	03.78	01.65	02.39	03.94

HMA Safety Factor (GE) = 0000.20 ft
HMA Ultimate Depth = 0001.65 ft
(HMA MAX. Depth shown in Table)

HMA MIN. Depth (from Base) = 0000.20 ft

HMA MIN. Depth (selected) = 0000.20 ft

Note: Positive Residual GE indicates over-design.
Note: Negative Safety Factor in Subbase

HMA ft	TPB ft	T-Base ft	B-Base ft	Subbase ft	Res-GE ft	Cost HMA-GF ft	ft	$/y^2
00.60	00.00	01.00	00.00	01.10	-00.01	0000.00	01.70	
00.65	00.00	00.90	00.00	01.10	00.00	0000.00	01.75	
00.70	00.00	00.80	00.00	01.10	00.01	0000.00	01.79	
00.75	00.00	00.65	00.00	01.15	00.02	0000.00	01.84	
00.80	00.00	00.55	00.00	01.10	-00.02	0000.00	01.88	
00.85	00.00	00.45	00.00	01.10	-00.01	0000.00	01.91	
00.90	00.00	00.35	00.00	01.10	00.01	0000.00	01.95	
00.95	00.00	00.35	00.00	00.95	-00.00	0000.00	01.99	
01.00	00.00	00.35	00.00	00.80	-00.02	0000.00	02.02	
01.05	00.00	00.35	00.00	00.70	00.01	0000.00	02.05	
01.10	00.00	00.35	00.00	00.55	00.01	0000.00	02.09	
01.15	00.00	00.35	00.00	00.40	-00.00	0000.00	02.12	
01.20	00.00	00.35	00.00	00.35	00.09	0000.00	02.15	

***** FINISH *****

CALFP Ver. 1.1

Unit System = E

Ramps, Drained

Title: SR-91 WB Widening
Traffic Index (TI) = 12.0
R.Value of Subgrade (Native Soil) = 40
Required GE = 0002.30 ft

Base Type = AB-Class 2

Base Gravel Factor = 0001.10
Base R.Value = 0078.00
0.0032*TI*(100-R.VALUE) = 0000.84 ft
Base MAX. depth = 0002.00 ft
Base MIN. depth = 0000.35 ft

TPB Type = ATPB

TPB Gravel Factor = 0001.40
TPB R.Value = 0100.00
0.0032*TI*(100-R.VALUE) = 0000.00 ft
TPB MAX. depth = 0000.25 ft
TPB MIN. depth = 0000.25 ft

Depth (ft)	GF	GE (ft)	Depth (ft)	GF	GE (ft)
00.10	01.64	00.16	00.15	01.64	00.25
00.20	01.64	00.33	00.25	01.64	00.41
00.30	01.64	00.49	00.35	01.64	00.57
00.40	01.64	00.66	00.45	01.64	00.74
00.50	01.64	00.82	00.55	01.66	00.91
00.60	01.70	01.02	00.65	01.75	01.14
00.70	01.79	01.25	00.75	01.84	01.38
00.80	01.88	01.50	00.85	01.91	01.62
00.90	01.95	01.76	00.95	01.99	01.89
01.00	02.02	02.02	01.05	02.05	02.15
01.10	02.09	02.30	01.15	02.12	02.44
01.20	02.15	02.58	01.25	02.18	02.73
01.30	02.21	02.87	01.35	02.23	03.01
01.40	02.26	03.16	01.45	02.29	03.32
01.50	02.31	03.47	01.55	02.34	03.63
01.60	02.36	03.78	01.65	02.39	03.94

HMA Safety Factor (GE) = 0000.20 ft
HMA Ultimate Depth = 0001.65 ft
(HMA MAX. Depth shown in Table)
HMA MIN. Depth (from TPB) = 0000.00 ft
HMA MIN. Depth (from Ratio) = 0000.00 ft

HMA MIN. Depth (selected) = 0000.60 ft

Note: To locate the TPB (Treated Permeable Base) as close as possible to the surface
(to facilitate drainage) you might want to 'sandwich' the TPB somewhere within the HMA.
If so, use the minimum HMA depth shown above for the top layer of the 'sandwich' ft 0.6
and then from the following table select an HMA depth of at least ft 0.75
which will provide a minimum depth of 0.15 ft for the bottom layer.

Note: Positive Residual GE indicates over-design.
Note: Negative Safety Factor in Base
Note: Layer Number and Minimum Layer Ratio (GE) 5 0.427083333333333

HMA ft	TPB ft	T-Base ft	B-Base ft	Subbase ft	Res-GE ft	Cost HMA-GF ft	ft	$/y^2
00.60	00.25	00.85	00.00	00.00	00.00	0000.00	01.70	
00.65	00.25	00.75	00.00	00.00	00.01	0000.00	01.75	
00.70	00.25	00.65	00.00	00.00	00.01	0000.00	01.79	
00.75	00.25	00.50	00.00	00.00	-00.02	0000.00	01.84	
00.80	00.25	00.40	00.00	00.00	-00.01	0000.00	01.88	
00.85	00.25	00.35	00.00	00.00	00.05	0000.00	01.91	
00.90	00.25	00.35	00.00	00.00	00.19	0000.00	01.95	
00.95	00.25	00.35	00.00	00.00	00.32	0000.00	01.99	
01.00	00.25	00.35	00.00	00.00	00.45	0000.00	02.02	
01.05	00.25	00.35	00.00	00.00	00.58	0000.00	02.05	

***** FINISH *****

CALFP Ver. 1.1

Unit System = E

Ramps, Drained

Title: SR-91 WB Widening
Traffic Index (TI) = 12.0
R.Value of Subgrade (Native Soil) = 20
Required GE = 0003.07 ft

Base Type = AB-Class 2

Base Gravel Factor = 0001.10
Base R.Value = 0078.00
0.0032*TI*(100-R.VALUE) = 0000.84 ft
Base MAX. depth = 0002.00 ft
Base MIN. depth = 0000.35 ft

TPB Type = ATPB

TPB Gravel Factor = 0001.40
TPB R.Value = 0100.00
0.0032*TI*(100-R.VALUE) = 0000.00 ft
TPB MAX. depth = 0000.25 ft
TPB MIN. depth = 0000.25 ft

Depth (ft)	GF	GE (ft)	Depth (ft)	GF	GE (ft)
00.10	01.64	00.16	00.15	01.64	00.25
00.20	01.64	00.33	00.25	01.64	00.41
00.30	01.64	00.49	00.35	01.64	00.57
00.40	01.64	00.66	00.45	01.64	00.74
00.50	01.64	00.82	00.55	01.66	00.91
00.60	01.70	01.02	00.65	01.75	01.14
00.70	01.79	01.25	00.75	01.84	01.38
00.80	01.88	01.50	00.85	01.91	01.62
00.90	01.95	01.76	00.95	01.99	01.89
01.00	02.02	02.02	01.05	02.05	02.15
01.10	02.09	02.30	01.15	02.12	02.44
01.20	02.15	02.58	01.25	02.18	02.73
01.30	02.21	02.87	01.35	02.23	03.01
01.40	02.26	03.16	01.45	02.29	03.32
01.50	02.31	03.47	01.55	02.34	03.63
01.60	02.36	03.78	01.65	02.39	03.94

HMA Safety Factor (GE) = 0000.20 ft
HMA Ultimate Depth = 0001.65 ft
(HMA MAX. Depth shown in Table)
HMA MIN. Depth (from TPB) = 0000.00 ft
HMA MIN. Depth (from Ratio) = 0000.00 ft

HMA MIN. Depth (selected) = 0000.60 ft

Note: To locate the TPB (Treated Permeable Base) as close as possible to the surface
(to facilitate drainage) you might want to 'sandwich' the TPB somewhere within the HMA.
If so, use the minimum HMA depth shown above for the top layer of the 'sandwich' ft 0.6
and then from the following table select an HMA depth of at least ft 0.75
which will provide a minimum depth of 0.15 ft for the bottom layer.

Note: Positive Residual GE indicates over-design.
Note: Negative Safety Factor in Base
Note: Layer Number and Minimum Layer Ratio (GE) 5 0.427083333333333

HMA ft	TPB ft	T-Base ft	B-Base ft	Subbase ft	Res-GE ft	Cost	HMA-GF ft	ft	$/y^2
00.60	00.25	01.55	00.00	00.00	00.00		0000.00	01.70	
00.65	00.25	01.45	00.00	00.00	00.01		0000.00	01.75	
00.70	00.25	01.35	00.00	00.00	00.02		0000.00	01.79	
00.75	00.25	01.20	00.00	00.00	-00.02		0000.00	01.84	
00.80	00.25	01.10	00.00	00.00	-00.01		0000.00	01.88	
00.85	00.25	01.00	00.00	00.00	00.00		0000.00	01.91	
00.90	00.25	00.90	00.00	00.00	00.02		0000.00	01.95	
00.95	00.25	00.75	00.00	00.00	-00.01		0000.00	01.99	
01.00	00.25	00.65	00.00	00.00	00.01		0000.00	02.02	
01.05	00.25	00.50	00.00	00.00	-00.02		0000.00	02.05	
01.10	00.25	00.40	00.00	00.00	00.02		0000.00	02.09	
01.15	00.25	00.35	00.00	00.00	00.10		0000.00	02.12	
01.20	00.25	00.35	00.00	00.00	00.24		0000.00	02.15	

***** FINISH *****

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CALFP Ver. 1.1

Unit System = E

Ramps, Drained

Title: SR-91 WB Widening
Traffic Index (TI) = 12.0
R.Value of Subgrade (Native Soil) = 16
Required GE = 0003.23 ft

Subbase Type = AB-Class 2

Subbase Gravel Factor = 0001.00
Subbase R.Value = 0050.00
0.0032*TI*(100-R.VALUE) = 0001.92 ft
Subbase MAX. depth = 0005.00 ft
Subbase MIN. depth = 0000.35 ft

Base Type = AB-Class 2

Base Gravel Factor = 0001.10
Base R.Value = 0078.00
0.0032*TI*(100-R.VALUE) = 0000.84 ft
Base MAX. depth = 0002.00 ft
Base MIN. depth = 0000.35 ft

TPB Type = ATPB

TPB Gravel Factor = 0001.40
TPB R.Value = 0100.00
0.0032*TI*(100-R.VALUE) = 0000.00 ft
TPB MAX. depth = 0000.25 ft
TPB MIN. depth = 0000.25 ft

Depth (ft)	GF	GE (ft)	Depth (ft)	GF	GE (ft)
00.10	01.64	00.16	00.15	01.64	00.25
00.20	01.64	00.33	00.25	01.64	00.41
00.30	01.64	00.49	00.35	01.64	00.57
00.40	01.64	00.66	00.45	01.64	00.74
00.50	01.64	00.82	00.55	01.66	00.91
00.60	01.70	01.02	00.65	01.75	01.14
00.70	01.79	01.25	00.75	01.84	01.38
00.80	01.88	01.50	00.85	01.91	01.62
00.90	01.95	01.76	00.95	01.99	01.89
01.00	02.02	02.02	01.05	02.05	02.15
01.10	02.09	02.30	01.15	02.12	02.44
01.20	02.15	02.58	01.25	02.18	02.73
01.30	02.21	02.87	01.35	02.23	03.01
01.40	02.26	03.16	01.45	02.29	03.32
01.50	02.31	03.47	01.55	02.34	03.63
01.60	02.36	03.78	01.65	02.39	03.94

HMA Safety Factor (GE) = 0000.20 ft
HMA Ultimate Depth = 0001.65 ft
(HMA MAX. Depth shown in Table)
HMA MIN. Depth (from TPB) = 0000.00 ft
HMA MIN. Depth (from Ratio) = 0000.00 ft

HMA MIN. Depth (selected) = 0000.60 ft

Note: To locate the TPB (Treated Permeable Base) as close as possible to the surface
(to facilitate drainage) you might want to 'sandwich' the TPB somewhere within the HMA.
If so, use the minimum HMA depth shown above for the top layer of the 'sandwich' ft 0.6
and then from the following table select an HMA depth of at least ft 0.75
which will provide a minimum depth of 0.15 ft for the bottom layer.

Note: Positive Residual GE indicates over-design.
Note: Negative Safety Factor in Subbase
Note: Layer Number and Minimum Layer Ratio (GE) 4 0.427083333333333

HMA ft	TPB ft	T-Base ft	B-Base ft	Subbase ft	Res-GE ft	Cost $/y^2	HMA-GF ft	ft
00.60	00.25	00.70	00.00	01.10	00.01	0000.00	01.70	
00.65	00.25	00.60	00.00	01.10	00.02	0000.00	01.75	
00.70	00.25	00.45	00.00	01.15	00.02	0000.00	01.79	
00.75	00.25	00.35	00.00	01.10	-00.01	0000.00	01.84	
00.80	00.25	00.35	00.00	01.00	00.01	0000.00	01.88	
00.85	00.25	00.35	00.00	00.85	-00.02	0000.00	01.91	
00.90	00.25	00.35	00.00	00.75	00.01	0000.00	01.95	
00.95	00.25	00.35	00.00	00.60	-00.00	0000.00	01.99	
01.00	00.25	00.35	00.00	00.45	-00.02	0000.00	02.02	
01.05	00.25	00.35	00.00	00.35	00.01	0000.00	02.05	
01.10	00.25	00.35	00.00	00.35	00.16	0000.00	02.09	
01.15	00.25	00.35	00.00	00.35	00.30	0000.00	02.12	
01.20	00.25	00.35	00.00	00.35	00.44	0000.00	02.15	

12/19

Untitled

CALFP Ver. 1.1

Unit System = E

Title: SR-91 WB Mainline Shoulder Undrained
Traffic Index (TI) = 09.5
R.Value of Subgrade (Native Soil) = 40
Required GE = 0001.82 ft

Base Type = AB-Class 2

Base Gravel Factor = 0001.10
Base R.Value = 0078.00
0.0032*TI*(100-R.VALUE) = 0000.67 ft
Base MAX. depth = 0002.00 ft
Base MIN. depth = 0000.35 ft

Depth (ft)	GF	GE (ft)	Depth (ft)	GF	GE (ft)
00.10	01.84	00.18	00.15	01.84	00.28
00.20	01.84	00.37	00.25	01.84	00.46
00.30	01.84	00.55	00.35	01.84	00.64
00.40	01.84	00.74	00.45	01.84	00.83
00.50	01.84	00.92	00.55	01.86	01.02
00.60	01.92	01.15	00.65	01.97	01.28
00.70	02.02	01.41	00.75	02.06	01.55
00.80	02.11	01.69	00.85	02.15	01.83
00.90	02.19	01.97	00.95	02.23	02.12
01.00	02.27	02.27	01.05	02.31	02.43
01.10	02.34	02.57	01.15	02.38	02.74
01.20	02.41	02.89	01.25	02.45	03.06
01.30	02.48	03.22	01.35	02.51	03.39

HMA Safety Factor (GE) = 0000.20 ft
HMA Ultimate Depth = 0001.30 ft
(HMA MAX. Depth shown in Table)

HMA MIN. Depth (from Base) = 0000.20 ft

HMA MIN. Depth (selected) = 0000.20 ft

Note: Positive Residual GE indicates over-design.
Note: Negative Safety Factor in Base

HMA ft	TPB ft	T-Base ft	B-Base ft	Subbase ft	Res-GE ft	Cost $/y^2	HMA-GF ft
00.50	00.00	00.80	00.00	00.00	-00.02	0000.00	01.84

Untitled

00.55	00.00	00.75	00.00	00.00	00.02	0000.00	01.86
00.60	00.00	00.60	00.00	00.00	-00.01	0000.00	01.92
00.65	00.00	00.50	00.00	00.00	00.01	0000.00	01.97
00.70	00.00	00.35	00.00	00.00	-00.02	0000.00	02.02
00.75	00.00	00.35	00.00	00.00	00.11	0000.00	02.06
00.80	00.00	00.35	00.00	00.00	00.25	0000.00	02.11
00.85	00.00	00.35	00.00	00.00	00.39	0000.00	02.15
00.90	00.00	00.35	00.00	00.00	00.53	0000.00	02.19

***** FINISH *****

CALFP Ver. 1.1

Unit System = E

Undrained

Title: SR-91 WB Mainline Shoulder
Traffic Index (TI) = 09.5
R.Value of Subgrade (Native Soil) = 20
Required GE = 0002.43 ft

Base Type = AB-Class 2

Base Gravel Factor = 0001.10
Base R.Value = 0078.00
0.0032*TI*(100-R.VALUE) = 0000.67 ft
Base MAX. depth = 0002.00 ft
Base MIN. depth = 0000.35 ft

Depth (ft)	GF	GE (ft)	Depth (ft)	GF	GE (ft)
00.10	01.84	00.18	00.15	01.84	00.28
00.20	01.84	00.37	00.25	01.84	00.46
00.30	01.84	00.55	00.35	01.84	00.64
00.40	01.84	00.74	00.45	01.84	00.83
00.50	01.84	00.92	00.55	01.86	01.02
00.60	01.92	01.15	00.65	01.97	01.28
00.70	02.02	01.41	00.75	02.06	01.55
00.80	02.11	01.69	00.85	02.15	01.83
00.90	02.19	01.97	00.95	02.23	02.12
01.00	02.27	02.27	01.05	02.31	02.43
01.10	02.34	02.57	01.15	02.38	02.74
01.20	02.41	02.89	01.25	02.45	03.06
01.30	02.48	03.22	01.35	02.51	03.39

HMA Safety Factor (GE) = 0000.20 ft
HMA Ultimate Depth = 0001.30 ft
(HMA MAX. Depth shown in Table)

HMA MIN. Depth (from Base) = 0000.20 ft

HMA MIN. Depth (selected) = 0000.20 ft

Note: Positive Residual GE indicates over-design.
Note: Negative Safety Factor in Base

Untitled

HMA ft	TPB ft	T-Base ft	B-Base ft	Subbase ft	Res-GE ft	Cost $/y^2	HMA-GF ft	ft
00.50	00.00	01.35	00.00	00.00	-00.03	0000.00	01.84	
00.55	00.00	01.30	00.00	00.00	00.02	0000.00	01.86	
00.60	00.00	01.15	00.00	00.00	-00.01	0000.00	01.92	
00.65	00.00	01.05	00.00	00.00	00.00	0000.00	01.97	
00.70	00.00	00.95	00.00	00.00	00.03	0000.00	02.02	
00.75	00.00	00.80	00.00	00.00	-00.01	0000.00	02.06	
00.80	00.00	00.70	00.00	00.00	00.03	0000.00	02.11	
00.85	00.00	00.55	00.00	00.00	00.00	0000.00	02.15	
00.90	00.00	00.40	00.00	00.00	-00.02	0000.00	02.19	
00.95	00.00	00.35	00.00	00.00	00.07	0000.00	02.23	
01.00	00.00	00.35	00.00	00.00	00.22	0000.00	02.27	
01.05	00.00	00.35	00.00	00.00	00.38	0000.00	02.31	
01.10	00.00	00.35	00.00	00.00	00.53	0000.00	02.34	

***** FINISH *****

CALFP Ver. 1.1

Unit System = E

Mainline Shoulder, Drained

Title: SR-91 WB Widening
Traffic Index (TI) = 09.5
R.Value of Subgrade (Native Soil) = 40
Required GE = 0001.82 ft

Base Type = AB-Class 2

Base Gravel Factor = 0001.10
Base R.Value = 0078.00
0.0032*TI*(100-R.VALUE) = 0000.67 ft
Base MAX. depth = 0002.00 ft
Base MIN. depth = 0000.35 ft

TPB Type = ATPB

TPB Gravel Factor = 0001.40
TPB R.Value = 0100.00
0.0032*TI*(100-R.VALUE) = 0000.00 ft
TPB MAX. depth = 0000.25 ft
TPB MIN. depth = 0000.25 ft

Depth (ft)	GF	GE (ft)	Depth (ft)	GF	GE (ft)
00.10	01.84	00.18	00.15	01.84	00.28
00.20	01.84	00.37	00.25	01.84	00.46
00.30	01.84	00.55	00.35	01.84	00.64
00.40	01.84	00.74	00.45	01.84	00.83
00.50	01.84	00.92	00.55	01.86	01.02
00.60	01.92	01.15	00.65	01.97	01.28
00.70	02.02	01.41	00.75	02.06	01.55
00.80	02.11	01.69	00.85	02.15	01.83
00.90	02.19	01.97	00.95	02.23	02.12
01.00	02.27	02.27	01.05	02.31	02.43
01.10	02.34	02.57	01.15	02.38	02.74
01.20	02.41	02.89	01.25	02.45	03.06
01.30	02.48	03.22	01.35	02.51	03.39

HMA Safety Factor (GE) = 0000.20 ft
HMA Ultimate Depth = 0001.30 ft
(HMA MAX. Depth shown in Table)
HMA MIN. Depth (from TPB) = 0000.00 ft
HMA MIN. Depth (from Ratio) = 0000.00 ft

HMA MIN. Depth (selected) = 0000.45 ft

Note: To locate the TPB (Treated Permeable Base) as close as possible to the surface
(to facilitate drainage) you might want to 'sandwich' the TPB somewhere within the HMA.
If so, use the minimum HMA depth shown above for the top layer of the 'sandwich' ft 0.45
and then from the following table select an HMA depth of at least ft 0.6
which will provide a minimum depth of 0.15 ft for the bottom layer.

Note: Positive Residual GE indicates over-design.
Note: Negative Safety Factor in Base
Note: Layer Number and Minimum Layer Ratio (GE) 5 0.413157894736842

HMA ft	TPB ft	T-Base ft	B-Base ft	Subbase ft	Res-GE ft	Cost HMA-GF ft	ft	$/y^2
00.45	00.25	00.60	00.00	00.00	00.01	0000.00	01.84	
00.50	00.25	00.50	00.00	00.00	-00.00	0000.00	01.84	
00.55	00.25	00.40	00.00	00.00	-00.01	0000.00	01.86	
00.60	00.25	00.35	00.00	00.00	00.06	0000.00	01.92	
00.65	00.25	00.35	00.00	00.00	00.19	0000.00	01.97	
00.70	00.25	00.35	00.00	00.00	00.33	0000.00	02.02	
00.75	00.25	00.35	00.00	00.00	00.46	0000.00	02.06	
00.80	00.25	00.35	00.00	00.00	00.60	0000.00	02.11	

***** FINISH *****

CALFP Ver. 1.1

Unit System = E

Title: SR-91 WB Widening Mainline Shoulder, Drained
Traffic Index (TI) = 09.5
R.Value of Subgrade (Native Soil) = 20
Required GE = 0002.43 ft

Base Type = AB-Class 2

Base Gravel Factor = 0001.10
Base R.Value = 0078.00
0.0032*TI*(100-R.VALUE) = 0000.67 ft
Base MAX. depth = 0002.00 ft
Base MIN. depth = 0000.35 ft

TPB Type = ATPB

TPB Gravel Factor = 0001.40
TPB R.Value = 0100.00
0.0032*TI*(100-R.VALUE) = 0000.00 ft
TPB MAX. depth = 0000.25 ft
TPB MIN. depth = 0000.25 ft

Depth (ft)	GF	GE (ft)	Depth (ft)	GF	GE (ft)
00.10	01.84	00.18	00.15	01.84	00.28
00.20	01.84	00.37	00.25	01.84	00.46
00.30	01.84	00.55	00.35	01.84	00.64
00.40	01.84	00.74	00.45	01.84	00.83
00.50	01.84	00.92	00.55	01.86	01.02
00.60	01.92	01.15	00.65	01.97	01.28
00.70	02.02	01.41	00.75	02.06	01.55
00.80	02.11	01.69	00.85	02.15	01.83
00.90	02.19	01.97	00.95	02.23	02.12
01.00	02.27	02.27	01.05	02.31	02.43
01.10	02.34	02.57	01.15	02.38	02.74
01.20	02.41	02.89	01.25	02.45	03.06
01.30	02.48	03.22	01.35	02.51	03.39

HMA Safety Factor (GE) = 0000.20 ft
HMA Ultimate Depth = 0001.30 ft
(HMA MAX. Depth shown in Table)
HMA MIN. Depth (from TPB) = 0000.00 ft
HMA MIN. Depth (from Ratio) = 0000.00 ft

HMA MIN. Depth (selected) = 0000.45 ft

Note: To locate the TPB (Treated Permeable Base) as close as possible to the surface
(to facilitate drainage) you might want to 'sandwich' the TPB somewhere within the HMA.
If so, use the minimum HMA depth shown above for the top layer of the 'sandwich' ft 0.45
and then from the following table select an HMA depth of at least ft 0.6
which will provide a minimum depth of 0.15 ft for the bottom layer.

Note: Positive Residual GE indicates over-design.
Note: Negative Safety Factor in Base
Note: Layer Number and Minimum Layer Ratio (GE) 5 0.413157894736842

HMA ft	TPB ft	T-Base ft	B-Base ft	Subbase ft	Res-GE ft	Cost HMA-GF	ft	$/y^2
00.45	00.25	01.15	00.00	00.00	00.01	0000.00	01.84	
00.50	00.25	01.05	00.00	00.00	-00.01	0000.00	01.84	
00.55	00.25	00.95	00.00	00.00	-00.01	0000.00	01.86	
00.60	00.25	00.85	00.00	00.00	00.00	0000.00	01.92	
00.65	00.25	00.75	00.00	00.00	00.02	0000.00	01.97	
00.70	00.25	00.60	00.00	00.00	-00.01	0000.00	02.02	
00.75	00.25	00.50	00.00	00.00	00.01	0000.00	02.06	
00.80	00.25	00.35	00.00	00.00	-00.01	0000.00	02.11	
00.85	00.25	00.35	00.00	00.00	00.13	0000.00	02.15	
00.90	00.25	00.35	00.00	00.00	00.27	0000.00	02.19	
00.95	00.25	00.35	00.00	00.00	00.42	0000.00	02.23	
01.00	00.25	00.35	00.00	00.00	00.57	0000.00	02.27	

***** FINISH *****

SR91 TI=7.0 R=40 without ATPB.TXT

CALFP Ver. 1.1

Unit System = E

MVP, Undrained

Title: SR-91 WB Widening
Traffic Index (TI) = 07.0
R.Value of Subgrade (Native Soil) = 40
Required GE = 0001.34 ft

Base Type = AB-Class 2

Base Gravel Factor = 0001.10
Base R.Value = 0078.00
0.0032*TI*(100-R.VALUE) = 0000.49 ft
Base MAX. depth = 0002.00 ft
Base MIN. depth = 0000.35 ft

Depth (ft)	GF	GE (ft)	Depth (ft)	GF	GE (ft)
00.10	02.14	00.21	00.15	02.14	00.32
00.20	02.14	00.43	00.25	02.14	00.54
00.30	02.14	00.64	00.35	02.14	00.75
00.40	02.14	00.86	00.45	02.14	00.96
00.50	02.14	01.07	00.55	02.17	01.19
00.60	02.23	01.34	00.65	02.29	01.49
00.70	02.35	01.65	00.75	02.40	01.80
00.80	02.46	01.97	00.85	02.51	02.13
00.90	02.55	02.30	00.95	02.60	02.47

HMA Safety Factor (GE) = 0000.20 ft
HMA Ultimate Depth = 0000.95 ft
(HMA MAX. Depth shown in Table)

HMA MIN. Depth (from Base) = 0000.20 ft

HMA MIN. Depth (selected) = 0000.20 ft

Note: Positive Residual GE indicates over-design.
Note: Negative Safety Factor in Base

HMA ft	TPB ft	T-Base ft	B-Base ft	Subbase ft	Res-GE ft	Cost ft	HMA-GF ft	$/y^2
00.35	00.00	00.55	00.00	00.00	00.01	0000.00	02.14	
00.40	00.00	00.45	00.00	00.00	00.01	0000.00	02.14	
00.45	00.00	00.35	00.00	00.00	00.00	0000.00	02.14	
00.50	00.00	00.35	00.00	00.00	00.11	0000.00	02.14	
00.55	00.00	00.35	00.00	00.00	00.23	0000.00	02.17	
00.60	00.00	00.35	00.00	00.00	00.38	0000.00	02.23	
00.65	00.00	00.35	00.00	00.00	00.53	0000.00	02.29	

***** FINISH *****

CALFP Ver. 1.1

Unit System = E

MVP, Unbrushed

Title: SR-91 WB Widening
Traffic Index (TI) = 07.0
R.Value of Subgrade (Native Soil) = 20
Required GE = 0001.79 ft

Base Type = AB-Class 2

Base Gravel Factor = 0001.10
Base R.Value = 0078.00
0.0032*TI*(100-R.VALUE) = 0000.49 ft
Base MAX. depth = 0002.00 ft
Base MIN. depth = 0000.35 ft

Depth (ft)	GF	GE (ft)	Depth (ft)	GF	GE (ft)
00.10	02.14	00.21	00.15	02.14	00.32
00.20	02.14	00.43	00.25	02.14	00.54
00.30	02.14	00.64	00.35	02.14	00.75
00.40	02.14	00.86	00.45	02.14	00.96
00.50	02.14	01.07	00.55	02.17	01.19
00.60	02.23	01.34	00.65	02.29	01.49
00.70	02.35	01.65	00.75	02.40	01.80
00.80	02.46	01.97	00.85	02.51	02.13
00.90	02.55	02.30	00.95	02.60	02.47

HMA Safety Factor (GE) = 0000.20 ft
HMA Ultimate Depth = 0000.95 ft
(HMA MAX. Depth shown in Table)

HMA MIN. Depth (from Base) = 0000.20 ft

HMA MIN. Depth (selected) = 0000.20 ft

Note: Positive Residual GE indicates over-design.
Note: Negative Safety Factor in Base

HMA ft	TPB ft	T-Base ft	B-Base ft	Subbase ft	Res-GE ft	Cost HMA-GF ft	ft	$/y^2
00.35	00.00	00.95	00.00	00.00	00.00	0000.00	02.14	
00.40	00.00	00.85	00.00	00.00	-00.00	0000.00	02.14	
00.45	00.00	00.75	00.00	00.00	-00.00	0000.00	02.14	
00.50	00.00	00.65	00.00	00.00	-00.01	0000.00	02.14	
00.55	00.00	00.55	00.00	00.00	00.01	0000.00	02.17	
00.60	00.00	00.40	00.00	00.00	-00.01	0000.00	02.23	
00.65	00.00	00.35	00.00	00.00	00.08	0000.00	02.29	
00.70	00.00	00.35	00.00	00.00	00.24	0000.00	02.35	
00.75	00.00	00.35	00.00	00.00	00.39	0000.00	02.40	
00.80	00.00	00.35	00.00	00.00	00.56	0000.00	02.46	

***** FINISH *****

SR91 TI=7.0 R=16 without ATPB.TXT

CALFP Ver. 1.1

Unit System = E

MVP, Undrained

Title: SR-91 WB Widening
Traffic Index (TI) = 07.0
R.Value of Subgrade (Native Soil) = 16
Required GE = 0001.88 ft

Subbase Type = AB-Class 2

Subbase Gravel Factor = 0001.00
Subbase R.Value = 0050.00
0.0032*TI*(100-R.VALUE) = 0001.12 ft
Subbase MAX. depth = 0005.00 ft
Subbase MIN. depth = 0000.35 ft

Base Type = AB-Class 2

Base Gravel Factor = 0001.10
Base R.Value = 0078.00
0.0032*TI*(100-R.VALUE) = 0000.49 ft
Base MAX. depth = 0002.00 ft
Base MIN. depth = 0000.35 ft

Depth (ft)	GF	GE (ft)	Depth (ft)	GF	GE (ft)
00.10	02.14	00.21	00.15	02.14	00.32
00.20	02.14	00.43	00.25	02.14	00.54
00.30	02.14	00.64	00.35	02.14	00.75
00.40	02.14	00.86	00.45	02.14	00.96
00.50	02.14	01.07	00.55	02.17	01.19
00.60	02.23	01.34	00.65	02.29	01.49
00.70	02.35	01.65	00.75	02.40	01.80
00.80	02.46	01.97	00.85	02.51	02.13
00.90	02.55	02.30	00.95	02.60	02.47

HMA Safety Factor (GE) = 0000.20 ft
HMA Ultimate Depth = 0000.95 ft
(HMA MAX. Depth shown in Table)

HMA MIN. Depth (from Base) = 0000.20 ft

HMA MIN. Depth (selected) = 0000.20 ft

Note: Positive Residual GE indicates over-design.
Note: Negative Safety Factor in Subbase

HMA ft	TPB	T-Base ft	B-Base ft	Subbase ft	Res-GE ft	Cost	HMA-GF ft	ft	$/y^2
00.35	00.00	00.50	00.00	00.60	00.02	0000.00	02.14		
00.40	00.00	00.40	00.00	00.60	00.01	0000.00	02.14		
00.45	00.00	00.35	00.00	00.55	00.02	0000.00	02.14		
00.50	00.00	00.35	00.00	00.45	00.02	0000.00	02.14		
00.55	00.00	00.35	00.00	00.35	00.05	0000.00	02.17		
00.60	00.00	00.35	00.00	00.35	00.19	0000.00	02.23		
00.65	00.00	00.35	00.00	00.35	00.34	0000.00	02.29		
00.70	00.00	00.35	00.00	00.35	00.50	0000.00	02.35		
00.75	00.00	00.35	00.00	00.35	00.65	0000.00	02.40		

***** FINISH *****

FINAL FOUNDATION REPORT
NON-STANDARD WALLS

Earth Mechanics, Inc.

February 14, 2012

FINAL FOUNDATION REPORT

Wall 107 (Bridge No. 55-E0125), PM 1.0
Wall 159 (Bridge No. 55-E0126), PM 2.0
Wall 173 (Bridge No. 55-E0122), PM 2.3
Wall 255 (Bridge No. 55-E0123), PM 3.8
Wall 293 (Bridge No. 55-E0127), PM 4.5
Wall 307 (Bridge No. 55-E0128), PM 4.8
and
Wall 315 (Bridge No. 55-E0124), PM 4.9

State Route 91 Westbound Widening
Orange County, California
12-ORA-91, PM 0.9/5.4
Caltrans Project No. 12000000791 (EA 12-0C5701)
EMI Project No. 10-126
Date: February 14, 2012

EARTH MECHANICS, INC.

Geotechnical and Earthquake Engineering

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

February 14, 2012

EMI Project No. 10-126

RBF Consulting
14725 Alton Parkway
Irvine, California 92618

Attention: Mr. Steve Huff, P.E.

Subject: Final Foundation Report for Non-Standard Walls
State Route 91 Westbound Widening
Orange County, California
12-ORA-91, PM 0.9/5.4
Caltrans Project No. 12000000791 (EA 12-0C5701)

Dear Mr. Huff:

Attached please find the Foundation Report for the non-standard walls for the State Route 91 Westbound Widening project. This report contains the findings and conclusions of our field investigation and laboratory testing program. This report also contains our recommendations for the design and construction of the wall foundations.

Earlier versions of this report dated May 17, 2011 and December 16, 2011 were submitted to Caltrans for review. Caltrans review comments and EMI responses are included in Appendix D. Our responses to the review comments have been incorporated into this report.

We appreciate the opportunity to provide geotechnical design services for this project. If you have any questions, please call us.

Sincerely,

EARTH MECHANICS, INC.

2/14/12

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FINAL FOUNDATION REPORT

WALL 107 (BRIDGE NO. 55-E0125), PM 1.0
WALL 159 (BRIDGE NO. 55-E0126), PM 2.0
WALL 173 (BRIDGE NO. 55-E0122), PM 2.3
WALL 255 (BRIDGE NO. 55-E0123), PM 3.8
WALL 293 (BRIDGE NO. 55-E0127), PM 4.5
WALL 307 (BRIDGE NO. 55-E0128), PM 4.8
AND
WALL 315 (BRIDGE NO. 55-E0124), PM 4.9

STATE ROUTE 91 WESTBOUND WIDENING
ORANGE COUNTY, CALIFORNIA
12-ORA-91, PM 0.9/5.4
CALTRANS PROJECT NO. 12000000791 (EA 12-0C5701)

Prepared for:

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EMI Project No. 10-126

February 14, 2012

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE OF STUDY

This Foundation Report presents the findings and conclusions of a geotechnical investigation conducted by Earth Mechanics, Inc. (EMI). It presents foundation design and construction recommendations for the proposed non-standard walls within the State Route 91 (SR-91) Westbound (WB) Widening Project in Orange County, California. A site location map is presented in Figure 1-1.

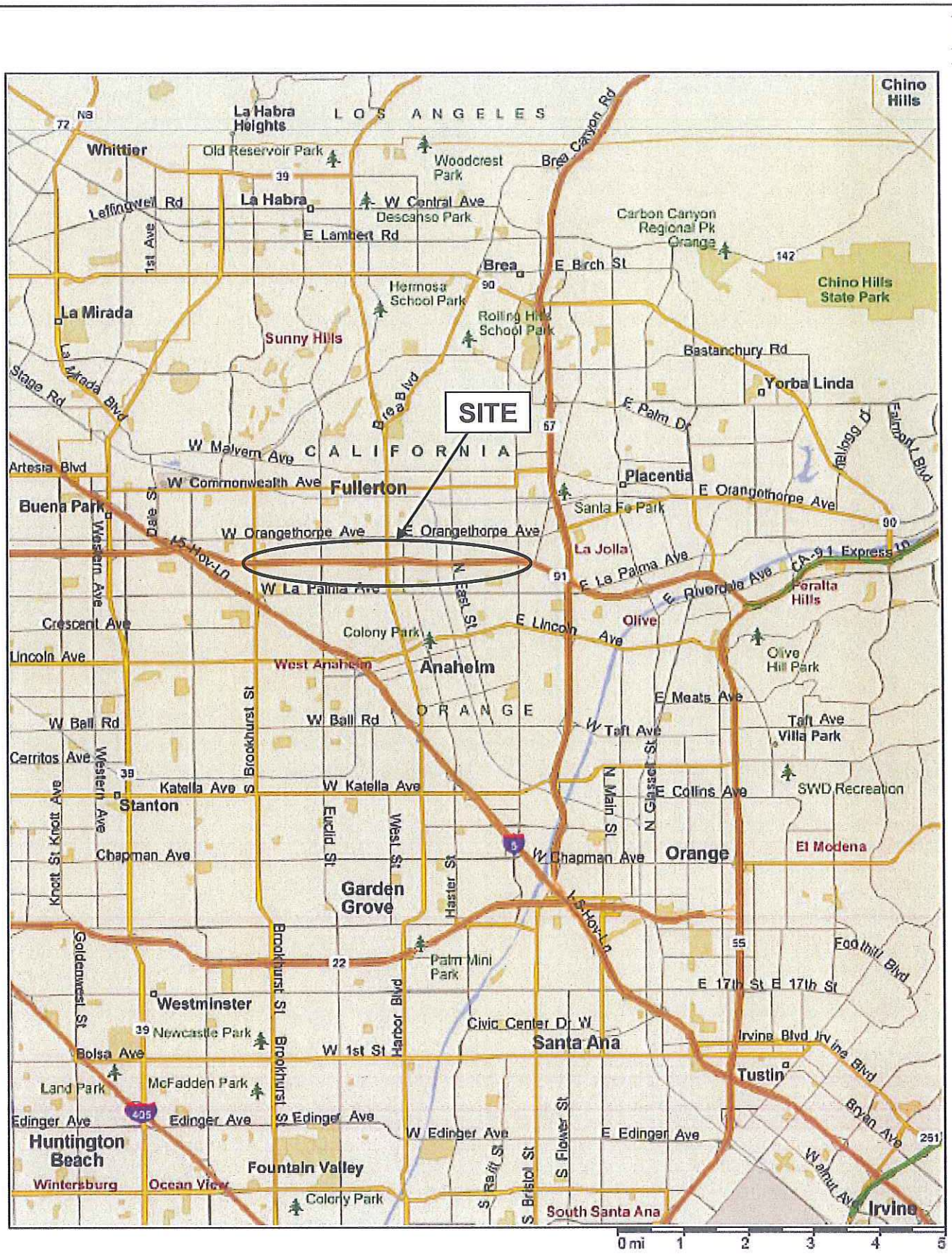
EMI is a subconsultant to RBF Consulting (RBF). The geotechnical services provided for this project included the following tasks:

- Field exploration consisting of drilling and logging exploratory borings;
- Laboratory testing of selected bulk and relatively undisturbed soil samples;
- Engineering calculations and analysis to develop foundation design and construction recommendations; and
- Preparation of this report presenting our findings, conclusions, and recommendations.

1.2 PROJECT DESCRIPTION

The California Department of Transportation (Caltrans), in cooperation with the Orange County Transportation Authority (OCTA) and the cities of Anaheim and Fullerton, proposes to widen the westbound State Route 91 (SR-91) from State Route 57 (SR-57) to Interstate 5 (I-5). SR-91 is a major east-west freeway facility that begins at the eastern junction with SR-60 in the city of Riverside in Riverside County, and continues west through Orange County to its terminus at the junction with Pacific Coast Highway 1 near the city of Hermosa Beach in Los Angeles County. The proposed project limits cover a distance of 4.5 miles; however, actual improvements are limited to a total of 3.8 miles within the project area.

The proposed project consists of the westbound mainline widening that connects the existing lanes through each interchange and the addition of two-lane exit ramps and associated auxiliary lanes at the westbound exit ramps to Raymond Avenue, Lemon Street, Euclid Street and Brookhurst Street. To accommodate the bridge and road widening improvements, a series of retaining walls and soundwalls are proposed. This foundation report addresses the non-standard walls.



SR-91 WB Widening Retaining Walls and Soundwalls

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

SITE LOCATION MAP

Figure 1-1

Project No. 10-126

Date: 03-31-11

A total of seven walls are included in the report. The wall locations are presented in Figure 1-2. Walls pertinent information is presented in Table 1-1.

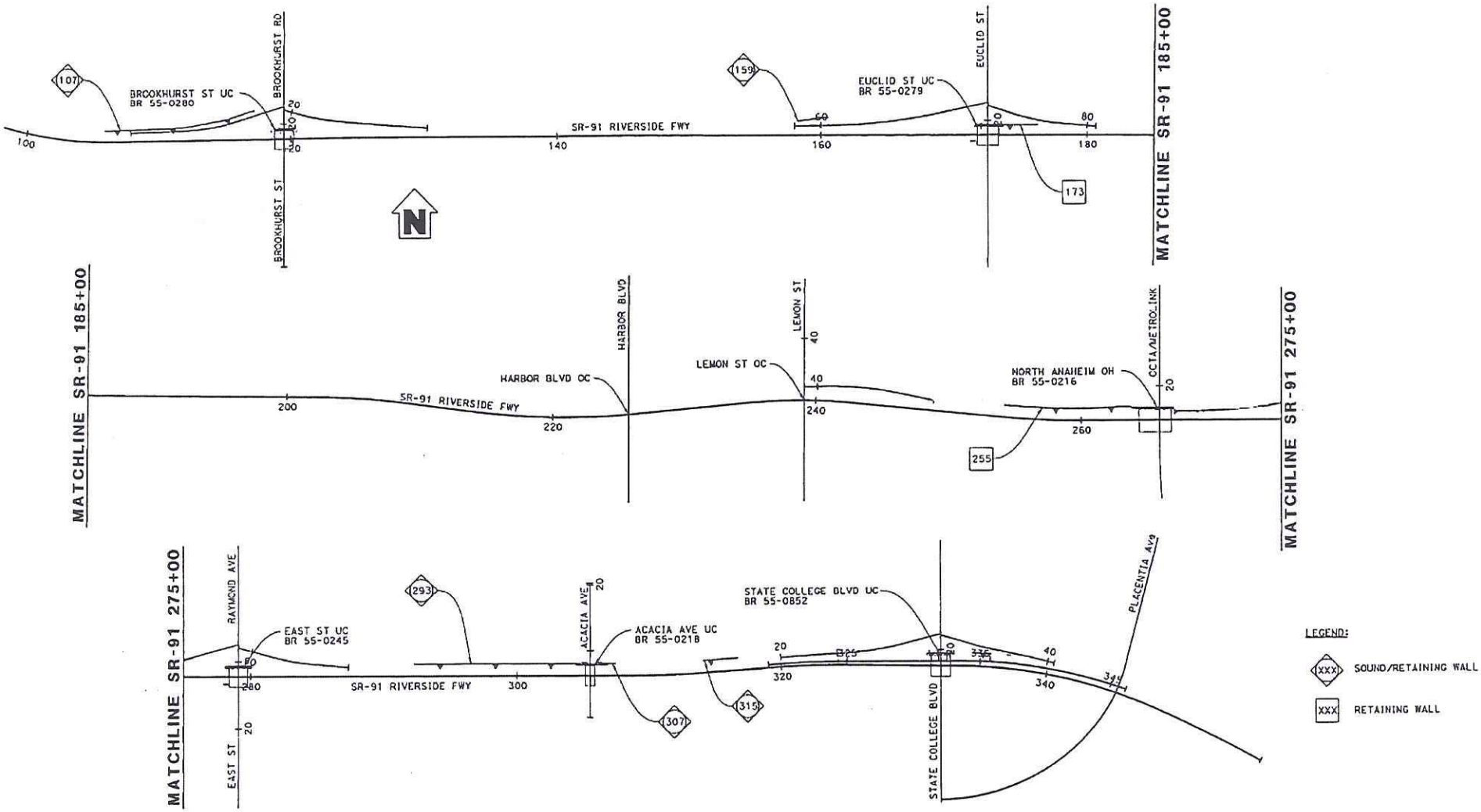
Table 1-1. Retaining Walls and Soundwalls Pertinent Data

Wall	Wall Type	Location *		Length (ft)	Retaining Wall / Barrier Height (ft)	Approx. Bottom of Footing / Barrier Elevation (ft)	Backfill Slope Condition
		Begin Wall	End Wall				
107	Type 736S Type 736SV Type 1SWB	106+00.00 86.48 Lt	17+50.06 33.41 Lt (BH1 Line)	1140	0 to 12	+102.65 to +110.43	Level
159	Type 736S	158+23.59 110.60 Lt	160+57.06 136.22 Lt	235	0	+111.70 to +113.23	-
173	Type 1	173+39.16 78.50 Lt	176+28.85 78.50Lt	293	6 to 14	+139.00 to +143.00	Level
255	Type 1	254+00.00 90.50 Lt	264+31.30 90.50 Lt	1026	4 to 16	+161.67 to +191.67	Level
293	Type 736S Type 736SV Type 1SWB Type 1SWBP	292+29.00 90.50 Lt	304+63.78 90.50 Lt	1262	0 to 18	+176.46 to +180.46	Level
307	Type 736S Type 736SV Type 1SWB	306+17.97 90.50 Lt	307+49.97 90.50 Lt	132	2 to 8	+192.82 to +197.75	Level
315	Type 736S Type 736SV Type 1SWB Type 5SWBP	314+10.00 90.50 Lt	316+78.00 90.80 Lt	268	2.5 to 6	+183.24 to +185.74	Level

* All Stations are based on "A Line" unless noted otherwise.

The above walls are considered to be non-standard due to the following conditions:

- Walls 107, 293, 307 – Portions of these walls are Soundwall on Retaining Wall, either Type 1SWB or Type 1SWBP.
- Wall 159 – A portion of this wall is founded on a reinforced concrete box (RCB).
- Walls 173 and 255 – Portions of these Caltrans Standard Type 1 retaining walls are supported on pile footings.
- Wall 315 – Portions of this wall are Soundwall on Retaining Wall, either Type 1SWB or Type 5SWBP.



SR-91 WB Widening Retaining Walls and Soundwalls

RETAINING WALLS AND SOUNDWALLS KEY MAP

Figure 1-2

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Project No. 10-126

Date: 03-31-11

2.0 FIELD INVESTIGATION AND LABORATORY TESTING

2.1 FIELD INVESTIGATION

Applicable as-built Log-of-Test-Borings (LOTB) sheets are included in Appendix A. About 2.3 feet should be added to the elevation on the as-built LOTB sheets to match the current vertical datum (NAV88).

A geotechnical field investigation was conducted between January 5 and 24, 2011. Fifteen exploratory borings and three cone penetrometer tests (CPTs) were accomplished under the supervision of EMI. Boring information, including exploration number, stations, offsets, ground surface elevations, bottom of boring elevations and water level measurements are summarized in Table 2-1. Locations of the exploratory borings and CPTs are shown on the LOTB sheets provided in Appendix A.

Table 2-1. Geotechnical Exploration Information

Boring No.	Station Line	Station	Approx. Offset (feet)	Approx. Ground Surface El. (feet)	Approx. Bottom of Boring El. (feet)	Approx. Groundwater El. (feet)
A-10-002	A-Line	109+44	78 Lt	+112.0	+80.5	Not Encountered
A-10-003		112+86	101 Lt	+112.0	+80.5	Not Encountered
A-10-005		116+24	176 Lt	+114.3	+62.8	+70.9
A-10-018		159+18	95 Lt	+130.0	+98.5	Not Encountered
A-10-019		160+55	106 Lt	+131.0	+99.5	Not Encountered
A-10-024		173+76	62 Lt	+152.6	+66.1	+80.4
CPT-10-026		176+21	60 Lt	+148.0	+137.3	Not Measured
A-10-036		253+33	89 Lt	+168.0	+116.5	Not Encountered
A-10-037		256+96	79 Lt	+178.0	+146.5	Not Encountered
A-10-038		260+40	79 Lt	+188.0	+156.5	Not Encountered
A-10-039		264+14	88 Lt	+198.4	+96.9	Not Encountered
A-10-050		293+06	77 Lt	+180.0	+148.5	Not Encountered
CPT-10-051		296+68	80 Lt	+180.0	+122.6	Not Measured
A-10-052		300+05	82 Lt	+192.0	+160.5	Not Encountered
CPT-10-053		304+43	73 Lt	+200.0	+140.6	Not Measured
A-10-055		306+48	76 Lt	+200.5	+129.3	Not Encountered
A-10-057		313+75	82 Lt	+188.0	+156.5	Not Encountered
A-10-058		316+80	84 Lt	+185.9	+154.5	Not Encountered

Exploratory borings were drilled using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers. Sampling was performed by alternating the Modified California Drive (MCD) sampler and Standard Penetration Test (SPT) sampler. The soil sampling interval is generally 5 feet. Relatively undisturbed soil samples were obtained using a 3.25-inch outer diameter MCD sampler lined with brass rings. Each of these brass rings is 1-inch long with a 2.5-inch outside diameter. The SPT sampler (1.4-inch inside diameter) was also used to obtain

soil samples. The MCD and SPT samplers were driven 18 inches into the ground or until refusal was encountered using a 140-lb hammer free falling from a height of 30 inches. The numbers of blows to advance the sampler each 6 inches of penetration was recorded. The numbers of blows for the final 12 inches or shorter of driving was recorded on the LOTB sheets.

The CPT sounding was performed using an electronic cone penetrometer in general accordance with current ASTM Standards (ASTM D5778 and ASTM D3441). The CPT equipment consisted of a cone penetrometer assembly mounted at the end of a series of hollow sounding rods. The cone penetrometer assembly consisted of a conical tip with a 60° apex angle and a projected cross sectional area of 1.55 in^2 (10 cm^2) and a cylindrical friction sleeve with a surface area of 23.25 in^2 (150 cm^2). The interior of the cone penetrometer is instrumented with strain gauges that allow simultaneous measurements of cone tip and friction sleeve resistance during penetration. The cone penetrometer assembly is continuously pushed into the soil by a set of hydraulic rams at a standard rate of 0.79 inch per second (20 mm per second) while the cone tip resistance and sleeve friction resistance are recorded every 1.967 inches (50 mm) and stored in digital form. A specially designed all-wheel drive 25-ton truck provides the required reaction weight for pushing the cone assembly and is also used to transport and house the testing equipment. The computer generated graphical logs include tip resistance, friction resistance, and friction ratio. Soil behavior type interpretations are based on guidelines by Robertson and Campanella (1989).

Charts published by Winterkorn and Fang (1975) can be used to determine a reduction factor used to convert blowcounts recorded using the MCD sampler into SPT blowcounts. Using those charts, we obtained a reduction factor of 0.5 which was used for this project.

2.2 LABORATORY TESTING

Soil samples considered representative of the subsurface conditions were tested to obtain or derive relevant physical and engineering soil properties. The following laboratory tests were conducted to supplement the observations recorded during the field investigation:

- In-situ Moisture Content and Unit Weight
- Percent Passing No. 200 Sieve
- Atterberg Limit
- Direct Shear
- Unconsolidated Undrained Triaxial
- Penetrometer
- Consolidation
- Minimum Resistivity, pH, Sulfate Content and Chloride Content
- Compaction

The laboratory tests were conducted in general accordance with California Test Methods or American Society for Testing and Materials (ASTM) Standards. Laboratory test results are included in Appendix B.

3.0 GEOLOGY AND SEISMICITY

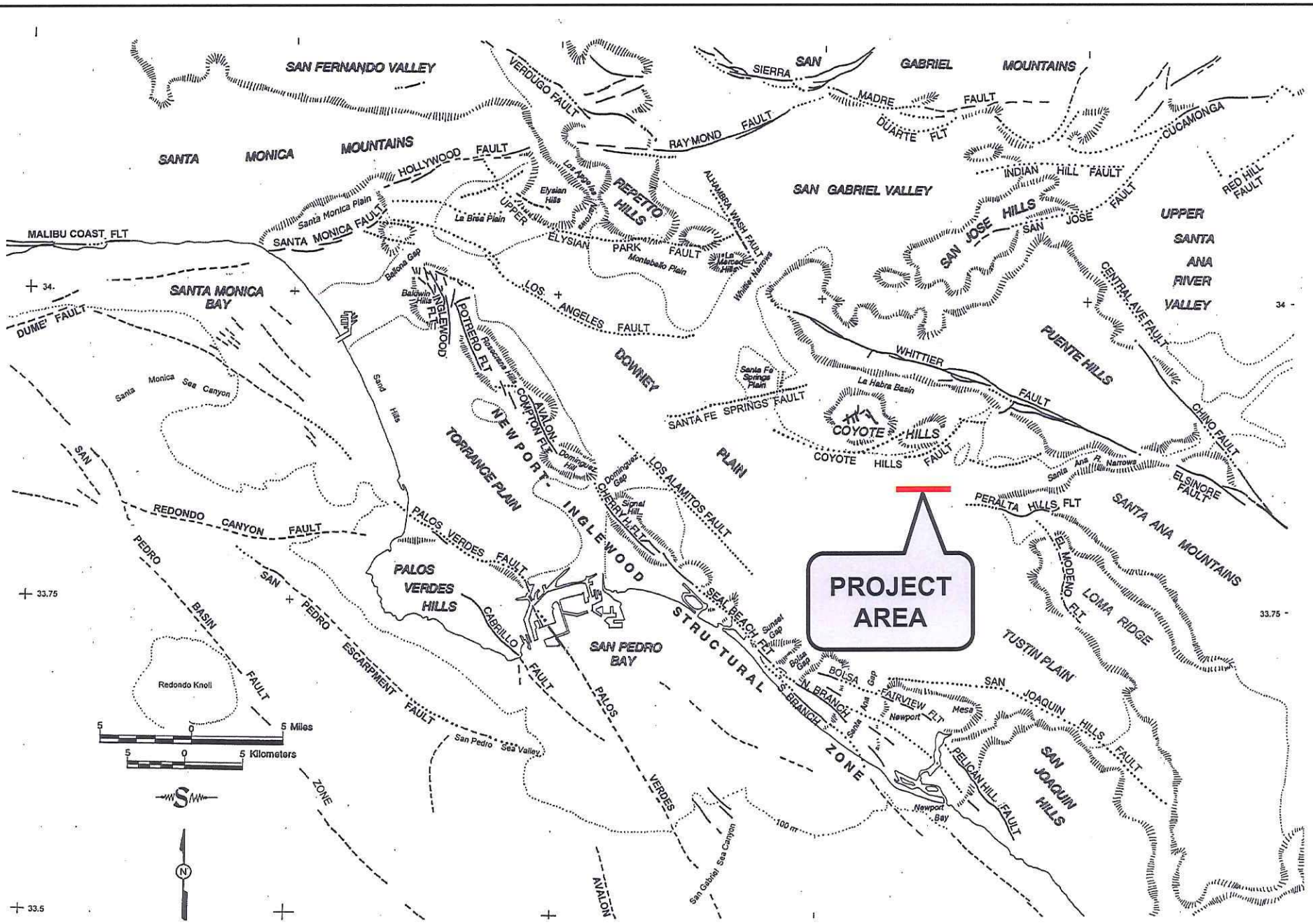
3.1 PHYSIOGRAPHY

The project area is in the east-central part of the Los Angeles Basin as shown in Figure 3-1 which comprises a transition zone between the Peninsular Ranges physiographic province on the east, and the Transverse Ranges physiographic province to the north. The Peninsular Ranges physiographic province comprises a northwest-southeast trending group of fault-bounded ranges such as Santa Ana Mountains, Puente Hills and San Joaquin Hills between the Salton Trough and the Pacific Ocean. The Transverse Ranges physiographic province comprises east-west trending ranges and valleys such as the Santa Monica Mountains, San Fernando Valley and San Gabriel Mountains. Valleys such as the Los Angeles Basin, the San Gabriel Valley and the Upper Santa Ana River Valley have characteristics compatible with both physiographic provinces and form a transition zone between the two provinces.

The Los Angeles Basin is essentially a large, relatively flat, low-lying and coastal plain surrounded by mountains on the north, east and southeast which rise abruptly to a few thousand feet above the plains. The western margin of the basin is bordered by the sea, the Palos Verdes Hills and the San Joaquin Hills. The floor of the basin gradually rises inland to a series of uplifted terrain along the margins of the surrounding mountains. This elevated marginal terrain includes the Santa Monica, La Brea, Montebello, Santa Fe Springs plains, and the Coyote Hills. The generally flat-lying nature and gradual inland rise of the Basin floor is disrupted by an alignment of northwest-southeast trending, low-elevation hills along the Newport-Inglewood Structural Zone (NISZ). The areas on either side of the NISZ are essentially flat and comprise the Downey-Tustin plain on the northeast and the Torrance Plain on the southwest. The site area is near the transition between the Downey and the Tustin plains.

3.2 GEOLOGIC STRUCTURE

The Los Angeles Basin is a deep structural basin comprising two major downward folds (synclines) separated by the NISZ uplift; the Paramount syncline is east of the NISZ under the Downey-Tustin Plain, and the Gardena syncline is west of the NISZ under the Torrance Plain. The Paramount syncline is the larger and deeper syncline with basement rocks as deep as about 30,000 feet (Yerkes et al, 1965). As described in the physiography section, the basin is rimmed by marginal elevated plains that rise about a hundred feet to as much as a couple hundred feet above the general level of the basin floor. These elevated plains and the Coyote Hills are underlain by fault-bounded, upward folds (anticlines) that are prolific oil fields. Most of the major faults associated with these folds are blind thrust faults and are shown on Figure 3-1 as dotted lines. The nearest faults to the project area are the blind thrust faults of the Puente Hills Blind Thrust Fault System and Compton-Los Alamitos Blind Fault System. Larger surface faults, such as the NISZ and the Elsinore Fault Zone (Whittier Section) lie to the southwest and northeast of the project site, respectively.



State Route 91 Westbound Widening Project

Earth Mechanics, Inc.
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REGIONAL MAP OF ACTIVE FAULTS AND PHYSIOGRAPHY

Figure 3-1

Project No. 10-126

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3.3 GEOLOGICAL HAZARDS

The only significant geological hazard at the site is earthquake shaking and perhaps local liquefaction. There are no known active surface faults within the project area so ground rupture is not a factor. The flat-lying nature of the area is not susceptible to landsliding. The site is too far from the ocean to be affected by tsunamis, and there are no large bodies of water within the site area that could generate a seiche. There are no volcanoes in the region.

The western part of the project corridor may be susceptible to liquefaction during a large earthquake. As presented in Figure 3-2, the California Geological Survey (1997, 1998) has designated the area between Brookhurst Street and Euclid Street as having a potential for liquefaction. The potential for liquefaction is discussed in detail in Section 5.2.

3.4 SEISMICITY

The project is in seismically active Southern California. The present-day seismotectonic stress field in the Los Angeles region is one of north-northeasterly compression. This is indicated by the geologic structures, by earthquake focal-mechanism solutions and by geodetic measurements. These data suggest crustal shortening of between 0.2 and 0.35 inches per year across the greater Los Angeles area (Argus et al., 1999).

Historical earthquake epicenter maps show widespread seismicity throughout the Los Angeles region. Earthquakes occur primarily as loose clusters along the NISZ, the southern margin of the Santa Monica Mountains, the margin between the Santa Susana-San Fernando Valley and the southern margin of the San Gabriel Mountains, and in the Coyote Hills-Puente Hills area.

The largest historical earthquakes within the Los Angeles Basin were the 1933 Long Beach (moment magnitude (M_W) of about 6.4), 1994 Northridge (M_W = 6.7), 1971 San Fernando (M_W = 6.7), 1987 Whittier (M_W = 5.9), and 2008 Chino Hills (M_W = 5.4). There have been no significant historical earthquakes in the immediate site area. There may have been a few random small events (M_W < 3.0). The nearest concentrated earthquake activity has been within the Puente Hills about 5 or 6 miles to the north of the site.

The 1933 Long Beach earthquake did not rupture the surface but is believed to have been associated with the NISZ (Benioff, 1938). Reevaluation of the seismic data by Hauksson and Gross (1991) relocated the 1933 earthquake hypocenter to a depth of about 6 miles below the Huntington Beach-Newport Beach city boundary.

The 1994 Northridge earthquake occurred on a southerly dipping subsurface fault which was unknown prior to the earthquake. The main shock occurred at a depth of about 12 miles. Earthquake aftershocks clearly defined the rupture surface dipping about 35 degrees southerly from a depth of about 1 or 2 miles to 14 miles. The causative fault was never identified with certainty.

The 1971 San Fernando earthquake involves surface rupture. The 1971 event occurred on a northerly dipping thrust fault that dips from the northern side of the San Fernando Valley to a depth of about 9 miles under the San Gabriel Mountains, and considered part of the Sierra Madre Fault System.

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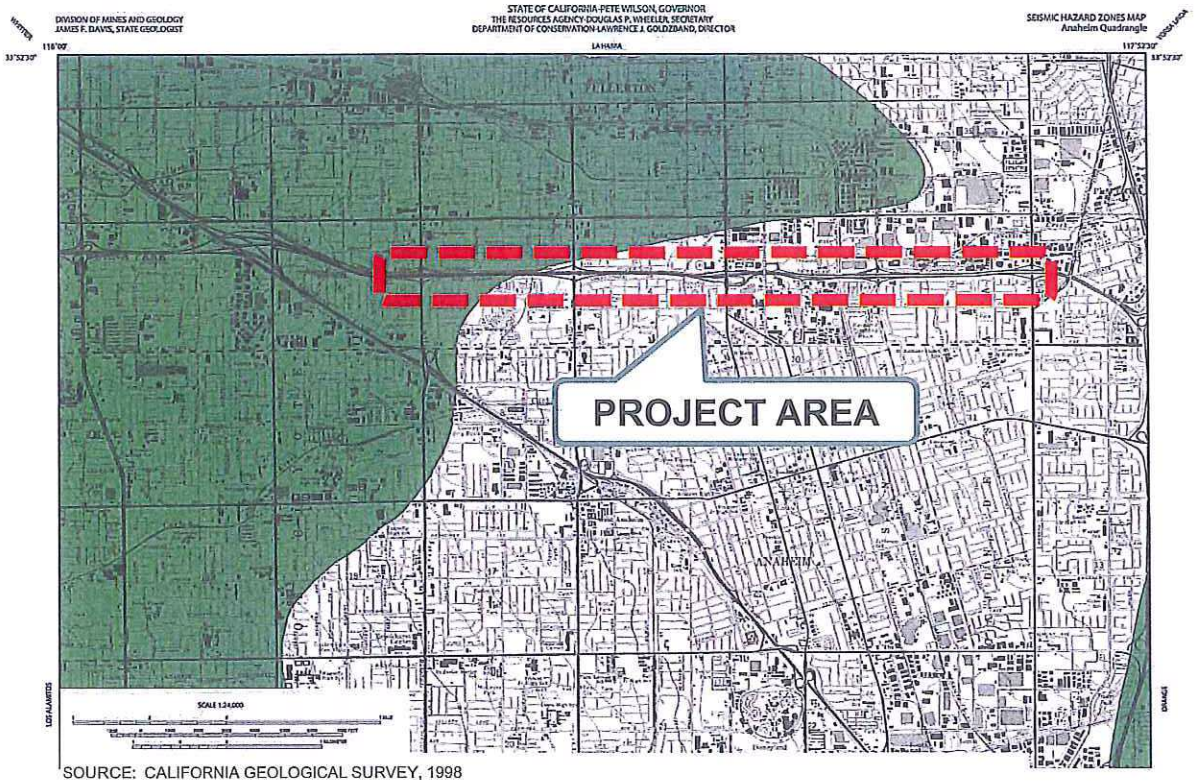

SOURCE: CALIFORNIA GEOLOGICAL SURVEY, 1998

MAP EXPLANATION

Zones of Required Investigation:

Liquefaction

Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

SR-91 WB Widening Retaining Walls and Soundwalls	MAP OF LIQUEFACTION POTENTIAL
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 3-2
	Project No. 10-126 | Date: 03-31-11

The 1987 Whittier earthquake occurred on a subsurface fault dipping under the Puente Hills to about 10 miles beneath the San Gabriel Basin (Shaw and Shearer, 1999; Shaw et al., 2002). This event did not rupture the ground surface.

The 2008 Chino Hills event epicenter was in the Chino Hills area between the Elsinore-Fault-Zone Chino Section and Whittier Section. Preliminary data were inconclusive with regard to the causative fault. Detailed analysis by Shao and Hauksson (2009) indicated a rupture plane striking N71°W, dipping 62° northeast. This event did not rupture the ground surface.

Another significant earthquake was the 1812 earthquake which caused damage at the San Juan Capistrano Mission. The location and magnitude of the 1812 earthquake are unknown because of the sparse population at the time, but geological studies (Jacoby et al., 1988; Fumal et al., 1993; Weldon et al., 2004) postulate that it did not occur in the Capistrano area, but rather was a large (M_W > 7.0) distant event on the San Andreas fault in the Wrightwood area of the San Gabriel Mountains.

The earliest documented earthquake in the region was reported by the Portola′ expedition as they camped near the Santa Ana River in 1769. This event has been attributed by various geoscientists to just about every fault in the Los Angeles area but it could just as well have been a distant event that shook a wide area as did the 1971 San Fernando, the 1987 Whittier, and the 1994 Northridge events, as well as many other more-distant events such as 1992 Landers event.

4.0 SUBSURFACE CONDITIONS

4.1 SOIL CONDITIONS

The idealized soil profiles for each wall are presented in Table 4-1. Based on the correlations with SPT blowcounts (Lam and Martin, 1986) and laboratory test results, material shear strength parameters were selected and are included in Table 4-1. The shear strength parameters in Table 4-1 may appear to be inconsistent when relating to the SPT blowcounts (i.e., for the same soil type, higher blowcounts in one soil layer resulted in a lower shear strength than another soil layer with a lower blowcounts). This is because these shear strength parameters are based on the lower of the SPT blowcount correlation and laboratory strength tests, if available. It should be pointed out that the shear strength parameters obtained from the laboratory strength tests are lower than those obtained from SPT blowcount correlation for the same idealized soil layer.

Table 4-1. Idealized Soil Profile and Strength Parameters

Approximate Elevation (feet)	Predominant Soil Type	Equivalent SPT Blowcount* (blows/foot)	Total Unit Weight (pcf)	Friction Angle (degree)	Cohesion / Undrained Shear Strength (psf)
Wall 107 - Begin Wall to Wall LOL Station 18+39 (Borings A-10-002 and A-10-003)					
+112 to +75	Silty Sand and Clayey Sand	3 to (33) Average = 16	120	31	100
Wall 107 – Wall LOL Station 18+39 to End Wall (Boring A-10-005)					
+114 to +107	Sandy Silt and Clayey Sand	15	120	31	100
+107 to +99	Sandy Silt	7	115	-	1000
+99 to +94	Silty Sand and Clayey Sand	30	120	31	100
+94 to +89	Sandy Silt	7	115	-	1000
+89 to +80	Silty Sand and Clayey Sand	13	120	31	100
Wall 159 (Borings A-10-018 and A-10-019)					
+131 to +120	Silty Sand	5 to (12) Average = 9	120	31	100
+120 to +110	Sandy Silt	6 to 12 Average = 10	115	-	1000
+110 to +98	Silty Sand and Sand with Silt	4 to (36) Average = 16	120	31	100

Approximate Elevation (feet)	Predominant Soil Type	Equivalent SPT Blowcount* (blows/foot)	Total Unit Weight (pcf)	Friction Angle (degree)	Cohesion / Undrained Shear Strength (psf)
Wall 173 (Boring A-10-024 and CPT-10-026)					
+153 to +134	Silty Sand and Sand with Silt	13 to (57) Average = 31	120	32	100
+134 to +105	Silty Sand	9 to (23) Average = 15	115	31	100
+105 to +98	Sandy Silt	(14)	115	-	1500
+98 to +78	Silty Sand and Sand with Silt with interbedded Sandy Silt	16 to (43) Average = 32	120	32	100
Wall 255 (Borings A-10-036, A-10-037, A-10-038 and A-10-039)					
+198 to +170	Sand and Sand with Silt	10 to (42) Average = 31	120	30	100
+170 to +140	Sand and Sand with Silt	6 to (47) Average = 20	120	32	50
+140 to +125	Silty Sand	12 to (29) Average = 21	120	33	50
+125 to +115	Silt	16	115	-	2000
+115 to +97	Sand and Sand with Silt	(30) to 69 Average = 50	125	38	50
Wall 293 (Borings A-10-050 and A-10-052, and CPT-10-051 and CPT-10-053)					
+200 to +170	Silty Sand and Sand with Silt	8 to 20 Average = 11	120	30	100
+170 to +130	Sand	17 to (42) Average = 28	120	32	50
+130 to +125	Silt	5 to 34 Average = 14	115	-	2000
+125 to +122	Sand and Sand with Silt	26 to 43 Average = 39	125	38	50
Wall 307 (Boring A-10-055)					
+200 to +175	Sand and Sand with Silt	9 to 30 Average = 21	120	32	50
+175 to +150	Sand and Sand with Silt	26 to (30) Average = 28	120	33	50
+150 to +129	Sand and Sand with Silt	27 to (72) Average = 47	120	36	50

Approximate Elevation (feet)	Predominant Soil Type	Equivalent SPT Blowcount* (blows/foot)	Total Unit Weight (pcf)	Friction Angle (degree)	Cohesion / Undrained Shear Strength (psf)
Wall 315 (Borings A-10-057 and A-10-058)					
+188 to +175	Silty Sand and Sand with Silt	9 to (52) Average = 22	120	32	50
+175 to +154	Sand	18 to (52) Average = 28	120	33	50

* Values in ( ) are converted SPT blowcounts corrected for sampler size; correction factor from Modified California Drive sampler blowcounts to SPT blowcounts is 0.5.

4.2 GROUNDWATER CONDITIONS

Groundwater was encountered between elevations +70.9 feet near SR-91 Mainline Station 116+24 and +80.4 feet near SR-91 Mainline Station 173+76. Groundwater was also encountered between elevations +59.5 feet near Brookhurst Street Undercrossing (UC) and +128 feet near Acacia Street UC in 1993 and between elevations +72.2 and +73.5 feet near Brookhurst Street UC in 1955. Based on California Geological Survey (Division of Mines and Geology, 1997 and 1998), the recorded highest historical groundwater at the project site is between 40 and 50 feet below the existing ground surface. The existing ground surface elevations vary from +108 to +210 feet between the western and eastern end of the project, respectively. Therefore, using a historical high groundwater depth of 40 feet, the historical high groundwater elevations vary from +68 to +170 feet between the western and eastern end of the project, respectively.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 SEISMIC DESIGN CRITERIA

We have determined the design ARS curve based on the 2009 Seismic Design Criteria (SDC) (Caltrans, 2009a and 2009c) procedures. The peak ground acceleration (PGA) is the zero-period spectral acceleration in the ARS curve. A PGA of 0.52g is obtained from the design ARS curve.

For analyzing global slope stability, Section 3.10 of the Caltrans Guidelines for Structures Foundation Reports (Caltrans, 2009b) recommends using a horizontal seismic coefficient equal to one-third of the peak acceleration but not exceeding 0.2. Therefore, a horizontal seismic coefficient of 0.17 was used in the slope stability analysis.

As presented in Section 11.8.6 of AASHTO (2007), the seismic earth pressures can be computed using a seismic coefficient equal to half of the peak acceleration. Therefore, a seismic coefficient of 0.26g can be used for the computation of seismic earth pressures.

5.2 LIQUEFACTION

Liquefaction analysis was performed using the available site-specific subsurface information and the historical high groundwater elevations between +68 and +170 feet near western and eastern end of the project, respectively.

The liquefaction potential of the saturated, granular materials below the historical high groundwater table was evaluated using the procedures outlined by Seed et al. (1983), Seed and Harder (1990), and updated by NCEER (1997). Results of the liquefaction analysis are included in Appendix C. Based on the analysis, relatively thin layers of granular materials susceptible to liquefaction were encountered in some of the borings below the historical high groundwater table. These liquefiable layers, which are relatively deep and isolated, are not anticipated to impact the proposed improvements. Therefore, the liquefaction potential is anticipated to be low

5.3 SOIL CORROSIVITY

Nine soil samples were tested for pH, minimum resistivity, soluble chloride content and soluble sulfate content. The test results are summarized in Table 5-1. Minimum resistivities were between 750 and 5,700 ohm-cm. The pH values were between 7.2 and 8.6. The soluble sulfate measurements were between 10 and 130 parts per million (ppm), and the soluble chloride measurements were between 95 and 332 ppm.

Table 5-1. Soil Corrosion Test Results

Boring	Station (Offset) / "Station Line"	Sample Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Soluble Sulfate Content (ppm)	Soluble Chloride Content (ppm)
A-10-002	109+44 (78 Lt) / A Line	2.5	SC	3200	7.9	70	95
A-10-003	112+86 (101 Lt) / A Line	5	SC	5700	8.5	80	97
A-10-005	116+24 (176 Lt) / A Line	1.5-5	SC	2000	8.6	130	149
A-10-019	160+55 (106 Lt) / A Line	10	SM	2200	8.5	110	118
A-10-024	173+76 (62 Lt) / A Line	25	SM	750	7.8	40	332
A-10-037	256+96 (79 Lt) / A Line	0-3	CL	1200	7.2	10	114
A-10-039	264+14 (88 Lt) / A Line	5	SM	4800	8.0	120	191
A-10-039	264+14 (88 Lt) / A Line	75	MH	760	7.9	40	253
A-10-052	300+05 (82 Lt) / A Line	10	SM	5400	7.8	100	139

Based on the Caltrans Corrosion Guidelines (2003b), soils are considered corrosive if the pH is 5.5 or less, or the chloride concentration is 500 ppm or greater, or the sulfate concentration is 2,000 ppm or greater. Based on the test results and the Caltrans criteria, the on-site soils are considered to be non-corrosive to bare metals and concrete.

5.4 FOUNDATION DESIGN FOR TYPE 1 RETAINING WALLS

Walls 173 and 255 are proposed to be Caltrans Standard Type 1 retaining walls (Caltrans, 2010a). For wall heights 12 feet or less, spread footing is recommended provided overexcavation and recompaction are performed for soils below the footing bottom. For wall heights greater than 12 feet, pile foundation is recommended. A portion of the Wall 255 is also supported on an existing RCB; design of this portion of the wall is the responsibility of the structural designer.

5.4.1 Spread Footing

Shallow footings are recommended for wall heights 12 feet or less for Walls 173 and 255. Settlement and bearing capacity calculations are presented in Appendix C. Based on these calculations, the allowable bearing capacity exceeds the maximum toe pressure as shown on the Caltrans Standard Plans (2010a) for a level backfill, provided overexcavation and recompaction are performed for soils below the footing bottom. The recommended minimum overexcavation depths are presented in Table 5-2 for each wall height.

The minimum embedment and offset (from a slope face) of the footings should be based on Section 4.4.5.1 of Caltrans Bridge Design Specifications (2003a).

Table 5-2. Recommended Minimum Overexcavation Depth for Caltrans Standard Type 1 Retaining Walls

Retaining Wall No.	Wall Height (feet)	Bottom of Footing Elevation (feet)	Recommended Minimum Overexcavation Depth (feet)
173	6	+143.0	1
	8	+141.0	1
	10	+139.0	1
	12	+139.0	3
255 (Between Begin Wall and Wall LOL Station 15+88)	6	+163.67	1
	8	+161.67	1
	10	+161.67 to +175.67	2
	12	+161.67 to +163.67	4
255 (Between Wall LOL Station 15+88 and End Wall)	6	+191.67	1
	8	+177.67 to +189.67	1
	10	+177.67 to +179.67	1
	12	+179.67 to +183.67	3

The horizontal limits of the overexcavation should begin one foot from each edge of the footing bottom and extending downward at a 45-degree imaginary plane until the plane intersects the recommended minimum excavation depth presented in Table 5-2 for each wall height. In some areas, the 45-degree imaginary plane would intersect temporary shoring. In this case only, the horizontal limit of the overexcavation should begin from the edge of the footing bottom and extending out a minimum of 1 foot and down until the plane intersects the recommended excavation depths. Onsite soils or Caltrans Structure Backfill should be used for backfilling with a minimum relative compaction of 95% of maximum density as determined by Caltrans Test Method 216. The overexcavation bottom should be proof rolled prior to backfilling. Further, the overexcavation bottom should be inspected by a qualified geotechnical engineer or technician to confirm the presence of an unyielding and competent surface.

5.4.2 Deep Foundation

Pile footings are recommended for wall heights greater than 12 feet for Walls 173 and 255. Per Caltrans policy, the LRFD Service Limit State I load and Strength and Extreme Event Limit State load combinations are used for the design of Caltrans Standard Type 1 retaining walls on pile footings. Foundation loads for the Caltrans Standard Type 1 retaining wall are provided by the structural designers and presented in Table 5-3.

These retaining walls are located near residential homes. Therefore, 16-inch diameter Cast-in-Drilled-Hole (CIDH) piles were selected over driven piles due to noise and vibration concerns associated with pile driving.

Table 5-3. Pile Foundation Design Loads for Caltrans Standard Type 1 Retaining Walls

Wall Height (feet)	Footing Width (feet)	Min. Embed. Depth (feet)	Pile	Service-I Limit State Loads per Pile (kips)	Foundation Loads per Pile (kips)			
					Strength Limit State		Extreme Event Limit State	
					Compression	Tension	Compression	Tension
14	8.00	3.00	16" CIDH	75.1	112.3	0	109.9	0
16	9.00	3.00	16" CIDH	73.4	109.2	0	109.6	0

Foundation design recommendations are presented in Table 5-4. The Pile Data Table for the contract plans is presented in Table 5-5.

A pile-group efficiency factor (GEF) of 0.65 is used for a center-to-center pile spacing of 2.5 times the pile diameter, and a GEF of 1.0 is used for a center-to-center spacing of 4.0 times the pile diameter or greater (Section 10.8.3.6.3, AASHTO, 2007). Linear interpolation can be used to determine the GEF for intermediate spacing. Based on the pile layout provided by the structural designers, GEF's of 0.94 were used for the analysis.

The pile capacity is also based on soil resistance only and may be further limited by the pile-head connection details and the strength of the pile materials.

Table 5-4. Pile Foundation Design Recommendations for Caltrans Standard Type 1 Retaining Walls

Wall	Wall Height (feet)	Pile Type	Cut-off El. (feet)	Service-I Limit State Loads per Pile (kips)	Total Wall Settlement (inch)	Required Factored Nominal Resistance (kips)				Design Tip El. (feet)	Specified tip El. (feet)
						Strength Limit		Extreme Event			
						Comp. (ϕ=0.7)	Tension (ϕ=0.7)	Comp. (ϕ=1.0)	Tension (ϕ=1.0)		
173	14	16" CIDH	+139.00	75.1	1	112.3	0	109.9	0	+111 (a-I) +117 (a-II) +114 (d)	+111
255	14	16" CIDH	+177.67	75.1	1	112.3	0	109.9	0	+148 (a-I) +154 (a-II) +152 (d)	+148
	16	16" CIDH	+177.67 to +179.67	73.4	1	109.2	0	109.6	0	+148 (a-I) +154 (a-II) +152 (d)	+148

Notes:
1. Design tip elevations are controlled by the following demands: (a-I) Compression (Strength Limit), (a-II) Compression (Extreme Event) and (d) Lateral Load.
2. There are no design tip elevations for Tension and Tolerable Settlement.
3. The specified tip elevations shall not be raised above the design tip elevation for Lateral Load.

Table 5-5. Pile Data Table for Caltrans Standard Type 1 Retaining Walls

Wall	Wall Height (feet)	Pile Type	Nominal Resistance (kips)		Design Tip Elevations (feet)	Specified Tip Elevation (feet)
			Compression	Tension		
173	14	16" CIDH	170	0	+111 (a) +114 (d)	+111
255	14	16" CIDH	180	0	+148 (a) +152 (d)	+148
	16	16" CIDH	180	0	+148 (a) +152 (d)	+148

Notes:
1. Design tip elevations are controlled by the following demands: (a) Compression and (d) Lateral Load.
2. There are no design tip elevations for Tension and Tolerable Settlement.
3. The specified tip elevations shall not be raised above the design tip elevation for Lateral Load.

Results of lateral pile analysis in terms of pile-head shear and lateral deflection for a free-head condition are presented in Appendix C and summarized in Table 5-6. The maximum bending moment and the location of maximum moment are also presented. The solutions presented in Table 5-6 are entirely based on soil resistance and linear pile properties. Therefore, these values may be limited by the flexural strength (plastic moment) of the piles and pile-head connection details. Based on the pile layout provided by the structural designers, a group efficiency factor of 0.88 was used for the lateral solutions. The structural designer should compare the lateral pile demands with the results in Table 5-6 to determine whether the wall deflections are within tolerable limits.

Table 5-6. Lateral Pile Solutions for Caltrans Standard Type 1 Retaining Walls

Wall (Pile type)	Wall Height (feet)	Pile Head Deflection (inch)	Pile Head Shear (kips)	Maximum Moment (kip-inch)	Depth to Max. Moment from Pile Top (feet)
173 (16-inch CIDH)	14	¼	14.5	332	3.5
		½	23.9	615	4.0
		1	38.5	1128	4.5
		2	55.3	1999	5.0
		5	82.9	3931	6.0
255 (16-inch CIDH)	14 and 16	¼	14.6	328	3.8
		½	24.5	627	4.2
		1	36.9	1144	4.5
		2	52.3	1982	5.1
		5	79.0	3861	6.4

5.5 FOUNDATION DESIGN FOR SOUND WALLS ON RETAINING WALLS

Portions of Walls 107, 293, 307 and 315 are proposed to be Caltrans Standard Soundwall on Retaining Wall Type 1SWB. Another portion of Wall 293 is proposed to be Caltrans Standard

Soundwall on Retaining Wall Type 1SWBP. Another portion of Wall 315 is proposed to be Caltrans Standard Soundwall on Retaining Wall Type 5SWBP. Wall Type 1SWB is supported on spread footings and Wall Types 1SWBP and 5SWBP are supported on 16-inch diameter CIDH piles.

Per Caltrans policy, the LRFD Service Limit State I load and Strength and Extreme Event Limit State load combinations are used for the design of soundwall on retaining wall.

5.5.1 Spread footing

Foundation data and foundation loads for Soundwall on Retaining Wall Type 1SWB were provided by the structural designers and presented in the Table 5-7.

Table 5-7. Spread Footing Foundation Design Loads for Soundwall on Retaining Wall Type 1SWB

Wall Height (feet)	Footing Width (feet)	Minimum Embedment Depth (feet)	Foundation Loads (ksf)		
			Service Limit State I	Strength Limit State	Extreme Event Limit State
6	6.75	3.00	1.83	2.64	9.69
8	7.00	3.00	2.19	3.18	9.58
10	7.50	3.00	2.48	3.75	8.69
12	8.25	3.25	2.85	4.43	10.02

Spread footing design recommendations are presented in Table 5-8 for Walls 107, 293, 307 and 315. The design data presented in Table 5-8 are valid provided overexcavation and recompaction are performed for soils immediately below the footings. The recommended minimum overexcavation depths are also included in Table 5-8 for each wall height. At Wall 107, between Wall LOL Station 18+39 and End of the Wall, sandy silt with blowcount of 7 blows per foot was encountered near the bottom of footing. Therefore, 4 feet of overexcavation and recompaction is recommended for soils immediately below the footings at this location.

The minimum embedment and offset (from a slope face) of the footings should be based on Section 4.4.5.1 of the Caltrans BDS (2003a).

Table 5-8. Foundation Design Recommendations for Soundwall on Retaining Wall Type 1SWB on Spread Footings

Wall	Wall Height (feet)	Footing Width (feet)	Bottom of Footing El. (feet)	Min. Footing Embed. Depth (feet)	LRFD			Recommended Minimum Overexcavation Depth (feet)
					Service	Strength	Extreme Event	
					Permissible Net Contact Stress (ksf)	Factored Gross Nominal Bearing Resistance (ksf)	Factored Gross Nominal Bearing Resistance (ksf)	
107 (Between Begin Wall and Wall LOL Station 18+39)	6	6.75	+104.65	3.00	2.0	10.2	22.7	1
	8	7.00	+104.65	3.00	2.3	10.4	23.1	2
	10	7.50	+104.65	3.00	2.6	10.8	23.9	3
	12	8.25	+102.65 to +104.65	3.25	2.9	11.6	25.8	3
107 (Between Wall LOL Station 18+39 and End Wall)	8	7.00	+106.65	3.00	2.3	4.3	9.6	4
	10	7.50	+106.65	3.00	2.6	4.1	9.2	4
293	8	7.00	+176.46 to +178.46	3.00	2.2	4.3	9.6	2
	10	7.50	+178.46	3.00	2.5	4.6	10.2	3
	12	8.25	+176.46 to +178.46	3.25	2.9	4.9	10.9	4
307	8	7.00	192.82	3.00	2.2	5.2	11.6	1
315	6	6.75	183.24	3.00	2.0	5.0	11.2	1

The horizontal limits of the overexcavation should begin one foot from each edge of the footing bottom and extending downward at a 45-degree imaginary plane until the plane intersects the recommended minimum excavation depth presented in Table 5-8 for each wall height. In some areas, the 45-degree imaginary plane would intersect temporary shoring. In this case only, the horizontal limit of the overexcavation should begin from the edge of the footing bottom and extending out a minimum of 1 foot and down until the plane intersects the recommended excavation depths. Caltrans Structure Backfill should be used for backfilling at Wall 107 between Wall LOL Station 18+39 and End of the Wall. For other wall locations included in Table 5-8, on-site soils or Caltrans Structure Backfill should be used for backfilling. The backfill material should be compacted to a minimum relative compaction of 95% of maximum density as determined by Caltrans Test Method 216. The overexcavation bottom should be proof rolled prior to backfilling. Further, the overexcavation bottom should be inspected by a qualified geotechnical engineer or technician to confirm the presence of an unyielding and competent surface.

5.5.2 Pile Foundation

Portions of Walls 293 and 315 are Soundwall on Retaining Wall Types 1SWBP and 5SWBP, respectively. The Wall Types 1SWBP and 5SWBP are supported on 16-inch diameter CIDH piles. The foundation design data and foundation loads are provided by the structural designers and presented in Table 5-9.

Table 5-9. Pile Foundation Design Loads for Soundwall on Retaining Wall Types 1SWBP and 5SWBP

Wall	Wall Height (feet)	Footing Width (feet)	Min. Embed. Depth (feet)	Pile	Service-I Limit State Loads per Pile (kips)	Foundation Loads per Pile (kips)			
						Strength Limit State		Extreme Event Limit State	
						Compression	Tension	Compression	Tension
293	14	9.25	3.25	16" CIDH	74.5	106.4	0	106.0	0
	16	10.25	3.50	16" CIDH	58.9	84.5	0	86.2	0
	18	11.00	4.00	16" CIDH	72.3	103.9	0	108.9	0
315	2.5	5.75	4.00	16" CIDH	34.7	38.6	12.4	62.4	30.4

Foundation design recommendations are presented in Table 5-10. The Pile Data Table for the contract plans is presented in Table 5-11.

A pile-group efficiency factor (GEF) of 0.65 is used for a center-to-center pile spacing of 2.5 times the pile diameter, and a GEF of 1.0 is used for a center-to-center spacing of 4.0 times the pile diameter or greater (Section 10.8.3.6.3, AASHTO, 2007). Linear interpolation can be used to determine the GEF for intermediate spacing. Based on the pile layout provided by the structural designers, GEF's of 0.88 and 0.55 were used for the analysis of Walls 293 and 315, respectively.

The pile capacity is also based on soil resistance only and may be further limited by the pile-head connection details and the strength of the pile materials.

Table 5-10. Pile Foundation Design Recommendations for Soundwall on Retaining Wall Types 1SWBP and 5SWBP

Wall	Wall Height (feet)	Pile Type	Cut-off El. (feet)	Service-I Limit State Loads per Pile (kips)	Total Wall Settlement (inch)	Required Factored Nominal Resistance (kips)				Design Tip El. (feet)	Specified Tip El. (feet)
						Strength Limit		Extreme Event			
						Comp. (ϕ=0.7)	Tension (ϕ=0.7)	Comp. (ϕ=1.0)	Tension (ϕ=1.0)		
293	14	16" CIDH	+176.46 +178.46	74.5	1	106.4	0	106.0	0	+148 (a-I) +151 (a-II) +151 (d)	+148
	16	16" CIDH	+178.46 +180.46	58.9	1	84.5	0	86.2	0	+153 (a-I) +157 (a-II) +155 (d)	+153
	18	16" CIDH	+180.46	72.3	1	103.9	0	108.9	0	+151 (a-I) +155 (a-II) +155 (d)	+151
315	2.5	16" CIDH	+183.60	34.7	1	38.6	12.4	62.4	30.4	+162 (a-I) +160 (a-II) +168 (b-I) +164 (b-II) +162 (d)	+160

Notes:

1. Design tip elevations are controlled by the following demands: (a-I) Compression (Strength Limit), (a-II) Compression (Extreme Event), (b-I) Tension (Strength Limit), (b-II) Tension (Extreme Event) and (d) Lateral Load.
2. There are no design tip elevations for Tension and Tolerable Settlement for Wall 293.
3. There is no design tip elevation for Tolerable Settlement for Wall 315.
4. The specified tip elevations shall not be raised above the design tip elevation for Lateral Load for Wall 293.
5. The specified tip elevation shall not be raised above the design tip elevations for Tension and Lateral Load for Wall 315.

Table 5-11. Pile Data Table for Soundwall on Retaining Wall Types 1SWBP and 5SWBP

Wall	Wall Height (feet)	Pile Type	Nominal Resistance (kips)		Design Tip Elevations (feet)	Specified Tip Elevation (feet)
			Compression	Tension		
293	14	16" CIDH	180	0	+148 (a) +151 (d)	+148
	16	16" CIDH	140	0	+153 (a) +155 (d)	+153
	18	16" CIDH	180	0	+151 (a) +155 (d)	+151
315	2.5	16" CIDH	120	60	+160 (a) +164 (b) +162 (d)	+160

Notes:

1. Design tip elevations are controlled by the following demands: (a) Compression, (b) Tension and (d) Lateral Load.
2. There are no design tip elevations for Tension and Tolerable Settlement for Wall 293.
3. There is no design tip elevation for Tolerable Settlement for Wall 315.
4. The specified tip elevations shall not be raised above the design tip elevation for Lateral Load.
5. The specified tip elevation shall not be raised above the design tip elevation for Tension and Tolerable Settlement for Wall 315.

Results of lateral pile analysis in terms of pile-head shear and lateral deflection for a free-head condition are presented in Appendix C and summarized in Table 5-12. The maximum bending moment and the location of maximum moment are also presented. The solutions presented in Table 5-12 are entirely based on soil resistance and linear pile properties. Therefore, these values may be limited by the flexural strength (plastic moment) of the piles and pile-head connection details. Based on the pile layout provided by the structural designers, a group efficiency factor of 0.88 and 0.68 was used for the lateral solutions of Wall 293 and 315, respectively. The structural designer should compare the lateral pile demands with the results in Table 5-12 to determine whether the wall deflections are within tolerable limits.

Table 5-12. Lateral Pile Solutions for Soundwall on Retaining Wall Types 1SWBP and 5SWBP

Wall (Pile Type)	Wall Height (feet)	Pile Head Deflection (inch)	Pile Head Shear (kips)	Maximum Moment (kip-inch)	Depth to Max. Moment from Pile Top (feet)
293 (16-inch CIDH)	14 to 18	¼	14.6	328	3.80
		½	24.5	628	4.10
		1	36.9	1144	4.60
		2	52.2	1984	5.20
		5	78.8	3863	6.40
315 (16-inch CIDH)	2.5	¼	12.2	301	4.00
		½	20.2	557	4.25
		1	32.6	1018	4.75
		2	46.8	1800	5.25
		5	70.2	3557	6.50

5.6 FOUNDATION DESIGN FOR SOUND WALLS

Portions of Walls 107, 293, 307 and 315 are proposed to be Soundwalls on Barrier Types 736S and 736SV. Wall 159 is proposed to be Soundwall on Barrier Type 736S. A portion of Wall 159 is also supported on the proposed "Houston Storm Channel" RCB; design of this portion of the wall is the responsibility of the structural designer.

Caltrans Standard Plan Sheets B15-6 through B15-8 (Caltrans, 2010a) are recommended for foundation design including pile type, length, and spacing. Based on the soil data, we recommend using a minimum friction angle of 30 degrees for foundation design.

5.7 LATERAL EARTH PRESSURES

For retaining wall design, static active lateral earth pressure of 36 psf per foot of depth is recommended for a free draining, level and compacted backfill. For seismic incremental pressure, an inverted triangular pressure distribution with a horizontal pressure of 22H psf (H is the height of the wall) at the top of the wall is recommended for a free draining, level and

compacted backfill. The inverted triangular seismic incremental pressure should be added to the static pressure to determine the total pressure for earthquake design.

If applicable, a uniform lateral pressure due to traffic loading, equivalent to a vertical pressure produced by at least 2 feet of earth with a soil unit weight of 120 lb/ft^3, should be added to the above lateral earth pressure. Using an active earth pressure of 0.3, the recommended uniform lateral earth pressure due to traffic loading is 72 psf.

5.8 GLOBAL STABILITY ANALYSES

Global stability analyses were performed using the computer program SLIDE 5.0 (Rocscience, 2006) for both static and pseudostatic conditions and the results are presented in Appendix C. The maximum wall heights at each of the following retaining wall locations were analyzed:

- RW 107 at about Wall LOL Station 17+13,
- RW 173 at about Wall LOL Station 10+00,
- RW 255 at about Wall LOL Station 19+02,
- RW 293 at about Wall LOL Station 22+33,
- RW 307 at about Wall LOL Station 10+04, and
- RW 315 at about Wall LOL Station 12+00

For each wall, the calculated factor of safety for a deep-seated failure is greater than the minimum required 1.5 under static condition with a 2-foot soil surcharge to represent traffic loading. Slope stability analysis under pseudo-static condition was performed using a seismic coefficient equal to 0.17g. Analysis indicates that the calculated factor of safety is greater than the required minimum of 1.1 under pseudo-static condition.

6.0 CONSTRUCTION RECOMMENDATIONS

6.1 EARTHWORK

Earthwork should be performed in accordance with Caltrans Standard Specifications, Section 19 (Caltrans, 2010b). Appropriate measures should be taken to prevent damage to adjacent structures and utilities. Any design and construction of temporary sloping, sheeting, or shoring should be made the contractor's responsibility. It should be noted that it is the responsibility of the contractor to oversee the safety of the workers in the field during construction. The contractor shall conform to all applicable occupational and health standards, rules, regulations, and orders established by the State of California. In addition, other State, County, or Municipal regulations may supersede the recommendations presented in this section. If a trench shoring design and safety plan is required, the geotechnical consultant should review the plan to confirm that recommendations presented in this report have been applied to the design.

During the recent field investigation conducted between January 5 and 24, 2011, groundwater was encountered between elevations +70.9 feet near SR-91 Mainline Station 116+24 and +80.4 feet near SR-91 Mainline Station 173+76. As shown on the as-built LOTB sheets in Appendix A, groundwater was also encountered between elevations +59.5 feet near Brookhurst Street Undercrossing (UC) and +128 feet near Acacia Street UC in 1993 and between elevations +72.2 and +73.5 feet near Brookhurst Street UC in 1955. Using the above groundwater measurements, groundwater is not anticipated to be encountered during footing construction. However, groundwater level can fluctuate due to seasonal rainfall amount, local irrigation and groundwater recharge program and other man-made conditions. If groundwater is encountered during footing construction, it should be controlled in accordance with Section 19-3.03D of the Caltrans Standard Specifications (2010b). If wet subgrade conditions are encountered during construction, the soft bottom will require stabilization prior to any earthwork. Subgrade stabilization can be accomplished by using a combination of geotextile, geogrid, gravel, or aggregate base. In addition, low ground pressure earthmoving equipment may be necessary during excavation and relatively lightweight equipment may be needed to compact the select material to minimize the potential for soil pumping.

6.2 PILE CONSTRUCTION

Construction of CIDH piles should follow Section 49-4.03B, "Drilled Holes" of the Caltrans Standard Specifications (2010b). The Contractor should be required to drill the bottom of the shaft boring with a clean-out bucket to ensure adequate removal of loose soils. Both clean-out and concrete placement should be addressed in the specifications. The shaft borings should be inspected and approved by the Resident Engineer prior to installation of reinforcement. Per latest Caltrans requirement, 3-inch of concrete cover over reinforcement should be provided to improve the construction of the CIDH piles.

The onsite soils generally range from loose to very dense coarse grained materials, and these materials are susceptible to caving. If caving occurs, a temporary casing can be used. The casing should have an inside diameter larger than or equal to the pile diameter and should be placed tight in the hole. Vibratory hammers or oversized drilling are not allowed for casing installation. In the event that any boring becomes bell-shaped and cannot be advanced due to severe caving, all loose material should be removed from the bottom of the boring and the caved region filled

with a low strength sand-cement slurry. Drilling may continue when the slurry has reached its initial set.

6.3 REVIEW OF CONSTRUCTION PLANS

Recommendations contained in this report are based on preliminary plans. The geotechnical consultant should review the final construction plans and specifications in order to confirm that the general intent of the recommendations contained in this report have been incorporated into the final construction documents. Recommendations contained in this report may require modification or additional recommendations may be necessary based on the final design.

6.4 GEOTECHNICAL OBSERVATION AND TESTING

It is recommended that inspections and testing be performed by the geotechnical consultant during the following stages of construction:

- Grading operations, including excavations and placement of compacted fill
- Shoring installation
- Spread and pile footing excavations and constructions
- Backdrain installation and backfilling of walls
- Removal or installation of support of buried utilities or structures
- When any unusual subsurface conditions are encountered

7.0 LIMITATIONS

This report is intended for the use of OCTA, RBF and Caltrans for the design and construction of non-standard walls. This report is based on the project as described and the information obtained from the exploratory borings at the approximate locations indicated on the attached plans. The findings and recommendations contained in this report are based on the results of the field investigation, laboratory tests, and engineering analyses. In addition, soils and subsurface conditions encountered in the exploratory borings are presumed to be representative of the project site. However, subsurface conditions and characteristics of soils between exploratory borings can vary. The findings reflect an interpretation of the direct evidence obtained. The recommendations presented in this report are based on the assumption that an appropriate level of quality control and quality assurance (inspections and tests) will be provided during construction. EMI should be notified of any pertinent changes in the project plans or if subsurface conditions are found to vary from those described herein. Such changes or variations may require a re-evaluation of the recommendations contained in this report.

The data, opinions, and recommendations contained in this report are applicable to the specific design element(s) and location(s) which is (are) the subject of this report. They have no applicability to any other design elements or to any other locations and any and all subsequent users accept any and all liability resulting from any use or reuse of the data, opinions, and recommendations without the prior written consent of EMI.

EMI has no responsibility for construction means, methods, techniques, sequences, or procedures; for safety precautions or programs in connection with the construction; for the acts or omissions of the CONTRACTOR or any other person performing any of the construction; or for the failure of any worker to carry out the construction in accordance with the Final Construction Drawings and Specifications.

Services performed by EMI have been conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, expressed or implied, and no warranty or guarantee is included or intended.

8.0 REFERENCES

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Appendix A

LOG OF TEST BORINGS SHEETS

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
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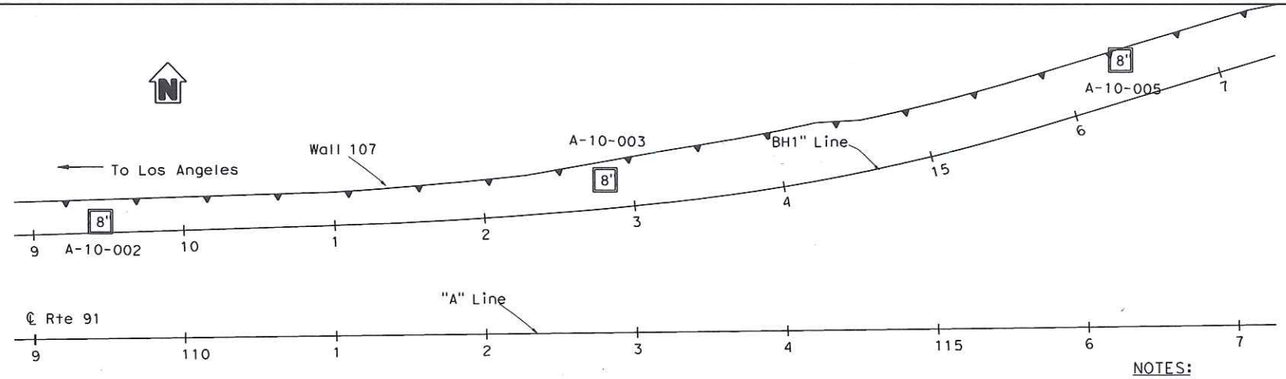

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER _____ DATE _____

PLANS APPROVAL DATE _____

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550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

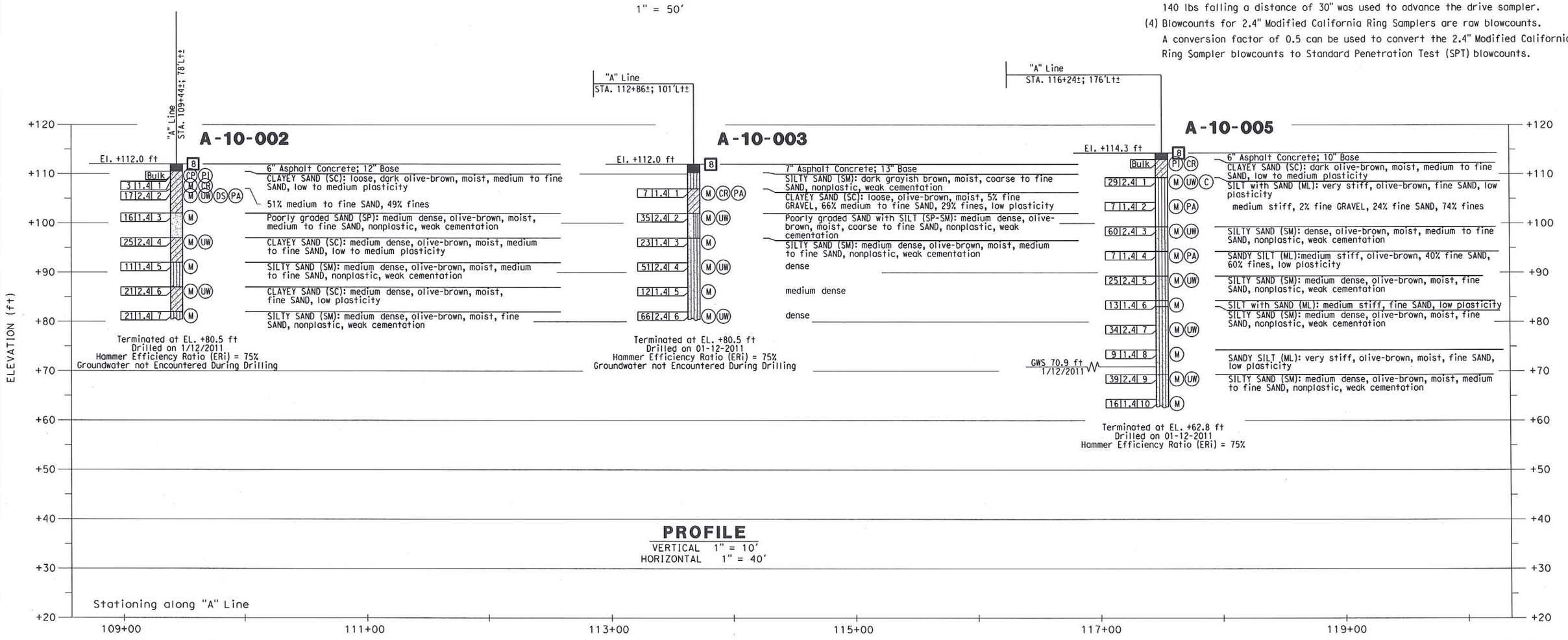
NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).
(2) 2.4" samples were taken using a California Modified Sampler.
(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.
(4) Blowcounts for 2.4" Modified California Ring Samplers are raw blowcounts. A conversion factor of 0.5 can be used to convert the 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts.

PLAN

1" = 50'

To Corona →



PROFILE

VERTICAL 1" = 10'
HORIZONTAL 1" = 40'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -	WALL 107
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 1/12/2011			PROJECT ENGINEER	POST MILES -	LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARK

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Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

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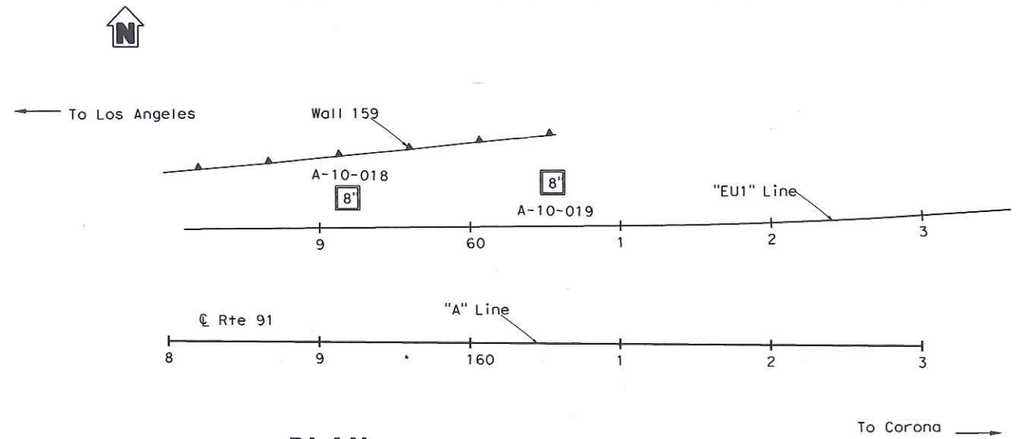

PLAN
1" = 50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

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FOUNTAIN VALLEY, CA 92708

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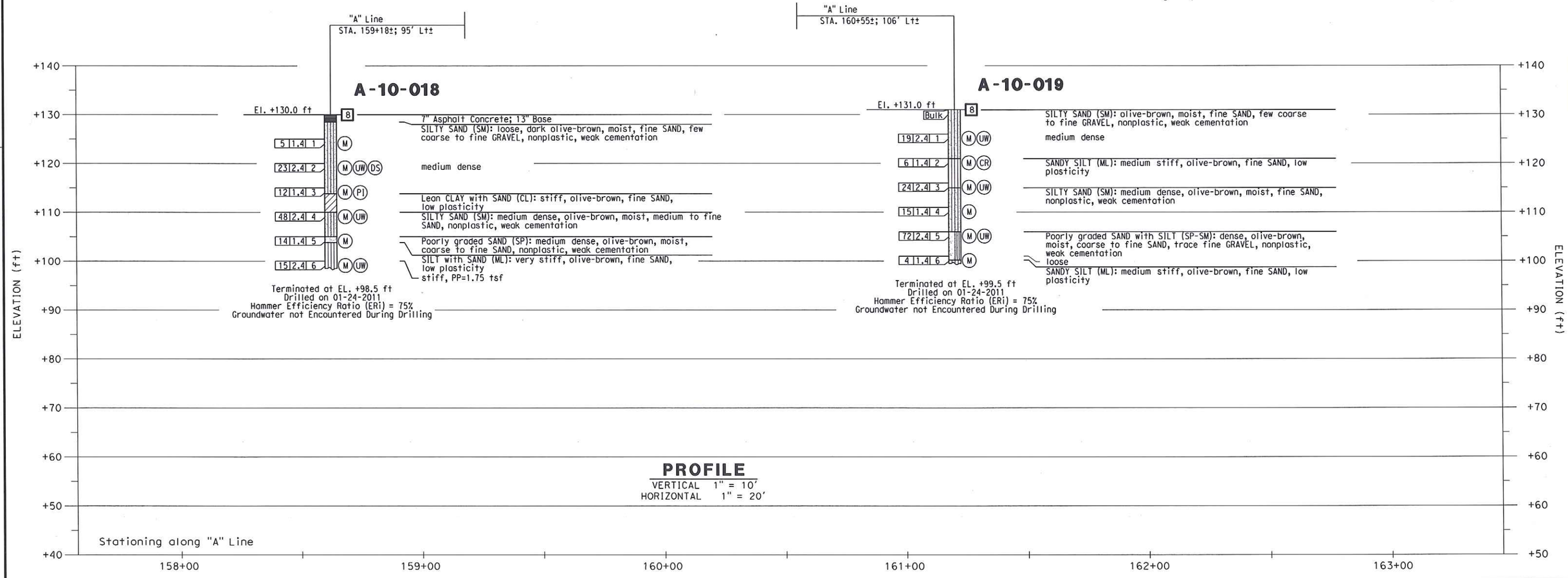

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -	WALL 159
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 1/24/2011			PROJECT ENGINEER	POST MILES -	LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

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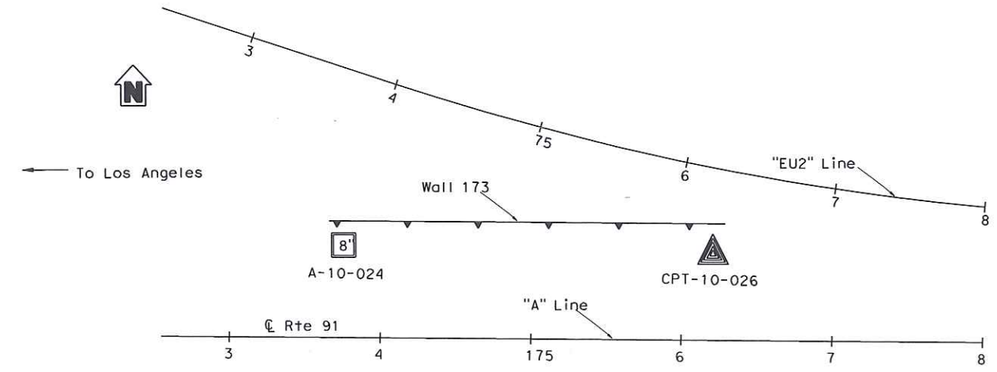

PLAN
1" = 50'

To Corona

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

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REGISTERED PROFESSIONAL ENGINEER
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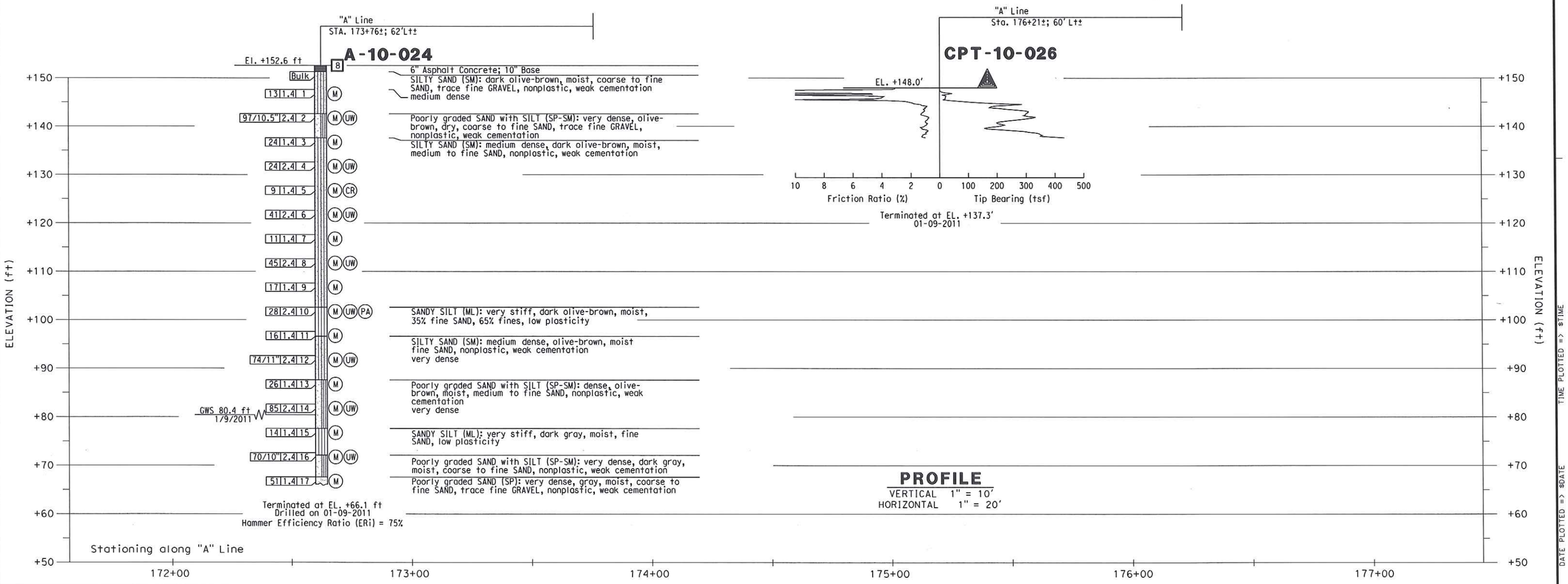

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. -
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 1/9/2011			POST MILES -

WALL 173

LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

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BENCH MARK

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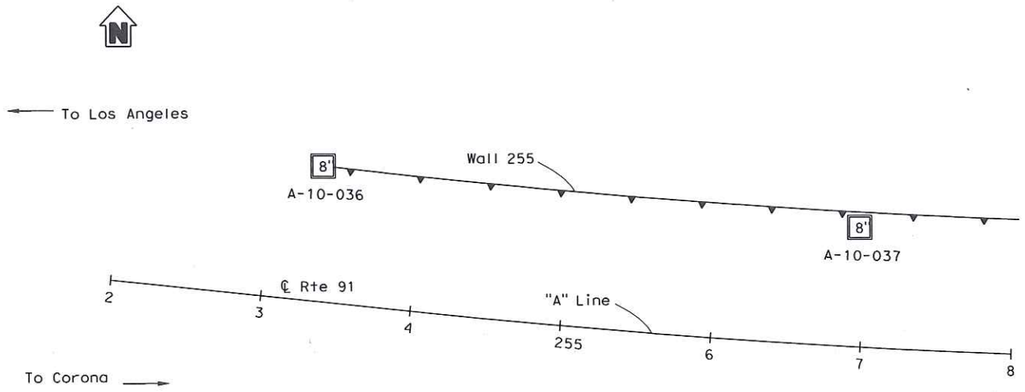

PLAN
1" = 50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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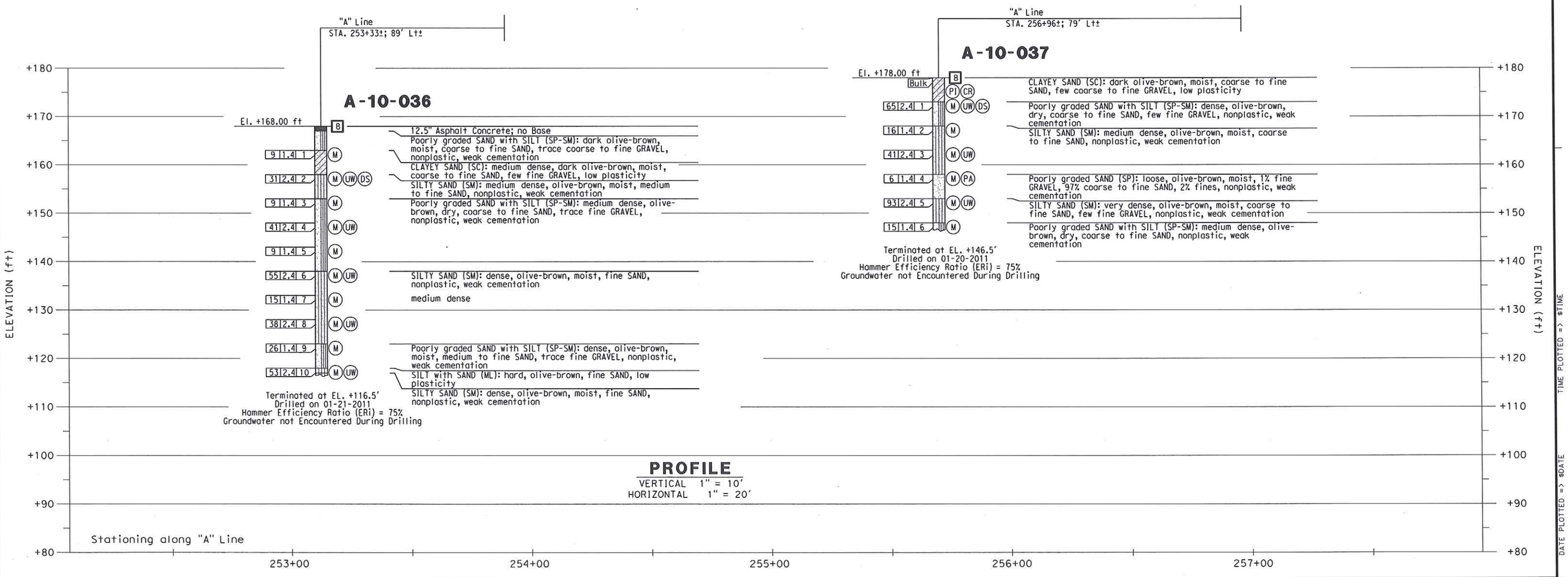

PROFILE
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HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. PIRATHIVIRAJ PROJECT ENGINEER	BRIDGE NO. -
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/2011			POST MILES -

WALL 255

LOG OF TEST BORINGS 1 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

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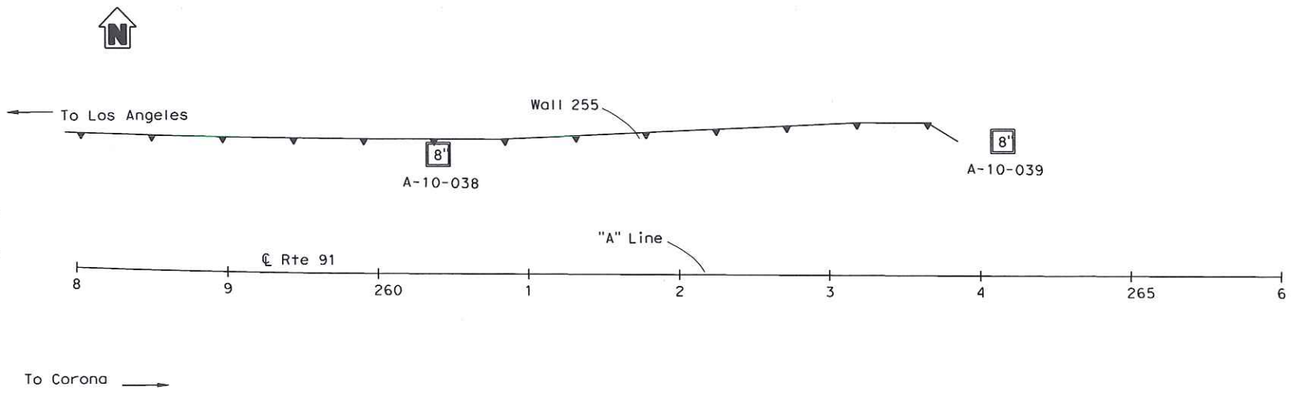

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

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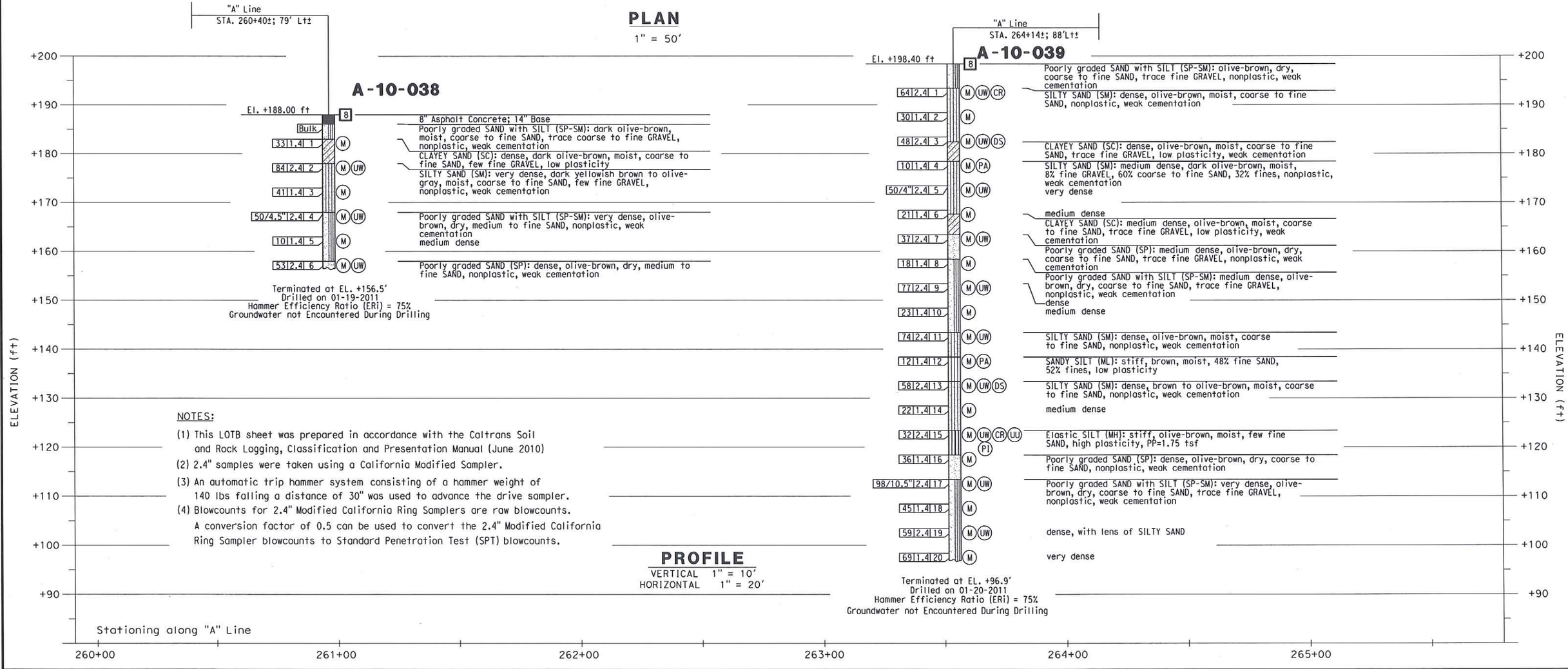
ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

PLAN
1" = 50'



NOTES:

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PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT
SIGN OFF DATE

DRAWN BY: J. Fang
CHECKED BY: G. J. Gunaranjan

R. Jie
FIELD INVESTIGATION BY:
DATE: 1/2011

PREPARED FOR THE STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

S. Pirathiviraj
PROJECT ENGINEER

BRIDGE NO. -
POST MILES -

WALL 255
LOG OF TEST BORINGS 2 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
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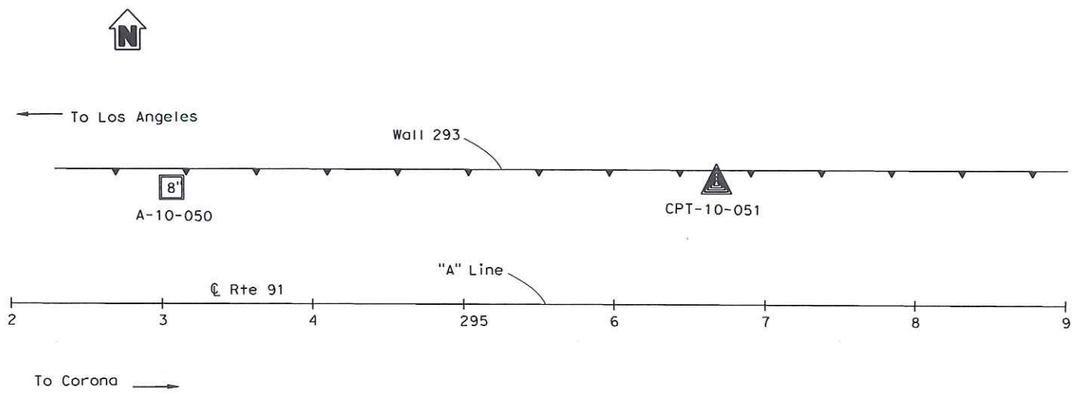
Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

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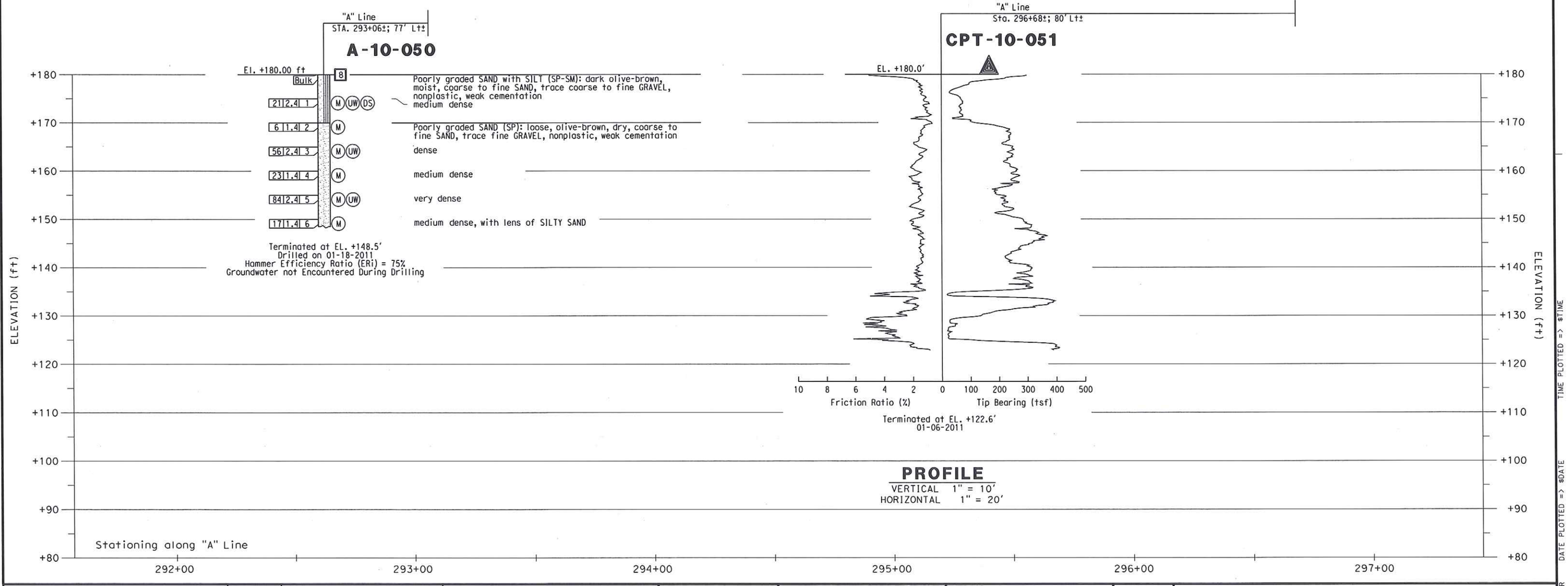

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -	WALL 293
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/2011			PROJECT ENGINEER	POST MILES -	LOG OF TEST BORINGS 1 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

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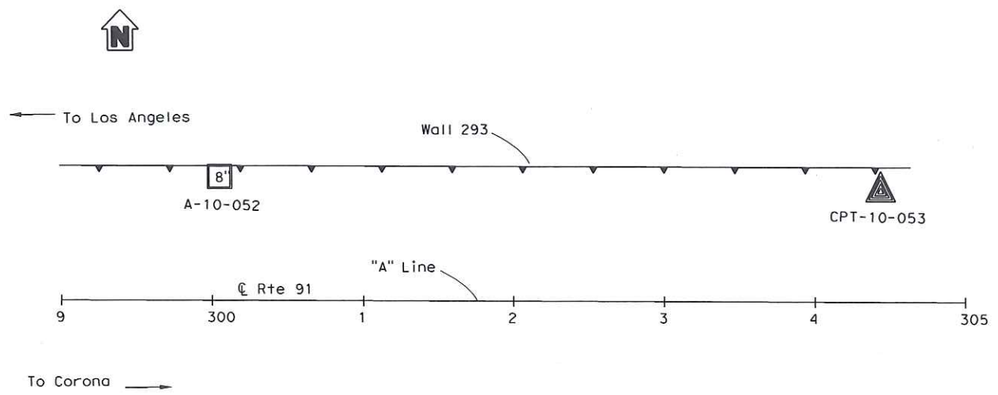

PLAN
1" = 50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
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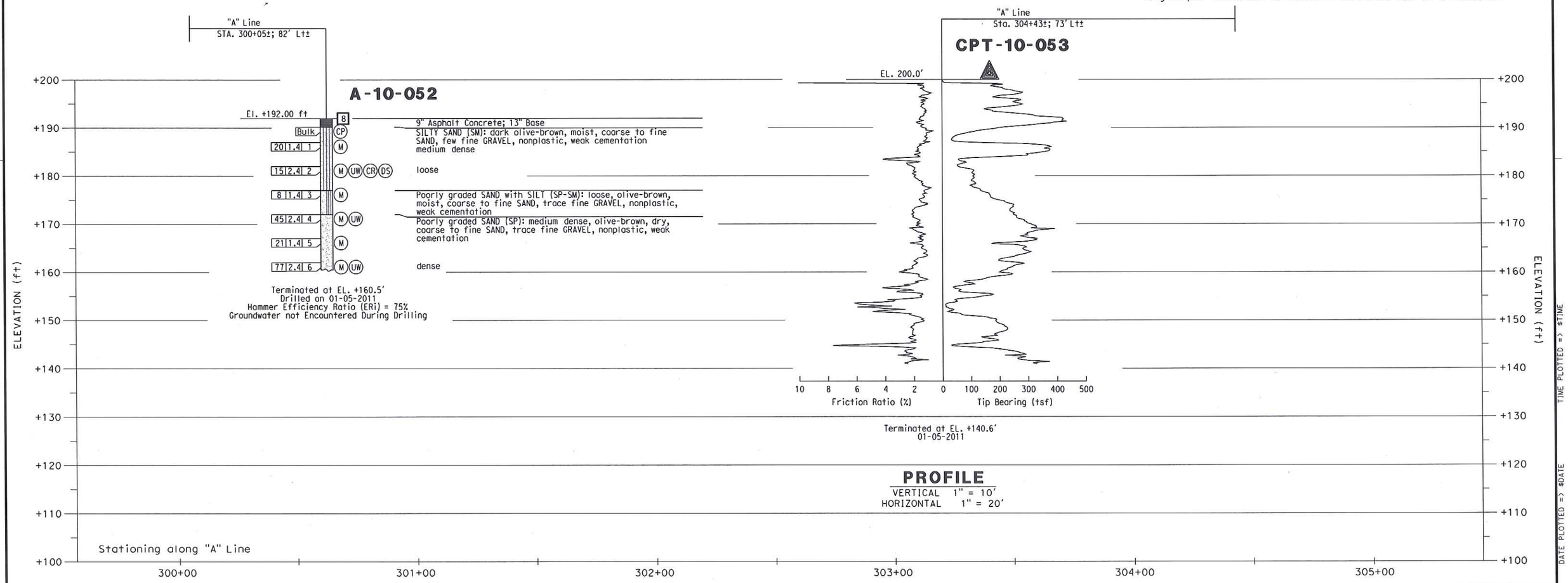

PROFILE
VERTICAL 1" = 10'
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DESIGN OVERSIGHT / SIGN OFF DATE	DRAWN BY	J. Fang	R. Jie — FIELD INVESTIGATION BY:	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj — PROJECT ENGINEER	BRIDGE NO. -
	CHECKED BY	G. J. Gunaranjan	DATE: 1/2011			POST MILES -

WALL 293
LOG OF TEST BORINGS 2 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

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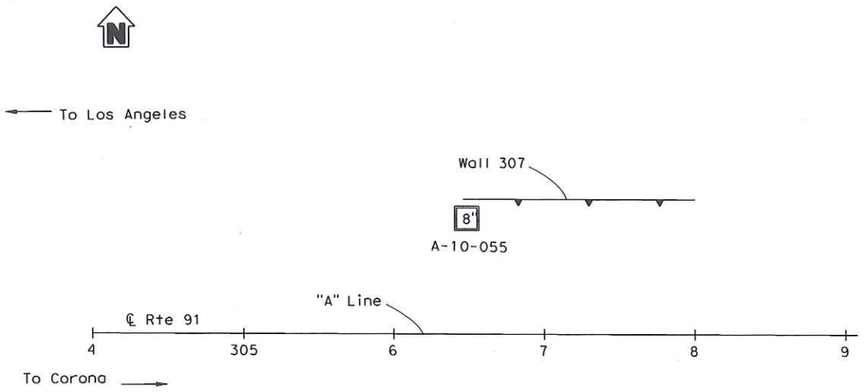

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
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ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
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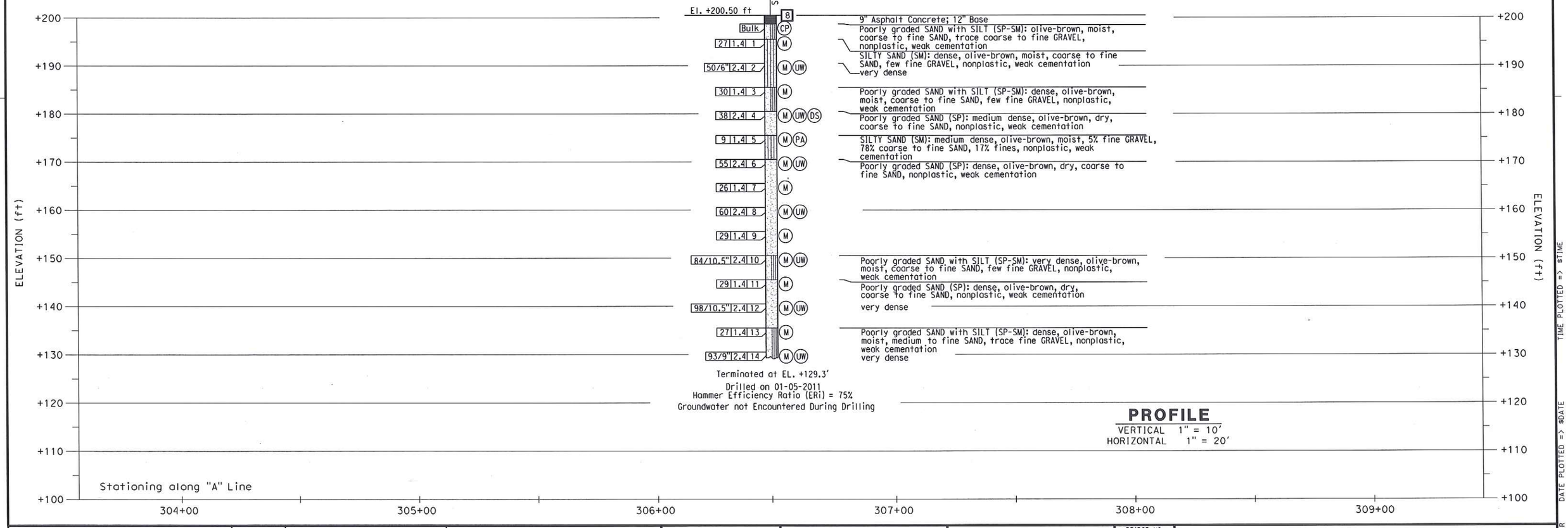

PROFILE

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DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -	WALL 307
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/2011			PROJECT ENGINEER	POST MILES -	LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295 PROJECT NUMBER & PHASE: 12000000791

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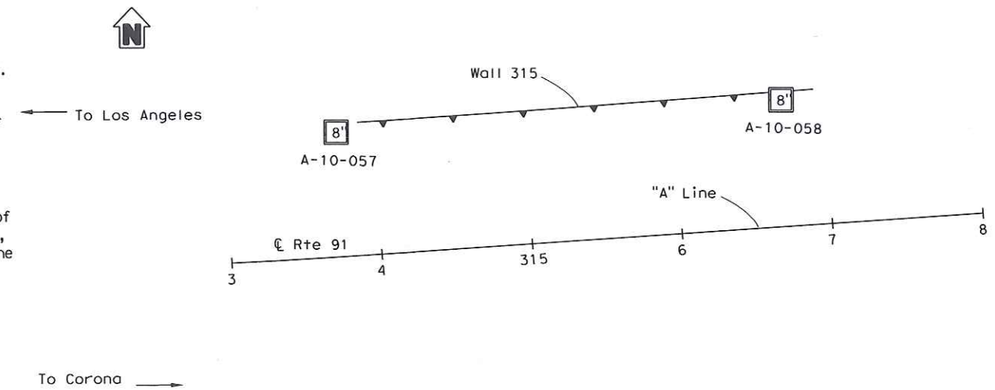

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

PLAN

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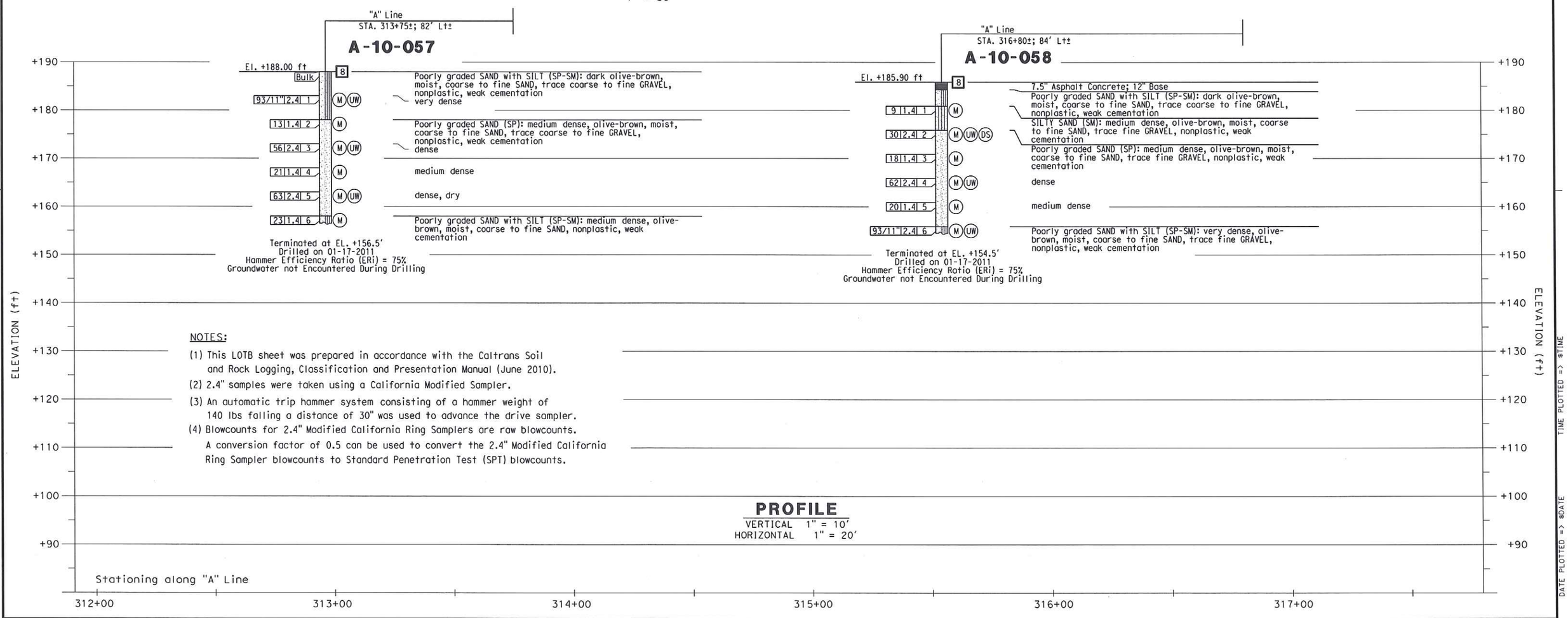

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PROFILE

VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

Stationing along "A" Line

312+00 313+00 314+00 315+00 316+00 317+00

DESIGN OVERSIGHT
SIGN OFF DATE

DRAWN BY J. Fang
CHECKED BY G. J. Gunaranjan

R. Jie
FIELD INVESTIGATION BY:
DATE: 1/2011

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

S. Pirathiviraj
PROJECT ENGINEER

BRIDGE NO. -
POST MILES -

WALL 315

LOG OF TEST BORING 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

This verification has been considered in preparing the geotechnical report for this project — Thomas D. Shantz — 1/22/96 Date

9-16-96
TO ACCOMPANY PLANS DATED

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	Ora	91	10/28	312	312

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DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES

As-Built Log of Test Borings sheet is considered an informational document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date confirm that this is a true and accurate copy of the original document. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.

DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
12	ORA	91	0.9/5.4		

GEOTECHNICAL PROFESSIONAL — DATE

EUCLID STREET UC (WIDEN)

LOG OF TEST BORINGS 1 OF 2

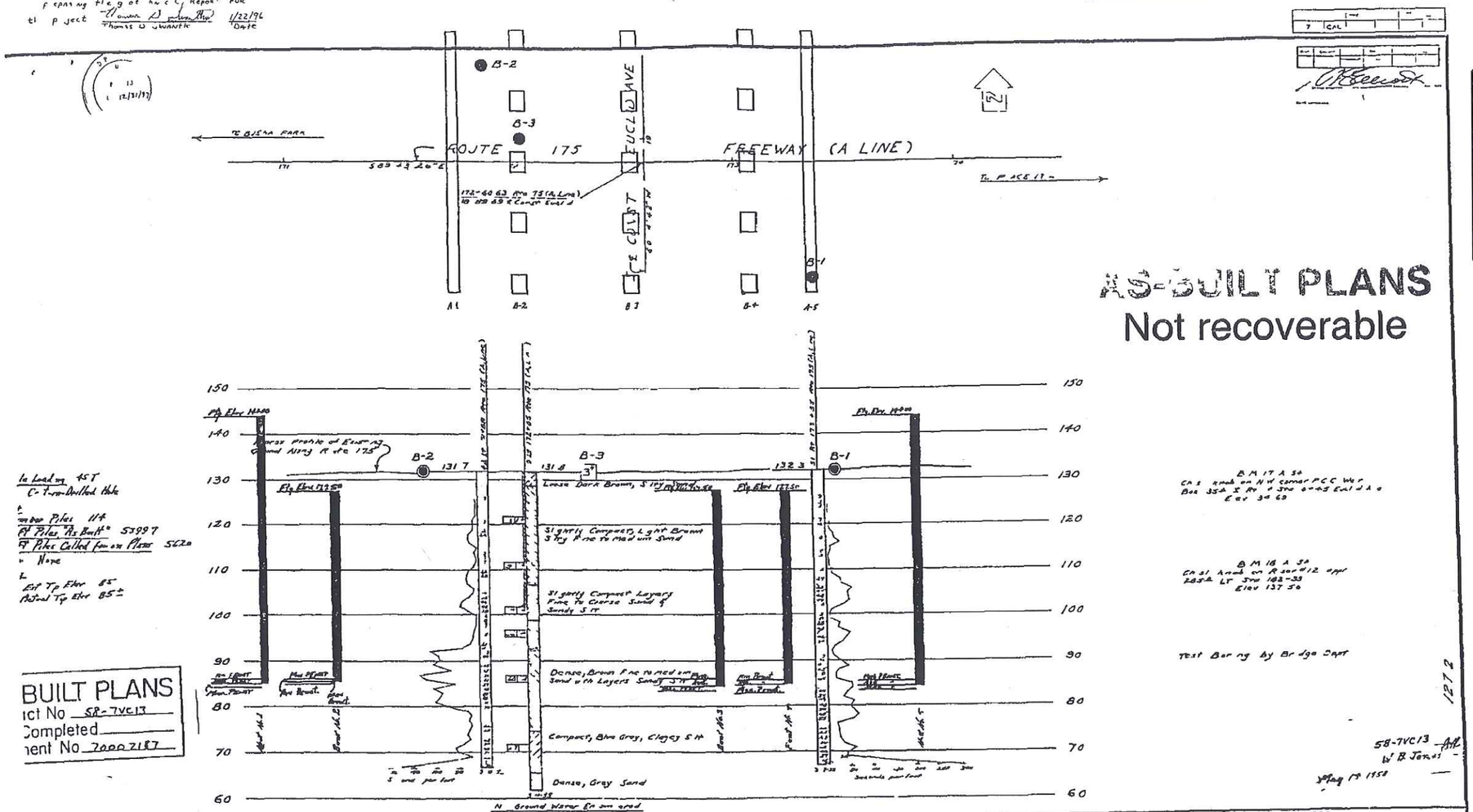
NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

BRIDGE No.	Sheet	Of
55-0279	X	X

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

AS-BUILT PLANS
Not recoverable



In Loading 45T
Cast-in-Drilled Hole

Number Piles 114
Ft Piles "As Built" 53997
Ft Piles Called for on Plans 5620
None

Est Tip Elev 85±
Actual Tip Elev 85±

B.M. 17 A 34
Cast mark on NW corner P.C.C. Wall
Box 35A X Rd + 3700 6+43 Eml J.A.
Elev 34.69

B.M. 16 A 34
Cast mark on R face #12 appr 283 ft LT Sta 182+39
Elev 137.36

Test Boring by Bridge Dept

58-7VC13 Ant
W. B. Jones
Aug 15 1958

1272

AS BUILT PLANS
Project No SR-7VC13
Completed
Document No 7000 7187

LEGEND OF EARTH MATERIALS

Gravel	Silty Clay or Clayey Silt
Sand	Peat and/or Organic Matter
Silt	Fill Material
Clay	Igneous Rock
Sandy Clay or Clayey Sand	Sedimentary Rock
Sandy Silt or Silty Sand	Metamorphic Rock

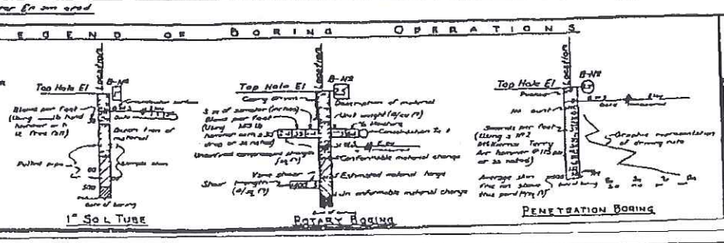
DESCRIPTION OF MATERIAL BASED ON STANDARD GRADE SIZE LIMITS

Diagram showing the basis for estimates of grade size distribution used in determination of class names.

If gravel is present in appreciable amounts the term gravelly may be added to the class name, viz gravelly sand. The terms coarse, medium and fine when used to describe sand, silt and gravel, refer to standard grade size limits.

LEGEND OF BORING OPERATIONS

Plan of Any Boring
Penetrometer
2½ Cone Penetrometer
Sampler Boring (Dry)
Rotary Bor ing (Wet)
Auger Bor ing (Dry)
Jet Boring
Core Bor ing
Test Pit



NOTES

The contractor's attention is directed to Section 2 Article (a) of the Standard Specifications and to the Special Provisions accompanying the set of plans. Classification of soils encountered as shown on this sheet is based upon field inspection and not to be construed to imply mechanical analysis.

EUCLID AVE U C

LOG OF TEST BORINGS

Scale 1" = 5' | Bridge 55-279 | Rt 91 | O.S. 4.65 10

Engineer — DATE 4-22-96
DESIGN NOTE: ADDITIONAL AS BUILT FOUNDATION DATA MAY BE AVAILABLE AT THE DIVISION OF NEW TECHNOLOGY MATERIALS AND RESEARCH 5900 FOLSOM BOULEVARD SACRAMENTO CALIFORNIA 95819

DESIGN	J Bishop	CHECKED	Y Hu
DETAILS	K Dang	CHECKED	Y Hu
QUANTITIES	J Bishop	CHECKED	T Young

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

J S Bishop
DISTRICT ENGINEER

CU 12209
EA 012411

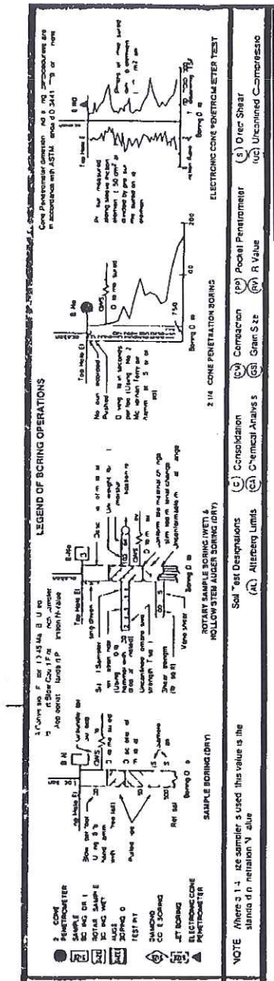
BRIDGE NO 55 279
POST MILE 22

EUCLID AVENUE UNDERCROSSING (WIDEN)

AS-BUILT LOG OF TEST BORINGS

REVISIONS PREPARED BY — DATE — STATE OF CALIFORNIA — SHEET 16 OF 16

ClibPDF - www.fastio.com



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DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
12	ORA	91	0.9/5.4		

GEOTECHNICAL PROFESSIONAL — DATE

EUCLID STREET UC (WIDEN)

LOG OF TEST BORINGS 2 OF 2

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UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

BRIDGE No.	Sheet	of
55-0279	x	x

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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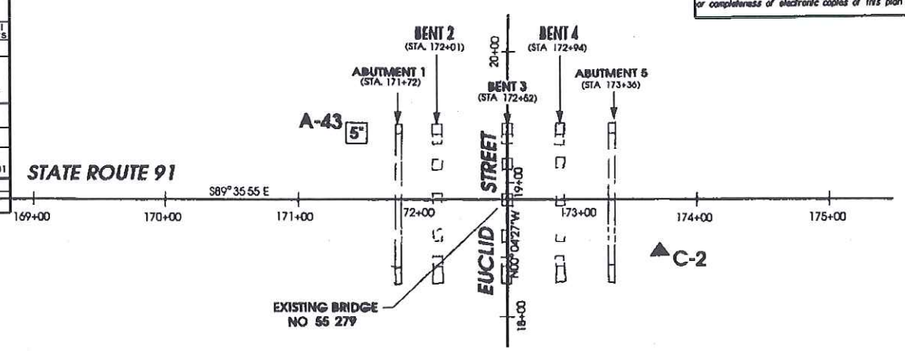


PLAN
SCALE 1 =50 FEET

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	Ora	91	10/28	311	312

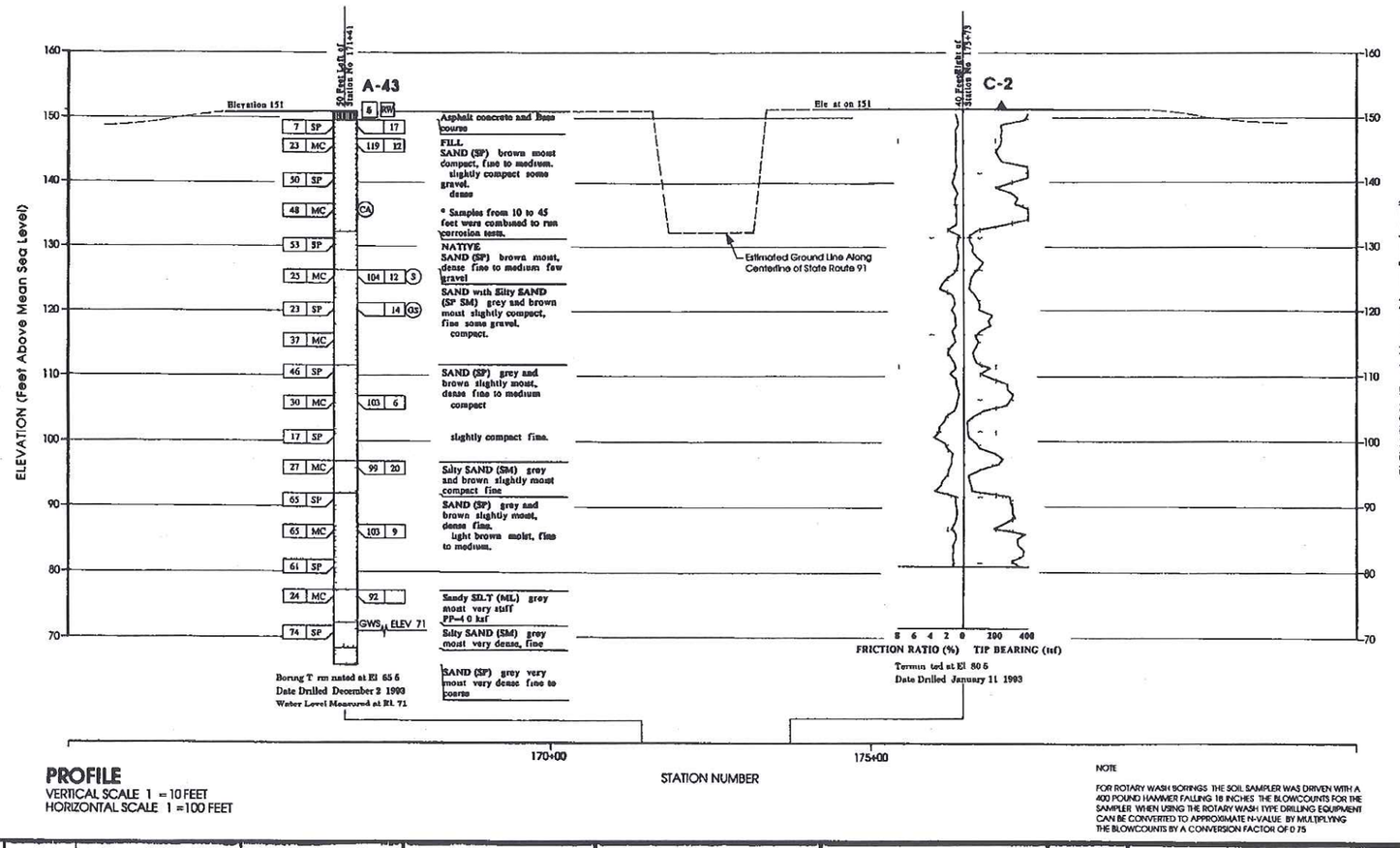
GEOTECHNICAL PROFESSIONAL — 3/5/96
9-16-96
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — THOMAS D SWANTKO — NO. GE 813 — EXP 12/31/97 — GEOTECHNICAL — STATE OF CALIFORNIA

GEOFON Inc
5532 Cerritos Avenue Suite B
Cypress California 90630
Job Number 92 336

PHOTO CONTROL POINT 2069
NULL & FLASH ON SURFACE
427 FEET LEFT OF STATION 170+88 CENTERLINE ROUTE 91
ELEVATION 134.26

AS-BUILT PLANS
Not recoverable



PROFILE
VERTICAL SCALE 1 = 10 FEET
HORIZONTAL SCALE 1 =100 FEET

NOTE

FOR ROTARY WASH BORINGS THE SOIL SAMPLER WAS DRIVEN WITH A 400 POUND HAMMER FALLING 18 INCHES THE BLOWCOUNTS FOR THE SAMPLER WHEN USING THE ROTARY WASH TYPE DRILLING EQUIPMENT CAN BE CONVERTED TO APPROXIMATE N-VALUE BY MULTIPLYING THE BLOWCOUNTS BY A CONVERSION FACTOR OF 0 75

DESIGN OVERSIGHT BC Newton 4-23-96 SIGN OFF DATE	DRAWN BY H LEE	J KNIGHT FIELD INVESTIGATOR SEE EXPLORATION DATE		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER

BRIDGE NO	EUCLID STREET UNDERCROSSING (WIDEN)
55 279	
POST MILE	LOG OF TEST BORINGS
0 96/2 8	

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3
CU 12209
EA 012411
DISREGARD PRINTS BEARING EARLIER REVISION DATES
REVISION DATES (PRE PRELIMINARY STAGE ONLY)
SHEET 15 OF 16
PLATE 1

ClibPDF - www.fastio.com

DIST.	COUNTY	ROUTE	POST MILES	TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
07	Ora	91	3.6/4.6	214	323	

JULY 11 1958

DATE APPROVED

To accompany plans dated April 19, 1965

DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES

As-Built Log of Test Borings sheet is considered an informational document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date confirm that this is a true and accurate copy of the original document. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.

DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
12	ORA	91	0.9/5.4		

GEOTECHNICAL PROFESSIONAL — DATE

ACACIA STREET U.C. (WIDEN)

LOG OF TEST BORINGS 1 OF 2

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

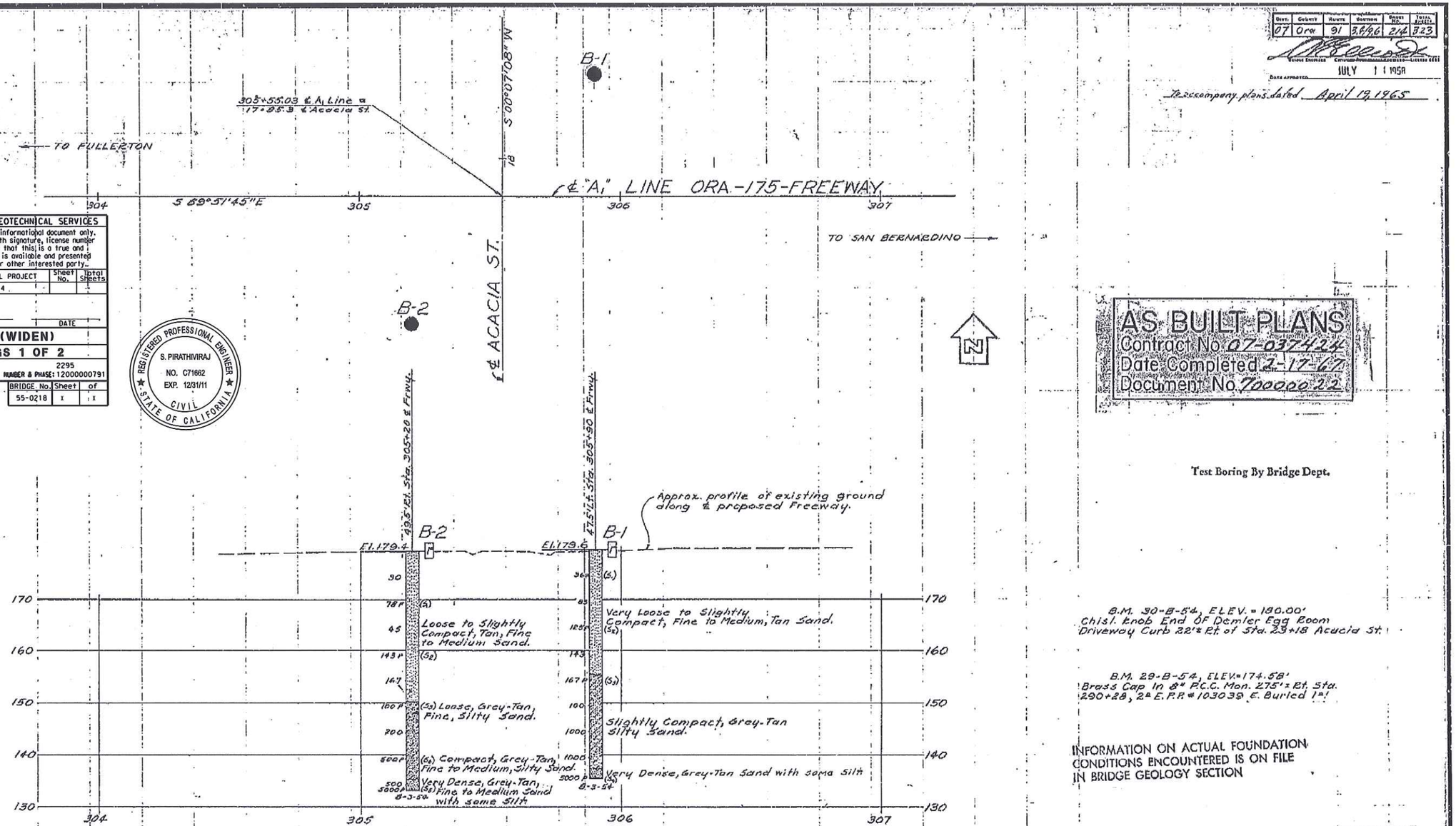
UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

BRIDGE No.	Sheet	of
55-0218	X	X

REGISTERED PROFESSIONAL ENGINEER
S. PIRATHIVIRAJ
NO. C71662
EXP. 12/31/11
CIVIL
STATE OF CALIFORNIA

AS BUILT PLANS
Contract No. 07-032424
Date Completed 2-17-67
Document No. 7000022

Test Boring By Bridge Dept.



B.M. 30-B-54, ELEV. = 180.00'
Chisl. Knob End Of Demler Egg Room Driveway Curb 22'± Rt. of Sta. 23+18 Acacia St.

B.M. 29-B-54, ELEV. = 174.58'
Brass Cap In 8" P.C.C. Mon. 275'± Rt. Sta. 290+28, 2± E. P.R. = 103039 E. Buried 1±!

INFORMATION ON ACTUAL FOUNDATION CONDITIONS ENCOUNTERED IS ON FILE IN BRIDGE GEOLOGY SECTION

SHEET	OF
8	12

CLASSIFICATION OF MATERIAL BASED ON STANDARD GRADE SIZE LIMITS

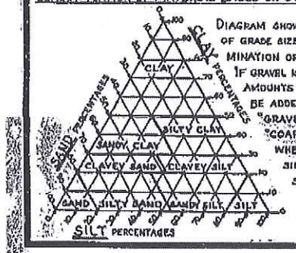


DIAGRAM SHOWING THE BASIS FOR ESTIMATES OF GRADE SIZE DISTRIBUTION USED IN DETERMINATION OF CLASS NAMES.

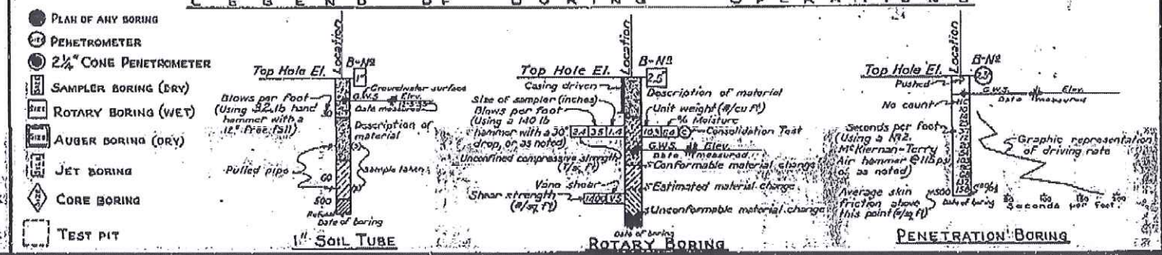
IF GRAVEL IS PRESENT IN APPRECIABLE AMOUNTS THE TERM "GRAVELLY" MAY BE ADDED TO THE CLASS NAME, VIZ. "GRAVELLY SAND." THE TERMS "COARSE", "MEDIUM" AND "FINE" WHEN USED TO DESCRIBE SAND, SILT AND GRAVEL REFER TO STANDARD GRADE SIZE LIMITS.

LEGEND OF EARTH MATERIALS

- GRAVEL
- SAND
- SILT
- CLAY
- SANDY CLAY OR CLAYEY SAND
- SANDY SILT OR SILTY SAND
- SILTY CLAY OR CLAYEY SILT
- PEAT AND/OR ORGANIC MATTER
- FILL MATERIAL
- IGNEOUS ROCK
- SEDIMENTARY ROCK
- METAMORPHIC ROCK

LEGEND OF BORING OPERATIONS

- PLAN OF ANY BORING
- PENETROMETER
- 2½" CONE PENETROMETER
- SAMPLER BORING (DRY)
- ROTARY BORING (WET)
- AUGER BORING (DRY)
- JET BORING
- CORE BORING
- TEST PIT



NOTES

The contractor's attention is directed to Section 2, Article (c) of the Standard Specifications and to the Special Provisions accompanying this set of plans.

Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

ACACIA STREET U.C.

LOG OF TEST BORINGS

SCALE: Horiz. 1"=20' Vert. 1"=10' | BRIDGE 55-218 LER | FILE E-55 | DRAWING 55218-11

DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES					
As-Built Log of Test Borings sheet is considered an informational document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date confirm that this is a true and accurate copy of the original document. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.					
DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
12	ORA	91	0.9/5.4		

GEOTECHNICAL PROFESSIONAL _____ DATE _____

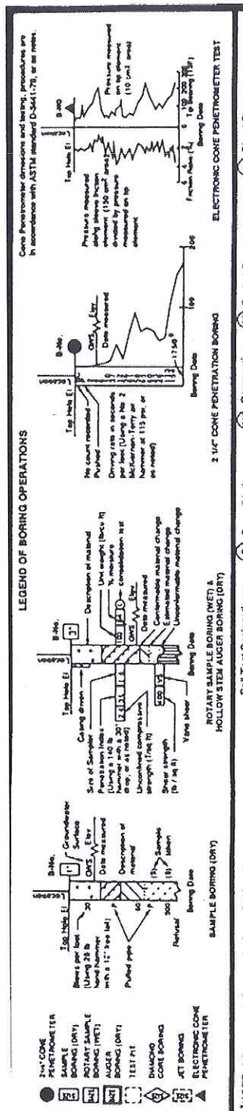
ACACIA STREET UC (WIDEN)

LOG OF TEST BORINGS 2 OF 2

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

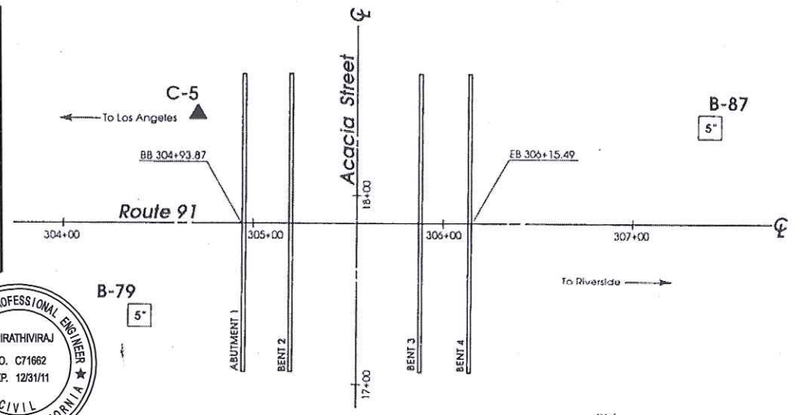
UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

BRIDGE No.	Sheet	of
55-0218	X	X



*NOTE: Where a 1.4" dia sampler is used, this value is the standard penetration N-value.

NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.



Bench Mark: 310-C-72 (PM 4.85)
Set R.S. Nail on Top of Headwall at Station 310 on North Side of Fwy. 30 Feet North of Edge of Shoulder
Elevation: 184.14 Feet

North
PLAN
SCALE: 1"= 40 FEET

DIST.	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	Ora	91	2.8/5.0	577	615

GEOTECHNICAL PROFESSIONAL 1/14/97

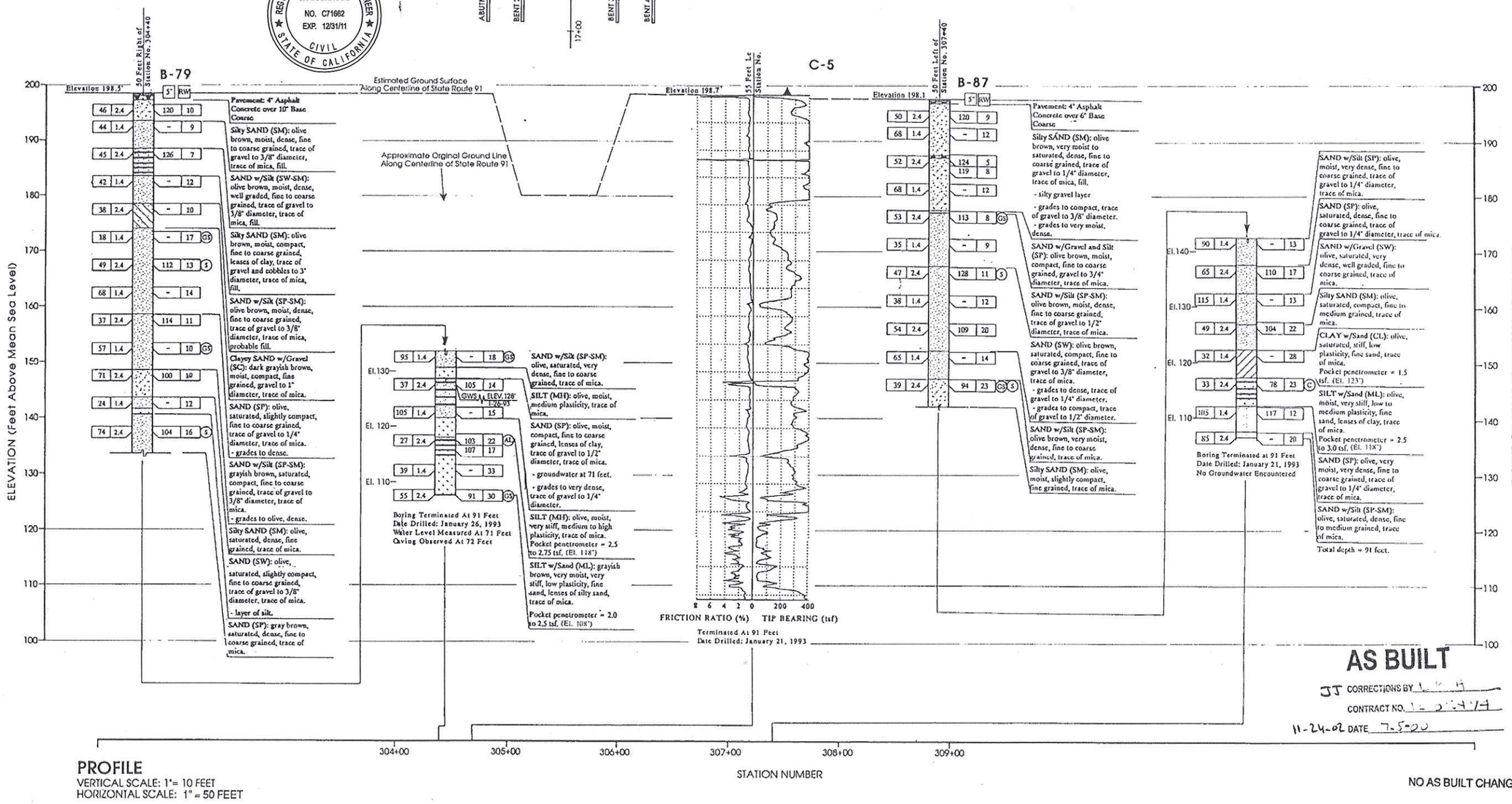
1-20-97
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — THOMAS D. SWANTKO — NO. GE 813 — EXP. 12/31/97 — STATE OF CALIFORNIA

GEOFON, Inc.
5552 Cerritos Avenue, Suite B
Cypress, California 90630
Job Number 92-337

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA



PROFILE
VERTICAL SCALE: 1"= 10 FEET
HORIZONTAL SCALE: 1" = 50 FEET

AS BUILT
JJ CORRECTIONS BY L. H.
CONTRACT NO. 12-218704
11-24-02 DATE 7-5-00

NO AS BUILT CHANGES

DESIGN OVERSIGHT BE NGUYEN 7-22-96 SIGN OFF DATE	DRAWN BY	H. LEE	S. MOHAMMAD J. CUNNEEN FIELD INVESTIGATOR SEE EXPLORATION DATE	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	D. K. HAGHIGHI PROJECT ENGINEER	BRIDGE NO. 55-218 POST MILE 4.8	ACACIA STREET UNDERCROSSING WIDEN AND RETROFIT LOG OF TEST BORINGS
	CHECKED BY	D. CORDS					

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER _____ DATE _____

PLANS APPROVAL DATE _____

REGISTERED PROFESSIONAL ENGINEER
S. PIRATHIVIRAJ
NO. C71662
EXP. 12/31/11
CIVIL
STATE OF CALIFORNIA

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

CEMENTATION

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

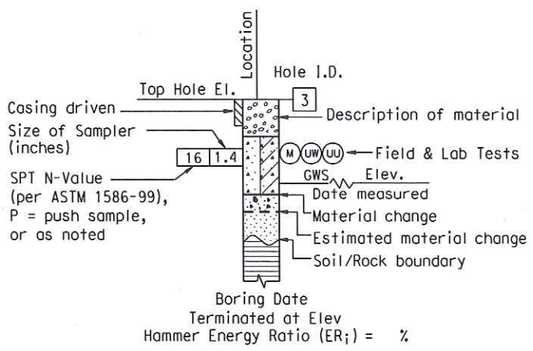
BOREHOLE IDENTIFICATION

Symbol	Hole Type	Description
Size	A	Auger Boring (hollow or solid stem bucket)
Size	R RW RC P	Rotary drilled boring (conventional) Rotary drilled with self-casing wire-line Rotary core with continuously-sampled, self-casing wire-line Rotary percussion boring (air)
Size	R	Rotary drilled diamond core
Size	HD HA	Hand driven (1-inch soil tube) Hand Auger
●	D	Dynamic Cone Penetration Boring
▲	CPT	Cone Penetration Test (ASTM D 5778)
[ ]	O	Other (note on LOTB)

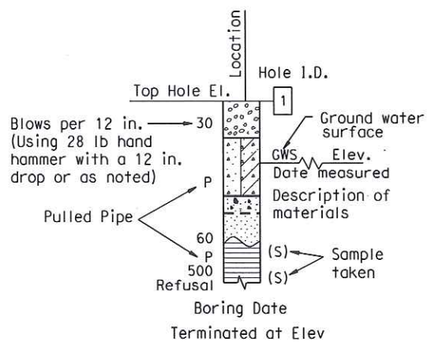
Note: Size in inches.

CONSISTENCY OF COHESIVE SOILS

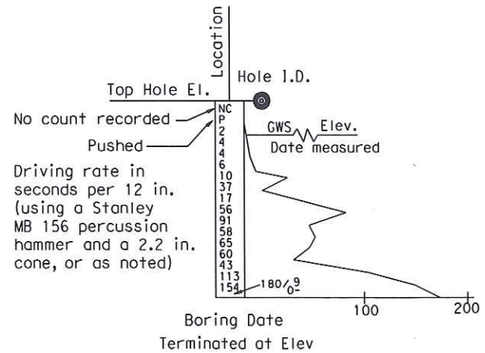
Description	Shear Strength (tsf)	Pocket Penetrometer Measurement, PP, (tsf)	Torvane Measurement, TV, (tsf)	Vane Shear Measurement, VS, (tsf)
Very Soft	Less than 0.12	Less than 0.25	Less than 0.12	Less than 0.12
Soft	0.12 - 0.25	0.25 - 0.5	0.12 - 0.25	0.12 - 0.25
Medium Stiff	0.25 - 0.5	0.5 - 1	0.25 - 0.5	0.25 - 0.5
Stiff	0.5 - 1	1 - 2	0.5 - 1	0.5 - 1
Very Stiff	1 - 2	2 - 4	1 - 2	1 - 2
Hard	Greater than 2	Greater than 4	Greater than 2	Greater than 2



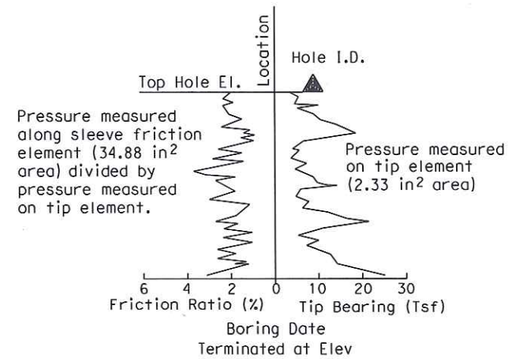
ROTARY BORING



HAND BORING



DYNAMIC CONE PENETRATION BORING



CONE PENETRATION TEST (CPT) BORING

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. -	SOIL LEGEND
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011				POST MILES -	LOG OF TEST BORINGS 1 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

GROUP SYMBOLS AND NAMES

Graphic/Symbol	Group Names	Graphic/Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND	CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
GP	Poorly-graded GRAVEL Poorly-graded GRAVEL with SAND		
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND	CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GP-GM	Poorly-graded GRAVEL with SILT Poorly-graded GRAVEL with SILT and SAND	ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
GP-GC	Poorly-graded GRAVEL with CLAY (or SILTY CLAY) Poorly-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GM	SILTY GRAVEL SILTY GRAVEL with SAND	OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND		
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND	OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL		
SP	Poorly-graded SAND Poorly-graded SAND with GRAVEL	CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL		
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
SP-SM	Poorly-graded SAND with SILT Poorly-graded SAND with SILT and GRAVEL		
SP-SC	Poorly-graded SAND with CLAY (or SILTY CLAY) Poorly-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
SM	SILTY SAND SILTY SAND with GRAVEL		
SC	CLAYEY SAND CLAYEY SAND with GRAVEL	OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY ORGANIC elastic SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL		
PT	PEAT	OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND
	COBBLES COBBLES and BOULDERS BOULDERS		

FIELD AND LABORATORY TESTING

- (C) Consolidation (ASTM D 2435)
- (CL) Collapse Potential (ASTM D 5333)
- (CP) Compaction Curve (CTM 216)
- (CR) Corrosivity Testing (CTM 643, CTM 422, CTM 417)
- (CU) Consolidated Undrained Triaxial (ASTM D 4767)
- (DS) Direct Shear (ASTM D 3080)
- (EI) Expansion Index (ASTM D 4829)
- (M) Moisture Content (ASTM D 2216)
- (OC) Organic Content-% (ASTM D 2974)
- (P) Permeability (CTM 220)
- (PA) Particle Size Analysis (ASTM D 422)
- (PI) Plasticity Index (AASHTO T 90) Liquid Limit (AASHTO T 89)
- (PL) Point Load Index (ASTM D 5731)
- (PM) Pressure Meter
- (R) R-Value (CTM 301)
- (SE) Sand Equivalent (CTM 217)
- (SG) Specific Gravity (AASHTO T 100)
- (SL) Shrinkage Limit (ASTM D 427)
- (SW) Swell Potential (ASTM D 4546)
- (UC) Unconfined Compression-Soil (ASTM D 2166) Unconfined Compression-Rock (ASTM D 2938)
- (UU) Unconsolidated Undrained Triaxial (ASTM D 2850)
- (UW) Unit Weight (ASTM D 4767)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER — DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

APPARENT DENSITY OF COHESIONLESS SOILS

Description	SPT N_{60} (Blows / 12 in.)
Very Loose	0 - 5
Loose	5 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Greater than 50

MOISTURE

Description	Criteria
Dry	No discernable moisture
Moist	Moisture present, but no free water
Wet	Visible free water

PERCENT OR PROPORTION OF SOILS

Description	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5% - 10%
Little	15% - 25%
Some	30% - 45%
Mostly	50% - 100%

PARTICLE SIZE

Description		Size (in.)
Boulder		Greater than 12
Cobble		3 - 12
Gravel	Coarse	3/4 - 3
	Fine	1/5 - 3/4
Sand	Coarse	1/16 - 1/5
	Medium	1/64 - 1/16
	Fine	1/300 - 1/64
Silt and Clay		Less than 1/300

DESIGN OVERSIGHT — SIGN OFF DATE

DRAWN BY: J. Fang

CHECKED BY: S. Pirathiviraj

R. Jie — FIELD INVESTIGATION BY:

DATE: 12/2010,1/2011

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

S. Pirathiviraj — PROJECT ENGINEER

BRIDGE NO. -

POST MILES -

SOIL LEGEND
LOG OF TEST BORINGS 2 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

Appendix B

LABORATORY TEST RESULTS

TABLE B1 SUMMARY OF LABORATORY TEST RESULTS FOR RETAINING WALLS (1 OF 4)

Project No. : *10-126* Project Name : SR-91 WB Widening

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-002	*B-0*	1.5-5	SC							27/18/9				
A-10-002	*S-1*	2.5	SC	15.4							3200	7.9	70	95
A-10-002	*D-2*	5	SC	17.8	128.8			0:51:49						
A-10-002	*S-3*	10	SP	5.5										
A-10-002	*D-4*	15	SC	7.1	132.1									
A-10-002	*S-5*	20	SM	17.4										
A-10-002	*D-6*	25	SC	19.3	125.5									
A-10-002	*S-7*	30	SM	13.1										
A-10-003	*S-1*	5	SC	12.0				5:66:29			5700	8.5	80	97
A-10-003	*D-2*	10	SP-SM	2.6	106.5									
A-10-003	*S-3*	15	SM	8.5										
A-10-003	*D-4*	20	SM	6.5	124.6									
A-10-003	*S-5*	25	SM	14.8										
A-10-003	*D-6*	30	SM	7.9	115.2									
A-10-005	*B-0*	1.5-5	SC							24/17/7	2000	8.6	130	149
A-10-005	*D-1*	5	ML	16.3	129.9	4.5								
A-10-005	*S-2*	10	ML	20.7				2:24:74						
A-10-005	*D-3*	15	SM	7.2	132.9									
A-10-005	*S-4*	20	ML	22.5				0:40:60						
A-10-005	*D-5*	25	SM	13.4	130.2									
A-10-005	*S-6*	30	ML/SM	18.6										
A-10-005	*D-7*	35	SM	19.4	126.0									
A-10-005	*S-8*	40	ML	21.2										
A-10-005	*D-9*	45	SM	24.6	121.6									
A-10-005	*S-10*	50	SM	20.5										
A-10-018	*S-1*	5	SM	17.8										
A-10-018	*D-2*	10	SM	15.8	127.1									
A-10-018	*S-3*	15	CL	21.3						28/17/11				
A-10-018	*D-4*	20	SM	7.6	124.6									
A-10-018	*S-5*	25	SP	6.5										
A-10-018	*D-6*	30	ML	23.2	117.4	1.75								
A-10-019	*D-1*	5	SM	10.1	124.9									
A-10-019	*S-2*	10	ML	14.8							2200	8.5	110	118
A-10-019	*D-3*	15	SM	16.8	125.7									
A-10-019	*S-4*	20	SM	12.3										
A-10-019	*D-5*	25	SP-SM	3.7	113.7									
A-10-019	*S-6*	30	SP-SM to ML	24.3										
A-10-024	*S-1*	5	SM	8.3										
A-10-024	*D-2*	10	SP-SM	2.3	118.6									
A-10-024	*S-3*	15	SM	10.5										
A-10-024	*D-4*	20	SM	8.9	118.5									
A-10-024	*S-5*	25	SM	11.2							750	7.8	40	332

TABLE B1 SUMMARY OF LABORATORY TEST RESULTS FOR RETAINING WALLS (2 OF 4)

Project No. : 10-126 Project Name : SR-91 WB Widening

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-024	D-6	30	SM	6.4	113.1									
A-10-024	S-7	35	SM	13.1										
A-10-024	D-8	40	SM	11.1	128.3									
A-10-024	S-9	45	SM	12.2										
A-10-024	D-10	50	ML	17.7	126.6			0:35:65						
A-10-024	S-11	55	ML to SM	22.6										
A-10-024	D-12	60	SM	26.5	120.0									
A-10-024	S-13	65	SP-SM	6.5										
A-10-024	D-14	70	SP-SM	14.5	125.9									
A-10-024	S-15	75	ML	26.5										
A-10-024	D-16	80	SP-SM	11.5	126.0									
A-10-024	S-17	85	SP	3.9										
A-10-036	S-1	5	SC	15.0										
A-10-036	D-2	10	SM	3.3	108.9									
A-10-036	S-3	15	SP-SM	2.1										
A-10-036	D-4	20	SP-SM	2.5	118.0									
A-10-036	S-5	25	SP-SM	7.1										
A-10-036	D-6	30	SM	9.5	129.4									
A-10-036	S-7	35	SM	7.2										
A-10-036	D-8	40	SM	17.9	130.0									
A-10-036	S-9	45	SP-SM	4.3										
A-10-036	D-10	50	ML to SM	16.1	125.9									
A-10-037	B-0	0-3	SC							33/14/19	1200	7.2	10	144
A-10-037	D-1	5	SP-SM	8.9	129.2									
A-10-037	S-2	10	SM	9.2										
A-10-037	D-3	15	SM	3.3	113.6									
A-10-037	S-4	20	SP	1.8				1:97:2						
A-10-037	D-5	25	SM	2.2	126.1									
A-10-037	S-6	30	SP-SM	1.1										
A-10-038	S-1	5	SC	12.8										
A-10-038	D-2	10	SM	12.9	128.1									
A-10-038	S-3	15	SM	6.6										
A-10-038	D-4	20	SP-SM	3.3	115.3									
A-10-038	S-5	25	SP-SM	4.3										
A-10-038	D-6	30	SP	1.6	111.1									
A-10-039	D-1	5	SM	8.3	139.2						4800	8.0	120	191
A-10-039	S-2	10	SM	16.4										
A-10-039	D-3	15	SM to SC	10.9	136.0									
A-10-039	S-4	20	SM	13.1				8:60:32						
A-10-039	D-5	25	SM	3.1	115.0									
A-10-039	S-6	30	SM to SC	3.4										
A-10-039	D-7	35	SP	0.8	110.7									
A-10-039	S-8	40	SP-SM	3.6										
A-10-039	D-9	45	SP-SM	4.1	113.1									

TABLE B1 SUMMARY OF LABORATORY TEST RESULTS FOR RETAINING WALLS (3 OF 4)

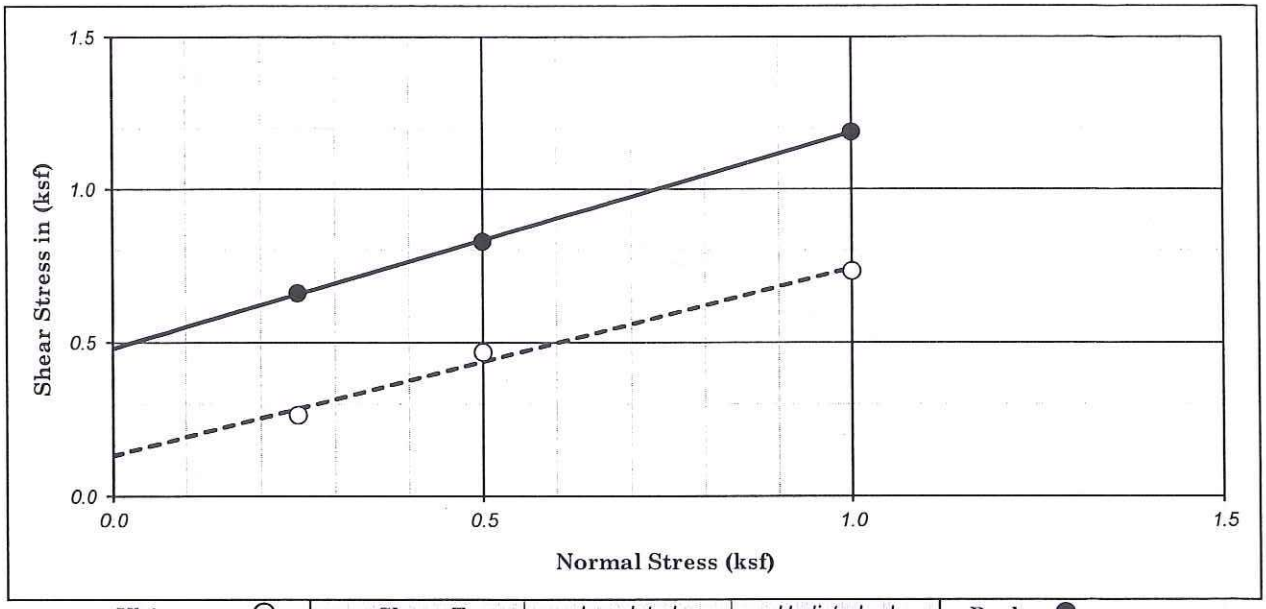
Project No. : *10-126* Project Name : SR-91 WB Widening

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil-pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-039	*S-10*	50	SP-SM	6.3										
A-10-039	*D-11*	55	SM	5.6	113.6									
A-10-039	*S-12*	60	ML	15.1				0:48:52						
A-10-039	*D-13*	65	SM	10.5	134.4									
A-10-039	*S-14*	70	SM	12.3										
A-10-039	*D-15*	75	MH	28.7	120.9	1.75				67/34/33	760	7.9	40	253
A-10-039	*S-16*	80	SP	3.6										
A-10-039	*D-17*	85	SP-SM	2.3	114.5									
A-10-039	*S-18*	90	SP-SM	3.5										
A-10-039	*D-19*	85	SP-SM	8.8	130.9									
A-10-039	*S-20*	100	SP-SM	3.5										
A-10-050	*D-1*	5	SP-SM	5.7	107.9									
A-10-050	*S-2*	10	SP	3.4										
A-10-050	*D-3*	15	SP	2.4	113.9									
A-10-050	*S-4*	20	SP	3.7										
A-10-050	*D-5*	25	SP	3.3	116.3									
A-10-050	*S-6*	30	SP	10.5										
A-10-052	*S-1*	5	SM	7.5										
A-10-052	*D-2*	10	SM	6.4	123.3						5400	7.8	100	139
A-10-052	*S-3*	15	SP-SM	5.5										
A-10-052	*D-4*	20	SP	2.8	107.8									
A-10-052	*S-5*	25	SP	3.3										
A-10-052	*D-6*	10	SP	2.3	115.0									
A-10-055	*S-1*	5	SM	9.9										
A-10-055	*D-2*	10	SM	5.1	123.6									
A-10-055	*S-3*	15	SP-SM	2.5										
A-10-055	*D-4*	20	SP	2.2	113.4									
A-10-055	*S-5*	25	SM	6.4				5:78:17						
A-10-055	*D-6*	30	SP	2.4	105.9									
A-10-055	*S-7*	35	SP	2.3										
A-10-055	*D-8*	40	SP	2.6	109.8									
A-10-055	*S-9*	45	SP	4.1										
A-10-055	*D-10*	50	SP-SM	3.6	112.1									
A-10-055	*S-11*	55	SP	2.9										
A-10-055	*D-12*	60	SP	1.9	114.4									
A-10-055	*S-13*	65	SP-SM	6.4										
A-10-055	*D-14*	70	SP-SM	3.6	113.0									
A-10-057	*D-1*	5	SP-SM	6.3	126.1									
A-10-057	*S-2*	10	SP	3.6										
A-10-057	*D-3*	15	SP	6.6	111.4									
A-10-057	*S-4*	20	SP	4.9										
A-10-057	*D-5*	25	SP	7.8	121.6									
A-10-057	*S-6*	30	SP-SM	10.7										

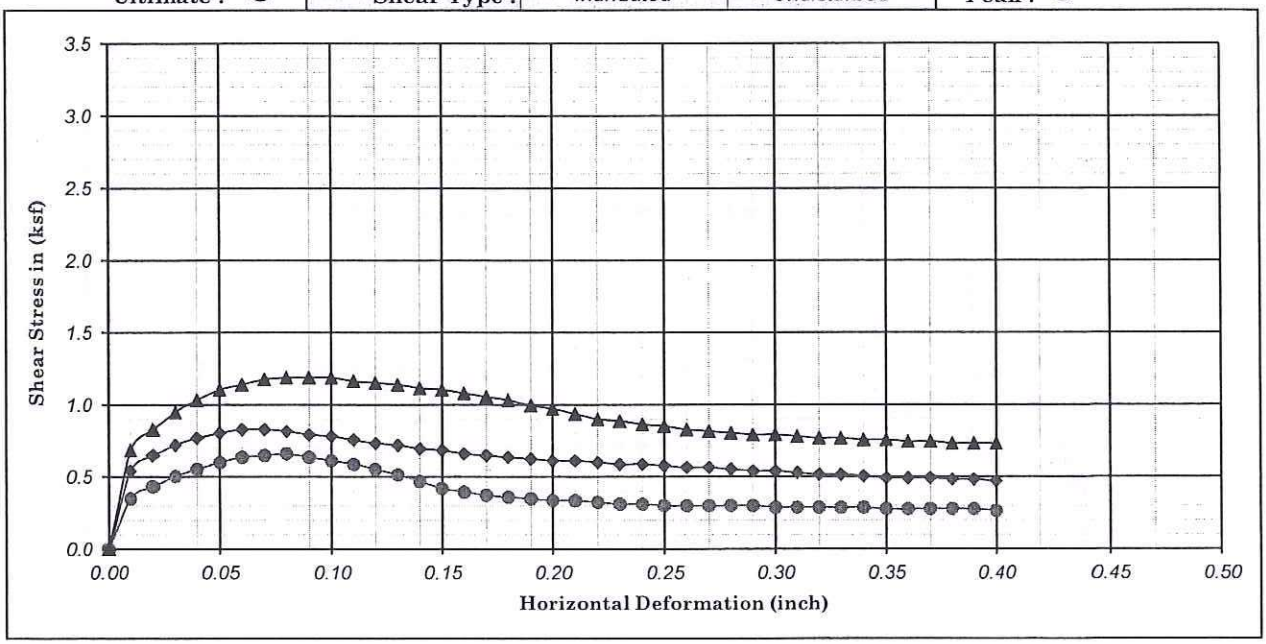
TABLE B1 SUMMARY OF LABORATORY TEST RESULTS FOR RETAINING WALLS (4 OF 4)

Project No. : *10-126* Project Name : SR-91 WB Widening

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil-pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-058	*S-1*	5	SM	8.3										
A-10-058	*D-2*	10	SP	2.0	111.5									
A-10-058	*S-3*	15	SP	4.2										
A-10-058	*D-4*	20	SP	3.2	114.8									
A-10-058	*S-5*	25	SP	5.9										
A-10-058	*D-6*	30	SP-SM	4.5	129.9									



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-002		Strength Intercept (C) :	0.48	(ksf)	Peak	0.13	(ksf)	Ultimate
Sample No. : D-2			22.98	(kPa)		6.32	(kPa)	
Depth (ft/m) : 5.0	0.00	Friction Angle (ϕ) :	35.23	Degree		31.40	Degree	
Description : Dark grayish brown, CLAYEY SAND (SC)					Shear Rate (inch/minute) :		0.02	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	22.04	103.71	16.32	0.63	0.25	11.97	0.66	31.60	0.26	12.64
◆	22.51	106.36	16.74	0.58	0.50	23.94	0.83	39.64	0.47	22.41
▲	21.80	106.54	16.77	0.58	1.00	47.88	1.19	56.88	0.73	35.05

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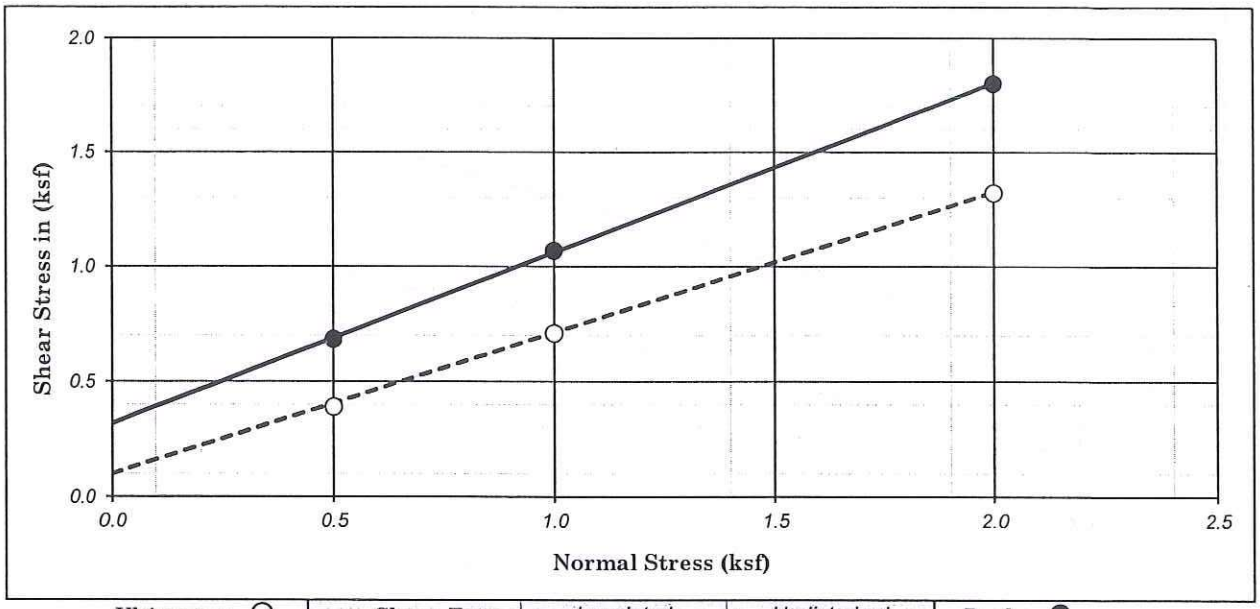
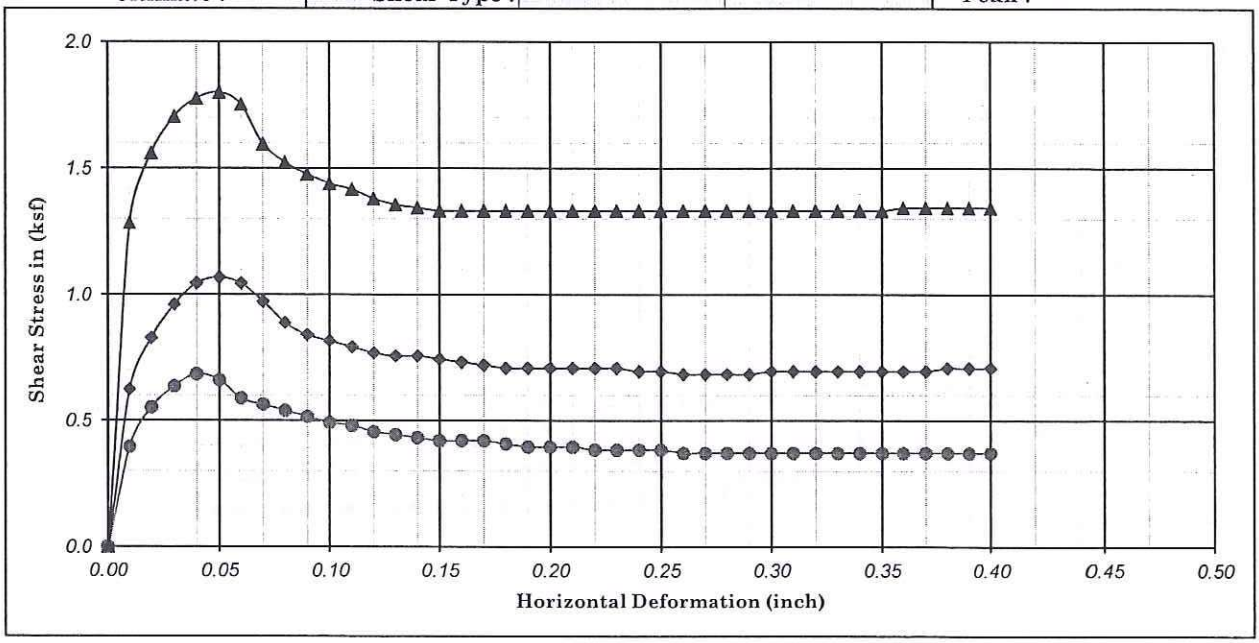
Project No. : 10-126 | Date : 02/08/11 | Figure No. :



Ultimate : ○ | Shear Type : Inundated | Undisturbed | Peak : ●



Boring No. : A-10-018	Strength Intercept (C) :	0.32	(ksf)	Peak	0.10	(ksf)	Ultimate
Sample No. : D-2		15.23	(kPa)		4.79	(kPa)	
Depth (ft/m) : 10.0 | 0.00	Friction Angle (ϕ) :	36.59	Degree		31.48	Degree	

Description : Olive-brown, SILTY SAND (SM) — Shear Rate (inch/minute) : 0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	19.75	107.09	16.86	0.57	0.50	23.94	0.68	32.75	0.39	18.67
◆	20.01	108.27	17.04	0.56	1.00	47.88	1.07	51.14	0.71	33.99
▲	20.28	107.37	16.90	0.57	2.00	95.76	1.80	86.18	1.32	63.20

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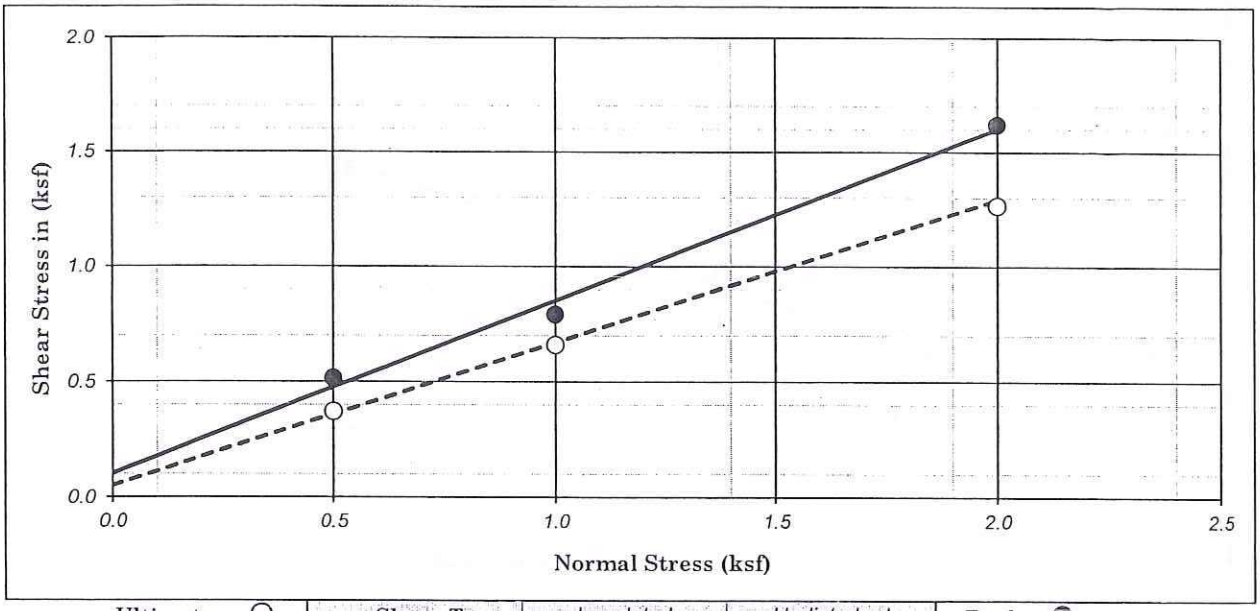
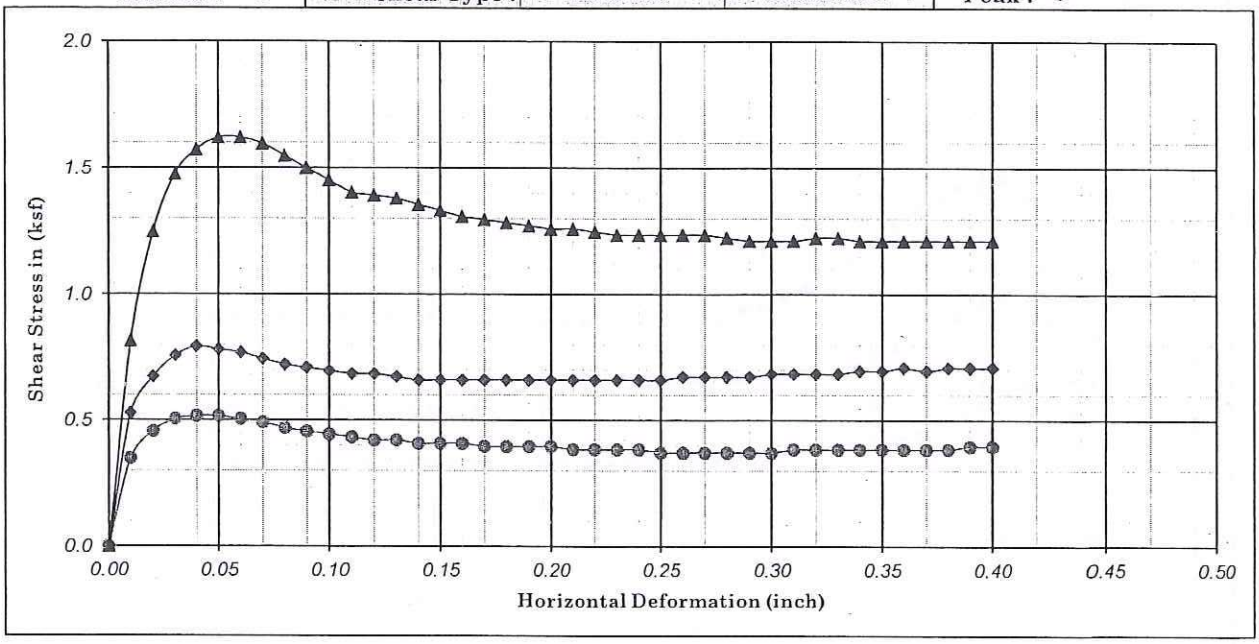
DIRECT SHEAR TEST
(ASTM D-3080)

Project No. : 10-126 | Date : 02/09/11 | Figure No. :



Ultimate : ○ | Shear Type : Inundated | Undisturbed | Peak : ●



Boring No. : A-10-036	Strength Intercept (C) :	0.10	(ksf)	Peak	0.07	(ksf)	Ultimate
Sample No. : D-2		4.88	(kPa)		3.33	(kPa)	
Depth (ft/m) : 10.0 | 0.00	Friction Angle (ϕ) :	36.84	Degree		31.80	Degree	
Description : Olive-brown, SILTY SAND (SM)					Shear Rate (inch/minute) :		0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	20.00	90.34	14.22	0.87	0.50	23.94	0.52	24.71	0.37	17.81
◆	21.22	89.86	14.14	0.88	1.00	47.88	0.79	37.92	0.66	31.60
▲	20.41	92.34	14.53	0.83	2.00	95.76	1.62	77.57	1.27	60.57

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DIRECT SHEAR TEST
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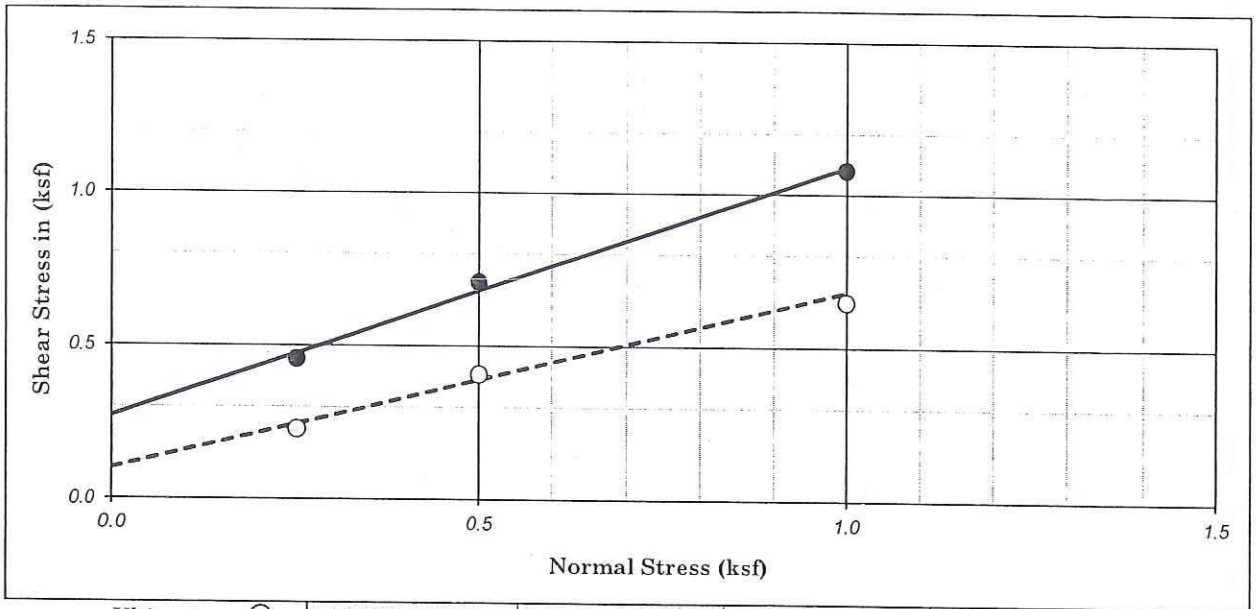
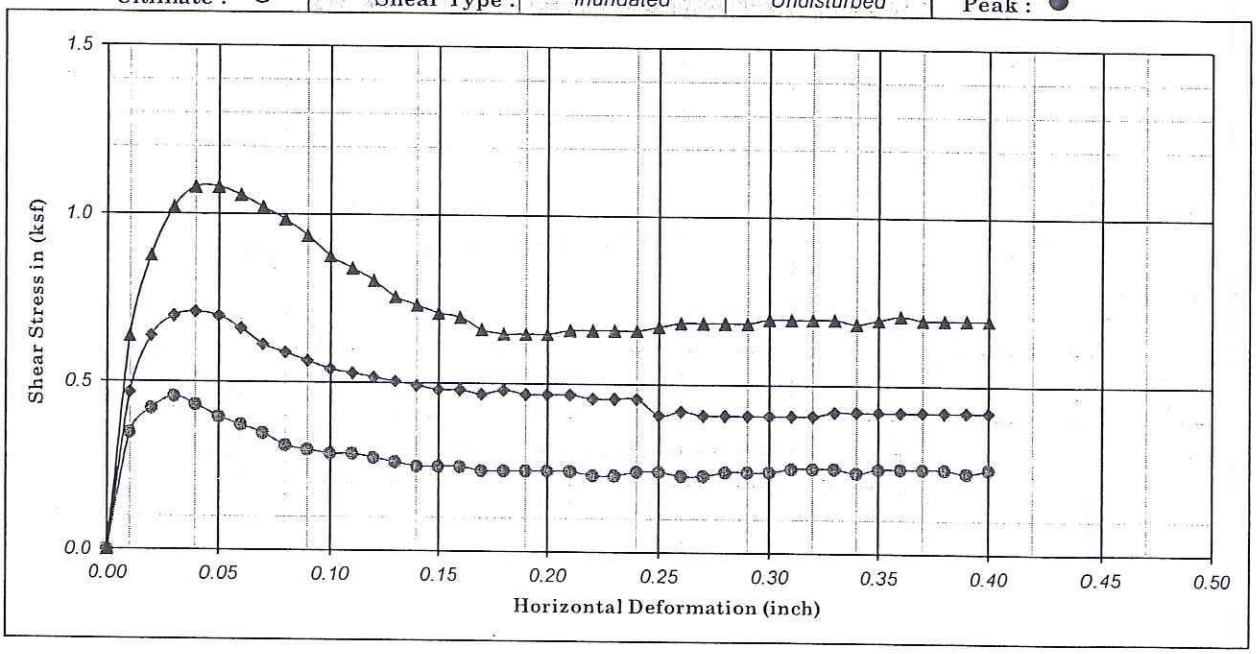
Project No. : 10-126 | Date : 02/09/11 | Figure No. :



Ultimate : ○ | Shear Type : Inundated | Undisturbed | Peak : ●



Boring No. : A-10-037		Strength Intercept (C) :	0.27	(ksf)	Peak	0.11	(ksf)	Ultimate
Sample No. : D-1			12.93	(kPa)		5.17	(kPa)	
Depth (ft/m) : 5.0	0.00	Friction Angle (ϕ) :	39.33	Degree		30.11	Degree	

Description : Olive-brown, Poorly graded SAND with SILT (SP-SM) — Shear Rate (inch/minute) : 0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m³)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	13.04	110.32	17.36	0.53	0.25	11.97	0.46	21.83	0.23	10.92
◆	13.04	111.06	17.48	0.52	0.50	23.94	0.71	33.90	0.41	19.54
▲	13.18	110.26	17.36	0.53	1.00	47.88	1.08	51.71	0.65	31.03

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Project No. : 10-126 | Date : 02/12/11

DIRECT SHEAR TEST
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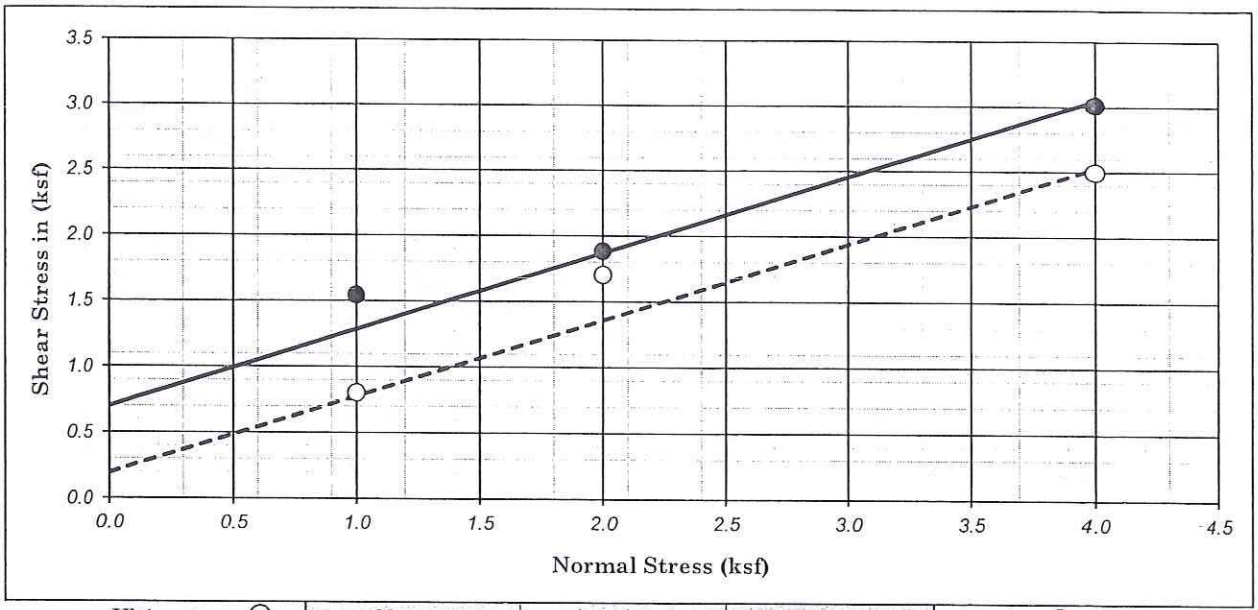
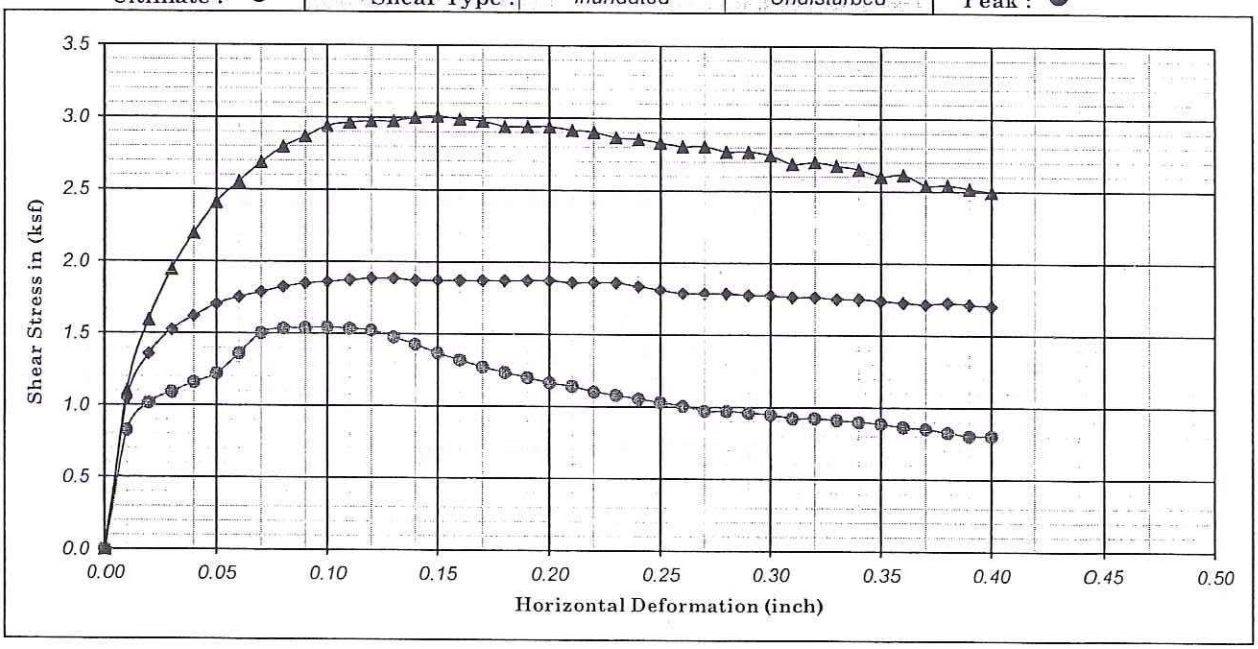
Figure No. :



Ultimate : ○ | Shear Type : Inundated | Undisturbed | Peak : ●



Boring No. : A-10-039	Strength Intercept (C) :	0.98	(ksf)	Peak	0.41	(ksf)	Ultimate
Sample No. : D-3		46.92	(kPa)		19.54	(kPa)	
Depth (ft/m) : 15.0 | 0.00	Friction Angle (ϕ) :	30.33	Degree		30.17	Degree	

Description : Dark brown, CLAYEY SAND (SC) — Shear Rate (inch/minute) : 0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	18.16	117.85	18.55	0.43	1.00	47.88	1.54	73.93	0.80	38.50
◆	20.18	114.11	17.96	0.48	2.00	95.76	1.88	90.21	1.70	81.59
▲	17.41	114.75	18.06	0.47	4.00	191.52	3.01	144.21	2.50	119.51

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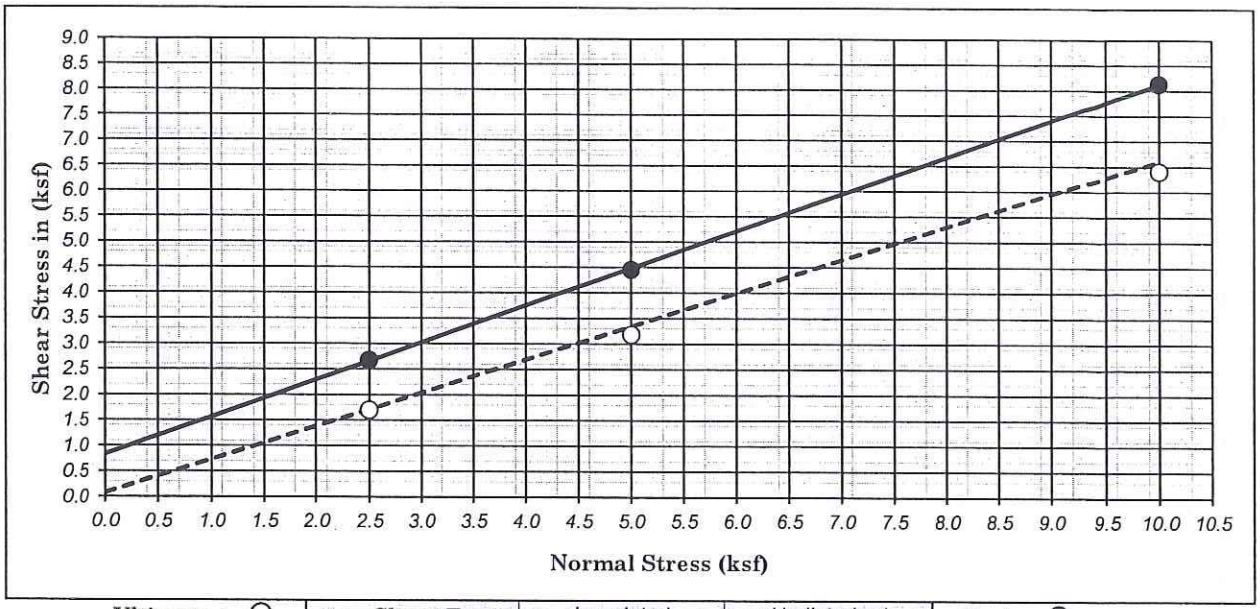
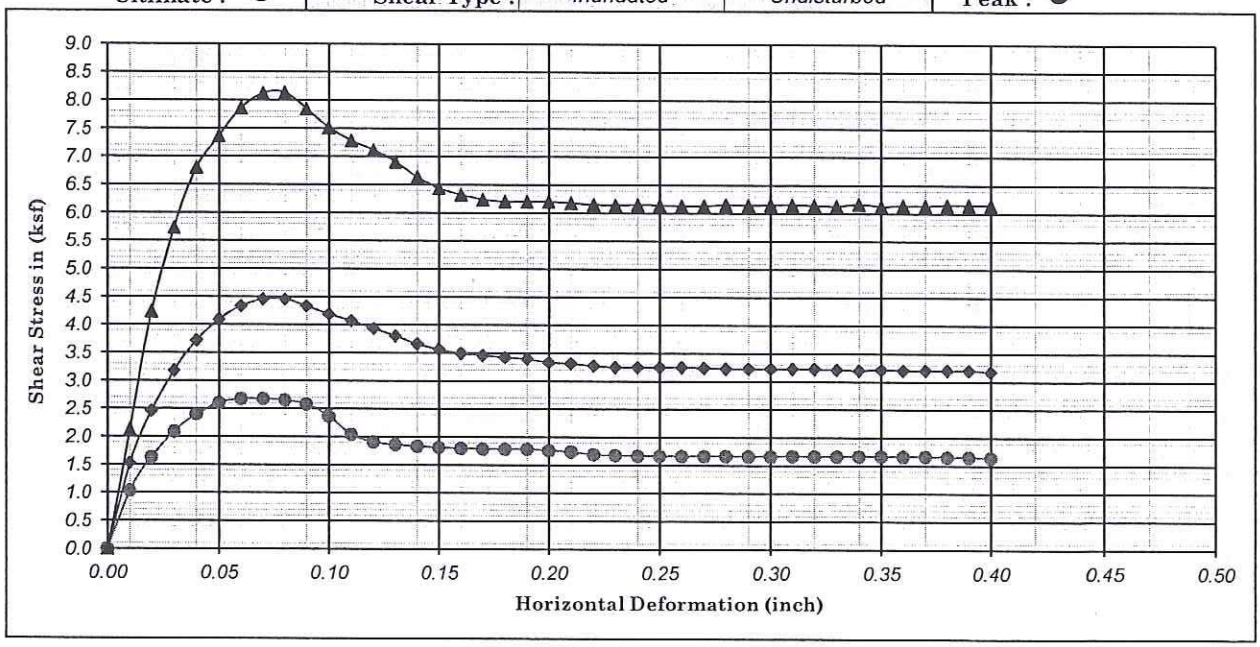
DIRECT SHEAR TEST
(ASTM D-3080)

Project No. : 10-126 | Date : 02/09/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-039		Strength Intercept (C) :	0.83	(ksf)	Peak	0.09	(ksf)	Ultimate	
Sample No. : D-13			39.96	(kPa)		4.31	(kPa)		
Depth (ft/m) : 65.0	0.00	Friction Angle (ϕ) :	36.10	Degree		33.10	Degree		
Description : Olive-brown, SILTY SAND (SM)					Shear Rate (inch/minute) :			0.02	

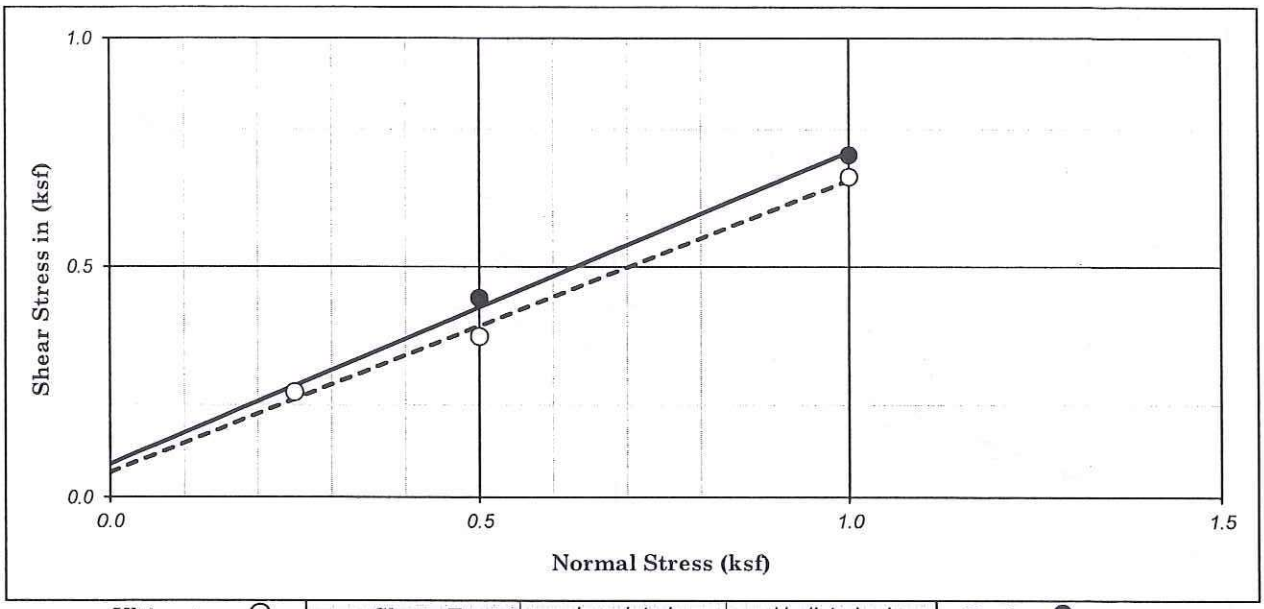
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	17.49	116.61	18.35	0.45	2.50	119.70	2.68	128.13	1.70	81.40
◆	17.58	117.17	18.44	0.44	5.00	239.40	4.45	213.16	3.18	152.26
▲	16.23	117.59	18.51	0.43	10.00	478.80	8.14	389.50	6.40	306.43

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

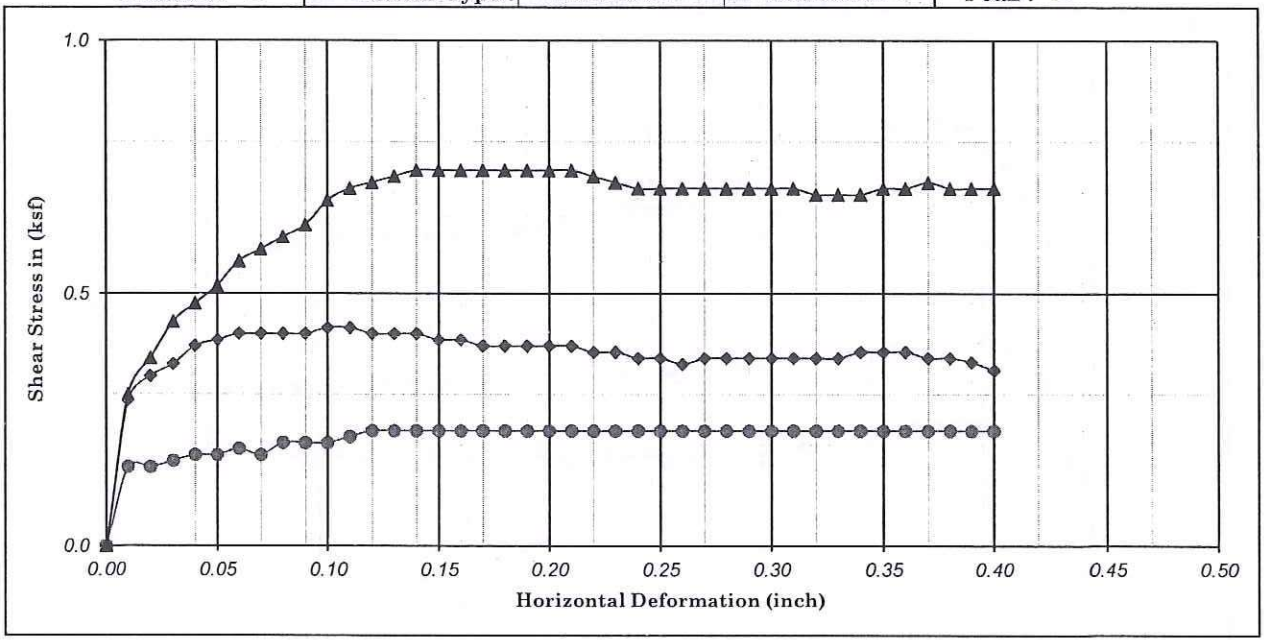
RBF/SR-91 WB Widening

DIRECT SHEAR TEST
(ASTM D-3080)

Project No. : 10-126 | Date : 02/12/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-050		Strength Intercept (C) :	0.07	(ksf)	Peak	0.05	(ksf)	Ultimate
Sample No. : D-1			3.45	(kPa)		2.59	(kPa)	
Depth (ft/m) : 5.0	0.00	Friction Angle (ϕ) :	34.17	Degree		32.39	Degree	
Description : Light yellowish brown, Poorly graded SAND (SP)					Shear Rate (inch/minute) :		0.02	

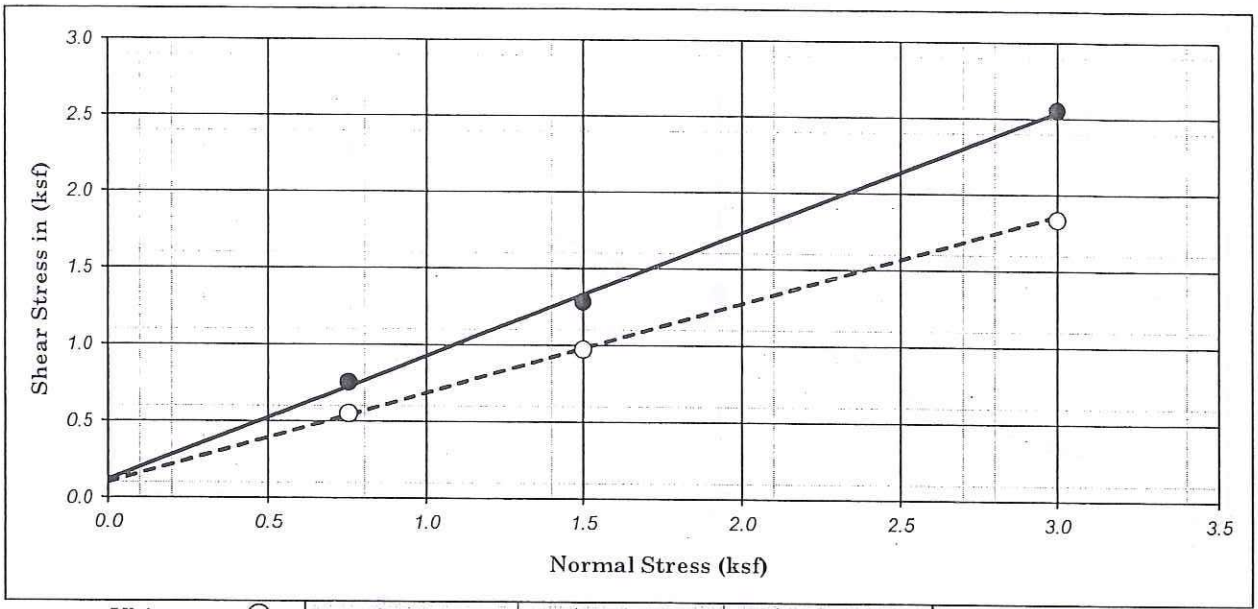
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	19.02	89.83	14.14	0.88	0.25	11.97	0.23	10.92	0.23	10.92
◆	19.83	90.04	14.17	0.87	0.50	23.94	0.43	20.68	0.35	16.66
▲	20.44	90.93	14.31	0.85	1.00	47.88	0.74	35.62	0.70	33.32

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

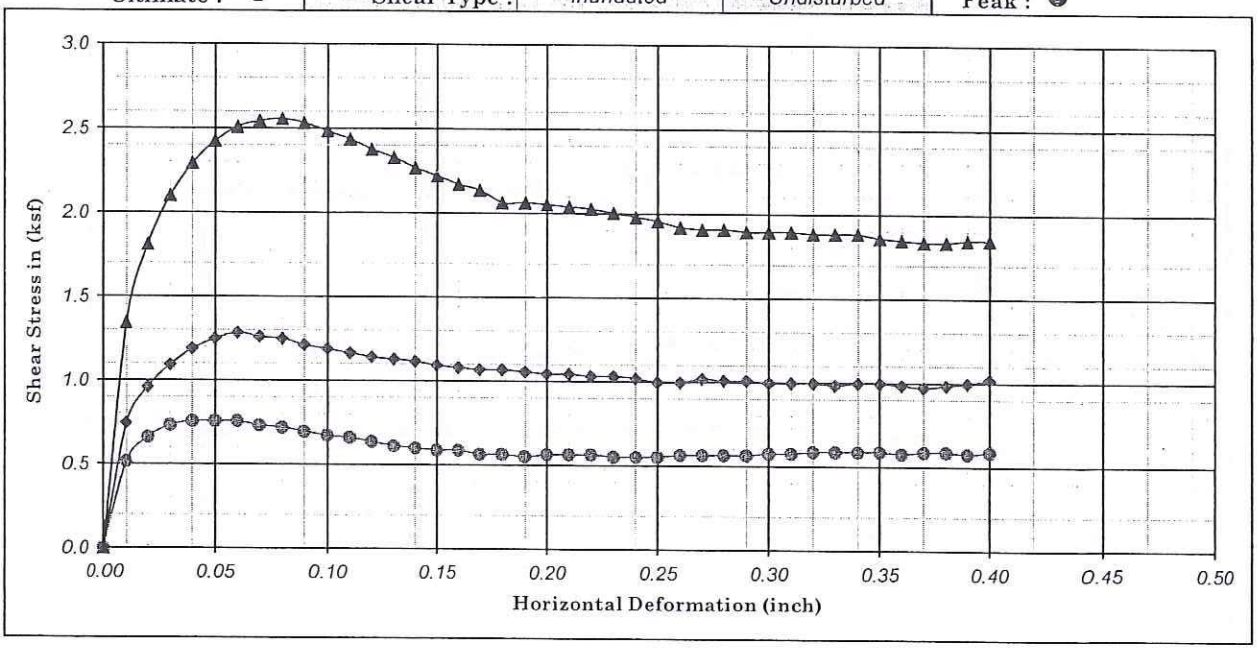
RBF/SR-91 WB Widening

DIRECT SHEAR TEST
(ASTM D-3080)

Project No. : 10-126 | Date : 02/14/11 | Figure No. :



Ultimate : ○ | Shear Type : *Inundated* | *Undisturbed* | Peak : ●



Boring No. : *A-10-052*	Strength Intercept (C) :	*0.12*	(ksf)	Peak	*0.12*	(ksf)	Ultimate
Sample No. : *D-2*		*5.75*	(kPa)		*5.75*	(kPa)	
Depth (ft/m) : *10.0* *0.00*	Friction Angle (ϕ) :	*38.90*	Degree		*30.40*	Degree	

Description : *Light yellowish brown, Poorly graded SAND with SILT (SP-SM)* Shear Rate (inch/minute) : *0.02*

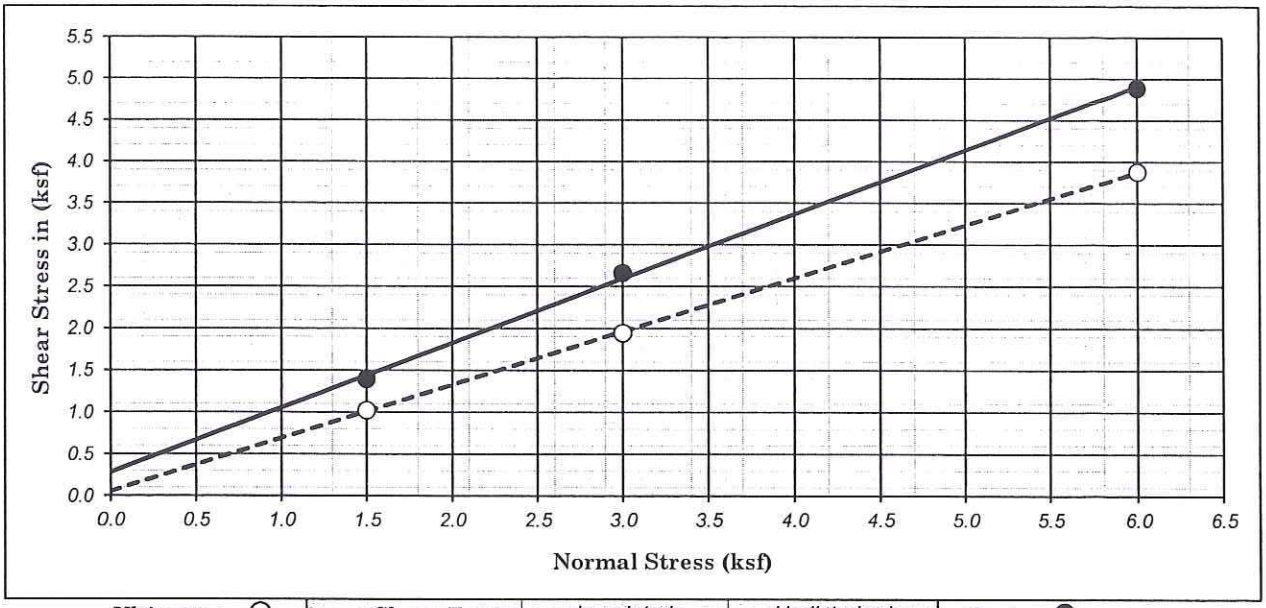
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	*14.63*	*111.32*	*17.52*	*0.51*	*0.75*	*35.91*	*0.76*	*36.20*	*0.55*	*26.43*
◆	*15.29*	*110.40*	*17.38*	*0.53*	*1.50*	*71.82*	*1.28*	*61.48*	*0.97*	*46.54*
▲	*13.78*	*110.44*	*17.38*	*0.53*	*3.00*	*143.64*	*2.56*	*122.38*	*1.84*	*87.91*

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

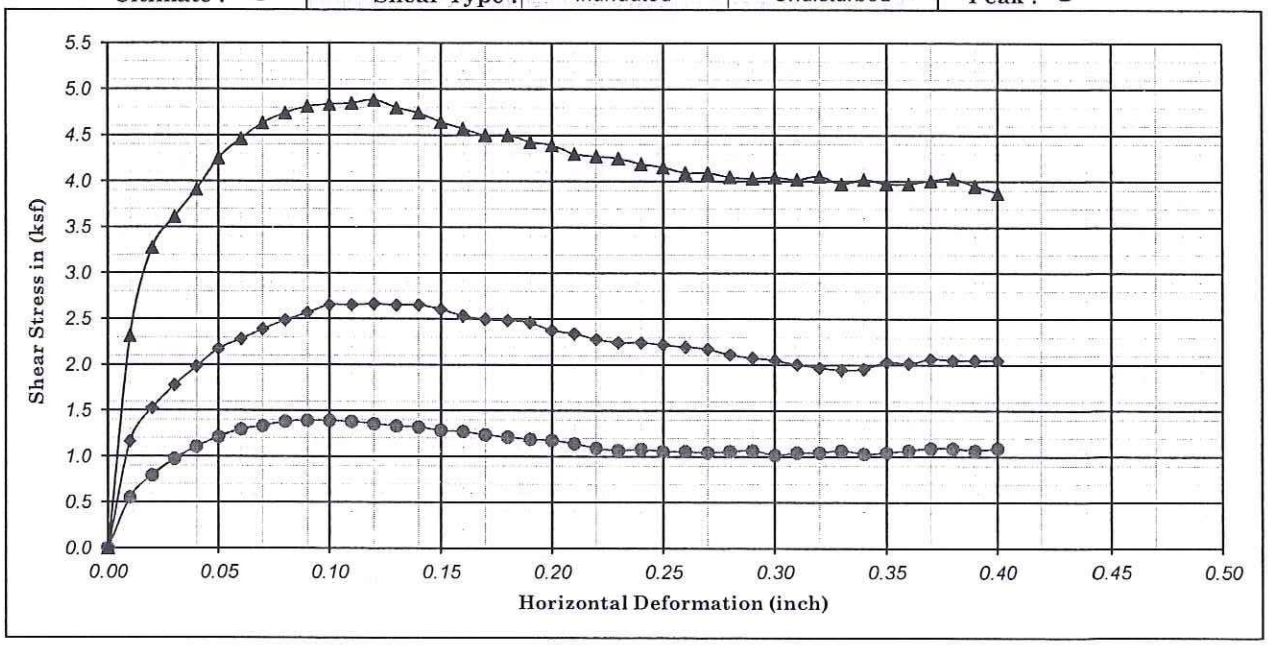
RBF/SR-91 WB Widening

DIRECT SHEAR TEST
(ASTM D-3080)

Project No. : *10-126* | Date : *02/14/11* | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-055		Strength Intercept (C) :	0.28	(ksf)	Peak	0.05	(ksf)	Ultimate	
Sample No. : D-4			13.50	(kPa)		2.59	(kPa)		
Depth (ft/m) : 20.0	0.00	Friction Angle (ϕ) :	37.63	Degree		32.46	Degree		
Description : Light yellowish brown, Poorly graded SAND (SP)						Shear Rate (inch/minute) :		0.02	

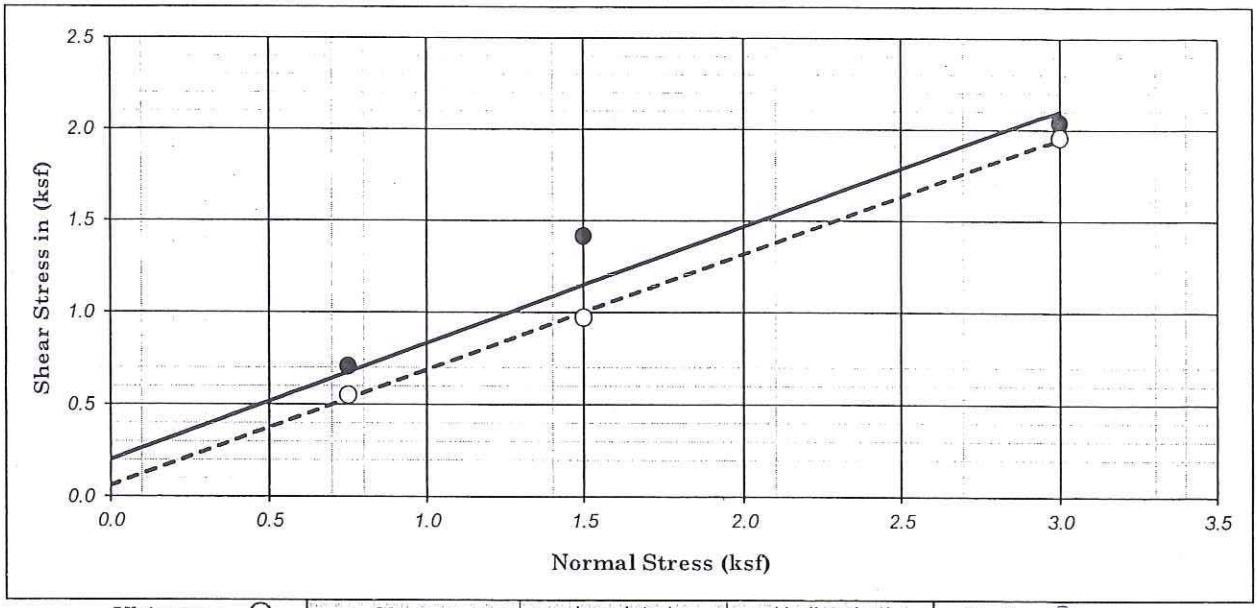
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	17.03	94.93	14.94	0.78	1.50	71.82	1.39	66.65	1.02	48.84
◆	16.41	97.96	15.42	0.72	3.00	143.64	2.66	127.55	1.94	93.08
▲	11.19	101.59	15.99	0.66	6.00	287.28	4.88	233.85	3.88	185.58

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

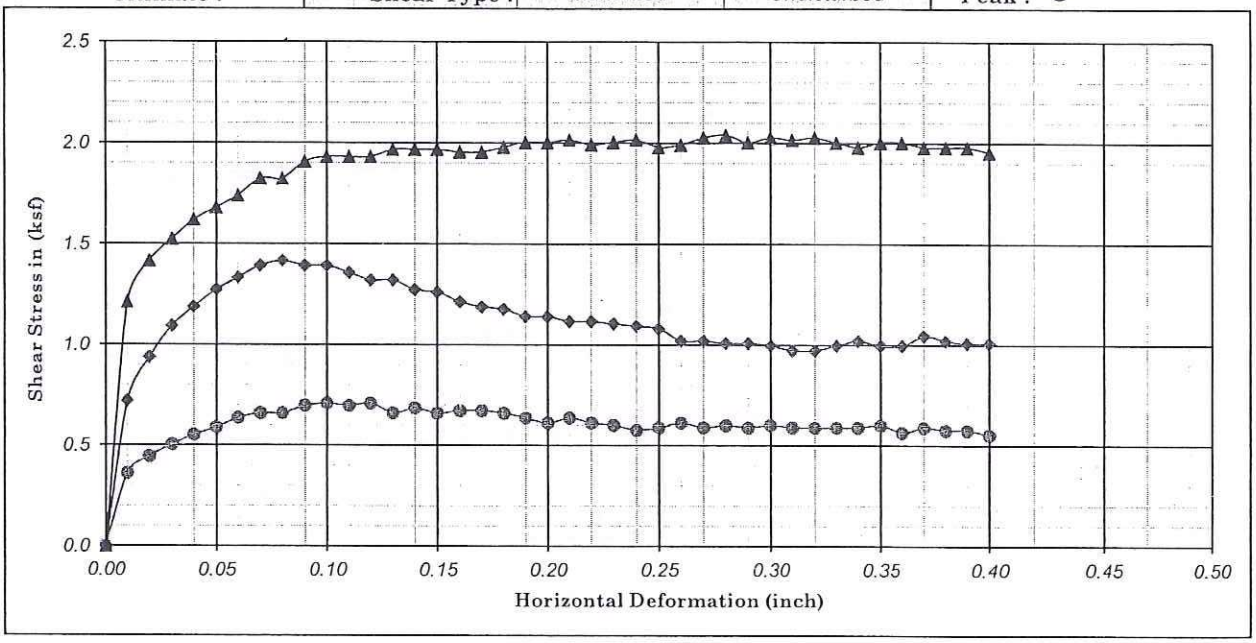
RBF/SR-91 WB Widening

DIRECT SHEAR TEST
(ASTM D-3080)

Project No. : 10-126 | Date : 02/15/11 | Figure No. :



Ultimate : ○ | Shear Type : *Inundated* | *Undisturbed* | Peak : ●



Boring No. : *A-10-058*	Strength Intercept (C) :	*0.40*	(ksf)	Peak	*0.06*	(ksf)	Ultimate
Sample No. : *D-2*		*18.96*	(kPa)		*2.87*	(kPa)	
Depth (ft/m) : *10.0* *0.00*	Friction Angle (ϕ) :	*32.35*	Degree		*32.15*	Degree	

Description : *Light yellowish brown, Poorly graded SAND with SILT (SP-SM)* Shear Rate (inch/minute) : *0.02*

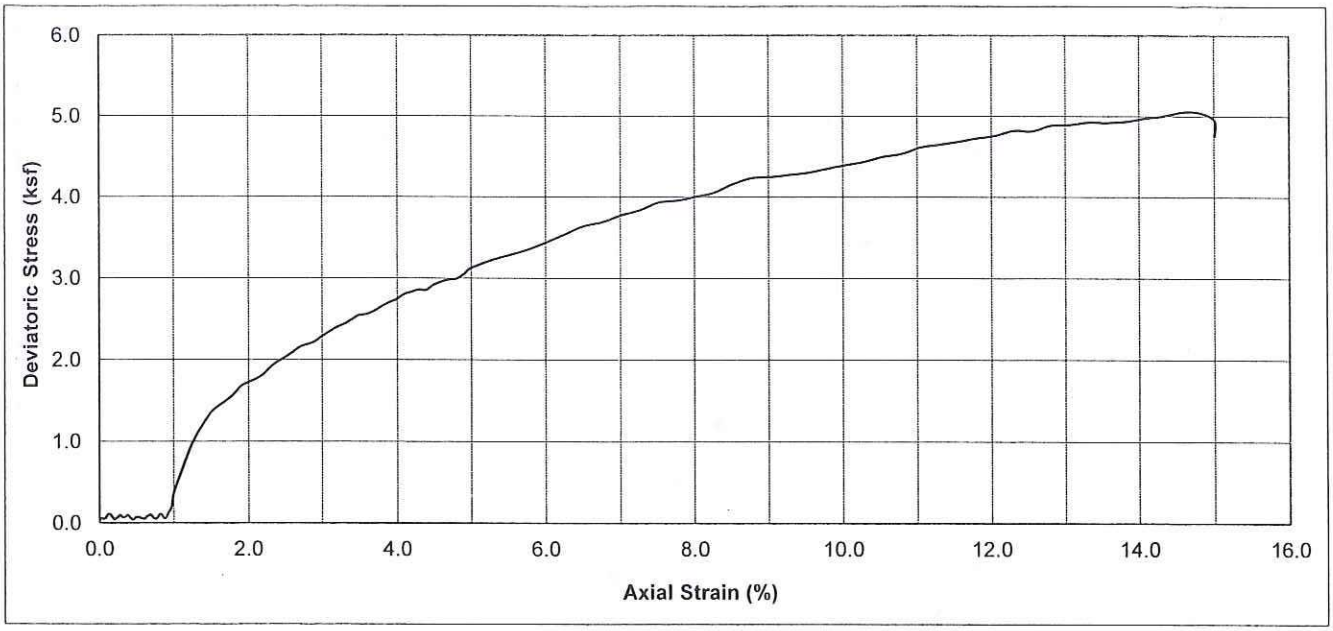
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	*17.05*	*100.78*	*15.86*	*0.67*	*0.75*	*35.91*	*0.71*	*33.90*	*0.55*	*26.43*
◆	*17.94*	*92.99*	*14.64*	*0.81*	*1.50*	*71.82*	*1.42*	*67.80*	*0.97*	*46.54*
▲	*19.82*	*91.78*	*14.45*	*0.84*	*3.00*	*143.64*	*2.04*	*97.68*	*1.96*	*93.65*

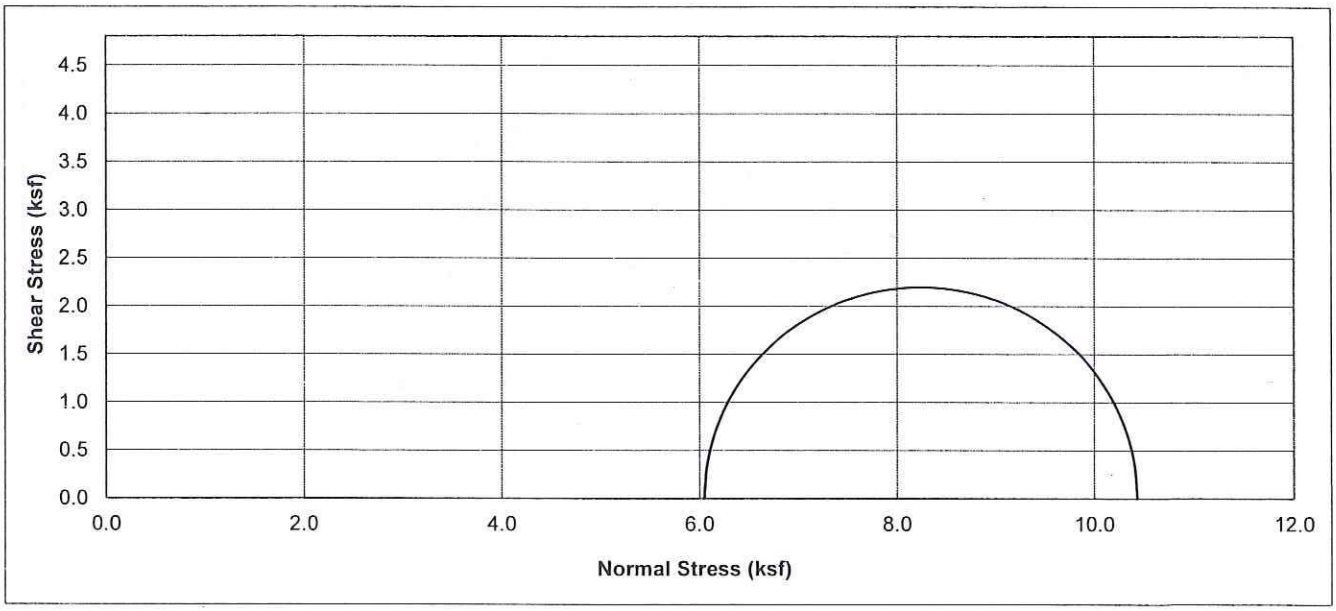
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

RBF/SR-91 WB Widening

DIRECT SHEAR TEST
(ASTM D-3080)

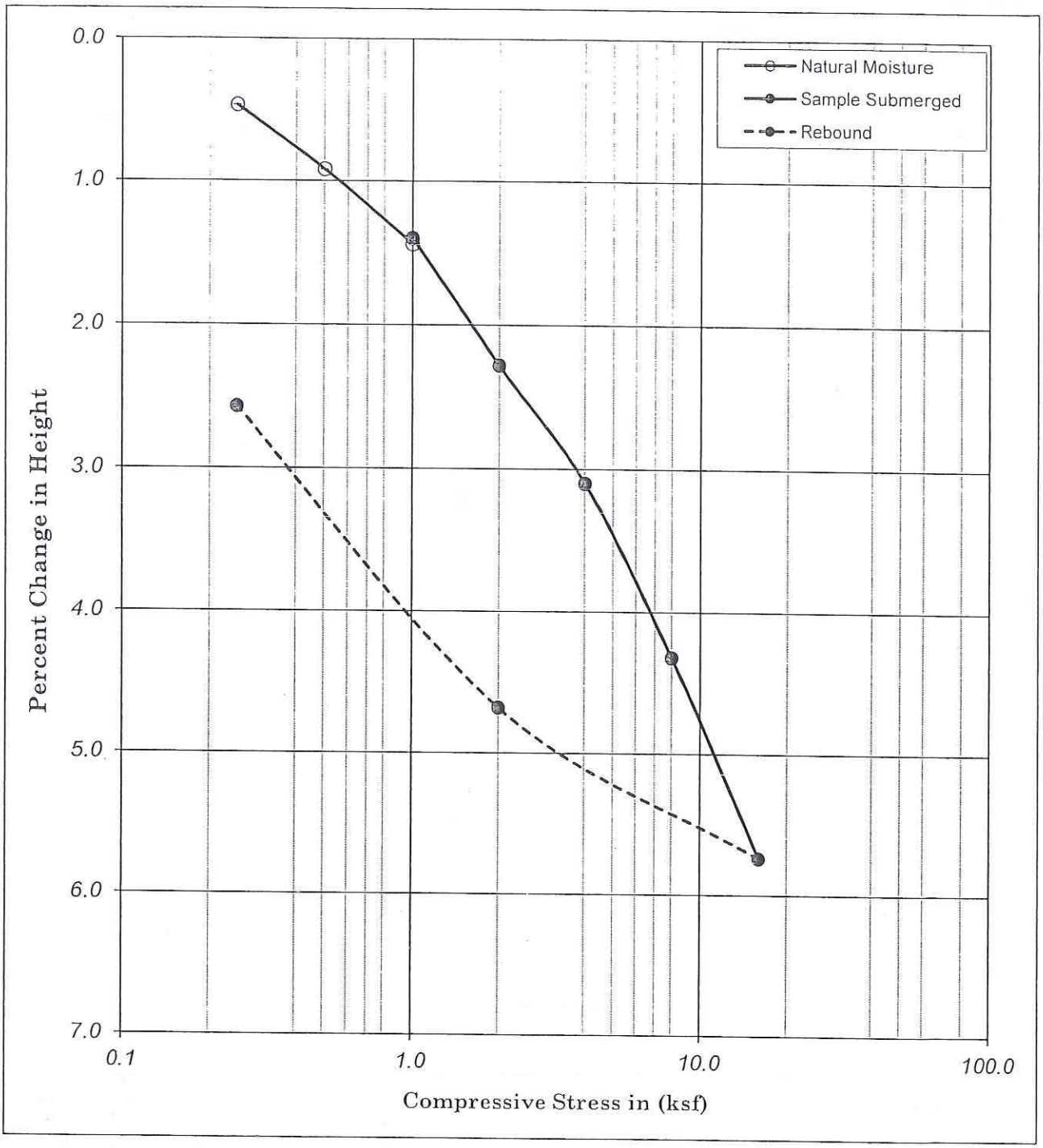
Project No. : *10-126* | Date : *02/15/11* | Figure No. :





Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-039	D-15	75	Olive Brown, Elastic SILT (MH)	92.9	28.75	6.04	4.39	95.5

Earth Mechanics, Inc.	RBF/SR-91 WB Widening
Geotechnical and Earthquake Engineering	UNCONSOLIDATED UNDRAINED TEST
Project No. : 10-126 / Date : 02/08/11	(ASTM D2850) Figure No. :



Boring No.	: A-10-005		Liquid Limit :	-		Moisture Content (%)	Dry Density (pcf)	Dry Density (kN/m³)	Percent Saturation	Void Ratio
Sample No.	: D-1		Plastic Limit :	-						
Depth (ft)	: 5.0	6.5	Plastic Index :	-	Initial	16.48	114.20	17.98	93.47	0.48
Depth (m)	: 1.53	1.98	Specific Gravity :	2.70	Final	18.45	117.24	18.45	113.80	0.44
Description : Olive-brown, SANDY SILT (ML)										

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

RBF/ SR-91 WB Widening

Project No. : 10-126 02/24/11

CONSOLIDATION TEST
(ASTM D-2435 / CT-219)

AP Engineering & Testing, Inc.

CAL 216 PART 2

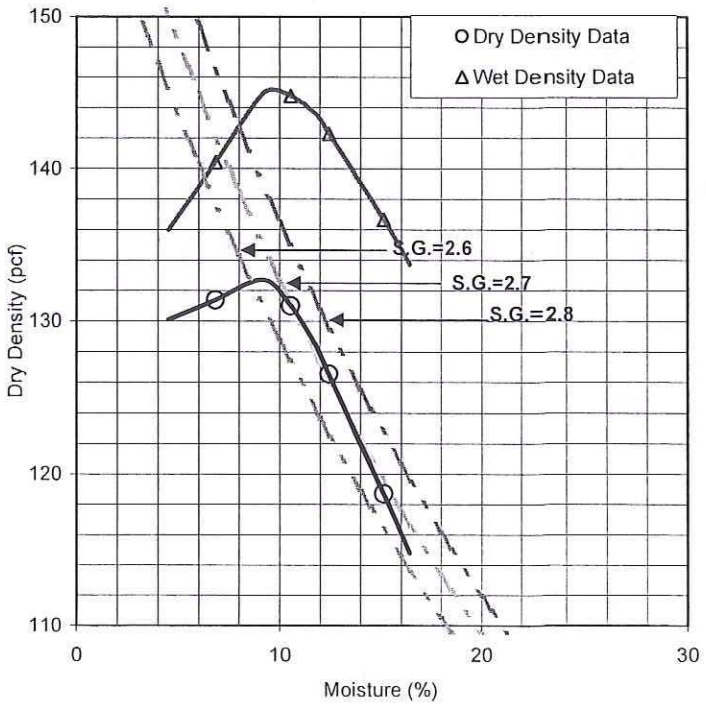
LABORATORY COMPACTED TEST MAXIMUM WET DENSITY

Client:	Earth Mechanics, Inc.			AP Number:	11-0210
Project Name:	SR-91 WB Widening	Tested By:	KM	Date:	02/08/11
Project No. :	10126	Calculated By:	KM	Date:	02/18/11
Boring No.:	A10-002	Checked By:	AP	Date:	02/21/11
Sample No. :	B-0	Depth (ft):	1.5-5		
Visual Sample Description:	Clayey Sand w/gravel				

IMPACT TEST DATA							
I	Initial Wet Weight of Test Specimen (Grams)	2450					
	Increment No.	1	2	3	4	5	6
	Water Adjustment (grams)	-98	-49	0	-165		
J	Tamper Reading	10.0	10.2	10.6	10.3		
K	Wet Density (gm/cc) from Table 1	2.32	2.28	2.19	2.25		
	Dry Density (gm/cc)	2.10	2.03	1.90	2.11		
	Dry Density (pcf)	**131.0**	**126.5**	**118.7**	**131.4**		
	Wt. of Container (gm.)	105.80	104.80	105.50	103.90		
	Wet Wt. of Soil + Cont. (gm.)	901.00	944.60	943.00	833.60		
	Dry Wt. of Soil + Cont. (gm.)	825.30	851.69	832.93	786.76		
	Moisture Content (%)	**10.52**	**12.44**	**15.13**	**6.86**		

ROCK CORRECTION				
L	Total Sample Weight		(grams)	10636.5
M	+19 mm (¾") Weight in Air		(grams)	20
N	+19 mm (¾") Weight in Water		(grams)	12.59
O	+19 mm (¾") Volume		(M-N)	7.41
P	% +19 mm (¾")	100*	(M/L)	0.19
Q	% -19 mm (¾")		(100-P)	99.81
R	Density of +19 mm (¾")		(M/O)	2.70
S	(%+19 mm)/Density of +19 mm		(P/RY)	0.07
T	(%-19 mm)/Density of -19 mm		(Q/K)	43.02
U	Sum of S and T		(S+T)	43.09
V	Average Adjusted Density		(100/U)	2.32
Percent Relative* Compaction		Spec	Failed	or less
			Passed	
*(H/K) for 10% or less +19 mm; (H/V) for > 10% +19 mm				
Note: 62.4 x (gm/cc) = P.C.F.				

Maximum Dry Density (pcf)	**132.5**
Optimum Moisture Content (%)	**9.5**
Maximum Wet Density (pcf)	**145.1**



AP Engineering & Testing, Inc.

CAL 216 PART 2

LABORATORY COMPACTED TEST MAXIMUM WET DENSITY

Client: Earth Mechanics, Inc.
Project Name: SR-91 WB Widening
Project No. : 10126
Boring No.: A10-052
Sample No. : B-0
Visual Sample Description: Poorly-Graded Sand w/silt

Tested By: JT
Calculated By: KM
Checked By: AP
Depth (ft): 2-5

AP Number: 11-0210
Date: 02/21/11
Date: 02/22/11
Date: 02/25/11

IMPACT TEST DATA

I	Initial Wet Weight of Test Specimen (Grams)		2500				
	Increment No.	1	2	3	4	5	6
	Water Adjustment (grams)	0	50	100	150		
J	Tamper Reading	11.3	10.9	10.7	11.3		
K	Wet Density (gm/cc) from Table 1	2.10	2.17	2.21	2.10		
	Dry Density (gm/cc)	1.99	2.02	2.02	1.89		
	Dry Density (pcf)	**124.4**	**126.3**	**126.3**	**117.7**		
	Wt. of Container (gm.)	155.29	194.93	158.17	155.01		
	Wet Wt. of Soil + Cont. (gm.)	695.61	639.82	829.34	736.23		
	Dry Wt. of Soil + Cont. (gm.)	668.39	609.78	772.70	677.01		
	Moisture Content (%)	**5.31**	**7.24**	**9.22**	**11.34**		

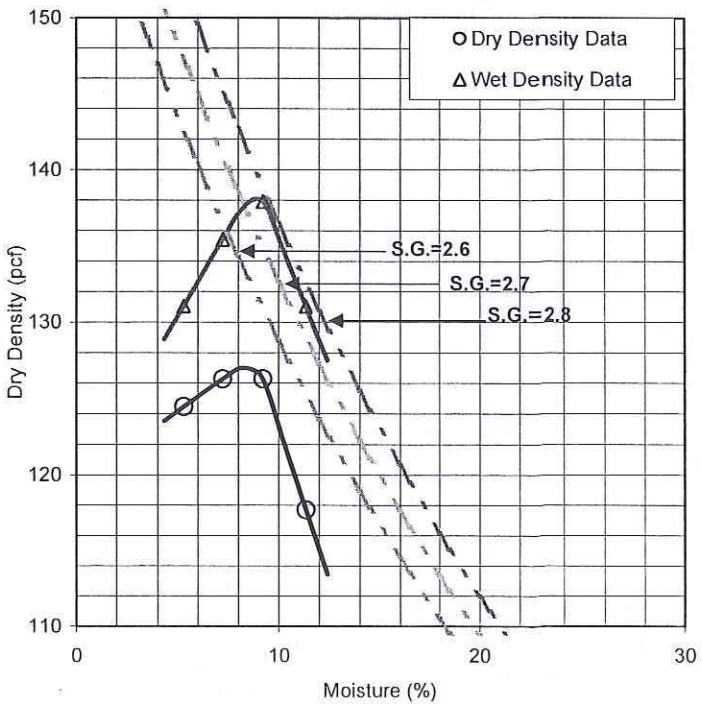
ROCK CORRECTION

L	Total Sample Weight (grams)		13124
M	+19 mm (¾") Weight in Air (grams)		44
N	+19 mm (¾") Weight in Water (grams)		29
O	+19 mm (¾") Volume (M-N)		15
P	% +19 mm (¾") 100* (M/L)		0.34
Q	% -19 mm (¾") (100-P)		99.66
R	Density of +19 mm (¾") (M/O)		2.93
S	(%+19 mm)/Density of +19 mm (P/RY)		0.11
T	(%-19 mm)/Density of -19 mm (Q/K)		45.10
U	Sum of S and T (S+T)		45.21
V	Average Adjusted Density (100/U)		2.21
Percent Relative* Compaction	Spec	Failed	or less
		Passed	

*(H/K) for 10% or less +19 mm; (H/V) for > 10% +19 mm

Note: 62.4 x (gm/cc) = P.C.F.

Maximum Dry Density (pcf)	**127.0**
Optimum Moisture Content (%)	**8.7**
Maximum Wet Density (pcf)	**138.0**



AP Engineering & Testing, Inc.

CAL 216 PART 2

LABORATORY COMPACTED TEST MAXIMUM WET DENSITY

Client:	Earth Mechanics, Inc.			AP Number:	11-0210
Project Name:	SR-91 WB Widening	Tested By:	JT	Date:	02/22/11
Project No. :	10126	Calculated By:	KM	Date:	03/03/11
Boring No.:	A10-055	Checked By:	AP	Date:	03/06/11
Sample No. :	B-0	Depth (ft):	2-5		
Visual Sample Description:	Poorly-Graded Sand w/silt				

IMPACT TEST DATA

I	Initial Wet Weight of Test Specimen (Grams)		2500				
	Increment No.	1	2	3	4	5	6
	Water Adjustment (grams)	0	50	100	-60		
J	Tamper Reading	10.5	10.5	10.7	10.9		
K	Wet Density (gm/cc) from Table 1	2.26	2.26	2.21	2.17		
	Dry Density (gm/cc)	2.11	2.07	2.00	2.08		
	Dry Density (pcf)	**131.6**	**129.0**	**124.7**	**129.6**		
	Wt. of Container (gm.)	190.00	154.76	186.30	192.82		
	Wet Wt. of Soil + Cont. (gm.)	700.04	816.71	800.76	845.59		
	Dry Wt. of Soil + Cont. (gm.)	666.03	760.39	742.00	817.46		
	Moisture Content (%)	**7.14**	**9.30**	**10.57**	**4.50**		

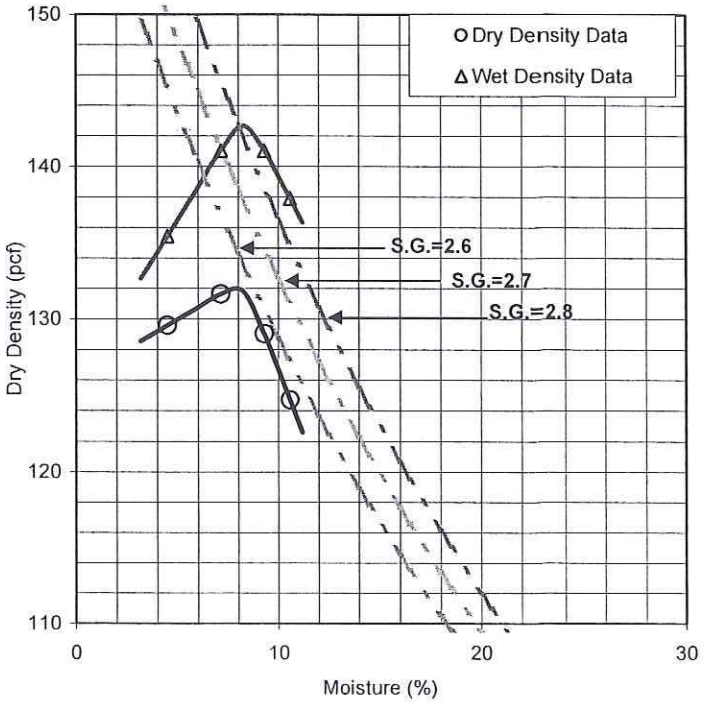
ROCK CORRECTION

L	Total Sample Weight		(grams)	13002
M	+19 mm (¾") Weight in Air		(grams)	242
N	+19 mm (¾") Weight in Water		(grams)	147
O	+19 mm (¾") Volume		(M-N)	95
P	% +19 mm (¾")	100*	(M/L)	1.86
Q	% -19 mm (¾")		(100-P)	98.14
R	Density of +19 mm (¾")		(M/O)	2.55
S	(%+19 mm)/Density of +19 mm		(P/RY)	0.73
T	(%-19 mm)/Density of -19 mm		(Q/K)	43.42
U	Sum of S and T		(S+T)	44.15
V	Average Adjusted Density		(100/U)	2.26

Percent Relative* Compaction	Spec	Failed	or less
		Passed	

*(H/K) for 10% or less +19 mm; (H/V) for > 10% +19 mm

Note: 62.4 x (gm/cc) = P.C.F.



Maximum Dry Density (pcf)	**132.0**
Optimum Moisture Content (%)	**8.0**
Maximum Wet Density (pcf)	**142.6**

Appendix C

DESIGN CALCULATIONS

RETAINING WALL 107

Retaining Wall 107 SP 10-126

LIQUEFACTION ANALYSIS; ACC. = 0.52 g 21-Nov-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
$^{1}C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-002

Emean (%)	75	Sur.=	psf	112	=top of ground el.	Borehole Diamet	8						72	=water table El.			acc. max =	0.52	g	Earthq. M=	7.3
C_E	1.25					C_B	1.15													Cm=	1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
109.5	112	2.5	0.15	0.15	2.50	2.00	0.75	1.20	1.00	120	1	1	3	0.99	0.34	8	30.0	14	1.00	0.15	0.16	0.48	AboveWT
107	109.5	2.5	0.30	0.30	5.00	1.87	0.75	1.00	0.60	120	2	2	17	0.99	0.33	21	30.0	29	1.00	0.41	0.44	1.32	AboveWT
102	107	5	0.60	0.60	10.00	1.32	0.75	1.20	1.00	120	1	1	16	0.98	0.33	28	4.0	28	1.00	0.37	0.40	1.20	AboveWT
97	102	5	0.90	0.90	15.00	1.08	0.85	1.00	0.60	120	2	2	25	0.97	0.33	20	30.0	28	1.00	0.37	0.40	1.21	AboveWT
92	97	5	1.20	1.20	20.00	0.93	0.85	1.20	1.00	120	1	1	11	0.95	0.32	16	35.0	25	0.97	0.29	0.30	0.94	AboveWT
87	92	5	1.50	1.50	25.00	0.83	0.95	1.00	0.60	120	2	2	21	0.94	0.32	15	30.0	23	0.93	0.26	0.26	0.80	AboveWT
82	87	5	1.80	1.80	30.00	0.76	0.95	1.20	1.00	120	1	1	21	0.93	0.31	27	25.0	35	0.89	high N	high N	LARGE	AboveWT

Retaining Wall 107 SP 10-126

LIQUEFACTION ANALYSIS; ACC. = 0.52 g 21-Nov-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
$^{1}C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-003

Emean (%)	75	Sur.=	psf	112	=top of ground el.	Borehole Diamet	8							72	=water table El.			acc. max =	0.52	g	Earthq. M=	7.3
C_E	1.25					C_B	1.15														Cm=	1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
107	112	5	0.30	0.30	5.00	1.87	0.75	1.20	1.00	120	1	1	7	0.99	0.33	17	25.0	24	1.00	0.27	0.29	0.88	AboveWT
102	107	5	0.60	0.60	10.00	1.32	0.75	1.00	0.60	120	2	2	35	0.98	0.33	30	6.0	31	1.00	high N	high N	LARGE	AboveWT
97	102	5	0.90	0.90	15.00	1.08	0.85	1.20	1.00	120	1	1	23	0.97	0.33	37	15.0	42	1.00	high N	high N	LARGE	AboveWT
92	97	5	1.20	1.20	20.00	0.93	0.85	1.00	0.60	120	2	2	51	0.95	0.32	35	15.0	40	0.97	high N	high N	LARGE	AboveWT
87	92	5	1.50	1.50	25.00	0.83	0.95	1.20	1.00	120	1	1	12	0.94	0.32	17	40.0	26	0.93	0.31	0.31	0.98	AboveWT
82	87	5	1.80	1.80	30.00	0.76	0.95	1.00	0.60	120	2	2	66	0.93	0.31	42	15.0	47	0.89	high N	high N	LARGE	AboveWT

Retaining Wall 107 SP 10-126
LIQUEFACTION ANALYSIS; ACC. = 0 52 g 21-Nov-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
^1C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-005

Emean (%) 75 Sur.= psf 114.3 =top of ground el. Borehole Diamet 8 74.3 =water table El. acc. max = 0.52 g Earthq. M= 7.3
C_E 1.25 C_B 1.15 Cm= 1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
109.3	114.3	5	0.30	0.30	5.00	1.87	0.75	1.00	0.60	120	2	2	29	0.99	0.33	35	55.0	47	1.00	high N	high N	LARGE	AboveWT
104.3	109.3	5	0.60	0.60	10.00	1.32	0.75	1.20	1.00	120	1	1	7	0.98	0.33	12	25.0	18	1.00	0.19	0.21	0.62	AboveWT
99.3	104.3	5	0.90	0.90	15.00	1.08	0.85	1.00	0.60	120	2	2	60	0.97	0.33	48	20.0	56	1.00	high N	high N	LARGE	AboveWT
94.3	99.3	5	1.20	1.20	20.00	0.93	0.85	1.20	1.00	120	1	1	7	0.95	0.32	10	85.0	17	0.97	0.18	0.19	0.58	AboveWT
89.3	94.3	5	1.50	1.50	25.00	0.83	0.95	1.00	0.60	120	2	2	25	0.94	0.32	18	35.0	27	0.93	0.34	0.34	1.06	AboveWT
84.3	89.3	5	1.80	1.80	30.00	0.76	0.95	1.20	1.00	120	1	1	13	0.93	0.31	17	75.0	26	0.89	0.31	0.30	0.95	AboveWT
79.3	84.3	5	2.10	2.10	35.00	0.71	1.00	1.00	0.60	120	2	2	34	0.89	0.30	21	40.0	31	0.87	high N	high N	LARGE	AboveWT
74.3	79.3	5	2.40	2.40	40.00	0.66	1.00	1.20	1.00	120	1	1	9	0.85	0.29	11	65.0	19	0.85	0.20	0.18	0.64	fines
73.5	74.3	0.8	2.45	2.42	40.80	0.66	1.00	1.00	0.60	120	2	2	39	0.84	0.29	23	35.0	33	0.85	high N	high N	LARGE	high N
68.5	73.5	5	2.75	2.57	45.80	0.64	1.00	1.00	0.60	120	2	2	39	0.80	0.29	22	35.0	32	0.83	high N	high N	LARGE	high N
63.5	68.5	5	3.05	2.71	50.80	0.62	1.00	1.20	1.00	120	1	1	16	0.76	0.29	18	35.0	27	0.82	0.34	0.30	1.03	no

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

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Project SR-91 WB widening - Retaining Wall 107 **Project No.** 10-126

By SP **Date** 04-01-11 **Checked By** GJ **Date** 04/04/11 **Sheet** 1 **of** 4

Retaining wall 107

combination wall; Type 736S
Type 736SU
Type 1SWB
Type 1SWBP

Soundwall on Barrier Type 736S

bottom of barrier elevation = 108 feet

use friction angle ϕ_{min} = 30° for design

Soundwall on Barrier Type 736SU

Retained Barrier height H_e = 1 to 4 feet

bottom of barrier elevation = +108 feet to +106.8 feet.

use friction angle ϕ_{min} = 30° for design.

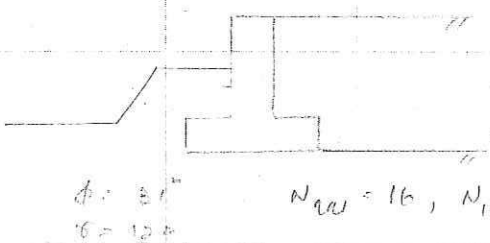
Soundwall on Retaining wall Type 1SWB

Begin wall to Sta 1447+46 (Begin wall to wall 40L sta 1849)

Maximum retaining wall ht = 12.7 ft.

footing width = 8.5 feet

bottom of footing elevation = +102.65 feet



$N_{160} = C_N N_{raw}$ $\left(\frac{tsf}{60}\right)$

$C_N = 0.77 \log\left(\frac{40}{\sigma'}\right)$

ϕ = 31°
β = 12°

$N_{raw} = 16$, $N_{160} = 16$

bearing resistance
service limit state = 2.8 ksf
strength limit state = 4.48 ksf
extreme event limit state = 10 ksf

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Project SR91 wB widening - Retaining wall 107 **Project No.** 10-126

By SP **Date** 04-01-11 **Checked By** GJ **Date** 04/04/11 **Sheet** 2 **of** 4

bearing capacity

$q_u = cN_{cm} + \gamma D_f N_{qm} + \frac{1}{2}\gamma B N_{\gamma m}$

$N_{cm} = N_c s_c i_c$; $N_{qm} = N_q s_q i_q d_q$; $N_{\gamma m} = N_\gamma s_\gamma i_\gamma$

load inclination factors $i_c = i_q = i_\gamma = 1$

shape factors $s_c = s_q = s_\gamma = 1$ for $B \ll L$

depth $D_f = 1.75 + 1.5 = 3.25$ ft

depth factor $d_q = 1.2$

for $\phi = 31°$, $N_c = 32.7$, $N_q = 20.6$, $N_\gamma = 26$

$q_u = 100 \times 32.7 + 120 \times 3.25 \times 20.6 \times 1.2 + \frac{1}{2} \times 120 \times 8.25 \times 26$

$= 25.8$ ksf

strength limit state

$q_{all} = \phi q_u$ $\phi = 0.45$ resistance factor

$q_{all} = 0.45 \times 25.8 = 11.6$ ksf

Extreme event limit state

$q_{all} = 1.0 \times 25.8 = 25.8$ ksf

service limit state

consider 2.9 ksf bearing pressure with 3 ft over excavation & recompaction.

σ_0	$\Delta\sigma$	settlement
$10.75 \times 120 = 1.29$	$2.9 \times 0.55 = 1.6$	$9 \times \frac{1}{55} \log\left(\frac{1.29 + 1.6}{1.29}\right) = 0.69$
$22.75 \times 120 = 2.73$	$2.9 \times 0.25 = 0.73$	$15 \times \frac{1}{55} \log\left(\frac{2.73 + 0.73}{2.73}\right) = 0.34$
		$1.03''$

$q_{all} = 2.9$ ksf > 2.85 ksf

wall ht (ft)	Bearing capacity (ksf) service	strength	extreme	over excavation depth (ft)
6	2.0	10.2	24.7	1
8	2.3	10.9	28.1	2
10	2.6	10.8	29.9	3
12	2.9	11.6	25.8	3

Begin wall to sta 149+91 Begin wall to wall col sta (5+39)

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Project SR 91 WB widening – Retaining Wall 107 **Project No.** 10-126

By SP **Date** 09-01-11 **Checked By** GJ **Date** 04/04/11 **Sheet** 3 **of** 4

from station 14+46 to End wall
(wall col sta 18+39 to end wall)
wall ht = 10 ft
footing width = 7.5 ft
bottom of footing = +106.65 ft

106.65 ft

① MC S_u=1.0 (c=115) N_{cm} = 7, N_{160} = 12 — 99'

② SM (c=120) N_{cm} = 36, N_{160} = 42 — 94'

③ MC (c=115) N_{cm} = 7, N_{160} = 9 — 89'

④ SM (c=120) N_{cm} = 13, N_{160} = 14 — 80'

$N_{160} = (N)_{cm}\left(\frac{FL}{60}\right)$

$(N)_{cm} = 0.77 \log\left(\frac{40}{\sigma'_v}\right)$

Bearing capacity

$q_u = cN_{cm} + qN_{qm} + \frac{1}{2}\gamma B N_{\gamma m}$

$N_{cm} = N_c s_c i_c$; $N_{qm} = N_z s_q i_q d_q$; $N_{\gamma m} = N_\gamma s_\gamma i_\gamma$

load inclination factors $i_c = i_q = i_\gamma = 1$
shape factors $s_c = s_q = s_\gamma = 1$

for footing on clay $N_c = 5.14$, $N_q = 1$, $N_\gamma = 0$

$q_u = 5.14 \times 1 + 0.120 \times 3 \times 1 \times 1.2$
$= 6.6$ ksf

consider removal & recompaction with select material ($\phi = 36°$)
for layered soil $2K\tan\phi \frac{H}{B}\left(1+\frac{B}{L}\right)$

$q_u = q\,e$

$K = \frac{1-\sin^2\phi}{1+\sin^2\phi} = 0.49$

$2 \times 0.49 \times \tan 36 \times \frac{4}{7} = (1.47)(4/7)$ for 4 ft of recompacted soil

$q_u = 5.6 \times e$
$= 8.9$ ksf

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Project SR91 WB widening – Retaining wall 107 **Project No.** 10-126

By SP **Date** 04-04-11 **Checked By** GJ **Date** 04/04/11 **Sheet** 4 **of** 4

for strength limit state

$q_{all} = \phi q_u$

$= 0.45 \times 8.4 = 3.8$ ksf

Extreme event limit state

$q_{all} = 1.0 \times 8.4 = 8.4$ ksf.

Service limit state

for bearing pressure of 2.6 ksf with 4 feet overexcavation

	$\sum V_D$	Δ_G	Settlement
①	$7 \times 120 + 1.85 \times 115 = 1.05$	$2.6 \times 0.65 = 1.69$	$3.7 \times \frac{1}{35} \log\left(\frac{1.05+1.69}{1.05}\right) = 0.53$
②	$9.5 \times 120 + 3.7 \times 115 = 1.57$	$2.6 \times 0.45 = 1.17$	$5 \times \frac{1}{100} \log\left(\frac{1.57+1.17}{1.57}\right) = 0.14$
③	$12 \times 120 + 6.5 \times 115 = 2.16$	$2.6 \times 0.3 = 0.78$	$5 \times \frac{1}{35} \log\left(\frac{2.16+0.78}{2.16}\right) = 0.23$
④	$16.6 \times 120 + 8.7 \times 115 = 2.98$	$2.6 \times 0.2 = 0.52$	$9 \times \frac{1}{50} \log\left(\frac{2.98+0.52}{2.16}\right) = 0.15$

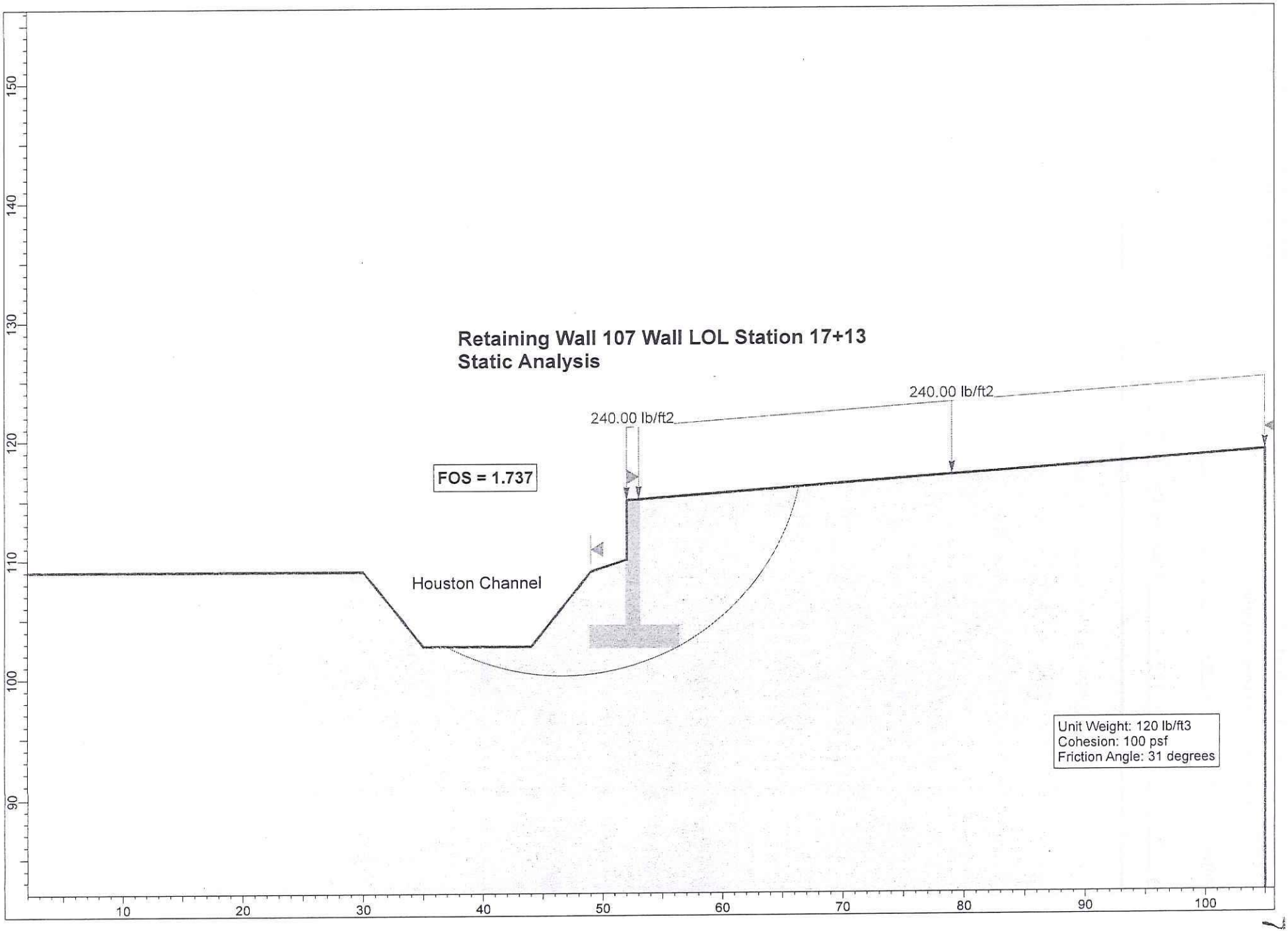
$1.05''$

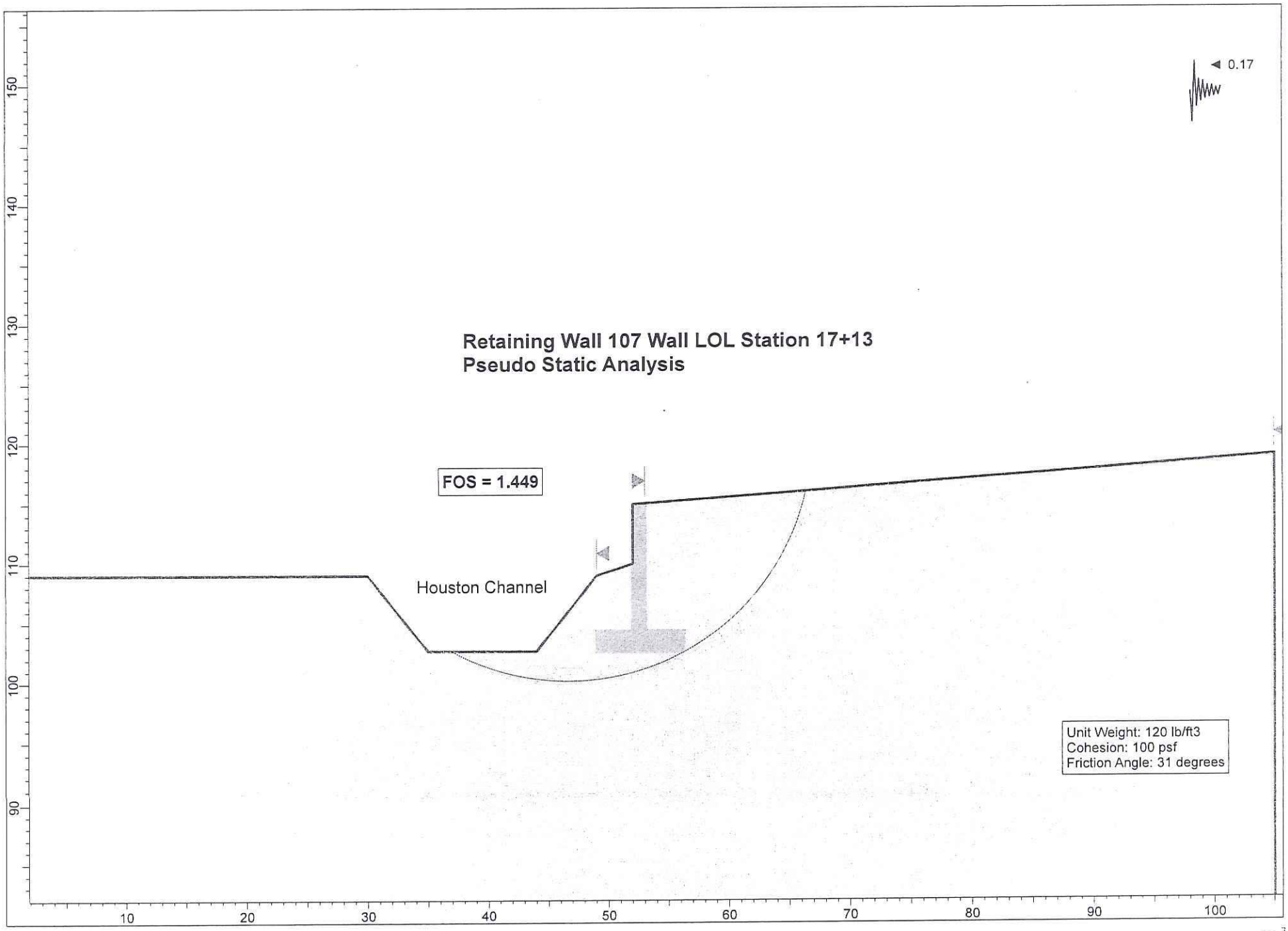
$q_{all} = 2.6$ ksf

Wall #	Bearing capacity (ksf) Service	Strength	Extreme	Depth of excavation (ft)
8	2.3	4.3	9.6	4
10	2.6	4.1	9.2	4

[from Sta 14+46 to Endwall]

(from wall 101 sta 13+39 to endwall)


Retaining Wall 107 Wall LOL Station 17+13
Static Analysis
240.00 lb/ft2
240.00 lb/ft2
FOS = 1.737
Houston Channel
Unit Weight: 120 lb/ft3
Cohesion: 100 psf
Friction Angle: 31 degrees
150
140
130
120
110
100
90
10
20
30
40
50
60
70
80
90
100


0.17
Retaining Wall 107 Wall LOL Station 17+13
Pseudo Static Analysis
FOS = 1.449
Houston Channel
Unit Weight: 120 lb/ft3
Cohesion: 100 psf
Friction Angle: 31 degrees
150
140
130
120
110
100
90
10
20
30
40
50
60
70
80
90
100

RETAINING WALL 173

Retaining Wall 173
LIQUEFACTION ANALYSIS; ACC. = 0.52 g

SP 10-126
21-Nov-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-024

Emean (%)	75	Sur.=	psf	152.6	=top of ground el.	Borehole Diamet	8										112.6	=water table El.		acc. max =	0.52	g	Earthq. M=	7.3
C_E	1.25					C_B	1.15																Cm=	1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
147.6	152.6	5	0.30	0.30	5.00	1.87	0.75	1.20	1.00	120	1	1	13	0.99	0.33	32	30.0	42	1.00	high N	high N	LARGE	AboveWT
142.6	147.6	5	0.60	0.60	10.00	1.32	0.75	1.00	0.60	120	2	2	100	0.98	0.33	86	6.0	87	1.00	high N	high N	LARGE	AboveWT
137.6	142.6	5	0.90	0.90	15.00	1.08	0.85	1.20	1.00	120	1	1	24	0.97	0.33	38	25.0	47	1.00	high N	high N	LARGE	AboveWT
132.6	137.6	5	1.20	1.20	20.00	0.93	0.85	1.00	0.60	120	2	2	24	0.95	0.32	17	25.0	24	0.97	0.27	0.28	0.88	AboveWT
127.6	132.6	5	1.50	1.50	25.00	0.83	0.95	1.20	1.00	120	1	1	9	0.94	0.32	13	35.0	21	0.93	0.23	0.23	0.71	AboveWT
122.6	127.6	5	1.80	1.80	30.00	0.76	0.95	1.00	0.60	120	2	2	41	0.93	0.31	26	25.0	34	0.89	high N	high N	LARGE	AboveWT
117.6	122.6	5	2.10	2.10	35.00	0.71	1.00	1.20	1.00	120	1	1	11	0.89	0.30	14	25.0	20	0.87	0.22	0.20	0.67	AboveWT
112.6	117.6	5	2.40	2.40	40.00	0.66	1.00	1.00	0.60	120	2	2	45	0.85	0.29	26	25.0	34	0.85	high N	high N	LARGE	high N
107.6	112.6	5	2.70	2.54	45.00	0.64	1.00	1.20	1.00	120	1	1	17	0.81	0.29	19	25.0	26	0.84	0.31	0.28	0.97	yes
102.6	107.6	5	3.00	2.69	50.00	0.62	1.00	1.00	0.60	120	2	2	28	0.77	0.29	16	65.0	25	0.82	0.29	0.26	0.89	fines
97.6	102.6	5	3.30	2.83	55.00	0.61	1.00	1.20	1.00	120	1	1	16	0.73	0.29	17	80.0	26	0.81	0.31	0.27	0.95	fines
92.6	97.6	5	3.60	2.98	60.00	0.59	1.00	1.00	0.60	120	2	2	100	0.69	0.28	52	70.0	68	0.80	high N	high N	LARGE	high N/fines
87.6	92.6	5	3.90	3.12	65.00	0.58	1.00	1.20	1.00	120	1	1	26	0.64	0.27	26	7.0	27	0.77	0.34	0.28	1.03	no
82.6	87.6	5	4.20	3.26	70.00	0.57	1.00	1.00	0.60	120	2	2	85	0.60	0.26	42	10.0	44	0.77	high N	high N	LARGE	high N
77.6	82.6	5	4.50	3.41	75.00	0.55	1.00	1.20	1.00	120	1	1	14	0.56	0.25	14	70.0	22	0.76	0.24	0.20	0.78	fines
72.6	77.6	5	4.80	3.55	80.00	0.54	1.00	1.00	0.60	120	2	2	100	0.55	0.25	47	10.0	49	0.75	high N	high N	LARGE	high N
67.6	72.6	5	5.10	3.70	85.00	0.53	1.00	1.20	1.00	120	1	1	51	0.54	0.25	47	4.0	47	0.74	high N	high N	LARGE	high N

CI

Retaining Wall 173

Note: Units are tons/cf, tons/sf, and feet

Sounding: CPT-10-026

PGA: 0.52 Mag 7.3 Gwdepth 108 Ground EL 148

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	CQ2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
1.15	146.9	43.54	2.068	0.06	0.07	0.07	630.01	4.76	2.01	3.88	162.54	2.28	Sand	Sand	Sand	162.54	2.28	1.88	305.13	2.72	0.34	1.00	FALSE	0.00	Above WT
1.31	146.7	27.97	1.294	0.06	0.08	0.08	354.85	4.64	2.10	3.64	97.83	2.40	Sand	Sand	Sand	97.83	2.40	2.30	225.21	1.14	0.34	1.00	FALSE	0.00	Above WT
1.48	146.5	8.98	1.236	0.06	0.09	0.09	100.13	13.90	2.78	Clay	Clay	Clay	Clay	Clay	Clay	100.13	2.76	4.64	464.48	9.40	0.34	1.00	FALSE	0.00	Above WT
1.64	146.4	22.45	1.191	0.06	0.10	0.10	227.15	5.33	2.24	3.25	70.18	2.53	Sand	Sand	Sand	70.18	2.53	2.95	207.08	0.91	0.34	1.00	FALSE	0.00	Above WT
1.80	146.2	21.74	0.839	0.06	0.11	0.11	200.30	3.88	2.15	3.10	64.87	2.45	Sand	Sand	Sand	64.87	2.45	2.55	165.10	0.50	0.34	1.00	FALSE	0.00	Above WT
1.97	146.0	20.21	0.800	0.06	0.12	0.12	169.98	3.98	2.20	2.97	57.64	2.50	Sand	Sand	Sand	57.64	2.50	2.75	158.71	0.45	0.34	1.00	FALSE	0.00	Above WT
2.13	145.9	20.30	0.823	0.06	0.13	0.13	157.84	4.08	2.23	2.85	55.68	2.51	Sand	Sand	Sand	55.68	2.51	2.84	158.37	0.45	0.34	1.00	FALSE	0.00	Above WT
2.30	145.7	19.19	0.885	0.06	0.14	0.14	138.06	4.64	2.31	2.75	50.65	2.58	Sand	Sand	Sand	50.65	2.58	3.23	163.59	0.49	0.34	0.99	FALSE	0.00	Above WT
2.46	145.5	11.97	1.240	0.06	0.15	0.15	80.10	10.49	2.73	Clay	Clay	Clay	Clay	Clay	Clay	80.10	2.73	4.25	340.40	3.75	0.34	0.99	FALSE	0.00	Above WT
2.62	145.4	36.06	1.336	0.06	0.16	0.16	228.39	3.72	2.11	2.57	89.18	2.35	Sand	Sand	Sand	89.18	2.35	2.11	188.57	0.70	0.34	0.99	FALSE	0.00	Above WT
2.79	145.2	73.30	1.766	0.06	0.17	0.17	436.87	2.41	1.80	2.49	175.67	2.02	Sand	Sand	Sand	175.67	2.02	1.32	232.51	1.25	0.34	0.99	FALSE	0.00	Above WT
2.95	145.1	106.80	2.277	0.06	0.18	0.18	602.39	2.14	1.70	2.42	248.92	1.89	Sand	Sand	Sand	248.92	1.89	1.18	292.55	2.41	0.34	0.99	FALSE	0.00	Above WT
3.12	144.9	150.97	2.848	0.06	0.19	0.19	805.46	1.89	1.60	2.36	342.15	1.76	Sand	Sand	Sand	342.15	1.76	1.08	370.12	4.80	0.34	0.99	FALSE	0.00	Above WT
3.28	144.7	216.15	3.880	0.06	0.20	0.20	1097.32	1.80	1.54	2.30	477.78	1.67	Sand	Sand	Sand	477.78	1.67	1.02	487.12	10.83	0.34	0.99	FALSE	0.00	Above WT
3.44	144.6	285.74	3.775	0.06	0.21	0.21	1383.40	1.32	1.38	2.24	616.74	1.50	Sand	Sand	Sand	616.74	1.50	1.00	616.74	21.90	0.34	0.99	FALSE	0.00	Above WT
3.61	144.4	236.45	2.953	0.06	0.22	0.22	1090.64	1.25	1.39	2.19	498.19	1.53	Sand	Sand	Sand	498.19	1.53	1.00	498.19	11.58	0.34	0.99	FALSE	0.00	Above WT
3.77	144.2	192.56	1.697	0.06	0.23	0.23	850.28	0.88	1.28	2.14	397.01	1.46	Sand	Sand	Sand	397.01	1.46	1.00	397.01	5.90	0.34	0.99	FALSE	0.00	Above WT
3.94	144.1	177.25	1.604	0.06	0.24	0.24	748.79	0.91	1.32	2.10	357.48	1.49	Sand	Sand	Sand	357.48	1.49	1.00	357.48	4.33	0.33	0.99	FALSE	0.00	Above WT
4.10	143.9	174.04	1.773	0.06	0.25	0.25	706.48	1.02	1.38	2.06	344.08	1.54	Sand	Sand	Sand	344.08	1.54	1.00	344.08	3.87	0.33	0.99	FALSE	0.00	Above WT
4.27	143.7	207.48	2.076	0.06	0.26	0.26	808.84	1.00	1.34	2.01	401.95	1.50	Sand	Sand	Sand	401.95	1.50	1.00	401.95	6.12	0.33	0.99	FALSE	0.00	Above WT
4.43	143.6	231.58	2.591	0.06	0.27	0.27	870.26	1.12	1.38	1.98	440.46	1.51	Sand	Sand	Sand	440.46	1.51	1.00	440.46	8.03	0.33	0.99	FALSE	0.00	Above WT
4.59	143.4	267.09	2.825	0.06	0.28	0.28	968.83	1.06	1.34	1.94	499.07	1.46	Sand	Sand	Sand	499.07	1.46	1.00	499.07	11.64	0.33	0.99	FALSE	0.00	Above WT
4.76	143.2	297.21	3.066	0.06	0.29	0.29	1039.65	1.03	1.31	1.91	545.34	1.44	Sand	Sand	Sand	545.34	1.44	1.00	545.34	15.16	0.33	0.99	FALSE	0.00	Above WT
4.92	143.1	308.15	3.395	0.06	0.30	0.30	1042.87	1.10	1.34	1.88	556.14	1.46	Sand	Sand	Sand	556.14	1.46	1.00	556.14	16.08	0.33	0.99	FALSE	0.00	Above WT
5.09	142.9	307.03	3.612	0.06	0.31	0.31	1004.34	1.18	1.37	1.85	544.79	1.48	Sand	Sand	Sand	544.79	1.48	1.00	544.79	15.12	0.33	0.99	FALSE	0.00	Above WT
5.25	142.8	302.02	3.742	0.06	0.32	0.32	957.79	1.24	1.40	1.82	527.67	1.51	Sand	Sand	Sand	527.67	1.51	1.00	527.67	13.74	0.33	0.99	FALSE	0.00	Above WT
5.41	142.6	299.00	3.895	0.06	0.32	0.32	920.13	1.30	1.43	1.79	514.61	1.54	Sand	Sand	Sand	514.61	1.54	1.00	514.61	12.75	0.33	0.99	FALSE	0.00	Above WT
5.58	142.4	297.99	3.819	0.06	0.33	0.33	889.05	1.28	1.43	1.76	505.00	1.53	Sand	Sand	Sand	505.00	1.53	1.00	505.00	12.06	0.33	0.99	FALSE	0.00	Above WT
5.74	142.3	291.37	3.171	0.06	0.34	0.34	845.02	1.09	1.37	1.74	486.85	1.48	Sand	Sand	Sand	486.85	1.48	1.00	486.85	10.81	0.33	0.99	FALSE	0.00	Above WT
5.91	142.1	306.05	2.658	0.06	0.35	0.35	862.09	0.87	1.28	1.71	503.97	1.39	Sand	Sand	Sand	503.97	1.39	1.00	503.97	11.98	0.33	0.99	FALSE	0.00	Above WT
6.07	141.9	332.38	2.486	0.06	0.36	0.36	911.63	0.75	1.21	1.69	540.07	1.32	Sand	Sand	Sand	540.07	1.32	1.00	540.07	14.73	0.33	0.99	FALSE	0.00	Above WT
6.23	141.8	324.94	2.403	0.06	0.37	0.37	868.29	0.74	1.21	1.67	521.15	1.32	Sand	Sand	Sand	521.15	1.32	1.00	521.15	13.24	0.33	0.99	FALSE	0.00	Above WT
6.40	141.6	302.62	2.486	0.06	0.38	0.38	787.07	0.82	1.27	1.65	478.87	1.38	Sand	Sand	Sand	478.87	1.38	1.00	478.87	10.29	0.33	0.99	FALSE	0.00	Above WT
6.56	141.4	281.49	2.320	0.06	0.39	0.39	714.17	0.83	1.29	1.63	439.97	1.41	Sand	Sand	Sand	439.97	1.41	1.00	439.97	8.00	0.33	0.98	FALSE	0.00	Above WT
6.73	141.3	252.72	2.284	0.06	0.40	0.40	624.85	0.91	1.36	1.60	389.98	1.47	Sand	Sand	Sand	389.98	1.47	1.00	389.98	5.60	0.33	0.98	FALSE	0.00	Above WT
6.89	141.1	228.91	2.245	0.06	0.41	0.41	552.73	0.98	1.41	1.59	349.11	1.53	Sand	Sand	Sand	349.11	1.53	1.00	349.11	4.04	0.33	0.98	FALSE	0.00	Above WT
7.05	141.0	208.10	2.056	0.06	0.42	0.42	490.96	0.99	1.44	1.57	313.75	1.56	Sand	Sand	Sand	313.75	1.56	1.00	313.75	2.95	0.33	0.98	FALSE	0.00	Above WT
7.22	140.8	199.37	1.856	0.06	0.43	0.43	459.23	0.93	1.44	1.55	297.03	1.55	Sand	Sand	Sand	297.03	1.55	1.00	297.03	2.52	0.33	0.98	FALSE	0.00	Above WT
7.38	140.6	202.75	1.697	0.06	0.44	0.44	456.88	0.84	1.40	1.53	298.77	1.52	Sand	Sand	Sand	298.77	1.52	1.00	298.77	2.56	0.33	0.98	FALSE	0.00	Above WT
7.55	140.5	216.90	1.919	0.06	0.45	0.45	477.81	0.89	1.41	1.52	316.00	1.52	Sand	Sand	Sand	316.00	1.52	1.00	316.00	3.01	0.33	0.98	FALSE	0.00	Above WT
7.71	140.3	225.97	2.067	0.06	0.46	0.46	487.48	0.92	1.42	1.50	325.79	1.52	Sand	Sand	Sand	325.79	1.52	1.00	325.79	3.30	0.33	0.98	FALSE	0.00	Above WT
7.87	140.1	216.25	2.243	0.06	0.47	0.47	456.96	1.04	1.48	1.48	308.59	1.58	Sand	Sand	Sand	308.59	1.58	1.00	308.59	2.81	0.33	0.98	FALSE	0.00	Above WT
8.04	140.0	199.23	2.168	0.06	0.48	0.48	412.00	1.09	1.52	1.47	281.28	1.62	Sand	Sand	Sand	281.28	1.62	1.00	281.28	2.15	0.33	0.98	FALSE	0.00	Above WT
8.20	139.8	173.77	2.292	0.06	0.49	0.49	352.19	1.32	1.63	1.45	242.93	1.72	Sand	Sand	Sand	242.93	1.72	1.05	256.21	1.64	0.33	0.98	FALSE	0.00	Above WT
8.37	139.6	156.32	1.914	0.06	0.50	0.50	310.27	1.23	1.63	1.44	216.30	1.73	Sand	Sand	Sand	216.30	1.73	1.06	229.27	1.20	0.33	0.98	FALSE	0.00	Above WT
8.53	139.5	167.66	2.037	0.06	0.51	0.51	326.59	1.22	1.62	1.43	229.81	1.71	Sand	Sand	Sand	229.81	1.71	1.05	240.53	1.37	0.33	0.98	FALSE	0.00	Above WT
8.69	139.3	216.69	1.972	0.06	0.52	0.52	414.59	0.91	1.46	1.41	294.26	1.55	Sand	Sand	Sand	294.26	1.55	1.00	294.26	2.45	0.33	0.98	FALSE	0.00	Above WT
8.86	139.1	254.24	2.020	0.06	0.53	0.53	477.25	0.80	1.37	1.40	341.93	1.46	Sand	Sand	Sand	341.93	1.46	1.00	341.93	3.80	0.33	0.98	FALSE	0.00	Above WT
9.02	139.0	293.56	2.427	0.06	0.54	0.54	541.42	0.83	1.36	1.39	391.29	1.44	Sand	Sand	Sand	391.29	1.44	1.00	391.29	5.65	0.33	0.98	FALSE	0.00	Above WT
9.19	138.8	310.40	2.941	0.06	0.55	0.55	561.93	0.95	1.40	1.37	409.89	1.47	Sand	Sand	Sand	409.89	1.47	1.00	409.89	6.48	0.33	0.98	FALSE	0.00	Above WT
9.35	138.7	336.76	3.223	0.06	0.56	0.56	599.29	0.96	1.39	1.36	440.88	1.46	Sand	Sand	Sand	440.88	1.46	1.00	440.88	8.05	0.33	0.98	FALSE	0.00	Above WT
9.51	138.5	346.26	3.212	0.06	0.57	0.57	605.83	0.93	1.37	1.35	449.49	1.44	Sand	Sand	Sand	449.49	1.44	1.00	449.49	8.53	0.33	0.98	FALSE	0.00	Above WT
9.68	138.3	349.48	4.016	0.06	0.58	0.58	600.72	1.15	1.46	1.34	449.67	1.52	Sand	Sand	Sand	449.67	1.52	1.00	449.67	8.54	0.33	0.98	FALSE	0.00	Above WT
9.84	138.2	356.69	4.162	0.06	0.59	0.59	603.15	1.17	1.46	1.33	455.20	1.52	Sand	Sand	Sand	455.20	1.52	1.00	455.20	8.85	0.33	0.98	FALSE	0.00	Above WT
10.01	138.0	348.87	4.319	0.06	0.60	0.60	579.87	1.24	1.49	1.32	441.42	1.55	Sand	Sand	Sand	441.42	1.55	1.00	441.42	8.08	0.33	0.98	FALSE	0.00	Above WT
10.17	137.8	386.18	4.720	0.06	0.61	0.61	631.87	1.22	1.47	1.31	484.77	1.53	Sand	Sand	Sand	484.77	1.53	1.00	484.77	10.67	0.33	0.98	FALSE	0.00	Above WT
10.33	137.7	433.02	4.268	0.06	0.62	0.62	697.64	0.99	1.37	1.30	539.34	1.42	Sand	Sand	Sand	539.34	1.42	1.00	539.34	14.67	0.33	0.98	FALSE	0.00	Above WT

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Project SR-91 WB Widening Retaining Wall 173 **Project No.** 10-126

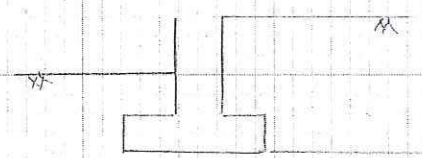
By SP **Date** 04-01-11 **Checked By** GJ **Date** 04/04/11 **Sheet** 1 **of** 5

Retaining wall 173 - spread footing

Maximum wall ht = 14 feet

footing width = 8.0 feet

Bottom of footing = 139 feet



$N_{160} = C_N N_{aw} \left(\frac{P_a}{\sigma_v'}\right)$

$C_N = 0.77 \log\left(\frac{40}{\sigma_v'}\right)$

Bearing capacity

$q_u = cN_{cm} + \gamma D_f N_{qm} + \frac{1}{2}\gamma B N_{\gamma m}$

$N_{cm} = N_c s_c i_c$; $N_{qm} = N_q s_q i_q d_q$; $N_{\gamma m} = N_\gamma s_\gamma i_\gamma$

load inclination factors $i_c = i_q = i_\gamma = 1$

shape factors $s_c = s_q = s_\gamma = 1$ for B << L

depth $D_f = 1.5 + 1.5 = 3.0$ feet

depth factor $d_q = 1.2$

for wall on slope $N_c = N_{cq} = 5.14$ $N_q = 0$, $N_\gamma = 21$

$q_{ult} = 100 \times 5.14 + 0 + \frac{1}{2} \times 120 \times 8 \times 21$

$= 10.6$ ksf

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Project SR-91 WB widening – Retaining wall 173 **Project No.** 10-136

By SP **Date** 04-01-11 **Checked By** GJ **Date** 04/04/11 **Sheet** 2 of 5

$q_{all} = 10.6/3$

$= 3.52$ ksf

Settlement

considered 3.5 ksf bearing pressure

consider 5 ft of over-excavation

	σ_{vo}	$\Delta\sigma$	Settlement
①	over excavate entire layer ①		0
②	$8\times120 + 7\times115 = 1.77$	$3.5\times0.9 = 1.4$	$14\times\frac{1}{55}\log\left(\frac{1.77+1.4}{1.77}\right) = 0.17$
	$8\times120 + 2.5\times115 = 3.93$	$3.5\times0.15 = 0.53$	$15\times\frac{1}{55}\log\left(\frac{3.93+0.53}{3.93}\right) = \frac{0.03}{1.0''}$

for 14 feet wide ft
perform 5 ft of over excavation

for wall height = 12 feet

footing width = 7.25 ft

bottom of footing = 13 ft

depth D_f = 11.33 + 1.5 = 12.83 ft

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Project SR-91 WB widening - Retaining wall 173 **Project No.** 10-126

By SP **Date** 04-01-11 **Checked By** GJ **Date** 04/04/11 **Sheet** 3 **of** 5

$q_{ult} = 100 \times 5.6 + \frac{1}{2} \times 120 \times 7.25 \times 21$

$= 9.7$ ksf

$q_{all} = 3.2$ ksf

Settlement

consider 3 ksf bearing pressure

consider 3 feet of overexcavation

	σ_{vo}	$\Delta\sigma$	Settlement
①	$7.25 \times 120 = 0.87$	$3 \times 0.81 = 2.43$	$2 \times \frac{1}{125} \log\left(\frac{0.87+2.43}{0.87}\right) = 0.11$
②	$8.25 \times 120 + 7 \times 115 = 1.8$	$3 \times 0.91 = 1.29$	$14 \times \frac{1}{55} \log\left(\frac{1.8+1.29}{1.8}\right) = 0.69$
	$8.25 \times 120 + 21.5 \times 115 = 3.96$	$3 \times 0.2 = 0.6$	$15 \times \frac{1}{55} \log\left(\frac{3.96+.06}{3.96}\right) = 0.29$ / 1.09"

consider 3ft of overexcavation for 12 ft wall

wall ht	overexcavation depth (feet)
6	1
8	1
10	1
12	3
14	5

wall ht $\leq$ 12 feet - shallow footing

wall ht = 14 feet - pile footing

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Project SR-91 WB Widening - Retaining Wall 173 **Project No.** 10-126

By SP **Date** 04-06-11 **Checked By** GJ **Date** 04/04/11 **Sheet** 4 **of** 5

Retaining wall 173 - pile footing

16-inch diameter CIDH pile

Area = $\frac{\pi}{4}(16^2)$ = 201 in^2

$I = \frac{\pi}{64}(16)^4$ = 3217 in^4; $I_{cracked}$ = 1608 in^4

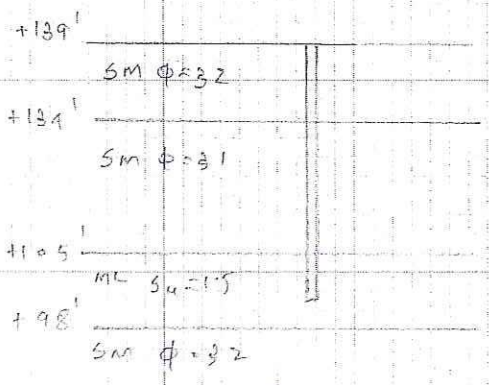
Perimeter = $\pi(16)$ = 50.3 inch = 4.19 ft

$E = 57000\sqrt{3250}$ = 3.2×10^6 kip/in^2

Retaining wall wt = 114 k/ft

footing width = 8 ft

bottom of footing = +139 ft



Nominal resistance

Strength limit state = 112.29/0.7 = 160.4 kips

consider 170 kips

Extreme event limit state = 109.9/1.0 = 109.9 kips

consider 110 kips

Group efficiency factor = 1.0

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Project SR-91 WB widening - Retaining wall 178 **Project No.** 10-126

By SP **Date** 04-06-11 **Checked By** GJ **Date** 04/04/11 **Sheet** 5 **of** 5

from the analysis

Strength limit state

at 22 feet, pile capacity = 175 kips > 170 kips

pile tip elevation for compression = 139 - 22

= 117 feet

Extreme event limit state

at 22 feet, pile capacity = 113 kips > 110 kips

pile tip elevation for compression = 139 - 22

= 117 feet.

Service limit state I

Total load = 13.7 kips per 1 foot of footing length.

$Q = 13.7 \times 8 = 1.7$ kst

for 12 feet long pile

settlement < 1".

Therefore, there is no applicable pile length for settlement.

SKIN FRICTION FOR DRILLED SHAFT IN BOTH COHESIONLESS AND COHESIVE SOILS USING REESE AND O'NEILL'S METHOD (1999)

PROJECT: Retaining Wall 173 — ITEM: 16-inch Diameter CIDH Existing Pile
PROJECT NO.: 10-126 — Wall Height = 14 feet
DONE BY: SP DATE: 04/06/11
CHECKED BY: DATE:

D_s =>	1.33 ft	Hw =>	60.0 ft	Hg =>	0.0 ft	Hw is the depth to water table.
p =	4.19 ft	Ho =>	0.0 ft	Hf =>	0.0 ft	Hg is the depth to ground surface used in calculation.
						Ho is the depth to location starting initial overburden pressure
						Hf is the depth to location starting accumulation of skin frictio
						bottom of footing = 139 ft

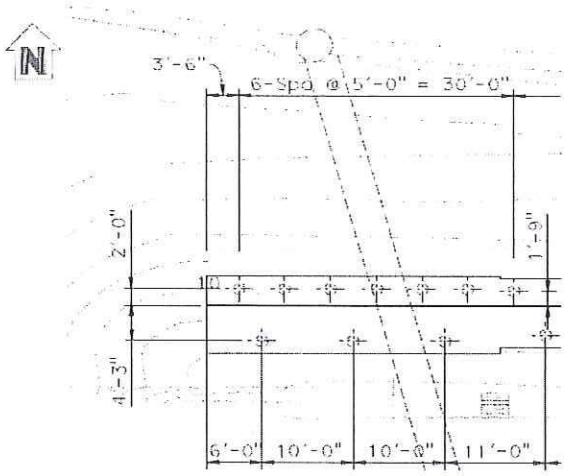
Soil Layer =>	from Top	to Bottom =>	γ (pcf)=>	γ' (pcf)=	c' (ksf) =>	ϕ' =>	
(1)	0	5	120	57.6	0.00	32	SM
(2)	5	34	120	57.6	0.00	31	SM
(3)	34	41	115	52.6	1.50	0	ML
(4)	41	60	120	57.6	0.00	32	SM

Sublayer No.	Depth, z (ft)	z_i (ft)	New Depth (ft)	Soil Unit Weight (pcf)	Overburden Pressure (psf)	c' (ksf)	β	f_i^s (ksf)	ΔQ_s^s (kips)	Q_s^s (kips)	f_i^c (ksf)	ΔQ_s^c (kips)	Q_s^c (kips)	Q_s (kips)
0	0.0	0.0	0.0	120.0	0									
1	0.0	0.0	0.0	120.0	0	0.0				0.0			0.0	0.0
2	1.0	0.5	0.5	120.0	60	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
3	2.0	1.5	1.5	120.0	180	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
4	3.0	2.5	2.5	120.0	300	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
5	4.0	3.5	3.5	120.0	420	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
6	5.0	4.5	4.5	120.0	540	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
7	6.0	5.5	5.5	120.0	660	0.0	1.18	0.78	3.3	3.3	0.00	0.0	0.0	3.3
8	7.0	6.5	6.5	120.0	780	0.0	1.16	0.90	3.8	7.0	0.00	0.0	0.0	7.0
9	8.0	7.5	7.5	120.0	900	0.0	1.13	1.02	4.3	11.3	0.00	0.0	0.0	11.3
10	9.0	8.5	8.5	120.0	1020	0.0	1.11	1.13	4.7	16.0	0.00	0.0	0.0	16.0
11	10.0	9.5	9.5	120.0	1140	0.0	1.08	1.24	5.2	21.2	0.00	0.0	0.0	21.2
12	11.0	10.5	10.5	120.0	1260	0.0	1.06	1.34	5.6	26.8	0.00	0.0	0.0	26.8
13	12.0	11.5	11.5	120.0	1380	0.0	1.04	1.44	6.0	32.8	0.00	0.0	0.0	32.8
14	13.0	12.5	12.5	120.0	1500	0.0	1.02	1.53	6.4	39.3	0.00	0.0	0.0	39.3
15	14.0	13.5	13.5	120.0	1620	0.0	1.00	1.63	6.8	46.1	0.00	0.0	0.0	46.1
16	15.0	14.5	14.5	120.0	1740	0.0	0.99	1.72	7.2	53.3	0.00	0.0	0.0	53.3
17	16.0	15.5	15.5	120.0	1860	0.0	0.97	1.80	7.5	60.8	0.00	0.0	0.0	60.8
18	17.0	16.5	16.5	120.0	1980	0.0	0.95	1.88	7.9	68.7	0.00	0.0	0.0	68.7
19	18.0	17.5	17.5	120.0	2100	0.0	0.94	1.96	8.2	76.9	0.00	0.0	0.0	76.9
20	19.0	18.5	18.5	120.0	2220	0.0	0.92	2.04	8.5	85.5	0.00	0.0	0.0	85.5
21	20.0	19.5	19.5	120.0	2340	0.0	0.90	2.12	8.9	94.3	0.00	0.0	0.0	94.3
22	21.0	20.5	20.5	120.0	2460	0.0	0.89	2.19	9.2	103.5	0.00	0.0	0.0	103.5
23	22.0	21.5	21.5	120.0	2580	0.0	0.87	2.25	9.4	112.9	0.00	0.0	0.0	112.9
24	23.0	22.5	22.5	120.0	2700	0.0	0.86	2.32	9.7	122.7	0.00	0.0	0.0	122.7
25	24.0	23.5	23.5	120.0	2820	0.0	0.85	2.38	10.0	132.7	0.00	0.0	0.0	132.7
26	25.0	24.5	24.5	120.0	2940	0.0	0.83	2.45	10.2	142.9	0.00	0.0	0.0	142.9
27	26.0	25.5	25.5	120.0	3060	0.0	0.82	2.50	10.5	153.4	0.00	0.0	0.0	153.4
28	27.0	26.5	26.5	120.0	3180	0.0	0.81	2.56	10.7	164.1	0.00	0.0	0.0	164.1
29	28.0	27.5	27.5	120.0	3300	0.0	0.79	2.61	10.9	175.1	0.00	0.0	0.0	175.1
30	29.0	28.5	28.5	120.0	3420	0.0	0.78	2.67	11.2	186.2	0.00	0.0	0.0	186.2
31	30.0	29.5	29.5	120.0	3540	0.0	0.77	2.71	11.4	197.6	0.00	0.0	0.0	197.6
32	31.0	30.5	30.5	120.0	3660	0.0	0.75	2.76	11.6	209.2	0.00	0.0	0.0	209.2
33	32.0	31.5	31.5	120.0	3780	0.0	0.74	2.81	11.8	220.9	0.00	0.0	0.0	220.9
34	33.0	32.5	32.5	120.0	3900	0.0	0.73	2.85	11.9	232.8	0.00	0.0	0.0	232.8
35	34.0	33.5	33.5	120.0	4020	0.0	0.72	2.89	12.1	244.9	0.00	0.0	0.0	244.9
36	35.0	34.5	34.5	115.0	4135	1.5	0.71	0.00	0.0	244.9	0.83	3.5	3.5	248.4
37	36.0	35.5	35.5	115.0	4250	1.5	0.70	0.00	0.0	244.9	0.83	3.5	6.9	251.9
38	37.0	36.5	36.5	115.0	4365	1.5	0.68	0.00	0.0	244.9	0.83	3.5	10.4	255.3
39	38.0	37.5	37.5	115.0	4480	1.5	0.67	0.00	0.0	244.9	0.83	3.5	13.8	258.8
40	39.0	38.5	38.5	115.0	4595	1.5	0.66	0.00	0.0	244.9	0.83	3.5	17.3	262.2
41	40.0	39.5	39.5	115.0	4710	1.5	0.65	0.00	0.0	244.9	0.83	3.5	20.7	265.7
42	41.0	40.5	40.5	115.0	4825	1.5	0.64	0.00	0.0	244.9	0.83	3.5	24.2	269.1

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering
17800 Newhope Street, Suite B, Fountain Valley, CA 92708
phone: (714)751-3826, Fax (714)751-3928

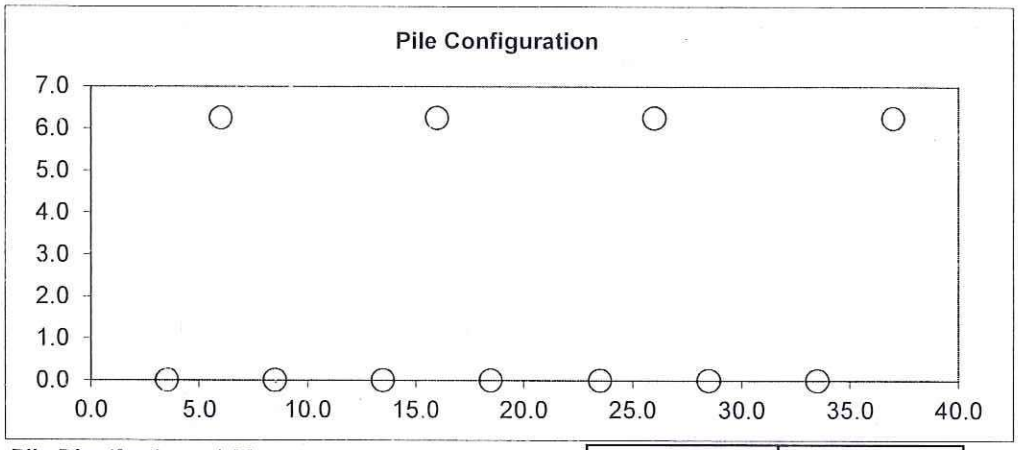
Project: **RW 173** Project No. **10-126**
By SP Date 03/04/11 Check by Date Sheet

Proposed RW 173 Pile Layout



Calculation of Pile Group Efficiency for Lateral Load Capacity

(using formula in Group 7.0 Technical Manual)



Pile Dia. (feet): 1.33
No. of Piles: 11

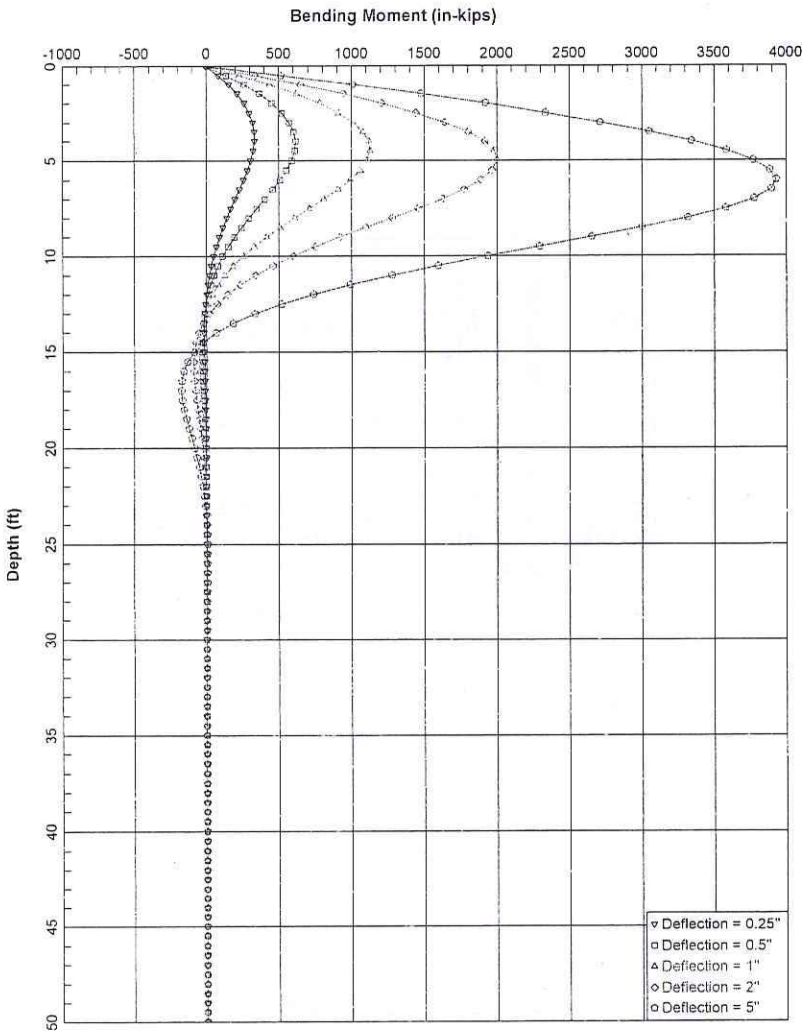
	X-Dir	Y-Dir
Group Efficiency	0.873	0.942

Use **0.88**

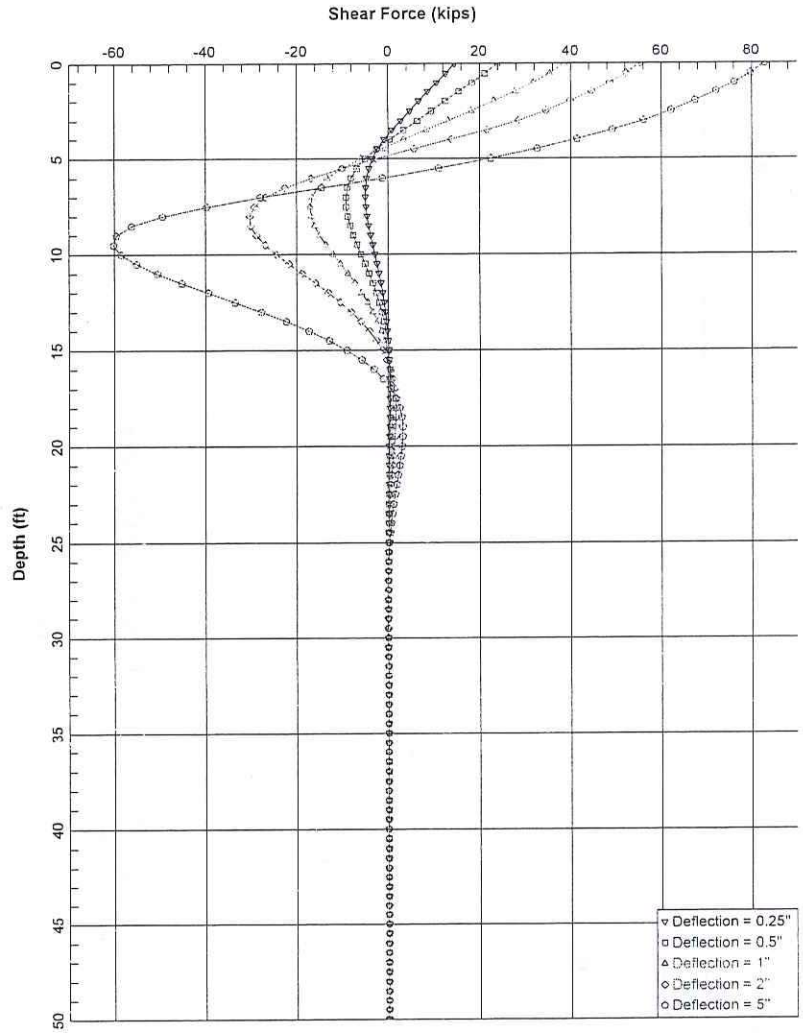
Coordinates

Pile No.	X	Y
1	3.5	0.0
2	8.5	0.0
3	13.5	0.0
4	18.5	0.0
5	23.5	0.0
6	28.5	0.0
7	33.5	0.0
8	6.0	6.3
9	16.0	6.3
10	26.0	6.3
11	37.0	6.3

Reduction Factors in X-dir	Reduction Factors in Y-dir
0.782	0.905
0.784	0.905
0.773	0.905
0.784	0.905
0.773	0.905
0.784	0.905
0.967	0.932
0.985	1.000
0.985	1.000
0.985	1.000
1.000	1.000



Retaining Wall 173 16-inch CIDH (Freehead)



Retaining Wall 173 16-inch CIDH (Freehead)

```
================================================================================

                LPile Plus for Windows, Version 6.0 (6.0.09)

              Analysis of Individual Piles and Drilled Shafts
            Subjected to Lateral Loading Using the p-y Method

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                        All Rights Reserved

================================================================================

This program is licensed to:

Earth Mechanics, Inc.
Earth Mechanics, Inc.

--------------------------------------------------------------------------------
                            Files Used for Analysis
--------------------------------------------------------------------------------

Path to file locations:      X:\Projects\2010\10-126 - RBF SR 91 Westbound Widening\Reports\Foundation Report\07 Retaining Walls\Analysis\RW No. 173\03 Lateral Capacity\
Name of input data file:     Retaining Wall 173 16-inch CIDH (Freehead).lp6d
Name of output file:         Retaining Wall 173 16-inch CIDH (Freehead).lp6o
Name of plot output file:    Retaining Wall 173 16-inch CIDH (Freehead).lp6p
Name of runtime file:        Retaining Wall 173 16-inch CIDH (Freehead).lp6r

--------------------------------------------------------------------------------
                          Date and Time of Analysis
--------------------------------------------------------------------------------

               Date:  April 6, 2011     Time:  11:00:35

--------------------------------------------------------------------------------
                               Problem Title
--------------------------------------------------------------------------------

Project Name:

Job Number:

Client:

Engineer:

Description:

--------------------------------------------------------------------------------
                             Program Options
--------------------------------------------------------------------------------

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
  Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum
  bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:
- Number of pile increments                          =         100
- Maximum number of iterations allowed               =         100
- Deflection tolerance for convergence               =  1.0000E-05  in
- Maximum allowable deflection                       =    100.0000  in
```



```
Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment,
  and maximum shear force are to be written to output report file.

--------------------------------------------------------------------------------
                        Pile Structural Properties and Geometry
--------------------------------------------------------------------------------

Total Number of Sections                                =         1

Total Pile Length                                       =      50.00 ft

Depth of ground surface below top of pile               =      -4.00 ft

Slope angle of ground surface                           =       0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over
the length of the pile.

Point        Depth            Pile
              X            Diameter
              ft              in
-----      ----------      ----------
  1         0.00000        16.0000000
  2        50.000000       16.0000000


Input Structural Properties:
----------------------------

Section No. 1:

   Section Type                                         =    Elastic Pile
   Cross-sectional Shape                                =        Circular
   Section Length                                       =        50.000 in
   Top Width                                            =        16.000 in
   Bottom Width                                         =        16.000 in
   Top Area                                             =    201.000000 sq. in
   Bottom Area                                          =    201.000000 sq. in
   Moment of Inertia at Top                             =      1.608E+03 in4
   Moment of Inertia at Bottom                          =      1.608E+03 in4
   Elastic Modulus                                      =   3200000.000 lbs/in


--------------------------------------------------------------------------------
                        Ground Slope and Pile Batter Angles
--------------------------------------------------------------------------------

Ground Slope Angle                                      =       0.000 degrees
                                                        =       0.000 radians

Pile Batter Angle                                       =       0.000 degrees
                                                        =       0.000 radians


--------------------------------------------------------------------------------
                        Soil and Rock Layering Information
--------------------------------------------------------------------------------

The soil profile is modelled using 4 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer               =      -4.000 ft
Distance from top of pile to bottom of layer            =       5.000 ft
p-y subgrade modulus k for top of soil layer            =      55.000 lbs/in**3
p-y subgrade modulus k for bottom of layer              =      55.000 lbs/in**3

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer               =       5.000 ft
Distance from top of pile to bottom of layer            =      34.000 ft
p-y subgrade modulus k for top of soil layer            =      50.000 lbs/in**3
p-y subgrade modulus k for bottom of layer              =      50.000 lbs/in**3
```

Layer 3 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 34.000 ft
Distance from top of pile to bottom of layer = 41.000 ft

Layer 4 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 41.000 ft
Distance from top of pile to bottom of layer = 60.000 ft
p-y subgrade modulus k for top of soil layer = 55.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 55.000 lbs/in**3

(Depth of lowest layer extends 10.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 8 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	-4.00	120.00000
2	5.00	120.00000
3	5.00	115.00000
4	34.00	115.00000
5	34.00	115.00000
6	41.00	115.00000
7	41.00	120.00000
8	60.00	120.00000

Summary of Soil Properties

Layer Subgr. Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. pci
1	Sand (Reese, et al.)	-4.000	120.000	--	32.000	--	--	--	55.000	--	--	--	--	--
		5.000	120.000	--	32.000	--	--	--	55.000	--	--	--	--	--
2	Sand (Reese, et al.)	5.000	115.000	--	31.000	--	--	--	50.000	--	--	--	--	--
		34.000	115.000	--	31.000	--	--	--	50.000	--	--	--	--	--
3	Soft Clay	34.000	115.000	1500.000	--	--	--	0.00500	--	--	--	--	--	--
		41.000	115.000	1500.000	--	--	--	0.00500	--	--	--	--	--	--
4	Sand (Reese, et al.)	41.000	120.000	--	32.000	--	--	--	55.000	--	--	--	--	--
		60.000	120.000	--	32.000	--	--	--	55.000	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.8800	1.0000
2	50.000	0.8800	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	60000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	60000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	60000.000
4	4	y =	2.000 in	M =	0.000 in-lbs	60000.000
5	4	y =	5.000 in	M =	0.000 in-lbs	60000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

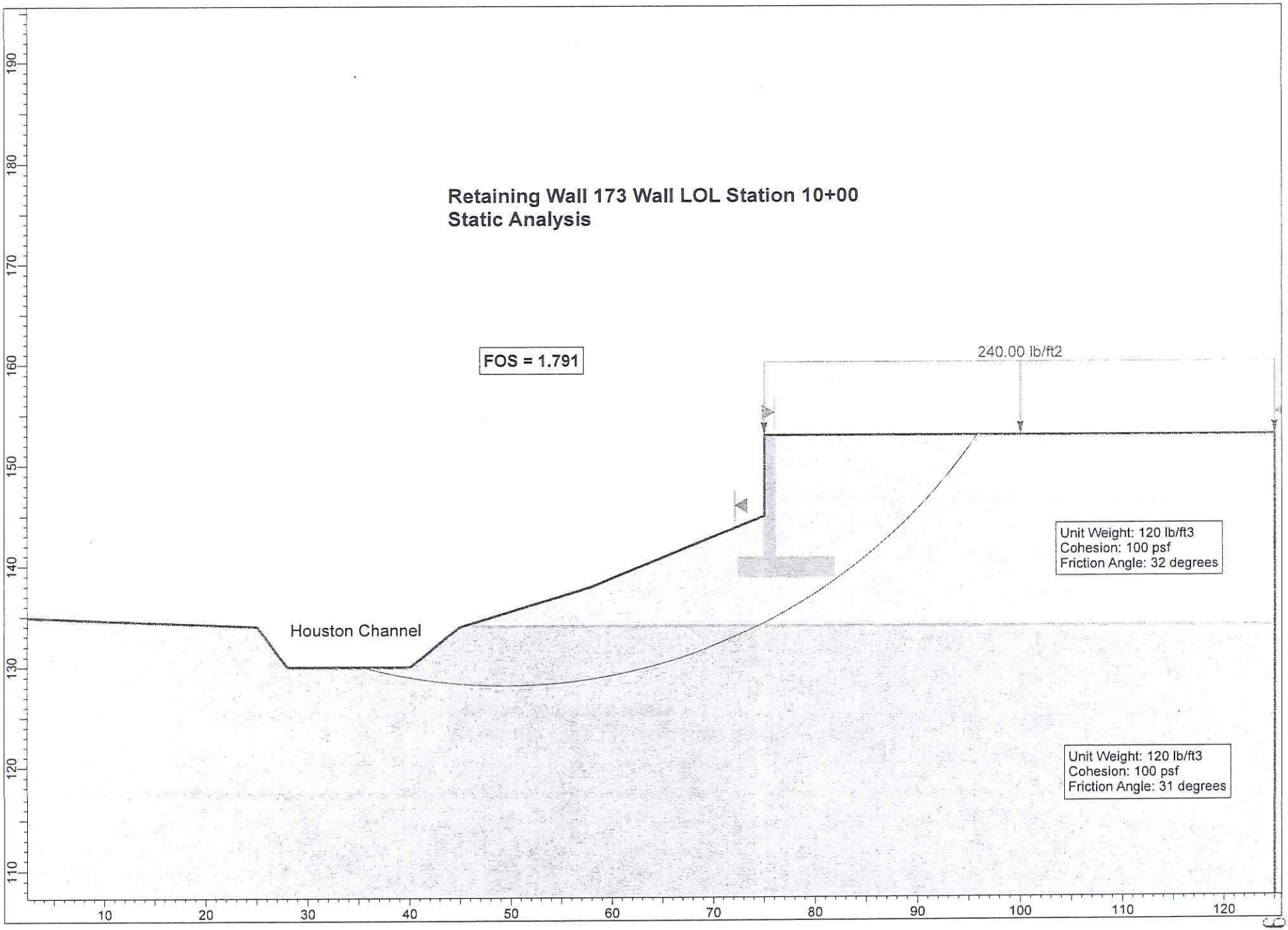
Load Case No.	Load Type No.	Condition 1 y(inches)		Condition 2 in-lb, rad, or in-lb/rad.		Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y =	0.2500	M =	0.000	60000.	0.25000000	332457.	24515.	0.00000000
2	4	y =	0.5000	M =	0.000	60000.	0.50000000	615135.	23907.	0.00000000
3	4	y =	1.0000	M =	0.000	60000.	1.00000000	1127589.	38545.	0.00000000
4	4	y =	2.0000	M =	0.000	60000.	2.00000000	1956728.	55318.	0.00000000
5	4	y =	5.0000	M =	0.000	60000.	5.00000000	3930651.	82888.	0.00000000

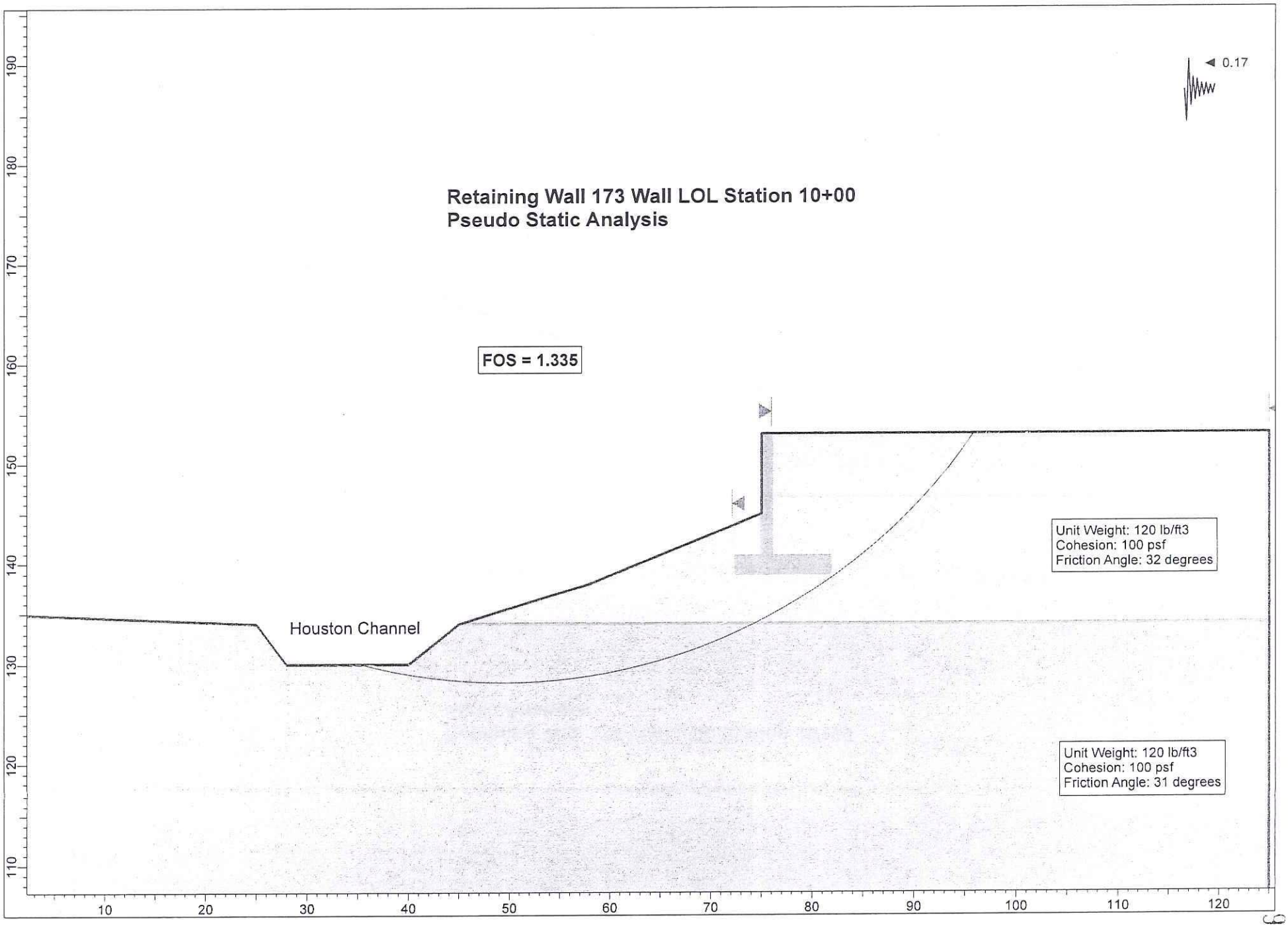
Summary of Warning Messages

The following warning was reported 143 times

**** Warning ****

An unreasonable input value for shear strength has been specified for a soil defined using the soft clay criteria. The input value is greater than 8.66 psi (1,250 psf). You should check your input data for correctness.


Retaining Wall 173 Wall LOL Station 10+00
Static Analysis
FOS = 1.791
240.00 lb/ft2
Unit Weight: 120 lb/ft3
Cohesion: 100 psf
Friction Angle: 32 degrees
Houston Channel
Unit Weight: 120 lb/ft3
Cohesion: 100 psf
Friction Angle: 31 degrees
190
180
170
160
150
140
130
120
110
10
20
30
40
50
60
70
80
90
100
110
120


0.17
Retaining Wall 173 Wall LOL Station 10+00
Pseudo Static Analysis
FOS = 1.335
Unit Weight: 120 lb/ft3
Cohesion: 100 psf
Friction Angle: 32 degrees
Houston Channel
Unit Weight: 120 lb/ft3
Cohesion: 100 psf
Friction Angle: 31 degrees
190
180
170
160
150
140
130
120
110
10
20
30
40
50
60
70
80
90
100
110
120

RETAINING WALL 255

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening - Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/11/11 Checked By: Lino Date: 4-5-11 Sheet: 1 of 1
Subject:

Retaining Wall 255 - Liquefaction Potential Analyses

* Historical high ground water elevation of +125' feet was used. (average surrounding grade elevation of 171.5' = 165 - 40 = 125')
* Analysis was performed using the current two borings (A-10-036 & A-10-039).
* Borings A-10-037 and A-10-038 deepest depths are located above the historical high ground water elevation (+125'). Therefore, liquefaction potential was not performed for these explorations.

⇒ Based on the analyses, liquefaction potential at the site is low

17660 Newhope Street, Suite E, Fountain Valley, CA 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

SR-91 Westbound Widening - RW No. 255 **EMI Project No. 10-126** Version - 12/05

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
^1C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

F_L = CRR r / CSR i

A-10-036

Emean (%)	75		Present Ground El.	168	Borehole Dia. (in)	8	Tot. Unit Wt. (pcf)	43.0	=Design Water Table Depth	51.5	=Field Water Table Depth	Acc. max =	0.520	g						Earthq. M=	7.3
C_E	1.25		Future Ground El.	168	C_B	1.15	120	125	=Design Water El.	116.5	=Field Water El.									Cm=	1.07

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
5	163	9	SC	23.0	0.30	0.30	1.70	0.80	1.20	1.00	1	1	0.99	0.30	0.33	21	27	1.00	0.35	0.37	1.11	AboveWT
10	158	31	SM	25.0	0.60	0.60	1.32	0.85	1.00	0.67	2	2	0.98	0.60	0.33	33	41	1.00	High N	0.00	LARGE	AboveWT
15	153	9	SP-SM	5.0	0.90	0.90	1.08	0.85	1.20	1.00	1	1	0.97	0.90	0.33	14	14	1.00	0.15	0.16	0.50	AboveWT
20	148	41	SP-SM	5.0	1.20	1.20	0.93	0.95	1.00	0.67	2	2	0.95	1.20	0.32	35	35	0.97	High N	0.00	LARGE	AboveWT
25	143	9	SP-SM	5.0	1.50	1.50	0.83	0.95	1.20	1.00	1	1	0.94	1.50	0.32	12	12	0.93	0.13	0.13	0.42	AboveWT
30	138	55	SM	30.0	1.80	1.80	0.76	1.00	1.00	0.67	2	2	0.93	1.80	0.31	40	51	0.89	High N	0.00	LARGE	AboveWT
35	133	15	SM	30.0	2.10	2.10	0.71	1.00	1.20	1.00	1	1	0.89	2.10	0.30	18	26	0.87	0.31	0.29	0.96	AboveWT
40	128	38	SM	30.0	2.40	2.40	0.66	1.00	1.00	0.67	2	2	0.85	2.40	0.29	24	32	0.85	High N	0.00	LARGE	AboveWT
45	123	26	SP-SM	10.0	2.70	2.70	0.62	1.00	1.20	1.00	1	1	0.81	2.64	0.28	28	29	0.83	0.43	0.38	1.36	no
50	118	53	ML/SM	40.0	3.00	3.00	0.59	1.00	1.00	0.67	2	2	0.77	2.78	0.28	30	41	0.82	High N	0.00	LARGE	high N

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
$CRR\ r = CRR_{7.5} \times Cm \times K\ sigma$

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines (Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

$F_L = CRR\ r / CSR\ i$

A-10-039

Design Water Table depth is calculated based on average surrounding grade elevation of 171.5 feet (Metrolink track level)

Emean (%)	75			Present Ground El.	198.4	Borehole Dia. (in)	8	Tot. Unit Wt. (pcf)	73.4	=Design Water Table Depth	101.5	=Field Water Table Depth	Acc. max =	0.520 g				Earthq. M=	7.3		
C_E	1.25			Future Ground El.	198.4	C_B	1.15	120	125	=Design Water El.	96.9	=Field Water El.						Cm=	1.07		

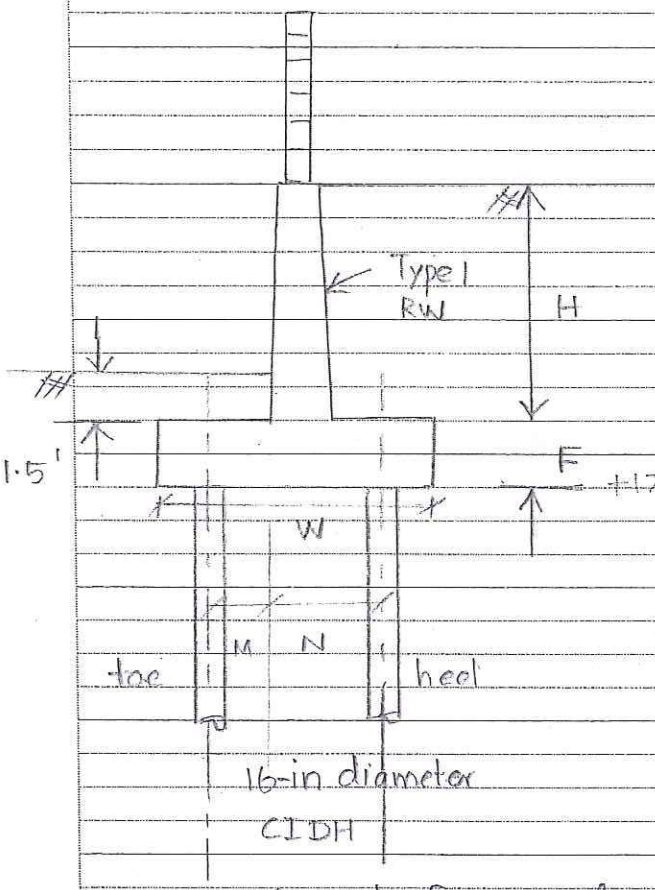
DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
-		-		-	-	-	-				-		-	-	-	-	-	-	-	-	-	-
5	193	64	SM	20.0	0.30	0.30	1.70	0.80	1.00	0.67	2	2	0.99	0.30	0.33	83	94	1.00	High N	0.00	LARGE	AboveWT
10	188	30	SM	15.0	0.60	0.60	1.32	0.85	1.20	1.00	1	1	0.98	0.60	0.33	58	63	1.00	High N	0.00	LARGE	AboveWT
15	183	48	SP-SM/SC	20.0	0.90	0.90	1.08	0.85	1.00	0.67	2	2	0.97	0.90	0.33	42	49	1.00	High N	0.00	LARGE	AboveWT
20	178	10	SM	32.0	1.20	1.20	0.93	0.95	1.20	1.00	1	1	0.95	1.20	0.32	15	23	0.97	0.25	0.26	0.82	AboveWT
25	173	80	SP-SM	10.0	1.50	1.50	0.83	0.95	1.00	0.67	2	2	0.94	1.50	0.32	61	63	0.93	High N	0.00	LARGE	AboveWT
30	168	21	SM/SC	25.0	1.80	1.80	0.76	1.00	1.20	1.00	1	1	0.93	1.80	0.31	28	35	0.89	High N	0.00	LARGE	AboveWT
35	163	37	SP	3.0	2.10	2.10	0.71	1.00	1.00	0.67	2	2	0.89	2.10	0.30	25	25	0.87	0.29	0.27	0.91	AboveWT
40	158	18	SP-SM	5.0	2.40	2.40	0.66	1.00	1.20	1.00	1	1	0.85	2.40	0.29	20	20	0.85	0.22	0.20	0.70	AboveWT
45	153	77	SP-SM	5.0	2.70	2.70	0.62	1.00	1.00	0.67	2	2	0.81	2.70	0.27	46	46	0.82	High N	0.00	LARGE	AboveWT
50	148	23	SP-SM	6.0	3.00	3.00	0.59	1.00	1.20	1.00	1	1	0.77	3.00	0.26	23	24	0.78	0.27	0.22	0.86	AboveWT
55	143	74	SM	15.0	3.30	3.30	0.56	1.00	1.00	0.67	2	2	0.73	3.30	0.25	40	44	0.76	High N	0.00	LARGE	AboveWT
60	138	12	ML	52.0	3.60	3.60	0.54	1.00	1.20	1.00	1	1	0.69	3.60	0.23	11	18	0.75	0.20	0.16	0.68	AboveWT
65	133	58	SM	30.0	3.90	3.90	0.52	1.00	1.00	0.67	2	2	0.64	3.90	0.22	29	38	0.73	High N	0.00	LARGE	AboveWT
70	128	22	MH	85.0	4.20	4.20	0.50	1.00	1.20	1.00	1	1	0.60	4.20	0.20	19	28	0.71	0.36	0.28	1.35	AboveWT
75	123	32	SP	4.0	4.50	4.50	0.48	1.00	1.00	0.67	2	2	0.56	4.45	0.19	15	15	0.70	0.16	0.12	0.61	yes
80	118	36	SP-SM	6.0	4.80	4.80	0.47	1.00	1.20	1.00	1	1	0.55	4.59	0.19	29	29	0.69	0.42	0.31	1.59	no
85	113	98	SP-SM	6.0	5.10	5.10	0.45	1.00	1.00	0.67	2	2	0.54	4.74	0.20	42	43	0.68	High N	0.00	LARGE	high N
90	108	45	SP-SM	6.0	5.40	5.40	0.44	1.00	1.20	1.00	1	1	0.52	4.88	0.20	34	34	0.68	High N	0.00	LARGE	high N
95	103	59	SM/SP-SM	5.0	5.70	5.70	0.43	1.00	1.00	0.67	2	2	0.51	5.03	0.20	24	24	0.67	0.28	0.20	1.01	no
100	98.4	69	SP-SM	5.0	6.00	6.00	0.42	0.95	1.20	1.00	1	1	0.50	5.17	0.20	47	47	0.67	High N	0.00	LARGE	high N

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening - Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-5-11 Sheet: 1 of 3
Subject:

RW No. 255 - Axial pile Calculations (using SHAFT 6.0)

For 16-ft,



M = 1.42'
N = 4.58'
M+N = 6' = 4.5ϕ
⇒ η = 1.0

Toe pile spacing = 5' = 3.75ϕ
⇒ η = 0.94

Heel pile spacing = 10' = 7.5ϕ
⇒ η = 1.0

Select toe pile for axial analyses,

Under strength limit,

maximum load per pile = 109.16 kips ≈ 110 kips
= 55 tons

Apply ϕ = 0.7 & η = 0.94,

nominal resistance = $\frac{55}{0.7 \times 0.94}$ = 84 tons

SELECT 90 tons //

From SHAFT,

Required pile tip El. = +177' - 29' = +148' //

17660 Newhope Street, Suite E, Fountain Valley, CA 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening – Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-5-11 Sheet: 2 of 3
Subject:

Under extreme limit

maximum load per toe pile = 109.58 kips ≈ 110 kips
= 55 tons

Apply $\phi = 1.0$ & $\eta = 0.94$,

nominal resistance = $\frac{55}{1 \times 0.94}$ = 58.5 tons

SELECT 60 tons //

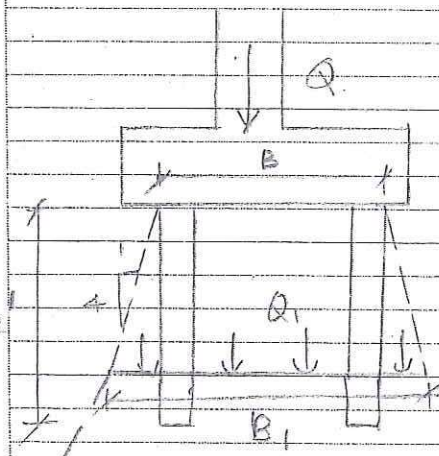
From SHAFT,

Required pile tip El = +177' − 23' = +154' //

Settlement check

Service load = 20 kip/ft (Q)

Permissible settlement under service load = 1"



$B = M + N + 1.33' = 7.33'$

$L = 1'$

$\Rightarrow B_1 = 7.33' + 4' = 11.33'$

$L_1 = 1' + 4' = 5'$

$N_1 = 25$, $C' = 67$

$N_2 = 26$, $C' = 69$

$N_3 = 20$, $C' = 50$

$\Delta H_i = \frac{H_i}{C'} \log\left(\frac{\bar{\sigma}_o' + \Delta\sigma_v'}{\bar{\sigma}_o'}\right)$

Layer	H (ft)	C'	$\bar{\sigma}_o'$ (ksf)	$\Delta\sigma_v'$ (ksf)	ΔH_i
Sand	30	67	2.76	0.04	0.04
Sand	15	69	5.46	0.01	0.01
Clay	10	50	6.96	0.008	0.005

$\Rightarrow$ No design tip for settlement //

$\sum \Delta H_i = 0.06$"

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Project: SR-91 WB Widening – Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-5-11 Sheet: 3 of 3
Subject:

H (ft)	BOF (ft)	Required Q_s (tons)		Required pile tip El. (ft)	
		Strength	Extreme	Strength	Extreme
16	+177.67	90	60	+148'	+154'
	+179.67	90	60	+150'	+156'
14	+177.67	90	60	+148'	+154'

Design pile tip for lateral load

Based on LPILE analyses,
25-ft depth was selected for design tip

∴ Design tip El. = +177' - 25'
= +152' //

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VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
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SR-91 WB Widening Project - RW No. 255 (H=16 ft)

TOTAL LOAD = 150.0 TONS

NUMBER OF LAYERS = 5

WATER TABLE DEPTH = 52.7 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00

SOIL INFORMATION

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.100E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.750E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.770E+01

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.113E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.770E+01

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.671E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.377E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.671E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.330E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.377E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.520E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.330E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.527E+02

LAYER NO 4----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.200E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.527E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.200E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.627E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.431E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.627E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.100E+03

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	= 1.333	FT.
DIAMETER OF BASE	= 1.333	FT.
END OF STEM TO BASE	= 0.000	FT.
ANGLE OF BELL	= 0.000	DEG.
IGNORED TOP PORTION	= 0.000	FT.
IGNORED BOTTOM PORTION	= 0.000	FT.
AREA OF ONE PERCENT STEEL	= 2.010	SQ.IN.
ELASTIC MODULUS, Ec	= 0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	= 0.000	CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
1.0	0.05	0.23	1.88	2.11	2.11	2.11	40.88
2.0	0.10	0.67	2.51	3.18	3.18	3.18	30.76
3.0	0.16	1.30	3.14	4.44	4.44	4.44	28.66
4.0	0.21	2.13	3.77	5.90	5.90	5.90	28.52
5.0	0.26	3.13	4.40	7.53	7.53	7.53	29.13
6.0	0.31	4.31	5.03	9.33	9.33	9.33	30.09
7.0	0.36	5.65	5.03	10.67	10.67	10.67	29.50
8.0	0.41	7.15	5.59	12.73	12.73	12.73	30.78
9.0	0.47	9.62	6.14	15.77	15.77	15.77	33.89
10.0	0.52	12.32	6.70	19.02	19.02	19.02	36.80
11.0	0.57	15.23	7.26	22.49	22.49	22.49	39.55
12.0	0.62	18.34	7.44	25.79	25.79	25.79	41.57
13.0	0.67	21.65	7.44	29.10	29.10	29.10	43.30
14.0	0.72	25.15	7.44	32.60	32.60	32.60	45.04
15.0	0.78	28.83	7.44	36.28	36.28	36.28	46.79
16.0	0.83	32.69	7.44	40.14	40.14	40.14	48.53
17.0	0.88	36.72	7.44	44.17	44.17	44.17	50.26
18.0	0.93	40.92	7.44	48.36	48.36	48.36	51.98
19.0	0.98	45.27	7.44	52.72	52.72	52.72	53.67
20.0	1.03	49.78	7.44	57.22	57.22	57.22	55.35
21.0	1.09	54.43	7.44	61.87	61.87	61.87	56.99
22.0	1.14	59.22	7.44	66.66	66.66	66.66	58.62
23.0	1.19	64.15	7.44	71.59	71.59	71.59	60.21
24.0	1.24	69.20	7.44	76.65	76.65	76.65	61.78
25.0	1.29	74.39	7.44	81.83	81.83	81.83	63.32
26.0	1.34	79.69	7.44	87.14	87.14	87.14	64.83
27.0	1.40	85.11	7.44	92.55	92.55	92.55	66.31
28.0	1.45	90.64	7.44	98.08	98.08	98.08	67.76
29.0	1.50	96.27	7.44	103.71	103.71	103.71	69.18
30.0	1.55	102.00	7.44	109.45	109.45	109.45	70.57
31.0	1.60	107.83	7.44	115.28	115.28	115.28	71.94
32.0	1.65	113.75	7.44	121.20	121.20	121.20	73.27
33.0	1.71	119.76	7.44	127.21	127.21	127.21	74.57
34.0	1.76	125.85	7.44	133.30	133.30	133.30	75.84
35.0	1.81	132.02	7.44	139.47	139.47	139.47	77.08
36.0	1.86	138.26	7.44	145.71	145.71	145.71	78.30
37.0	1.91	144.58	11.17	155.74	155.74	155.74	81.43

Extreme - H = 16 ft.

Strength - H = 16 ft

Required Q_s = 90 tons

@ 28' depth, Q_s = 90.6 ton

⇒ Conservatively, 29-feet depth was selected (i.e Q_s = 96 tons)

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.4566E-01	0.4110E-04	0.2443E-03	0.1000E-04
0.2283E+00	0.2055E-03	0.1222E-02	0.5000E-04

0.4566E+00	0.4110E-03	0.2443E-02	0.1000E-03
0.2325E+02	0.2077E-01	0.1222E+00	0.5000E-02
0.3436E+02	0.3106E-01	0.1833E+00	0.7500E-02
0.4460E+02	0.4098E-01	0.2443E+00	0.1000E-01
0.8521E+02	0.8794E-01	0.6109E+00	0.2500E-01
0.1137E+03	0.1374E+00	0.1222E+01	0.5000E-01
0.1270E+03	0.1742E+00	0.1833E+01	0.7500E-01
0.1339E+03	0.2059E+00	0.2429E+01	0.1000E+00
0.1404E+03	0.3630E+00	0.5525E+01	0.2500E+00
0.1430E+03	0.6163E+00	0.8363E+01	0.5000E+00
0.1442E+03	0.7428E+00	0.9672E+01	0.6250E+00
0.1455E+03	0.9007E+00	0.1116E+02	0.7813E+00
0.1456E+03	0.9195E+00	0.1133E+02	0.7998E+00

RESULT FROM UPPER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.7015E-01	0.5584E-04	0.3491E-03	0.1000E-04
0.3507E+00	0.2792E-03	0.1745E-02	0.5000E-04
0.7015E+00	0.5584E-03	0.3491E-02	0.1000E-03
0.3561E+02	0.2834E-01	0.1745E+00	0.5000E-02
0.5155E+02	0.4195E-01	0.2618E+00	0.7500E-02
0.6543E+02	0.5469E-01	0.3491E+00	0.1000E-01
0.1120E+03	0.1087E+00	0.8727E+00	0.2500E-01
0.1350E+03	0.1557E+00	0.1745E+01	0.5000E-01
0.1415E+03	0.1872E+00	0.2618E+01	0.7500E-01
0.1440E+03	0.2149E+00	0.3435E+01	0.1000E+00
0.1481E+03	0.3699E+00	0.7545E+01	0.2500E+00
0.1501E+03	0.6224E+00	0.9549E+01	0.5000E+00
0.1511E+03	0.7486E+00	0.1060E+02	0.6250E+00
0.1524E+03	0.9065E+00	0.1191E+02	0.7813E+00
0.1526E+03	0.9252E+00	0.1206E+02	0.7998E+00

RESULT FROM LOWER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.2603E-01	0.2855E-04	0.1396E-03	0.1000E-04
0.1301E+00	0.1427E-03	0.6981E-03	0.5000E-04
0.2603E+00	0.2855E-03	0.1396E-02	0.1000E-03
0.1315E+02	0.1434E-01	0.6981E-01	0.5000E-02
0.1973E+02	0.2153E-01	0.1047E+00	0.7500E-02
0.2610E+02	0.2867E-01	0.1396E+00	0.1000E-01
0.5696E+02	0.6682E-01	0.3491E+00	0.2500E-01
0.9005E+02	0.1179E+00	0.6981E+00	0.5000E-01
0.1114E+03	0.1606E+00	0.1047E+01	0.7500E-01
0.1235E+03	0.1966E+00	0.1424E+01	0.1000E+00
0.1328E+03	0.3561E+00	0.3505E+01	0.2500E+00
0.1359E+03	0.6102E+00	0.7177E+01	0.5000E+00
0.1372E+03	0.7369E+00	0.8747E+01	0.6250E+00
0.1385E+03	0.8949E+00	0.1041E+02	0.7813E+00
0.1387E+03	0.9137E+00	0.1061E+02	0.7998E+00

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening - Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-5-11 Sheet: 1 of 1
Subject:

Lateral Pile Analyses

Area = 201.1 in^2

$I = \pi/4 \times 8^4 = 3{,}220\ in^4$

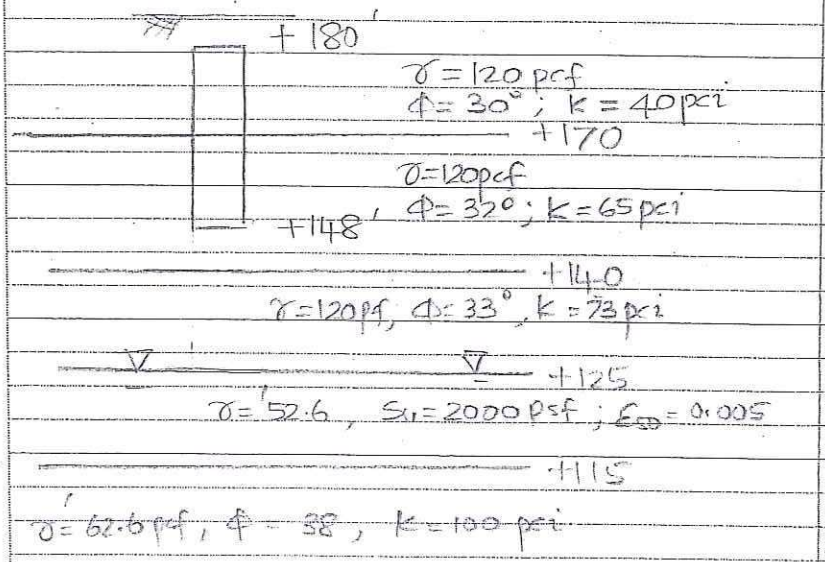
$E = 3.6 \times 10^6$ psi

Use 50% EI & Free head conditions.

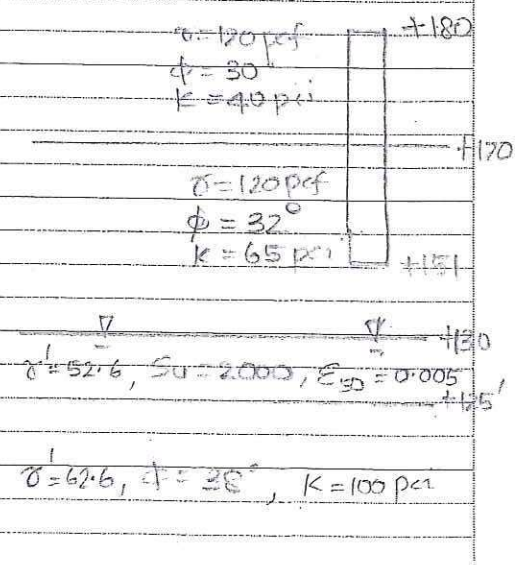
δ = 0.25", 0.5", 1", 2" and 5"

Group reduction factor = 0.88

RW No. 255



RW No. 293



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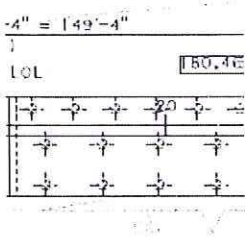
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
phone: (714)751-3826, Fax (714)751-3928

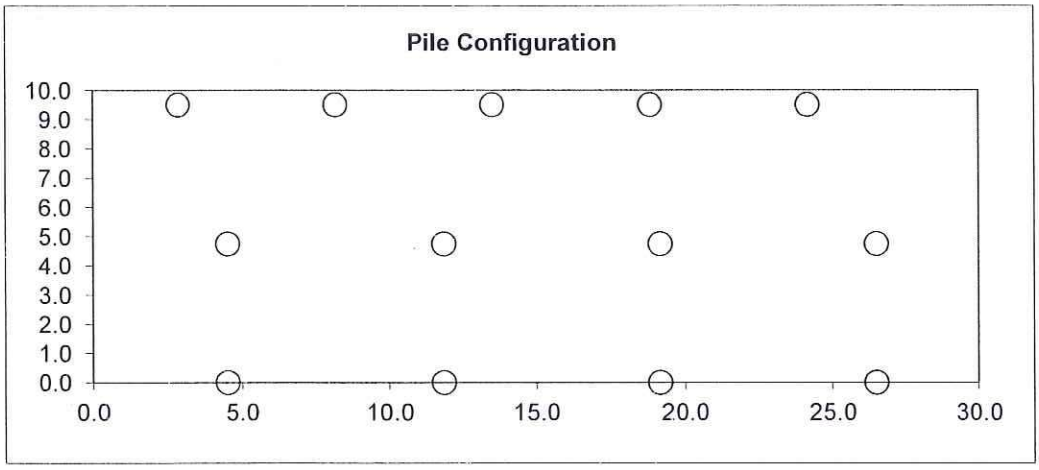
Project: **RW 255** Project No. **10-126**
By SP Date 05/20/11 Check by Date Sheet

Proposed RW 293 Pile Layout



Calculation of Pile Group Efficiency for Lateral Load Capacity

(using formula in Group 7.0 Technical Manual)



Pile Dia. (feet): 1.33
No. of Piles: 13

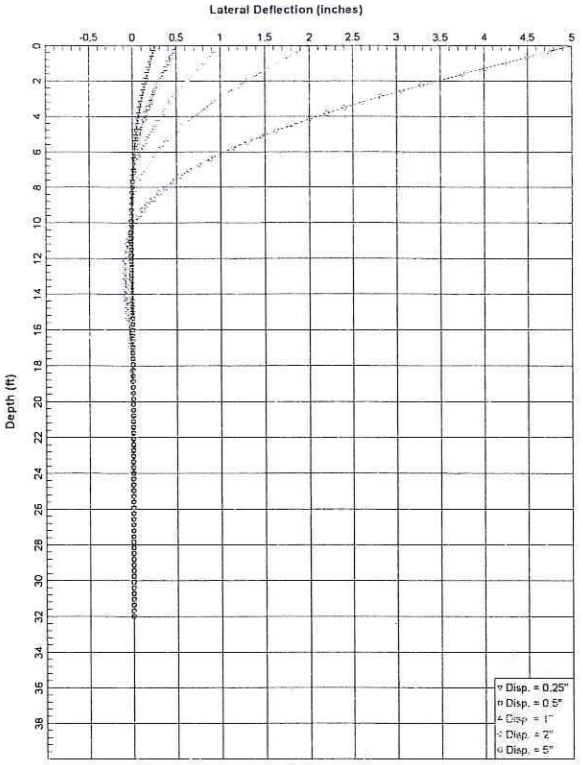
	X-Dir	Y-Dir
Group Efficiency	0.893	0.760

Use **0.88**

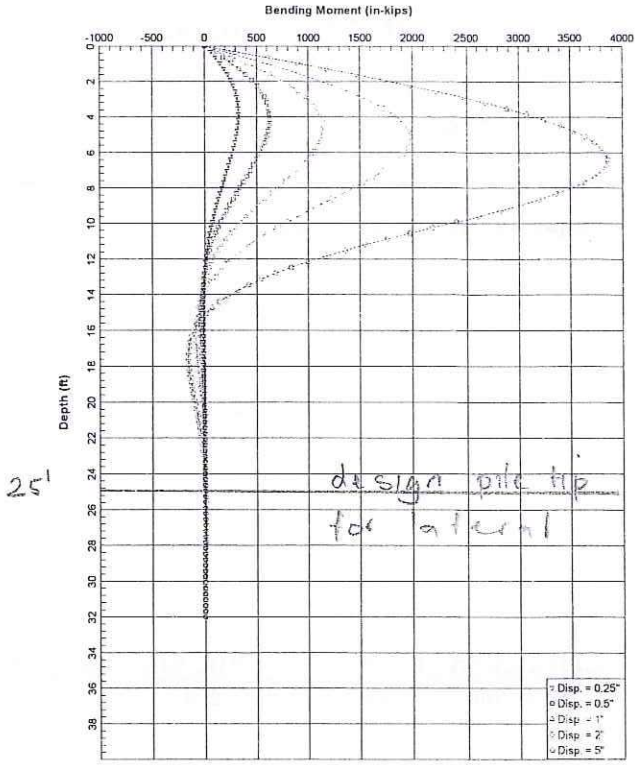
Coordinates

Pile No.	X	Y
1	4.5	0.0
2	11.8	0.0
3	19.2	0.0
4	26.5	0.0
5	4.5	4.8
6	11.8	4.8
7	19.2	4.8
8	26.5	4.8
9	2.8	9.5
10	8.2	9.5
11	13.5	9.5
12	18.8	9.5
13	24.2	9.5

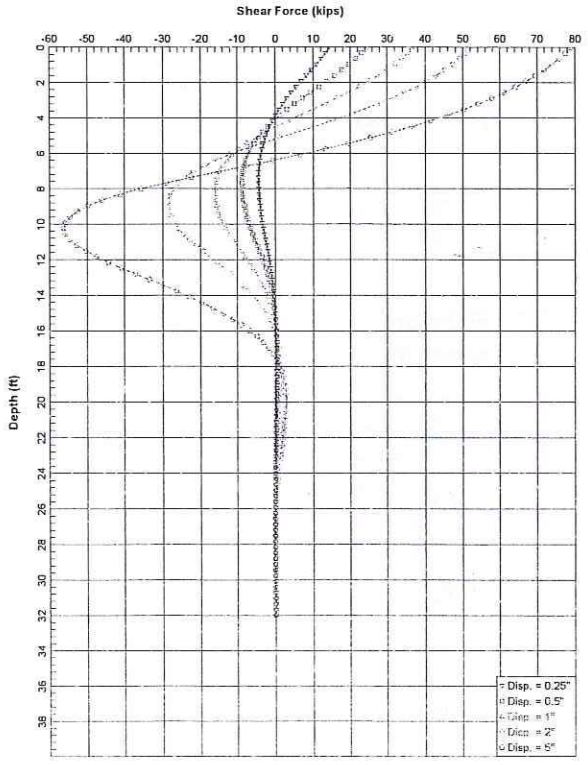
Reduction Factors in X-dir	Reduction Factors in Y-dir
0.892	0.773
0.892	0.769
0.892	0.769
0.986	0.773
0.844	0.726
0.855	0.719
0.833	0.700
0.986	0.827
0.796	0.990
0.770	1.000
0.775	0.990
0.797	0.975
0.966	1.000



RW No. 255 - 16-in CIDH Pile - Free



RW No. 255 - 16-in CIDH Pile - Free



RW No. 255 - 16-in CIDH Pile - Free

```
================================================================================

                LPile Plus for Windows, Version 6.0 (6.0.09)

              Analysis of Individual Piles and Drilled Shafts
            Subjected to Lateral Loading Using the p-y Method

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                           All Rights Reserved

================================================================================

This program is licensed to:

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--------------------------------------------------------------------------------
                            Files Used for Analysis
--------------------------------------------------------------------------------

Path to file locations:      X:\Projects\2010\10-126 - RBF, SR 91 Westbound Widening\Reports\Foundation Report\07 Retaining Walls\Analysis\RW No. 255\LPILE\
Name of input data file:     16-inch CIDH pile.lp6d
Name of output file:         16-inch CIDH pile.lp6o
Name of plot output file:    16-inch CIDH pile.lp6p
Name of runtime file:        16-inch CIDH pile.lp6r

--------------------------------------------------------------------------------
                            Date and Time of Analysis
--------------------------------------------------------------------------------

               Date:  November 17, 2011     Time:   9:38:49

--------------------------------------------------------------------------------
                                  Problem Title
--------------------------------------------------------------------------------

Project Name: SR-91 WB Widening
Job Number: 10-126
Client:
Engineer: GJG
Description: 16-inch CIDH at RW No. 255


--------------------------------------------------------------------------------
                                Program Options
--------------------------------------------------------------------------------

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
  Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum
  bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:
- Number of pile increments                    =          100
- Maximum number of iterations allowed         =          300
- Deflection tolerance for convergence         =  1.0000E-05  in
- Maximum allowable deflection                 =    100.0000  in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment,
  and maximum shear force are to be written to output report file.

--------------------------------------------------------------------------------
                      Pile Structural Properties and Geometry
--------------------------------------------------------------------------------

Total Number of Sections                      =          1

Total Pile Length                             =      32.00 ft

Depth of ground surface below top of pile     =      -4.00 ft
```

Slope angle of ground surface = 0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over
the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	16.0000000
2	32.000000	16.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	32.000 in
Top Width	=	16.000 in
Bottom Width	=	16.000 in
Top Area	=	201.061930 sq. in
Bottom Area	=	201.061930 sq. in
Moment of Inertia at Top	=	3.217E+03 inA4
Moment of Inertia at Bottom	=	3.217E+03 inA4
Elastic Modulus	=	1800000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 5 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = -4.000 ft
Distance from top of pile to bottom of layer = 10.000 ft
p-y subgrade modulus k for top of soil layer = 40.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 40.000 lbs/in**3

Layer 2 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 10.000 ft
Distance from top of pile to bottom of layer = 40.000 ft
p-y subgrade modulus k for top of soil layer = 65.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 65.000 lbs/in**3

Layer 3 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 40.000 ft
Distance from top of pile to bottom of layer = 55.000 ft
p-y subgrade modulus k for top of soil layer = 73.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 73.000 lbs/in**3

Layer 4 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 55.000 ft
Distance from top of pile to bottom of layer = 65.000 ft

Layer 5 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 65.000 ft
Distance from top of pile to bottom of layer = 100.000 ft
p-y subgrade modulus k for top of soil layer = 100.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 100.000 lbs/in**3

(Depth of lowest layer extends 68.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 10 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	-4.00	120.00000
2	10.00	120.00000
3	10.00	120.00000
4	40.00	120.00000
5	40.00	120.00000
6	55.00	120.00000
7	55.00	52.60000
8	65.00	52.60000
9	65.00	62.60000
10	100.00	62.60000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. Subgr. pci
1	API Sand	-4.000	120.000	--	30.000	--	--	--	40.000	--	--	--	--	--
		10.000	120.000	--	30.000	--	--	--	40.000	--	--	--	--	--
2	API Sand	10.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
		40.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
3	API Sand	40.000	120.000	--	33.000	--	--	--	73.000	--	--	--	--	--
		55.000	120.000	--	33.000	--	--	--	73.000	--	--	--	--	--
4	Soft Clay	55.000	52.600	2000.000	--	--	--	0.00500	--	--	--	--	--	--
		65.000	52.600	2000.000	--	--	--	0.00500	--	--	--	--	--	--
5	API Sand	65.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--
		100.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.8800	1.0000
2	32.000	0.8800	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	20000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	20000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	20000.000
4	4	y =	2.000 in	M =	0.000 in-lbs	20000.000
5	4	y =	5.000 in	M =	0.000 in-lbs	20000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

---

Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)	Condition 2 in-lb, rad., or in-lb/rad.	Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y = 0.2500	M = 0.000	20000.	0.25000000	328171.	14590.	0.00000000
2	4	y = 0.5000	M = 0.000	20000.	0.50000000	627244.	24467.	0.00000000
3	4	y = 1.0000	M = 0.000	20000.	1.00000000	1143650.	36918.	0.00000000
4	4	y = 2.0000	M = 0.000	20000.	2.00000000	1982415.	52272.	0.00000000
5	4	y = 5.0000	M = 0.000	20000.	5.00000000	3860941.	78968.	0.00000000

The analysis ended normally.

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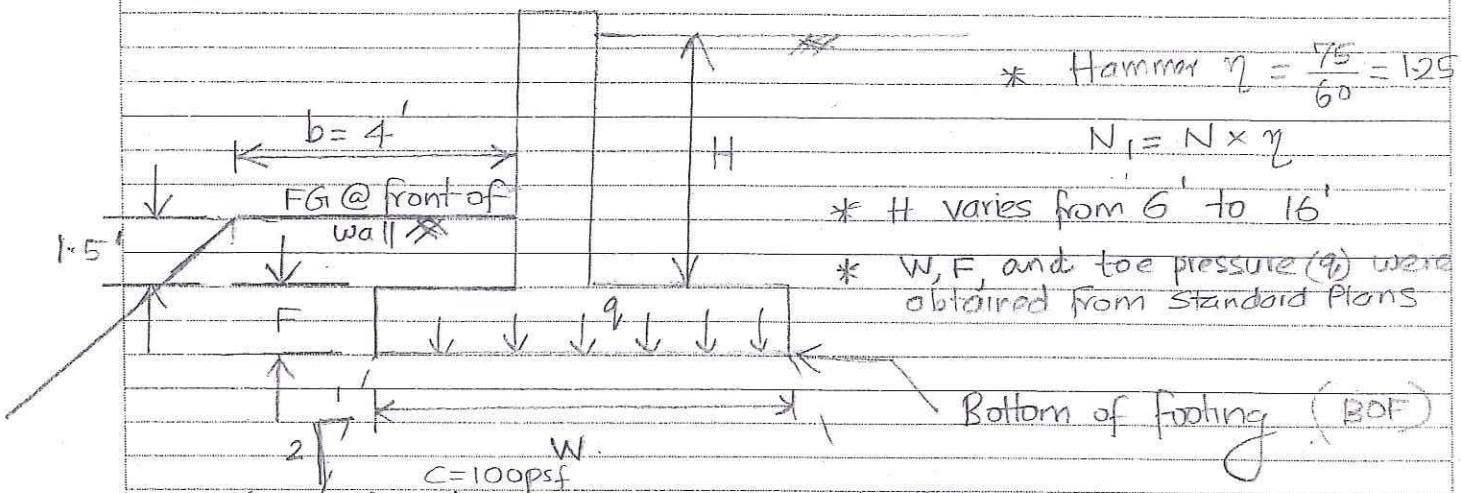
Project: SR-91 WB Widening - Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-5-11 Sheet: 1 of 5
Subject:

Retaining Wall No. 255 - Caltrans Standard Type 1 Wall



* Hammer $\eta = \frac{75}{60} = 1.25$
$N_1 = N \times \eta$
* H varies from 6' to 16'
* W, F, and toe pressure (q) were obtained from Standard Plans

$\gamma = 120$ pcf ; $\phi = 30$; $N_{avg} = 30$; $N_1 = 37$ — +170'

$C = 50$ psf
$\gamma = 120$; $\phi = 32°$; $N_{avg} = 20$; $N_1 = 25$ — +140'

$\gamma = 120$; $\phi = 33$; $N_{avg} = 21$; $N_1 = 26$ — +125'

$\gamma' = 52.6$; $S_u = 2000$ psf ; $N = 16$; $N_1 = 20$ — +115'

$\gamma' = 62.6$; $\phi = 38$; $N_{avg} = 50$

Case I

$H = 6'$
$W = 4.25'$
$F = 1.33'$
Bottom of footing (BOF) $= +163.17'$
Assume minimum fill of 1.5' @ front of wall
$\therefore FG = 163.7' + 1.5' + 1.33' = +166.53' \perp +166.5'$ //
From Standard Plans,
Toe pressure, $q = 1.9$ ksf (loading case 1)
Total settlement $= 0.9$ ft {Using AASHTO $\Delta H = \frac{H}{C'} \log\left(\frac{\sigma_o' + \Delta\sigma_v}{\sigma_o'}\right)$}
$\Rightarrow$ Required Overex $= 1'$

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening – Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-5-11 Sheet: 2 of 5
Subject:

Case II

$H = 8'$; $W = 5.25'$; $F = 1.33$

BOF = +161.7', +177.7', +179.7', +187.7', +189.7'

Assume a min. fill of 1.5' @ front of wall.

∴ FG = +164.5' to +192.5'

Toe pressure, q_v = 2.2 ksf (from Standard plans)

For BOF = +161.7' Total settlement = 1.06"
For remaining BOFs, total settlement < 1"

⇒ Required overex. = 1'

Case III

$H = 10'$; $W = 6.25'$; $F = 1.33$

BOF = +161.7', +163.7', +167.7', +169.7', +171.7', +173.7', +175.7', +177.7', +179.7'

Assume a min fill of 1.5' @ front of wall,

∴ FG = +164.5' to +182.5'

q_v = 2.5 ksf

Based on the analyses,

BOF (ft)	Total Settlement (in)	Required overex (ft)
+161.7	1.24	2
+163.7	1.25	2
+167.7	1.25	2
+169.7	1.26	2
+171.7	1.21	2
+173.7	1.16	2
+175.7	1.13	2
+177.7	1.10	1
+179.7	1.09	1

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Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening - Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-5-11 Sheet: 3 of 5
Subject:

Case IV H = 12'; W = 7.25'; F = 1.33'

BOF = +161.7', +163.7', +179.7', +183.7',

Assume a min. fill of 1.5' @ front of wall

∴ FG = +164.5' to +186.5'

q_v = 2.8 ksf

Based on the analyses,

BOF (ft)	Total Settlement (in)	Required overex (ft)
+161.7	1.42	4
+163.7	1.43	4
+179.7	1.26	3
+183.7	1.23	3

Case V H = 14', W = 8', F = 1.5'

BOF = +177.7'

Assume a min fill of 1.5' @ front of wall

∴ FG = +180.7'

q_v = 3.3 ksf

Total Settlement = 1.5'

Required overex = 6 ft

Case VI H = 16', W = 9', F = 1.5'

BOF = +177.7', +179.7'

FG = +180.7' and +182.7' (Assume a min. fill of 1.5' @ front of wall)

q_v = 3.5 ksf

For BOF = +177.7'
ΔS = 1.64"
overex = 8'

For BOF = +179.7'
ΔS = 1.61"
overex = 8'

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Earth Mechanics, Inc.
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Project: SR-91 WB Widening - Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-5-11 Sheet: 4 of 5
Subject:

RW No. 255 - Bearing Capacity Calculations

For H = 12',

B = 7.25', F = 1.33', q_a = 2.8 ksf (Per Std. Plans)

Select BOF = +161.7'

D = 1.33' + 1.5' = 2.83' //

Assume a minimum horizontal distance of 4-feet between footing and slope face (b)

b/B = 4/7.25 = 0.55 (< 2)

Using AASHTO LRFD Eq^n 10.6.3.1.2a-1,

$$q_u = c N_{cm} + \gamma D N_{qm} + \frac{1}{2}\gamma B N_{\gamma m}$$

Modified factors

$N_{cm} = N_{cq} s_c i_c$; $N_{qm} = N_q s_q i_q d_q$; $N_{\gamma m} = N_{\gamma q} s_\gamma i_\gamma$

load inclination factors, $i_c = i_q = i_\gamma = 1$

Shape factors, $s_c = s_q = s_\gamma = 1$ ($\because B \ll\ll L$)

depth factor, $d_q = 1.2$ for $\phi = 32°$

For footing near slopes; slope height $H_s > B$ & Slope angle $i \approx 26°$

$\therefore N_q = 0$; $N_\gamma = 0$

For b/B = 0.55 & D/B = 0.4 & $\phi = 32°$,

$N_{cq} = 5.6$ & $N_{\gamma q} = 28$ (AASHTO LRFD Figures 10.6.3.1.2c-1&2)

$q_u = (100 \times 5.6) + (\frac{1}{2} \times 120 \times 7.25' \times 27)$

$= 0.56 + 11.745$

$= 12.3$ ksf

$q_{all} = q_u / FOS$

$q_{all} = \frac{12.3}{3} = 4.1$ ksf > toe pressure of 2.8 ksf //

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By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-5-11 Sheet: 5 of 5
Subject:

Based on settlement estimates, q_{all} = 2.8 ksf is recommended provided a minimum 3-foot overex for 12-ft high wall with BOF = +179.7' and +183.7'. and a minimum 4-foot overex for 12-ft high wall with BOF = +161.7' and +163.7' are performed.

RW. No. 255 ALLOWABLE BEARING CAPACITY SUMMARY

H (ft)	B (ft)	BOF (ft)	D (ft)	q_{all} (ksf)		Recommend overex. (ft)
				Calculated	Recommend	
6	4.25	+163.7	2.83	2.07	1.9	1
8	5.25	+161.7	2.83	3.04	2.2	1
8	5.25	+189.7	2.83	2.50	2.2	1
10	6.25	+161.7	2.83	3.34	2.5	2
10	6.25	+179.7	2.83	2.87	2.5	2
12	7.25	+161.7	2.83	4.10	2.8	4
12	7.25	+183.7	2.83	3.23	2.8	3

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Project: **SR-91 WB Widening Project** Project No. **10-126**
By GJG Date 4/1/2011 Check by Lino Date 4-5-11 Sheet

Settlement Calculation for Spread Footing - RW No. 255 (H=6 ft)

Footing Info

Footing Elevation= 163.7 ft = Embedded Depth = 3 ft
Load Width= 4.25 ft
Net Contact Stress = 1.90 ksf => **Gross Contact Stress = 2.3 ksf**

Check Settlement:

Method: AASHTO LRFD Bridge Design Spec - Hough's Method

Layer	Top Elev. (ft)	Bottom Elev. (ft)	Top Depth (ft)	Bottom Depth (ft)	Soil Type	γ' pcf	(N')	c'
1	166.5	140	0	26.5	SM	120	25	67
2	140	125	26.5	41.5	SM	120	26	69
3	125	115	41.5	51.5	ML	52.6	20	50
4	115	95	51.5	71.5	SM	62.6	50	118

Note: 1. C'= Bearing Capacity Index
2. N'= Average Corrected SPT Blowcount

Depth (ft)	Layer Thick. (ft)	Mid Point Depth (ft)	Effec. Unit Weight, γ' kcf	Initial Stress, σ_{vo}' (ksf)	Depth to Equiv. Footing (ft)	Stress Increase, $\Delta\sigma_v'$ (ksf)	Total Stress, σ_{vt} (ksf)	Bearing Capacity Index, C'	ΔS (in)	Total ΔS (in)
0										
3	3	1.5	0.120	0.18	-1.5	0.00	0.18	67	0.00	0.00
4	1	3.5	0.120	0.42	0.5	1.70	2.12	67	0.13	0.13
5	1	4.5	0.120	0.54	1.5	1.40	1.94	67	0.10	0.23
6	1	5.5	0.120	0.66	2.5	1.20	1.86	67	0.08	0.31
7	1	6.5	0.120	0.78	3.5	1.04	1.82	67	0.07	0.37
8	1	7.5	0.120	0.90	4.5	0.92	1.82	67	0.05	0.43
10	2	9	0.120	1.08	6	0.79	1.87	67	0.09	0.51
12	2	11	0.120	1.32	8	0.66	1.98	67	0.06	0.58
14	2	13	0.120	1.56	10	0.57	2.13	67	0.05	0.62
15.5	1.5	14.75	0.120	1.77	11.75	0.50	2.27	67	0.03	0.65
19.5	4	17.5	0.120	2.10	14.5	0.43	2.53	67	0.06	0.71
23.5	4	21.5	0.120	2.58	18.5	0.35	2.93	67	0.04	0.75
26.5	3	25	0.120	3.00	22	0.31	3.31	67	0.02	0.77
30.5	4	28.5	0.120	3.42	25.5	0.27	3.69	69	0.02	0.80
34.5	4	32.5	0.120	3.90	29.5	0.24	4.14	69	0.02	0.81
38.5	4	36.5	0.120	4.38	33.5	0.21	4.59	69	0.01	0.83
41.5	3	40	0.120	4.80	37	0.20	5.00	69	0.01	0.84
45.5	4	43.5	0.053	5.09	40.5	0.18	5.27	50	0.01	0.85
49.5	4	47.5	0.053	5.30	44.5	0.17	5.46	50	0.01	0.87
51.5	2	50.5	0.053	5.45	47.5	0.16	5.61	50	0.01	0.87

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Project: **SR-91 WB Widening Project** Project No. **10-126**
By GJG Date 4/1/2011 Check by Lino Date 4-5-11 Sheet

Settlement Calculation for Spread Footing - RW No. 255 (H=8 ft)

Footing Info

Footing Elevation= 161.7 ft = Embedded Depth = 3 ft
Load Width= 5.25 ft
Net Contact Stress = 2.20 ksf => **Gross Contact Stress = 2.6 ksf**

Check Settlement:

Method: AASHTO LRFD Bridge Design Spec - Hough's Method

Layer	Top Elev. (ft)	Bottom Elev. (ft)	Top Depth (ft)	Bottom Depth (ft)	Soil Type	γ' pcf	(N')	c'
1	164.5	140	0	24.5	SM	120	25	67
2	140	125	24.5	39.5	SM	120	26	69
3	125	115	39.5	49.5	ML	52.6	20	50

Note: 1. C'= Bearing Capacity Index
2. N'= Average Corrected SPT Blowcount

Depth (ft)	Layer Thick. (ft)	Mid Point Depth (ft)	Effec. Unit Weight, γ' kcf	Initial Stress, σ_{vo}' (ksf)	Depth to Equiv. Footing (ft)	Stress Increase, $\Delta\sigma_v'$ (ksf)	Total Stress, σ_{vt} (ksf)	Bearing Capacity Index, C'	ΔS (in)	Total ΔS (in)
0										
3	3	1.5	0.120	0.18	-1.5	0.00	0.18	67	0.00	0.00
4	1	3.5	0.120	0.42	0.5	2.01	2.43	67	0.14	0.14
5	1	4.5	0.120	0.54	1.5	1.71	2.25	67	0.11	0.25
6	1	5.5	0.120	0.66	2.5	1.49	2.15	67	0.09	0.34
7	1	6.5	0.120	0.78	3.5	1.32	2.10	67	0.08	0.42
8	1	7.5	0.120	0.90	4.5	1.18	2.08	67	0.07	0.48
10	2	9	0.120	1.08	6	1.03	2.11	67	0.10	0.59
12	2	11	0.120	1.32	8	0.87	2.19	67	0.08	0.66
13.5	1.5	12.75	0.120	1.53	9.75	0.77	2.30	67	0.05	0.71
17.5	4	15.5	0.120	1.86	12.5	0.65	2.51	67	0.09	0.81
21.5	4	19.5	0.120	2.34	16.5	0.53	2.87	67	0.06	0.87
24.5	3	23	0.120	2.76	20	0.46	3.22	67	0.04	0.90
28.5	4	26.5	0.120	3.18	23.5	0.40	3.58	69	0.04	0.94
32.5	4	30.5	0.120	3.66	27.5	0.35	4.01	69	0.03	0.97
36.5	4	34.5	0.120	4.14	31.5	0.31	4.45	69	0.02	0.99
39.5	3	38	0.120	4.56	35	0.29	4.85	69	0.01	1.00
43.5	4	41.5	0.053	4.85	38.5	0.26	5.11	50	0.02	1.03
45.5	2	44.5	0.053	5.00	41.5	0.25	5.25	50	0.01	1.04
47.5	2	46.5	0.053	5.11	43.5	0.24	5.35	50	0.01	1.05
49.5	2	48.5	0.053	5.21	45.5	0.23	5.44	50	0.01	1.06

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Project: **SR-91 WB Widening Project** Project No. **10-126**
By GJG Date 4/1/2011 Check by Lino Date 4-5-11 Sheet

Settlement Calculation for Spread Footing - RW No. 255 (H=8 ft)

Footing Info

Footing Elevation= 189.7 ft = Embedded Depth = 3 ft
Load Width= 5.25 ft
Net Contact Stress = 2.20 ksf => **Gross Contact Stress = 2.6 ksf**

Check Settlement:
Method: AASHTO LRFD Bridge Design Spec - Hough's Method

Layer	Top Elev. (ft)	Bottom Elev. (ft)	Top Depth (ft)	Bottom Depth (ft)	Soil Type	γ' pcf	(N')	c'
1	192.5	170	0	22.5	SM	120	37	90
2	170	140	22.5	52.5	SM	120	25	67
3	140	125	52.5	67.5	SM	120	26	69
4	125	115	67.5	77.5	ML	52.6	20	50

Note: 1. C'= Bearing Capacity Index
2. N'= Average Corrected SPT Blowcount
2. N'= average corrected SPT blowcount

Depth (ft)	Layer Thick. (ft)	Mid Point Depth (ft)	Effec. Unit Weight, γ' kcf	Initial Stress, σ_{vo}' (ksf)	Depth to Equiv. Footing (ft)	Stress Increase, $\Delta\sigma_v'$ (ksf)	Total Stress, σ_{vt} (ksf)	Bearing Capacity Index, C'	ΔS (in)	Total ΔS (in)
0										
3	3	1.5	0.120	0.18	-1.5	0.00	0.18	90	0.00	0.00
4	1	3.5	0.120	0.42	0.5	2.01	2.43	90	0.10	0.10
5	1	4.5	0.120	0.54	1.5	1.71	2.25	90	0.08	0.18
6	1	5.5	0.120	0.66	2.5	1.49	2.15	90	0.07	0.25
7	1	6.5	0.120	0.78	3.5	1.32	2.10	90	0.06	0.31
8	1	7.5	0.120	0.90	4.5	1.18	2.08	90	0.05	0.36
9	1	8.5	0.120	1.02	5.5	1.07	2.09	90	0.04	0.40
11	2	10	0.120	1.20	7	0.94	2.14	90	0.07	0.47
13	2	12	0.120	1.44	9	0.81	2.25	90	0.05	0.52
17	4	15	0.120	1.80	12	0.67	2.47	90	0.07	0.59
21	4	19	0.120	2.28	16	0.54	2.82	90	0.05	0.64
22.5	1.5	21.75	0.120	2.61	18.75	0.48	3.09	90	0.01	0.66
26.5	4	24.5	0.120	2.94	21.5	0.43	3.37	67	0.04	0.70
30.5	4	28.5	0.120	3.42	25.5	0.38	3.80	67	0.03	0.73
34.5	4	32.5	0.120	3.90	29.5	0.33	4.23	67	0.03	0.76
38.5	4	36.5	0.120	4.38	33.5	0.30	4.68	67	0.02	0.78
41.5	3	40	0.120	4.80	37	0.27	5.07	67	0.01	0.79
45.5	4	43.5	0.120	5.22	40.5	0.25	5.47	67	0.01	0.81
51.5	6	48.5	0.120	5.82	45.5	0.23	6.05	67	0.02	0.82
52.5	1	52	0.12	6.24	49	0.21	6.45	67	0.00	0.83
60.5	8	56.5	0.12	6.78	53.5	0.20	6.98	69	0.02	0.84
67.5	7	64	0.12	7.68	61	0.17	7.85	69	0.01	0.85
75.5	8	71.5	0.0526	8.31	68.5	0.16	8.47	50	0.02	0.87
77.5	2	76.5	0.0526	8.57	73.5	0.15	8.72	50	0.00	0.87

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Project: **SR-91 WB Widening Project** Project No. **10-126**
By GJG Date 4/1/2011 Check by Lino Date 4-5-11 Sheet

Settlement Calculation for Spread Footing - RW No. 255 (H=10 ft)

Footing Info

Footing Elevation= 161.7 ft = Embedded Depth = 3 ft
Load Width= 6.25 ft
Net Contact Stress = 2.50 ksf => **Gross Contact Stress = 2.9 ksf**

Check Settlement:
Method: AASHTO LRFD Bridge Design Spec - Hough's Method

Layer	Top Elev. (ft)	Bottom Elev. (ft)	Top Depth (ft)	Bottom Depth (ft)	Soil Type	γ' pcf	(N')	c'
1	164.5	140	0	24.5	SM	120	25	67
2	140	125	24.5	39.5	SM	120	26	69
3	125	115	39.5	49.5	ML	52.6	20	50

Note: 1. C'= Bearing Capacity Index
2. N'= Average Corrected SPT Blowcount

Depth (ft)	Layer Thick. (ft)	Mid Point Depth (ft)	Effec. Unit Weight, γ' kcf	Initial Stress, σ_{vo}' (ksf)	Depth to Equiv. Footing (ft)	Stress Increase, $\Delta\sigma_v'$ (ksf)	Total Stress, σ_{vt} (ksf)	Bearing Capacity Index, C'	ΔS (in)	Total ΔS (in)	
0											
3	3	1.5	0.120	0.18	-1.5	0.00	0.18	67	0.00	0.00	
4	1	3.5	0.120	0.42	0.5	2.31	2.73	67	0.15	0.15	
5	1	4.5	0.120	0.54	1.5	2.02	2.56	67	0.12	0.27	ovarex
6	1	5.5	0.120	0.66	2.5	1.79	2.45	67	0.10	0.37	
7	1	6.5	0.120	0.78	3.5	1.60	2.38	67	0.09	0.46	
8	1	7.5	0.120	0.90	4.5	1.45	2.35	67	0.07	0.53	
10	2	9	0.120	1.08	6	1.28	2.36	67	0.12	0.65	
12	2	11	0.120	1.32	8	1.10	2.42	67	0.09	0.75	
13.5	1.5	12.75	0.120	1.53	9.75	0.98	2.51	67	0.06	0.80	
17.5	4	15.5	0.120	1.86	12.5	0.83	2.69	67	0.12	0.92	
21.5	4	19.5	0.120	2.34	16.5	0.69	3.03	67	0.08	1.00	
24.5	3	23	0.120	2.76	20	0.60	3.36	67	0.05	1.04	
28.5	4	26.5	0.120	3.18	23.5	0.53	3.71	69	0.05	1.09	
32.5	4	30.5	0.120	3.66	27.5	0.46	4.12	69	0.04	1.13	
36.5	4	34.5	0.120	4.14	31.5	0.41	4.55	69	0.03	1.15	
39.5	3	38	0.120	4.56	35	0.38	4.94	69	0.02	1.17	
43.5	4	41.5	0.053	4.85	38.5	0.35	5.19	50	0.03	1.20	
45.5	2	44.5	0.053	5.00	41.5	0.33	5.33	50	0.01	1.22	
47.5	2	46.5	0.053	5.11	43.5	0.31	5.42	50	0.01	1.23	
49.5	2	48.5	0.053	5.21	45.5	0.30	5.52	50	0.01	1.24	

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Project: **SR-91 WB Widening Project** Project No. **10-126**
By GJG Date 4/1/2011 Check by Lino Date 4-5-11 Sheet

Settlement Calculation for Spread Footing - RW No. 255 (H=10 ft)

Footing Info

Footing Elevation= 179.7 ft = Embedded Depth = 3 ft
Load Width= 6.25 ft
Net Contact Stress = 2.50 ksf => **Gross Contact Stress = 2.9 ksf**

Check Settlement:
Method: AASHTO LRFD Bridge Design Spec - Hough's Method

Layer	Top Elev. (ft)	Bottom Elev. (ft)	Top Depth (ft)	Bottom Depth (ft)	Soil Type	γ' pcf	(N')	c'
1	182.5	170	0	12.5	SM	120	37	90
2	170	140	12.5	42.5	SM	120	25	67
3	140	125	42.5	57.5	SM	120	26	69
4	125	115	57.5	67.5	ML	52.6	20	50

Note: 1. C'= Bearing Capacity Index
2. N'= Average Corrected SPT Blowcount
2. N'= average corrected SPT blowcount

Depth (ft)	Layer Thick. (ft)	Mid Point Depth (ft)	Effec. Unit Weight, γ' kcf	Initial Stress, σ_{vo}' (ksf)	Depth to Equiv. Footing (ft)	Stress Increase, $\Delta\sigma_v'$ (ksf)	Total Stress, σ_{vt} (ksf)	Bearing Capacity Index, C'	ΔS (in)	Total ΔS (in)	
0											
3	3	1.5	0.120	0.18	-1.5	0.00	0.18	90	0.00	0.00	
4	1	3.5	0.120	0.42	0.5	2.31	2.73	90	0.11	0.11	overex.
5	1	4.5	0.120	0.54	1.5	2.02	2.56	90	0.09	0.20	
6	1	5.5	0.120	0.66	2.5	1.79	2.45	90	0.08	0.27	
7	1	6.5	0.120	0.78	3.5	1.60	2.38	90	0.06	0.34	
8	1	7.5	0.120	0.90	4.5	1.45	2.35	90	0.06	0.39	
10	2	9	0.120	1.08	6	1.28	2.36	90	0.09	0.48	
12	2	11	0.120	1.32	8	1.10	2.42	90	0.07	0.56	
12.5	0.5	12.25	0.120	1.47	9.25	1.01	2.48	90	0.02	0.57	
16.5	4	14.5	0.120	1.74	11.5	0.88	2.62	67	0.13	0.70	
20.5	4	18.5	0.120	2.22	15.5	0.72	2.94	67	0.09	0.78	
24.5	4	22.5	0.120	2.70	19.5	0.61	3.31	67	0.06	0.85	
28.5	4	26.5	0.120	3.18	23.5	0.53	3.71	67	0.05	0.90	
31.5	3	30	0.120	3.60	27	0.47	4.07	67	0.03	0.92	
35.5	4	33.5	0.120	4.02	30.5	0.43	4.45	67	0.03	0.96	
39.5	4	37.5	0.120	4.50	34.5	0.38	4.88	67	0.03	0.98	
42.5	3	41	0.120	4.92	38	0.35	5.27	67	0.02	1.00	
46.5	4	44.5	0.120	5.34	41.5	0.33	5.67	69	0.02	1.01	
52.5	6	49.5	0.120	5.94	46.5	0.30	6.24	69	0.02	1.04	
57.5	5	55	0.12	6.60	52	0.27	6.87	69	0.02	1.05	
61.5	4	59.5	0.0526	7.01	56.5	0.25	7.25	50	0.01	1.07	
65.5	4	63.5	0.0526	7.22	60.5	0.23	7.45	50	0.01	1.08	
67.5	2	66.5	0.0526	7.37	63.5	0.22	7.60	50	0.01	1.09	

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Project: **SR-91 WB Widening Project** Project No. **10-126**
By GJG Date 4/1/2011 Check by Lino Date 4-5-11 Sheet

Settlement Calculation for Spread Footing - RW No. 255 (H=12 ft)

Footing Info

Footing Elevation= 161.7 ft = Embedded Depth = 3 ft
Load Width= 7.25 ft
Net Contact Stress = 2.80 ksf => **Gross Contact Stress = 3.2 ksf**

Check Settlement:
Method: AASHTO LRFD Bridge Design Spec - Hough's Method

Layer	Top Elev. (ft)	Bottom Elev. (ft)	Top Depth (ft)	Bottom Depth (ft)	Soil Type	γ' pcf	(N')	c'
1	164.5	140	0	24.5	SM	120	25	67
2	140	125	24.5	39.5	SM	120	26	69
3	125	115	39.5	49.5	ML	52.6	20	50

Note: 1. C'= Bearing Capacity Index
2. N'= Average Corrected SPT Blowcount

Depth (ft)	Layer Thick. (ft)	Mid Point Depth (ft)	Effec. Unit Weight, γ' kcf	Initial Stress, σ_{vo}' (ksf)	Depth to Equiv. Footing (ft)	Stress Increase, $\Delta\sigma_v'$ (ksf)	Total Stress, σ_{vt} (ksf)	Bearing Capacity Index, C'	ΔS (in)	Total ΔS (in)	
0											
3	3	1.5	0.120	0.18	-1.5	0.00	0.18	67	0.00	0.00	
4	1	3.5	0.120	0.42	0.5	2.62	3.04	67	0.15	0.15	
5	1	4.5	0.120	0.54	1.5	2.32	2.86	67	0.13	0.28	
6	1	5.5	0.120	0.66	2.5	2.08	2.74	67	0.11	0.39	
7	1	6.5	0.120	0.78	3.5	1.89	2.67	67	0.10	0.49	overex.
8	1	7.5	0.120	0.90	4.5	1.73	2.63	67	0.08	0.57	
10	2	9	0.120	1.08	6	1.53	2.61	67	0.14	0.71	
12	2	11	0.120	1.32	8	1.33	2.65	67	0.11	0.82	
13.5	1.5	12.75	0.120	1.53	9.75	1.19	2.72	67	0.07	0.89	
17.5	4	15.5	0.120	1.86	12.5	1.03	2.89	67	0.14	1.02	
21.5	4	19.5	0.120	2.34	16.5	0.85	3.19	67	0.10	1.12	
24.5	3	23	0.120	2.76	20	0.74	3.50	67	0.06	1.18	
28.5	4	26.5	0.120	3.18	23.5	0.66	3.84	69	0.06	1.23	
32.5	4	30.5	0.120	3.66	27.5	0.58	4.24	69	0.04	1.28	
36.5	4	34.5	0.120	4.14	31.5	0.52	4.66	69	0.04	1.31	
39.5	3	38	0.120	4.56	35	0.48	5.04	69	0.02	1.34	
43.5	4	41.5	0.053	4.85	38.5	0.44	5.29	50	0.04	1.37	
45.5	2	44.5	0.053	5.00	41.5	0.42	5.42	50	0.02	1.39	
47.5	2	46.5	0.053	5.11	43.5	0.40	5.51	50	0.02	1.41	
49.5	2	48.5	0.053	5.21	45.5	0.38	5.60	50	0.01	1.42	

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
phone: (714)751-3826, Fax (714)751-3928

Project: **SR-91 WB Widening Project** Project No. **10-126**
By GJG Date 4/1/2011 Check by Lino Date 4-5-11 Sheet

Settlement Calculation for Spread Footing - RW No. 255 (H=12 ft)

Footing Info

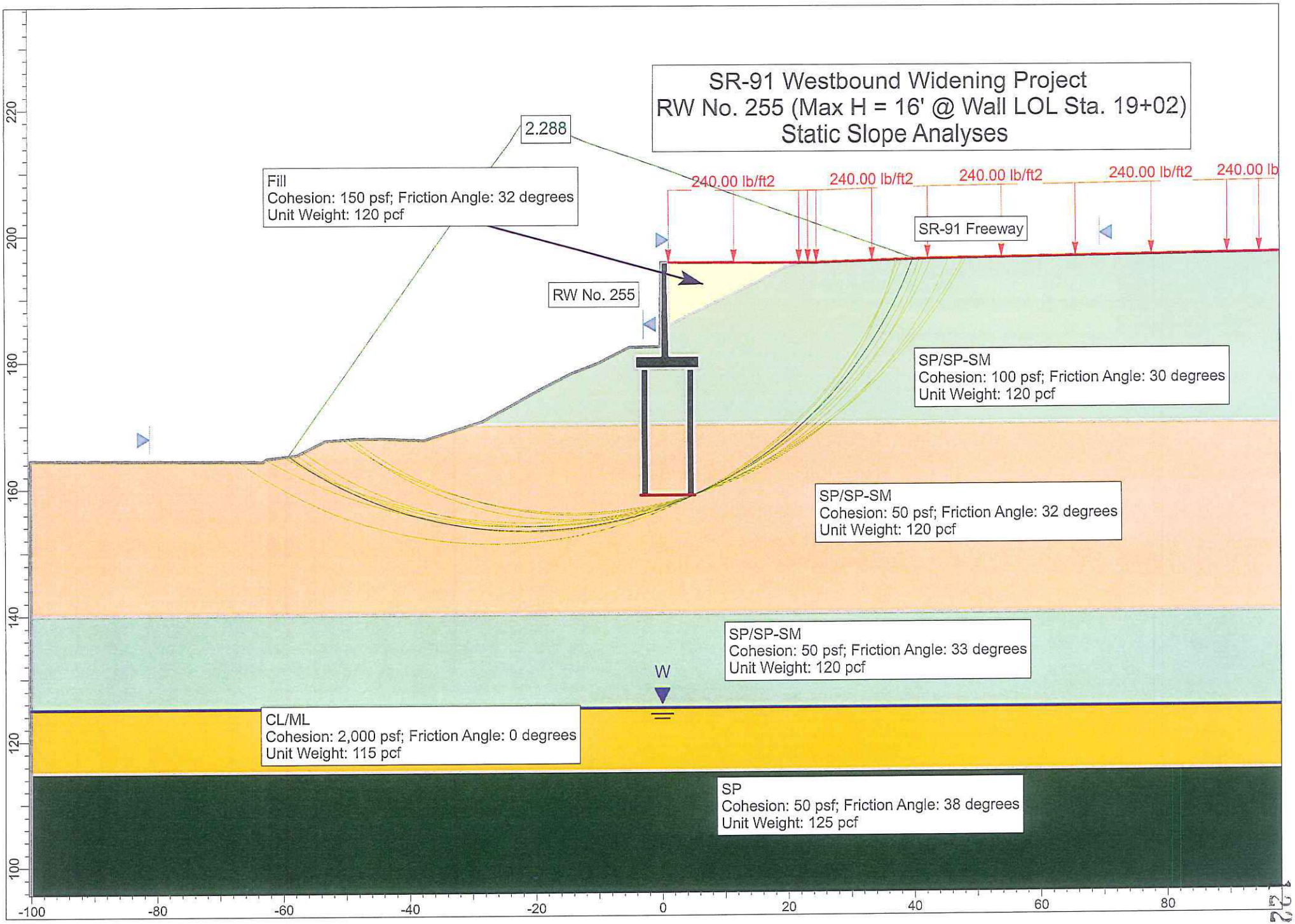
Footing Elevation= 183.7 ft = Embedded Depth = 3 ft
Load Width= 7.25 ft
Net Contact Stress = 2.80 ksf => **Gross Contact Stress = 3.2 ksf**

Check Settlement:
Method: AASHTO LRFD Bridge Design Spec - Hough's Method

Layer	Top Elev. (ft)	Bottom Elev. (ft)	Top Depth (ft)	Bottom Depth (ft)	Soil Type	γ' pcf	(N')	c'
1	186.5	170	0	16.5	SM	120	37	90
2	170	140	16.5	46.5	SM	120	25	67
3	140	125	46.5	61.5	SM	120	26	69
4	125	115	61.5	71.5	ML	52.6	20	50

Note: 1. C'= Bearing Capacity Index
2. N'= Average Corrected SPT Blowcount
2. N'= average corrected SPT blowcount

Depth (ft)	Layer Thick. (ft)	Mid Point Depth (ft)	Effec. Unit Weight, γ' kcf	Initial Stress, σ_{vo}' (ksf)	Depth to Equiv. Footing (ft)	Stress Increase, $\Delta\sigma_v'$ (ksf)	Total Stress, σ_{vt} (ksf)	Bearing Capacity Index, C'	ΔS (in)	Total ΔS (in)	
0											
3	3	1.5	0.120	0.18	-1.5	0.00	0.18	90	0.00	0.00	
4	1	3.5	0.120	0.42	0.5	2.62	3.04	90	0.11	0.11	
5	1	4.5	0.120	0.54	1.5	2.32	2.86	90	0.10	0.21	
6	1	5.5	0.120	0.66	2.5	2.08	2.74	90	0.08	0.29	overex.
7	1	6.5	0.120	0.78	3.5	1.89	2.67	90	0.07	0.36	
8	1	7.5	0.120	0.90	4.5	1.73	2.63	90	0.06	0.43	
10	2	9	0.120	1.08	6	1.53	2.61	90	0.10	0.53	
12	2	11	0.120	1.32	8	1.33	2.65	90	0.08	0.61	
14	2	13	0.120	1.56	10	1.18	2.74	90	0.07	0.68	
16.5	2.5	15.25	0.120	1.83	12.25	1.04	2.87	90	0.07	0.74	
20.5	4	18.5	0.120	2.22	15.5	0.89	3.11	67	0.11	0.85	
24.5	4	22.5	0.120	2.70	19.5	0.76	3.46	67	0.08	0.92	
28.5	4	26.5	0.120	3.18	23.5	0.66	3.84	67	0.06	0.98	
32.5	4	30.5	0.120	3.66	27.5	0.58	4.24	67	0.05	1.03	
35.5	3	34	0.120	4.08	31	0.53	4.61	67	0.03	1.06	
39.5	4	37.5	0.120	4.50	34.5	0.49	4.99	67	0.03	1.09	
43.5	4	41.5	0.120	4.98	38.5	0.44	5.42	67	0.03	1.11	
46.5	3	45	0.120	5.40	42	0.41	5.81	67	0.02	1.13	
52.5	6	49.5	0.120	5.94	46.5	0.38	6.32	69	0.03	1.16	
58.5	6	55.5	0.12	6.66	52.5	0.34	7.00	69	0.02	1.18	
61.5	3	60	0.12	7.20	57	0.32	7.52	69	0.01	1.19	
65.5	4	63.5	0.0526	7.49	60.5	0.30	7.78	50	0.02	1.21	
69.5	4	67.5	0.0526	7.70	64.5	0.28	7.98	50	0.02	1.22	
71.5	2	70.5	0.0526	7.85	67.5	0.27	8.12	50	0.01	1.23	


SR-91 Westbound Widening Project
RW No. 255 (Max H = 16' @ Wall LOL Sta. 19+02)
Static Slope Analyses
2.288
Fill
Cohesion: 150 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
240.00 lb/ft2
240.00 lb/ft2
240.00 lb/ft2
240.00 lb/ft2
240.00 lb
SR-91 Freeway
RW No. 255
SP/SP-SM
Cohesion: 100 psf; Friction Angle: 30 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 33 degrees
Unit Weight: 120 pcf
W
CL/ML
Cohesion: 2,000 psf; Friction Angle: 0 degrees
Unit Weight: 115 pcf
SP
Cohesion: 50 psf; Friction Angle: 38 degrees
Unit Weight: 125 pcf
220
200
180
160
140
120
100
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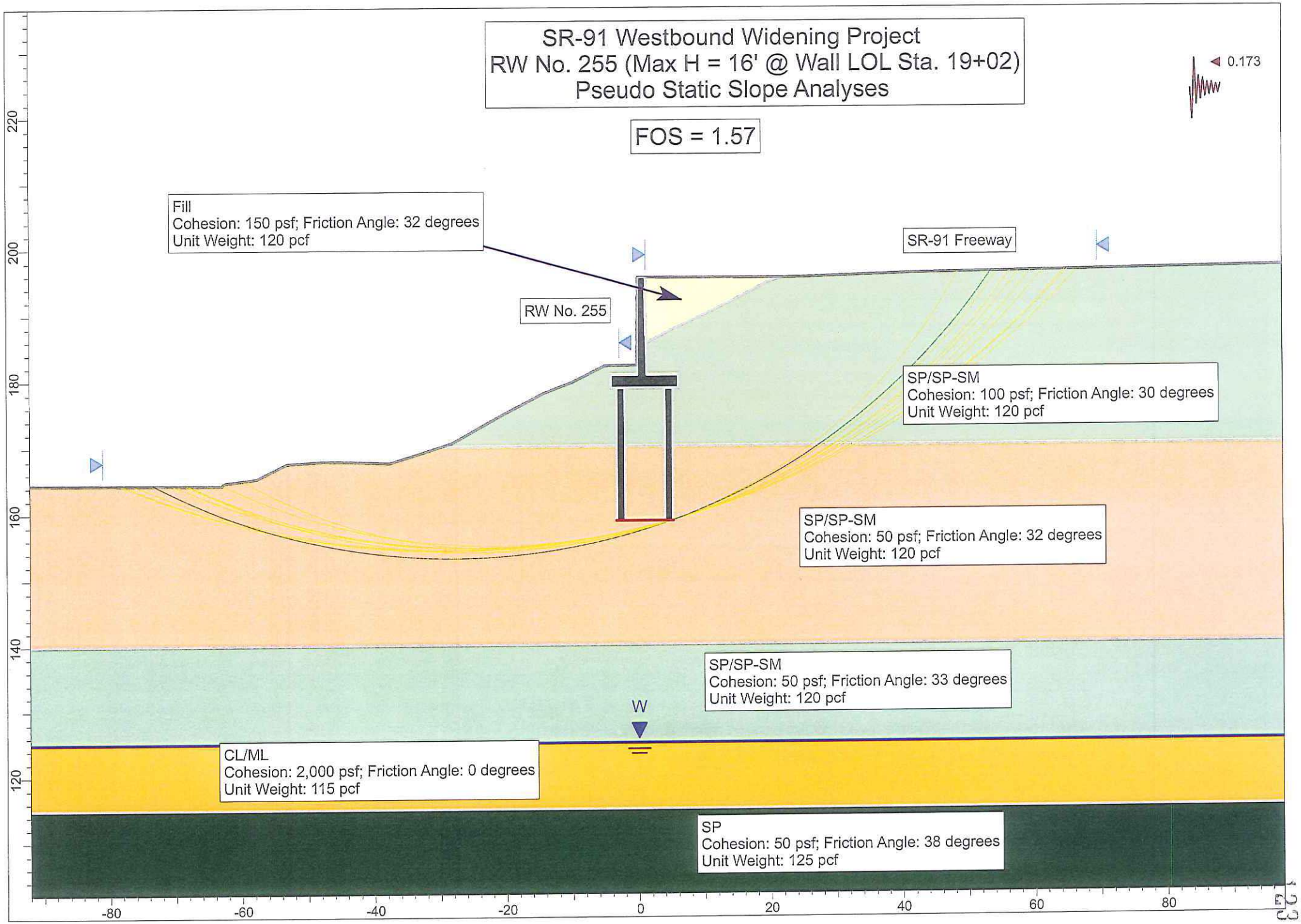
-80
-60
-40
-20
0
20
40
60
80


SR-91 Westbound Widening Project
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Pseudo Static Slope Analyses
FOS = 1.57
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Fill
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Unit Weight: 120 pcf
SR-91 Freeway
RW No. 255
SP/SP-SM
Cohesion: 100 psf; Friction Angle: 30 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 33 degrees
Unit Weight: 120 pcf
W
CL/ML
Cohesion: 2,000 psf; Friction Angle: 0 degrees
Unit Weight: 115 pcf
SP
Cohesion: 50 psf; Friction Angle: 38 degrees
Unit Weight: 125 pcf
220
200
180
160
140
120
-80
-60
-40
-20
0
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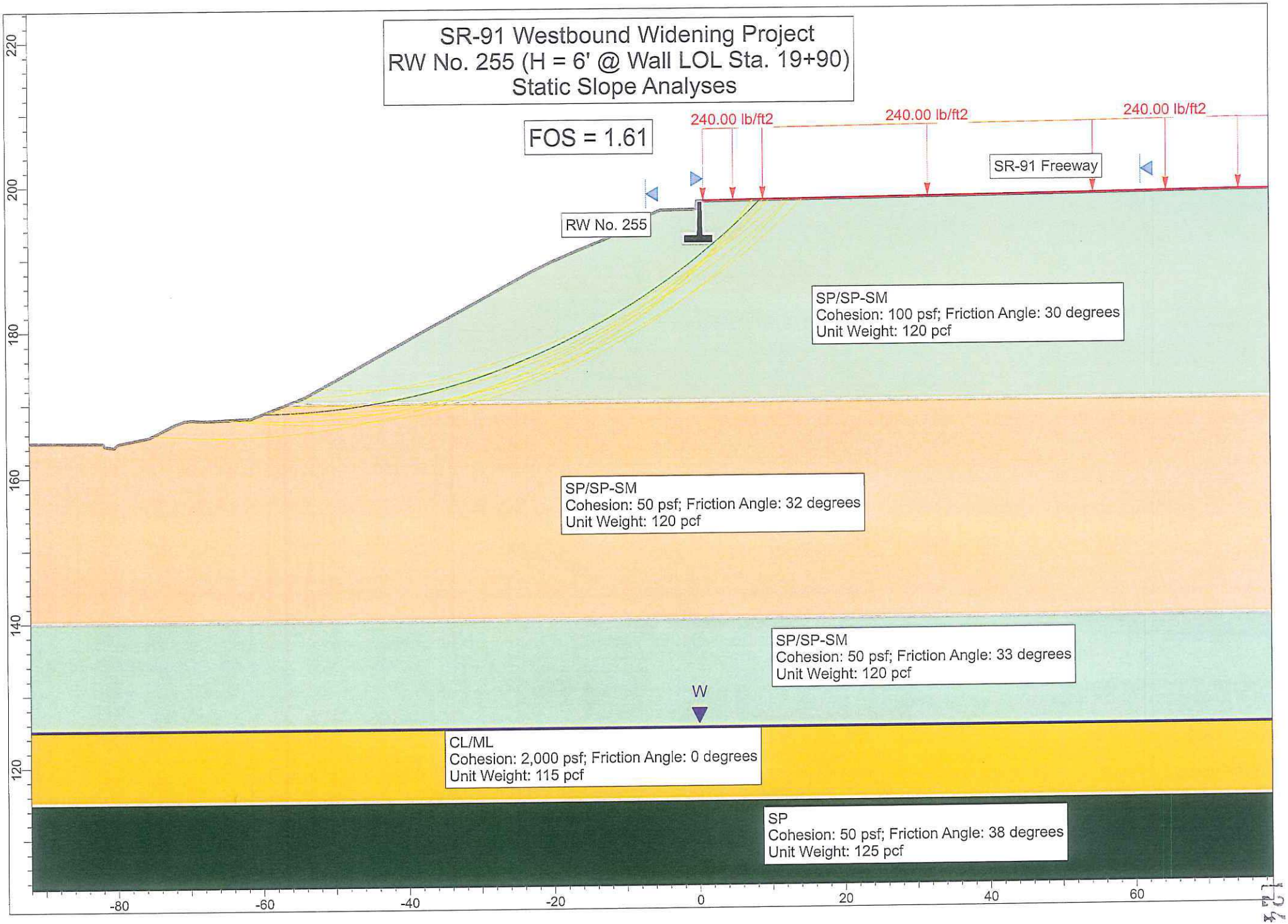
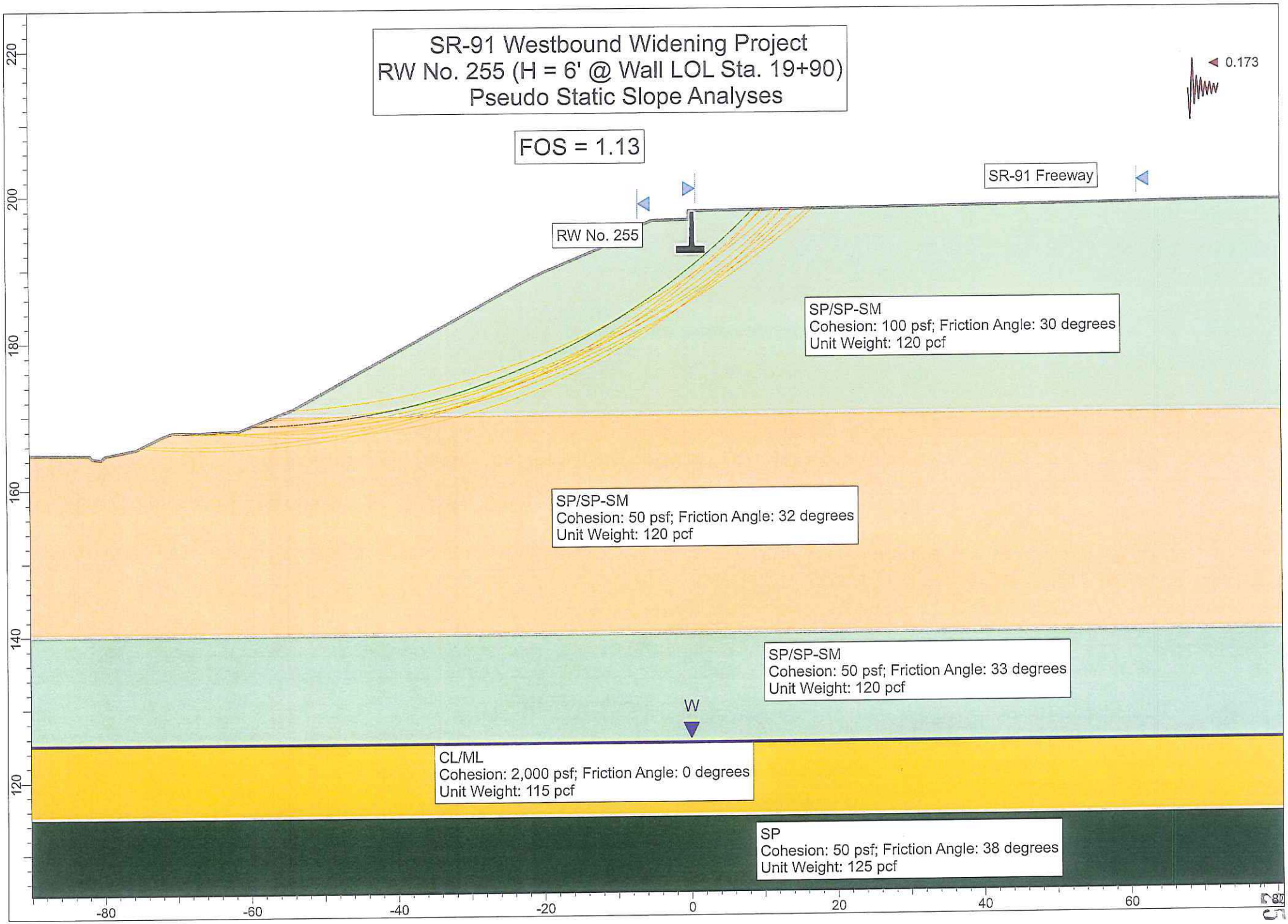
40
60
80


SR-91 Westbound Widening Project
RW No. 255 (H = 6' @ Wall LOL Sta. 19+90)
Static Slope Analyses
FOS = 1.61
240.00 lb/ft2
240.00 lb/ft2
240.00 lb/ft2
SR-91 Freeway
RW No. 255
SP/SP-SM
Cohesion: 100 psf; Friction Angle: 30 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 33 degrees
Unit Weight: 120 pcf
W
CL/ML
Cohesion: 2,000 psf; Friction Angle: 0 degrees
Unit Weight: 115 pcf
SP
Cohesion: 50 psf; Friction Angle: 38 degrees
Unit Weight: 125 pcf
220
200
180
160
140
120
-80
-60
-40
-20
0
20
40
60


SR-91 Westbound Widening Project
RW No. 255 (H = 6' @ Wall LOL Sta. 19+90)
Pseudo Static Slope Analyses
FOS = 1.13
0.173
SR-91 Freeway
RW No. 255
SP/SP-SM
Cohesion: 100 psf; Friction Angle: 30 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 33 degrees
Unit Weight: 120 pcf
W
CL/ML
Cohesion: 2,000 psf; Friction Angle: 0 degrees
Unit Weight: 115 pcf
SP
Cohesion: 50 psf; Friction Angle: 38 degrees
Unit Weight: 125 pcf
220
200
180
160
140
120
-80
-60
-40
-20
0
20
40
60
80

RETAINING WALL 293

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening - Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-6-11 Sheet: 1 of 1
Subject:

Retaining Wall 293 - Liquefaction Potential Analyses

* Historical high ground water elevation of +140 feet was used.

* Analysis was performed using the current CPT sounding (CPT-10-051).

* Borings A-10-050 and A-10-052 and CPT sounding CPT-10-053 deepest depths are located above the historical high GW elevation (+140'). Therefore, liquefaction potential was not performed for these explorations.

⇒ Based on the analyses, liquefaction potential at the site is low.

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SR-91 Westbound Widening - RW No. 293 | **EMI Project No.** 10-126 | **Sounding:** CPT-10-051

PGA (g) 0.52 | Mag 7.3 | GW depth (ft) 40.0 | Ground EL. (ft MLLW) 180.0 | Note: Units are tons/cf, tons/sf, and feet

Depth (ft)	El. (ft MLLW)	$q_{c,tip}$ (tsf)	f_s (tsf)	Unit Wt (tcf)	Total OB (tsf)	Eff OB (tsf)	Q_1	F (%)	I_{c1}	C_{Q2}	Q_2	I_{c2}	C_{Q3}	Q_3	I_{c3}	q_{c1N}	I_c	K_c	$(q_{c1n})_{cs}$	$CRR_{7.5}$	CSR	r_d	MSF	FOS	Liquefaction
0.33	179.7	288.4	12.5	0.06	0.02	0.02	14564.7	4.33	1.98	7.25	2009.63	1.86	Sand	Sand	Sand	2009.77	1.86	1.16	2325.45	1169.60	0.34	1.00	1.07	3705.42	Above WT
0.82	179.2	222.4	4.7	0.06	0.05	0.05	4519.33	2.11	1.56	4.60	982.97	1.62	Sand	Sand	Sand	983.19	1.62	1.00	983.19	88.47	0.34	1.00	1.07	280.60	Above WT
1.31	178.7	134.1	2.2	0.06	0.08	0.08	1705.11	1.64	1.45	3.64	468.76	1.64	Sand	Sand	Sand	469.03	1.64	1.00	468.14	9.62	0.34	1.00	1.07	30.55	Above WT
1.80	178.2	96.8	1.5	0.06	0.11	0.11	895.30	1.55	1.50	3.10	288.51	1.73	Sand	Sand	Sand	288.83	1.73	1.06	306.56	2.76	0.34	1.00	1.07	8.77	Above WT
2.30	177.7	79.1	1.1	0.06	0.14	0.14	572.19	1.39	1.54	2.75	208.43	1.78	Sand	Sand	Sand	208.80	1.78	1.10	228.78	1.19	0.34	0.99	1.07	3.80	Above WT
2.79	177.2	56.8	0.8	0.06	0.17	0.17	338.31	1.41	1.66	2.49	135.73	1.91	Sand	Sand	Sand	136.13	1.91	1.20	163.74	0.49	0.34	0.99	1.07	1.56	Above WT
3.28	176.7	35.4	0.5	0.06	0.20	0.20	178.88	1.42	1.83	2.30	77.81	2.09	Sand	Sand	Sand	78.25	2.09	1.44	112.71	0.21	0.34	0.99	1.07	0.68	Above WT
3.77	176.2	28.5	0.4	0.06	0.23	0.23	124.99	1.41	1.94	2.14	58.29	2.19	Sand	Sand	Sand	58.76	2.19	1.64	96.12	0.16	0.34	0.99	1.07	0.52	Above WT
4.27	175.7	52.6	0.7	0.06	0.26	0.26	204.31	1.34	1.78	2.01	101.40	1.99	Sand	Sand	Sand	101.90	1.99	1.29	131.01	0.29	0.33	0.99	1.07	0.92	Above WT
4.76	175.2	66.3	0.7	0.06	0.29	0.29	231.14	1.06	1.67	1.91	121.13	1.86	Sand	Sand	Sand	121.65	1.86	1.16	140.71	0.34	0.33	0.99	1.07	1.09	Above WT
5.25	174.8	69.6	0.9	0.06	0.32	0.32	219.95	1.30	1.75	1.82	121.05	1.92	Sand	Sand	Sand	121.60	1.92	1.21	147.44	0.38	0.33	0.99	1.07	1.21	Above WT
5.74	174.3	72.9	0.6	0.06	0.34	0.34	210.67	0.83	1.61	1.74	121.23	1.79	Sand	Sand	Sand	121.81	1.79	1.10	134.21	0.30	0.33	0.99	1.07	0.98	Above WT
6.23	173.8	66.9	0.8	0.06	0.37	0.37	177.97	1.20	1.78	1.67	106.70	1.94	Sand	Sand	Sand	107.30	1.94	1.23	132.03	0.29	0.33	0.99	1.07	0.94	Above WT
6.73	173.3	62.7	0.7	0.06	0.40	0.40	154.27	1.12	1.80	1.60	96.13	1.96	Sand	Sand	Sand	96.75	1.96	1.25	120.61	0.24	0.33	0.98	1.07	0.78	Above WT
7.22	172.8	68.5	0.8	0.06	0.43	0.43	157.13	1.18	1.81	1.55	101.41	1.95	Sand	Sand	Sand	102.05	1.95	1.24	126.68	0.27	0.33	0.98	1.07	0.87	Above WT
7.71	172.3	64.6	0.6	0.06	0.46	0.46	138.65	0.94	1.78	1.50	92.47	1.92	Sand	Sand	Sand	93.14	1.92	1.21	112.39	0.21	0.33	0.98	1.07	0.68	Above WT
8.20	171.8	69.3	0.6	0.06	0.49	0.49	139.85	0.87	1.76	1.45	96.19	1.89	Sand	Sand	Sand	96.88	1.89	1.18	113.94	0.22	0.33	0.98	1.07	0.70	Above WT
8.69	171.3	74.7	0.7	0.06	0.52	0.52	142.27	0.94	1.78	1.41	100.73	1.89	Sand	Sand	Sand	101.44	1.89	1.18	119.83	0.24	0.33	0.98	1.07	0.78	Above WT
9.19	170.8	40.2	0.8	0.06	0.55	0.55	71.91	2.02	2.22	1.37	52.36	2.32	Sand	Sand	Sand	53.09	2.32	2.02	107.29	0.19	0.33	0.98	1.07	0.63	Above WT
9.68	170.3	100.6	0.8	0.06	0.58	0.58	172.21	0.80	1.67	1.34	128.69	1.76	Sand	Sand	Sand	129.44	1.76	1.08	139.96	0.33	0.33	0.98	1.07	1.08	Above WT
10.17	169.8	136.9	0.9	0.06	0.61	0.61	223.35	0.66	1.53	1.31	171.08	1.62	Sand	Sand	Sand	171.85	1.62	1.00	171.85	0.55	0.33	0.98	1.07	1.79	Above WT
10.66	169.3	192.7	2.3	0.06	0.64	0.64	300.28	1.20	1.63	1.28	235.49	1.70	Sand	Sand	Sand	236.27	1.70	1.04	245.27	1.45	0.33	0.98	1.07	4.71	Above WT
11.16	168.8	226.5	2.9	0.06	0.67	0.67	337.26	1.28	1.63	1.25	270.62	1.69	Sand	Sand	Sand	271.42	1.69	1.03	279.08	2.10	0.33	0.97	1.07	6.83	Above WT
11.65	168.4	233.4	3.3	0.06	0.70	0.70	332.91	1.42	1.67	1.22	272.92	1.72	Sand	Sand	Sand	273.74	1.72	1.05	287.38	2.29	0.33	0.97	1.07	7.44	Above WT
12.14	167.9	243.3	3.4	0.06	0.73	0.73	333.02	1.40	1.66	1.19	278.70	1.71	Sand	Sand	Sand	279.54	1.71	1.04	291.67	2.39	0.33	0.97	1.07	7.78	Above WT
12.63	167.4	238.0	3.1	0.06	0.76	0.76	313.07	1.31	1.65	1.17	267.24	1.70	Sand	Sand	Sand	268.09	1.70	1.03	277.35	2.06	0.33	0.97	1.07	6.73	Above WT
13.12	166.9	235.7	3.7	0.06	0.79	0.79	298.42	1.58	1.73	1.15	259.63	1.77	Sand	Sand	Sand	260.50	1.77	1.08	282.23	2.17	0.33	0.97	1.07	7.09	Above WT
13.62	166.4	237.0	3.6	0.06	0.82	0.82	289.01	1.52	1.73	1.13	256.19	1.76	Sand	Sand	Sand	257.08	1.76	1.08	277.12	2.06	0.33	0.97	1.07	6.73	Above WT
14.11	165.9	215.8	4.1	0.06	0.85	0.85	253.90	1.91	1.84	1.11	229.08	1.87	Sand	Sand	Sand	229.98	1.87	1.16	266.49	1.84	0.33	0.97	1.07	6.02	Above WT
14.60	165.4	225.5	4.1	0.06	0.88	0.88	256.42	1.83	1.82	1.09	235.34	1.84	Sand	Sand	Sand	236.25	1.84	1.14	269.40	1.90	0.33	0.97	1.07	6.22	Above WT
15.09	164.9	248.2	3.9	0.06	0.91	0.91	273.13	1.58	1.75	1.07	254.85	1.77	Sand	Sand	Sand	255.78	1.77	1.09	278.06	2.08	0.33	0.96	1.07	6.82	Above WT
15.58	164.4	255.0	2.6	0.06	0.93	0.93	271.79	1.02	1.61	1.05	257.67	1.62	Sand	Sand	Sand	258.62	1.62	1.00	258.62	1.69	0.33	0.96	1.07	5.55	Above WT
16.08	163.9	231.5	2.9	0.06	0.96	0.96	238.95	1.26	1.71	1.04	230.15	1.72	Sand	Sand	Sand	231.11	1.72	1.05	243.46	1.42	0.33	0.96	1.07	4.68	Above WT
16.57	163.4	251.5	3.9	0.06	0.99	0.99	251.97	1.56	1.77	1.02	246.36	1.78	Sand	Sand	Sand	247.33	1.78	1.09	269.64	1.90	0.32	0.96	1.07	6.27	Above WT
17.06	162.9	248.4	3.2	0.06	1.02	1.02	241.67	1.29	1.72	1.01	239.76	1.72	Sand	Sand	Sand	240.75	1.72	1.05	253.29	1.59	0.32	0.96	1.07	5.25	Above WT
17.55	162.5	231.5	3.5	0.06	1.05	1.05	218.85	1.52	1.80	0.99	220.21	1.80	Sand	Sand	Sand	221.22	1.80	1.11	244.58	1.44	0.32	0.96	1.07	4.76	Above WT
18.05	162.0	216.8	3.8	0.06	1.08	1.08	199.18	1.76	1.88	0.98	203.26	1.87	Sand	Sand	Sand	204.28	1.87	1.16	237.44	1.32	0.32	0.96	1.07	4.38	Above WT
18.54	161.5	239.3	4.5	0.06	1.11	1.11	214.12	1.89	1.88	0.97	221.45	1.87	Sand	Sand	Sand	222.48	1.87	1.16	258.85	1.69	0.32	0.96	1.07	5.60	Above WT
19.03	161.0	240.3	4.8	0.06	1.14	1.14	209.46	2.01	1.91	0.95	219.47	1.90	Sand	Sand	Sand	220.52	1.90	1.18	261.18	1.74	0.32	0.96	1.07	5.75	Above WT
19.52	160.5	262.6	5.2	0.06	1.17	1.17	223.21	1.99	1.89	0.94	236.88	1.87	Sand	Sand	Sand	237.94	1.87	1.16	276.96	2.06	0.32	0.95	1.07	6.82	Above WT
20.01	160.0	263.0	4.5	0.06	1.20	1.20	218.06	1.72	1.84	0.93	234.29	1.82	Sand	Sand	Sand	235.36	1.82	1.12	264.74	1.81	0.32	0.95	1.07	6.00	Above WT

Depth (ft)	El. (ft MLLW)	$q_{c,tip}$ (tsf)	f_s (tsf)	Unit Wt (tcf)	Total OB (tsf)	Eff OB (tsf)	Q_1	F (%)	I_{c1}	C_{Q2}	Q_2	I_{c2}	C_{Q3}	Q_3	I_{c3}	q_{c1N}	I_c	K_c	$(q_{c1n})_{cs}$	$CRR_{7.5}$	CSR	r_d	MSF	FOS	Liquefaction
20.51	159.5	243.5	3.8	0.06	1.23	1.23	196.87	1.57	1.84	0.92	214.15	1.82	Sand	Sand	Sand	215.24	1.82	1.12	240.91	1.38	0.32	0.95	1.07	4.59	Above WT
21.00	159.0	274.8	5.3	0.06	1.26	1.26	217.10	1.94	1.89	0.91	238.96	1.86	Sand	Sand	Sand	240.06	1.86	1.15	277.08	2.06	0.32	0.95	1.07	6.85	Above WT
21.49	158.5	252.2	5.2	0.06	1.29	1.29	194.59	2.07	1.94	0.90	216.67	1.91	Sand	Sand	Sand	217.79	1.91	1.20	260.95	1.73	0.32	0.95	1.07	5.77	Above WT
21.98	158.0	246.2	4.9	0.06	1.32	1.32	185.68	2.00	1.94	0.89	209.10	1.91	Sand	Sand	Sand	210.22	1.91	1.20	251.28	1.56	0.32	0.95	1.07	5.19	Above WT
22.47	157.5	271.0	4.3	0.06	1.35	1.35	200.01	1.59	1.84	0.88	227.72	1.81	Sand	Sand	Sand	228.86	1.81	1.11	254.29	1.61	0.32	0.95	1.07	5.38	Above WT
22.97	157.0	246.0	3.8	0.06	1.38	1.38	177.49	1.55	1.87	0.87	204.33	1.83	Sand	Sand	Sand	205.48	1.83	1.13	231.49	1.23	0.32	0.95	1.07	4.13	Above WT
23.46	156.5	204.5	2.7	0.06	1.41	1.41	144.28	1.33	1.88	0.86	167.86	1.83	Sand	Sand	Sand	169.02	2.60	3.33	562.28	16.61	0.32	0.95	1.07	55.63	Above WT
23.95	156.1	195.6	2.8	0.06	1.44	1.44	135.12	1.44	1.92	0.85	158.83	1.87	Sand	Sand	Sand	160.00	2.60	3.33	532.28	14.11	0.32	0.94	1.07	47.29	Above WT
24.44	155.6	189.9	2.7	0.06	1.47	1.47	128.50	1.43	1.94	0.84	152.59	1.88	Sand	Sand	Sand	153.77	2.60	3.33	511.56	12.53	0.32	0.94	1.07	42.06	Above WT
24.94	155.1	194.9	2.7	0.06	1.50	1.50	129.25	1.40	1.93	0.83	155.03	1.87	Sand	Sand	Sand	156.23	2.60	3.33	519.74	13.14	0.32	0.94	1.07	44.16	Above WT
25.43	154.6	220.7	3.5	0.06	1.53	1.53	143.65	1.60	1.94	0.83	173.99	1.88	Sand	Sand	Sand	175.20	2.60	3.33	582.85	18.49	0.32	0.94	1.07	62.24	Above WT
25.92	154.1	221.9	3.2	0.06	1.56	1.56	141.68	1.45	1.91	0.82	173.26	1.85	Sand	Sand	Sand	174.48	2.60	3.33	580.45	18.27	0.32	0.94	1.07	61.55	Above WT
26.41	153.6	231.9	3.7	0.06	1.58	1.58	145.35	1.61	1.93	0.81	179.41	1.87	Sand	Sand	Sand	180.64	2.60	3.33	600.95	20.26	0.32	0.94	1.07	68.36	Above WT
26.90	153.1	210.9	4.2	0.06	1.61	1.61	129.67	2.01	2.04	0.80	161.54	1.98	Sand	Sand	Sand	162.78	2.60	3.33	541.53	14.85	0.32	0.94	1.07	50.15	Above WT
27.40	152.6	219.0	4.9	0.06	1.64	1.64	132.21	2.25	2.07	0.80	166.23	2.01	Sand	Sand	Sand	167.49	2.60	3.33	557.18	16.17	0.32	0.94	1.07	54.67	Above WT
27.89	152.1	252.7	4.0	0.06	1.67	1.67	150.01	1.59	1.92	0.79	190.28	1.85	Sand	Sand	Sand	191.55	2.60	3.33	637.24	24.15	0.32	0.93	1.07	81.76	Above WT
28.38	151.6	220.5	2.8	0.06	1.70	1.70	128.49	1.28	1.90	0.78	164.42	1.83	Sand	Sand	Sand	165.70	2.60	3.33	551.22	15.66	0.32	0.93	1.07	53.08	Above WT
28.87	151.1	195.1	3.1	0.06	1.73	1.73	111.63	1.60	2.01	0.77	144.07	1.94	Sand	Sand	Sand	145.36	2.60	3.33	483.57	10.60	0.32	0.93	1.07	35.97	Above WT
29.36	150.6	240.4	3.0	0.06	1.76	1.76	135.47	1.26	1.88	0.77	176.31	1.80	Sand	Sand	Sand	177.61	2.60	3.33	590.85	19.26	0.31	0.93	1.07	65.46	Above WT
29.86	150.1	280.3	5.2	0.06	1.79	1.79	155.45	1.87	1.96	0.76	204.03	1.89	Sand	Sand	Sand	205.35	2.60	3.33	683.13	29.73	0.31	0.93	1.07	101.15	Above WT
30.35	149.7	287.2	6.3	0.06	1.82	1.82	156.72	2.21	2.02	0.76	207.37	1.94	Sand	Sand	Sand	208.70	2.60	3.33	694.27	31.20	0.31	0.93	1.07	106.56	Above WT
30.84	149.2	292.8	5.8	0.06	1.85	1.85	157.24	1.99	1.98	0.75	209.73	1.90	Sand	Sand	Sand	211.07	1.90	1.19	251.87	1.57	0.31	0.92	1.07	5.37	Above WT
31.33	148.7	312.8	6.3	0.06	1.88	1.88	165.40	2.03	1.97	0.74	222.37	1.90	Sand	Sand	Sand	223.71	1.90	1.18	264.96	1.81	0.31	0.92	1.07	6.23	Above WT
31.83	148.2	308.6	5.3	0.06	1.91	1.91	160.59	1.73	1.93	0.74	217.62	1.85	Sand	Sand	Sand	218.97	2.60	3.33	728.45	36.03	0.31	0.91	1.07	124.67	Above WT
32.32	147.7	306.9	4.7	0.06	1.94	1.94	157.26	1.54	1.90	0.73	214.74	1.81	Sand	Sand	Sand	216.11	2.60	3.33	718.93	34.64	0.31	0.91	1.07	120.38	Above WT
32.81	147.2	339.4	4.4	0.06	1.97	1.97	171.41	1.30	1.82	0.73	235.83	1.73	Sand	Sand	Sand	237.20	1.73	1.06	250.71	1.55	0.31	0.91	1.07	5.39	Above WT
33.30	146.7	360.5	5.8	0.06	2.00	2.00	179.43	1.62	1.88	0.72	248.70	1.79	Sand	Sand	Sand	250.09	2.60	3.33	831.97	53.64	0.31	0.90	1.07	188.05	Above WT
33.79	146.2	355.3	4.7	0.06	2.03	2.03	174.25	1.33	1.82	0.72	243.29	1.73	Sand	Sand	Sand	244.69	1.73	1.06	258.33	1.68	0.30	0.90	1.07	5.93	Above WT
34.29	145.7	358.4	5.2	0.06	2.06	2.06	173.20	1.46	1.85	0.71	243.61	1.76	Sand	Sand	Sand	245.01	1.76	1.08	263.84	1.79	0.30	0.89	1.07	6.33	Above WT
34.78	145.2	316.6	4.7	0.06	2.09	2.09	150.72	1.49	1.90	0.71	213.49	1.80	Sand	Sand	Sand	214.91	1.80	1.11	238.07	1.33	0.30	0.89	1.07	4.74	Above WT
35.27	144.7	304.0	3.8	0.06	2.12	2.12	142.65	1.26	1.86	0.70	203.49	1.76	Sand	Sand	Sand	204.92	1.76	1.08	220.74	1.08	0.30	0.89	1.07	3.86	Above WT
35.76	144.2	273.9	4.0	0.06	2.15	2.15	126.66	1.47	1.95	0.70	181.92	1.84	Sand	Sand	Sand	183.36	1.84	1.14	208.68	0.93	0.30	0.88	1.07	3.32	Above WT
36.26	143.7	277.5	4.1	0.06	2.18	2.18	126.55	1.49	1.95	0.69	183.04	1.84	Sand	Sand	Sand	184.48	1.84	1.14	210.27	0.94	0.30	0.88	1.07	3.40	Above WT
36.75	143.3	243.0	3.7	0.06	2.21	2.21	109.20	1.54	2.01	0.69	159.01	1.89	Sand	Sand	Sand	160.47	1.89	1.18	189.89	0.72	0.30	0.87	1.07	2.59	Above WT
37.24	142.8	235.7	3.2	0.06	2.23	2.23	104.49	1.37	1.99	0.68	153.15	1.87	Sand	Sand	Sand	154.62	1.87	1.16	179.47	0.62	0.29	0.87	1.07	2.25	Above WT
37.73	142.3	220.9	2.8	0.06	2.26	2.26	96.58	1.28	1.99	0.68	142.49	1.87	Sand	Sand	Sand	143.97	1.87	1.16	167.19	0.51	0.29	0.87	1.07	1.88	Above WT
38.22	141.8	229.3	3.3	0.06	2.29	2.29	98.99	1.45	2.02	0.67	146.99	1.90	Sand	Sand	Sand	148.48	1.90	1.19	176.45	0.59	0.29	0.86	1.07	2.17	Above WT
38.72	141.3	233.9	3.2	0.06	2.32	2.32	99.68	1.38	2.00	0.67	148.98	1.88	Sand	Sand	Sand	150.48	1.88	1.17	176.08	0.59	0.29	0.86	1.07	2.17	Above WT
39.21	140.8	267.4	3.7	0.06	2.35	2.35	112.66	1.40	1.97	0.66	169.45	1.84	Sand	Sand	Sand	170.95	1.84	1.14	195.02	0.77	0.29	0.85	1.07	2.85	Above WT
39.70	140.3	298.8	5.2	0.06	2.38	2.38	124.44	1.75	2.01	0.66	188.33	1.89	Sand	Sand	Sand	189.84	1.89	1.18	223.92	1.12	0.29	0.85	1.07	4.18	Above WT
40.19	139.8	315.2	5.2	0.06	2.41	2.41	130.03	1.66	1.98	0.66	197.76	1.86	Sand	Sand	Sand	199.28	1.86	1.15	229.58	1.21	0.29	0.85	1.07	4.49	Nonliq
40.68	139.3	309.2	5.1	0.06	2.44	2.42	126.77	1.66	1.99	0.66	193.37	1.86	Sand	Sand	Sand	194.91	1.86	1.16	225.56	1.15	0.29	0.84	1.07	4.27	Nonliq
41.18	138.8	262.2	5.1	0.06	2.47	2.43	106.70	1.96	2.09	0.65	163.24	1.97	Sand	Sand	Sand	164.79	1.97	1.26	207.54	0.91	0.29	0.84	1.07	3.39	Nonliq
41.67	138.3	305.7	4.0	0.06	2.50	2.45	123.83	1.32	1.92	0.65	190.01	1.79	Sand	Sand	Sand	191.57	1.79	1.10	211.06	0.95	0.29	0.83	1.07	3.54	Nonliq
42.16	137.8	255.6	4.3	0.06	2.53	2.46	102.76	1.70	2.06	0.65	158.13	1.93	Sand	Sand	Sand	159.71	2.61	3.39	541.20	14.82	0.29	0.83	1.07	54.98	Clay

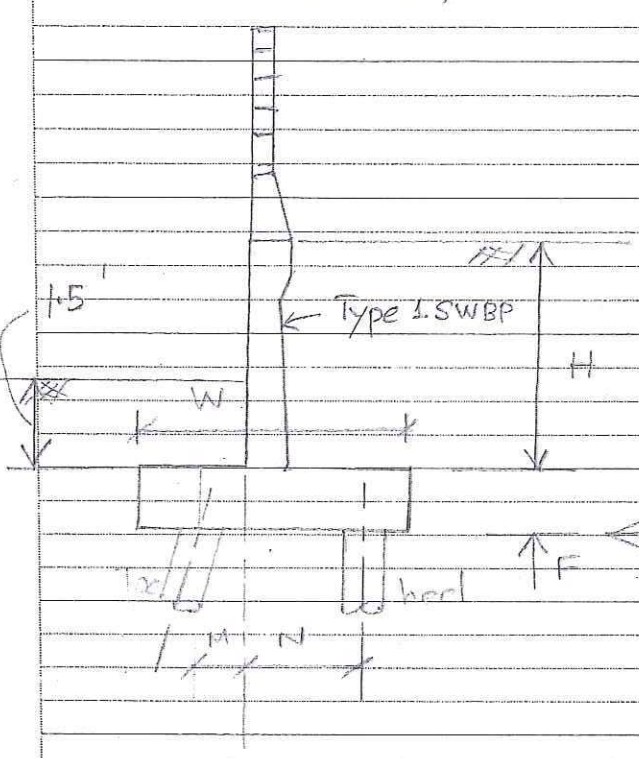
Depth (ft)	El. (ft MLLW)	$q_{c,tip}$ (tsf)	f_s (tsf)	Unit Wt (tcf)	Total OB (tsf)	Eff OB (tsf)	Q_1	F (%)	I_{c1}	C_{Q2}	Q_2	I_{c2}	C_{Q3}	Q_3	I_{c3}	q_{c1N}	I_c	K_c	$(q_{c1n})_{CS}$	$CRR_{7.5}$	CSR	r_d	MSF	FOS	Liquefaction
42.65	137.4	293.4	4.7	0.06	2.56	2.48	117.42	1.62	2.00	0.65	181.21	1.87	Sand	Sand	Sand	182.81	1.87	1.16	212.90	0.98	0.29	0.83	1.07	3.62	Nonliq
43.15	136.9	309.7	4.7	0.06	2.59	2.49	123.27	1.53	1.97	0.65	190.79	1.84	Sand	Sand	Sand	192.40	1.84	1.14	218.88	1.06	0.29	0.82	1.07	3.91	Nonliq
43.64	136.4	306.3	5.2	0.06	2.62	2.51	121.20	1.71	2.01	0.64	188.13	1.88	Sand	Sand	Sand	189.75	1.88	1.17	222.47	1.10	0.29	0.82	1.07	4.08	Nonliq
44.13	135.9	317.6	5.1	0.06	2.65	2.52	124.99	1.62	1.98	0.64	194.56	1.85	Sand	Sand	Sand	196.19	2.61	3.39	664.80	27.41	0.29	0.81	1.07	101.33	Clay
44.62	135.4	245.0	2.9	0.06	2.68	2.53	95.63	1.20	1.98	0.64	149.27	1.83	Sand	Sand	Sand	150.92	1.83	1.13	170.92	0.54	0.29	0.81	1.07	2.01	Nonliq
45.11	134.9	52.1	1.7	0.06	2.71	2.55	19.38	3.44	2.80	Clay	Clay	Clay	Clay	Clay	Clay	20.45	2.80	4.80	98.12	0.17	0.29	0.81	1.07	0.62	Clay
45.61	134.4	18.0	0.7	0.06	2.74	2.56	5.96	4.59	3.29	Clay	Clay	Clay	Clay	Clay	Clay	7.02	3.29	10.51	73.85	0.12	0.29	0.80	1.07	0.43	Clay
46.10	133.9	178.4	3.8	0.06	2.77	2.58	68.16	2.16	2.26	0.64	107.29	2.12	Sand	Sand	Sand	108.98	2.12	1.49	162.42	0.48	0.29	0.80	1.07	1.77	Nonliq
46.59	133.4	371.5	7.7	0.06	2.80	2.59	142.30	2.09	2.03	0.63	224.60	1.90	Sand	Sand	Sand	226.31	1.90	1.19	269.73	1.91	0.29	0.79	1.07	7.03	Nonliq
47.08	132.9	387.2	9.0	0.06	2.82	2.61	147.53	2.34	2.05	0.63	233.51	1.93	Sand	Sand	Sand	235.23	1.93	1.22	287.59	2.29	0.29	0.79	1.07	8.46	Nonliq
47.57	132.4	372.0	6.8	0.06	2.85	2.62	140.92	1.84	1.99	0.63	223.65	1.86	Sand	Sand	Sand	225.38	1.86	1.15	260.04	1.72	0.29	0.79	1.07	6.33	Nonliq
48.07	131.9	320.2	5.3	0.06	2.88	2.63	120.47	1.67	2.00	0.63	191.72	1.87	Sand	Sand	Sand	193.46	1.87	1.16	224.53	1.13	0.29	0.78	1.07	4.18	Nonliq
48.56	131.4	252.8	5.1	0.06	2.91	2.65	94.36	2.04	2.14	0.63	150.57	2.00	Sand	Sand	Sand	152.33	2.00	1.30	198.54	0.81	0.29	0.78	1.07	2.98	Nonliq
49.05	131.0	187.0	5.0	0.06	2.94	2.66	69.13	2.72	2.32	0.62	110.61	2.18	Sand	Sand	Sand	112.38	2.18	1.63	183.00	0.65	0.29	0.77	1.07	2.40	Nonliq
49.54	130.5	157.5	4.9	0.06	2.97	2.68	57.73	3.17	2.43	0.62	92.62	2.29	Sand	Sand	Sand	94.40	2.29	1.90	179.58	0.62	0.29	0.77	1.07	2.29	Nonliq
50.04	130.0	134.2	3.3	0.06	3.00	2.69	48.75	2.52	2.41	0.62	78.42	2.26	Sand	Sand	Sand	80.22	2.26	1.83	146.60	0.37	0.29	0.77	1.07	1.38	Nonliq
50.53	129.5	50.0	2.5	0.06	3.03	2.71	17.36	5.32	2.96	Clay	Clay	Clay	Clay	Clay	Clay	18.48	2.96	6.31	116.63	0.23	0.29	0.76	1.07	0.84	Clay
51.02	129.0	27.4	1.1	0.06	3.06	2.72	8.95	4.52	3.14	Clay	Clay	Clay	Clay	Clay	Clay	10.08	3.14	8.43	84.97	0.14	0.29	0.76	1.07	0.51	Clay
51.51	128.5	28.1	1.5	0.06	3.09	2.73	9.15	6.00	3.21	Clay	Clay	Clay	Clay	Clay	Clay	10.28	3.21	9.35	96.09	0.16	0.29	0.75	1.07	0.60	Clay
52.00	128.0	46.1	2.0	0.06	3.12	2.75	15.64	4.65	2.96	Clay	Clay	Clay	Clay	Clay	Clay	16.78	2.96	6.28	105.28	0.19	0.29	0.75	1.07	0.70	Clay
52.50	127.5	21.9	0.9	0.06	3.15	2.76	6.79	4.80	3.25	Clay	Clay	Clay	Clay	Clay	Clay	7.93	3.25	9.99	79.23	0.13	0.29	0.75	1.07	0.47	Clay
52.99	127.0	19.7	0.6	0.06	3.18	2.78	5.95	3.63	3.23	Clay	Clay	Clay	Clay	Clay	Clay	7.09	3.23	9.68	68.66	0.11	0.29	0.74	1.07	0.41	Clay
53.48	126.5	27.3	1.0	0.06	3.21	2.79	8.63	4.15	3.13	Clay	Clay	Clay	Clay	Clay	Clay	9.78	3.13	8.31	81.32	0.13	0.29	0.74	1.07	0.48	Clay
53.97	126.0	20.8	0.7	0.06	3.24	2.81	6.26	3.99	3.23	Clay	Clay	Clay	Clay	Clay	Clay	7.41	3.23	9.74	72.20	0.12	0.29	0.73	1.07	0.43	Clay
54.46	125.5	21.4	0.7	0.06	3.27	2.82	6.43	3.86	3.22	Clay	Clay	Clay	Clay	Clay	Clay	7.59	3.22	9.49	72.01	0.11	0.29	0.73	1.07	0.43	Clay
54.96	125.0	100.0	3.7	0.06	3.30	2.83	34.12	3.83	2.65	Clay	Clay	Clay	Clay	Clay	Clay	35.29	2.65	3.62	127.77	0.27	0.29	0.73	1.07	1.03	Clay
55.45	124.6	276.0	6.2	0.06	3.33	2.85	95.74	2.27	2.17	0.60	158.44	2.02	Sand	Sand	Sand	160.37	2.02	1.33	213.87	0.99	0.29	0.72	1.07	3.71	Nonliq
55.94	124.1	394.7	8.2	0.06	3.36	2.86	136.73	2.10	2.04	0.60	226.82	1.90	Sand	Sand	Sand	228.77	1.90	1.19	272.38	1.96	0.28	0.72	1.07	7.36	Nonliq
56.43	123.6	394.9	8.7	0.06	3.39	2.88	136.11	2.22	2.06	0.60	226.36	1.92	Sand	Sand	Sand	228.32	1.92	1.21	276.59	2.05	0.28	0.71	1.07	7.71	Nonliq
56.93	123.1	383.5	3.8	0.06	3.42	2.89	131.47	1.00	1.82	0.60	219.20	1.66	Sand	Sand	Sand	221.17	1.66	1.01	223.82	1.12	0.28	0.71	1.07	4.23	Nonliq
57.09	122.9	388.7	3.2	0.06	3.43	2.90	133.05	0.83	1.76	0.60	222.02	1.60	Sand	Sand	Sand	223.99	1.60	1.00	223.99	1.13	0.28	0.71	1.07	4.25	Nonliq

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening – Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/7/11 Checked By: Lino Date: 4-6-11 Sheet: 1 of 3
Subject:

RW No. 293 – Axial pile Calculations (using SHAFT 6.0)

For H = 18 ft,



M+N = 8' = 6ϕ
η = 1.0

Toe pile spacing = 4 ft
= 3ϕ
⇒ η = 0.77

Heel pile spacing = 6 ft
= 4.5ϕ
η = 1.0

16-in diameter CIDH piles

Under Strength Limit State,

maximum load per toe pile = 104 kips = 52 tons
maximum load per heel pile = 62 kips = 31 tons

⇒ Select toe pile for axial pile analyses

Group reduction factor for toe pile = (1+1+0.77+0.77)/4
= 0.88

For toe piles,

nominal resistance = 52/0.7 = 75 tons

Apply η = 0.88 ⇒ nominal resistance = 75/0.88 = 85 tons SELECT 90 tons

From SHAFT analysis, Required pile length = 29 ft
Required pile tip El = +180' – 29' = +151'

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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening - Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-6-11 Sheet: 2 of 3
Subject:

Under extreme limit state,

max load per toe pile = 109 kips = 54.5 tons

Apply $\eta = 0.88$ & $\phi = 1.0$ ⇒

nominal resistance = $\frac{54.5 \times 1.0}{0.88}$ = 62 tons

SELECT 70 tons //

From SHAFT,

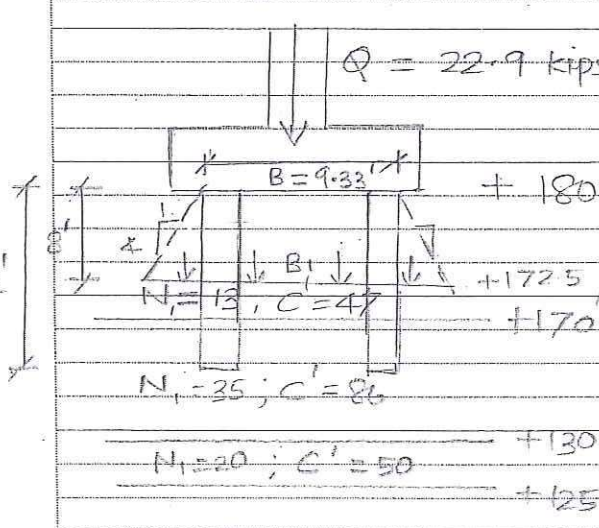
Required pile length = 25 ft

Required pile tip El = +180' − 25' = +155' //

Settlement check

Permissible settlement under service load = 1"

Service load = 22.9 kips/ft



B = M + N + 1.33' = 9.33'

L = 1'

@ Equivalent footing,

$B_1 = 9.33' + 4' = 13.33'$

$L_1 = 1' + 4' = 5'$

$\Delta H_i = \frac{H_i}{C'} \log\left(\frac{\sigma_o' + \Delta\sigma_v'}{\sigma_o'}\right)$

Layer	H (ft)	C'	σ_o' (ksf)	$\Delta\sigma_v'$ (ksf)	ΔH_i (in)
Sand	2.5'	47	1.05	0.3	0.07
sand	40'	86	3.6	0.03	0.02
clay	5'	50	6.3	0.01	0.01

$\sum \Delta H_i = 0.1" < 1"$ //

⇒ No design tip for settlement for RW No. 293 //

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Project: SR-91 WB Widening – Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-6-11 Sheet: 3 of 3
Subject:

H (ft)	BOF (ft)	Required Qs (tons)		Required pile tip El. (ft)	
		Strength	Extreme	Strength	Extreme
16	+180.5	70	50	+155'	+159'
	+178.5			+153'	+157'
14	+178.5	90	70	+149'	+153'
	+176.5			+148'	+151'

Design pile tip for lateral load

Based on LPILE analyses,
25-ft depth was selected for design tip

∴ Design tip El. = +180' − 25'
= +155' //

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VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
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SR-91 WB Widening Project - RW No. 293 (H=18 ft)

BOF = + 180.5'

TOTAL LOAD = 150.0 TONS

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 55.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00

SOIL INFORMATION

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.100E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.708E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.105E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.106E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.105E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.541E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.505E+02

LAYER NO 3----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.200E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.505E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.200E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.555E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.494E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.555E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.100E+03

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	= 1.333	FT.
DIAMETER OF BASE	= 1.333	FT.
END OF STEM TO BASE	= 0.000	FT.
ANGLE OF BELL	= 0.000	DEG.
IGNORED TOP PORTION	= 0.000	FT.
IGNORED BOTTOM PORTION	= 0.000	FT.
AREA OF ONE PERCENT STEEL	= 2.010	SQ.IN.
ELASTIC MODULUS, Ec	= 0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	= 0.000	CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
1.0	0.05	0.23	1.88	2.11	2.11	2.11	40.88
2.0	0.10	0.67	2.51	3.18	3.18	3.18	30.76
3.0	0.16	1.30	3.14	4.44	4.44	4.44	28.66
4.0	0.21	2.13	3.77	5.90	5.90	5.90	28.52
5.0	0.26	3.13	4.40	7.53	7.53	7.53	29.13
6.0	0.31	4.31	5.03	9.33	9.33	9.33	30.09
7.0	0.36	5.65	5.65	11.30	11.30	11.30	31.23
8.0	0.41	7.15	6.28	13.43	13.43	13.43	32.47
9.0	0.47	8.80	6.91	15.71	15.71	15.71	33.76
10.0	0.52	10.59	6.70	17.30	17.30	17.30	33.46
11.0	0.57	12.53	7.26	19.79	19.79	19.79	34.81
12.0	0.62	15.65	7.44	23.09	23.09	23.09	37.22
13.0	0.67	18.96	7.44	26.40	26.40	26.40	39.29
14.0	0.72	22.46	7.44	29.90	29.90	29.90	41.32
15.0	0.78	26.14	7.44	33.59	33.59	33.59	43.31
16.0	0.83	30.00	7.44	37.45	37.45	37.45	45.27
17.0	0.88	34.03	7.44	41.48	41.48	41.48	47.20
18.0	0.93	38.22	7.44	45.67	45.67	45.67	49.08
19.0	0.98	42.58	7.44	50.02	50.02	50.02	50.93
20.0	1.03	47.08	7.44	54.53	54.53	54.53	52.74
21.0	1.09	51.73	7.44	59.18	59.18	59.18	54.51
22.0	1.14	56.52	7.44	63.97	63.97	63.97	56.25
23.0	1.19	61.45	7.44	68.90	68.90	68.90	57.95
24.0	1.24	66.51	7.44	73.96	73.96	73.96	59.61
25.0	1.29	71.69	7.44	79.14	79.14	79.14	61.24
26.0	1.34	77.00	7.44	84.44	84.44	84.44	62.83
27.0	1.40	82.41	7.44	89.86	89.86	89.86	64.38
28.0	1.45	87.94	7.44	95.39	95.39	95.39	65.90
29.0	1.50	93.58	7.44	101.02	101.02	101.02	67.39
30.0	1.55	99.31	7.44	106.75	106.75	106.75	68.84
31.0	1.60	105.14	7.44	112.58	112.58	112.58	70.25
32.0	1.65	111.06	7.44	118.51	118.51	118.51	71.64
33.0	1.71	117.07	7.44	124.51	124.51	124.51	72.99
34.0	1.76	123.16	7.44	130.60	130.60	130.60	74.31
35.0	1.81	129.33	7.44	136.77	136.77	136.77	75.59
36.0	1.86	135.57	7.44	143.01	143.01	143.01	76.85
37.0	1.91	141.88	7.44	149.33	149.33	149.33	78.07
38.0	1.96	148.26	7.44	155.70	155.70	155.70	79.26

BOF = +180.5'

Extreme ⇒ H = 18'

Strength ⇒ H = 18'

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.4707E-01	0.4305E-04	0.1629E-03	0.1000E-04
0.2353E+00	0.2153E-03	0.8145E-03	0.5000E-04
0.4707E+00	0.4305E-03	0.1629E-02	0.1000E-03
0.2395E+02	0.2177E-01	0.8145E-01	0.5000E-02
0.3536E+02	0.3254E-01	0.1222E+00	0.7500E-02
0.4583E+02	0.4288E-01	0.1629E+00	0.1000E-01
0.8711E+02	0.9151E-01	0.4072E+00	0.2500E-01
0.1158E+03	0.1420E+00	0.8145E+00	0.5000E-01
0.1291E+03	0.1791E+00	0.1222E+01	0.7500E-01
0.1359E+03	0.2108E+00	0.1620E+01	0.1000E+00
0.1415E+03	0.3669E+00	0.3683E+01	0.2500E+00
0.1431E+03	0.6191E+00	0.5575E+01	0.5000E+00
0.1438E+03	0.7451E+00	0.6448E+01	0.6250E+00
0.1446E+03	0.9024E+00	0.7440E+01	0.7813E+00
0.1447E+03	0.9211E+00	0.7557E+01	0.7998E+00

RESULT FROM UPPER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.7255E-01	0.5886E-04	0.2327E-03	0.1000E-04
0.3627E+00	0.2943E-03	0.1164E-02	0.5000E-04
0.7255E+00	0.5886E-03	0.2327E-02	0.1000E-03

0.3675E+02	0.2987E-01	0.1164E+00	0.5000E-02
0.5307E+02	0.4417E-01	0.1745E+00	0.7500E-02
0.6718E+02	0.5748E-01	0.2327E+00	0.1000E-01
0.1143E+03	0.1134E+00	0.5818E+00	0.2500E-01
0.1373E+03	0.1610E+00	0.1164E+01	0.5000E-01
0.1436E+03	0.1924E+00	0.1745E+01	0.7500E-01
0.1458E+03	0.2199E+00	0.2290E+01	0.1000E+00
0.1486E+03	0.3733E+00	0.5030E+01	0.2500E+00
0.1499E+03	0.6250E+00	0.6366E+01	0.5000E+00
0.1506E+03	0.7509E+00	0.7064E+01	0.6250E+00
0.1515E+03	0.9082E+00	0.7937E+01	0.7813E+00
0.1516E+03	0.9269E+00	0.8041E+01	0.7998E+00

RESULT FROM LOWER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.2674E-01	0.2967E-04	0.9308E-04	0.1000E-04
0.1337E+00	0.1483E-03	0.4654E-03	0.5000E-04
0.2674E+00	0.2967E-03	0.9308E-03	0.1000E-03
0.1351E+02	0.1490E-01	0.4654E-01	0.5000E-02
0.2026E+02	0.2238E-01	0.6981E-01	0.7500E-02
0.2679E+02	0.2979E-01	0.9308E-01	0.1000E-01
0.5832E+02	0.6924E-01	0.2327E+00	0.2500E-01
0.9196E+02	0.1216E+00	0.4654E+00	0.5000E-01
0.1135E+03	0.1651E+00	0.6981E+00	0.7500E-01
0.1257E+03	0.2015E+00	0.9495E+00	0.1000E+00
0.1344E+03	0.3606E+00	0.2336E+01	0.2500E+00
0.1363E+03	0.6132E+00	0.4784E+01	0.5000E+00
0.1370E+03	0.7393E+00	0.5832E+01	0.6250E+00
0.1378E+03	0.8967E+00	0.6943E+01	0.7813E+00
0.1379E+03	0.9153E+00	0.7073E+01	0.7998E+00

Strength-Compression,H=16ft.sfo

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
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SR-91 WB Widening Project - RW No. 293 (H=16 ft)

BOF = +178.5'

TOTAL LOAD = 150.0 TONS

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 53.5 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00

SOIL INFORMATION

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.100E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.738E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.850E+01

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.111E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.850E+01

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.560E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.485E+02

LAYER NO 3----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.200E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.485E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.200E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.535E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.513E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.535E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.100E+03

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	= 1.333	FT.
DIAMETER OF BASE	= 1.333	FT.
END OF STEM TO BASE	= 0.000	FT.
ANGLE OF BELL	= 0.000	DEG.
IGNORED TOP PORTION	= 0.000	FT.
IGNORED BOTTOM PORTION	= 0.000	FT.
AREA OF ONE PERCENT STEEL	= 2.010	SQ.IN.
ELASTIC MODULUS, Ec	= 0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	= 0.000	CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)	
1.0	0.05	0.23	1.88	2.11	2.11	2.11	40.88	
2.0	0.10	0.67	2.51	3.18	3.18	3.18	30.76	
3.0	0.16	1.30	3.14	4.44	4.44	4.44	28.66	
4.0	0.21	2.13	3.77	5.90	5.90	5.90	28.52	
5.0	0.26	3.13	4.40	7.53	7.53	7.53	29.13	
6.0	0.31	4.31	5.03	9.33	9.33	9.33	30.09	
7.0	0.36	5.65	5.65	11.30	11.30	11.30	31.23	
8.0	0.41	7.15	5.59	12.73	12.73	12.73	30.78	
9.0	0.47	8.80	6.14	14.94	14.94	14.94	32.11	
10.0	0.52	11.49	6.70	18.20	18.20	18.20	35.20	
11.0	0.57	14.40	7.26	21.66	21.66	21.66	38.10	
12.0	0.62	17.52	7.44	24.96	24.96	24.96	40.24	
13.0	0.67	20.83	7.44	28.27	28.27	28.27	42.07	
14.0	0.72	24.33	7.44	31.77	31.77	31.77	43.90	
15.0	0.78	28.01	7.44	35.45	35.45	35.45	45.72	
16.0	0.83	31.87	7.44	39.31	39.31	39.31	47.53	
17.0	0.88	35.90	7.44	43.34	43.34	43.34	49.32	
18.0	0.93	40.09	7.44	47.54	47.54	47.54	51.09	
19.0	0.98	44.45	7.44	51.89	51.89	51.89	52.83	
20.0	1.03	48.95	7.44	56.40	56.40	56.40	54.55	Extreme H = 16'
21.0	1.09	53.60	7.44	61.05	61.05	61.05	56.23	
22.0	1.14	58.39	7.44	65.84	65.84	65.84	57.89	
23.0	1.19	63.32	7.44	70.77	70.77	70.77	59.52	
24.0	1.24	68.38	7.44	75.82	75.82	75.82	61.12	
25.0	1.29	73.56	7.44	81.01	81.01	81.01	62.68	Strength H = 16'
26.0	1.34	78.86	7.44	86.31	86.31	86.31	64.22	
27.0	1.40	84.28	7.44	91.73	91.73	91.73	65.72	
28.0	1.45	89.81	7.44	97.26	97.26	97.26	67.19	
29.0	1.50	95.44	7.44	102.89	102.89	102.89	68.63	
30.0	1.55	101.18	7.44	108.62	108.62	108.62	70.04	
31.0	1.60	107.01	7.44	114.45	114.45	114.45	71.42	
32.0	1.65	112.93	7.44	120.37	120.37	120.37	72.77	
33.0	1.71	118.94	7.44	126.38	126.38	126.38	74.08	
34.0	1.76	125.03	7.44	132.47	132.47	132.47	75.37	
35.0	1.81	131.20	7.44	138.64	138.64	138.64	76.63	
36.0	1.86	137.44	7.44	144.88	144.88	144.88	77.85	
37.0	1.91	143.75	7.44	151.19	151.19	151.19	79.05	

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.4466E-01	0.4057E-04	0.1629E-03	0.1000E-04
0.2233E+00	0.2028E-03	0.8145E-03	0.5000E-04
0.4466E+00	0.4057E-03	0.1629E-02	0.1000E-03
0.2274E+02	0.2050E-01	0.8145E-01	0.5000E-02
0.3364E+02	0.3067E-01	0.1222E+00	0.7500E-02
0.4370E+02	0.4047E-01	0.1629E+00	0.1000E-01
0.8376E+02	0.8702E-01	0.4072E+00	0.2500E-01
0.1118E+03	0.1361E+00	0.8145E+00	0.5000E-01
0.1249E+03	0.1726E+00	0.1222E+01	0.7500E-01
0.1316E+03	0.2040E+00	0.1620E+01	0.1000E+00
0.1371E+03	0.3599E+00	0.3683E+01	0.2500E+00
0.1387E+03	0.6120E+00	0.5575E+01	0.5000E+00
0.1395E+03	0.7380E+00	0.6448E+01	0.6250E+00
0.1403E+03	0.8953E+00	0.7440E+01	0.7813E+00
0.1404E+03	0.9140E+00	0.7557E+01	0.7998E+00

RESULT FROM UPPER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.6844E-01	0.5497E-04	0.2327E-03	0.1000E-04
0.3422E+00	0.2749E-03	0.1164E-02	0.5000E-04
0.6844E+00	0.5497E-03	0.2327E-02	0.1000E-03
0.3476E+02	0.2790E-01	0.1164E+00	0.5000E-02

0.5040E+02	0.4134E-01	0.1745E+00	0.7500E-02
0.6406E+02	0.5393E-01	0.2327E+00	0.1000E-01
0.1102E+03	0.1075E+00	0.5818E+00	0.2500E-01
0.1329E+03	0.1541E+00	0.1164E+01	0.5000E-01
0.1391E+03	0.1852E+00	0.1745E+01	0.7500E-01
0.1413E+03	0.2126E+00	0.2290E+01	0.1000E+00
0.1440E+03	0.3659E+00	0.5030E+01	0.2500E+00
0.1454E+03	0.6176E+00	0.6366E+01	0.5000E+00
0.1461E+03	0.7434E+00	0.7064E+01	0.6250E+00
0.1469E+03	0.9007E+00	0.7937E+01	0.7813E+00
0.1470E+03	0.9194E+00	0.8041E+01	0.7998E+00

RESULT FROM LOWER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.2554E-01	0.2827E-04	0.9308E-04	0.1000E-04
0.1277E+00	0.1414E-03	0.4654E-03	0.5000E-04
0.2554E+00	0.2827E-03	0.9308E-03	0.1000E-03
0.1289E+02	0.1419E-01	0.4654E-01	0.5000E-02
0.1936E+02	0.2132E-01	0.6981E-01	0.7500E-02
0.2562E+02	0.2839E-01	0.9308E-01	0.1000E-01
0.5598E+02	0.6623E-01	0.2327E+00	0.2500E-01
0.8857E+02	0.1169E+00	0.4654E+00	0.5000E-01
0.1096E+03	0.1594E+00	0.6981E+00	0.7500E-01
0.1216E+03	0.1952E+00	0.9495E+00	0.1000E+00
0.1302E+03	0.3539E+00	0.2336E+01	0.2500E+00
0.1321E+03	0.6064E+00	0.4784E+01	0.5000E+00
0.1329E+03	0.7325E+00	0.5832E+01	0.6250E+00
0.1337E+03	0.8899E+00	0.6943E+01	0.7813E+00
0.1338E+03	0.9085E+00	0.7073E+01	0.7998E+00

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

SR-91 WB Widening Project - RW No. 293 (H=14 ft)

BOF = +176.5'

TOTAL LOAD = 150.0 TONS

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 51.5 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00

SOIL INFORMATION

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.100E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.771E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.650E+01

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.116E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.650E+01

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.579E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.465E+02

LAYER NO 3----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.200E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.465E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.200E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.515E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.531E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.515E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.100E+03

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	= 1.333	FT.
DIAMETER OF BASE	= 1.333	FT.
END OF STEM TO BASE	= 0.000	FT.
ANGLE OF BELL	= 0.000	DEG.
IGNORED TOP PORTION	= 0.000	FT.
IGNORED BOTTOM PORTION	= 0.000	FT.
AREA OF ONE PERCENT STEEL	= 2.010	SQ.IN.
ELASTIC MODULUS, Ec	= 0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	= 0.000	CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)	
1.0	0.05	0.23	1.88	2.11	2.11	2.11	40.88	
2.0	0.10	0.67	2.51	3.18	3.18	3.18	30.76	
3.0	0.16	1.30	3.14	4.44	4.44	4.44	28.66	
4.0	0.21	2.13	3.77	5.90	5.90	5.90	28.52	
5.0	0.26	3.13	4.40	7.53	7.53	7.53	29.13	
6.0	0.31	4.31	4.47	8.78	8.78	8.78	28.29	
7.0	0.36	5.65	5.03	10.67	10.67	10.67	29.50	
8.0	0.41	7.90	5.59	13.48	13.48	13.48	32.60	
9.0	0.47	10.37	6.14	16.52	16.52	16.52	35.50	
10.0	0.52	13.07	6.70	19.77	19.77	19.77	38.24	
11.0	0.57	15.98	7.26	23.24	23.24	23.24	40.87	
12.0	0.62	19.09	7.44	26.53	26.53	26.53	42.78	
13.0	0.67	22.40	7.44	29.85	29.85	29.85	44.41	
14.0	0.72	25.90	7.44	33.35	33.35	33.35	46.07	
15.0	0.78	29.58	7.44	37.03	37.03	37.03	47.75	
16.0	0.83	33.44	7.44	40.89	40.89	40.89	49.44	
17.0	0.88	37.47	7.44	44.92	44.92	44.92	51.11	
18.0	0.93	41.67	7.44	49.11	49.11	49.11	52.78	
19.0	0.98	46.02	7.44	53.47	53.47	53.47	54.43	
20.0	1.03	50.52	7.44	57.97	57.97	57.97	56.07	
21.0	1.09	55.18	7.44	62.62	62.62	62.62	57.68	
22.0	1.14	59.97	7.44	67.41	67.41	67.41	59.28	
23.0	1.19	64.90	7.44	72.34	72.34	72.34	60.84	
24.0	1.24	69.95	7.44	77.40	77.40	77.40	62.38	Extreme H = 14'
25.0	1.29	75.14	7.44	82.58	82.58	82.58	63.90	
26.0	1.34	80.44	7.44	87.88	87.88	87.88	65.39	
27.0	1.40	85.86	7.44	93.30	93.30	93.30	66.85	
28.0	1.45	91.39	7.44	98.83	98.83	98.83	68.28	
29.0	1.50	97.02	7.44	104.46	104.46	104.46	69.68	
30.0	1.55	102.75	7.44	110.20	110.20	110.20	71.06	Strength H = 14'
31.0	1.60	108.58	7.44	116.03	116.03	116.03	72.40	
32.0	1.65	114.50	7.44	121.95	121.95	121.95	73.72	
33.0	1.71	120.51	7.44	127.96	127.96	127.96	75.01	
34.0	1.76	126.60	7.44	134.05	134.05	134.05	76.27	
35.0	1.81	132.77	7.44	140.22	140.22	140.22	77.50	
36.0	1.86	139.01	7.44	146.46	146.46	146.46	78.70	
37.0	1.91	145.32	7.44	152.77	152.77	152.77	79.87	

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.4574E-01	0.4097E-04	0.1629E-03	0.1000E-04
0.2287E+00	0.2049E-03	0.8145E-03	0.5000E-04
0.4574E+00	0.4097E-03	0.1629E-02	0.1000E-03
0.2329E+02	0.2071E-01	0.8145E-01	0.5000E-02
0.3441E+02	0.3097E-01	0.1222E+00	0.7500E-02
0.4467E+02	0.4085E-01	0.1629E+00	0.1000E-01
0.8522E+02	0.8765E-01	0.4072E+00	0.2500E-01
0.1136E+03	0.1369E+00	0.8145E+00	0.5000E-01
0.1267E+03	0.1734E+00	0.1222E+01	0.7500E-01
0.1334E+03	0.2049E+00	0.1620E+01	0.1000E+00
0.1389E+03	0.3608E+00	0.3683E+01	0.2500E+00
0.1405E+03	0.6129E+00	0.5575E+01	0.5000E+00
0.1413E+03	0.7388E+00	0.6448E+01	0.6250E+00
0.1421E+03	0.8962E+00	0.7440E+01	0.7813E+00
0.1422E+03	0.9148E+00	0.7557E+01	0.7998E+00

RESULT FROM UPPER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.7028E-01	0.5564E-04	0.2327E-03	0.1000E-04
0.3514E+00	0.2782E-03	0.1164E-02	0.5000E-04
0.7028E+00	0.5564E-03	0.2327E-02	0.1000E-03
0.3568E+02	0.2824E-01	0.1164E+00	0.5000E-02

Strength-Compression,H=14ft.sfo

0.5163E+02	0.4180E-01	0.1745E+00	0.7500E-02
0.6550E+02	0.5449E-01	0.2327E+00	0.1000E-01
0.1120E+03	0.1083E+00	0.5818E+00	0.2500E-01
0.1348E+03	0.1549E+00	0.1164E+01	0.5000E-01
0.1410E+03	0.1861E+00	0.1745E+01	0.7500E-01
0.1432E+03	0.2135E+00	0.2290E+01	0.1000E+00
0.1459E+03	0.3668E+00	0.5030E+01	0.2500E+00
0.1473E+03	0.6185E+00	0.6366E+01	0.5000E+00
0.1480E+03	0.7443E+00	0.7064E+01	0.6250E+00
0.1488E+03	0.9016E+00	0.7937E+01	0.7813E+00
0.1489E+03	0.9203E+00	0.8041E+01	0.7998E+00

RESULT FROM LOWER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.2607E-01	0.2849E-04	0.9308E-04	0.1000E-04
0.1303E+00	0.1424E-03	0.4654E-03	0.5000E-04
0.2607E+00	0.2849E-03	0.9308E-03	0.1000E-03
0.1316E+02	0.1430E-01	0.4654E-01	0.5000E-02
0.1976E+02	0.2149E-01	0.6981E-01	0.7500E-02
0.2613E+02	0.2860E-01	0.9308E-01	0.1000E-01
0.5701E+02	0.6666E-01	0.2327E+00	0.2500E-01
0.9006E+02	0.1176E+00	0.4654E+00	0.5000E-01
0.1113E+03	0.1601E+00	0.6981E+00	0.7500E-01
0.1233E+03	0.1960E+00	0.9495E+00	0.1000E+00
0.1319E+03	0.3547E+00	0.2336E+01	0.2500E+00
0.1338E+03	0.6072E+00	0.4784E+01	0.5000E+00
0.1346E+03	0.7333E+00	0.5832E+01	0.6250E+00
0.1354E+03	0.8907E+00	0.6943E+01	0.7813E+00
0.1355E+03	0.9094E+00	0.7073E+01	0.7998E+00

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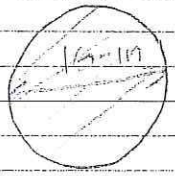
Project: SR-91 WB Widening – Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-5-11 Sheet: 1 of 1
Subject:

Lateral Pile Analyses

Area = 201.1 in^2

$I = \pi/4 \times 8^4 = 3{,}220\ in^4$

$E = 3.6 \times 10^6$ psi



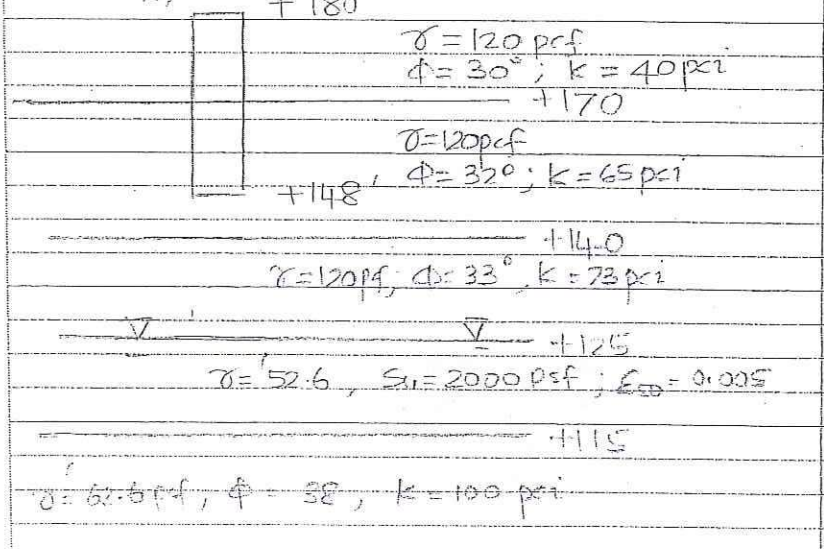
CIDH

Use 50% EI & Free head conditions.

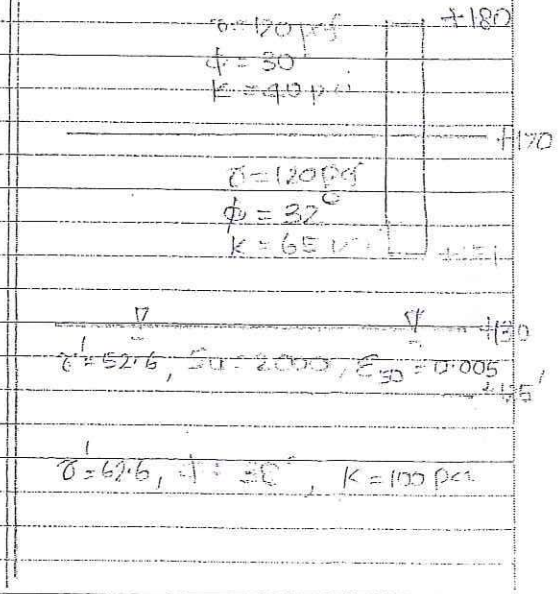
δ = 0.25", 0.5", 1", 2" and 5"

Group reduction factor = 0.88

RW No. 255



RW No. 293



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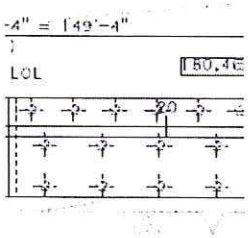
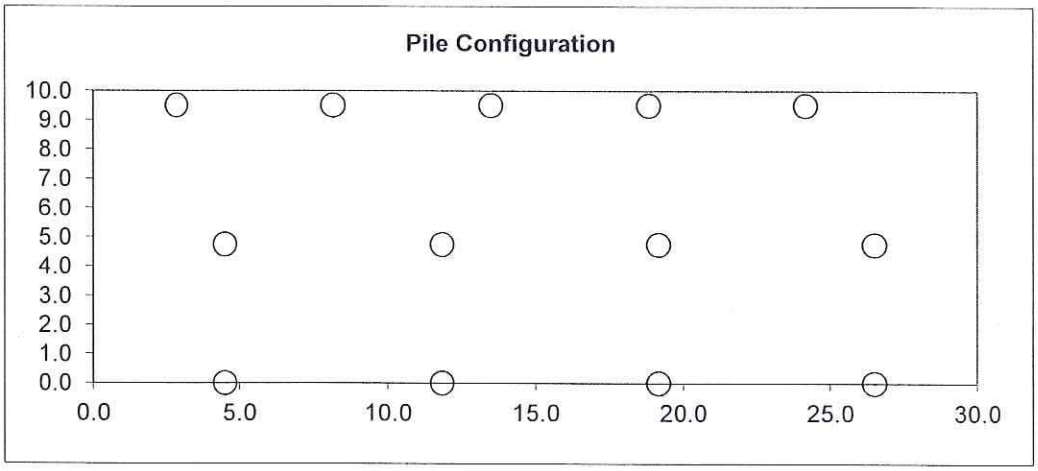
Project: **RW 293** Project No. **10-126**
By SP Date 05/20/11 Check by Date Sheet

Proposed RW 293 Pile Layout



Calculation of Pile Group Efficiency for Lateral Load Capacity

(using formula in Group 7.0 Technical Manual)



Pile Dia. (feet): 1.33
No. of Piles: 13

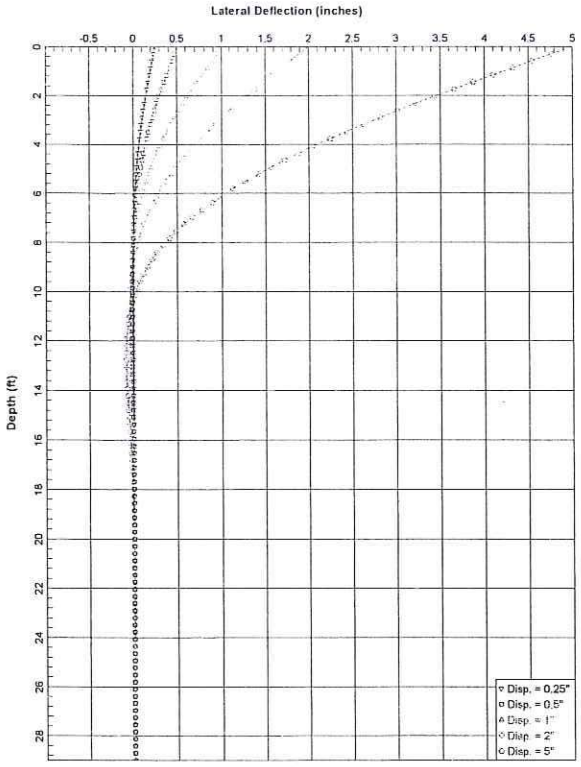
	X-Dir	Y-Dir
Group Efficiency	0.893	0.760

Use **0.88**

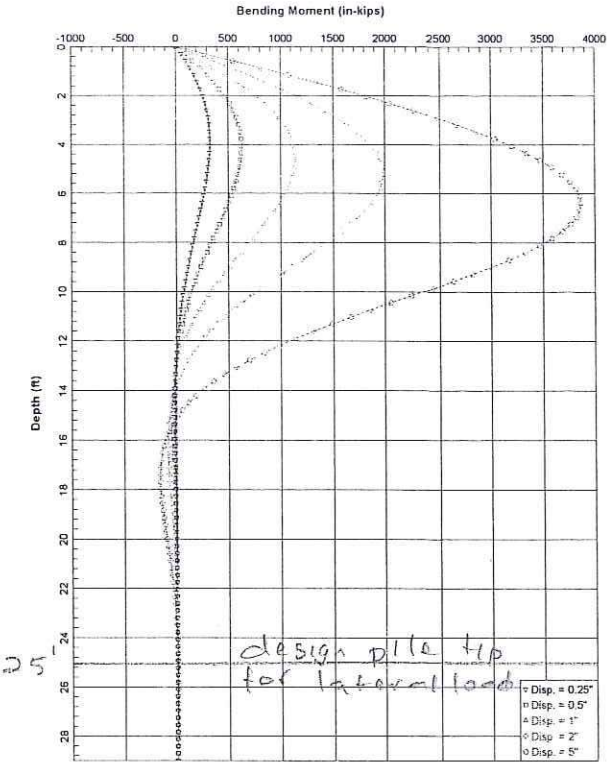
Coordinates

Pile No.	X	Y
1	4.5	0.0
2	11.8	0.0
3	19.2	0.0
4	26.5	0.0
5	4.5	4.8
6	11.8	4.8
7	19.2	4.8
8	26.5	4.8
9	2.8	9.5
10	8.2	9.5
11	13.5	9.5
12	18.8	9.5
13	24.2	9.5

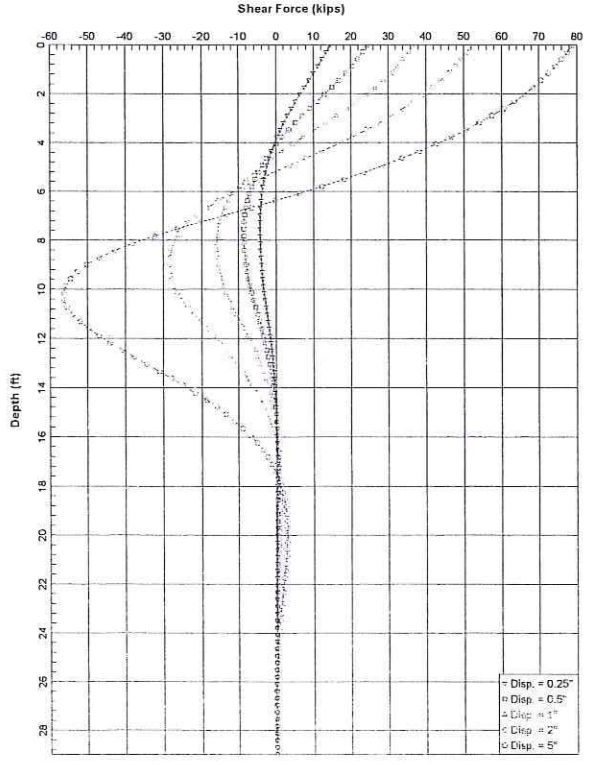
Reduction Factors in X-dir	Reduction Factors in Y-dir
0.892	0.773
0.892	0.769
0.892	0.769
0.986	0.773
0.844	0.726
0.855	0.719
0.833	0.700
0.986	0.827
0.796	0.990
0.770	1.000
0.775	0.990
0.797	0.975
0.966	1.000



RW No. 293 - 16-in CIDH Pile - Free



RW No. 293 - 16-in CIDH Pile - Free



RW No. 293 - 16-in CIDH Pile - Free

LPile Plus for Windows, Version 6.0 (6.0.09)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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Files Used for Analysis

Path to file locations: X:\Projects\2010\10-126 - RBF, SR 91 Westbound Widening\Reports\Foundation Report\07 Retaining Walls\Analysis\RW No. 293\LPILE\
Name of input data file: 16-inch CIDH pile.lp6d
Name of output file: 16-inch CIDH pile.lp6o
Name of plot output file: 16-inch CIDH pile.lp6p
Name of runtime file: 16-inch CIDH pile.lp6r

Date and Time of Analysis

Date: November 17, 2011 Time: 9:56:31

Problem Title

Project Name: SR-91 WB Widening
Job Number: 10-126
Client:
Engineer: GJG
Description: 16-inch CIDH at RW No. 293

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	300	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections	=	1
Total Pile Length	=	29.00 ft
Depth of ground surface below top of pile	=	-4.00 ft

Slope angle of ground surface = 0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over
the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.000000	16.0000000
2	29.000000	16.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	29.000 in
Top Width	=	16.000 in
Bottom Width	=	16.000 in
Top Area	=	201.061930 sq. in
Bottom Area	=	201.061930 sq. in
Moment of Inertia at Top	=	3.217E+03 in^4
Moment of Inertia at Bottom	=	3.217E+03 in^4
Elastic Modulus	=	1800000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer	=	-4.000 ft
Distance from top of pile to bottom of layer	=	10.000 ft
p-y subgrade modulus k for top of soil layer	=	40.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	40.000 lbs/in**3

Layer 2 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer	=	10.000 ft
Distance from top of pile to bottom of layer	=	50.000 ft
p-y subgrade modulus k for top of soil layer	=	65.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	65.000 lbs/in**3

Layer 3 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	50.000 ft
Distance from top of pile to bottom of layer	=	55.000 ft

Layer 4 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer	=	55.000 ft
Distance from top of pile to bottom of layer	=	100.000 ft
p-y subgrade modulus k for top of soil layer	=	100.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	100.000 lbs/in**3

(Depth of lowest layer extends 71.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 8 points

Point No.	Depth X ft	Eff. Unit Weight pcf

1	-4.00	120.00000
2	10.00	120.00000
3	10.00	120.00000
4	50.00	120.00000
5	50.00	52.60000
6	55.00	52.60000
7	55.00	62.60000
8	100.00	62.60000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. Subgr. pci
1	API Sand	-4.000	120.000	--	30.000	--	--	--	40.000	--	--	--	--	--
		10.000	120.000	--	30.000	--	--	--	40.000	--	--	--	--	--
2	API Sand	10.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
		50.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
3	Soft Clay	50.000	52.600	2000.000	--	--	--	0.00500	--	--	--	--	--	--
		55.000	52.600	2000.000	--	--	--	0.00500	--	--	--	--	--	--
4	API Sand	55.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--
		100.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.8800	1.0000
2	29.000	0.8800	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	23000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	23000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	23000.000
4	4	y =	2.000 in	M =	0.000 in-lbs	23000.000
5	4	y =	5.000 in	M =	0.000 in-lbs	23000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)		Condition 2 in-lb, rad., or in-lb/rad.	Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y = 0.2500	M =	0.000	23000.	0.25000000	328121.	14582.	0.00000000
2	4	y = 0.5000	M =	0.000	23000.	0.50000000	627577.	24452.	0.00000000
3	4	y = 1.0000	M =	0.000	23000.	1.00000000	1143539.	36887.	0.00000000
4	4	y = 2.0000	M =	0.000	23000.	2.00000000	1983758.	52213.	0.00000000
5	4	y = 5.0000	M =	0.000	23000.	5.00000000	3862722.	78839.	0.00000000

The analysis ended normally.

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Project: SR-91 WB Widening - Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-6-11 Sheet: 1 of 5
Subject:

Retaining Wall No. 293 - Type 1 SWB, Type 1 SWBP

Type 736A, 736SV

SW

* $N_1 = N \times \eta$ ← Hammer efficiency

$\eta = 75/60 = 1.25$

* H varies from 0' to 18'
* W, F, and bearing pressure were given by the designers

Type 736A (Mod.)

* Settlement $\Delta S = \frac{H}{C'} \log\left(\frac{\sigma_o' + \Delta\sigma_v'}{\sigma_o'}\right)$

(AASHTO LRFD)

Type 1 RW.

H

FG.

1.5' = Fill @ Front of wall

F

q

BOF

W

c = 100 psf

$\gamma = 120$; $\Phi = 30$; Navg = 11; $N_1 = 13$

+170'

$\gamma = 120$; $\Phi = 32°$; Navg = 28; $N_1 = 35$

+130'

$\gamma = 115$, $S_u = 2000$ psf; $N_1 = 20$ (assume)

+125'

$\gamma = 125$; $\Phi = 28°$;

2

1

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Project: SR-91 WB Widening - Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-6-11 Sheet: 2 of 5
Subject:

Case I

$H = 8'$, $W = 7'$, $F = 1.5'$, BOF = $+176.5'$ and $+178.5'$

$\therefore$ FG = $+176.5' + 1.5' + 1.5' = +179.5'$ and $+181.5'$

Max. Service bearing (90) = 2.192 ksf

for BOF = $+176.5'$,
$\Delta S = 1.31''$ & overex = $2'$

For BOF = $+178.5'$
$\Delta S = 1.38''$ & overex. = $2'$

Case II

$H = 10'$; $W = 7.5'$, $F = 1.5'$, BOF = $+178.5'$

$\therefore$ FG = $+181.5'$
$q = 2.475$ ksf

$\Rightarrow \Delta S = 1.53''$; Required overex. = $3'$

Case III

$H = 12'$; $W = 8.25'$; $F = 1.75'$, BOF = $+176.5'$ and $+178.5'$

$\therefore$ FG = $+179.75'$ and $+181.75'$

$q = 2.847$ ksf

For BOF = $+176.5'$
$\Delta S = 1.61''$
overex. = $4'$

For BOF = $+178.5'$
$\Delta S = 1.74''$
overex = $4'$

Case IV $H = 14'$, $W = 9.25'$, $F = 1.75'$, BOF = $+176.5'$ and $+178.5'$

$\therefore$ FG = $+179.75'$ and $+181.75'$

$q = 3.118$ ksf

For BOF = $+176.5'$
$\Delta S = 1.77''$
Overex = $5'$

For BOF = $+178.5'$
$\Delta S = 1.97''$
Overex = $6'$

$\Rightarrow$ RW with H = $14'$ will require 6-ft or more overex.

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Project: SR-91 WB Widening - Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-6-11 Sheet: 3 of 5
Subject:

Case VII $H < 6'$

Foundation design should be performed using $\phi = 30°$ & $\gamma = 120$ pcf in Caltrans Standard Plans.

RW No. 293 Bearing Capacity Summary

H (ft)	B (ft)	BOF (ft)	D (ft)	q_{all} (ksf)			Recommd overex. (ft)
				Strength	Extreme	Service	
8	7	+176.5	3	4.3	9.6	2.2	2
8	7	+178.5	3	4.3	9.6	2.2	2
10	7.5	+178.5	3	4.6	10.2	2.5	3
12	8.25	+176.5	3.25	4.9	10.9	2.9	4
12	8.25	+178.5	3.25	4.9	10.9	2.9	4
14*	9.25	+176.5	3.25	5.4	11.9	3.2	5
14*	9.25	+178.5	3.25	5.4	11.9	3.2	6

* For wall with $H = 14'$,

Max bearing under extreme limit state = 12.753 ksf

$\therefore$ q_{all} under extreme limit state $<$ max. bearing under extreme limit state

$\Rightarrow$ Pile foundation is recommended for wall with $H > 12$ //

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Project: SR-91 WB Widening – Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-6-11 Sheet: 4 of 5
Subject:

KW No. 293 - Bearing Capacity Sample Calculations

For H = 12',

B = 8.25'; F = 1.75'; BOF = +178.5'; D = 1.75' + 1.5' = 3.25'

Bearing Pressures,

Service Limit State = 2.847 ksf
Strength Limit State = 4.428 ksf
Extreme Limit State = 10.017 ksf

Assume a minimum horizontal distance between footing and slope face

b = 4'

$b/B = 0.48 \approx 0.5$

$D/B = \frac{3.25'}{8.25'} \approx 0.4$

$q_u = c N_{cm} + \gamma D N_{qm} + \frac{1}{2} \gamma B N_{\gamma m}$

Modified factors

$N_{cm} = N_c s_c i_c d_c$; $N_{qm} = N_q s_q i_q d_q$; $N_{\gamma m} = N_{\gamma q} s_\gamma i_\gamma d_\gamma$

load inclination factors, $i_c = i_q = i_c = 1$

shape factors, $s_c = s_q = s_\gamma = 1$ ($\because B << L$)

depth factor, $d_q = 1.0$ for $\phi = 30°$

Slope height $H_s > B$; Slope angle $i = 26°$

$\therefore N_q = 0$; $N_s = 0$

For $b/B = 0.5$ & $D/B = 0.4$ & $\phi = 30°$,

$N_{cq} = 5.6$ & $N_{\gamma q} = 21$ (AASHTO LRFD Tab 10.6.3.1.2c-1 &2)

$q_u = (100 \times 5.6) + (\frac{1}{2} \times 120 \times 8.25 \times 21) = 10.9$ ksf

Strength Limit State

$q_{all} = \phi q_u$ ϕ - Resistance factor

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By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-6-11 Sheet: 5 of 5
Subject:

$\phi = 0.45$

$\therefore q_{all} = 0.45 \times 10.9 = 4.9$ ksf $>$ 4.428 ksf (bearing pressure)

Extreme Limit State

$q_{all} = \phi q_u$

$\phi = 1.0$

$q_{all} = 10.9$ ksf $>$ 10.017 ksf (bearing pressure)

Service Limit State

Based on the settlement estimates,

$q_{all} = 2.9$ ksf is recommended provided a minimum 4-foot overexcavation are performed for 12-foot high wall.

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Project: **SR-91 WB Widening Project** Project No. **10-126**
By GJG Date 4/1/2011 Check by Lino Date 4-6-11 Sheet

Settlement Calculation for Spread Footing - RW No. 293 (H=8 ft)

Footing Info

Footing Elevation= 176.5 ft = Embedded Depth = 3 ft
Load Width= 7.00 ft
Net Contact Stress = 2.19 ksf => **Gross Contact Stress = 2.6 ksf**

Check Settlement:

Method: AASHTO LRFD Bridge Design Spec - Hough's Method

Layer	Top Elev. (ft)	Bottom Elev. (ft)	Top Depth (ft)	Bottom Depth (ft)	Soil Type	γ' pcf	(N')	c'
1	179.5	170	0	9.5	SM	120	13	47
2	170	130	9.5	49.5	SM	120	35	86
3	130	125	49.5	54.5	ML	115	20	50

Note: 1. C'= Bearing Capacity Index
2. N'= Average Corrected SPT Blowcount

Depth (ft)	Layer Thick. (ft)	Mid Point Depth (ft)	Effec. Unit Weight, γ' kcf	Initial Stress, σ_{vo}' (ksf)	Depth to Equiv. Footing (ft)	Stress Increase, $\Delta\sigma_v'$ (ksf)	Total Stress, σ_{vt} (ksf)	Bearing Capacity Index, C'	ΔS (in)	Total ΔS (in)	
0											
3	3	1.5	0.120	0.18	-1.5	0.00	0.18	47	0.00	0.00	
4	1	3.5	0.120	0.42	0.5	2.05	2.47	47	0.20	0.20	
5	1	4.5	0.120	0.54	1.5	1.81	2.35	47	0.16	0.36	Overex.
6	1	5.5	0.120	0.66	2.5	1.62	2.28	47	0.14	0.50	
7	1	6.5	0.120	0.78	3.5	1.46	2.24	47	0.12	0.61	
8	1	7.5	0.120	0.90	4.5	1.33	2.23	47	0.10	0.71	
9.5	1.5	8.75	0.120	1.05	5.75	1.20	2.25	47	0.13	0.84	
11.5	2	10.5	0.120	1.26	7.5	1.06	2.32	86	0.07	0.92	
13.5	2	12.5	0.120	1.50	9.5	0.93	2.43	86	0.06	0.97	
17.5	4	15.5	0.120	1.86	12.5	0.79	2.65	86	0.09	1.06	
21.5	4	19.5	0.120	2.34	16.5	0.65	2.99	86	0.06	1.12	
25.5	4	23.5	0.120	2.82	20.5	0.56	3.38	86	0.04	1.16	
28.5	3	27	0.120	3.24	24	0.49	3.73	86	0.03	1.19	
32.5	4	30.5	0.120	3.66	27.5	0.44	4.10	86	0.03	1.22	
36.5	4	34.5	0.120	4.14	31.5	0.40	4.54	86	0.02	1.24	
40.5	4	38.5	0.120	4.62	35.5	0.36	4.98	86	0.02	1.26	
44.5	4	42.5	0.120	5.10	39.5	0.33	5.43	86	0.02	1.27	
48.5	4	46.5	0.120	5.58	43.5	0.30	5.88	86	0.01	1.28	
49.5	1	49	0.120	5.88	46	0.29	6.17	86	0.00	1.29	
53.5	4	51.5	0.115	6.17	48.5	0.28	6.45	50	0.02	1.31	
54.5	1	54	0.115	6.46	51	0.26	6.72	50	0.00	1.31	

Earth Mechanics, Inc.
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Project: **SR-91 WB Widening Project** Project No. **10-126**
By GJG Date 4/1/2011 Check by Lino Date 4-6-11 Sheet

Settlement Calculation for Spread Footing - RW No. 293 (H=8 ft)

Footing Info

Footing Elevation= 178.5 ft = Embedded Depth = 3 ft
Load Width= 7.00 ft
Net Contact Stress = 2.19 ksf => **Gross Contact Stress = 2.6 ksf**

Check Settlement:
Method: AASHTO LRFD Bridge Design Spec - Hough's Method

Layer	Top Elev. (ft)	Bottom Elev. (ft)	Top Depth (ft)	Bottom Depth (ft)	Soil Type	γ' pcf	(N')	c'
1	181.5	170	0	11.5	SM	120	13	47
2	170	130	11.5	51.5	SM	120	35	86
3	130	125	51.5	56.5	ML	115	20	50

Note: 1. C'= Bearing Capacity Index
2. N'= Average Corrected SPT Blowcount

Depth (ft)	Layer Thick. (ft)	Mid Point Depth (ft)	Effec. Unit Weight, γ' kcf	Initial Stress, σ_{vo}' (ksf)	Depth to Equiv. Footing (ft)	Stress Increase, $\Delta\sigma_v'$ (ksf)	Total Stress, σ_{vt} (ksf)	Bearing Capacity Index, C'	ΔS (in)	Total ΔS (in)	
0											
3	3	1.5	0.120	0.18	-1.5	0.00	0.18	47	0.00	0.00	
4	1	3.5	0.120	0.42	0.5	2.05	2.47	47	0.20	0.20	
5	1	4.5	0.120	0.54	1.5	1.81	2.35	47	0.16	0.36	overlay
6	1	5.5	0.120	0.66	2.5	1.62	2.28	47	0.14	0.50	
7	1	6.5	0.120	0.78	3.5	1.46	2.24	47	0.12	0.61	
8	1	7.5	0.120	0.90	4.5	1.33	2.23	47	0.10	0.71	
10	2	9	0.120	1.08	6	1.18	2.26	47	0.16	0.88	
11.5	1.5	10.75	0.120	1.29	7.75	1.04	2.33	47	0.10	0.98	
13.5	2	12.5	0.120	1.50	9.5	0.93	2.43	86	0.06	1.03	
17.5	4	15.5	0.120	1.86	12.5	0.79	2.65	86	0.09	1.12	
21.5	4	19.5	0.120	2.34	16.5	0.65	2.99	86	0.06	1.18	
25.5	4	23.5	0.120	2.82	20.5	0.56	3.38	86	0.04	1.22	
29.5	4	27.5	0.120	3.30	24.5	0.49	3.79	86	0.03	1.26	
30.5	1	30	0.120	3.60	27	0.45	4.05	86	0.01	1.26	
34.5	4	32.5	0.120	3.90	29.5	0.42	4.32	86	0.02	1.29	
38.5	4	36.5	0.120	4.38	33.5	0.38	4.76	86	0.02	1.31	
42.5	4	40.5	0.120	4.86	37.5	0.34	5.20	86	0.02	1.33	
46.5	4	44.5	0.120	5.34	41.5	0.32	5.66	86	0.01	1.34	
50.5	4	48.5	0.120	5.82	45.5	0.29	6.11	86	0.01	1.35	
51.5	1	51	0.120	6.12	48	0.28	6.40	86	0.00	1.35	
55.5	4	53.5	0.115	6.41	50.5	0.27	6.68	50	0.02	1.37	
56.5	1	56	0.115	6.70	53	0.26	6.95	50	0.00	1.38	

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Project: **SR-91 WB Widening Project** Project No. **10-126**
By GJG Date 4/1/2011 Check by Lino Date 4-6-11 Sheet

Settlement Calculation for Spread Footing - RW No. 293 (H=10 ft)

Footing Info

Footing Elevation= 178.5 ft = Embedded Depth = 3 ft
Load Width= 7.50 ft
Net Contact Stress = 2.48 ksf => **Gross Contact Stress = 2.8 ksf**

Check Settlement:
Method: AASHTO LRFD Bridge Design Spec - Hough's Method

Layer	Top Elev. (ft)	Bottom Elev. (ft)	Top Depth (ft)	Bottom Depth (ft)	Soil Type	γ' pcf	(N')	c'
1	181.5	170	0	11.5	SM	120	13	47
2	170	130	11.5	51.5	SM	120	35	86
3	130	125	51.5	56.5	ML	115	20	50

Note: 1. C'= Bearing Capacity Index
2. N'= Average Corrected SPT Blowcount

Depth (ft)	Layer Thick. (ft)	Mid Point Depth (ft)	Effec. Unit Weight, γ' kcf	Initial Stress, σ_{vo}' (ksf)	Depth to Equiv. Footing (ft)	Stress Increase, $\Delta\sigma_v'$ (ksf)	Total Stress, σ_{vt} (ksf)	Bearing Capacity Index, C'	ΔS (in)	Total ΔS (in)	
0											
3	3	1.5	0.120	0.18	-1.5	0.00	0.18	47	0.00	0.00	
4	1	3.5	0.120	0.42	0.5	2.32	2.74	47	0.21	0.21	
5	1	4.5	0.120	0.54	1.5	2.06	2.60	47	0.17	0.38	
6	1	5.5	0.120	0.66	2.5	1.86	2.52	47	0.15	0.53	overex.
7	1	6.5	0.120	0.78	3.5	1.69	2.47	47	0.13	0.66	
8	1	7.5	0.120	0.90	4.5	1.55	2.45	47	0.11	0.77	
10	2	9	0.120	1.08	6	1.38	2.46	47	0.18	0.95	
11.5	1.5	10.75	0.120	1.29	7.75	1.22	2.51	47	0.11	1.06	
13.5	2	12.5	0.120	1.50	9.5	1.09	2.59	86	0.07	1.13	
17.5	4	15.5	0.120	1.86	12.5	0.93	2.79	86	0.10	1.23	
21.5	4	19.5	0.120	2.34	16.5	0.77	3.11	86	0.07	1.30	
25.5	4	23.5	0.120	2.82	20.5	0.66	3.48	86	0.05	1.35	
29.5	4	27.5	0.120	3.30	24.5	0.58	3.88	86	0.04	1.39	
30.5	1	30	0.120	3.60	27	0.54	4.14	86	0.01	1.39	
34.5	4	32.5	0.120	3.90	29.5	0.50	4.40	86	0.03	1.42	
38.5	4	36.5	0.120	4.38	33.5	0.45	4.83	86	0.02	1.45	
42.5	4	40.5	0.120	4.86	37.5	0.41	5.27	86	0.02	1.47	
46.5	4	44.5	0.120	5.34	41.5	0.38	5.72	86	0.02	1.48	
50.5	4	48.5	0.120	5.82	45.5	0.35	6.17	86	0.01	1.50	
51.5	1	51	0.120	6.12	48	0.33	6.45	86	0.00	1.50	
55.5	4	53.5	0.115	6.41	50.5	0.32	6.73	50	0.02	1.52	
56.5	1	56	0.115	6.70	53	0.31	7.00	50	0.00	1.53	

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Project: **SR-91 WB Widening Project** Project No. **10-126**
By GJG Date 4/1/2011 Check by Lino Date 4-6-11 Sheet

Settlement Calculation for Spread Footing - RW No. 293 (H=12 ft)

Footing Info

Footing Elevation= 176.5 ft = Embedded Depth = 3.25 ft
Load Width= 8.25 ft
Net Contact Stress = 2.85 ksf => **Gross Contact Stress = 3.2 ksf**

Check Settlement:
Method: AASHTO LRFD Bridge Design Spec - Hough's Method

Layer	Top Elev. (ft)	Bottom Elev. (ft)	Top Depth (ft)	Bottom Depth (ft)	Soil Type	γ' pcf	(N')	c'
1	179.8	170	0	9.75	SM	120	13	47
2	170	130	9.75	49.75	SM	120	35	86
3	130	125	49.75	54.75	ML	115	20	50

Note: 1. C'= Bearing Capacity Index
2. N'= Average Corrected SPT Blowcount

Depth (ft)	Layer Thick. (ft)	Mid Point Depth (ft)	Effec. Unit Weight, γ' kcf	Initial Stress, σ_{vo}' (ksf)	Depth to Equiv. Footing (ft)	Stress Increase, $\Delta\sigma_v'$ (ksf)	Total Stress, σ_{vt} (ksf)	Bearing Capacity Index, C'	ΔS (in)	Total ΔS (in)	
0											
3	3	1.5	0.120	0.18	-1.75	0.00	0.18	47	0.00	0.00	
3.25	0.25	3.125	0.120	0.38	-0.125	0.00	0.38	47	0.00	0.00	
4.25	1	3.75	0.120	0.45	0.5	2.68	3.13	47	0.22	0.22	
5.25	1	4.75	0.120	0.57	1.5	2.41	2.98	47	0.18	0.40	
6.25	1	5.75	0.120	0.69	2.5	2.18	2.87	47	0.16	0.56	
7.25	1	6.75	0.120	0.81	3.5	2.00	2.81	47	0.14	0.69	overex.
9.25	2	8.25	0.120	0.99	5	1.77	2.76	47	0.23	0.92	
9.75	0.5	9.5	0.120	1.14	6.25	1.62	2.76	47	0.05	0.97	
11.75	2	10.75	0.120	1.29	7.5	1.49	2.78	86	0.09	1.06	
15.75	4	13.75	0.120	1.65	10.5	1.25	2.90	86	0.14	1.20	
19.75	4	17.75	0.120	2.13	14.5	1.03	3.16	86	0.10	1.30	
23.75	4	21.75	0.120	2.61	18.5	0.88	3.49	86	0.07	1.37	
27.75	4	25.75	0.120	3.09	22.5	0.76	3.85	86	0.05	1.42	
28.75	1	28.25	0.120	3.39	25	0.71	4.10	86	0.01	1.43	
32.75	4	30.75	0.120	3.69	27.5	0.66	4.35	86	0.04	1.47	
36.75	4	34.75	0.120	4.17	31.5	0.59	4.76	86	0.03	1.50	
40.75	4	38.75	0.120	4.65	35.5	0.54	5.19	86	0.03	1.53	
44.75	4	42.75	0.120	5.13	39.5	0.49	5.62	86	0.02	1.55	
48.75	4	46.75	0.120	5.61	43.5	0.45	6.06	86	0.02	1.57	
49.75	1	49.25	0.120	5.91	46	0.43	6.34	86	0.00	1.58	
53.75	4	51.75	0.115	6.20	48.5	0.41	6.61	50	0.03	1.60	
54.75	1	54.25	0.115	6.49	51	0.40	6.88	50	0.01	1.61	

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Project: **SR-91 WB Widening Project** Project No. **10-126**
By GJG Date 4/1/2011 Check by Lino Date 4-6-11 Sheet

Settlement Calculation for Spread Footing - RW No. 293 (H=12 ft)

Footing Info

Footing Elevation= 178.5 ft = Embedded Depth = 3.25 ft
Load Width= 8.25 ft
Net Contact Stress = 2.85 ksf => **Gross Contact Stress = 3.2 ksf**

Check Settlement:
Method: AASHTO LRFD Bridge Design Spec - Hough's Method

Layer	Top Elev. (ft)	Bottom Elev. (ft)	Top Depth (ft)	Bottom Depth (ft)	Soil Type	γ' pcf	(N')	c'
1	184.8	170	0	14.75	SM	120	13	47
2	170	130	14.75	54.75	SM	120	35	86
3	130	125	54.75	59.75	ML	115	20	50

Note: 1. C'= Bearing Capacity Index
2. N'= Average Corrected SPT Blowcount

Depth (ft)	Layer Thick. (ft)	Mid Point Depth (ft)	Effec. Unit Weight, γ' kcf	Initial Stress, σ_{vo}' (ksf)	Depth to Equiv. Footing (ft)	Stress Increase, $\Delta\sigma_v'$ (ksf)	Total Stress, σ_{vt} (ksf)	Bearing Capacity Index, C'	ΔS (in)	Total ΔS (in)	
0											
3	3	1.5	0.120	0.18	-1.75	0.00	0.18	47	0.00	0.00	
3.25	0.25	3.125	0.120	0.38	-0.125	0.00	0.38	47	0.00	0.00	
4.25	1	3.75	0.120	0.45	0.5	2.68	3.13	47	0.22	0.22	
5.25	1	4.75	0.120	0.57	1.5	2.41	2.98	47	0.18	0.40	
6.25	1	5.75	0.120	0.69	2.5	2.18	2.87	47	0.16	0.56	
7.25	1	6.75	0.120	0.81	3.5	2.00	2.81	47	0.14	0.69	Overex.
8.25	1	7.75	0.120	0.93	4.5	1.84	2.77	47	0.12	0.82	
10.25	2	9.25	0.120	1.11	6	1.65	2.76	47	0.20	1.02	
12.25	2	11.25	0.120	1.35	8	1.45	2.80	47	0.16	1.18	
14.75	2.5	13.5	0.120	1.62	10.25	1.27	2.89	47	0.16	1.34	
18.75	4	16.75	0.120	2.01	13.5	1.08	3.09	86	0.10	1.44	
22.75	4	20.75	0.120	2.49	17.5	0.91	3.40	86	0.08	1.52	
26.75	4	24.75	0.120	2.97	21.5	0.79	3.76	86	0.06	1.58	
30.75	4	28.75	0.120	3.45	25.5	0.70	4.15	86	0.04	1.62	
33.75	3	32.25	0.120	3.87	29	0.63	4.50	86	0.03	1.65	
37.75	4	35.75	0.120	4.29	32.5	0.58	4.87	86	0.03	1.68	
41.75	4	39.75	0.120	4.77	36.5	0.52	5.29	86	0.03	1.70	
45.75	4	43.75	0.120	5.25	40.5	0.48	5.73	86	0.02	~~1.73~~	
49.75	4	47.75	0.120	5.73	44.5	0.45	6.18	86	0.02	1.74	

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Project: **SR-91 WB Widening Project** Project No. **10-126**
By GJG Date 4/1/2011 Check by Lino Date 4-6-11 Sheet

Settlement Calculation for Spread Footing - RW No. 293 (H=14 ft)

Footing Info

Footing Elevation= 176.5 ft = Embedded Depth = 3.25 ft
Load Width= 9.25 ft
Net Contact Stress = 3.12 ksf => **Gross Contact Stress = 3.5 ksf**

Check Settlement:
Method: AASHTO LRFD Bridge Design Spec - Hough's Method

Layer	Top Elev. (ft)	Bottom Elev. (ft)	Top Depth (ft)	Bottom Depth (ft)	Soil Type	γ' pcf	(N')	c'
1	179.8	170	0	9.75	SM	120	13	47
2	170	130	9.75	49.75	SM	120	35	86
3	130	125	49.75	54.75	ML	115	20	50

Note: 1. C'= Bearing Capacity Index
2. N'= Average Corrected SPT Blowcount

Depth (ft)	Layer Thick. (ft)	Mid Point Depth (ft)	Effec. Unit Weight, γ' kcf	Initial Stress, σ_{vo}' (ksf)	Depth to Equiv. Footing (ft)	Stress Increase, $\Delta\sigma_v'$ (ksf)	Total Stress, σ_{vt} (ksf)	Bearing Capacity Index, C'	ΔS (in)	Total ΔS (in)	
0											
3	3	1.5	0.120	0.18	-1.75	0.00	0.18	47	0.00	0.00	
3.25	0.25	3.125	0.120	0.38	-0.125	0.00	0.38	47	0.00	0.00	
4.25	1	3.75	0.120	0.45	0.5	2.96	3.41	47	0.22	0.22	
5.25	1	4.75	0.120	0.57	1.5	2.68	3.25	47	0.19	0.42	
6.25	1	5.75	0.120	0.69	2.5	2.45	3.14	47	0.17	0.59	
7.25	1	6.75	0.120	0.81	3.5	2.26	3.07	47	0.15	0.73	
8.25	1	7.75	0.120	0.93	4.5	2.10	3.03	47	0.13	0.86	overex.
9.75	1.5	9	0.120	1.08	5.75	1.92	3.00	47	0.17	1.03	
11.75	2	10.75	0.120	1.29	7.5	1.72	3.01	86	0.10	1.14	
15.75	4	13.75	0.120	1.65	10.5	1.46	3.11	86	0.15	1.29	
19.75	4	17.75	0.120	2.13	14.5	1.21	3.34	86	0.11	1.40	
23.75	4	21.75	0.120	2.61	18.5	1.04	3.65	86	0.08	1.48	
27.75	4	25.75	0.120	3.09	22.5	0.91	4.00	86	0.06	1.54	
28.75	1	28.25	0.120	3.39	25	0.84	4.23	86	0.01	1.56	
32.75	4	30.75	0.120	3.69	27.5	0.78	4.47	86	0.05	1.60	
36.75	4	34.75	0.120	4.17	31.5	0.71	4.88	86	0.04	1.64	
40.75	4	38.75	0.120	4.65	35.5	0.64	5.29	86	0.03	1.67	
44.75	4	42.75	0.120	5.13	39.5	0.59	5.72	86	0.03	1.70	
48.75	4	46.75	0.120	5.61	43.5	0.55	6.16	86	0.02	1.72	
49.75	1	49.25	0.120	5.91	46	0.52	6.43	86	0.01	1.73	
53.75	4	51.75	0.115	6.20	48.5	0.50	6.70	50	0.03	1.76	
54.75	1	54.25	0.115	6.49	51	0.48	6.97	50	0.01	1.77	

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Project: **SR-91 WB Widening Project** Project No. **10-126**
By GJG Date 4/1/2011 Check by Lino Date 4-6-11 Sheet

Settlement Calculation for Spread Footing - RW No. 293 (H=14 ft)

Footing Info

Footing Elevation= 178.5 ft = Embedded Depth = 3.25 ft
Load Width= 9.25 ft
Net Contact Stress = 3.12 ksf => **Gross Contact Stress = 3.5 ksf**

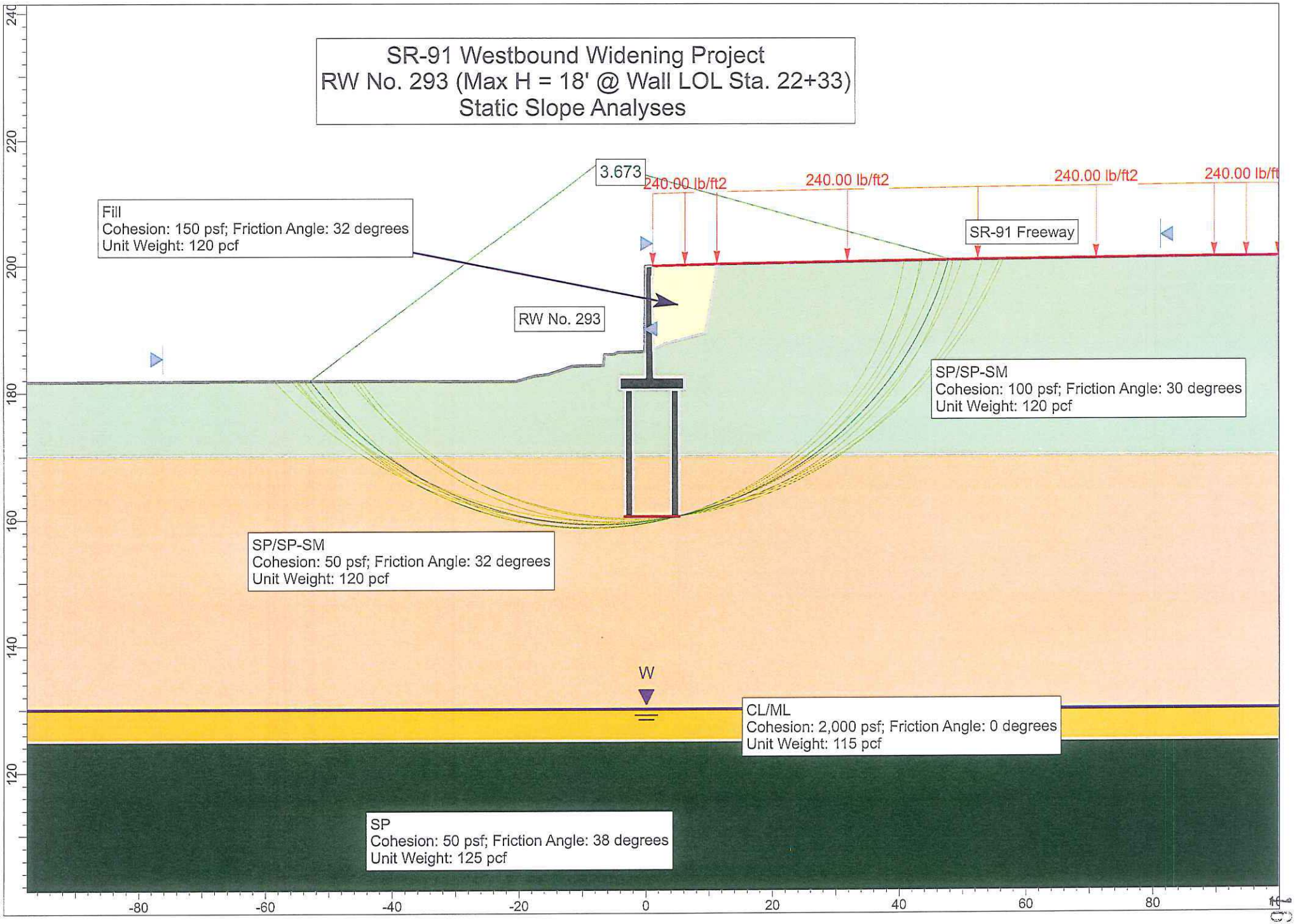
Check Settlement:
Method: AASHTO LRFD Bridge Design Spec - Hough's Method

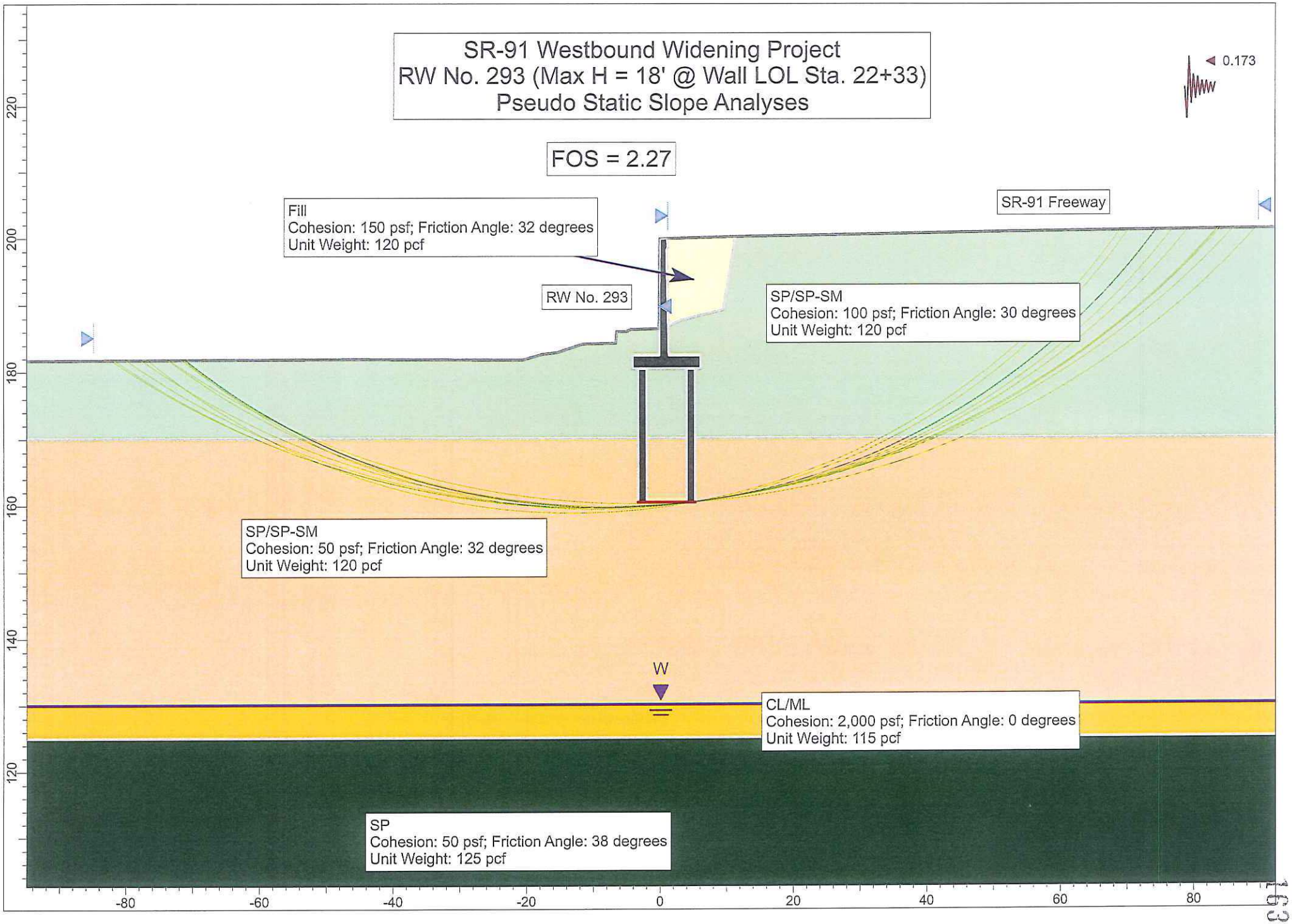
Layer	Top Elev. (ft)	Bottom Elev. (ft)	Top Depth (ft)	Bottom Depth (ft)	Soil Type	γ' pcf	(N')	c'
1	184.8	170	0	14.75	SM	120	13	47
2	170	130	14.75	54.75	SM	120	35	86
3	130	125	54.75	59.75	ML	115	20	50

Note: 1. C'= Bearing Capacity Index
2. N'= Average Corrected SPT Blowcount

Depth (ft)	Layer Thick. (ft)	Mid Point Depth (ft)	Effec. Unit Weight, γ' kcf	Initial Stress, σ_{vo}' (ksf)	Depth to Equiv. Footing (ft)	Stress Increase, $\Delta\sigma_v'$ (ksf)	Total Stress, σ_{vt} (ksf)	Bearing Capacity Index, C'	ΔS (in)	Total ΔS (in)
0										
3	3	1.5	0.120	0.18	-1.75	0.00	0.18	47	0.00	0.00
3.25	0.25	3.125	0.120	0.38	-0.125	0.00	0.38	47	0.00	0.00
4.25	1	3.75	0.120	0.45	0.5	2.96	3.41	47	0.22	0.22
5.25	1	4.75	0.120	0.57	1.5	2.68	3.25	47	0.19	0.42
6.25	1	5.75	0.120	0.69	2.5	2.45	3.14	47	0.17	0.59
7.25	1	6.75	0.120	0.81	3.5	2.26	3.07	47	0.15	0.73
8.25	1	7.75	0.120	0.93	4.5	2.10	3.03	47	0.13	0.86
9.25	1	8.75	0.120	1.05	5.5	1.96	3.01	47	0.12	0.98
11.25	2	10.25	0.120	1.23	7	1.77	3.00	47	0.20	1.18
14.75	3.5	13	0.120	1.56	9.75	1.52	3.08	47	0.26	1.44
18.75	4	16.75	0.120	2.01	13.5	1.27	3.28	86	0.12	1.56
22.75	4	20.75	0.120	2.49	17.5	1.08	3.57	86	0.09	1.65
26.75	4	24.75	0.120	2.97	21.5	0.94	3.91	86	0.07	1.72
30.75	4	28.75	0.120	3.45	25.5	0.83	4.28	86	0.05	1.77
33.75	3	32.25	0.120	3.87	29	0.75	4.62	86	0.03	1.80
37.75	4	35.75	0.120	4.29	32.5	0.69	4.98	86	0.04	1.84
41.75	4	39.75	0.120	4.77	36.5	0.63	5.40	86	0.03	1.87
45.75	4	43.75	0.120	5.25	40.5	0.58	5.83	86	0.03	1.89
49.75	4	47.75	0.120	5.73	44.5	0.54	6.27	86	0.02	1.91
53.75	4	51.75	0.120	6.21	48.5	0.50	6.71	86	0.02	1.93
54.75	1	54.25	0.120	6.51	51	0.48	6.99	86	0.00	1.94
58.75	4	56.75	0.115	6.80	53.5	0.46	7.26	50	0.03	1.96
59.75	1	59.25	0.115	7.09	56	0.44	7.53	50	0.01	1.97

OVRBY


SR-91 Westbound Widening Project
RW No. 293 (Max H = 18' @ Wall LOL Sta. 22+33)
Static Slope Analyses
3.673
240.00 lb/ft2
240.00 lb/ft2
240.00 lb/ft2
240.00 lb/ft
SR-91 Freeway
Fill
Cohesion: 150 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
RW No. 293
SP/SP-SM
Cohesion: 100 psf; Friction Angle: 30 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
W
CL/ML
Cohesion: 2,000 psf; Friction Angle: 0 degrees
Unit Weight: 115 pcf
SP
Cohesion: 50 psf; Friction Angle: 38 degrees
Unit Weight: 125 pcf
240
220
200
180
160
140
120
-80
-60
-40
-20
0
20
40
60
80


SR-91 Westbound Widening Project
RW No. 293 (Max H = 18' @ Wall LOL Sta. 22+33)
Pseudo Static Slope Analyses
FOS = 2.27
0.173
Fill
Cohesion: 150 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
SR-91 Freeway
RW No. 293
SP/SP-SM
Cohesion: 100 psf; Friction Angle: 30 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
W
CL/ML
Cohesion: 2,000 psf; Friction Angle: 0 degrees
Unit Weight: 115 pcf
SP
Cohesion: 50 psf; Friction Angle: 38 degrees
Unit Weight: 125 pcf
220
200
180
160
140
120
-80
-60
-40
-20
0
20
40
60
80

RETAINING WALL 307

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening - Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-6-11 Sheet: 1 of 1
Subject:

Retaining Wall 307 - Liquefaction Potential Analyses

* Historical high ground water elevation of +140 feet was used: 180 − 40 = 140
average Acacia street level is at +180'

⇒ Based on the analyses, liquefaction potential at the site is low.

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LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
$CRR\ r = CRR_{7.5} \times Cm \times K\ sigma$

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines (Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

$F_L = CRR\ r / CSR\ i$

A-10-055

Emean (%)	75			Present Ground El.	200.5	Borehole Dia. (in)	8	Tot. Unit Wt. (pcf)	60.5	=Design Water Table Depth	70.5	=Field Water Table Depth	Acc. max =	0.520	g			Earthq. M=	7.3		
C_E	1.25			Future Ground El.	200.5	C_B	1.15	120	140	=Design Water El.	130	=Field Water El.						Cm=	1.07		

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
5	196	27	SM	25.0	0.30	0.30	1.70	0.80	1.20	1.00	1	1	0.99	0.30	0.33	63	75	1.00	High N	0.00	LARGE	AboveWT
10	191	80	SM	25.0	0.60	0.60	1.32	0.85	1.00	0.67	2	2	0.98	0.60	0.33	86	100	1.00	High N	0.00	LARGE	AboveWT
15	186	30	SP-SM	10.0	0.90	0.90	1.08	0.85	1.20	1.00	1	1	0.97	0.90	0.33	47	49	1.00	High N	0.00	LARGE	AboveWT
20	181	38	SP	4.0	1.20	1.20	0.93	0.95	1.00	0.67	2	2	0.95	1.20	0.32	32	32	0.97	High N	0.00	LARGE	AboveWT
25	176	9	SM	17.0	1.50	1.50	0.83	0.95	1.20	1.00	1	1	0.94	1.50	0.32	12	16	0.93	0.17	0.17	0.53	AboveWT
30	171	55	SP	4.0	1.80	1.80	0.76	1.00	1.00	0.67	2	2	0.93	1.80	0.31	40	40	0.89	High N	0.00	LARGE	AboveWT
35	166	26	SP	4.0	2.10	2.10	0.71	1.00	1.20	1.00	1	1	0.89	2.10	0.30	32	32	0.87	High N	0.00	LARGE	AboveWT
40	161	60	SP	4.0	2.40	2.40	0.66	1.00	1.00	0.67	2	2	0.85	2.40	0.29	38	38	0.85	High N	0.00	LARGE	AboveWT
45	156	29	SP	4.0	2.70	2.70	0.62	1.00	1.20	1.00	1	1	0.81	2.70	0.27	31	31	0.82	High N	0.00	LARGE	AboveWT
50	151	85	SP-SM	6.0	3.00	3.00	0.59	1.00	1.00	0.67	2	2	0.77	3.00	0.26	48	48	0.78	High N	0.00	LARGE	AboveWT
55	146	29	SP	4.0	3.30	3.30	0.56	1.00	1.20	1.00	1	1	0.73	3.30	0.25	28	28	0.76	0.37	0.31	1.25	AboveWT
60	141	98	SP	4.0	3.60	3.60	0.54	1.00	1.00	0.67	2	2	0.69	3.60	0.23	51	51	0.75	High N	0.00	LARGE	AboveWT
65	136	27	SP-SM	6.0	3.90	3.90	0.52	1.00	1.20	1.00	1	1	0.64	3.76	0.23	24	24	0.74	0.28	0.22	0.97	yes
70	131	93	SP-SM	6.0	4.20	4.20	0.50	1.00	1.00	0.67	2	2	0.60	3.90	0.22	44	45	0.73	High N	0.00	LARGE	high N

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening - Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-6-11 Sheet: 1 of 3
Subject:

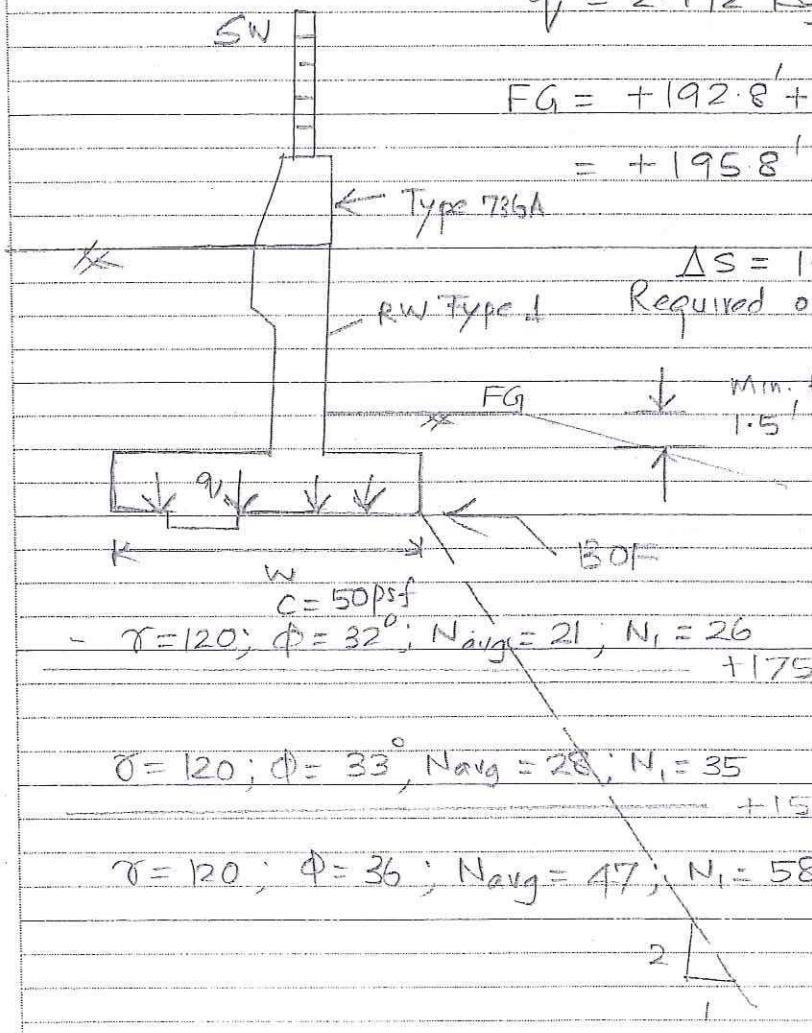
Retaining Wall No. 307 - Type 1SWB, 736SV, 736A

* H varies from 2' to 8'

Case I

H = 8', W = 7', F = 1.5', BOF = +192.8'

q_v = 2.192 ksf



ΔS = 1.09"
Required overex. = 1'

⇒ 1-foot overex. is adequate for RW 307.

Case II H < 6'

Foundation design should be performed using Φ = 30° & γ = 120pcf in Caltrans standard plans

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Project: SR-91 WB Widening - Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-6-11 Sheet: 2 of 3
Subject:

RW No. 307 - Bearing Capacity Calculations

For $H = 8'$,

$B = 7'$, $F = 1.5'$, $BOF = +192.8'$; $D = 1.5' + 1.5' = 3'$

Bearing Pressures,

Service Limit State = 2.192 ksf
Strength Limit State = 3.180 ksf
Extreme Limit State = 9.583 ksf

$b = 4'$ (assume)

$b/B = 4/7 = 0.57 \approx 0.6$

$D/B = 3/7 = 0.42 \approx 0.4$

$q_u = cN_{cm} + \gamma D N_{qm} + \frac{1}{2}\gamma B N_{\gamma m}$

$N_{cm} = N_c s_c i_c d_c$; $N_{qm} = N_q s_q i_q d_q$; $N_{\gamma m} = N_{\gamma q} s_\gamma i_\gamma d_\gamma$

Shape factors, $s_c = s_q = s_\gamma = 1$ ($\because B \ll\ll L$)
load inclination factors, $i_c = i_q = i_c = 1$
depth factor, $d_q = 1.2$ for $\phi = 32°$
Slope height $H_s > B$ & Slope angle $i \approx 26°$,
$\therefore N_q = 0$; $N_c = 0$

For $b/B = 0.6$ & $D/B = 0.4$ & $\phi = 32°$,

$N_{cq} = 5.6$ & $N_{\gamma q} = 27$ (AASHTO LRFD Figures 10.6.3.1.2c - 1&2)

$q_u = (50 \times 5.6) + (\frac{1}{2} \times 120 \times 7 \times 27)$
$= 11.62$ ksf //

Strength Limit State

$q_{all} = 0.45 \times 11.62 = 5.2$, ksf $>$ 3.180 ksf //

Extreme Limit State

$q_{all} = 1.0 \times 11.62 = 11.6$ ksf $>$ 9.583 ksf //

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Project: SR-91 WB Widening - Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-6-11 Sheet: 3 of 3
Subject:

Service Limit State

Based on settlement estimates,

⇒ Recommend q_{all} = 2.2 ksf provided 1-foot overex is performed.

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phone: (714)751-3826, Fax (714)751-3928

Project: **SR-91 WB Widening Project** Project No. **10-126**
By GJG Date 4/1/2011 Check by Lino Date 4-6-11 Sheet

Settlement Calculation for Spread Footing - RW No. 307 (H=8 ft)

Footing Info

Footing Elevation= 192.8 ft = Embedded Depth = 3 ft
Load Width= 7.00 ft
Net Contact Stress = 2.19 ksf => Gross Contact Stress = 2.6 ksf

Check Settlement:

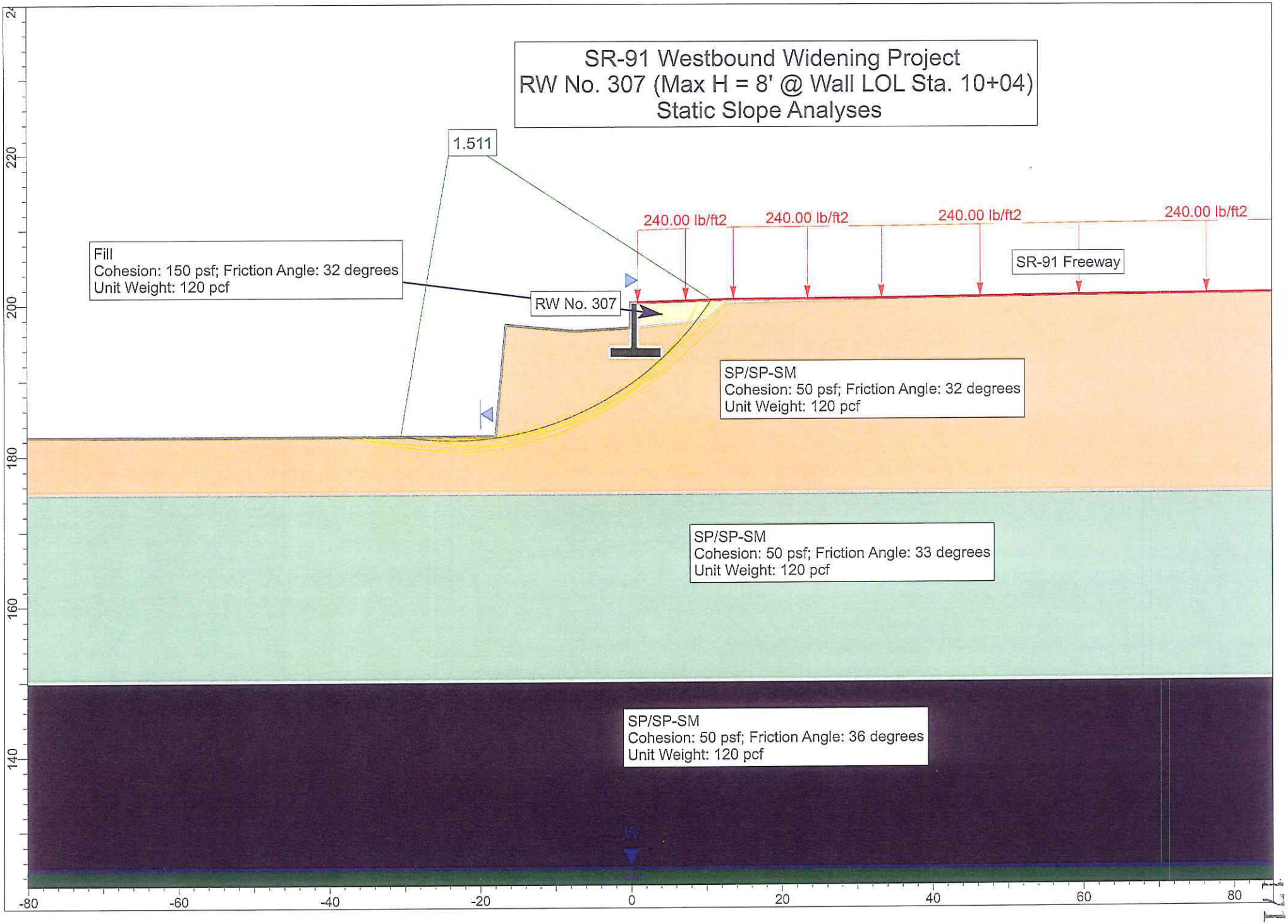
Method: AASHTO LRFD Bridge Design Spec - Hough's Method

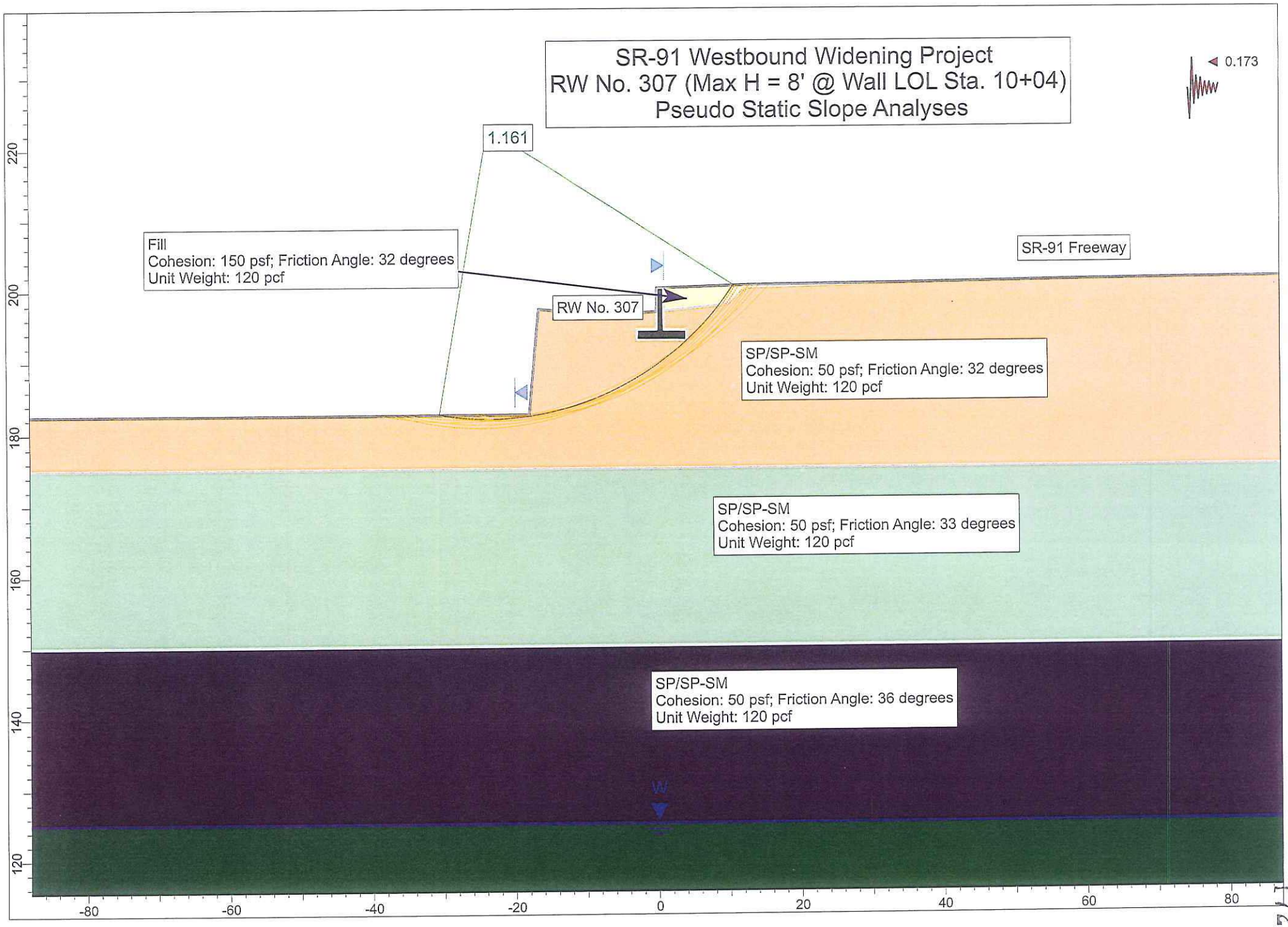
Layer	Top Elev. (ft)	Bottom Elev. (ft)	Top Depth (ft)	Bottom Depth (ft)	Soil Type	γ' pcf	(N')	c'
1	195.8	175	0	20.8	SM	120	26	69
2	175	150	20.8	45.8	SM	120	35	86
3	150	125	45.8	70.8	SM	120	58	136

Note: 1. C'= Bearing Capacity Index
2. N'= Average Corrected SPT Blowcount

Depth (ft)	Layer Thick. (ft)	Mid Point Depth (ft)	Effec. Unit Weight, γ' kcf	Initial Stress, σ_{vo}' (ksf)	Depth to Equiv. Footing (ft)	Stress Increase, $\Delta\sigma_v'$ (ksf)	Total Stress, σ_{vt} (ksf)	Bearing Capacity Index, C'	ΔS (in)	Total ΔS (in)
0										
3.0	3	1.5	0.120	0.18	-1.5	0.00	0.18	69	0.00	0.00
4.0	1	3.5	0.120	0.42	0.5	2.05	2.47	69	0.13	0.13
5.0	1	4.5	0.120	0.54	1.5	1.81	2.35	69	0.11	0.24
6.0	1	5.5	0.120	0.66	2.5	1.62	2.28	69	0.09	0.34
7.0	1	6.5	0.120	0.78	3.5	1.46	2.24	69	0.08	0.42
8.0	1	7.5	0.120	0.90	4.5	1.33	2.23	69	0.07	0.49
10.0	2	9	0.120	1.08	6	1.18	2.26	69	0.11	0.60
12.0	2	11	0.120	1.32	8	1.02	2.34	69	0.09	0.68
14.0	2	13	0.120	1.56	10	0.90	2.46	69	0.07	0.75
18.0	4	16	0.120	1.92	13	0.77	2.69	69	0.10	0.86
20.8	2.8	19.4	0.120	2.33	16.4	0.66	2.98	69	0.05	0.91
24.8	4	22.8	0.120	2.74	19.8	0.57	3.31	86	0.05	0.95
28.8	4	26.8	0.120	3.22	23.8	0.50	3.71	86	0.03	0.99
32.8	4	30.8	0.120	3.70	27.8	0.44	4.14	86	0.03	1.02
36.8	4	34.8	0.120	4.18	31.8	0.40	4.57	86	0.02	1.04
40.8	4	38.8	0.120	4.66	35.8	0.36	5.01	86	0.02	1.06
44.8	4	42.8	0.120	5.14	39.8	0.33	5.46	86	0.01	1.07
45.8	1	45.3	0.120	5.44	42.3	0.31	5.75	86	0.00	1.07
49.8	4	47.8	0.120	5.74	44.8	0.30	6.03	136	0.01	1.08
53.8	4	51.8	0.120	6.22	48.8	0.27	6.49	136	0.01	1.09
57.8	4	55.8	0.120	6.70	52.8	0.26	6.95	136	0.01	1.09

0.13 OK.


SR-91 Westbound Widening Project
RW No. 307 (Max H = 8' @ Wall LOL Sta. 10+04)
Static Slope Analyses
1.511
240.00 lb/ft2
240.00 lb/ft2
240.00 lb/ft2
240.00 lb/ft2
SR-91 Freeway
Fill
Cohesion: 150 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
RW No. 307
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 33 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 36 degrees
Unit Weight: 120 pcf
240
220
200
180
160
140
-80
-60
-40
-20
0
20
40
60
80


SR-91 Westbound Widening Project
RW No. 307 (Max H = 8' @ Wall LOL Sta. 10+04)
Pseudo Static Slope Analyses
0.173
1.161
Fill
Cohesion: 150 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
SR-91 Freeway
RW No. 307
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 33 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 36 degrees
Unit Weight: 120 pcf
220
200
180
160
140
120
-80
-60
-40
-20
0
20
40
60
80

RETAINING WALL 315

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening - Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-6-11 Sheet: 1 of 1
Subject:

Retaining Wall 315 - Liquefaction Potential Analyses

* Historical high ground water elevation of +130 feet was used.

* Borings A-10-057 and A-10-058 deepest depths are located above the historical high ground water elevation (+130 feet). Therefore, liquefaction potential analyses was not performed for these explorations.

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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening – Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-6-11 Sheet: 1 of 3
Subject:

Retaining Wall No. 315 – Type 1 SWB, 736A, 736SV

* H Varies from 3' to 6'

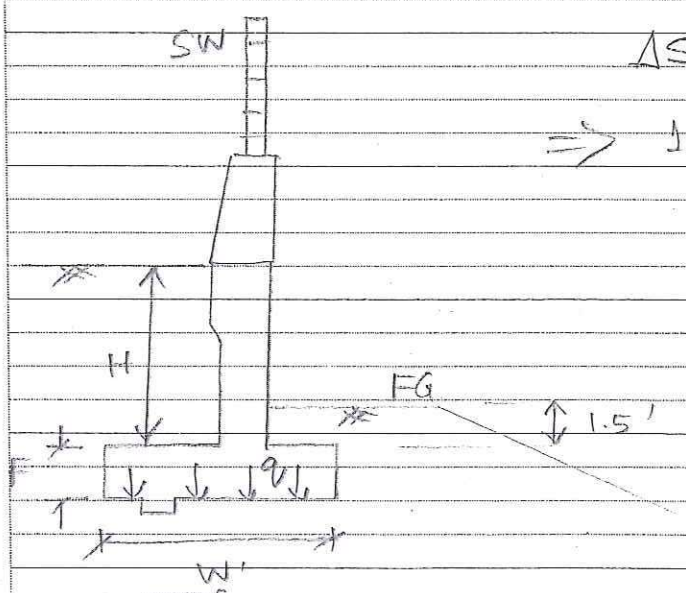
Case I

H = 6', W = 6.75', F = 1.5',

BOF = +183.25'

∴ FG = +186.25'

q = 1.833 ksf



$\Delta S = 0.88'' < 1''$

⇒ 1-foot overex. is adequate for RW 315. //

C = 50 psf
$\phi = 32^\circ$, $\gamma = 120$, $N_{avg} = 22$; $N_1 = 27$
+175'

$\phi = 33^\circ$, $\gamma = 120$; $N_{avg} = 28$; $N_1 = 35$
+155'

Assume $\gamma = 120$, $\phi = 36^\circ$; $N_1 = 50$

Case II H < 6'

Foundation design should be performed using $\phi = 30^\circ$ & $\gamma = 125$ pcf in Std. Plans

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Project: SR-91 WB Widening - Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-6-11 Sheet: 2 of 3
Subject:

RW No. 315 - Bearing Capacity Calculations

For $H = 6'$,

$B = 6.75'$; $F = 1.5'$, $BOF = +183.25'$; $D = 1.5' + 1.5' = 3'$

Bearing Pressures

Service Limit State = 1.833 ksf
Strength Limit State = 2.644 ksf
Extreme Limit State = 9.693 ksf

$b = 4'$ (assume)

$b/B = 0.59 \approx 0.6$

$D/B = 3/6.75 = 0.44 \approx 0.4$

$q_u = c N_{cm} + \gamma D N_{qm} + \frac{1}{2} \gamma B N_{\gamma m}$

$N_{cm} = N_c s_c i_c d_c$; $N_{qm} = N_q s_q i_q d_q$; $N_{\gamma m} = N_{\gamma q} s_\gamma i_\gamma d_\gamma$

Shape factors, $s_c = s_q = s_\gamma = 1$
load inclination factors, $i_c = i_q = i_\gamma = 1$
depth factors, $d_q = 1.2$
Slope height $H_s > B$ & Slope angle $i \leq 26°$,
$\therefore N_q = 0$; $N_s = 0$
For $b/B = 0.6$ & $D/B = 0.4$ & $\Phi = 32°$,
$N_{cq} = 5.6$ & $N_{\gamma q} = 27$ (AASHTO LRFD Figures 10.6.3.1.2c-1&2)

$q_u = (50 \times 5.6) + (\frac{1}{2} \times 120 \times 6.75' \times 27)$
$= 11.2$ ksf //

Strength Limit State

$q_{all} = 0.45 \times 11.2 = 5.0$ ksf $>$ 2.644 ksf //

Extreme Limit State

$q_{all} = 1.0 \times 11.2 = 11.2$ ksf $>$ 9.693 ksf //

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Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening - Retaining Walls Project No.: 10-126
By: Ranjan Date: 4/1/11 Checked By: Lino Date: 4-6-11 Sheet: 3 of 3
Subject:

Service Limit State

Based on settlement estimates,

⇒ Recommend $q_{all} = 2$ ksf provided 1-foot overex. is performed. //

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Earth Mechanics, Inc.
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17800 Newhope Street, Suite B, Fountain Valley, CA 92708
phone: (714)751-3826, Fax (714)751-3928

Project: **SR-91 WB Widening Project** Project No. **10-126**
By GJG Date 11/21/2011 Check by Lino Date Sheet

Settlement Calculation for Spread Footing - RW No. 315 (H=6 ft)

Footing Info

Footing Elevation= 183.25 ft = Embedded Depth = 3 ft
Load Width= 6.75 ft
Net Contact Stress = 2.00 ksf => Gross Contact Stress = 2.4 ksf

Check Settlement:
Method: AASHTO LRFD Bridge Design Spec - Hough's Method

Layer	Top Elev. (ft)	Bottom Elev. (ft)	Top Depth (ft)	Bottom Depth (ft)	Soil Type	γ' pcf	(N')	c'
1	186.3	175	0	11.25	SM	120	27	71
2	175	155	11.25	31.25	SM	120	35	86
3	155	125	31.25	61.25	SM	120	50	118

Note: 1. C'= Bearing Capacity Index
2. N'= Average Corrected SPT Blowcount

Depth (ft)	Layer Thick. (ft)	Mid Point Depth (ft)	Effec. Unit Weight, γ' kcf	Initial Stress, σ_{vo}' (ksf)	Depth to Equiv. Footing (ft)	Stress Increase, $\Delta\sigma_v'$ (ksf)	Total Stress, σ_{vt} (ksf)	Bearing Capacity Index, C'	ΔS (in)	Total ΔS (in)
0										
3.0	3	1.5	0.120	0.18	-1.5	0.00	0.18	71	0.00	0.00
4.0	1	3.5	0.120	0.42	0.5	1.86	2.28	71	0.12	0.12
5.0	1	4.5	0.120	0.54	1.5	1.64	2.18	71	0.10	0.23
6.0	1	5.5	0.120	0.66	2.5	1.46	2.12	71	0.09	0.31
7.0	1	6.5	0.120	0.78	3.5	1.32	2.10	71	0.07	0.38
8.0	1	7.5	0.120	0.90	4.5	1.20	2.10	71	0.06	0.45
10.0	2	9	0.120	1.08	6	1.06	2.14	71	0.10	0.55
11.3	1.25	10.63	0.120	1.28	7.625	0.94	2.21	71	0.05	0.60
13.3	2	12.25	0.120	1.47	9.25	0.84	2.31	86	0.05	0.65
17.3	4	15.25	0.120	1.83	12.25	0.71	2.54	86	0.08	0.73
21.25	4	19.25	0.120	2.31	16.25	0.59	2.90	86	0.05	0.79
25.25	4	23.25	0.120	2.79	20.25	0.50	3.29	86	0.04	0.83
29.25	4	27.25	0.120	3.27	24.25	0.44	3.71	86	0.03	0.86
31.25	2	30.25	0.120	3.63	27.25	0.40	4.03	86	0.01	0.87
35.25	4	33.25	0.120	3.99	30.25	0.36	4.35	118	0.02	0.89
39.25	4	37.25	0.120	4.47	34.25	0.33	4.80	118	0.01	0.90
43.25	4	41.25	0.120	4.95	38.25	0.30	5.25	118	0.01	0.91
47.25	4	45.25	0.120	5.43	42.25	0.28	5.71	118	0.01	0.92
51.25	4	49.25	0.120	5.91	46.25	0.25	6.16	118	0.01	0.92
55.25	4	53.25	0.120	6.39	50.25	0.24	6.63	118	0.01	0.93
59.25	4	57.25	0.120	6.87	54.25	0.22	7.09	118	0.01	0.94

OVER EX

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

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Project SR-91 WB Widening - Wall 315 **Project No.** 10-126

By SP **Date** 05-20-11 **Checked By** GJ **Date** 5/23/11 **Sheet** 1 **of** 2

Wall 315 - Type SSCWBP on piles

16-inch diameter CIDH piles

$A = \frac{\pi}{4}(16)^2 = 201\ in^2$

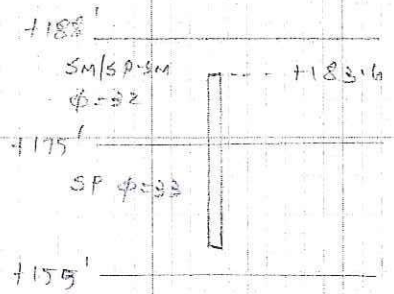
$I = \frac{\pi}{64}(16)^4 = 3217\ in^4$, $I_{cracked} = 1608\ in^4$

Perimeter $= \pi(16) = 50.3\ in = 4.19\ ft$

Retaining wall ht = 2.5 feet

footing width = 5.75 feet

bottom of footing = +182.6'



Nominal resistance

strength limit state $= \frac{38.6}{0.7 \times 0.55} = 100.2$ kips

consider 110 kips compressive

Tension $= \frac{12.4}{0.7 \times 0.55} = 32$ kips

consider 40 kips tension

extreme event limit state $= \frac{62.4}{1.0 \times 0.55} = 113$ kips

consider 120 kips compressive

Tension $= \frac{30.4}{1.0 \times 0.55} = 55$ kips

consider 60 kips tension

group efficiency factor = 0.55 for 2D pile spacing

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Project SR-91 WB widening – Wall 315 **Project No.** 10-126

By SP **Date** 05-20-11 **Checked By** GJ **Date** 5/23/11 **Sheet** 2 of 2

from analysis

Strength limit state

at 22 feet pile compression capacity = 113 kips
pile tip elevation for compression = 184 - 22
= +162 feet

at 16 feet tension capacity = 2/3 x 60.7 = 40.5 kips
pile tip elevation for tension = 184 - 16
= +168 feet

Extreme event limit state

at 23 feet pile compression capacity = 122 kips
pile tip elevation for compression = 184 - 23
= +161 feet

consider +160 feet

at 20 feet tension capacity = 2/3 x 94.1 = 62.7 kips
pile tip elevation for tension = 184 - 20
= +164 feet

Service limit state I

Total load = 34.7 x 6 = 208.2 kips

$q = \frac{208.2}{5.75 \times 19.4} = 1.9$ ksf

for 12 feet long pile
Settlement < 1"

Therefore, no applicable pile length for settlement

SKIN FRICTION FOR DRILLED SHAFT IN BOTH COHESIONLESS AND COHESIVE SOILS USING REESE AND O'NEILL'S METHOD (1999)

PROJECT: Retaining Wall 315 — ITEM: 16-inch Diameter CIDH Existing Pile
PROJECT NO.: 10-126 — Wall Height = 2.5 feet
DONE BY: SP DATE: 05/20/11
CHECKED BY: DATE:

D_s =>	1.33 ft	Hw =>	60.0 ft	Hg =>	0.0 ft	Hw is the depth to water table.
p =	4.18 ft	Ho =>	0.0 ft	Hf =>	0.0 ft	Hg is the depth to ground surface used in calculation.

Ho is the depth to location starting initial overburden pressure
Hf is the depth to location starting accumulation of skin frictio
bottom of footing = 184 ft

Soil Layer =>	from Top	to Bottom =>	γ (pcf)=>	γ' (pcf)=	c' (ksf) =>	ϕ' =>	
(1)	0	5	120	57.6	0.00	32	SM/SP-SM
(2)	5	9	120	57.6	0.00	32	SM/SP-SM
(3)	9	30	120	57.6	0.00	33	SP

Sublayer No.	Depth, z (ft)	z_i (ft)	New Depth (ft)	Soil Unit Weight (pcf)	Overburden Pressure (psf)	c' (ksf)	β	f_i^s (ksf)	ΔQ_s^s (kips)	Q_s^s (kips)	f_i^c (ksf)	ΔQ_s^c (kips)	Q_s^c (kips)	Q_s (kips)
0	0.0	0.0	0.0	120.0	0									
1	0.0	0.0	0.0	120.0	0	0.0				0.0			0.0	0.0
2	1.0	0.5	0.5	120.0	60	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
3	2.0	1.5	1.5	120.0	180	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
4	3.0	2.5	2.5	120.0	300	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
5	4.0	3.5	3.5	120.0	420	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
6	5.0	4.5	4.5	120.0	540	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
7	6.0	5.5	5.5	120.0	660	0.0	1.18	0.78	3.3	3.3	0.00	0.0	0.0	3.3
8	7.0	6.5	6.5	120.0	780	0.0	1.16	0.90	3.8	7.0	0.00	0.0	0.0	7.0
9	8.0	7.5	7.5	120.0	900	0.0	1.13	1.02	4.3	11.3	0.00	0.0	0.0	11.3
10	9.0	8.5	8.5	120.0	1020	0.0	1.11	1.13	4.7	16.0	0.00	0.0	0.0	16.0
11	10.0	9.5	9.5	120.0	1140	0.0	1.08	1.24	5.2	21.2	0.00	0.0	0.0	21.2
12	11.0	10.5	10.5	120.0	1260	0.0	1.06	1.34	5.6	26.8	0.00	0.0	0.0	26.8
13	12.0	11.5	11.5	120.0	1380	0.0	1.04	1.44	6.0	32.8	0.00	0.0	0.0	32.8
14	13.0	12.5	12.5	120.0	1500	0.0	1.02	1.53	6.4	39.2	0.00	0.0	0.0	39.2
15	14.0	13.5	13.5	120.0	1620	0.0	1.00	1.63	6.8	46.0	0.00	0.0	0.0	46.0
16	15.0	14.5	14.5	120.0	1740	0.0	0.99	1.72	7.2	53.1	0.00	0.0	0.0	53.1
17	16.0	15.5	15.5	120.0	1860	0.0	0.97	1.80	7.5	60.7	0.00	0.0	0.0	60.7
18	17.0	16.5	16.5	120.0	1980	0.0	0.95	1.88	7.9	68.5	0.00	0.0	0.0	68.5
19	18.0	17.5	17.5	120.0	2100	0.0	0.94	1.96	8.2	76.7	0.00	0.0	0.0	76.7
20	19.0	18.5	18.5	120.0	2220	0.0	0.92	2.04	8.5	85.3	0.00	0.0	0.0	85.3
21	20.0	19.5	19.5	120.0	2340	0.0	0.90	2.12	8.8	94.1	0.00	0.0	0.0	94.1
22	21.0	20.5	20.5	120.0	2460	0.0	0.89	2.19	9.1	103.2	0.00	0.0	0.0	103.2
23	22.0	21.5	21.5	120.0	2580	0.0	0.87	2.25	9.4	112.7	0.00	0.0	0.0	112.7
24	23.0	22.5	22.5	120.0	2700	0.0	0.86	2.32	9.7	122.4	0.00	0.0	0.0	122.4
25	24.0	23.5	23.5	120.0	2820	0.0	0.85	2.38	10.0	132.3	0.00	0.0	0.0	132.3
26	25.0	24.5	24.5	120.0	2940	0.0	0.83	2.45	10.2	142.5	0.00	0.0	0.0	142.5
27	26.0	25.5	25.5	120.0	3060	0.0	0.82	2.50	10.5	153.0	0.00	0.0	0.0	153.0
28	27.0	26.5	26.5	120.0	3180	0.0	0.81	2.56	10.7	163.7	0.00	0.0	0.0	163.7
29	28.0	27.5	27.5	120.0	3300	0.0	0.79	2.61	10.9	174.6	0.00	0.0	0.0	174.6
30	29.0	28.5	28.5	120.0	3420	0.0	0.78	2.67	11.1	185.8	0.00	0.0	0.0	185.8
31	30.0	29.5	29.5	120.0	3540	0.0	0.77	2.71	11.3	197.1	0.00	0.0	0.0	197.1

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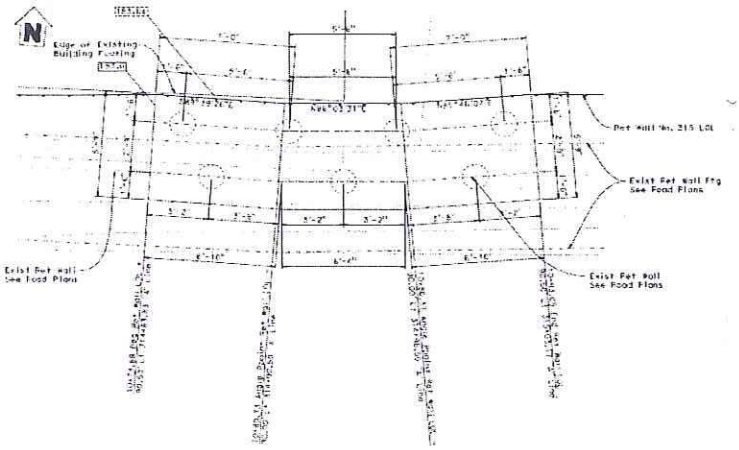
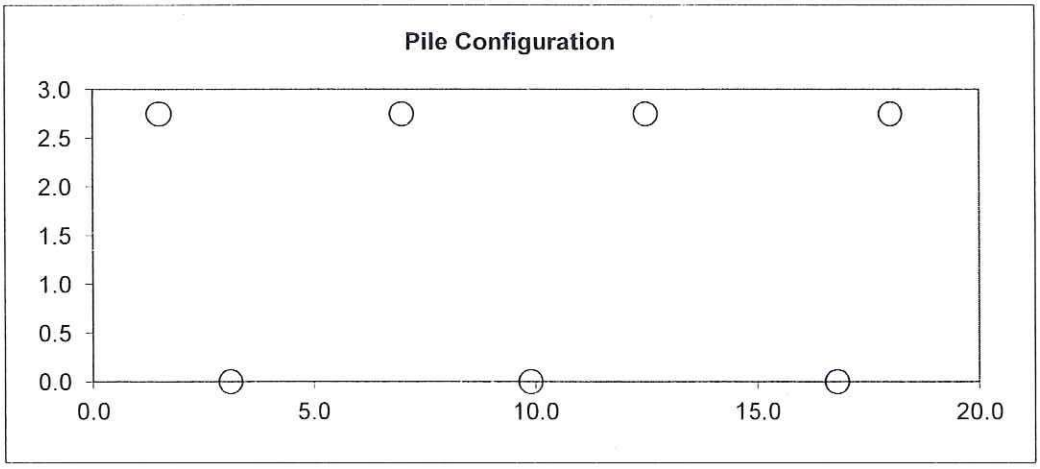
Project: **RW 293** Project No. **10-126**
By SP Date 05/20/11 Check by Date Sheet

Proposed RW 315 Pile Layout



Calculation of Pile Group Efficiency for Lateral Load Capacity

(using formula in Group 7.0 Technical Manual)



Pile Dia. (feet): 1.33
No. of Piles: 7

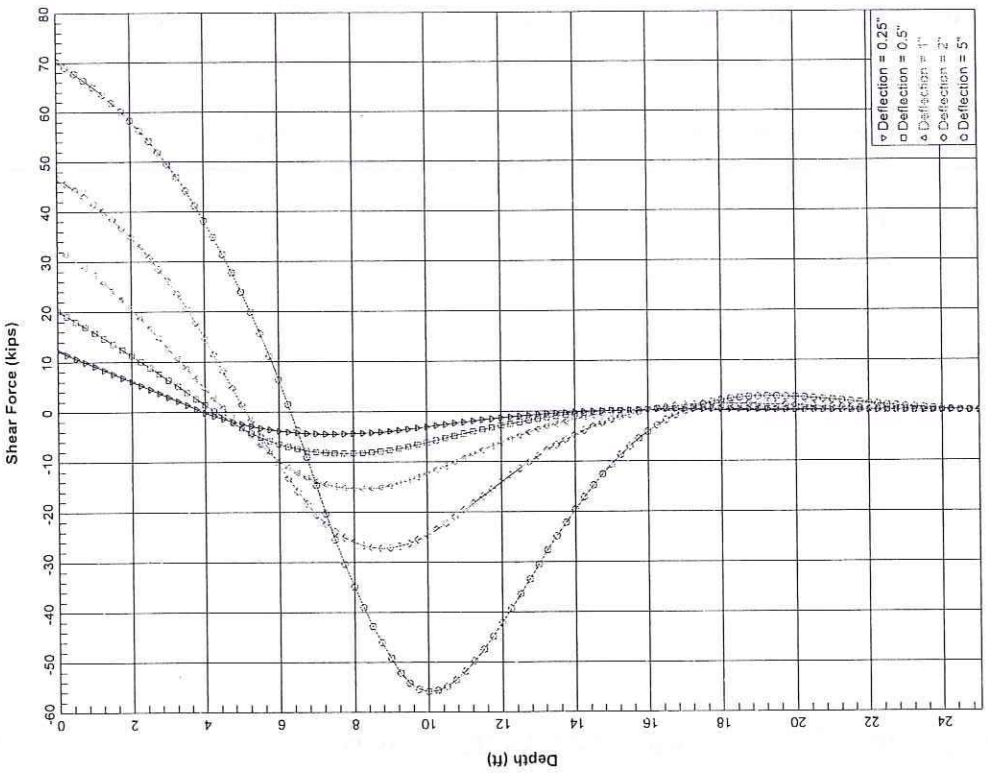
	X-Dir	Y-Dir
Group Efficiency	0.687	0.780

Use **0.68**

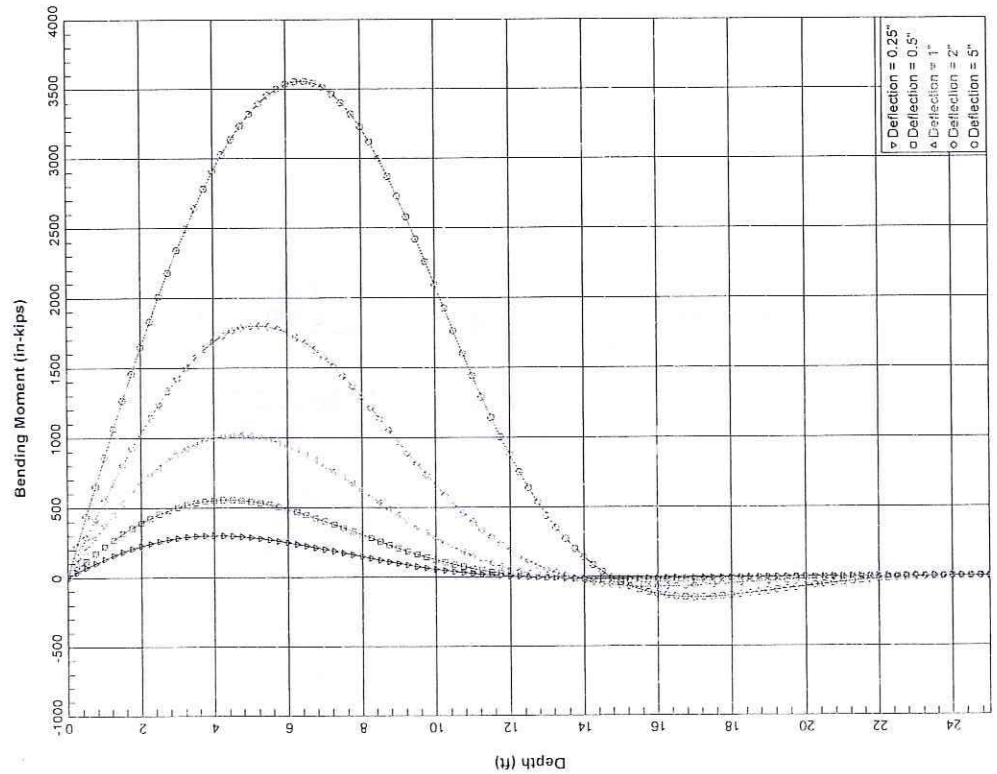
Coordinates

Pile No.	X	Y
1	3.1	0.0
2	9.9	0.0
3	16.8	0.0
4	1.5	2.8
5	7.0	2.8
6	12.5	2.8
7	18.0	2.8

Reduction Factors in X-dir	Reduction Factors in Y-dir
0.658	0.666
0.671	0.681
0.811	0.650
0.662	0.873
0.668	0.915
0.649	0.913
0.847	0.861



Retaining Wall 315 16-inch CIDH (Freehead)



Retaining Wall 315 16-inch CIDH (Freehead)

LPile Plus for Windows, Version 6.0 (6.0.09)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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This program is licensed to:

Earth Mechanics, Inc.
Earth Mechanics, Inc.

Files Used for Analysis

Path to file locations:	X:\Projects\2010\10-126 - RBF, SR 91 Westbound Widening\Reports\Foundation Report\07 Retaining Walls\Analysis\Special Walls\RW No. 315\03 Lateral Capacity\
Name of input data file:	Retaining Wall 315 16-inch CIDH (Freehead).lp6d
Name of output file:	Retaining Wall 315 16-inch CIDH (Freehead).lp6o
Name of plot output file:	Retaining Wall 315 16-inch CIDH (Freehead).lp6p
Name of runtime file:	Retaining Wall 315 16-inch CIDH (Freehead).lp6r

Date and Time of Analysis

Date: May 20, 2011 Time: 12:12:58

Problem Title

Project Name:

Job Number:

Client:

Engineer:

Description:

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multiplers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	100	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections	=	1
Total Pile Length	=	25.00 ft
Depth of ground surface below top of pile	=	-4.00 ft
Slope angle of ground surface	=	0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.

p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth x ft	Pile Diameter in
1	0.00000	16.0000000
2	25.000000	16.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	25.000 in
Top Width	=	16.000 in
Bottom Width	=	16.000 in
Top Area	=	201.000000 sq. in
Bottom Area	=	201.000000 sq. in
Moment of Inertia at Top	=	3.608E+03 in^4
Moment of Inertia at Bottom	=	3.608E+03 in^4
Elastic Modulus	=	3200000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	-4.000 ft
Distance from top of pile to bottom of layer	=	9.000 ft
p-y subgrade modulus k for top of soil layer	=	55.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	55.000 lbs/in**3

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	9.000 ft
Distance from top of pile to bottom of layer	=	30.000 ft
p-y subgrade modulus k for top of soil layer	=	80.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	80.000 lbs/in**3

(Depth of lowest layer extends 5.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 4 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	-4.00	120.00000
2	9.00	120.00000
3	9.00	120.00000
4	30.00	120.00000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. Subgr. pci
1	Sand (Reese, et al.)	-4.000	120.000	--	32.000	--	--	--	55.000	--	--	--	--	--
		9.000	120.000	--	32.000	--	--	--	55.000	--	--	--	--	--
2	Sand (Reese, et al.)	9.000	120.000	--	33.000	--	--	--	80.000	--	--	--	--	--
		30.000	120.000	--	33.000	--	--	--	80.000	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.6800	1.0000
2	25.000	0.6800	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	60000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	60000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	60000.000
4	4	y =	2.000 in	M =	0.000 in-lbs	60000.000
5	4	y =	5.000 in	M =	0.000 in-lbs	60000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

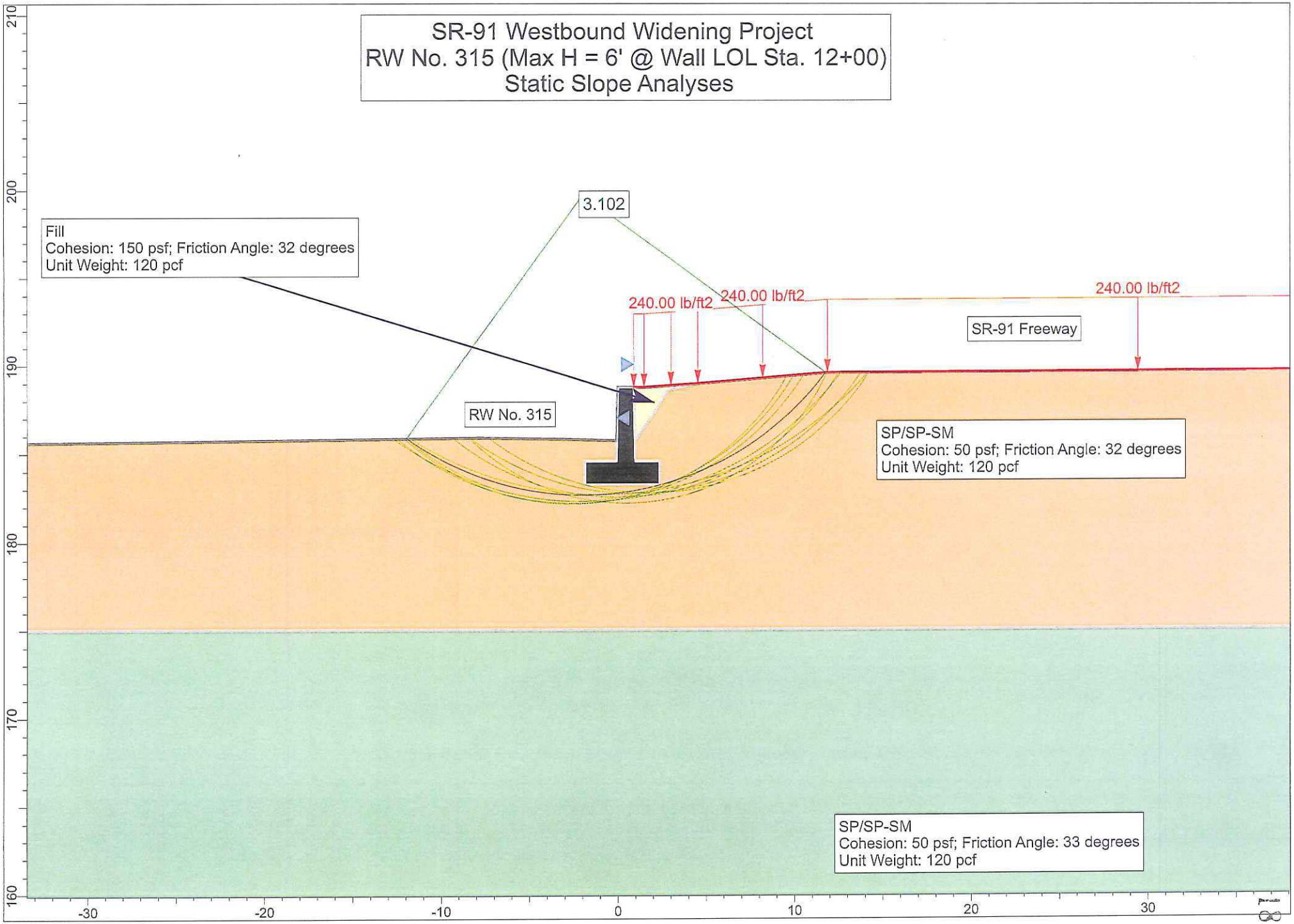
Summary of Pile Response(s)

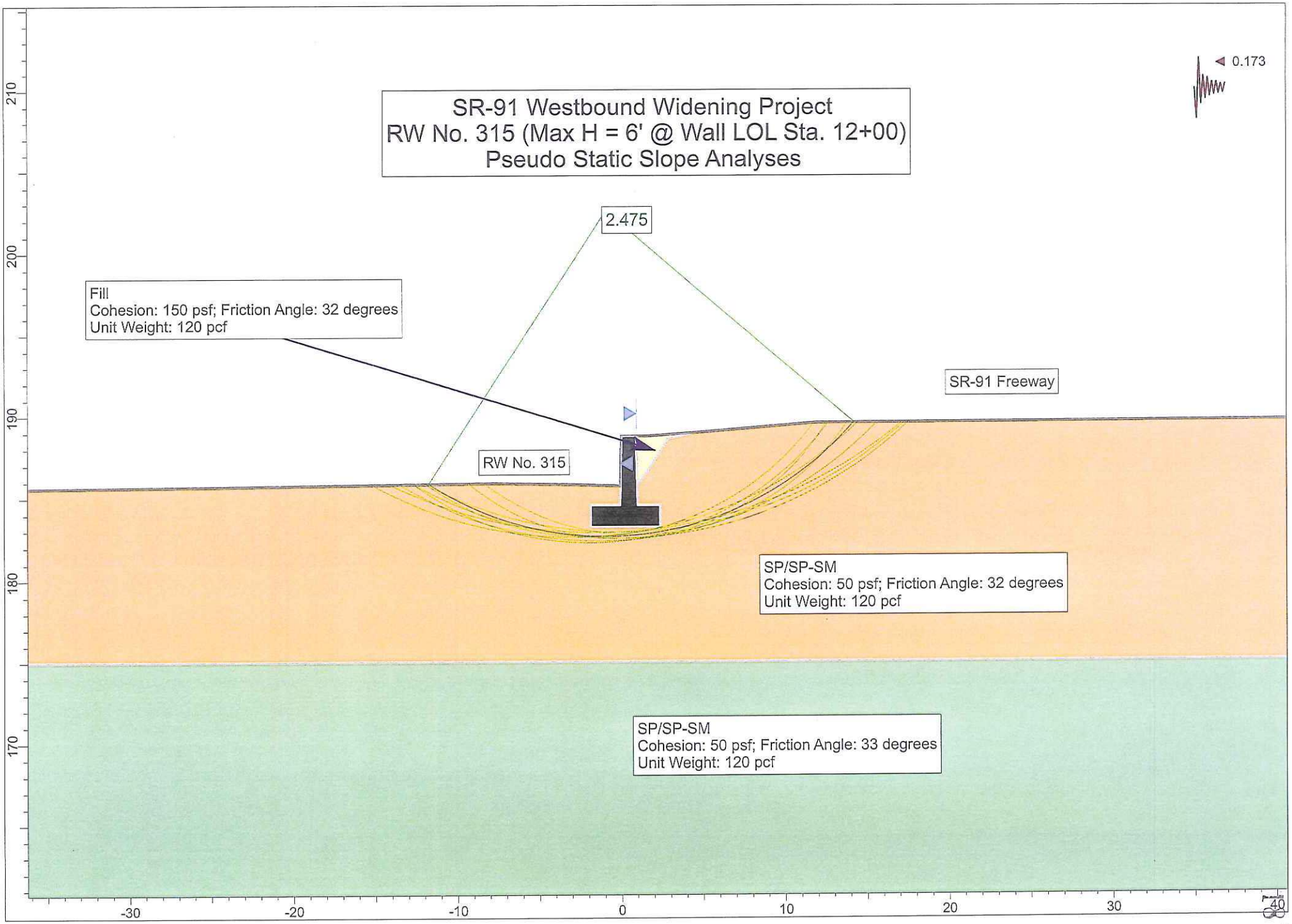
Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)		Condition 2 in-lb, rad., or in-lb/rad.		Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y =	0.2500	M =	0.000	60000.	0.25000000	300626.	12184.	0.00000000
2	4	y =	0.5000	M =	0.000	60000.	0.50000000	556532.	20161.	0.00000000
3	4	y =	1.0000	M =	0.000	60000.	1.00000000	1018041.	32553.	0.00000000
4	4	y =	2.0000	M =	0.000	60000.	2.00000000	1798526.	46758.	0.00000000
5	4	y =	5.0000	M =	0.000	60000.	5.00000000	3556607.	70708.	0.00000000

The analysis ended normally.


SR-91 Westbound Widening Project
RW No. 315 (Max H = 6' @ Wall LOL Sta. 12+00)
Static Slope Analyses
3.102
Fill
Cohesion: 150 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
240.00 lb/ft2
240.00 lb/ft2
240.00 lb/ft2
SR-91 Freeway
RW No. 315
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 33 degrees
Unit Weight: 120 pcf
210
200
190
180
170
160
-30
-20
-10
0
10
20
30


SR-91 Westbound Widening Project
RW No. 315 (Max H = 6' @ Wall LOL Sta. 12+00)
Pseudo Static Slope Analyses
0.173
2.475
Fill
Cohesion: 150 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
SR-91 Freeway
RW No. 315
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 33 degrees
Unit Weight: 120 pcf
210
200
190
180
170
-30
-20
-10
0
10
20
30
40

Appendix D

CALTRANS REVIEW COMMENTS AND EMI RESPONSES

DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

TO: MR. JOHN FUJIMOTO
Office of Special Funded Projects (OSFP)
Attention: Ms. Luqi Yang
Fax: (916) 227-8683

DATE: January 17, 2012

FILE: 12 ORA 91 1.0
District County Route Post mile

FDN REPORT BY: Earth Mechanics, Inc DATED: December 16, 2011

Wall 107
Structure Name

GENERAL PLAN DATED: NA FDN PLAN DATED: NA

12-0C5701 ?
EA Number Bridge Number

Submittal (*Check One*): [ ] 1st [ ] 2nd [X] 3rd [ ] 4th [ ] Other:

The Office of Geotechnical Design South 1 (OGDS-1) has reviewed the submittal titled "Final Foundation Report, Non-Standard Walls, State Route 91 Westbound Widening, Orange County, California, 12-ORA-91, PM 0.9/5.4, Caltrans Project No. 1200000791, (EA 12-0C5701)", prepared by Earth Mechanics, Inc. dated December 16, 2011 and received by our office on December 29, 2011.

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We have the following comments:

1. Are there any utilities crossing the subject wall?
2. If the response to the comment No.1 is affirmative, elaborate on the impact of these utilities on the foundation design and construction.
3. Are the geotechnical design recommendations with regards to the over-excavation incorporated into the plans? Provide supporting documentation.
4. Revise the subject report's title on the cover and the subject to include each wall number, post mile and bridge number.

Please call Sharid Amiri at (949)724-2599, if you have any questions.

Approval:

Reviewed By: Sharid Amiri, PhD, P.E.
Geotechnical Design South-1

(C3) Not Approved
Office of Special Funded projects

Cc: OGDS (Sacramento) DES Office of Specifications and Estimates (All Reviews) OSC R.E Pending File

DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

TO: MR. JOHN FUJIMOTO
Office of Special Funded Projects (OSFP)
Attention: Ms. Luqi Yang
Fax: (916) 227-8683

DATE: January 17, 2012

FILE: 12 ORA 91 2.0
District County Route Post mile

FDN REPORT BY: Earth Mechanics, Inc DATED: December 16, 2011

Wall 159
Structure Name

GENERAL PLAN DATED: NA FDN PLAN DATED: NA

12-0C5701 ?
EA Number Bridge Number

Submittal (*Check One*): [ ] 1st [ ] 2nd [X] 3rd [ ] 4th [ ] Other:

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Geotechnical Design South-1

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DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

TO: MR. JOHN FUJIMOTO
Office of Special Funded Projects (OSFP)
Attention: Ms. Luqi Yang
Fax: (916) 227-8683

DATE: January 17, 2012

FILE: 12 ORA 91 2.3
District County Route Post mile

FDN REPORT BY: Earth Mechanics, Inc DATED: December 16, 2011

Wall 173
Structure Name

GENERAL PLAN DATED: NA FDN PLAN DATED: NA

12-0C5701 ?
EA Number Bridge Number

Submittal (*Check One*): [ ] 1st [ ] 2nd [X] 3rd [ ] 4th [ ] Other:

The Office of Geotechnical Design South 1 (OGDS-1) has reviewed the submittal titled "Final Foundation Report, Non-Standard Walls, State Route 91 Westbound Widening, Orange County, California, 12-ORA-91, PM 0.9/5.4, Caltrans Project No. 1200000791, (EA 12-0C5701)", prepared by Earth Mechanics, Inc. dated December 16, 2011 and received by our office on December 29, 2011.

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Geotechnical Design South-1

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DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

TO: MR. JOHN FUJIMOTO
Office of Special Funded Projects (OSFP)
Attention: Ms. Luqi Yang
Fax: (916) 227-8683

DATE: January 17, 2012

FILE: 12 ORA 91 3.8
District County Route Post mile

FDN REPORT BY: Earth Mechanics, Inc DATED: December 16, 2011

Wall 255
Structure Name

GENERAL PLAN DATED: NA FDN PLAN DATED: NA

12-0C5701 ?
EA Number Bridge Number

Submittal (*Check One*): [ ] 1st [ ] 2nd [X] 3rd [ ] 4th [ ] Other:

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Approval:

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Geotechnical Design South-1

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DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

TO: MR. JOHN FUJIMOTO
Office of Special Funded Projects (OSFP)
Attention: Ms. Luqi Yang
Fax: (916) 227-8683

DATE: January 17, 2012

FILE: 12 ORA 91 4.5
District County Route Post mile

FDN REPORT BY: Earth Mechanics, Inc DATED: December 16, 2011

Wall 293
Structure Name

GENERAL PLAN DATED: NA FDN PLAN DATED: NA

12-0C5701 ?
EA Number Bridge Number

Submittal (*Check One*): [ ] 1st [ ] 2nd [X] 3rd [ ] 4th [ ] Other:

The Office of Geotechnical Design South 1 (OGDS-1) has reviewed the submittal titled "Final Foundation Report, Non-Standard Walls, State Route 91 Westbound Widening, Orange County, California, 12-ORA-91, PM 0.9/5.4, Caltrans Project No. 1200000791, (EA 12-0C5701)", prepared by Earth Mechanics, Inc. dated December 16, 2011 and received by our office on December 29, 2011.

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DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

TO: MR. JOHN FUJIMOTO
Office of Special Funded Projects (OSFP)
Attention: Ms. Luqi Yang
Fax: (916) 227-8683

DATE: January 17, 2012

FILE: 12 ORA 91 4.8
District County Route Post mile

FDN REPORT BY: Earth Mechanics, Inc DATED: December 16, 2011

Wall 307
Structure Name

GENERAL PLAN DATED: NA FDN PLAN DATED: NA

12-0C5701 ?
EA Number Bridge Number

Submittal (*Check One*): [ ] 1st [ ] 2nd [X] 3rd [ ] 4th [ ] Other:

The Office of Geotechnical Design South 1 (OGDS-1) has reviewed the submittal titled "Final Foundation Report, Non-Standard Walls, State Route 91 Westbound Widening, Orange County, California, 12-ORA-91, PM 0.9/5.4, Caltrans Project No. 1200000791, (EA 12-0C5701)", prepared by Earth Mechanics, Inc. dated December 16, 2011 and received by our office on December 29, 2011.

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Please call Sharid Amiri at (949)724-2599, if you have any questions.

Approval:

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Geotechnical Design South-1

(C3) Not Approved
Office of Special Funded projects

Cc: OGDS (Sacramento) DES Office of Specifications and Estimates (All Reviews) OSC R.E Pending File

DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

TO: MR. JOHN FUJIMOTO
Office of Special Funded Projects (OSFP)
Attention: Ms. Luqi Yang
Fax: (916) 227-8683

DATE: January 17, 2012

FILE: 12 ORA 91 4.9
District County Route Post mile

FDN REPORT BY: Earth Mechanics, Inc DATED: December 16, 2011 Wall 315
Structure Name

GENERAL PLAN DATED: NA FDN PLAN DATED: NA 12-0C5701 ?
EA Number Bridge Number

Submittal (*Check One*): [ ] 1st [ ] 2nd [X] 3rd [ ] 4th [ ] Other:

The Office of Geotechnical Design South 1 (OGDS-1) has reviewed the submittal titled "Final Foundation Report, Non-Standard Walls, State Route 91 Westbound Widening, Orange County, California, 12-ORA-91, PM 0.9/5.4, Caltrans Project No. 1200000791, (EA 12-0C5701)", prepared by Earth Mechanics, Inc. dated December 16, 2011 and received by our office on December 29, 2011.

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Geotechnical Design South-1

(C3) Not Approved
Office of Special Funded projects

Cc: OGDS (Sacramento) DES Office of Specifications and Estimates (All Reviews) OSC R.E Pending File

February 1, 2012
Earth Mechanics, Inc.

Response to Caltrans Review Comments Dated January 17, 2012
EA 12-0C5701
12-ORA-91

There were seven (7) separate Review Sheets prepared by Caltrans for Walls 107, 159, 173, 255, 293, 307 and 315. The Caltrans comments are the same for each review sheet, and our responses are presented below:

Comment 1: Are there any utilities crossing the subject wall ?

Response: Yes. RBF (Structural Designer) has provided the attached Details sheets showing how the foundations will span over utilities. The first sheet shows both pile and spread footings spanning a utility line, and the second sheet pertains to Wall 107 only.

Comment 2: If the response to the comment No. 1 is affirmative, elaborate on the impact of these utilities on the foundation design and construction.

Response: For pile footings spanning utilities, there is minimal disturbance during installation because pile type is CIDH. For spread footings spanning utilities, the footing is designed to span over the utility. In the unlikely event when the footing settles, the 3-inch Expanded Polystyrene will prevent loading from the footing on the utility.

Comment 3: Are the geotechnical design recommendations with regards to the over-excavation incorporated into the plans ? Provide supporting documentation.

Response: Yes, overexcavation recommendations have been incorporated into the plans, and the supporting documentation is attached. There is no overexcavation for Wall 159 because this is a non-standard soundwall on piles.

Comment 4: Revise the subject report's title on the cover and the subject o include each wall number, post mile and bridge number.

Response: see attached revised report cover.

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	Ora	91			

REGISTERED CIVIL ENGINEER — DATE

PLANS APPROVAL DATE

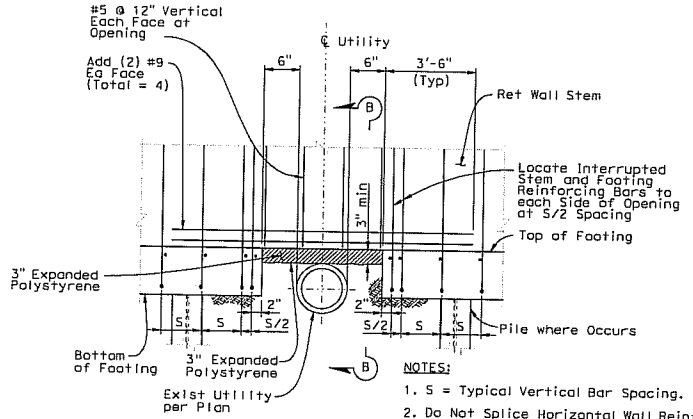
The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

REGISTERED PROFESSIONAL ENGINEER — Christopher Cho — No. C74020 — Exp. 06/30/13 — CIVIL — STATE OF CALIFORNIA

OCTA
550 S MAIN STREET
ORANGE, CA. 92868

RBF CONSULTING
14725 ALTON PARKWAY
IRVINE, CA 92677

Used Typ on all walls where Util crosses wall.

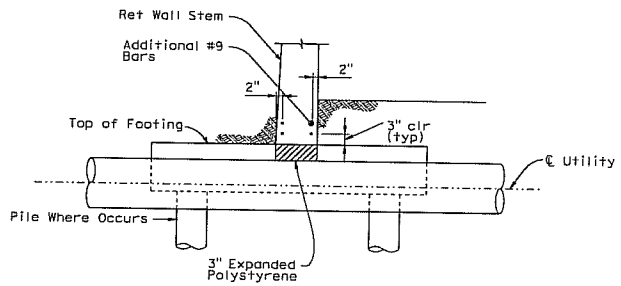


NOTES:

1. S = Typical Vertical Bar Spacing.
2. Do Not Splice Horizontal Wall Reinf Above Utility Bridge.

UTILITY BRIDGE OVER DETAIL

NO SCALE



SECTION B-B

NO SCALE

DESIGN OVERSIGHT					
SIGN OFF DATE					
DESIGN DETAIL SHEET (ENGLISH) (REV. 7/16/10)					
	DESIGN	BY C. Cho	CHECKED C. Harden		
	DETAILS	BY C. Cho	CHECKED C. Harden		
	QUANTITIES	BY C. Cho	CHECKED J. Voepel		

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS: 0 1 2 3

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

Chad Harden
PROJECT ENGINEER

BRIDGE NO. --
POST MILES 1.0

RETAINING WALL No. 107
MISCELLANEOUS DETAILS No. 1

UNIT: 2295
PROJECT NUMBER & PHASE: 1200000791
CONTRACT NO.: 12-0C5701
FILE => 55-Ret Wall 107-u-miscdt08.dgn

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES						SHEET	OF
						12	20

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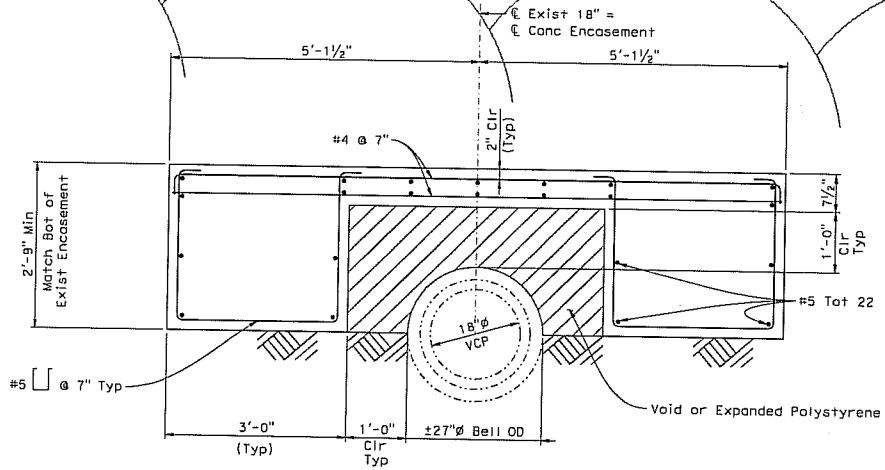
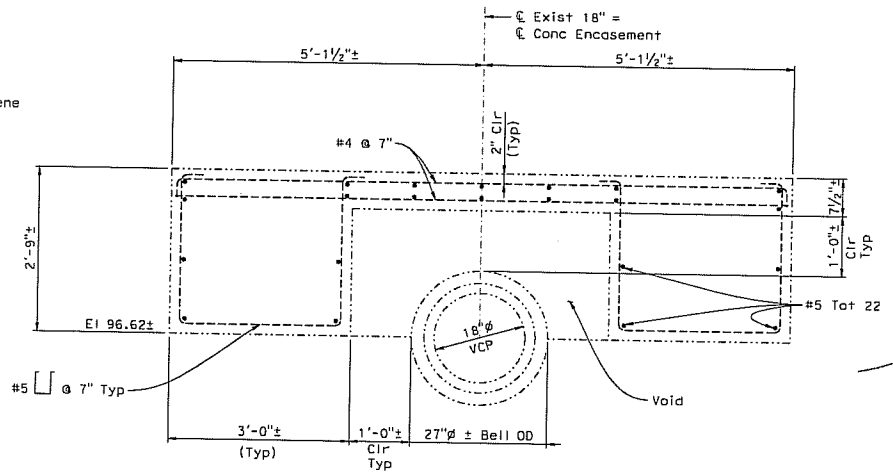
197



SECTION E-E

TYPICAL ENCASEMENT SECTION

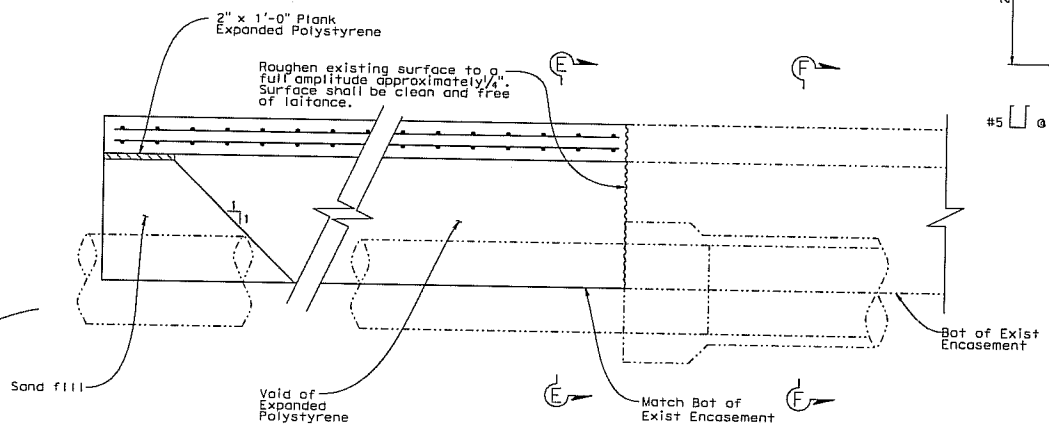
NO SCALE



SECTION F-F

EXISTING PIPE ENCASEMENT

NO SCALE



JOIN TO EXISTING ENCASEMENT DETAIL

NO SCALE

Used one location only.

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEET
12	Ora	91			

REGISTERED CIVIL ENGINEER — DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER — Christopher Cho — No. C74020 — Exp. 06/30/13 — CIVIL — STATE OF CALIFORNIA

OCTA
550 S MAIN STREET
ORANGE, CA. 92868

RBF CONSULTING
14725 ALTON PARKWAY
IRVINE, CA 92677

DESIGN OVERSIGHT			
SIGN OFF DATE			
DESIGN DETAIL SHEET (ENGLISH) (REV.7/16/10)			
DESIGN	BY C. Cho	CHECKED C. Harden	
DETAILS	BY C. Cho	CHECKED C. Harden	
QUANTITIES	BY C. Cho	CHECKED J. Veepel	

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS: 0 1 2 3

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

Chad Harden
PROJECT ENGINEER

BRIDGE NO. --
POST MILES 1.0

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791 CONTRACT NO.: 12-0C5701
FILE => 55-Ret Wall 107-u-misadtl1.dgn

RETAINING WALL No. 107
CONCRETE ENCASEMENT DETAILS

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

SHEET 15 OF 20

H:\pdata\10106833\CADD\Struc\Div\Retaining Walls\Structure\55-Ret Wall 107-u-misadtl1.dgn

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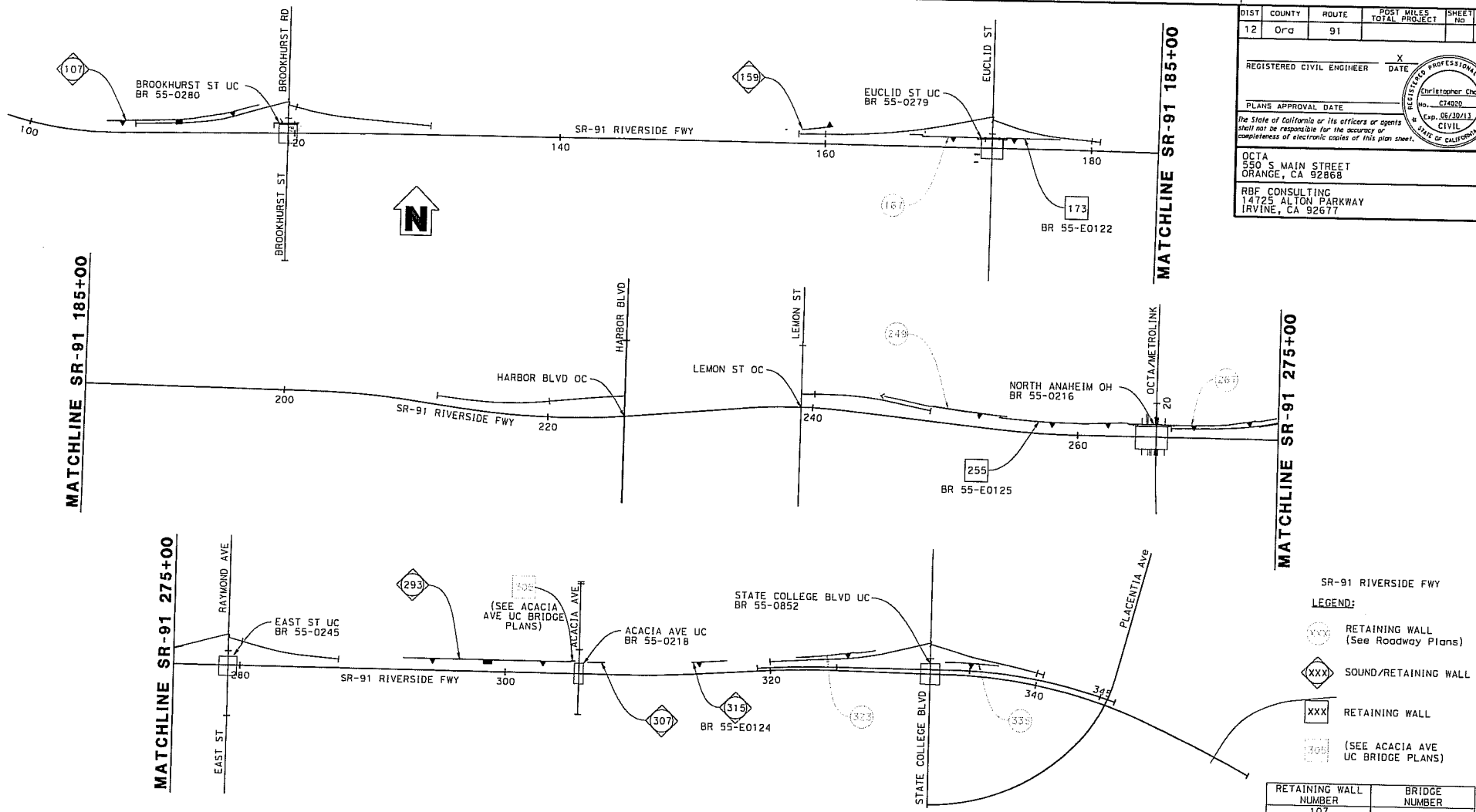
DATE PLOTTED => 31-DEC-201

1981



RETAINING WALL NUMBER	BRIDGE NUMBER
107	--
159	--
173	55-E0122
255	55-E0123
293	--
307	--
315	55-E0124

SOUND WALL & RETAINING WALL KEY PLAN

1" = 350'

NOTE:
THE CONTRACTOR SHALL VERIFY ALL CONTROLLING FIELD DIMENSIONS BEFORE ORDERING OR FABRICATING ANY MATERIAL.

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	Ora	91			

REGISTERED CIVIL ENGINEER — DATE

PLANS APPROVAL DATE

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Registered Professional Engineer — Christopher Cho — No. C74920 — Exp. 06/30/13 — CIVIL — State of California

OCTA
550 S MAIN STREET
ORANGE, CA 92868

RBF CONSULTING
14725 ALTON PARKWAY
IRVINE, CA 92677

DESIGN OVERSIGHT	DESIGN	BY C. Cho	CHECKED C. Harden
	DETAILS	BY J. Saldana	CHECKED C. Harden
SIGN OFF DATE	QUANTITIES	BY C. Harden	CHECKED J. Voepel

LOAD & RESISTANCE FACTOR DESIGN — LIVE LOADING: HL93 W/"LOW-BOY"; PERMIT DESIGN VEHICLE

LAYOUT — BY C. Cho — CHECKED C. Harden

SPECIFICATIONS — BY S. Sheikh — PLANS AND SPECS COMPARED S. Sheikh

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV.7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS: 0 1 2 3

PREPARED FOR THE STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

Chad Harden
PROJECT ENGINEER

BRIDGE NO. 55-E0122, 55-E0123, 55-E0124
POST MILES: Varies

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791
CONTRACT NO.: 12-0C5701

FILE => 55-E0122-a-kp01.dgn

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES				SHEET	OF
				1	10

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USERNAME => CCHO

DATE PLOTTED => 21-DEC-2011

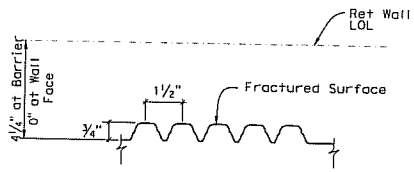
TIME PLOTTED => 11:38

TOP OF WALL ELEVATION TABLE

Wall LOL Station	Top of Wall Elev
9+80.00	108.07
+90	108.13
10+00.00	108.19
+10	108.25
+20	108.31
+30	108.37
+40	108.44
+50	108.50
+60	108.59
+70	108.68
+80	108.76
+90	108.85
11+00.00	108.94
+10	109.03
+20	109.12
+30	109.20
+40	109.29
+50	109.38
+60	109.47
+70	109.56
+80	109.65
+90	109.76
12+00.00	109.86
+10	109.92
+20	109.98
+30	110.03
+40	110.06
+50	110.09
+60	110.13
+70	110.17
+80	110.21
+90	110.24
13+00.00	110.28
+10	110.32
+20	110.36
+30	110.40
+40	110.44
+50	110.48
+60	110.56
+70	110.64
+80	110.72
+90	110.80

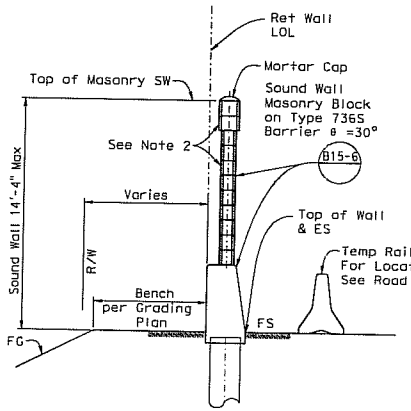
Wall LOL Station	Top of Wall Elev
14+00.00	110.88
+10	110.96
+20	111.03
+30	111.11
+40	111.20
+50	111.28
+60	111.41
+70	111.54
+80	111.66
+90	111.78
15+00.00	111.89
+10	111.97
+20	112.06
+30	112.16
+40	112.27
+50	112.38
+60	112.54
+70	112.71
+80	112.86
+90	113.00
16+00.00	113.14
+10	113.28
+20	113.43
+30	113.58
+40	113.73
+50	113.89
+60	114.06
+70	114.23
+80	114.41
+90	114.62
17+00.00	114.82
+10	115.01
+20	115.20
+30	115.39
+40	115.58
+50	115.77
+60	115.91
+70	116.06
+80	116.18
+90	116.28

Wall LOL Station	Top of Wall Elev
18+00.00	116.38
+10	116.43
+20	116.48
+30	116.50
+40	116.47
+50	116.44
+60	116.41
+70	116.39
+80	116.36
+90	116.33
19+00.00	116.30
+10	116.30
+20	116.30
+30	116.28
+40	116.23
+50	116.18
+60	116.09
+70	116.00
+80	115.88
+90	115.74
20+00.00	115.60
+10	115.42
+20	115.25
+30	115.06
+40	114.85
+50	114.64
+60	114.46
+70	114.28
+80	114.13
+90	114.02
21+00.00	113.90
+10	113.83
+20	113.77
+30	113.74
+40.04	113.72

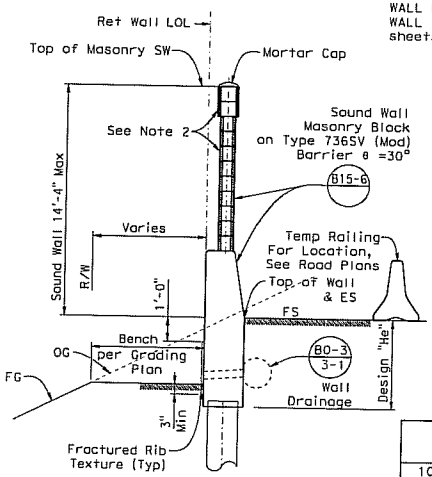


FRACTURED RIB TEXTURE 3/4" (PROJECTING)

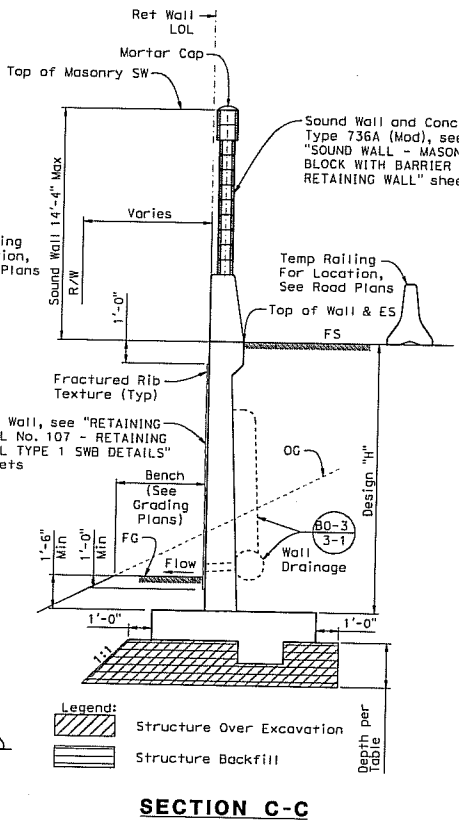
NO SCALE



SECTION A-A

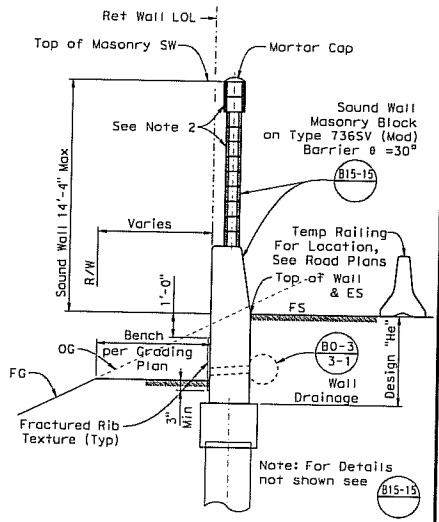


SECTION B-B



SECTION C-C

Wall Station	Design "H"	Over Excavation Depth
10+00 to 18+39	6'-0"	1'-0"
	8'-0"	2'-0"
	10'-0"	3'-0"
	12'-0"	3'-0"
18+39 to 21+40.04	8'-0"	4'-0"
	10'-0"	4'-0"



SECTION D-D

TYPICAL SECTIONS

No Scale

NOTES:

1. This Plan Accurate for Sound Wall and Retaining Wall Work Only.
2. For Sound Wall Block Size, Texture and Color, See "SOUND WALL - MASONRY BLOCK WITH BARRIER ON RETAINING WALL - DETAILS No. 2" Sheet
3. For Excavation and Backfill Details, See "RETAINING WALL No. 107 - LIMITS OF PAYMENT FOR EXCAVATION AND BACKFILL" Sheet.

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	Ora	91			

REGISTERED CIVIL ENGINEER — DATE

REGISTERED PROFESSIONAL ENGINEER — Christopher Cho — No. C74020 — Exp. 06/30/13 — CIVIL — STATE OF CALIFORNIA

PLANS APPROVAL DATE

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OCTA
550 S. MAIN STREET
ORANGE, CA. 92868

RBF CONSULTING
14725 ALTON PARKWAY
IRVINE, CA 92677

DESIGN OVERSIGHT

SIGN OFF DATE

DESIGN DETAIL SHEET (ENGLISH) (REV.7/16/10)

	BY	CHECKED
DESIGN	C. Cho	C. Harden
DETAILS	C. Cho	C. Harden
QUANTITIES	C. Cho	J. Vaepel

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

Chad Harden
PROJECT ENGINEER

BRIDGE NO. --
POST MILES 1.0

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791
CONTRACT NO.: 12-0C5701

FILE => 55-Ret Wall 107-k-ta01.dgn

RETAINING WALL No. 107
TYPICAL SECTIONS

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES				SHEET	OF
				8	20

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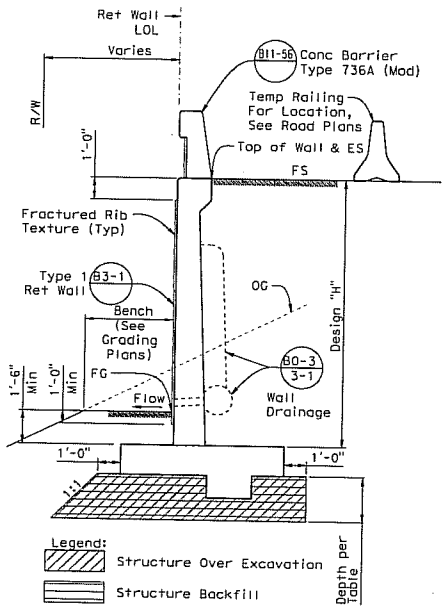
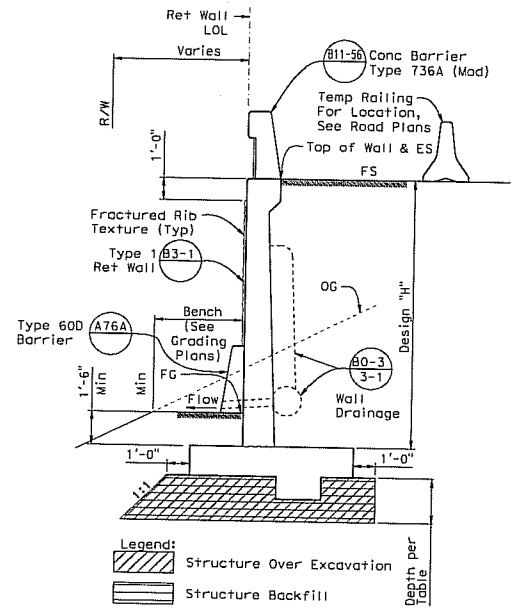
USERNAME => CCHO

DATE PLOTTED => 21-DEC-2011

TIME PLOTTED => 11:41



SECTION A-A



SECTION B-B

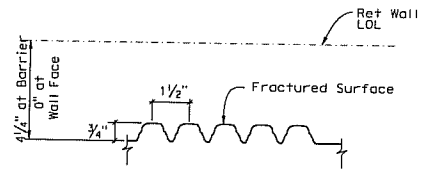
Design "H"	Over Excavation Depth
4'-0"	1'-0"
6'-0"	1'-0"
8'-0"	1'-0"
10'-0"	1'-0"
12'-0"	3'-0"

TYPICAL SECTION
No Scale

TOP OF WALL ELEVATION TABLE

Wall LOL Station	Top of Wall Elev
10+00.00	152.42
+10	152.31
+20	152.20
+30	152.07
+40	151.91
+50	151.75
+60	151.59
+70	151.43
+80	151.27
+90	151.12
11+00.00	150.96
+10	150.80
+20	150.64
+30	150.49
+40	150.34
+50	150.19
+60	150.04
+70	149.89
+80	149.74
+90	149.57
12+00.00	149.41
+10	149.23
+20	149.05
+30	148.86
+40	148.67
+50	148.48
+60	148.27
+70	148.06
+80	147.84
+90	147.62
13+00.00	147.37
+10	147.13
+20	146.88
+30	146.63
+40	146.38
+50	146.12
+60	145.85
+70	145.58
+80	145.31
+90	145.03

Wall LOL Station	Top of Wall Elev
14+00.00	144.75
+10	144.47
+20	144.18
+26.02	144.01



FRACTURED RIB TEXTURE 3/4" (PROJECTING)
NO SCALE

NOTES:

1. This Plan Accurate for Retaining Wall Work Only.
2. For Excavation and Backfill Details, See "RETAINING WALL No. 173 - LIMITS OF PAYMENT FOR EXCAVATION AND BACKFILL" Sheet.

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	Ora	91			

REGISTERED CIVIL ENGINEER — DATE

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

Registered Professional Engineer — Christopher Cho — No. C74020 — Exp. 06/30/13 — CIVIL — State of California

OCTA
550 S MAIN STREET
ORANGE, CA. 92868

RBF CONSULTING
14725 ALTON PARKWAY
IRVINE, CA 92677

DESIGN OVERSIGHT

SIGN OFF DATE

DESIGN DETAIL SHEET (ENGLISH) (REV.7/16/10)

	BY	CHECKED
DESIGN	C. Cho	C. Harden
DETAILS	C. Cho	C. Harden
QUANTITIES	C. Cho	J. Voepel

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

Chad Harden
PROJECT ENGINEER

BRIDGE NO. 55-E0122
POST MILES 2.3

RETAINING WALL No. 173
TYPICAL SECTION

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791 CONTRACT NO.: 12-0C5701
FILE => 55-E0122-k-ta01.dgn

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

SHEET 5 OF 10

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USERNAME => CCHO

DATE PLOTTED => 21-DEC-2011 TIME PLOTTED => 11:18

105

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEET
12	Ora	91			

REGISTERED CIVIL ENGINEER — DATE

PLANS APPROVAL DATE

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Christopher Cho, No. C74020, Exp. 06/30/13, CIVIL, REGISTERED PROFESSIONAL ENGINEER, STATE OF CALIFORNIA

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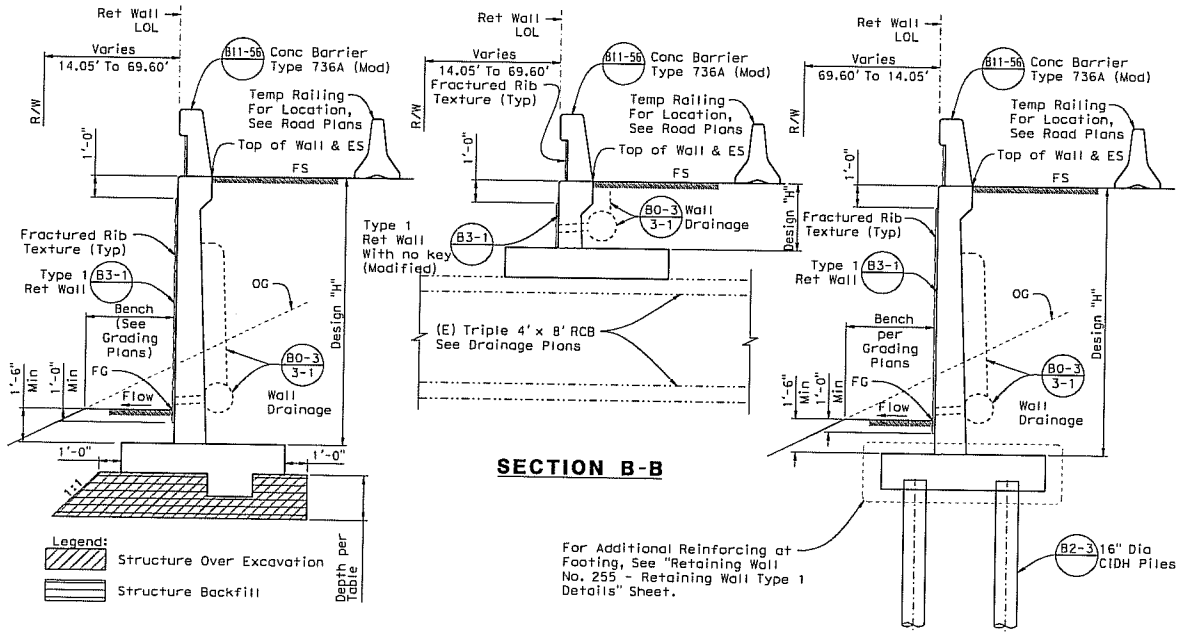
550 S MAIN STREET
ORANGE, CA. 92868

RBF CONSULTING
14725 ALTON PARKWAY
IRVINE, CA 92677



SECTION A-A

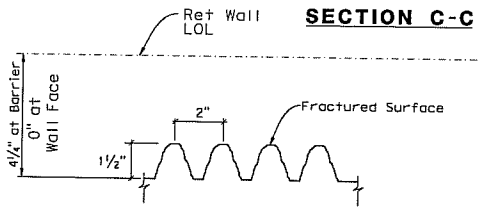
SECTION B-B

SECTION C-C

Wall Station	Design "H"	Over Excavation Depth
10+00 to 15+88	6'-0"	1'-0"
	8'-0"	1'-0"
	10'-0"	2'-0"
	12'-0"	4'-0"
15+88 to 20+26.00	6'-0"	1'-0"
	8'-0"	1'-0"
	10'-0"	1'-0"
	12'-0"	3'-0"

TYPICAL SECTIONS

No Scale



FRACTURED RIB TEXTURE 1 1/2" (PROJECTING)

NO SCALE

TOP OF WALL ELEVATION TABLE

Wall LOL Station	Top of Wall Elev
10+00.00	169.44
+10	169.60
+20	169.77
+30	169.95
+40	170.16
+50	170.36
+60	170.58
+70	170.80
+80	171.04
+90	171.30
11+00.00	171.56
+10	171.83
+20	172.10
+30	172.37
+40	172.64
+50	172.91
+60	173.19
+70	173.46
+80	173.75
+90	174.04
12+00.00	174.34
+10	174.64
+20	174.94
+30	175.24
+40	175.54
+50	175.84
+60	176.15
+70	176.45
+80	176.75
+90	177.05
13+00.00	177.35
+10	177.65
+20	177.95
+30	178.25
+40	178.56
+50	178.86
+60	179.16
+70	179.46
+80	179.76
+90	180.06

Wall LOL Station	Top of Wall Elev
14+00.00	180.36
+10	180.66
+20	180.97
+30	181.27
+40	181.57
+50	181.87
+60	182.17
+70	182.47
+80	182.77
+90	183.08
15+00.00	183.38
+10	183.68
+20	183.99
+30	184.29
+40	184.60
+50	184.91
+60	185.21
+70	185.52
+80	185.82
+90	186.13
16+00.00	186.43
+10	186.73
+20	187.03
+30	187.33
+40	187.64
+50	187.94
+60	188.40
+70	188.86
+80	189.19
+90	189.50
17+00.00	189.81
+10	190.12
+20	190.43
+30	190.74
+40	191.05
+50	191.36
+60	191.67
+70	191.98
+80	192.29
+90	192.60

Wall LOL Station	Top of Wall Elev
18+00.00	192.91
+10	193.21
+20	193.51
+30	193.81
+40	194.10
+50	194.40
+60	194.69
+70	194.98
+80	195.27
+90	195.56
19+00.00	195.85
+10	196.13
+20	196.40
+30	196.67
+40	196.95
+50	197.23
+60	197.43
+70	197.53
+80	197.62
+90	197.69
20+00.00	197.76
+10	197.99
+20	198.22
+25.11	198.33

NOTES:

1. This Plan Accurate for Retaining Wall Work Only.
2. For Excavation and Backfill Details, See "RETAINING WALL No. 255 - LIMITS OF PAYMENT FOR EXCAVATION AND BACKFILL" Sheet.

DESIGN OVERSIGHT
SIGN OFF DATE
DESIGN DETAIL SHEET (ENGLISH) (REV. 7/16/10)

	BY	CHECKED
DESIGN	C. Cho	C. Harden
DETAILS	C. Cho	C. Harden
QUANTITIES	C. Cho	J. Voepel

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

PREPARED FOR THE STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

Chad Harden
PROJECT ENGINEER

BRIDGE NO. 55-E0123
POST MILES 3.8

RETAINING WALL No. 255
TYPICAL SECTIONS

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791
CONTRACT NO.: 12-0C5701

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET 8 | OF 15

FILE => 55-E0123-k-ts01.dgn

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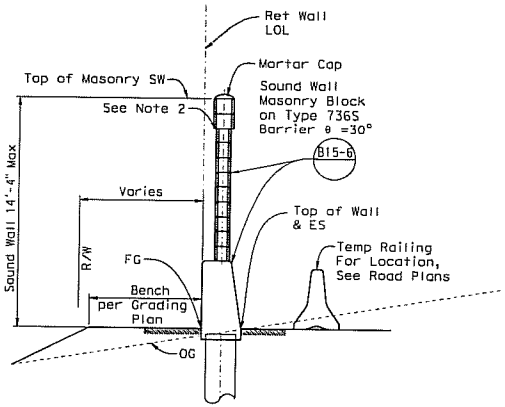
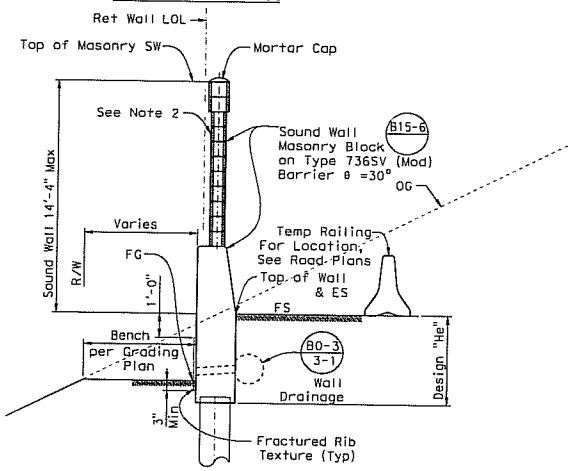
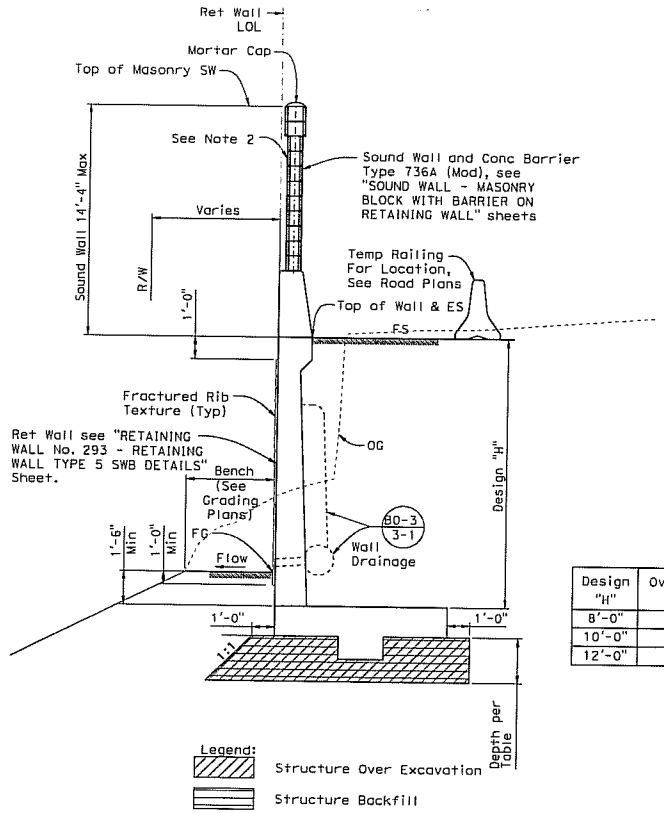
2012



SECTION A-A

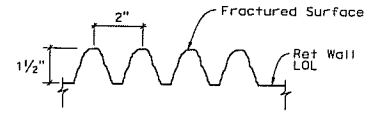


SECTION B-B



SECTION C-C

Design "H"	Over Excavation Depth
8'-0"	2'-0"
10'-0"	3'-0"
12'-0"	4'-0"



FRACTURED RIB TEXTURE 1 1/2" (PROJECTING)

NO SCALE

NOTES:

1. This Plan Accurate for Sound Wall and Retaining Wall Work Only.
2. For Sound Wall Block Size, Texture and Color, See "SOUND WALL - MASONRY BLOCK WITH BARRIER ON RETAINING WALL - DETAILS No. 2" Sheet.
3. For Excavation and Backfill Details, See "RETAINING WALL No. 293 - LIMITS OF PAYMENT FOR EXCAVATION AND BACKFILL" Sheet.

TYPICAL SECTIONS

No Scale

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	Ora	91			

REGISTERED CIVIL ENGINEER — DATE

PLANS APPROVAL DATE

Christopher Cho, No. C74020, Exp. 06/30/13, CIVIL, REGISTERED PROFESSIONAL ENGINEER, STATE OF CALIFORNIA

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550 S MAIN STREET
ORANGE, CA. 92868

RBF CONSULTING
14725 ALTON PARKWAY
IRVINE, CA 92677

	BY	CHECKED
DESIGN	C. Cho	C. Harden
DETAILS	C. Cho	C. Harden
QUANTITIES	C. Cho	J. Voepel

PREPARED FOR THE STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

Chad Harden
PROJECT ENGINEER

BRIDGE NO. --
POST MILES 4.5

RETAINING WALL No. 293
TYPICAL SECTIONS No. 1

DESIGN OVERSIGHT
SIGN OFF DATE
DESIGN DETAIL SHEET (ENGLISH) (REV.7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS: 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791
CONTRACT NO.: 12-0C5701
FILE => 55-Ret Wall 293-k-ts01.dgn

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

SHEET 11 OF 24

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USERNAME => ECHO

DATE PLOTTED => 21-DEC-2011 TIME PLOTTED => 11:13

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	Ora	91			

REGISTERED CIVIL ENGINEER — DATE

PLANS APPROVAL DATE

Christopher Cho, No. C74020, Exp. 06/30/13, CIVIL, REGISTERED PROFESSIONAL ENGINEER, STATE OF CALIFORNIA

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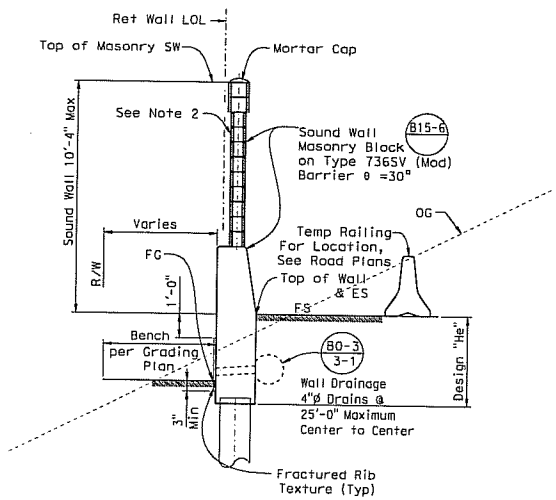
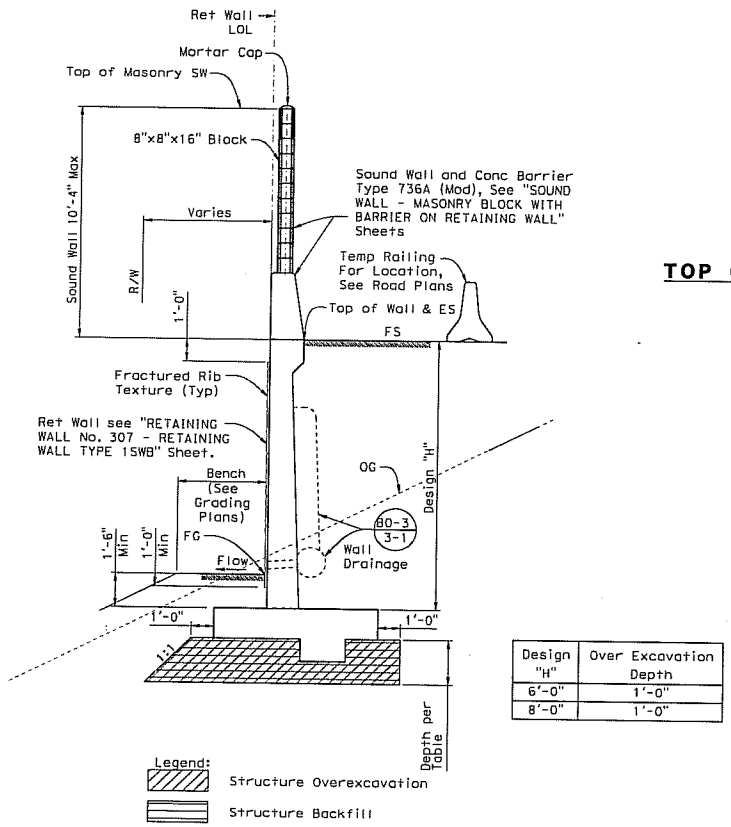
550 S MAIN STREET
ORANGE, CA. 92868

RBF CONSULTING
14725 ALTON PARKWAY
IRVINE, CA 92677



SECTION A-A



SECTION B-B

Design "H"	Over Excavation Depth
6'-0"	1'-0"
8'-0"	1'-0"

TOP OF WALL ELEVATION TABLE

Wall LOL Station	Top of Wall Elev
10+00.00	200.36
+10	200.28
+20	200.20
+30	200.09
+40	199.96
+50	199.82
+60	199.69
+70	199.56
+80	199.44
+90	199.32
11+00.00	199.20
+10	199.04
+20	198.87
+30	198.71
+32.00	198.68

NOTES:

1. This Plan Accurate for Sound Wall and Retaining Wall Work Only.
2. For Sound Wall Block Size, Texture and Color, See "SOUND WALL - MASONRY BLOCK WITH BARRIER ON RETAINING WALL - DETAILS No. 2" Sheet.
3. For Excavation and Backfill Details, See "RETAINING WALL No. 307 - LIMITS OF PAYMENT FOR EXCAVATION AND BACKFILL" Sheet.

TYPICAL SECTIONS

No Scale

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DESIGN OVERSIGHT
SIGN OFF DATE
DESIGN DETAIL SHEET (ENGLISH) (REV.7/16/10)

	BY	CHECKED
DESIGN	C. Cho	C. Harden
DETAILS	C. Cho	C. Harden
QUANTITIES	C. Cho	J. Voepel

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS: 0 1 2 3

PREPARED FOR THE STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

Chad Harden
PROJECT ENGINEER

BRIDGE NO. --
POST MILES 4.8

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791
CONTRACT NO.: 12-0C5701
FILE => 55-Ret Wall 307-k-ts01.dgn

RETAINING WALL No. 307
TYPICAL SECTIONS

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES				SHEET	OF
				3	12

USERNAME => CHO

DATE PLOTTED => 11-JUN-2013

20[illegible]

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	Ora	91			

REGISTERED CIVIL ENGINEER — DATE

PLANS APPROVAL DATE

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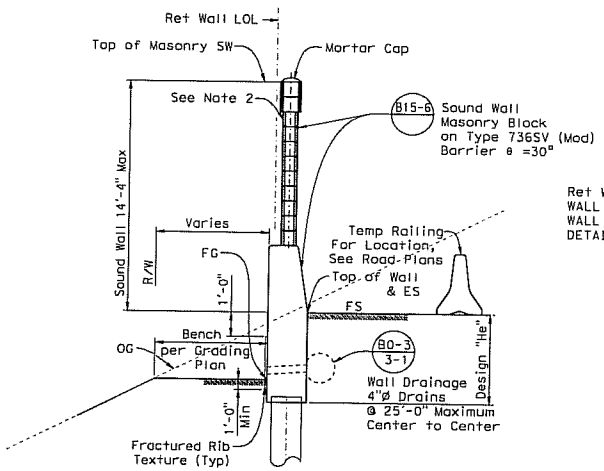
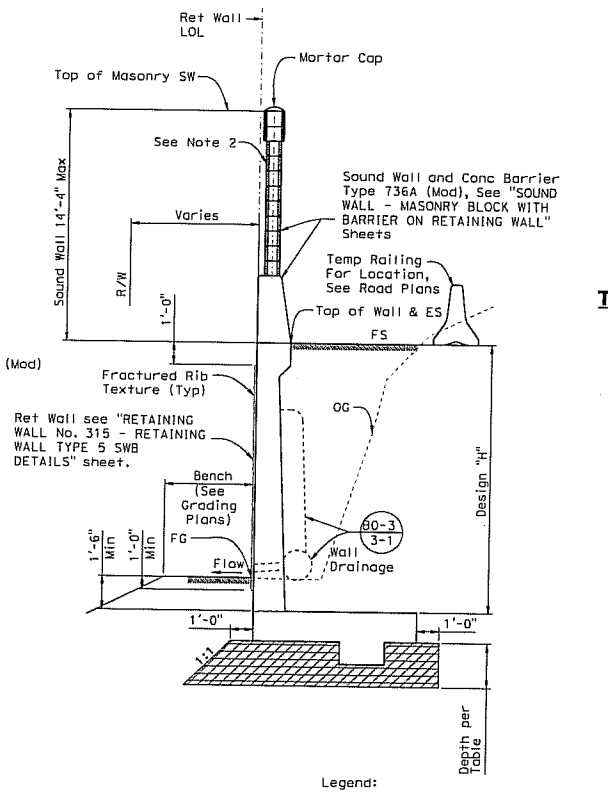
REGISTERED PROFESSIONAL ENGINEER — Christopher Cho — No. C74020 — Exp. 06/30/13 — CIVIL — STATE OF CALIFORNIA

OCTA
550 S MAIN STREET
ORANGE, CA. 92868

RBF CONSULTING
14725 ALTON PARKWAY
IRVINE, CA 92677





Legend:

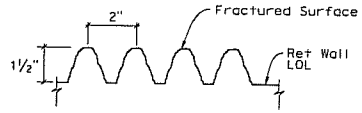
Structure Over Excavation

Structure Backfill

Design "H"	Over Excavation Depth
6'-0"	1'-0"

TOP OF WALL ELEVATION TABLE

Wall LOL Station	Top of Wall Elev
10+00.00	187.05
+10	187.12
+20	187.19
+30	187.26
+40	187.33
+50	187.40
+60	187.48
+70	187.55
+80	187.63
+90	187.72
11+00.00	187.80
+10	187.92
+20	188.03
+30	188.16
+40	188.29
+50	188.43
+60	188.57
+70	188.71
+80	188.85
+90	188.98
12+00.00	189.11
+10	189.21
+20	189.32
+30	189.41
+40	189.50
+50	189.58
+60	189.67
+67.92	189.74



FRACTURED RIB TEXTURE 1 1/2" (PROJECTING)

NO SCALE

NOTES:

1. This Plan Accurate for Sound Wall and Retaining Wall Work Only.
2. For Sound Wall Block Size, Texture and Color, See "SOUND WALL - MASONRY BLOCK WITH BARRIER ON RETAINING WALL - DETAILS No. 2" Sheet
3. For Excavation and Backfill Details, See "RETAINING WALL No. 315 - LIMITS OF PAYMENT FOR EXCAVATION AND BACKFILL" Sheet.

SECTION A-A

SECTION B-B

TYPICAL SECTIONS

No Scale

DESIGN OVERSIGHT

SIGN OFF DATE

DESIGN DETAIL SHEET (ENGLISH) (REV.7/16/10)

	BY	CHECKED
DESIGN	C. Cho	C. Harden
DETAILS	C. Cho	C. Harden
QUANTITIES	C. Cho	J. Voepel

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

Chad Harden
PROJECT ENGINEER

BRIDGE NO.	POST MILES
55-E0124	4.9

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791
CONTRACT NO.: 12-0C5701
FILE => 55-E0124-K-TS01.dgn

RETAINING WALL No. 315
TYPICAL SECTIONS No. 1

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES				SHEET	OF
				5	14

H:\pdata\10106833\CADD\Struc\Div\Retaining Walls\Structure\55-E0124-K-TS01.dgn

USERNAME => CCHO

DATE PLOTTED => 01-FEB-2012

TIME PLOTTED => 08:41

2012

FINAL FOUNDATION REPORT

Wall 107 (Bridge No. 55-E0125), PM 1.0
Wall 159 (Bridge No. 55-E0126), PM 2.0
Wall 173 (Bridge No. 55-E0122), PM 2.3
Wall 255 (Bridge No. 55-E0123), PM 3.8
Wall 293 (Bridge No. 55-E0127), PM 4.5
Wall 307 (Bridge No. 55-E0128), PM 4.8
and
Wall 315 (Bridge No. 55-E0124), PM 4.9

State Route 91 Westbound Widening
Orange County, California
12-ORA-91, PM 0.9/5.4
Caltrans Project No. 12000000791 (EA 12-0C5701)
EMI Project No. 10-126
Date: February 1, 2012

EARTH MECHANICS, INC.

Geotechnical and Earthquake Engineering

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****

---- Forwarded by Sharid Amiri/D12/Caltrans/CAGov on 10/29/2011 04:50 PM ----

Sharid Amiri/D12/Caltrans/CAGov
10/29/2011 04:48 PM

To Luqi Yang/HQ/Caltrans/CAGov

cc Andrew Oshrin/D12/Caltrans/CAGov@DOT, Leo Chen/D12/Caltrans/CAGov@DOT

Subject SR 91, Project, project ID: 12000000791 Consultant Responses to Caltrans Review Comments on the Foundation Report for Non-Standard Walls

Luqi

I have reviewed the subject item dated September 16, 2011 and concur with the responses. I will review the revised Foundation Report when received by our office.

Thanks

Sharid Khan Amiri,Ph.D.,P.E.

Senior Transportation Engineer
California Department of Transportation
Geotechnical Services, District 12 Oversight
3347 Michelson Dr., Suite 100
Irvine, Ca.92612-1699
Office (949)-724-2599

****

" For individuals with sensory disabilities , this document will be made available, upon request, in Braille, large print, audiocassette, or computer disk. To obtain a copy of one of these alternate formats, please call Della Moore at (916) 227-8185 or TTY (916) 227-8454 or write to Della Moore, Division of Engineering Services, P.O. Box 168041 Sacramento, CA 95816-8041"
****

State of California

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: Ms. Luqi Yang
Office of Special Funded Projects

Date: August 2, 2011

File: 12-ORA-91-PM 0.9/5.4
EA: 12-0C5701
Proj. No: 1200000097
Rte Walls 173, 255 +5
Houston Storm Channel

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
Geotechnical Services
Office of Geotechnical Design-South 1
Branch B

Subject: Review of "Foundation Report for Non-standard Walls, State Route 91 Westbound Widening Orange County, California", by Earth Mechanics Inc, dated May 27, 2011.

We have reviewed the subject Foundation Report, and have made the following comments that need to be addressed.

Most important, it appears the general intent of this geotechnical report was not incorporated or wrongly incorporated in the contract plans for some walls. The contract plans need to be revised according to the revision of the geotechnical report. Please refer the following comments for detail.

If you have any questions or comments, please contact Quanyan (Michael) Liao by 213-620-2662 or Sam Sukiasian by 213-620-2135.

Prepared by: Date: 8/2/11

Quanyan Liao, G.E
Transportation Engineer
Office of Geotechnical Design - South 1
Branch B

Supervised by: Date: 8/2/11

Sam Sukiasian, G.E.
Senior Transportation Engineer
Office of Geotechnical Design- South 1
Branch B

cc: OGDS1 – Los Angeles File
OGDS1 - Sacramento File (MS-5)
GS – SAC File (MS-5)

CALTRANS
DESIGN REVIEW COMMENTS
EMI RESPONSES

DATE: 09/16/2011

Reviewer's name: Q Liao			**PROJECT: W 91 Widening, Non-Standard Walls**		
Review Date: 7/28/11			**PROJECT No.: 12000000791 (EA 12-0C5701)**		
Comment No.	**Source (page No.)**	**Source (wall No.)**	**Comments**	**Response/Actions**	**Accepted By (Reviewer)**
1	General		1: The whole report should be page numbered for an easier reference.	We will comply.	
2			2: The general intent of this geotechnical report was not incorporated or wrongly incorporated in the contract plans for some walls. The contract plans need to be revised according to the revision of the geotechnical report.	RBF Consulting will comply.	
3			3: Following comments are provided to highlight some of the items but are not the only items need revision.	NA	
4	Page 6		1: Compaction curves should be included because there are overexcavation and compaction activities involved.	We will comply.	
5			2:If the R-value data was not used for this report, it should not be noted in the LOTB to confuse the contractor. Symbols need to be deleted from LOTB.	We will comply.	
6	Page 12		Table 4-1, Wall 107, idealized soil profile layer separation (elevation) is not clear. Plus, soil profile doesn't match what was used in the calculation sheets.	We will revise Table 4-1 to match the soil profile used in the calculation sheets.	
7			Table 4-1, Wall 159, idealized layer separation (elevation) is not clear. Plus, according to the LOTB, it appears 3 idealized soil layers more reasonable for this wall.	We will revise Table 4-1 to match the soil profile used in the calculation sheets.	
8	Page 13		ground water ELEVATION information should be provided as well, rather than depth only.	We will comply.	
9	Page 14		ground water ELEVATION information should be provided as well, rather than depth only.	We will comply.	

CALTRANS
DESIGN REVIEW COMMENTS
EMI RESPONSES

DATE: 09/16/2011

Reviewer's name: Q Liao			PROJECT: W 91 Widening, Non-Standard Walls		
Review Date: 7/28/11			PROJECT No.: 12000000791 (EA 12-0C5701)		
Comment No.	Source (page No.)	Source (wall No.)	Comments	Response/Actions	Accepted By (Reviewer)
10	Page 15		1: Why wall 293 needs a soil corrosion test at 75 feet deep? No any structure goes that deep.	This corrosion test was performed for a soil sample recovered in Boring A-10-039 drilled for RW 255. We anticipated long piles for this wall at the time of the lab test assignment.	
11			2: Table 5-1: why wall 307 and 315 don't have corrosion tests?	This wall foundation report only include 9 corrosion test results for wall borings. There are 18 additional corrosion test results included in the Materials report for this project and all corrosion test results conclude onsite soils are non-corrosive to bare metal and concrete per Caltrans criteria. We do not believe there is need to add more corrosion tests for Walls 307 and 315.	
12	Page 16		1:For wall 173, the geotechnical report recommended pile foundation for wall height greater than 12 feet, while contractor plans adopted pile foundation for wall height equal to 12 feet. The intent of the geotechnical report was wrongly incorporated in the contractor plans. The contractor plans need to be revised.	RBF Consulting will comply.	
13			2: group efficiency factor should be revised as well in the lateral analysis since the pile layout is changed.	Group efficiency factor was calculated using the latest pile layout. We will include the group efficiency factor calculation sheets in Appendix C.	
14	Page 17		1: Table 5-4, wall 173, typing error? service load should be 75.1 kips instead of 73.4 kips.	Yes it is a typo. We will revise Table 5-4	
15	Page 18		1: Table 5-5, wall 255, normial resistance (compression) should be 180 kips for both 14 and 16 feet high wall, per calculation sheets.	We will revise Table 5-5 to show the correct nominal resistance (compression) of 180 kips.	
16			2: The pile data table for wall 255 in the contract plans should be revised as well.	RBF Consulting is updating the plans.	
17			3: Table 5-6, wall 255, pile head deflection doesn't match the calculation sheets.	We will revise Table 5-6 and present LPILE solutions for pile-head deflections of 1/4", 1/2", 1", 2" and 5".	
18	Page 20		1: Table 5-8, Wall 107 (between 18+39 and End Wall), the recommended overexcavation depth (4') doesn't match its supporting calculation (5').	We will revise calculation sheets to show an overexcavation depth of 4 feet.	
19			2: Table 5-8, wall 315, the recommended net contact pressure doesn't match calculation.	We will revise calculation sheet to match the Table 5-8.	

CALTRANS
DESIGN REVIEW COMMENTS
EMI RESPONSES

DATE: 09/16/2011

Reviewer's name: Q Liao			**PROJECT: W 91 Widening, Non-Standard Walls**		
Review Date: 7/28/11			**PROJECT No.: 12000000791 (EA 12-0C5701)**		
Comment No.	**Source (page No.)**	**Source (wall No.)**	**Comments**	**Response/Actions**	**Accepted By (Reviewer)**
20	Page 22	Wall 293	1: Table 5-11, wall 293, normial resistance (compression) should be 180,140, and 180 kips for wall height 14, 16 and 18 feet respectively, per calculation.	We will revise the nominal resistance of Table 5-11 to match the calculation sheet.	
21			2: The pile data table in the contract plans should be revised as well.	RBF Consulting will comply.	
22			3: The pile data table in the contract plans also has typing errors for design tip elevations.	RBF Consulting will comply.	
23			4: The pile data table was repeated in the contract plans.	RBF Consulting will comply.	
24		Wall 315	1: Table 5-10, wall 315. Design tip elevation (lateral) doesn't match calculation. The lateral demand requires a 25 feet long pile with a tip elevation of +158 (d).	Per lateral capacity calculations presented in Appendix C, lateral pile deflection is zero at a depth of 21 feet. Therefore, a pile length of 21 feet was selected which resulted in a pile tip elevation for lateral demand of +162 feet. LPILE solutions using a 25-foot long versus a 21-foot long piles should be almost identical.	
25			2: The specified tip elevation should also change accordingly in Table 5-10.	See response to Comment No. 24.	
26			3: Table 5-11, revise tip elevation accordingly per lateral demand.	See response to Comment No. 24.	
27			4: Revise the pile data table in contract plans: all information of the pile data table was incomplete or incorrect.	See response to Comment No. 24.	
28	Page 23	Wall 293	1: Table 5-12, for wall 293, pile head deflection doesn't match calculation.	We will revise Table 5-6 and present LPILE solutions for pile-head deflections of 1/4", 1/2", 1", 2" and 5".	
29		Wall 315	2: For wall 315, group efficiency factor should be 0.6 per AASHTO LRFD, page 10-84A.	The group efficiency factor for lateral load is calculated based on the formula presented in Group 7.0 technical manual by Ensoft. Based on the pile layout presented in the contract plans the group efficiency factor is 0.68. We will include this calculation sheet in Appendix C.	

CALTRANS
DESIGN REVIEW COMMENTS
EMI RESPONSES

DATE: 09/16/2011

Reviewer's name: Q Liao			**PROJECT: W 91 Widening, Non-Standard Walls**		
Review Date: 7/28/11			**PROJECT No.: 12000000791 (EA 12-0C5701)**		
Comment No.	**Source (page No.)**	**Source (wall No.)**	**Comments**	**Response/Actions**	**Accepted By (Reviewer)**
30	Appendix A - LOTB's	General	Note 4 is misleading. The MC blowcounts on each LOTB are actually field raw data, but this note 4 leads people to think the raw blowcounts in the LOTBs have been converted. Adding like:"the MC blowcounts on the LOTBs are raw data, conversion to SPT using a factor of 0.5...." will make it more clear. This clarification applies to ALL LOTB sheets.	We will comply.	
31		Wall 107	Boring No. A-10-002: 1: lab test symbols CP, R, PI didn't have testing data. 2: CR test symbol repeated.	We will present the CP and PI test results in Appendix B. The test symbol R will be removed from the LOTB per Comment No. 5. We will remove the repeated CR test symbol from the LOTB.	
32			Boring No. A-10-005: 1: lab test symbols R, PI didn't have testing data.	We will present the PI test results in Appendix B. The test symbol R will be removed from the LOTB per Comment No. 5.	
33		Wall 159	Boring No. A-10-018: 1: lab test symbol PI didn't have testing data.	We will present the PI test results in Appendix B.	
34			Boring No. A-10-019: 1: lab test symbol R didn't have testing data.	The test symbol R is removed from the LOTB per Comment No. 5.	
35		Wall 173	Boring No. A-10-024: 1: lab test symbol R didn't have testing data.	The test symbol R will be removed from the LOTB per Comment No. 5.	
36		Wall 255	Boring No. A-10-036: at elevation +132, should be "medium dense" with blowcount 15.	We will add "medium dense" near elevation +132 ft.	
37			Boring No. A-10-037: 1: lab test symbols PI, R didn't have testing data.	We will present the PI test results in Appendix B. The test symbol R will be removed from the LOTB per Comment No. 5.	
38		Wall 293	Boring No. A-10-052: 1: lab test symbols CP, R didn't have testing data.	We will present the CP test results in Appendix B. The test symbol R will be removed from the LOTB per Comment No. 5.	
39		Wall 307	1: Boring No. A-10-055: lab test symbols CP, R didn't have testing data.	We will present the CP test results in Appendix B. The test symbol R will be removed from the LOTB per Comment No. 5.	
40			2: Wall No. is wrong on the plan view. It should be wall No. 307 instead of 293.	We will comply.	
41			3: 6th layer should be "medium dense" with blowcount 9.	We will comply.	

CALTRANS
DESIGN REVIEW COMMENTS
EMI RESPONSES

DATE: 09/16/2011

Reviewer's name: Q Liao			**PROJECT: W 91 Widening, Non-Standard Walls**		
Review Date: 7/28/11			**PROJECT No.: 12000000791 (EA 12-0C5701)**		
Comment No.	**Source (page No.)**	**Source (wall No.)**	**Comments**	**Response/Actions**	**Accepted By (Reviewer)**
42	Appendix B - Lab Results		Lab test results summary pages: 1: sand equivalent test - typing error? 2: missing PI data 3: missing corrosion testing data.	We will correct the typo under sand equivalent tests. We will add the missing PI and CR test data into the summary sheet.	
43	Appendix C	Wall 107	1: water table used for liquefaction analysis doesn't match field or historical data.	We will revise ALL liqefaction calculations using a historical high groundwater depth of 40 feet below the Original (pre-freeway construction) ground elevation.	
44			2: Calculation sheet 3 should clarify that it is for section from LOL 18+39 to the end of wall.	We will comply.	
45			3: assumed overexcavation depth used in calculation sheet 3 didn't match recommendation in sheet 4.	We will revise calculation sheets to show an overexcavation depth of 4 feet.	
46			4: sheet 4, layer thicknesses used for effective overburden pressure were not correct.	We will revise the calculations.	
47			5: sheet 4, typing error ?- station 14+14.	We will correct the typo.	
48		Wall 159	Design calculation sheets were not included in the submitted report.	A portion of this wall is supported on a RCB and the structural engineer will design this portion of the wall. The remaining portion is a Caltrans standard soundwall. Foundation report already indicated a phi angle of 30 degrees for design of the standard soundwall.	
49		Wall 173	1: Historical water table should be used for liquefaction analysis.	See response to Comment No. 43.	
50			2: Contractor plans didn't match the intent of the geotechnical report. Geotechnical recommended pile foundation for wall height greater than 12 feet, while contractor plans used pile foundation for wall height equal to 12 feet. Contractor plans need to be revised.	RBF Consulting will comply.	
51			3: the corresponding group deduction factor (0.88 used) for lateral pile analysis needs to be revised as well since the pile layout changed.	Group efficiency factor (GEF) was calculated using the latest pile layout. We will include the GEF calculation sheets in Appendix C.	

CALTRANS
DESIGN REVIEW COMMENTS
EMI RESPONSES

DATE: 09/16/2011

Reviewer's name: Q Liao			PROJECT: W 91 Widening, Non-Standard Walls		
Review Date: 7/28/11			PROJECT No.: 12000000791 (EA 12-0C5701)		
Comment No.	Source (page No.)	Source (wall No.)	Comments	Response/Actions	Accepted By (Reviewer)
52	Appendix C (conti)	Wall 255	1: Axial pile calculation, sheet 3, normial resistances (compression) for both 14 and 16 feet high walls were not reflected in Table 5-5 on page 18 of this report.	We will revise the nominal resistance in Table 5-5.	
53			2: lateral analysis, sheet 1, historical water table used (+125) doesn't match what was used for liquefaction(+120).	After revising the liquefaction analysis using the method described in our response to Comment No. 43, the groundwater elevation for lateral analysis will become +125 feet. Therefore, no change is required for the lateral solutions.	
54			3: pile head deflection doesn't match Table 5-6.	We will revise Table 5-6 and present LPILE solutions for pile-head deflections of 1/4", 1/2", 1", 2" and 5".	
55			4: Lateral analysis sheets for wall 293 were wrongly inserted in wall 255 calculations.	We will remove the RW 293 calculations.	
56			5: Settlement calculation, sheet 1, historical water table used doesn't match what was used for liquefaction analysis.	After revising the liquefaction analysis using the method described in our response to Comment No. 43, the groundwater elevation for settlement calculations will become +125 feet. Therefore, no change is required for the settlement calculations.	
57			6: Settlement calculation, sheet 5, for wall height of 12 feet with BOF of +161.7, allowable bearing pressure should be 4.1 per calculation instead of 4.01.	We will correct the typo.	
58		Wall 293	1: normial resistance (compression) calculation is not reflected in pile data Table 5-11.	We will revise the nominal resistance in Table 5-11.	
59			2: pile head deflection doesn't match Table 5-12.	We will revise Table 5-6 and present LPILE solutions for pile-head deflections of 1/4", 1/2", 1", 2" and 5".	
60		Wall 307	1: liquefaction analysis was not attached.	We will comply.	
61			2: contract plans didn't include overexcavation depth information.	RBF Consulting will comply.	
62		Wall 315	1: liquefaction analysis was not attached.	Since the deepest depth of the borings are above historical high groundwater elevation, liquefaction analysis were not performed.	
63			2: recommended net contact pressure doesn't match calculation.	We will revise the Table 5-8 to match the calculation sheet per Comment No. 19	
64			3: For lateral analysis, group efficiency should use 0.6 instead of 0.68 per pile layout.	See response to Comment No. 29.	
65			4: contract plans didn't include overexcavation depth information.	RBF Consulting will comply.	

FINAL FOUNDATION REPORT
OVERHEAD SIGN STRUCTURES

Earth Mechanics, Inc.

January 10, 2012

FINAL FOUNDATION REPORT

Overhead Sign Structures
State Route 91 Westbound Widening
Orange County, California
12-ORA-91, PM 0.9/5.4
Caltrans Project No. 12000000791 (EA 12-0C5701)
EMI Project No. 10-126
Date: January 10, 2012

EARTH MECHANICS, INC.

Geotechnical and Earthquake Engineering

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

January 10, 2012

EMI Project No. 10-126

RBF Consulting
14725 Alton Parkway
Irvine, California 92618

Attention: Mr. Steve Huff, P.E.

Subject: **Final Foundation Report for Overhead Sign Structures**
State Route 91 Westbound Widening, Orange County, California
12-ORA-91, PM 0.9/5.4
Caltrans Project No. 12000000791 (EA 12-0C5701)

Dear Mr. Huff:

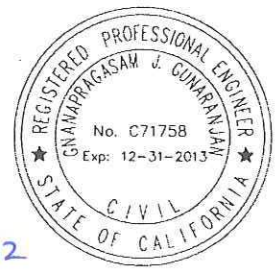
Attached is our Final Foundation Report for the proposed overhead sign structures for the State Route 91 Westbound Widening Project. This report presents the findings and conclusions of our field investigation and laboratory testing program and the results of our analyses and recommendations for design and construction of the foundations for the proposed overhead sign structures. It should be noted that two new Sign Structures "B" and "L" were added to this Final Foundation Report.

A Foundation Report for the subject overhead sign structures, dated July 1, 2011, was submitted to Caltrans for review. The Caltrans Office of Geotechnical Design South 1 (OGDS-1) reviewed the report and provided their comments in a memorandum dated August 10, 2011. EMI developed responses to the OGDS-1 review comments and submitted them in a letter dated September 1, 2011. These responses were reviewed and concurred by OGDS-1 reviewer. Caltrans approval email along with review comments and EMI responses are included in Appendix D. Caltrans review comments have been incorporated into this Final Foundation Report.

We appreciate the opportunity to provide geotechnical design services for this project. If you have any questions, please call us.

Sincerely,

EARTH MECHANICS, INC.



01-10-2012

(Ranjan) G. J. Gunaranjan, PE 71758
Senior Staff Engineer

1-10-2012

Lino Cheang, GE 2345
Project Manager

GJG/gjg,lcc

FINAL FOUNDATION REPORT

OVERHEAD SIGN STRUCTURES
STATE ROUTE 91 WESTBOUND WIDENING
ORANGE COUNTY, CALIFORNIA
12-ORA-91, PM 0.9/5.4
CALTRANS PROJECT NO. 12000000791 (EA 12-0C5701)

Prepared for:

RBF Consulting
14725 Alton Parkway
Irvine, California 92618-2027

Prepared By:

Earth Mechanics, Inc.
17800 Newhope Street, Suite B
Fountain Valley, California 92708

EMI Project No. 10-126

January 10, 2012

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APPENDICES

Appendix A. Log of Test Borings Sheets
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1.0 INTRODUCTION

1.1 Purpose and Scope of Study

This Foundation Report presents the findings and conclusions of a geotechnical investigation conducted by Earth Mechanics, Inc. (EMI) for the proposed overhead (OH) sign structures as a part of the State Route (SR)-91 Westbound (WB) Widening Project in Orange County, California. A site location map is presented in Figure 1-1.

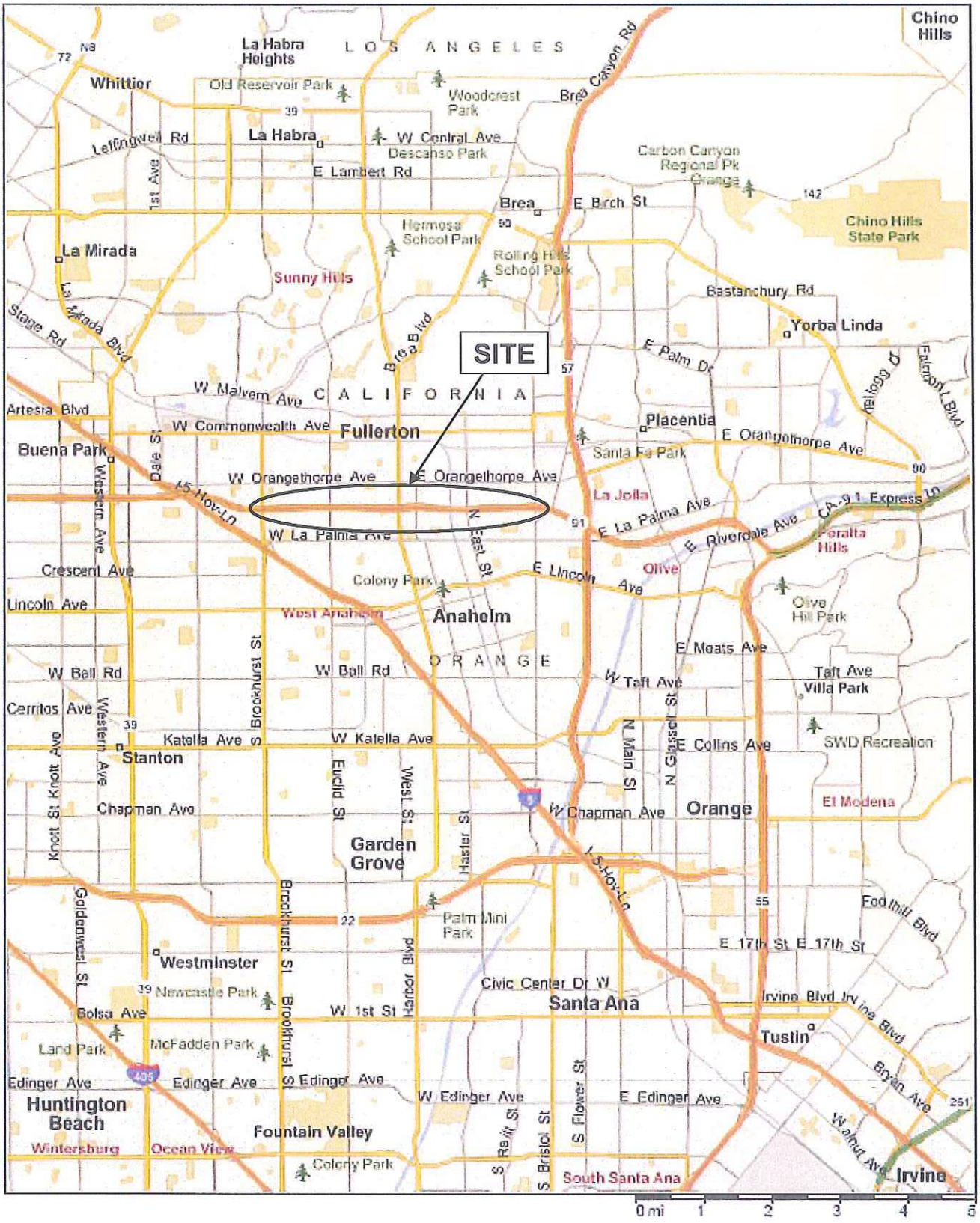
EMI is a subconsultant to RBF Consulting (RBF). The geotechnical services provided for this project included the following tasks:

- Field exploration consisting of drilling and logging exploratory borings and Cone Penetration Test (CPT) soundings;
- Laboratory testing of selected bulk and relatively undisturbed soil samples;
- Engineering calculations and analysis to develop foundation design and construction recommendations; and
- Preparation of this report presenting our findings, conclusions, and recommendations.

1.2 Project Description

The California Department of Transportation (Caltrans), in cooperation with the Orange County Transportation Authority (OCTA) and the cities of Anaheim and Fullerton, proposes to widen the westbound State Route 91 (SR-91) from State Route 57 (SR-57) to Interstate 5 (I-5). SR-91 is a major east-west freeway facility that begins at the eastern junction with SR-60 in the city of Riverside in Riverside County, and continues west through Orange County to its terminus at the junction with Pacific Coast Highway 1 near the city of Hermosa Beach in Los Angeles County. The proposed project limits cover a distance of 4.5 miles; however, actual improvements are limited to a total of 3.8 miles within the project area.

As part of this project, a total of twelve OH sign structures are proposed to be constructed. The proposed OH sign structures consist of nine "cantilever" type single-post structures, one "unbalanced butterfly" type single-post structure, and two "bridge" type double-post structures. Locations and types of the proposed OH sign structures are presented in Table 1-1.



SR-91 WB Widening – Overhead Sign Structures

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SITE LOCATION MAP

Figure 1-1

Project No. 10-126

Date: 06-20-11

TABLE 1-1. PROPOSED OVERHEAD SIGN STRUCTURE INFORMATION

Sign Structure	Station Line	Station	Sign Structure Type	Sign Post Type	Standard Plan Sheet No.
C	"A" Line	118+45	Cantilever	VI	S8
H [1]	"A" Line	131+97	Cantilever	VII	-
I [1]	"A" Line	150+60	Cantilever	VIII	-
L	"A" Line	166+23	Unbalanced Butterfly	24NPS	S116
B	"A" Line	105+10	Bridge	V-S	S14 and S15
O	"EU2" Line	74+50	Bridge	III-S	S15
T [2]	"A" Line	250+25	Cantilever	IX	-
U [2]	"A" Line	263+93	Cantilever	VIII	-
W	"A" Line	278+00	Cantilever	VII	S8
Z	"A" Line	288+83	Cantilever	VIII	S8
BB [2]	"A" Line	307+42	Cantilever	VIII	-
DD	"A" Line	330+85	Cantilever	VII	S8

[1] *Require special foundation design.*
[2] *Supported on retaining wall and foundation design of these sign structures is included in the retaining wall foundation report and Geotechnical Design Report.*

Sign Structure "H" is located above an existing double-cell reinforced concrete box (RCB) culvert adjacent to an existing soundwall. In order to support this OH sign, a row of 16-inch diameter Cast-in-Drilled-Hole (CIDH) piles will be installed on each side of the RCB culvert, and the top slab of the RCB culvert will be strengthened to act as a pile cap connecting the CIDH piles spanning the RCB culvert.

Sign Structure "I" is located in-between an existing double-cell RCB culvert and an existing soundwall. The foundation supporting this sign structure is a single 54-inch diameter CIDH pile similar to Standard Plan Sheet No. S8. To prevent the CIDH pile from loading the side walls of the RCB culvert and the soundwall piles, the 54-inch diameter CIDH pile will be encased in a 60-inch diameter by 9.33-foot long steel casing.

Caltrans Standard Plan design is not suitable for the foundation support Sign Structures "H" and "I" and a special design is required which is included in this report.

Sign Structures "T", "U", and "BB" will be supported on Retaining Walls 249, 255, and 307, respectively. Foundation design of these retaining walls is addressed in separate foundation reports (EMI, 2011 and 2012a).

Caltrans Standard Plan design should be suitable for the remaining sign structures ("C", "L", "B" "O", "W", "Z" and "DD"). However, assumptions used for soil friction angle and unit weight in the Caltrans Standard Plan design will need to be compared with soil friction angle and unit weight from site-specific soil borings for confirmation. The comparison is included in this report.

2.0 FIELD INVESTIGATION AND LABORATORY TESTING

2.1 Field Investigation

A geotechnical field investigation was conducted between December 6, 2010 and December 16, 2011. Ten exploratory borings and two cone penetrometer test (CPT) soundings were performed under the supervision of EMI near the proposed OH sign structures. Soil exploration information, including exploration number, stations, offsets, ground surface elevations, bottom of exploration elevations and water level measurements are summarized in Table 2-1. Locations of the exploratory borings and CPT soundings are shown on the LOTB sheets provided in Appendix A.

TABLE 2-1. GEOTECHNICAL EXPLORATION INFORMATION

Boring / CPT Sounding No.	Station Line	Station	Approx. Offset (ft)	Approx. Ground Surface El. (feet)	Approx. Bottom of Exploration El. (feet)	Approx. Groundwater El. (feet)
A-10-006	"A" Line	118+55	76 Lt	+130.0	+43.5	+73.5
A-10-012		131+14	91 Lt	+119.0	+87.5	Not Encountered
A-10-016		150+46	86 Lt	+126.2	+94.7	Not Encountered
A-10-020		165+00	63 Lt	+138.0	+106.5	Not Encountered
A-10-021		168+00	58 Lt	+146.8	+115.3	Not Encountered
A-10-024		173+76	62 Lt	+152.6	+66.1	+80.4
CPT-10-026		176+21	60 Lt	+148.0	+137.3	Not Measured
A-10-044		278+00	77 Lt	+193.0	+111.5	+113.3
A-10-049		288+71	77 Lt	+178.0	+146.5	Not Encountered
CPT-10-062		330+80	69 Lt	+208.7	+162.6	Not Measured
A-10-063		332+01	90 Lt	+190.2	+109.7	Not Encountered
A-11-073		106+21	91 Lt	+108.5	+72.0	Not Encountered

2.1.1 Soil Borings

Exploratory soil borings, except the boring A-11-073 were drilled using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers. Due to space constraint, Boring A-11-073 was drilled using a portable drill system equipped with 6-inch diameter solid-fly augers. Sampling was performed by alternating the Modified California Drive (MCD) sampler and Standard Penetration Test (SPT) sampler. The soil sampling interval is generally 5 feet. Relatively undisturbed soil samples were obtained using a 3.25-inch outer diameter MCD sampler lined with brass rings. Each of these brass rings is 1-inch long with a 2.5-inch outside diameter. The SPT sampler (1.4-inch inside diameter) was also used to obtain soil samples. The MCD and SPT samplers were driven 18 inches into the ground or until refusal was encountered using a 140-lb hammer free falling from a height of 30 inches. Automatic hammer and rope hammer were used to drive samplers in the truck-mounted drill rig and tripod drill system, respectively. The numbers of blows to advance the sampler each 6 inches of penetration were recorded on the field boring logs. The numbers of blows for the final 12 inches or shorter of

driving were recorded on the LOTB sheets.

Charts published by Winterkorn and Fang (1975) can be used to determine a reduction factor used to convert blowcounts recorded using the California Drive sampler into SPT blowcounts. Using those charts, we obtained a reduction factor of 0.5 and this one-half reduction factor was used for this project.

2.1.2 CPT Soundings

The CPT sounding was performed using an electronic cone penetrometer in general accordance with current ASTM Standards (ASTM D5778 and ASTM D3441). The CPT equipment consisted of a cone penetrometer assembly mounted at the end of a series of hollow sounding rods. The cone penetrometer assembly consisted of a conical tip with a 60° apex angle and a projected cross sectional area of 1.55 in² (10 cm²) and a cylindrical friction sleeve with a surface area of 23.25 in² (150 cm²). The interior of the cone penetrometer is instrumented with strain gauges that allow simultaneous measurements of cone tip and friction sleeve resistance during penetration. The cone penetrometer assembly is continuously pushed into the soil by a set of hydraulic rams at a standard rate of 0.79 inch per second (20 mm per second) while the cone tip resistance and sleeve friction resistance are recorded every 1.967 inches (50 mm) and stored in digital form. A specially designed all-wheel drive 25-ton truck provides the required reaction weight for pushing the cone assembly and is also used to transport and house the testing equipment. The computer generated graphical logs include tip resistance, friction resistance, and friction ratio. Soil behavior type interpretations are based on guidelines by Robertson and Campanella (1989).

2.2 Laboratory Testing

Soil samples considered representative of the subsurface conditions were tested to obtain or derive relevant physical and engineering soil properties. The following laboratory tests were conducted to supplement the observations recorded during the field investigation:

- In-situ Moisture Content and Unit Weight
- Pocket Penetrometer
- Percent Passing No. 200 Sieve
- Atterberg Limits
- Direct Shear
- Unconsolidated Undrained Triaxial
- Minimum Resistivity, pH, Sulfate Content, and Chloride Content

The laboratory tests were conducted in general accordance with California Test Methods or American Society for Testing and Materials (ASTM) Standards. Laboratory test results are included in Appendix B.

Compaction, R-value, and consolidation tests are noted on the LOTB sheets in Appendix A. These test results were not used in preparation of the recommendations included in this report and therefore, they were omitted from Appendix B.

3.0 GEOLOGY AND SEISMICITY

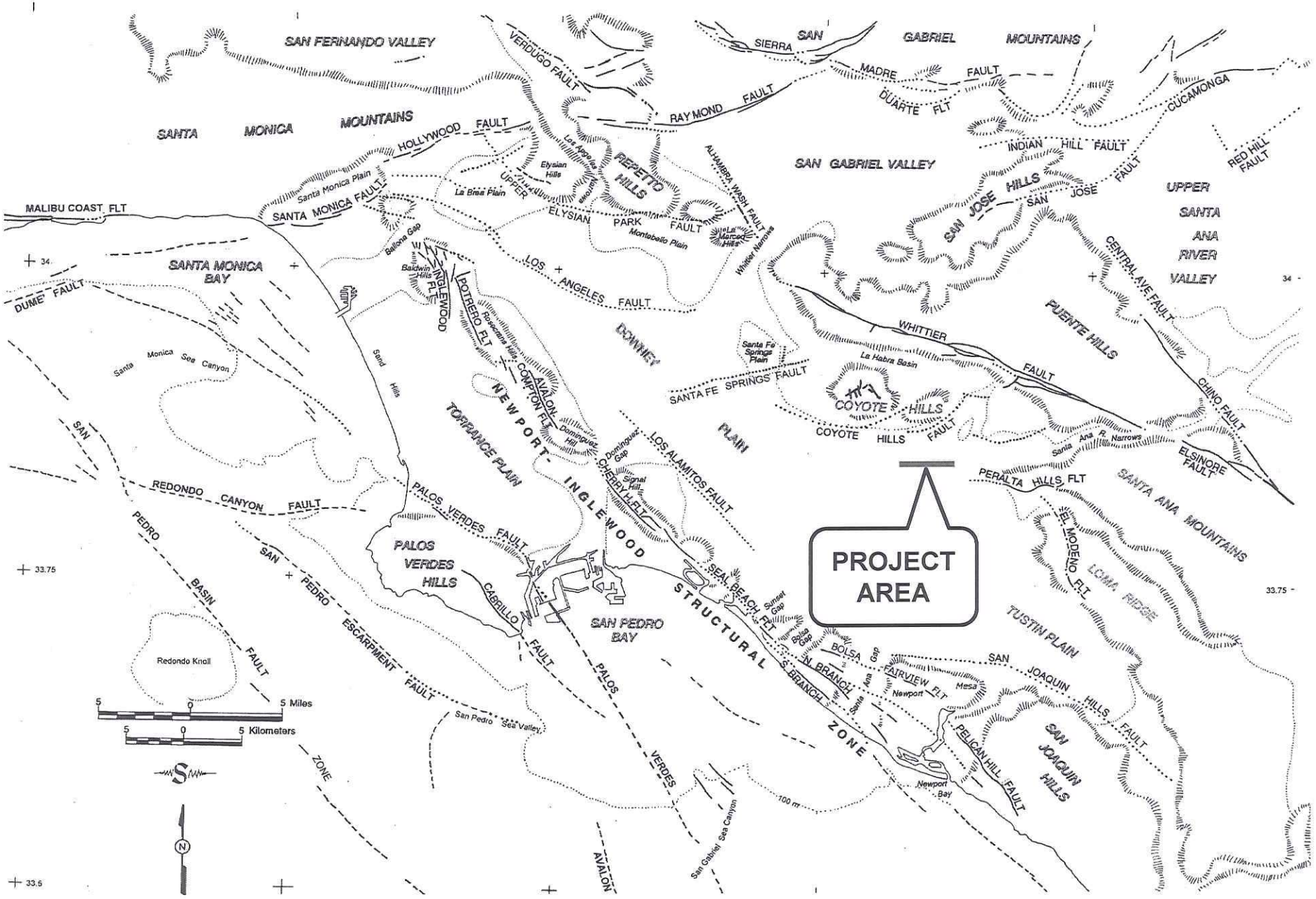
3.1 Physiography

The project area is located in the east-central part of the Los Angeles Basin as shown in Figure 3-1 which comprises a transition zone between the Peninsular Ranges physiographic province on the east, and the Transverse Ranges physiographic province to the north. The Peninsular Ranges physiographic province comprises a northwest-southeast trending group of fault-bounded ranges such as Santa Ana Mountains, Puente Hills and San Joaquin Hills between the Salton Trough and the Pacific Ocean. The Transverse Ranges physiographic province comprises east-west trending ranges and valleys such as the Santa Monica Mountains, San Fernando Valley and San Gabriel Mountains. Valleys such as the Los Angeles Basin, the San Gabriel Valley and the Upper Santa Ana River Valley have characteristics compatible with both physiographic provinces and form a transition zone between the two provinces.

The Los Angeles Basin is essentially a large, relatively flat, low-lying and coastal plain surrounded by mountains on the north, east and southeast which rise abruptly to a few thousand feet above the plains. The western margin of the basin is bordered by the sea, the Palos Verdes Hills and the San Joaquin Hills. The floor of the basin gradually rises inland to a series of uplifted terrain along the margins of the surrounding mountains. This elevated marginal terrain includes the Santa Monica, La Brea, Montebello, Santa Fe Springs plains, and the Coyote Hills. The generally flat-lying nature and gradual inland rise of the Basin floor is disrupted by an alignment of northwest-southeast trending, low-elevation hills along the Newport-Inglewood Structural Zone (NISZ). The areas on either side of the NISZ are essentially flat and comprise the Downey-Tustin plain on the northeast and the Torrance Plain on the southwest. The site area is near the transition between the Downey and the Tustin plains.

3.2 Geologic Structure

The Los Angeles Basin is a deep structural basin comprising two major downward folds (synclines) separated by the NISZ uplift; the Paramount syncline is east of the NISZ under the Downey-Tustin Plain, and the Gardena syncline is west of the NISZ under the Torrance Plain. The Paramount syncline is the larger and deeper syncline with basement rocks as deep as about 30,000 feet (Yerkes et al, 1965). As described in the physiography section, the basin is rimmed by marginal elevated plains that rise about a hundred feet to as much as a couple hundred feet above the general level of the basin floor. These elevated plains and the Coyote Hills are underlain by fault-bounded, upward folds (anticlines) that are prolific oil fields. Most of the major faults associated with these folds are blind thrust faults and are shown on Figure 3-1 as dotted lines. The nearest faults to the project area are the blind thrust faults of the Puente Hills Blind Thrust Fault System and Compton-Los Alamitos Blind Fault System. Larger surface faults, such as the NISZ and the Elsinore Fault Zone (Whittier Section) lie to the southwest and northeast of the project site, respectively.



SR 91 Westbound Widening Project – Sign Structures

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REGIONAL MAP OF ACTIVE FAULTS AND PHYSIOGRAPHY

Figure 3-1

Project No. 10-126

Date: 06-20-11

3.3 Geologic Hazards

The only significant geological hazard at the site is earthquake shaking and perhaps local liquefaction. There are no known active surface faults within the project area so ground rupture is not a factor. The flat-lying nature of the area is not susceptible to landsliding. The site is too far from the ocean to be affected by tsunamis, and there are no large bodies of water within the site area that could generate a seiche. There are no volcanoes in the region.

The western part of the project corridor may be susceptible to liquefaction during a large earthquake. As presented in Figure 3-2, the California Geological Survey (1997, 1998) has designated the area between Brookhurst Street and Euclid Street, where the proposed OH sign structures "C", "H", "I", "L", and "B" are located, as having a potential for liquefaction. The potential for liquefaction is discussed in detail in Section 5.2.

3.4 Seismicity

The project is in seismically active Southern California. The present-day seismotectonic stress field in the Los Angeles region is one of north-northeasterly compression. This is indicated by the geologic structures, by earthquake focal-mechanism solutions and by geodetic measurements. These data suggest crustal shortening of between 0.2 and 0.35 inches per year across the greater Los Angeles area (Argus et al., 1999).

Historical earthquake epicenter maps show widespread seismicity throughout the Los Angeles region. Earthquakes occur primarily as loose clusters along the NISZ, the southern margin of the Santa Monica Mountains, the margin between the Santa Susana-San Fernando Valley and the southern margin of the San Gabriel Mountains, and in the Coyote Hills-Puente Hills area.

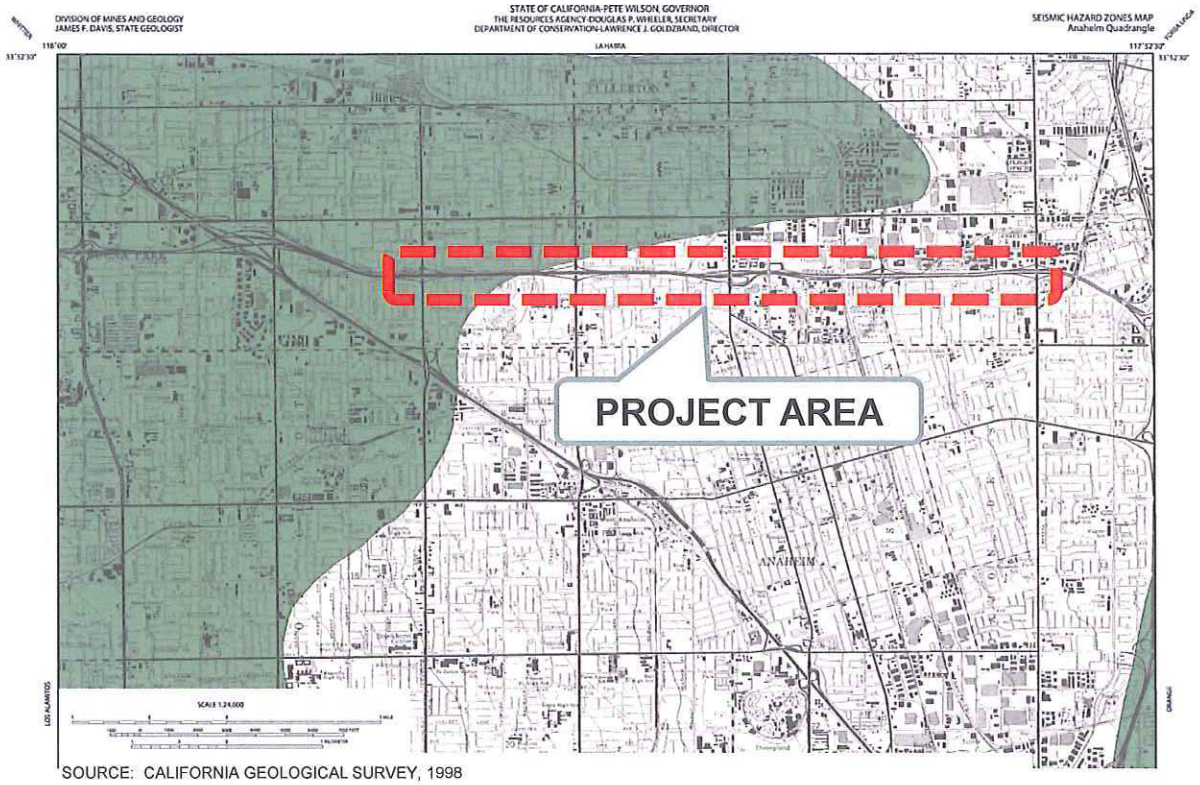
The largest historical earthquakes within the Los Angeles Basin were the 1933 Long Beach (moment magnitude (M_W) of about 6.4), 1994 Northridge (M_W = 6.7), 1971 San Fernando (M_W = 6.7), 1987 Whittier (M_W = 5.9), and 2008 Chino Hills (M_W = 5.4). There have been no significant historical earthquakes in the immediate site area. There may have been a few random small events (M_W < 3.0). The nearest concentrated earthquake activity has been within the Puente Hills about 5 or 6 miles to the north of the site.

The 1933 Long Beach earthquake did not rupture the surface but is believed to have been associated with the NISZ (Benioff, 1938). Reevaluation of the seismic data by Hauksson and Gross (1991) relocated the 1933 earthquake hypocenter to a depth of about 6 miles below the Huntington Beach-Newport Beach city boundary.

The 1994 Northridge earthquake occurred on a southerly dipping subsurface fault which was unknown prior to the earthquake. The main shock occurred at a depth of about 12 miles. Earthquake aftershocks clearly defined the rupture surface dipping about 35 degrees southerly from a depth of about 1 or 2 to 14 miles. The causative fault was never identified with certainty.

The 1971 San Fernando earthquake involves surface rupture. The 1971 event occurred on a northerly dipping thrust fault that dips from the northern side of the San Fernando Valley to a depth of about 9 miles under the San Gabriel Mountains, and considered part of the Sierra Madre Fault System.

N



SOURCE: CALIFORNIA GEOLOGICAL SURVEY, 1998

MAP EXPLANATION

Zones of Required Investigation:

Liquefaction

Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

SR-91 Westbound Widening – Sign Structures	MAP OF LIQUEFACTION POTENTIAL
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 3-2
Project No. 10-126	Date: 06-20-11

The 1987 Whittier earthquake occurred on a subsurface fault dipping under the Puente Hills to about 10 miles beneath the San Gabriel Basin (Shaw and Shearer, 1999; Shaw et al., 2002). This event did not rupture the ground surface.

The 2008 Chino Hills event epicenter was in the Chino Hills area between the Elsinore-Fault-Zone Chino Section and Whittier Section. Preliminary data were inconclusive with regard to the causative fault. Detailed analysis by Shao and Hauksson (2009) indicated a rupture plane striking N71°W, dipping 62° northeast. This event did not rupture the ground surface.

Another significant earthquake was the 1812 earthquake which caused damage at the San Juan Capistrano Mission. The location and magnitude of the 1812 earthquake are unknown because of the sparse population at the time, but geological studies (Jacoby et al., 1987; Fumal et al., 1993; Weldon et al., 2004) postulate that it did not occur in the Capistrano area, but rather was a large ($M_W > 7.0$) distant event on the San Andreas fault in the Wrightwood area of the San Gabriel Mountains.

The earliest documented earthquake in the region was reported by the Portola expedition as they camped near the Santa Ana River in 1769. This event has been attributed by various geoscientists to just about every fault in the Los Angeles area but it could just as well have been a distant event that shook a wide area as did the 1971 San Fernando, the 1987 Whittier, and the 1994 Northridge events, as well as many other more-distant events such as 1992 Landers event.

4.0 SUBSURFACE CONDITIONS

4.1 Soil Conditions

Based on information collected from soil borings and CPT soundings performed near the proposed OH sign structures, the idealized soil profile and design strength parameters for foundation design are developed and presented in Table 4-1. As shown in the calculation sheets included in Appendix C, foundation design of sign structures is not sensitive to soil condition at deep depths. For this reason, the idealized soil profiles and strength parameters in Table 4-1 were limited to a depth of no more than 50 feet.

TABLE 4-1. IDEALIZED SOIL PROFILE AND STRENGTH PARAMETERS

Approximate Elevation (ft)	Predominant Soil Type	Range of Measured and Converted SPT Blowcount; Average (blows/foot)	Total Unit Weight (pcf)	Friction Angle (degree)	Cohesion/ Undrained Shear Strength (psf)
Sign C at Sta. 118+45 ("A" Line) (Boring A-10-006)					
+130 to +105	Silty Sand and Clayey Sand	12 to (33) Average = 17	120	31	100
+105 to +100	Sandy Silt	8	115	-	1,000
+100 to +95	Silty Sand	(27)	120	32	100
Sign H at Sta. 131+97 ("A" Line) (Boring A-10-012)					
+119 to +99	Silty Sand	7 to (14) Average = 11	120	30	100
+99 to +87	Sand with Silt and Clayey Sand	5 to (28) Average = 20	120	33	100
Sign I at Sta. 150+60 ("A" Line) (Boring A-10-016)					
+126 to +101	Silty Sand, Sand with Silt, and Sandy Silt	5 to (17) Average = 11	120	30	100
+101 to +96	Silt with Sand	9	115	-	1,000
+96 to +94	Silty Sand	(31)	120	33	100
Sign L at Sta. 166+23 ("A" Line) (Borings A-10-020 and A-10-021)					
+141 to +135	Sand with Silt, Silty Sand	17 to 30 Average = 24	120	32	50
+135 to +117	Silty Sand	8 to (20) Average = 13	120	31	100

TABLE 4-1. IDEALIZED SOIL PROFILE AND STRENGTH PARAMETERS (CONT.)

Approximate Elevation (ft)	Predominant Soil Type	Range of Measured and Converted SPT Blowcount; Average (blows/foot)	Total Unit Weight (pcf)	Friction Angle (degree)	Cohesion/ Undrained Shear Strength (psf)
Sign B at Sta. 105+10 ("A" Line) (Boring A-11-073)					
+109 to +99	Silty Sand and Sandy Lean Clay	17	120	31	100
+99 to +74	Sand, Sand with Silt, Silty Sand, and Silty Clayey Sand	(17) to (25) Average = 22	120	33	100
+74 to +72	Silty Clayey Sand	50	120	34	50
Sign O at Sta. 74+50 ("EU2" Line) (Boring A-10-024 and Sounding CPT-10-026)					
+153 to +134	Silty Sand and Sand with Silt	13 to (57) Average = 31	120	32	100
+134 to +105	Silty Sand	9 to (23) Average = 15	120	31	100
Sign W at Sta. 278+00 ("A" Line) (Boring A-10-044)					
+193 to +152	Sand, Sand with Silt, Silty Sand, and Clayey Sand	12 to (38) Average = 24	120	32	100
Sign Z at Sta. 288+83 ("A" Line) (Boring A-10-049)					
+178 to +160	Sand and Sand with Silt	6 to 15 Average = 10	120	30	100
+160 to +146	Sand	(14) to (27) Average = 19	120	32	50
Sign DD at Sta. 330+85 ("A" Line) (Boring A-10-063 and Sounding CPT-10-062)					
+209 to +188	Sand with Silt and Silty Sand	[25]	120	32	100
+188 to +180	Sand	9 to (20) Average = 14	120	30	50
+180 to +159	Sand and Sand with Silt	16 to (34) Average = 26	120	33	50

Notes:
(1) SPT = Standard Penetration Test.
(2) Values in ( ) are converted SPT blowcounts from the California sampler corrected for sampler size; correction factor from California sampler blowcounts to SPT blowcounts is 0.5.
(3) *Values in [ ] are converted SPT blowcounts from the CPT sounding (Robertson and Campanella, 1989).*

The soil strength parameters in Table 4-1 are based on the correlations with SPT blowcounts (Lam and Martin, 1986) and laboratory test results. The above soil strength parameters may appear to be inconsistent when relating to the SPT blowcounts (i.e., for the same soil type, higher blowcounts in one soil layer resulted in a lower shear strength than another soil layer with a lower blowcounts). This is because these shear strength parameters are based on the lower of the SPT blowcount correlation and laboratory strength tests, if available. It should be noted that the shear strength parameters obtained from the laboratory strength tests are lower than those obtained from SPT blowcount correlation for the same idealized soil layer.

4.2 Groundwater Conditions

During the recent field investigation conducted between December 6, 2010 and December 16, 2011, groundwater was encountered in three soil borings between the depths of 72 feet and 80 feet below the ground surface, which is between El. +73.5 feet and El. +113.3 feet. Based on California Geological Survey (Division of Mines and Geology, 1997), the recorded highest historical groundwater depth varies from about 40 feet at the western project limit to about 50 feet at the eastern project limit. However, groundwater level can fluctuate due to seasonal rainfall amount, local irrigation and groundwater recharge program and other man-made conditions.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Seismic Design Criteria

The design ARS curve was determined based on the 2009 Seismic Design Criteria (SDC) (Caltrans, 2009a and 2009b) procedures. The peak ground acceleration (PGA) is the zero-period spectral acceleration in the ARS curve. A design PGA of 0.52g is obtained from the design ARS curve for the proposed OH sign structures.

5.2 Liquefaction

Liquefaction analysis was performed using the available site-specific subsurface information and the historical high groundwater depths described in Section 4.2.

The liquefaction potential of the saturated, granular materials below the historical high groundwater table was evaluated using the procedures outlined by Seed et al. (1983), Seed and Harder (1990), and updated by NCEER (1997). Results of the liquefaction analysis are included in Appendix C. Based on the analysis, granular materials susceptible to liquefaction were not encountered below the historical high groundwater table. Therefore, the liquefaction potential at each sign structure site is anticipated to be low.

5.3 Soil Corrosivity

Eight soil samples were tested for pH, minimum resistivity, soluble chloride content and soluble sulfate content. The test results are summarized in Table 5-1. Minimum resistivities were between 750 and 14,000 ohm-cm. The pH values were between 7.5 and 8.7. The soluble sulfate measurements were between 10 and 150 parts per million (ppm), and the soluble chloride measurements were between 10 and 332 ppm.

TABLE 5-1. SOIL CORROSION TEST RESULTS

Boring	Station (Offset) / "Station Line"	Sample Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Soluble Sulfate Content (ppm)	Soluble Chloride Content (ppm)
A-10-006	118+55 (76 Lt) / A Line	5	SC	2,600	8.5	10	83
A-10-016	131+14 (91 Lt) / A Line	15	ML	2,200	8.7	70	94
A-10-024	173+76 (62 Lt) / A Line	25	SM	750	7.8	40	332
A-10-044	278+00 (77 Lt) / A Line	45	CL	760	7.6	130	322
A-10-044	278+00 (77 Lt) / A Line	70	CL	810	7.8	70	255
A-10-063	332+01 (90 Lt) / A Line	35	SP-SM	13,000	7.8	10	158
A-11-073	106+21 (91 Lt) / A Line	5	CL	1,200	8.6	150	204
A-11-073	106+21 (91 Lt) / A Line	20	SP	14,000	7.5	20	10

Based on the Caltrans Corrosion Guidelines (2003), soils are considered corrosive if the pH is 5.5 or less, or the chloride concentration is 500 ppm or greater, or the sulfate concentration is 2,000 ppm or greater. Based on the test results and the Caltrans criteria, the on-site soils are not considered to be corrosive to bare metals and concrete.

Additional soil samples were tested for pH, minimum resistivity, soluble chloride content and soluble sulfate content along the 3.8-mile project corridor. Test results are summarized in the Materials Report (EMI, 2012b) for this project. Those test results also indicate that the on-site soils are not corrosive to bare metals and concrete per Caltrans criteria.

5.4 Standard and "Special" Overhead Sign Structures

Foundation design recommendations for nine OH sign structures are included in this report. Caltrans Standard Plan (Caltrans, 2010a) design is suitable for the foundations supporting seven of these sign structures ("C", "L", "B", "O", "W", "Z", and "DD"). The remaining two sign structures ("H" and "I") require a "special" (non-standard) foundation design due to space constraints. Foundation design of three additional sign structures ("T", "U", and "BB"), which are supported on retaining walls, is addressed in separate foundation reports (EMI, 2011 and 2012a).

5.5 Pile Foundation Design of Standard OH Sign Structures

The applicable Caltrans Standard Plan sheets for the standard OH sign structures ("C", "L", "B", "O", "W", "Z", and "DD") were provided by RBF. Based on these plan sheets, the foundation data are provided in Table 5-2.

TABLE 5-2. FOUNDATION DATA FOR STANDARD OH SIGN STRUCTURES

Sign Structure	Station Line	Station	Sign Structure Type	Sign Post Type	CIDH Pile Diameter (ft)	Foundation Depth (ft)	2010 Standard Plan Sheet No.
C	"A" Line	118+45	Cantilever	VI	5.0	22'-0"	S8
L	"A" Line	166+23	Unbalanced Butterfly	24NPS	5.0	22'-0"	S116
B	"A" Line	105+10	Bridge	V-S	5.0	26'-3"	S14 and S15
O	"EU2"	74+50	Bridge	III-S	4.5	23'-0"	S15
W	"A" Line	278+00	Cantilever	VII	5.0	23'-0"	S8
Z	"A" Line	288+83	Cantilever	VIII	5.0	25'-0"	S8
DD	"A" Line	330+85	Cantilever	VII	5.0	23'-0"	S8

As noted in Table 5-2, the foundation depths were obtained from the 2010 Caltrans Standard Plan Sheets. These foundation depths are the same as those shown on the 2006 Caltrans Standard Plan Sheets. However, based on the comparison between the 2006 and 2010 Caltrans Standard Plan Sheets, a foundation design note was removed from the 2010 Caltrans Standard Plan Sheets.

Our foundation design criteria for the above sign structures are based on the 2006 Standard Plan design note stating "Foundation designs is based on 2001 AASHTO article 13.6 Broms' approximate procedure assuming a cohesionless material. The angle of internal friction used is 30 degrees and unit weight of soil used is 120 lb/ft^3", which is missing in the 2010 Caltrans Standard Plan Sheets. Although this design note is missing, the 2010 Caltrans Standard Plan Sheets also indicate that this note was transferred to the Caltrans Specifications. Therefore, this design note should still be valid. However, as a precaution, RBF should compare the above 2006 and 2010 Caltrans Standard Plan Sheets to confirm that there are no changes in the structural information, details, and design notes.

The site-specific field investigation reveals that the subsurface soil type within the "foundation depth" zone consists of coarse-grained materials of silty sand and sand with silt with an angle of internal friction of 30 degrees or more and a unit weight of 120 lb/ft^3 (See Table 4-1). As a result, the designated Caltrans Standard Plan sheets are suitable for foundation design of the proposed standard OH sign structures ("C", "L", "B", "O", "W", "Z", and "DD").

5.6 Pile Foundation Design for "Special" OH Sign Structures

Proposed configurations and foundation types of the special OH sign structures ("H" and "I") were provided by RBF and briefly described below:

- Sign "H" at Station 131+97 (A-Line): Sign "H" is situated directly above an existing double-cell RCB culvert. Structural designers proposed to demolish the top slab of the RCB and construct a new concrete slab, which will be used to transfer the sign structure loadings to piles anchored at each end of the new slab. A total of six 16-inch diameter CIDH piles are proposed, three on each side of the slab.

- Sign "I" at Station 150+60 (A-Line): Sign "I" seats on a typical pedestal on a single large diameter CIDH pile. The CIDH pile will be located in-between an existing double-cell RCB culvert and an existing soundwall on CIDH piles. The diameter of the single CIDH pile supporting the proposed sign structure is 54 inches. To prevent loading from the new CIDH pile on the existing RCB and soundwall piles, the top 9.33-foot portion of the new CIDH pile will be encased in a 60-inch ID steel casing with an estimated thickness of 0.5 inch.

The pertinent foundation information for the non-standard OH sign structures is summarized in Table 5-3. The pile-head loads in Table 5-3 were provided by the structural designers.

TABLE 5-3. FOUNDATION INFORMATION FOR SPECIAL OH SIGN STRUCTURES

Sign Structure	Foundation Demands						CIDH Pile Diameter	Encased Steel Casing ID	Encased Steel Casing Depth
	Fx (kips)	Fy (kips)	Fz (kips)	Mx (kip-ft)	My (kip-ft)	Mz (kip-ft)			
H	-	+45 - 11	12	-	-	-	16″	-	-
I	17	+24	5	361	269	362	54″	60″	9.33'

Notes:

x: Horizontal direction perpendicular to freeway centerline;

y: Vertical direction; and

z: Horizontal direction parallel to freeway centerline.

5.6.1 Sign Structure "H"

Axial Capacity: Required pile embedment (from cut-off) of sign structure "H" is controlled by the axial load demand provided by the structural designers in Table 5-3. Based on the plans, the pile cut-off elevation is about +116 ft. The axial pile capacity calculations are presented in Appendix C. Axial capacity of a single CIDH pile is estimated using the computer program SHAFT Version 6.0 (Ensoft, 2007) and soil strength parameters in Table 4-1. The Pile Data Table for the Contract Plans is presented in Table 5-4.

TABLE 5-4. PILE DATA TABLE FOR SIGN "H"

Pile Type	Nominal Resistance (kips)		Design Tip Elevations (feet)	Specified Tip Elevation (feet)
	Compression	Tension		
16" CIDH	90	20	+85 (a) +95 (b)	+85

Notes:

1. *Design tip elevations are controlled by the following demands: (a) Compression, (b) Tension, (c) Settlement, and (d) Lateral Load.*
2. *There are no design tip elevations for Tolerable Settlement and Lateral Load.*
3. *The specified tip elevations shall not be raised.*

Lateral Capacity: According to the structural designers, the total lateral load is only 12 kips. This lateral load will be transferred and resisted by the Reinforced Concrete Box (RCB) through friction at the base of the box and passive soil resistance on the face of the box. Therefore, no lateral load will be resisted by the individual piles.

5.6.2 Sign Structure "I"

The axial, lateral, and torsional pile capacity calculations are presented in Appendix C. Required pile embedment (from cut-off) of sign structure "I" is controlled by the torsional demand provided by the structural designers in Table 5-3. Based on the plans, the pile cut-off elevation is about +126.5 ft.

Torsional Capacity: Torsional capacity is estimated using the soil strength parameters in Table 4-1 and the guidelines in NAVFAC Design Manual (NVAFAC, 1986). Based on the results of the analysis, the minimum recommended pile embedment is 35 feet.

Axial Capacity: Axial capacity is estimated using the computer program SHAFT Version 6.0 (Ensoft, 2007), the soil strength parameters in Table 4-1 and a pile embedment of 35 feet. The Pile Data Table for the Contract Plans is presented Table 5-5. Calculations indicate that the resulting soil capacity exceeds the axial load demand provided by the structural designers.

TABLE 5-5. PILE DATA TABLE FOR SIGN "I"

Pile Type	Nominal Resistance (kips)		Design Tip Elevations (feet)	Specified Tip Elevation (feet)
	Compression	Tension		
54" CIDH	50	0	+115.5 (a) +81.0 (d)	+81.0

Notes: 1. Design tip elevations are controlled by the following demands: (a) Compression, (b) Tension, (c) Settlement, and (d) Lateral Load.
2. There are no design tip elevations for Tension and Tolerable Settlement.
3. The specified tip elevations shall not be raised.

Lateral Capacity: A lateral pile solution was performed using the computer program LPILE (Ensoft, 2010), the soil strength parameters in Table 4-1, and a combined maximum horizontal load (F_x) of 17 kips and overturning moment (M_z) of 362 k-ft. The soil resistance versus pile deflection (p-y) curves for sandy soils were developed using the API criteria (API, 2000), and the p-y curves for clayey soils were developed using the Matlock criteria (1970). A cracked section modulus (EI) of the CIDH pile was provided by the structural designers.

Results of the lateral pile analysis in terms of shear, bending moment, and lateral deflection along the pile length for a free-head condition are included in Appendix C. A summary is presented below:

- Maximum Pile-Top Deflection = 0.6 inch
- Maximum Bending Moment = 570 kip-ft at a depth of 14 feet below the pile top.
- Maximum Shear = 44 kips at a depth of 26 feet below the pile top.

5.7 Slope Stability

The proposed OH sign structure "B" is supported on the ground near the proposed Houston Channel. Based on the analyses, the calculated factor of safety under static and seismic conditions is greater than the required minimum values for global slope stability.

Based on plans provided by the designers, the proposed OH sign structures "H", "I", "L", and "O" are founded on relatively flat grades; therefore, the global slope stability of the ground supporting these OH sign structures under static and seismic conditions are not considered to be a design issue. The proposed OH sign structures "C", "W", and "DD" are founded adjacent to proposed engineered 4H:1V or flatter slopes; therefore, the global slope stability of the ground supporting these OH sign structures under static and seismic conditions are also not considered to be a design issue.

The proposed OH sign structures "T", "U", and "BB" are supported on Retaining Walls 249, 255, and 307, respectively. Based on the global stability analyses performed for these retaining walls (EMI, 2011 and EMI, 2012b) the calculated factor of safety under static and seismic conditions is greater than the required minimum values.

6.0 CONSTRUCTION RECOMMENDATIONS

6.1 Earthwork

Earthwork should be performed in accordance with Caltrans Standard Specifications, Section 19 (Caltrans, 2010b). Appropriate measures should be taken to prevent damage to adjacent structures and utilities. Any design and construction of temporary sloping, sheeting, or shoring should be made the contractor's responsibility. It should be noted that it is the responsibility of the contractor to oversee the safety of the workers in the field during construction. The contractor shall conform to all applicable occupational and health standards, rules, regulations, and orders established by the State of California. In addition, other State, County, or Municipal regulations may supersede the recommendations presented in this section. If a trench shoring design and safety plan is required, the geotechnical consultant should review the plan to confirm that recommendations presented in this report have been applied to the design.

During the recent field investigation conducted between December 6, 2010 and December 16, 2011, groundwater was encountered between El. +73.5 feet and El. +113.3 feet, which is more than 70 feet from the below the ground surface. Therefore, groundwater is not expected to be encountered during pile and footing construction. However, groundwater level can fluctuate due to seasonal rainfall amount, local irrigation and groundwater recharge program and other man-made conditions. If groundwater is encountered, it should be controlled in accordance with Section 19-3.04 of the Caltrans Standard Specifications (Caltrans, 2010b).

6.2 Pile Construction

Construction of CIDH piles should follow Section 49-4.03, "Drilled Holes" of the Caltrans Standard Specifications (Caltrans, 2010b). The Contractor should drill the bottom of the shaft boring with a clean-out bucket to ensure adequate removal of loose soils. Both clean-out and concrete placement should be addressed in the specifications. The shaft borings should be inspected and approved by the Resident Engineer prior to installation of reinforcement. Per latest Caltrans requirement, 3-inch, 4-inch, and 6-inch of concrete covers over reinforcement should be provided to improve the construction of 16-inch, 54-inch, and 60-inch diameter CIDH piles, respectively.

The onsite soils generally range from loose to dense coarse grained materials, and these materials are susceptible to caving. If caving occurs, a temporary casing can be used. The casing should have an inside diameter larger than or equal to the pile diameter and should be placed tight in the hole. Vibratory hammers or oversized drilling are not allowed for casing installation. In the event that any boring becomes bell-shaped and cannot be advanced due to severe caving, all loose material should be removed from the bottom of the boring and the caved region filled with a low strength sand-cement slurry. Drilling may continue when the slurry has reached its initial set.

6.3 Review of Construction Plans

Recommendations contained in this report are based on preliminary plans. The geotechnical consultant should review the final construction plans and specifications in order to confirm that the general intent of the recommendations contained in this report have been incorporated into the final construction documents. Recommendations contained in this report may require

modification or additional recommendations may be necessary based on the final design.

6.4 Geotechnical Observation and Testing

It is recommended that inspections and testing be performed by the geotechnical consultant during the following stages of construction:

- Grading operations, including excavations and placement of compacted fill
- Shoring installation
- Footing excavations and pile constructions
- When any unusual subsurface conditions are encountered

7.0 LIMITATIONS

This report is intended for the use of RBF Consulting, Orange County Transportation Authority and Caltrans for the proposed overhead sign structures on CIDH pile foundation within the SR-91 Westbound Widening Project. This report is based on the project as described and the information obtained from the exploratory borings and CPT sounding at the approximate locations indicated on the attached plans. The findings and recommendations contained in this report are based on the results of the field investigation, laboratory tests, and engineering analyses. In addition, soils and subsurface conditions encountered in the exploratory borings are presumed to be representative of the project site. However, subsurface conditions and characteristics of soils between exploratory borings and CPT sounding can vary. The findings reflect an interpretation of the direct evidence obtained. The recommendations presented in this report are based on the assumption that an appropriate level of quality control and quality assurance (inspections and tests) will be provided during construction. EMI should be notified of any pertinent changes in the project plans or if subsurface conditions are found to vary from those described herein. Such changes or variations may require a re-evaluation of the recommendations contained in this report.

The data, opinions, and recommendations contained in this report are applicable to the specific design element(s) and location(s) which is (are) the subject of this report. They have no applicability to any other design elements or to any other locations and any and all subsequent users accept any and all liability resulting from any use or reuse of the data, opinions, and recommendations without the prior written consent of EMI.

EMI has no responsibility for construction means, methods, techniques, sequences, or procedures; for safety precautions or programs in connection with the construction; for the acts or omissions of the CONTRACTOR or any other person performing any of the construction; or for the failure of any worker to carry out the construction in accordance with the Final Construction Drawings and Specifications.

Services performed by EMI have been conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, expressed or implied, and no warranty or guarantee is included or intended.

8.0 REFERENCES

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APPENDIX A

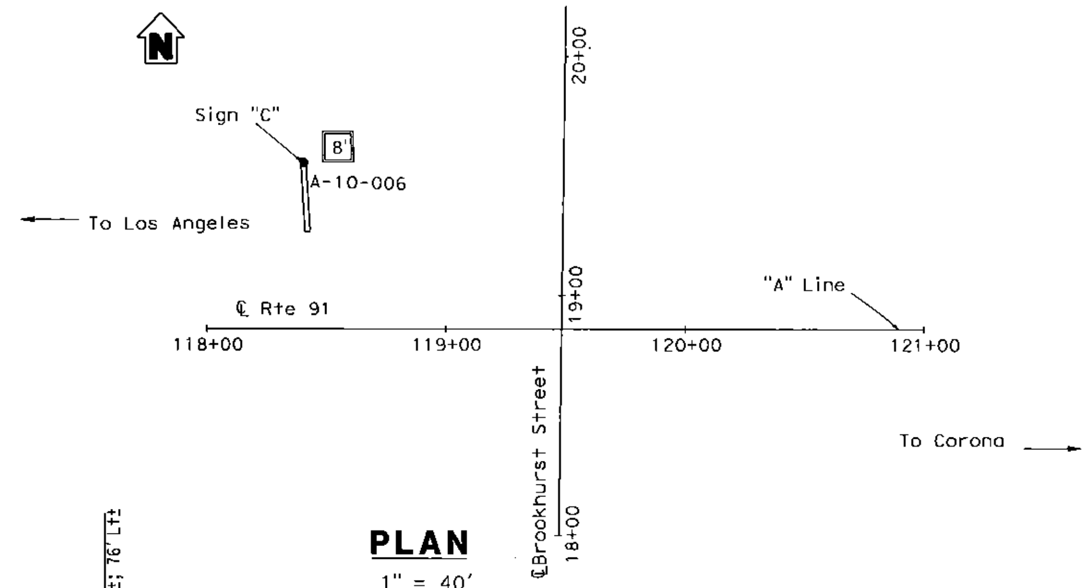
LOG OF TEST BORINGS SHEETS

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¾" OCS Aluminum Benchmark Disk
Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¾" OCS Aluminum Benchmark Disk
Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¾" OCS Aluminum Benchmark Disk
Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 40'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

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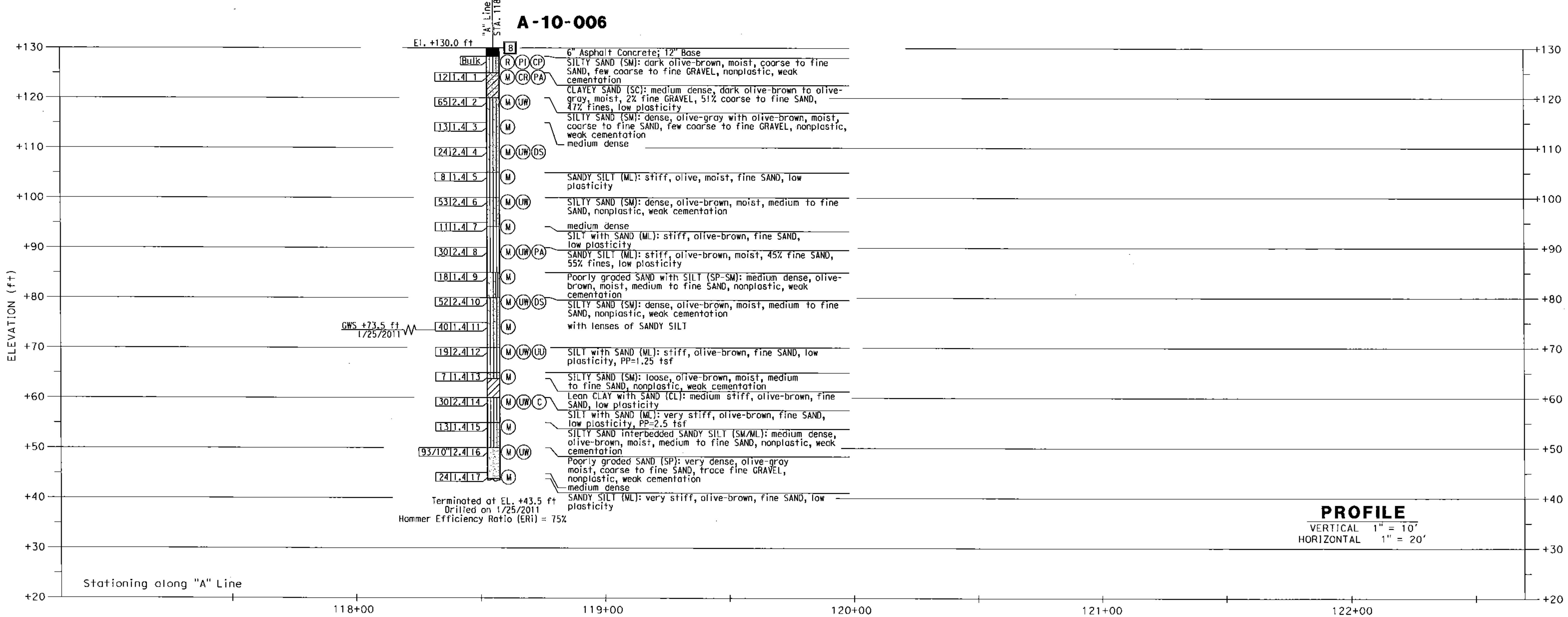
REGISTERED PROFESSIONAL ENGINEER S. PIRATHIVIRAJ NO. C71662 EXP. 12/31/13 CIVIL STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).
(2) 2.4" samples were taken using a California Modified Sampler.
(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.



PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie FIELD INVESTIGATION BY:
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	DATE: 1/25/2011

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

S. Pirathiviraj
PROJECT ENGINEER

BRIDGE NO. -
POST MILES -

OVERHEAD SIGN STRUCTURES
LOG OF TEST BORING 1 OF 11

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

FILE => $REQUEST

CONTRACT NO.: 12-0C5701 PROJECT ID:

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

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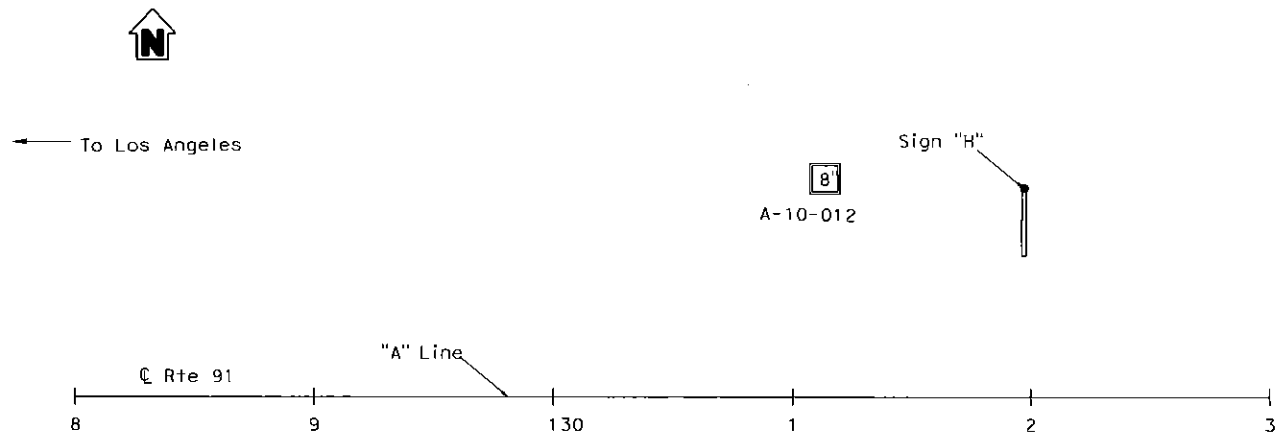

PLAN
1" = 40'

To Corona

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

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A-10-012

"A" Line STA. 131+14±; 91' L±±

El. +119.0 ft

8	Bulk			5" Asphalt Concrete; 16" Base
7	11.4	1	M	SILTY SAND (SM): dark olive-brown, moist, coarse to fine SAND, trace fine GRAVEL, nonplastic, weak cementation loose, olive-brown
28	2.4	2	M UW DS	medium dense
14	1.4	3	M	
53	2.4	4	M UW	Poorly graded SAND with SILT (SP-SM): dense, olive-brown, moist, medium to fine SAND, nonplastic, weak cementation
5	1.4	5	M	SANDY SILT (ML): soft, olive-brown, moist, fine SAND, low plasticity
				CLAYEY SAND (SC): loose, olive-brown, moist, medium to fine SAND, low plasticity
55	2.4	6	M UW	Poorly graded SAND with SILT (SP-SM): dense, olive-brown, moist, medium to fine SAND, nonplastic, weak cementation

Terminated at EL. +87.5 ft
Drilled on 1/25/2011
Hammer Efficiency Ratio (ERi) = 75%
Groundwater not Encountered During Drilling

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

ELEVATION (ft)

+120 +110 +100 +90 +80 +70 +60 +50 +40 +30 +20

Stationing along "A" Line

129+00 130+00 131+00 132+00 133+00 134+00

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviroj	BRIDGE NO. -	OVERHEAD SIGN STRUCTURES
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/25/2011		PROJECT ENGINEER	POST MILES -	LOG OF TEST BORING 2 OF 11

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

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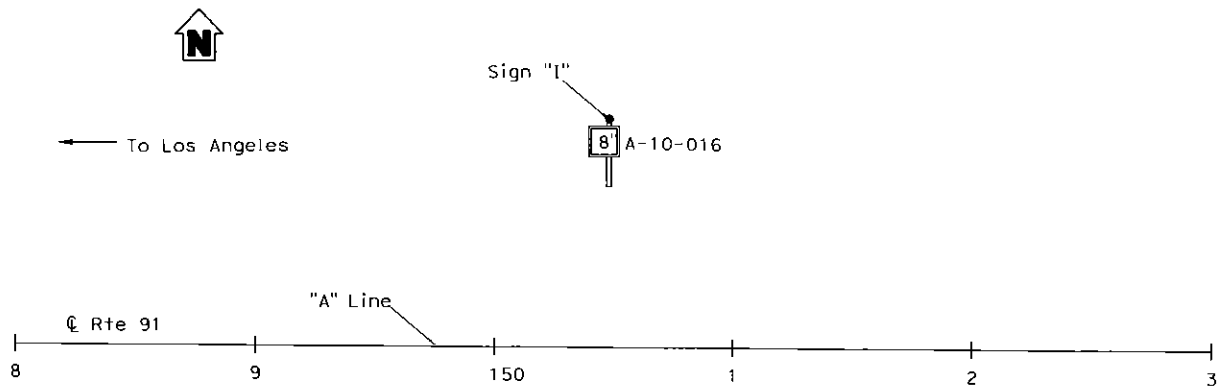

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
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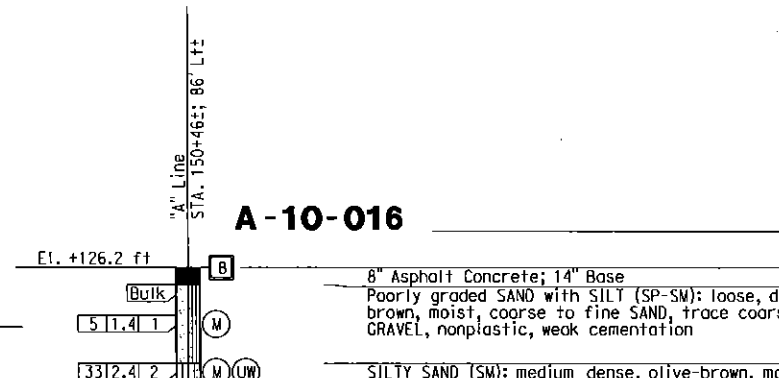
(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

PLAN
1" = 40'

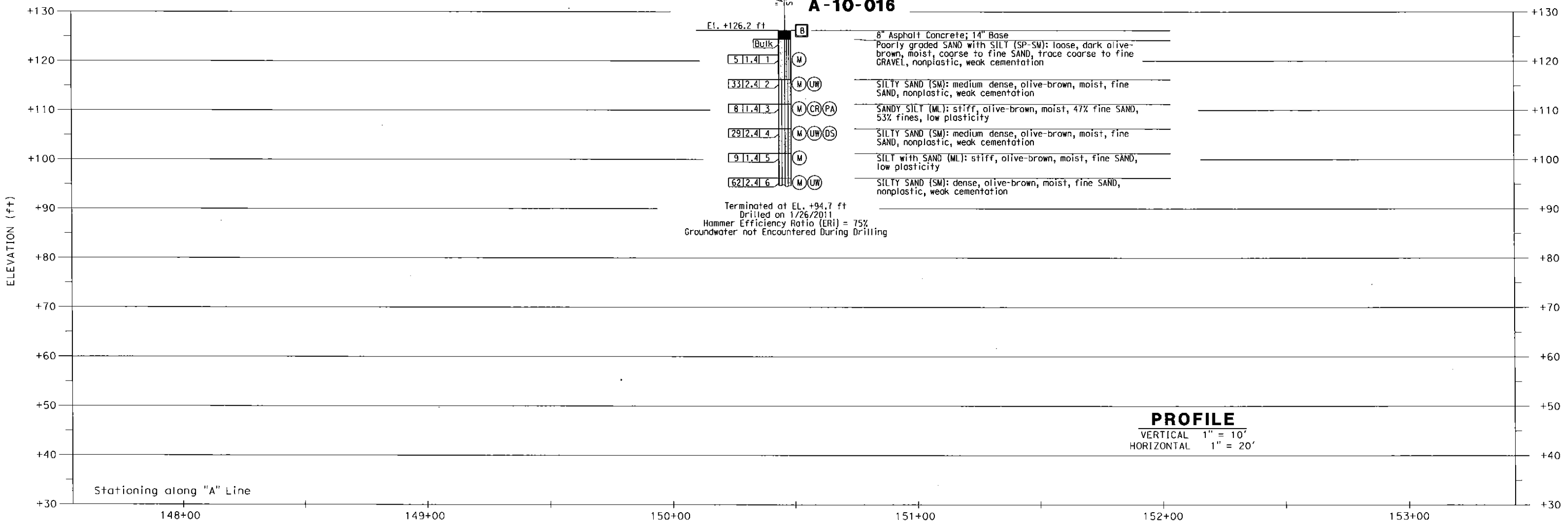


A-10-016

El. +126.2 ft

B				8" Asphalt Concrete; 14" Base
Bulk				Poorly graded SAND with SILT (SP-SM): loose, dark olive-brown, moist, coarse to fine SAND, trace coarse to fine GRAVEL, nonplastic, weak cementation
5	1.4	1	M	
33	2.4	2	M UW	SILTY SAND (SM): medium dense, olive-brown, moist, fine SAND, nonplastic, weak cementation
8	1.4	3	M CR PA	SANDY SILT (ML): stiff, olive-brown, moist, 47% fine SAND, 53% fines, low plasticity
29	2.4	4	M UW DS	SILTY SAND (SM): medium dense, olive-brown, moist, fine SAND, nonplastic, weak cementation
9	1.4	5	M	SILT with SAND (ML): stiff, olive-brown, moist, fine SAND, low plasticity
62	2.4	6	M UW	SILTY SAND (SM): dense, olive-brown, moist, fine SAND, nonplastic, weak cementation

Terminated at EL. +94.7 ft
Drilled on 1/26/2011
Hammer Efficiency Ratio (ERi) = 75%
Groundwater not Encountered During Drilling



PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirothiviraj PROJECT ENGINEER	BRIDGE NO. -	OVERHEAD SIGN STRUCTURES
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/26/2011				POST MILES -	LOG OF TEST BORING 3 OF 11

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

FILE => $REQUEST

CONTRACT NO.: 12-0C5701 PROJECT ID:

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER S. PIRATHIVIRAJ NO. C71662 EXP. 12/31/13 CIVIL STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

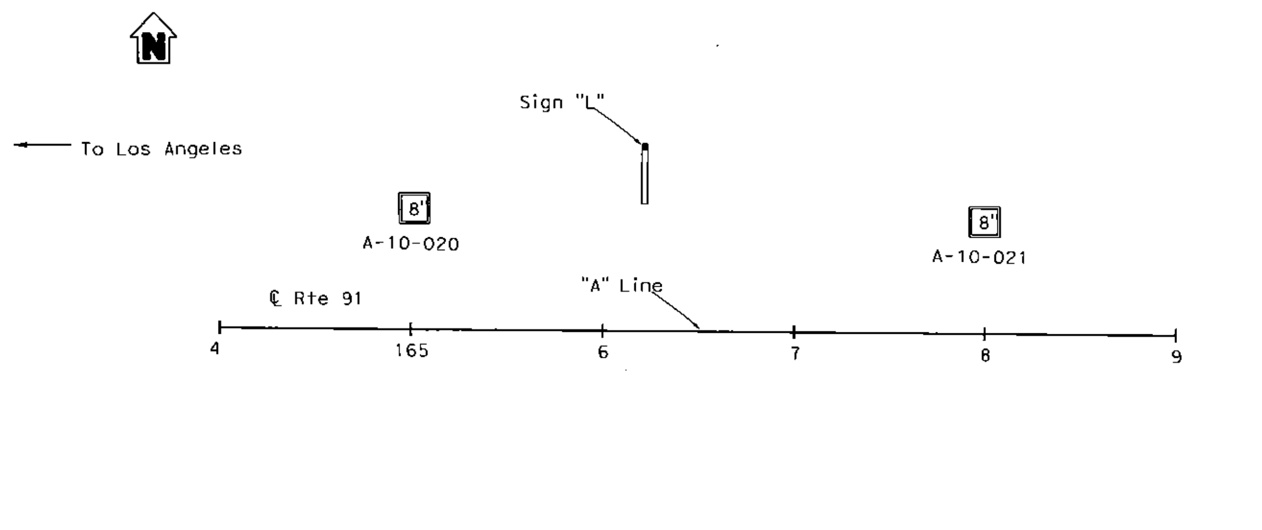
EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¾" OCS Aluminum Benchmark Disk
Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¾" OCS Aluminum Benchmark Disk
Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¾" OCS Aluminum Benchmark Disk
Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 50'

NOTES:

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(2) 2.4" samples were taken using a California Modified Sampler.
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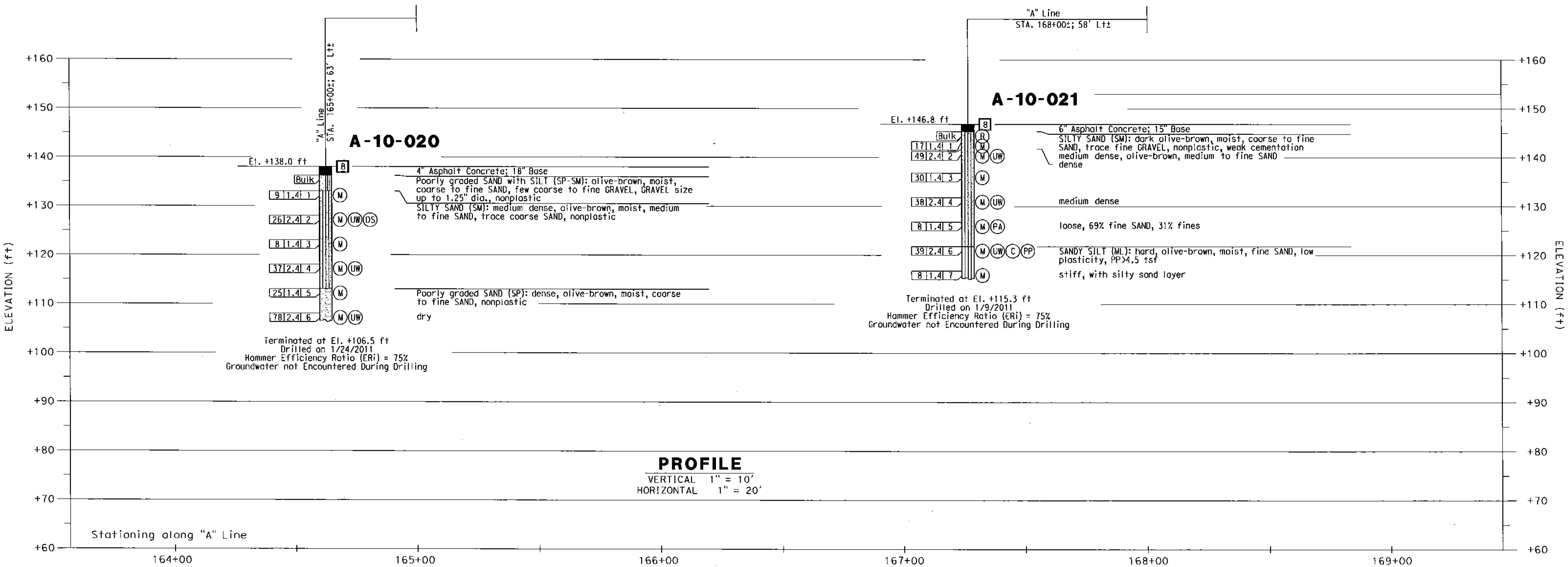

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY: J. Fang	R. Jie FIELD INVESTIGATION BY:	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. -	OVERHEAD SIGN STRUCTURES
SIGN OFF DATE	CHECKED BY: G. J. Gunaranjan	DATE: 1/9/2011, 1/24/2011			POST MILES -	LOG OF TEST BORINGS 4 OF 11

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

FILE => $REQUEST

CONTRACT NO.: 12-0C5701 PROJECT ID:

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

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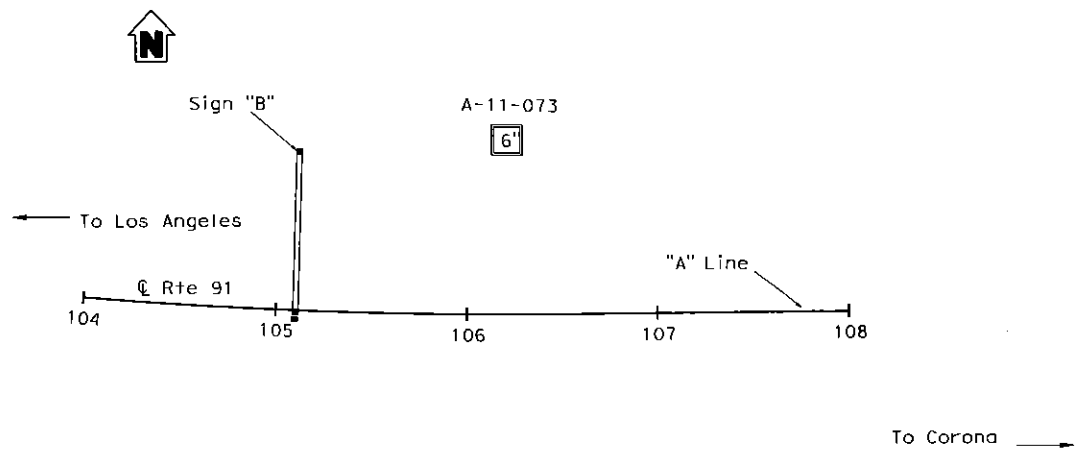
Described by OCS 2004 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER S. PIRATHIVIRAJ NO. C71662 EXP. 12/31/13 CIVIL STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

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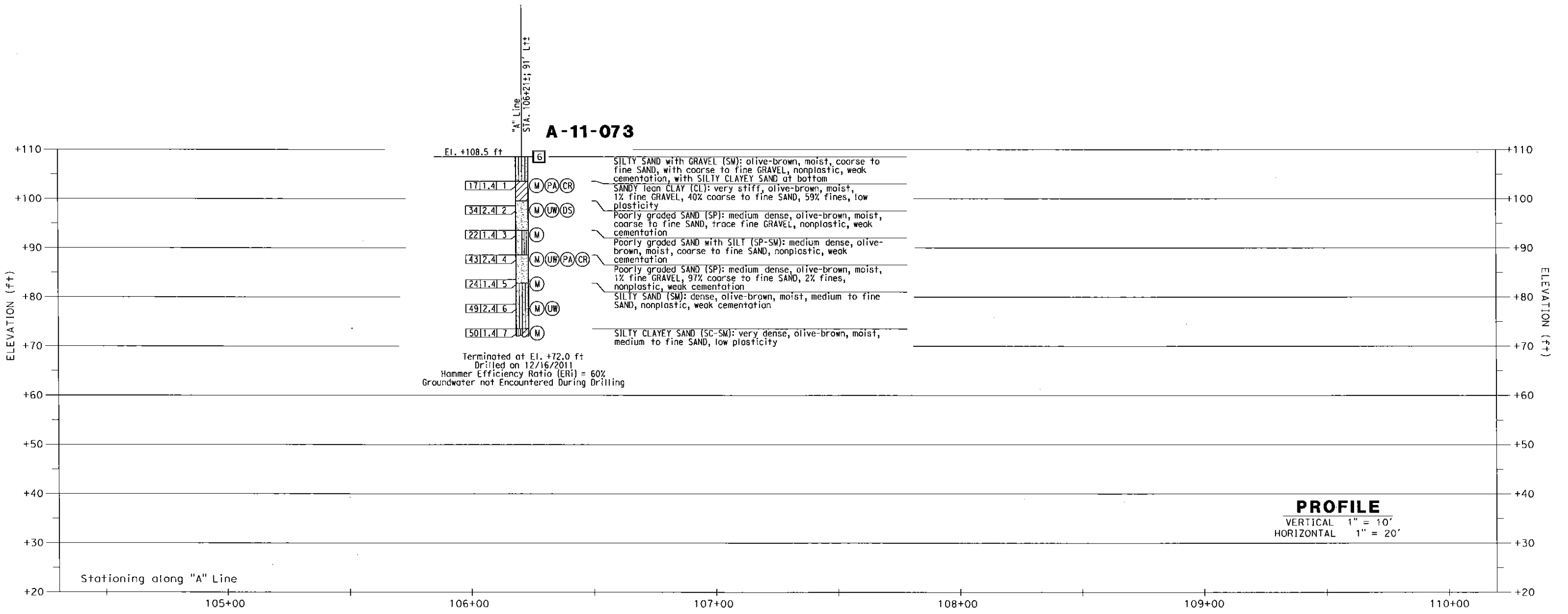
(3) A rope hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.



PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -	OVERHEAD SIGN STRUCTURES
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 12/16/2011		PROJECT ENGINEER	POST MILES -	LOG OF TEST BORING 5 OF 11

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

FILE => $REQUEST

CONTRACT NO.: 12-0C5701 PROJECT ID:

PLOTTED => $DATE$TIME

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¾" OCS Aluminum Benchmark Disk
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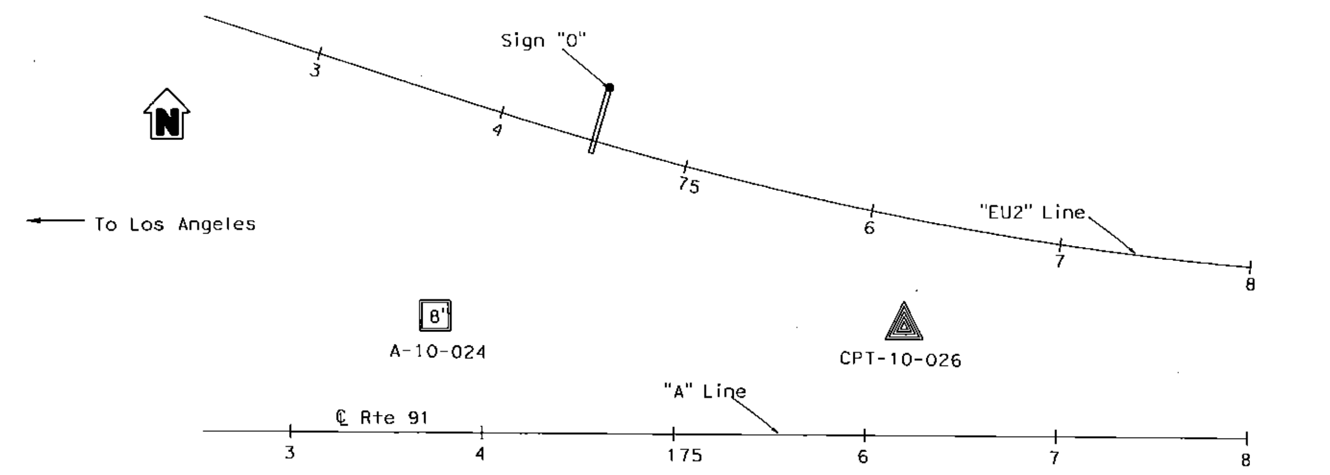
Described by OCS 2003 - Found 3¾" OCS Aluminum Benchmark Disk
Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

S. PIRATHIVIRAJ, NO. C71662, EXP. 12/31/13, CIVIL, REGISTERED PROFESSIONAL ENGINEER, STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

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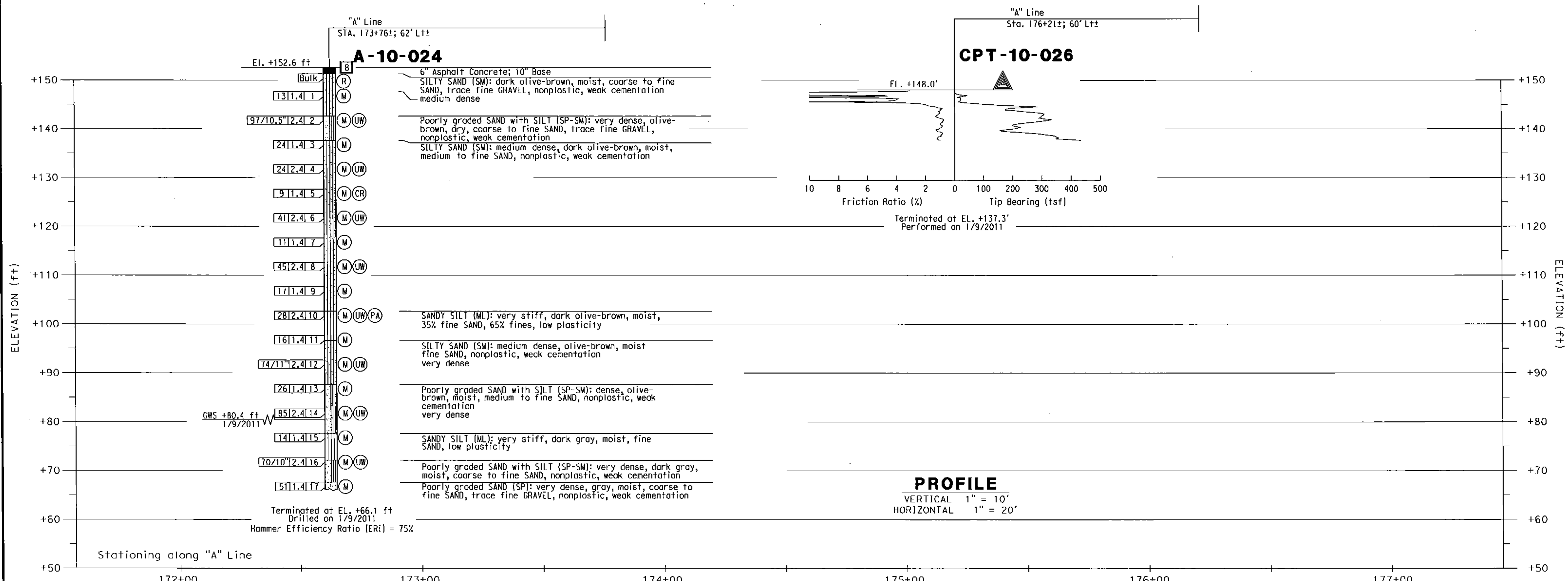

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan

R. Jie
FIELD INVESTIGATION BY:
DATE: 1/9/2011

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

S. Pirathiviraj
PROJECT ENGINEER

BRIDGE NO. -
POST MILES -

OVERHEAD SIGN STRUCTURES
LOG OF TEST BORINGS 6 OF 11

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791
FILE => $REQUEST

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

SHEET OF

CONTRACT NO.: 12-0C5701 PROJECT ID:

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

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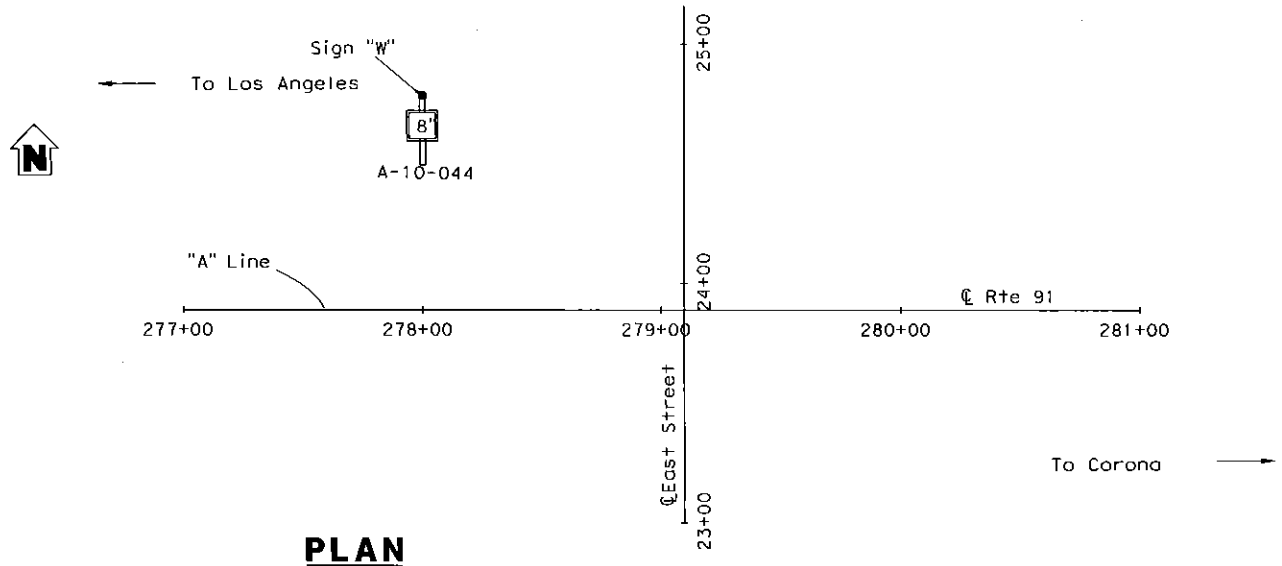
Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 40'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71682 — EXP. 12/31/13 — CIVIL — STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

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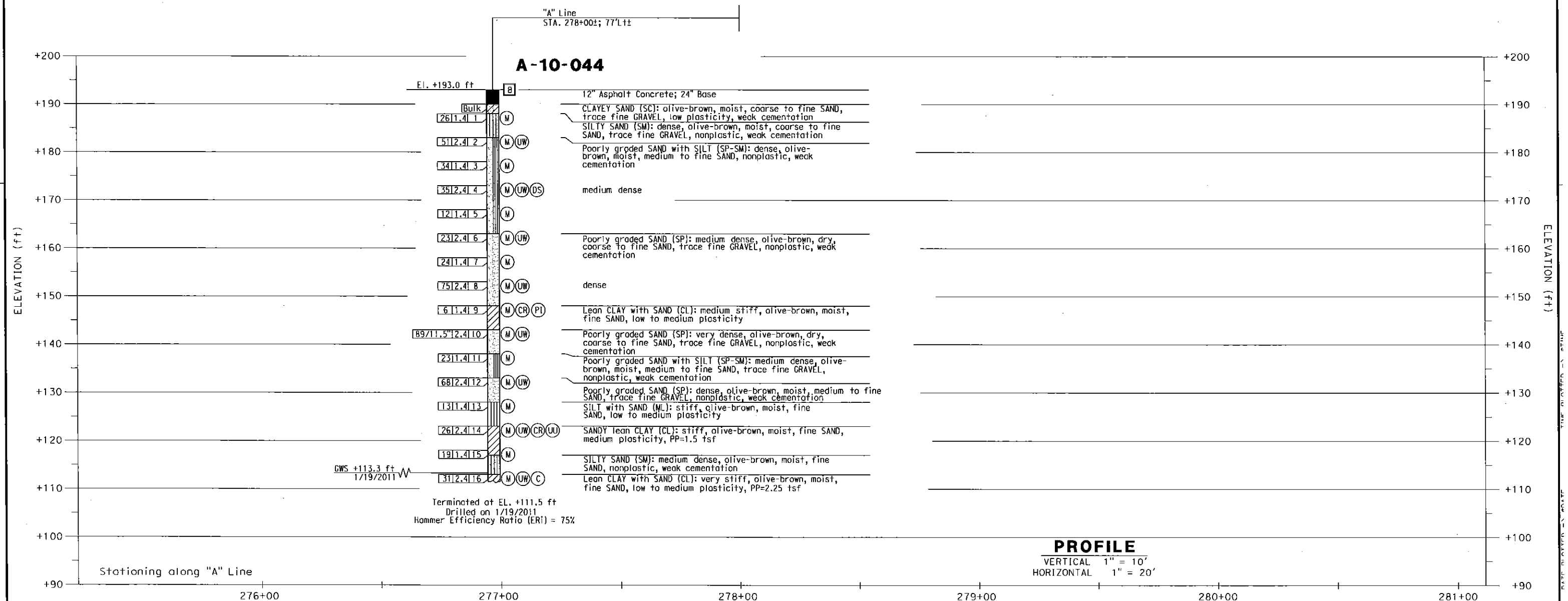

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 1/19/2011		PROJECT ENGINEER

BRIDGE NO. –
POST MILES –

OVERHEAD SIGN STRUCTURES
LOG OF TEST BORING 7 OF 11

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 1200000079

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

FILE => $REQUEST

CONTRACT NO.: 12-0C5701 PROJECT ID:

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk
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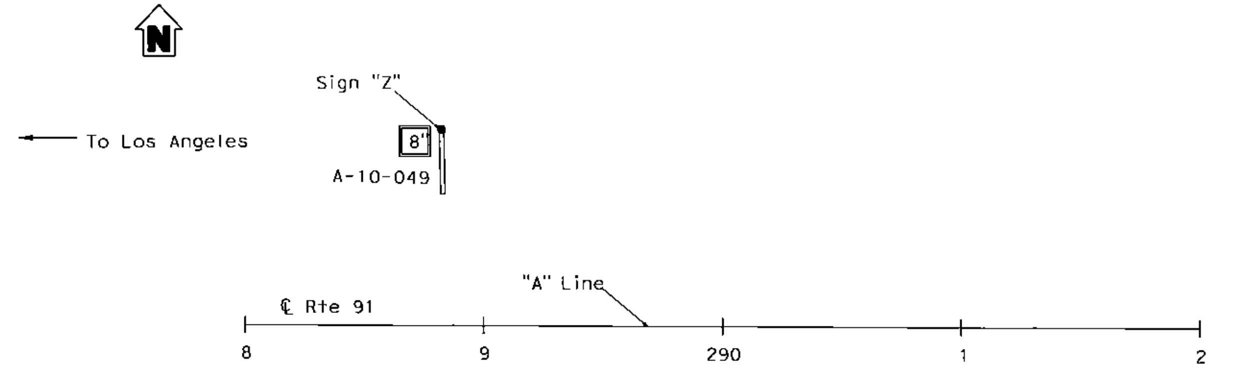

PLAN
1" = 40'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER S. PIRATHIVIRAJ NO. C71662 EXP. 12/31/13 CIVIL STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

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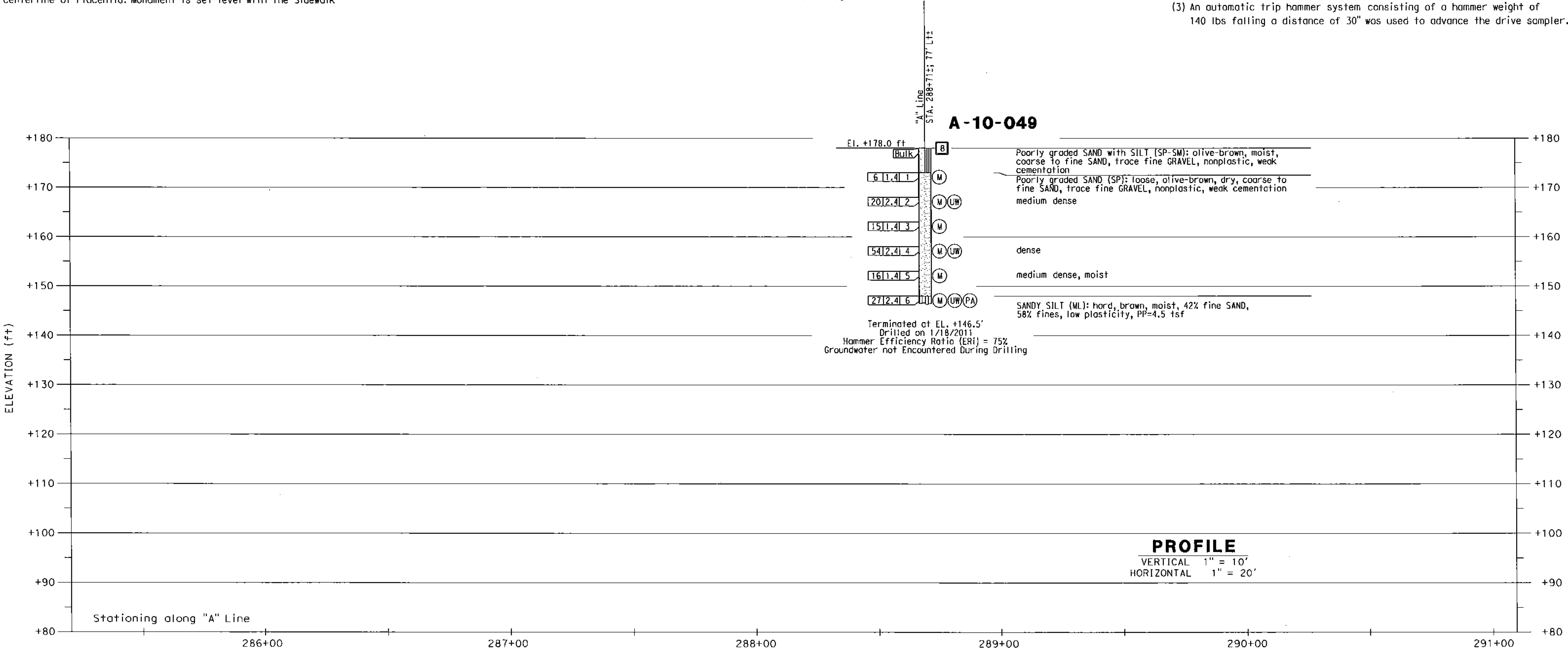

PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY J. Fang	R. Jie FIELD INVESTIGATION BY:	
SIGN OFF DATE	CHECKED BY G. J. Gunaranjan	DATE: 1/18/2010	

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

S. Pirathiviraj
PROJECT ENGINEER

BRIDGE NO. -
POST MILES -

OVERHEAD SIGN STRUCTURES
LOG OF TEST BORING 8 OF 11

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

CONTRACT NO.: 12-0C5701 PROJECT ID:

FILE => $REQUEST

BENCH MARKS:

Designation: 1G-164-05 Elev = 109.804
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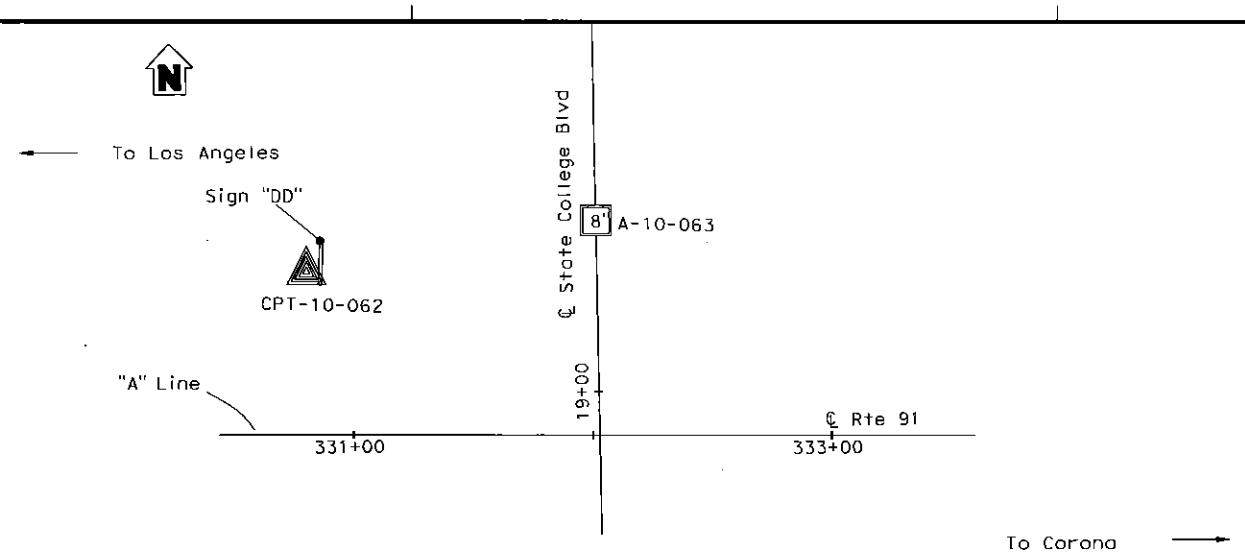

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER S. PIRATHIVIRAJ NO. C71662 EXP. 12/31/13 CIVIL STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).

(2) 2.4" samples were taken using a California Modified Sampler.

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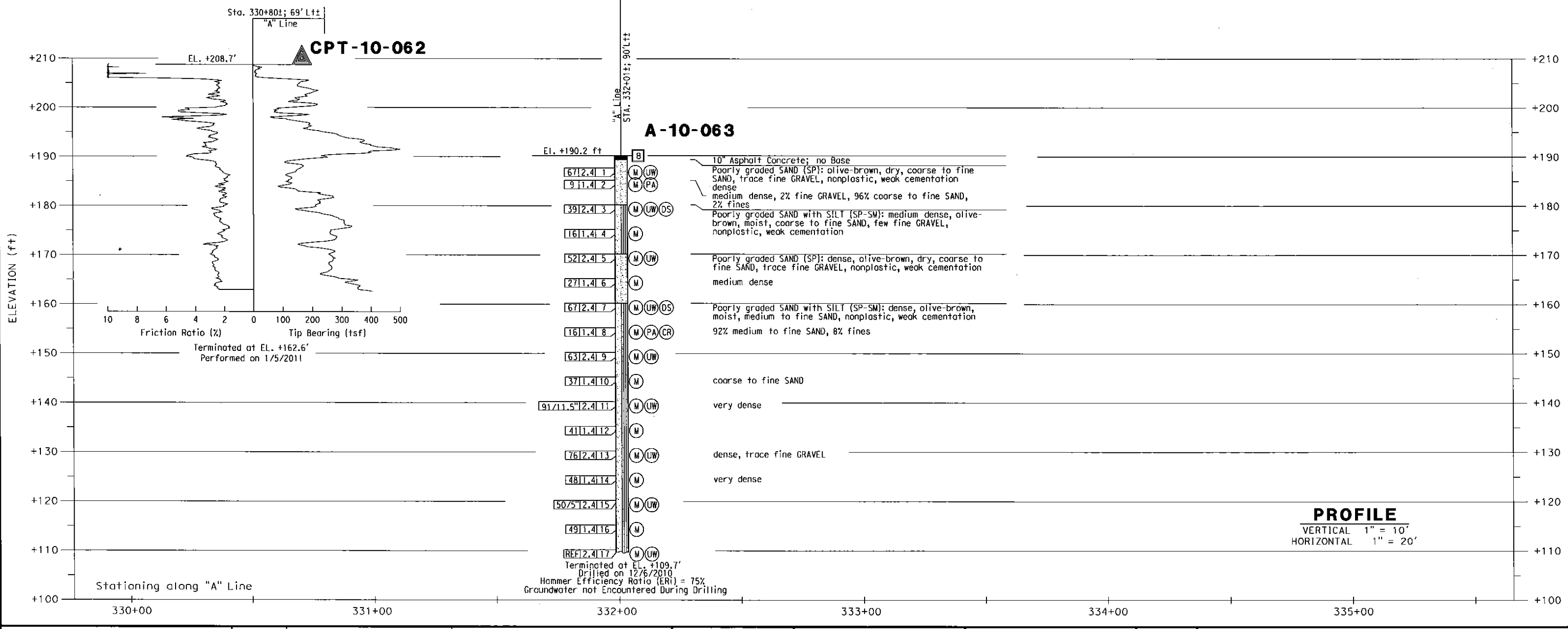
PLAN

1" = 40'



PROFILE

VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. -	OVERHEAD SIGN STRUCTURES
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 12/6/2010		PROJECT ENGINEER	POST MILES -	LOG OF TEST BORINGS 9 OF 11

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

FILE => @REQUEST

CONTRACT NO.: 12-0C5701 PROJECT ID:

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER S. PIRATHIVIRAJ NO. C71662 EXP. 12/31/13 CIVIL STATE OF CALIFORNIA

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

CEMENTATION

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

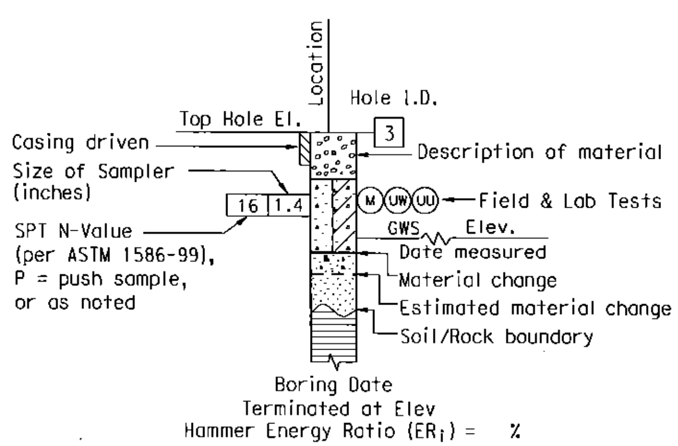
BOREHOLE IDENTIFICATION

Symbol	Hole Type	Description
[Size]	A	Auger Boring (hollow or solid stem bucket)
[Size]	R RW RC P	Rotary drilled boring (conventional) Rotary drilled with self-casing wire-line Rotary core with continuously-sampled, self-casing wire-line Rotary percussion boring (air)
◇Size	R	Rotary drilled diamond core
[Size]	HD HA	Hand driven (1-inch soil tube) Hand Auger
●	D	Dynamic Cone Penetration Boring
▲	CPT	Cone Penetration Test (ASTM D 5778)
[ ]	O	Other (note on LOTB)

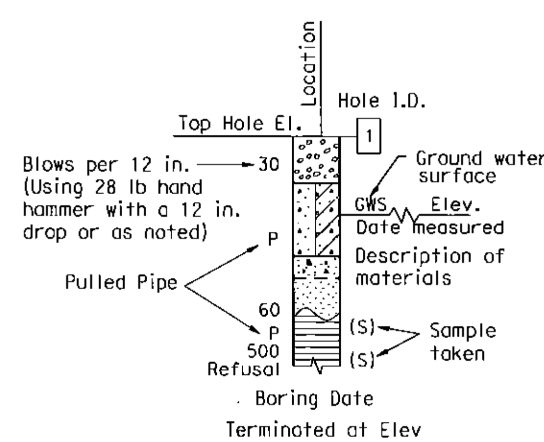
Note: Size in inches.

CONSISTENCY OF COHESIVE SOILS

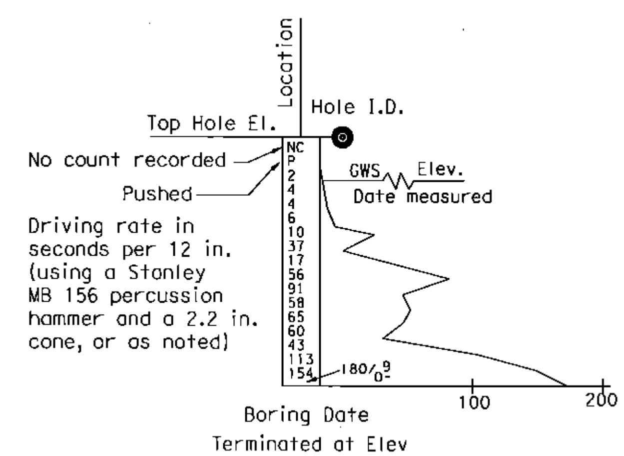
Description	Shear Strength (tsf)	Pocket Penetrometer Measurement, PP, (tsf)	Torvane Measurement, TV, (tsf)	Vane Shear Measurement, VS, (tsf)
Very Soft	Less than 0.12	Less than 0.25	Less than 0.12	Less than 0.12
Soft	0.12 - 0.25	0.25 - 0.5	0.12 - 0.25	0.12 - 0.25
Medium Stiff	0.25 - 0.5	0.5 - 1	0.25 - 0.5	0.25 - 0.5
Stiff	0.5 - 1	1 - 2	0.5 - 1	0.5 - 1
Very Stiff	1 - 2	2 - 4	1 - 2	1 - 2
Hard	Greater than 2	Greater than 4	Greater than 2	Greater than 2



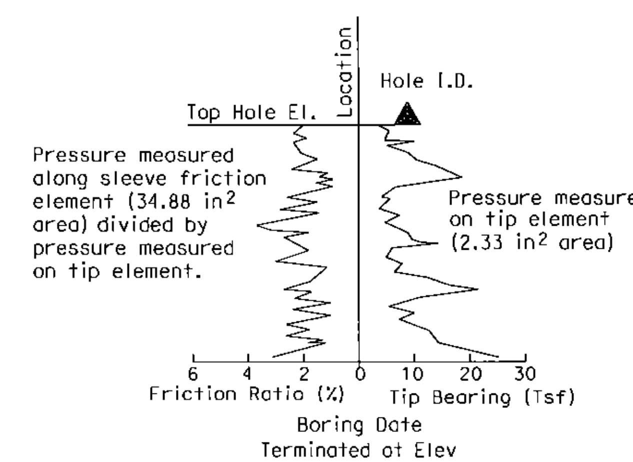
ROTARY BORING



HAND BORING



DYNAMIC CONE PENETRATION BORING



CONE PENETRATION TEST (CPT) BORING

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie FIELD INVESTIGATION BY:
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	DATE: 1/2011

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

S. Pirathiviraj
PROJECT ENGINEER

BRIDGE NO. -
POST MILES -

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

OVERHEAD SIGN STRUCTURES

LOG OF TEST BORINGS 10 OF 11

REVISION DATES | SHEET | OF

FILE => $REQUEST

CONTRACT NO.: 12-0C5701 PROJECT ID:

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

GROUP SYMBOLS AND NAMES

Graphic/Symbol	Group Names	Graphic/Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND	CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
GP	Poorly-graded GRAVEL Poorly-graded GRAVEL with SAND		
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND	CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GP-GM	Poorly-graded GRAVEL with SILT Poorly-graded GRAVEL with SILT and SAND	ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
GP-GC	Poorly-graded GRAVEL with CLAY (or SILTY CLAY) Poorly-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GM	SILTY GRAVEL SILTY GRAVEL with SAND	OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND		
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND	OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL		
SP	Poorly-graded SAND Poorly-graded SAND with GRAVEL	CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL		
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
SP-SM	Poorly-graded SAND with SILT Poorly-graded SAND with SILT and GRAVEL		
SP-SC	Poorly-graded SAND with CLAY (or SILTY CLAY) Poorly-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
SM	SILTY SAND SILTY SAND with GRAVEL		
SC	CLAYEY SAND CLAYEY SAND with GRAVEL	OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY ORGANIC elastic SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL		
PT	PEAT	OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND
	COBBLES COBBLES and BOULDERS BOULDERS		

FIELD AND LABORATORY TESTING

- (C) Consolidation (ASTM D 2435)
- (CL) Collapse Potential (ASTM D 5333)
- (CP) Compaction Curve (CTM 216)
- (CR) Corrosivity Testing (CTM 643, CTM 422, CTM 417)
- (CU) Consolidated Undrained Triaxial (ASTM D 4767)
- (DS) Direct Shear (ASTM D 3080)
- (EI) Expansion Index (ASTM D 4829)
- (M) Moisture Content (ASTM D 2216)
- (OC) Organic Content-% (ASTM D 2974)
- (P) Permeability (CTM 220)
- (PA) Particle Size Analysis (ASTM D 422)
- (PI) Plasticity Index (AASHTO T 90) Liquid Limit (AASHTO T 89)
- (PL) Point Load Index (ASTM D 5731)
- (PM) Pressure Meter
- (R) R-Value (CTM 301)
- (SE) Sand Equivalent (CTM 217)
- (SG) Specific Gravity (AASHTO T 100)
- (SL) Shrinkage Limit (ASTM D 427)
- (SW) Swell Potential (ASTM D 4546)
- (UC) Unconfined Compression-Soil (ASTM D 2166)
Unconfined Compression-Rock (ASTM D 2938)
- (UU) Unconsolidated Undrained Trioxial (ASTM D 2850)
- (UW) Unit Weight (ASTM D 4767)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER _____ DATE _____

S. PIRATHIVIRAJ NO. C71662 EXP. 12/31/13 CIVIL REGISTERED PROFESSIONAL ENGINEER STATE OF CALIFORNIA

PLANS APPROVAL DATE _____

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

APPARENT DENSITY OF COHESIONLESS SOILS

Description	SPT N_{60} (Blows / 12 in.)
Very Loose	0 - 5
Loose	5 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Greater than 50

MOISTURE

Description	Criteria
Dry	No discernable moisture
Moist	Moisture present, but no free water
Wet	Visible free water

PERCENT OR PROPORTION OF SOILS

Description	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5% - 10%
Little	15% - 25%
Some	30% - 45%
Mostly	50% - 100%

PARTICLE SIZE

Description		Size (in.)
Boulder		Greater than 12
Cobble		3 - 12
Gravel	Coarse	3/4 - 3
	Fine	1/5 - 3/4
Sand	Coarse	1/16 - 1/5
	Medium	1/64 - 1/16
	Fine	1/300 - 1/64
Silt and Clay		Less than 1/300

DESIGN OVERSIGHT _____ SIGN OFF DATE _____

DRAWN BY: J. Fang
CHECKED BY: G. J. Gunaranjan

R. Jie
FIELD INVESTIGATION BY:
DATE: 1/2011

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

S. Pirathiviraj
PROJECT ENGINEER

BRIDGE NO. -
POST MILES -

OVERHEAD SIGN STRUCTURES
LOG OF TEST BORINGS 11 OF 11

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 1200000079I

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

FILE => $REQUEST

CONTRACT NO.: 12-0C5701 PROJECT ID:

DATE PLOTTED => 4/1/2013 TIME PLOTTED => 07:11

APPENDIX B

LABORATORY TEST RESULTS

TABLE B1 SUMMARY OF LABORATORY TEST RESULTS FOR SIGN STRUCTURES (1 OF 3)

Project No. : *10-126* Project Name : SR-91 WB Widening - Overhead Sign Structures

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil- Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil- Soluble Sulfate Content CT-417 (ppm)	Soil- Moisture Free Chloride Content CT-422 (ppm)
A-10-006	*S-1*	5	SC	15.3				2:51:47			2600	8.5	10	83
A-10-006	*D-2*	10	SM	11.7	134.0									
A-10-006	*S-3*	15	SM	12.9										
A-10-006	*D-4*	20	SM	8.3	122.8									
A-10-006	*S-5*	25	ML	15.3										
A-10-006	*D-6*	30	SM	6.1	129.3									
A-10-006	*S-7*	35	SM to ML	28.9										
A-10-006	*D-8*	40	ML	15.3	130.3			0:45:55						
A-10-006	*S-9*	45	SP-SM	4.0										
A-10-006	*D-10*	50	SM	23.5	119.9									
A-10-006	*S-11*	55	SM	22.5										
A-10-006	*D-12*	60	ML	34.1	123.1	1.25								
A-10-006	*S-13*	65	SM to CL	22.9										
A-10-006	*D-14*	70	ML	32.0	120.7	2.5								
A-10-006	*S-15*	75	SM/ML	19.7										
A-10-006	*D-16*	80	SP	14.6	137.2									
A-10-006	*S-17*	85	SP-SM to ML	15.4										
A-10-012	*S-1*	5	SM	11.6										
A-10-012	*D-2*	10	SM	11.2	121.7									
A-10-012	*S-3*	15	SM	9.9										
A-10-012	*D-4*	20	SP-SM	5.4	113.5									
A-10-012	*S-5*	25	ML	20.4										
A-10-012	*D-6*	30	SP-SM	2.3	106.1									
A-10-016	*S-1*	5	SM to SP-SM	9.5										
A-10-016	*D-2*	10	SM	8.5	123.2									
A-10-016	*S-3*	15	ML	15.2				0:47:53			2200	8.7	70	94
A-10-016	*D-4*	20	SM	16.5	132.4									
A-10-016	*S-5*	25	ML	29.5										
A-10-016	*D-6*	30	SM	9.7	117.9									
A-10-020	*S-1*	5	SM	9.3										
A-10-020	*D-2*	10	SM	6.8	119.3									
A-10-020	*S-3*	15	SM	15.8										
A-10-020	*D-4*	20	SM	13.6	131.6									
A-10-020	*S-5*	25	SP	3.5										
A-10-020	*D-6*	30	SP	2.1	111.1									
A-10-021	*S-1*	2.5	SM	6.0										
A-10-021	*D-2*	5	SM	9.9	127.9									
A-10-021	*S-3*	10	SM	9.5										
A-10-021	*D-4*	15	SM	9.9	128.3									
A-10-021	*S-5*	20	SM	9.4				0:69:31						

TABLE B1 SUMMARY OF LABORATORY TEST RESULTS FOR SIGN STRUCTURES (2 OF 3)

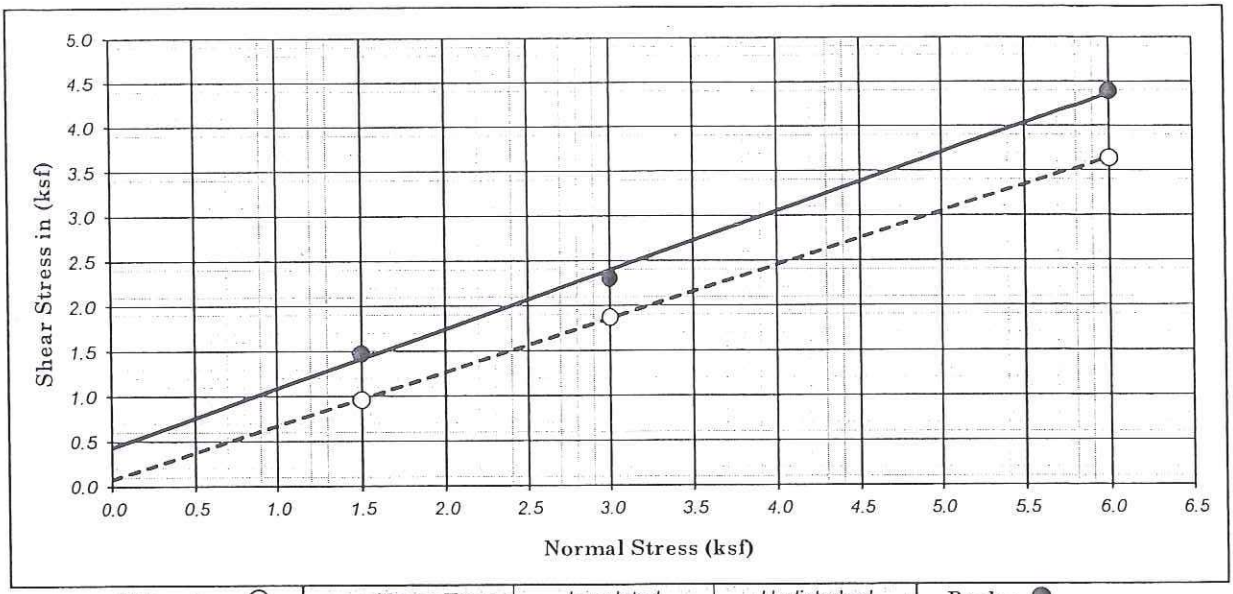
Project No. : *10-126* Project Name : SR-91 WB Widening - Overhead Sign Structures

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-021	*D-6*	25	ML	10.6	118.4	>4.5								
A-10-021	*S-7*	30	SM to ML	14.4										
A-10-024	*S-1*	5	SM	8.3										
A-10-024	*D-2*	10	SP-SM	2.3	118.6									
A-10-024	*S-3*	15	SM	10.5										
A-10-024	*D-4*	20	SM	8.9	118.5									
A-10-024	*S-5*	25	SM	11.2							750	7.8	40	332
A-10-024	*D-6*	30	SM	6.4	113.1									
A-10-024	*S-7*	35	SM	13.1										
A-10-024	*D-8*	40	SM	11.1	128.3									
A-10-024	*S-9*	45	SM	12.2										
A-10-024	*D-10*	50	ML	17.7	126.6			0:35:65						
A-10-024	*S-11*	55	ML to SM	22.6										
A-10-024	*D-12*	60	SM	26.5	120.0									
A-10-024	*S-13*	65	SP-SM	6.5										
A-10-024	*D-14*	70	SP-SM	14.5	125.9									
A-10-024	*S-15*	75	ML	26.5										
A-10-024	*D-16*	80	SP-SM	11.5	126.0									
A-10-024	*S-17*	85	SP	3.9										
A-10-044	*S-1*	5	SM	11.6										
A-10-044	*D-2*	10	SP-SM	6.1	131.8									
A-10-044	*S-3*	15	SP-SM	6.8										
A-10-044	*D-4*	20	SP-SM	2.0	109.3									
A-10-044	*S-5*	25	SP-SM	2.1										
A-10-044	*D-6*	30	SP	1.1	104.4									
A-10-044	*S-7*	35	SP	4.2										
A-10-044	*D-8*	40	SP	1.7	111.1									
A-10-044	*S-9*	45	CL	30.0						36/22/14	760	7.6	130	322
A-10-044	*D-10*	50	SP	3.1	110.9									
A-10-044	*S-11*	55	SP-SM	5.0										
A-10-044	*D-12*	60	SP	3.6	117.6									
A-10-044	S-13	65	ML	31.0										
A-10-044	*D-14*	70	CL	19.6	126.7	1.5					810	7.8	70	255
A-10-044	*S-15*	75	CL to SM	23.6										
A-10-044	*D-16*	80	CL	34.1	119.2	2.25								
A-10-049	*S-1*	5	SP	3.9										
A-10-049	*D-2*	10	SP	2.3	105.9									
A-10-049	*S-3*	15	SP	3.6										

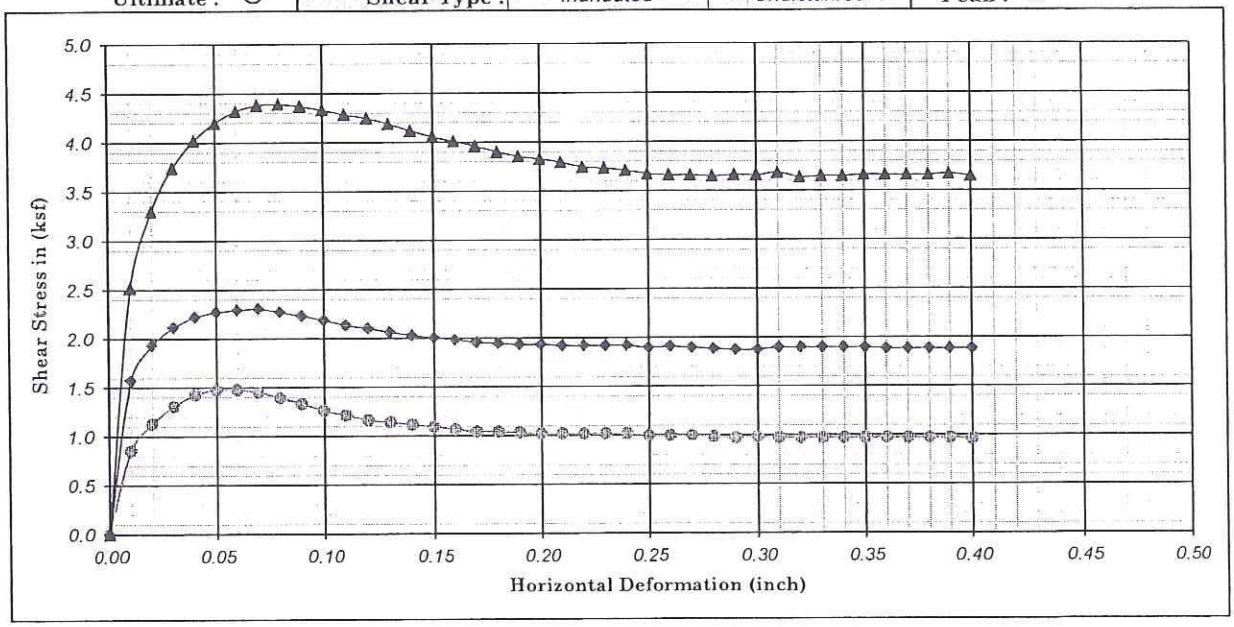
TABLE B1 SUMMARY OF LABORATORY TEST RESULTS FOR SIGN STRUCTURES (3 OF 3)

Project No. : 10-126 Project Name : SR-91 WB Widening - Overhead Sign Structures

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-049	*D-4*	20	SP	2.9	113.4									
A-10-049	*S-5*	25	SP	8.2										
A-10-049	*D-6*	30	ML	16.5	129.9	4.5		0:42:58						
A-10-063	*D-1*	2.5	SP-SM	2.6	114.9									
A-10-063	*S-2*	5	SP	1.7				2:96:2						
A-10-063	*D-3*	10	SP-SM	1.8	113.3									
A-10-063	*S-4*	15	SP-SM	2.6										
A-10-063	*D-5*	20	SP	3.4	108.1									
A-10-063	*S-6*	25	SP-SM	2.8										
A-10-063	*D-7*	30	SP-SM	4.8	112.4									
A-10-063	*S-8*	35	SP-SM	5.2				0:92:8			13000	7.8	10	158
A-10-063	*D-9*	40	SP-SM	2.6	109.4									
A-10-063	*S-10*	45	SP-SM	2.0										
A-10-063	*D-11*	50	SP-SM	2.7	117.4									
A-10-063	*S-12*	55	SP-SM	3.2										
A-10-063	*D-13*	60	SP-SM	1.8	115.7									
A-10-063	*S-14*	65	SP-SM	2.9										
A-10-063	*D-15*	70	SP-SM	3.1	103.7									
A-11-073	*S-1*	5	CL	14.4				1:40:59			1200	8.6	150	204
A-11-073	*D-2*	10	SP	6.0	106.6									
A-11-073	*S-3*	15	SP-SM	7.9										
A-11-073	*D-4*	20	SP	3.0	102.5			1:97:2			14000	7.47	20.0	10
A-11-073	*S-5*	25	SP-SM to SM	14.1										
A-11-073	*D-6*	30	SM	12.6	114.4									
A-11-073	*S-7*	35	SC-SM	19.6										



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-006	Strength Intercept (C) :	0.43	(ksf)	Peak	0.08	(ksf)	Ultimate
Sample No. : D-4		20.68	(kPa)		3.73	(kPa)	
Depth (ft/m) : 20.0 | 0.00	Friction Angle (ϕ) :	33.22	Degree		30.70	Degree	
Description : Olive-gray with olive-brown, SILTY SAND (SM)					Shear Rate (inch/minute) :		0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	15.76	102.81	16.18	0.64	1.50	71.82	1.48	70.67	0.96	45.96
◆	15.71	102.38	16.11	0.65	3.00	143.64	2.30	110.32	1.87	89.63
▲	16.43	106.14	16.71	0.59	6.00	287.28	4.39	210.29	3.64	174.09

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

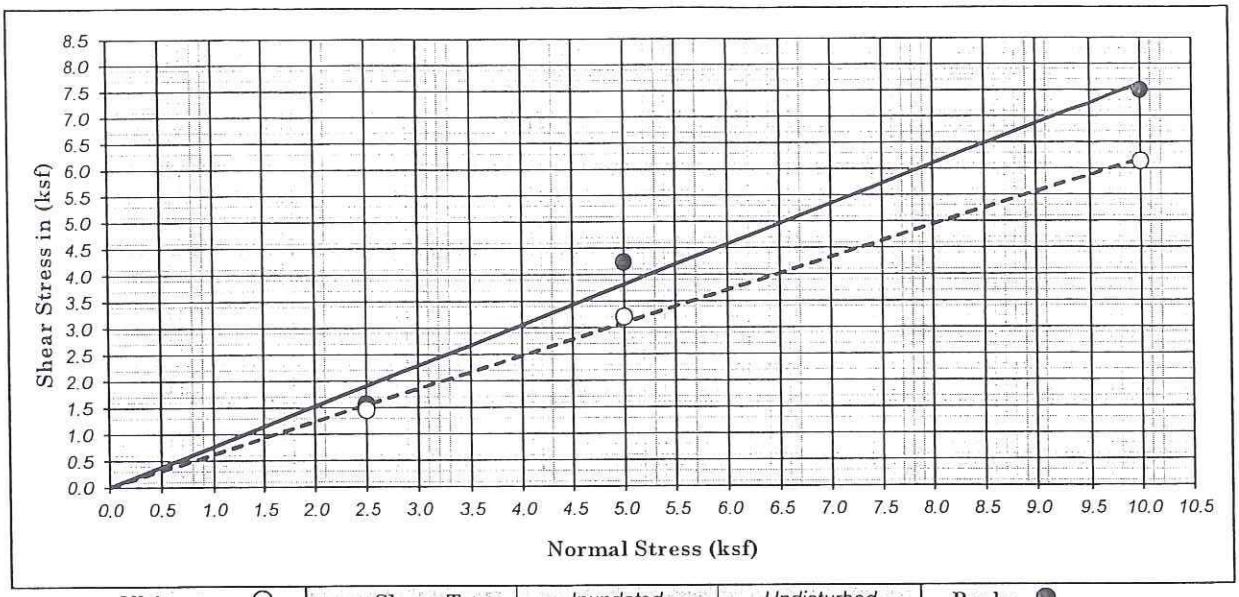
Brookhurst Street UC (Widen)

SR-91 WB Widening Project

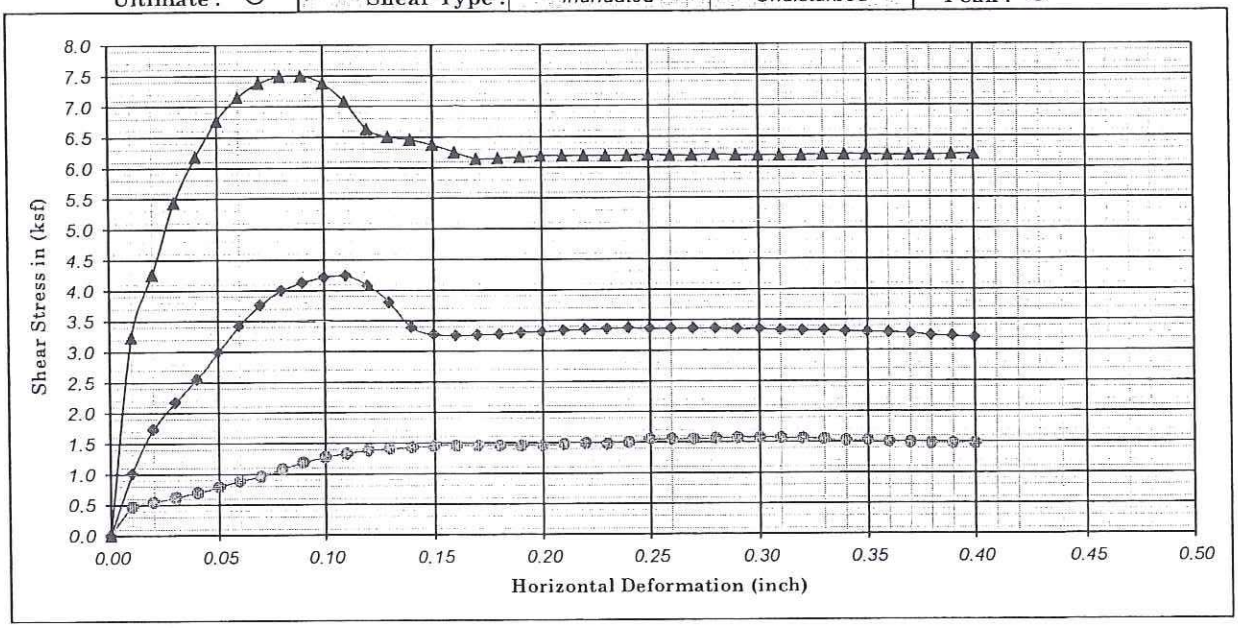
DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126 | Date : 02/08/11

Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-006		Strength Intercept (C) :	0.00	(ksf)	Peak	0.00	(ksf)	Ultimate
Sample No. : D-10			0.00	(kPa)		0.00	(kPa)	
Depth (ft/m) : 50.0	0.00	Friction Angle (ϕ) :	37.33	Degree		31.71	Degree	
Description : Olive-brown, SILTY SAND (SM)						Shear Rate (inch/minute) :		0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	26.42	92.24	14.52	0.83	2.50	119.70	1.57	75.27	1.45	69.52
◆	23.82	97.69	15.38	0.73	5.00	239.40	4.24	202.82	3.20	153.41
▲	24.64	103.58	16.30	0.63	10.00	478.80	7.50	359.05	6.14	294.13

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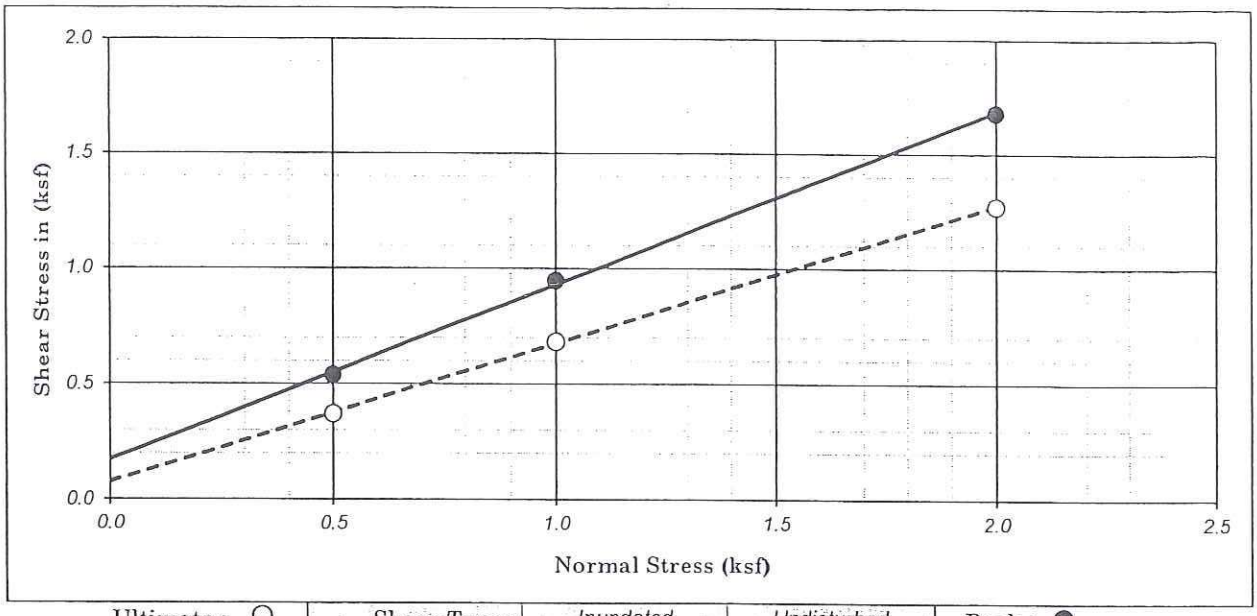
Brookhurst Street UC (Widen)

SR-91 WB Widening Project

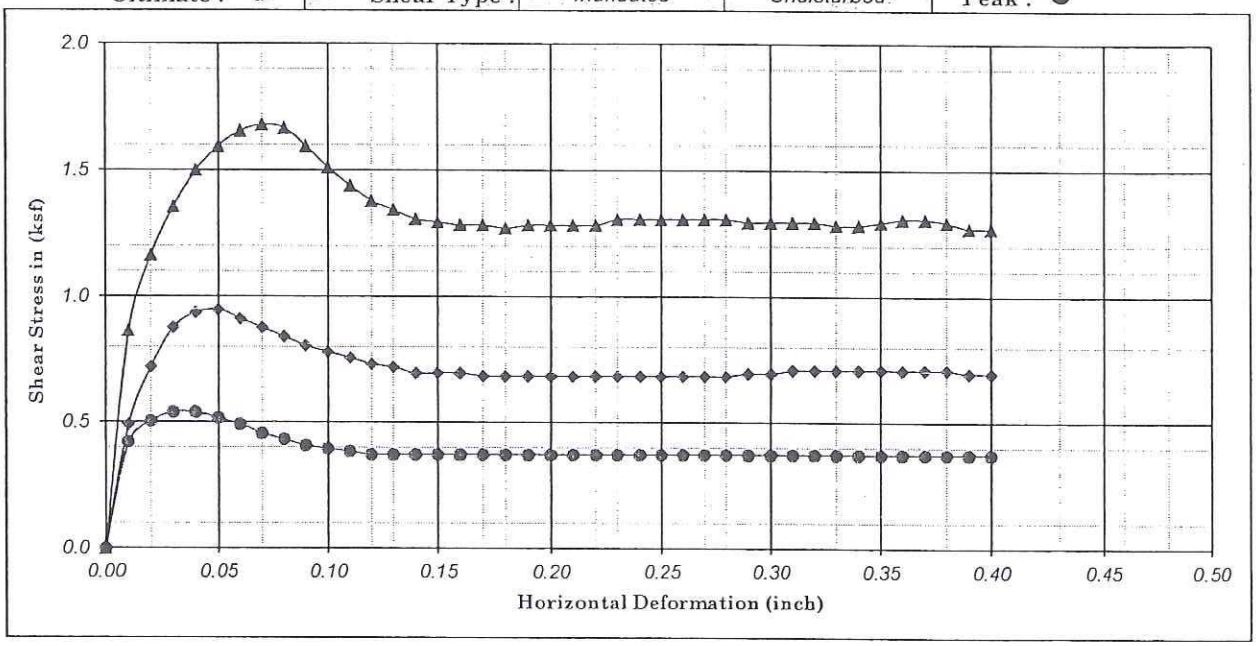
DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126 | Date : 02/08/11

Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-012		Strength Intercept (C) :	0.17	(ksf)		0.08	(ksf)		
Sample No. : D-2			8.33	(kPa)	Peak	3.73	(kPa)	Ultimate	
Depth (ft/m) : 10.0	0.00	Friction Angle (ϕ) :	37.09	Degree		30.89	Degree		
Description : Dark olive-brown, SILTY SAND (SM)						Shear Rate (inch/minute) :		0.02	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	20.70	92.84	14.61	0.82	0.50	23.94	0.54	25.86	0.37	17.81
◆	20.96	92.02	14.48	0.83	1.00	47.88	0.95	45.39	0.68	32.75
▲	20.35	90.20	14.20	0.87	2.00	95.76	1.68	80.44	1.27	60.90

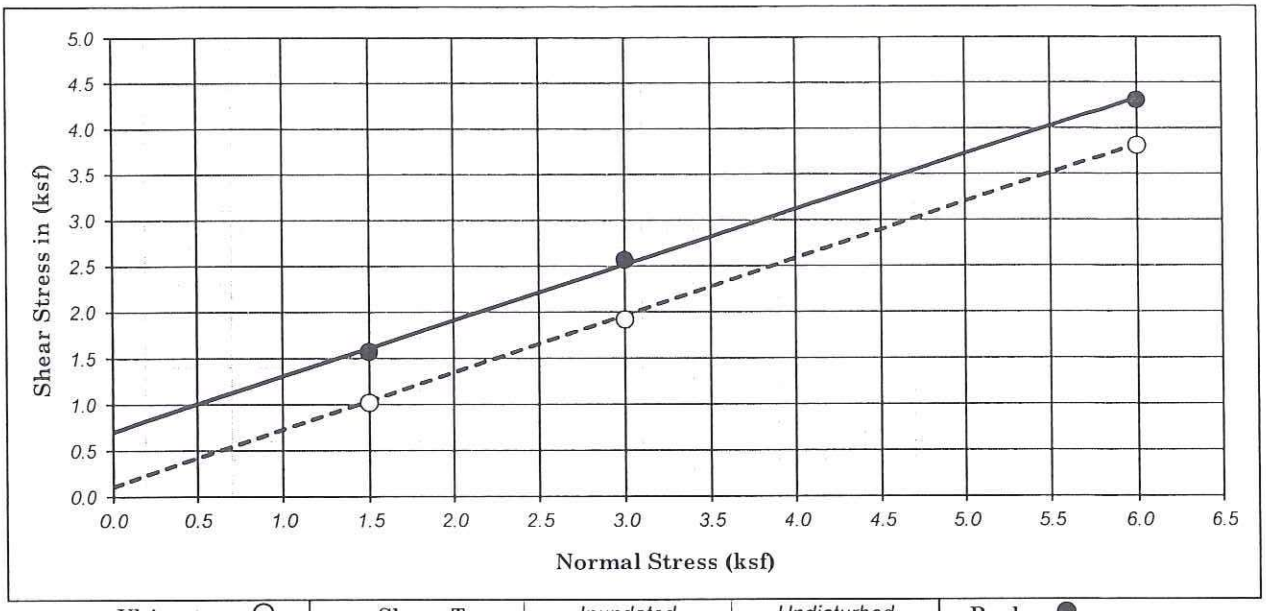
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

RBF/SR-91 WB Widening

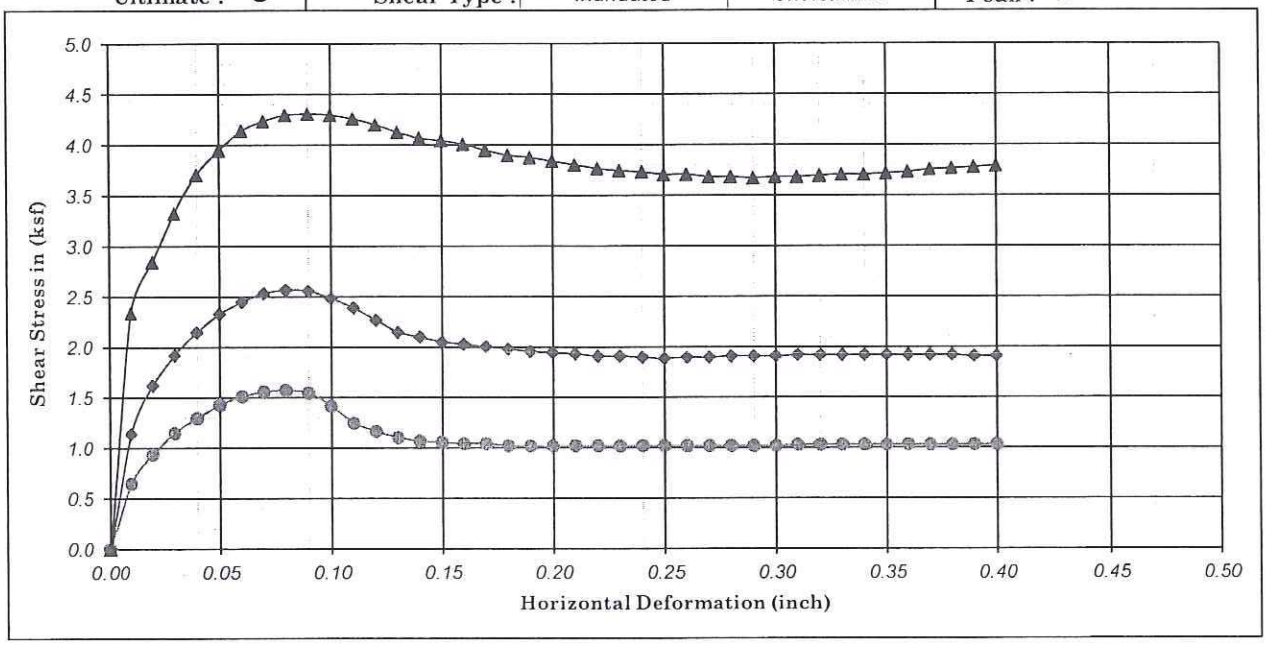
Project No. : 10-126 | Date : 02/09/11

DIRECT SHEAR TEST (ASTM D-3080)

Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-016		Strength Intercept (C) :	0.70	(ksf)	Peak	0.08	(ksf)	Ultimate	
Sample No. : D-4			33.61	(kPa)		3.59	(kPa)		
Depth (ft/m) : 20.0	0.00	Friction Angle (ϕ) :	31.13	Degree		31.73	Degree		
Description : Olive-brown, SILTY SAND (SM)						Shear Rate (inch/minute) :		0.02	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	18.37	110.34	17.37	0.53	1.50	71.82	1.57	75.27	1.02	48.84
◆	17.76	111.65	17.57	0.51	3.00	143.64	2.57	122.96	1.92	91.93
▲	17.81	113.74	17.90	0.48	6.00	287.28	4.31	206.27	3.81	182.42

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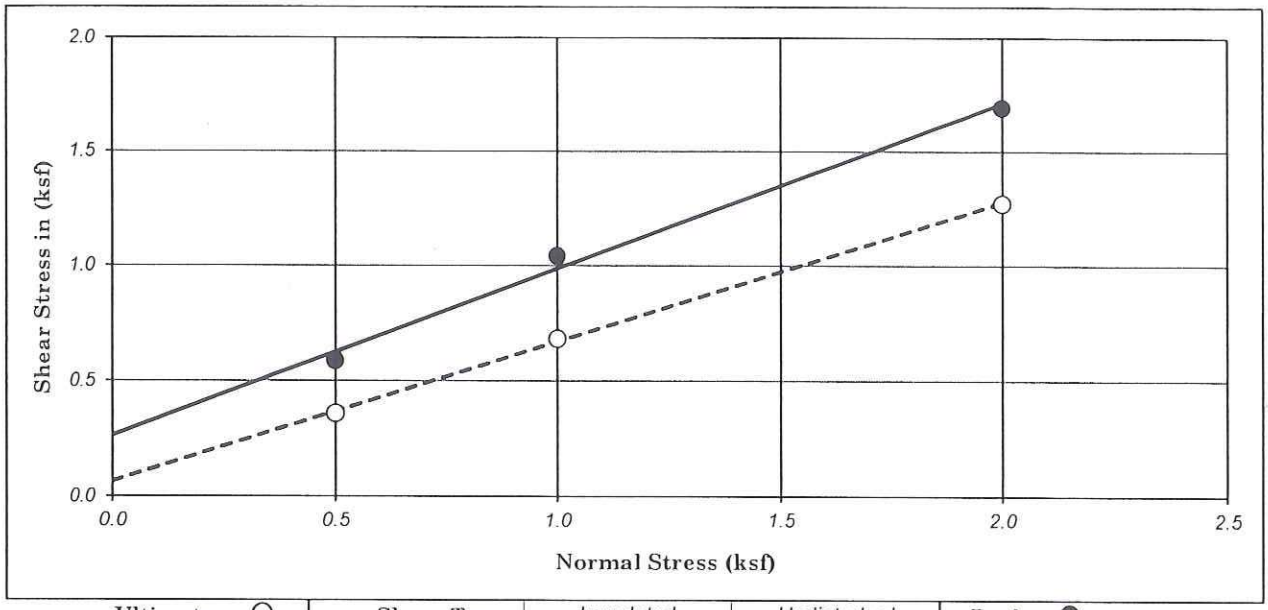
Geotechnical and Earthquake Engineering

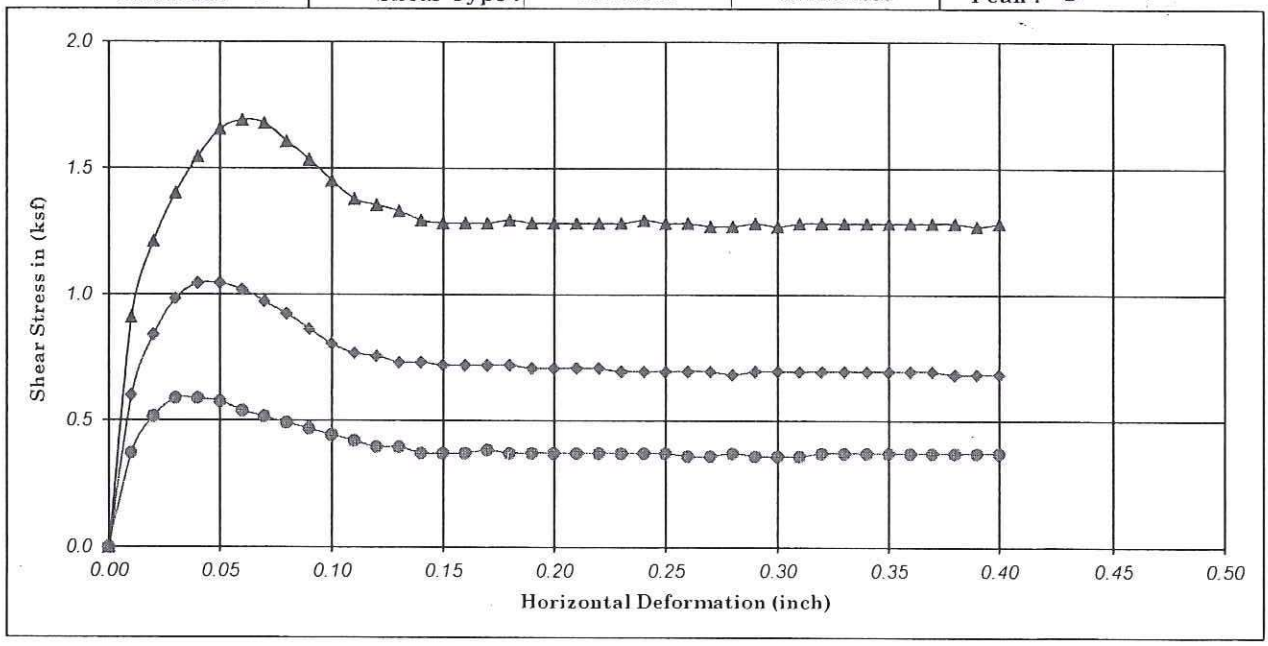
RBF/SR-91 WB Widening

DIRECT SHEAR TEST
(ASTM D-3080)

Project No. : 10-126 | Date : 02/09/11 | Figure No. :



Ultimate : ○ | Shear Type : Inundated | Undisturbed | Peak : ●



Boring No. : A-10-020		Strength Intercept (C) :	0.26	(ksf)	Peak	0.07	(ksf)	Ultimate
Sample No. : D-2			12.64	(kPa)		3.16	(kPa)	
Depth (ft/m) : 10.0	0.00	Friction Angle (ϕ) :	35.88	Degree		31.18	Degree	

Description : Olive-brown, SILTY SAND (SM) — Shear Rate (inch/minute) : 0.02

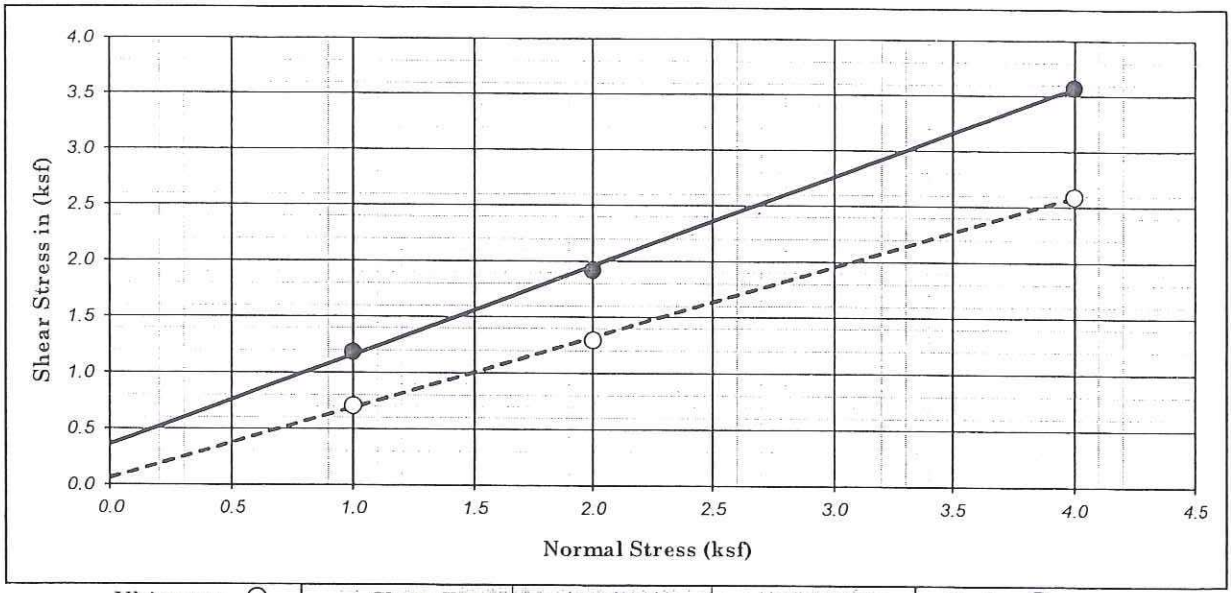
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	18.32	101.91	16.04	0.65	0.50	23.94	0.59	28.15	0.36	17.24
◆	18.31	100.61	15.84	0.68	1.00	47.88	1.04	49.99	0.68	32.75
▲	18.65	99.16	15.61	0.70	2.00	95.76	1.69	81.01	1.27	60.90

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

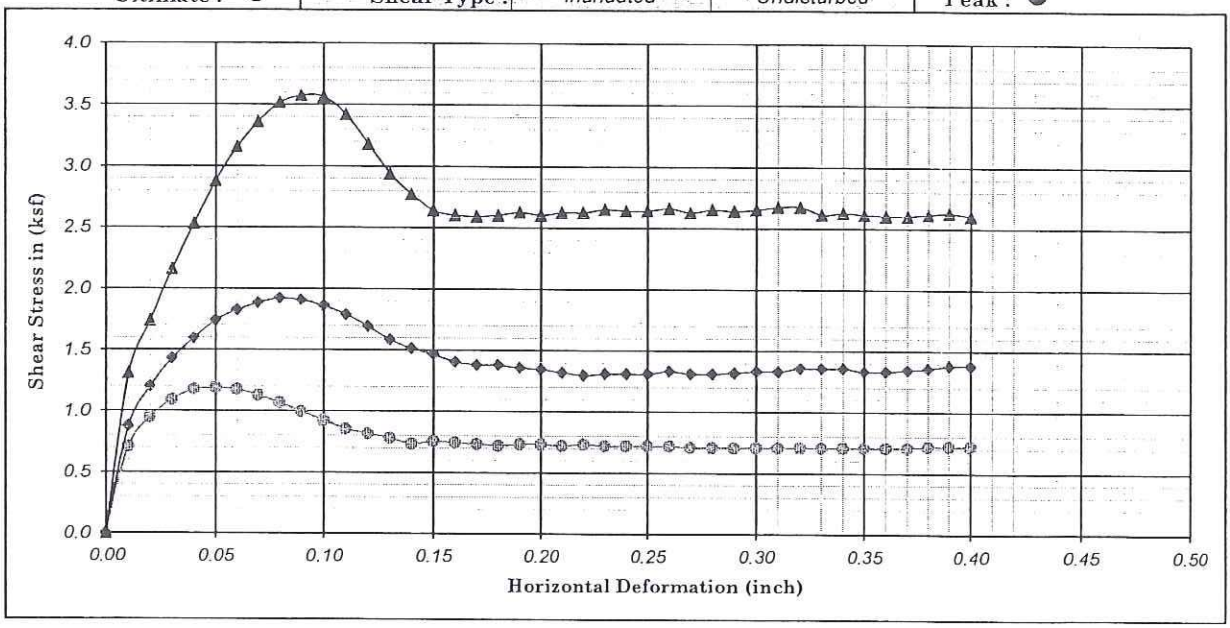
RBF/SR-91 WB Widening

DIRECT SHEAR TEST
(ASTM D-3080)

Project No. : 10-126 | Date : 02/10/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-044		Strength Intercept (C) :	0.36	(ksf)	Peak	0.06	(ksf)	Ultimate
Sample No. : D-4			17.24	(kPa)		2.87	(kPa)	
Depth (ft/m) : 20.0	0.00	Friction Angle (ϕ) :	38.68	Degree		32.25	Degree	

Description : *Olive-brown, Poorly graded SAND with SILT (SP-SM)* Shear Rate (inch/minute) : 0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	17.67	96.23	15.15	0.75	1.00	47.88	1.19	56.88	0.71	33.90
◆	17.31	97.48	15.34	0.73	2.00	95.76	1.92	91.93	1.30	62.05
▲	18.82	93.50	14.72	0.80	4.00	191.52	3.58	171.22	2.59	124.10

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

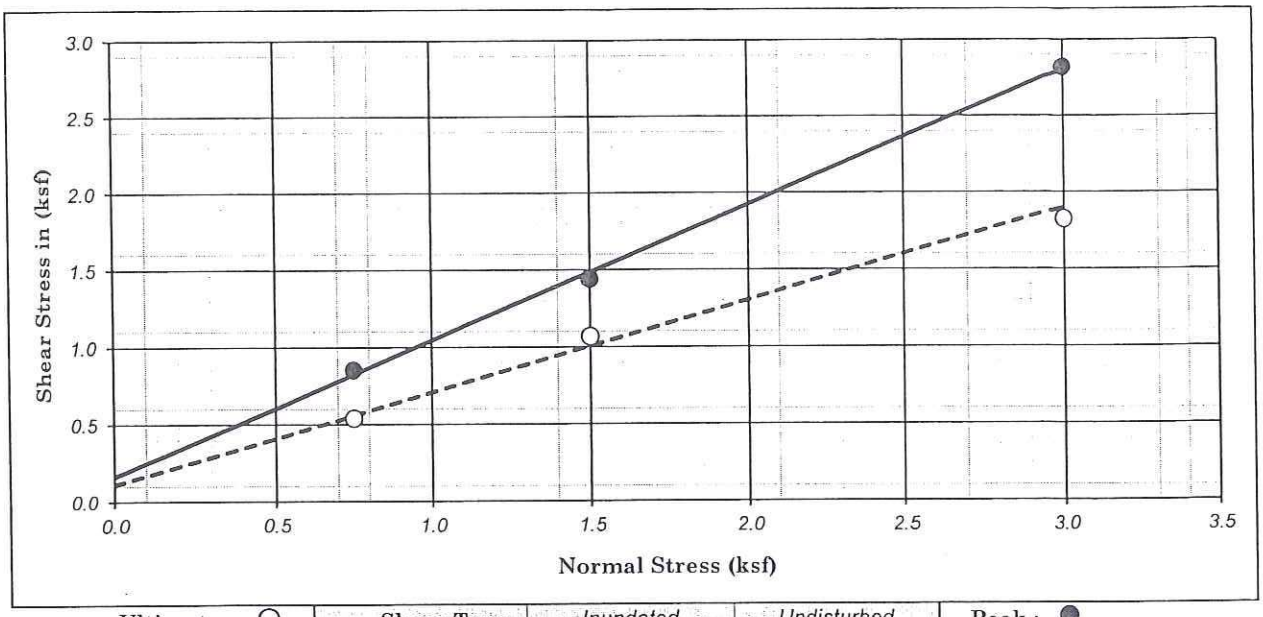
East Street UC (Widen)

SR-91 WB Widening Project

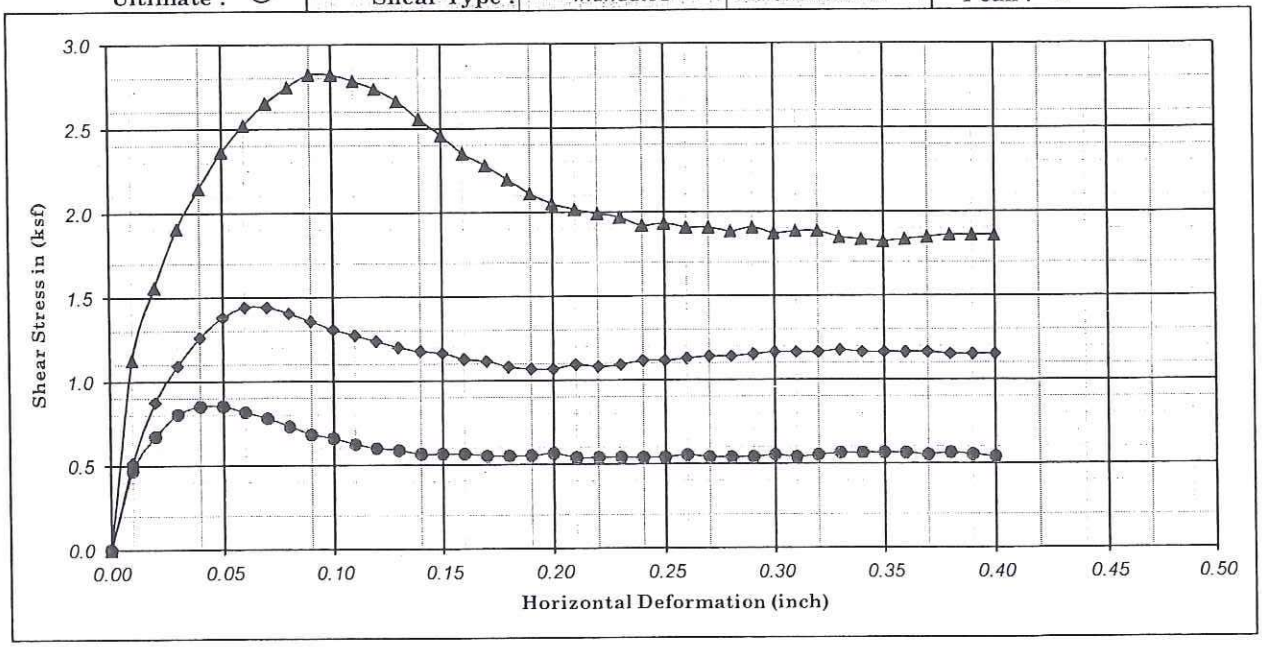
DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126 Date : 02/14/11

Figure No. :



Ultimate : ○ | Shear Type : Inundated | Undisturbed | Peak : ●



Boring No. : A-10-063		Strength Intercept (C) :	0.16	(ksf)	Peak	0.16	(ksf)	Ultimate
Sample No. : D-3			7.76	(kPa)		7.76	(kPa)	
Depth (ft/m) : 10.0	0.00	Friction Angle (ϕ) :	41.38	Degree		30.82	Degree	

Description : Light yellowish brown, Poorly graded SAND with SILT (SP-SM) — Shear Rate (inch/minute) : 0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	17.41	95.73	15.07	0.76	0.75	35.91	0.85	40.79	0.54	25.86
◆	19.31	94.89	14.93	0.78	1.50	71.82	1.44	68.95	1.07	51.14
▲	18.90	93.74	14.75	0.80	3.00	143.64	2.82	135.02	1.82	87.33
					0.00	0.00	0.16	7.76	0.11	
					3.0	143.64	2.81	134.32	1.90	

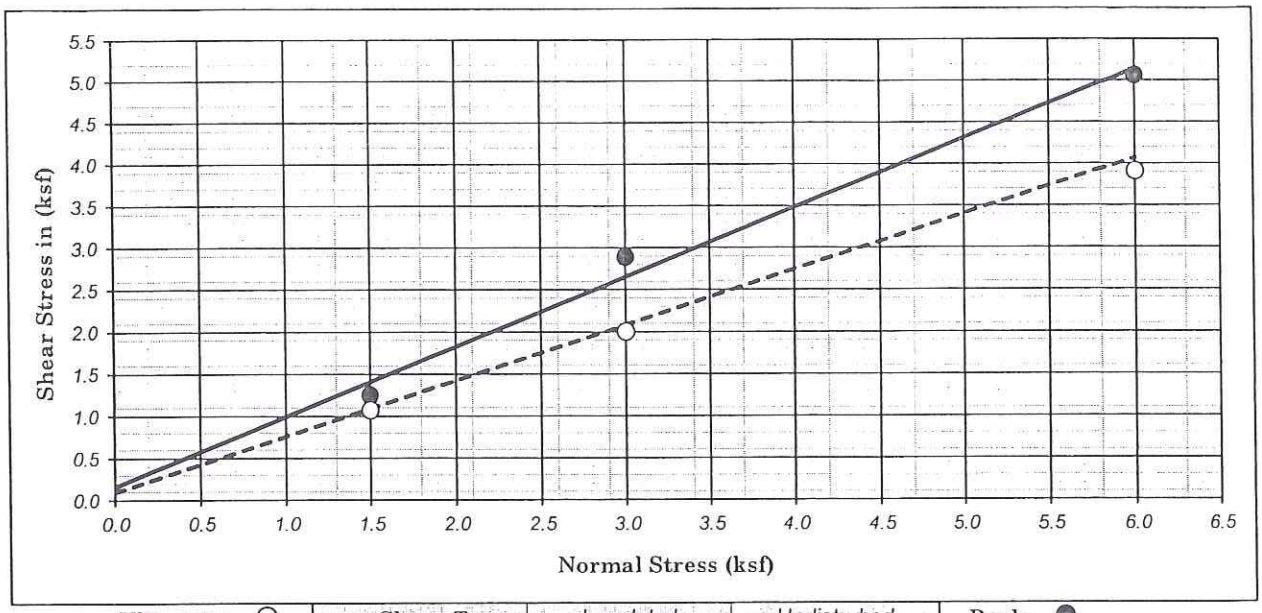
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

RBF/SR-91 WB Widening

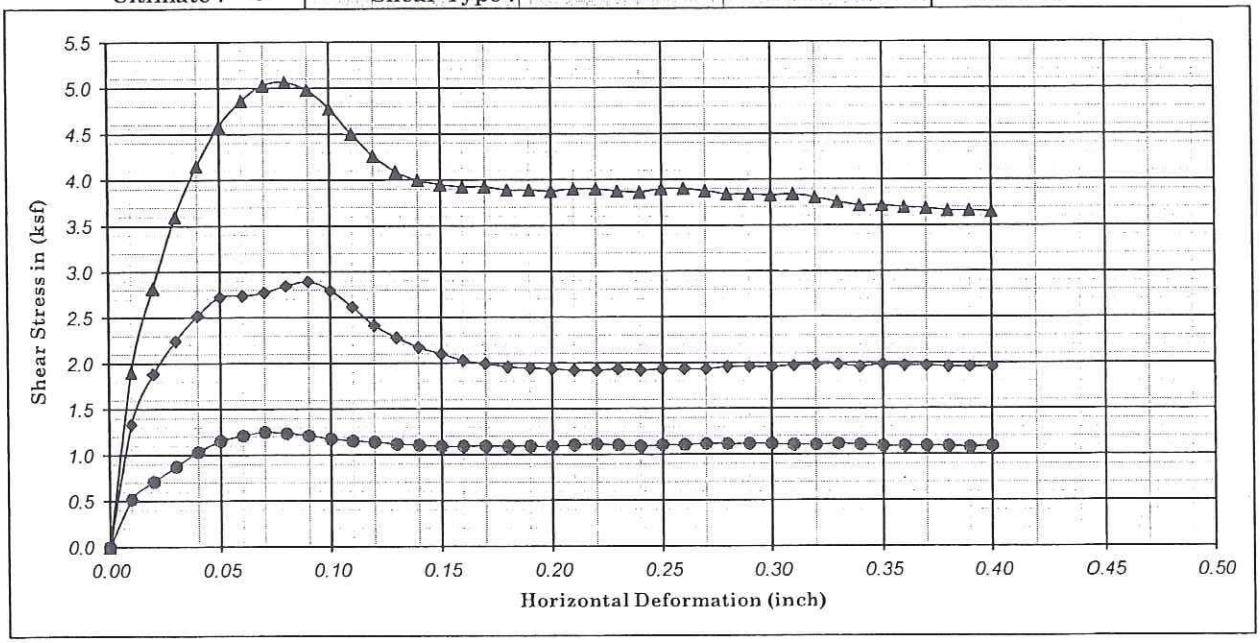
DIRECT SHEAR TEST

(ASTM D-3080)

Project No. : 10-126 | Date : 02/16/11 | Figure No. :



Ultimate : ○ | Shear Type : *Inundated* | *Undisturbed* | Peak : ●



Boring No. : *A-10-063*		Strength Intercept (C) :	*0.16*	(ksf)	Peak	*0.10*	(ksf)	Ultimate
Sample No. : *D-7*			*7.76*	(kPa)		*4.57*	(kPa)	
Depth (ft/m) : *30.0*	*0.00*	Friction Angle (ϕ) :	*39.70*	Degree		*33.51*	Degree	
Description : *Light yellowish brown, Poorly graded SAND with SILT (SP-SM)*						Shear Rate (inch/minute) :		*0.02*

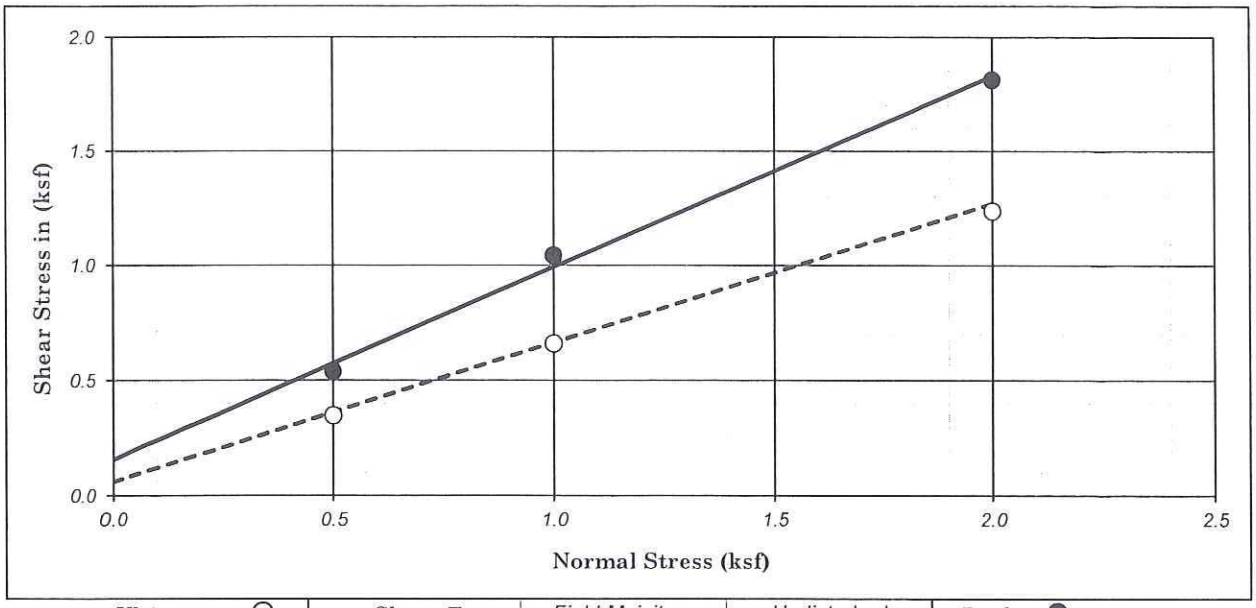
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	*22.18*	*91.04*	*14.33*	*0.85*	*1.50*	*71.82*	*1.25*	*59.75*	*1.07*	*51.23*
◆	*20.89*	*93.74*	*14.75*	*0.80*	*3.00*	*143.64*	*2.89*	*138.47*	*2.00*	*95.76*
▲	*20.21*	*93.57*	*14.73*	*0.80*	*6.00*	*287.28*	*5.06*	*242.46*	*3.91*	*187.21*

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

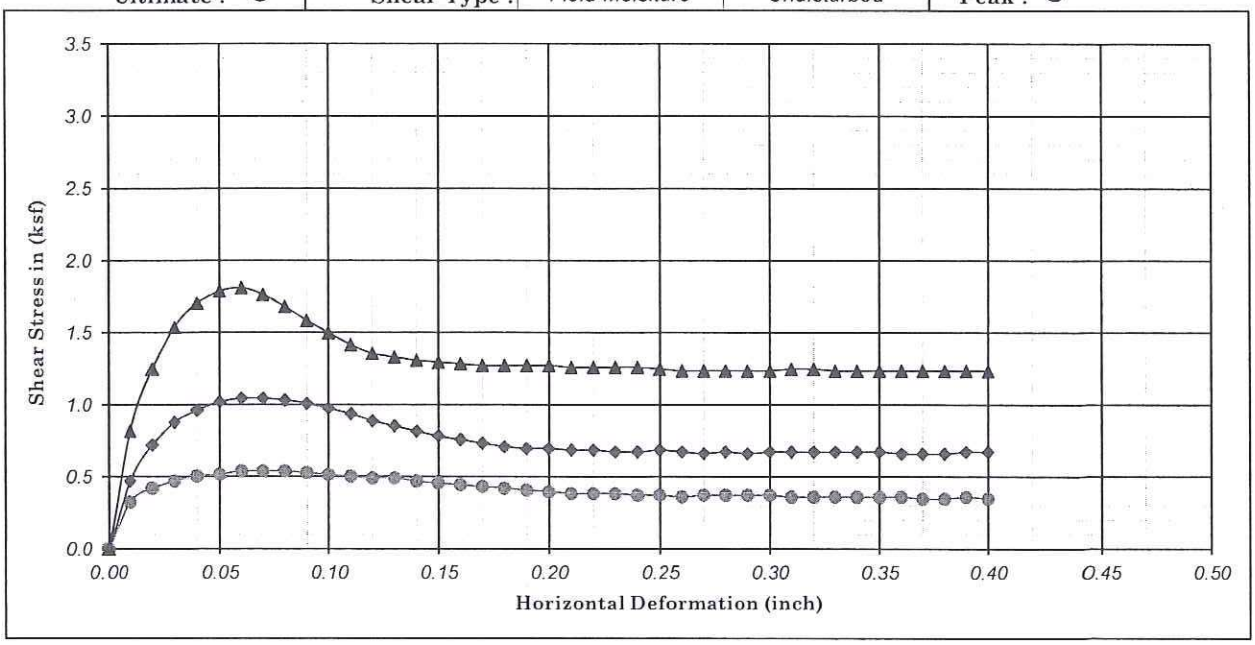
RBF/SR-91 WB Widening

DIRECT SHEAR TEST
(ASTM D-3080)

Project No. : *10-126* | Date : *02/15/11* | Figure No. :



Ultimate : ○	Shear Type :	Field Moisiture	Undisturbed	Peak : ●



Boring No. : A-11-073		Strength Intercept (C) :	0.16	(ksf)	Peak	0.06	(ksf)	Ultimate
Sample No. : D-2			7.47	(kPa)		2.87	(kPa)	
Depth (ft/m) : 10.0	0.00	Friction Angle (ϕ) :	39.91	Degree		31.17	Degree	
Description : Olive-brown, Poorly graded SAND (SP)					Shear Rate (inch/minute) :			0.02

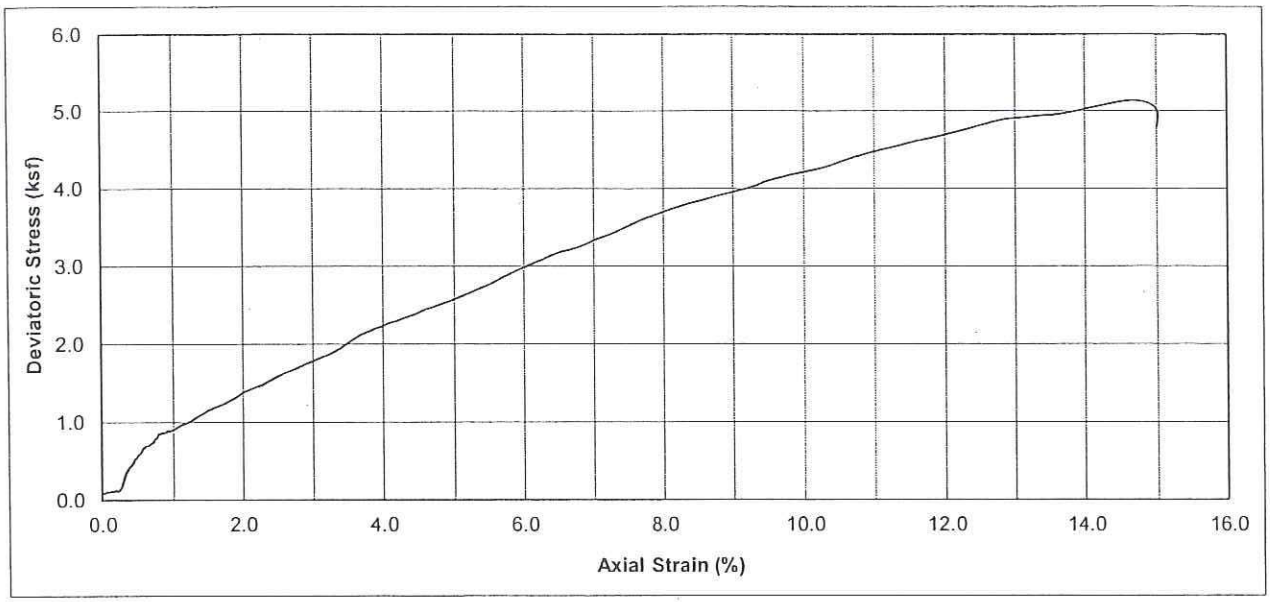
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	3.16	103.36	16.27	0.63	0.50	23.94	0.54	25.86	0.35	16.66
◆	5.80	102.54	16.14	0.64	1.00	47.88	1.04	49.99	0.66	31.60
▲	9.20	100.62	15.84	0.68	2.00	95.76	1.81	86.76	1.24	59.18

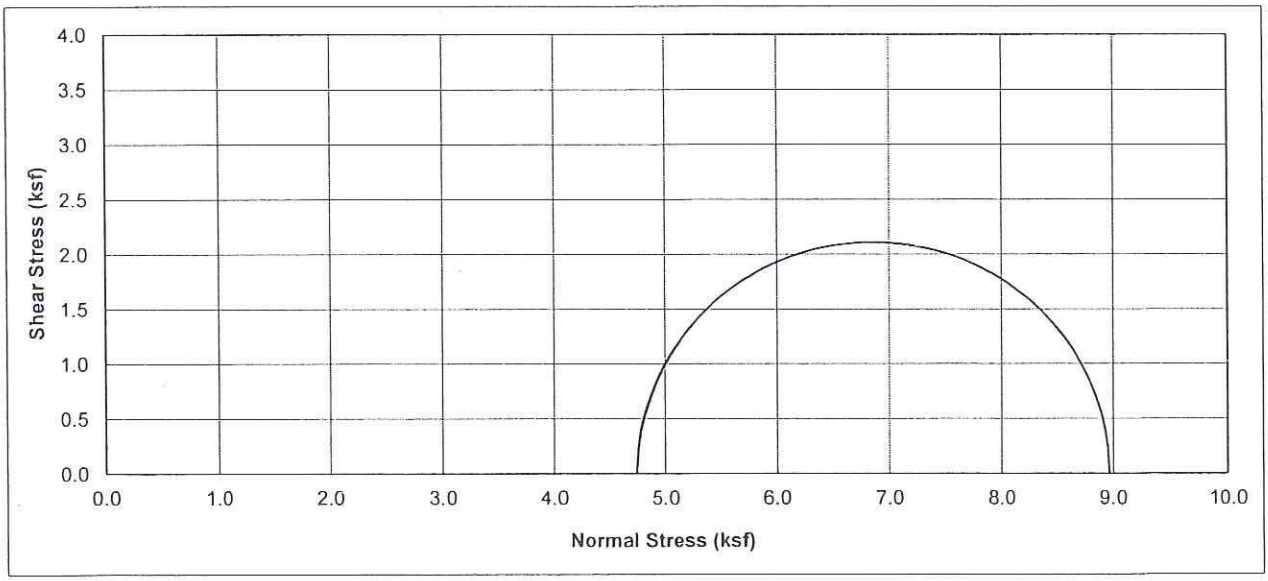
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

RBF/SR-91 WB Widening

DIRECT SHEAR TEST
(ASTM D-3080)

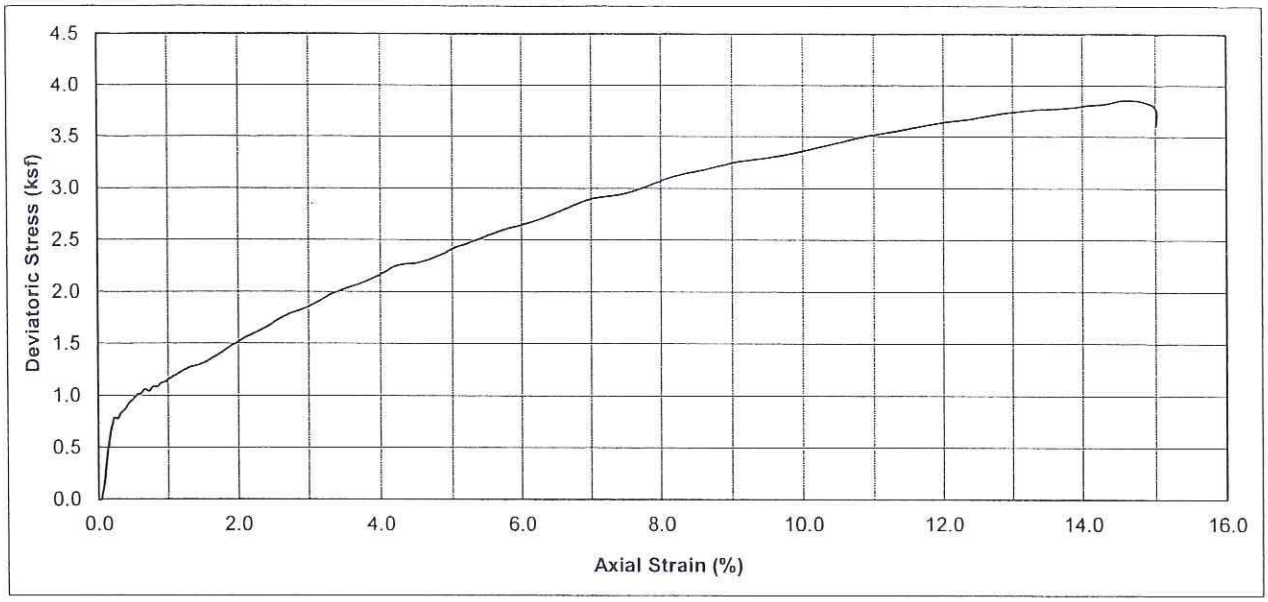
Project No. : 10-126 | Date : 12/19/11 | Figure No. :

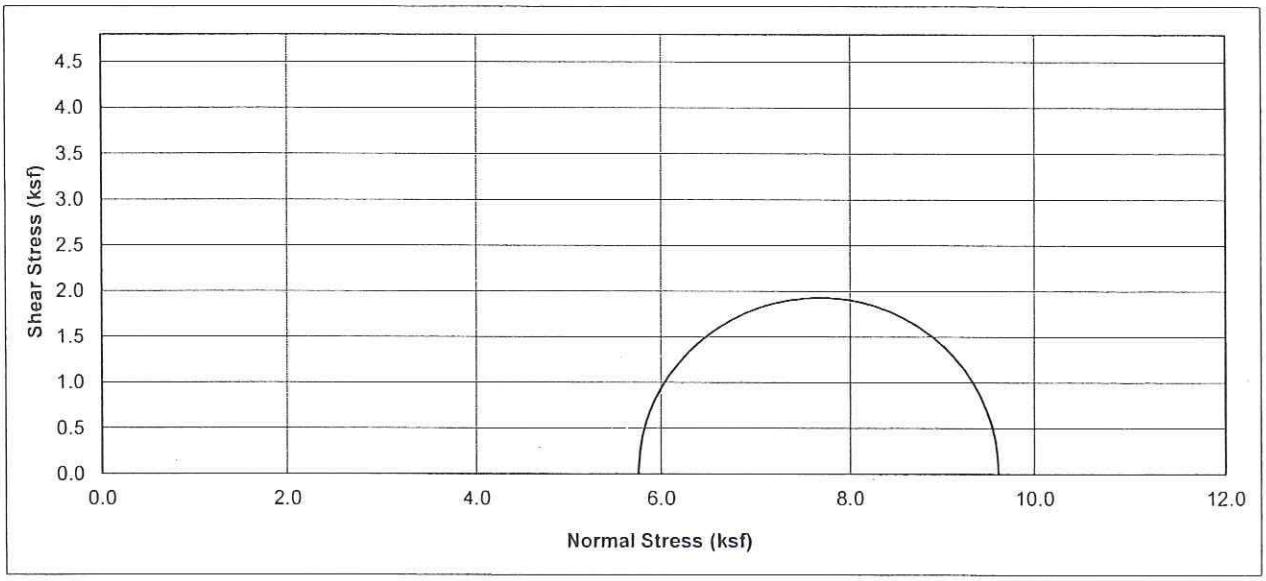




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-006	D-12	60	Olive-brown , SILT with SAND (ML)	92.5	34.07	4.75	4.22	112.0

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Brookhurst Street UC (Widen)
	UNCONSOLIDATED UNDRAINED TEST
Project No. : 10-126 Date : 02/07/11	(ASTM D2850) Figure No. :





Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-044	D-14	70	Olive-brown , SANDY Lean CLAY (CL)	105.9	19.56	5.75	3.36	89.4

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	East Street UC (Widen)
	UNCONSOLIDATED UNDRAINED TEST
Project No. : 10-126 Date : 02/08/11	(ASTM D2850) Figure No. :

APPENDIX C

DESIGN CALCULATIONS

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening - OH Sign Structures Project No.: 10-126
By: Ranjan Date: 6/15/11 Checked By: Lino Date: 6/16/11 Sheet: 1 of 1
Subject:

Proposed OH Signs – Liquefaction Potential Analyses

* Historical high ground water elevations used varied between +73.5 feet and +138 feet.
* Analysis was performed using the site-specific soil borings A-10-006, A-10-024, A-10-044, and A-10-063.
* Analysis was not performed using the site-specific borings A-10-012, A-10-016, A-10-020, A-10-021, A-10-049, and A-11-073 and CPTs CPT-10-026 and CPT-10-062, since the deepest depths of these explorations are located above the historical high groundwater elevations.

∴ Liquefaction potential at the site is low.

17660 Newhope Street, Suite E, Fountain Valley, CA 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

SR-91 WB Widening - OH Sign Structures
LIQUEFACTION ANALYSIS; ACC. = 0.52 g

GJG 10-126
15-Jun-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
$'C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max x total normal stress x rd / (effective normal stress x g)

where rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-006

Emean (%)	75	Sur.=	psf	130	=top of ground el.	Borehole Diamet	8										73.5	=water table El.		acc. max =	0.52	g	Earthq. M=	7.3
C_E	1.25					C_B	1.15																Cm=	1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
125	130	5	0.30	0.30	5.00	1.87	0.75	1.20	1.00	120	1	1	12	0.99	0.33	29	20.0	35	1.00	high N	high N	LARGE	AboveWT
120	125	5	0.60	0.60	10.00	1.32	0.75	1.00	0.60	120	2	2	65	0.98	0.33	56	20.0	65	1.00	high N	high N	LARGE	AboveWT
115	120	5	0.90	0.90	15.00	1.08	0.85	1.20	1.00	120	1	1	13	0.97	0.33	21	30.0	29	1.00	0.41	0.44	1.35	AboveWT
110	115	5	1.20	1.20	20.00	0.93	0.85	1.00	0.60	120	2	2	24	0.95	0.32	17	30.0	25	0.97	0.29	0.30	0.94	AboveWT
105	110	5	1.50	1.50	25.00	0.83	0.95	1.20	1.00	120	1	1	8	0.94	0.32	11	70.0	19	0.93	0.20	0.20	0.64	AboveWT
100	105	5	1.79	1.79	30.00	0.76	0.95	1.00	0.60	115	2	2	53	0.93	0.31	34	25.0	43	0.89	high N	high N	LARGE	AboveWT
95	100	5	2.09	2.09	35.00	0.71	1.00	1.20	1.00	120	1	1	11	0.89	0.30	14	35.0	22	0.87	0.24	0.23	0.75	AboveWT
90	95	5	2.38	2.38	40.00	0.66	1.00	1.00	0.60	115	2	2	30	0.85	0.29	18	65.0	27	0.85	0.34	0.31	1.07	AboveWT
85	90	5	2.66	2.66	45.00	0.63	1.00	1.20	1.00	115	1	1	18	0.81	0.27	20	7.0	21	0.83	0.23	0.20	0.74	AboveWT
80	85	5	2.96	2.96	50.00	0.59	1.00	1.00	0.60	120	2	2	52	0.77	0.26	27	20.0	33	0.80	high N	high N	LARGE	AboveWT
75	80	5	3.26	3.26	55.00	0.57	1.00	1.20	1.00	120	1	1	40	0.73	0.25	40	15.0	45	0.77	high N	high N	LARGE	AboveWT
73.5	75	1.5	3.35	3.35	56.50	0.56	1.00	1.00	0.60	120	2	2	19	0.71	0.24	10	90.0	17	0.76	0.18	0.15	0.61	fines
70	73.5	3.5	3.56	3.45	60.00	0.55	1.00	1.00	0.60	120	2	2	19	0.69	0.24	10	90.0	17	0.76	0.18	0.15	0.61	fines
65	70	5	3.85	3.58	65.00	0.54	1.00	1.20	1.00	115	1	1	7	0.64	0.23	7	90.0	14	0.75	0.15	0.12	0.51	fines
60	65	5	4.14	3.72	70.00	0.53	1.00	1.00	0.60	115	2	2	30	0.60	0.23	14	80.0	22	0.74	0.24	0.19	0.84	fines
55	60	5	4.43	3.85	75.00	0.52	1.00	1.20	1.00	115	1	1	13	0.56	0.22	12	51.0	20	0.73	0.22	0.17	0.77	fines
50	55	5	4.73	3.99	80.00	0.51	1.00	1.00	0.60	120	2	2	100	0.55	0.22	45	4.0	45	0.73	high N	high N	LARGE	high N
45	50	5	5.03	4.14	85.00	0.50	1.00	1.20	1.00	120	1	1	24	0.54	0.22	21	30.0	29	0.72	0.41	0.32	1.43	no

SR-91 WB Widening - OH Sign Structures
LIQUEFACTION ANALYSIS; ACC. = 0.52 g

GJG 10-126
15-Jun-11 17:12

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
$'C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-024

Emean (%)	75	Sur =	psf	152.6	=top of ground el.	Borehole Diamet	8								81	=water table El.			acc. max =	0.52	g	Earthq. M=	7.3
C_E	1.25					C_B	1.15															Cm=	1.07

ELEVATION BASE OF LAYER (ft)	TOP OF LAYER ELEVATION (ft)	LAYER THICKNESS L (ft)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
147.6	152.6	5	0.30	0.30	5.00	1.83	0.75	1.20	1.00	120	1	1	13	0.99	0.33	31	30.0	40	1.00	high N	high N	LARGE	AboveWT
142.6	147.6	5	0.60	0.60	10.00	1.29	0.75	1.00	0.60	120	2	2	100	0.98	0.33	84	6.0	84	1.00	high N	high N	LARGE	AboveWT
137.6	142.6	5	0.90	0.90	15.00	1.05	0.85	1.20	1.00	120	1	1	24	0.97	0.33	37	25.0	46	1.00	high N	high N	LARGE	AboveWT
132.6	137.6	5	1.20	1.20	20.00	0.91	0.85	1.00	0.60	120	2	2	24	0.95	0.32	16	25.0	22	0.97	0.24	0.25	0.78	AboveWT
127.6	132.6	5	1.50	1.50	25.00	0.82	0.95	1.20	1.00	120	1	1	9	0.94	0.32	12	35.0	19	0.93	0.21	0.21	0.66	AboveWT
122.6	127.6	5	1.80	1.80	30.00	0.75	0.95	1.00	0.60	120	2	2	41	0.93	0.31	25	25.0	32	0.89	high N	high N	LARGE	AboveWT
117.6	122.6	5	2.10	2.10	35.00	0.69	1.00	1.20	1.00	120	1	1	11	0.89	0.30	13	25.0	19	0.87	0.20	0.19	0.63	AboveWT
112.6	117.6	5	2.40	2.40	40.00	0.65	1.00	1.00	0.60	120	2	2	45	0.85	0.29	25	25.0	32	0.85	high N	high N	LARGE	AboveWT
107.6	112.6	5	2.70	2.70	45.00	0.61	1.00	1.20	1.00	120	1	1	17	0.81	0.27	18	25.0	24	0.82	0.27	0.24	0.87	AboveWT
102.6	107.6	5	3.00	3.00	50.00	0.58	1.00	1.00	0.60	120	2	2	28	0.77	0.26	14	65.0	22	0.78	0.24	0.20	0.76	AboveWT
97.6	102.6	5	3.30	3.30	55.00	0.55	1.00	1.20	1.00	120	1	1	16	0.73	0.25	15	80.0	23	0.76	0.26	0.21	0.85	AboveWT
92.6	97.6	5	3.60	3.60	60.00	0.53	1.00	1.00	0.60	120	2	2	100	0.69	0.23	45	70.0	60	0.75	high N	high N	LARGE	AboveWT
87.6	92.6	5	3.90	3.90	65.00	0.51	1.00	1.20	1.00	120	1	1	26	0.64	0.22	23	7.0	23	0.73	0.25	0.20	0.91	AboveWT
82.6	87.6	5	4.20	4.20	70.00	0.49	1.00	1.00	0.60	120	2	2	85	0.60	0.20	36	10.0	37	0.71	high N	high N	LARGE	AboveWT
77.6	82.6	5	4.50	4.34	75.00	0.48	1.00	1.20	1.00	120	1	1	14	0.56	0.20	12	70.0	19	0.71	0.20	0.15	0.78	fines
72.6	77.6	5	4.80	4.49	80.00	0.47	1.00	1.00	0.60	120	2	2	100	0.55	0.20	41	10.0	42	0.70	high N	high N	LARGE	high N
67.6	72.6	5	5.10	4.63	85.00	0.46	1.00	1.20	1.00	120	1	1	51	0.54	0.20	41	4.0	41	0.69	high N	high N	LARGE	high N

SR-91 WB Widening - OH Sign Structures
LIQUEFACTION ANALYSIS; ACC. = 0.52 g

GJG 10-126
15-Jun-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
$'C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-044

Emean (%) 75 Sur = psf 193 =top of ground el. Borehole Diamet 8 121 =water table El. acc. max = 0.52 g Earthq. M= 7.3
C_E 1.25 C_B 1.15 Cm= 1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
188	193	5	0.30	0.30	5.00	1.83	0.75	1.20	1.00	120	1	1	26	0.99	0.33	61	20.0	70	1.00	high N	high N	LARGE	AboveWT
183	188	5	0.60	0.60	10.00	1.29	0.75	1.00	0.60	120	2	2	51	0.98	0.33	43	7.0	43	1.00	high N	high N	LARGE	AboveWT
178	183	5	0.90	0.90	15.00	1.05	0.85	1.20	1.00	120	1	1	34	0.97	0.33	53	8.0	54	1.00	high N	high N	LARGE	AboveWT
173	178	5	1.20	1.20	20.00	0.91	0.85	1.00	0.60	120	2	2	35	0.95	0.32	23	5.0	23	0.97	0.26	0.27	0.84	AboveWT
168	173	5	1.50	1.50	25.00	0.82	0.95	1.20	1.00	120	1	1	12	0.94	0.32	16	5.0	16	0.93	0.17	0.17	0.54	AboveWT
163	168	5	1.80	1.80	30.00	0.75	0.95	1.00	0.60	120	2	2	23	0.93	0.31	14	3.0	14	0.89	0.15	0.14	0.46	AboveWT
158	163	5	2.10	2.10	35.00	0.69	1.00	1.20	1.00	120	1	1	24	0.89	0.30	29	3.0	29	0.87	0.36	0.34	1.12	AboveWT
153	158	5	2.40	2.40	40.00	0.65	1.00	1.00	0.60	120	2	2	75	0.85	0.29	42	3.0	42	0.85	high N	high N	LARGE	AboveWT
148	153	5	2.70	2.70	45.00	0.61	1.00	1.20	1.00	120	1	1	6	0.81	0.27	6	80.0	13	0.82	0.14	0.12	0.44	AboveWT
143	148	5	3.00	3.00	50.00	0.58	1.00	1.00	0.60	120	2	2	100	0.77	0.26	50	3.0	50	0.78	high N	high N	LARGE	AboveWT
138	143	5	3.30	3.30	55.00	0.55	1.00	1.20	1.00	120	1	1	23	0.73	0.25	22	5.0	22	0.76	0.24	0.19	0.79	AboveWT
133	138	5	3.60	3.60	60.00	0.53	1.00	1.00	0.60	120	2	2	68	0.69	0.23	31	4.0	31	0.75	high N	high N	LARGE	AboveWT
128	133	5	3.90	3.90	65.00	0.51	1.00	1.20	1.00	120	1	1	13	0.64	0.22	11	80.0	19	0.73	0.20	0.16	0.72	AboveWT
123	128	5	4.20	4.20	70.00	0.49	1.00	1.00	0.60	120	2	2	26	0.60	0.20	11	70.0	18	0.71	0.20	0.15	0.73	AboveWT
118	123	5	4.50	4.34	75.00	0.48	1.00	1.20	1.00	120	1	1	19	0.56	0.20	16	65.0	24	0.71	0.27	0.20	1.02	fines
113	118	5	4.80	4.49	80.00	0.47	1.00	1.00	0.60	120	2	2	31	0.55	0.20	13	65.0	20	0.70	0.22	0.16	0.82	fines

SR-91 WB Widening - OH Sign Structures

EMI Project No. 10-126

Version - 12/05

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
^1C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines (Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

F_L = CRR r / CSR i

A-10-063

Emean (%	75			Present Ground El.	190.2	Borehole Dia. (in	8	Tot. Unit Wt. (pcf)	52.2	=Design Water Table Dep	52.2	=Field Water Table Dep	Acc. max	0.520	g			Earthq. M=	7.3			
C_E	1.25			Future Ground El.	190.2	C_B	1.15	120	138	=Design Water El.	138	=Field Water El.						Cm=	1.07			

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
2.5	188	67	SP-SM	7.0	0.15	0.15	1.70	0.75	1.00	0.67	2	2	0.99	0.15	0.34	82	83	1.00	High N	0.00	LARGE	AboveWT
5	185	9	SP	2.0	0.30	0.30	1.70	0.80	1.20	1.00	1	1	0.99	0.30	0.33	21	21	1.00	0.23	0.25	0.74	AboveWT
10	180	39	SP-SM	7.0	0.60	0.60	1.32	0.85	1.00	0.67	2	2	0.98	0.60	0.33	42	42	1.00	High N	0.00	LARGE	AboveWT
15	175	16	SP-SM	7.0	0.90	0.90	1.08	0.85	1.20	1.00	1	1	0.97	0.90	0.33	25	26	1.00	0.30	0.33	1.00	AboveWT
20	170	52	SP	4.0	1.20	1.20	0.93	0.95	1.00	0.67	2	2	0.95	1.20	0.32	44	44	0.97	High N	0.00	LARGE	AboveWT
25	165	27	SP-SM	7.0	1.50	1.50	0.83	0.95	1.20	1.00	1	1	0.94	1.50	0.32	37	37	0.93	High N	0.00	LARGE	AboveWT
30	160	67	SP-SM	7.0	1.80	1.80	0.76	1.00	1.00	0.67	2	2	0.93	1.80	0.31	49	49	0.89	High N	0.00	LARGE	AboveWT
35	155	16	SP-SM	7.0	2.10	2.10	0.71	1.00	1.20	1.00	1	1	0.89	2.10	0.30	19	20	0.87	0.21	0.20	0.66	AboveWT
40	150	63	SP-SM	7.0	2.40	2.40	0.66	1.00	1.00	0.67	2	2	0.85	2.40	0.29	40	40	0.85	High N	0.00	LARGE	AboveWT
45	145	37	SP-SM	7.0	2.70	2.70	0.62	1.00	1.20	1.00	1	1	0.81	2.70	0.27	40	40	0.82	High N	0.00	LARGE	AboveWT
50	140	91	SP-SM	7.0	3.00	3.00	0.59	1.00	1.00	0.67	2	2	0.77	3.00	0.26	51	52	0.78	High N	0.00	LARGE	AboveWT
55	135	41	SP-SM	7.0	3.30	3.21	0.57	1.00	1.20	1.00	1	1	0.73	3.21	0.25	40	41	0.77	High N	0.00	LARGE	high N
60	130	76	SP-SM	7.0	3.60	3.36	0.56	1.00	1.00	0.67	2	2	0.69	3.36	0.25	41	41	0.76	High N	0.00	LARGE	high N
65	125	48	SP-SM	7.0	3.90	3.50	0.55	1.00	1.20	1.00	1	1	0.64	3.50	0.24	45	46	0.75	High N	0.00	LARGE	high N
70	120	80	SP-SM	7.0	4.20	3.64	0.54	1.00	1.00	0.67	2	2	0.60	3.64	0.24	41	41	0.74	High N	0.00	LARGE	high N
75	115	49	SP-SM	7.0	4.50	3.79	0.52	1.00	1.20	1.00	1	1	0.56	3.79	0.23	44	45	0.74	High N	0.00	LARGE	high N
80	110	80	SP-SM	7.0	4.80	3.93	0.52	1.00	1.00	0.67	2	2	0.55	3.93	0.23	39	40	0.73	High N	0.00	LARGE	high N

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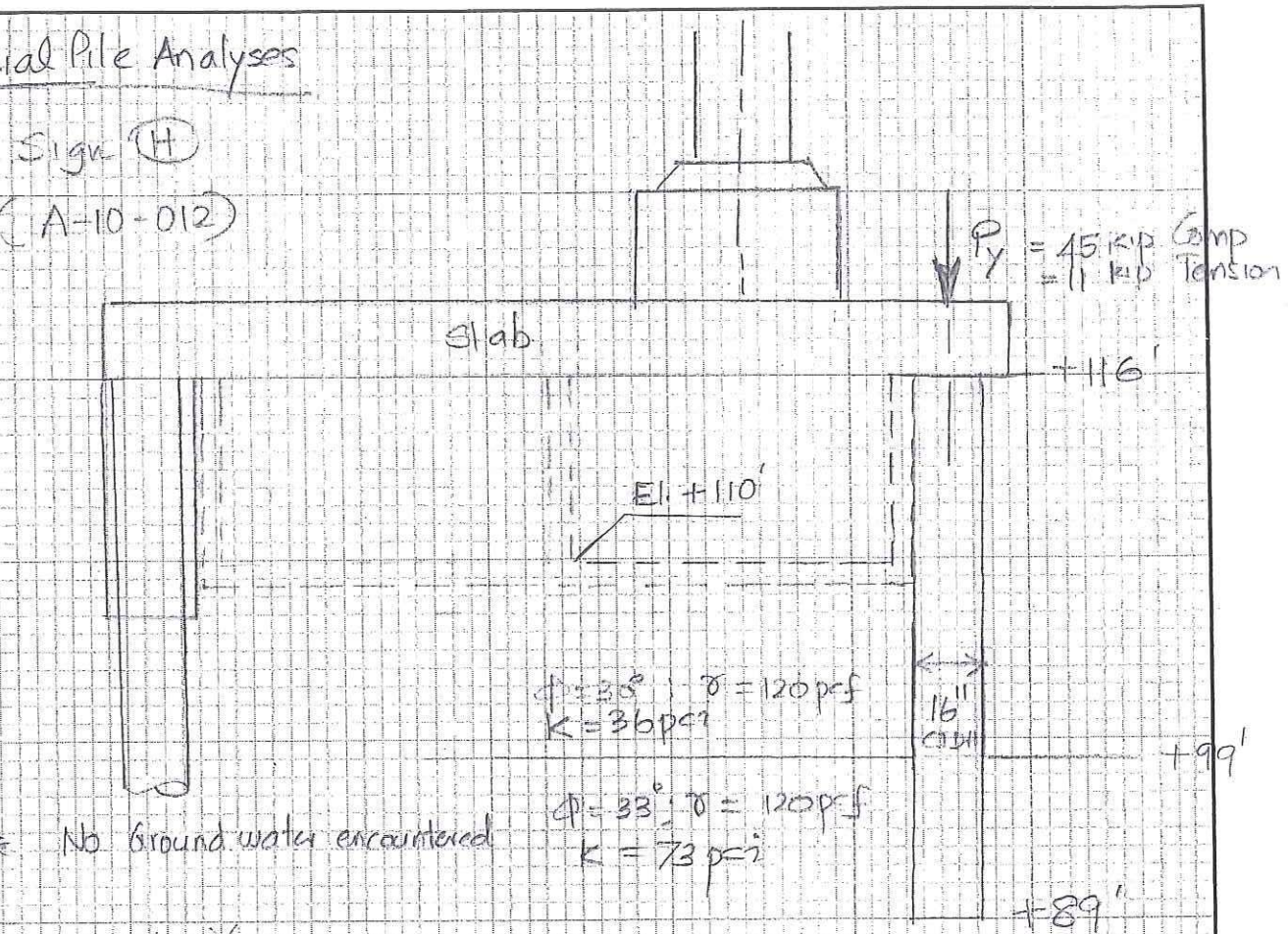
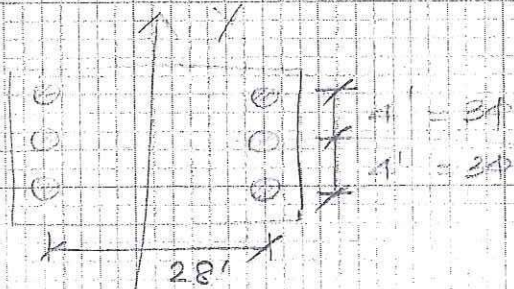
Project SR-91 WB Widening - Sign Structures Project No. 10-126

By Ranjan Date 6/8/11 Checked By Lino Date 6/10/11 Sheet 1 of 2

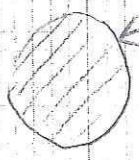
Axial Pile Analyses

Sign (H)
(A-10-012)





Pile Information



Area = 201.1 in^2

EI = 3,171,000 kip·in^2 (Per RBF)

Perimeter = 50.25 in

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Project SR-91 WB Widening - Sign Structures Project No. 10-126

By Ranjan Date 6/8/11 Checked By Lino Date 6/10/11 Sheet 2 of 2

Per RBF,

For Sign (H)

@ Service State,

P = 45 kips Compression

= 11 kips Tension

Compression:

Ultimate compression resistance = 45X2
= 90 kips

Per AASHTO, Group factor η = 0.75 for 3d spacing

Required skin Resistance = $\frac{90}{0.75}$
= 120 kips
= 60 tons

Per SHAFT, Required pile tip El. = +116' - 27'
= +89' //

Tension:

P = 11 kips Service load

P = 22 kips ultimate resistance

Apply η = 0.75 => Required resistance = $\frac{22}{0.75}$ = 30 kips

Required compression skin = $\frac{30}{0.5}$ = 60 kips
= 30 tons

Per SHAFT, Required pile tip El = +116 - 21'
= +95' //

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

SR-91 WB Widening Project - Sign H

TOTAL LOAD = 100.0 TONS

NUMBER OF LAYERS = 2

WATER TABLE DEPTH = 50.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00

SOIL INFORMATION

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.700E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.300E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.700E+01
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.440E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.300E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.700E+01
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.170E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.943E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.330E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.170E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.545E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.330E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.500E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	= 1.333	FT.
DIAMETER OF BASE	= 1.333	FT.
END OF STEM TO BASE	= 0.000	FT.
ANGLE OF BELL	= 0.000	DEG.
IGNORED TOP PORTION	= 7.500	FT.
IGNORED BOTTOM PORTION	= 0.000	FT.
AREA OF ONE PERCENT STEEL	= 2.010	SQ.IN.
ELASTIC MODULUS, Ec	= 0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	= 0.000	CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
9.0	0.47	1.10	0.00	1.10	1.10	1.10	2.37
10.0	0.52	2.31	0.00	2.31	2.31	2.31	4.47
11.0	0.57	3.62	0.00	3.62	3.62	3.62	6.36
12.0	0.62	5.02	0.00	5.02	5.02	5.02	8.10
13.0	0.67	6.52	0.00	6.52	6.52	6.52	9.71
14.0	0.72	8.11	0.00	8.11	8.11	8.11	11.21
15.0	0.78	9.79	0.00	9.79	9.79	9.79	12.62
16.0	0.83	11.55	11.17	22.72	22.72	22.72	27.47
17.0	0.88	13.39	11.17	24.56	24.56	24.56	27.95
18.0	0.93	19.62	11.17	30.79	30.79	30.79	33.09
19.0	0.98	24.09	11.17	35.26	35.26	35.26	35.89
20.0	1.03	28.71	11.17	39.87	39.87	39.87	38.57
21.0	1.09	33.47	11.17	44.63	44.63	44.63	41.12
22.0	1.14	38.37	11.17	49.54	49.54	49.54	43.56
23.0	1.19	43.40	11.17	54.57	54.57	54.57	45.90
24.0	1.24	48.57	11.17	59.73	59.73	59.73	48.15
25.0	1.29	53.85	11.17	65.02	65.02	65.02	50.31
26.0	1.34	59.26	11.17	70.43	70.43	70.43	52.40
27.0	1.40	64.78	11.17	75.94	75.94	75.94	54.41
28.0	1.45	70.40	11.17	81.57	81.57	81.57	56.30
29.0	1.50	76.13	11.17	87.30	87.30	87.30	58.23
30.0	1.55	81.96	11.17	93.13	93.13	93.13	60.05
31.0	1.60	87.89	11.17	99.05	99.05	99.05	61.81
32.0	1.65	93.90	11.17	105.07	105.07	105.07	63.52

Tension Required length = 21'

Compression Required length = 27'

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.2461E-01	0.2711E-04	0.2443E-03	0.1000E-04
0.1231E+00	0.1355E-03	0.1222E-02	0.5000E-04
0.2461E+00	0.2711E-03	0.2443E-02	0.1000E-03
0.1250E+02	0.1366E-01	0.1222E+00	0.5000E-02
0.1878E+02	0.2052E-01	0.1833E+00	0.7500E-02
0.2483E+02	0.2732E-01	0.2443E+00	0.1000E-01
0.5184E+02	0.6225E-01	0.6109E+00	0.2500E-01
0.7286E+02	0.1038E+00	0.1222E+01	0.5000E-01
0.8316E+02	0.1369E+00	0.1833E+01	0.7500E-01
0.8902E+02	0.1668E+00	0.2429E+01	0.1000E+00
0.9512E+02	0.3226E+00	0.5525E+01	0.2500E+00
0.9777E+02	0.5755E+00	0.8363E+01	0.5000E+00
0.9899E+02	0.7018E+00	0.9672E+01	0.6250E+00
0.1004E+03	0.8596E+00	0.1116E+02	0.7813E+00
0.1005E+03	0.8783E+00	0.1133E+02	0.7998E+00

RESULT FROM UPPER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.3553E-01	0.3414E-04	0.3491E-03	0.1000E-04
0.1777E+00	0.1707E-03	0.1745E-02	0.5000E-04
0.3553E+00	0.3414E-03	0.3491E-02	0.1000E-03
0.1821E+02	0.1731E-01	0.1745E+00	0.5000E-02
0.2712E+02	0.2595E-01	0.2618E+00	0.7500E-02
0.3559E+02	0.3443E-01	0.3491E+00	0.1000E-01
0.6932E+02	0.7494E-01	0.8727E+00	0.2500E-01
0.8865E+02	0.1160E+00	0.1745E+01	0.5000E-01
0.9441E+02	0.1459E+00	0.2618E+01	0.7500E-01
0.9675E+02	0.1732E+00	0.3435E+01	0.1000E+00
0.1009E+03	0.3275E+00	0.7545E+01	0.2500E+00
0.1029E+03	0.5797E+00	0.9549E+01	0.5000E+00
0.1039E+03	0.7058E+00	0.1060E+02	0.6250E+00
0.1052E+03	0.8634E+00	0.1191E+02	0.7813E+00
0.1054E+03	0.8821E+00	0.1206E+02	0.7998E+00

RESULT FROM LOWER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.1500E-01	0.2067E-04	0.1396E-03	0.1000E-04
0.7500E-01	0.1034E-03	0.6981E-03	0.5000E-04
0.1500E+00	0.2067E-03	0.1396E-02	0.1000E-03
0.7555E+01	0.1036E-01	0.6981E-01	0.5000E-02
0.1137E+02	0.1557E-01	0.1047E+00	0.7500E-02
0.1516E+02	0.2077E-01	0.1396E+00	0.1000E-01
0.3432E+02	0.4970E-01	0.3491E+00	0.2500E-01
0.5624E+02	0.9111E-01	0.6981E+00	0.5000E-01
0.7139E+02	0.1276E+00	0.1047E+01	0.7500E-01
0.8107E+02	0.1604E+00	0.1424E+01	0.1000E+00
0.8937E+02	0.3177E+00	0.3505E+01	0.2500E+00

0.9267E+02	0.5713E+00	0.7177E+01	0.5000E+00
0.9407E+02	0.6979E+00	0.8747E+01	0.6250E+00
0.9552E+02	0.8557E+00	0.1041E+02	0.7813E+00
0.9569E+02	0.8745E+00	0.1061E+02	0.7998E+00

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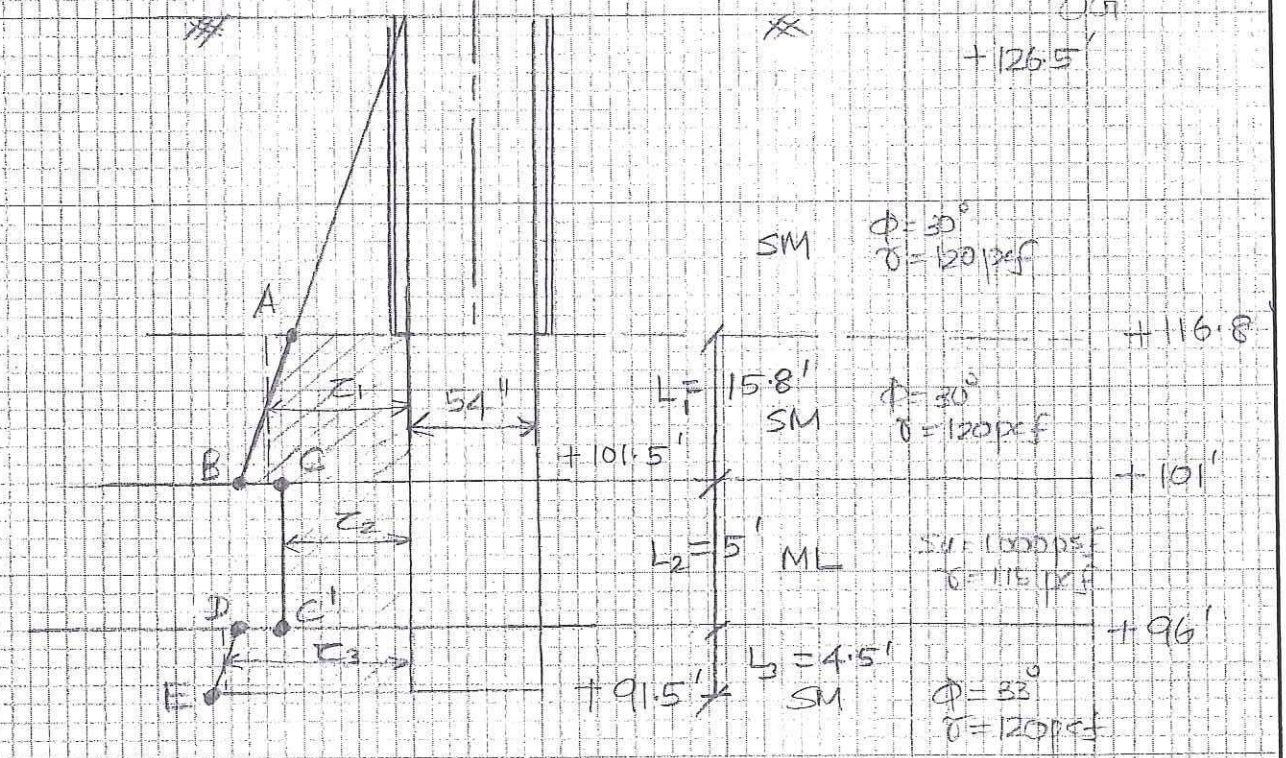
Project SR-91 WB Widening - Sign Structures Project No. 10-126

By Ranjan Date 6/8/11 Checked By Lino Date 6/13/11 Sheet 1 of 2

Sign (I) - Torsion Capacity

M_y = 269 k-ft under service condition



Per NAVFAC,

$K_{hc} = 0.7$ for drilled pile

$\delta = \frac{3}{4}\Phi$

Adhesion $\frac{C_A}{C} = 0.75$ for $C = 1000$ psf

@ point A, Vertical stress $\sigma_{v_A} = 9.7 \times 120 = 1.16$ ksf

horizontal stress $\sigma_{h_A} = K \sigma_{v_A}$

$= 0.7 \times 1.16 = 815$ psf

$\therefore \tau_A = \sigma_{h_A} \tan\delta = 337.5$ psf

Similarly $\tau_B = 870$ psf

$\tau_D = 1172$ psf & $\tau_E = 1347$ psf

For ML layer, $\tau_2 = 750$ psf

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Resisting Torsional Moment $M_T = (\pi d) L \, \tau_{avg} \times r$

$\tau_{avg} = [(15.8 \times 603) + (750 \times 5) + (1259 \times 4.5)] / 25.3$

$= 748.7$ psf

$M_T = (\pi \times 4.5) 25.3 \times 748.7 \times \left(\frac{4.5}{2}\right)$

$= 602.5$ kip-ft

$M_u = M_y \times FOS = 269 \times 2 = 538$ kip-ft

$\Rightarrow M_T > M_u$ CHECK SATISFIED //

∴ 4.5' diameter & 35' long CIDH pile has adequate torsional capacity. //

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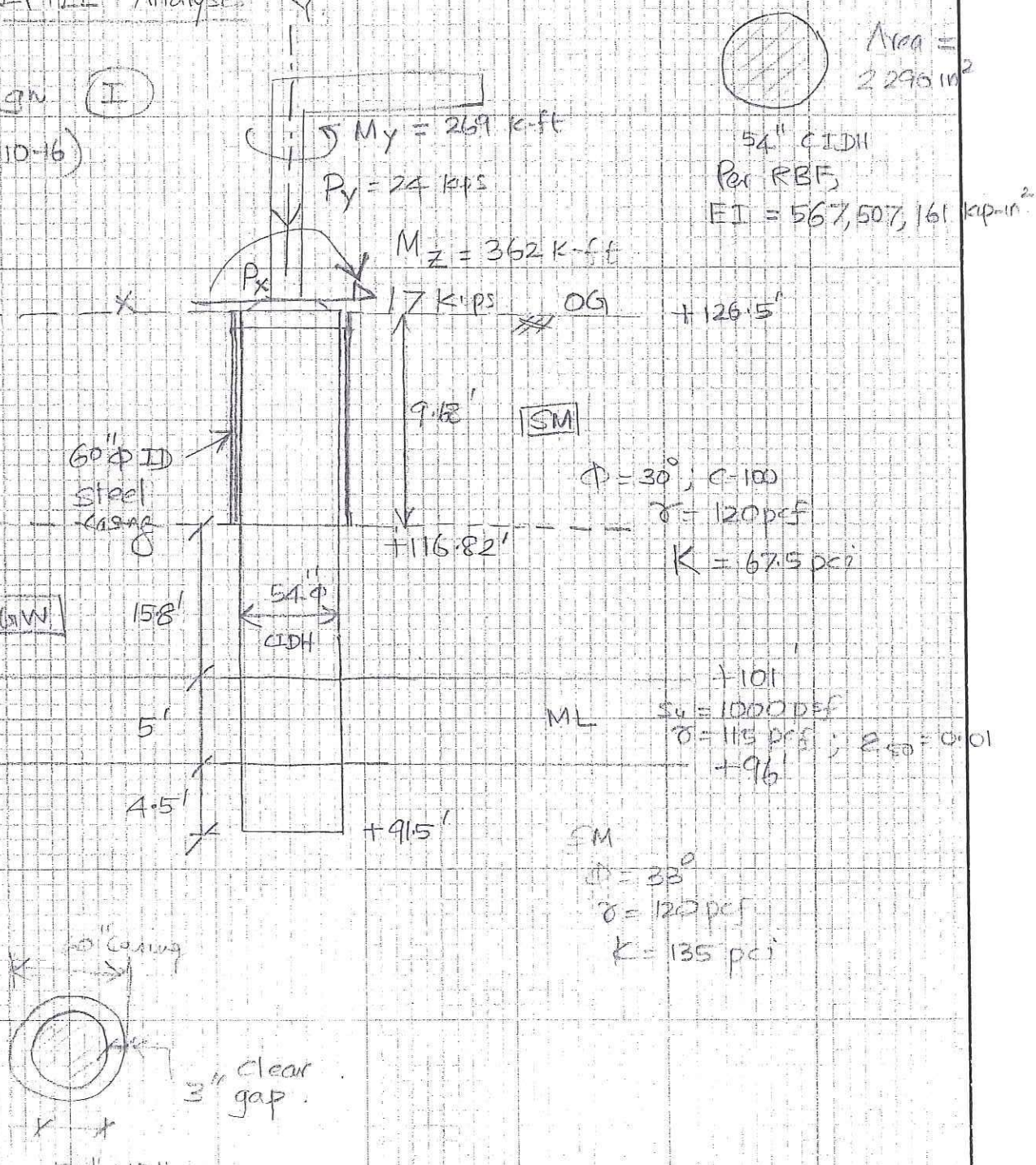
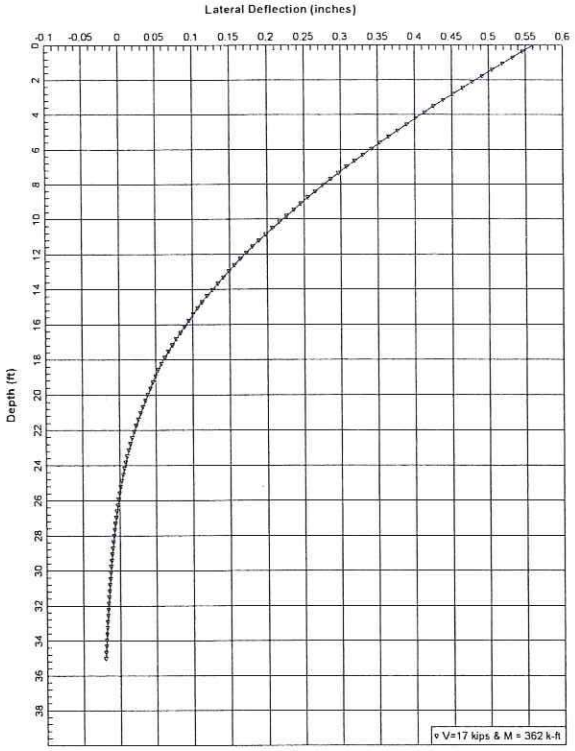
Project SR-91 WB Widening - Sign Structures Project No. 10-126

By Ranjan Date 6/8/11 Checked By Lino Date 6/10/11 Sheet 1 of 1

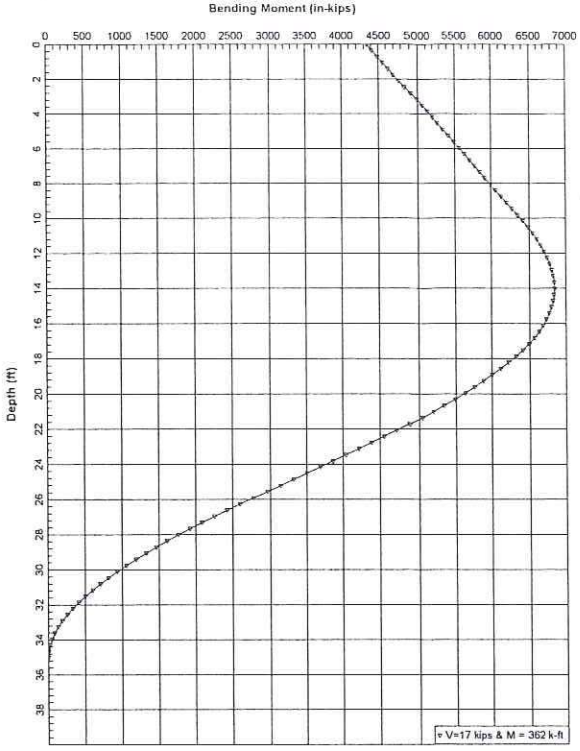
LPILE Analyses

SIGN (I)
(A-10-16)

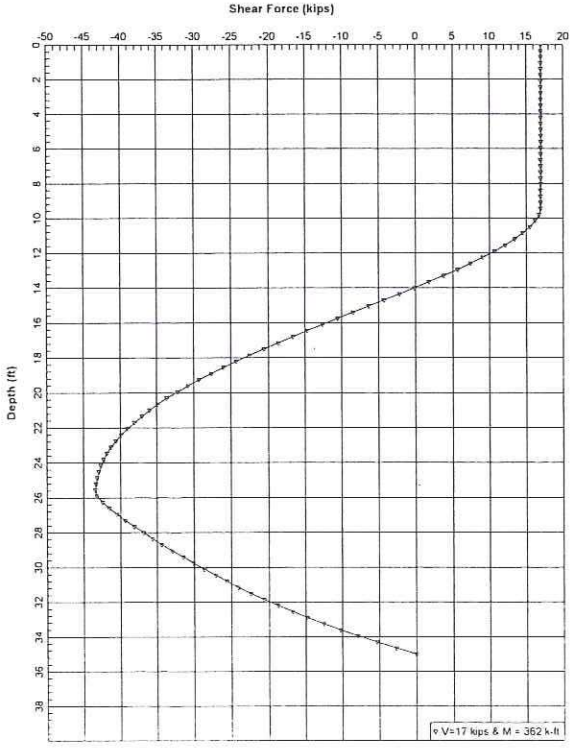




SR-91 WB Widening - Sign I - 54" CIDH - Free



SR-91 WB Widening - Sign I - 54" CIDH - Free



SR-91 WB Widening - Sign I - 54" CIDH - Free

LPile Plus for Windows, Version 6.0 (6.0.09)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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This program is licensed to:

Files Used for Analysis

Path to file locations: X:\Projects\2010\10-126 - RBF, SR 91 Westbound Widening\Reports\Foundation Report\08 Sign Structures\Analyses\LPILE\
Name of input data file: 54-in CIDH at Sign I.lp6d
Name of output file: 54-in CIDH at Sign I.lp6o
Name of plot output file: 54-in CIDH at Sign I.lp6p
Name of runtime file: 54-in CIDH at Sign I.lp6r

Date and Time of Analysis

Date: June 24, 2011 Time: 13:46:24

Problem Title

Project Name: SR-91 WB Widening - Sign Structures

Job Number: 10-126

Client: RBF

Engineer: GJG

Description: 54-in CIDH piles at Sign I

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	300	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections = 1

Total Pile Length = 35.00 ft

Depth of ground surface below top of pile = 0.00 ft

Slope angle of ground surface = 0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	54.0000000
2	35.000000	54.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	35.000 in
Top Width	=	54.000 in
Bottom Width	=	54.000 in
Top Area	=	2290.221044 sq. in
Bottom Area	=	2290.221044 sq. in
Moment of Inertia at Top	=	4.174E+05 in^4
Moment of Inertia at Bottom	=	4.174E+05 in^4
Elastic Modulus	=	1359648.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 0.000 ft
Distance from top of pile to bottom of layer = 9.680 ft

Layer 2 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 9.680 ft
Distance from top of pile to bottom of layer = 25.500 ft
p-y subgrade modulus k for top of soil layer = 67.500 lbs/in**3
p-y subgrade modulus k for bottom of layer = 67.500 lbs/in**3

Layer 3 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 25.500 ft
Distance from top of pile to bottom of layer = 30.500 ft

Layer 4 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 30.500 ft
Distance from top of pile to bottom of layer = 46.500 ft

p-y subgrade modulus k for top of soil layer = 135.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 135.000 lbs/in**3

(Depth of lowest layer extends 11.50 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 8 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	0.00	115.00000
2	9.68	115.00000
3	9.68	120.00000
4	25.50	120.00000
5	25.50	115.00000
6	30.50	115.00000
7	30.50	120.00000
8	46.50	120.00000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. Subgr. pci
1	Soft Clay	0.00	115.000	1.000	--	--	--	0.10000	--	--	--	--	--	--
		9.680	115.000	1.000	--	--	--	0.10000	--	--	--	--	--	--
2	API Sand	9.680	120.000	--	30.000	--	--	--	67.500	--	--	--	--	--
		25.500	120.000	--	30.000	--	--	--	67.500	--	--	--	--	--
3	Soft Clay	25.500	115.000	1000.000	--	--	--	0.01000	--	--	--	--	--	--
		30.500	115.000	1000.000	--	--	--	0.01000	--	--	--	--	--	--
4	API Sand	30.500	120.000	--	33.000	--	--	--	135.000	--	--	--	--	--
		46.500	120.000	--	33.000	--	--	--	135.000	--	--	--	--	--

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs
1	1	V = 17000.000 lbs	M = 4344000.000 in-lbs	24000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)	Condition 2 in-lb, rad., or in-lb/rad.	Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	1	V = 17000.	M = 4344000.	24000.	0.56066682	6851375.	-43411.	0.00000000

The analysis ended normally.

AXIAL PILE

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

SR-91 WB Widening Project - Sign I

TOTAL LOAD = 100.0 TONS

NUMBER OF LAYERS = 3

WATER TABLE DEPTH = 50.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00

SOIL INFORMATION

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.700E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.300E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.700E+01
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.382E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.300E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.700E+01
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.255E+02

LAYER NO 2----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.100E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.900E+01
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.255E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.100E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.900E+01
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.305E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.754E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.330E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.305E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.646E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.330E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00

SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.400E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	= 4.500	FT.
DIAMETER OF BASE	= 4.500	FT.
END OF STEM TO BASE	= 0.000	FT.
ANGLE OF BELL	= 0.000	DEG.
IGNORED TOP PORTION	= 10.000	FT.
IGNORED BOTTOM PORTION	= 0.000	FT.
AREA OF ONE PERCENT STEEL	= 22.905	SQ.IN.
ELASTIC MODULUS, Ec	= 0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	= 0.000	CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
11.0	6.48	4.58	0.00	4.58	4.58	4.58	0.71
12.0	7.07	9.49	0.00	9.49	9.49	9.49	1.34
13.0	7.66	14.70	0.00	14.70	14.70	14.70	1.92
14.0	8.25	20.22	0.00	20.22	20.22	20.22	2.45
15.0	8.84	26.02	0.00	26.02	26.02	26.02	2.94
16.0	9.43	32.10	0.00	32.10	32.10	32.10	3.41
17.0	10.02	38.45	0.00	38.45	38.45	38.45	3.84
18.0	10.60	45.06	9.42	54.47	54.47	54.47	5.14
19.0	11.19	51.91	19.78	71.69	71.69	71.69	6.40
20.0	11.78	59.01	31.08	90.09	90.09	90.09	7.65
21.0	12.37	66.34	43.32	109.66	109.66	109.66	8.86

Required pile length = 15'
(NOT CONTROLLED)

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.5592E-02	0.1023E-04	0.2808E-03	0.1000E-04
0.2796E-01	0.5114E-04	0.1404E-02	0.5000E-04
0.5592E-01	0.1023E-03	0.2808E-02	0.1000E-03
0.2796E+01	0.5114E-02	0.1404E+00	0.5000E-02
0.4194E+01	0.7671E-02	0.2106E+00	0.7500E-02
0.5592E+01	0.1023E-01	0.2808E+00	0.1000E-01
0.1398E+02	0.2557E-01	0.7020E+00	0.2500E-01
0.2796E+02	0.5114E-01	0.1404E+01	0.5000E-01
0.3891E+02	0.7659E-01	0.2106E+01	0.7500E-01
0.4932E+02	0.1020E+00	0.2808E+01	0.1000E+00
0.7821E+02	0.2533E+00	0.7020E+01	0.2500E+00
0.9526E+02	0.5041E+00	0.1386E+02	0.5000E+00
0.9659E+02	0.5442E+00	0.1495E+02	0.5400E+00
0.1095E+03	0.1355E+01	0.2773E+02	0.1350E+01
0.1255E+03	0.2706E+01	0.4397E+02	0.2700E+01

RESULT FROM UPPER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.7546E-02	0.1031E-04	0.4011E-03	0.1000E-04
0.3773E-01	0.5154E-04	0.2006E-02	0.5000E-04
0.7546E-01	0.1031E-03	0.4011E-02	0.1000E-03
0.3773E+01	0.5154E-02	0.2006E+00	0.5000E-02
0.5660E+01	0.7731E-02	0.3009E+00	0.7500E-02
0.7546E+01	0.1031E-01	0.4011E+00	0.1000E-01
0.1887E+02	0.2577E-01	0.1003E+01	0.2500E-01
0.3773E+02	0.5154E-01	0.2006E+01	0.5000E-01
0.5186E+02	0.7712E-01	0.3009E+01	0.7500E-01
0.6516E+02	0.1027E+00	0.4011E+01	0.1000E+00
0.9237E+02	0.2539E+00	0.1003E+02	0.2500E+00
0.1046E+03	0.5046E+00	0.1932E+02	0.5000E+00
0.1061E+03	0.5447E+00	0.2080E+02	0.5400E+00
0.1182E+03	0.1355E+01	0.3293E+02	0.1350E+01
0.1320E+03	0.2706E+01	0.4679E+02	0.2700E+01

RESULT FROM LOWER-BOUND LINE

Service - Compression Sign I.sfo

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.3643E-02	0.1015E-04	0.1605E-03	0.1000E-04
0.1822E-01	0.5074E-04	0.8023E-03	0.5000E-04
0.3643E-01	0.1015E-03	0.1605E-02	0.1000E-03
0.1822E+01	0.5074E-02	0.8023E-01	0.5000E-02
0.2733E+01	0.7611E-02	0.1203E+00	0.7500E-02
0.3643E+01	0.1015E-01	0.1605E+00	0.1000E-01
0.9108E+01	0.2537E-01	0.4011E+00	0.2500E-01
0.1822E+02	0.5074E-01	0.8023E-00	0.5000E-01
0.2598E+02	0.7606E-01	0.1203E+01	0.7500E-01
0.3351E+02	0.1014E+00	0.1605E+01	0.1000E+00
0.6403E+02	0.2526E+00	0.4011E+01	0.2500E+00
0.8594E+02	0.5036E+00	0.8392E+01	0.5000E+00
0.8712E+02	0.5437E+00	0.9098E+01	0.5400E+00
0.1008E+03	0.1354E+01	0.2253E+02	0.1350E+01
0.1189E+03	0.2706E+01	0.4116E+02	0.2700E+01

APPENDIX D

CALTRANS APPROVAL EMAIL OF FOUNDATION REPORT

WITH REVIEW COMMENTS AND RESPONSES

Sharid Amiri/D12/Caltrans/CAGov
10/29/2011 05:05 PM

To Luqi Yang/HQ/Caltrans/CAGov@DOT, Andrew Oshrin/D12/Caltrans/CAGov@DOT
cc Leo Chen/D12/Caltrans/CAGov@DOT
bcc
Subject SR 91, Project, project ID: 12000000791,Consultant Responses to Caltrans Review Comments on the Foundation Report for Overhead Sign Structures

I have reviewed the subject item and concur with it. I will review the Foundation Report once received by our office.

thanks

Sharid Khan Amiri,Ph.D.,P.E.

Senior Transportation Engineer
California Department of Transportation
Geotechnical Services, District 12 Oversight
3347 Michelson Dr.; Suite 100
Irvine, Ca.92612-1699
Office (949)-724-2599

****

" For individuals with sensory disabilities , this document will be made available, upon request, in Braille, large print, audiocassette, or computer disk. To obtain a copy of one of these alternate formats, please call Della Moore at (916) 227-8185 or TTY (916) 227-8454 or write to Della Moore, Division of Engineering Services, P.O. Box 168041 Sacramento, CA 95816-8041"

****

---- Forwarded by Sharid Amiri/D12/Caltrans/CAGov on 10/29/2011 05:01 PM ----

Sharid Amiri/D12/Caltrans/CAGov
10/29/2011 04:55 PM

To Andrew Oshrin/D12/Caltrans/CAGov
cc Leo Chen/D12/Caltrans/CAGov@DOT
Subject SR 91, Project, project ID: 12000000791 Consultant Responses to Caltrans Review Comments on the Geotechnical Design Report

Andrew

I have reviewed the subject item and concur with it. I will review the revised Geotechnical Design Report once received by our office.

Thanks

Sharid Khan Amiri,Ph.D.,P.E.

Senior Transportation Engineer
California Department of Transportation
Geotechnical Services, District 12 Oversight
3347 Michelson Dr., Suite 100
Irvine, Ca.92612-1699
Office (949)-724-2599

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

September 1, 2011

EMI Project No. 10-126

RBF Consulting
14725 Alton Parkway
Irvine, California 92618

Attention: Mr. Steve Huff, P.E.

Subject: ***State Route 91 Westbound Widening Project, Responses to Caltrans Comments on the Foundation Report for Overhead Sign Structures, Orange County, California, 12-ORA-91, PM 0.9/5.4, Caltrans Project No. 12000000791 (EA 12-0C5701)***

Dear Mr. Huff:

Earth Mechanics, Inc. (EMI) submitted the Foundation Report for the proposed overhead sign structures, dated July1, 2011, to Caltrans for review and comments. Caltrans Office of Geotechnical Design South 1 (OGDS-1) reviewed the report and provided comments in a memorandum dated August 10, 2011. EMI has prepared responses to the Caltrans comments as documented in this letter. For convenience, Caltrans review comments are provided in italics followed by EMI responses. EMI will incorporate these responses into the Final Foundation Report after Caltrans approval.

1. Provide Pile Data Table in Foundation Report.

Pile Data Tables for the Contract Plans for "Special" Overhead Sign Structures "H" and "I" are provided below:

TABLE 5-4. PILE DATA TABLE FOR SIGN "H"

Pile Type	Nominal Resistance (kips)		Design Tip Elevations (feet)	Specified Tip Elevation (feet)
	Compression	Tension		
16" CIDH	90	20	+85 (a) +95 (b)	+85

Notes:
1. Design tip elevations are controlled by the following demands: (a) Compression, (b) Tension, (c) Settlement, and (d) Lateral Load.
2. There are no design tip elevations for Tolerable Settlement and Lateral Load.
3. The specified tip elevations shall not be raised.

17800 Newhope Street, Suite B, Fountain Valley, California 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

TABLE 5-5. PILE DATA TABLE FOR SIGN "I"

Pile Type	Nominal Resistance (kips)		Design Tip Elevations (feet)	Specified Tip Elevation (feet)
	Compression	Tension		
54" CIDH	50	0	+115.5 (a) +81.0 (d)	+81.0

Notes:
1. Design tip elevations are controlled by the following demands: (a) Compression, (b) Tension, (c) Settlement, and (d) Lateral Load.
2. There are no design tip elevations for Tension and Tolerable Settlement.
3. The specified tip elevations shall not be raised.

The above Pile Data tables will be added in the Final Foundation Report.

2. *Sign Structure "H", in structural analysis lateral load is not considered, please clarify?*

According to the structural designers, the TOTAL lateral load is only 12 kips. This lateral load will be transferred and resisted by the Reinforced Concrete Box (RCB) through friction at the base of the box and passive soil resistance on the face of the box. Therefore, no lateral load will be resisted by the individual piles.

The above paragraph text will be added in Section 5.6.1 of the Final Foundation Report.

EMI will incorporate the above responses in the Final Foundation Report. Please submit this letter to Caltrans for their review of our responses and comments/concurrence.

Sincerely,

EARTH MECHANICS, INC.

9-1-2011

(Ranjan) G. J. Gunaranjan, PE 71758
Senior Staff Engineer

9-1-2011

Lino Cheang, GE 2345
Project Manager

Attachment A – Review Comments on the Foundation Report for Overhead Sign Structures by Caltrans Office of Geotechnical South 1 (OGDS-1), Dated August 10, 2011.

ATTACHMENT A

Review Comments on the Foundation Report for Overhead Sign Structures by Caltrans Office of Geotechnical South 1 (OGDS-1), Dated August 10, 2011

State of California

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: LUQI YANG
Liaison Engineer

Date: August 10, 2011

File: 12-ORA-91 PM
EA 12-0C5701, 1200000079
Overhead Structures

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
Geotechnical Services
Office of Geotechnical Design – South 1

Subject: Foundation Report- Overhead Structures

Per your request, the Geotechnical Design South 1 - Branch B has reviewed the subject submittal, containing the following item:

1. Foundation Report for Overhead Sign Structures, ORA-91 Westbound Widening Orange County CA, dated July 01, 2011

Our office has following comments on above submitted item.

1. Provide Pile Data table in Foundation Report.
2. Sign Structure H, in structural analysis lateral load is not considered, please clarify.

Should you have any questions, please contact Mushtaq Ahmed at (213) 620-2132.

Reviewed by: Date: 8/10/11

Mushtaq Ahmed, P.E.
Transportation Engineer-Civil
Office of Geotechnical Design – South 1
Branch B

Supervised by: Date: 8/10/11

Sam Sukiasian, G.E.
Chief Branch B
Office of Geotechnical Design – South 1

cc: OGDS1 – Nor. File, OGDS1- Sac. File, GS-Sac. File

FOUNDATION REPORT
BROOKHURST ST UC (Widen)
Bridge No. 55-0280

Earth Mechanics, Inc.

September 16, 2011

FOUNDATION REPORT

Brookhurst Street Undercrossing (Widen)
Bridge No. 55-0280
Orange County, California
12-ORA-91, PM 1.23
Caltrans Project No. 12000000791 (EA 12-0C5701)
EMI Project No. 10-126
Date: September 16, 2011

EARTH MECHANICS, INC.

Geotechnical and Earthquake Engineering

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

September 16, 2011

EMI Project No. 10-126

RBF Consulting
14725 Alton Parkway
Irvine, California 92618

Attention: Mr. Steve Huff, P.E.

Subject: Foundation Report for Brookhurst Street Undercrossing (Widen)
Bridge No. 55-0280
Orange County, California
12-ORA-91, PM 1.23
Caltrans Project No. 12000000791 (EA 12-0C5701)

Dear Mr. Huff:

Attached please find the Foundation Report for the subject bridge widening project. This report contains the findings and conclusions of our field investigation and laboratory testing program. This report also contains our recommendations for the design and construction of the bridge foundations.

An earlier version of this report dated April 15, 2011 was submitted to Caltrans for review. Caltrans prepared a memorandum dated May 2, 2011 indicating they have no comments. A copy of this Caltrans memorandum is included in Appendix D.

We appreciate the opportunity to provide geotechnical design services for this project. If you have any questions, please call us.

Sincerely,

EARTH MECHANICS, INC.

REGISTERED PROFESSIONAL ENGINEER
S. PIRATHIVIRAJ
NO. C71662
EXP. 12/31/11
CIVIL
STATE OF CALIFORNIA

9/16/11

(Raja) S. Pirathiviraj, PE 71662
Senior Staff Engineer

REGISTERED PROFESSIONAL ENGINEER
LINO C. CHEANG
NO. GE 2345
EXP. 9/30/13
GEOTECHNICAL
STATE OF CALIFORNIA

9-16-11

Lino Cheang, GE 2345
Project Manager

SP/sp,lcc

17800 Newhope Street, Suite B, Fountain Valley, California 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

FOUNDATION REPORT

BROOKHURST STREET UNDERCROSSING (WIDEN)
BRIDGE NO. 55-0280
ORANGE COUNTY, CALIFORNIA
12-ORA-91, PM 1.23
CALTRANS PROJECT NO. 12000000791 (EA 12-0C5701)

Prepared for:

RBF Consulting
14725 Alton Parkway
Irvine, California 92618

Prepared By:

Earth Mechanics, Inc.
17800 Newhope Street, Suite B
Fountain Valley, California 92708

EMI Project No. 10-126

September 16, 2011

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE OF STUDY

This Foundation Report presents the findings and conclusions of a geotechnical investigation conducted by Earth Mechanics, Inc. (EMI). It presents foundation design and construction recommendations for the proposed widening of Brookhurst Street Undercrossing (UC) in Orange County, California. A site location map is presented in Figure 1-1.

EMI is a subconsultant to RBF Consulting (RBF). The geotechnical services provided for this project included the following tasks:

- Collection and review of existing geotechnical information;
- Field exploration consisting of drilling and logging exploratory borings;
- Laboratory testing of selected bulk and relatively undisturbed soil samples;
- Engineering calculations and analysis to develop foundation design and construction recommendations; and
- Preparation of this report presenting our findings, conclusions, and recommendations.

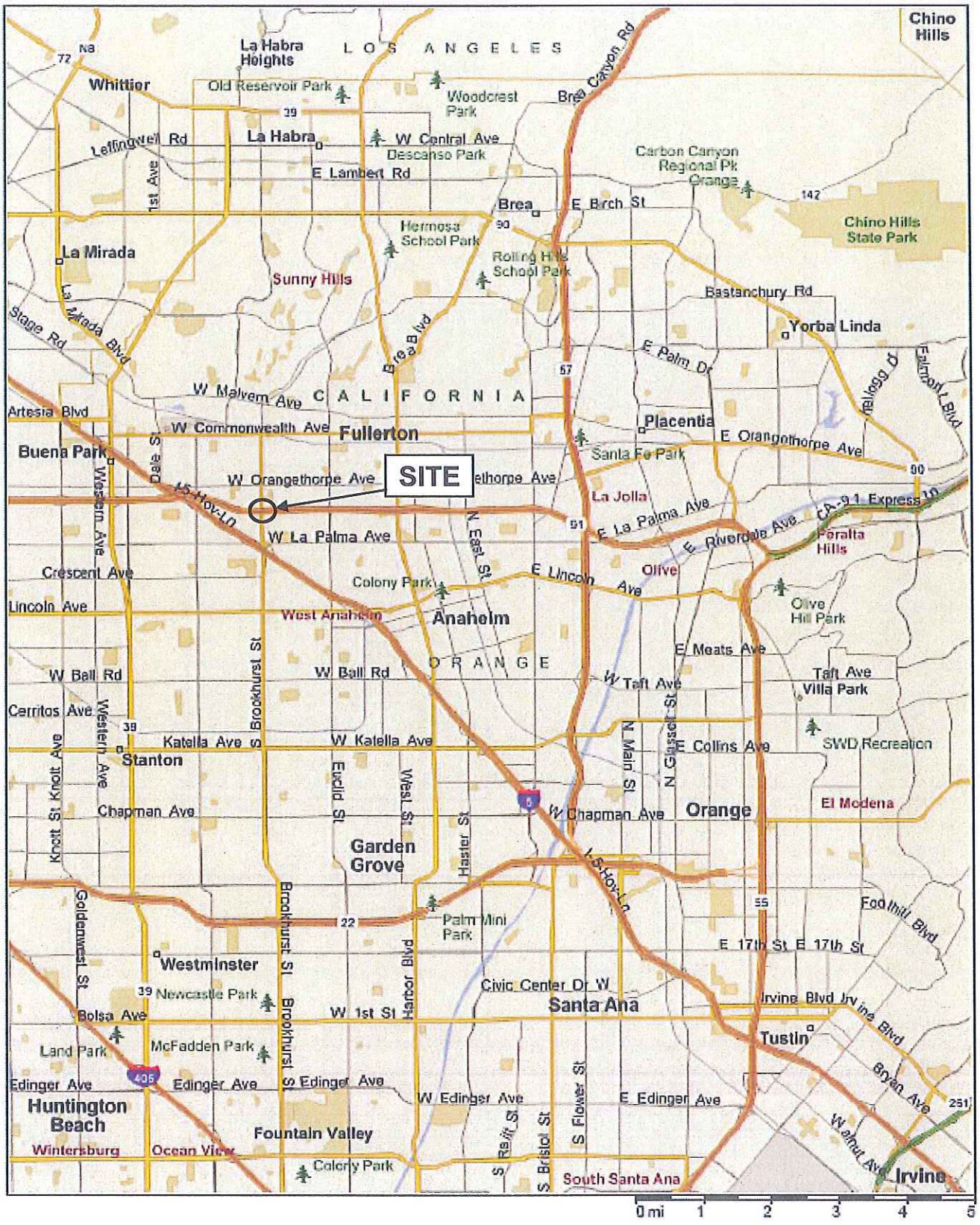
1.2 PROJECT DESCRIPTION

The California Department of Transportation (Caltrans), in cooperation with the Orange County Transportation Authority (OCTA) and the cities of Anaheim and Fullerton, proposes to widen the westbound State Route 91 (SR-91) from State Route 57 (SR-57) to Interstate 5 (I-5). SR-91 is a major east-west freeway facility that begins at the eastern junction with SR-60 in the city of Riverside in Riverside County, and continues west through Orange County to its terminus at the junction with Pacific Coast Highway 1 near the city of Hermosa Beach in Los Angeles County.

The proposed project limits cover a distance of 4.5 miles; however, actual improvements are limited to a total of 3.8 miles within the project area. The proposed project consists of widening six bridges. This foundation report addresses only the Brookhurst Street UC.

The existing UC was constructed in May 1958 and widened in September 1996. The existing UC is a four-span precast, prestressed concrete structure with total length of 136.5 feet and width of 145.5 feet. The original UC is supported on 45-ton, 12-inch diameter cast-in-place concrete piles (driven steel shell filled with concrete) with average pile tip elevation of 60 feet at Abutments 1 and 5 and Bents 2 through 4. The 1996 widening is supported on 16 and 18-inch diameter Cast-in-Drilled-Hole (CIDH) piles with service demands of 45 and 70 tons at the abutments and bents, respectively. The as-built pile-tip elevation at the abutments is +75 feet, and the as-built pile-tip elevation at the bents is +65 feet.

The existing Brookhurst Street UC will be widened by about 12-feet only in the north side in order to accommodate widening of the westbound SR-91.



Brookhurst Street UC (Widen)	SITE LOCATION MAP
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 1-1
Project No. 10-126	Date: 03-01-11

2.0 FIELD INVESTIGATION AND LABORATORY TESTING

2.1 FIELD INVESTIGATION

As-built Log-of-Test-Borings (LOTB) sheets are included in Appendix A for the original construction and 1996 widening.

One rotary-wash boring and two penetration borings were drilled in March 1955 for the original construction. The deepest boring was advanced to about elevation +28 feet. Existing grade at the borehole locations at the time of the investigation was between +109.1 and +109.7 feet, which is same as the roadway surface of Brookhurst Street.

One rotary-wash boring was drilled in December 1993 and one cone penetration test (CPT) sounding was performed in January 1993 for the 1996 widening. The deepest boring was advanced to about elevation +41.5 feet. Existing grade at the borehole locations at the time of the investigation was elevation +128 feet, which is same as the freeway surface elevation.

To supplement the existing subsurface information, three soil borings were performed between December 9, 2010 and January 11, 2011. Boring information, including exploration number, stations, offsets, ground surface elevations, bottom of boring elevations and water level measurements are summarized in Table 2-1. Locations of the exploratory boring are shown on the LOTB sheets provided in Appendix A.

Table 2-1. Geotechnical Exploration Information

Boring No.	Station Line	Station	Approx. Offset (feet)	Approx. Ground Surface El. (feet)	Approx. Bottom of Boring El. (feet)	Approx. Groundwater El. (feet)
A-10-006	A Line	118+55	76 Lt	+130.0	+43.5	+73.5
A-10-007		119+36	63 Lt	+112.4	+30.9	+68.4
A-10-008		120+42	55 Lt	+130.0	+49.2	+71.6

Exploratory borings were drilled using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers. Sampling was performed by alternating the Modified California Drive (MCD) sampler and Standard Penetration Test (SPT) sampler. The soil sampling interval is generally 5 feet.

Relatively undisturbed soil samples were obtained using a 3.25-inch outer diameter MCD sampler lined with brass rings. Each of these brass rings is 1-inch long with a 2.5-inch outside diameter. The SPT sampler (1.4-inch inside diameter) was also used to obtain soil samples. The MCD and SPT samplers were driven 18 inches into the ground or until refusal was encountered using a 140-lb hammer free falling from a height of 30 inches. The numbers of blows to advance the sampler each 6 inches of penetration was recorded. The numbers of blows for the final 12 inches or shorter of driving was recorded on the LOTB sheets.

Charts published by Winterkorn and Fang (1975) can be used to determine a reduction factor used to convert blowcounts recorded using the MCD sampler into SPT blowcounts. Using those charts, we obtained a reduction factor of 0.5 which was used for this project.

2.2 LABORATORY TESTING

Soil samples considered representative of the subsurface conditions were tested to obtain or derive relevant physical and engineering soil properties. The following laboratory tests were conducted to supplement the observations recorded during the field investigation:

- In-situ Moisture Content and Unit Weight
- Percent Passing No. 200 Sieve
- Direct Shear
- Unconsolidated Undrained Triaxial
- Consolidation
- Minimum Resistivity, pH, Sulfate Content and Chloride Content

The laboratory tests were conducted in general accordance with California Test Methods or American Society for Testing and Materials (ASTM) Standards. Laboratory test results are included in Appendix B.

3.0 GEOLOGY AND SEISMICITY

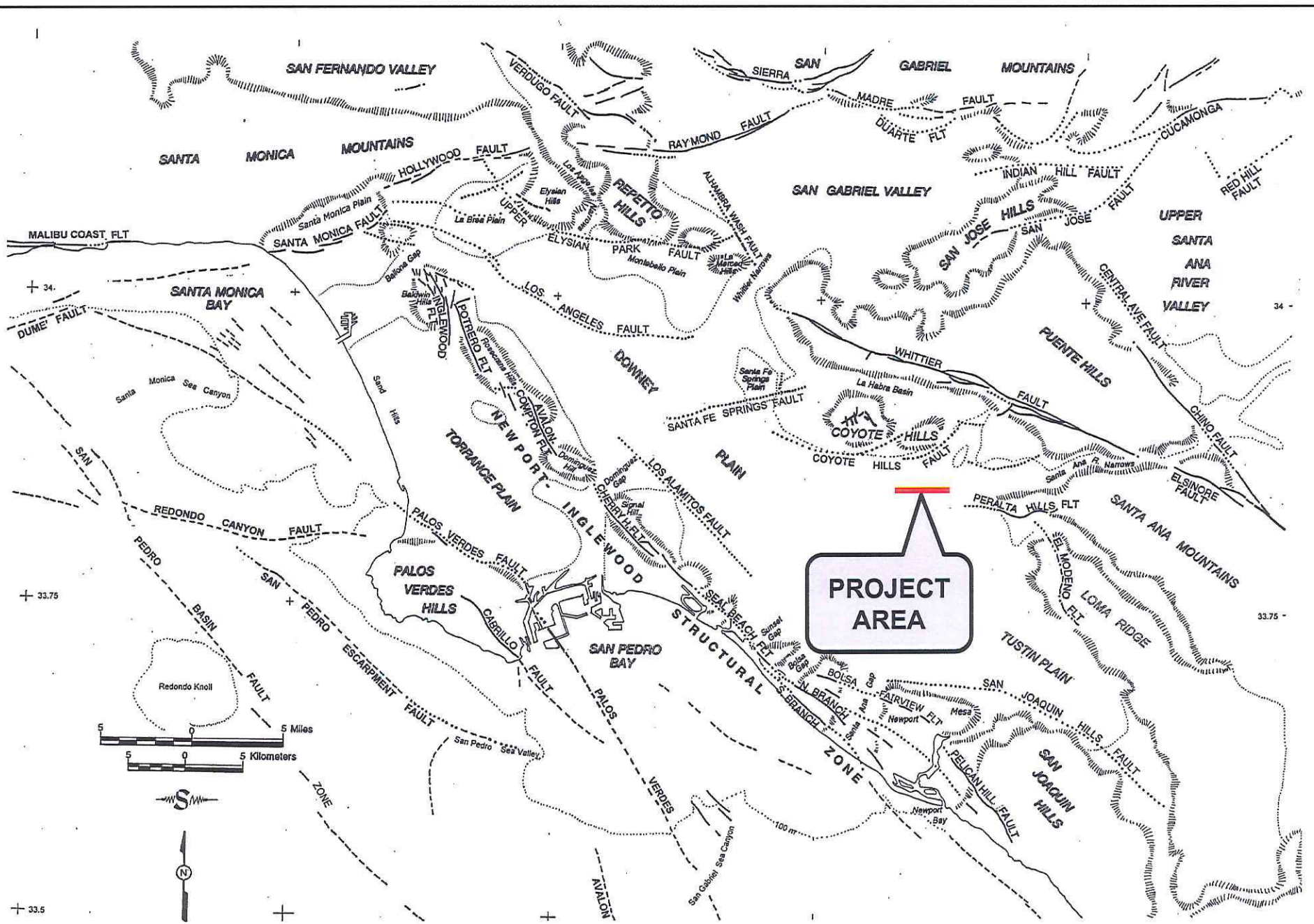
3.1 PHYSIOGRAPHY

The project area is in the east-central part of the Los Angeles Basin as shown in Figure 3-1 which comprises a transition zone between the Peninsular Ranges physiographic province on the east, and the Transverse Ranges physiographic province to the north. The Peninsular Ranges physiographic province comprises a northwest-southeast trending group of fault-bounded ranges such as Santa Ana Mountains, Puente Hills and San Joaquin Hills between the Salton Trough and the Pacific Ocean. The Transverse Ranges physiographic province comprises east-west trending ranges and valleys such as the Santa Monica Mountains, San Fernando Valley and San Gabriel Mountains. Valleys such as the Los Angeles Basin, the San Gabriel Valley and the Upper Santa Ana River Valley have characteristics compatible with both physiographic provinces and form a transition zone between the two provinces.

The Los Angeles Basin is essentially a large, relatively flat, low-lying and coastal plain surrounded by mountains on the north, east and southeast which rise abruptly to a few thousand feet above the plains. The western margin of the basin is bordered by the sea, the Palos Verdes Hills and the San Joaquin Hills. The floor of the basin gradually rises inland to a series of uplifted terrain along the margins of the surrounding mountains. This elevated marginal terrain includes the Santa Monica, La Brea, Montebello, Santa Fe Springs plains, and the Coyote Hills. The generally flat-lying nature and gradual inland rise of the Basin floor is disrupted by an alignment of northwest-southeast trending, low-elevation hills along the Newport-Inglewood Structural Zone (NISZ). The areas on either side of the NISZ are essentially flat and comprise the Downey-Tustin plain on the northeast and the Torrance Plain on the southwest. The site area is near the transition between the Downey and the Tustin plains.

3.2 GEOLOGIC STRUCTURE

The Los Angeles Basin is a deep structural basin comprising two major downward folds (synclines) separated by the NISZ uplift; the Paramount syncline is east of the NISZ under the Downey-Tustin Plain, and the Gardena syncline is west of the NISZ under the Torrance Plain. The Paramount syncline is the larger and deeper syncline with basement rocks as deep as about 30,000 feet (Yerkes et al, 1965). As described in the physiography section, the basin is rimmed by marginal elevated plains that rise about a hundred feet to as much as a couple hundred feet above the general level of the basin floor. These elevated plains and the Coyote Hills are underlain by fault-bounded, upward folds (anticlines) that are prolific oil fields. Most of the major faults associated with these folds are blind thrust faults and are shown on Figure 3-1 as dotted lines. The nearest faults to the project area are the blind thrust faults of the Puente Hills Blind Thrust Fault System and Compton-Los Alamitos Blind Fault System. Larger surface faults, such as the NISZ and the Elsinore Fault Zone (Whittier Section) lie to the southwest and northeast of the project site, respectively.



State Route 91 Westbound Widening Project

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

REGIONAL MAP OF ACTIVE FAULTS AND PHYSIOGRAPHY

Figure 3-1

Project No. 10-126

Date: 03-01-11

3.3 GEOLOGICAL HAZARDS

The only significant geological hazard at the site is earthquake shaking and perhaps local liquefaction. There are no known active surface faults within the project area so ground rupture is not a factor. The flat-lying nature of the area is not susceptible to landsliding. The site is too far from the ocean to be affected by tsunamis, and there are no large bodies of water within the site area that could generate a seiche. There are no volcanoes in the region.

The project site may be susceptible to liquefaction during a large earthquake. As presented in Figure 3-2, the California Geological Survey (1997, 1998) has designated project site as having a potential for liquefaction. The potential for liquefaction is discussed in detail in Section 5.2.

3.4 SEISMICITY

The project is in seismically active Southern California. The present-day seismotectonic stress field in the Los Angeles region is one of north-northeasterly compression. This is indicated by the geologic structures, by earthquake focal-mechanism solutions and by geodetic measurements. These data suggest crustal shortening of between 0.2 and 0.35 inches per year across the greater Los Angeles area (Argus et al., 1999).

Historical earthquake epicenter maps show widespread seismicity throughout the Los Angeles region. Earthquakes occur primarily as loose clusters along the NISZ, the southern margin of the Santa Monica Mountains, the margin between the Santa Susana-San Fernando Valley and the southern margin of the San Gabriel Mountains, and in the Coyote Hills-Puente Hills area.

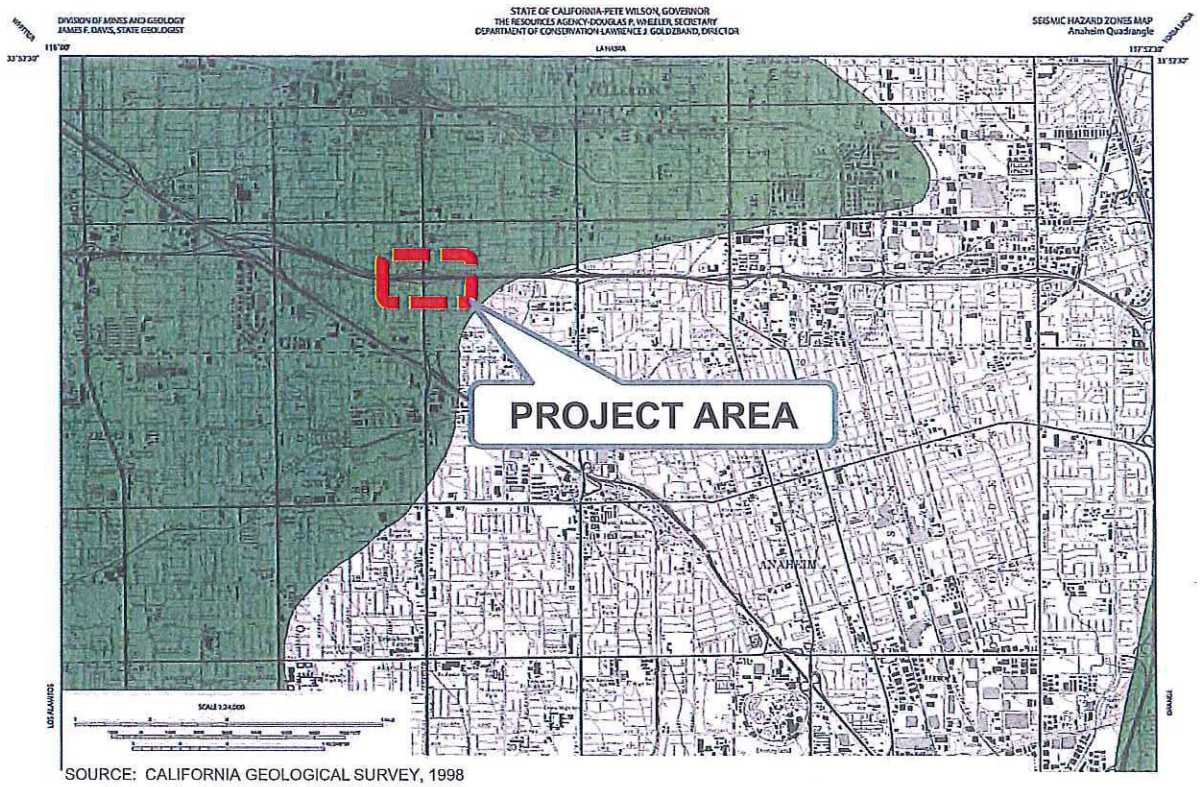
The largest historical earthquakes within the Los Angeles Basin were the 1933 Long Beach (moment magnitude (M_W) of about 6.4), 1994 Northridge (M_W = 6.7), 1971 San Fernando (M_W = 6.7), 1987 Whittier (M_W = 5.9), and 2008 Chino Hills (M_W = 5.4). There have been no significant historical earthquakes in the immediate site area. There may have been a few random small events (M_W < 3.0). The nearest concentrated earthquake activity has been within the Puente Hills about 5 or 6 miles to the north of the site.

The 1933 Long Beach earthquake did not rupture the surface but is believed to have been associated with the NISZ (Benioff, 1938). Reevaluation of the seismic data by Hauksson and Gross (1991) relocated the 1933 earthquake hypocenter to a depth of about 6 miles below the Huntington Beach-Newport Beach city boundary.

The 1994 Northridge earthquake occurred on a southerly dipping subsurface fault which was unknown prior to the earthquake. The main shock occurred at a depth of about 12 miles. Earthquake aftershocks clearly defined the rupture surface dipping about 35 degrees southerly from a depth of about 1 or 2 miles to 14 miles. The causative fault was never identified with certainty.

The 1971 San Fernando earthquake involves surface rupture. The 1971 event occurred on a northerly dipping thrust fault that dips from the northern side of the San Fernando Valley to a depth of about 9 miles under the San Gabriel Mountains, and considered part of the Sierra Madre Fault System.

N



SOURCE: CALIFORNIA GEOLOGICAL SURVEY, 1998

MAP EXPLANATION

Zones of Required Investigation:

Liquefaction

Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Brookhurst Street UC (Widen)	MAP OF LIQUEFACTION POTENTIAL
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 3-2
Project No. 10-126	Date: 03-01-11

The 1987 Whittier earthquake occurred on a subsurface fault dipping under the Puente Hills to about 10 miles beneath the San Gabriel Basin (Shaw and Shearer, 1999; Shaw et al., 2002). This event did not rupture the ground surface.

The 2008 Chino Hills event epicenter was in the Chino Hills area between the Elsinore-Fault-Zone Chino Section and Whittier Section. Preliminary data were inconclusive with regard to the causative fault. Detailed analysis by Shao and Hauksson (2009) indicated a rupture plane striking N71°W, dipping 62° northeast. This event did not rupture the ground surface.

Another significant earthquake was the 1812 earthquake which caused damage at the San Juan Capistrano Mission. The location and magnitude of the 1812 earthquake are unknown because of the sparse population at the time, but geological studies (Jacoby et al., 1988; Fumal et al., 1993; Weldon et al., 2004) postulate that it did not occur in the Capistrano area, but rather was a large ($M_W > 7.0$) distant event on the San Andreas fault in the Wrightwood area of the San Gabriel Mountains.

The earliest documented earthquake in the region was reported by the Portola′ expedition as they camped near the Santa Ana River in 1769. This event has been attributed by various geoscientists to just about every fault in the Los Angeles area but it could just as well have been a distant event that shook a wide area as did the 1971 San Fernando, the 1987 Whittier, and the 1994 Northridge events, as well as many other more-distant events such as 1992 Landers event.

4.0 SUBSURFACE CONDITIONS

4.1 SOIL CONDITIONS

The roadway elevation of the existing Brookhurst Street is about +112.5 feet and the roadway elevation at the SR-91 level is about +131.2 feet. Based on the recent field investigation and as-built LOTB sheets, the site is underlain primarily by silty sand and sandy silt. The idealized soil profile and design strength parameters for foundation design are presented in Table 4-1.

Table 4-1. Idealized Soil Profile and Strength Parameters

Approximate Elevation (feet)	Predominant Soil Type	Equivalent SPT Blowcount* (blows/foot)	Total Unit Weight (pcf)	Friction Angle (degree)	Cohesion / Undrained Shear Strength (psf)
Abutments 1 and 5					
+130 to +105	Silty Sand and Clayey Sand	12 to (33) Average = 17	120	31	100
+105 to +100	Sandy Silt	8	115	-	1000
+100 to +95	Silty Sand	(27)	120	32	100
+95 to +85	Sandy Silt	11 to (15) Average = 13	115	-	1700
+85 to +70	Silty Sand and Sand with Silt	18 to 40 Average = 28	120	32	100
+70 to +55	Sandy Silt and Silt	7 to (15) Average = 11	115	-	1700
+55 to +44	Silty Sand and Sand	13 to (59) Average = 32	120	36	50
Bents 2 to 4					
+112 to +107	Silty Sand and Sand	11	120	31	100
+107 to +80	Sandy Silt with interbedded Silty Sand	(7) to (11) Average = 10	115	-	1700
+80 to +67	Silty Sand	22 to (27) Average = 25	120	32	100
+67 to +52	Sandy Silt with interbedded Silty Sand	(11) to 20 Average = 15	115	-	1700
+52 to +37	Sand and Silty Sand with interbedded Sandy Clay	(11) to 22 Average = 18	120	32	100
+37 to +30	Sandy Silt	19 to (25) Average = 22	120	-	2500

* Values in ( ) are converted SPT blowcounts corrected for sampler size; correction factor from Modified California Drive sampler blowcounts to SPT blowcounts is 0.5.

The soil strength parameters are based on direct shear test results or unconsolidated-undrained triaxial test results or published correlations with SPT blowcounts (Lam and Martin, 1986). The design strength parameters of most of the idealized soil layers were based on direct shear or triaxial tests performed on similar soil layers across the borings. The design strength parameters of the 2nd and 7th idealized layers at Abutments 1 and 5, and the 3rd to 5th idealized layers at Bents 2 through 4 are based on published correlations with SPT blowcounts. It should be noted that the strength parameters obtained from the direct shear tests or triaxial tests are lower than those obtained using SPT correlations for the same idealized soil layers.

4.2 GROUNDWATER CONDITIONS

Groundwater was encountered between elevations +68.4 and +73.5 feet during the recent field investigation. Groundwater was also encountered at elevation +59.5 feet in December 1993, and between elevations +72.2 and +73.5 feet in March 1955. Based on California Geological Survey (Division of Mines and Geology, 1997), the recorded highest historical groundwater at the project site is 40 feet below the ground surface. The average ground surface elevation at the Brookhurst Street grade is about +111 feet. Therefore, the CGS historical highest groundwater elevation would be about +71 feet. Based on the above groundwater data, a groundwater elevation of +73.5 feet can be used for liquefaction assessment.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 SEISMIC DESIGN CRITERIA

To develop ARS curves in accordance with the 2009 Seismic Design Criteria (SDC) (Caltrans, 2009b and 2009d) procedures, we considered the following response spectra:

- Deterministic Criteria based on late-Quaternary faults in 2007 fault database (Caltrans, 2007a and 2007b, Shantz and Merriam, 2009);
- Probabilistic Criteria based on 5% in 50 years probability of exceedance ground motion; and
- Minimum Deterministic Spectrum based on a M_w= 6.5 strike-slip event occurring at a distance of 7.5 miles (12 km) from the site.

The design ARS curve is the envelope of the above spectra.

We used the Caltrans Deterministic Response Spectrum Spreadsheet as recommended by the 2009 SDC to develop the deterministic ARS curves. The spreadsheet uses the arithmetic average of two Next Generation Attenuation (NGA) relationships developed by Chiou-Youngs (2008) and Campbell-Bozorgnia (2008) with user-provided input parameters, including fault characteristics, site-to-fault distances and site condition parameters as presented in Table 5-1.

Table 5-1. Controlling Faults for Deterministic Response Spectrum

Controlling Fault	Fault ID	Maximum Moment Magnitude M_{max}	Site to Fault Distance R_{RUP} (miles)	Style of Fault	Fault Dip /Direction
Puente Hills Blind Thrust	240	7.3	5.5	Reverse	25° / North
Elsinore Fault Zone (Whittier Section)	241	7.6	7.1	Reverse Lateral Strike Slip	75° / Northeast
Compton – Los Alamitos Blind Thrust	291	6.8	7.8	Reverse	20° / Northeast

Results obtained from the spreadsheet were then verified with the Caltrans online web tool (Caltrans, 2009a). The spreadsheet method is recommended because the online web tool, though more user-friendly, does not include updates since 2007 in its calculation database and presently is not approved to develop spectra for final design.

The probabilistic response spectrum is based on data from the 2008 United States Geological Survey (USGS, 2008a) National Seismic Hazard Map for the 5% in 50 years probability of exceedance (975-year return period) ground motion. To develop the probabilistic spectrum, the Caltrans Probabilistic Response Spectrum Spreadsheet and the USGS Interactive Deaggregation Tool (USGS, 2008b) were used. Results obtained from both the spreadsheet and deaggregation tool were then verified with the Caltrans online web tool. Again, the spreadsheet and deaggregation tool are recommended because the online web tool, though more user-friendly, does not include updates since 2007 in its calculation database.

The resulting design ARS curve and the digitized coordinates are presented in Figure 5-1. A peak ground acceleration (PGA) of 0.52g is obtained from the design ARS curve.

5.2 LIQUEFACTION

Liquefaction analysis was performed using the available site-specific subsurface information and historical high groundwater elevation of +73.5 feet. The liquefaction potential of the saturated, granular materials below the historical high groundwater table was evaluated using the procedures outlined by Seed et al. (1983), Seed and Harder (1990), and updated by NCEER (1997). Results of the liquefaction analysis are included in Appendix C. Based on the analysis, granular materials susceptible to liquefaction were not encountered below the historical high groundwater table. Therefore, the liquefaction potential at the bridge site is anticipated to be low. As a result, seismic settlement of onsite soils is also low

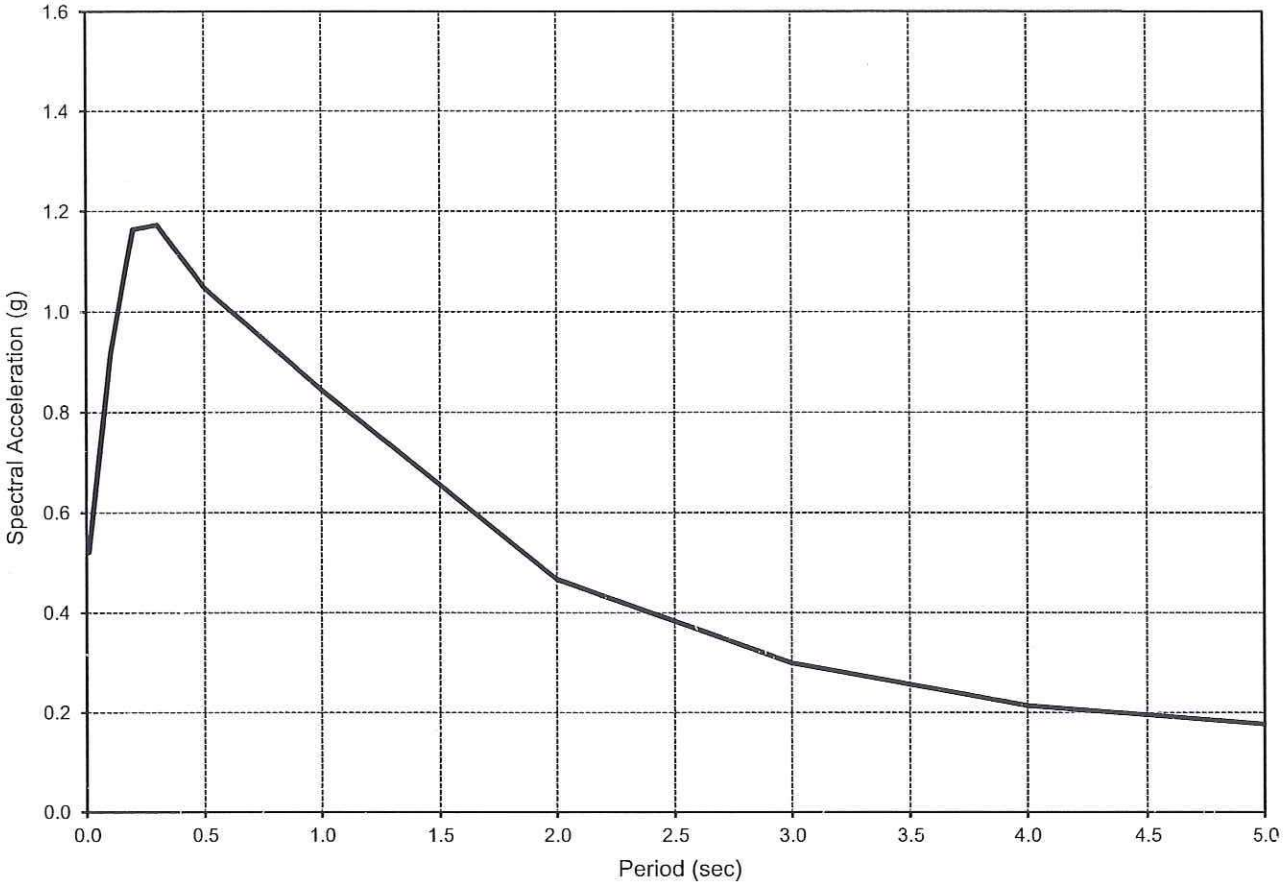
5.3 SOIL CORROSIVITY

Two soil samples were tested for pH, minimum resistivity, soluble chloride content and soluble sulfate content. The test results are summarized in Table 5-2. Minimum resistivities were 2,200 and 2,600 ohm-cm. The pH values were 8.0 and 8.5. The soluble sulfate measurements were 10 and 60 parts per million (ppm), and the soluble chloride measurements were 83 and 161 ppm.

Table 5-2. Soil Corrosion Test Results

Boring	Station (Offset) / "Station Line"	Sample Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Soluble Sulfate Content (ppm)	Soluble Chloride Content (ppm)
A-10-006	118+55 (76 Lt) / A Line	5	SC	2,600	8.5	10	83
A-10-008	120+42 (55 Lt) / A Line	45	SM	2,200	8.0	60	161

Based on the Caltrans Corrosion Guidelines (2003b), soils are considered corrosive if the pH is 5.5 or less, or the chloride concentration is 500 ppm or greater, or the sulfate concentration is 2,000 ppm or greater. Based on the test results and the Caltrans criteria, the on-site soils are considered to be non-corrosive to bare metals and concrete.



Latitude = 33.8539 °
Longitude = -117.9591 °

Damping Ratio = 5%

Spectral Coordinates	
Period (sec)	Acc. (g)
0.010	0.520
0.100	0.915
0.200	1.164
0.300	1.173
0.500	1.049
1.000	0.844
2.000	0.467
3.000	0.299
4.000	0.214
5.000	0.176

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Brookhurst Street UC (Widen)	Design ARS Curve
	Project: 10-126 Date: 03/01/11	Figure 5-1

5.5 PILE FOUNDATION DESIGN

5.5.1 Foundation Type

According to the as-built plans, the 1996 widening of Brookhurst Street UC is supported on CIDH piles. Abutments 1 and 5 are supported on 16-inch diameter CIDH piles with a design capacity of 45 tons, and Bents 2 through 4 are supported on 18-inch diameter CIDH piles with design capacity of 70 tons. The original UC is supported on 12-inch diameter cast-in-place concrete piles (driven steel shell filled with concrete) with a design capacity of 45-ton at Abutments 1 and 5 and Bents 2 through 4.

We recommend matching the existing foundation type of the 1996 widening for the proposed bridge widening. Twenty-four-inch diameter CIDH piles are recommended (1) to limit the pile length over pile diameter ratio to less than 30, and (2) due to the possibility of encountering groundwater during pile construction. According to Caltrans Memo To Designers (Caltrans, 2008), the minimum CIDH pile diameter for a wet construction is 24 inches.

5.5.2 Foundation Data Provided by Structural Designers

Per Caltrans policy, LRFD Service-I Limit State load combinations and Working Stress Design (WSD) method provided in the Caltrans Bridge Design Specifications (2003a) are used for design of the abutment footing. The LRFD Service-I Limit State, Strength Limit State, and Extreme Event Limit State load combinations are used for the design of the bent footing.

The foundation design data sheet is presented in Table 5-3. Foundation loads were provided by the structural designers following the latest Caltrans Memo To Designers (Caltrans, 2008) and these loads are presented in Table 5-4.

Table 5-3. Foundation Design Data Sheet

Support No.	Design Method	Pile Type	Finished Grade Elevation (feet)	Cut-off Elevation (feet)	Pile Cap Size (feet)		Permissible Settlement under Service Load (inch)	Number of Pile per Support
					B	L		
Abut 1	WSD	24" CIDH	+126.0	+121.75	10.0	12.0	1	4
Bent 2	LRFD	24" CIDH	+113.9	+106.65	10.0	16.5	1	6
Bent 3	LRFD	24" CIDH	+113.9	+106.65	10.0	16.5	1	6
Bent 4	LRFD	24" CIDH	+113.9	+106.65	10.0	16.5	1	6
Abut 5	WSD	24" CIDH	+126.0	+121.75	10.0	12.0	1	4

Table 5-4. Foundation Design Loads

Support No.	Service-I Limit State (kips)			Strength Limit State (Controlling Group, kips)				Extreme Event Limit State (Controlling Group, kips)			
	Total Load		Permanent Loads	Compression		Tension		Compression		Tension	
	Per Support	Max. Per Pile	Per Support	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile
Abut 1	245	70	180	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bent 2	500	100	375	700	135	0	0	375	400	N/A	200
Bent 3	550	110	410	750	150	0	0	410	325	N/A	190
Bent 4	500	100	375	700	135	0	0	375	325	N/A	190
Abut 5	245	70	180	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

5.5.3 Axial Pile Capacity

Abutments 1 and 5, and Bents 2 through 4 foundation design recommendations are presented in Table 5-5 and Table 5-6, respectively. The Pile Data Table for the contract plans is presented in Table 5-7.

A pile-group efficiency factor (GEF) of 0.65 is used for a center-to-center pile spacing of 2.5 times the pile diameter, and a GEF of 1.0 is used for a center-to-center spacing of 4.0 times the pile diameter or greater (Section 10.8.3.6.3, AASHTO, 2007). Linear interpolation can be used to determine the GEF for intermediate spacings. Based on the layouts provided by the structural designers, GEF's of 0.65, 0.7 and 0.77 were used for the Abutments 1 and 5, Bent 2 and Bents 3 and 4 piles, respectively.

Based on the information provided by RBF, a 5-foot diameter storm drain is located near the Bent 2 footing. The invert elevation of the storm drain is +104.73 feet. A special pile layout is presented by RBF for the Bent-2 footing. Based on the information presented in the special pile layout, each of the two piles closest to the storm drain will be installed inside a 30-inch diameter casing to protect the storm drain from pile loading. The recommended length of the casing is 4 feet, measured from the footing bottom elevation of +106.4 feet.

The pile capacity calculations are presented in Appendix C. The nominal resistance presented in Table 5-5 and Table 5-7 for the abutment piles is controlled by the Service-I Limit State "Total Load Per Support" and not by the Service-I Limit State "Maximum Per Pile Load". The nominal resistance presented in Table 5-6 and Table 5-7 for the bent piles is controlled by the Strength Limit State "Compression Per Support" and not by the Strength Limit State or Extreme Limit State "Maximum Per Pile Load".

The pile capacity is also based on soil resistance only and may be further limited by the pile-head connection details and the strength of the pile materials.

Table 5-5. Abutments Foundation Design Recommendations

Support	Pile	Cut-off Elevation (feet)	LRFD Service-I Limit State Load per Support (kips)		LRFD Service-I Limit State Total Load per Pile (Compression) (kips)	Nominal Resistance (kips)	Design Tip Elevations (feet)	Specified Tip Elevation (feet)
			Total	Permanent				
Abut 1	24" CIDH	+121.75	245	180	70	190	+87 (a) +99 (d)	+87
Abut 5	24" CIDH	+121.75	245	180	70	190	+87 (a) +99 (d)	+87

Notes:
1. Design tip elevations are controlled by the following demands: (a) Compression and (d) Lateral Load.
2. There are no design tip elevations for Tension and Tolerable Settlement at Abutments 1 and 5.
3. The specified tip elevations for Abutments 1 and 5 shall not be raised above the design tip elevations for Lateral Load.

Table 5-6. Bent Foundation Design Recommendations

Support Location	Pile Type	Cut-off Elevation (feet)	Service-I Limit State Loads per Support (kips)	Total Permissible Support Settlement (inch)	Required Factored Nominal Resistance (kips)				Design Tip Elevations (feet)	Specified tip Elevation (feet)
					Strength Limit		Extreme Event			
					Comp. (ϕ=0.7)	Tension (ϕ=0.7)	Comp. (ϕ=1.0)	Tension (ϕ=1.0)		
Bent 2	24" CIDH	+106.65	500	1	135	0	400	200	+75 (a-I) +68 (a-II) +73 (b-II) +81 (d)	+68
Bent 3	24" CIDH	+106.65	550	1	150	0	325	190	+76 (a-I) +71 (a-II) +73 (b-II) +81 (d)	+71
Bent 4	24" CIDH	+106.65	500	1	135	0	325	190	+76 (a-I) +71 (a-II) +73 (b-II) +81 (d)	+71

Notes:
1. Design tip elevations are controlled by the following demands: (a-I) Compression (Strength Limit), (a-II) Compression (Extreme Event), (b-II) Tension (Extreme Event) and (d) Lateral Load.
2. There are no design tip elevations for Tension (Strength Limit) and Tolerable Settlement at Bents 2 through 4.
3. The Specified tip elevations for Bents 2 through 4 shall not be raised above the design tip elevations for Tension and Lateral Load.

Table 5-7. Pile Data Table

Location	Pile Type	Nominal Resistance (kips)		Design Tip Elevations (feet)	Specified Tip Elevation (feet)
		Compression	Tension		
Abut 1	24" CIDH	190	0	+87 (a) +99 (d)	+87
Bent 2	24" CIDH	400	200	+68 (a) +73 (b) +81 (d)	+68
Bent 3	24" CIDH	330	190	+71 (a) +73 (b) +81 (d)	+71
Bent 4	24" CIDH	330	190	+71 (a) +73 (b) +81 (d)	+71
Abut 5	24" CIDH	190	0	+87 (a) +99 (d)	+87

Notes:

1. Design tip elevations are controlled by the following demands: (a) Compression, (b) Tension and (d) Lateral Load.
2. There are no design tip elevations for Tension and Tolerable Settlement at Abutments 1 and 5.
3. There is no design tip elevation Tolerable Settlement at Bents 2 through 4.
4. The specified tip elevations for Abutments 1 and 5 shall not be raised above the design tip elevation for Lateral Load.
5. The specified tip elevations for Bents 2 through 4 shall not be raised above the design tip elevation for Tension and Lateral Load.

5.5.4 Lateral Pile Capacity

5.5.4.1 Lateral Pile Solutions

Results of lateral pile analysis in terms of pile-head shear and lateral deflection for a free-head condition are presented in Appendix C and summarized in Table 5-8. The maximum bending moment and the location of maximum moment are also presented. The solutions presented in Table 5-8 are entirely based on soil resistance and linear pile properties. Therefore, these values may be limited by the flexural strength (plastic moment) of the piles and pile-head connection details. Based on the pile layout provided by the structural designers, a group efficiency factor of 0.7 was used for the abutment piles. Group efficiency factors at Bent 2 and Bents 3 and 4 were 0.6 and 0.68, respectively.

Lateral solutions are provided for pile-head deflections from 0.25 to 5 inches at the abutments and Bents 3 and 4, and linear interpolation can be used for solutions between pile-head deflections of 0.25 and 5 inches. At Bent 2, lateral solutions are provided for both the cased and un-cased piles for pile-head deflections from 0.25 to 3 inches, and linear interpolation can be used for solutions between pile-head deflections of 0.25 and 3 inches. Solutions at Bent 2 were limited to 3 inches because pile-head deflections greater than 3 inches will engage the casing used to protect the existing storm drain from pile loading. As a result, piles at Bent 2 should be designed based on a limiting pile-head deflection of 3 inches or less.

Table 5-8. Lateral Pile Solutions

Support Location	Pile Head Deflection (in)	Pile Head shear (kips)	Maximum Moment (kip-in)	Depth to Max. Moment from Pile Top (ft)
Abutments 1 and 5 (24-inch CIDH)	¼	13.5	572	7.0
	½	21.3	1020	7.5
	1	34.5	1826	8.0
	2	53.0	3269	8.5
	5	83.8	6730	10.5
Bent 2 (Cased Piles, 24-inch CIDH)	¼	11.6	759	7.0
	½	18.1	1250	7.5
	1	28.1	2054	8.0
	2	43.1	3368	9.0
	3	55.3	4495	9.5
Bent 2 (Un-Cased Piles, 24-inch CIDH)	¼	24.7	849	6.0
	½	35.3	1371	6.5
	1	50.6	2208	7.5
	2	72.6	3568	8.0
	3	89.0	4724	8.5
Bents 3 and 4 (24-inch CIDH)	¼	27.1	902	5.5
	½	38.7	1452	6.5
	1	55.4	2342	7.0
	2	79.4	3779	8.0
	5	120.1	7074	9.0

5.5.4.2 Lateral Load Resistance of Bent Pile Footing

Passive earth pressure at the bent pile cap can be used to resist a portion of the lateral loads transferred to the soil. For static design, the passive soil resistance against the embedded face of the bent pile cap should be neglected. Under earthquake loading, this ultimate passive soil resistance should be added to the pile group capacity to determine the total lateral resistance of the pile footing. At the bent location, the ultimate passive soil resistance against the pile footing is estimated to be equal to a maximum equivalent fluid pressure of 360 psf per foot of depth. Note that development of full passive earth pressure requires a lateral pile cap displacement equal to approximately 2 percent of the embedded height (measured from the nearest and lowest ground surface to the bottom of the pile cap). For displacement magnitudes smaller than what is required to mobilize full resistance, the actual resistance magnitude should be determined by linearly interpolating between zero and the full resistance.

5.6 EMBANKMENTS SETTLEMENT AND SLOPE STABILITY

5.6.1 Settlement and Settlement Period

Fill will need to be placed to construct the approaches to the bridge widening. Up to 19 feet of sliver fill will be placed to construct the approaches to Abutments 1 and 5. Based on the onsite soil type, calculated ground subsidence at Abutments 1 and 5 is estimated to be less than 1 inch. Since the onsite soils are primarily coarse-grained materials, soil settlement should occur relatively quickly, and a settlement period for pile construction is not required.

5.6.2 Slope Stability

Global stability analyses were conducted for both static and pseudo-static conditions for the bridge approach embankment slopes. The analysis was performed using the computer program SLIDE 5.0 (Rocscience, 2006). The soil strength parameters in Table 4-1 were used in the static and pseudo-static analysis and the results are presented in Appendix C.

The calculated factor of safety for a deep-seated failure is greater than the minimum required 1.5 under static condition with a 2-foot soil surcharge to represent traffic loading. Slope stability analysis under pseudo-static condition was performed using a seismic coefficient equal to 0.17g (which is the smaller of either one-third the horizontal peak ground acceleration or 0.2g) in accordance with guidelines provided in Section 3.10 of the Caltrans Guidelines for Structures Foundation Reports (Caltrans, 2009c). Analysis indicates that the calculated factor of safety is greater than the required minimum of 1.1 under pseudo-static condition.

For embankment slopes with a gradient of 2H:1V or flatter, surficial stability should not be a design concern. If slope paving is proposed for embankment slopes with a gradient of 1.5H:1V, then surficial stability is also not a design concern. If slope paving is not used for the 1.5H:1V slopes, it is recommended that the upper 4 feet of any new 1.5H:1V slope face be covered with materials with a minimum internal friction angle of 32 degrees and a minimum cohesion of 230 psf. This select material should be properly keyed and benched into the sloping ground. In all cases, proper maintenance with erosion protection and drainage control in accordance with Section 21 of Caltrans Standard Specifications (Caltrans, 2010b) are also recommended.

5.6.3 Structure Approach Slabs

Selection of the approach type (if required) will be performed by the structural designer following the flowchart in Caltrans Memo to Designers 5-3, Attachment A, dated May 1996 (Caltrans, 1996).

5.7 BRIDGE ABUTMENT WALL DESIGN

5.7.1 Abutment Earth Pressures

If abutment walls are free to move laterally at the top, a static active lateral earth pressure of 36 psf per foot of depth is recommended for a free draining, level and compacted backfill. If lateral movement at the top of abutment walls is restrained, the lateral earth pressure for a free draining, level and compacted backfill should follow Section 5.5.5.11 of the Caltrans BDS dated August

2004. For this condition, we recommend a coefficient of active lateral earth pressure of 0.3, a coefficient of at-rest lateral earth pressure of 0.46 and a soil unit weight of 120 lb/ft^3. If applicable, a uniform lateral pressure of at least 72 psf due to vehicle loads, equivalent to a vertical pressure produced by at least 2 feet of earth, should be added to the above lateral earth pressure.

5.7.2 Passive Resistance of Abutment Backfill

Under seismic loading, an ultimate passive earth pressure of 5 ksf may be used for the approach backfill and abutment walls with a height equal to or greater than 5.5 feet. For abutment walls with heights less than 5.5 feet, the passive pressure may be calculated proportionally (e.g., for a 4-foot high wall, the passive pressure is [4/5.5] x 5 ksf = 3.64 ksf. The horizontal movement at which the maximum passive pressure is expected to be fully mobilized can be determined following the procedure outlined in Section 7.8.1 of the Caltrans SDC (2009c).

5.8 GROUND ANCHOR WALL DESIGN

To construct the Bents 2 and 4 footings, the portion of the existing retaining walls has to be removed and replaced with ground anchor wall. Based on the General Plan provided by RBF, the height of the wall is 5 feet and one row of ground anchors will be used.

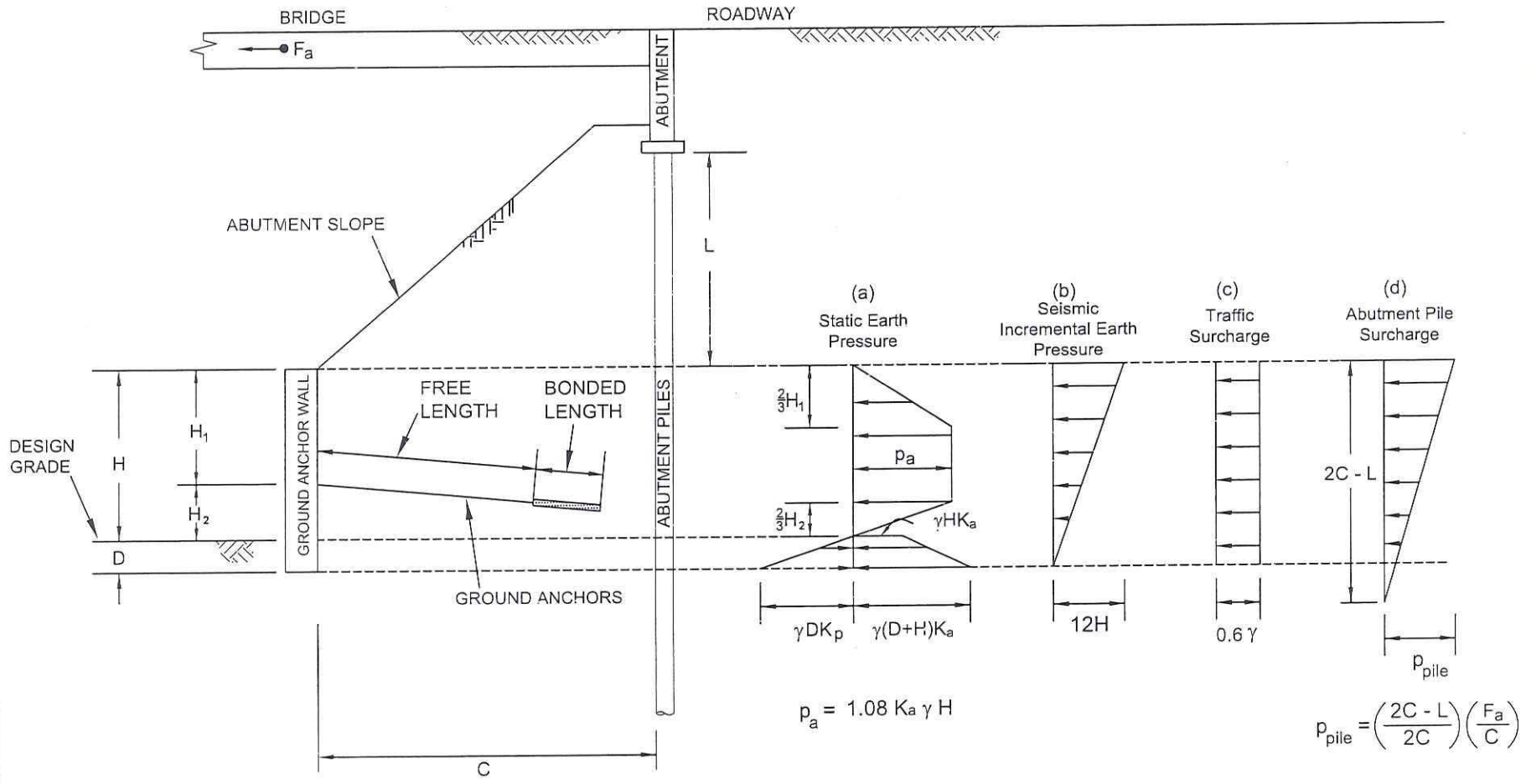
5.8.1 Lateral Pressures

Ground anchors should be designed to resist all lateral pressures against the ground anchor wall. For the purpose of estimating lateral pressures, the following soil parameters are recommended: a soil unit weight of 120 lb/ft^3; an internal friction angle of 31°; and a cohesion of 100 psf. The lateral pressures against the ground anchor wall are shown in Figure 5-2 and include the following: (a) the active earth pressure (for a sloping backfill) in accordance with Caltrans Bridge Design Specifications (Caltrans, 2004) and the passive pressure at the bottom of the wall; (b) incremental seismic earth pressure, (c) lateral static pressure due to traffic loading; and (d) pressure from the existing piles. The incremental seismic pressure should be added to the static pressure to determine the total pressure. Traffic loading at the approach roadway surface is represented by a 2-foot thick soil surcharge.

5.8.2 Unbonded Length

The unbonded length (or "free length") of the anchor is that portion of the anchor which is not grouted. The unbonded length should fall outside the Rankine wedge, which is defined by the ground surface, the ground anchor wall, and an assumed failure plane. This failure plane extends from the bottom of the ground anchor wall up at an angle of 30° measured clockwise from the vertical. In any case, the unbonded length should not be less than 15 feet.

The angle of inclination of the anchors should be at least 10° to facilitate tendon installation and grouting.



K_a = 0.85 (Active earth pressure coefficient for sloping backfill)

K_p = 2.5 (Passive earth pressure coefficient)

γ = Soil density = 120 pcf

F_a = Horizontal (longitudinal) loading from piles due to structural demand (pound per foot)

C = Distance in feet between tieback wall and abutment piles

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Brookhurst Street UC (Widen)	Lateral Earth Pressure Against Ground Anchor Wall
	Project No. 10-126 / Date: 03-10-11	Figure 5-2

5.8.3 Bonded Length

The bonded length of ground anchors is that portion which is grouted and provides the lateral resistance due to friction between the soil and concrete.

The maximum allowable anchor design load is computed by multiplying the bonded length by the ultimate transfer load and dividing by a factor of safety. For cost estimating purposes, we recommend an ultimate load transfer of 10 kips per foot and a factor of safety of 2.5 (Cheney, 1984). The contractor is responsible for determining the bonded length of the ground anchors; however, the bonded length of the anchors should not be less than 15 feet. Additionally, the bonded length should fall outside a zone defined by the distance of 4 times the pile diameter from the outer edge of abutment piles.

5.8.4 Spacing of Ground Anchors

Ground anchors should not be spaced closer than five diameters of the bonded zone or 5 feet, whichever is greater. The ground anchors should be located to maximize their distance from the abutment piles.

5.8.5 Bearing Capacity and Wall Friction

The allowable bearing capacity for the footing (or leveling pad) at the bottom of the ground anchor wall is 1.5 kips per square foot (ksf), which is based on a minimum embedment depth and footing width of 2 feet and 1.67 feet, respectively. A friction coefficient of 0.3 and 0.4 can be used between the vertical concrete wall and the soil behind the wall for the permanent and temporary (during construction) condition, respectively, provided the wall is in full-contact with the wall backfill.

6.0 CONSTRUCTION RECOMMENDATIONS

6.1 EARTHWORK

Earthwork should be performed in accordance with Caltrans Standard Specifications, Section 19 (Caltrans, 2010b). Appropriate measures should be taken to prevent damage to adjacent structures and utilities. Any design and construction of temporary sloping, sheeting, or shoring should be made the contractor's responsibility. It should be noted that it is the responsibility of the contractor to oversee the safety of the workers in the field during construction. The contractor shall conform to all applicable occupational and health standards, rules, regulations, and orders established by the State of California. In addition, other State, County, or Municipal regulations may supersede the recommendations presented in this section. If a trench shoring design and safety plan is required, the geotechnical consultant should review the plan to confirm that recommendations presented in this report have been applied to the design.

During the recent field investigation conducted between December 9, 2010 and January 11, 2011, groundwater was encountered between elevations +67.4 feet and +73.5 feet. As shown on the as-built LOTB sheets in Appendix A, groundwater was encountered at elevation +59.5 feet in December 1993, and between elevations +72.2 feet and +73.5 feet in March 1955. Using the above groundwater measurements, a wet construction may be required for the CIDH piles at the bent locations. Groundwater is not anticipated to be encountered during footing construction. However, groundwater level can fluctuate due to seasonal rainfall amount, local irrigation and groundwater recharge program and other man-made conditions. If groundwater is encountered during footing construction, it should be controlled in accordance with Section 19-3.03D of the Caltrans Standard Specifications (2010b).

6.2 PILE CONSTRUCTION

Construction of CIDH piles should follow Section 49-4.03B, "Drilled Holes" of the Caltrans Standard Specifications (2010b). The Contractor should be required to drill the bottom of the shaft boring with a clean-out bucket to ensure adequate removal of loose soils. Both clean-out and concrete placement should be addressed in the specifications. The shaft borings should be inspected and approved by the Resident Engineer prior to installation of reinforcement. Per latest Caltrans requirement, 3-inch of concrete cover over reinforcement should be provided to improve the construction of the CIDH piles.

Based on groundwater measurements shown on the LOTB sheets in Appendix A, a wet construction is anticipated. Contractor should be fully prepared to implement the Caltrans Standard Specifications and Special Provisions for a wet construction. Localized dewatering is not recommended because the operation could induce soil settlement which could damage buried utilities and nearby structures including the existing bridge.

Special pile layout is presented by RBF for Bent 2 footing due to proximity to the storm drain. Two of the piles near the storm drain will be installed inside the 30-inch diameter casings. The recommended length of the casing is 4 feet.

The onsite fill and alluvial soils generally range from loose to very dense coarse grained materials, and these materials are susceptible to caving. If caving occurs, a temporary casing can be used. The casing should have an inside diameter larger than or equal to the pile diameter and should be placed tight in the hole. Vibratory hammers or oversized drilling are not allowed for casing installation. In the event that any boring becomes bell-shaped and cannot be advanced due to severe caving, all loose material should be removed from the bottom of the boring and the caved region filled with a low strength sand-cement slurry. Drilling may continue when the slurry has reached its initial set.

6.3 GROUND ANCHOR INSTALLATION

Ground anchors should be constructed and proof-tested in the field in accordance with Caltrans procedures and specifications. The contractor is responsible for determining the bonded length of ground anchors. Minimum bonded length is 15 feet. The unbonded length should not be less than 15 feet.

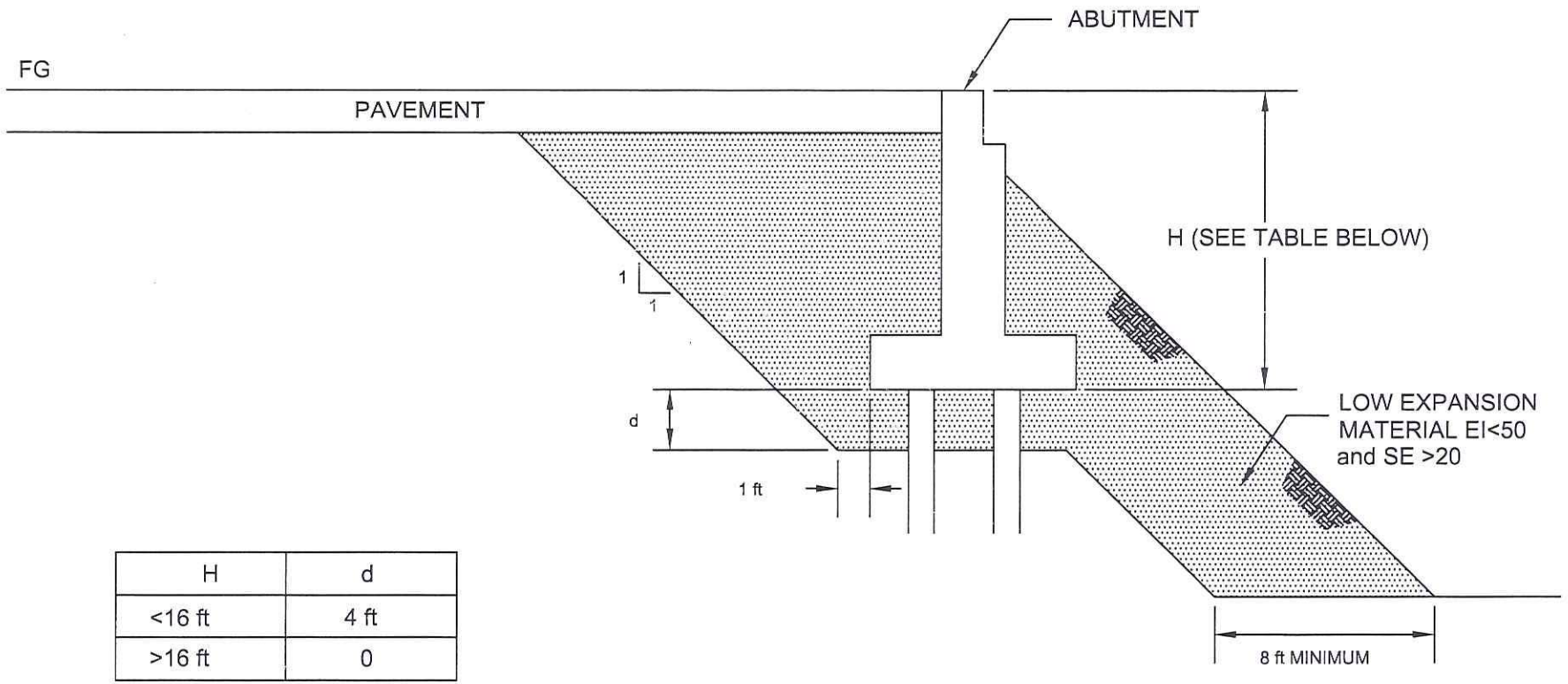
The anchors should be inclined at least 10° to facilitate tendon installation and grouting. Ground anchors should not be spaced closer than five diameters of the bonded zone or 5 feet, whichever is greater. The ground anchors should be located to maximize their distance from the abutment piles.

The contractor should exercise care to minimize impact to the abutment and piles due to the installation of ground anchors and construction of the ground anchor wall. We recommend that a monitoring program be implemented during construction to monitor movement of the abutment. If the measured vertical or lateral movement is excessive, construction should be stopped immediately and measures to mitigate the movement should be implemented.

6.4 BACKDRAIN AND BACKFILL REQUIREMENTS FOR ABUTMENT WALLS

Expansive soils should not be placed as part of the embankment within the limits of a bridge abutment as shown in Figure 6-1. Materials placed behind abutment walls should be low-expansive soil with an Expansion Index (EI) less than 50 and Sand Equivalent (SE) of more than 20. The low-expansive material requirement should be supplemental to the abutment structure and pervious backfill requirement as described in Caltrans Standard Plans (2010a) and Caltrans Standard Specifications (2010b) under Sections 19-3.03E and 19-3.03G, respectively.

Backfill should be compacted in accordance with Section 19-5 of the Caltrans Standard Specifications (2010b). Backfill should be placed in loose lifts not exceeding 8 inches in thickness, moisture-conditioned to near optimum moisture content, and compacted to at least 95 percent relative compaction. The relative compaction should be based on the maximum density determined by California Test Method 216. Jetting or flooding to compact backfill is not recommended. Heavy compaction equipment, such as vibratory rollers, dozers, or loaders, should not be used adjacent to the abutment walls in order to avoid damaging the walls due to large lateral earth pressures.



H	d
<16 ft	4 ft
>16 ft	0

EXPANSION INDEX TO BE DETERMINED BY ASTM D4829
SAND EQUIVALENT TO BE DETERMINED BY CALIFORNIA TEST METHOD 217

NO SCALE

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Brookhurst Street UC (Widen)

Project No. 10-126 | Date: 03-10-11

Low Expansion Material
In Bridge Embankment

Figure 6-1

Backdrains should be installed behind abutment walls to relieve hydrostatic pressure. Backdrains should be constructed in accordance with Bridge Detail 3-1 on Sheet B0-3 per Caltrans Standard Plans (2010a) or the geocomposite drain alternative per Section 6 of the Caltrans Bridge Design Details (1992).

6.5 REVIEW OF CONSTRUCTION PLANS

Recommendations contained in this report are based on preliminary plans. The geotechnical consultant should review the final construction plans and specifications in order to confirm that the general intent of the recommendations contained in this report have been incorporated into the final construction documents. Recommendations contained in this report may require modification or additional recommendations may be necessary based on the final design.

6.6 GEOTECHNICAL OBSERVATION AND TESTING

It is recommended that inspections and testing be performed by the geotechnical consultant during the following stages of construction:

- Grading operations, including excavations and placement of compacted fill
- Shoring installation
- Footing excavations and pile constructions
- Ground anchor wall installation
- Backdrain installation and backfilling of bridge abutment walls
- Removal or installation of support of buried utilities or structures
- When any unusual subsurface conditions are encountered

7.0 LIMITATIONS

This report is intended for the use of OCTA, RBF and Caltrans for the widening of Brookhurst Street UC. This report is based on the project as described and the information obtained from the exploratory borings at the approximate locations indicated on the attached plans. The findings and recommendations contained in this report are based on the results of the field investigation, laboratory tests, and engineering analyses. In addition, soils and subsurface conditions encountered in the exploratory borings are presumed to be representative of the project site. However, subsurface conditions and characteristics of soils between exploratory borings can vary. The findings reflect an interpretation of the direct evidence obtained. The recommendations presented in this report are based on the assumption that an appropriate level of quality control and quality assurance (inspections and tests) will be provided during construction. EMI should be notified of any pertinent changes in the project plans or if subsurface conditions are found to vary from those described herein. Such changes or variations may require a re-evaluation of the recommendations contained in this report.

The data, opinions, and recommendations contained in this report are applicable to the specific design element(s) and location(s) which is (are) the subject of this report. They have no applicability to any other design elements or to any other locations and any and all subsequent users accept any and all liability resulting from any use or reuse of the data, opinions, and recommendations without the prior written consent of EMI.

EMI has no responsibility for construction means, methods, techniques, sequences, or procedures; for safety precautions or programs in connection with the construction; for the acts or omissions of the CONTRACTOR or any other person performing any of the construction; or for the failure of any worker to carry out the construction in accordance with the Final Construction Drawings and Specifications.

Services performed by EMI have been conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, expressed or implied, and no warranty or guarantee is included or intended.

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Appendix A

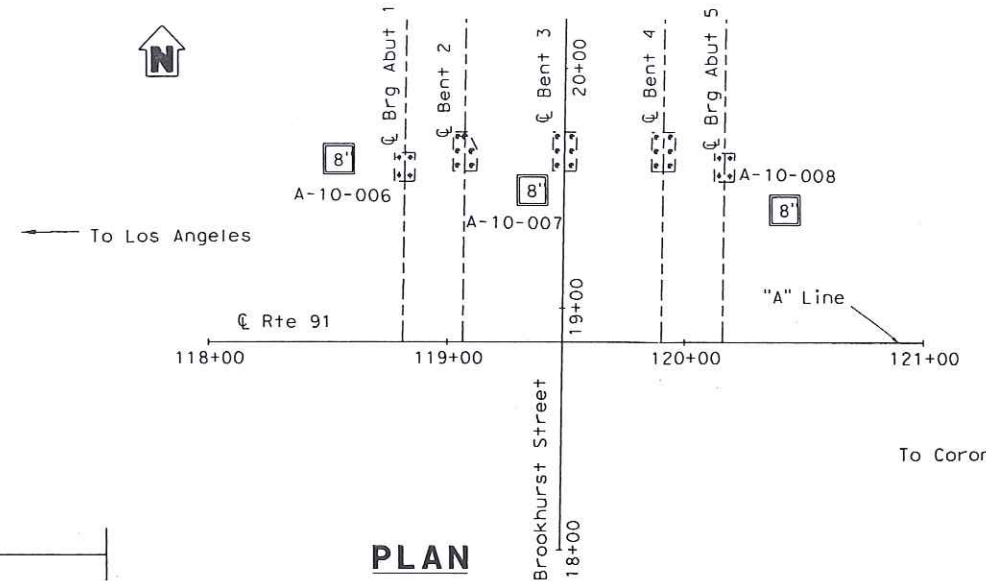
LOG OF TEST BORINGS SHEETS

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



PLAN
1" = 40'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER — DATE 09/16/11

S. PIRATHIVIRAJ NO. C71662 EXP. 12/31/11 REGISTERED PROFESSIONAL ENGINEER CIVIL STATE OF CALIFORNIA

PLANS APPROVAL DATE

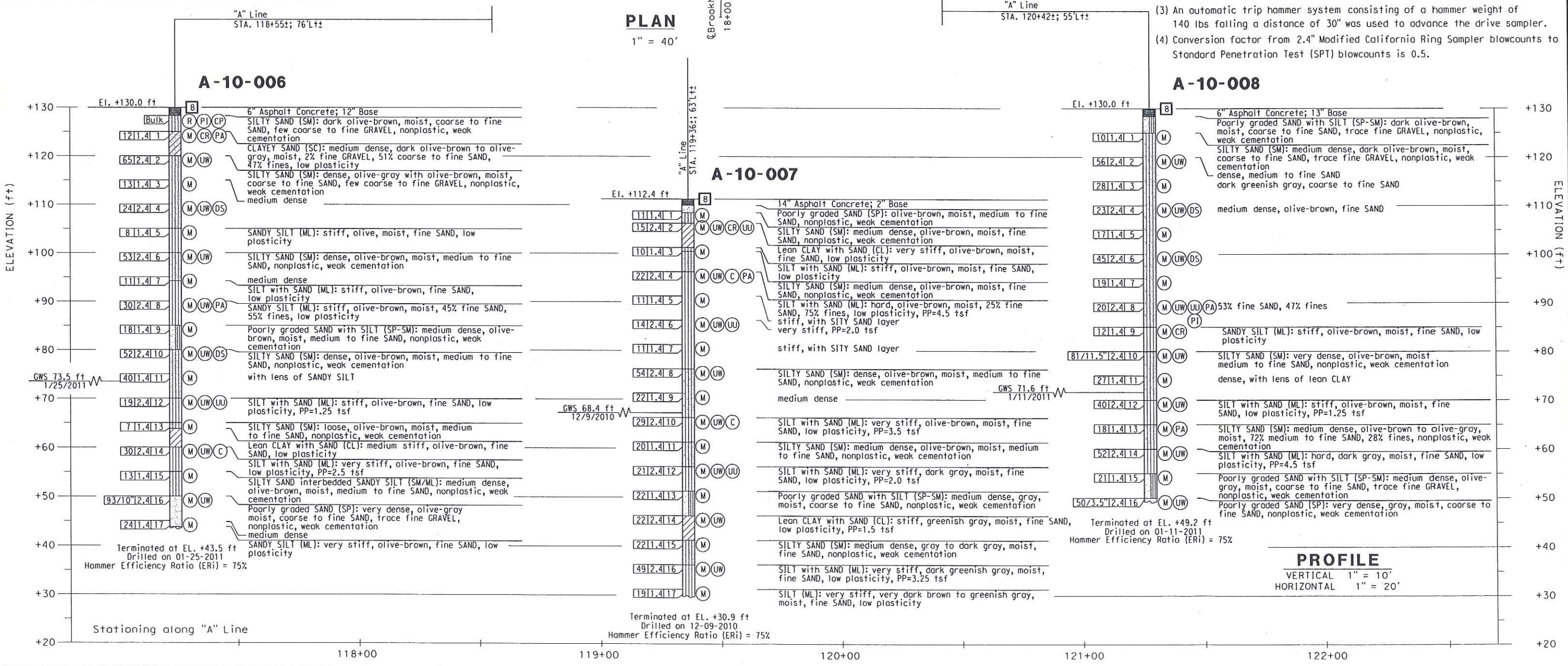
The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).
(2) 2.4" samples were taken using a California Modified Sampler.
(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.
(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.



PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. 55-0280	BROOKHURST STREET UC (WIDEN)
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011				POST MILES 1.2	LOG OF TEST BORINGS 1 OF 5

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER — DATE 09/16/11

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

CEMENTATION

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

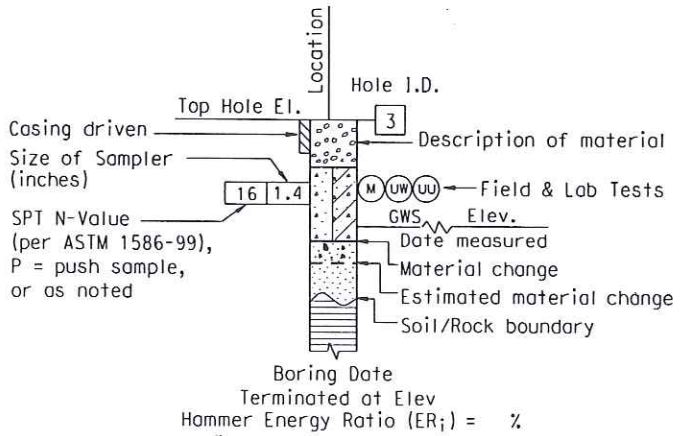
BOREHOLE IDENTIFICATION

Symbol	Hole Type	Description
Size	A	Auger Boring (hollow or solid stem bucket)
Size	R	Rotary drilled boring (conventional)
	RW	Rotary drilled with self-casing wire-line
	RC	Rotary core with continuously-sampled, self-casing wire-line
	P	Rotary percussion boring (air)
Size	R	Rotary drilled diamond core
Size	HD	Hand driven (1-inch soil tube)
	HA	Hand Auger
●	D	Dynamic Cone Penetration Boring
▲	CPT	Cone Penetration Test (ASTM D 5778)
[ ]	O	Other (note on LOTB)

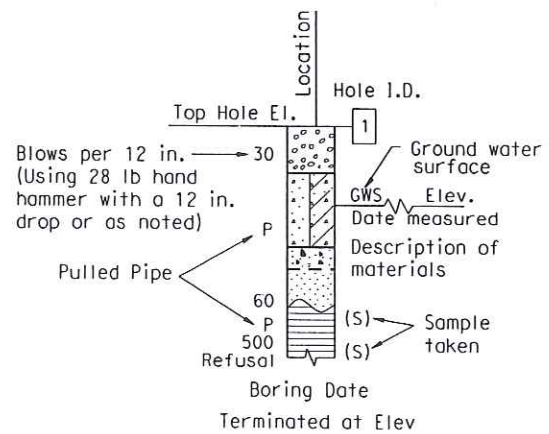
Note: Size in inches.

CONSISTENCY OF COHESIVE SOILS

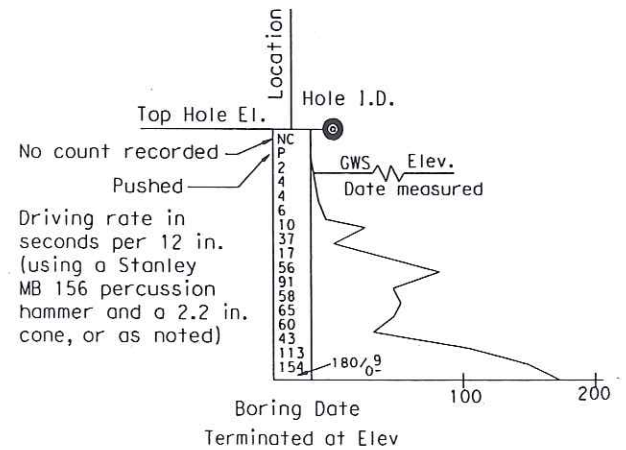
Description	Shear Strength (tsf)	Pocket Penetrometer Measurement, PP, (tsf)	Torvane Measurement, TV, (tsf)	Vane Shear Measurement, VS, (tsf)
Very Soft	Less than 0.12	Less than 0.25	Less than 0.12	Less than 0.12
Soft	0.12 - 0.25	0.25 - 0.5	0.12 - 0.25	0.12 - 0.25
Medium Stiff	0.25 - 0.5	0.5 - 1	0.25 - 0.5	0.25 - 0.5
Stiff	0.5 - 1	1 - 2	0.5 - 1	0.5 - 1
Very Stiff	1 - 2	2 - 4	1 - 2	1 - 2
Hard	Greater than 2	Greater than 4	Greater than 2	Greater than 2



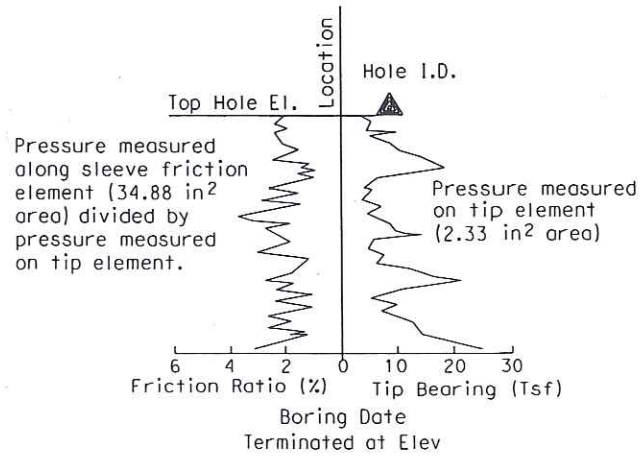
ROTARY BORING



HAND BORING



DYNAMIC CONE PENETRATION BORING



CONE PENETRATION TEST (CPT) BORING

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. 55-0280	BROOKHURST STREET UC (WIDEN)
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011		PROJECT ENGINEER	POST MILES 1.2	LOG OF TEST BORINGS 2 OF 5

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

GROUP SYMBOLS AND NAMES

Graphic/Symbol	Group Names	Graphic/Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND	CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
GP	Poorly-graded GRAVEL Poorly-graded GRAVEL with SAND		
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND	CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GP-GM	Poorly-graded GRAVEL with SILT Poorly-graded GRAVEL with SILT and SAND	ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
GP-GC	Poorly-graded GRAVEL with CLAY (or SILTY CLAY) Poorly-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GM	SILTY GRAVEL SILTY GRAVEL with SAND	OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND		
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND	OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL		
SP	Poorly-graded SAND Poorly-graded SAND with GRAVEL	CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL		
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
SP-SM	Poorly-graded SAND with SILT Poorly-graded SAND with SILT and GRAVEL		
SP-SC	Poorly-graded SAND with CLAY (or SILTY CLAY) Poorly-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
SM	SILTY SAND SILTY SAND with GRAVEL		
SC	CLAYEY SAND CLAYEY SAND with GRAVEL	OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY ORGANIC elastic SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL		
PT	PEAT	OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND
	COBBLES COBBLES and BOULDERS BOULDERS		

FIELD AND LABORATORY TESTING

- (C) Consolidation (ASTM D 2435)
- (CL) Collapse Potential (ASTM D 5333)
- (CP) Compaction Curve (CTM 216)
- (CR) Corrosivity Testing (CTM 643, CTM 422, CTM 417)
- (CU) Consolidated Undrained Triaxial (ASTM D 4767)
- (DS) Direct Shear (ASTM D 3080)
- (EI) Expansion Index (ASTM D 4829)
- (M) Moisture Content (ASTM D 2216)
- (OC) Organic Content-% (ASTM D 2974)
- (P) Permeability (CTM 220)
- (PA) Particle Size Analysis (ASTM D 422)
- (PI) Plasticity Index (AASHTO T 90) Liquid Limit (AASHTO T 89)
- (PL) Point Load Index (ASTM D 5731)
- (PM) Pressure Meter
- (R) R-Value (CTM 301)
- (SE) Sand Equivalent (CTM 217)
- (SG) Specific Gravity (AASHTO T 100)
- (SL) Shrinkage Limit (ASTM D 427)
- (SW) Swell Potential (ASTM D 4546)
- (UC) Unconfined Compression-Soil (ASTM D 2166) Unconfined Compression-Rock (ASTM D 2938)
- (UU) Unconsolidated Undrained Triaxial (ASTM D 2850)
- (UW) Unit Weight (ASTM D 4767)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER — DATE 09/16/11

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

APPARENT DENSITY OF COHESIONLESS SOILS

Description	SPT N_{60} (Blows / 12 in.)
Very Loose	0 - 5
Loose	5 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Greater than 50

MOISTURE

Description	Criteria
Dry	No discernable moisture
Moist	Moisture present, but no free water
Wet	Visible free water

PERCENT OR PROPORTION OF SOILS

Description	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5% - 10%
Little	15% - 25%
Some	30% - 45%
Mostly	50% - 100%

PARTICLE SIZE

Description		Size (in.)
Boulder		Greater than 12
Cobble		3 - 12
Gravel	Coarse	3/4 - 3
	Fine	1/5 - 3/4
Sand	Coarse	1/16 - 1/5
	Medium	1/64 - 1/16
	Fine	1/300 - 1/64
Silt and Clay		Less than 1/300

DESIGN OVERSIGHT — SIGN OFF DATE

DRAWN BY: J. Fang — CHECKED BY: S. Pirathiviraj

R. Jie — FIELD INVESTIGATION BY:

DATE: 12/2010,1/2011

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

S. Pirathiviraj — PROJECT ENGINEER

BRIDGE NO.	BROOKHURST STREET UC (WIDEN)
55-0280	
POST MILES 1.2	LOG OF TEST BORINGS 3 OF 5

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 1200000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

USERNAME => %USER DATE PLOTTED => %DATE TIME PLOTTED => %TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	Ora	91	10/28	256	312

9-16-96
TO ACCOMPANY PLANS DATED

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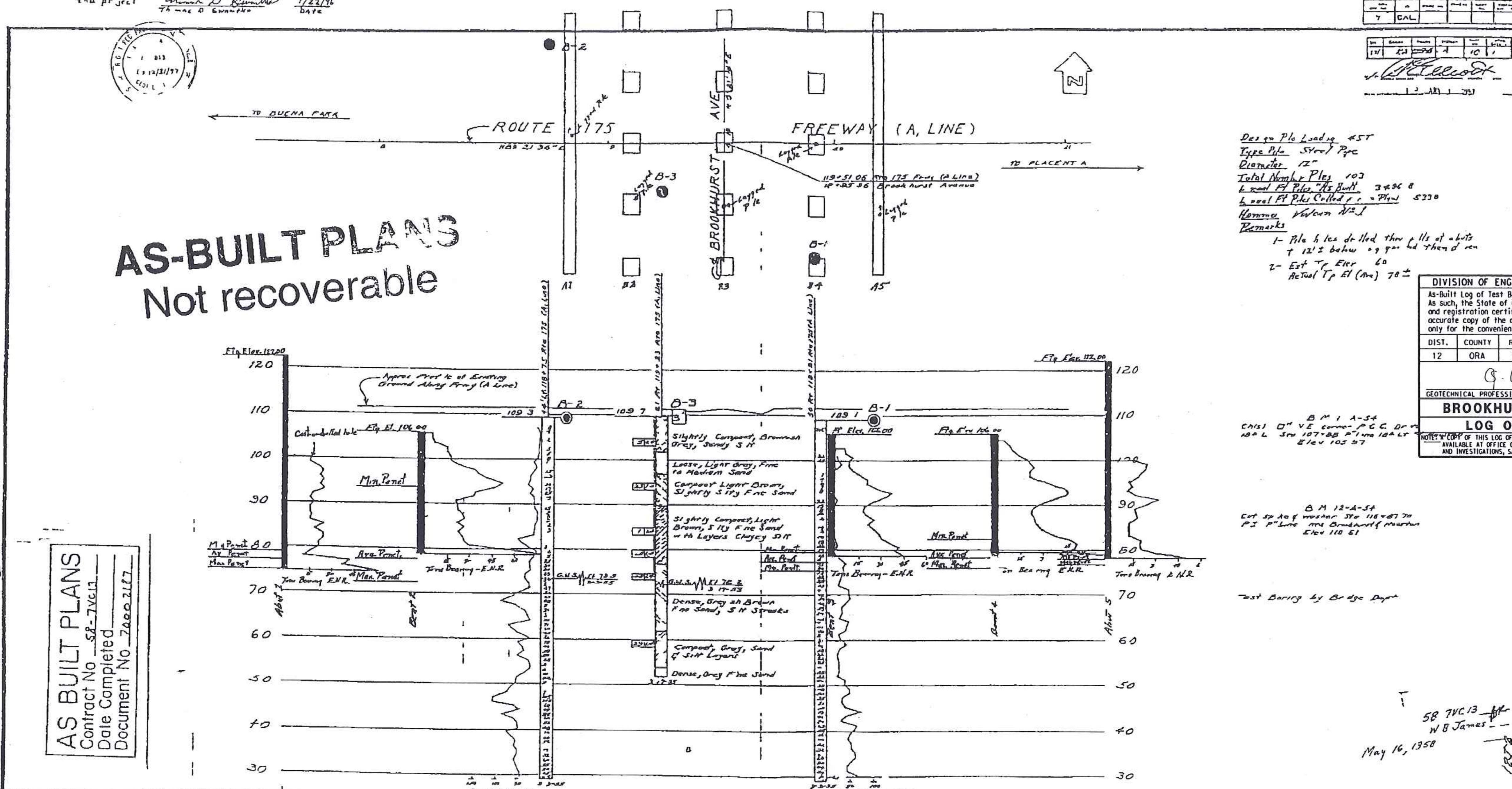
AS-BUILT PLANS
Not recoverable



ORIGINAL
BRIDGE DEPARTMENT

AS BUILT PLANS
Contract No 58-7VC13
Date Completed
Document No 70002187

DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES

As-Built Log of Test Borings sheet is considered an informational document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date confirm that this is a true and accurate copy of the original document. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.

DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
12	ORA	91	0.9/5.4		

GEOTECHNICAL PROFESSIONAL — 09/16/11 DATE

BROOKHURST STREET UC (WIDEN)
LOG OF TEST BORINGS 4 OF 5

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

BRIDGE No.	Sheet	of
55-0280	1	1

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

NOTES

BROOKHURST AVE U C
LOG OF TEST BORINGS

CLASSIFICATION OF MATERIAL BASED ON STANDARD GRADE SIZE LIMITS

LEGEND OF EARTH MATERIALS

LEGEND OF BORING OPERATIONS

NOTE:
ADDITIONAL AS BUILT FOUNDATION DATA MAY BE AVAILABLE AT THE DIVISION OF NEW TECHNOLOGY MATERIALS AND RESEARCH 5900 FOLSOM BOULEVARD SACRAMENTO CALIFORNIA 95819

	BY	CHECKED
DESIGN	J Bishop	Y Hu
DETAILS	K Dang	Y Hu
QUANTITIES	J Bishop	T Young

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

J S Bishop
PROJECT ENGINEER

CU 12209

BRIDGE NO 55 280
POST MILE 12

BROOKHURST AVENUE UNDERCROSSING (WIDEN)
AS-BUILT LOG OF TEST BORINGS

ORIGINAL SCALE IN INCHES
DISREGARD PRINTS BEARING EARLIER REVISION DATES
REVISION DATES (PRELIMINARY STAGE ONLY)
SHEET OF

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	Ora	91	10/28	255	312

Thomas D Swantko 3/5/96
GEOTECHNICAL PROFESSIONAL

9-16-96
PLANS APPROVAL DATE

THOMAS D SWANTKO — No. GE 933 — EXP 12/31/97 — GEOTECHNICAL — STATE OF CALIFORNIA

GEOFON Inc
5552 Cerritos Ave Ste B
Cypress Calif 90630
Job Number 92 336

DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES

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DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
12	ORA	91	0.9/5.4		

09/16/11
GEOTECHNICAL PROFESSIONAL — DATE

BROOKHURST STREET UC (WIDEN)

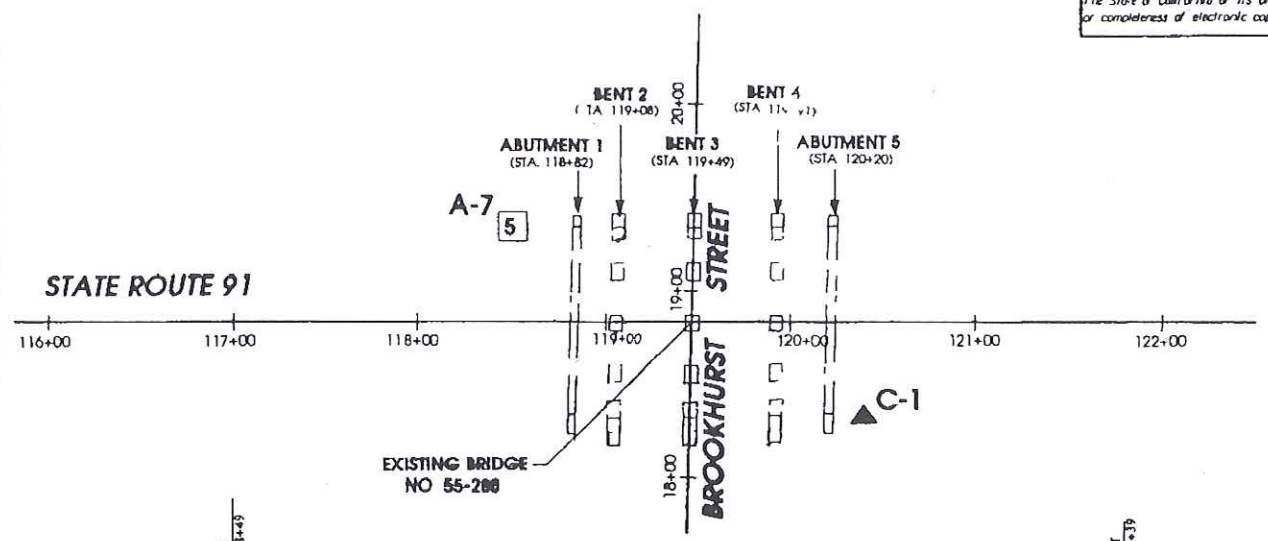
LOG OF TEST BORINGS 5 OF 5

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

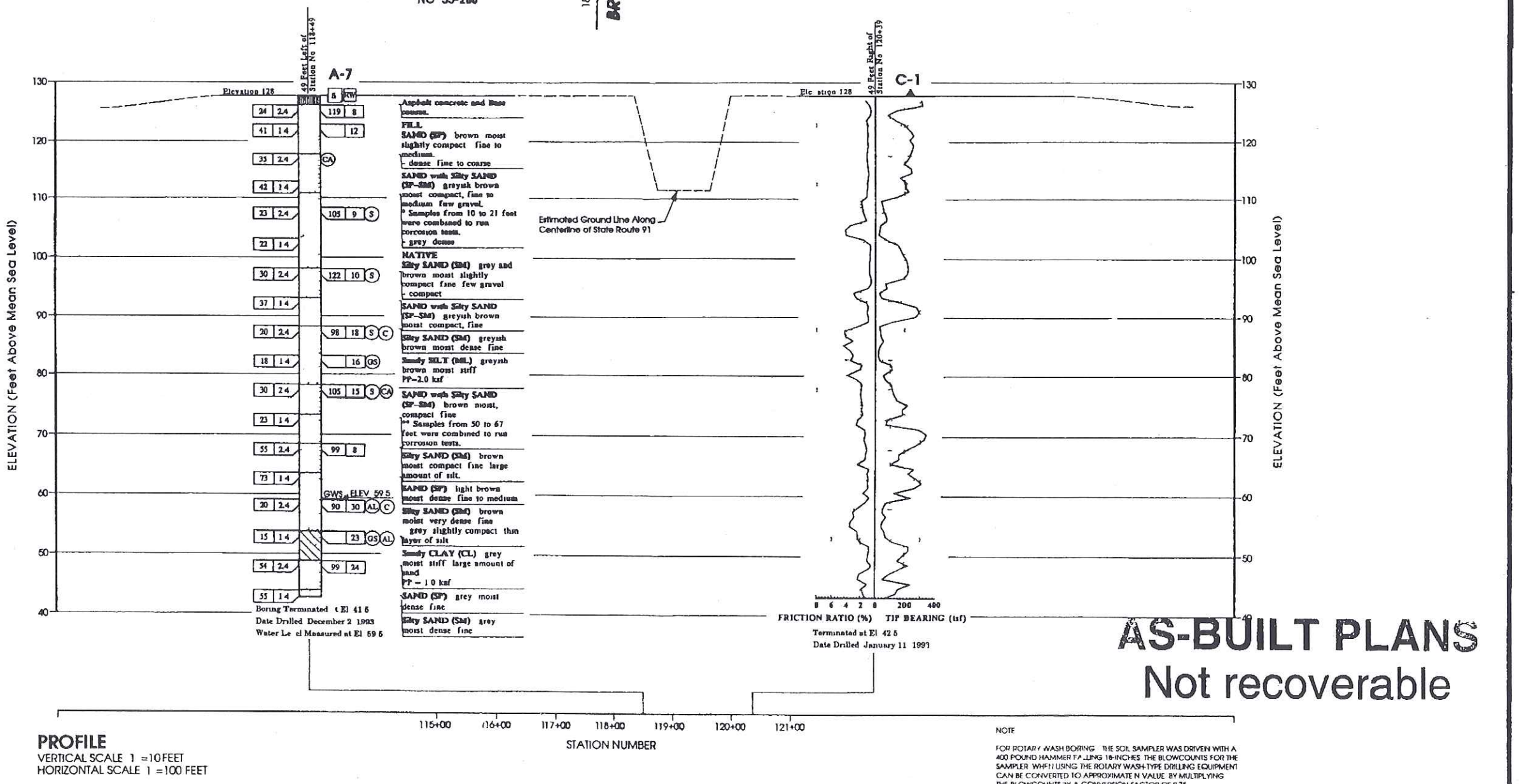
BRIDGE No.	Sheet	of
55-0280	1	1

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA



PLAN
SCALE 1 =50 FEET

PHOTO CONTROL POINT 2080
NULL & FLASH ON SURFACE
274 FEET LEFT OF STATION 116+61 CENTERLINE ROUTE 91
ELEVATION 107 52

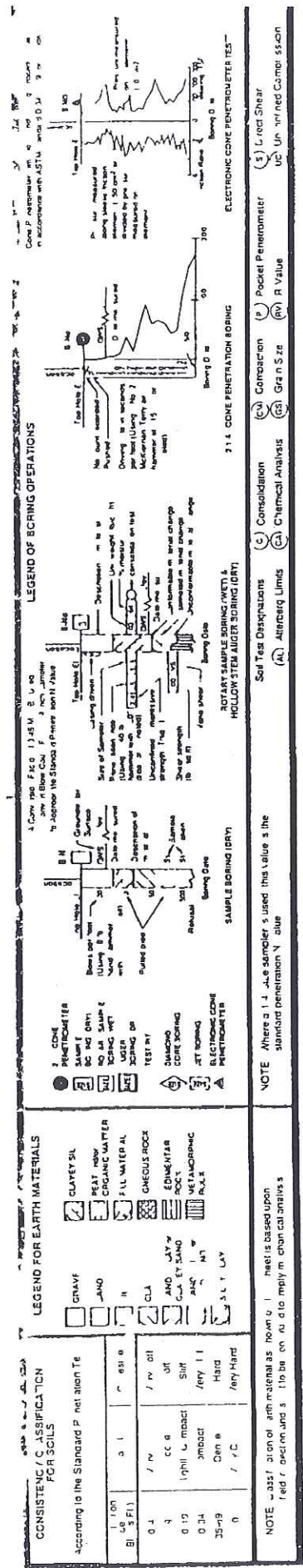


PROFILE
VERTICAL SCALE 1 =10 FEET
HORIZONTAL SCALE 1 =100 FEET

AS-BUILT PLANS
Not recoverable

NOTE

FOR ROTARY WASH BORING THE SOIL SAMPLER WAS DRIVEN WITH A 400 POUND HAMMER FALLING 18-INCHES THE BLOWCOUNTS FOR THE SAMPLER WHEN USING THE ROTARY WASH-TYPE DRILLING EQUIPMENT CAN BE CONVERTED TO APPROXIMATE N VALUE BY MULTIPLYING THE BLOWCOUNTS BY A CONVERSION FACTOR OF 0.75



DESIGN OVERSIGHT	DRAWN BY	CHECKED BY	FIELD INVESTIGATOR	PREPARED FOR THE	PROJECT ENGINEER	BRIDGE NO	POST MILE
4-27-96	H LEE	D MAR	J KNIGHT SEE EXPLORATION	STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION		55 280	09.6/28.8

SIGN OFF DATE — DATE

BRIDGE NO 55 280
POST MILE 09.6/28.8

BROOKHURST AVENUE UNDERCROSSING (WIDEN)

LOG OF TEST BORINGS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 12209
EA 012411

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRE PRIMARY STAGE ONLY)

SHEET 15 OF 16

PLATE 1

Appendix B

LABORATORY TEST RESULTS

TABLE B-1 SUMMARY OF LABORATORY TEST RESULTS

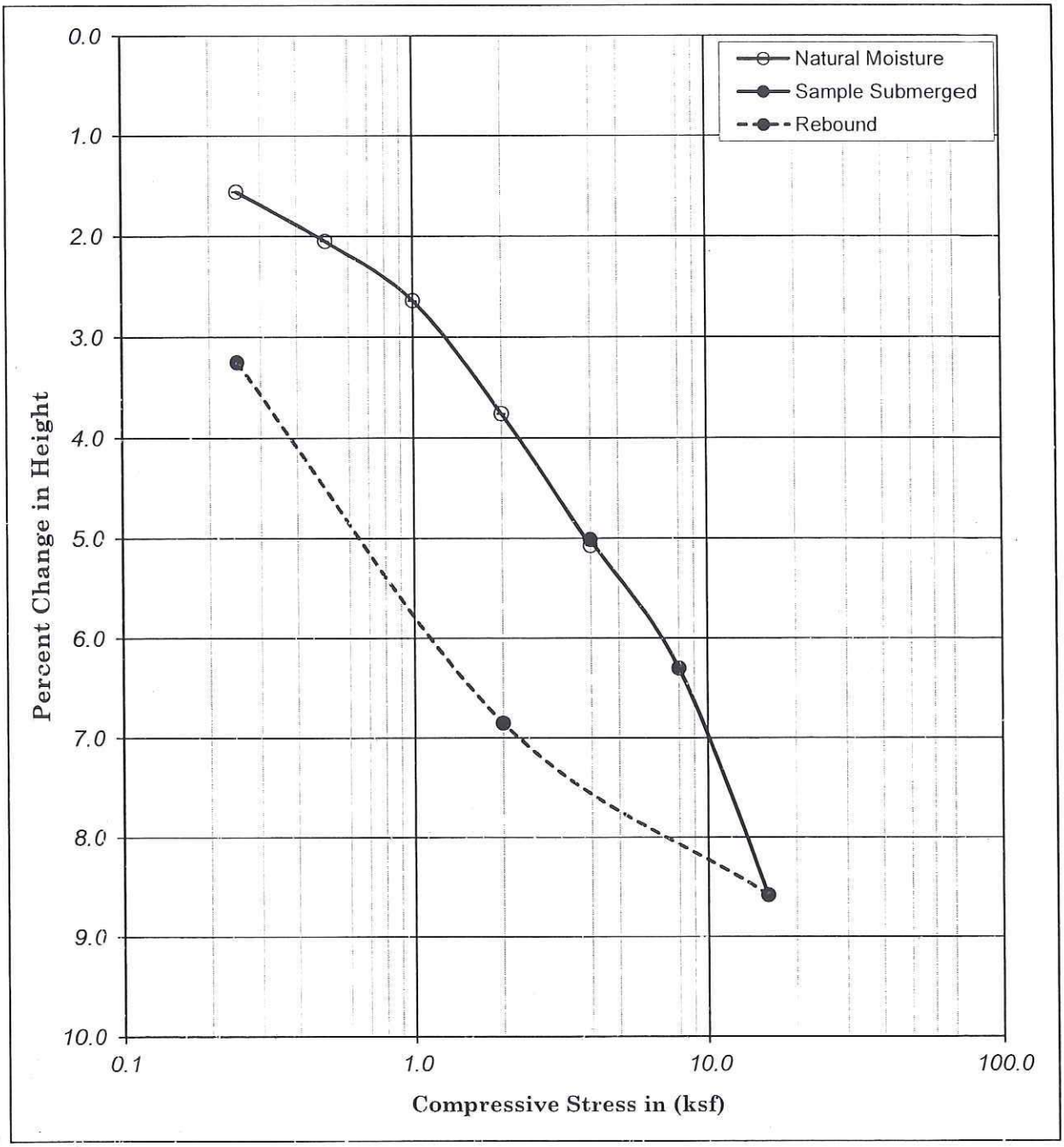
Project No. : 10-126 Project Name : Brookhurst Street UC (Widen)

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-006	S-1	5	SC	15.3				2:51:47			2600	8.5	10	83
A-10-006	D-2	10	SM	11.7	134.0									
A-10-006	S-3	15	SM	12.9										
A-10-006	D-4	20	SM	8.3	122.8									
A-10-006	S-5	25	ML	15.3										
A-10-006	D-6	30	SM	6.1	129.3									
A-10-006	S-7	35	SM to ML	28.9										
A-10-006	D-8	40	ML	15.3	130.3			0:45:55						
A-10-006	S-9	45	SP-SM	4.0										
A-10-006	D-10	50	SM	23.5	119.9									
A-10-006	S-11	55	SM	22.5										
A-10-006	D-12	60	ML	34.1	123.1	1.25								
A-10-006	S-13	65	SM to CL	22.9										
A-10-006	D-14	70	ML	32.0	120.7	2.5								
A-10-006	S-15	75	SM/ML	19.7										
A-10-006	D-16	80	SP	14.6	137.2									
A-10-006	S-17	85	SP-SM to ML	15.4										
A-10-007	S-1	2.5	SP to SM	11.1										
A-10-007	D-2	5	CL	18.6	125.4	3.75								
A-10-007	S-3	10	ML to SM	10.9										
A-10-007	D-4	15	ML	18.6	118.5	4.5		0:25:75						
A-10-007	S-5	20	ML	5.9										
A-10-007	D-6	25	ML	19.9	126.7	2.0								
A-10-007	S-7	30	ML	15.0										
A-10-007	D-8	35	SM	12.1	126.8									
A-10-007	S-9	40	SM	22.3										
A-10-007	D-10	45	ML	26.7	129.7	3.5								
A-10-007	S-11	50	SM	19.0										
A-10-007	D-12	55	ML	27.1	115.1	2.0								
A-10-007	S-13	60	SP-SM	21.1										
A-10-007	D-14	65	CL	30.2	121.2	1.5								
A-10-007	S-15	70	SM	29.4										
A-10-007	D-16	75	ML	22.8	124.5	3.25								
A-10-007	S-17	80	ML	29.2										
A-10-008	S-1	5	SM	10.3										
A-10-008	D-2	10	SM	10.5	127.0									
A-10-008	S-3	15	SM	10.4										
A-10-008	D-4	20	SM	11.1	131.0									
A-10-008	S-5	25	SM	17.7										

TABLE B-1 SUMMARY OF LABORATORY TEST RESULTS

Project No. : *10-126* Project Name : Brookhurst Street UC (Widen)

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-008	*D-6*	30	SM	8.1	125.8									
A-10-008	*S-7*	35	SM	15.9										
A-10-008	*D-8*	40	SM	18.5	131.6			0:53:47		20/17/3				
A-10-008	*S-9*	45	ML	16.0							2200	8.0	60	161
A-10-008	*D-10*	50	SM	9.7	115.1									
A-10-008	*S-11*	55	SM	21.9										
A-10-008	*D-12*	60	ML	25.0	123.6	1.25								
A-10-008	*S-13*	65	SM	24.1				0:72:28						
A-10-008	*D-14*	70	ML	26.5	119.6	4.5								
A-10-008	*S-15*	75	SP-SM	23.0										
A-10-008	*D-16*	80	SP	17.4	132.6									



Boring No. : A-10-006				Liquid Limit :	-		Moisture Content (%)	Dry Density (pcf)	Dry Density (kN/m³)	Percent Saturation	Void Ratio
Sample No. : D-14				Plastic Limit :	-						
Depth	(ft) :	70.0	71.5	Plastic Index :	-	Initial	33.19	89.62	14.11	101.73	0.88
	(m) :	21.35	21.81	Specific Gravity :	2.70	Final	32.46	92.73	14.60	107.15	0.82
Description : Olive-brown, SILT with SAND											

Earth Mechanics, Inc.
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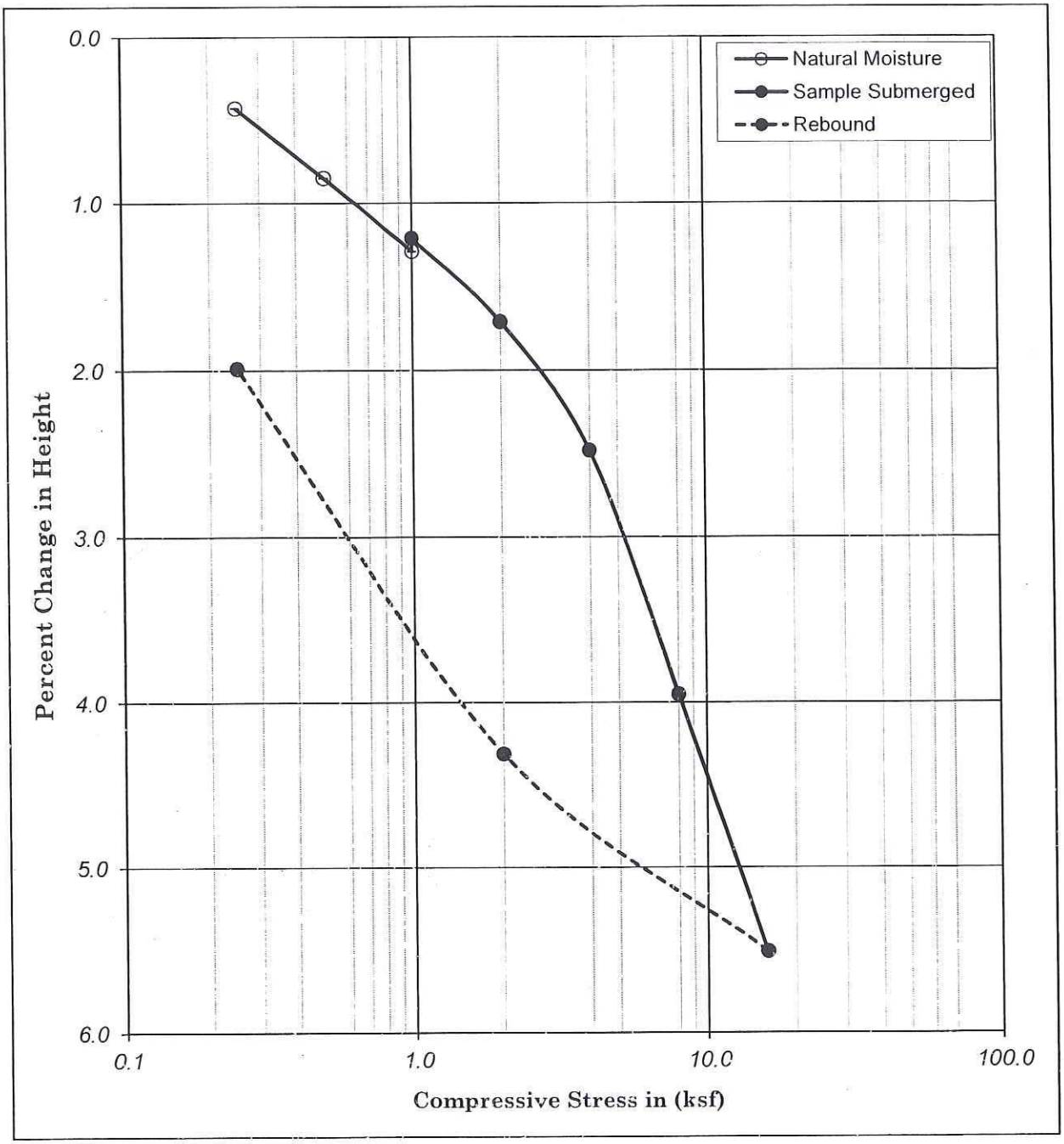
Brookhurst Street UC (Widen)

Project No. : 10-126 02/24/11

CONSOLIDATION TEST
(ASTM D-2435 / CT-219)



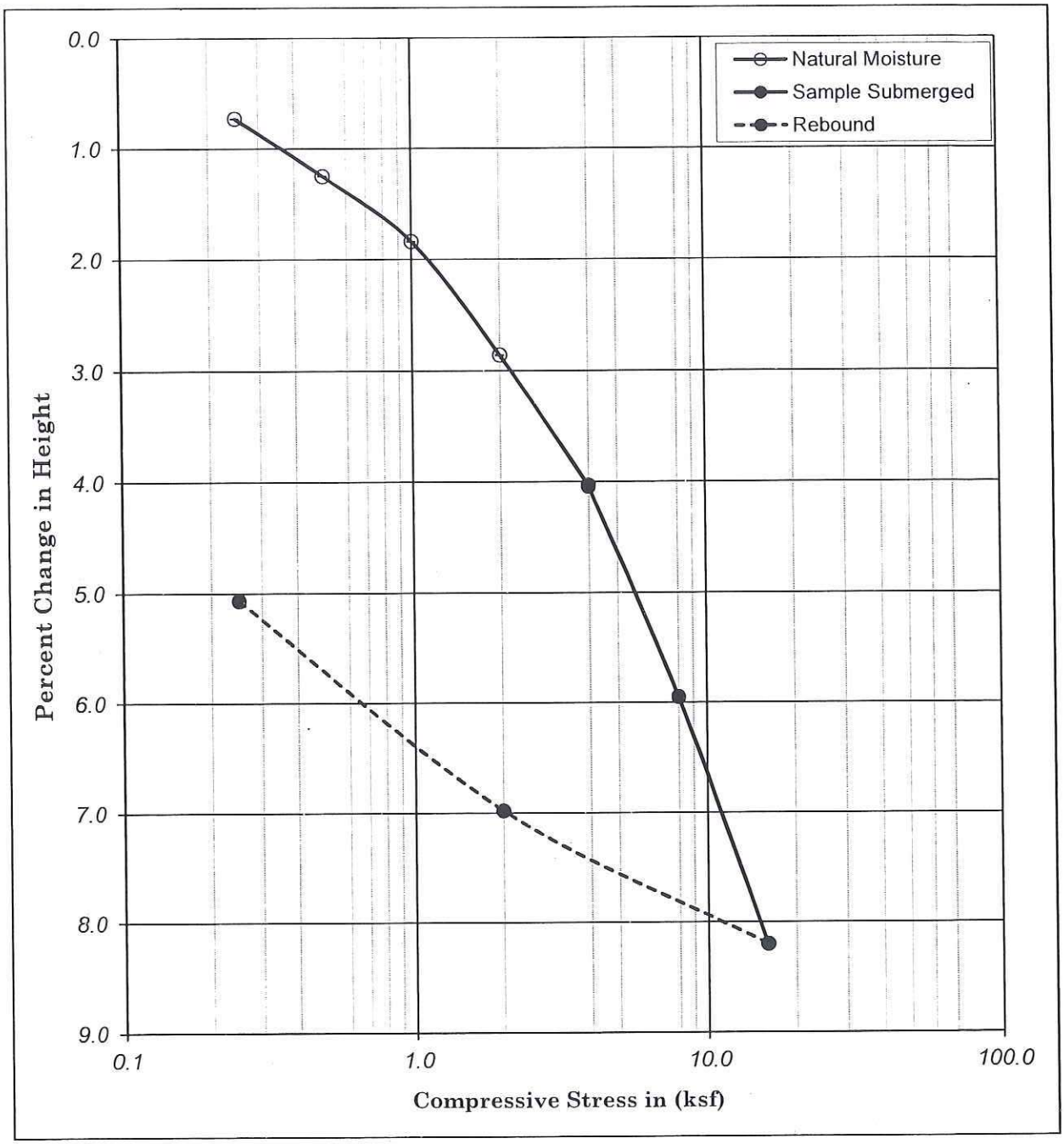
Boring No. : A-10-007			Liquid Limit :	-		Moisture Content (%)	Dry Density (pcf)	Dry Density (kN/m^3)	Percent Saturation	Void Ratio
Sample No. : D-4			Plastic Limit :	-						
Depth	(ft) : 15.0	16.5	Plastic Index :	-	Initial	23.57	99.57	15.67	91.83	0.69
	(m) : 4.58	5.03	Specific Gravity :	2.70	Final	26.34	101.60	15.99	107.89	0.66
Description : Olive-brown, SILT with SAND (ML)										

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Brookhurst Street UC (Widen)

Project No. : 10-126 02/24/11

CONSOLIDATION TEST
(ASTM D-2435 / CT-219)



Boring No.	: A-10-007		Liquid Limit :	-		Moisture Content (%)	Dry Density (pcf)	Dry Density (kN/m³)	Percent Saturation	Void Ratio
Sample No.	: D-10		Plastic Limit :	-						
Depth (ft)	: 45.0	46.5	Plastic Index :	-	Initial	23.29	103.75	16.33	100.65	0.62
Depth (m)	: 13.73	14.18	Specific Gravity :	2.70	Final	21.85	109.41	17.22	109.11	0.54

Description : Olive-brown, SILT with SAND (ML)

Earth Mechanics, Inc.
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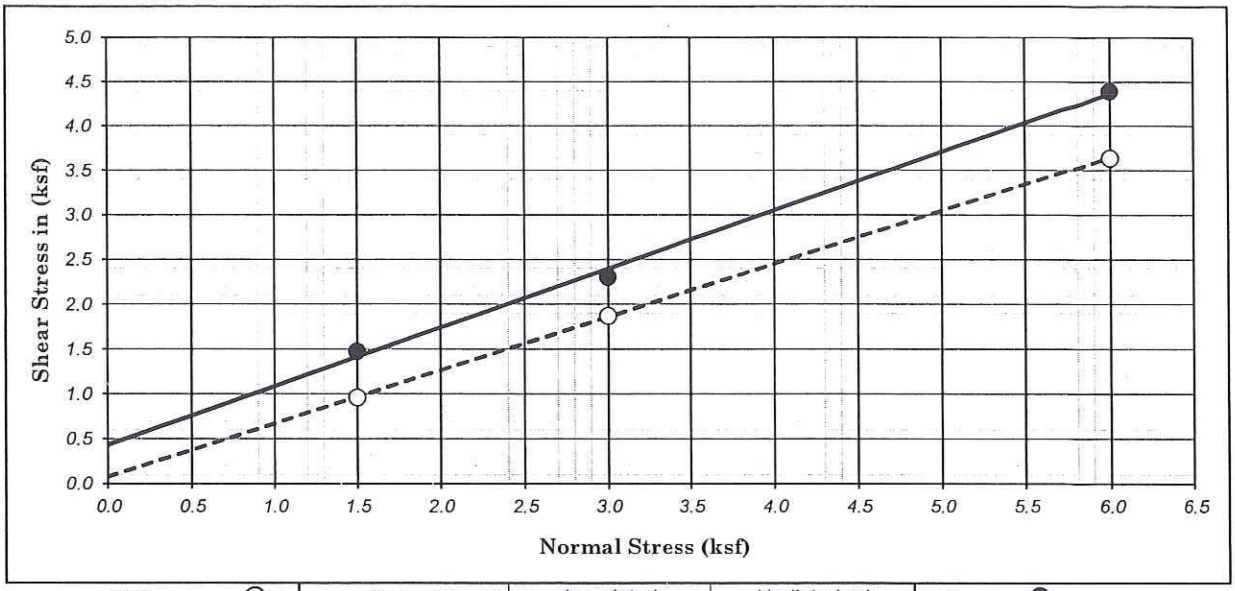
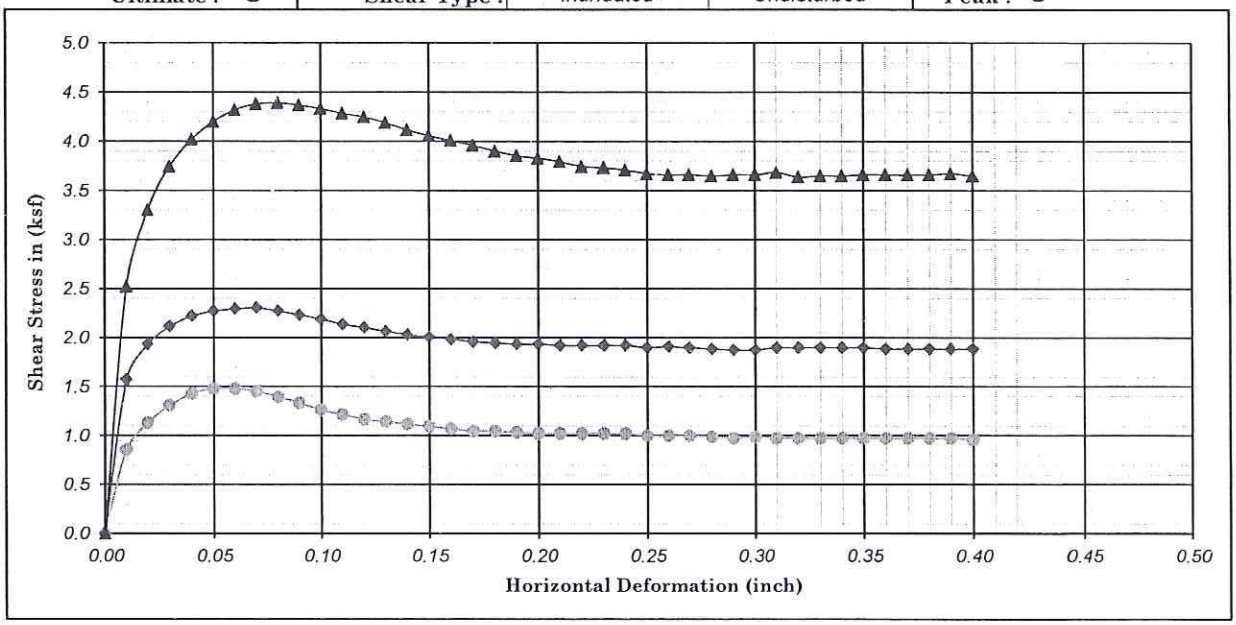
Brookhurst Street UC (Widen)

Project No. : 10-126 02/24/11

CONSOLIDATION TEST
(ASTM D-2435 / CT-219)



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-006		Strength Intercept (C) :	0.43	(ksf)	Peak	0.08	(ksf)	Ultimate
Sample No. : D-4			20.68	(kPa)		3.73	(kPa)	
Depth (ft/m) : 20.0	0.00	Friction Angle (ϕ) :	33.22	Degree		30.70	Degree	
Description : Olive-gray with olive-brown, SILTY SAND (SM)					Shear Rate (inch/minute) :			0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	15.76	102.81	16.18	0.64	1.50	71.82	1.48	70.67	0.96	45.96
◆	15.71	102.38	16.11	0.65	3.00	143.64	2.30	110.32	1.87	89.63
▲	16.43	106.14	16.71	0.59	6.00	287.28	4.39	210.29	3.64	174.09

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Brookhurst Street UC (Widen)

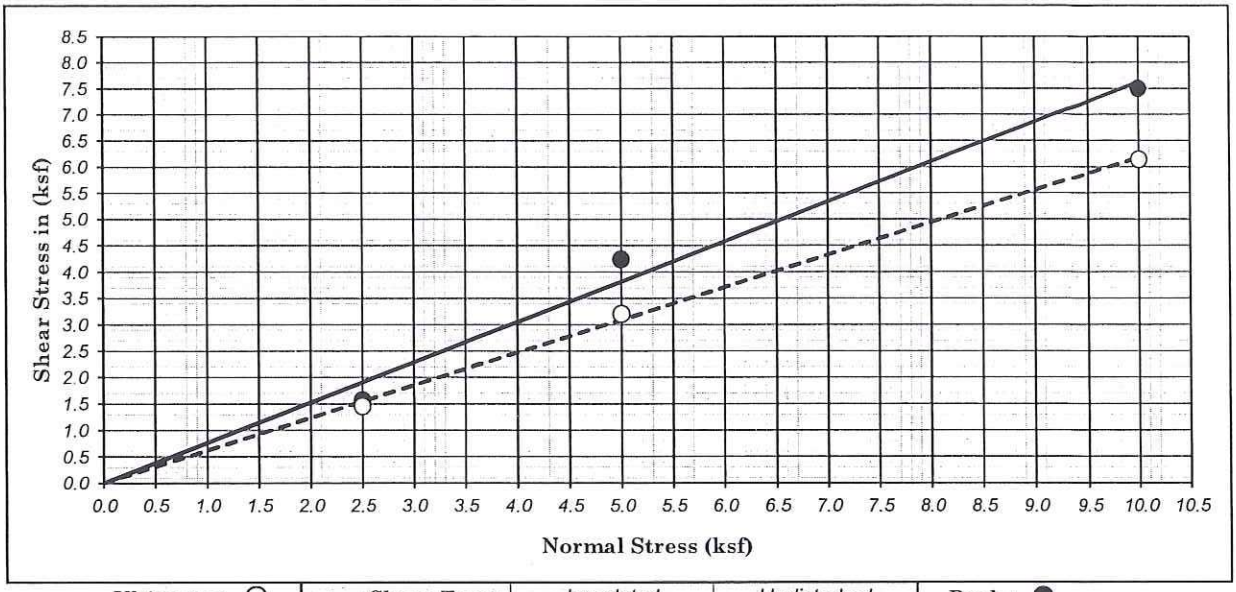
SR-91 WB Widening Project

DIRECT SHEAR TEST (ASTM D-3080)

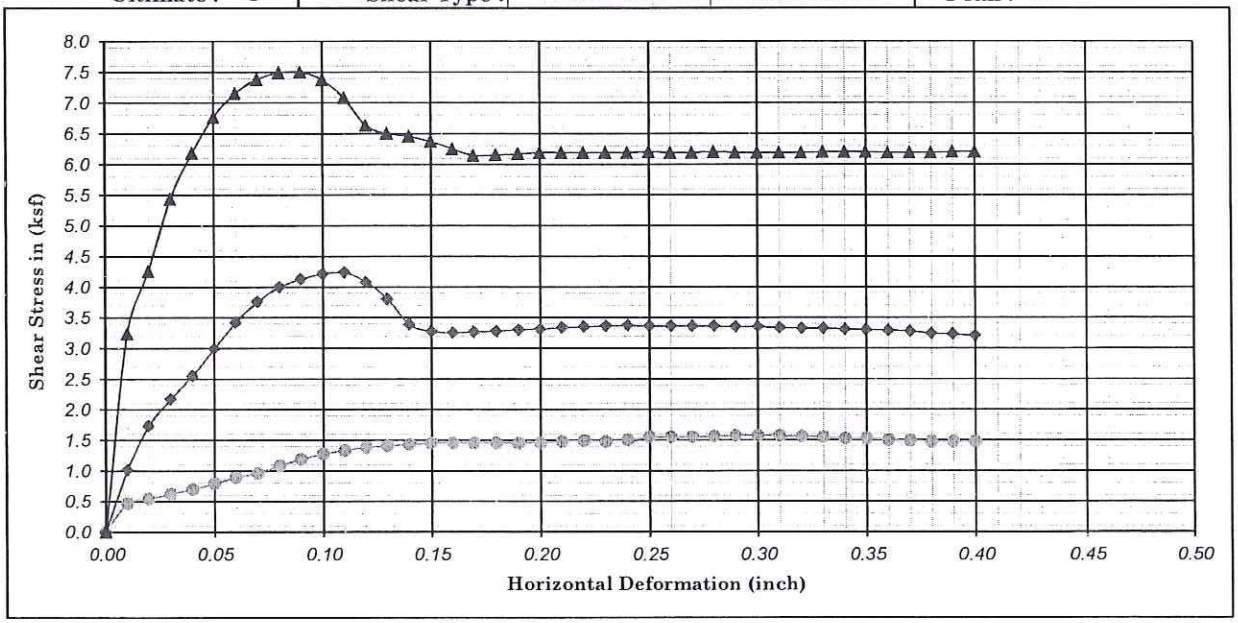
Project No. : 10-126

Date : 02/08/11

Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-006		Strength Intercept (C) :	0.00	(ksf)	Peak	0.00	(ksf)	Ultimate
Sample No. : D-10			0.00	(kPa)		0.00	(kPa)	
Depth (ft/m) : 50.0	0.00	Friction Angle (ϕ) :	37.33	Degree		31.71	Degree	
Description : Olive-brown, SILTY SAND (SM)						Shear Rate (inch/minute) :		0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	26.42	92.24	14.52	0.83	2.50	119.70	1.57	75.27	1.45	69.52
◆	23.82	97.69	15.38	0.73	5.00	239.40	4.24	202.82	3.20	153.41
▲	24.64	103.58	16.30	0.63	10.00	478.80	7.50	359.05	6.14	294.13

Earth Mechanics, Inc.
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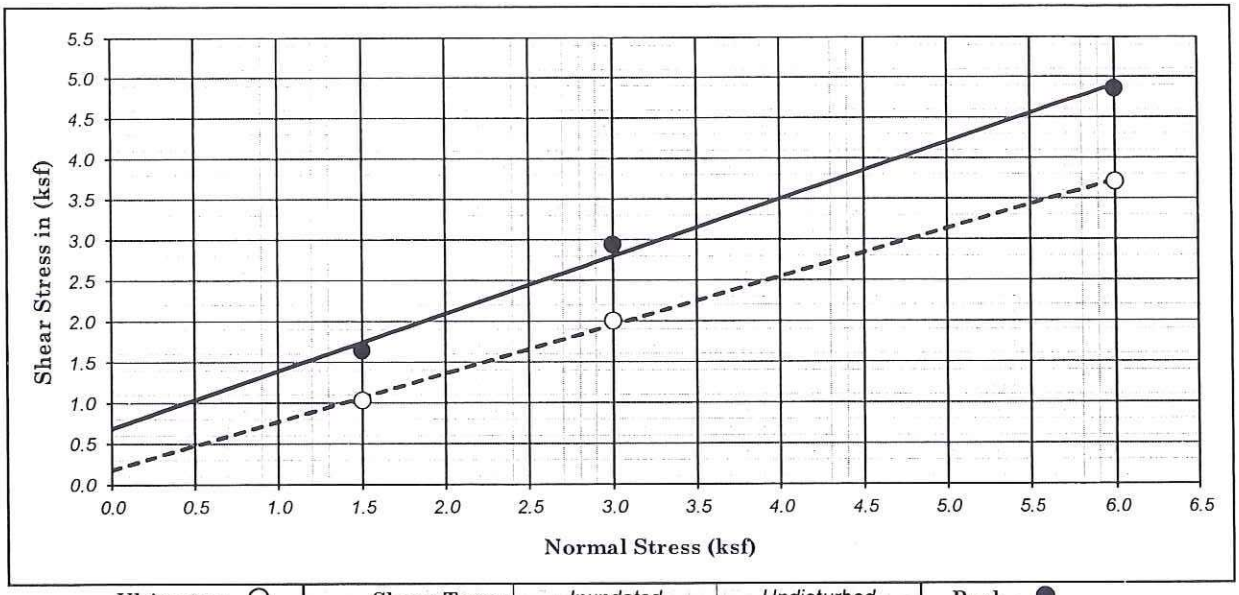
Brookhurst Street UC (Widen)

SR-91 WB Widening Project

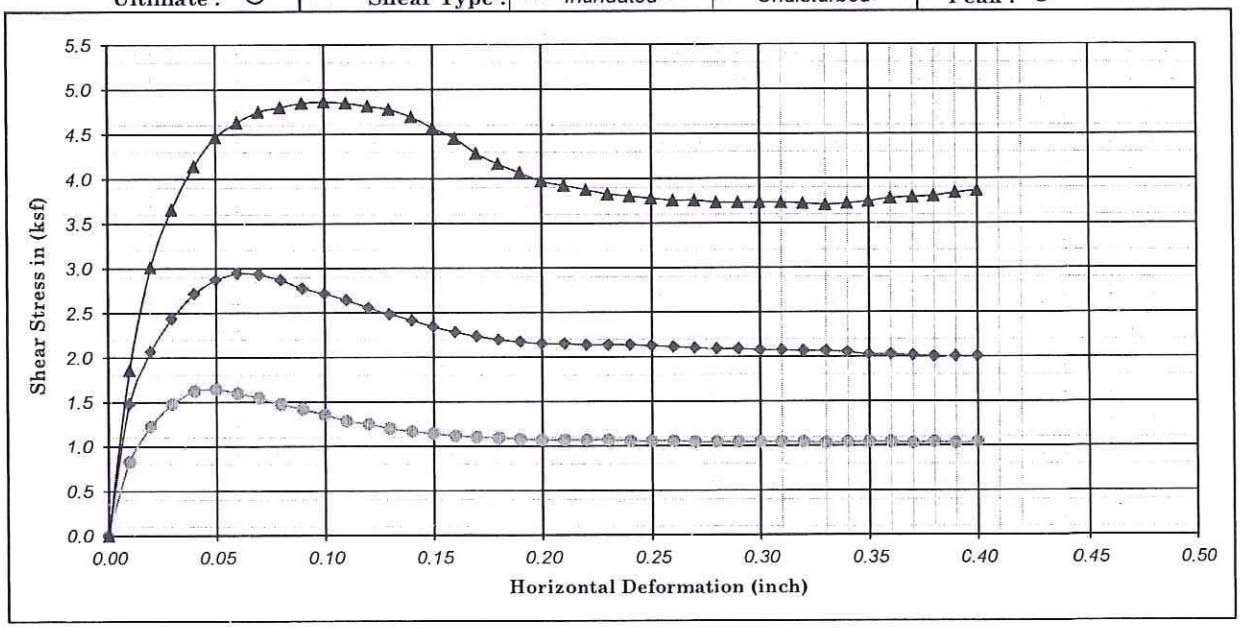
DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126 | Date : 02/08/11

Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-008		Strength Intercept (C) :	0.68	(ksf)	Peak	0.18	(ksf)	Ultimate
Sample No. : D-4			32.75	(kPa)		8.62	(kPa)	
Depth (ft/m) : 20.0	0.00	Friction Angle (ϕ) :	35.15	Degree		30.58	Degree	
Description : Olive-brown, SILTY SAND (SM)					Shear Rate (inch/minute) :			0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	16.11	114.74	18.06	0.47	1.50	71.82	1.64	78.71	1.03	49.41
◆	16.12	114.74	18.06	0.47	3.00	143.64	2.94	140.77	2.00	95.95
▲	15.97	114.45	18.01	0.47	6.00	287.28	4.86	232.70	3.71	177.54

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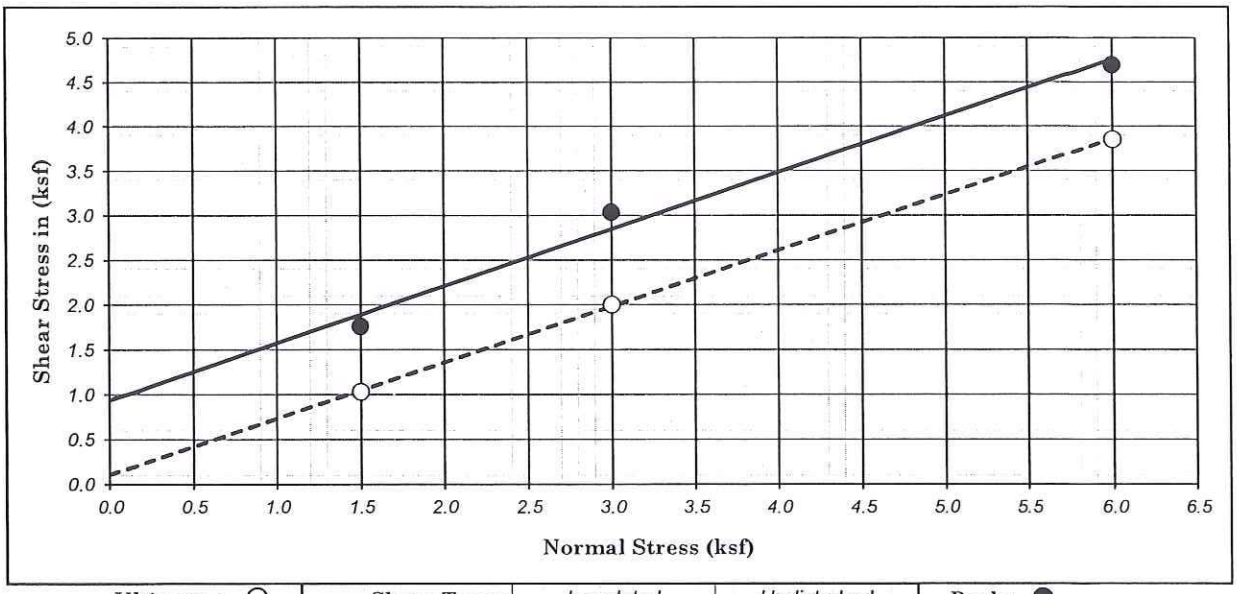
Brookhurst Street UC (Widen)

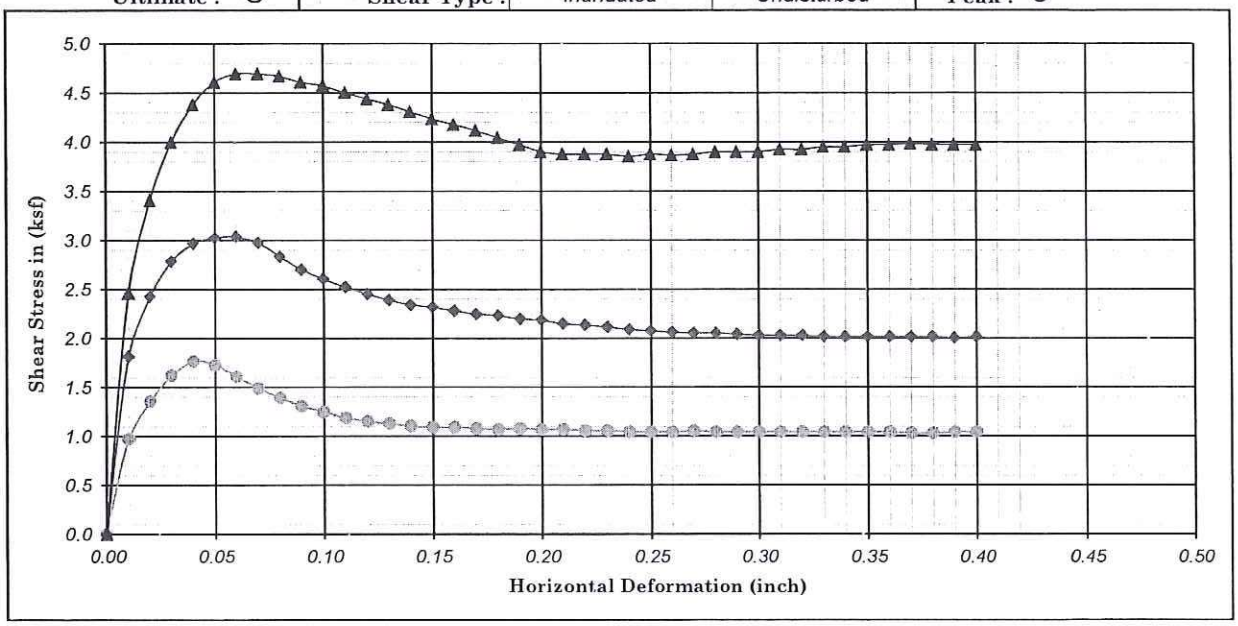
SR-91 WB Widening Project

DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126 | Date : 02/08/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-008		Strength Intercept (C) :	0.94	(ksf)	Peak	0.11	(ksf)	Ultimate
Sample No. : D-6			44.82	(kPa)		5.17	(kPa)	
Depth (ft/m) : 30.0	0.00	Friction Angle (ϕ) :	32.48	Degree		32.01	Degree	

Description : Olive-brown, SILTY SAND (SM) Shear Rate (inch/minute) : 0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	15.49	109.54	17.24	0.54	1.50	71.82	1.76	84.46	1.03	49.41
◆	15.96	110.16	17.34	0.53	3.00	143.64	3.04	145.36	2.00	95.95
▲	16.89	108.35	17.05	0.56	6.00	287.28	4.69	224.65	3.85	184.43

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Brookhurst Street UC (Widen)

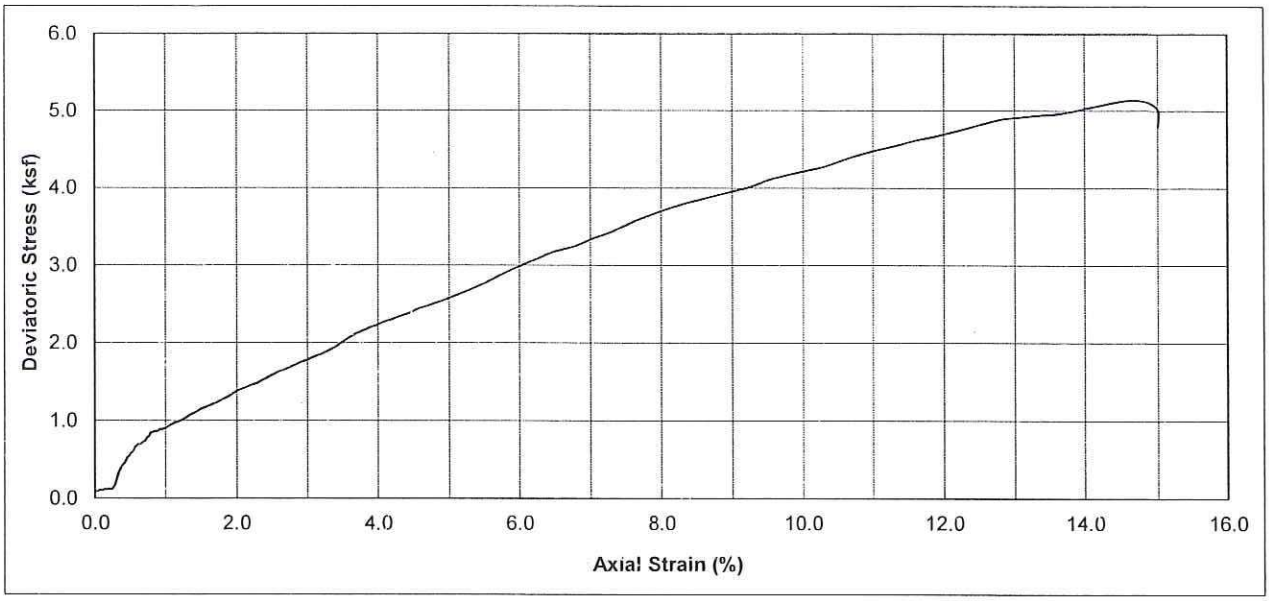
SR-91 WB Widening Project

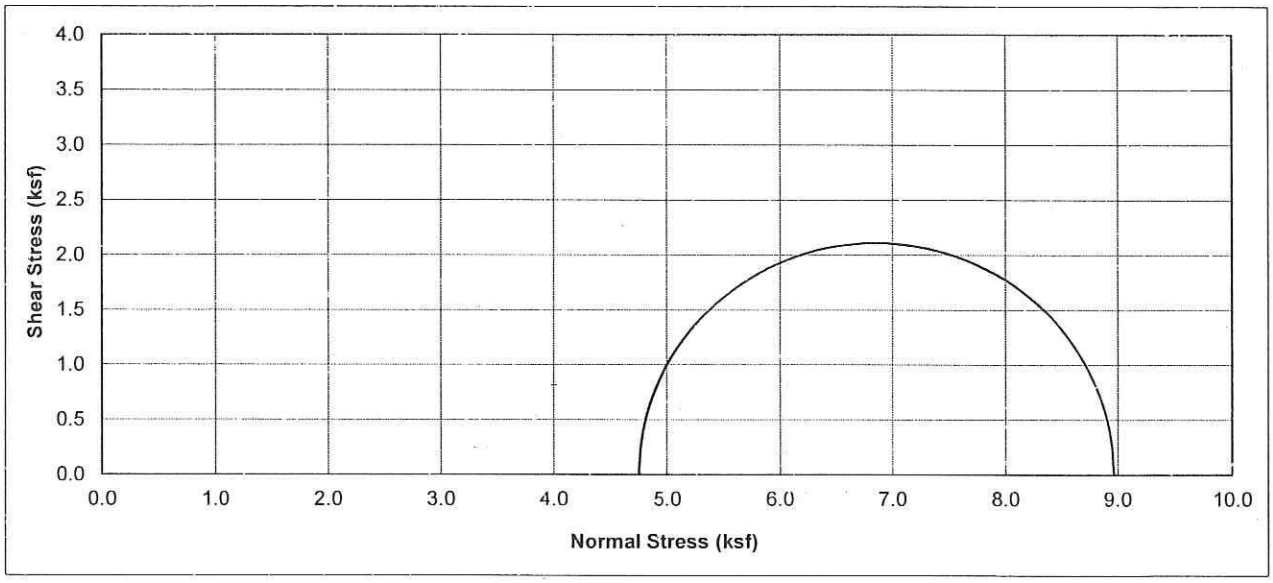
DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126

Date : 02/09/11

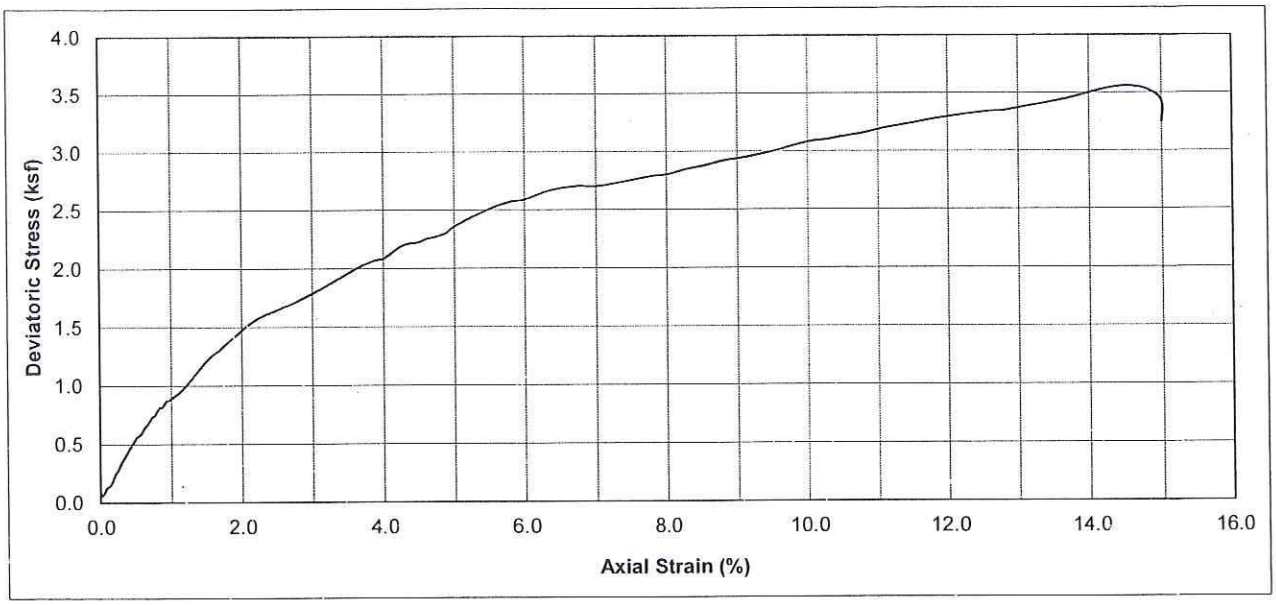
Figure No. :

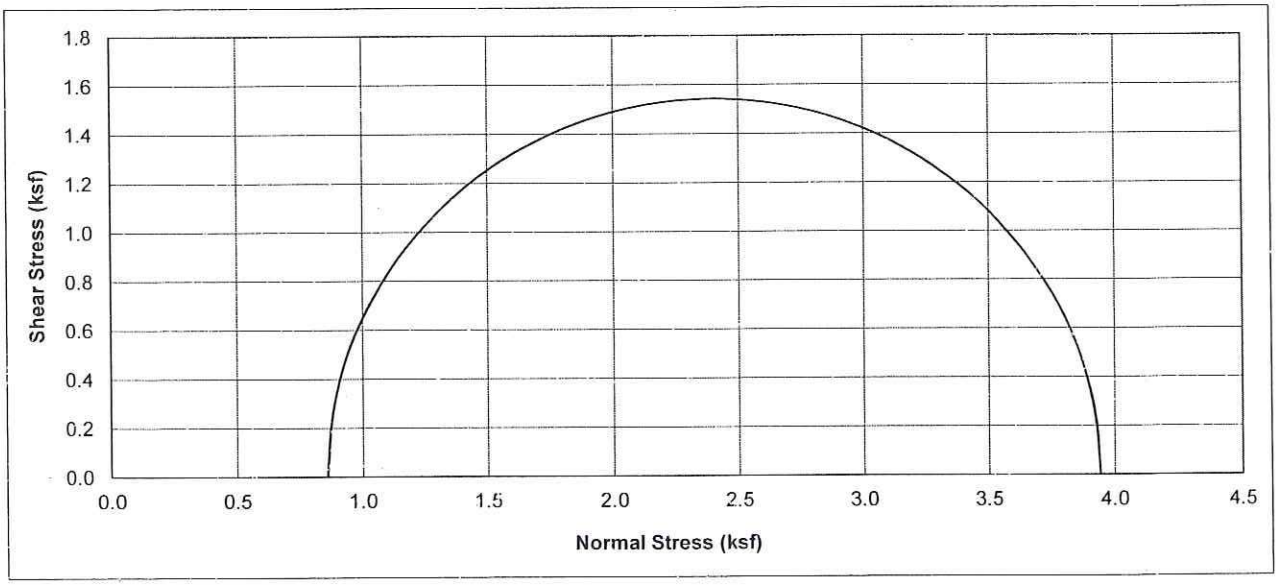




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-006	D-12	60	Olive-brown , SILT with SAND (ML)	92.5	34.07	4.75	4.22	112.0

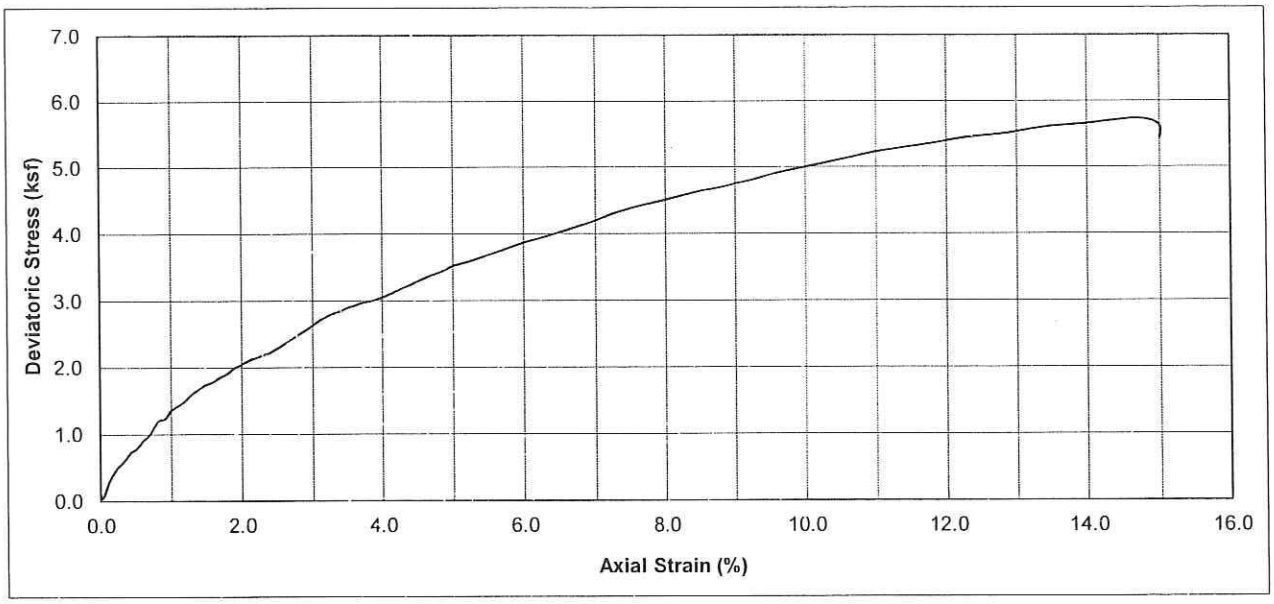
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Brookhurst Street UC (Widen)
	UNCONSOLIDATED UNDRAINED TEST
Project No. : 10-126 / Date : 02/07/11	(ASTM D2850) Figure No. :

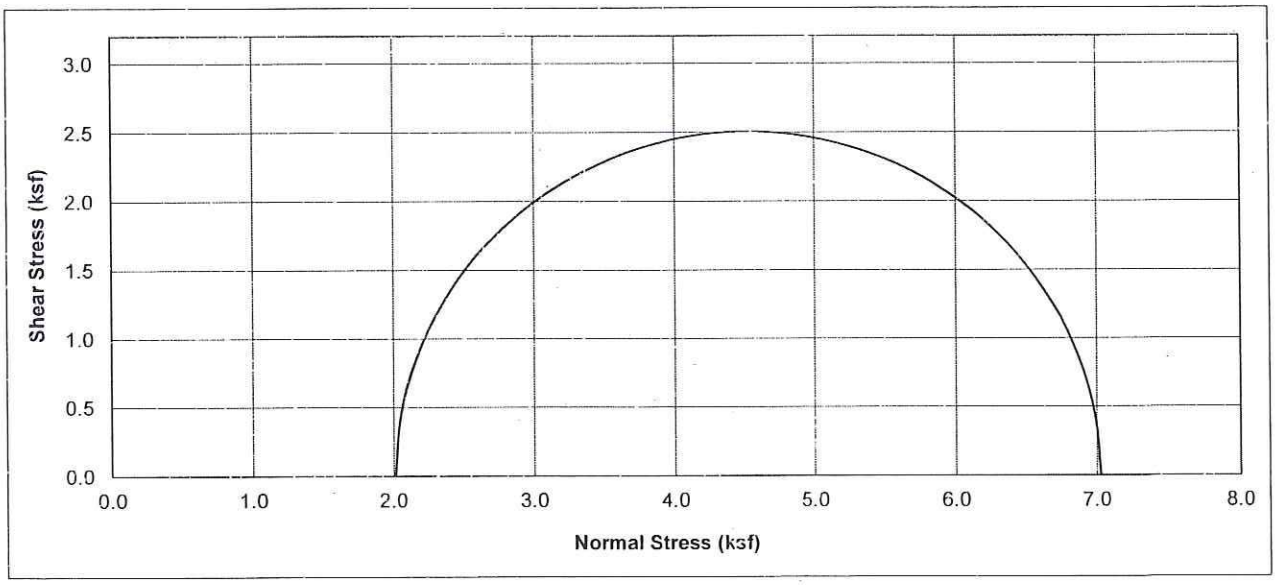




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-007	D-2	5	Olive-brown , Lean CLAY with SAND(CL)	106.1	18.61	0.86	3.09	85.4

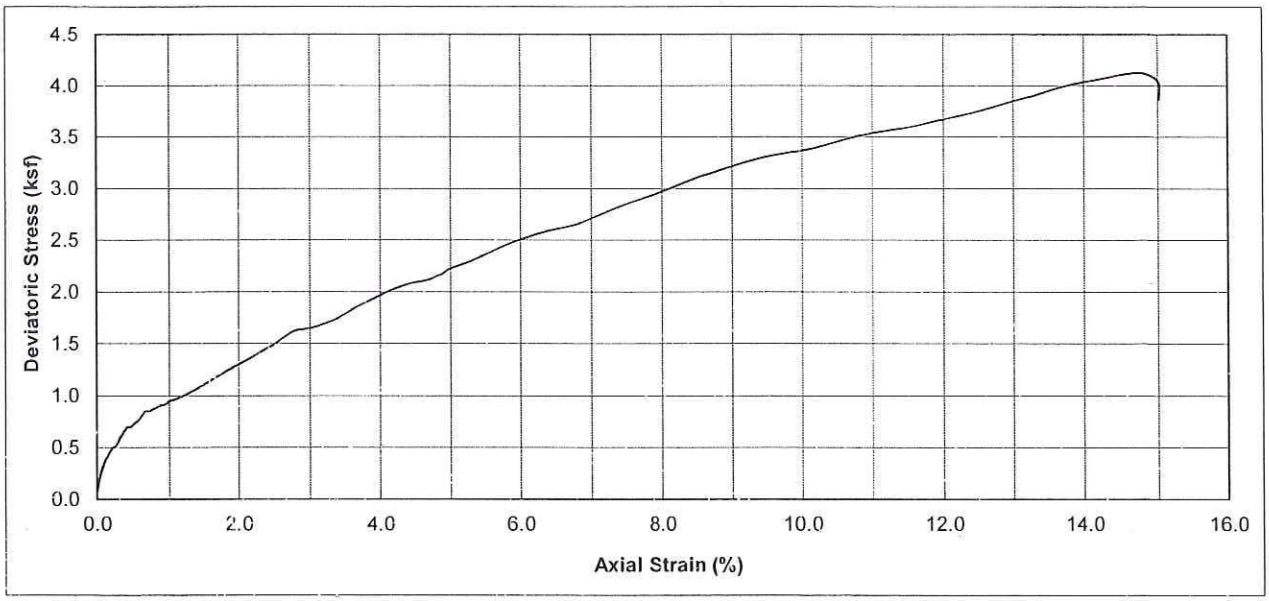
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Brookhurst Street UC (Widen)
	UNCONSOLIDATED UNDRAINED TEST (ASTM D2850) Figure No. :
Project No. : 10-126 Date : 02/07/11	

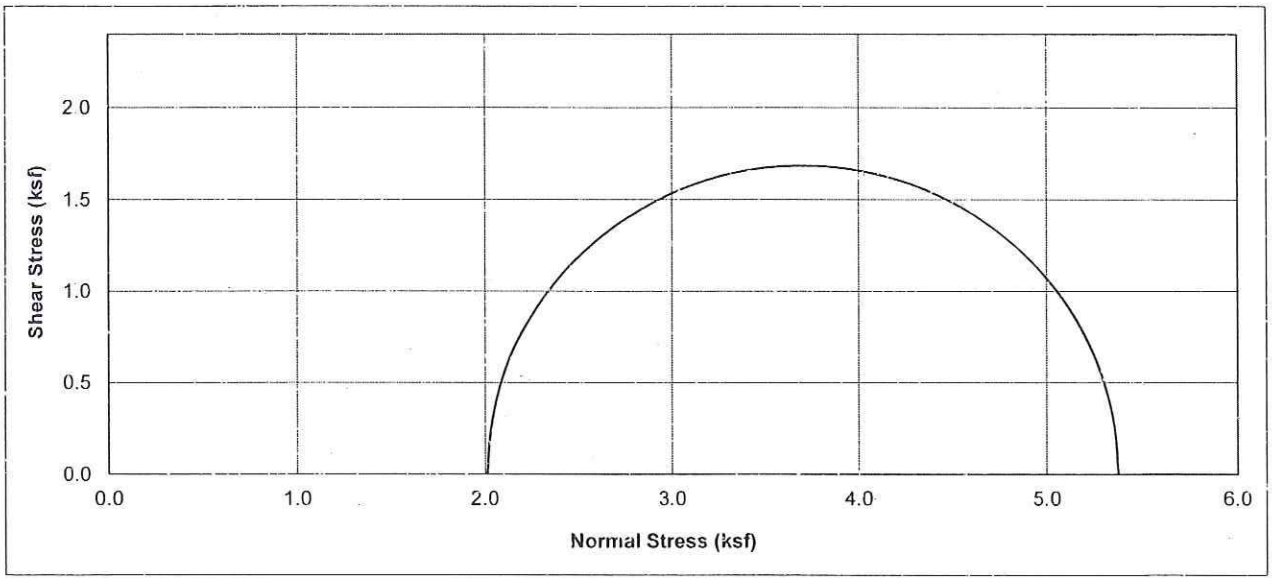




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-007	D-6	25	Olive-brown , SILT with SAND (ML)	106.8	19.88	2.01	5.01	92.8

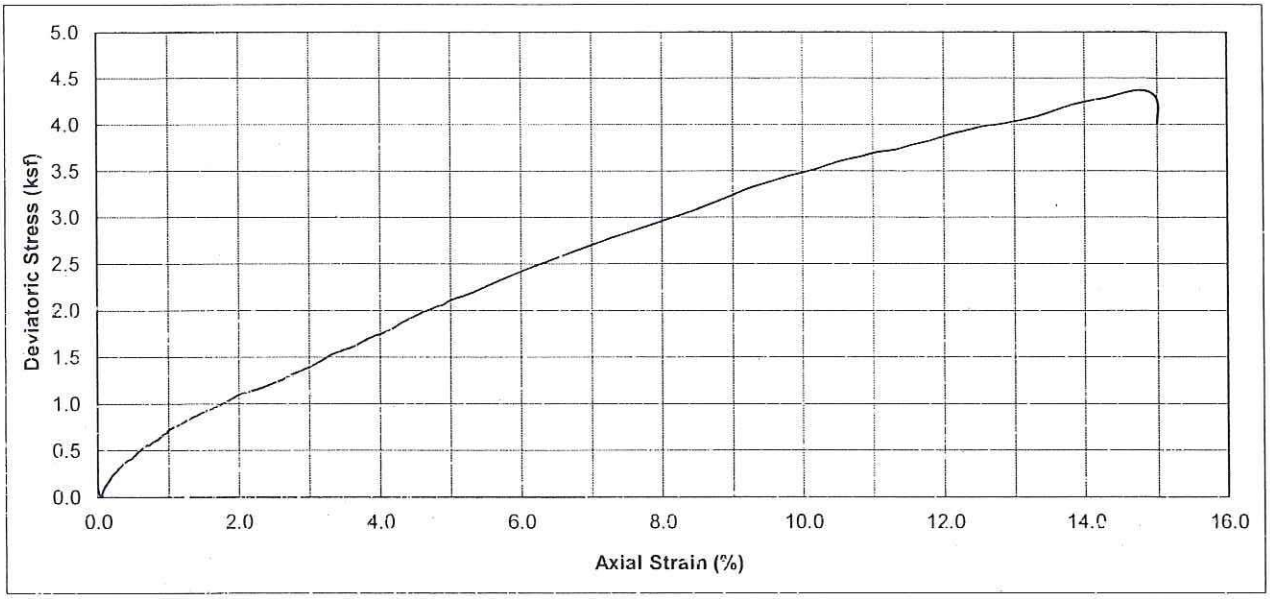
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Brookhurst Street UC (Widen)
	UNCONSOLIDATED UNDRAINED TEST (ASTM D2850)
Project No. : 10-126 Date : 02/07/11	Figure No. :

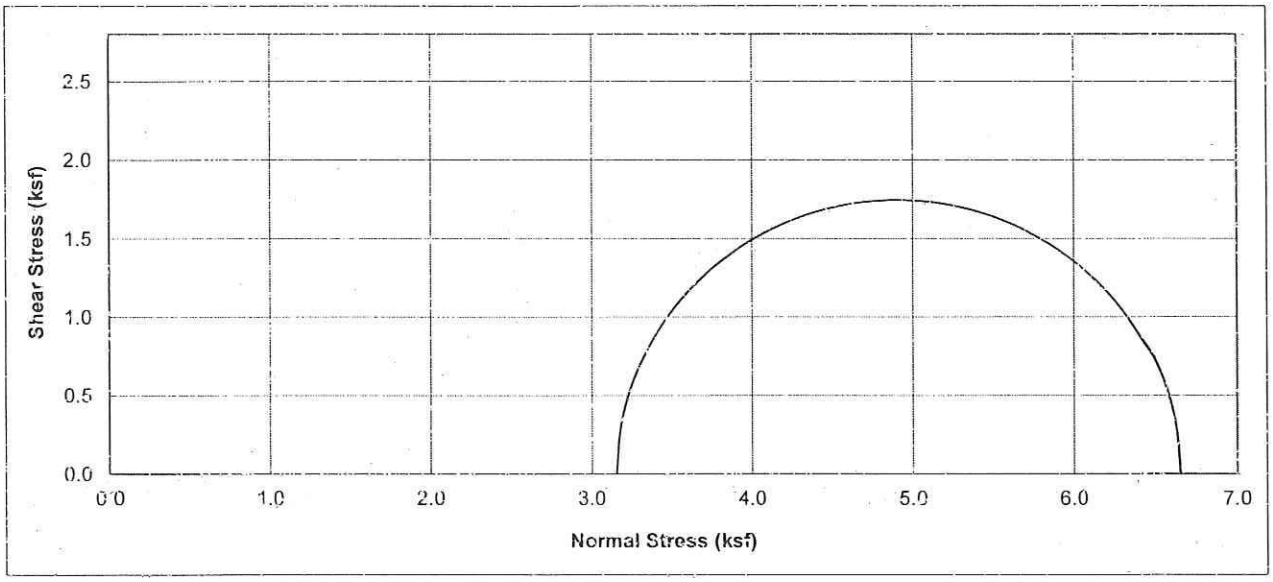




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-007	D-12	55	Dark gray , SILT with SAND (ML)	89.3	27.07	2.01	3.37	82.5

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Brookhurst Steet UC (Widen)
	UNCONSOLIDATED UNDRAINED TEST
Project No. : 10-126 Date : 02/08/11	(ASTM D2850) Figure No. :



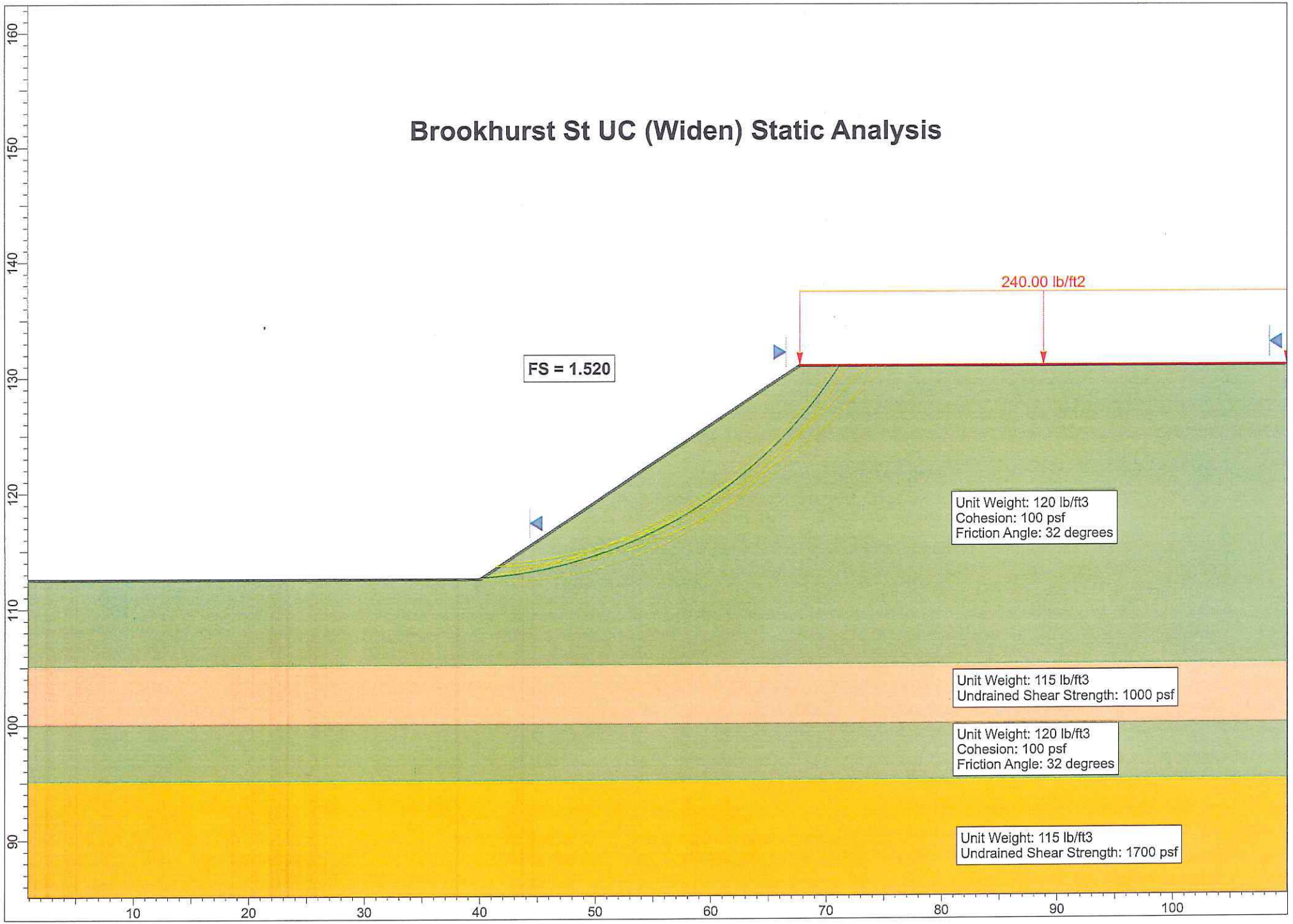


Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-008	D-8	40	Olive-brown SILTY SAND	112.3	18.55	3.16	3.49	100.0

Earth Mechanics, Inc.	Brookhurst Street UC (Widen)
Geotechnical and Earthquake Engineering	UNCONSOLIDATED UNDRAINED TEST
Project No. : 10-126 / Date : 02/08/11	(ASTM D2850) Figure No. :

Appendix C

DESIGN CALCULATIONS


Brookhurst St UC (Widen) Static Analysis
240.00 lb/ft2
FS = 1.520
Unit Weight: 120 lb/ft3
Cohesion: 100 psf
Friction Angle: 32 degrees
Unit Weight: 115 lb/ft3
Undrained Shear Strength: 1000 psf
Unit Weight: 120 lb/ft3
Cohesion: 100 psf
Friction Angle: 32 degrees
Unit Weight: 115 lb/ft3
Undrained Shear Strength: 1700 psf
160
150
140
130
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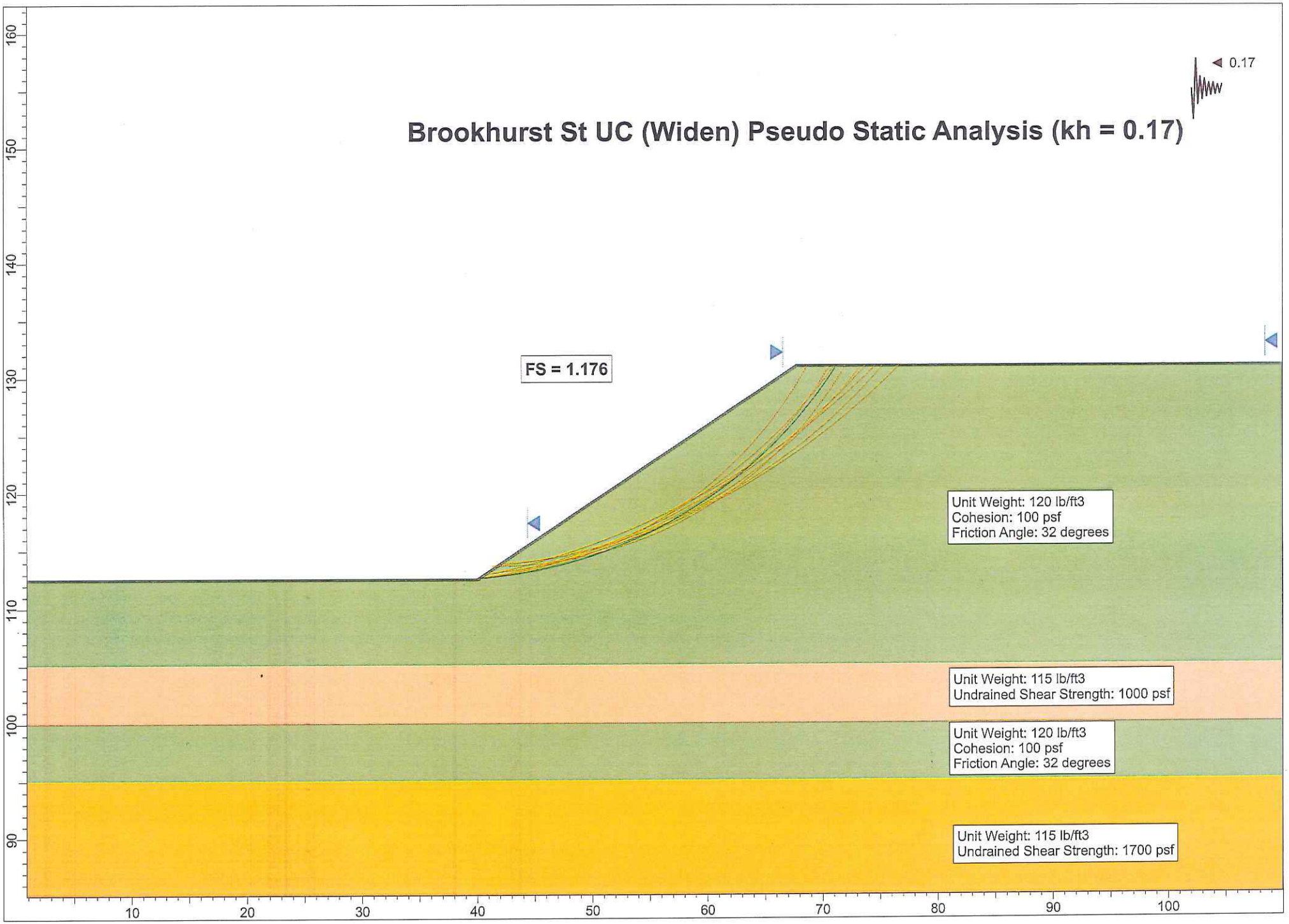
110
100
90
10
20
30
40
50
60
70
80
90
100


Brookhurst St UC (Widen) Pseudo Static Analysis (kh = 0.17)
0.17
FS = 1.176
Unit Weight: 120 lb/ft3
Cohesion: 100 psf
Friction Angle: 32 degrees
Unit Weight: 115 lb/ft3
Undrained Shear Strength: 1000 psf
Unit Weight: 120 lb/ft3
Cohesion: 100 psf
Friction Angle: 32 degrees
Unit Weight: 115 lb/ft3
Undrained Shear Strength: 1700 psf
160
150
140
130
120
110
100
90
10
20
30
40
50
60
70
80
90
100

Brookhurst Street Undercrossing (Widen)
LIQUEFACTION ANALYSIS; ACC. = 0.52 g

SP 10-125
25-Mar-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
$'C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1998), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-006

Emean (%) 75 Sur.= psf 130 =top of ground el. Borehole Diamet 8 73.5 =water table El. acc. max = 0.52 g Earthq. M= 7.3
C_E 1.25 C_B 1.15 Cm= 1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
125	130	5	0.30	0.30	5.00	1.87	0.75	1.20	1.00	120	1	1	12	0.99	0.33	29	20.0	35	1.00	high N	high N	LARGE	AboveWT
120	125	5	0.60	0.60	10.00	1.32	0.75	1.00	0.60	120	2	2	65	0.98	0.33	56	20.0	65	1.00	high N	high N	LARGE	AboveWT
115	120	5	0.90	0.90	15.00	1.08	0.85	1.20	1.00	120	1	1	13	0.97	0.33	21	30.0	29	1.00	0.41	0.44	1.35	AboveWT
110	115	5	1.20	1.20	20.00	0.93	0.85	1.00	0.60	120	2	2	24	0.95	0.32	17	30.0	25	0.97	0.29	0.30	0.94	AboveWT
105	110	5	1.50	1.50	25.00	0.83	0.95	1.20	1.00	120	1	1	8	0.94	0.32	11	70.0	19	0.93	0.20	0.20	0.64	AboveWT
100	105	5	1.79	1.79	30.00	0.76	0.95	1.00	0.60	115	2	2	53	0.93	0.31	34	25.0	43	0.89	high N	high N	LARGE	AboveWT
95	100	5	2.09	2.09	35.00	0.71	1.00	1.20	1.00	120	1	1	11	0.89	0.30	14	35.0	22	0.87	0.24	0.23	0.75	AboveWT
90	95	5	2.38	2.38	40.00	0.66	1.00	1.00	0.60	115	2	2	30	0.85	0.29	18	65.0	27	0.85	0.34	0.31	1.07	AboveWT
85	90	5	2.66	2.66	45.00	0.63	1.00	1.20	1.00	115	1	1	18	0.81	0.27	20	7.0	21	0.83	0.23	0.20	0.74	AboveWT
80	85	5	2.96	2.96	50.00	0.59	1.00	1.00	0.60	120	2	2	52	0.77	0.26	27	20.0	33	0.80	high N	high N	LARGE	AboveWT
75	80	5	3.26	3.26	55.00	0.57	1.00	1.20	1.00	120	1	1	40	0.73	0.25	40	15.0	45	0.77	high N	high N	LARGE	AboveWT
73.5	75	1.5	3.35	3.35	56.50	0.56	1.00	1.00	0.60	120	2	2	19	0.71	0.24	10	90.0	17	0.76	0.18	0.15	0.61	fines
70	73.5	3.5	3.56	3.45	60.00	0.55	1.00	1.00	0.60	120	2	2	19	0.69	0.24	10	90.0	17	0.76	0.18	0.15	0.61	fines
65	70	5	3.85	3.53	65.00	0.54	1.00	1.20	1.00	115	1	1	7	0.64	0.23	7	90.0	14	0.75	0.15	0.12	0.51	fines
60	65	5	4.14	3.72	70.00	0.53	1.00	1.00	0.60	115	2	2	30	0.60	0.23	14	80.0	22	0.74	0.24	0.19	0.84	fines
55	60	5	4.43	3.85	75.00	0.52	1.00	1.20	1.00	115	1	1	13	0.56	0.22	12	51.0	20	0.73	0.22	0.17	0.77	fines
50	55	5	4.73	3.93	80.00	0.51	1.00	1.00	0.60	120	2	2	100	0.55	0.22	45	4.0	45	0.73	high N	high N	LARGE	high N
45	50	5	5.03	4.14	85.00	0.50	1.00	1.20	1.00	120	1	1	24	0.54	0.22	21	30.0	29	0.72	0.41	0.32	1.43	no

Brookhurst Street Undercrossing (Widen)
LIQUEFACTION ANALYSIS; ACC. = 0.52 g

SP 10-126
25-Mar-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
^1C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-007

Emean (%) 75 Sur.= psf 112.4 =top of ground el. Borehole Diamete 8
C_E 1.25 C_B 1.15

73.5 =water table El.

acc. max = 0.52 g
Earthq. M= 7.3
Cm= 1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
109.9	112.4	2.5	0.15	0.15	2.50	2.00	0.75	1.20	1.00	120	1	1	11	0.99	0.34	20	4.0	29	1.00	0.41	0.44	1.31	AboveWT
107.4	109.9	2.5	0.30	0.30	5.00	1.87	0.75	1.00	0.60	120	2	2	15	0.99	0.33	19	80.0	28	1.00	0.37	0.40	1.19	AboveWT
102.4	107.4	5	0.59	0.59	10.00	1.33	0.75	1.20	1.00	115	1	1	10	0.98	0.33	18	80.0	27	1.00	0.34	0.36	1.10	AboveWT
97.4	102.4	5	0.88	0.88	15.00	1.09	0.85	1.00	0.60	115	2	2	22	0.97	0.33	18	65.0	27	1.00	0.34	0.36	1.11	AboveWT
92.4	97.4	5	1.16	1.16	20.00	0.95	0.85	1.20	1.00	115	1	1	11	0.95	0.32	16	35.0	25	0.98	0.29	0.31	0.95	AboveWT
87.4	92.4	5	1.45	1.45	25.00	0.85	0.95	1.00	0.60	115	2	2	14	0.94	0.32	10	70.0	17	0.94	0.18	0.18	0.57	AboveWT
82.4	87.4	5	1.74	1.74	30.00	0.78	0.95	1.20	1.00	115	1	1	11	0.93	0.31	14	20.0	19	0.90	0.20	0.20	0.62	AboveWT
77.4	82.4	5	2.04	2.04	35.00	0.72	1.00	1.00	0.60	120	2	2	54	0.89	0.30	34	30.0	44	0.88	high N	high N	LARGE	AboveWT
73.5	77.4	3.9	2.27	2.27	38.90	0.68	1.00	1.20	1.00	120	1	1	22	0.86	0.29	26	25.0	34	0.86	high N	high N	LARGE	high N
72.4	73.5	1.1	2.34	2.30	40.00	0.67	1.00	1.20	1.00	120	1	1	22	0.85	0.29	26	25.0	34	0.86	high N	high N	LARGE	high N
67.4	72.4	5	2.64	2.45	45.00	0.65	1.00	1.00	0.60	120	2	2	29	0.81	0.29	17	85.0	26	0.84	0.31	0.28	0.96	fines
62.4	67.4	5	2.93	2.58	50.00	0.64	1.00	1.20	1.00	115	1	1	20	0.77	0.29	22	25.0	29	0.83	0.41	0.37	1.25	no
57.4	62.4	5	3.21	2.71	55.00	0.62	1.00	1.00	0.60	115	2	2	21	0.73	0.29	12	75.0	20	0.82	0.22	0.19	0.65	fines
52.4	57.4	5	3.50	2.84	60.00	0.61	1.00	1.20	1.00	115	1	1	22	0.69	0.29	24	12.0	27	0.81	0.34	0.29	1.03	no
47.4	52.4	5	3.80	2.99	65.00	0.59	1.00	1.00	0.60	120	2	2	22	0.64	0.28	12	85.0	20	0.80	0.22	0.18	0.67	fines
42.4	47.4	5	4.10	3.13	70.00	0.58	1.00	1.20	1.00	120	1	1	22	0.60	0.27	22	30.0	31	0.77	high N	high N	LARGE	high N
37.4	42.4	5	4.40	3.27	75.00	0.56	1.00	1.00	0.60	120	2	2	49	0.56	0.26	24	75.0	34	0.76	high N	high N	LARGE	high N/fines
32.4	37.4	5	4.70	3.42	80.00	0.55	1.00	1.20	1.00	120	1	1	19	0.55	0.26	13	85.0	28	0.76	0.37	0.30	1.17	fines

Brookhurst Street Undercrossing (Widen)
LIQUEFACTION ANALYSIS; ACC. = 0.52 g

SP 10-126
25-Mar-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
$'C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1998), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-008

Emean (%)	75	Sur.=	psf	130	=top of ground el.	Borehole Diamet	8							73.5	=water table El			acc. max =	0.52	g	Earthq. M=	7.3
C_E	1.25					C_B	1.15														Cm=	1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA,MOD	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
125	130	5	0.30	0.30	5.00	1.87	0.75	1.20	1.00	120	1	1	10	0.99	0.33	25	30.0	34	1.00	high N	high N	LARGE	AboveWT
120	125	5	0.60	0.60	10.00	1.32	0.75	1.00	0.60	120	2	2	66	0.98	0.33	48	30.0	61	1.00	high N	high N	LARGE	AboveWT
115	120	5	0.90	0.90	15.00	1.08	0.85	1.20	1.00	120	1	1	23	0.97	0.33	45	30.0	57	1.00	high N	high N	LARGE	AboveWT
110	115	5	1.20	1.20	20.00	0.93	0.85	1.00	0.60	120	2	2	23	0.95	0.32	16	35.0	25	0.97	0.29	0.30	0.94	AboveWT
105	110	5	1.50	1.50	25.00	0.83	0.95	1.20	1.00	120	1	1	17	0.94	0.32	24	35.0	34	0.93	high N	high N	LARGE	AboveWT
100	105	5	1.79	1.79	30.00	0.76	0.95	1.00	0.60	115	2	2	45	0.93	0.31	29	15.0	33	0.89	high N	high N	LARGE	AboveWT
95	100	5	2.09	2.09	35.00	0.71	1.00	1.20	1.00	120	1	1	19	0.89	0.30	24	45.0	34	0.87	high N	high N	LARGE	AboveWT
90	95	5	2.38	2.38	40.00	0.66	1.00	1.00	0.60	115	2	2	20	0.85	0.29	12	60.0	20	0.85	0.22	0.20	0.68	AboveWT
85	90	5	2.66	2.66	45.00	0.63	1.00	1.20	1.00	115	1	1	12	0.81	0.27	13	55.0	21	0.83	0.23	0.20	0.74	AboveWT
80	85	5	2.96	2.96	50.00	0.59	1.00	1.00	0.60	120	2	2	100	0.77	0.26	52	20.0	60	0.80	high N	high N	LARGE	AboveWT
75	80	5	3.26	3.26	55.00	0.57	1.00	1.20	1.00	120	1	1	27	0.73	0.25	27	20.0	33	0.77	high N	high N	LARGE	AboveWT
73.5	75	1.5	3.35	3.35	56.50	0.56	1.00	1.00	0.60	120	2	2	40	0.71	0.24	20	80.0	29	0.76	0.41	0.33	1.38	fines
70	73.5	3.5	3.56	3.45	60.00	0.55	1.00	1.00	0.60	120	2	2	40	0.69	0.24	19	80.0	28	0.76	0.37	0.30	1.25	fines
65	70	5	3.85	3.58	65.00	0.54	1.00	1.20	1.00	115	1	1	18	0.64	0.23	16	28.0	26	0.75	0.31	0.25	1.07	no
60	65	5	4.14	3.72	70.00	0.53	1.00	1.00	0.60	115	2	2	52	0.60	0.23	24	80.0	34	0.74	high N	high N	LARGE	high N/fines
55	60	5	4.43	3.85	75.00	0.52	1.00	1.20	1.00	115	1	1	21	0.53	0.22	19	30.0	27	0.73	0.34	0.27	1.21	no
50	55	5	4.73	3.99	80.00	0.51	1.00	1.00	0.60	120	2	2	100	0.55	0.22	45	4.0	45	0.73	high N	high N	LARGE	high N

Brookhurst Street Undercrossing (Widen)
LIQUEFACTION ANALYSIS; ACC. = 0.52 g

10-126

22-Mar-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Stark and Olsen (1995), and Youd et al (2001).

The cyclic stress ratio (CSR) is equal to:

CSR i = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
^1C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (Seed, et al) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wilde (1980), Marcuson (US Army Eng), p. [illegible])
g = acceleration of gravity

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-7 (1996 boring)

Emean (%) 45 Sur.= psf 128 =top of ground El. Borehole Diam= 0
C_E 0.75 C_B 1.15 70.5 =water table El. acc. max = 0.52 g Earthq. M= 7.3
Cm= 1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA,3=CO	SAMPLER LINED (1=LINED 0=UNLINED)	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Ns	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
123	128	5	0.30	0.30	5.00	1.87	0.75	1.20	1.00	120	1	1	41	0.99	0.33	60	5.0	60	1.00	high N	high N	LARGE	AboveWT
113	123	10	0.90	0.90	15.00	1.08	0.85	1.20	1.00	120	1	1	42	0.97	0.33	40	12.0	43	1.00	high N	high N	LARGE	AboveWT
103	113	10	1.50	1.50	25.00	0.83	0.95	1.20	1.00	120	1	1	22	0.94	0.32	19	30.0	27	0.93	0.34	0.34	1.06	AboveWT
93	103	10	2.10	2.10	35.00	0.71	1.00	1.20	1.00	120	1	1	37	0.89	0.30	28	30.0	38	0.87	high N	high N	LARGE	AboveWT
83	93	10	2.70	2.70	45.00	0.62	1.00	1.20	1.00	120	1	1	18	0.81	0.27	12	60.0	20	0.82	0.22	0.19	0.70	AboveWT
73.5	83	9.49	3.27	3.27	54.49	0.57	1.00	1.20	1.00	120	1	1	25	0.73	0.25	14	45.0	22	0.77	0.24	0.20	0.80	AboveWT
63	73.51	10.51	3.90	3.57	65.00	0.54	1.00	1.20	1.00	120	1	1	70	0.64	0.24	41	30.0	53	0.75	high N	high N	LARGE	high N
53	63	10	4.50	3.90	75.00	0.52	1.00	1.20	1.00	120	1	1	15	0.58	0.22	9	60.0	16	0.73	0.17	0.13	0.60	fines
43	53	10	5.10	4.15	85.00	0.50	1.00	1.20	1.00	120	1	1	55	0.54	0.22	29	30.0	39	0.72	high N	high N	LARGE	high N

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
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Project SR-91 WB Widening - Brookhurst St UC **Project No.** 10-126

By SP **Date** 08-30-11 **Checked By** S-J **Date** 8/30/11 **Sheet** ____ **of** ____

Abutments 1 and 5

24-INCH diameter CIDH piles

$\pi D = \pi (24) = 6.283$ ft

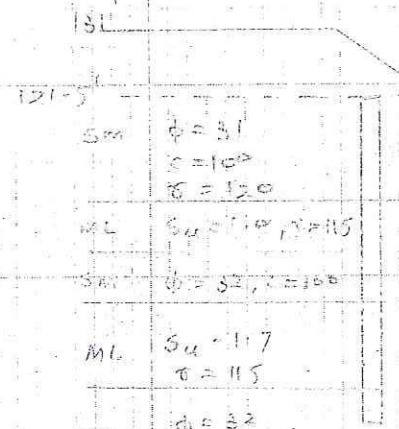
$\frac{\pi D^2}{4} = \pi \frac{24^2}{4} = 3.142$ ft^2 = 452.4 in^2

$I = \frac{\pi}{64}(24)^4 = 16286$ in^4 ; $I_{cracked} = 8143$ in^4

$E_c = 57000\sqrt{5250} = 3.2 \times 10^6$ lb/in^2

$E_c I = 2.12 \times 10^{11}$ lb-in^2

$E_c I_{cracked} = 1.06 \times 10^{11}$ lb-in^2



EL	DEPTH
121.5'	0
112.5'	9
105'	16
100'	21
95'	26
85'	36
70'	51
55'	66

} neglect these layers

Maximum load per pile = 70 kips

Nominal resistance = 70 x 2 = 140 kips

Total load per support = 245 kips

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Project SR-91 WB widening - Brookhurst St UC Project No. 10-126

By SP Date 08-30-11 Checked By S.S Date 8/30/11 Sheet ___ of ___

from the analysis

at depth of 25 ft, pile capacity = 143 kips

pile tip elevation for compression = 121 - 25

= 96 ft

consider 96 feet

center to center spacing = 2.5d

group efficiency factor = 0.65

Required nominal resistance per support = 245 x 2

= 490 kips

Available group nominal resistance at tip

elevation 96 feet = 0.65 x 4 x 143

= 371.8 kips < 490 kips

compression capacity needed per pile = $\frac{490}{0.65 \times 4}$ = 188 kips

at 32 feet, calculated pile capacity = 194 kips

pile tip elevation for compression = 121 - 32

= 89 feet

consider 87 feet

nominal resistance = 190 kips

Lateral capacity

Group reduction factor = 0.7

pile tip elevation for lateral = 121 - 22

= 99'

SKIN FRICTION FOR DRILLED SHAFT IN BOTH COHESIONLESS AND COHESIVE SOILS USING REESE AND O'NEILL'S METHOD (1999)

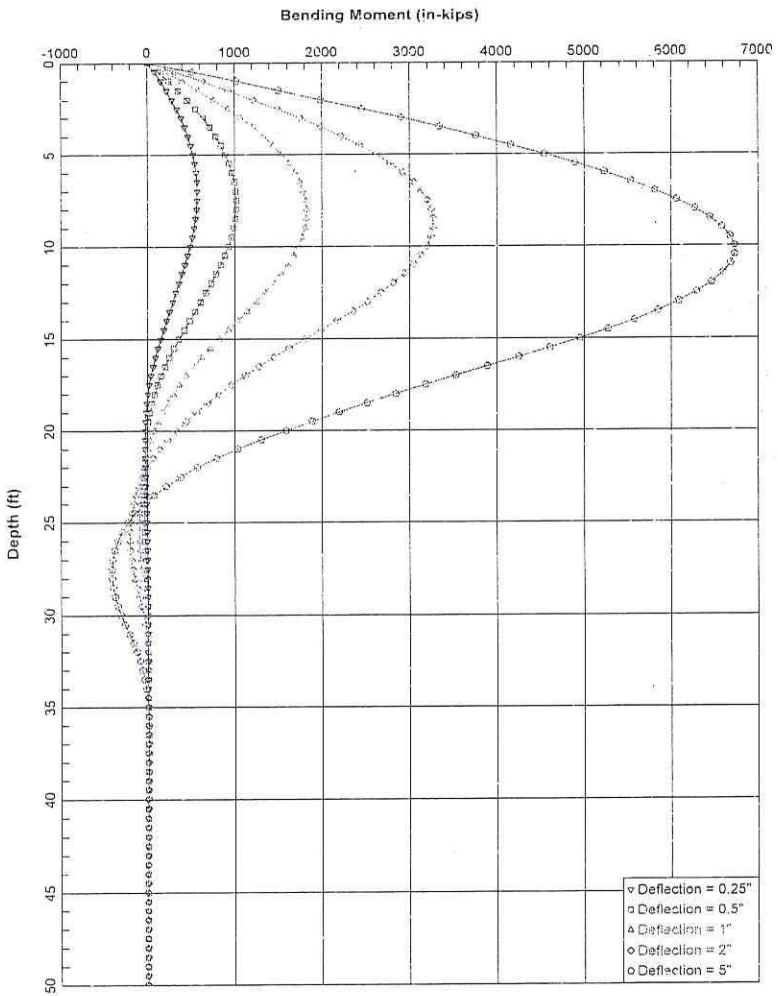
PROJECT: Brookhurst St UC — ITEM: 24-inch Diameter CIDH Existing Pile
PROJECT NO.: 10-126 — Abutments 1 and 5
DONE BY: SP DATE: 03/04/11
CHECKED BY: DATE:

D_s => 2.00 ft — Hw => 48.0 ft — Hg => 0.0 ft
p = 6.28 ft — Ho => 0.0 ft — Hf => 0.0 ft

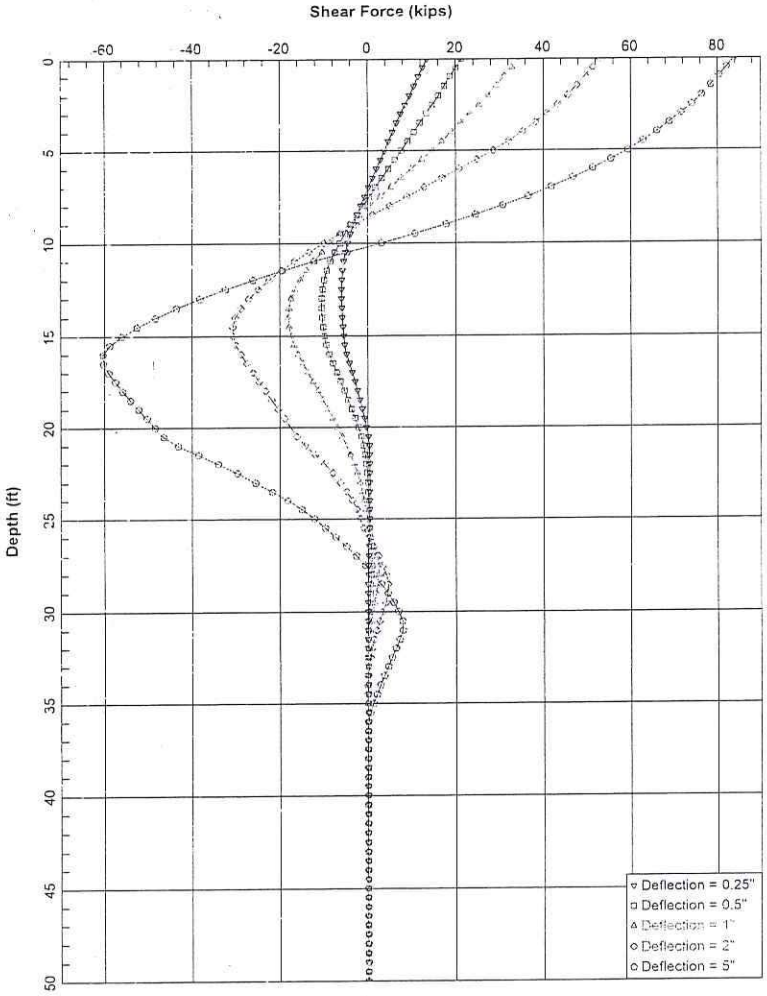
Hw is the depth to water table.
Hg is the depth to ground surface used in calculation.
Ho is the depth to location starting initial overburden pressure
Hf is the depth to location starting accumulation of skin friction
bottom of footing = 121.5 ft

Soil Layer =>	from Top	to Bottom =>	γ (pcf)=>	γ' (pcf)=	c' (ksf) =>	φ' =>	
(1)	0	9	120	57.6	0.00	31	SM
(2)	9	16	120	57.6	0.00	31	SM
(3)	16	21	115	52.6	1.00	0	ML
(4)	21	26	120	57.6	0.00	32	SM
(5)	26	36	115	52.6	1.70	0	ML
(6)	36	51	120	57.6	0.00	32	SM

Sublayer No.	Depth, z (ft)	z_i (ft)	New Depth (ft)	Soil Unit Weight (pcf)	Overburden Pressure (psf)	c' (ksf)	β	f_i^s (ksf)	ΔQ_s^s (kips)	Q_s^s (kips)	f_i^c (ksf)	ΔQ_s^c (kips)	Q_s^c (kips)	Q_s (kips)
0	0.0	0.0	0.0	120.0	0									
1	0.0	0.0	0.0	120.0	0	0.0				0.0			0.0	0.0
2	1.0	0.5	0.5	120.0	60	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
3	2.0	1.5	1.5	120.0	180	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
4	3.0	2.5	2.5	120.0	300	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
5	4.0	3.5	3.5	120.0	420	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
6	5.0	4.5	4.5	120.0	540	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
7	6.0	5.5	5.5	120.0	660	0.0	1.18	0.00	0.0	0.0	0.00	0.0	0.0	0.0
8	7.0	6.5	6.5	120.0	780	0.0	1.16	0.00	0.0	0.0	0.00	0.0	0.0	0.0
9	8.0	7.5	7.5	120.0	900	0.0	1.13	0.00	0.0	0.0	0.00	0.0	0.0	0.0
10	9.0	8.5	8.5	120.0	1020	0.0	1.11	0.00	0.0	0.0	0.00	0.0	0.0	0.0
11	10.0	9.5	9.5	120.0	1140	0.0	1.08	1.24	7.8	7.8	0.00	0.0	0.0	7.8
12	11.0	10.5	10.5	120.0	1260	0.0	1.06	1.34	8.4	16.2	0.00	0.0	0.0	16.2
13	12.0	11.5	11.5	120.0	1380	0.0	1.04	1.44	9.0	25.2	0.00	0.0	0.0	25.2
14	13.0	12.5	12.5	120.0	1500	0.0	1.02	1.53	9.6	34.9	0.00	0.0	0.0	34.9
15	14.0	13.5	13.5	120.0	1620	0.0	1.00	1.63	10.2	45.1	0.00	0.0	0.0	45.1
16	15.0	14.5	14.5	120.0	1740	0.0	0.99	1.72	10.8	55.8	0.00	0.0	0.0	55.9
17	16.0	15.5	15.5	120.0	1860	0.0	0.97	1.80	11.3	67.2	0.00	0.0	0.0	67.2
18	17.0	16.5	16.5	115.0	1975	1.0	0.95	0.00	0.0	67.2	0.55	3.5	3.5	70.6
19	18.0	17.5	17.5	115.0	2090	1.0	0.94	0.00	0.0	67.2	0.55	3.5	6.9	74.1
20	19.0	18.5	18.5	115.0	2205	1.0	0.92	0.00	0.0	67.2	0.55	3.5	10.4	77.5
21	20.0	19.5	19.5	115.0	2320	1.0	0.90	0.00	0.0	67.2	0.55	3.5	13.8	81.0
22	21.0	20.5	20.5	115.0	2435	1.0	0.89	0.00	0.0	67.2	0.55	3.5	17.3	84.5
23	22.0	21.5	21.5	120.0	2555	0.0	0.87	2.23	14.0	81.2	0.00	0.0	17.3	98.5
24	23.0	22.5	22.5	120.0	2675	0.0	0.86	2.30	14.4	95.6	0.00	0.0	17.3	112.9
25	24.0	23.5	23.5	120.0	2795	0.0	0.85	2.36	14.8	110.5	0.00	0.0	17.3	127.8
26	25.0	24.5	24.5	120.0	2915	0.0	0.83	2.42	15.2	125.7	0.00	0.0	17.3	143.0
27	26.0	25.5	25.5	120.0	3035	0.0	0.82	2.48	15.6	141.3	0.00	0.0	17.3	158.6
28	27.0	26.5	26.5	115.0	3150	1.7	0.81	0.00	0.0	141.3	0.94	5.9	23.2	164.5
29	28.0	27.5	27.5	115.0	3265	1.7	0.79	0.00	0.0	141.3	0.94	5.9	29.0	170.4
30	29.0	28.5	28.5	115.0	3380	1.7	0.78	0.00	0.0	141.3	0.94	5.9	34.9	176.3
31	30.0	29.5	29.5	115.0	3495	1.7	0.77	0.00	0.0	141.3	0.94	5.9	40.8	182.1
32	31.0	30.5	30.5	115.0	3610	1.7	0.75	0.00	0.0	141.3	0.94	5.9	46.7	188.0
33	32.0	31.5	31.5	115.0	3725	1.7	0.74	0.00	0.0	141.3	0.94	5.9	52.5	193.9
34	33.0	32.5	32.5	115.0	3840	1.7	0.73	0.00	0.0	141.3	0.94	5.9	58.4	199.8
35	34.0	33.5	33.5	115.0	3955	1.7	0.72	0.00	0.0	141.3	0.94	5.9	64.3	205.6
36	35.0	34.5	34.5	115.0	4070	1.7	0.71	0.00	0.0	141.3	0.94	5.9	70.2	211.5
37	36.0	35.5	35.5	115.0	4185	1.7	0.70	0.00	0.0	141.3	0.94	5.9	76.0	217.4
38	37.0	36.5	36.5	120.0	4305	0.0	0.68	2.95	18.5	159.8	0.00	0.0	76.0	235.9
39	38.0	37.5	37.5	120.0	4425	0.0	0.67	2.98	18.7	178.6	0.00	0.0	76.0	254.6
40	39.0	38.5	38.5	120.0	4545	0.0	0.66	3.01	18.9	197.5	0.00	0.0	76.0	273.5
41	40.0	39.5	39.5	120.0	4665	0.0	0.65	3.04	19.1	216.6	0.00	0.0	76.0	292.6



Brookhurst Street Undercrossing (Widen) 24-inch CIDH at Abutments 1 and 5 (Freehead)



Brookhurst Street Undercrossing (Widen) 24-inch CIDH at Abutments 1 and 5 (Freehead)

LPile Plus for Windows, Version 6.0 (6.0.03)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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Earth Mechanics, Inc.
Earth Mechanics, Inc.

Files Used for Analysis

Path to file locations: X:\Projects\2010\10-126 - R3F, SR 91 Westbound Widening\Reports\Foundation Report\01 Brookhurst St UC\Analysis\03 Lateral Capacity\
Name of input data file: Brookhurst St UC 24-inch CIDH (Abutments 1 and 5).lp6o
Name of output file: Brookhurst St UC 24-inch CIDH (Abutments 1 and 5).lp6o
Name of plot output file: Brookhurst St UC 24-inch CIDH (Abutments 1 and 5).lp6p
Name of runtime file: Brookhurst St UC 24-inch CIDH (Abutments 1 and 5).lp6r

Date and Time of Analysis

Date: August 30, 2011 Time: 15:36:06

Problem Title

Project Name:

Job Number:

Client:

Engineer:

Description:

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	100	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections = 1

Total Pile Length = 50.00 ft

Depth of ground surface below top of pile = -4.50 ft

Slope angle of ground surface = 26.60 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over
the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	24.0000000
2	50.000000	24.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	50.000 in
Top Width	=	24.000 in
Bottom Width	=	24.000 in
Top Area	=	452.400000 sq. in
Bottom Area	=	452.400000 sq. in
Moment of Inertia at Top	=	8.143E+03 in^4
Moment of Inertia at Bottom	=	8.143E+03 in^4
Elastic Modulus	=	3200000.000 lbs/in.

Ground Slope and Pile Batter Angles

Ground Slope Angle = 26.600 degrees
= 0.464 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 8 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = -4.500 ft
Distance from top of pile to bottom of layer = 16.000 ft
p-y subgrade modulus k for top of soil layer = 50.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 50.000 lbs/in**3

Layer 2 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 16.000 ft
Distance from top of pile to bottom of layer = 21.000 ft

Layer 3 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 21.000 ft
Distance from top of pile to bottom of layer = 26.000 ft
p-y subgrade modulus k for top of soil layer = 60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 60.000 lbs/in**3

Layer 4 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 26.000 ft
Distance from top of pile to bottom of layer = 36.000 ft

Layer 5 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 36.000 ft
Distance from top of pile to bottom of layer = 48.000 ft
p-y subgrade modulus k for top of soil layer = 60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 60.000 lbs/in**3

Layer 6 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 48.000 ft
Distance from top of pile to bottom of layer = 51.000 ft
p-y subgrade modulus k for top of soil layer = 35.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 35.000 lbs/in**3

Layer 7 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 51.000 ft
Distance from top of pile to bottom of layer = 66.000 ft

Layer 8 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 66.000 ft
Distance from top of pile to bottom of layer = 75.000 ft
p-y subgrade modulus k for top of soil layer = 85.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 85.000 lbs/in**3

(Depth of lowest layer extends 25.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 16 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	-4.50	120.00000
2	16.00	120.00000
3	16.00	115.00000
4	21.00	115.00000
5	21.00	120.00000
6	26.00	120.00000
7	26.00	115.00000
8	36.00	115.00000
9	36.00	120.00000
10	48.00	120.00000
11	48.00	57.60000
12	51.00	57.60000
13	51.00	52.60000
14	66.00	52.60000
15	66.00	57.60000
16	75.00	57.60000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. Subgr. pci
1	Sand (Reese, et al.)	-4.500	120.000	--	31.000	--	--	--	50.000	--	--	--	--	--
		16.000	120.000	--	31.000	--	--	--	50.000	--	--	--	--	--
2	Soft Clay	16.000	115.000	1000.000	--	--	--	0.00700	--	--	--	--	--	--
		21.000	115.000	1000.000	--	--	--	0.00700	--	--	--	--	--	--
3	Sand (Reese, et al.)	21.000	120.000	--	32.000	--	--	--	60.000	--	--	--	--	--
		26.000	120.000	--	32.000	--	--	--	60.000	--	--	--	--	--
4	Soft Clay	26.000	115.000	1700.000	--	--	--	0.00500	--	--	--	--	--	--
		36.000	115.000	1700.000	--	--	--	0.00500	--	--	--	--	--	--
5	Sand (Reese, et al.)	36.000	120.000	--	32.000	--	--	--	60.000	--	--	--	--	--
		48.000	120.000	--	32.000	--	--	--	60.000	--	--	--	--	--
6	Sand (Reese, et al.)	48.000	57.600	--	32.000	--	--	--	35.000	--	--	--	--	--
		51.000	57.600	--	32.000	--	--	--	35.000	--	--	--	--	--
7	Soft Clay	51.000	52.600	1700.000	--	--	--	0.00500	--	--	--	--	--	--
		66.000	52.600	1700.000	--	--	--	0.00500	--	--	--	--	--	--
8	Sand (Reese, et al.)	66.000	57.600	--	36.000	--	--	--	85.000	--	--	--	--	--
		75.000	57.600	--	36.000	--	--	--	85.000	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.7000	1.0000
2	50.000	0.7000	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	60000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	60000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	60000.000
4	4	y =	2.000 in	M =	0.000 in-lbs	60000.000
5	4	y =	5.000 in	M =	0.000 in-lbs	60000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

---

Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)		Condition 2 in-lb, rad., or in-lb/rad.		Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y =	0.2500	M =	0.000	60000.	0.25000000	572457.	13500.	0.00000000
2	4	y =	0.5000	M =	0.000	60000.	0.50000000	1020278.	21286.	0.00000000
3	4	y =	1.0000	M =	0.000	60000.	1.00000000	1825589.	34547.	0.00000000
4	4	y =	2.0000	M =	0.000	60000.	2.00000000	3269359.	53007.	0.00000000
5	4	y =	5.0000	M =	0.000	60000.	5.00000000	6730498.	83784.	0.00000000

Summary of Warning Messages

The following warning was reported 266 times

**** Warning ****

An unreasonable input value for shear strength has been specified for a soil defined using the soft clay criteria. The input value is greater than 8.68 psi (1,250 psf). You should check your input data for correctness.

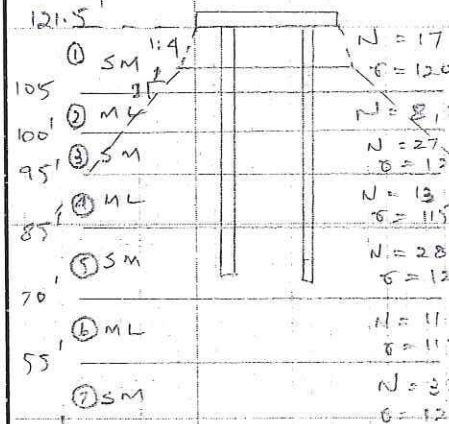
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
(714) 751-3826, Fax (714) 751-3928

Project SR-91 WB widening – Brookhurst st UC **Project No.** 10-126

By SP **Date** 08-30-11 **Checked By** SJ **Date** 8/30/11 **Sheet** ____ **of** ____

Abutments settlement



Total load = 245 kips

permanent load = 180 kips

pile cap = 10' x 12'

consider pile length = 12'

$2D/3 = 2/3 \times 12 = 8'$

Equivalent footing = $(10 + \frac{8}{1} \times 2) \times (12 + \frac{8}{4} \times 2)$

= 14' x 16'

$q = \frac{245}{14 \times 16} = 1.1$ ksf for immediate settlement

$= \frac{180}{14 \times 16} = 0.8$ ksf for consolidation settlement

Immediate settlement

	$\Delta\sigma_v$	$\Delta\sigma$	Settlement
① 12x12.0	= 1.44	$\frac{245}{(144+4)(16+4)} = 0.68$	$8 \times \frac{1}{50} \log\left(\frac{1.44+0.68}{1.44}\right) = 0.02$
② 16x12.0 + 2.5x115 = 3.21		$\frac{245}{(144+10.5)(16+10.5)} = 0.38$	$5 \times \frac{1}{40} \log\left(\frac{3.21+0.38}{3.21}\right) = 0.1$
③ 18.5x120 + 5x115 = 2.8		$\frac{245}{(144+15.5)(16+13.5)} = 0.26$	$5 \times \frac{1}{76} \log\left(\frac{2.8+0.26}{2.8}\right) = 0.05$
④ 21x120 + 10x115 = 3.67		$\frac{245}{(144+23)(16+23)} = 0.17$	$10 \times \frac{1}{45} \log\left(\frac{3.67+0.17}{3.67}\right) = 0.05$
⑤ 28.5x120 + 15x115 = 5.15		$\frac{245}{(144+35.5)(16+35.5)} = 0.1$	$15 \times \frac{1}{70} \log\left(\frac{5.15+0.1}{5.15}\right) = 0.05$
⑥ 36x120 + 15x113 + 5x57.6 + 15x52.4 = 7.12		$\frac{245}{(144+63)(16+63)} = 0.1$	$10 \times \frac{1}{80} \log\left(\frac{7.12+0.1}{7.12}\right) = 0.01$
			0.58"

Consolidation settlement = $15 \times 0.02 \log\left(\frac{6.44+0.1}{6.44}\right) = 0.14$"

total settlement = 0.68"

Pile length is less than 12' & settlement is less than 0.7".
no applicable pile length for settlement for Abutments 1 & 5.

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
(714) 751-3826, Fax (714) 751-3928

Project SR-91 WB widening – Bridge No. 54 4C **Project No.** 10-120

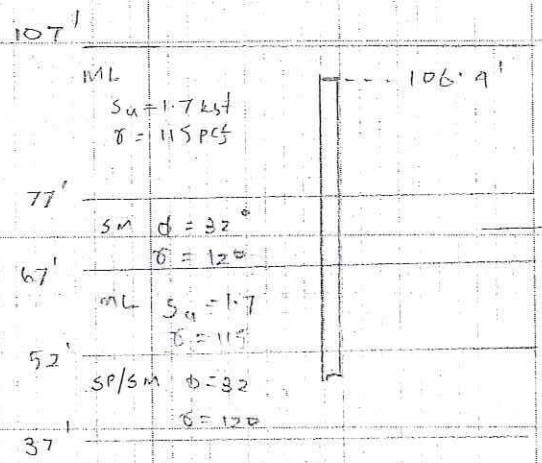
By SP **Date** 08-30-11 **Checked By** S J **Date** 8/31/11 **Sheet** ___ **of** ___

Bents 2 to 4

24-inch CIDH piles

area = 452.4 in²

I = 16286 in⁴ ; I cracked = 8143 in⁴



Bent 2

Nominal resistance per pile

Strength limit state = 135/0.7 = 193 kips

consider 200 kips

Extreme event limit state 400/1.0 = 400 kips

consider 400 kips

Tension = 200 kips

Nominal resistance per support

Strength limit state = 700/0.7 = 1000 kips

Extreme event limit state = 375/1.0 = 375 kips

group efficiency factor = 0.7 (SDC and pile type #1)

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
(714) 751-3826, Fax (714) 751-3928

Project SR-91 WB widening - Brookhurst St UC **Project No.** 10-126

By SP **Date** 08-10-11 **Checked By** S.S **Date** 8/31/11 **Sheet** ___ **of** ___

from analysis

strength limit state

at depth of 29 feet, pile capacity = 219 kips > 200 kips

pile tip elevation for compression = 106 - 29

= 77'

Available group nominal resistance at tip

elevation at 77' : 0.7 x 6 x 219

: 920 kips < 1000 kips

compression capacity needed per pile = $\frac{1000}{0.7 \times 6}$ = 238 kips

at 31 feet, pile capacity: 259 kips > 240 kips

pile tip elevation for compression = 106 - 31

= 75'

Nominal resistance = 240 kips

extreme event limit state

at 38 feet, pile capacity = 402 kips > 400 kips

pile tip elevation for compression = 106 - 38

= 68'

Available group nominal resistance at tip elevation 68'

: 0.7 x 6 x 400

: 1680 kips > 375 kips

pile tip elevation for compression (extreme event)

= 68 feet

at 33 feet, tension = 2/3 x 300 x 6 = 3600 kips > 200 kips

pile tip elevation for tension (extreme event)

= 106 - 33 = 73 feet

SKIN FRICTION FOR DRILLED SHAFT IN BOTH COHESIONLESS AND COHESIVE SOILS USING REESE AND O'NEILL'S METHOD (1999)

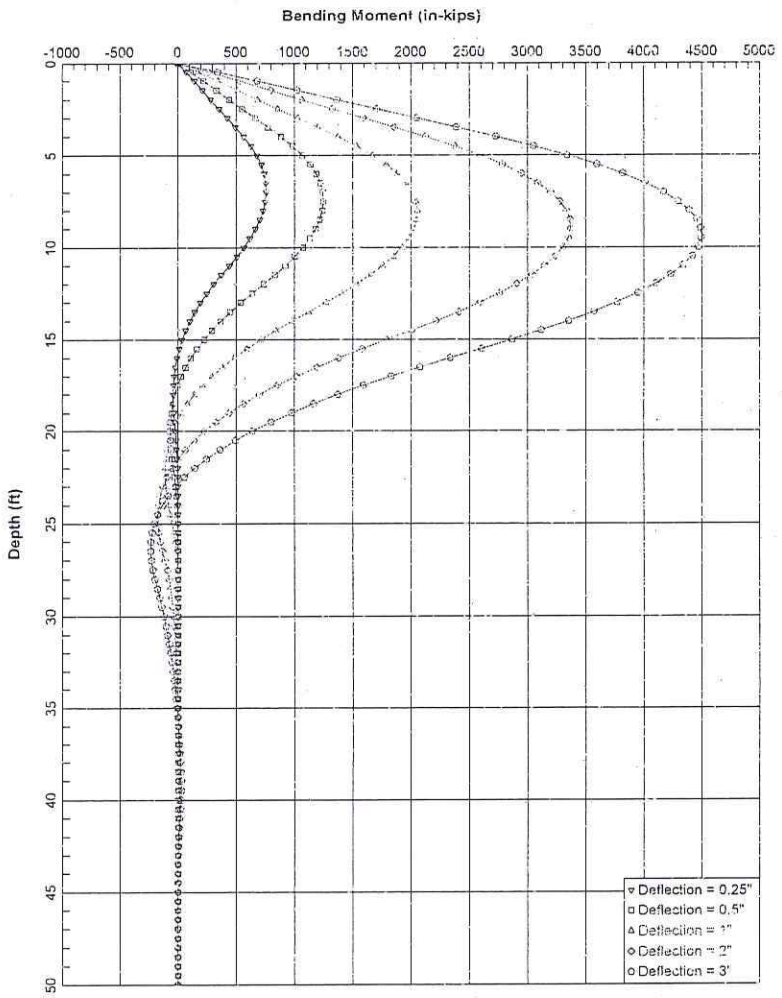
PROJECT: Brookhurst St UC — ITEM: 24-inch Diameter CIDH Existing Pile
PROJECT NO.: 10-126 — Bent 2
DONE BY: SP DATE: 03/10/11
CHECKED BY: DATE:

D_s => 2.00 ft — Hw => 33.0 ft — Hg => 0.0 ft
p = 6.28 ft — Ho => 0.0 ft — Hf => 0.0 ft

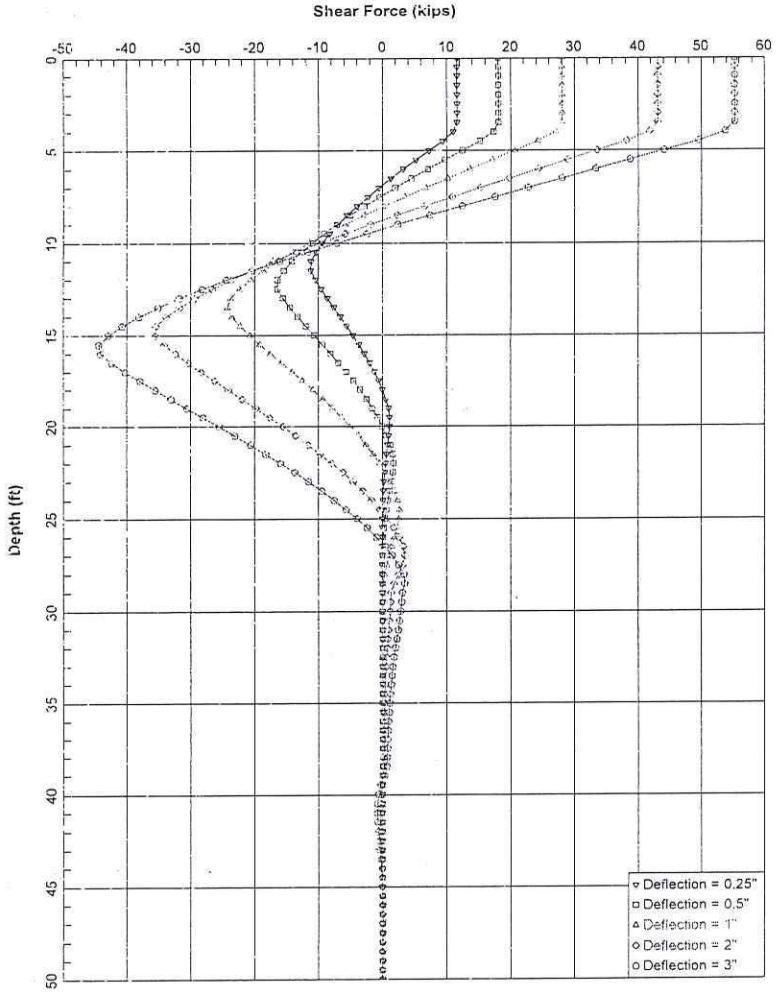
Hw is the depth to water table.
Hg is the depth to ground surface used in calculation.
Ho is the depth to location starting initial overburden pressure
Hf is the depth to location starting accumulation of skin frictio
bottom of footing = 106.4 ft

Soil Layer =>	from Top	to Bottom =>	γ (pcf)=>	γ' (pcf)=	c' (ksf) =>	φ' =>	
(1)	0	4	115	52.6	0.00	0	ML
(2)	4	10	115	52.6	0.00	31	SM
(3)	10	26	120	57.6	1.70	0	ML
(4)	26	39	115	52.6	0.00	32	SM
(5)	39	54	120	57.6	1.70	0	ML

Sublayer No.	Depth, z (ft)	z_i (ft)	New Depth (ft)	Soil Unit Weight (pcf)	Overburden Pressure (psf)	c' (ksf)	β	f_i^s (ksf)	ΔQ_s^s (kips)	Q_s^s (kips)	f_i^c (ksf)	ΔQ_s^c (kips)	Q_s^c (kips)	Q_s (kips)
0	0.0	0.0	0.0	115.0	720									
1	0.0	0.0	0.0	115.0	720	0.0				0.0			0.0	0.0
2	1.0	0.5	0.5	115.0	778	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
3	2.0	1.5	1.5	115.0	893	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
4	3.0	2.5	2.5	115.0	1008	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
5	4.0	3.5	3.5	115.0	1123	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
6	5.0	4.5	4.5	115.0	1238	0.0	1.20	1.49	9.3	9.3	0.00	0.0	0.0	9.3
7	6.0	5.5	5.5	115.0	1353	0.0	1.18	1.60	10.1	19.4	0.00	0.0	0.0	19.4
8	7.0	6.5	6.5	115.0	1468	0.0	1.16	1.70	10.7	30.0	0.00	0.0	0.0	30.0
9	8.0	7.5	7.5	115.0	1583	0.0	1.13	1.79	11.2	41.3	0.00	0.0	0.0	41.3
10	9.0	8.5	8.5	115.0	1698	0.0	1.11	1.88	11.8	53.1	0.00	0.0	0.0	53.1
11	10.0	9.5	9.5	115.0	1813	0.0	1.08	1.96	12.3	65.4	0.00	0.0	0.0	65.4
12	11.0	10.5	10.5	120.0	1933	1.7	1.06	0.00	0.0	65.4	0.94	5.9	5.9	71.3
13	12.0	11.5	11.5	120.0	2053	1.7	1.04	0.00	0.0	65.4	0.94	5.9	11.7	77.2
14	13.0	12.5	12.5	120.0	2173	1.7	1.02	0.00	0.0	65.4	0.94	5.9	17.6	83.1
15	14.0	13.5	13.5	120.0	2293	1.7	1.00	0.00	0.0	65.4	0.94	5.9	23.5	88.9
16	15.0	14.5	14.5	120.0	2413	1.7	0.99	0.00	0.0	65.4	0.94	5.9	29.4	94.8
17	16.0	15.5	15.5	120.0	2533	1.7	0.97	0.00	0.0	65.4	0.94	5.9	35.2	100.7
18	17.0	16.5	16.5	120.0	2653	1.7	0.95	0.00	0.0	65.4	0.94	5.9	41.1	106.6
19	18.0	17.5	17.5	120.0	2773	1.7	0.94	0.00	0.0	65.4	0.94	5.9	47.0	112.4
20	19.0	18.5	18.5	120.0	2893	1.7	0.92	0.00	0.0	65.4	0.94	5.9	52.9	118.3
21	20.0	19.5	19.5	120.0	3013	1.7	0.90	0.00	0.0	65.4	0.94	5.9	58.7	124.2
22	21.0	20.5	20.5	120.0	3133	1.7	0.89	0.00	0.0	65.4	0.94	5.9	64.6	130.0
23	22.0	21.5	21.5	120.0	3253	1.7	0.87	0.00	0.0	65.4	0.94	5.9	70.5	135.9
24	23.0	22.5	22.5	120.0	3373	1.7	0.86	0.00	0.0	65.4	0.94	5.9	76.4	141.8
25	24.0	23.5	23.5	120.0	3493	1.7	0.85	0.00	0.0	65.4	0.94	5.9	82.2	147.7
26	25.0	24.5	24.5	120.0	3613	1.7	0.83	0.00	0.0	65.4	0.94	5.9	88.1	153.5
27	26.0	25.5	25.5	120.0	3733	1.7	0.82	0.00	0.0	65.4	0.94	5.9	94.0	159.4
28	27.0	26.5	26.5	115.0	3848	0.0	0.81	3.10	19.5	84.9	0.00	0.0	94.0	178.9
29	28.0	27.5	27.5	115.0	3963	0.0	0.79	3.14	19.7	104.6	0.00	0.0	94.0	198.6
30	29.0	28.5	28.5	115.0	4078	0.0	0.78	3.18	20.0	124.6	0.00	0.0	94.0	218.6
31	30.0	29.5	29.5	115.0	4193	0.0	0.77	3.21	20.2	144.8	0.00	0.0	94.0	238.8
32	31.0	30.5	30.5	115.0	4308	0.0	0.75	3.25	20.4	165.2	0.00	0.0	94.0	259.2
33	32.0	31.5	31.5	115.0	4423	0.0	0.74	3.28	20.6	185.8	0.00	0.0	94.0	279.8
34	33.0	32.5	32.5	115.0	4538	0.0	0.73	3.31	20.8	206.6	0.00	0.0	94.0	300.6
35	34.0	33.5	33.5	52.6	4590	0.0	0.72	3.30	20.7	227.4	0.00	0.0	94.0	321.4
36	35.0	34.5	34.5	52.6	4643	0.0	0.71	3.28	20.6	248.0	0.00	0.0	94.0	342.0
37	36.0	35.5	35.5	52.6	4695	0.0	0.70	3.27	20.5	268.5	0.00	0.0	94.0	362.5
38	37.0	36.5	36.5	52.6	4748	0.0	0.68	3.25	20.4	288.9	0.00	0.0	94.0	382.9
39	38.0	37.5	37.5	52.6	4801	0.0	0.67	3.23	20.3	309.2	0.00	0.0	94.0	403.2
40	39.0	38.5	38.5	52.6	4853	0.0	0.66	3.21	20.2	329.4	0.00	0.0	94.0	423.4
41	40.0	39.5	39.5	57.6	4911	1.7	0.65	0.00	0.0	329.4	0.94	5.9	99.9	429.3
42	41.0	40.5	40.5	57.6	4968	1.7	0.64	0.00	0.0	329.4	0.94	5.9	105.7	435.2



Brookhurst Street Undercrossing (Widen) 24-inch CIDH with Casings at Bent 2 (Freehead)



Brookhurst Street Undercrossing (Widen) 24-inch CIDH with Casings at Bent 2 (Freehead)

LPile Plus for Windows, Version 6.0 (6.0.09)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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Files Used for Analysis

Path to file locations: X:\Projects\2010\10-225 - KBF SR 91 Westbound Widening\Reports\Foundation Report\Brookhurst St UC\Analysis\03 Lateral Capacity\
Name of input data file: Brookhurst St UC 24-inch CIDH (Bent 2 Cased).lpd
Name of output file: Brookhurst St UC 24-inch CIDH (Bent 2 Cased).lp6o
Name of plot output file: Brookhurst St UC 24-inch CIDH (Bent 2 Cased).lp6p
Name of runtime file: Brookhurst St UC 24-inch CIDH (Bent 2 Cased).lpar

Date and Time of Analysis

Date: March 24, 2011 Time: 15:46:21

Problem Title

Project Name:

Job Number:

Client:

Engineer:

Description:

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.000CE-05 in

- Maximum allowable deflection = [illegible] in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections = 1

Total Pile Length = 50.00 ft

Depth of ground surface below top of pile = -5.00 ft

Slope angle of ground surface = 0.00 deg.

Pile dimensions used for p-y curve computations defined using 3 points. p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	24.000000
2	50.000000	24.000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	50.000 in
Top Width	=	24.000 in
Bottom Width	=	24.000 in
Top Area	=	452.400000 sq. in
Bottom Area	=	452.400000 sq. in
Moment of Inertia at Top	=	8.143E+03 in^4
Moment of Inertia at Bottom	=	8.143E+03 in^4
Elastic Modulus	=	3200000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 6 layers

Layer 1 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = -5.000 ft
Distance from top of pile to bottom of layer = 4.000 ft

Layer 2 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 4.000 ft
Distance from top of pile to bottom of layer = 29.000 ft

Layer 3 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	29.000 ft
Distance from top of pile to bottom of layer	=	33.000 ft
p-y subgrade modulus k for top of soil layer	=	60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	60.000 lbs/in**3

Layer 4 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	33.000 ft
Distance from top of pile to bottom of layer	=	39.000 ft
p-y subgrade modulus k for top of soil layer	=	35.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	35.000 lbs/in**3

Layer 5 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	39.000 ft
Distance from top of pile to bottom of layer	=	54.000 ft

Layer 6 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	54.000 ft
Distance from top of pile to bottom of layer	=	69.000 ft
p-y subgrade modulus k for top of soil layer	=	35.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	35.000 lbs/in**3

(Depth of lowest layer extends 19.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 12 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	-5.00	115.00000
2	4.00	115.00000
3	4.00	115.00000
4	29.00	115.00000
5	29.00	120.00000
6	33.00	120.00000
7	33.00	57.60000
8	39.00	57.60000
9	39.00	52.60000
10	54.00	52.60000
11	54.00	57.60000
12	69.00	57.60000

Summary of Soil Properties

Layer Subgr. Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. pci
1	Soft Clay	-5.000	115.000	1.00E-03	--	--	--	0.00	--	--	--	--	--	--
		4.000	115.000	1.00E-03	--	--	--	0.00	--	--	--	--	--	--
2	Soft Clay	4.000	115.000	1700.000	--	--	--	0.00500	--	--	--	--	--	--
		29.000	115.000	1700.000	--	--	--	0.00500	--	--	--	--	--	--
3	Sand (Reese, et al.)	29.000	120.000	--	32.000	--	--	--	60.000	--	--	--	--	--
		33.000	120.000	--	32.000	--	--	--	60.000	--	--	--	--	--
4	Sand (Reese, et al.)	33.000	57.600	--	32.000	--	--	--	35.000	--	--	--	--	--
		39.000	57.600	--	32.000	--	--	--	35.000	--	--	--	--	--

5	Soft Clay	39.000	52.600	1700.000	--	--	--	0.00500	--	--	--	--	--	--
		54.000	52.600	1700.000	--	--	--	0.00500	--	--	--	--	--	--
6	Sand (Reese, et al.)	54.000	57.600	--	32.000	--	--	--	35.000	--	--	--	--	--
		69.000	57.600	--	32.000	--	--	--	35.000	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	4.000	0.6000	1.0000
2	50.000	0.6000	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	60000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	60000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	60000.000
4	4	y =	2.300 in	M =	0.000 in-lbs	60000.000
5	4	y =	3.000 in	M =	0.000 in-lbs	60000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs

Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

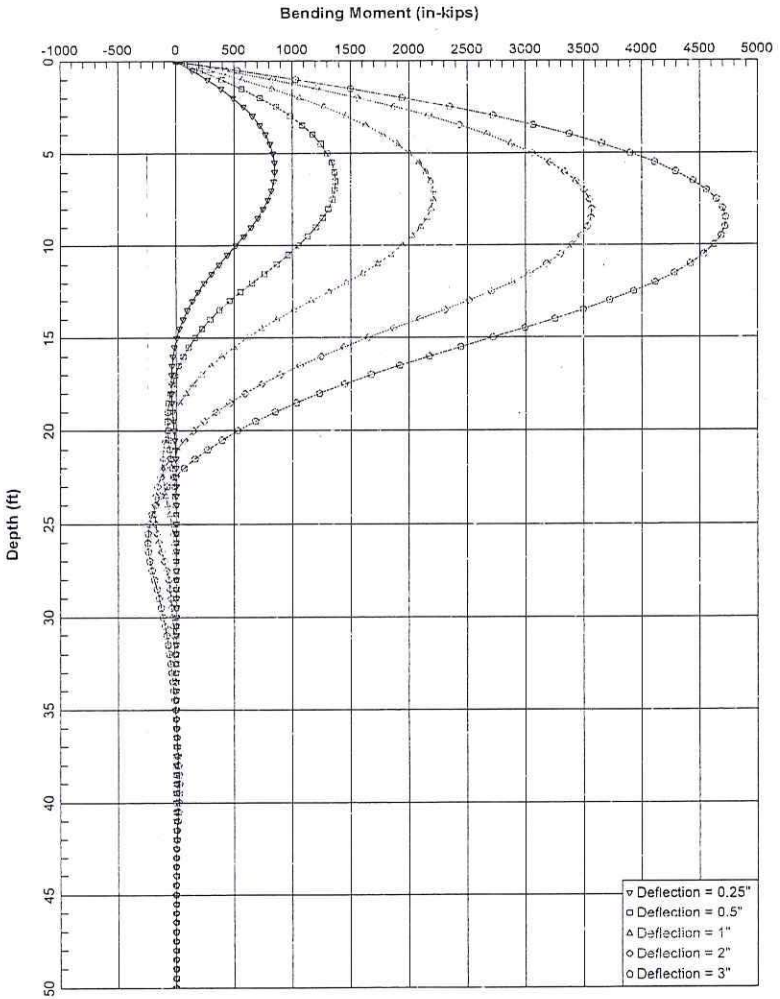
Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)	Condition 2 in-lb, rad., or in-lb/rad.	Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y = 0.2500	M = 0.000	60000.	0.25000000	758989.	11603.	0.00000000
2	4	y = 0.5000	M = 0.000	60000.	0.50000000	1250179.	18112.	0.00000000
3	4	y = 1.0000	M = 0.000	60000.	1.00000000	2054100.	28054.	0.00000000
4	4	y = 2.0000	M = 0.000	60000.	2.00000000	3367566.	43125.	0.00000000
5	4	y = 3.0000	M = 0.000	60000.	3.00000000	4495057.	55286.	0.00000000

Summary of Warning Messages

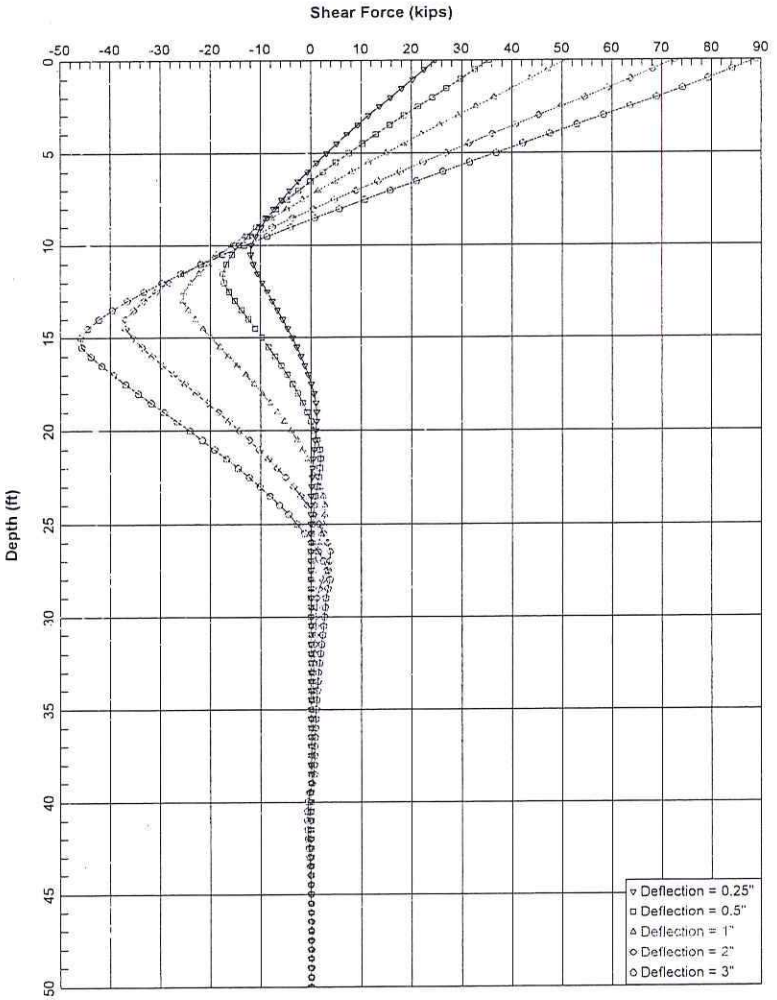
The following warning was reported 1207 times

**** Warning ****

An unreasonable input value for shear strength has been specified for a soil defined using the soft clay criteria. The input value is greater than 8.68 psi (1,250 psf). You should check your input data for correctness.



Brookhurst Street Undercrossing (Widen) 24-inch CIDH without Casings at Bent 2 (Freehead)



Brookhurst Street Undercrossing (Widen) 24-inch CIDH without Casings at Bent 2 (Freehead)

LPile Plus for Windows, Version 6.0 (6.0.09)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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Earth Mechanics, Inc.

Files Used for Analysis

Path to file locations: X:\Projects\2010\10-126 - RBF SR 91 Westbound Widening\Reports\Foundation Report\Brookhurst St UC\Analysis\03 Lateral Capacity\
Name of input data file: Brookhurst St UC 24-inch CIDH (Bent 2 Non Cased).lp6d
Name of output file: Brookhurst St UC 24-inch CIDH (Bent 2 Non Cased).lp6o
Name of plot output file: Brookhurst St UC 24-inch CIDH (Bent 2 Non Cased).lp6p
Name of runtime file: Brookhurst St UC 24-inch CIDH (Bent 2 Non Cased).lp6r

Date and Time of Analysis

Date: March 24, 2011 Time: 15:51:29

Problem Title

Project Name:

Job Number:

Client:

Engineer:

Description:

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	100	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections	=	1
Total Pile Length	=	50.00 ft
Depth of ground surface below top of pile	=	-5.00 ft
Slope angle of ground surface	=	0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	24.0000000
2	50.000000	24.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	50.000 in
Top Width	=	24.000 in
Bottom Width	=	24.000 in
Top Area	=	452.400000 sq. in
Bottom Area	=	452.400000 sq. in
Moment of Inertia at Top	=	8.143E+03 in^4
Moment of Inertia at Bottom	=	8.143E+03 in^4
Elastic Modulus	=	3200000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 5 layers

Layer 1 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	-5.000 ft
Distance from top of pile to bottom of layer	=	29.000 ft

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	29.000 ft
Distance from top of pile to bottom of layer	=	33.000 ft
p-y subgrade modulus k for top of soil layer	=	60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	60.000 lbs/in**3

Layer 3 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	33.000 ft

Distance from top of pile to bottom of layer = 39.000 ft
p-y subgrade modulus k for top of soil layer = 35.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 35.000 lbs/in**3

Layer 4 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 39.000 ft
Distance from top of pile to bottom of layer = 54.000 ft

Layer 5 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 54.000 ft
Distance from top of pile to bottom of layer = 69.000 ft
p-y subgrade modulus k for top of soil layer = 35.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 35.000 lbs/in**3

(Depth of lowest layer extends 19.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 10 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	-5.00	115.00000
2	29.00	115.00000
3	29.00	120.00000
4	33.00	120.00000
5	33.00	57.60000
6	39.00	57.60000
7	39.00	52.60000
8	54.00	52.60000
9	54.00	57.60000
10	69.00	57.60000

Summary of Soil Properties

Layer Subgr. Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. pci
1	Soft Clay	-5.000	115.000	1700.000	--	--	--	0.00500	--	--	--	--	--	--
		29.000	115.000	1700.000	--	--	--	0.00500	--	--	--	--	--	--
2	Sand (Reese, et al.)	29.000	120.000	--	32.000	--	--	--	60.000	--	--	--	--	--
		33.000	120.000	--	32.000	--	--	--	60.000	--	--	--	--	--
3	Sand (Reese, et al.)	33.000	57.600	--	32.000	--	--	--	35.000	--	--	--	--	--
		39.000	57.600	--	32.000	--	--	--	35.000	--	--	--	--	--
4	Soft Clay	39.000	52.600	1700.000	--	--	--	0.00500	--	--	--	--	--	--
		54.000	52.600	1700.000	--	--	--	0.00500	--	--	--	--	--	--
5	Sand (Reese, et al.)	54.000	57.600	--	32.000	--	--	--	35.000	--	--	--	--	--
		69.000	57.600	--	32.000	--	--	--	35.000	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point	Depth X	p-mult	y-mult

No.	ft		
1	0.000	0.6000	1.0000
2	50.000	0.6000	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	60000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	60000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	60000.000
4	4	y =	2.000 in	M =	0.000 in-lbs	60000.000
5	4	y =	3.000 in	M =	0.000 in-lbs	60000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)		Condition 2 in-lb, rad., or in-lb/rad.		Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y =	0.2500	M =	0.000	60000.	0.25000000	849437.	24705.	0.00000000
2	4	y =	0.5000	M =	0.000	60000.	0.50000000	1371166.	35371.	0.00000000
3	4	y =	1.0000	M =	0.000	60000.	1.00000000	2207600.	50637.	0.00000000
4	4	y =	2.0000	M =	0.000	60000.	2.00000000	3567813.	72581.	0.00000000
5	4	y =	3.0000	M =	0.000	60000.	3.00000000	4724330.	88954.	0.00000000

Summary of Warning Messages

The following warning was reported 1360 times

**** Warning ****

An unreasonable input value for shear strength has been specified for a soil defined using the soft clay criteria. The input value is greater than 8.68 psi (1,250 psf). You should check your input data for correctness.

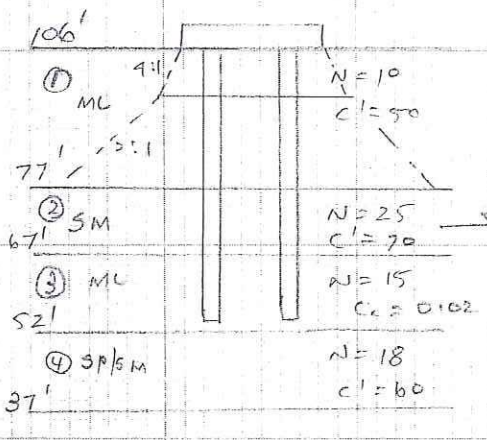
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
(714) 751-3826, Fax (714) 751-3928

Project SR-91 WB widening - Brookhurst St UC **Project No.** 10-126

By SP **Date** 03-17-11 **Checked By** S.S **Date** 3/21/11 **Sheet** ____ **of** ____

Bent 2 settlement



Total load = 500 kips
permanent load = 375 kips
pile cap = 10' x 16.5'

consider pile length D = 12'
2D/3 = 8'
equivalent footing = $(10 + \frac{8}{11} \times 2) \times (16.5 + \frac{8}{4} \times 2)$
= 14' x 20.5'

$q = \frac{500}{14 \times 20.5} = 1.74$ ksf for immediate settlement

$= \frac{375}{14 \times 20.5} = 1.3$ ksf for consolidation settlement.

Immediate settlement

	σ'vo	Δσ	Settlement
①	$18.5 \times 115 = 2.13$	$\frac{500}{(14+10.5)(20.5+10.5)} = 0.66$	$21 \times \frac{1}{50} \log\left(\frac{2.13+0.66}{2.13}\right) = 0.16$
②	$29 \times 115 + 3.5 \times 120 + 1.5 \times 57.6 = 3.84$	$\frac{500}{(14+26)(20.5+26)} = 0.27$	$10 \times \frac{1}{70} \log\left(\frac{3.84+0.27}{3.84}\right) = 0.1$
④	$29 \times 115 + 3.5 \times 120 + 14 \times 57.6 = 4.56$	$\frac{500}{(14+53.5)(20.5+53.5)} = 0.1$	$15 \times \frac{1}{60} \log\left(\frac{4.56+0.1}{4.56}\right) = 0.005$

0.175"

consolidation settlement = $15 \times 0.02 \log\left(\frac{4.52+0.12}{4.52}\right) = 0.05$"

Total settlement = 0.8"

pile length is less than 12" and settlement is less than 0.8".

do applicable pile length for settlement for Bent 2.

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Project SR-91 WB Widening - Brookhurst St UC Project No. 10-126

By SP Date 08-30-11 Checked By S.S Date 8/31/11 Sheet ____ of ____

Bent 3

Nominal resistance per pile

Strength limit state = 150/0.7 = 214 kips

consider 220 kips

Extreme event limit state: 325/1.0 = 325 kips

consider 330 kips

Tension = 190 kips

Nominal resistance per support

strength limit state = 750/0.7 = 1071 kips

Extreme event limit state = 410/1.0 = 410 kips

group efficiency factor = 0.77

from the analysis

Strength Limit state

at 30 feet, pile capacity = 239 kips > 220 kips

pile tip elevation for compression (strength limit)

= 106 - 30 = 76 ft

Available group nominal resistance at pile tip elevation 76 ft = 0.77 x 6 x 239

= 1104 kips > 1071 kips

Available group nominal resistance exceeds the required group nominal resistance

Nominal resistance per pile = $\frac{1071}{6 \times 0.7}$ = 232 kips controlled by group demand

consider nominal resistance = 240 kips

pile tip elevation for compression (strength limit state)

= 76 feet

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Project SR-91 WB widening - Brookhurst St UC **Project No.** 10-126

By SP **Date** 08-30-11 **Checked By** S.J **Date** 8/31/11 **Sheet** ____ **of** ____

Extreme event limit state

at 35 feet, pile capacity = 342 kips > 330 kips

pile tip elevation for compression = 106 - 35
= 71'

Available group nominal resistance at pile tip elevation 71' = 0.77 x 6 x 342
= 1580 kips > 410 kips

pile tip elevation for compression (Extreme event) = 71'

at 33 feet, Tension = 2/3 x 300 = 200 kips > 190 kips

pile tip elevation for Tension (Extreme Event)
= 106 - 33
= 73 feet

Bent 3 settlement

similar to calculation for Bent 2

pile length is less than 12 feet and settlement is less than 0.5". no applicable pile length for settlement for Bent 3

Bent 4

Nominal resistance per pile

Strength limit state = 135/0.7 = 193 kips
consider 200 kips

Extreme event limit state = 325/1.0 = 325 kips
consider 330 kips
Tension = 190 kips

Nominal resistance per support

Strength limit state = 700/0.7 = 1000 kips

Extreme event limit state = 375 kips

group efficiency factor = 0.77

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Project SR-91 WB widening - Brookhurst St UC **Project No.** 10-126

By SP **Date** 08-30-11 **Checked By** SJ **Date** 8/31/11 **Sheet** ____ **of** ____

- from the analysis

Strength limit state

at depth of 80 ft, pile capacity = 238 kips > 200 kips

pile tip elevation for compression = 106 - 30 = 76 feet

Available group nominal resistance at pile tip elevation 76 feet = 0.77 x 6 x 238
= 1100 kips < 1000 kips

Nominal resistance per pile = 1000 / 6 x 0.7 = 216 kips controlled by group demand.

considered nominal resistance = 220 kips

pile tip elevation for compression (strength limit)
= 76 feet

Extreme event limit state

at 35 feet, pile capacity = 342 kips > 330 kips

pile tip elevation for compression = 106 - 35
= 71 feet

Available group nominal resistance at pile tip elevation 85 feet = 0.77 x 6 x 342
= 1580 kips > 375 kips

pile tip elevation for compression (Extreme event)
= 71 feet

at 33 feet, tension = 2/3 x 300 = 200 kips > 190 kips

pile tip elevation for tension (Extreme event)
= 106 - 33
= 73 feet

Bent 4 settlement

Similar to Bent 2 calculations

pile length is less than 10 feet & so settlement is less than 0.2"

no applicable pile length for settlement for Bent 4.

SKIN FRICTION FOR DRILLED SHAFT IN BOTH COHESIONLESS AND COHESIVE SOILS USING REESE AND O'NEILL'S METHOD (1999)

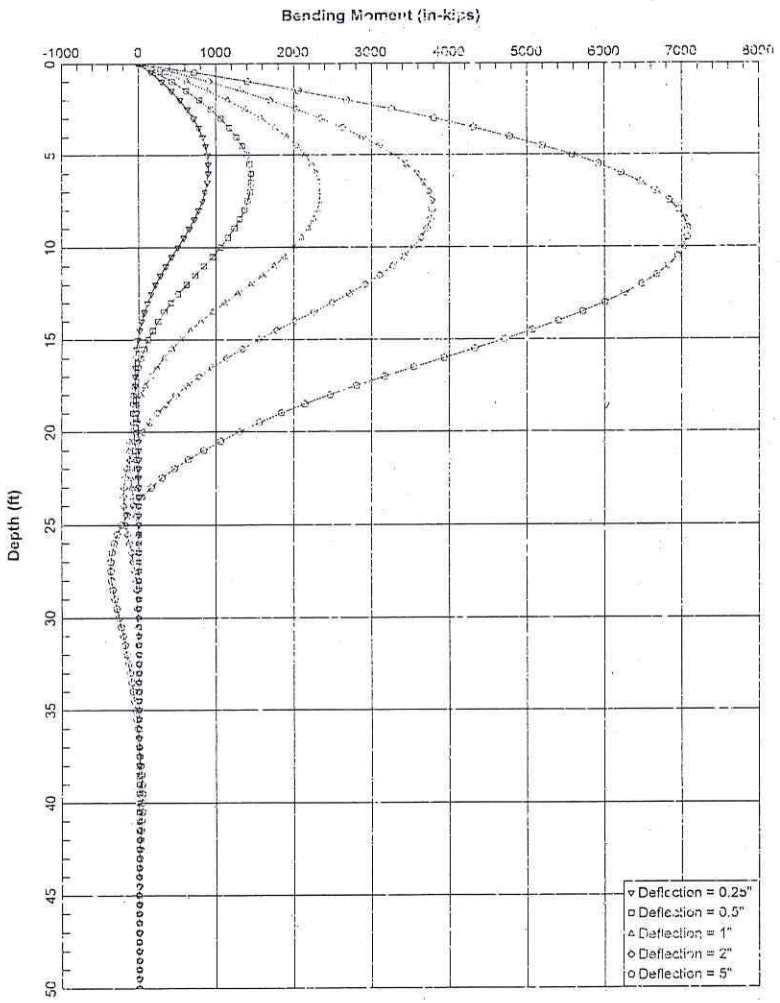
PROJECT: Brookhurst St UC
ITEM: 24-inch Diameter CIDH Existing Pile
PROJECT NO.: 10-126
Bents 3 and 4
DONE BY: SP DATE: 03/10/11
CHECKED BY: DATE:

D_s => 2.00 ft Hw => 33.0 ft Hg => 0.0 ft
p = 6.28 ft Ho => 0.0 ft Hf => 0.0 ft

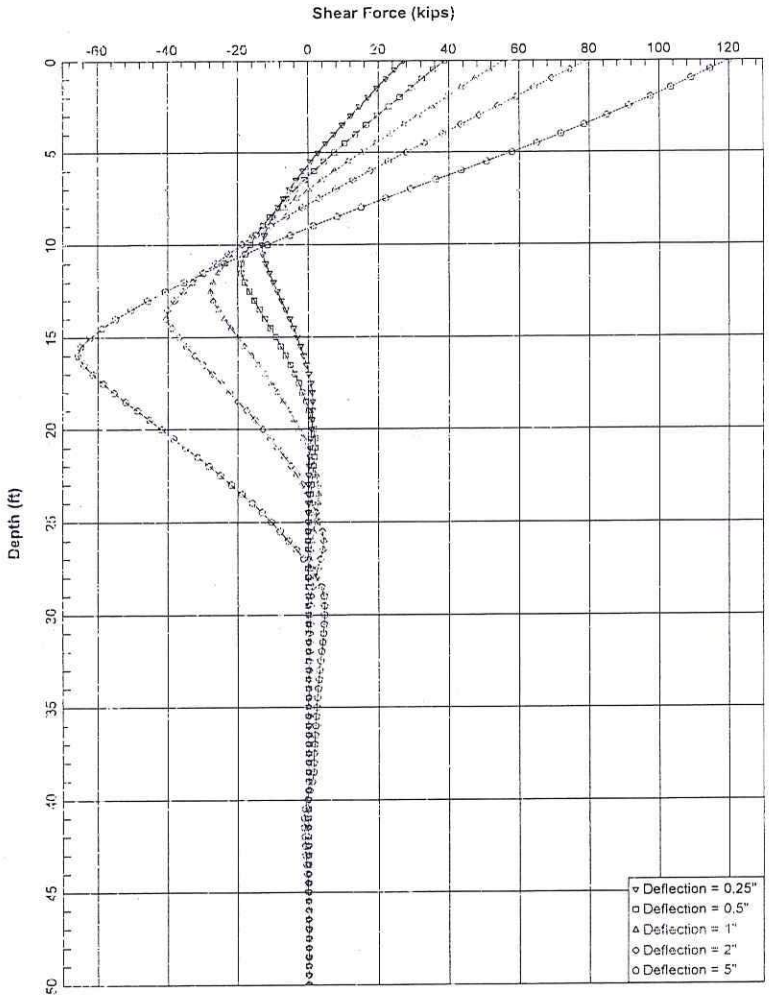
Hw is the depth to water table.
Hg is the depth to ground surface used in calculation.
Ho is the depth to location starting initial overburden pressure
Hf is the depth to location starting accumulation of skin frictio
bottom of footing = 106.4 ft

Soil Layer =>	from Top	to Bottom =>	γ (pcf)=>	γ' (pcf)=	c' (ksf) =>	ϕ' =>	
(1)	0	4	115	52.6	1.70	0	ML
(2)	4	10	115	52.6	0.00	31	SM
(3)	10	26	120	57.6	1.70	0	ML
(4)	26	39	115	52.6	0.00	32	SM
(5)	39	54	120	57.6	1.70	0	ML

Sublayer No.	Depth, z (ft)	z_i (ft)	New Depth (ft)	Soil Unit Weight (pcf)	Overburden Pressure (psf)	c' (ksf)	β	f_i^s (ksf)	ΔQ_s^s (kips)	Q_s^s (kips)	f_i^c (ksf)	ΔQ_s^c (kips)	Q_s^c (kips)	Q_s (kips)
0	0.0	0.0	0.0	115.0	720									
1	0.0	0.0	0.0	115.0	720	1.7				0.0			0.0	0.0
2	1.0	0.5	0.5	115.0	778	1.7	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
3	2.0	1.5	1.5	115.0	893	1.7	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
4	3.0	2.5	2.5	115.0	1008	1.7	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
5	4.0	3.5	3.5	115.0	1123	1.7	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
6	5.0	4.5	4.5	115.0	1238	0.0	1.20	1.49	9.3	9.3	0.00	0.0	0.0	9.3
7	6.0	5.5	5.5	115.0	1353	0.0	1.18	1.60	10.1	19.4	0.00	0.0	0.0	19.4
8	7.0	6.5	6.5	115.0	1468	0.0	1.16	1.70	10.7	30.0	0.00	0.0	0.0	30.0
9	8.0	7.5	7.5	115.0	1583	0.0	1.13	1.79	11.2	41.3	0.00	0.0	0.0	41.3
10	9.0	8.5	8.5	115.0	1698	0.0	1.11	1.88	11.8	53.1	0.00	0.0	0.0	53.1
11	10.0	9.5	9.5	115.0	1813	0.0	1.08	1.96	12.3	65.4	0.00	0.0	0.0	65.4
12	11.0	10.5	10.5	120.0	1933	1.7	1.06	0.00	0.0	65.4	0.94	5.9	5.9	71.3
13	12.0	11.5	11.5	120.0	2053	1.7	1.04	0.00	0.0	65.4	0.94	5.9	11.7	77.2
14	13.0	12.5	12.5	120.0	2173	1.7	1.02	0.00	0.0	65.4	0.94	5.9	17.6	83.1
15	14.0	13.5	13.5	120.0	2293	1.7	1.00	0.00	0.0	65.4	0.94	5.9	23.5	88.9
16	15.0	14.5	14.5	120.0	2413	1.7	0.99	0.00	0.0	65.4	0.94	5.9	29.4	94.8
17	16.0	15.5	15.5	120.0	2533	1.7	0.97	0.00	0.0	65.4	0.94	5.9	35.2	100.7
18	17.0	16.5	16.5	120.0	2653	1.7	0.95	0.00	0.0	65.4	0.94	5.9	41.1	106.6
19	18.0	17.5	17.5	120.0	2773	1.7	0.94	0.00	0.0	65.4	0.94	5.9	47.0	112.4
20	19.0	18.5	18.5	120.0	2893	1.7	0.92	0.00	0.0	65.4	0.94	5.9	52.9	118.3
21	20.0	19.5	19.5	120.0	3013	1.7	0.90	0.00	0.0	65.4	0.94	5.9	58.7	124.2
22	21.0	20.5	20.5	120.0	3133	1.7	0.89	0.00	0.0	65.4	0.94	5.9	64.6	130.0
23	22.0	21.5	21.5	120.0	3253	1.7	0.87	0.00	0.0	65.4	0.94	5.9	70.5	135.9
24	23.0	22.5	22.5	120.0	3373	1.7	0.86	0.00	0.0	65.4	0.94	5.9	76.4	141.8
25	24.0	23.5	23.5	120.0	3493	1.7	0.85	0.00	0.0	65.4	0.94	5.9	82.2	147.7
26	25.0	24.5	24.5	120.0	3613	1.7	0.83	0.00	0.0	65.4	0.94	5.9	88.1	153.5
27	26.0	25.5	25.5	120.0	3733	1.7	0.82	0.00	0.0	65.4	0.94	5.9	94.0	159.4
28	27.0	26.5	26.5	115.0	3848	0.0	0.81	3.10	19.5	84.9	0.00	0.0	94.0	178.9
29	28.0	27.5	27.5	115.0	3963	0.0	0.79	3.14	19.7	104.6	0.00	0.0	94.0	198.6
30	29.0	28.5	28.5	115.0	4078	0.0	0.78	3.18	20.0	124.6	0.00	0.0	94.0	218.6
31	30.0	29.5	29.5	115.0	4193	0.0	0.77	3.21	20.2	144.8	0.00	0.0	94.0	238.8
32	31.0	30.5	30.5	115.0	4308	0.0	0.75	3.25	20.4	165.2	0.00	0.0	94.0	259.2
33	32.0	31.5	31.5	115.0	4423	0.0	0.74	3.28	20.6	185.8	0.00	0.0	94.0	279.8
34	33.0	32.5	32.5	115.0	4538	0.0	0.73	3.31	20.8	206.6	0.00	0.0	94.0	300.6
35	34.0	33.5	33.5	52.6	4590	0.0	0.72	3.30	20.7	227.4	0.00	0.0	94.0	321.4
36	35.0	34.5	34.5	52.6	4643	0.0	0.71	3.28	20.6	248.0	0.00	0.0	94.0	342.0
37	36.0	35.5	35.5	52.6	4695	0.0	0.70	3.27	20.5	268.5	0.00	0.0	94.0	362.5
38	37.0	36.5	36.5	52.6	4748	0.0	0.68	3.25	20.4	288.9	0.00	0.0	94.0	382.9
39	38.0	37.5	37.5	52.6	4801	0.0	0.67	3.23	20.3	309.2	0.00	0.0	94.0	403.2
40	39.0	38.5	38.5	52.6	4853	0.0	0.66	3.21	20.2	329.4	0.00	0.0	94.0	423.4
41	40.0	39.5	39.5	57.6	4911	1.7	0.65	0.00	0.0	329.4	0.94	5.9	99.9	429.3
42	41.0	40.5	40.5	57.6	4968	1.7	0.64	0.00	0.0	329.4	0.94	5.9	105.7	435.2



Brockhurst Street Undercrossing (Widen) 24-inch CIDH at Bents 3 and 4 (Freehead)



Brockhurst Street Undercrossing (Widen) 24-inch CIDH at Bents 3 and 4 (Freehead)

LPile Plus for Windows, Version 6.0 (6.0.09)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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Files Used for Analysis

Path to file locations: X:\Projects\2010\10-135 - I-5 SB 92 Westbound Widening\Reports\Foundation Report\Brookhurst St UC\...7\...\03 Lateral Capacity\
Name of input data file: Brookhurst St UC 24-inch CIDH (Bents 3 and 4).lpd
Name of output file: Brookhurst St UC 24-inch CIDH (Bents 3 and 4).lp6o
Name of plot output file: Brookhurst St UC 24-inch CIDH (Bents 3 and 4).lp6p
Name of runtime file: Brookhurst St UC 24-inch CIDH (Bents 3 and 4).lp6r

Date and Time of Analysis

Date: March 24, 2011 Time: 15:57:35

Problem Title

Project Name:

Job Number:

Client:

Engineer:

Description:

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	100	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:

- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Soil Data

Total Number of Sections = 1

Total Pile Length = 50.00 ft

Depth of ground surface below top of pile = -5.00 ft

Slope angle of ground surface = 0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	24.000000
2	50.000000	24.000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	50.000 in
Top Width	=	24.000 in
Bottom Width	=	24.000 in
Top Area	=	452.400000 sq. in
Bottom Area	=	452.400001 sq. in
Moment of Inertia at Top	=	8.143E+03 in^4
Moment of Inertia at Bottom	=	8.143E+03 in^4
Elastic Modulus	=	3200000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 5 layers

Layer 1 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = -5.000 ft
Distance from top of pile to bottom of layer = 29.000 ft

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 29.000 ft
Distance from top of pile to bottom of layer = 33.000 ft
p-y subgrade modulus k for top of soil layer = 60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 60.000 lbs/in**3

Layer 3 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 33.000 ft

Distance from top of pile to bottom of layer =
p-y subgrade modulus k for top of soil layer =
p-y subgrade modulus k for bottom of layer =

Layer 4 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer =
Distance from top of pile to bottom of layer =

Layer 5 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer =
Distance from top of pile to bottom of layer =
p-y subgrade modulus k for top of soil layer =
p-y subgrade modulus k for bottom of layer =

(Depth of lowest layer extends 10.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 10 points

Point No.	Depth X ft	Eff. Unit Wt. pcf
1	-5.00	115.00000
2	29.00	115.00000
3	29.00	120.00000
4	33.00	120.00000
5	33.00	57.60000
6	39.00	57.60000
7	39.00	52.60000
8	54.00	52.60000
9	54.00	57.60000
10	69.00	57.60000

Summary of Soil Properties

Layer Subgr. Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion pcf	Friction Angle, deg.	Eq pcf	RQD Percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. pci
1	Soft Clay	-5.000	115.000	1700.000	--	--	--	0.02000	--	--	--	--	--	--
		29.000	115.000	1700.000	--	--	--	0.02000	--	--	--	--	--	--
2	Sand (Reese, et al.)	29.000	120.000	--	32.000	--	--	--	60.000	--	--	--	--	--
		33.000	120.000	--	32.000	--	--	--	60.000	--	--	--	--	--
3	Sand (Reese, et al.)	33.000	57.600	--	32.000	--	--	--	35.000	--	--	--	--	--
		39.000	57.600	--	32.000	--	--	--	35.000	--	--	--	--	--
4	Soft Clay	39.000	52.600	1700.000	--	--	--	0.00500	--	--	--	--	--	--
		54.000	52.600	1700.000	--	--	--	0.00500	--	--	--	--	--	--
5	Sand (Reese, et al.)	54.000	57.600	--	32.000	--	--	--	35.000	--	--	--	--	--
		69.000	57.600	--	32.000	--	--	--	35.000	--	--	--	--	--

---

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point	Depth X	p-mult	y-mult

No.	ft		
1	0.000	5.8600	1.0000
2	50.000	0.0000	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	60000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	60000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	60000.000
4	4	y =	2.000 in	M =	0.000 in-lbs	60000.000
5	4	y =	5.000 in	M =	0.000 in-lbs	60000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)		Condition 2 in-lb, rad., or in-lb/rad.		Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y =	0.2500	M =	0.000	60000.	0.25000000	901847.	27065.	0.00000000
2	4	y =	0.5000	M =	0.000	60000.	0.50000000	1452119.	38718.	0.00000000
3	4	y =	1.0000	M =	0.000	60000.	1.00000000	2342015.	55431.	0.00000000
4	4	y =	2.0000	M =	0.000	60000.	2.00000000	3779090.	79420.	0.00000000
5	4	y =	5.0000	M =	0.000	60000.	5.00000000	7073328.	120131.	0.00000000

Summary of Warning Messages

The following warning was reported 1520 times

**** Warning ****

An unreasonable input value for shear strength has been specified for a soil defined using the soft clay criteria. The input value is greater than 8.58 psi (1,250 psf). You should check your input data for correctness.

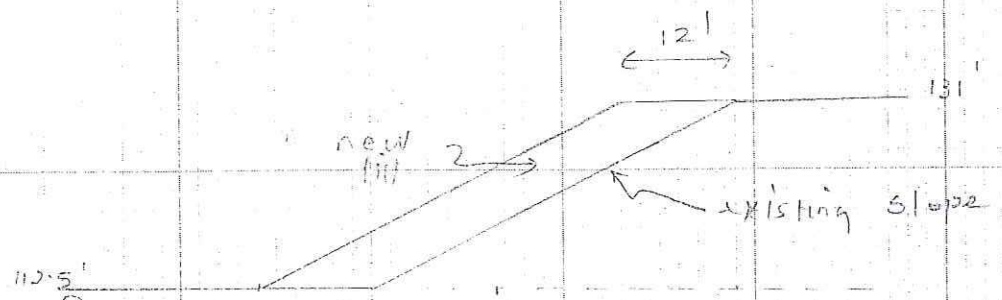
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
(714) 751-3826, Fax (714) 751-3928

Project SR-91 WB Widening - Brookhurst St UC **Project No.** 10-126

By SP **Date** 03-15-11 **Checked By** SJ **Date** 3/17/11 **Sheet** ____ **of** ____

Approach Embankment Settlement



① 105' SM $N=17$, $\phi' = 30$

② 100' ML $N=8$, $c' = 40$

③ 95' SM $N=27$, $c' = 70$

④ ML $N=13$, $c' = 45$

⑤ 85' SM $N=28$, $c' = 70$

⑥ 70' ML $N=11$, $c_c = 0.02$

⑦ 55' SM $N=32$, $c' = 80$

Del to new fill $Q = 19 \times 120 = 1.14$ KSF

	σ_{vo}	$\Delta\sigma$	Settlement
①	$11 \times 120 = 1.32$	$1.14 \times 0.9 = 1.03$	$75 \times \frac{1}{50} \log\left(\frac{1.32+1.03}{1.32}\right) = 0.145$
⑤	$15 \times 120 + 2.5 \times 115 = 2.09$	$1.14 \times 0.8 = 0.91$	$5 \times \frac{1}{70} \log\left(\frac{2.09+0.91}{2.09}\right) = 0.029$
③	$17 \times 120 + 5 \times 115 = 2.62$	$1.14 \times 0.7 = 0.8$	$5 \times \frac{1}{70} \log\left(\frac{2.62+0.8}{2.62}\right) = 0.1$
④	$30 \times 120 + 10 \times 115 = 3.55$	$1.14 \times 0.5 = 0.57$	$10 \times \frac{1}{45} \log\left(\frac{3.55+0.57}{3.55}\right) = 0.16$
②	$37 \times 120 + 15 \times 115 = 4.97$	$1.14 \times 0.3 = 0.34$	$15 \times \frac{1}{40} \log\left(\frac{4.97+0.34}{4.97}\right) = 0.04$
⑥	$31 \times 120 + 15 \times 115 + 3.5 \times 57.6 = 7.5 \times 5.6 = 6.04$	$1.14 \times 0.15 = 0.17$	$15 \times 0.02 \log\left(\frac{6.04+0.17}{6.04}\right) = 0.04$
⑦	$31 \times 120 + 15 \times 115 + 8.5 \times 57.6 = 15 \times 5.6 = 6.72$	$1.14 \times 0.1 = 0.11$	$10 \times \frac{1}{80} \log\left(\frac{6.72+0.11}{6.72}\right) = 0.01$

$\Sigma = 1.04$ ft

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
(714) 751-3826, Fax (714) 751-3928

Project SR-91 WB widening - Brookhurst St UC **Project No.** 10-126

By SP **Date** 03-15-11 **Checked By** SS **Date** 3/16/11 **Sheet** ____ **of** ____

Surficial stability

for 1.5:1 slope

$\phi = \tan^{-1}\left(\frac{1}{1.5}\right) = 33.7^\circ$

consider thickness of slide $h = 4$ ft

consider $\gamma = 120$ pcf

$\phi = 32^\circ$

$c = 230$ psf

factor of safety $= \dfrac{c + h\gamma' \cos^2\beta \tan\phi}{h\gamma \sin\beta \cos\beta}$

$= \dfrac{230 + 4 \times (120 - 62.4) \times \cos^2 33.7 \times \tan 32}{4 \times 120 \times \sin 33.7 \times \cos 33.7}$

$= 1.5$

Appendix D

CALTRANS REVIEW COMMENTS AND EMI RESPONSES

State of California

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: LUQI YANG
Liaison Engineer

Date: May 2, 2011

File: 12-ORA-91 PM Various
EA 12-0C5701, 1200000079
Brookhurst Ave UC + 5Br.
No. 55-0280 + 5

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
Geotechnical Services
Office of Geotechnical Design – South 1

Subject: Foundation Report- Bridge No. 55-0216, 55-0218, 55-0245, 55-0279, 55-0280 & 55-852

Per your request, the Geotechnical Design South 1 - Branch B has reviewed the subject submittal, containing the following item:

1. Foundation Reports for No. 55-0216, 55-0218, 55-0245, 55-0279, 55-0280 & 55-852, Anaheim, Orange County, dated April 15, 2011.

Our office has no comments on above submitted item.

Should you have any questions, please contact Mushtaq Ahmed at (213) 620-2132.

Reviewed by: Date: 5/2/11

Mushtaq Ahmed, P.E.
Transportation Engineer-Civil
Office of Geotechnical Design – South 1
Branch B

Supervised by: Date: 5/2/11

Sam Sukiasian, G.E.
Chief Branch B
Office of Geotechnical Design – South 1

cc: OGDS1 – Nor. File, OGDS1- Sac. File, GS-Sac. File

REGISTERED CIVIL ENGINEER
MOHAMMAD MUSHTAQ AHMED
No. C056390
Exp.
STATE OF CALIFORNIA

"Caltrans improves mobility across California"

FOUNDATION REPORT
EUCLID ST UC (Widen)
Bridge No. 55-0279

Earth Mechanics, Inc.

September 16, 2011

FOUNDATION REPORT

Euclid Street Undercrossing (Widen)
Bridge No. 55-0279
Orange County, California
12-ORA-91, PM 2.23
Caltrans Project No. 12000000791 (EA 12-0C5701)
EMI Project No. 10-126
Date: September 16, 2011

EARTH MECHANICS, INC.

Geotechnical and Earthquake Engineering

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

September 16, 2011

EMI Project No. 10-126

RBF Consulting
14725 Alton Parkway
Irvine, California 92618

Attention: Mr. Steve Huff, P.E.

Subject: Foundation Report for Euclid Street Undercrossing (Widen)
Bridge No. 55-0279
Orange County, California
12-ORA-91, PM 2.23
Caltrans Project No. 12000000791 (EA 12-0C5701)

Dear Mr. Huff:

Attached please find the Foundation Report for the subject bridge widening project. This report contains the findings and conclusions of our field investigation and laboratory testing program. This report also contains our recommendations for the design and construction of the bridge foundations.

An earlier version of this report dated April 15, 2011 was submitted to Caltrans for review. Caltrans prepared a memorandum dated May 2, 2011 indicating they have no comments. A copy of this Caltrans memorandum is included in Appendix D.

We appreciate the opportunity to provide geotechnical design services for this project. If you have any questions, please call us.

Sincerely,

EARTH MECHANICS, INC.

9/16/11

(Raja) S. Pirathiviraj, PE 71662
Senior Staff Engineer

9-16-11

Lino Cheang, GE 2345
Project Manager

SP/sp,lcc

FOUNDATION REPORT

EUCLID STREET UNDERCROSSING (WIDEN)
BRIDGE NO. 55-0279
ORANGE COUNTY, CALIFORNIA
12-ORA-91, PM 2.23
CALTRANS PROJECT NO. 12000000791 (EA 12-0C5701)

Prepared for:

RBF Consulting
14725 Alton Parkway
Irvine, California 92618

Prepared By:

Earth Mechanics, Inc.
17800 Newhope Street, Suite B
Fountain Valley, California 92708

EMI Project No. 10-126

September 16, 2011

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Appendix B. Laboratory Test Results
Appendix C. Design Calculations
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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE OF STUDY

This Foundation Report presents the findings and conclusions of a geotechnical investigation conducted by Earth Mechanics, Inc. (EMI). It presents foundation design and construction recommendations for the proposed widening of Euclid Street Undercrossing (UC) in Orange County, California. A site location map is presented in Figure 1-1.

EMI is a subconsultant to RBF Consulting (RBF). The geotechnical services provided for this project included the following tasks:

- Collection and review of existing geotechnical information;
- Field exploration consisting of drilling and logging exploratory borings;
- Laboratory testing of selected bulk and relatively undisturbed soil samples;
- Engineering calculations and analysis to develop foundation design and construction recommendations; and
- Preparation of this report presenting our findings, conclusions, and recommendations.

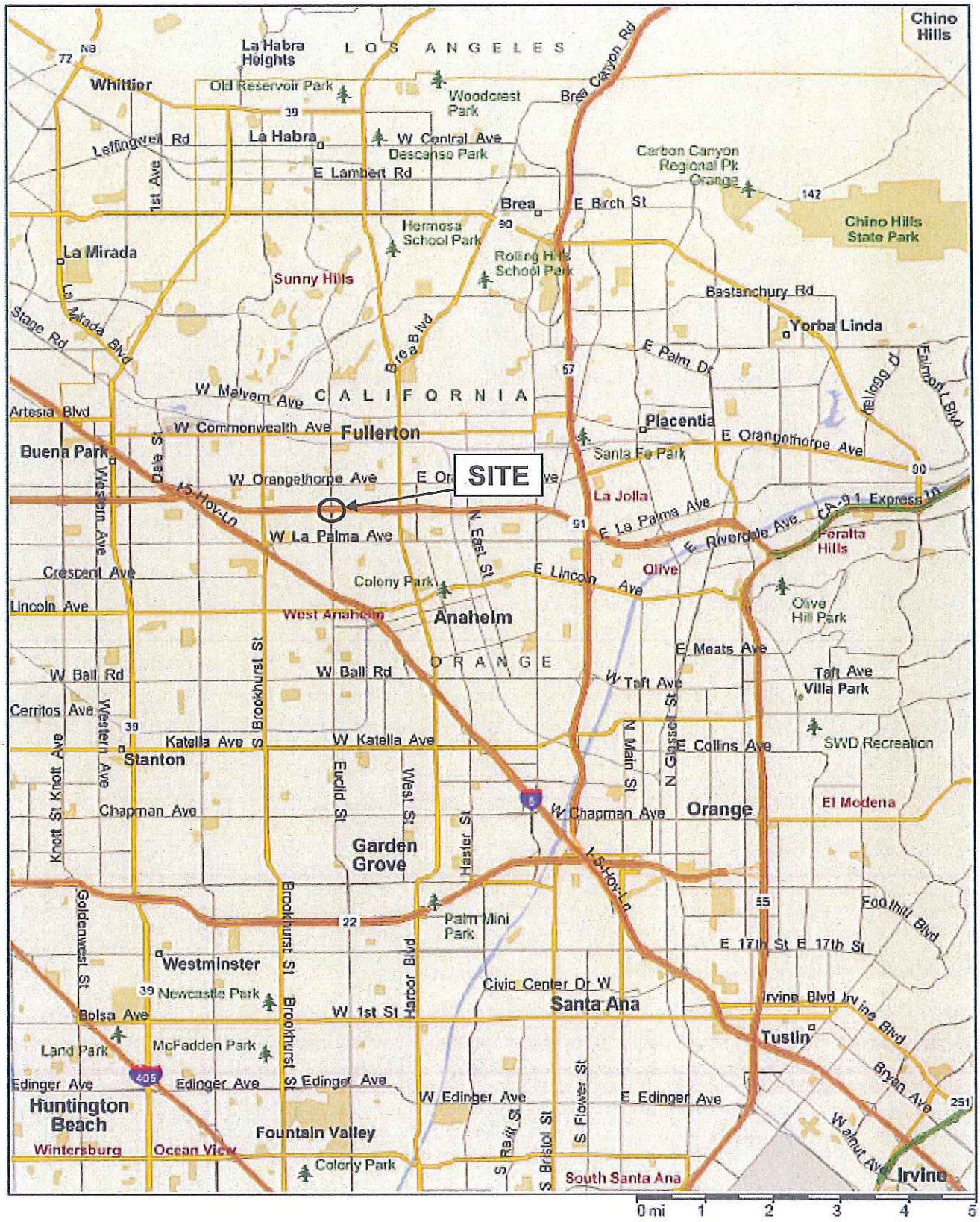
1.2 PROJECT DESCRIPTION

The California Department of Transportation (Caltrans), in cooperation with the Orange County Transportation Authority (OCTA) and the cities of Anaheim and Fullerton, proposes to widen the westbound State Route 91 (SR-91) from State Route 57 (SR-57) to Interstate 5 (I-5). SR-91 is a major east-west freeway facility that begins at the eastern junction with SR-60 in the city of Riverside in Riverside County, and continues west through Orange County to its terminus at the junction with Pacific Coast Highway 1 near the city of Hermosa Beach in Los Angeles County.

The proposed project limits cover a distance of 4.5 miles; however, actual improvements are limited to a total of 3.8 miles within the project area. The proposed project consists of widening six bridges. This foundation report addresses only the Euclid Street UC.

The existing UC was constructed in April 1958 and widened in September 1996. The existing UC is a four-span precast, prestressed concrete structure with a total length of 162.5 feet and a width of 145.5 feet. The original UC is supported on 45-ton, 16-inch diameter Cast-In-Drilled-Hole (CIDH) piles with an average specified pile tip elevation of +85 feet at Abutments 1 and 5 and Bents 2 through 4. The 1996 widening is supported on 18-inch diameter CIDH piles. The design capacity of the abutment piles is 45 tons and the specified pile tip elevation is +95 feet. The design capacity of the bent piles is 70 tons and the specified pile tip elevation is +83 feet.

The existing Euclid Street UC will be widened by about 12-feet only in the north side in order to accommodate widening of the westbound SR-91.



Euclid Street UC (Widen)	SITE LOCATION MAP
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 1-1
Project No. 10-126	Date: 03-18-11

2.0 FIELD INVESTIGATION AND LABORATORY TESTING

2.1 FIELD INVESTIGATION

As-built Log-of-Test-Borings (LOTB) sheets are included in Appendix A for the original construction and 1996 widening.

One rotary-wash boring and two penetration borings were drilled in March 1955 for the original construction of the Euclid Street UC. The deepest boring was advanced to about elevation +61 feet. Existing grade at the borehole locations at the time of the investigation was between elevations +131.7 and +132.3 feet.

One rotary-wash boring was drilled in December 1993 and one cone penetration test (CPT) sounding was performed in January 1993 for the 1996 widening. The deepest boring was advanced to about elevation +65.6 feet. Existing grade at the borehole locations at the time of the investigation was near elevation +151 feet. The current surface elevation of Euclid Street is between +134 feet and +135 feet.

To supplement the existing subsurface information, three soil borings were performed between December 8, 2010 and January 10, 2011. Boring information, including exploration number, stations, offsets, ground surface elevations, bottom of boring elevations and water level measurements are summarized in Table 2-1. Locations of the exploratory boring are shown on the LOTB sheet provided in Appendix A.

Table 2-1. Geotechnical Exploration Information

Boring No.	Station Line	Station	Approx. Offset (feet)	Approx. Ground Surface El. (feet)	Approx. Bottom of Boring El. (feet)	Approx. Groundwater El. (feet)
CPT-10-022	A Line	171+67	61 Lt	+153.0	+90.0	Not Measured
A-10-023		172+55	77 Lt	+135.0	+53.5	+65.0
A-10-024		173+76	62 Lt	+152.6	+66.1	+80.4

Exploratory borings were drilled using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers. Sampling was performed by alternating the Modified California Drive (MCD) sampler and Standard Penetration Test (SPT) sampler. The soil sampling interval is generally 5 feet.

Relatively undisturbed soil samples were obtained using a 3.25-inch outer diameter MCD sampler lined with brass rings. Each of these brass rings is 1-inch long with a 2.5-inch outside diameter. The SPT sampler (1.4-inch inside diameter) was also used to obtain soil samples. The MCD and SPT samplers were driven 18 inches into the ground or until refusal was encountered using a 140-lb hammer free falling from a height of 30 inches. The numbers of blows to advance the sampler each 6 inches of penetration was recorded. The numbers of blows for the final 12 inches or shorter of driving was recorded on the LOTB sheet.

The CPT sounding was performed using an electronic cone penetrometer in general accordance with current ASTM Standards (ASTM D5778 and ASTM D3441). The CPT equipment consisted of a cone penetrometer assembly mounted at the end of a series of hollow sounding rods. The cone penetrometer assembly consisted of a conical tip with a 60° apex angle and a projected cross sectional area of 1.55 in² (10 cm²) and a cylindrical friction sleeve with a surface area of 23.25 in² (150 cm²). The interior of the cone penetrometer is instrumented with strain gauges that allow simultaneous measurements of cone tip and friction sleeve resistance during penetration. The cone penetrometer assembly is continuously pushed into the soil by a set of hydraulic rams at a standard rate of 0.79 inch per second (20 mm per second) while the cone tip resistance and sleeve friction resistance are recorded every 1.967 inches (50 mm) and stored in digital form. A specially designed all-wheel drive 25-ton truck provides the required reaction weight for pushing the cone assembly and is also used to transport and house the testing equipment. The computer generated graphical logs include tip resistance, friction resistance, and friction ratio. Soil behavior type interpretations are based on guidelines by Robertson and Campanella (1989).

Charts published by Winterkorn and Fang (1975) can be used to determine a reduction factor used to convert blowcounts recorded using the MCD sampler into SPT blowcounts. Using those charts, we obtained a reduction factor of 0.5 which was used for this project.

2.2 LABORATORY TESTING

Soil samples considered representative of the subsurface conditions were tested to obtain or derive relevant physical and engineering soil properties. The following laboratory tests were conducted to supplement the observations recorded during the field investigation:

- In-situ Moisture Content and Unit Weight
- Percent Passing No. 200 Sieve
- Direct Shear
- Unconsolidated Undrained Triaxial
- Minimum Resistivity, pH, Sulfate Content and Chloride Content

The laboratory tests were conducted in general accordance with California Test Methods or American Society for Testing and Materials (ASTM) Standards. Laboratory test results are included in Appendix B.

3.0 GEOLOGY AND SEISMICITY

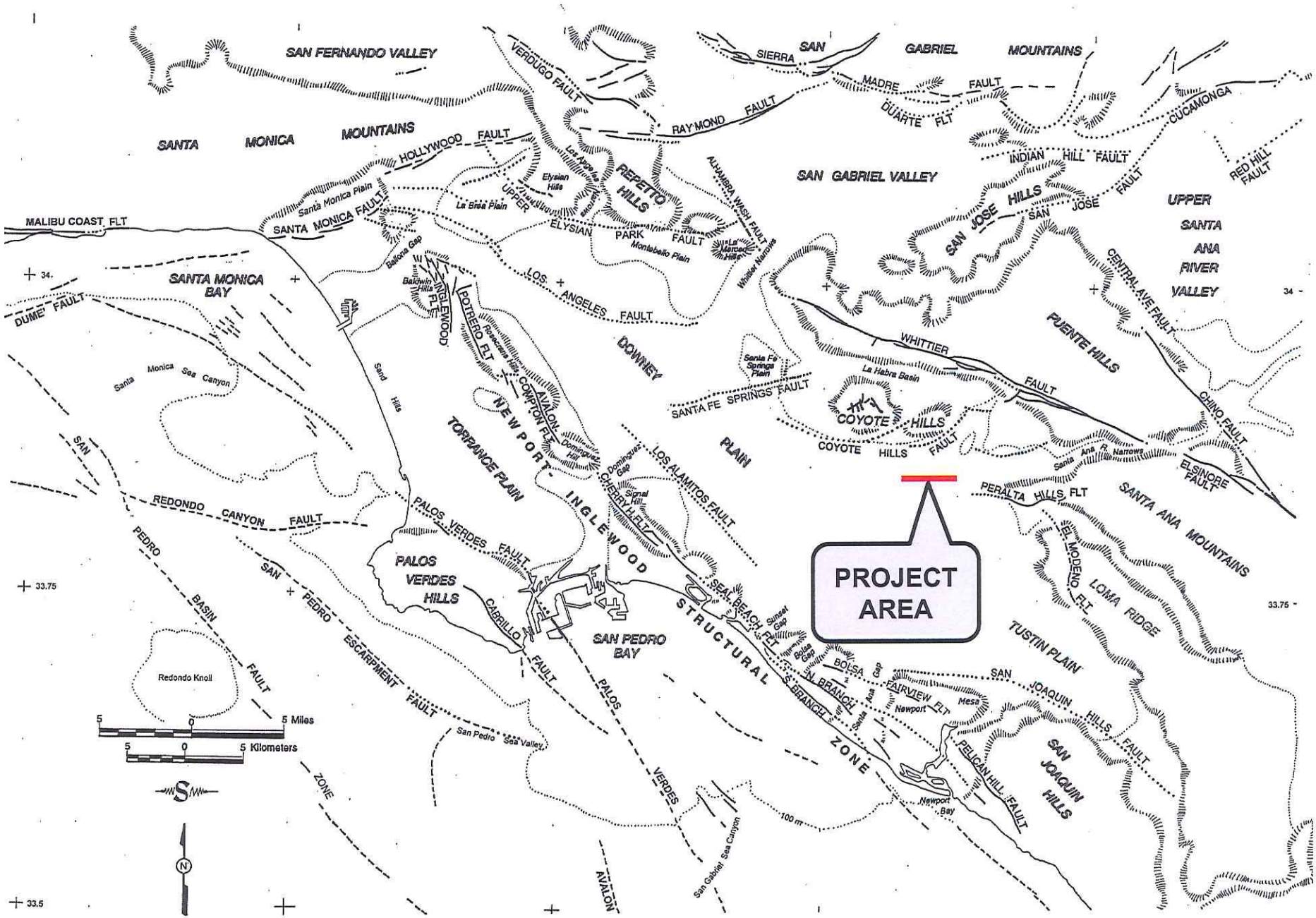
3.1 PHYSIOGRAPHY

The project area is in the east-central part of the Los Angeles Basin as shown in Figure 3-1 which comprises a transition zone between the Peninsular Ranges physiographic province on the east, and the Transverse Ranges physiographic province to the north. The Peninsular Ranges physiographic province comprises a northwest-southeast trending group of fault-bounded ranges such as Santa Ana Mountains, Puente Hills and San Joaquin Hills between the Salton Trough and the Pacific Ocean. The Transverse Ranges physiographic province comprises east-west trending ranges and valleys such as the Santa Monica Mountains, San Fernando Valley and San Gabriel Mountains. Valleys such as the Los Angeles Basin, the San Gabriel Valley and the Upper Santa Ana River Valley have characteristics compatible with both physiographic provinces and form a transition zone between the two provinces.

The Los Angeles Basin is essentially a large, relatively flat, low-lying and coastal plain surrounded by mountains on the north, east and southeast which rise abruptly to a few thousand feet above the plains. The western margin of the basin is bordered by the sea, the Palos Verdes Hills and the San Joaquin Hills. The floor of the basin gradually rises inland to a series of uplifted terrain along the margins of the surrounding mountains. This elevated marginal terrain includes the Santa Monica, La Brea, Montebello, Santa Fe Springs plains, and the Coyote Hills. The generally flat-lying nature and gradual inland rise of the Basin floor is disrupted by an alignment of northwest-southeast trending, low-elevation hills along the Newport-Inglewood Structural Zone (NISZ). The areas on either side of the NISZ are essentially flat and comprise the Downey-Tustin plain on the northeast and the Torrance Plain on the southwest. The site area is near the transition between the Downey and the Tustin plains.

3.2 GEOLOGIC STRUCTURE

The Los Angeles Basin is a deep structural basin comprising two major downward folds (synclines) separated by the NISZ uplift; the Paramount syncline is east of the NISZ under the Downey-Tustin Plain, and the Gardena syncline is west of the NISZ under the Torrance Plain. The Paramount syncline is the larger and deeper syncline with basement rocks as deep as about 30,000 feet (Yerkes et al, 1965). As described in the physiography section, the basin is rimmed by marginal elevated plains that rise about a hundred feet to as much as a couple hundred feet above the general level of the basin floor. These elevated plains and the Coyote Hills are underlain by fault-bounded, upward folds (anticlines) that are prolific oil fields. Most of the major faults associated with these folds are blind thrust faults and are shown on Figure 3-1 as dotted lines. The nearest faults to the project area are the blind thrust faults of the Puente Hills Blind Thrust Fault System and Compton-Los Alamitos Blind Fault System. Larger surface faults, such as the NISZ and the Elsinore Fault Zone (Whittier Section) lie to the southwest and northeast of the project site, respectively.



State Route 91 Westbound Widening Project

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

REGIONAL MAP OF ACTIVE FAULTS AND PHYSIOGRAPHY

Figure 3-1

Project No. 10-126

Date: 03-01-11

3.3 GEOLOGICAL HAZARDS

The only significant geological hazard at the site is earthquake shaking and perhaps local liquefaction. There are no known active surface faults within the project area so ground rupture is not a factor. The flat-lying nature of the area is not susceptible to landsliding. The site is too far from the ocean to be affected by tsunamis, and there are no large bodies of water within the site area that could generate a seiche. There are no volcanoes in the region.

As presented in Figure 3-2, the California Geological Survey (1997, 1998) shows designated project site is outside the liquefaction zone. Therefore, the liquefaction potential at the project site is low. The potential for liquefaction is discussed in detail in Section 5.2.

3.4 SEISMICITY

The project is in seismically active Southern California. The present-day seismotectonic stress field in the Los Angeles region is one of north-northeasterly compression. This is indicated by the geologic structures, by earthquake focal-mechanism solutions and by geodetic measurements. These data suggest crustal shortening of between 0.2 and 0.35 inches per year across the greater Los Angeles area (Argus et al., 1999).

Historical earthquake epicenter maps show widespread seismicity throughout the Los Angeles region. Earthquakes occur primarily as loose clusters along the NISZ, the southern margin of the Santa Monica Mountains, the margin between the Santa Susana-San Fernando Valley and the southern margin of the San Gabriel Mountains, and in the Coyote Hills-Puente Hills area.

The largest historical earthquakes within the Los Angeles Basin were the 1933 Long Beach (moment magnitude (M_W) of about 6.4), 1994 Northridge (M_W = 6.7), 1971 San Fernando (M_W = 6.7), 1987 Whittier (M_W = 5.9), and 2008 Chino Hills (M_W = 5.4). There have been no significant historical earthquakes in the immediate site area. There may have been a few random small events (M_W < 3.0). The nearest concentrated earthquake activity has been within the Puente Hills about 5 or 6 miles to the north of the site.

The 1933 Long Beach earthquake did not rupture the surface but is believed to have been associated with the NISZ (Benioff, 1938). Reevaluation of the seismic data by Hauksson and Gross (1991) relocated the 1933 earthquake hypocenter to a depth of about 6 miles below the Huntington Beach-Newport Beach city boundary.

The 1994 Northridge earthquake occurred on a southerly dipping subsurface fault which was unknown prior to the earthquake. The main shock occurred at a depth of about 12 miles. Earthquake aftershocks clearly defined the rupture surface dipping about 35 degrees southerly from a depth of about 1 or 2 miles to 14 miles. The causative fault was never identified with certainty.

The 1971 San Fernando earthquake involves surface rupture. The 1971 event occurred on a northerly dipping thrust fault that dips from the northern side of the San Fernando Valley to a depth of about 9 miles under the San Gabriel Mountains, and considered part of the Sierra Madre Fault System.

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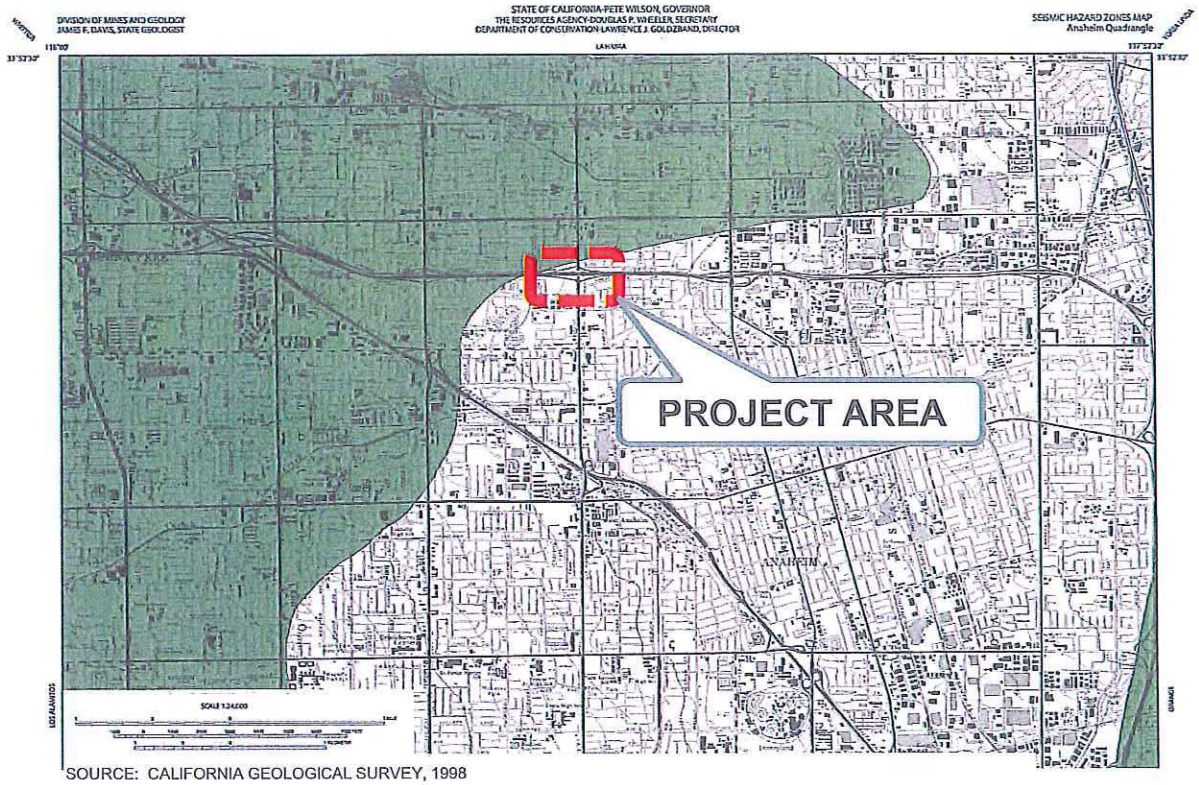


SOURCE: CALIFORNIA GEOLOGICAL SURVEY, 1998

MAP EXPLANATION

Zones of Required Investigation:

Liquefaction

Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Euclid Street UC (Widen)	MAP OF LIQUEFACTION POTENTIAL	
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering		Figure 3-2
	Project No. 10-126	Date: 03-18-11

The 1987 Whittier earthquake occurred on a subsurface fault dipping under the Puente Hills to about 10 miles beneath the San Gabriel Basin (Shaw and Shearer, 1999; Shaw et al., 2002). This event did not rupture the ground surface.

The 2008 Chino Hills event epicenter was in the Chino Hills area between the Elsinore-Fault-Zone Chino Section and Whittier Section. Preliminary data were inconclusive with regard to the causative fault. Detailed analysis by Shao and Hauksson (2009) indicated a rupture plane striking N71°W, dipping 62° northeast. This event did not rupture the ground surface.

Another significant earthquake was the 1812 earthquake which caused damage at the San Juan Capistrano Mission. The location and magnitude of the 1812 earthquake are unknown because of the sparse population at the time, but geological studies (Jacoby et al., 1988; Fumal et al., 1993; Weldon et al., 2004) postulate that it did not occur in the Capistrano area, but rather was a large (M_W > 7.0) distant event on the San Andreas fault in the Wrightwood area of the San Gabriel Mountains.

The earliest documented earthquake in the region was reported by the Portola´ expedition as they camped near the Santa Ana River in 1769. This event has been attributed by various geoscientists to just about every fault in the Los Angeles area but it could just as well have been a distant event that shook a wide area as did the 1971 San Fernando, the 1987 Whittier, and the 1994 Northridge events, as well as many other more-distant events such as 1992 Landers event.

4.0 SUBSURFACE CONDITIONS

4.1 SOIL CONDITIONS

The roadway surface elevation of the existing Euclid Street is about +135 feet and the SR-91 roadway surface elevation is about +154 feet. Based on the recent field investigation and as-built LOTB sheets, the site is underlain by interbedded silty sand, poorly graded sand, poorly graded sand with silt, sandy silt, silt and clay. The idealized soil profile and design strength parameters for foundation design are presented in Table 4-1.

Table 4-1. Idealized Soil Profile and Strength Parameters

Approximate Elevation (feet)	Predominant Soil Type	Equivalent SPT Blowcount* (blows/foot)	Total Unit Weight (pcf)	Friction Angle (degree)	Cohesion / Undrained Shear Strength (psf)
Abutments 1 and 5					
+153 to +134	Silty Sand and Sand with Silt	13 to (57) Average = 31	120	32	100
+134 to +105	Silty Sand	9 to (23) Average = 15	115	31	100
+105 to +98	Sandy Silt	(14)	115	-	1500
+98 to +78	Silty Sand and Sand with Silt with interbedded Sandy Silt	16 to (43) Average = 32	120	32	100
+78 to +73	Sandy Silt	14	115	-	1500
+73 to +66	Sand with Silt and Sand	(48) to 51 Average = 50	120	36	50
Bents 2 to 4					
+135 to +105	Silty Sand and Sand	6 to (25) Average = 10	120	31	100
+105 to +100	Sandy Silt	7	115	-	1000
+100 to +96	Silty Sand	(12) to 15 Average = 13	120	31	100
+96 to +85	Silt and Clay	(15)	115	-	1500
+85 to +80	Sand	35	120	34	100
+80 to +75	Silt and Clay	(14)	115	-	1500
+75 to +55	Silty Sand, Sand with Silt and Sand	23 to (>100) Average = 48	120	36	50

* Values in ( ) are converted SPT blowcounts corrected for sampler size; correction factor from Modified California Drive sampler blowcounts to SPT blowcounts is 0.5.

The soil strength parameters are based on direct shear test results or unconsolidated-undrained triaxial test results or published correlations with SPT blowcounts (Lam and Martin, 1986). The design strength parameters of most of the idealized soil layers are based on direct shear or triaxial tests performed on similar soil layers across the borings. The design strength parameters of the 1st, 4th and 6th idealized layers at Abutments 1 and 5, and the 2nd, 5th and 7th idealized layers at Bents 2 through 4 are based on published correlations with SPT blowcounts. It should be noted that the strength parameters obtained from the direct shear tests or triaxial tests are lower than those obtained using SPT correlations for the same idealized soil layers.

4.2 GROUNDWATER CONDITIONS

Groundwater was encountered between elevations +65 and +80.4 feet during the recent field investigation. Groundwater was encountered in the as-built boring at +71 feet in December 1993. Groundwater was not encountered in soil borings drilled in March 1955 for the original construction to the maximum depth explored at elevation +61 feet. Based on California Geological Survey (Division of Mines and Geology, 1997), the recorded highest historical groundwater at the project site is greater than 50 feet below the ground surface. The average ground surface elevation at the Euclid Street grade is about +134 feet. Therefore, the CGS historical highest groundwater elevation would be deeper than +84 feet. Based on the above groundwater data, a historical high groundwater elevation of +81 feet can be used for liquefaction assessment.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 SEISMIC DESIGN CRITERIA

To develop ARS curves in accordance with the 2009 Seismic Design Criteria (SDC) (Caltrans, 2009b and 2009d) procedures, we considered the following response spectra:

- Deterministic Criteria based on late-Quaternary faults in 2007 fault database (Caltrans, 2007a and 2007b, Shantz and Merriam, 2009);
- Probabilistic Criteria based on 5% in 50 years probability of exceedance ground motion; and
- Minimum Deterministic Spectrum based on a M_W= 6.5 strike-slip event occurring at a distance of 7.5 miles (12 km) from the site.

The design ARS curve is the envelope of the above spectra.

We used the Caltrans Deterministic Response Spectrum Spreadsheet as recommended by the 2009 SDC to develop the deterministic ARS curves. The spreadsheet uses the arithmetic average of two Next Generation Attenuation (NGA) relationships developed by Chiou-Youngs (2008) and Campbell-Bozorgnia (2008) with user-provided input parameters, including fault characteristics, site-to-fault distances and site condition parameters as presented in Table 5-1.

Table 5-1. Controlling Faults for Deterministic Response Spectrum

Controlling Fault	Fault ID	Maximum Moment Magnitude M_{max}	Site to Fault Distance R_{RUP} (miles)	Style of Fault	Fault Dip /Direction
Puente Hills Blind Thrust	240	7.3	8.6	Reverse	25° / North
Elsinore Fault Zone (Whittier Section)	241	7.6	11.0	Reverse Lateral Strike Slip	75° / Northeast
Compton – Los Alamitos Blind Thrust	291	6.8	12.9	Reverse	20° / Northeast

Results obtained from the spreadsheet were then verified with the Caltrans online web tool (Caltrans, 2009a). The spreadsheet method is recommended because the online web tool, though more user-friendly, does not include updates since 2007 in its calculation database and presently is not approved to develop spectra for final design.

The probabilistic response spectrum is based on data from the 2008 United States Geological Survey (USGS, 2008a) National Seismic Hazard Map for the 5% in 50 years probability of exceedance (975-year return period) ground motion. To develop the probabilistic spectrum, the Caltrans Probabilistic Response Spectrum Spreadsheet and the USGS Interactive Deaggregation Tool (USGS, 2008b) were used. Results obtained from both the spreadsheet and deaggregation tool were then verified with the Caltrans online web tool. Again, the spreadsheet and

deaggregation tool are recommended because the online web tool, though more user-friendly, does not include updates since 2007 in its calculation database.

The resulting design ARS curve and the digitized coordinates are presented in Figure 5-1. A peak ground acceleration (PGA) of 0.52g is obtained from the design ARS curve.

5.2 LIQUEFACTION

Liquefaction analysis was performed using the available site-specific subsurface information and historical high groundwater elevation of +81 feet. The liquefaction potential of the saturated, granular materials below the historical high groundwater table was evaluated using the procedures outlined by Seed et al. (1983), Seed and Harder (1990), and updated by NCEER (1997). Based on the analysis, granular materials susceptible to liquefaction were not encountered below the groundwater table. Therefore, the liquefaction potential at the bridge site is anticipated to be low. As a result, seismic settlement of onsite soils is also low.

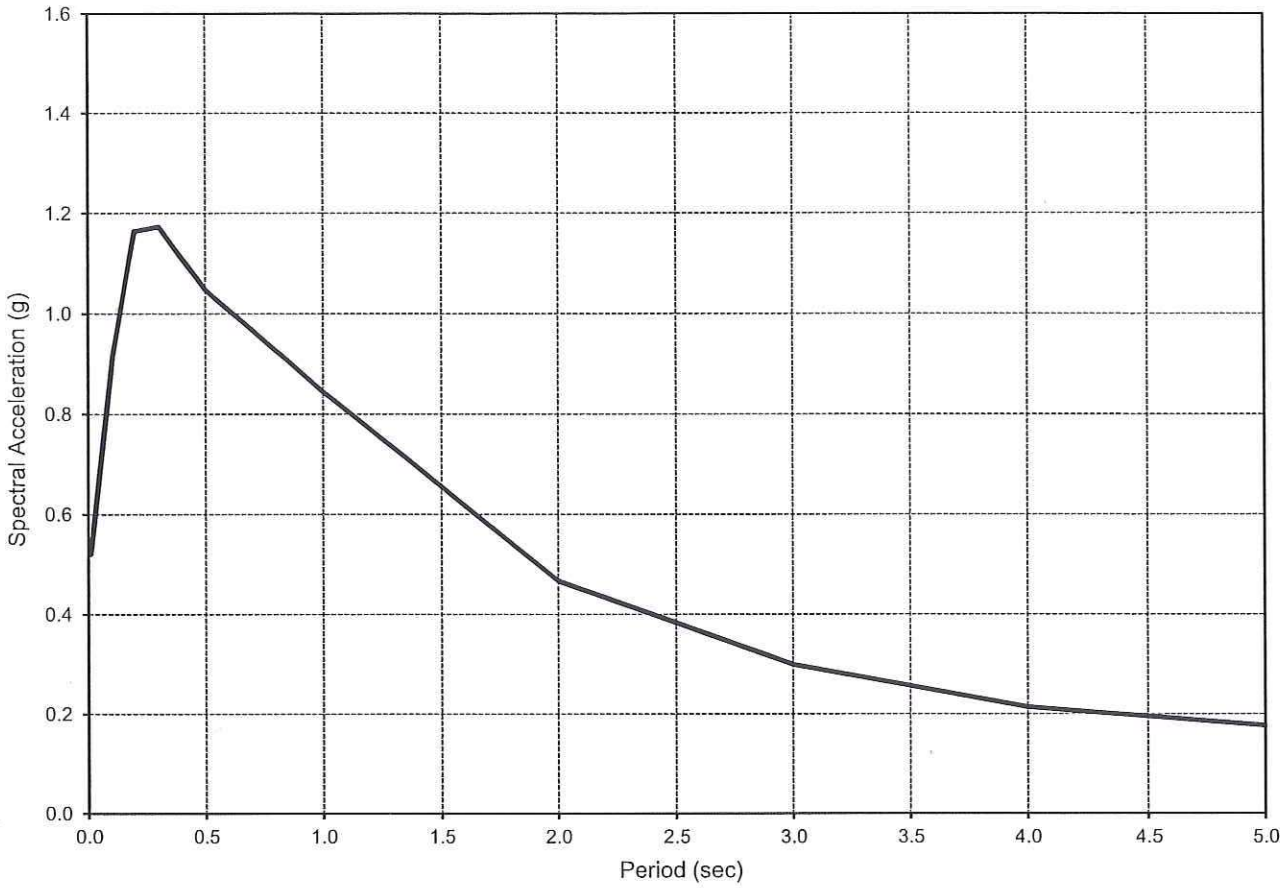
5.3 SOIL CORROSIVITY

One soil sample was tested for pH, minimum resistivity, soluble chloride content and soluble sulfate content. The test results are summarized in Table 5-2. Minimum resistivity was 750 ohm-cm. The pH value was 7.8. The soluble sulfate measurement was 40 parts per million (ppm), and the soluble chloride measurement was 332 ppm.

Table 5-2. Soil Corrosion Test Results

Boring	Station (Offset) / "Station Line"	Sample Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Soluble Sulfate Content (ppm)	Soluble Chloride Content (ppm)
A-10-024	173+76 (62 Lt) / A Line	25	SM	750	7.8	40	332

Based on the Caltrans Corrosion Guidelines (2003c), soils are considered corrosive if the pH is 5.5 or less, or the chloride concentration is 500 ppm or greater, or the sulfate concentration is 2,000 ppm or greater. Based on the test results and the Caltrans criteria, the on-site soils are considered to be non-corrosive to bare metals and concrete.



Latitude = 33.8539 °
Longitude = -117.9591 °

Damping Ratio = 5%

Spectral Coordinates	
Period (sec)	Acc. (g)
0.010	0.520
0.100	0.915
0.200	1.164
0.300	1.173
0.500	1.049
1.000	0.844
2.000	0.467
3.000	0.299
4.000	0.214
5.000	0.176

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Euclid Street UC (Widen)	Design ARS Curve
	Project: 10-126 Date: 03/01/11	Figure 5-1

5.5 PILE FOUNDATION DESIGN

5.5.1 Foundation Type

According to the as-built plans, the original UC is supported on 45-ton, 16-inch diameter CIDH piles. The 1996 widening is also support on CIDH piles with a pile diameter of 18 inches. The service demands were 45 and 70 tons for the abutment and bent pile, respectively.

For the proposed widening, we recommend using 18-inch diameter CIDH piles at the abutments which match the 1996 foundation type. At the bents, we anticipate that the design pile tip elevation would be below the groundwater table for a 18-inch diameter CIDH pile. Therefore, 24-inch diameter CIDH piles are recommended to minimize the potential of a wet construction.

5.5.2 Foundation Data Provided by Structural Designers

Per Caltrans policy, LRFD Service-I Limit State load combinations and Working Stress Design (WSD) method provided in the Caltrans Bridge Design Specifications (2003a) are used for design of the abutment footing. The LRFD Service-I Limit State, Strength Limit State, and Extreme Event Limit State load combinations are used for the design of the bent footing.

The foundation design data sheet is presented in Table 5-3. Foundation loads were provided by the structural designers following the latest Caltrans Memo To Designers (Caltrans, 2008) and these loads are presented in Table 5-4.

Table 5-3. Foundation Design Data Sheet

Support No.	Design Method	Pile Type	Finished Grade Elevation (feet)	Cut-off Elevation (feet)	Pile Cap Size (feet)		Permissible Settlement under Service Load (inch)	Number of Pile per Support
					B	L		
Abut 1	WSD	18" CIDH	+142.0	+138.75	7.5	12.0	1	4
Bents 2, 3 and 4	LRFD	24" CIDH	+135.0	+128.15	10.5	16.0	1	6
Abut 1	WSD	18" CIDH	+142.0	+138.75	7.5	12.0	1	4

Table 5-4. Foundation Design Loads

Support No.	Service-I Limit State (kips)			Strength Limit State (Controlling Group, kips)				Extreme Event Limit State (Controlling Group, kips)			
	Total Load		Permanent Loads	Compression		Tension		Compression		Tension	
	Per Support	Max. Per Pile	Per Support	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile
Abut 1	275	90	205	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bents 2, 3 and 4	650	110	500	850	155	0	0	500	270	N/A	185
Abut 5	275	90	205	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

5.5.3 Axial Pile Capacity

Abutments and bents foundation design recommendations are presented in Table 5-5 and Table 5-6, respectively. The Pile Data Table for the contract plans is presented in Table 5-7.

A pile-group efficiency factor (GEF) of 0.65 is used for a center-to-center pile spacing of 2.5 times the pile diameter, and a GEF of 1.0 is used for a center-to-center spacing of 4.0 times the pile diameter or greater (Section 10.8.3.6.3, AASHTO, 2007). Linear interpolation can be used to determine the GEF for intermediate spacings. Based on the layouts provided by the structural designers, GEF's of 0.77 were used for both the abutments and bents piles.

The pile capacity calculations are presented in Appendix C. The nominal resistance presented in Table 5-5 and Table 5-7 for the abutment piles is controlled by the Service-I Limit State "Maximum Per Pile Load". The nominal resistance presented in Table 5-6 and Table 5-7 for the bent piles is controlled by the Strength Limit State "Compression Per Support" and not by the Strength Limit State or Extreme Limit State "Maximum Per Pile Load".

The pile capacity is also based on soil resistance only and may be further limited by the pile-head connection details and the strength of the pile materials.

Table 5-5. Abutments Foundation Design Recommendations

Support	Pile	Cut-off Elevation (feet)	LRFD Service-I Limit State Load per Support (kips)		LRFD Service-I Limit State Total Load per Pile (Compression) (kips)	Nominal Resistance (kips)	Design Tip Elevations (feet)	Specified Tip Elevation (feet)
			Total	Permanent				
Abut 1	18" CIDH	+138.75	275	205	90	180	+95 (a) +113 (d)	+95
Abut 5	18" CIDH	+138.75	275	205	90	180	+95 (a) +113 (d)	+95

Notes:
1. Design tip elevations are controlled by the following demands: (a) Compression and (d) Lateral Load.
2. There are no design tip elevations for Tension and Tolerable Settlement at Abutments 1 and 5.
3. The specified tip elevation for Abutments 1 and 5 shall not be raised above the design tip elevation for Lateral Load.

Table 5-6. Bent Foundation Design Recommendations

Support Location	Pile Type	Cut-off Elevation (feet)	Service-I Limit State Loads per Support (kips)	Total Permissible Support Settlement (inch)	Required Factored Nominal Resistance (kips)				Design Tip Elevations (feet)	Specified tip Elevation (feet)
					Strength Limit		Extreme Event			
					Comp. (ϕ=0.7)	Tension (ϕ=0.7)	Comp. (ϕ=1.0)	Tension (ϕ=1.0)		
Bents 2, 3 and 4	24" CIDH	128.15	650	1	155	0	270	185	+88 (a-I) +88 (a-II) +88 (b-II) +113 (c) +103 (d)	+88

Notes:
1. Design tip elevations are controlled by the following demands: (a-I) Compression (Strength Limit), (a-II) Compression (Extreme Event), (b-II) Tension (Extreme Event), (c) Tolerable Settlement and (d) Lateral Load.
2. There is no design tip elevation for Tension (Strength Limit) at Bents 2 through 4.
3. The Specified tip elevations for Bents 2 through 4 shall not be raised above the design tip elevations for Tension, Tolerable Settlement and Lateral Load.

Table 5-7. Pile Data Table

Location	Pile Type	Nominal Resistance (kips)		Design Tip Elevations (feet)	Specified Tip Elevation (feet)
		Compression	Tension		
Abut 1	18" CIDH	180	0	+95 (a) +113 (d)	+95
Bents 2, 3 and 4	24" CIDH	270	190	+88 (a) +88 (b) +113 (c) +103 (d)	+88
Abut 5	18" CIDH	180	0	+95 (a) +113 (d)	+95

Notes:
1. Design tip elevations are controlled by the following demands: (a) Compression, (b) Tension, (c) Tolerable Settlement and (d) Lateral Load.
2. There are no design tip elevations for Tension and Tolerable Settlement at Abutments 1 and 5.
3. The specified tip elevations for Abutments 1 and 5 shall not be raised above the design tip elevation for Lateral Load.
4. The specified tip elevations for Bents 2 through 4 shall not be raised above the design tip elevation for Tension, Tolerable Settlement and Lateral Load.

5.5.4 Lateral Pile Capacity

5.5.4.1 Lateral Pile Solutions

Results of lateral pile analysis in terms of pile-head shear and lateral deflection for a free-head condition are presented in Appendix C and summarized Table 5-8. The maximum bending moment and the location of maximum moment are also presented. The solutions presented in Table 5-8 are entirely based on soil resistance and linear pile properties. Therefore, these values may be limited by the flexural strength (plastic moment) of the piles and pile-head connection details. Linear interpolation can be used for solutions between pile-head deflections of 0.25 and 5 inches. Based on the layouts provided by the structural engineers, group reduction factors of 0.82 and 0.68 were incorporated in the analysis for Abutments 1 and 5, and Bents 2 through 4, respectively.

Table 5-8. Lateral Pile Solutions

Support Location	Pile Head Deflection (in)	Pile Head Shear (kips)	Maximum Moment (kip-in)	Depth to Max. Moment from Pile Top (ft)
Abutments 1 and 5 (18-inch CIDH)	¼	15.6	401	4.5
	½	24.5	723	5.0
	1	38.9	1304	5.5
	2	56.1	2315	6.0
	5	84.8	4634	7.0

Support Location	Pile Head Deflection (in)	Pile Head Shear (kips)	Maximum Moment (kip-in)	Depth to Max. Moment from Pile Top (ft)
Bents 2, 3 and 4 (24-inch CIDH)	¼	23.3	761	5.5
	½	36.1	1366	6.5
	1	57.6	2458	7.0
	2	87.1	4414	7.5
	5	136.0	9069	9.0

5.5.4.2 Lateral Load Resistance of Bent Pile Footing

Passive earth pressure at the bent pile cap can be used to resist a portion of the lateral loads transferred to the soil. For static design, the passive soil resistance against the embedded face of the bent pile cap should be neglected. Under earthquake loading, this ultimate passive soil resistance should be added to the pile group capacity to determine the total lateral resistance of the pile footing. At the bent location, the ultimate passive soil resistance against the pile footing is estimated to be equal to a maximum equivalent fluid pressure of 375 psf per foot of depth. Note that development of full passive earth pressure requires a lateral pile cap displacement equal to approximately 2 percent of the embedded height (measured from the nearest and lowest ground surface to the bottom of the pile cap). For displacement magnitudes smaller than what is required to mobilize full resistance, the actual resistance magnitude should be determined by linearly interpolating between zero and the full resistance.

5.6 EMBANKMENTS SETTLEMENT AND SLOPE STABILITY

5.6.1 Settlement and Settlement Period

Fill will need to be placed to construct the approaches to the bridge widening. Up to 20 feet of sliver fill will be placed to construct the approaches to Abutments 1 and 5. Based on the onsite soil type, calculated ground subsidence at Abutments 1 and 5 is estimated to be about 1.5 inches. Since the onsite soils are primarily coarse-grained materials, soil settlement should occur relatively quickly, and a settlement period for pile construction is not required.

5.6.2 Slope Stability

Global stability analyses were conducted for both static and pseudo-static conditions for the bridge approach embankment slopes. The analysis was performed using the computer program SLIDE 5.0 (Rocscience, 2006). The soil strength parameters in Table 4-1 were used in the static and pseudo-static analysis and the results are presented in Appendix C.

The calculated factor of safety for a deep-seated failure is greater than the minimum required 1.5 under static condition with a 2-foot soil surcharge to represent traffic loading. Slope stability analysis under pseudo-static condition was performed using a seismic coefficient equal to 0.17g (which is the smaller of either one-third the horizontal peak ground acceleration or 0.2g) in accordance with guidelines provided in Section 3.10 of the Caltrans Guidelines for Structures

Foundation Reports (Caltrans, 2009c). Analysis indicates that the calculated factor of safety is greater than the required minimum of 1.1 under pseudo-static condition.

For embankment slopes with a gradient of 2H:1V or flatter, surficial stability should not be a design concern. If slope paving is proposed for embankment slopes with a gradient of 1.5H:1V, then surficial stability is also not a design concern. If slope paving is not used for the 1.5H:1V slopes, it is recommended that the upper 4 feet of any new 1.5H:1V slope face be covered with materials with a minimum internal friction angle of 32 degrees and a minimum cohesion of 230 psf. This select material should be properly keyed and benched into the sloping ground. In all cases, proper maintenance with erosion protection and drainage control in accordance with Section 21 of Caltrans Standard Specifications (Caltrans, 2010b) are also recommended.

5.6.3 Structure Approach Slabs

Selection of the approach type (if required) will be performed by the structural designer following the flowchart in Caltrans Memo to Designers 5-3, Attachment A, dated May 1996 (Caltrans, 1996).

5.7 BRIDGE ABUTMENT WALL DESIGN

5.7.1 Abutment Earth Pressures

If abutment walls are free to move laterally at the top, a static active lateral earth pressure of 36 psf per foot of depth is recommended for a free draining, level and compacted backfill. If lateral movement at the top of abutment walls is restrained, the lateral earth pressure for a free draining, level and compacted backfill should follow Section 5.5.5.11 of the Caltrans BDS dated August 2004. For this condition, we recommend a coefficient of active lateral earth pressure of 0.3, a coefficient of at-rest lateral earth pressure of 0.46 and a soil unit weight of 120 lb/ft^3. If applicable, a uniform lateral pressure of at least 72 psf due to vehicle loads, equivalent to a vertical pressure produced by at least 2 feet of earth, should be added to the above lateral earth pressure.

5.7.2 Passive Resistance of Abutment Backfill

Under seismic loading, an ultimate passive earth pressure of 5 ksf may be used for the approach backfill and abutment walls with a height equal to or greater than 5.5 feet. For abutment walls with heights less than 5.5 feet, the passive pressure may be calculated proportionally (e.g., for a 4-foot high wall, the passive pressure is [4/5.5] x 5 ksf = 3.64 ksf. The horizontal movement at which the maximum passive pressure is expected to be fully mobilized can be determined following the procedure outlined in Section 7.8.1 of the Caltrans SDC (2009c).

6.0 CONSTRUCTION RECOMMENDATIONS

6.1 EARTHWORK

Earthwork should be performed in accordance with Caltrans Standard Specifications, Section 19 (Caltrans, 2010b). Appropriate measures should be taken to prevent damage to adjacent structures and utilities. Any design and construction of temporary sloping, sheeting, or shoring should be made the contractor's responsibility. It should be noted that it is the responsibility of the contractor to oversee the safety of the workers in the field during construction. The contractor shall conform to all applicable occupational and health standards, rules, regulations, and orders established by the State of California. In addition, other State, County, or Municipal regulations may supersede the recommendations presented in this section. If a trench shoring design and safety plan is required, the geotechnical consultant should review the plan to confirm that recommendations presented in this report have been applied to the design.

During the recent field investigation conducted between December 8, 2010 and January 10, 2011, groundwater was encountered between elevations +65 feet and +80.4 feet. As shown on the as-built LOTB sheets in Appendix A, groundwater was encountered at elevation +71 feet in December 1993. Groundwater was not encountered in March 1955 for the original construction. Using the above groundwater measurements, groundwater is not anticipated to be encountered during footing construction at the abutments and bents. However, groundwater level can fluctuate due to seasonal rainfall amount, local irrigation and groundwater recharge program and other man-made conditions. If groundwater is encountered during construction, it should be controlled in accordance with Section 19-3.03D of the Caltrans Standard Specifications (2010b).

6.2 PILE CONSTRUCTION

Construction of CIDH piles should follow Section 49-4.03B, "Drilled Holes" of the Caltrans Standard Specifications (2010b). The Contractor should be required to drill the bottom of the shaft boring with a clean-out bucket to ensure adequate removal of loose soils. Both clean-out and concrete placement should be addressed in the specifications. The shaft borings should be inspected and approved by the Resident Engineer prior to installation of reinforcement. Per latest Caltrans requirement, 3-inch of concrete cover over reinforcement should be provided to improve the construction of the CIDH piles.

The onsite fill and alluvial soils generally range from loose to very dense coarse grained materials, and these materials are susceptible to caving. If caving occurs, a temporary casing can be used. The casing should have an inside diameter larger than or equal to the pile diameter and should be placed tight in the hole. Vibratory hammers or oversized drilling are not allowed for casing installation. In the event that any boring becomes bell-shaped and cannot be advanced due to severe caving, all loose material should be removed from the bottom of the boring and the caved region filled with a low strength sand-cement slurry. Drilling may continue when the slurry has reached its initial set.

6.3 BACKDRAIN AND BACKFILL REQUIREMENTS FOR ABUTMENT WALLS

Expansive soils should not be placed as part of the embankment within the limits of a bridge abutment as shown in Figure 6-1. Materials placed behind abutment walls should be low-expansive soil with an Expansion Index (EI) less than 50 and Sand Equivalent (SE) of more than 20. The low-expansive material requirement should be supplemental to the abutment structure and pervious backfill requirement as described in Caltrans Standard Plans (2010a) and Caltrans Standard Specifications (2010b) under Sections 19-3.03E and 19-3.03G, respectively.

Backfill should be compacted in accordance with Section 19-5 of the Caltrans Standard Specifications (2010b). Backfill should be placed in loose lifts not exceeding 8 inches in thickness, moisture-conditioned to near optimum moisture content, and compacted to at least 95 percent relative compaction. The relative compaction should be based on the maximum density determined by California Test Method 216. Jetting or flooding to compact backfill is not recommended. Heavy compaction equipment, such as vibratory rollers, dozers, or loaders, should not be used adjacent to the abutment walls in order to avoid damaging the walls due to large lateral earth pressures.

Backdrains should be installed behind abutment walls to relieve hydrostatic pressure. Backdrains should be constructed in accordance with Bridge Detail 3-1 on Sheet B0-3 per Caltrans Standard Plans (2010a) or the geocomposite drain alternative per Section 6 of the Caltrans Bridge Design Details (1992).

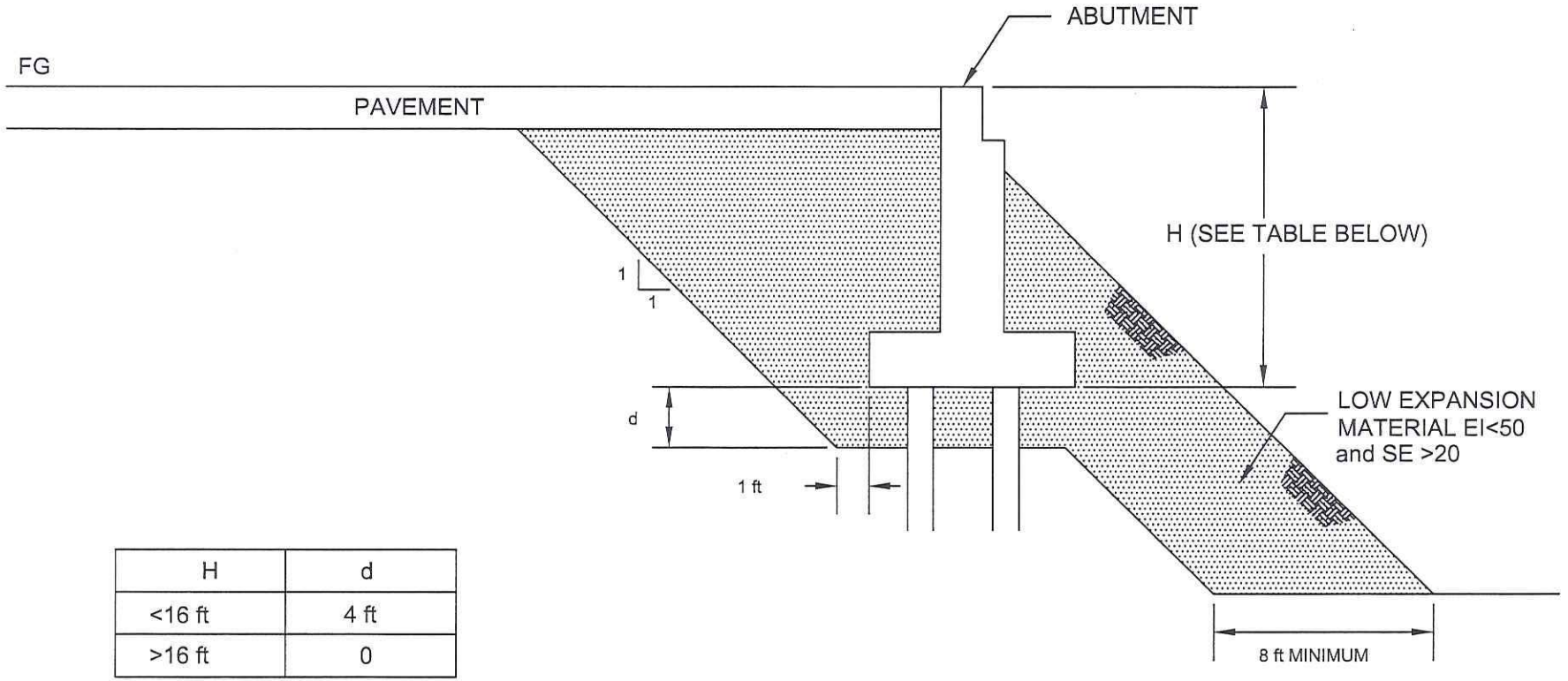
6.4 REVIEW OF CONSTRUCTION PLANS

Recommendations contained in this report are based on preliminary plans. The geotechnical consultant should review the final construction plans and specifications in order to confirm that the general intent of the recommendations contained in this report have been incorporated into the final construction documents. Recommendations contained in this report may require modification or additional recommendations may be necessary based on the final design.

6.5 GEOTECHNICAL OBSERVATION AND TESTING

It is recommended that inspections and testing be performed by the geotechnical consultant during the following stages of construction:

- Grading operations, including excavations and placement of compacted fill
- Shoring installation
- Footing excavations and pile constructions
- Backdrain installation and backfilling of bridge abutment walls
- Removal or installation of support of buried utilities or structures
- When any unusual subsurface conditions are encountered



H	d
<16 ft	4 ft
>16 ft	0

EXPANSION INDEX TO BE DETERMINED BY ASTM D4829
SAND EQUIVALENT TO BE DETERMINED BY CALIFORNIA TEST METHOD 217

NO SCALE

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Euclid Street UC (Widen)

Project No. 10-126 | Date: 03-10-11

Low Expansion Material
In Bridge Embankment

Figure 6-1

7.0 LIMITATIONS

This report is intended for the use of OCTA, RBF and Caltrans for the widening of Euclid Street UC. This report is based on the project as described and the information obtained from the exploratory borings at the approximate locations indicated on the attached plans. The findings and recommendations contained in this report are based on the results of the field investigation, laboratory tests, and engineering analyses. In addition, soils and subsurface conditions encountered in the exploratory borings are presumed to be representative of the project site. However, subsurface conditions and characteristics of soils between exploratory borings can vary. The findings reflect an interpretation of the direct evidence obtained. The recommendations presented in this report are based on the assumption that an appropriate level of quality control and quality assurance (inspections and tests) will be provided during construction. EMI should be notified of any pertinent changes in the project plans or if subsurface conditions are found to vary from those described herein. Such changes or variations may require a re-evaluation of the recommendations contained in this report.

The data, opinions, and recommendations contained in this report are applicable to the specific design element(s) and location(s) which is (are) the subject of this report. They have no applicability to any other design elements or to any other locations and any and all subsequent users accept any and all liability resulting from any use or reuse of the data, opinions, and recommendations without the prior written consent of EMI.

EMI has no responsibility for construction means, methods, techniques, sequences, or procedures; for safety precautions or programs in connection with the construction; for the acts or omissions of the CONTRACTOR or any other person performing any of the construction; or for the failure of any worker to carry out the construction in accordance with the Final Construction Drawings and Specifications.

Services performed by EMI have been conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, expressed or implied, and no warranty or guarantee is included or intended.

8.0 REFERENCES

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Appendix A

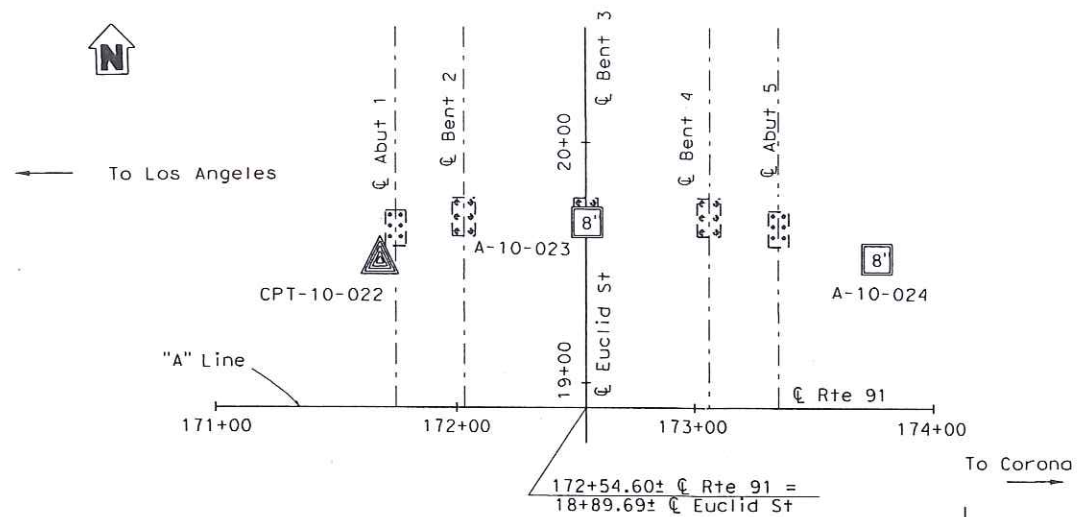
LOG OF TEST BORINGS SHEETS

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER — 09/16/11 DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).

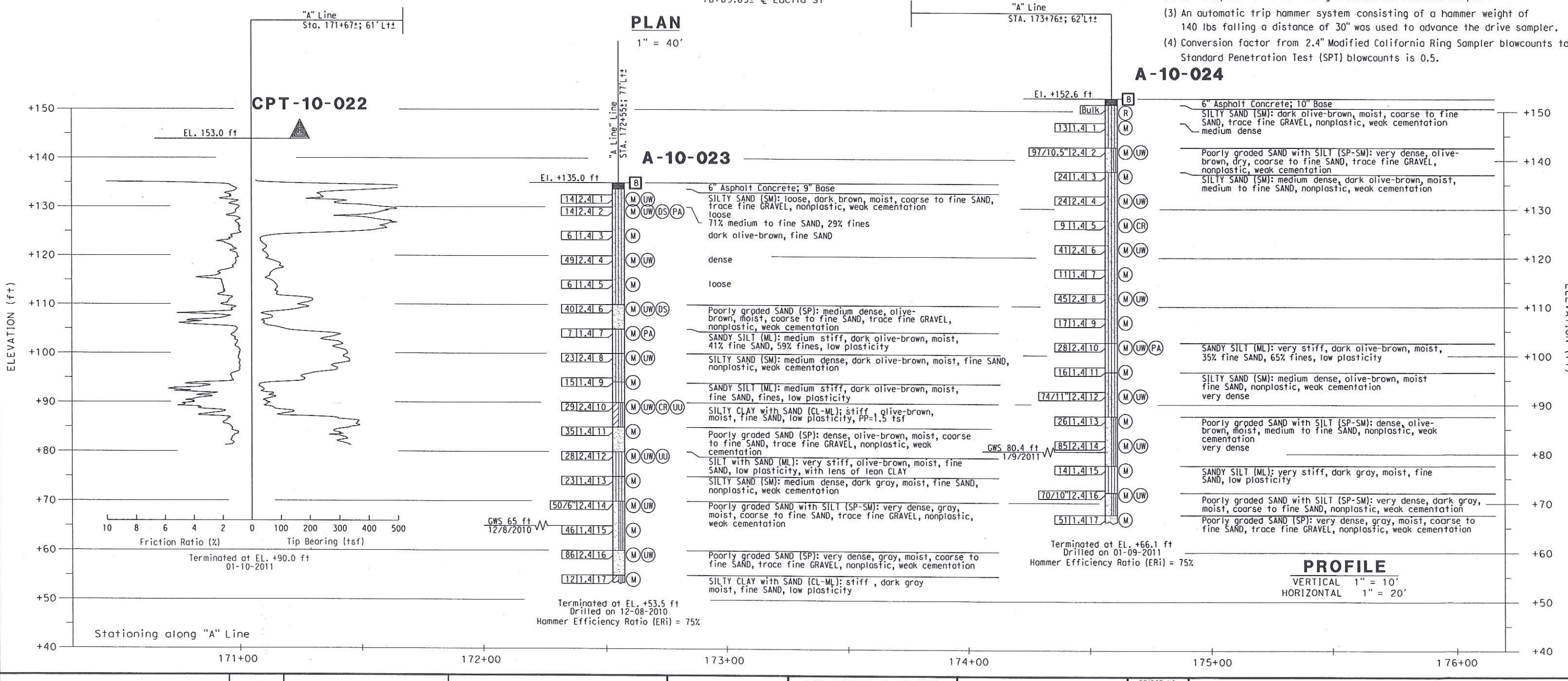
(2) 2.4" samples were taken using a California Modified Sampler.

(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.

PLAN

1" = 40'



A-10-024

6" Asphalt Concrete; 10" Base
SILTY SAND (SM): dark olive-brown, moist, coarse to fine SAND, trace fine GRAVEL, nonplastic, weak cementation
medium dense
Poorly graded SAND with SILT (SP-SM): very dense, olive-brown, dry, coarse to fine SAND, trace fine GRAVEL, nonplastic, weak cementation
SILTY SAND (SM): medium dense, dark olive-brown, moist, medium to fine SAND, nonplastic, weak cementation
SANDY SILT (ML): very stiff, dark olive-brown, moist, 35% fine SAND, 65% fines, low plasticity
SILTY SAND (SM): medium dense, olive-brown, moist fine SAND, nonplastic, weak cementation
very dense
Poorly graded SAND with SILT (SP-SM): dense, olive-brown, moist, medium to fine SAND, nonplastic, weak cementation
very dense
SANDY SILT (ML): very stiff, dark gray, moist, fine SAND, low plasticity
Poorly graded SAND with SILT (SP-SM): very dense, dark gray, moist, coarse to fine SAND, nonplastic, weak cementation
Poorly graded SAND (SP): very dense, gray, moist, coarse to fine SAND, trace fine GRAVEL, nonplastic, weak cementation

PROFILE

VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. 55-0279 / POST MILES 2.2	EUCLID STREET UC (WIDEN)
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011					LOG OF TEST BORINGS 1 OF 5

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER — DATE 09/16/11

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CEMENTATION

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

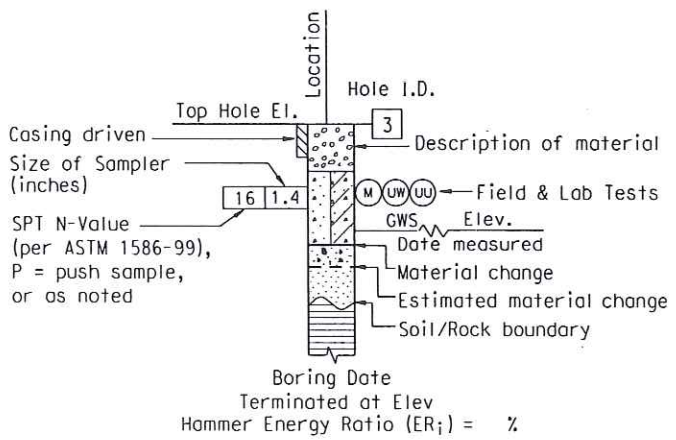
BOREHOLE IDENTIFICATION

Symbol	Hole Type	Description
Size	A	Auger Boring (hollow or solid stem bucket)
Size	R RW RC P	Rotary drilled boring (conventional) Rotary drilled with self-casing wire-line Rotary core with continuously-sampled, self-casing wire-line Rotary percussion boring (air)
Size	R	Rotary drilled diamond core
Size	HD HA	Hand driven (1-inch soil tube) Hand Auger
●	D	Dynamic Cone Penetration Boring
▲	CPT	Cone Penetration Test (ASTM D 5778)
[ ]	O	Other (note on LOTB)

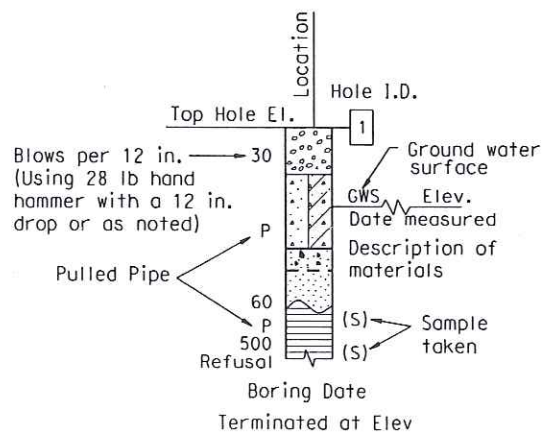
Note: Size in inches.

CONSISTENCY OF COHESIVE SOILS

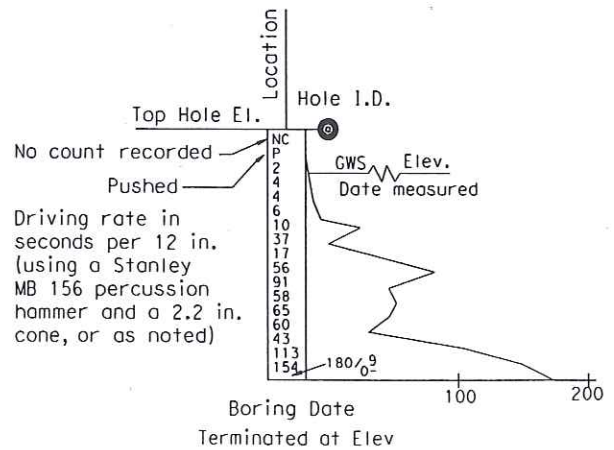
Description	Shear Strength (tsf)	Pocket Penetrometer Measurement, PP, (tsf)	Torvane Measurement, TV, (tsf)	Vane Shear Measurement, VS, (tsf)
Very Soft	Less than 0.12	Less than 0.25	Less than 0.12	Less than 0.12
Soft	0.12 - 0.25	0.25 - 0.5	0.12 - 0.25	0.12 - 0.25
Medium Stiff	0.25 - 0.5	0.5 - 1	0.25 - 0.5	0.25 - 0.5
Stiff	0.5 - 1	1 - 2	0.5 - 1	0.5 - 1
Very Stiff	1 - 2	2 - 4	1 - 2	1 - 2
Hard	Greater than 2	Greater than 4	Greater than 2	Greater than 2



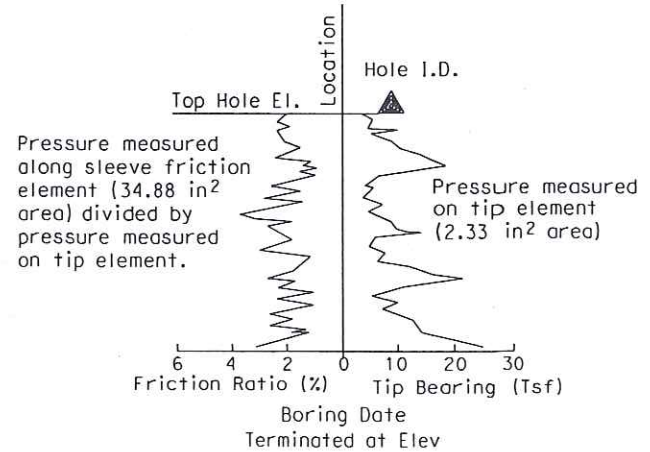
ROTARY BORING



HAND BORING



DYNAMIC CONE PENETRATION BORING



CONE PENETRATION TEST (CPT) BORING

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. 55-0279	EUCLID STREET UC (WIDEN)
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011		PROJECT ENGINEER	POST MILES 2.2	LOG OF TEST BORINGS 2 OF 5

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

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REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

GROUP SYMBOLS AND NAMES

Graphic/Symbol	Group Names	Graphic/Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND	CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
GP	Poorly-graded GRAVEL Poorly-graded GRAVEL with SAND		
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND	CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GP-GM	Poorly-graded GRAVEL with SILT Poorly-graded GRAVEL with SILT and SAND	ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
GP-GC	Poorly-graded GRAVEL with CLAY (or SILTY CLAY) Poorly-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GM	SILTY GRAVEL SILTY GRAVEL with SAND	OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND		
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND	OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL		
SP	Poorly-graded SAND Poorly-graded SAND with GRAVEL	CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL		
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
SP-SM	Poorly-graded SAND with SILT Poorly-graded SAND with SILT and GRAVEL		
SP-SC	Poorly-graded SAND with CLAY (or SILTY CLAY) Poorly-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
SM	SILTY SAND SILTY SAND with GRAVEL		
SC	CLAYEY SAND CLAYEY SAND with GRAVEL	OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY ORGANIC elastic SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL		
PT	PEAT	OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND
	COBBLES COBBLES and BOULDERS BOULDERS		

FIELD AND LABORATORY TESTING

- (C) Consolidation (ASTM D 2435)
- (CL) Collapse Potential (ASTM D 5333)
- (CP) Compaction Curve (CTM 216)
- (CR) Corrosivity Testing (CTM 643, CTM 422, CTM 417)
- (CU) Consolidated Undrained Triaxial (ASTM D 4767)
- (DS) Direct Shear (ASTM D 3080)
- (EI) Expansion Index (ASTM D 4829)
- (M) Moisture Content (ASTM D 2216)
- (OC) Organic Content-% (ASTM D 2974)
- (P) Permeability (CTM 220)
- (PA) Particle Size Analysis (ASTM D 422)
- (PI) Plasticity Index (AASHTO T 90) Liquid Limit (AASHTO T 89)
- (PL) Point Load Index (ASTM D 5731)
- (PM) Pressure Meter
- (R) R-Value (CTM 301)
- (SE) Sand Equivalent (CTM 217)
- (SG) Specific Gravity (AASHTO T 100)
- (SL) Shrinkage Limit (ASTM D 427)
- (SW) Swell Potential (ASTM D 4546)
- (UC) Unconfined Compression-Soil (ASTM D 2166) Unconfined Compression-Rock (ASTM D 2938)
- (UU) Unconsolidated Undrained Triaxial (ASTM D 2850)
- (UW) Unit Weight (ASTM D 4767)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

09/16/11
REGISTERED ENGINEER — DATE

PLANS APPROVAL DATE

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APPARENT DENSITY OF COHESIONLESS SOILS

Description	SPT N_{60} (Blows / 12 in.)
Very Loose	0 - 5
Loose	5 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Greater than 50

MOISTURE

Description	Criteria
Dry	No discernable moisture
Moist	Moisture present, but no free water
Wet	Visible free water

PERCENT OR PROPORTION OF SOILS

Description	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5% - 10%
Little	15% - 25%
Some	30% - 45%
Mostly	50% - 100%

PARTICLE SIZE

Description		Size (in.)
Boulder		Greater than 12
Cobble		3 - 12
Gravel	Coarse	3/4 - 3
	Fine	1/5 - 3/4
Sand	Coarse	1/16 - 1/5
	Medium	1/64 - 1/16
	Fine	1/300 - 1/64
Silt and Clay		Less than 1/300

DESIGN OVERSIGHT
SIGN OFF DATE

DRAWN BY: J. Fang
CHECKED BY: S. Pirathiviraj

R. Jie
FIELD INVESTIGATION BY:
DATE: 12/2010,1/2011

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

S. Pirathiviraj
PROJECT ENGINEER

BRIDGE NO. 55-0279
POST MILES 2.2

EUCLID STREET UC (WIDEN)
LOG OF TEST BORINGS 3 OF 5

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS: 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

TIME PLOTTED => $TIME
DATE PLOTTED => $DATE
USERNAME => $USER

This information has been considered in preparing the Log of Test Borings for this project

Thomas D Shantz — 1/22/96
Thomas D Shantz — Date

9-16-96 TO ACCOMPANY PLANS DATED	DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
	12	Ora	91	10/28	312	312

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DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES

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DIST.	COUNTY	ROUTE	POST MILES-TOTAL	PROJECT	Sheet No.	Total Sheets
12	ORA	91	0.9/5.4			

GEOTECHNICAL PROFESSIONAL — 09/16/11 DATE

EUCLID STREET UC (WIDEN)

LOG OF TEST BORINGS 4 OF 5

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

BRIDGE No.	Sheet	Of
55-0279	1	1

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

ROUTE 175 — FREEWAY (A LINE)

TO QUEEN PARK

EUCLID AVE — EUCLID CT

B-1 B-2 B-3

A1 A2 A3 A4 A5

172-60.63 Rte 73 (A Line) to 209.83 & Const Equiv

TO PACIFIC

AS-BUILT PLANS
Not recoverable

B M 17 A 34
Cap x'd on N W corner P C C Wall
Dist 33.8 E of x Inv 6.43 Elev 34.69

B M 18 A 34
Cap x'd on N side P/C Wall
Dist 33.8 E of x Inv 103.39
Elev 137.56

Test Boring by Bridge Dept

12-72

58-7VC13 Ltr
by B Jones
Mtg 1958

In Loading 45T
C-T-ra-Drilled Hole

Number Piles 114
At Piles As Built* 53997
At Piles Called for on Plans 5620
* None

Est Tip Elev 85
Actual Tip Elev 85±

BUILT PLANS
ject No 58-7VC13
Completed
ment No 70002187

B-2 131.7 — B-3 131.8 — B-1 132.3

Elev Ground Surface at Boring 132.5 (A Line)

Elev Ground Surface at Boring 131.5 (A Line)

Elev Ground Surface at Boring 127.5 (A Line)

Elev Ground Surface at Boring 127.5

Elev Top of Rock 125

Elev Top of Rock 122.5

Elev Top of Rock 117.5

Elev Top of Rock 117.5

Elev Bottom of Boring 70.5

Elev Bottom of Boring 70.5

Elev Bottom of Boring 70.5

Elev Bottom of Boring 70.5

Loose Dark Brown, Silty Fine to Coarse Sand

Slightly Compact, Light Brown Silty Fine to Med with Sand

Slightly Compact Layers Fine to Coarse Sand & Sandy Silt

Dense, Brown Fine to Med Sand with Layers Sandy Silt

Compact, Blue Grey, Clayey Silt

Dense, Grey Sand

N Ground Water En encountered

5 Blows per foot

Blows per foot

Sacramento Penetrometer

Blows per foot

Sacramento Penetrometer

Mid Point

Mid Point

Mid Point

Mid Point

Top Bent

Top Bent

Top Bent

Top Bent

Bottom Bent

Bottom Bent

Bottom Bent

Bottom Bent

Abutment

Abutment

Abutment

Abutment

Ftg Elev 117.5

Ftg Elev 117.5

Ftg Elev 122.5

Ftg Elev 122.5

Ftg Elev 127.5

Ftg Elev 127.5

Ftg Elev 132.5

Ftg Elev 132.5

Approx Profile of Existing Ground along A of Rte 175

Ftg Elev 127.5

Ftg Elev 132.5

Ftg Elev 127.5

Ftg Elev 132.5

Ftg Dr. Hole

Ftg Dr. Hole

150 140 130 120 110 100 90 80 70 60

PERCENTAGE OF MATERIAL BASED ON STANDARD GRADE SIZE LIMITS

Diagram showing the basis for estimates of grade size distribution used in determination of class names. If gravel is present in appreciable amounts the term "gravelly" may be added to the class name, viz gravelly sand. The terms coarse, medium and fine when used to describe sand, silt and gravel refer to standard grade size limits

CLAY — CLAYEY SOIL — SANDY SOIL — SILT

% CLAY — % SILT — % SAND

SIEVE SIZES: #200 #100 #50 #30 #16 #8 #4 3/8" 3/4" 1½" 3" 6"

LEGEND OF EARTH MATERIALS

- Gravel
- Sand
- Silt
- Clay
- Sandy Clay or Clayey Sand
- Sandy Silt or Silty Sand
- Silty Clay or Clayey Silt
- Peat, Muck or Organic Matter
- Fill Material
- Igneous Rock
- Sedimentary Rock
- Metamorphic Rock

LEGEND OF BORING OPERATIONS

- Plane of Ant Boring
- Penetrometer
- 2½ Cone Penetrometer
- Sampler boring (dry)
- Rotary Boring (wet)
- Auger Boring (dry)
- Jet Boring
- Core Boring
- Test Pit

1" Soil Tube — Rotary Boring — Penetration Boring

NOTES

The construction information is directed to Section 2 Article (a) of the Standard Specifications and to the Special Provisions accompanying this set of plans.

Classification of earth materials as shown on this sheet is based upon field inspection and not to be construed to imply mathematical analysis.

EUCLID AVE U C

LOG OF TEST BORINGS

SCALE Y 1" = 20' — SCALE X 1" = 5'

ENGINEER	DATE	DESIGN	DETAILS	QUANTITIES	CHECKED	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	J S Bishop DIST ENG EE	BRIDGE NO	EUCLID AVENUE UNDERCROSSING (WIDEN)
M Nguyen DIST ENGINEER	4-22-96 SIGNATURE DATE	J Bishop	K Dong	J Bishop	Y Hu / Y Hu / T Young		CU 12209 EA 012411	55 279 POST MILE 22	AS-BUILT LOG OF TEST BORINGS

NOTE: ADDITIONAL AS BUILT FOUNDATION DATA MAY BE AVAILABLE AT THE DIVISION OF NEW TECHNOLOGY MATERIALS AND RESEARCH 5900 FOLSOM BOULEVARD SACRAMENTO CALIFORNIA 95819

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

WHERE ARE PRINT BEARING EARLIER REVISION DATE → REVISION PRELIMINARY STAGE — SHEET 16 OF 16

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DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES

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DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
12	ORA	91	0.9/5.4		

GEOTECHNICAL PROFESSIONAL — DATE 09/16/11

EUCLID STREET UC (WIDEN)

LOG OF TEST BORINGS 5 OF 5

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

UNIT: 2295
PROJECT NUMBER & PHASE: 1200000079

BRIDGE No.	Sheet	of
55-0279	1	1

REGISTERED PROFESSIONAL ENGINEER
S. PIRATHIVIRAJ
NO. C71662
EXP. 12/31/11
CIVIL
STATE OF CALIFORNIA

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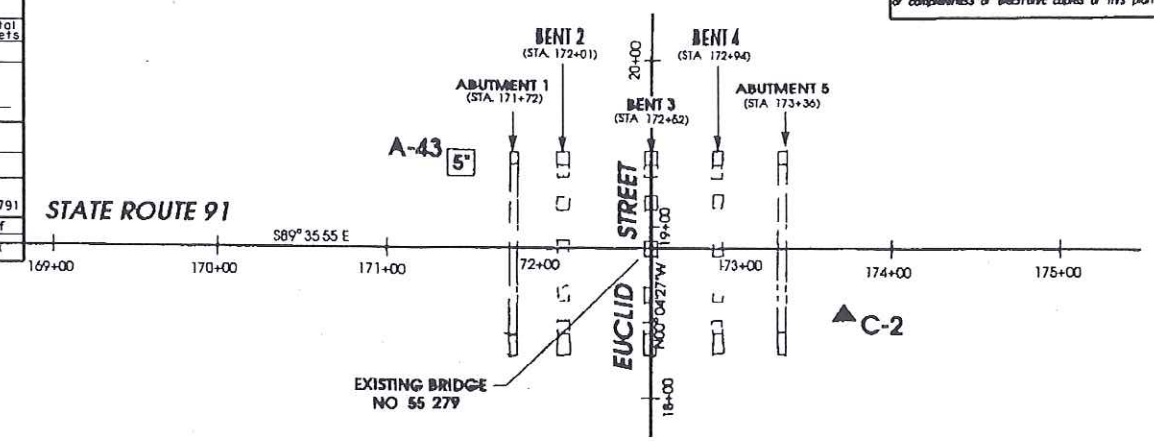
DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	Ora	91	1 0/2 8	311	312

GEOTECHNICAL PROFESSIONAL — 9-16-96 PLANS APPROVAL DATE

THOMAS D SWANTKO — NO. GE 813 — EXP 12/31/97 — GEOTECHNICAL — STATE OF CALIFORNIA

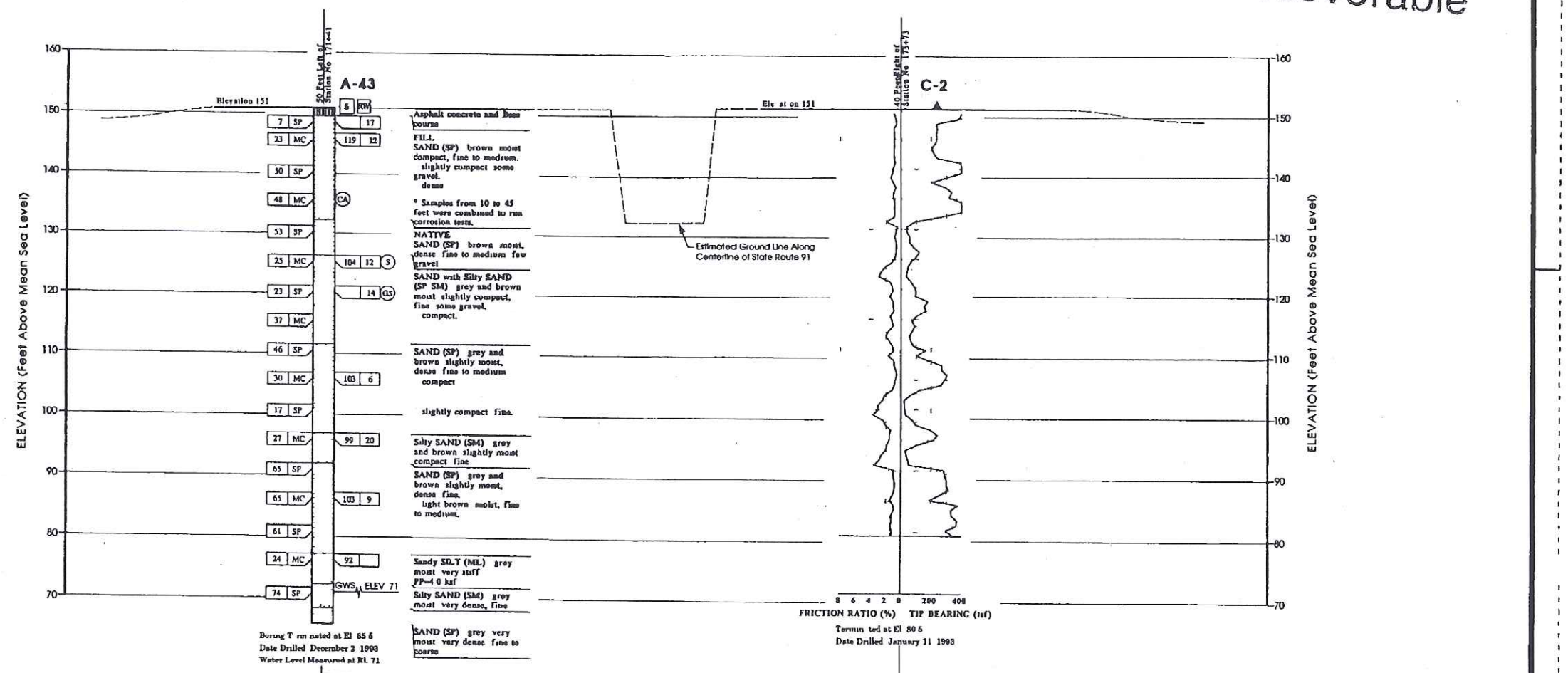
GEOFON Inc
5532 Cerrion A nue Suite B
Cypress California 90630
Job Number 92 336

PHOTO CONTROL POINT 2069
NULL & FLASH ON SURFACE
427 FEET LEFT OF STATION 178+88 CENTERLINE ROUTE 91
ELEVATION 134.26



PLAN
SCALE 1 =50 FEET

AS-BUILT PLANS
Not recoverable

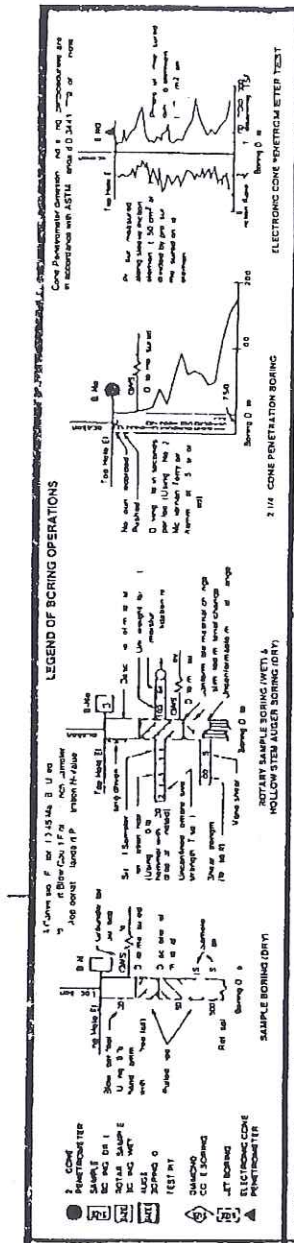


PROFILE
VERTICAL SCALE 1 = 10 FEET
HORIZONTAL SCALE 1 =100 FEET

NOTE

FOR ROTARY WASH BORINGS THE SOIL SAMPLER WAS DRIVEN WITH A 400 POUND HAMMER FALLING 18 INCHES THE BLOWCOUNTS FOR THE SAMPLER WHEN USING THE ROTARY WASH TYPE DRILLING EQUIPMENT CAN BE CONVERTED TO APPROXIMATE N-VALUE BY MULTIPLYING THE BLOWCOUNTS BY A CONVERSION FACTOR OF 0 75

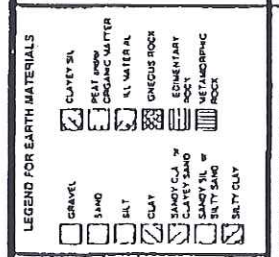
LEGEND OF BORING OPERATIONS



Soil Test Designations
(C) Consolidation
(CA) Chemical Analysis
(AL) Atterberg Limits
(S) Direct Shear
(UC) Unconfined Compression
(PP) Pocket Penetrometer
(R) R Value
(CO) Corrosion
(GS) Grain Size

NOTE Where a 2 1 4 inch sampler is used this value is the equivalent blow count for a standard penetration N value

LEGEND FOR EARTH MATERIALS



CONSISTENCY CLASSIFICATION FOR SOILS
According to the Standard Penetration Test

N (Blows/ft)	Density	C (tons/sq ft)	Consistency
4 or less	Very loose	0 25 or less	Very Soft
4 to 10	Loose	0 25 to 0 5	Soft
10 to 30	Slightly Compact	0 5 to 1 0	Stiff
30 to 50	Compact	1 0 to 2 0	Very Stiff
50 to 80	Dense	2 0 to 4 0	Hard
Over 80	Very Dense	Over 4 0	Very Hard

NOTE Classification of soil material as shown on this sheet is based upon field observation and is not to be construed to imply mechanical analyses

DESIGN OVERSIGHT R HELLMAN / BE HELLMAN — SIGN OFF DATE 9-25-96	DRAWN BY H LEE	J KNIGHT — FIELD INVESTIGATOR	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER	BRIDGE NO 55 279	EUCLID STREET UNDERCROSSING (WIDEN)
	CHECKED BY D MAR	SEE EXPLORATION — DATE			POST MILE 0 96/2 8	LOG OF TEST BORINGS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 12209
EA 012411

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES (PRE BINARY STAGE ONLY)

SHEET 15 of 16

PLATE 1

TLAO REV 29

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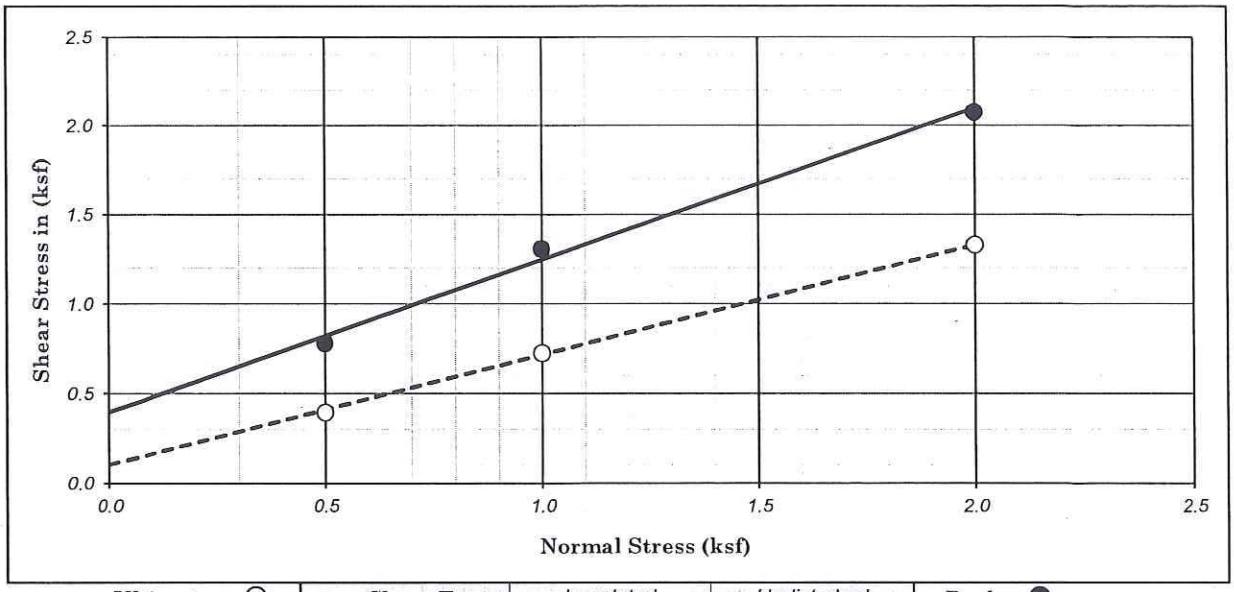
Appendix B

LABORATORY TEST RESULTS

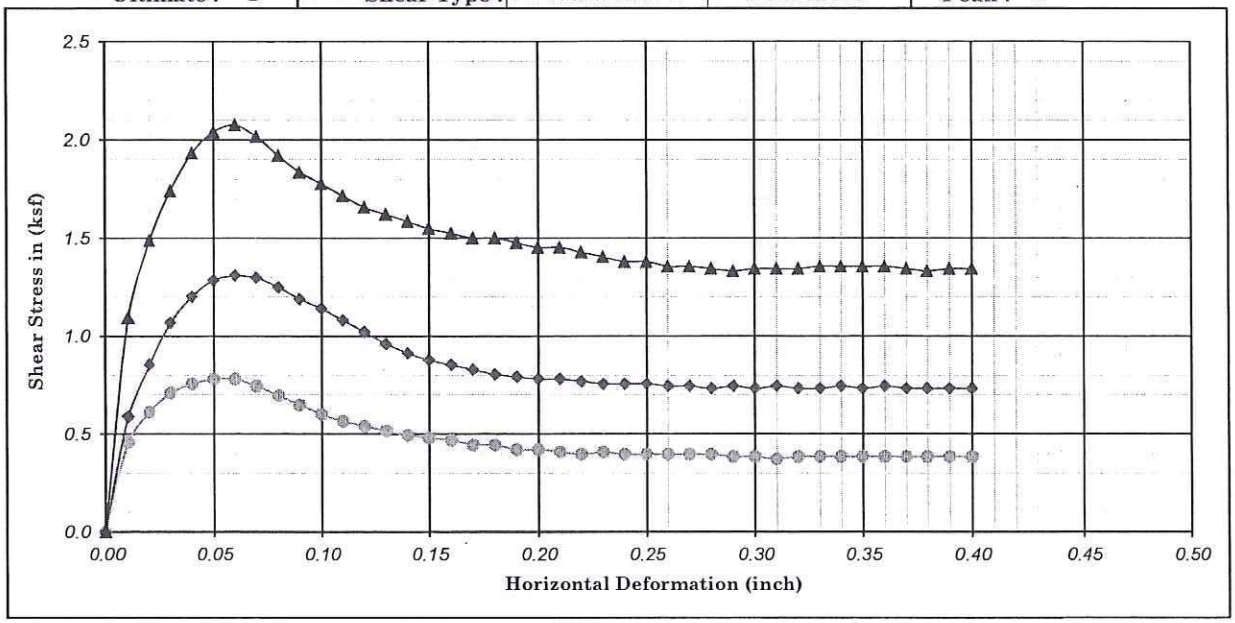
TABLE B-1 SUMMARY OF LABORATORY TEST RESULTS

Project No. : *10-126* Project Name : Euclid Street UC (Widen)

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-023	*D-1*	2.5	SM	15.3	126.8									
A-10-023	*D-2*	5	SM	11.2	125.6			0:71:29						
A-10-023	*S-3*	10	SM	15.0										
A-10-023	*D-4*	15	SM	8.4	130.2									
A-10-023	*S-5*	20	SM	19.1										
A-10-023	*D-6*	25	SP	3.1	107.0									
A-10-023	*S-7*	30	ML	19.4				0:41:59						
A-10-023	*D-8*	35	SM	17.3	129.7									
A-10-023	*S-9*	40	SM to ML	6.6										
A-10-023	*D-10*	45	CL-ML	27.5	114.9	1.5								
A-10-023	*S-11*	50	SP	4.0										
A-10-023	*D-12*	55	ML	25.4	113.9	2.5								
A-10-023	*S-13*	60	SM	22.5										
A-10-023	*D-14*	65	SP-SM	4.7	110.7									
A-10-023	*S-15*	70	SP-SM	8.9										
A-10-023	*D-16*	75	SP	13.4	131.9									
A-10-023	*S-17*	80	CL-ML	22.9										
A-10-024	*S-1*	5	SM	8.3										
A-10-024	*D-2*	10	SP-SM	2.3	118.6									
A-10-024	*S-3*	15	SM	10.5										
A-10-024	*D-4*	20	SM	8.9	118.5									
A-10-024	*S-5*	25	SM	11.2							750	7.8	40	332
A-10-024	*D-6*	30	SM	6.4	113.1									
A-10-024	*S-7*	35	SM	13.1										
A-10-024	*D-8*	40	SM	11.1	128.3									
A-10-024	*S-9*	45	SM	12.2										
A-10-024	*D-10*	50	ML	17.7	126.6			0:35:65						
A-10-024	*S-11*	55	ML to SM	22.6										
A-10-024	*D-12*	60	SM	26.5	120.0									
A-10-024	*S-13*	65	SP-SM	6.5										
A-10-024	*D-14*	70	SP-SM	14.5	125.9									
A-10-024	S-15	75	ML	26.5										
A-10-024	*D-16*	80	SP-SM	11.5	126.0									
A-10-024	*S-17*	85	SP	3.9										



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-023		Strength Intercept (C) :	0.40	(ksf)	Peak	0.10	(ksf)	Ultimate
Sample No. : D-2			18.96	(kPa)		4.98	(kPa)	
Depth (ft/m) : 10.0	0.00	Friction Angle (ϕ) :	40.37	Degree		31.48	Degree	

Description : Dark -brown, SILTY SAND (SM) — Shear Rate (inch/minute) : 0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	17.66	107.73	16.96	0.56	0.50	23.94	0.78	37.35	0.40	18.91
◆	16.52	109.98	17.31	0.53	1.00	47.88	1.31	62.63	0.73	34.71
▲	16.37	110.15	17.34	0.53	2.00	95.76	2.08	99.40	1.33	63.68

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

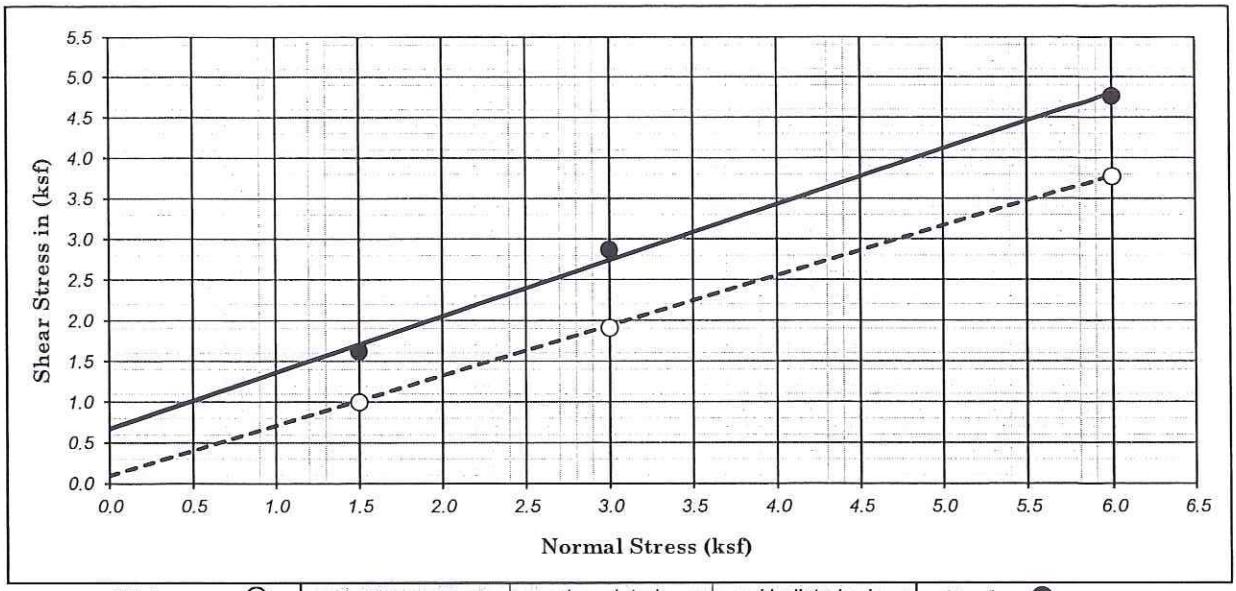
Euclid Street UC (Widen)

SR-91 WB Widening Project

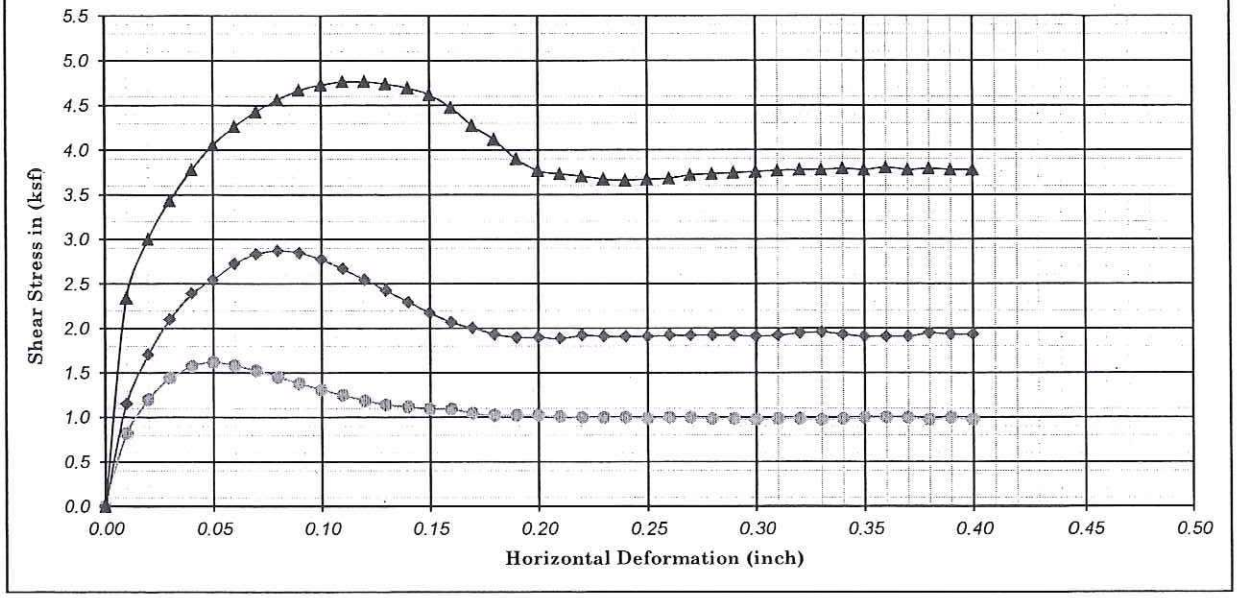
DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126 | Date : 02/09/11

Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-023		Strength Intercept (C) :	0.67	(ksf)	Peak	0.10	(ksf)	Ultimate
Sample No. : D-6			32.18	(kPa)		4.62	(kPa)	
Depth (ft/m) : 25.0	0.00	Friction Angle (ϕ) :	34.57	Degree		31.55	Degree	
Description : Olive-brown, Poorly graded SAND (SP)					Shear Rate (inch/minute) :			0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	20.66	90.03	14.17	0.87	1.50	71.82	1.62	77.57	1.00	47.88
◆	21.36	89.16	14.03	0.89	3.00	143.64	2.87	137.32	1.91	91.45
▲	23.30	85.48	13.45	0.97	6.00	287.28	4.76	228.10	3.77	180.51

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

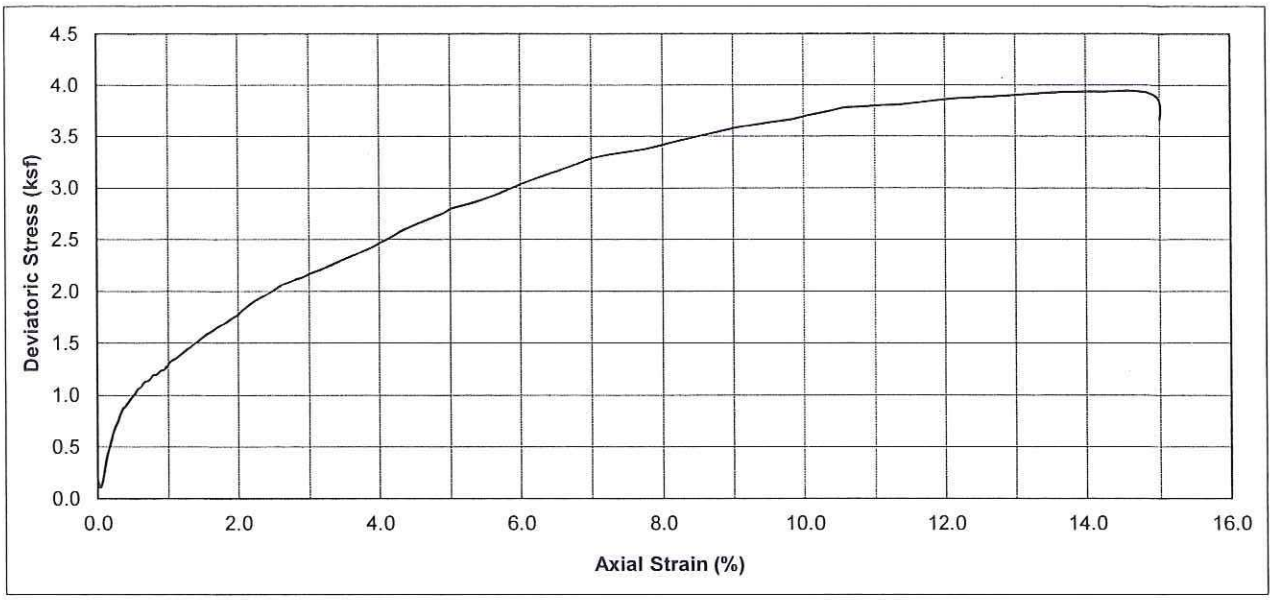
Euclid Street UC (Widen)

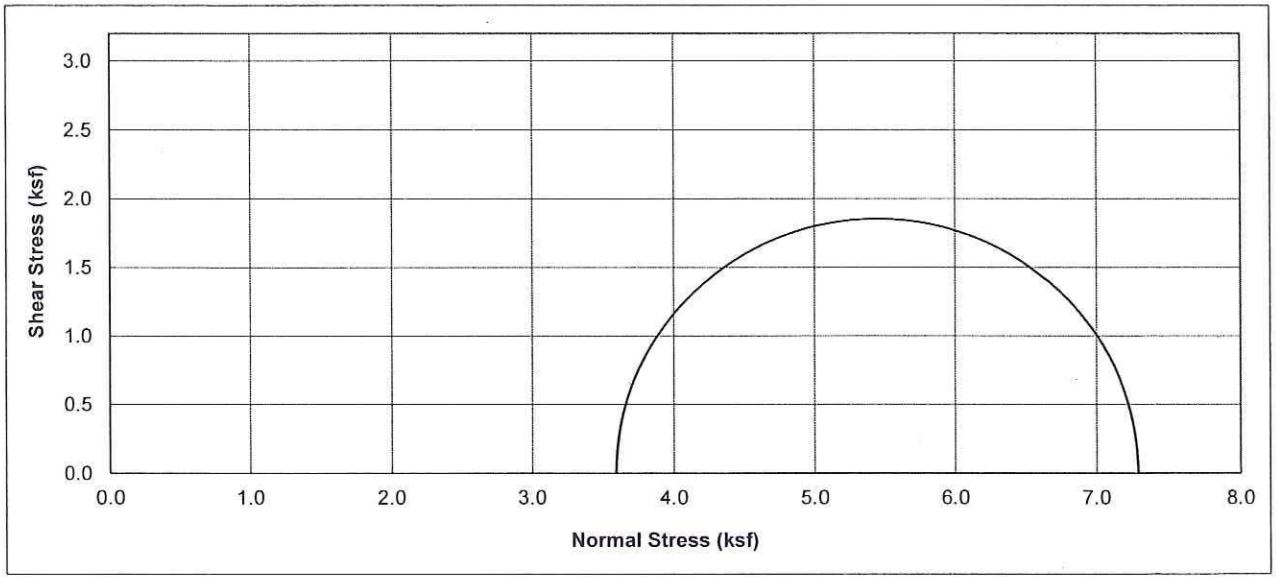
SR-91 WB Widening Project

DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126 | Date : 02/11/11

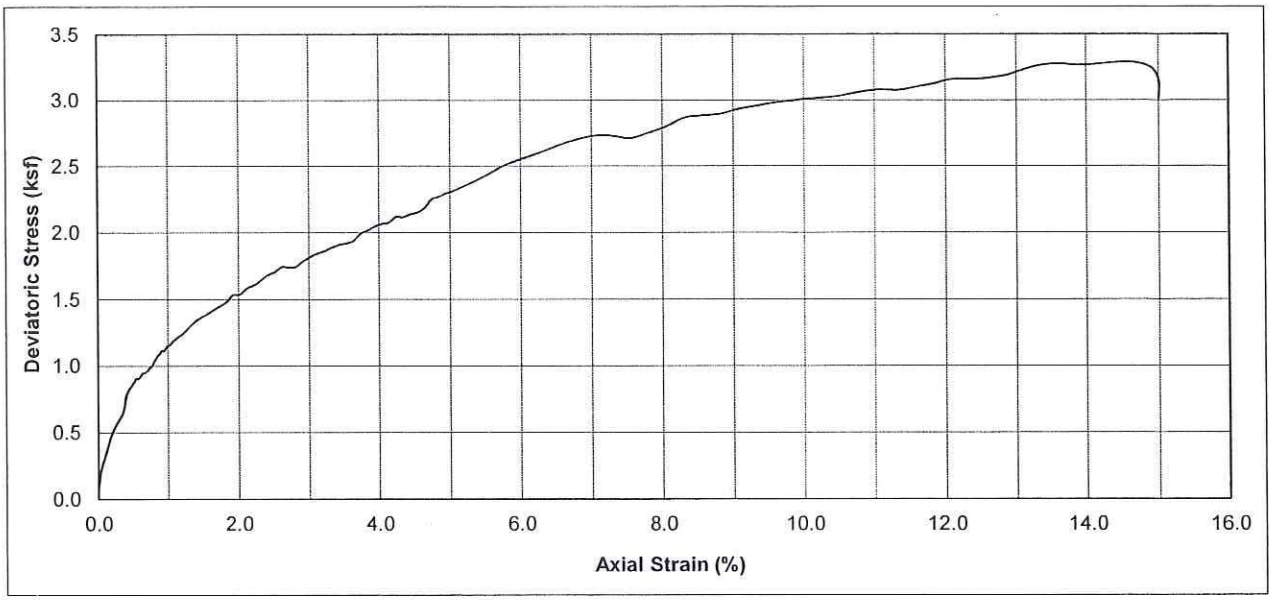
Figure No. :

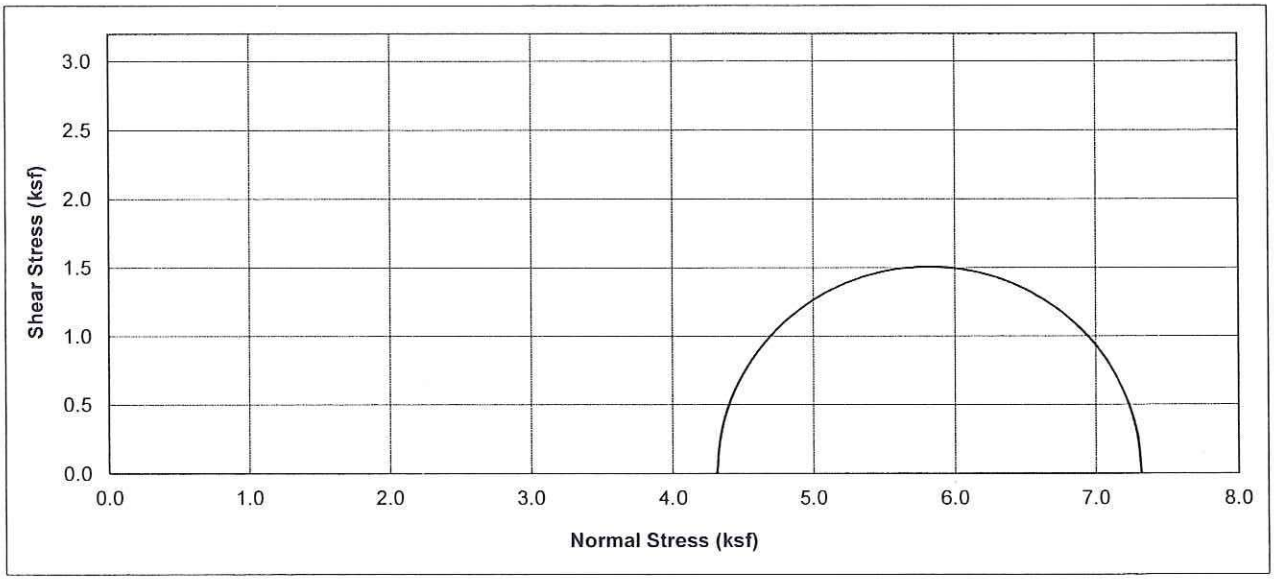




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-023	D-10	45	Olive-brown, SILTY CLAY with SAND (CL-ML)	89.9	27.55	3.59	3.71	85.2

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	**Euclid Street UC (Widen)**
	UNCONSOLIDATED UNDRAINED TEST
Project No. : 10-126 **Date :** 02/08/11	**(ASTM D2850)** Figure No. :





Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-023	D-12	55	Olive-brown, SILT with SAND (ML)	89.8	25.37	4.31	3.01	78.3

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Euclid Street UC (Widen)
Project No. : 10-126 Date : 02/08/11	UNCONSOLIDATED UNDRAINED TEST (ASTM D2850) Figure No. :

Appendix C

DESIGN CALCULATIONS

Euclid St UC (Widen) Sounding: CPT-10-022

PGA: 0.52 Mag 7.3 Gwdepth 72 Ground EL 153 Note: Units are tons/cf, tons/sf, and feet

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	CQ2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
7.55	145.5	11.68	1.048	0.06	0.45	0.45	24.78	9.33	3.02	Clay	Clay	Clay	Clay	Clay	Clay	24.78	3.02	6.94	172.00	0.55	0.33	0.98	FALSE	0.00	Above WT
7.71	145.3	11.61	0.930	0.06	0.46	0.46	24.10	8.34	2.99	Clay	Clay	Clay	Clay	Clay	Clay	24.10	2.99	6.64	160.06	0.46	0.33	0.98	FALSE	0.00	Above WT
7.87	145.1	11.11	1.021	0.06	0.47	0.47	22.53	9.60	3.06	Clay	Clay	Clay	Clay	Clay	Clay	22.53	3.06	7.38	166.20	0.51	0.33	0.98	FALSE	0.00	Above WT
8.04	145.0	12.35	1.233	0.06	0.48	0.48	24.60	10.39	3.05	Clay	Clay	Clay	Clay	Clay	Clay	24.60	3.05	7.36	181.08	0.63	0.33	0.98	FALSE	0.00	Above WT
8.20	144.8	14.32	1.442	0.06	0.49	0.49	28.11	10.43	3.02	Clay	Clay	Clay	Clay	Clay	Clay	28.11	3.02	6.92	194.53	0.76	0.33	0.98	FALSE	0.00	Above WT
8.37	144.6	16.92	1.503	0.06	0.50	0.50	32.69	9.15	2.93	Clay	Clay	Clay	Clay	Clay	Clay	32.69	2.93	6.00	196.01	0.78	0.33	0.98	FALSE	0.00	Above WT
8.53	144.5	16.00	1.858	0.06	0.51	0.51	30.26	11.99	3.04	Clay	Clay	Clay	Clay	Clay	Clay	30.26	3.04	7.20	217.91	1.04	0.33	0.98	FALSE	0.00	Above WT
8.69	144.3	19.25	2.843	0.06	0.52	0.52	35.92	15.18	3.07	Clay	Clay	Clay	Clay	Clay	Clay	35.92	3.07	7.57	271.94	1.95	0.33	0.98	FALSE	0.00	Above WT
8.86	144.1	67.30	4.456	0.06	0.53	0.53	125.60	6.67	2.46	1.40	90.51	2.54	Sand	Sand	Sand	90.51	2.54	3.00	271.38	1.94	0.33	0.98	FALSE	0.00	Above WT
9.02	144.0	159.60	6.066	0.06	0.54	0.54	294.27	3.81	2.06	1.39	213.00	2.13	Sand	Sand	Sand	213.00	2.13	1.52	322.92	3.21	0.33	0.98	FALSE	0.00	Above WT
9.19	143.8	308.56	5.833	0.06	0.55	0.55	558.59	1.89	1.66	1.37	407.46	1.73	Sand	Sand	Sand	407.46	1.73	1.06	430.20	7.48	0.33	0.98	FALSE	0.00	Above WT
9.35	143.7	437.33	6.398	0.06	0.56	0.56	778.55	1.46	1.50	1.36	572.55	1.56	Sand	Sand	Sand	572.55	1.56	1.00	572.55	17.53	0.33	0.98	FALSE	0.00	Above WT
9.51	143.5	549.24	8.107	0.06	0.57	0.57	961.57	1.48	1.47	1.35	712.98	1.52	Sand	Sand	Sand	712.98	1.52	1.00	712.98	33.79	0.33	0.98	FALSE	0.00	Above WT
9.68	143.3	608.58	7.978	0.06	0.58	0.58	1046.83	1.31	1.41	1.34	783.05	1.46	Sand	Sand	Sand	783.05	1.46	1.00	783.05	44.73	0.33	0.98	FALSE	0.00	Above WT
9.84	143.2	531.16	6.594	0.06	0.59	0.59	898.66	1.24	1.41	1.33	677.85	1.46	Sand	Sand	Sand	677.85	1.46	1.00	677.85	29.05	0.33	0.98	FALSE	0.00	Above WT
10.01	143.0	490.80	5.251	0.06	0.60	0.60	816.18	1.07	1.37	1.32	621.01	1.42	Sand	Sand	Sand	621.01	1.42	1.00	621.01	22.35	0.33	0.98	FALSE	0.00	Above WT
10.17	142.8	459.84	4.528	0.06	0.61	0.61	752.59	0.99	1.35	1.31	577.24	1.41	Sand	Sand	Sand	577.24	1.41	1.00	577.24	17.97	0.33	0.98	FALSE	0.00	Above WT
10.33	142.7	412.48	4.275	0.06	0.62	0.62	664.51	1.04	1.40	1.30	513.76	1.45	Sand	Sand	Sand	513.76	1.45	1.00	513.76	12.69	0.33	0.98	FALSE	0.00	Above WT
10.50	142.5	359.65	3.977	0.06	0.63	0.63	569.87	1.11	1.45	1.28	444.32	1.51	Sand	Sand	Sand	444.32	1.51	1.00	444.32	8.24	0.33	0.98	FALSE	0.00	Above WT
10.66	142.3	295.66	3.526	0.06	0.64	0.64	461.26	1.20	1.53	1.28	362.51	1.59	Sand	Sand	Sand	362.51	1.59	1.00	362.51	4.51	0.33	0.98	FALSE	0.00	Above WT
10.83	142.2	253.74	3.661	0.06	0.65	0.65	389.49	1.45	1.64	1.27	308.66	1.69	Sand	Sand	Sand	308.66	1.69	1.03	318.91	3.10	0.33	0.97	FALSE	0.00	Above WT
10.99	142.0	234.51	4.194	0.06	0.66	0.66	354.64	1.79	1.74	1.26	283.18	1.79	Sand	Sand	Sand	283.18	1.79	1.10	311.57	2.89	0.33	0.97	FALSE	0.00	Above WT
11.15	141.9	224.08	4.132	0.06	0.67	0.67	333.95	1.85	1.76	1.25	268.64	1.82	Sand	Sand	Sand	268.64	1.82	1.12	300.30	2.60	0.33	0.97	FALSE	0.00	Above WT
11.32	141.7	234.38	3.616	0.06	0.68	0.68	344.08	1.55	1.69	1.24	278.87	1.74	Sand	Sand	Sand	278.87	1.74	1.07	297.43	2.53	0.33	0.97	FALSE	0.00	Above WT
11.48	141.5	237.33	3.285	0.06	0.69	0.69	343.56	1.39	1.65	1.23	280.41	1.70	Sand	Sand	Sand	280.41	1.70	1.04	291.64	2.39	0.33	0.97	FALSE	0.00	Above WT
11.65	141.4	238.15	3.615	0.06	0.70	0.70	339.70	1.52	1.69	1.22	279.32	1.74	Sand	Sand	Sand	279.32	1.74	1.06	296.77	2.51	0.33	0.97	FALSE	0.00	Above WT
11.81	141.2	246.00	3.339	0.06	0.71	0.71	346.16	1.36	1.64	1.21	286.56	1.69	Sand	Sand	Sand	286.56	1.69	1.03	295.62	2.48	0.33	0.97	FALSE	0.00	Above WT
11.98	141.0	246.21	4.105	0.06	0.72	0.72	341.53	1.67	1.72	1.20	284.76	1.76	Sand	Sand	Sand	284.76	1.76	1.08	308.02	2.80	0.33	0.97	FALSE	0.00	Above WT
12.14	140.9	203.70	4.484	0.06	0.73	0.73	278.65	2.21	1.87	1.19	234.04	1.91	Sand	Sand	Sand	234.04	1.91	1.20	281.09	2.15	0.33	0.97	FALSE	0.00	Above WT
12.30	140.7	186.72	4.033	0.06	0.74	0.74	252.01	2.17	1.89	1.19	213.13	1.93	Sand	Sand	Sand	213.13	1.93	1.22	259.65	1.71	0.33	0.97	FALSE	0.00	Above WT
12.47	140.5	307.51	3.984	0.06	0.75	0.75	410.00	1.30	1.59	1.18	348.61	1.62	Sand	Sand	Sand	348.61	1.62	1.00	348.61	4.02	0.33	0.97	FALSE	0.00	Above WT
12.63	140.4	326.26	2.859	0.06	0.76	0.76	429.54	0.88	1.43	1.17	367.51	1.47	Sand	Sand	Sand	367.51	1.47	1.00	367.51	4.70	0.33	0.97	FALSE	0.00	Above WT
12.80	140.2	303.58	2.974	0.06	0.77	0.77	394.29	0.98	1.49	1.16	339.68	1.53	Sand	Sand	Sand	339.68	1.53	1.00	339.68	3.73	0.33	0.97	FALSE	0.00	Above WT
12.96	140.0	283.18	3.498	0.06	0.78	0.78	363.17	1.24	1.60	1.16	314.90	1.63	Sand	Sand	Sand	314.90	1.63	1.00	314.90	2.98	0.33	0.97	FALSE	0.00	Above WT
13.12	139.9	282.99	4.114	0.06	0.79	0.79	358.49	1.46	1.66	1.15	312.76	1.69	Sand	Sand	Sand	312.76	1.69	1.03	323.02	3.21	0.33	0.97	FALSE	0.00	Above WT
13.29	139.7	301.76	4.684	0.06	0.80	0.80	377.43	1.56	1.67	1.14	331.37	1.70	Sand	Sand	Sand	331.37	1.70	1.04	344.31	3.88	0.33	0.97	FALSE	0.00	Above WT
13.45	139.6	380.59	4.833	0.06	0.81	0.81	470.61	1.27	1.55	1.14	415.44	1.57	Sand	Sand	Sand	415.44	1.57	1.00	415.44	6.75	0.33	0.97	FALSE	0.00	Above WT
13.62	139.4	409.27	3.880	0.06	0.82	0.82	499.82	0.95	1.42	1.13	443.94	1.45	Sand	Sand	Sand	443.94	1.45	1.00	443.94	8.22	0.33	0.97	FALSE	0.00	Above WT
13.78	139.2	432.83	3.576	0.06	0.83	0.83	522.50	0.83	1.36	1.12	466.77	1.39	Sand	Sand	Sand	466.77	1.39	1.00	466.77	9.54	0.33	0.97	FALSE	0.00	Above WT
13.94	139.1	472.28	3.978	0.06	0.84	0.84	563.66	0.84	1.35	1.12	506.38	1.38	Sand	Sand	Sand	506.38	1.38	1.00	506.38	12.16	0.33	0.97	FALSE	0.00	Above WT
14.11	138.9	491.79	4.390	0.06	0.85	0.85	579.90	0.89	1.37	1.11	524.11	1.39	Sand	Sand	Sand	524.11	1.39	1.00	524.11	13.47	0.33	0.97	FALSE	0.00	Above WT
14.27	138.7	497.43	4.712	0.06	0.86	0.86	579.97	0.95	1.39	1.10	527.14	1.41	Sand	Sand	Sand	527.14	1.41	1.00	527.14	13.70	0.33	0.97	FALSE	0.00	Above WT
14.44	138.6	456.62	4.843	0.06	0.87	0.87	526.03	1.06	1.45	1.10	481.04	1.47	Sand	Sand	Sand	481.04	1.47	1.00	481.04	10.43	0.33	0.97	FALSE	0.00	Above WT
14.60	138.4	468.55	5.045	0.06	0.88	0.88	533.87	1.08	1.46	1.09	490.89	1.48	Sand	Sand	Sand	490.89	1.48	1.00	490.89	11.08	0.33	0.97	FALSE	0.00	Above WT
14.76	138.2	447.29	4.914	0.06	0.89	0.89	504.07	1.10	1.48	1.08	466.07	1.49	Sand	Sand	Sand	466.07	1.49	1.00	466.07	9.50	0.33	0.97	FALSE	0.00	Above WT
14.93	138.1	439.92	4.797	0.06	0.90	0.90	490.09	1.09	1.48	1.08	455.78	1.50	Sand	Sand	Sand	455.78	1.50	1.00	455.78	8.89	0.33	0.97	FALSE	0.00	Above WT
15.09	137.9	428.57	4.564	0.06	0.91	0.91	472.35	1.07	1.48	1.07	441.66	1.50	Sand	Sand	Sand	441.66	1.50	1.00	441.66	8.09	0.33	0.96	FALSE	0.00	Above WT
15.26	137.7	413.44	5.015	0.06	0.92	0.92	450.55	1.22	1.54	1.07	423.68	1.55	Sand	Sand	Sand	423.68	1.55	1.00	423.68	7.15	0.33	0.96	FALSE	0.00	Above WT
15.42	137.6	392.86	5.541	0.06	0.93	0.93	423.64	1.41	1.61	1.06	400.52	1.62	Sand	Sand	Sand	400.52	1.62	1.00	400.52	6.06	0.33	0.96	FALSE	0.00	Above WT
15.58	137.4	326.62	5.589	0.06	0.93	0.93	348.40	1.72	1.73	1.05	331.26	1.74	Sand	Sand	Sand	331.26	1.74	1.06	352.10	4.14	0.33	0.96	FALSE	0.00	Above WT
15.75	137.3	280.42	4.784	0.06	0.95	0.95	295.74	1.71	1.76	1.05	282.86	1.77	Sand	Sand	Sand	282.86	1.77	1.09	307.95	2.80	0.33	0.96	FALSE	0.00	Above WT
15.91	137.1	361.17	3.896	0.06	0.95	0.95	377.35	1.08	1.54	1.04	362.48	1.55	Sand	Sand	Sand	362.48	1.55	1.00	362.48	4.51	0.33	0.96	FALSE	0.00	Above WT
16.08	136.9	394.93	3.524	0.06	0.96	0.96	408.34	0.89	1.45	1.04	394.26	1.46	Sand	Sand	Sand	394.26	1.46	1.00	394.26	5.78	0.33	0.96	FALSE	0.00	Above WT
16.24	136.8	412.23	3.430	0.06	0.97	0.97	422.06	0.83	1.42	1.03	409.50	1.43	Sand	Sand	Sand	409.50	1.43	1.00	409.50	6.47	0.33	0.96	FALSE	0.00	Above WT
16.40	136.6	427.49	3.092	0.06	0.98	0.98	433.44	0.72	1.36	1.03	422.58	1.37	Sand	Sand	Sand	422.58	1.37	1.00	422.58	7.10	0.33	0.96	FALSE	0.00	Above WT
16.57	136.4	446.80	4.175	0.06	0.99	0.99	448.41	0.94	1.45	1.02	439.40	1.45	Sand	Sand	Sand	439.40	1.45	1.00	439.40	7.97	0.32	0.96	FALSE	0.00	Above WT
16.73	136.3	479.27	4.954	0.06	1.00	1.00	476.46	1.04	1.47	1.02	469.07	1.47	Sand	Sand	Sand	469.07	1.47	1.00	469.07	9.68	0.32	0.96	FALSE	0.00	Above WT
16.90	136.1	473.18	5.401	0.06	1.01	1.01	465.65	1.14	1.51	1.01	460.78	1.51	Sand	Sand	Sand	460.78	1.51	1.00	460.78	9.18	0.32	0.96	FALSE	0.00	Above WT
17.06	135.9	497.35	5.300	0.06	1.02	1.02	484.68	1.07	1.47	1.01	482.04	1.48	Sand	Sand	Sand	482.04	1.48	1.00	482.04	10.50	0.32	0.96	FALSE	0.00	Above WT
17.22	135.8	468.32	4.700	0.06	1.03	1.03	452.27	1.01	1.47	1.00	451.79	1.47	Sand	Sand	Sand	451.79	1.47	1.00	451.79	8.66	0.32	0.96	FALSE	0.00	Above WT
17.39	135.6	463.82	3.890	0.06	1.04	1.04	443.53	0.84	1.41	1.00	445.25	1.41	Sand	Sand	Sand	445.25	1.41	1.00	445.25	8.29	0.32	0.96	FALSE	0.00	Above WT
17.55	135.5	450.26	4.010	0.06	1.05	1.05	426.60	0.89	1.44	0.99	430.26	1.44	Sand	Sand	Sand	430.26	1.44	1.00	430.26	7.49	0.32	0.96	FALSE	0.00	Above WT
17.72	135.3	437.56	3.922	0.06	1.06	1.06	410.55	0.90	1.45	0.99	416.12	1.45	Sand	Sand	Sand	416.12	1.45	1.00	416.12	6.78	0.32	0.96	FALSE	0.00	Above WT
17.88	135.1	456.28	3.435	0.06	1.07	1.07	424.32	0.75	1.38	0.98	431.97	1.38	Sand	Sand	Sand	431.97	1.38	1.00	431.97	7.58	0.32	0.96	FALSE	0.00	Above WT
18.04	135.0	457.94	3.936	0.06	1.08	1.08	422.08	0.86	1.43	0.98	431.62	1.43	Sand	Sand	Sand	431.62	1.43	1.00	431.62	7.56	0.32	0.96	FALSE	0.00	Above WT
18.21	134.8	463.46	3.964	0.06	1.09	1.09	423.18	0.86	1.43	0.98	434.78	1.42	Sand	Sand	Sand	434.78	1.42	1.00	434.78	7.72	0.32	0.96	FALSE	0.00	Above WT
18.37	134.6	438.46	3.618	0.06	1.10	1.10	396.80	0.83	1.43	0.97	409.53	1.42	Sand	Sand	Sand	409.53	1.42	1.00	409.53	6.47	0.32	0.96	FALSE	0.00	Above WT
18.54	134.5	422.57	3.626	0.06	1.11	1.11	378.87	0.86	1.46	0.97	392.87	1.45	Sand	Sand	Sand	392.87	1.45	1.00	392.87	5.72	0.32	0.96	FALSE	0.00	Above WT
18.70	134.3	412.44	3.508	0.06	1.12	1.12	366.59	0.85	1.46	0.96	381.81	1.45	Sand	Sand	Sand	381.81	1.45	1.00	381.81	5.26	0.32	0.96	FALSE	0.00	Above WT
18.86	134.1	375.78	3.104	0.06	1.13	1.13	331.08	0.83	1.48	0.96	346.39	1.47	Sand	Sand	Sand	346.39	1.47	1.00	346.39	3.95	0.32	0.96	FALSE	0.00	Above WT
19.03	134.0	323.39	2.518	0.06	1.14	1.14	282.23	0.78	1.51	0.95	296.77	1.49	Sand	Sand	Sand	296.77	1.49	1.00	296.77	2.51	0.32	0.96	FALSE	0.00	Above WT
19.19	133.8	253.16	1.703	0.06	1.15	1.15	218.87	0.68	1.54	0.95	231.35	1.52	Sand	Sand	Sand	231.35	1.52	1.00	231.35	1.23	0.32	0.96	FALSE	0.00	Above WT
19.36	133.6	177.94	1.451	0.06	1.16	1.16	152.19	0.82	1.72	0.95	161.89	1.70	Sand	Sand	Sand	161.89	1.70	1.04	167.57	0.52	0.32	0.95	FALSE	0.00	Above WT
19.52	133.5	109.28	1.257	0.06	1.17	1.17	92.31	1.16	1.98	0.94	99.02	1.96	Sand	Sand	Sand	99.02	1.96	1.25	123.44	0.25	0.32	0.95	FALSE	0.00	Above WT
19.69	133.3	77.04	1.100	0.06	1.18	1.18	64.21	1.45	2.16	0.94	69.50	2.14	Sand	Sand	Sand	69.50	2.14	1.52	105.77	0.19	0.32	0.95	FALSE	0.00	Above WT
19.85	133.2	54.80	0.767	0.06	1.19	1.19	45.01	1.43	2.28	0.93	49.24	2.25	Sand	Sand	Sand	49.24	2.25	1.79	88.22	0.14	0.32	0.95	FALSE	0.00	Above WT
20.01	133.0	41.28	0.541	0.06	1.20	1.20	33.38	1.35	2.37	0.93	36.94	2.33	Sand	Sand	Sand	36.94	2.33	2.06	76.07	0.12	0.32	0.95	FALSE	0.00	Above WT
20.18	132.8	33.87	0.447	0.06	1.21	1.21	26.97	1.37	2.45	0.93	30.18	2.41	Sand	Sand	Sand	30.18	2.41	2.35	70.82	0.11	0.32	0.95	FALSE	0.00	Above WT
20.34	132.7	29.16	0.460	0.06	1.22	1.22	22.89	1.65	2.55	0.92	25.88	2.51	Sand	Sand	Sand	25.88	2.51	2.81	72.86	0.12	0.32	0.95	FALSE	0.00	Above WT
20.51	132.5	30.22	0.438	0.06	1.23	1.23	23.56	1.51	2.52	0.92	26.71	2.48	Sand	Sand	Sand	26.71	2.48	2.65	70.81	0.11	0.32	0.95	FALSE	0.00	Above WT
20.67	132.3	30.60	0.472	0.06	1.24	1.24	23.67	1.61	2.53	0.92	26.94	2.49	Sand	Sand	Sand	26.94	2.49	2.71	73.05	0.12	0.32	0.95	FALSE	0.00	Above WT
20.83	132.2	30.01	0.624	0.06	1.25	1.25	23.01	2.17	2.62	Clay	Clay	Clay	Clay	Clay	Clay	23.01	2.62	3.45	79.44	0.13	0.32	0.95	FALSE	0.00	Above WT

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	CQ2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
21.00	132.0	31.99	0.779	0.06	1.26	1.26	24.39	2.54	2.64	Clay	Clay	Clay	Clay	Clay	Clay	24.39	2.64	3.59	87.51	0.14	0.32	0.95	FALSE	0.00	Above WT
21.16	131.8	35.75	0.665	0.06	1.27	1.27	27.16	1.93	2.53	0.91	31.11	2.48	Sand	Sand	Sand	31.11	2.48	2.69	83.78	0.13	0.32	0.95	FALSE	0.00	Above WT
21.33	131.7	36.47	0.688	0.06	1.28	1.28	27.50	1.96	2.53	0.90	31.61	2.48	Sand	Sand	Sand	31.61	2.48	2.68	84.86	0.14	0.32	0.95	FALSE	0.00	Above WT
21.49	131.5	40.25	0.674	0.06	1.29	1.29	30.22	1.73	2.47	0.90	34.76	2.42	Sand	Sand	Sand	34.76	2.42	2.39	83.00	0.13	0.32	0.95	FALSE	0.00	Above WT
21.65	131.4	44.72	0.689	0.06	1.30	1.30	33.43	1.59	2.41	0.89	38.48	2.36	Sand	Sand	Sand	38.48	2.36	2.16	82.99	0.13	0.32	0.95	FALSE	0.00	Above WT
21.82	131.2	49.54	0.689	0.06	1.31	1.31	36.84	1.43	2.35	0.89	42.46	2.30	Sand	Sand	Sand	42.46	2.30	1.94	82.53	0.13	0.32	0.95	FALSE	0.00	Above WT
21.98	131.0	52.06	0.681	0.06	1.32	1.32	38.48	1.34	2.32	0.89	44.45	2.27	Sand	Sand	Sand	44.45	2.27	1.84	82.01	0.13	0.32	0.95	FALSE	0.00	Above WT
22.15	130.9	50.86	0.662	0.06	1.33	1.33	37.27	1.34	2.33	0.88	43.26	2.27	Sand	Sand	Sand	43.26	2.27	1.87	80.94	0.13	0.32	0.95	FALSE	0.00	Above WT
22.31	130.7	50.26	0.615	0.06	1.34	1.34	36.55	1.26	2.32	0.88	42.60	2.26	Sand	Sand	Sand	42.60	2.26	1.84	78.39	0.12	0.32	0.95	FALSE	0.00	Above WT
22.47	130.5	47.75	0.511	0.06	1.35	1.35	34.42	1.10	2.31	0.88	40.33	2.25	Sand	Sand	Sand	40.33	2.25	1.80	72.64	0.12	0.32	0.95	FALSE	0.00	Above WT
22.64	130.4	43.28	0.442	0.06	1.36	1.36	30.86	1.05	2.34	0.87	36.41	2.28	Sand	Sand	Sand	36.41	2.28	1.88	68.42	0.11	0.32	0.95	FALSE	0.00	Above WT
22.80	130.2	38.11	0.549	0.06	1.37	1.37	26.86	1.49	2.47	0.87	31.95	2.41	Sand	Sand	Sand	31.95	2.41	2.35	75.20	0.12	0.32	0.95	FALSE	0.00	Above WT
22.97	130.0	37.99	0.564	0.06	1.38	1.38	26.56	1.54	2.48	0.87	31.73	2.42	Sand	Sand	Sand	31.73	2.42	2.40	76.05	0.12	0.32	0.95	FALSE	0.00	Above WT
23.13	129.9	42.53	0.546	0.06	1.39	1.39	29.65	1.33	2.41	0.87	35.40	2.34	Sand	Sand	Sand	35.40	2.34	2.10	74.25	0.12	0.32	0.95	FALSE	0.00	Above WT
23.29	129.7	47.34	0.522	0.06	1.40	1.40	32.88	1.14	2.33	0.86	39.27	2.27	Sand	Sand	Sand	39.27	2.27	1.85	72.72	0.12	0.32	0.95	FALSE	0.00	Above WT
23.46	129.5	51.10	0.505	0.06	1.41	1.41	35.30	1.02	2.28	0.86	42.23	2.22	Sand	Sand	Sand	42.23	2.22	1.71	72.02	0.11	0.32	0.95	FALSE	0.00	Above WT
23.62	129.4	52.95	0.529	0.06	1.42	1.42	36.36	1.03	2.27	0.86	43.61	2.21	Sand	Sand	Sand	43.61	2.21	1.68	73.36	0.12	0.32	0.94	FALSE	0.00	Above WT
23.79	129.2	55.33	0.548	0.06	1.43	1.43	37.76	1.02	2.26	0.85	45.41	2.19	Sand	Sand	Sand	45.41	2.19	1.64	74.51	0.12	0.32	0.94	FALSE	0.00	Above WT
23.95	129.1	57.50	0.550	0.06	1.44	1.44	39.01	0.98	2.24	0.85	47.04	2.17	Sand	Sand	Sand	47.04	2.17	1.59	74.84	0.12	0.32	0.94	FALSE	0.00	Above WT
24.11	128.9	59.36	0.560	0.06	1.45	1.45	40.03	0.97	2.22	0.85	48.40	2.15	Sand	Sand	Sand	48.40	2.15	1.56	75.55	0.12	0.32	0.94	FALSE	0.00	Above WT
24.28	128.7	55.31	0.478	0.06	1.46	1.46	36.97	0.89	2.23	0.84	44.94	2.16	Sand	Sand	Sand	44.94	2.16	1.58	70.79	0.11	0.32	0.94	FALSE	0.00	Above WT
24.44	128.6	49.09	0.540	0.06	1.47	1.47	32.48	1.13	2.34	0.84	39.75	2.26	Sand	Sand	Sand	39.75	2.26	1.84	73.01	0.12	0.32	0.94	FALSE	0.00	Above WT
24.61	128.4	54.73	0.603	0.06	1.48	1.48	36.06	1.13	2.30	0.84	44.16	2.23	Sand	Sand	Sand	44.16	2.23	1.73	76.48	0.12	0.32	0.94	FALSE	0.00	Above WT
24.77	128.2	66.79	0.709	0.06	1.49	1.49	43.94	1.09	2.22	0.84	53.72	2.15	Sand	Sand	Sand	53.72	2.15	1.54	82.94	0.13	0.32	0.94	FALSE	0.00	Above WT
24.93	128.1	74.97	0.787	0.06	1.50	1.50	49.12	1.07	2.17	0.83	60.11	2.10	Sand	Sand	Sand	60.11	2.10	1.46	87.76	0.14	0.32	0.94	FALSE	0.00	Above WT
25.10	127.9	81.77	0.853	0.06	1.51	1.51	53.30	1.06	2.14	0.83	65.34	2.07	Sand	Sand	Sand	65.34	2.07	1.41	91.85	0.15	0.32	0.94	FALSE	0.00	Above WT
25.26	127.7	89.12	0.966	0.06	1.52	1.52	57.80	1.10	2.12	0.83	70.98	2.05	Sand	Sand	Sand	70.98	2.05	1.38	97.64	0.17	0.32	0.94	FALSE	0.00	Above WT
25.43	127.6	97.37	1.062	0.06	1.53	1.53	62.82	1.11	2.10	0.83	77.30	2.03	Sand	Sand	Sand	77.30	2.03	1.33	103.13	0.18	0.32	0.94	FALSE	0.00	Above WT
25.59	127.4	100.30	1.101	0.06	1.54	1.54	64.32	1.11	2.09	0.82	79.37	2.02	Sand	Sand	Sand	79.37	2.02	1.32	105.10	0.19	0.32	0.94	FALSE	0.00	Above WT
25.75	127.3	98.98	1.178	0.06	1.55	1.55	63.06	1.21	2.12	0.82	78.08	2.05	Sand	Sand	Sand	78.08	2.05	1.36	106.53	0.19	0.32	0.94	FALSE	0.00	Above WT
25.92	127.1	95.97	1.232	0.06	1.56	1.56	60.71	1.30	2.15	0.82	75.46	2.08	Sand	Sand	Sand	75.46	2.08	1.42	106.89	0.19	0.32	0.94	FALSE	0.00	Above WT
26.08	126.9	97.30	1.282	0.06	1.56	1.56	61.18	1.34	2.16	0.82	76.27	2.08	Sand	Sand	Sand	76.27	2.08	1.42	108.52	0.20	0.32	0.94	FALSE	0.00	Above WT
26.25	126.8	108.40	1.349	0.06	1.58	1.58	67.83	1.26	2.10	0.81	84.70	2.03	Sand	Sand	Sand	84.70	2.03	1.34	113.69	0.22	0.32	0.94	FALSE	0.00	Above WT
26.41	126.6	111.07	1.381	0.06	1.58	1.58	69.09	1.26	2.10	0.81	86.52	2.02	Sand	Sand	Sand	86.52	2.02	1.33	115.23	0.22	0.32	0.94	FALSE	0.00	Above WT
26.57	126.4	95.65	1.371	0.06	1.59	1.59	59.00	1.46	2.19	0.81	74.28	2.11	Sand	Sand	Sand	74.28	2.11	1.48	110.07	0.20	0.32	0.94	FALSE	0.00	Above WT
26.74	126.3	81.52	1.356	0.06	1.60	1.60	49.81	1.70	2.29	0.81	63.11	2.21	Sand	Sand	Sand	63.11	2.21	1.70	106.98	0.19	0.32	0.94	FALSE	0.00	Above WT
26.90	126.1	77.20	1.499	0.06	1.61	1.61	46.83	1.98	2.35	0.80	59.59	2.27	Sand	Sand	Sand	59.59	2.27	1.87	111.45	0.21	0.32	0.94	FALSE	0.00	Above WT
27.07	125.9	72.66	1.568	0.06	1.62	1.62	43.74	2.21	2.41	0.80	55.91	2.33	Sand	Sand	Sand	55.91	2.33	2.04	113.88	0.22	0.32	0.94	FALSE	0.00	Above WT
27.23	125.8	69.51	1.606	0.06	1.63	1.63	41.54	2.37	2.44	0.80	53.33	2.36	Sand	Sand	Sand	53.33	2.36	2.16	115.41	0.22	0.32	0.94	FALSE	0.00	Above WT
27.40	125.6	65.85	1.548	0.06	1.64	1.64	39.05	2.41	2.47	0.80	50.36	2.39	Sand	Sand	Sand	50.36	2.39	2.26	113.60	0.22	0.32	0.94	FALSE	0.00	Above WT
27.56	125.4	63.58	1.354	0.06	1.65	1.65	37.45	2.19	2.46	0.79	48.48	2.37	Sand	Sand	Sand	48.48	2.37	2.19	106.39	0.19	0.32	0.94	FALSE	0.00	Above WT
27.72	125.3	63.48	1.396	0.06	1.66	1.66	37.17	2.26	2.47	0.79	48.27	2.38	Sand	Sand	Sand	48.27	2.38	2.24	107.89	0.20	0.32	0.94	FALSE	0.00	Above WT
27.89	125.1	62.61	1.464	0.06	1.67	1.67	36.41	2.40	2.49	0.79	47.46	2.40	Sand	Sand	Sand	47.46	2.40	2.33	110.54	0.21	0.32	0.93	FALSE	0.00	Above WT
28.05	125.0	61.53	1.557	0.06	1.68	1.68	35.56	2.60	2.52	0.79	46.51	2.43	Sand	Sand	Sand	46.51	2.43	2.46	114.18	0.22	0.32	0.93	FALSE	0.00	Above WT
28.22	124.8	56.92	1.754	0.06	1.69	1.69	32.62	3.18	2.61	Clay	Clay	Clay	Clay	Clay	Clay	32.62	2.61	3.37	109.78	0.20	0.32	0.93	FALSE	0.00	Above WT
28.38	124.6	47.93	1.846	0.06	1.70	1.70	27.15	3.99	2.73	Clay	Clay	Clay	Clay	Clay	Clay	27.15	2.73	4.23	114.96	0.22	0.32	0.93	FALSE	0.00	Above WT
28.54	124.5	46.81	1.600	0.06	1.71	1.71	26.34	3.55	2.71	Clay	Clay	Clay	Clay	Clay	Clay	26.34	2.71	4.05	106.76	0.19	0.32	0.93	FALSE	0.00	Above WT
28.71	124.3	56.08	1.396	0.06	1.72	1.72	31.56	2.57	2.56	0.78	41.90	2.46	Sand	Sand	Sand	41.90	2.46	2.59	108.60	0.20	0.32	0.93	FALSE	0.00	Above WT
28.87	124.1	64.99	1.347	0.06	1.73	1.73	36.52	2.13	2.46	0.77	48.42	2.36	Sand	Sand	Sand	48.42	2.36	2.17	104.92	0.19	0.32	0.93	FALSE	0.00	Above WT
29.04	124.0	70.79	1.454	0.06	1.74	1.74	39.63	2.11	2.43	0.77	52.59	2.33	Sand	Sand	Sand	52.59	2.33	2.06	108.22	0.20	0.32	0.93	FALSE	0.00	Above WT
29.20	123.8	74.68	1.537	0.06	1.75	1.75	41.63	2.11	2.41	0.77	55.32	2.32	Sand	Sand	Sand	55.32	2.32	2.00	110.80	0.21	0.31	0.93	FALSE	0.00	Above WT
29.36	123.6	77.07	1.575	0.06	1.76	1.76	42.75	2.09	2.40	0.77	56.94	2.30	Sand	Sand	Sand	56.94	2.30	1.96	111.88	0.21	0.31	0.93	FALSE	0.00	Above WT
29.53	123.5	79.58	1.628	0.06	1.77	1.77	43.91	2.09	2.39	0.77	58.62	2.30	Sand	Sand	Sand	58.62	2.30	1.94	113.44	0.22	0.31	0.93	FALSE	0.00	Above WT
29.69	123.3	82.47	1.661	0.06	1.78	1.78	45.30	2.06	2.38	0.76	60.59	2.28	Sand	Sand	Sand	60.59	2.28	1.89	114.34	0.22	0.31	0.93	FALSE	0.00	Above WT
29.86	123.1	85.46	1.698	0.06	1.79	1.79	46.70	2.03	2.36	0.76	62.61	2.27	Sand	Sand	Sand	62.61	2.27	1.84	115.39	0.22	0.31	0.93	FALSE	0.00	Above WT
30.02	123.0	87.28	1.727	0.06	1.80	1.80	47.46	2.02	2.35	0.76	63.77	2.26	Sand	Sand	Sand	63.77	2.26	1.82	116.21	0.23	0.31	0.93	FALSE	0.00	Above WT
30.18	122.8	88.31	1.724	0.06	1.81	1.81	47.77	1.99	2.35	0.76	64.35	2.25	Sand	Sand	Sand	64.35	2.25	1.80	116.00	0.23	0.31	0.93	FALSE	0.00	Above WT
30.35	122.7	88.80	1.713	0.06	1.82	1.82	47.76	1.97	2.35	0.76	64.53	2.25	Sand	Sand	Sand	64.53	2.25	1.79	115.52	0.22	0.31	0.93	FALSE	0.00	Above WT
30.51	122.5	87.76	1.706	0.06	1.83	1.83	46.94	1.99	2.35	0.75	63.60	2.25	Sand	Sand	Sand	63.60	2.25	1.81	115.12	0.22	0.31	0.93	FALSE	0.00	Above WT
30.68	122.3	84.74	1.668	0.06	1.84	1.84	45.03	2.01	2.37	0.75	61.24	2.27	Sand	Sand	Sand	61.24	2.27	1.86	113.70	0.22	0.31	0.92	FALSE	0.00	Above WT
30.84	122.2	82.15	1.542	0.06	1.85	1.85	43.40	1.92	2.37	0.75	59.22	2.27	Sand	Sand	Sand	59.22	2.27	1.85	109.50	0.20	0.31	0.92	FALSE	0.00	Above WT
31.00	122.0	83.62	1.527	0.06	1.86	1.86	43.96	1.87	2.36	0.75	60.12	2.25	Sand	Sand	Sand	60.12	2.25	1.81	108.90	0.20	0.31	0.92	FALSE	0.00	Above WT
31.17	121.8	78.99	1.547	0.06	1.87	1.87	41.24	2.01	2.40	0.75	56.64	2.29	Sand	Sand	Sand	56.64	2.29	1.93	109.41	0.20	0.31	0.92	FALSE	0.00	Above WT
31.33	121.7	89.25	1.636	0.06	1.88	1.88	46.48	1.87	2.34	0.74	63.83	2.24	Sand	Sand	Sand	63.83	2.24	1.76	112.30	0.21	0.31	0.92	FALSE	0.00	Above WT
31.50	121.5	88.60	1.696	0.06	1.89	1.89	45.88	1.96	2.36	0.74	63.20	2.25	Sand	Sand	Sand	63.20	2.25	1.80	113.98	0.22	0.31	0.92	FALSE	0.00	Above WT
31.66	121.3	86.08	1.801	0.06	1.90	1.90	44.31	2.14	2.39	0.74	61.24	2.29	Sand	Sand	Sand	61.24	2.29	1.91	117.05	0.23	0.31	0.92	FALSE	0.00	Above WT
31.82	121.2	84.57	1.975	0.06	1.91	1.91	43.30	2.39	2.43	0.74	60.02	2.33	Sand	Sand	Sand	60.02	2.33	2.04	122.39	0.25	0.31	0.91	FALSE	0.00	Above WT
31.99	121.0	86.54	2.012	0.06	1.92	1.92	44.09	2.38	2.43	0.74	61.25	2.32	Sand	Sand	Sand	61.25	2.32	2.01	123.27	0.25	0.31	0.91	FALSE	0.00	Above WT
32.15	120.9	106.46	2.003	0.06	1.93	1.93	54.19	1.92	2.30	0.73	75.16	2.19	Sand	Sand	Sand	75.16	2.19	1.64	123.56	0.26	0.31	0.91	FALSE	0.00	Above WT
32.32	120.7	154.25	2.049	0.06	1.94	1.94	78.54	1.35	2.07	0.73	108.62	1.97	Sand	Sand	Sand	108.62	1.97	1.26	136.99	0.32	0.31	0.91	FALSE	0.00	Above WT
32.48	120.5	185.36	2.382	0.06	1.95	1.95	94.11	1.30	2.00	0.73	130.20	1.90	Sand	Sand	Sand	130.20	1.90	1.19	154.96	0.43	0.31	0.91	FALSE	0.00	Above WT
32.64	120.4	204.10	2.908	0.06	1.96	1.96	103.22	1.44	2.00	0.73	143.01	1.90	Sand	Sand	Sand	143.01	1.90	1.19	170.62	0.54	0.31	0.91	FALSE	0.00	Above WT
32.81	120.2	210.14	3.231	0.06	1.97	1.97	105.75	1.55	2.02	0.73	146.86	1.92	Sand	Sand	Sand	146.86	1.92	1.21	177.54	0.60	0.31	0.91	FALSE	0.00	Above WT
32.97	120.0	209.97	3.282	0.06	1.98	1.98	105.14	1.58	2.03	0.73	146.39	1.93	Sand	Sand	Sand	146.39	1.93	1.22	177.88	0.60	0.31	0.91	FALSE	0.00	Above WT
33.14	119.9	208.87	3.279	0.06	1.99	1.99	104.04	1.59	2.03	0.72	145.25	1.93	Sand	Sand	Sand	145.25	1.93	1.22	177.07	0.60	0.31	0.90	FALSE	0.00	Above WT
33.30	119.7	202.63	3.289	0.06	2.00	2.00	100.42	1.64	2.05	0.72	140.57	1.95	Sand	Sand	Sand	140.57	1.95	1.24	174.44	0.57	0.31	0.90	FALSE	0.00	Above WT
33.46	119.5	193.52	3.146	0.06	2.01	2.01	95.39	1.64	2.07	0.72	133.93	1.97	Sand	Sand	Sand	133.93	1.97	1.26	168.47	0.52	0.30	0.90	FALSE	0.00	Above WT
33.63	119.4	178.14	3.048	0.06	2.02	2.02	87.28	1.73	2.11	0.72	122.97	2.01	Sand	Sand	Sand	122.97	2.01	1.31	161.14	0.47	0.30	0.90	FALSE	0.00	Above WT
33.79	119.2	165.61	3.481	0.06	2.03	2.03	80.69	2.13	2.20	0.72	114.05	2.10	Sand	Sand	Sand	114.05	2.10	1.45	165.06	0.50	0.30	0.90	FALSE	0.00	Above WT
33.96	119.0	156.59	3.308	0.06	2.04	2.04	75.85	2.14	2.22	0.71	107.57	2.11	Sand	Sand	Sand	107.57	2.11	1.48	159.45	0.46	0.30	0.90	FALSE	0.00	Above WT
34.12	118.9	179.06	3.078	0.06	2.05	2.05	86.47	1.74	2.12	0.71	122.72	2.01	Sand	Sand	Sand	122.72	2.01	1.31	161.15	0.47	0.30	0.90	FALSE	0.00	Above WT
34.28	118.7	195.01	2.223	0.06	2.06	2.06	93.81	1.15	1.97	0.71	133.34	1.86	Sand	Sand	Sand	133.34	1.86	1.15	153.54	0.42	0.30	0.89	FALSE	0.00	Above WT
34.45	118.6	196.15	2.054	0.06	2.07	2.07	93.90	1.06	1.95	0.71	133.78	1.83	Sand	Sand	Sand	133.78	1.83	1.13	151.22	0.40	0.30	0.89	FALSE	0.00	Above WT
34.61	118.4	171.83	2.174	0.06	2.08	2.08	81.75	1.28	2.05	0.71	116.92	1.93	Sand	Sand	Sand	116.92	1.93	1.22	142.56	0.35	0.30	0.89	FALSE	0.00	Above WT
34.78	118.2	159.44	2.216	0.06	2.09	2.09	75.40	1.41	2.10	0.71	108.23	1.98	Sand	Sand	Sand	108.23	1.98	1.28	138.44	0.33	0.30	0.89	FALSE	0.00	Above WT
34.94	118.1	144.84	2.038	0.06	2.10	2.10	68.09	1.43	2.14	0.70	98.09	2.02	Sand	Sand	Sand	98.09	2.02	1.33	129.99	0.28	0.30	0.89	FALSE	0.00	Above WT
35.10	117.9	125.14	1.588	0.06	2.11	2.11	58.42	1.29	2.16	0.70	84.56	2.04	Sand	Sand	Sand	84.56	2.04	1.35	114.33	0.22	0.30	0.89	FALSE	0.00	Above WT

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	CQ2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
35.27	117.7	96.37	1.354	0.06	2.12	2.12	44.54	1.44	2.28	0.70	64.96	2.15	Sand	Sand	Sand	64.96	2.15	1.56	101.56	0.18	0.30	0.89	FALSE	0.00	Above WT
35.43	117.6	64.96	1.677	0.06	2.13	2.13	29.56	2.67	2.59	0.70	43.69	2.46	Sand	Sand	Sand	43.69	2.46	2.58	112.72	0.21	0.30	0.89	FALSE	0.00	Above WT
35.60	117.4	43.54	1.618	0.06	2.14	2.14	19.38	3.91	2.84	Clay	Clay	Clay	Clay	Clay	Clay	19.38	2.84	5.10	98.94	0.17	0.30	0.88	FALSE	0.00	Above WT
35.76	117.2	31.67	1.631	0.06	2.15	2.15	13.76	5.52	3.05	Clay	Clay	Clay	Clay	Clay	Clay	13.76	3.05	7.28	100.24	0.17	0.30	0.88	FALSE	0.00	Above WT
35.93	117.1	39.65	1.284	0.06	2.16	2.16	17.39	3.43	2.84	Clay	Clay	Clay	Clay	Clay	Clay	17.39	2.84	5.11	88.88	0.15	0.30	0.88	FALSE	0.00	Above WT
36.09	116.9	55.03	1.177	0.06	2.17	2.17	24.41	2.23	2.61	Clay	Clay	Clay	Clay	Clay	Clay	24.41	2.61	3.37	82.18	0.13	0.30	0.88	FALSE	0.00	Above WT
36.25	116.8	68.08	0.955	0.06	2.18	2.18	30.30	1.45	2.42	0.69	45.27	2.28	Sand	Sand	Sand	45.27	2.28	1.89	85.39	0.14	0.30	0.88	FALSE	0.00	Above WT
36.42	116.6	71.83	1.212	0.06	2.19	2.19	31.87	1.74	2.45	0.69	47.65	2.31	Sand	Sand	Sand	47.65	2.31	1.99	94.68	0.16	0.30	0.88	FALSE	0.00	Above WT
36.58	116.4	71.40	1.352	0.06	2.19	2.19	31.53	1.95	2.48	0.69	47.26	2.35	Sand	Sand	Sand	47.26	2.35	2.11	99.59	0.17	0.30	0.88	FALSE	0.00	Above WT
36.75	116.3	66.41	1.448	0.06	2.21	2.21	29.12	2.26	2.55	0.69	43.85	2.41	Sand	Sand	Sand	43.85	2.41	2.36	103.54	0.18	0.30	0.87	FALSE	0.00	Above WT
36.91	116.1	51.34	1.490	0.06	2.21	2.21	22.18	3.03	2.72	Clay	Clay	Clay	Clay	Clay	Clay	22.18	2.72	4.16	92.22	0.15	0.30	0.87	FALSE	0.00	Above WT
37.07	115.9	36.66	1.554	0.06	2.22	2.22	15.48	4.51	2.95	Clay	Clay	Clay	Clay	Clay	Clay	15.48	2.95	6.22	96.35	0.16	0.29	0.87	FALSE	0.00	Above WT
37.24	115.8	33.95	1.521	0.06	2.23	2.23	14.19	4.80	3.00	Clay	Clay	Clay	Clay	Clay	Clay	14.19	3.00	6.72	95.35	0.16	0.29	0.87	FALSE	0.00	Above WT
37.40	115.6	44.46	1.512	0.06	2.24	2.24	18.81	3.58	2.82	Clay	Clay	Clay	Clay	Clay	Clay	18.81	2.82	4.98	93.71	0.16	0.29	0.87	FALSE	0.00	Above WT
37.57	115.4	44.08	1.861	0.06	2.25	2.25	18.55	4.45	2.89	Clay	Clay	Clay	Clay	Clay	Clay	18.55	2.89	5.58	103.46	0.18	0.29	0.87	FALSE	0.00	Above WT
37.73	115.3	39.34	1.979	0.06	2.26	2.26	16.38	5.34	2.98	Clay	Clay	Clay	Clay	Clay	Clay	16.38	2.98	6.52	106.85	0.19	0.29	0.87	FALSE	0.00	Above WT
37.89	115.1	42.82	1.970	0.06	2.27	2.27	17.84	4.86	2.93	Clay	Clay	Clay	Clay	Clay	Clay	17.84	2.93	5.95	106.12	0.19	0.29	0.87	FALSE	0.00	Above WT
38.06	114.9	47.08	1.824	0.06	2.28	2.28	19.62	4.07	2.84	Clay	Clay	Clay	Clay	Clay	Clay	19.62	2.84	5.17	101.46	0.18	0.29	0.86	FALSE	0.00	Above WT
38.22	114.8	54.82	1.450	0.06	2.29	2.29	22.91	2.76	2.69	Clay	Clay	Clay	Clay	Clay	Clay	22.91	2.69	3.89	89.13	0.15	0.29	0.86	FALSE	0.00	Above WT
38.39	114.6	73.91	1.060	0.06	2.30	2.30	31.09	1.48	2.42	0.67	47.75	2.27	Sand	Sand	Sand	47.75	2.27	1.85	88.25	0.14	0.29	0.86	FALSE	0.00	Above WT
38.55	114.5	89.60	0.974	0.06	2.31	2.31	37.74	1.12	2.28	0.67	57.77	2.13	Sand	Sand	Sand	57.77	2.13	1.51	87.02	0.14	0.29	0.86	FALSE	0.00	Above WT
38.71	114.3	100.95	1.041	0.06	2.32	2.32	42.46	1.05	2.22	0.67	64.95	2.07	Sand	Sand	Sand	64.95	2.07	1.41	91.32	0.15	0.29	0.86	FALSE	0.00	Above WT
38.88	114.1	111.38	1.058	0.06	2.33	2.33	46.75	0.97	2.17	0.67	71.51	2.02	Sand	Sand	Sand	71.51	2.02	1.32	94.56	0.16	0.29	0.86	FALSE	0.00	Above WT
39.04	114.0	123.47	1.217	0.06	2.34	2.34	51.71	1.00	2.14	0.67	79.11	1.99	Sand	Sand	Sand	79.11	1.99	1.29	101.91	0.18	0.29	0.86	FALSE	0.00	Above WT
39.21	113.8	143.33	1.493	0.06	2.35	2.35	59.92	1.06	2.10	0.66	91.63	1.96	Sand	Sand	Sand	91.63	1.96	1.25	114.16	0.22	0.29	0.85	FALSE	0.00	Above WT
39.37	113.6	175.07	1.865	0.06	2.36	2.36	73.11	1.08	2.04	0.66	111.70	1.90	Sand	Sand	Sand	111.70	1.90	1.18	132.32	0.30	0.29	0.85	FALSE	0.00	Above WT
39.53	113.5	217.92	2.400	0.06	2.37	2.37	90.88	1.11	1.97	0.66	138.75	1.84	Sand	Sand	Sand	138.75	1.84	1.13	157.23	0.44	0.29	0.85	FALSE	0.00	Above WT
39.70	113.3	266.41	3.081	0.06	2.38	2.38	110.84	1.17	1.92	0.66	169.26	1.79	Sand	Sand	Sand	169.26	1.79	1.10	185.88	0.68	0.29	0.85	FALSE	0.00	Above WT
39.86	113.1	290.88	3.760	0.06	2.39	2.39	120.63	1.30	1.93	0.66	184.44	1.80	Sand	Sand	Sand	184.44	1.80	1.11	203.82	0.87	0.29	0.85	FALSE	0.00	Above WT
40.03	113.0	304.99	4.193	0.06	2.40	2.40	125.98	1.39	1.93	0.66	192.97	1.80	Sand	Sand	Sand	192.97	1.80	1.11	214.23	0.99	0.29	0.85	FALSE	0.00	Above WT
40.19	112.8	293.93	4.212	0.06	2.41	2.41	120.89	1.44	1.96	0.66	185.61	1.83	Sand	Sand	Sand	185.61	1.83	1.13	209.52	0.94	0.29	0.85	FALSE	0.00	Above WT
40.35	112.7	282.61	3.828	0.06	2.42	2.42	115.73	1.37	1.95	0.66	178.10	1.82	Sand	Sand	Sand	178.10	1.82	1.12	200.19	0.83	0.29	0.85	FALSE	0.00	Above WT
40.52	112.5	273.04	3.384	0.06	2.43	2.43	111.31	1.25	1.94	0.65	171.71	1.81	Sand	Sand	Sand	171.71	1.81	1.11	190.73	0.73	0.29	0.84	FALSE	0.00	Above WT
40.68	112.3	256.33	2.781	0.06	2.44	2.44	104.02	1.10	1.92	0.65	160.89	1.78	Sand	Sand	Sand	160.89	1.78	1.10	176.20	0.59	0.28	0.84	FALSE	0.00	Above WT
40.85	112.2	241.34	2.824	0.06	2.45	2.45	97.47	1.18	1.97	0.65	151.16	1.83	Sand	Sand	Sand	151.16	1.83	1.13	170.30	0.54	0.28	0.84	FALSE	0.00	Above WT
41.01	112.0	237.16	2.672	0.06	2.46	2.46	95.38	1.14	1.96	0.65	148.25	1.82	Sand	Sand	Sand	148.25	1.82	1.12	166.40	0.51	0.28	0.84	FALSE	0.00	Above WT
41.17	111.8	247.69	2.895	0.06	2.47	2.47	99.27	1.18	1.96	0.65	154.53	1.82	Sand	Sand	Sand	154.53	1.82	1.12	173.24	0.56	0.28	0.84	FALSE	0.00	Above WT
41.34	111.7	275.15	2.678	0.06	2.48	2.48	109.93	0.98	1.87	0.65	171.31	1.73	Sand	Sand	Sand	171.31	1.73	1.06	181.41	0.64	0.28	0.84	FALSE	0.00	Above WT
41.50	111.5	297.07	2.857	0.06	2.49	2.49	118.31	0.97	1.85	0.65	184.60	1.70	Sand	Sand	Sand	184.60	1.70	1.04	192.15	0.74	0.28	0.84	FALSE	0.00	Above WT
41.67	111.3	302.35	2.946	0.06	2.50	2.50	119.93	0.98	1.85	0.64	187.50	1.70	Sand	Sand	Sand	187.50	1.70	1.04	195.06	0.77	0.28	0.83	FALSE	0.00	Above WT
41.83	111.2	307.50	3.161	0.06	2.51	2.51	121.52	1.04	1.86	0.64	190.33	1.72	Sand	Sand	Sand	190.33	1.72	1.05	199.56	0.82	0.28	0.83	FALSE	0.00	Above WT
41.99	111.0	311.77	3.275	0.06	2.52	2.52	122.75	1.06	1.86	0.64	192.61	1.72	Sand	Sand	Sand	192.61	1.72	1.05	202.36	0.85	0.28	0.83	FALSE	0.00	Above WT
42.16	110.8	303.94	3.407	0.06	2.53	2.53	119.15	1.13	1.89	0.64	187.39	1.75	Sand	Sand	Sand	187.39	1.75	1.07	200.52	0.83	0.28	0.83	FALSE	0.00	Above WT
42.32	110.7	287.26	3.312	0.06	2.54	2.54	112.13	1.16	1.92	0.64	176.77	1.77	Sand	Sand	Sand	176.77	1.77	1.09	192.37	0.74	0.28	0.83	FALSE	0.00	Above WT
42.49	110.5	275.78	3.121	0.06	2.55	2.55	107.17	1.14	1.93	0.64	169.37	1.78	Sand	Sand	Sand	169.37	1.78	1.09	185.16	0.67	0.28	0.83	FALSE	0.00	Above WT
42.65	110.4	278.67	2.922	0.06	2.56	2.56	107.90	1.06	1.90	0.64	170.82	1.76	Sand	Sand	Sand	170.82	1.76	1.08	183.65	0.66	0.28	0.83	FALSE	0.00	Above WT
42.81	110.2	291.66	2.625	0.06	2.57	2.57	112.55	0.91	1.84	0.64	178.45	1.69	Sand	Sand	Sand	178.45	1.69	1.03	184.58	0.66	0.28	0.83	FALSE	0.00	Above WT
42.98	110.0	302.43	2.615	0.06	2.58	2.58	116.28	0.87	1.82	0.64	184.67	1.67	Sand	Sand	Sand	184.67	1.67	1.02	188.13	0.70	0.28	0.82	FALSE	0.00	Above WT
43.14	109.9	313.48	2.601	0.06	2.59	2.59	120.11	0.84	1.80	0.63	191.06	1.65	Sand	Sand	Sand	191.06	1.65	1.00	191.54	0.73	0.28	0.82	FALSE	0.00	Above WT
43.31	109.7	321.71	2.497	0.06	2.60	2.60	122.80	0.78	1.77	0.63	195.69	1.62	Sand	Sand	Sand	195.69	1.62	1.00	195.69	0.78	0.28	0.82	FALSE	0.00	Above WT
43.47	109.5	323.87	2.521	0.06	2.61	2.61	123.17	0.78	1.77	0.63	196.65	1.62	Sand	Sand	Sand	196.65	1.62	1.00	196.65	0.79	0.28	0.82	FALSE	0.00	Above WT
43.64	109.4	325.93	2.653	0.06	2.62	2.62	123.48	0.82	1.78	0.63	197.51	1.63	Sand	Sand	Sand	197.51	1.63	1.00	197.51	0.80	0.28	0.82	FALSE	0.00	Above WT
43.80	109.2	326.77	2.840	0.06	2.63	2.63	123.34	0.88	1.80	0.63	197.66	1.65	Sand	Sand	Sand	197.66	1.65	1.00	198.64	0.81	0.28	0.82	FALSE	0.00	Above WT
43.96	109.0	328.25	2.689	0.06	2.64	2.64	123.45	0.83	1.79	0.63	198.19	1.63	Sand	Sand	Sand	198.19	1.63	1.00	198.19	0.80	0.28	0.82	FALSE	0.00	Above WT
44.13	108.9	321.92	2.699	0.06	2.65	2.65	120.58	0.85	1.80	0.63	193.99	1.65	Sand	Sand	Sand	193.99	1.65	1.00	194.25	0.76	0.28	0.81	FALSE	0.00	Above WT
44.29	108.7	312.46	2.713	0.06	2.66	2.66	116.58	0.88	1.82	0.63	187.95	1.67	Sand	Sand	Sand	187.95	1.67	1.02	190.92	0.73	0.27	0.81	FALSE	0.00	Above WT
44.46	108.5	313.85	2.814	0.06	2.67	2.67	116.65	0.90	1.83	0.62	188.43	1.68	Sand	Sand	Sand	188.43	1.68	1.02	192.57	0.74	0.27	0.81	FALSE	0.00	Above WT
44.62	108.4	311.45	2.856	0.06	2.68	2.68	115.33	0.93	1.84	0.62	186.65	1.69	Sand	Sand	Sand	186.65	1.69	1.03	192.02	0.74	0.27	0.81	FALSE	0.00	Above WT
44.78	108.2	322.82	2.989	0.06	2.69	2.69	119.15	0.93	1.83	0.62	193.12	1.68	Sand	Sand	Sand	193.12	1.68	1.02	197.66	0.80	0.27	0.81	FALSE	0.00	Above WT
44.95	108.1	330.44	3.020	0.06	2.70	2.70	121.52	0.92	1.82	0.62	197.30	1.67	Sand	Sand	Sand	197.30	1.67	1.02	200.50	0.83	0.27	0.81	FALSE	0.00	Above WT
45.11	107.9	334.96	2.888	0.06	2.71	2.71	122.76	0.87	1.80	0.62	199.65	1.65	Sand	Sand	Sand	199.65	1.65	1.00	199.65	0.82	0.27	0.81	FALSE	0.00	Above WT
45.28	107.7	333.25	2.697	0.06	2.72	2.72	121.66	0.82	1.79	0.62	198.26	1.63	Sand	Sand	Sand	198.26	1.63	1.00	198.26	0.80	0.27	0.81	FALSE	0.00	Above WT
45.44	107.6	333.34	2.610	0.06	2.73	2.73	121.26	0.79	1.78	0.62	197.96	1.62	Sand	Sand	Sand	197.96	1.62	1.00	197.96	0.80	0.27	0.80	FALSE	0.00	Above WT
45.60	107.4	335.55	2.650	0.06	2.74	2.74	121.64	0.80	1.78	0.62	198.92	1.62	Sand	Sand	Sand	198.92	1.62	1.00	198.92	0.81	0.27	0.80	FALSE	0.00	Above WT
45.77	107.2	317.01	2.705	0.06	2.75	2.75	114.44	0.86	1.82	0.62	187.58	1.66	Sand	Sand	Sand	187.58	1.66	1.01	189.94	0.72	0.27	0.80	FALSE	0.00	Above WT
45.93	107.1	302.19	2.632	0.06	2.76	2.76	108.66	0.88	1.85	0.61	178.50	1.68	Sand	Sand	Sand	178.50	1.68	1.03	183.44	0.65	0.27	0.80	FALSE	0.00	Above WT
46.10	106.9	285.68	2.470	0.06	2.77	2.77	102.28	0.87	1.87	0.61	168.44	1.70	Sand	Sand	Sand	168.44	1.70	1.04	174.97	0.58	0.27	0.80	FALSE	0.00	Above WT
46.26	106.7	273.86	2.235	0.06	2.78	2.78	97.67	0.82	1.87	0.61	161.19	1.70	Sand	Sand	Sand	161.19	1.70	1.04	167.14	0.51	0.27	0.80	FALSE	0.00	Above WT
46.42	106.6	271.67	2.197	0.06	2.79	2.79	96.54	0.82	1.87	0.61	159.62	1.70	Sand	Sand	Sand	159.62	1.70	1.04	165.57	0.50	0.27	0.80	FALSE	0.00	Above WT
46.59	106.4	278.50	2.173	0.06	2.80	2.80	98.63	0.79	1.85	0.61	163.34	1.68	Sand	Sand	Sand	163.34	1.68	1.03	167.44	0.52	0.27	0.79	FALSE	0.00	Above WT
46.75	106.3	286.00	2.319	0.06	2.81	2.81	100.96	0.82	1.85	0.61	167.45	1.68	Sand	Sand	Sand	167.45	1.68	1.03	172.00	0.55	0.27	0.79	FALSE	0.00	Above WT
46.92	106.1	293.66	2.455	0.06	2.82	2.82	103.31	0.84	1.85	0.61	171.62	1.69	Sand	Sand	Sand	171.62	1.69	1.03	176.42	0.59	0.27	0.79	FALSE	0.00	Above WT
47.08	105.9	293.19	2.507	0.06	2.82	2.82	102.79	0.86	1.86	0.61	171.06	1.69	Sand	Sand	Sand	171.06	1.69	1.03	176.74	0.59	0.27	0.79	FALSE	0.00	Above WT
47.24	105.8	290.06	2.279	0.06	2.83	2.83	101.34	0.79	1.84	0.61	168.94	1.67	Sand	Sand	Sand	168.94	1.67	1.02	172.14	0.55	0.27	0.79	FALSE	0.00	Above WT
47.41	105.6	280.17	2.345	0.06	2.84	2.84	97.49	0.85	1.87	0.60	162.89	1.70	Sand	Sand	Sand	162.89	1.70	1.04	169.34	0.53	0.27	0.79	FALSE	0.00	Above WT
47.57	105.4	257.14	2.241	0.06	2.85	2.85	89.09	0.88	1.92	0.60	149.25	1.74	Sand	Sand	Sand	149.25	1.74	1.07	159.20	0.46	0.27	0.79	FALSE	0.00	Above WT
47.74	105.3	229.16	2.396	0.06	2.86	2.86	79.00	1.06	2.01	0.60	132.77	1.83	Sand	Sand	Sand	132.77	1.83	1.13	150.34	0.40	0.27	0.79	FALSE	0.00	Above WT
47.90	105.1	211.96	2.580	0.06	2.87	2.87	72.75	1.23	2.08	0.60	122.60	1.90	Sand	Sand	Sand	122.60	1.90	1.19	146.31	0.37	0.27	0.78	FALSE	0.00	Above WT
48.06	104.9	201.64	2.757	0.06	2.88	2.88	68.93	1.39	2.13	0.60	116.44	1.96	Sand	Sand	Sand	116.44	1.96	1.25	145.16	0.36	0.26	0.78	FALSE	0.00	Above WT
48.23	104.8	188.79	2.679	0.06	2.89	2.89	64.24	1.44	2.16	0.60	108.82	1.99	Sand	Sand	Sand	108.82	1.99	1.29	139.90	0.33	0.26	0.78	FALSE	0.00	Above WT
48.39	104.6	173.37	2.526	0.06	2.90	2.90	58.71	1.48	2.20	0.60	99.77	2.02	Sand	Sand	Sand	99.77	2.02	1.33	133.02	0.30	0.26	0.78	FALSE	0.00	Above WT
48.56	104.4	168.92	2.375	0.06	2.91	2.91	56.98	1.43	2.20	0.60	97.04	2.02	Sand	Sand	Sand	97.04	2.02	1.33	129.15	0.28	0.26	0.78	FALSE	0.00	Above WT
48.72	104.3	169.72	2.379	0.06	2.92	2.92	57.06	1.43	2.20	0.60	97.34	2.02	Sand	Sand	Sand	97.34	2.02	1.33	129.29	0.28	0.26	0.78	FALSE	0.00	Above WT
48.88	104.1	175.80	2.387	0.06	2.93	2.93	58.94	1.38	2.18	0.60	100.66	2.00	Sand	Sand	Sand	100.66	2.00	1.30	130.94	0.29	0.26	0.78	FALSE	0.00	Above WT
49.05	104.0	183.88	2.513	0.06	2.94	2.94	61.48	1.39	2.16	0.59	105.10	1.99	Sand	Sand	Sand	105.10	1.99	1.29	135.10	0.31	0.26	0.77	FALSE	0.00	Above WT
49.21	103.8	179.33	2.449	0.06	2.95	2.95	59.74	1.39	2.17	0.59	102.34	2.00	Sand	Sand	Sand	102.34	2.00	1.30	132.64	0.30	0.26	0.77	FALSE	0.00	Above WT
49.38	103.6	180.41	2.248	0.06	2.96	2.96	59.89	1.27	2.15	0.59	102.78	1.97	Sand	Sand	Sand	102.78	1.97	1.26	129.61	0.28	0.26	0.77	FALSE	0.00	Above WT

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	CQ2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
49.54	103.5	165.97	2.054	0.06	2.97	2.97	54.84	1.26	2.18	0.59	94.40	1.99	Sand	Sand	Sand	94.40	1.99	1.29	122.06	0.25	0.26	0.77	FALSE	0.00	Above WT
49.70	103.3	123.93	2.115	0.06	2.98	2.98	40.56	1.75	2.37	0.59	70.37	2.18	Sand	Sand	Sand	70.37	2.18	1.63	114.70	0.22	0.26	0.77	FALSE	0.00	Above WT
49.87	103.1	66.71	2.303	0.06	2.99	2.99	21.29	3.61	2.78	Clay	Clay	Clay	Clay	Clay	Clay	21.29	2.78	4.65	98.94	0.17	0.26	0.77	FALSE	0.00	Above WT
50.03	103.0	40.55	1.767	0.06	3.00	3.00	12.51	4.71	3.04	Clay	Clay	Clay	Clay	Clay	Clay	12.51	3.04	7.14	89.37	0.15	0.26	0.77	FALSE	0.00	Above WT
50.20	102.8	27.97	1.290	0.06	3.01	3.01	8.29	5.17	3.20	Clay	Clay	Clay	Clay	Clay	Clay	8.29	3.20	9.27	76.80	0.12	0.26	0.77	FALSE	0.00	Above WT
50.36	102.6	25.33	0.730	0.06	3.02	3.02	7.38	3.27	3.13	Clay	Clay	Clay	Clay	Clay	Clay	7.38	3.13	8.27	61.08	0.10	0.26	0.76	FALSE	0.00	Above WT
50.52	102.5	24.94	0.724	0.06	3.03	3.03	7.23	3.30	3.14	Clay	Clay	Clay	Clay	Clay	Clay	7.23	3.14	8.40	60.72	0.10	0.26	0.76	FALSE	0.00	Above WT
50.69	102.3	26.03	0.859	0.06	3.04	3.04	7.56	3.74	3.15	Clay	Clay	Clay	Clay	Clay	Clay	7.56	3.15	8.58	64.88	0.11	0.26	0.76	FALSE	0.00	Above WT
50.85	102.2	32.71	1.204	0.06	3.05	3.05	9.72	4.06	3.08	Clay	Clay	Clay	Clay	Clay	Clay	9.72	3.08	7.72	75.01	0.12	0.26	0.76	FALSE	0.00	Above WT
51.02	102.0	38.27	2.051	0.06	3.06	3.06	11.50	5.82	3.12	Clay	Clay	Clay	Clay	Clay	Clay	11.50	3.12	8.20	94.34	0.16	0.26	0.76	FALSE	0.00	Above WT
51.18	101.8	41.15	2.378	0.06	3.07	3.07	12.40	6.25	3.12	Clay	Clay	Clay	Clay	Clay	Clay	12.40	3.12	8.13	100.82	0.18	0.26	0.76	FALSE	0.00	Above WT
51.35	101.7	43.76	2.286	0.06	3.08	3.08	13.20	5.62	3.07	Clay	Clay	Clay	Clay	Clay	Clay	13.20	3.07	7.51	99.10	0.17	0.26	0.76	FALSE	0.00	Above WT
51.51	101.5	38.73	1.625	0.06	3.09	3.09	11.53	4.56	3.05	Clay	Clay	Clay	Clay	Clay	Clay	11.53	3.05	7.37	84.98	0.14	0.26	0.75	FALSE	0.00	Above WT
51.67	101.3	30.98	1.666	0.06	3.10	3.10	8.99	5.98	3.21	Clay	Clay	Clay	Clay	Clay	Clay	8.99	3.21	9.42	84.68	0.14	0.25	0.75	FALSE	0.00	Above WT
51.84	101.2	44.29	1.605	0.06	3.11	3.11	13.24	3.90	2.97	Clay	Clay	Clay	Clay	Clay	Clay	13.24	2.97	6.36	84.26	0.14	0.25	0.75	FALSE	0.00	Above WT
52.00	101.0	73.75	1.743	0.06	3.12	3.12	22.64	2.47	2.66	Clay	Clay	Clay	Clay	Clay	Clay	22.64	2.66	3.71	84.01	0.14	0.25	0.75	FALSE	0.00	Above WT
52.17	100.8	75.78	1.978	0.06	3.13	3.13	23.21	2.72	2.68	Clay	Clay	Clay	Clay	Clay	Clay	23.21	2.68	3.83	88.97	0.15	0.25	0.75	FALSE	0.00	Above WT
52.33	100.7	64.07	2.229	0.06	3.14	3.14	19.41	3.66	2.82	Clay	Clay	Clay	Clay	Clay	Clay	19.41	2.82	4.94	95.86	0.16	0.25	0.75	FALSE	0.00	Above WT
52.49	100.5	57.79	2.221	0.06	3.15	3.15	17.35	4.07	2.88	Clay	Clay	Clay	Clay	Clay	Clay	17.35	2.88	5.55	96.29	0.16	0.25	0.75	FALSE	0.00	Above WT
52.66	100.3	81.66	2.220	0.06	3.16	3.16	24.85	2.83	2.66	Clay	Clay	Clay	Clay	Clay	Clay	24.85	2.66	3.74	93.01	0.15	0.25	0.75	FALSE	0.00	Above WT
52.82	100.2	83.71	2.316	0.06	3.17	3.17	25.41	2.88	2.66	Clay	Clay	Clay	Clay	Clay	Clay	25.41	2.66	3.72	94.61	0.16	0.25	0.74	FALSE	0.00	Above WT
52.99	100.0	67.94	2.422	0.06	3.18	3.18	20.37	3.74	2.81	Clay	Clay	Clay	Clay	Clay	Clay	20.37	2.81	4.85	98.84	0.17	0.25	0.74	FALSE	0.00	Above WT
53.15	99.9	56.74	2.183	0.06	3.19	3.19	16.79	4.08	2.90	Clay	Clay	Clay	Clay	Clay	Clay	16.79	2.90	5.66	95.11	0.16	0.25	0.74	FALSE	0.00	Above WT
53.31	99.7	43.16	1.752	0.06	3.20	3.20	12.49	4.38	3.02	Clay	Clay	Clay	Clay	Clay	Clay	12.49	3.02	6.93	86.58	0.14	0.25	0.74	FALSE	0.00	Above WT
53.48	99.5	38.63	1.764	0.06	3.21	3.21	11.04	4.98	3.09	Clay	Clay	Clay	Clay	Clay	Clay	11.04	3.09	7.84	86.53	0.14	0.25	0.74	FALSE	0.00	Above WT
53.64	99.4	51.90	2.049	0.06	3.22	3.22	15.13	4.21	2.94	Clay	Clay	Clay	Clay	Clay	Clay	15.13	2.94	6.11	92.34	0.15	0.25	0.74	FALSE	0.00	Above WT
53.81	99.2	49.20	2.021	0.06	3.23	3.23	14.24	4.40	2.97	Clay	Clay	Clay	Clay	Clay	Clay	14.24	2.97	6.45	91.77	0.15	0.25	0.74	FALSE	0.00	Above WT
53.97	99.0	63.73	2.509	0.06	3.24	3.24	18.68	4.15	2.87	Clay	Clay	Clay	Clay	Clay	Clay	18.68	2.87	5.37	100.28	0.17	0.25	0.73	FALSE	0.00	Above WT
54.13	98.9	52.89	2.550	0.06	3.25	3.25	15.28	5.14	2.99	Clay	Clay	Clay	Clay	Clay	Clay	15.28	2.99	6.66	101.74	0.18	0.25	0.73	FALSE	0.00	Above WT
54.30	98.7	52.69	2.413	0.06	3.26	3.26	15.17	4.88	2.98	Clay	Clay	Clay	Clay	Clay	Clay	15.17	2.98	6.53	99.02	0.17	0.25	0.73	FALSE	0.00	Above WT
54.46	98.5	47.28	2.191	0.06	3.27	3.27	13.47	4.98	3.03	Clay	Clay	Clay	Clay	Clay	Clay	13.47	3.03	7.03	94.72	0.16	0.25	0.73	FALSE	0.00	Above WT
54.63	98.4	41.12	2.109	0.06	3.28	3.28	11.54	5.57	3.11	Clay	Clay	Clay	Clay	Clay	Clay	11.54	3.11	8.03	92.73	0.15	0.25	0.73	FALSE	0.00	Above WT
54.79	98.2	65.46	2.376	0.06	3.29	3.29	18.91	3.82	2.84	Clay	Clay	Clay	Clay	Clay	Clay	18.91	2.84	5.12	96.89	0.16	0.25	0.73	FALSE	0.00	Above WT
54.95	98.1	75.65	2.632	0.06	3.30	3.30	21.95	3.64	2.78	Clay	Clay	Clay	Clay	Clay	Clay	21.95	2.78	4.58	100.47	0.17	0.25	0.73	FALSE	0.00	Above WT
55.12	97.9	75.58	2.821	0.06	3.31	3.31	21.85	3.90	2.80	Clay	Clay	Clay	Clay	Clay	Clay	21.85	2.80	4.75	103.90	0.18	0.25	0.73	FALSE	0.00	Above WT
55.28	97.7	81.90	2.701	0.06	3.32	3.32	23.69	3.44	2.73	Clay	Clay	Clay	Clay	Clay	Clay	23.69	2.73	4.25	100.70	0.17	0.24	0.72	FALSE	0.00	Above WT
55.45	97.6	112.54	2.502	0.06	3.33	3.33	32.83	2.29	2.51	0.56	60.50	2.31	Sand	Sand	Sand	60.50	2.31	1.99	120.32	0.24	0.24	0.72	FALSE	0.00	Above WT
55.61	97.4	140.72	2.506	0.06	3.34	3.34	41.17	1.82	2.37	0.56	75.54	2.17	Sand	Sand	Sand	75.54	2.17	1.61	121.33	0.25	0.24	0.72	FALSE	0.00	Above WT
55.77	97.2	145.82	2.719	0.06	3.35	3.35	42.58	1.91	2.38	0.56	78.17	2.18	Sand	Sand	Sand	78.17	2.18	1.61	126.01	0.27	0.24	0.72	FALSE	0.00	Above WT
55.94	97.1	140.51	3.075	0.06	3.36	3.36	40.86	2.24	2.43	0.56	75.21	2.24	Sand	Sand	Sand	75.21	2.24	1.76	132.65	0.30	0.24	0.72	FALSE	0.00	Above WT
56.10	96.9	121.50	3.230	0.06	3.37	3.37	35.10	2.73	2.54	0.56	64.94	2.34	Sand	Sand	Sand	64.94	2.34	2.10	136.14	0.31	0.24	0.72	FALSE	0.00	Above WT
56.27	96.7	105.56	3.197	0.06	3.38	3.38	30.27	3.13	2.63	Clay	Clay	Clay	Clay	Clay	Clay	30.27	2.63	3.49	105.72	0.19	0.24	0.72	FALSE	0.00	Above WT
56.43	96.6	86.06	3.173	0.06	3.39	3.39	24.42	3.84	2.76	Clay	Clay	Clay	Clay	Clay	Clay	24.42	2.76	4.42	107.81	0.20	0.24	0.71	FALSE	0.00	Above WT
56.59	96.4	98.56	3.633	0.06	3.40	3.40	28.03	3.82	2.71	Clay	Clay	Clay	Clay	Clay	Clay	28.03	2.71	4.06	113.77	0.22	0.24	0.71	FALSE	0.00	Above WT
56.76	96.2	212.50	4.403	0.06	3.41	3.41	61.40	2.11	2.28	0.55	112.91	2.10	Sand	Sand	Sand	112.91	2.10	1.45	163.33	0.49	0.24	0.71	FALSE	0.00	Above WT
56.92	96.1	272.21	4.008	0.06	3.42	3.42	78.71	1.49	2.10	0.55	144.44	1.91	Sand	Sand	Sand	144.44	1.91	1.20	173.49	0.57	0.24	0.71	FALSE	0.00	Above WT
57.09	95.9	295.35	4.334	0.06	3.43	3.43	85.22	1.48	2.08	0.55	156.48	1.89	Sand	Sand	Sand	156.48	1.89	1.18	184.26	0.66	0.24	0.71	FALSE	0.00	Above WT
57.25	95.8	294.45	4.920	0.06	3.44	3.44	84.72	1.69	2.12	0.55	155.79	1.93	Sand	Sand	Sand	155.79	1.93	1.22	189.99	0.72	0.24	0.71	FALSE	0.00	Above WT
57.41	95.6	336.41	5.674	0.06	3.44	3.44	96.66	1.70	2.08	0.55	177.74	1.90	Sand	Sand	Sand	177.74	1.90	1.19	210.68	0.95	0.24	0.71	FALSE	0.00	Above WT
57.58	95.4	364.73	6.279	0.06	3.45	3.45	104.57	1.74	2.06	0.55	192.42	1.88	Sand	Sand	Sand	192.42	1.88	1.17	225.39	1.14	0.24	0.71	FALSE	0.00	Above WT
57.74	95.3	366.94	6.653	0.06	3.46	3.46	104.92	1.83	2.07	0.55	193.31	1.90	Sand	Sand	Sand	193.31	1.90	1.19	229.31	1.20	0.24	0.70	FALSE	0.00	Above WT
57.91	95.1	359.77	7.069	0.06	3.47	3.47	102.54	1.98	2.11	0.55	189.26	1.93	Sand	Sand	Sand	189.26	1.93	1.22	230.66	1.22	0.24	0.70	FALSE	0.00	Above WT
58.07	94.9	360.85	7.128	0.06	3.48	3.48	102.57	1.99	2.11	0.55	189.57	1.93	Sand	Sand	Sand	189.57	1.93	1.22	231.31	1.23	0.24	0.70	FALSE	0.00	Above WT
58.23	94.8	356.35	7.093	0.06	3.49	3.49	100.99	2.01	2.11	0.55	186.94	1.94	Sand	Sand	Sand	186.94	1.94	1.23	229.37	1.20	0.24	0.70	FALSE	0.00	Above WT
58.40	94.6	355.75	5.920	0.06	3.50	3.50	100.53	1.68	2.06	0.54	186.36	1.88	Sand	Sand	Sand	186.36	1.88	1.17	217.89	1.04	0.24	0.70	FALSE	0.00	Above WT
58.56	94.4	369.71	5.616	0.06	3.51	3.51	104.22	1.53	2.02	0.54	193.41	1.84	Sand	Sand	Sand	193.41	1.84	1.14	219.54	1.06	0.24	0.70	FALSE	0.00	Above WT
58.73	94.3	363.80	5.216	0.06	3.52	3.52	102.24	1.45	2.01	0.54	190.04	1.82	Sand	Sand	Sand	190.04	1.82	1.12	213.64	0.99	0.24	0.70	FALSE	0.00	Above WT
58.89	94.1	335.01	4.751	0.06	3.53	3.53	93.81	1.43	2.03	0.54	174.76	1.84	Sand	Sand	Sand	174.76	1.84	1.14	199.30	0.82	0.23	0.69	FALSE	0.00	Above WT
59.06	93.9	334.08	4.489	0.06	3.54	3.54	93.28	1.36	2.02	0.54	174.02	1.83	Sand	Sand	Sand	174.02	1.83	1.13	196.25	0.78	0.23	0.69	FALSE	0.00	Above WT
59.22	93.8	308.57	4.047	0.06	3.55	3.55	85.84	1.33	2.04	0.54	160.52	1.84	Sand	Sand	Sand	160.52	1.84	1.14	183.09	0.65	0.23	0.69	FALSE	0.00	Above WT
59.38	93.6	289.77	3.986	0.06	3.56	3.56	80.33	1.39	2.08	0.54	150.54	1.88	Sand	Sand	Sand	150.54	1.88	1.17	176.07	0.59	0.23	0.69	FALSE	0.00	Above WT
59.55	93.5	279.00	3.795	0.06	3.57	3.57	77.09	1.38	2.09	0.54	144.73	1.89	Sand	Sand	Sand	144.73	1.89	1.18	170.37	0.54	0.23	0.69	FALSE	0.00	Above WT
59.71	93.3	278.81	3.389	0.06	3.58	3.58	76.82	1.23	2.06	0.54	144.44	1.85	Sand	Sand	Sand	144.44	1.85	1.15	165.77	0.50	0.23	0.69	FALSE	0.00	Above WT
59.88	93.1	283.13	2.624	0.06	3.59	3.59	77.80	0.94	1.98	0.54	146.47	1.77	Sand	Sand	Sand	146.47	1.77	1.08	158.70	0.45	0.23	0.69	FALSE	0.00	Above WT
60.04	93.0	303.53	2.728	0.06	3.60	3.60	83.26	0.91	1.95	0.54	156.82	1.74	Sand	Sand	Sand	156.82	1.74	1.06	166.57	0.51	0.23	0.69	FALSE	0.00	Above WT
60.20	92.8	298.79	2.895	0.06	3.61	3.61	81.72	0.98	1.97	0.54	154.16	1.76	Sand	Sand	Sand	154.16	1.76	1.08	166.67	0.51	0.23	0.68	FALSE	0.00	Above WT
60.37	92.6	312.59	2.881	0.06	3.62	3.62	85.30	0.93	1.95	0.54	161.05	1.74	Sand	Sand	Sand	161.05	1.74	1.06	170.95	0.54	0.23	0.68	FALSE	0.00	Above WT
60.53	92.5	262.92	3.206	0.06	3.63	3.63	71.39	1.24	2.08	0.54	135.28	1.87	Sand	Sand	Sand	135.28	1.87	1.17	157.71	0.44	0.23	0.68	FALSE	0.00	Above WT
60.70	92.3	301.96	3.679	0.06	3.64	3.64	81.91	1.23	2.04	0.53	155.15	1.83	Sand	Sand	Sand	155.15	1.83	1.13	175.41	0.58	0.23	0.68	FALSE	0.00	Above WT
60.86	92.1	309.28	4.091	0.06	3.65	3.65	83.70	1.34	2.05	0.53	158.71	1.85	Sand	Sand	Sand	158.71	1.85	1.15	181.81	0.64	0.23	0.68	FALSE	0.00	Above WT
61.02	92.0	321.67	4.297	0.06	3.66	3.66	86.86	1.35	2.04	0.53	164.85	1.84	Sand	Sand	Sand	164.85	1.84	1.14	187.75	0.70	0.23	0.68	FALSE	0.00	Above WT
61.19	91.8	325.08	4.477	0.06	3.67	3.67	87.54	1.39	2.05	0.53	166.36	1.85	Sand	Sand	Sand	166.36	1.85	1.14	190.41	0.72	0.23	0.68	FALSE	0.00	Above WT
61.35	91.7	328.17	4.487	0.06	3.68	3.68	88.15	1.38	2.04	0.53	167.73	1.84	Sand	Sand	Sand	167.73	1.84	1.14	191.33	0.73	0.23	0.67	FALSE	0.00	Above WT
61.52	91.5	305.98	4.441	0.06	3.69	3.69	81.89	1.47	2.09	0.53	156.17	1.88	Sand	Sand	Sand	156.17	1.88	1.17	183.50	0.65	0.23	0.67	FALSE	0.00	Above WT
61.68	91.3	289.92	4.143	0.06	3.70	3.70	77.34	1.45	2.10	0.53	147.78	1.90	Sand	Sand	Sand	147.78	1.90	1.19	175.22	0.58	0.23	0.67	FALSE	0.00	Above WT
61.84	91.2	293.14	3.857	0.06	3.71	3.71	78.00	1.33	2.07	0.53	149.23	1.87	Sand	Sand	Sand	149.23	1.87	1.16	173.08	0.56	0.23	0.67	FALSE	0.00	Above WT
62.01	91.0	307.57	3.693	0.06	3.72	3.72	81.67	1.22	2.03	0.53	156.36	1.82	Sand	Sand	Sand	156.36	1.82	1.13	175.93	0.59	0.23	0.67	FALSE	0.00	Above WT
62.17	90.8	316.28	3.840	0.06	3.73	3.73	83.79	1.23	2.03	0.53	160.58	1.82	Sand	Sand	Sand	160.58	1.82	1.12	180.11	0.62	0.23	0.67	FALSE	0.00	Above WT
62.34	90.7	328.05	4.345	0.06	3.74	3.74	86.70	1.34	2.04	0.53	166.33	1.84	Sand	Sand	Sand	166.33	1.84	1.13	188.73	0.71	0.23	0.67	FALSE	0.00	Above WT
62.50	90.5	333.13	4.461	0.06	3.75	3.75	87.83	1.35	2.04	0.53	168.69	1.84	Sand	Sand	Sand	168.69	1.84	1.13	191.31	0.73	0.22	0.67	FALSE	0.00	Above WT
62.66	90.3	338.92	6.213	0.06	3.76	3.76	89.15	1.85	2.13	0.53	171.40	1.93	Sand	Sand	Sand	171.40	1.93	1.22	209.63	0.94	0.22	0.66	FALSE	0.00	Above WT

Euclid Street Undercrossing (Widen) SP 10-126

LIQUEFACTION ANALYSIS; ACC. = 0.52 g 31-Mar-11 13:35

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
^1C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-023

Emean (%)	75	Sur.=	psf	135	=top of ground el.	Borehole Diamet	8							81	=water table El.		acc. max =	0.52	g	Earthq. M=	7.3			
C_E	1.25					C_B	1.15													Cm=	1.07			

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
-	-	-	-	-	-	-				-	-		-	-	-	-	-	-	-	-		-	-
132.5	135	2.5	0.15	0.15	2.50	2.00	0.75	1.00	0.60	120	2	2	14	0.99	0.34	18	29.0	25	1.00	0.29	0.31	0.92	AboveWT
130	132.5	2.5	0.30	0.30	5.00	1.83	0.75	1.00	0.60	120	2	2	14	0.99	0.33	17	30.0	24	1.00	0.26	0.28	0.85	AboveWT
125	130	5	0.60	0.60	10.00	1.29	0.75	1.20	1.00	120	1	1	6	0.98	0.33	10	30.0	16	1.00	0.18	0.19	0.57	AboveWT
120	125	5	0.90	0.90	15.00	1.05	0.85	1.00	0.60	120	2	2	49	0.97	0.33	38	30.0	48	1.00	high N	high N	LARGE	AboveWT
115	120	5	1.20	1.20	20.00	0.91	0.85	1.20	1.00	120	1	1	6	0.95	0.32	8	30.0	14	0.97	0.15	0.16	0.49	AboveWT
110	115	5	1.50	1.50	25.00	0.82	0.95	1.00	0.60	120	2	2	40	0.94	0.32	27	4.0	27	0.93	0.31	0.31	0.98	AboveWT
105	110	5	1.80	1.80	30.00	0.75	0.95	1.20	1.00	120	1	1	7	0.93	0.31	9	59.0	15	0.89	0.16	0.16	0.50	AboveWT
100	105	5	2.10	2.10	35.00	0.69	1.00	1.00	0.60	120	2	2	23	0.89	0.30	14	40.0	21	0.87	0.23	0.22	0.72	AboveWT
95	100	5	2.40	2.40	40.00	0.65	1.00	1.20	1.00	120	1	1	15	0.85	0.29	17	20.0	22	0.85	0.24	0.21	0.75	AboveWT
90	95	5	2.70	2.70	45.00	0.61	1.00	1.00	0.60	120	2	2	29	0.81	0.27	15	90.0	23	0.82	0.26	0.23	0.83	AboveWT
85	90	5	3.00	3.00	50.00	0.58	1.00	1.20	1.00	120	1	1	35	0.77	0.26	35	4.0	35	0.78	high N	high N	LARGE	AboveWT
80	85	5	3.30	3.14	55.00	0.56	1.00	1.00	0.60	120	2	2	28	0.73	0.26	14	90.0	21	0.77	0.23	0.19	0.74	fines
75	80	5	3.60	3.29	60.00	0.55	1.00	1.20	1.00	120	1	1	23	0.69	0.25	22	25.0	29	0.76	0.36	0.30	1.17	no
70	75	5	3.90	3.43	65.00	0.54	1.00	1.00	0.60	120	2	2	100	0.64	0.25	47	5.0	47	0.76	high N	high N	LARGE	high N
65	70	5	4.20	3.58	70.00	0.53	1.00	1.20	1.00	120	1	1	46	0.60	0.24	42	6.0	42	0.75	high N	high N	LARGE	high N
60	65	5	4.50	3.72	75.00	0.52	1.00	1.00	0.60	120	2	2	86	0.56	0.23	38	3.0	38	0.74	high N	high N	LARGE	high N
55	60	5	4.80	3.86	80.00	0.51	1.00	1.20	1.00	120	1	1	12	0.55	0.23	11	90.0	18	0.73	0.19	0.15	0.65	fines

Euclid Street Undercrossing (Widen) SP 10-126
LIQUEFACTION ANALYSIS; ACC. = 0.52 g 31-Mar-11 13:35

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
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The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-024

Emean (%) 75 Sur.= psf 152.6 =top of ground el. Borehole Diamet 8 81 =water table El. acc. max = 0.52 g Earthq. M= 7.3
C_E 1.25 C_B 1.15 Cm= 1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
147.6	152.6	5	0.30	0.30	5.00	1.83	0.75	1.20	1.00	120	1	1	13	0.99	0.33	31	30.0	40	1.00	high N	high N	LARGE	AboveWT
142.6	147.6	5	0.60	0.60	10.00	1.29	0.75	1.00	0.60	120	2	2	100	0.98	0.33	84	6.0	84	1.00	high N	high N	LARGE	AboveWT
137.6	142.6	5	0.90	0.90	15.00	1.05	0.85	1.20	1.00	120	1	1	24	0.97	0.33	37	25.0	46	1.00	high N	high N	LARGE	AboveWT
132.6	137.6	5	1.20	1.20	20.00	0.91	0.85	1.00	0.60	120	2	2	24	0.95	0.32	16	25.0	22	0.97	0.24	0.25	0.78	AboveWT
127.6	132.6	5	1.50	1.50	25.00	0.82	0.95	1.20	1.00	120	1	1	9	0.94	0.32	12	35.0	19	0.93	0.21	0.21	0.66	AboveWT
122.6	127.6	5	1.80	1.80	30.00	0.75	0.95	1.00	0.60	120	2	2	41	0.93	0.31	25	25.0	32	0.89	high N	high N	LARGE	AboveWT
117.6	122.6	5	2.10	2.10	35.00	0.69	1.00	1.20	1.00	120	1	1	11	0.89	0.30	13	25.0	19	0.87	0.20	0.19	0.63	AboveWT
112.6	117.6	5	2.40	2.40	40.00	0.65	1.00	1.00	0.60	120	2	2	45	0.85	0.29	25	25.0	32	0.85	high N	high N	LARGE	AboveWT
107.6	112.6	5	2.70	2.70	45.00	0.61	1.00	1.20	1.00	120	1	1	17	0.81	0.27	18	25.0	24	0.82	0.27	0.24	0.87	AboveWT
102.6	107.6	5	3.00	3.00	50.00	0.58	1.00	1.00	0.60	120	2	2	28	0.77	0.26	14	65.0	22	0.78	0.24	0.20	0.76	AboveWT
97.6	102.6	5	3.30	3.30	55.00	0.55	1.00	1.20	1.00	120	1	1	16	0.73	0.25	15	80.0	23	0.76	0.26	0.21	0.85	AboveWT
92.6	97.6	5	3.60	3.60	60.00	0.53	1.00	1.00	0.60	120	2	2	100	0.69	0.23	45	70.0	60	0.75	high N	high N	LARGE	AboveWT
87.6	92.6	5	3.90	3.90	65.00	0.51	1.00	1.20	1.00	120	1	1	26	0.64	0.22	23	7.0	23	0.73	0.25	0.20	0.91	AboveWT
82.6	87.6	5	4.20	4.20	70.00	0.49	1.00	1.00	0.60	120	2	2	85	0.60	0.20	36	10.0	37	0.71	high N	high N	LARGE	AboveWT
77.6	82.6	5	4.50	4.34	75.00	0.48	1.00	1.20	1.00	120	1	1	14	0.56	0.20	12	70.0	19	0.71	0.20	0.15	0.78	fines
72.6	77.6	5	4.80	4.49	80.00	0.47	1.00	1.00	0.60	120	2	2	100	0.55	0.20	41	10.0	42	0.70	high N	high N	LARGE	high N
67.6	72.6	5	5.10	4.63	85.00	0.46	1.00	1.20	1.00	120	1	1	51	0.54	0.20	41	4.0	41	0.69	high N	high N	LARGE	high N

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
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Project SR-91 WB widening - Euclid St UC **Project No.** 10-126

By SP **Date** 08-30-11 **Checked By** LCC **Date** 8/30/11 **Sheet** ____ **of** ____

Abutments 1 and 5

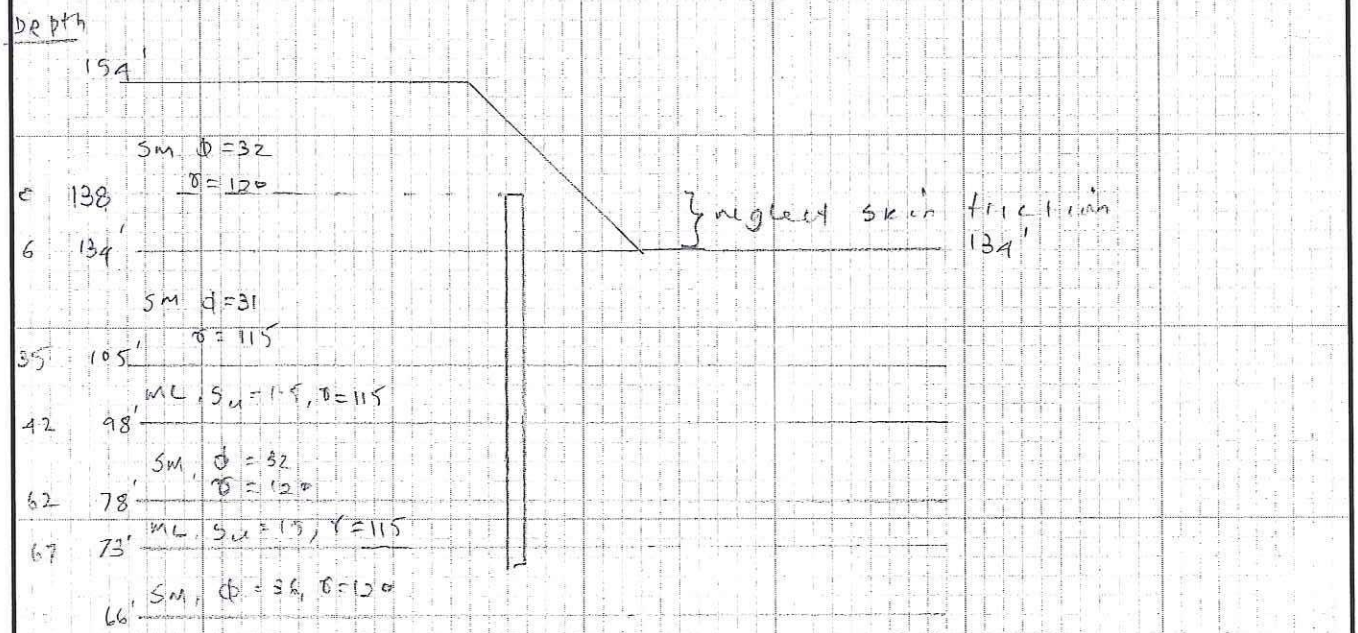
18-inch diameter CIDH piles

Area: $\frac{\pi}{4} \times 18^2 = 254 \text{ in}^2$

perimeter $= \pi \times 18 = 4.712$ ft

$I = \frac{\pi}{64} \times 18^4 = 5153 \text{ in}^4$; $I_{cracked} = 2576 \text{ in}^4$.

$E = 57000\sqrt{8250} = 3.2 \times 10^6 \text{ kip/in}^2$



Maximum load per pile = 90 kips

Nominal resistance = 90 x 2 = 180 kips

Total load per support = 275 kips

Nominal resistance per support = 275 x 2 = 550 kips

flow analysis,

at 42 feet, pile capacity = 1885 kips > 180 kips

pile tip elevation for compression = 138 - 42 = 96 feet

consider 95 feet

Available group nominal resistance = 4 x 0.77 x 183.5

565 kips > 550 kips

Available group nominal resistance exceeds required nominal resistance

pile tip elevation for compression = 95 feet.

SKIN FRICTION FOR DRILLED SHAFT IN BOTH COHESIONLESS AND COHESIVE SOILS USING REESE AND O'NEILL'S METHOD (1999)

PROJECT: Euclid St UC
PROJECT NO.: 10-126
DONE BY: SP DATE: 08/30/11
CHECKED BY: DATE:

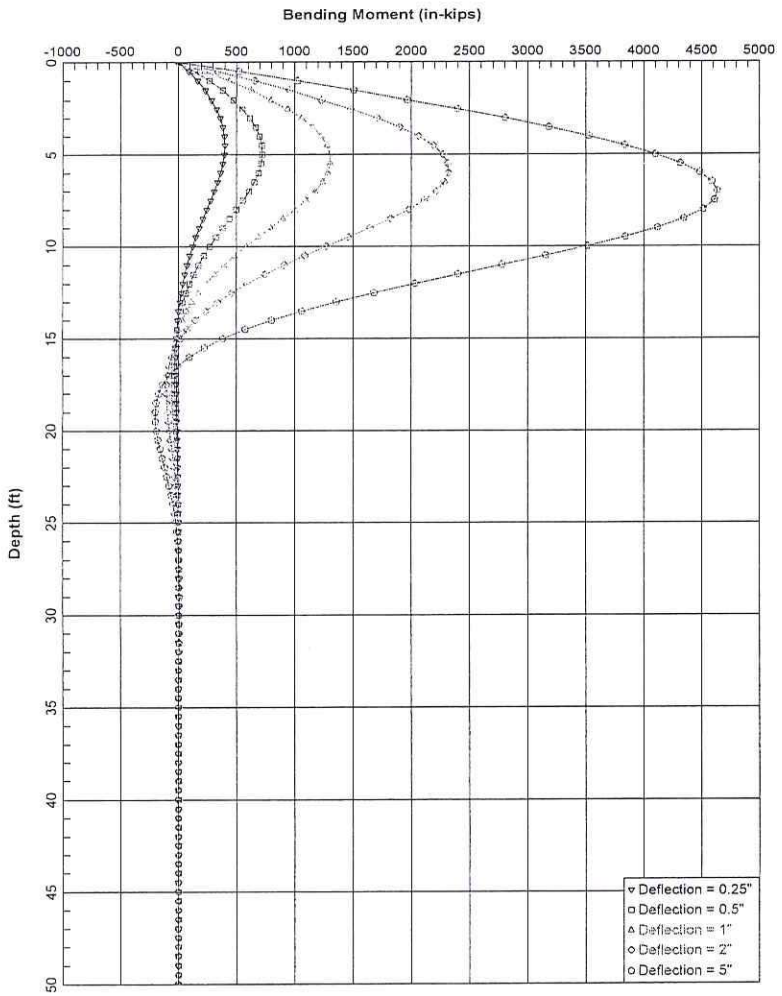
ITEM: 18-inch Diameter CIDH Existing Pile
Abutments 1 and 5

D_s => 1.50 ft Hw => 59.0 ft Hg => 0.0 ft
p = 4.71 ft Ho => 0.0 ft Hf => 0.0 ft

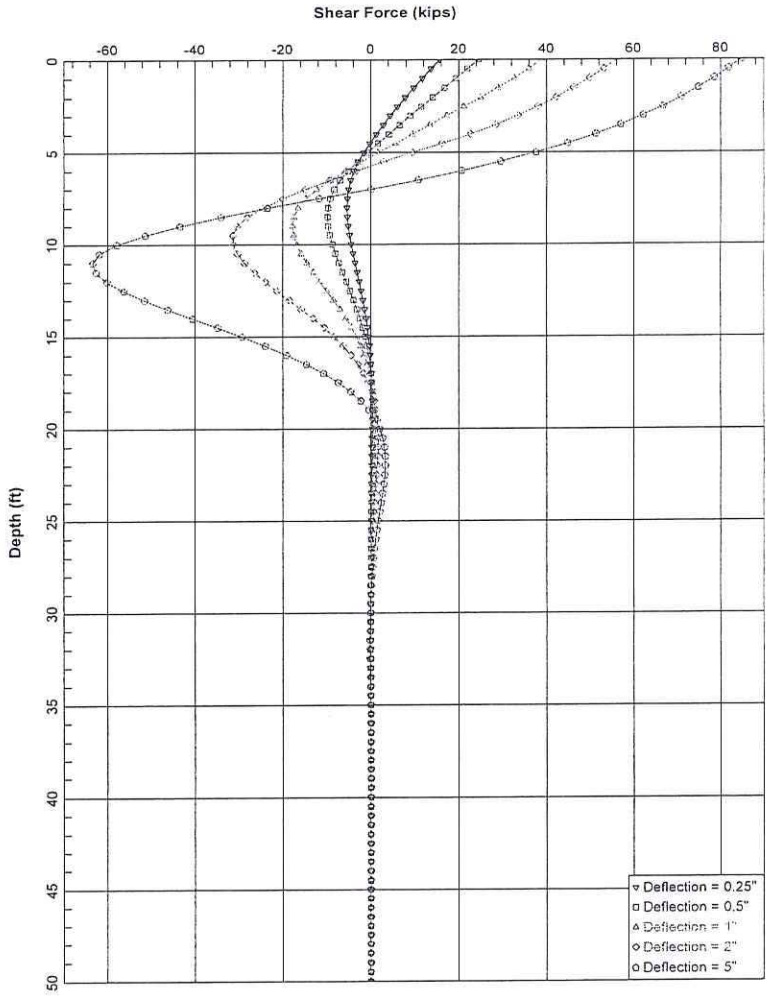
Hw is the depth to water table.
Hg is the depth to ground surface used in calculation.
Ho is the depth to location starting initial overburden pressure
Hf is the depth to location starting accumulation of skin frictio
bottom of footing = 138 ft

Soil Layer =>	from Top	to Bottom =>	γ (pcf)=>	γ' (pcf)=	c' (ksf) =>	ϕ' =>	
(1)	0	13	58	0.0	0.00	31	SM
(2)	13	30	115	52.6	0.00	31	SM
(3)	30	40	115	52.6	1.50	0	ML
(4)	40	58	120	57.6	0.00	32	SM

Sublayer No.	Depth, z (ft)	z_i (ft)	New Depth (ft)	Soil Unit Weight (pcf)	Overburden Pressure (psf)	c' (ksf)	β	f_i^s (ksf)	ΔQ_s^s (kips)	Q_s^s (kips)	f_i^c (ksf)	ΔQ_s^c (kips)	Q_s^c (kips)	Q_s (kips)
0	0.0	0.0	0.0	58.0	0					0.0			0.0	0.0
1	0.0	0.0	0.0	58.0	0	0.0								
2	1.0	0.5	0.5	58.0	29	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
3	2.0	1.5	1.5	58.0	87	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
4	3.0	2.5	2.5	58.0	145	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
5	4.0	3.5	3.5	58.0	203	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
6	5.0	4.5	4.5	58.0	261	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
7	6.0	5.5	5.5	58.0	319	0.0	1.18	0.00	0.0	0.0	0.00	0.0	0.0	0.0
8	7.0	6.5	6.5	58.0	377	0.0	1.16	0.00	0.0	0.0	0.00	0.0	0.0	0.0
9	8.0	7.5	7.5	58.0	435	0.0	1.13	0.00	0.0	0.0	0.00	0.0	0.0	0.0
10	9.0	8.5	8.5	58.0	493	0.0	1.11	0.00	0.0	0.0	0.00	0.0	0.0	0.0
11	10.0	9.5	9.5	58.0	551	0.0	1.08	0.00	0.0	0.0	0.00	0.0	0.0	0.0
12	11.0	10.5	10.5	58.0	609	0.0	1.06	0.00	0.0	0.0	0.00	0.0	0.0	0.0
13	12.0	11.5	11.5	58.0	667	0.0	1.04	0.00	0.0	0.0	0.00	0.0	0.0	0.0
14	13.0	12.5	12.5	58.0	725	0.0	1.02	0.00	0.0	0.0	0.00	0.0	0.0	0.0
15	14.0	13.5	13.5	115.0	840	0.0	1.00	0.84	4.0	4.0	0.00	0.0	0.0	4.0
16	15.0	14.5	14.5	115.0	955	0.0	0.99	0.94	4.4	8.4	0.00	0.0	0.0	8.4
17	16.0	15.5	15.5	115.0	1070	0.0	0.97	1.04	4.9	13.3	0.00	0.0	0.0	13.3
18	17.0	16.5	16.5	115.0	1185	0.0	0.95	1.13	5.3	18.6	0.00	0.0	0.0	18.6
19	18.0	17.5	17.5	115.0	1300	0.0	0.94	1.22	5.7	24.3	0.00	0.0	0.0	24.4
20	19.0	18.5	18.5	115.0	1415	0.0	0.92	1.30	6.1	30.5	0.00	0.0	0.0	30.5
21	20.0	19.5	19.5	115.0	1530	0.0	0.90	1.38	6.5	37.0	0.00	0.0	0.0	37.0
22	21.0	20.5	20.5	115.0	1645	0.0	0.89	1.46	6.9	43.9	0.00	0.0	0.0	43.9
23	22.0	21.5	21.5	115.0	1760	0.0	0.87	1.54	7.2	51.1	0.00	0.0	0.0	51.1
24	23.0	22.5	22.5	115.0	1875	0.0	0.86	1.61	7.6	58.7	0.00	0.0	0.0	58.7
25	24.0	23.5	23.5	115.0	1990	0.0	0.85	1.68	7.9	66.6	0.00	0.0	0.0	66.7
26	25.0	24.5	24.5	115.0	2105	0.0	0.83	1.75	8.3	74.9	0.00	0.0	0.0	74.9
27	26.0	25.5	25.5	115.0	2220	0.0	0.82	1.82	8.6	83.5	0.00	0.0	0.0	83.5
28	27.0	26.5	26.5	115.0	2335	0.0	0.81	1.88	8.9	92.3	0.00	0.0	0.0	92.3
29	28.0	27.5	27.5	115.0	2450	0.0	0.79	1.94	9.1	101.5	0.00	0.0	0.0	101.5
30	29.0	28.5	28.5	115.0	2565	0.0	0.78	2.00	9.4	110.9	0.00	0.0	0.0	110.9
31	30.0	29.5	29.5	115.0	2680	0.0	0.77	2.05	9.7	120.6	0.00	0.0	0.0	120.6
32	31.0	30.5	30.5	115.0	2795	1.5	0.75	0.00	0.0	120.6	0.83	3.9	3.9	124.5
33	32.0	31.5	31.5	115.0	2910	1.5	0.74	0.00	0.0	120.6	0.83	3.9	7.8	128.4
34	33.0	32.5	32.5	115.0	3025	1.5	0.73	0.00	0.0	120.6	0.83	3.9	11.7	132.2
35	34.0	33.5	33.5	115.0	3140	1.5	0.72	0.00	0.0	120.6	0.83	3.9	15.6	136.1
36	35.0	34.5	34.5	115.0	3255	1.5	0.71	0.00	0.0	120.6	0.83	3.9	19.5	140.0
37	36.0	35.5	35.5	115.0	3370	1.5	0.70	0.00	0.0	120.6	0.83	3.9	23.3	143.9
38	37.0	36.5	36.5	115.0	3485	1.5	0.68	0.00	0.0	120.6	0.83	3.9	27.2	147.8
39	38.0	37.5	37.5	115.0	3600	1.5	0.67	0.00	0.0	120.6	0.83	3.9	31.1	151.7
40	39.0	38.5	38.5	115.0	3715	1.5	0.66	0.00	0.0	120.6	0.83	3.9	35.0	155.6
41	40.0	39.5	39.5	115.0	3830	1.5	0.65	0.00	0.0	120.6	0.83	3.9	38.9	159.5
42	41.0	40.5	40.5	120.0	3950	0.0	0.64	2.53	11.9	132.5	0.00	0.0	38.9	171.4
43	42.0	41.5	41.5	120.0	4070	0.0	0.63	2.57	12.1	144.6	0.00	0.0	38.9	183.5
44	43.0	42.5	42.5	120.0	4190	0.0	0.62	2.60	12.2	156.8	0.00	0.0	38.9	195.7
45	44.0	43.5	43.5	120.0	4310	0.0	0.61	2.63	12.4	169.2	0.00	0.0	38.9	208.1
46	45.0	44.5	44.5	120.0	4430	0.0	0.60	2.66	12.5	181.7	0.00	0.0	38.9	220.6



Euclid Street Undercrossing (Widen) 18-inch CIDH at Abutments 1 and 5 (Freehead)



Euclid Street Undercrossing (Widen) 18-inch CIDH at Abutments 1 and 5 (Freehead)

LPile Plus for Windows, Version 6.0 (6.0.09)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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Earth Mechanics, Inc.
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Files Used for Analysis

Path to file locations: X:\Projects\2010\10-126 - RBF, SR 91 Westbound Widening\Reports\Foundation Report\02 Euclid St UC\Analysis\03 Lateral Capacity\
Name of input data file: Euclid St UC 18-inch CIDH (Abutments 1 and 5).lp6d
Name of output file: Euclid St UC 18-inch CIDH (Abutments 1 and 5).lp6o
Name of plot output file: Euclid St UC 18-inch CIDH (Abutments 1 and 5).lp6p
Name of runtime file: Euclid St UC 18-inch CIDH (Abutments 1 and 5).lp6r

Date and Time of Analysis

Date: August 30, 2011 Time: 16:45:22

Problem Title

Project Name:

Job Number:

Client:

Engineer:

Description:

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	100	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections = 1

Total Pile Length = 50.00 ft

Depth of ground surface below top of pile = -3.50 ft

Slope angle of ground surface = 0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over
the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	18.0000000
2	50.000000	18.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	50.000 in
Top Width	=	18.000 in
Bottom Width	=	18.000 in
Top Area	=	254.000000 sq. in
Bottom Area	=	254.000000 sq. in
Moment of Inertia at Top	=	2.576E+03 inA4
Moment of Inertia at Bottom	=	2.576E+03 inA4
Elastic Modulus	=	3200000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 7 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = -3.500 ft
Distance from top of pile to bottom of layer = 2.000 ft
p-y subgrade modulus k for top of soil layer = 70.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 70.000 lbs/in**3

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 2.000 ft
Distance from top of pile to bottom of layer = 31.000 ft
p-y subgrade modulus k for top of soil layer = 60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 60.000 lbs/in**3

Layer 3 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 31.000 ft
Distance from top of pile to bottom of layer = 38.000 ft

Layer 4 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 38.000 ft
Distance from top of pile to bottom of layer = 55.000 ft
p-y subgrade modulus k for top of soil layer = 70.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 70.000 lbs/in**3

Layer 5 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 55.000 ft
Distance from top of pile to bottom of layer = 58.000 ft
p-y subgrade modulus k for top of soil layer = 50.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 50.000 lbs/in**3

Layer 6 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 58.000 ft
Distance from top of pile to bottom of layer = 63.000 ft

Layer 7 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 63.000 ft
Distance from top of pile to bottom of layer = 68.000 ft
p-y subgrade modulus k for top of soil layer = 90.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 90.000 lbs/in**3

(Depth of lowest layer extends 18.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 14 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	-3.50	120.00000
2	2.00	120.00000
3	2.00	115.00000
4	31.00	115.00000
5	31.00	115.00000
6	38.00	115.00000
7	38.00	120.00000
8	55.00	120.00000
9	55.00	57.60000
10	58.00	57.60000
11	58.00	52.40000
12	63.00	52.40000
13	63.00	57.60000
14	68.00	57.60000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. Subgr. pci
1	Sand (Reese, et al.)	-3.500	120.000	--	32.000	--	--	--	70.000	--	--	--	--	--
		2.000	120.000	--	32.000	--	--	--	70.000	--	--	--	--	--
2	Sand (Reese, et al.)	2.000	115.000	--	31.000	--	--	--	60.000	--	--	--	--	--
		31.000	115.000	--	31.000	--	--	--	60.000	--	--	--	--	--
3	Soft Clay	31.000	115.000	1500.000	--	--	--	0.00700	--	--	--	--	--	--
		38.000	115.000	1500.000	--	--	--	0.00700	--	--	--	--	--	--
4	Sand (Reese, et al.)	38.000	120.000	--	32.000	--	--	--	70.000	--	--	--	--	--
		55.000	120.000	--	32.000	--	--	--	70.000	--	--	--	--	--
5	Sand (Reese, et al.)	55.000	57.600	--	32.000	--	--	--	50.000	--	--	--	--	--
		58.000	57.600	--	32.000	--	--	--	50.000	--	--	--	--	--
6	Soft Clay	58.000	52.400	1500.000	--	--	--	0.00700	--	--	--	--	--	--
		63.000	52.400	1500.000	--	--	--	0.00700	--	--	--	--	--	--
7	Sand (Reese, et al.)	63.000	57.600	--	36.000	--	--	--	90.000	--	--	--	--	--
		68.000	57.600	--	36.000	--	--	--	90.000	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.8200	1.0000
2	50.000	0.8200	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	60000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	60000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	60000.000
4	4	y =	2.000 in	M =	0.000 in-lbs	60000.000
5	4	y =	5.000 in	M =	0.000 in-lbs	60000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

---

Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)		Condition 2 in-lb, rad., or in-lb/rad.	Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y = 0.2500	M =	0.000	60000.	0.25000000	401439.	15574.	0.00000000
2	4	y = 0.5000	M =	0.000	60000.	0.50000000	723343.	24460.	0.00000000
3	4	y = 1.0000	M =	0.000	60000.	1.00000000	1303602.	38650.	0.00000000
4	4	y = 2.0000	M =	0.000	60000.	2.00000000	2314915.	56124.	0.00000000
5	4	y = 5.0000	M =	0.000	60000.	5.00000000	4634553.	84783.	0.00000000

Summary of Warning Messages

The following warning was reported 143 times

**** Warning ****

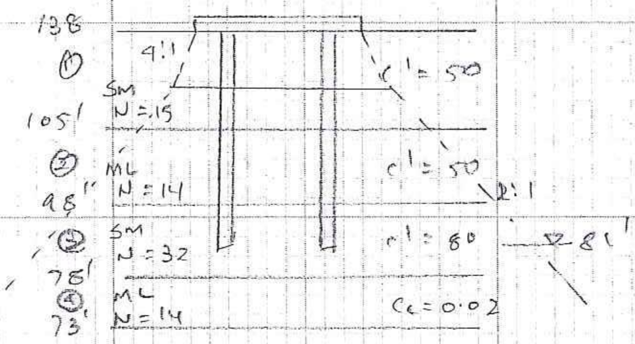
An unreasonable input value for shear strength has been specified for a soil defined using the soft clay criteria. The input value is greater than 8.68 psi (1,250 psf). You should check your input data for correctness.

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering
17800 Newhope Street, Suite B, Fountain Valley, CA 92708
(714) 751-3826, Fax (714) 751-3928

Project SD-91 WB widening - Euclid St UC Project No. 10-126

By SP Date 08-30-11 Checked By LCC Date 8/30/11 Sheet ___ of ___

Abutments settlement



Total load : 275 kips
permanent load = 205 kips
pile cap = 7.5' x 12'

consider pile length D = 12'
2D/3 = 8'

Equivalent footing = (7.5 + 8/4 x 2) x (12 + 8/4 x 2)
= 11.5' x 16'

q = 275 / (11.5 x 16) = 1.5 ksf for Immediate settlement

= 205 / (11.5 x 16) = 1.11 ksf for consolidation settlement

Immediate settlement

σvo	Δσ		settlement
① 20.5 x 115 = 2.36	275 / ((11.5 + 12.5)(16 + 12.5))	= 0.4	25 x 1/50 log((2.36 + 0.4)/2.36) = 0.41
② 36.5 x 115 = 4.2	275 / ((11.5 + 28.5)(16 + 28.5))	= 0.15	7 x 1/50 log((4.2 + 0.15)/4.2) = 0.1
③ 40 x 115 + 10 x 120 = 5.8	275 / ((11.5 + 42)(16 + 42))	= 0.1	20 x 1/80 log((5.8 + 0.1)/5.8) = 0.02
			0.53"

consolidation settlement < 0.1"

pile length is less than 12 feet, settlement is less than 0.55"

no applicable pile length for settlement for Abutments 1&5

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Project SR91 WB Widening - Euclid St UC **Project No.** 10-126

By SP **Date** 08-30-11 **Checked By** LEC **Date** 08/30/11 **Sheet** ____ **of** ____

Bents 2, 3 and 4

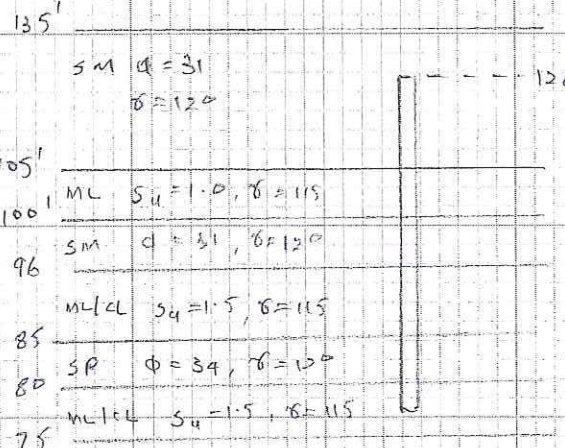
24-inch diameter CIDH piles

Area : $\frac{\pi}{4} \times 24^2 = 452 \text{ in}^2$

Perimeter = $\pi \times 24 = 6.28$ ft

$I = \frac{I}{64} \times 24^4 = 16286 \text{ in}^4$; $I_{cracked} = 8143 \text{ in}^4$

$E = 57000 \cdot \sqrt{3250} = 3.2 \times 10^6 \text{ lb/in}^2$



Nominal resistance per pile

Strength limit state = 155/0.7 = 221 kips
consider 230 kips

Extreme event limit state = 270/1.0 = 270 kips
consider 270 kips
Tension = 185 kips
consider 190 kips

Nominal resistance per support

Strength limit state = 850/0.7 = 1214 kips
Extreme event limit state = 500 kips

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Project SR91 WB widening - Euclid st UC **Project No.** 10-126

By SP **Date** 08-30-11 **Checked By** WC **Date** 8/30/11 **Sheet** ___ **of** ___

for 3d pile spacing
pile group efficiency factor = 0.77
from analysis

Strength limit state

at the depth of 32 feet, pile capacity = 246 kips > 230 kips
pile tip elevation for compression = 128 - 32
= 96 feet.

Available group nominal resistance at pile tip
elevation of 96 feet = 6 x 0.77 x 246
= 1137 kips < 1214 kips

compression capacity needed per pile = $\frac{1214}{6 \times 0.77}$ = 269 kips

at 37 feet, pile capacity = 271 kips

pile tip elevation for compression (strength limit) = 128-37 = 91'
consider 88 feet

Nominal resistance = 270 kips controlled by
per support
demand

Extreme Event Limit state

at 37 feet, pile capacity = 271 kips > 270 kips
pile tip elevation for compression = 128 - 37 = 91'
consider 88 feet
Available group nominal resistance = 6 x 0.77 x 271
1252 kips > 500 kips

Available group nominal resistance exceeds required group nominal resistance for extreme event limit state

pile tip elevation for compression (Extreme event) = 88 ft

at 40 feet, tension capacity = 2(sy287) = 191.3 kips > 190 kips

pile tip elevation for tension (Extreme event) = 128 - 40
= 88 kips

SKIN FRICTION FOR DRILLED SHAFT IN BOTH COHESIONLESS AND COHESIVE SOILS USING REESE AND O'NEILL'S METHOD (1999)

PROJECT: Euclid St UC
ITEM: 24-inch Diameter CIDH Existing Pile
PROJECT NO.: 10-126
Bents 2, 3 and 4
DONE BY: SP DATE: 03/28/11
CHECKED BY: DATE:

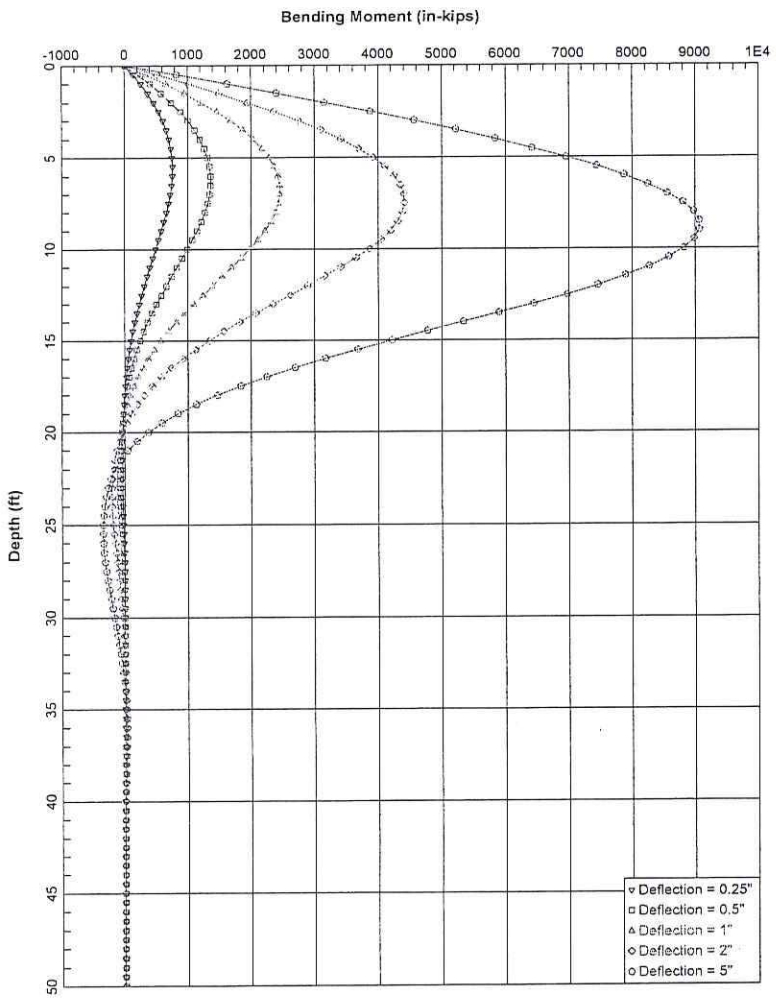
D_s => 2.00 ft Hw => 47.0 ft Hg => 0.0 ft
p = 6.28 ft Ho => 0.0 ft Hf => 0.0 ft

Hw is the depth to water table.
Hg is the depth to ground surface used in calculation.
Ho is the depth to location starting initial overburden pressure
Hf is the depth to location starting accumulation of skin frictio
bottom of footing = 128 feet

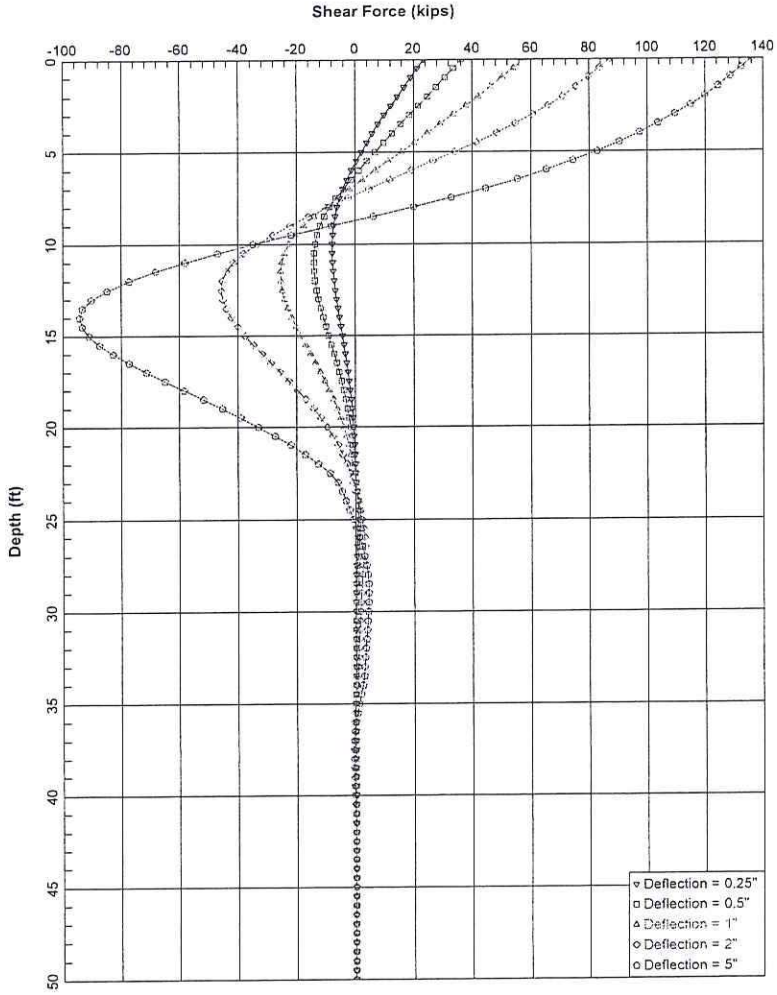
Soil Layer =>	from Top	to Bottom =>	γ (pcf)=>	γ' (pcf)=	c' (ksf) =>	ϕ' =>	
(1)	0	9	120	57.6	0.00	31	SM
(2)	9	23	120	57.6	0.00	31	SM
(3)	23	28	115	52.6	1.00	0	ML
(4)	28	32	120	57.6	0.00	31	SM
(5)	32	43	115	52.6	1.50	0	ML/CL
(6)	43	48	120	57.6	0.00	34	SP

Sublayer No.	Depth, z (ft)	z_i (ft)	New Depth (ft)	Soil Unit Weight (pcf)	Overburden Pressure (psf)	c' (ksf)	β	f_l^s (ksf)	ΔQ_s^s (kips)	Q_s^s (kips)	f_l^c (ksf)	ΔQ_s^c (kips)	Q_s^c (kips)	Q_s (kips)
0	0.0	0.0	0.0	120.0	0									
1	0.0	0.0	0.0	120.0	0	0.0				0.0			0.0	0.0
2	1.0	0.5	0.5	120.0	60	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
3	2.0	1.5	1.5	120.0	180	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
4	3.0	2.5	2.5	120.0	300	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
5	4.0	3.5	3.5	120.0	420	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
6	5.0	4.5	4.5	120.0	540	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
7	6.0	5.5	5.5	120.0	660	0.0	1.18	0.00	0.0	0.0	0.00	0.0	0.0	0.0
8	7.0	6.5	6.5	120.0	780	0.0	1.16	0.00	0.0	0.0	0.00	0.0	0.0	0.0
9	8.0	7.5	7.5	120.0	900	0.0	1.13	0.00	0.0	0.0	0.00	0.0	0.0	0.0
10	9.0	8.5	8.5	120.0	1020	0.0	1.11	0.00	0.0	0.0	0.00	0.0	0.0	0.0
11	10.0	9.5	9.5	120.0	1140	0.0	1.08	1.24	7.8	7.8	0.00	0.0	0.0	7.8
12	11.0	10.5	10.5	120.0	1260	0.0	1.06	1.34	8.4	16.2	0.00	0.0	0.0	16.2
13	12.0	11.5	11.5	120.0	1380	0.0	1.04	1.44	9.0	25.2	0.00	0.0	0.0	25.2
14	13.0	12.5	12.5	120.0	1500	0.0	1.02	1.53	9.6	34.9	0.00	0.0	0.0	34.9
15	14.0	13.5	13.5	120.0	1620	0.0	1.00	1.63	10.2	45.1	0.00	0.0	0.0	45.1
16	15.0	14.5	14.5	120.0	1740	0.0	0.99	1.72	10.8	55.8	0.00	0.0	0.0	55.9
17	16.0	15.5	15.5	120.0	1860	0.0	0.97	1.80	11.3	67.2	0.00	0.0	0.0	67.2
18	17.0	16.5	16.5	120.0	1980	0.0	0.95	1.88	11.8	79.0	0.00	0.0	0.0	79.0
19	18.0	17.5	17.5	120.0	2100	0.0	0.94	1.96	12.3	91.3	0.00	0.0	0.0	91.3
20	19.0	18.5	18.5	120.0	2220	0.0	0.92	2.04	12.8	104.2	0.00	0.0	0.0	104.2
21	20.0	19.5	19.5	120.0	2340	0.0	0.90	2.12	13.3	117.5	0.00	0.0	0.0	117.5
22	21.0	20.5	20.5	120.0	2460	0.0	0.89	2.19	13.7	131.2	0.00	0.0	0.0	131.2
23	22.0	21.5	21.5	120.0	2580	0.0	0.87	2.25	14.2	145.4	0.00	0.0	0.0	145.4
24	23.0	22.5	22.5	120.0	2700	0.0	0.86	2.32	14.6	159.9	0.00	0.0	0.0	160.0
25	24.0	23.5	23.5	115.0	2815	1.0	0.85	0.00	0.0	159.9	0.55	3.5	3.5	163.4
26	25.0	24.5	24.5	115.0	2930	1.0	0.83	0.00	0.0	159.9	0.55	3.5	6.9	166.9
27	26.0	25.5	25.5	115.0	3045	1.0	0.82	0.00	0.0	159.9	0.55	3.5	10.4	170.3
28	27.0	26.5	26.5	115.0	3160	1.0	0.81	0.00	0.0	159.9	0.55	3.5	13.8	173.8
29	28.0	27.5	27.5	115.0	3275	1.0	0.79	0.00	0.0	159.9	0.55	3.5	17.3	177.2
30	29.0	28.5	28.5	120.0	3395	0.0	0.78	2.65	16.6	176.6	0.00	0.0	17.3	193.9
31	30.0	29.5	29.5	120.0	3515	0.0	0.77	2.70	16.9	193.5	0.00	0.0	17.3	210.8
32	31.0	30.5	30.5	120.0	3635	0.0	0.75	2.74	17.2	210.7	0.00	0.0	17.3	228.0
33	32.0	31.5	31.5	120.0	3755	0.0	0.74	2.79	17.5	228.3	0.00	0.0	17.3	245.5
34	33.0	32.5	32.5	115.0	3870	1.5	0.73	0.00	0.0	228.3	0.83	5.2	22.5	250.7
35	34.0	33.5	33.5	115.0	3985	1.5	0.72	0.00	0.0	228.3	0.83	5.2	27.6	255.9
36	35.0	34.5	34.5	115.0	4100	1.5	0.71	0.00	0.0	228.3	0.83	5.2	32.8	261.1

Sublayer No.	Depth, z (ft)	z_i (ft)	New Depth (ft)	Soil Unit Weight (pcf)	Overburden Pressure (psf)	c' (ksf)	β	f_i^s (ksf)	ΔQ_s^s (kips)	Q_s^s (kips)	f_i^c (ksf)	ΔQ_s^c (kips)	Q_s^c (kips)	Q_s (kips)
37	36.0	35.5	35.5	115.0	4215	1.5	0.70	0.00	0.0	228.3	0.83	5.2	38.0	266.3
38	37.0	36.5	36.5	115.0	4330	1.5	0.68	0.00	0.0	228.3	0.83	5.2	43.2	271.4
39	38.0	37.5	37.5	115.0	4445	1.5	0.67	0.00	0.0	228.3	0.83	5.2	48.4	276.6
40	39.0	38.5	38.5	115.0	4560	1.5	0.66	0.00	0.0	228.3	0.83	5.2	53.6	281.8
41	40.0	39.5	39.5	115.0	4675	1.5	0.65	0.00	0.0	228.3	0.83	5.2	58.7	287.0
42	41.0	40.5	40.5	115.0	4790	1.5	0.64	0.00	0.0	228.3	0.83	5.2	63.9	292.2
43	42.0	41.5	41.5	115.0	4905	1.5	0.63	0.00	0.0	228.3	0.83	5.2	69.1	297.4
44	43.0	42.5	42.5	115.0	5020	1.5	0.62	0.00	0.0	228.3	0.83	5.2	74.3	302.6
45	44.0	43.5	43.5	120.0	5140	0.0	0.61	3.13	19.7	247.9	0.00	0.0	74.3	322.2
46	45.0	44.5	44.5	120.0	5260	0.0	0.60	3.15	19.8	267.8	0.00	0.0	74.3	342.1
47	46.0	45.5	45.5	120.0	5380	0.0	0.59	3.17	19.9	287.7	0.00	0.0	74.3	362.0
48	47.0	46.5	46.5	120.0	5500	0.0	0.58	3.19	20.0	307.7	0.00	0.0	74.3	382.0



Euclid Street Undercrossing (Widen) 24-inch CIDH at Bents 2, 3 and 4 (Freehead)



Euclid Street Undercrossing (Widen) 24-inch CIDH at Bents 2, 3 and 4 (Freehead)

LPile Plus for Windows, Version 6.0 (6.0.09)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

(c) 1985-2010 by Ensoft, Inc.
All Rights Reserved

This program is licensed to:

Earth Mechanics, Inc.
Earth Mechanics, Inc.

Files Used for Analysis

Path to file locations: X:\Projects\2010\10-126 - RBF SR 91 Westbound Widening\Reports\Foundation Report\Euclid St UC\Analysis\03 Lateral Capacity\
Name of input data file: Euclid St UC 24-inch CIDH (Bents 2, 3 and 4).lp6d
Name of output file: Euclid St UC 24-inch CIDH (Bents 2, 3 and 4).lp6o
Name of plot output file: Euclid St UC 24-inch CIDH (Bents 2, 3 and 4).lp6p
Name of runtime file: Euclid St UC 24-inch CIDH (Bents 2, 3 and 4).lp6r

Date and Time of Analysis

Date: March 28, 2011 Time: 15:26:11

Problem Title

Project Name:

Job Number:

Client:

Engineer:

Description:

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	100	
- Deflection tolerance for convergence	=	1.0000E-05	in

- Maximum allowable deflection = 100.0000 in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections = 1

Total Pile Length = 50.00 ft

Depth of ground surface below top of pile = -4.00 ft

Slope angle of ground surface = 0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	24.0000000
2	50.000000	24.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	50.000 in
Top Width	=	24.000 in
Bottom Width	=	24.000 in
Top Area	=	452.000000 sq. in
Bottom Area	=	452.000000 sq. in
Moment of Inertia at Top	=	8.143E+03 in^4
Moment of Inertia at Bottom	=	8.143E+03 in^4
Elastic Modulus	=	3200000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 8 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = -4.000 ft
Distance from top of pile to bottom of layer = 23.000 ft
p-y subgrade modulus k for top of soil layer = 60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 60.000 lbs/in**3

Layer 2 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 23.000 ft
Distance from top of pile to bottom of layer = 28.000 ft

Layer 3 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 28.000 ft
Distance from top of pile to bottom of layer = 34.000 ft
p-y subgrade modulus k for top of soil layer = 60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 60.000 lbs/in**3

Layer 4 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 34.000 ft
Distance from top of pile to bottom of layer = 43.000 ft

Layer 5 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 43.000 ft
Distance from top of pile to bottom of layer = 47.000 ft
p-y subgrade modulus k for top of soil layer = 90.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 90.000 lbs/in**3

Layer 6 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 47.000 ft
Distance from top of pile to bottom of layer = 48.000 ft
p-y subgrade modulus k for top of soil layer = 60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 60.000 lbs/in**3

Layer 7 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 48.000 ft
Distance from top of pile to bottom of layer = 53.000 ft

Layer 8 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 53.000 ft
Distance from top of pile to bottom of layer = 60.000 ft
p-y subgrade modulus k for top of soil layer = 90.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 90.000 lbs/in**3

(Depth of lowest layer extends 10.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 16 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	-4.00	120.00000
2	23.00	120.00000
3	23.00	115.00000
4	28.00	115.00000
5	28.00	120.00000
6	34.00	120.00000
7	34.00	115.00000
8	43.00	115.00000
9	43.00	120.00000
10	47.00	120.00000
11	47.00	57.60000
12	48.00	57.60000
13	48.00	52.60000
14	53.00	52.60000
15	53.00	57.60000
16	60.00	57.60000

Summary of Soil Properties

Layer Subgr. Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. pci

1	Sand (Reese, et al.)	-4.000	120.000	--	31.000	--	--	--	60.000	--	--	--	--	--
		23.000	120.000	--	31.000	--	--	--	60.000	--	--	--	--	--
2	Soft Clay	23.000	115.000	1000.000	--	--	--	0.00700	--	--	--	--	--	--
		28.000	115.000	1000.000	--	--	--	0.00700	--	--	--	--	--	--
3	Sand (Reese, et al.)	28.000	120.000	--	31.000	--	--	--	60.000	--	--	--	--	--
		34.000	120.000	--	31.000	--	--	--	60.000	--	--	--	--	--
4	Soft Clay	34.000	115.000	1500.000	--	--	--	0.00700	--	--	--	--	--	--
		43.000	115.000	1500.000	--	--	--	0.00700	--	--	--	--	--	--
5	Sand (Reese, et al.)	43.000	120.000	--	34.000	--	--	--	90.000	--	--	--	--	--
		47.000	120.000	--	34.000	--	--	--	90.000	--	--	--	--	--
6	Sand (Reese, et al.)	47.000	57.600	--	34.000	--	--	--	60.000	--	--	--	--	--
		48.000	57.600	--	34.000	--	--	--	60.000	--	--	--	--	--
7	Soft Clay	48.000	52.600	1500.000	--	--	--	0.00700	--	--	--	--	--	--
		53.000	52.600	1500.000	--	--	--	0.00700	--	--	--	--	--	--
8	Sand (Reese, et al.)	53.000	57.600	--	36.000	--	--	--	90.000	--	--	--	--	--
		60.000	57.600	--	36.000	--	--	--	90.000	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.6800	1.0000
2	50.000	0.6800	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	60000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	60000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	60000.000
4	4	y =	2.000 in	M =	0.000 in-lbs	60000.000
5	4	y =	5.000 in	M =	0.000 in-lbs	60000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

---

Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)	Condition 2 in-lb, rad., or in-lb/rad.	Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y = 0.2500	M = 0.000	60000.	0.25000000	761021.	23332.	0.00000000
2	4	y = 0.5000	M = 0.000	60000.	0.50000000	1365539.	36098.	0.00000000
3	4	y = 1.0000	M = 0.000	60000.	1.00000000	2457998.	57581.	0.00000000
4	4	y = 2.0000	M = 0.000	60000.	2.00000000	4414247.	87064.	0.00000000
5	4	y = 5.0000	M = 0.000	60000.	5.00000000	9068582.	136094.	0.00000000

Summary of Warning Messages

The following warning was reported 210 times

**** Warning ****

An unreasonable input value for shear strength has been specified for a soil defined using the soft clay criteria. The input value is greater than 8.68 psi (1,250 psf). You should check your input data for correctness.

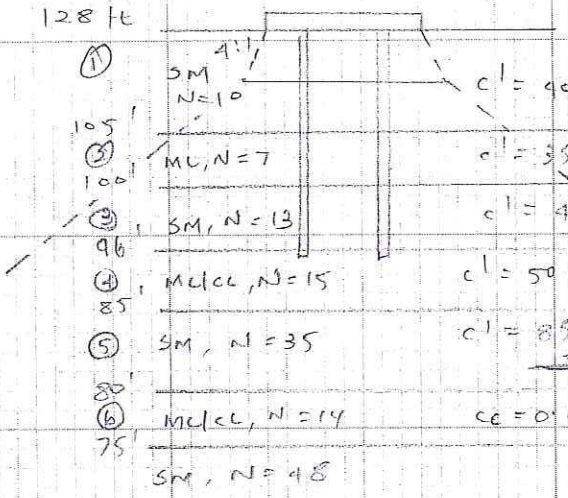
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
(714) 751-3826, Fax (714) 751-3928

Project SR 91 WB Widening - Euclid St UC **Project No.** 10-126

By SP **Date** 03-28-11 **Checked By** LCC **Date** 7/28/11 **Sheet** ____ **of** ____

Bents Settlement



total load = 650 kips
permanent load = 500 kips
pile cap = 10.5' x 16'

consider pile length D = 15'
20/3 = 10'

equivalent footing = $(10.5 + \frac{10}{4} \times 2) \times (16.0 + \frac{10}{4} \times 2)$

$= 15.5 \times 21.0'$

$q = \frac{650}{15.5 \times 21} = 2$ ksf for immediate settlement

$= \frac{500}{15.5 \times 21} = 1.54$ ksf for consolidation settlement

Immediate settlement

	σ_{vo}	$\Delta\sigma$	settlement
①	$16.5 \times 120 = 1.98$	$\frac{650}{(15.5+6.5)(21.0+6.5)} = 1.07$	$13 \times \frac{1}{40} \log\left(\frac{1.98+1.07}{1.98}\right) = 0.14$
②	$23 \times 120 + 2.5 \times 115 = 3.05$	$\frac{650}{(15.5+15.5)(21.0+15.5)} = 0.58$	$5 \times \frac{1}{35} \log\left(\frac{3.05+0.58}{3.05}\right) = 0.12$
③	$26 \times 120 + 5 \times 115 = 3.7$	$\frac{650}{(15.5+21)(21.0+21)} = 0.42$	$4 \times \frac{1}{45} \log\left(\frac{3.7+0.42}{3.7}\right) = 0.07$
④	$29 \times 120 + 9.5 \times 115 = 4.57$	$\frac{650}{(15.5+28.5)(21.0+28.5)} = 0.30$	$11 \times \frac{1}{50} \log\left(\frac{4.57+0.3}{4.57}\right) = 0.06$
⑤	$31.5 \times 120 + 14 \times 115 = 5.39$	$\frac{650}{(15.5+35.5)(21.0+35.5)} = 0.23$	$5 \times \frac{1}{85} \log\left(\frac{5.39+0.23}{5.39}\right) = 0.01$

$= 1.01''$

consolidation settlement $= 5 \times 0.02 \log\left(\frac{5.76+0.19}{5.76}\right) = 0.02''$

total settlement = 1.03"

pile tip elevation for settlement = 128 - 15

= 113 feet

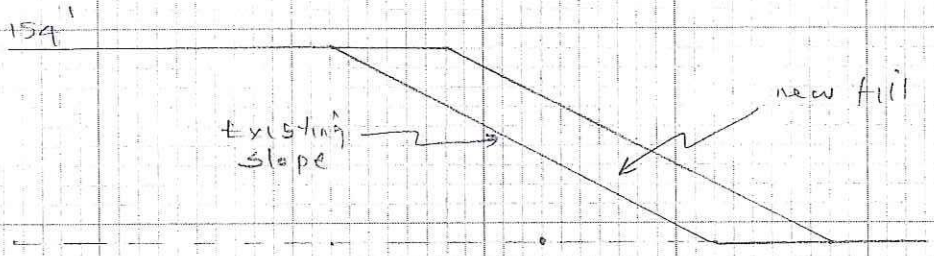
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

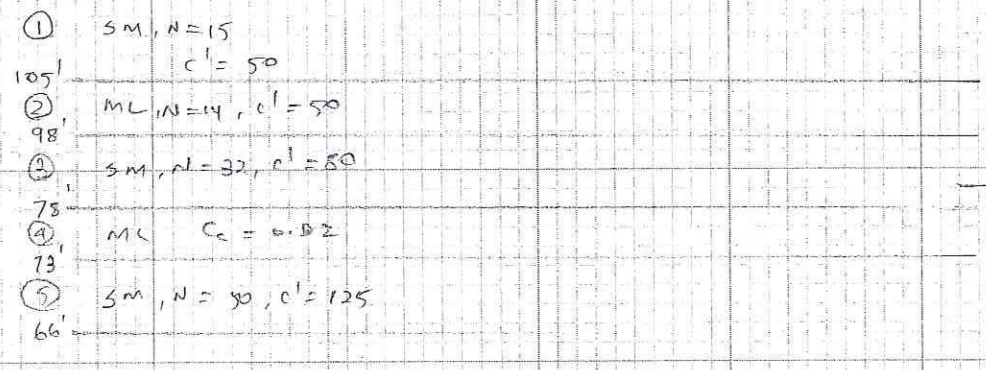
17800 Newhope Street, Suite B, Fountain Valley, CA 92708
(714) 751-3826, Fax (714) 751-3928

Project SR-91 WB widening - Euclid St UC **Project No.** 10-126

By SP **Date** 03-28-11 **Checked By** LCC **Date** 3/28/11 **Sheet** ____ **of** ____

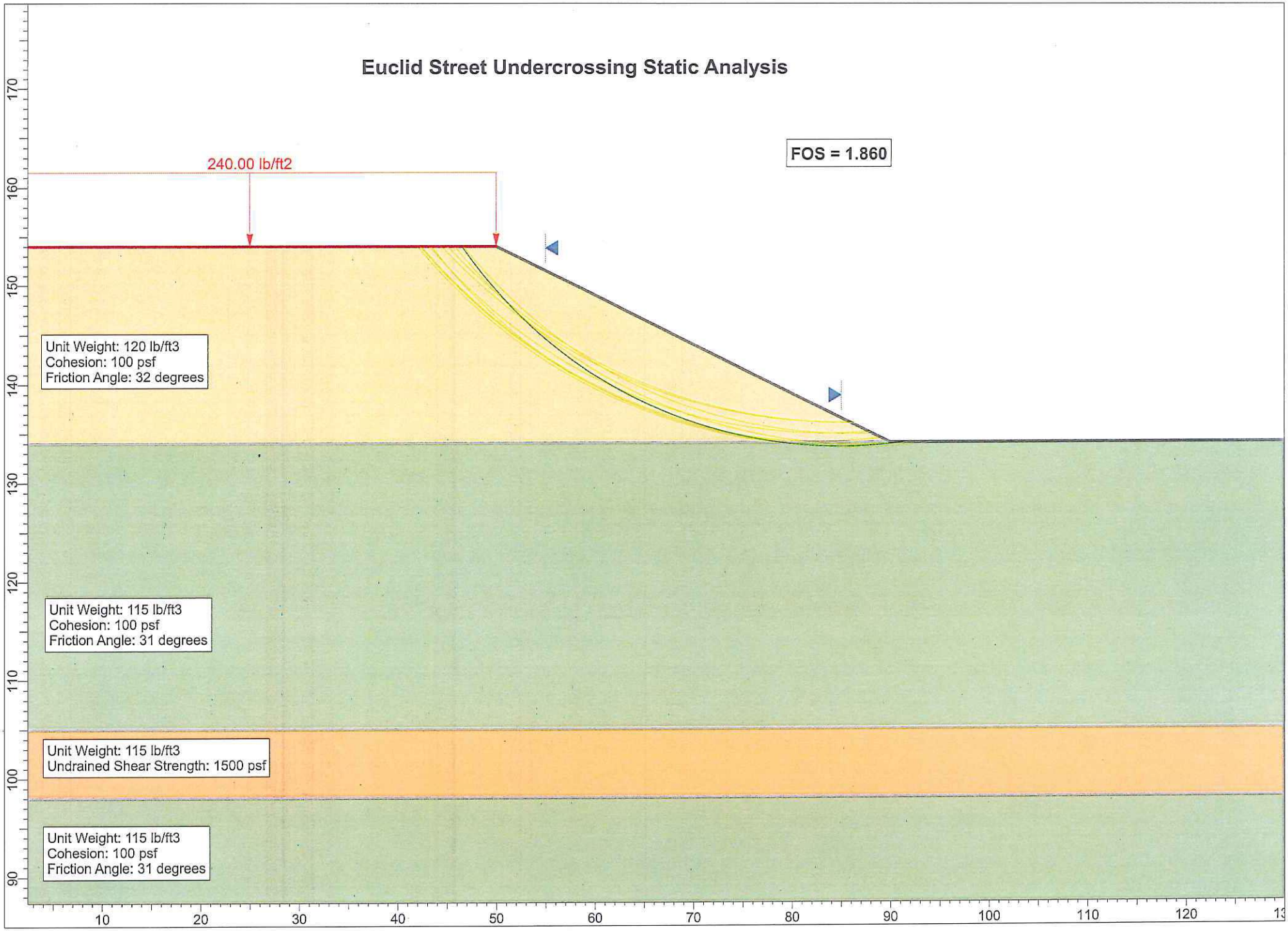
Abutment embankment

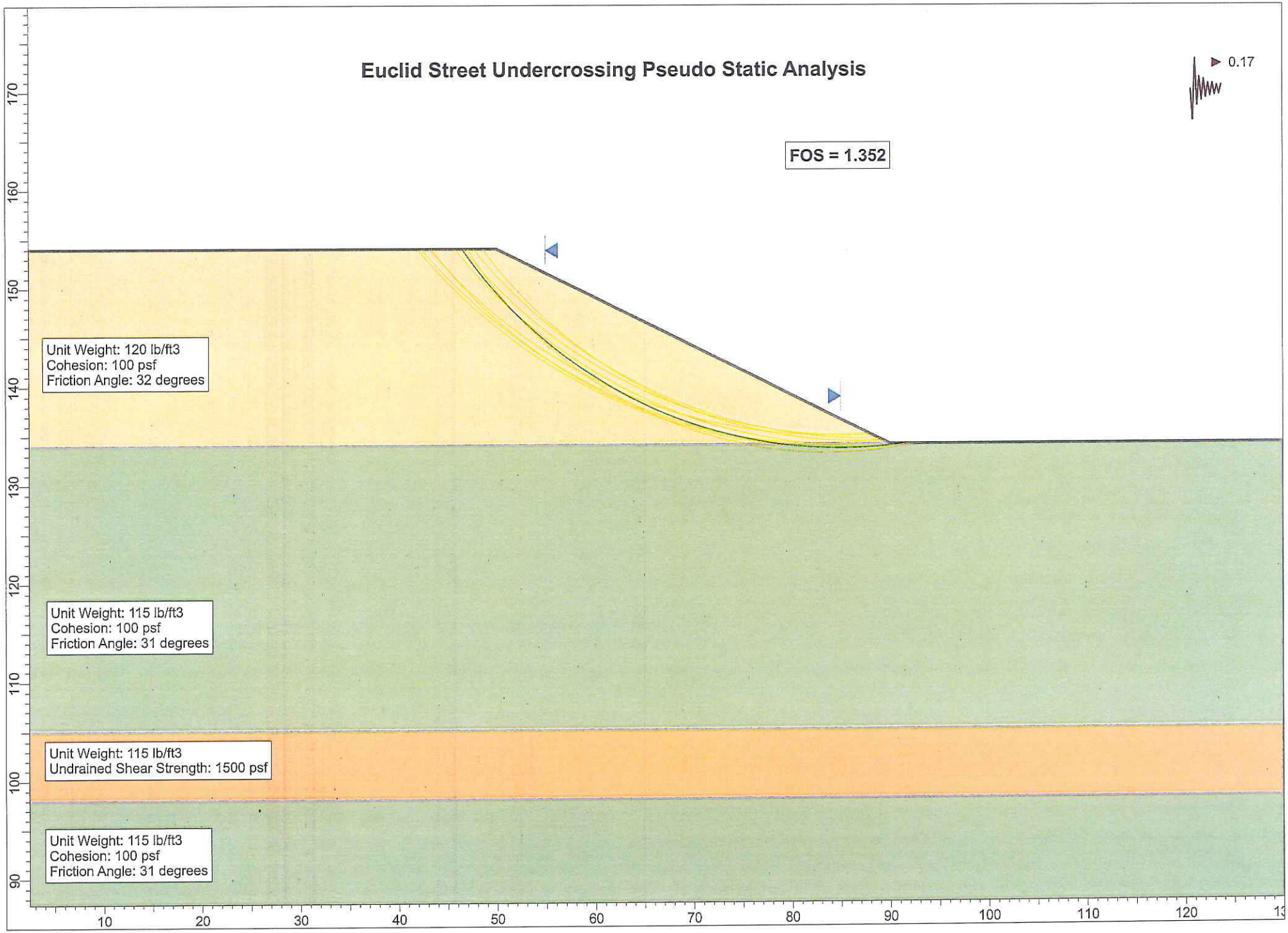




Dwl to new fill = 20x20 1/2 = 1.2 kst

	σ_{vo}	$\Delta\sigma$	Settlement
①	16x115 = 1.84 30x115 = 3.45	1.2x0.95 = 1.14 1.2x0.165 = 1.08	$14 \times \frac{1}{50} \log\left(\frac{1.84+1.14}{1.84}\right) = 0.7$ $15 \times \frac{1}{50} \log\left(\frac{3.45+1.08}{3.45}\right) = 0.1$
②	41.5x115 = 4.77	1.2x0.5 = 0.6	$7 \times \frac{1}{50} \log\left(\frac{4.77+0.6}{4.77}\right) = 0.1$
③	45x115 + 10x120 = 6.39	1.2x0.4 = 0.48	$30 \times \frac{1}{80} \log\left(\frac{6.39+0.48}{6.39}\right) = 0.1$
④	45x115 + 17x120 + 3x57.6 + 2.5x52.6 = 7.52	1.2x0.3 = 0.36	$5 \times 0.02 \log\left(\frac{7.52+0.36}{7.52}\right) = 0.02$
⑤	45x115 + 17x120 + 6.5x57.6 + 5x52.6 = 7.85	1.2x0.25 = 0.3	$7 \times \frac{1}{125} \log\left(\frac{7.85+0.3}{7.85}\right) = 0.01$ 1.32"


Euclid Street Undercrossing Static Analysis
FOS = 1.860
240.00 lb/ft2
Unit Weight: 120 lb/ft3
Cohesion: 100 psf
Friction Angle: 32 degrees
Unit Weight: 115 lb/ft3
Cohesion: 100 psf
Friction Angle: 31 degrees
Unit Weight: 115 lb/ft3
Undrained Shear Strength: 1500 psf
Unit Weight: 115 lb/ft3
Cohesion: 100 psf
Friction Angle: 31 degrees
170
160
150
140
130
120
110
100
90
10
20
30
40
50
60
70
80
90
100
110
120


Euclid Street Undercrossing Pseudo Static Analysis
0.17
FOS = 1.352
Unit Weight: 120 lb/ft3
Cohesion: 100 psf
Friction Angle: 32 degrees
Unit Weight: 115 lb/ft3
Cohesion: 100 psf
Friction Angle: 31 degrees
Unit Weight: 115 lb/ft3
Undrained Shear Strength: 1500 psf
Unit Weight: 115 lb/ft3
Cohesion: 100 psf
Friction Angle: 31 degrees
170
160
150
140
130
120
110
100
90
10
20
30
40
50
60
70
80
90
100
110
120

Earth Mechanics, Inc.
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17800 Newhope Street, Suite B, Fountain Valley, CA 92708
(714) 751-3826, Fax (714) 751-3928

Project SR-91 WB widening - Euclid St UC **Project No.** 10-126

By SP **Date** 03-28-11 **Checked By** LLC **Date** 3/28/11 **Sheet** ____ **of** ____

Surficial stability

for 1.5:1 slope

$\beta = \tan^{-1}\left(\frac{1}{1.5}\right) = 33.7°$

consider thickness of slide $h = 4$ ft

consider $\gamma = 120$ pcf

$\phi = 32°$

$c = 230$ psf for sliding material

factor of safety $= \frac{c + h\gamma' \cos^2\beta \tan\phi}{h\gamma \sin\beta \cos\beta}$

$= \frac{230 + 4(120 - 62.4)\cos^2 33.7 \tan 32}{4 \times 120 \times \sin 33.7 \cos 33.7}$

$= 1.5$

Appendix D

CALTRANS REVIEW COMMENTS AND EMI RESPONSES

State of California

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: LUQI YANG
Liaison Engineer

Date: May 2, 2011

File: 12-ORA-91 PM Various
EA 12-0C5701, 1200000079
Brookhurst Ave UC + 5Br.
No. 55-0280 + 5

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
Geotechnical Services
Office of Geotechnical Design – South 1

Subject: Foundation Report- Bridge No. 55-0216, 55-0218, 55-0245, 55-0279, 55-0280 & 55-852

Per your request, the Geotechnical Design South 1 - Branch B has reviewed the subject submittal, containing the following item:

1. Foundation Reports for No. 55-0216, 55-0218, 55-0245, 55-0279, 55-0280 & 55-852, Anaheim, Orange County, dated April 15, 2011.

Our office has no comments on above submitted item.

Should you have any questions, please contact Mushtaq Ahmed at (213) 620-2132.

Reviewed by: Date: 5/2/11

Mushtaq Ahmed, P.E.
Transportation Engineer-Civil
Office of Geotechnical Design – South 1
Branch B

Supervised by: Date: 5/4/11

Sam Sukiasian, G.E.
Chief Branch B
Office of Geotechnical Design – South 1

cc: OGDS1 – Nor. File, OGDS1- Sac. File, GS-Sac. File

REGISTERED CIVIL ENGINEER
MOHAMMAD MUSHTAQ AHMED
No. C056390
Exp. 6-30-11
STATE OF CALIFORNIA

FOUNDATION REPORT
NORTH ANAHEIM OH (Widen)
Bridge No. 55-0216

Earth Mechanics, Inc.

September 16, 2011

FOUNDATION REPORT

North Anaheim Overhead (Widen)
Bridge No. 55-0216
Orange County, California
12-ORA-91, PM 4.0
Caltrans Project No. 12000000791 (EA 12-0C5701)
EMI Project No. 10-126
Date: September 16, 2011

EARTH MECHANICS, INC.

Geotechnical and Earthquake Engineering

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

September 16, 2011

EMI Project No. 10-126

RBF Consulting
14725 Alton Parkway
Irvine, California 92618

Attention: Mr. Steve Huff, P.E.

Subject: Foundation Report for North Anaheim Overhead (Widen)
Bridge No. 55-0216
Anaheim, Orange County, California
12-Ora-91, PM 4.0
Caltrans Project No. 12000000791 (EA 12-0C5701)

Dear Mr. Huff:

Attached please find the Foundation Report for the subject bridge widening project. This report contains the findings and conclusions of our field investigation and laboratory testing program. This report also contains our recommendations for the design and construction of the bridge foundations.

An earlier version of this report dated April 15, 2011 was submitted to Caltrans for review. Caltrans prepared a memorandum dated May 2, 2011 indicating they have no comments. A copy of this Caltrans memorandum is included in Appendix D.

We appreciate the opportunity to provide geotechnical design services for this project. If you have any questions, please call us.

Sincerely,

EARTH MECHANICS, INC.

REGISTERED PROFESSIONAL ENGINEER
GNANAPRAGASAM J. GUNARANJAN
No. C71758
Exp: 12-31-2011
CIVIL
STATE OF CALIFORNIA

09-16-11

(Ranjan) G. J. Gunaranjan, PE 71758
Senior Staff Engineer

REGISTERED PROFESSIONAL ENGINEER
LINO C. CHEANG
NO. GE 2345
EXP. 9/30/11
GEOTECHNICAL
STATE OF CALIFORNIA

9-16-11

Lino Cheang, GE 2345
Project Manager

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FOUNDATION REPORT

NORTH ANAHEIM OVERHEAD (WIDEN)
BRIDGE NO. 55-0216
ANAHEIM, ORANGE COUNTY, CALIFORNIA
12-ORA-91, PM 4.0
CALTRANS PROJECT NO. 12000000791 (EA 12-0C5701)

Prepared for:

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EMI Project No. 10-126

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1.0 INTRODUCTION

1.1 Purpose and Scope of Study

This Foundation Report presents the findings and conclusions of a geotechnical investigation conducted by Earth Mechanics, Inc. (EMI). It presents foundation design and construction recommendations for the proposed widening of the North Anaheim Overhead (OH) in the City of Anaheim, County of Orange, California. A site location map is presented in Figure 1-1.

EMI is a subconsultant to RBF Consulting (RBF). The geotechnical services provided for this project included the following tasks:

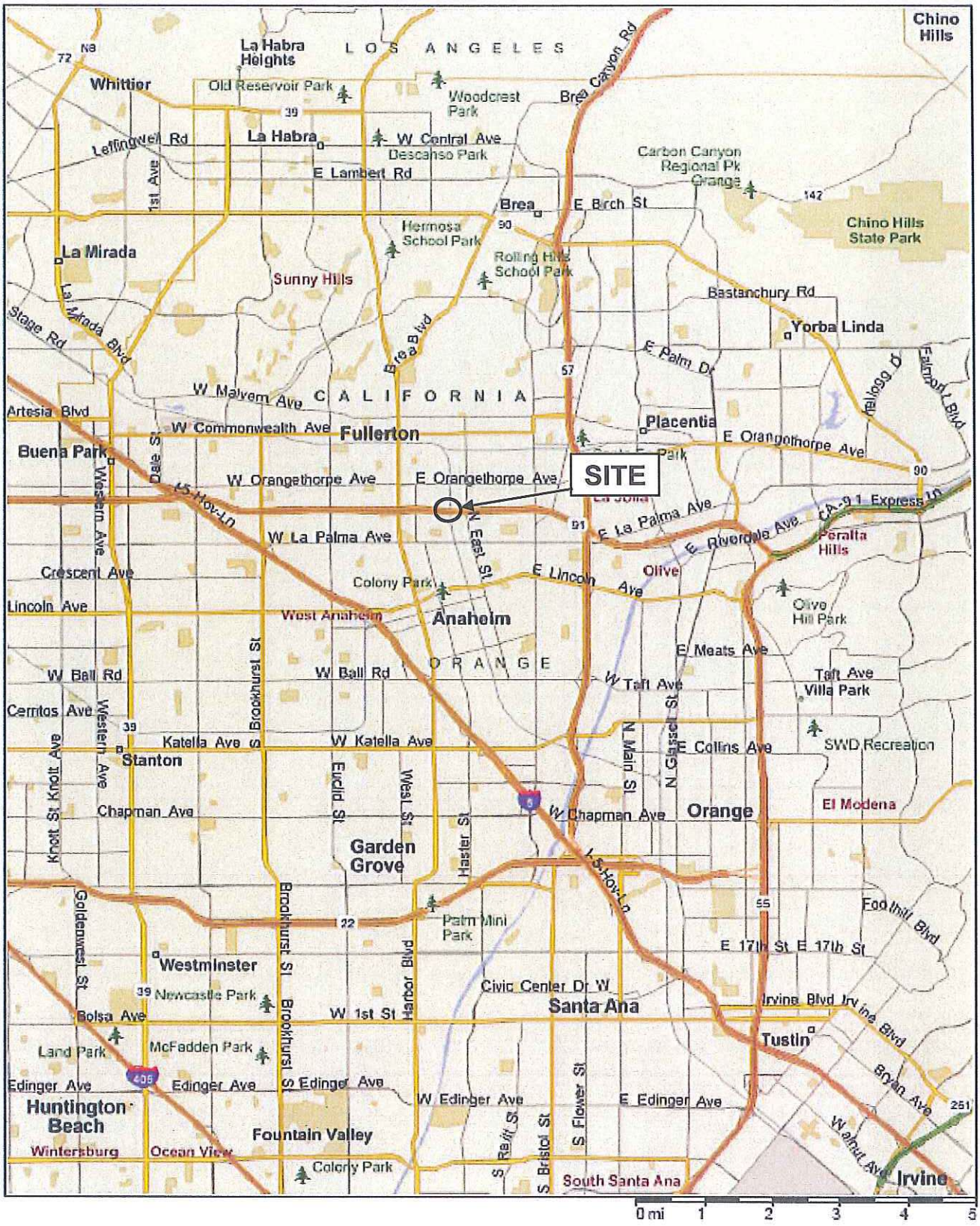
- Collection and review of existing geotechnical information;
- Field exploration consisting of drilling and logging exploratory borings;
- Laboratory testing of selected bulk and relatively undisturbed soil samples;
- Engineering calculations and analysis to develop foundation design and construction recommendations; and
- Preparation of this report presenting our findings, conclusions, and recommendations.

1.2 Project Description

The California Department of Transportation (Caltrans), in cooperation with the Orange County Transportation Authority (OCTA) and the cities of Anaheim and Fullerton, proposes to widen the westbound State Route 91 (SR-91) from State Route 57 (SR-57) to Interstate 5 (I-5). SR-91 is a major east-west freeway facility that begins at the eastern junction with SR-60 in the city of Riverside in Riverside County, and continues west through Orange County to its terminus at the junction with Pacific Coast Highway 1 near the city of Hermosa Beach in Los Angeles County.

The proposed project limits cover a distance of 4.5 miles; however, actual improvements are limited to a total of 3.8 miles within the project area. The proposed project consists of widening six bridges. The subject foundation report addresses only the North Anaheim OH (Bridge No. 55-0216) where the SR-91 crosses over Southern California Regional Rail Authority (SCRRA) mainline railroad tracks.

The existing North Anaheim OH will be widened by about 12 feet only on the north side in order to accommodate widening of the westbound SR-91. The proposed widened North Anaheim OH is a four-span structure supported on seat type abutments (Abutments 1 & 5) and single-column bents (Bents 2, 3, and 4). The new bridge deck will be approximately 181 feet wide and the bridge length is about 240 feet. Based on the design plans, the existing pier protection wall and footing, located adjacent to Bent 3, will be extended to protect the new Bent-3 column.



North Anaheim OH (Widen)	SITE LOCATION MAP
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 1-1
Project No. 10-126	Date: 03-21-11

1.3 Existing Bridge Information

The existing OH was originally constructed in November 1959, widened in February 1967, and widened and retrofitted in July 2000. Based on the as-built plans, the original OH is supported on 45-ton, driven concrete piles and the 1967 widened portion is supported on 45-ton, 16-inch diameter Cast-In-Drilled-Hole (CIDH) piles. Foundation type of the widening and retrofitting in 2000 consists of 16-inch diameter CIDH piles with design loadings of 70 tons and 100 tons at abutments and bents, respectively.

As-built pile tip elevations for the original bridge vary between +119 and +124 feet. For the 1967 widening, the as-built pile tip elevations vary between +118 and +120 feet. The specified pile tip elevations for the 2000 widening and retrofitting are +135 and +130 feet at the abutments and bents, respectively.

The existing pier protection wall, located adjacent to Bent 3, is approximately 204.25 feet long and the existing wall footing width is about 7.5 feet. The northern 52.5-foot long and the southern 53-foot long portions of the existing wall are supported on 70-ton, 16-inch diameter CIDH piles to allow the wall to span the Bent-3 footings. The specified pile tip elevation is at +134 feet. The remaining 98.75-foot long portion of the existing wall is supported on spread footings with an allowable soil bearing pressure of 4 ksf.

2.0 FIELD INVESTIGATION AND LABORATORY TESTING

2.1 Existing Information

The as-built Logs-of-Test-Borings (LOTB) sheets for the previous widening and retrofitting of the existing North Anaheim OH were reviewed as part of the preparation of this report. Copies of these LOTB sheets are provided in Appendix A.

For the widening and retrofitting in 2000, two rotary-wash borings and one CPT sounding were performed in January 1993. The deepest boring was advanced to about elevation +102.3 feet. Existing grade at the borehole locations at the time of the investigation was between elevations +198.3 and +201.3 feet, which are near the freeway surface elevation.

As-Built LOTB sheet of the original OH was used for the widening in February 1967.

For the original OH construction in 1959, two 3-inch rotary wash borings were drilled in March 1955. The deepest boring was advanced to about elevation +92.3 feet. Existing grade at the borehole locations at the time of the investigation was between +167.8 and +169.4 feet, which are near the surface elevation of the railroad tracks.

2.2 Field Investigation

To supplement the existing subsurface information, two soil borings were performed by EMI in January, 2011. Exploration information, including Boring number, stations, offsets, ground surface elevations, bottom elevations and water level measurements are summarized in Table 2-1. Locations of the geotechnical exploration are also shown on the LOTB sheet provided in Appendix A.

Table 2-1. Geotechnical Exploration Information

Boring No.	Station Line	Approx. Station	Approx. Offset (feet)	Approx. Ground Surface El. (feet)	Approx. Bottom of Boring El. (feet)	Approx. Ground Water El. (feet)
A-10-039	"A" Line	264+14	88 Lt	+198.4	+96.9	Not Encountered
A-10-040		267+05	74 Lt	+201.2	+100.7	Not Encountered

Boring A-10-039 and A-10-040 were drilled on the SR-91 freeway shoulder, west of Abutment 1 and east of Abutment 5, respectively.

Exploratory borings were drilled by 2R Drilling under subcontract with EMI using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers. The sampling interval is usually 5 feet. Sampling was performed by alternating the Modified California Drive (MCD) sampler and Standard Penetration Test (SPT) sampler.

Relatively undisturbed drive samples were obtained using a 3.25-inch outer diameter MCD sampler lined with brass rings. Each of these brass rings is 1-inch long with a 2.5-inch outside

diameter. The MCD sampler was driven into the ground using successive blows of a 140-lb hammer falling a distance of 30 inches. The numbers of blow to advance the sampler each 6 inches of penetration or less were recorded. The numbers of blow for the final 12 inches or shorter of driving are shown on the LOTB sheet.

The SPT sampler (1.4-inch inside diameter) was also used to obtain soil samples. The SPT sampler was driven into the ground using a 140-lb hammer falling from a height of 30 inches. The numbers of blow to advance the sampler each 6 inches of penetration or less were recorded. The blow counts required to drive the sampler for the last 12 inches or less were recorded as the Standard Penetration Resistance (N-value) on the LOTB sheet.

Charts published by Winterkorn and Fang (1975) can be used to determine a reduction factor used to convert blowcounts recorded using the California Drive sampler into SPT blowcounts. Using those charts, we obtained a reduction factor of 0.5 and this one-half reduction factor was used for this project.

2.3 Laboratory Testing

Soil samples considered representative of the subsurface conditions were tested to obtain or derive relevant physical and engineering soil properties. The following laboratory tests were conducted to supplement the observations recorded during the field investigation:

- In-situ Moisture Content and Unit Weight
- Percent Passing No. 200 Sieve
- Atterberg Limits
- Direct Shear
- Unconsolidated Undrained Triaxial
- Pocket Penetrometer
- R-Value
- Minimum Resistivity, pH, Sulfate Content and Chloride Content

The laboratory tests were conducted in general accordance with California Test Methods or American Society for Testing and Materials (ASTM) Standards. Laboratory test results are included in Appendix B.

An R-value test is noted on the LOTB in Appendix A. This test was conducted for the pavement design; this test result was not used in preparation of the recommendations included in this report and therefore, it was omitted from Appendix B.

3.0 GEOLOGY AND SEISMICITY

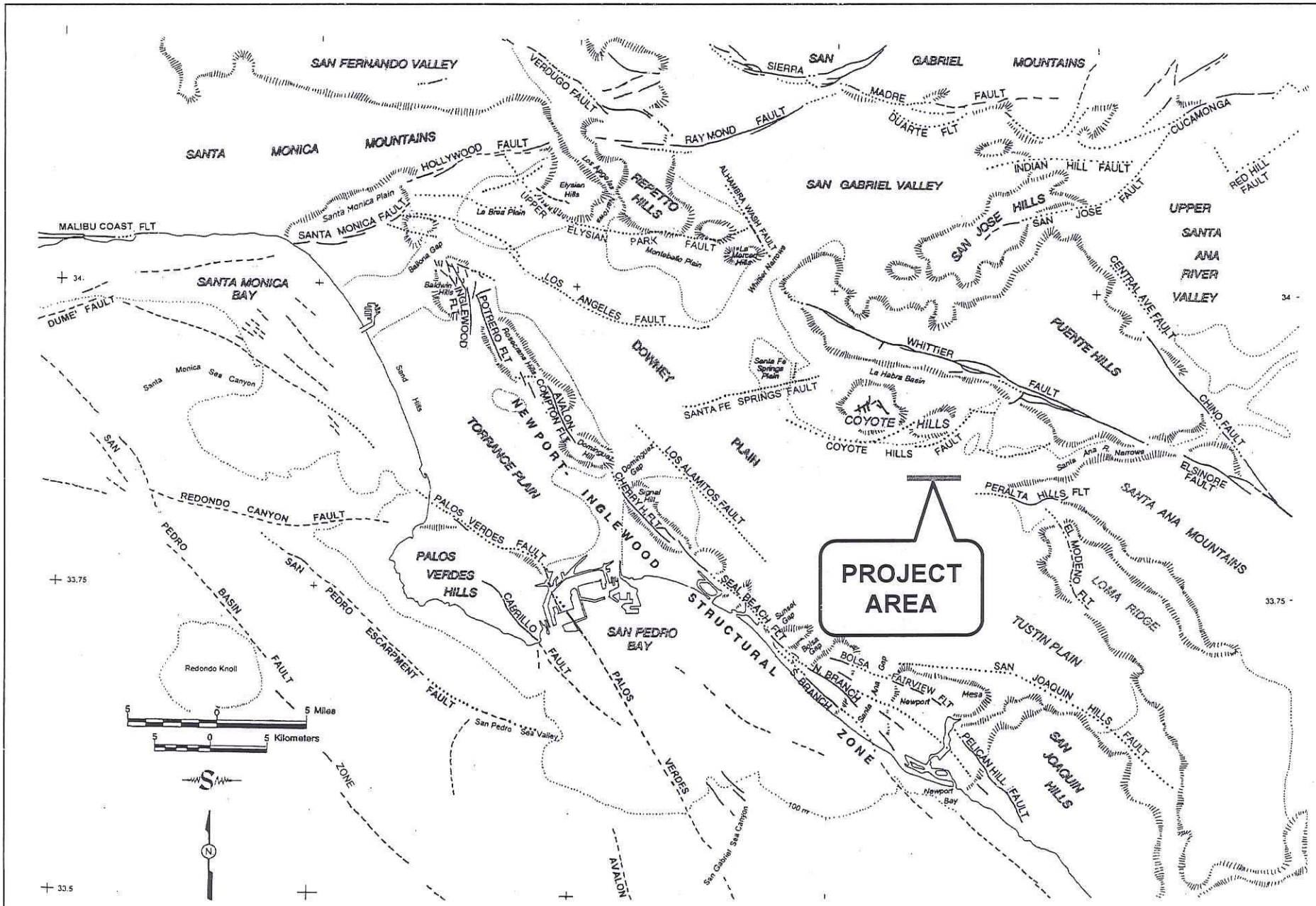
3.1 Physiography

The project area is in the east-central part of the Los Angeles Basin as shown in Figure 3-1 which comprises a transition zone between the Peninsular Ranges physiographic province on the east, and the Transverse Ranges physiographic province to the north. The Peninsular Ranges physiographic province comprises a northwest-southeast trending group of fault-bounded ranges such as Santa Ana Mountains, Puente Hills and San Joaquin Hills between the Salton Trough and the Pacific Ocean. The Transverse Ranges physiographic province comprises east-west trending ranges and valleys such as the Santa Monica Mountains, San Fernando Valley and San Gabriel Mountains. Valleys such as the Los Angeles Basin, the San Gabriel Valley and the Upper Santa Ana River Valley have characteristics compatible with both physiographic provinces and form a transition zone between the two provinces.

The Los Angeles Basin is essentially a large, relatively flat, low-lying and coastal plain surrounded by mountains on the north, east and southeast which rise abruptly to a few thousand feet above the plains. The western margin of the basin is bordered by the sea, the Palos Verdes Hills and the San Joaquin Hills. The floor of the basin gradually rises inland to a series of uplifted terrain along the margins of the surrounding mountains. This elevated marginal terrain includes the Santa Monica, La Brea, Montebello, Santa Fe Springs plains, and the Coyote Hills. The generally flat-lying nature and gradual inland rise of the Basin floor is disrupted by an alignment of northwest-southeast trending, low-elevation hills along the Newport-Inglewood Structural Zone (NISZ). The areas on either side of the NISZ are essentially flat and comprise the Downey-Tustin plain on the northeast and the Torrance Plain on the southwest. The site area is near the transition between the Downey and the Tustin plains.

3.2 Geologic Structure

The Los Angeles Basin is a deep structural basin comprising two major downward folds (synclines) separated by the NISZ uplift; the Paramount syncline is east of the NISZ under the Downey-Tustin Plain, and the Gardena syncline is west of the NISZ under the Torrance Plain. The Paramount syncline is the larger and deeper syncline with basement rocks as deep as about 30,000 feet (Yerkes et al, 1965). As described in the physiography section, the basin is rimmed by marginal elevated plains that rise about a hundred feet to as much as a couple hundred feet above the general level of the basin floor. These elevated plains and the Coyote Hills are underlain by fault-bounded, upward folds (anticlines) that are prolific oil fields. Most of the major faults associated with these folds are blind thrust faults and are shown on Figure 3-1 as dotted lines. The nearest faults to the project area are the blind thrust faults of the Puente Hills Blind Thrust Fault System and Compton-Los Alamitos Blind Fault System. Larger surface faults, such as the NISZ and the Elsinore Fault Zone (Whittier Section) lie to the southwest and northeast of the project site, respectively.



State Route 91 Westbound Widening Project

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

REGIONAL MAP OF ACTIVE FAULTS AND PHYSIOGRAPHY

Figure 3-1

Project No. 10-126

Date: 03-21-11

3.3 Geological Hazards

The only significant geological hazard at the site is earthquake shaking and perhaps local liquefaction. There are no known active surface faults within the project area so ground rupture is not a factor. The flat-lying nature of the area is not susceptible to landsliding. The site is too far from the ocean to be affected by tsunamis, and there are no large bodies of water within the site area that could generate a seiche. There are no volcanoes in the region.

As presented in Figure 3-2, the California Geological Survey (1997, 1998) shows designated project site is outside the liquefaction zone. Therefore, the liquefaction potential at the project site is low. The potential for liquefaction is discussed in detail in Section 5.2.

3.4 Seismicity

The project is in seismically active Southern California. The present-day seismotectonic stress field in the Los Angeles region is one of north-northeasterly compression. This is indicated by the geologic structures, by earthquake focal-mechanism solutions and by geodetic measurements. These data suggest crustal shortening of between 0.2 and 0.35 inches per year across the greater Los Angeles area (Argus et al., 1999).

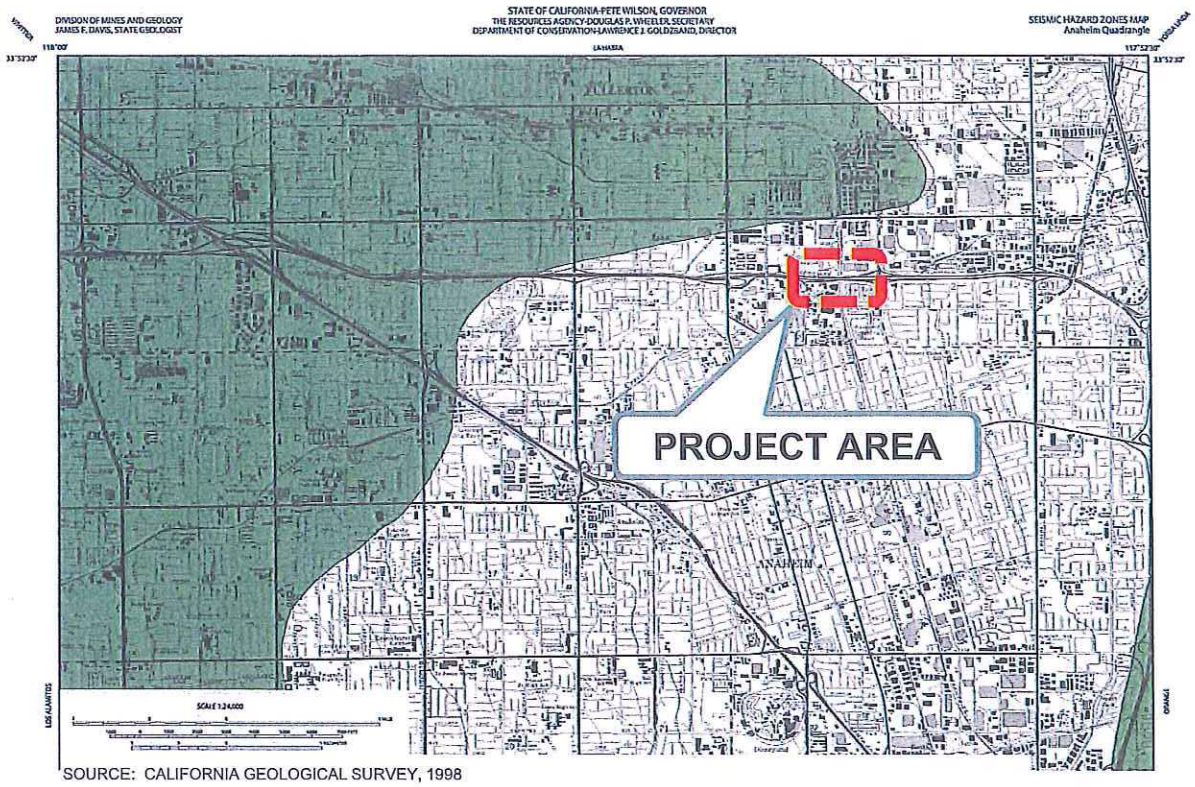
Historical earthquake epicenter maps show widespread seismicity throughout the Los Angeles region. Earthquakes occur primarily as loose clusters along the NISZ, the southern margin of the Santa Monica Mountains, the margin between the Santa Susana-San Fernando Valley and the southern margin of the San Gabriel Mountains, and in the Coyote Hills-Puente Hills area.

The largest historical earthquakes within the Los Angeles Basin were the 1933 Long Beach (moment magnitude (M_W) of about 6.4), 1994 Northridge (M_W = 6.7), 1971 San Fernando (M_W = 6.7), 1987 Whittier (M_W = 5.9), and 2008 Chino Hills (M_W = 5.4). There have been no significant historical earthquakes in the immediate site area. There may have been a few random small events (M_W < 3.0). The nearest concentrated earthquake activity has been within the Puente Hills about 5 or 6 miles to the north of the site.

The 1933 Long Beach earthquake did not rupture the surface but is believed to have been associated with the NISZ (Benioff, 1938). Reevaluation of the seismic data by Hauksson and Gross (1991) relocated the 1933 earthquake hypocenter to a depth of about 6 miles below the Huntington Beach-Newport Beach city boundary.

The 1994 Northridge earthquake occurred on a southerly dipping subsurface fault which was unknown prior to the earthquake. The main shock occurred at a depth of about 12 miles. Earthquake aftershocks clearly defined the rupture surface dipping about 35 degrees southerly from a depth of about 1 or 2 miles to 14 miles. The causative fault was never identified with certainty.

The 1971 San Fernando earthquake involves surface rupture. The 1971 event occurred on a northerly dipping thrust fault that dips from the northern side of the San Fernando Valley to a depth of about 9 miles under the San Gabriel Mountains, and considered part of the Sierra Madre Fault System.



SOURCE: CALIFORNIA GEOLOGICAL SURVEY, 1998

MAP EXPLANATION

Zones of Required Investigation:

Liquefaction

Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

North Anaheim OH (Widen)	MAP OF LIQUEFACTION POTENTIAL
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 3-2
Project No. 10-126	Date: 03-21-11

The 1987 Whittier earthquake occurred on a subsurface fault dipping under the Puente Hills to about 10 miles beneath the San Gabriel Basin (Shaw and Shearer, 1999; Shaw et al., 2002). This event did not rupture the ground surface.

The 2008 Chino Hills event epicenter was in the Chino Hills area between the Elsinore-Fault-Zone Chino Section and Whittier Section. Preliminary data were inconclusive with regard to the causative fault. Detailed analysis by Shao and Hauksson (2009) indicated a rupture plane striking N71°W, dipping 62° northeast. This event did not rupture the ground surface.

Another significant earthquake was the 1812 earthquake which caused damage at the San Juan Capistrano Mission. The location and magnitude of the 1812 earthquake are unknown because of the sparse population at the time, but geological studies (Jacoby et al., 1987; Fumal et al., 1993; Weldon et al., 2004) postulate that it did not occur in the Capistrano area, but rather was a large ($M_W > 7.0$) distant event on the San Andreas fault in the Wrightwood area of the San Gabriel Mountains.

The earliest documented earthquake in the region was reported by the Portola´ expedition as they camped near the Santa Ana River in 1769. This event has been attributed by various geoscientists to just about every fault in the Los Angeles area but it could just as well have been a distant event that shook a wide area as did the 1971 San Fernando, the 1987 Whittier, and the 1994 Northridge events, as well as many other more-distant events such as 1992 Landers event.

4.0 SUBSURFACE CONDITIONS

4.1 Soil Conditions

The proposed approach elevation is about +200 feet and the existing ground surface elevation at the railroad tracks is about +170 feet. Based on the recent and previous field investigations, the site materials are typically fill and alluvium. The upper 75 feet or so materials are predominately loose to very dense sand and sand with silt and traces of fine gravelly sands. This top soil layer is underlain by a 10-foot thick stratum of interbedded layers of very stiff to hard elastic silt, silt with sand, silty clay with sand, and sandy clay followed by a dense to very dense poorly graded sand with silt layer down to the boring termination depth.

The idealized soil profile and design strength parameters for foundation design are presented in Table 4-1.

Table 4-1. Idealized Soil Profile and Strength Parameters

Approximate Elevation (feet)	Predominant Soil Type	Equivalent SPT Blowcount* (blows/foot)	Total Unit Weight (pcf)	Friction Angle (degree)	Cohesion/ Undrained Shear Strength (psf)
+200 to +170	Fill	-	120	32	150
+170 to +145	Sand and Sand with Silt	14 to 100 Average = 42	120	32	50
+145 to +125	Sand and Sand with Silt	12 to 68 Average = 37	120	33	50
+125 to +115	Elastic Silt to Sandy Clay	(16) to 35 Average = 27	115	-	2,000
Below +115	Sand with Silt	(30) to 69 Average = 53	125	38	50

* Values in ( ) are converted SPT blowcounts corrected for sampler size; correction factor from California sampler blowcounts to SPT blowcounts is 0.5.

In Table 4-1, the soil strength parameters are based on direct shear test results or published correlations with SPT blowcounts (Lam and Martin, 1986). Direct shear tests were performed on soil samples obtained within the second and third idealized soil layers. The design strength parameters of these layers were based on the ultimate shear strength parameters obtained from the direct shear tests. The unconsolidated-undrained triaxial test results were used for the fourth idealized soil layer. Design strength parameters of the remaining idealized soil layers are based on correlation with SPT blowcounts. It should be noted that the strength parameters obtained from the direct shear and unconsolidated undrained triaxial tests are lower than those obtained using SPT correlations for the same idealized soil layers.

4.2 Groundwater Conditions

Groundwater was not encountered in any of the as-built or current borings. Based on California Geological Survey (Division of Mines and Geology, 1997), the recorded highest historical groundwater at the project site is greater than 50 feet below the ground surface. The average ground surface elevation at the railroad grade is about +170 feet. Therefore, the CGS historical highest groundwater elevation would be deeper than +120 feet. Based on the measured and historical highest groundwater elevations, a groundwater elevation of +120 feet can be used for liquefaction analysis.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Seismic Design Criteria

To develop ARS curves in accordance with the 2009 Seismic Design Criteria (SDC) (Caltrans, 2009b and 2009d) procedures, we considered the following response spectra:

- Deterministic Criteria based on late-Quaternary faults in 2007 fault database (Caltrans, 2007a and 2007b and Shantz and Merriam, 2009);
- Probabilistic Criteria based on 5% in 50 years probability of exceedance ground motion; and
- Minimum Deterministic Spectrum based on a M_w= 6.5 strike-slip event occurring at a distance of 7.5 miles (12 km) from the site.

The design ARS curve is the envelope of the above spectra.

We used the Caltrans Deterministic Response Spectrum Spreadsheet as recommended by the 2009 SDC to develop the deterministic ARS curves. The spreadsheet uses the arithmetic average of two Next Generation Attenuation (NGA) relationships developed by Chiou-Youngs (2008) and Campbell-Bozorgnia (2008) with user-provided input parameters, including fault characteristics, site-to-fault distances and site condition parameters as presented in Table 5-1.

Table 5-1. Controlling Faults for Deterministic Response Spectrum

Controlling Fault	Fault ID	Maximum Moment Magnitude M_{max}	Site to Fault Distance R_{RUP} (miles)	Style of Fault	Fault Dip /Direction
Puente Hills Blind Thrust	240	7.3	8.6	Reverse	25° / North
Elsinore Fault Zone (Whittier Section)	241	7.6	10.3	Reverse Lateral Strike Slip	75° / Northeast

Results obtained from the spreadsheet were then verified with the Caltrans online web tool (Caltrans, 2009a). The spreadsheet method is recommended because the online web tool, though more user-friendly, does not include updates since 2007 in its calculation database and presently is not approved to develop spectra for final design.

The probabilistic response spectrum is based on data from the 2008 United States Geological Survey (USGS, 2008a) National Seismic Hazard Map for the 5% in 50 years probability of exceedance (975-year return period) ground motion. To develop the probabilistic spectrum, the Caltrans Probabilistic Response Spectrum Spreadsheet and the USGS Interactive Deaggregation Tool (USGS, 2008b) were used. Results obtained from both the spreadsheet and deaggregation tool were then verified with the Caltrans online web tool. Again, the spreadsheet and deaggregation tool are recommended because the online web tool, though more user-friendly, does not include updates since 2007 in its calculation database.

The resulting design ARS curve and the digitized coordinates are presented in Figure 5-1. A peak ground acceleration (PGA) of 0.52g is obtained from the design ARS curve.

5.2 Liquefaction

Liquefaction analysis was performed using the available site-specific subsurface information and historical high groundwater elevation of +120 feet. The liquefaction potential of the saturated, granular materials below the design water table was evaluated using the procedures outlined by Seed et al. (1985), Seed and Harder (1990), and updated by NCEER (1997) and Youd et al., (2001).

Using the subsurface information obtained from four soil borings, the results of the analysis indicate that granular materials susceptible to liquefaction were not encountered below the groundwater table. Therefore, the liquefaction potential at the bridge site is anticipated to be low. Since liquefaction potential is low, seismically induced settlement should be negligible.

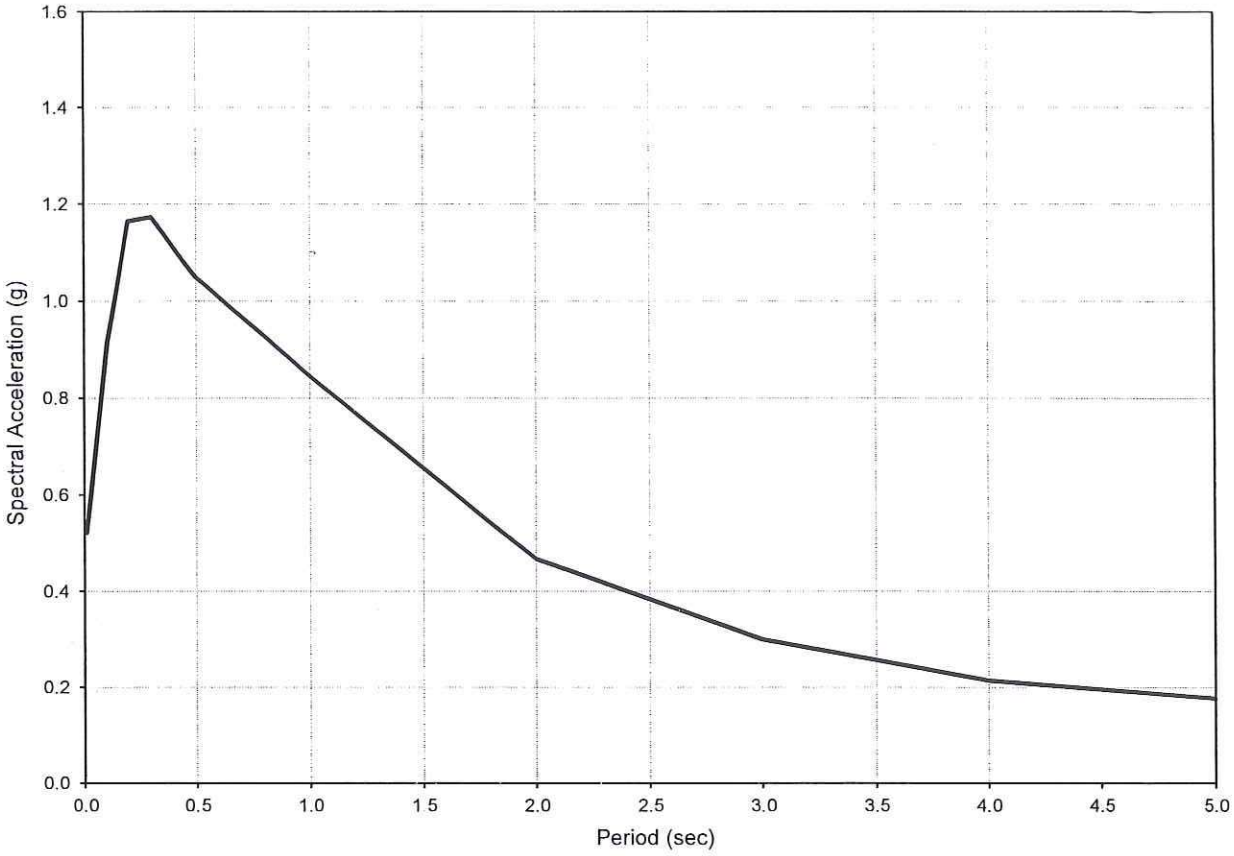
5.3 Soil Corrosivity

Two soil samples were tested for pH, minimum resistivity, soluble chloride content, and soluble sulfate content. The test results are summarized in Table 5-2. Minimum resistivities were 760 and 4,800 ohm-cm. The pH values were 7.9 and 8.0. The soluble sulfate measurements were 40 and 120 parts per million (ppm), and the soluble chloride measurements were 191 and 253 ppm.

Table 5-2. Soil Corrosion Test Results

Boring	Station (Offset) / "Station Line"	Sample Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Soluble Sulfate Content (ppm)	Soluble Chloride Content (ppm)
A-10-039	264+14 (88' Lt) / "A" Line	5	SM	4,800	8.0	120	191
		75	MH	760	7.9	40	253

Based on the Caltrans Corrosion Guidelines (2003b), soils are considered corrosive if the pH is 5.5 or less, or the chloride concentration is 500 ppm or greater, or the sulfate concentration is 2,000 ppm or greater. Based on the test results and the Caltrans criteria, the on-site soils are considered to be non-corrosive to bare metals and concrete.



Latitude = 33.8539 °
Longitude = -117.9591 °

Damping Ratio = 5%

Spectral Coordinates	
Period (sec)	Acc. (g)
0.010	0.520
0.100	0.915
0.200	1.164
0.300	1.173
0.500	1.049
1.000	0.844
2.000	0.467
3.000	0.299
4.000	0.214
5.000	0.176

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	North Anaheim OH (Widen)	Design ARS Curve
	Project: 10-126 Date: 03/01/11	Figure 5-1

5.4 Pile Foundation Design

5.4.1 Foundation Type

According to the as-built plans, foundation type of the previous widenings of North Anaheim OH consists of CIDH piles except the original OH is supported on driven concrete piles. We recommend matching the existing foundation type of the previous widenings for the proposed bridge widening.

The minimum embedment and offset (from a slope face) of the footings should be based on Section 4.4.5.1 of Caltrans BDS dated August 2004.

5.4.2 Foundation Data Provided by Structural Designers

Per Caltrans policy, LRFD Service-I Limit State load combinations and Working Stress Design (WSD) method provided in the Caltrans Bridge Design Specifications (2003a) are used for design of the abutment footing. The LRFD Service-I Limit State, Strength Limit State, and Extreme Event Limit State load combinations are used for the design of the bent footing.

The foundation design data sheet is presented in Table 5-3. Foundation loads were provided by the structural designers following the latest Caltrans Memo To Designers (Caltrans, 2008) and these loads are presented in Table 5-4.

Table 5-3. Foundation Design Data Sheet

Support No.	Design Method	Pile Type	Finished Grade Elevation (feet)	Cut-off Elevation (feet)	Pile Cap Size (feet)		Permissible Settlement under Service Load (inch)	Number of Pile per Support
					B	L		
Abut 1	WSD	16" CIDH	191.5	188.25	6	12.73	1	3
Bent 2	LRFD	16" CIDH	174.0	163.15	11.33	11.33	1	8
Bent 3	LRFD	16" CIDH	173.0	163.15	11.33	11.33	1	8
Bent 4	LRFD	16" CIDH	174.0	163.15	11.33	11.33	1	8
Abut 5	WSD	16" CIDH	192.5	190.75	6	12.73	1	3

Table 5-4. Foundation Design Loads

Support No.	Service-I Limit State (kips)			Strength Limit State (Controlling Group, kips)				Extreme Event Limit State (Controlling Group, kips)			
	Total Load		Permanent Loads	Compression		Tension		Compression		Tension	
	Per Support	Max. Per Pile	Per Support	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile
Abut 1	186	70	146	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bent 2	530	N/A	390	742	144	0	10	373	240	0	140
Bent 3	586	N/A	428	855	162	0	23	395	240	0	140
Bent 4	554	N/A	407	785	154	0	15	404	240	0	140
Abut 5	186	70	146	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

5.4.3 Axial Pile Capacity

Abutments 1 and 5, and Bents 2, 3, and 4 foundation design recommendations are presented in Table 5-5 and Table 5-6, respectively. The Pile Data Table for the contract plans is presented in Table 5-7.

A pile-group efficiency factor (GEF) of 0.65 is used for a center-to-center pile spacing of 2.5 times the pile diameter, and a GEF of 1.0 is used for a center-to-center spacing of 4.0 times the pile diameter or greater (Section 10.8.3.6.3, AASHTO, 2007). Linear interpolation can be used to determine the GEF for intermediate spacing. Based on the layout provided by the structural designers, GEF's of 1.0 and 0.77 were used for the abutments and bents piles, respectively.

Axial capacity of a single CIDH pile is estimated using the computer program SHAFT Version 6.0 (Ensoft, 2007). The pile capacity calculations are presented in Appendix C. The pile capacity is also based on soil resistance only and may be further limited by the pile-head connection details and the strength of the pile materials.

Table 5-5. Abutments Foundation Design Recommendations

Support	Pile	Cut-off Elevation (feet)	LRFD Service-I Limit State Load per Support (kips)		LRFD Service-I Limit State Total Load per Pile (Compression) (kips)	Nominal Resistance (kips)	Design Tip Elevations (feet)	Specified Tip Elevation (feet)
			Total	Permanent				
Abut 1	16" CIDH	188.25	186	146	70	140	+155 (a) +168 (d)	+155
Abut 5	16" CIDH	190.75	186	146	70	140	+155 (a) +170 (d)	+155

Notes:
1. Design tip elevations are controlled by the following demands: (a) Compression, (c) Settlement, and (d) Lateral Load.
2. There are no design tip elevations for Tension and Settlement at Abutments 1 and 5.
3. The specified tip elevation for Abutments 1 and 5 shall not be raised above the design tip elevation for Lateral Load.

Table 5-6. Bents Foundation Design Recommendations

Support Location	Pile Type	Cut-off Elevation (feet)	Service-I Limit State Loads per Support (kips)	Total Permissible Support Settlement (inch)	Required Factored Nominal Resistance (kips)				Design Tip Elevations (feet)	Specified tip Elevation (feet)
					Strength Limit		Extreme Event			
					Comp. (ϕ=0.7)	Tension (ϕ=0.7)	Comp. (ϕ=1.0)	Tension (ϕ=1.0)		
Bent 2	16" CIDH	163.15	530	1	144	10	240	140	+131 (a-I) +152 (b-I) +130 (a-II) +133 (b-II) +143 (d)	+130
Bent 3	16" CIDH	163.15	586	1	162	23	240	140	+130 (a-I) +148 (b-I) +130 (a-II) +133 (b-II) +143 (d)	+130
Bent 4	16" CIDH	163.15	554	1	154	15	240	140	+131 (a-I) +148 (b-I) +130 (a-II) +133 (b-II) +143 (d)	+130

Notes:
1. Design tip elevations are controlled by the following demands. (a-I) Compression (Strength Limit), (b-I) Tension (Strength Limit), (a-II) Compression (Extreme Event), (b-II) Tension (Extreme Event), (c) Settlement, and (d) Lateral Load.
2. There is no design tip elevation for Settlement at Bents 2, 3, and 4.
3. The Specified tip elevation for Bents 2, 3, and 4 shall not be raised above the design tip elevations for Tension and Lateral Load.

Table 5-7. Pile Data Table

Location	Pile Type	Nominal Resistance (kips)		Design Tip Elevations (feet)	Specified Tip Elevation (feet)
		Compression	Tension		
Abut 1	16" CIDH	140	0	+155 (a) +168 (d)	+155
Bent 2	16" CIDH	240	140	+130 (a) +133 (b) +143 (d)	+130
Bent 3	16" CIDH	240	140	+130 (a) +133 (b) +143 (d)	+130
Bent 4	16" CIDH	240	140	+130 (a) +133 (b) +143 (d)	+130
Abut 5	16" CIDH	140	0	+155 (a) +170 (d)	+155

Notes:

1. Design tip elevations are controlled by the following demands: (a) Compression, (b) Tension, (c) Settlement, and (d) Lateral Load.
2. There is no design tip elevation for Tension at Abutments 1 and 5.
3. There is no design tip elevation for Settlement at Abutments 1 and 5, and Bents 2, 3, and 4.
4. The specified tip elevations shall not be raised above the design tip elevation for Tension and Lateral Load.

5.4.4 Lateral Pile Capacity

5.4.4.1 Lateral Pile Solutions

Lateral pile capacity analyses were performed using the computer program LPILE (Ensoft, 2010). Results of lateral pile analysis in terms of pile-head shear and lateral deflection for a free-head condition are presented for abutments and bents in Table 5-8 and Table 5-9, respectively. The maximum bending moment and the location of maximum moment are also presented.

Based on the layout provided by the structural designers and the procedures outlined in the Ensoft Group 7.0 software Technical Manual (Ensoft, 2006), group reduction factors (P-Multipliers in the LPILE input) of 0.9 and 0.7 are incorporated in the analyses for the abutment and bent piles, respectively.

The solutions presented in Table 5-8 and Table 5-9 are entirely based on soil resistance and linear pile properties. Therefore, these values may be limited by the flexural strength (plastic moment) of the piles and pile-head connection details. Linear interpolation can be used for solutions between pile-head deflections of 0.25 and 5 inches.

Table 5-8. Lateral Pile Solutions for Abutments 1 & 5

Support Location	Pile Head Deflection (in)	Pile Head Shear (k)	Maximum Moment (k-in)	Depth to Max. Moment from Pile Top (feet)
Abutments 1 & 5 (16-in CIDH)	¼	13.8	344	4.1
	½	21.5	637	4.4
	1	30.8	1,126	4.8
	3	51.6	2,582	6.1
	5	64.6	3,709	6.8

Table 5-9. Lateral Pile Solutions for Bents 2, 3, & 4

Support Location	Pile Head Deflection (in)	Pile Head Shear (k)	Maximum Moment (k-in)	Depth to Max. Moment from Pile Top (feet)
Bents 2, 3, & 4 (16-in CIDH)	¼	18.7	387	3.5
	½	29.9	726	3.9
	1	43.1	1,291	4.2
	3	70.0	2,922	5.6
	5	86.0	4,155	6.3

5.4.4.2 Lateral Load Resistance of Bent Pile Footing

Passive earth pressure at the bent pile cap can be used to resist a portion of the lateral loads transferred to the soil. For static design, the passive soil resistance against the embedded face of the bent pile cap should be neglected. Under earthquake loading, this ultimate passive soil resistance should be added to the pile group capacity to determine the total lateral resistance of the pile footing. At the bent location, the ultimate passive soil resistance against the pile footing is estimated to be equal to a maximum equivalent fluid pressure of 360 psf per foot of depth. Note that development of full passive earth pressure requires a lateral pile cap displacement equal to approximately 2 percent of the embedded height (measured from the nearest and lowest ground surface to the bottom of the pile cap). For displacement magnitudes smaller than what is required to mobilize full resistance, the actual resistance magnitude should be determined by linearly interpolating between zero and the full resistance.

5.5 Pier Protection Wall Footing Design

Settlement and bearing capacity calculations for the pier protection wall are included in Appendix C. Using a footing width of 7.5 feet and an embedment of 4 feet (measured from the adjacent ground surface to the footing bottom) provided by the structural designer, an allowable bearing capacity of 3 ksf is recommended provided a minimum of 1 foot of remedial removal

and recompaction are performed. The allowable bearing capacity can be increased to 4 ksf if the minimum remedial removal and recompaction depth is 2 feet.

The above recommended minimum remedial removal and recompaction depths are measured from the footing bottom. The horizontal limits of the remedial removal should begin one-foot from each edge of the footing bottom and extending downward at a 45-degree imaginary plane until the plane intersects the above recommended minimum excavation depths. The excavated onsite soils are suitable for use as backfill with a minimum relative compaction of 95% of maximum density as determined by California Test 216. Prior to backfilling, the excavation bottom should be proof-rolled and after that the excavation bottom should be inspected by a qualified geotechnical engineer or technician to confirm the presence of an unyielding and competent surface.

Resistance to lateral loads may be developed by a combination of friction acting at the base of the wall and passive earth pressure. A maximum passive equivalent fluid pressure of 390 psf per foot and a frictional coefficient of 0.4 can be used for foundation design. We recommend 100% of the base friction only for static loading. For seismic loading, we recommend combining 100% of the passive resistance and 100% of the base friction.

5.6 Embankments Settlement and Slope Stability

5.6.1 Settlement and Settlement Period

Embankment fill will need to be placed to construct the approaches to the bridge widening. Up to 30 feet of embankment fill, approximately 15 feet wide at the crest with 2H:1V side slopes, will be placed to construct the approaches to Abutments 1 and 5. The resulting ground subsidence at Abutments 1 and 5 is estimated to be about 1 inch. Since the onsite soils are primarily coarse-grained materials, soil settlement should occur relatively quickly, and a settlement period for pile construction is not required.

5.6.2 Slope Stability

Global stability analyses were conducted for both static and pseudo-static conditions for the bridge approach embankment slopes. The analysis was performed using the computer program SLIDE 5.0 (Rocscience, 2006). The soil strength parameters in Table 4-1 were used in the static and pseudo-static analysis and the results are presented in Appendix C.

The calculated factor of safety is greater than the minimum required 1.5 under static condition with a 2-foot soil surcharge to represent traffic loading. Slope stability analysis under pseudo-static condition was performed using a seismic coefficient equal to 0.173g (which is the smaller of either one-third the horizontal peak ground acceleration or 0.2g) in accordance with guidelines provided in Section 3.10 of the Caltrans Guidelines for Structures Foundation Reports (Caltrans, 2009c). Analysis indicates that the calculated factor of safety is greater than the required minimum of 1.1 under pseudo-static condition.

For embankment slopes with a gradient of 2H:1V or flatter, surficial stability should not be a design concern. If slope paving is proposed for embankment slopes with a gradient of 1.5H:1V, then surficial stability is also not a design concern. If slope paving is not used for the 1.5H:1V

slopes, it is recommended that the upper 4 feet of any new 1.5H:1V slope face be covered with materials with a minimum internal friction angle of 32 degrees and a minimum cohesion of 230 psf. This select material should be properly keyed and benched into the sloping ground. In all cases, proper maintenance with erosion protection and drainage control in accordance with Section 21 of Caltrans Standard Specifications (Caltrans, 2010b) are also recommended.

5.6.3 Structure Approach Slabs

Selection of the approach type (if required) will be performed by the structural designer following the flowchart in Caltrans Memo to Designers 5-3, Attachment A, dated May 1996 (Caltrans, 1996).

5.7 Bridge Abutment Wall Design

5.7.1 Abutment Earth Pressures

If abutment walls are free to move laterally at the top, a static active lateral earth pressure of 36 psf per foot of depth is recommended for a free draining, level and compacted backfill. If lateral movement at the top of abutment walls is restrained, the lateral earth pressure for a free draining, level and compacted backfill should follow Section 5.5.5.11 of the Caltrans BDS dated August 2004. For this condition, we recommend a coefficient of active lateral earth pressure of 0.3, a coefficient of at-rest lateral earth pressure of 0.46 and a soil unit weight of 120 lb/ft^3. If applicable, a uniform lateral pressure of at least 72 psf due to vehicle loads, equivalent to a vertical pressure produced by at least 2 feet of earth, should be added to the above lateral earth pressure.

5.7.2 Passive Resistance of Abutment Backfill

Under seismic loading, an ultimate passive earth pressure of 5 ksf may be used for the approach backfill and abutment walls with a height equal to or greater than 5.5 feet. For abutment walls with heights less than 5.5 feet, the passive pressure may be calculated proportionally (e.g., for a 4-foot high wall, the passive pressure is [4/5.5]x 5 ksf = 3.64 ksf. The horizontal movement at which the maximum passive pressure is expected to be fully mobilized can be determined following the procedure outlined in Section 7.8.1 of the Caltrans SDC (2009d).

6.0 CONSTRUCTION RECOMMENDATIONS

6.1 Earthwork

Earthwork should be performed in accordance with Caltrans Standard Specifications, Section 19 (Caltrans, 2010b). Appropriate measures should be taken to prevent damage to adjacent structures and utilities. Any design and construction of temporary sloping, sheeting, or shoring should be made the contractor's responsibility. It should be noted that it is the responsibility of the contractor to oversee the safety of the workers in the field during construction. The contractor shall conform to all applicable occupational and health standards, rules, regulations, and orders established by the State of California. In addition, other State, County, or Municipal regulations may supersede the recommendations presented in this section. If a trench shoring design and safety plan is required, the geotechnical consultant should review the plan to confirm that recommendations presented in this report have been applied to the design.

Groundwater was not encountered in any of the as-built or current borings down to elevation +96.9 feet. Therefore, groundwater is not anticipated to be encountered during pile and footing construction at the abutments and bents. However, groundwater level can fluctuate due to seasonal rainfall amount, local irrigation and groundwater recharge program, and other man-made conditions. If groundwater is encountered during footing construction, it should be controlled in accordance with Section 19-3.03D of the Caltrans Standard Specifications (2010b).

6.2 Pile Construction

Construction of CIDH piles should follow Section 49-4.03B, "Drilled Holes" of the Caltrans Standard Specifications (2010b). The Contractor should be required to drill the bottom of the shaft boring with a clean-out bucket to ensure adequate removal of loose soils. Both clean-out and concrete placement should be addressed in the specifications. The shaft borings should be inspected and approved by the Resident Engineer prior to installation of reinforcement. Per latest Caltrans requirement, 3-inch of concrete cover over reinforcement should be provided to improve the construction of the CIDH piles.

The onsite fill and alluvial soils generally range from loose to very dense coarse grained materials, and these materials are susceptible to caving. If caving occurs, a temporary casing can be used. The casing should have an inside diameter larger than or equal to the pile diameter and should be placed tight in the hole. Vibratory hammers or oversized drilling are not allowed for casing installation. In the event that any boring becomes bell-shaped and cannot be advanced due to severe caving, all loose material should be removed from the bottom of the boring and the caved region filled with a low strength sand-cement slurry. Drilling may continue when the slurry has reached its initial set.

6.3 Backdrain and Backfill Requirements For Abutment Walls

Expansive soils should not be placed as part of the embankment within the limits of a bridge abutment as shown in Figure 6-1. Materials placed behind abutment walls should be low-expansive soil with an Expansion Index (EI) less than 50 and Sand Equivalent (SE) of more than 20. The low-expansive material requirement should be supplemental to the abutment structure and pervious backfill requirement as described in Caltrans Standard Plans (2010a) and Caltrans Standard Specifications (2010b) under Sections 19-3.03E and 19-3.03G, respectively.

Backfill should be compacted in accordance with Section 19-5 of the Caltrans Standard Specifications (2010b). Backfill should be placed in loose lifts not exceeding 8 inches in thickness, moisture-conditioned to near optimum moisture content, and compacted to at least 95 percent relative compaction. The relative compaction should be based on the maximum density determined by California Test Method 216. Jetting or flooding to compact backfill is not recommended. Heavy compaction equipment, such as vibratory rollers, dozers, or loaders, should not be used adjacent to the abutment walls in order to avoid damaging the walls due to large lateral earth pressures.

Backdrains should be installed behind abutment walls to relieve hydrostatic pressure. Backdrains should be constructed in accordance with Bridge Detail 3-1 on Sheet B0-3 per Caltrans Standard Plans (2010a) or the geocomposite drain alternative per Section 6 of the Caltrans Bridge Design Details (1992).

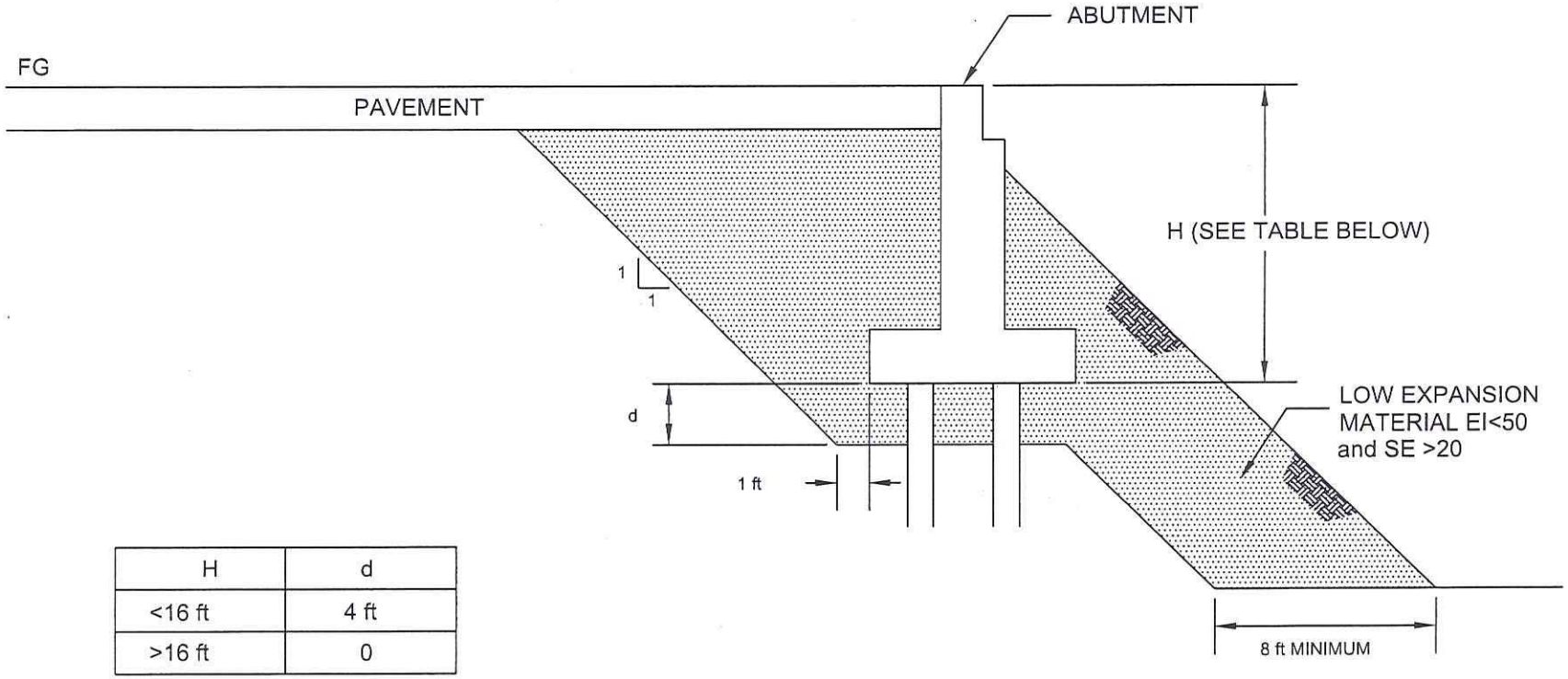
6.4 Review of Construction Plans

Recommendations contained in this report are based on preliminary plans. The geotechnical consultant should review the final construction plans and specifications in order to confirm that the general intent of the recommendations contained in this report have been incorporated into the final construction documents. Recommendations contained in this report may require modification or additional recommendations may be necessary based on the final design.

6.5 Geotechnical Observation and Testing

It is recommended that inspections and testing be performed by the geotechnical consultant during the following stages of construction:

- Grading operations, including excavations and placement of compacted fill
- Shoring installation
- Footing excavations and pile constructions
- Backdrain installation and backfilling of bridge abutment walls
- Removal or installation of support of buried utilities or structures
- When any unusual subsurface conditions are encountered



H	d
<16 ft	4 ft
>16 ft	0

EXPANSION INDEX TO BE DETERMINED BY ASTM D4829
SAND EQUIVALENT TO BE DETERMINED BY CALIFORNIA TEST METHOD 217

NO SCALE

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	North Anaheim OH (Widen)	Low Expansion Material In Bridge Embankment
	Project No. 10-126 / Date: 03-10-11	Figure 6-1

7.0 LIMITATIONS

This report is intended for the use of RBF, OCTA, and Caltrans for widening of North Anaheim OH. This report is based on the project as described and the information obtained from the exploratory borings at the approximate locations indicated on the attached plans. The findings and recommendations contained in this report are based on the results of the field investigation, laboratory tests, and engineering analyses. In addition, soils and subsurface conditions encountered in the exploratory borings are presumed to be representative of the project site. However, subsurface conditions and characteristics of soils between exploratory borings can vary. The findings reflect an interpretation of the direct evidence obtained. The recommendations presented in this report are based on the assumption that an appropriate level of quality control and quality assurance (inspections and tests) will be provided during construction. EMI should be notified of any pertinent changes in the project plans or if subsurface conditions are found to vary from those described herein. Such changes or variations may require a re-evaluation of the recommendations contained in this report.

The data, opinions, and recommendations contained in this report are applicable to the specific design element(s) and location(s) which is (are) the subject of this report. They have no applicability to any other design elements or to any other locations and any and all subsequent users accept any and all liability resulting from any use or reuse of the data, opinions, and recommendations without the prior written consent of EMI.

EMI has no responsibility for construction means, methods, techniques, sequences, or procedures; for safety precautions or programs in connection with the construction; for the acts or omissions of the CONTRACTOR or any other person performing any of the construction; or for the failure of any worker to carry out the construction in accordance with the Final Construction Drawings and Specifications.

Services performed by EMI have been conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, expressed or implied, and no warranty or guarantee is included or intended.

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Appendix A

LOG OF TEST BORINGS SHEETS

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk
Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

BENCH MARK

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4	25	29

REGISTERED ENGINEER — DATE 09/16/11

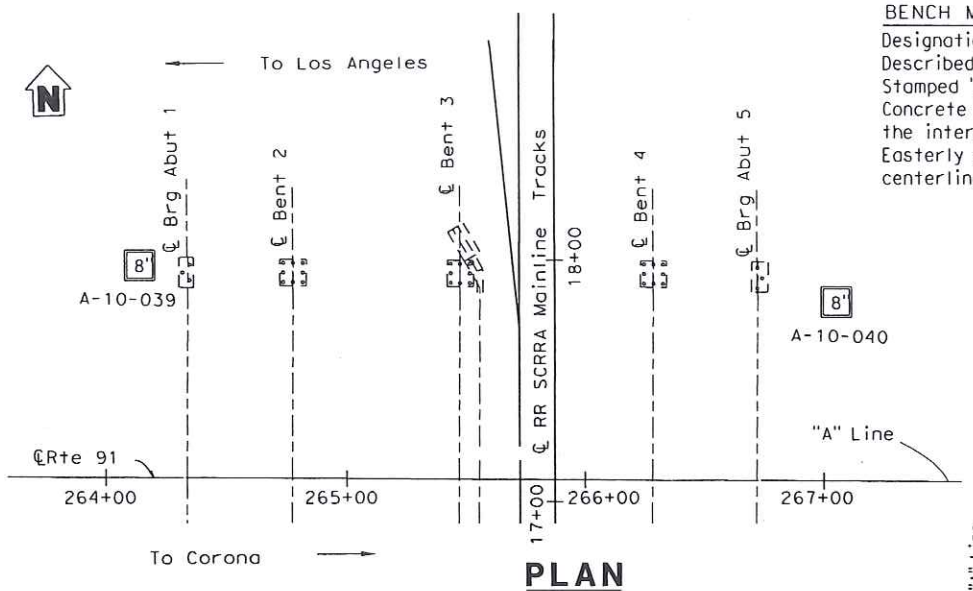
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

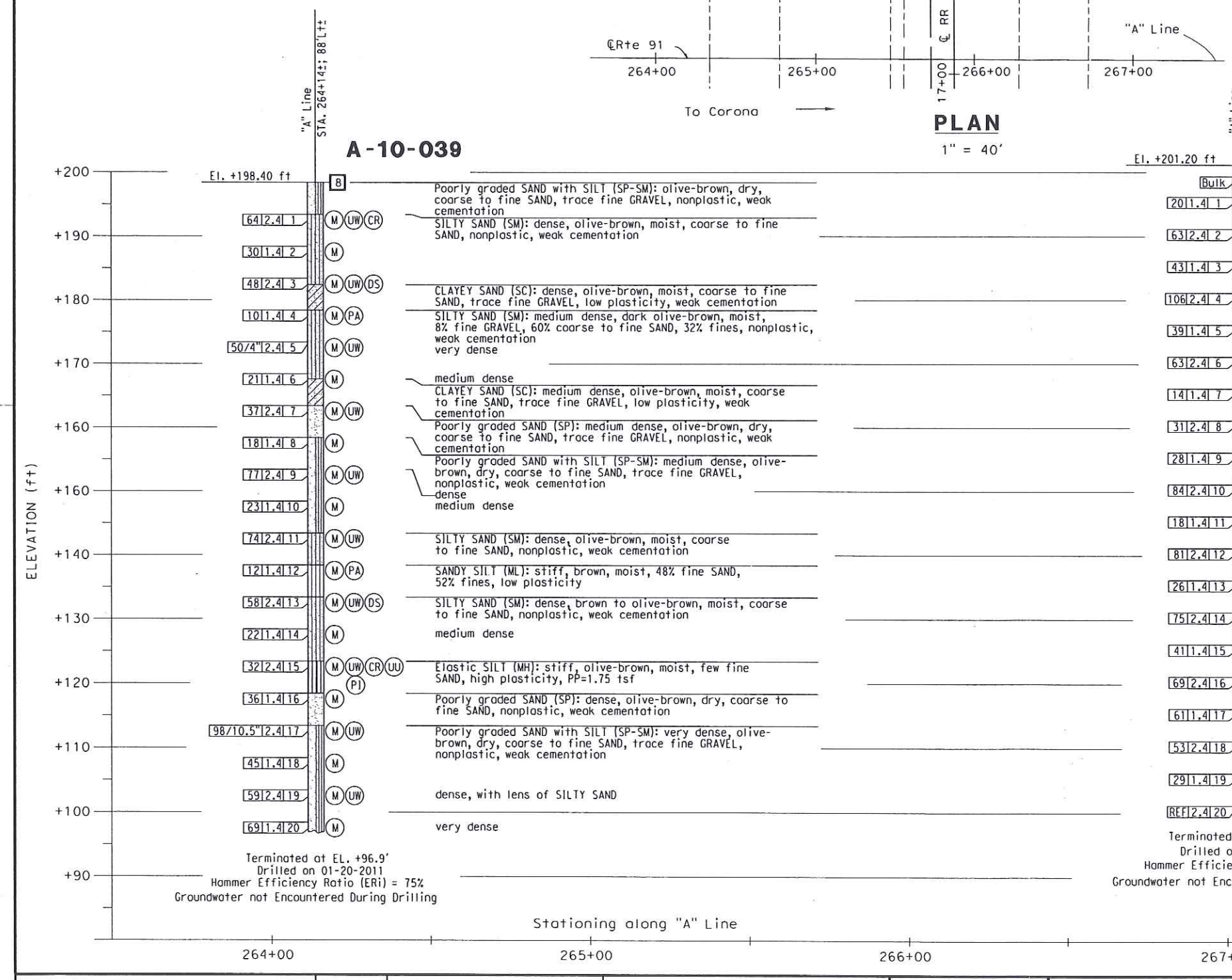
ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

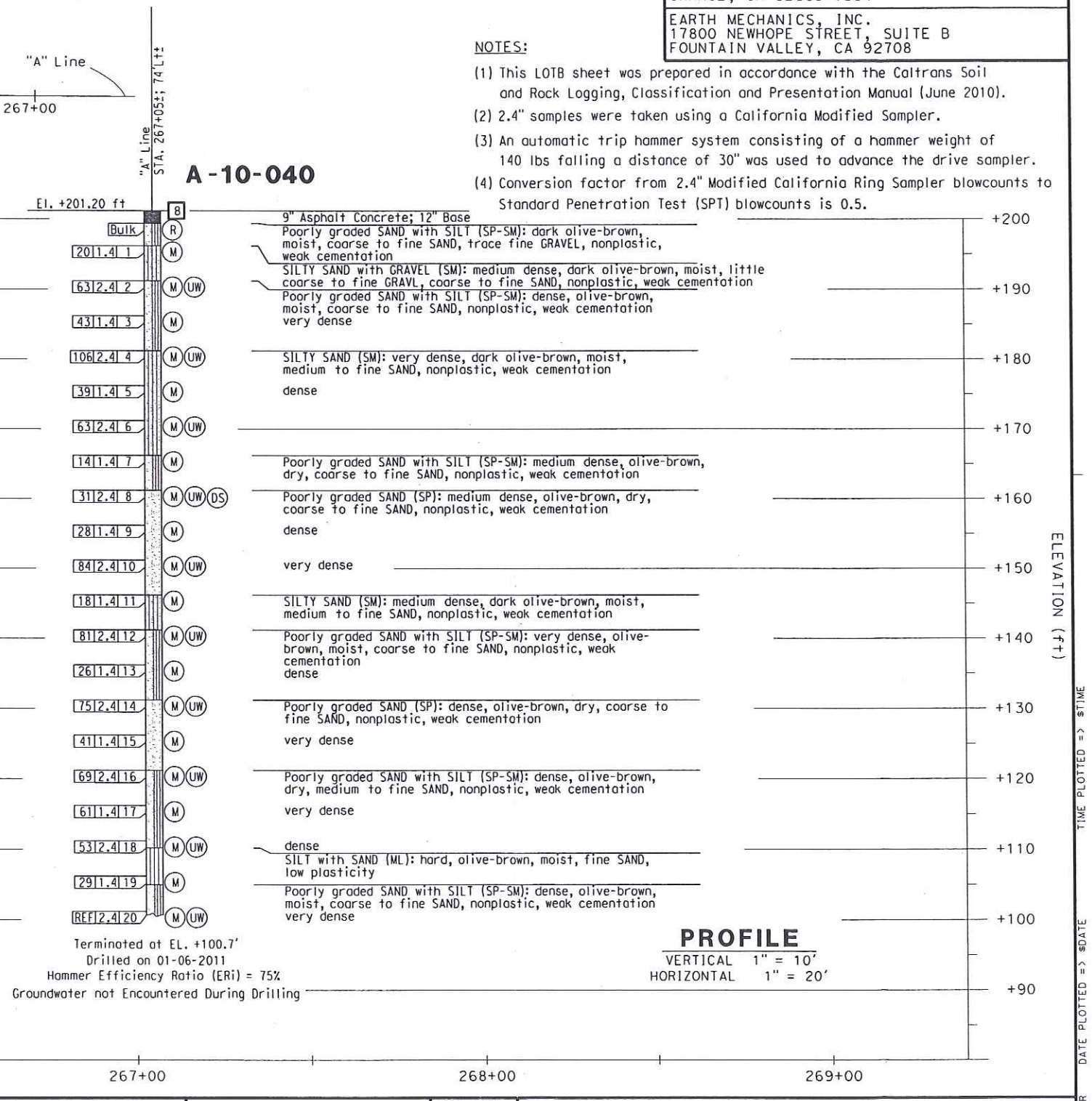
EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708



PLAN

1" = 40'





PROFILE

VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

Stationing along "A" Line
264+00
265+00
266+00
267+00
268+00
269+00

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).
(2) 2.4" samples were taken using a California Modified Sampler.
(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.
(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. 55-0216
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011			PROJECT ENGINEER	POST MILES 4.0

NORTH ANAHEIM OH (WIDEN)

LOG OF TEST BORINGS 1 OF 5

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

SHEET 25 OF 29

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4	26	29

REGISTERED ENGINEER — 09/16/11 DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

PLANS APPROVAL DATE

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550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

CEMENTATION

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

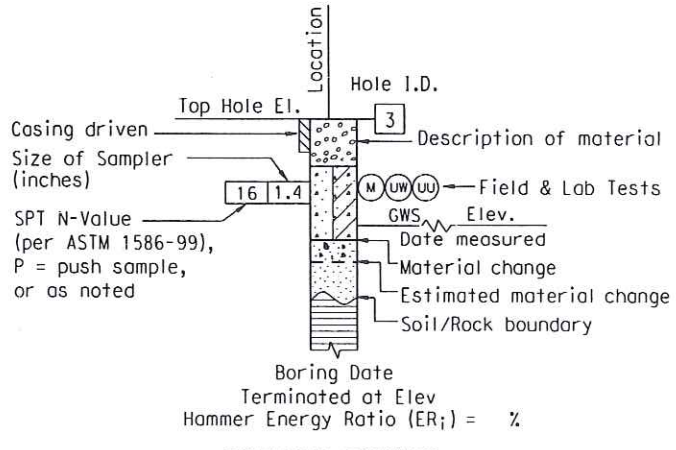
BOREHOLE IDENTIFICATION

Symbol	Hole Type	Description
Size	A	Auger Boring (hollow or solid stem bucket)
Size	R RW RC P	Rotary drilled boring (conventional) Rotary drilled with self-casing wire-line Rotary core with continuously-sampled, self-casing wire-line Rotary percussion boring (air)
Size	R	Rotary drilled diamond core
Size	HD HA	Hand driven (1-inch soil tube) Hand Auger
●	D	Dynamic Cone Penetration Boring
▲	CPT	Cone Penetration Test (ASTM D 5778)
[ ]	O	Other (note on LOTB)

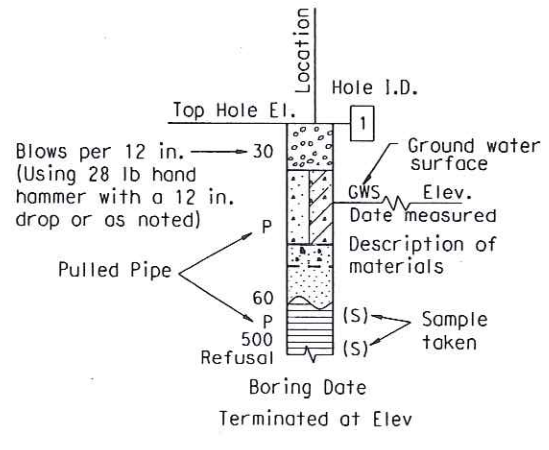
Note: Size in inches.

CONSISTENCY OF COHESIVE SOILS

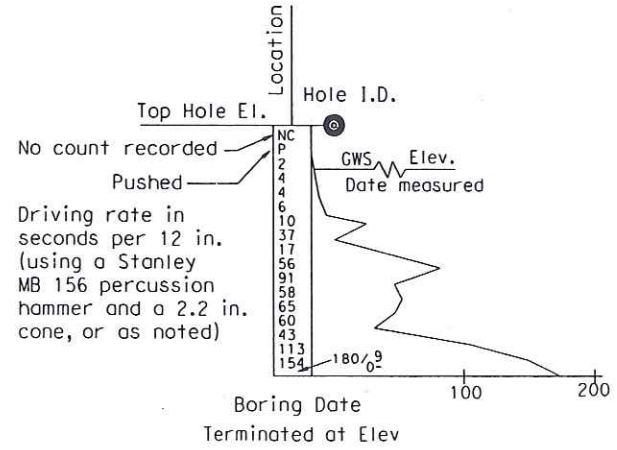
Description	Shear Strength (tsf)	Pocket Penetrometer Measurement, PP, (tsf)	Torvane Measurement, TV, (tsf)	Vane Shear Measurement, VS, (tsf)
Very Soft	Less than 0.12	Less than 0.25	Less than 0.12	Less than 0.12
Soft	0.12 - 0.25	0.25 - 0.5	0.12 - 0.25	0.12 - 0.25
Medium Stiff	0.25 - 0.5	0.5 - 1	0.25 - 0.5	0.25 - 0.5
Stiff	0.5 - 1	1 - 2	0.5 - 1	0.5 - 1
Very Stiff	1 - 2	2 - 4	1 - 2	1 - 2
Hard	Greater than 2	Greater than 4	Greater than 2	Greater than 2



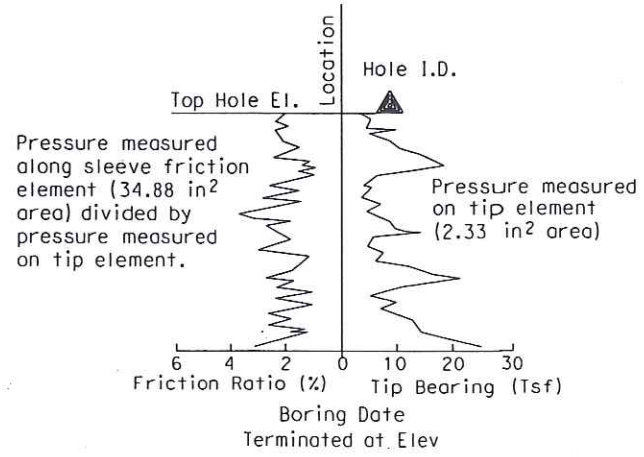
ROTARY BORING



HAND BORING



DYNAMIC CONE PENETRATION BORING



CONE PENETRATION TEST (CPT) BORING

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie FIELD INVESTIGATION BY:	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. 55-0216 POST MILES 4.0	NORTH ANAHEIM OH (WIDEN) LOG OF TEST BORINGS 2 OF 5
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	DATE: 12/2010,1/2011		UNIT: 2295 PROJECT NUMBER & PHASE: 12000000791	DISREGARD PRINTS BEARING EARLIER REVISION DATES →	REVISION DATES SHEET 26 OF 29

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

GROUP SYMBOLS AND NAMES

Graphic/Symbol	Group Names	Graphic/Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND	CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
GP	Poorly-graded GRAVEL Poorly-graded GRAVEL with SAND		
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND	CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GP-GM	Poorly-graded GRAVEL with SILT Poorly-graded GRAVEL with SILT and SAND	ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
GP-GC	Poorly-graded GRAVEL with CLAY (or SILTY CLAY) Poorly-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GM	SILTY GRAVEL SILTY GRAVEL with SAND	OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND		
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND	OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL		
SP	Poorly-graded SAND Poorly-graded SAND with GRAVEL	CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL		
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
SP-SM	Poorly-graded SAND with SILT Poorly-graded SAND with SILT and GRAVEL		
SP-SC	Poorly-graded SAND with CLAY (or SILTY CLAY) Poorly-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
SM	SILTY SAND SILTY SAND with GRAVEL		
SC	CLAYEY SAND CLAYEY SAND with GRAVEL	OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY ORGANIC elastic SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL		
PT	PEAT	OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND
	COBBLES COBBLES and BOULDERS BOULDERS		

FIELD AND LABORATORY TESTING

- (C) Consolidation (ASTM D 2435)
- (CL) Collapse Potential (ASTM D 5333)
- (CP) Compaction Curve (CTM 216)
- (CR) Corrosivity Testing (CTM 643, CTM 422, CTM 417)
- (CU) Consolidated Undrained Triaxial (ASTM D 4767)
- (DS) Direct Shear (ASTM D 3080)
- (EI) Expansion Index (ASTM D 4829)
- (M) Moisture Content (ASTM D 2216)
- (OC) Organic Content-% (ASTM D 2974)
- (P) Permeability (CTM 220)
- (PA) Particle Size Analysis (ASTM D 422)
- (PI) Plasticity Index (AASHTO T 90) Liquid Limit (AASHTO T 89)
- (PL) Point Load Index (ASTM D 5731)
- (PM) Pressure Meter
- (R) R-Value (CTM 301)
- (SE) Sand Equivalent (CTM 217)
- (SG) Specific Gravity (AASHTO T 100)
- (SL) Shrinkage Limit (ASTM D 427)
- (SW) Swell Potential (ASTM D 4546)
- (UC) Unconfined Compression-Soil (ASTM D 2166) Unconfined Compression-Rock (ASTM D 2938)
- (UU) Unconsolidated Undrained Triaxial (ASTM D 2850)
- (UW) Unit Weight (ASTM D 4767)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4	27	29

REGISTERED ENGINEER — DATE 09/16/11

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

PLANS APPROVAL DATE

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

APPARENT DENSITY OF COHESIONLESS SOILS

Description	SPT N_{60} (Blows / 12 in.)
Very Loose	0 - 5
Loose	5 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Greater than 50

MOISTURE

Description	Criteria
Dry	No discernable moisture
Moist	Moisture present, but no free water
Wet	Visible free water

PERCENT OR PROPORTION OF SOILS

Description	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5% - 10%
Little	15% - 25%
Some	30% - 45%
Mostly	50% - 100%

PARTICLE SIZE

Description		Size (in.)
Boulder		Greater than 12
Cobble		3 - 12
Gravel	Coarse	3/4 - 3
	Fine	1/5 - 3/4
Sand	Coarse	1/16 - 1/5
	Medium	1/64 - 1/16
	Fine	1/300 - 1/64
Silt and Clay		Less than 1/300

DESIGN OVERSIGHT — SIGN OFF DATE

DRAWN BY: J. Fang — CHECKED BY: G. J. Gunaranjan

FIELD INVESTIGATION BY: R. Jie — DATE: 12/2010,1/2011

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

S. Pirathiviraj — PROJECT ENGINEER

BRIDGE NO. 55-0216 — POST MILES 4.0

UNIT: 2295 — PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

NORTH ANAHEIM OH (WIDEN)

LOG OF TEST BORINGS 3 OF 5

REVISION DATES

SHEET 27 OF 29

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

USERNAME => $USER — DATE PLOTTED => $DATE — TIME PLOTTED => $TIME

BRIDGE DEPARTMENT

FED. ROAD DIV. NO.	STATE	PROJ. No.	FISCAL YEAR	SHEET No.	TOTAL SHEETS
7	CAL.			103	151

DIST.	COUNTY	ROUTE	SECTION	SHEET No.	TOTAL SHEETS
07	ORA	91	3.4/8.6	195	325

DATE APPROVED April 19 1965

FIELD STUDY	D. G. McCURDY
DRAWN	ANDY. LMP 4-1-65
CHECKED	J.M. 4-2-1965

DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES

As-Built Log of Test Borings sheet is considered an informational document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date confirm that this is a true and accurate copy of the original document. This drawing is available and presented only for the convenience of any bidder, contractor or other, interested party.

DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
12	ORA	91	0.9/5.4	28	29

GEOTECHNICAL PROFESSIONAL — DATE 09/16/11

NORTH ANAHEIM OH (WIDEN)

LOG OF TEST BORINGS 4 OF 5

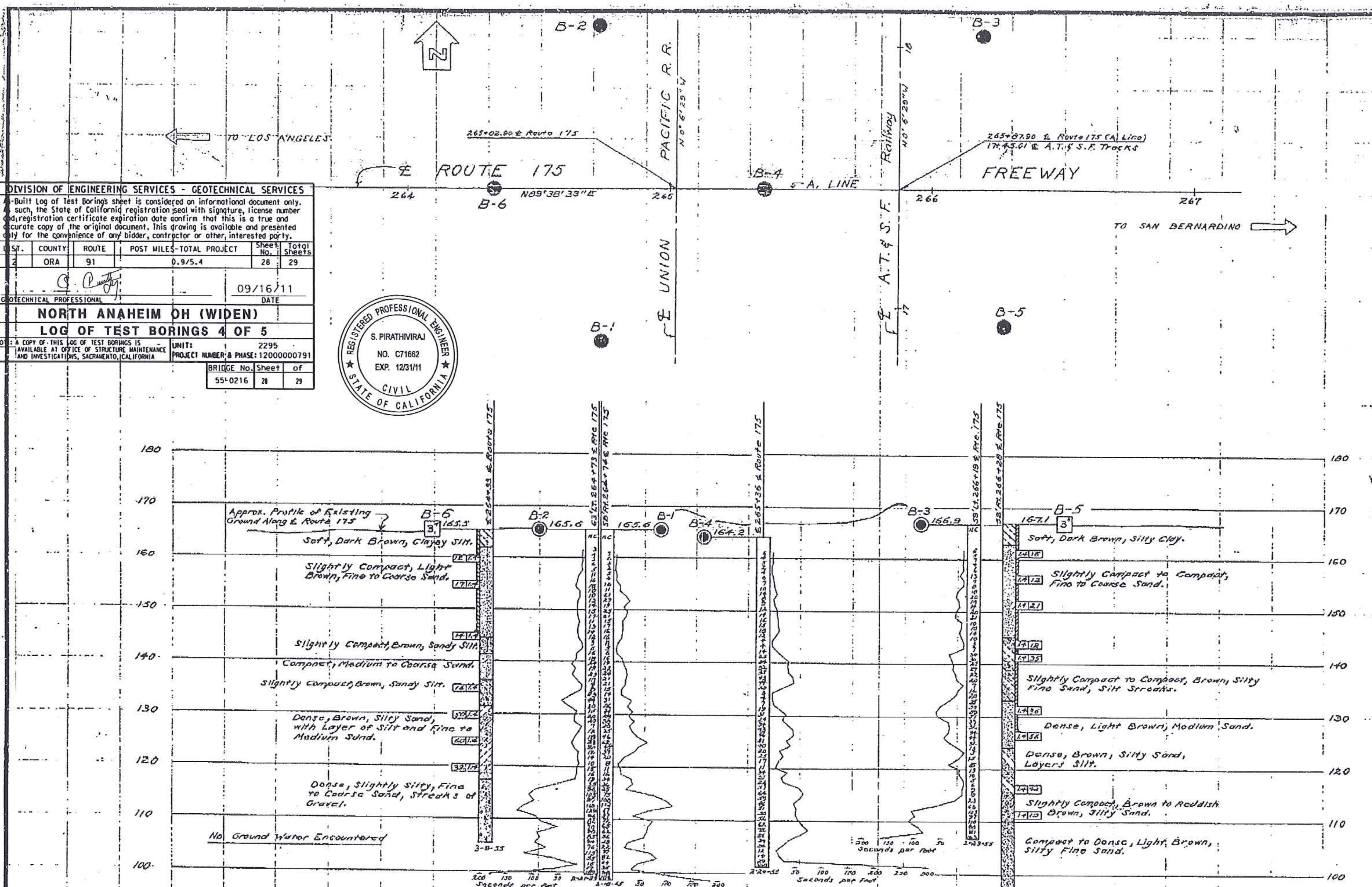
NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

UNIT: 2295

PROJECT NUMBER & PHASE: 12000000791

BRIDGE No.	Sheet	of
55-0216	28	29

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA



B.M. 26a B54
Brass cap in 8" P.C.C. Mon. 260' Rt. Sta. 257+32± "P" Line 2±' off chain Link Fence. Buried 1A'
Elev. 162.65'

B.M. 26b B54
Chis'ld Knob in S.E. Cor. R.R. Signal Switch box 8± Lt. Sta. 17+40 S.P. R.R. Tracks.
Elev. 170.56'

Test Boring by Bridge Dept.

AS BUILT PLANS
Contract No. 07-037424
Date Completed 2-17-67
Document No. 700000.22

AS BUILT
No CORRECTIONS BY C.J. Hixson HP 6/67
CONTRACT NO. 07-037424 (503)
DATE 2/21/67

SHEET	OF
8	8

CLASSIFICATION OF MATERIAL BASED ON STANDARD GRADE SIZE LIMITS

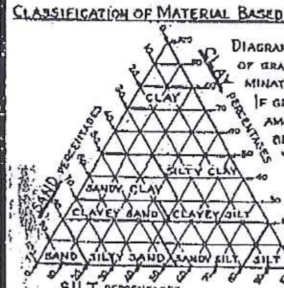


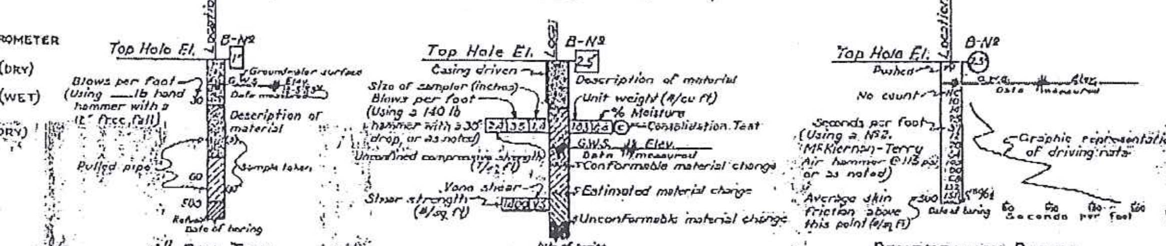
Diagram showing the basis for estimates of grade size distribution used in determination of class names. If gravel is present in appreciable amounts the term "gravelly" may be added to the class name, viz. "gravelly sand". The terms "coarse", "medium" and "fine" when used to describe sand, silt and gravel refer to standard grade size limits.

LEGEND OF EARTH MATERIALS

Gravel	Silty Clay or Clayey Silt
Sand	Peat and/or Organic Matter
Silt	Fill Material
Clay	Igneous Rock
Sandy Clay or Clayey Sand	Sedimentary Rock
Sandy Silt or Silty Sand	Metamorphic Rock

LEGEND OF BORING OPERATIONS

- Plan of any boring
- Penetrometer
- 2¼" Cone Penetrometer
- Sampler boring (dry)
- Rotary boring (wet)
- Auger boring (dry)
- Jet boring
- Core boring
- Test pit



NOTES

The contractor's attention is directed to Section 2, Article (c) of the Standard Specifications and to the Special Provisions accompanying this set of plans.

Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

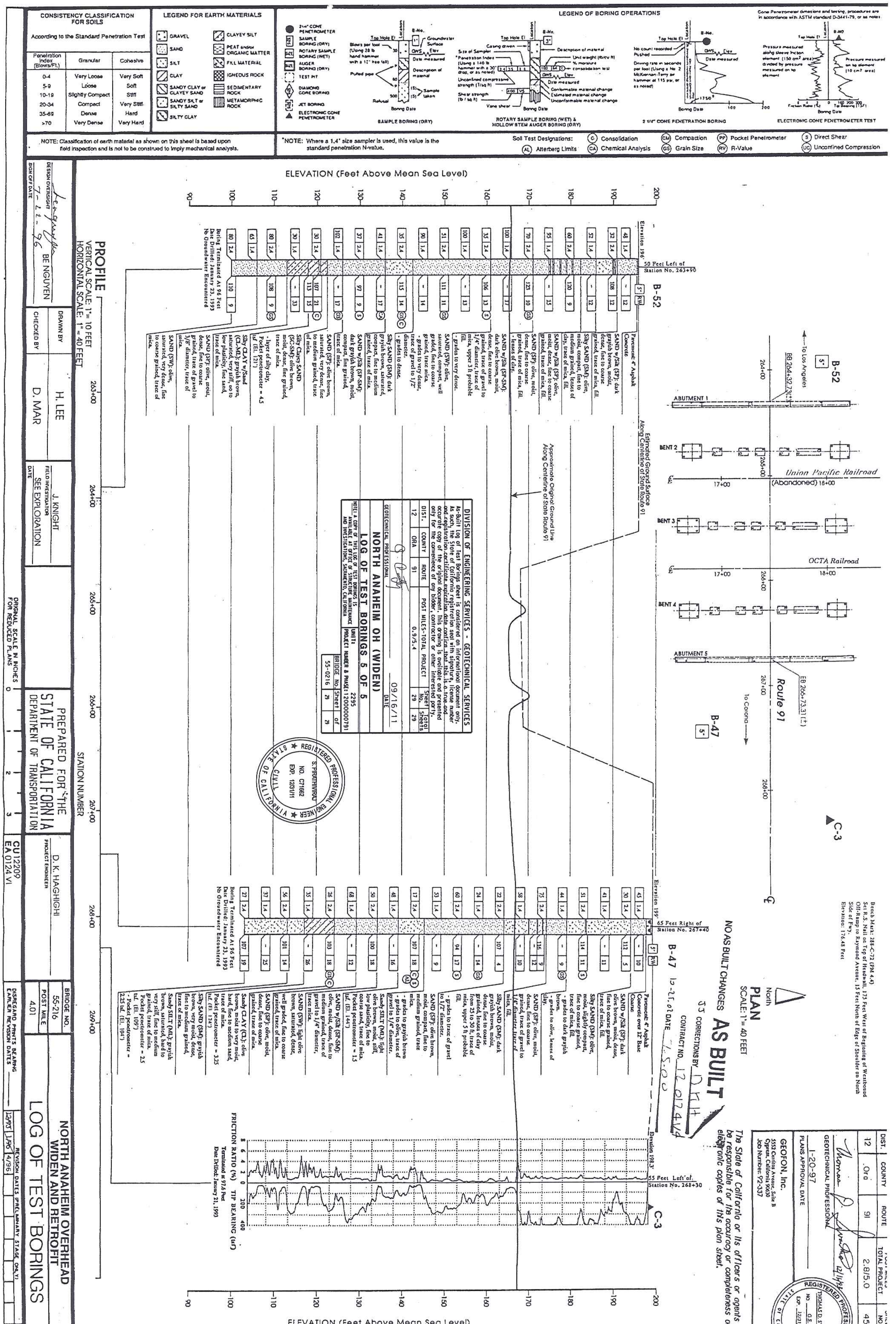
STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

NORTH ANAHEIM O.H.

LOG OF TEST BORINGS

SCALE Horiz.: 1"=20' Vert.: 1"=10'	BRIDGE 55-216 ½	FILE	DRAWING 55216-8

Box 181



CONSISTENCY CLASSIFICATION FOR SOILS
According to the Standard Penetration Test
LEGEND FOR EARTH MATERIALS
LEGEND OF BORING OPERATIONS
NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.
NOTE: Where a 1.4" size sampler is used, this value is the standard penetration N-value.
Soil Test Designations:
ELEVATION (Feet Above Mean Sea Level)
PROFILE
VERTICAL SCALE: 1"= 10 FEET
HORIZONTAL SCALE: 1" = 40 FEET
B-52
B-47
C-3
PLAN
SCALE: 1"= 40 FEET
Route 91
Union Pacific Railroad
OCTA Railroad
AS BUILT
DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES
NORTH ANAHEIM OH (WIDEN)
LOG OF TEST BORINGS 5 OF 5
STATION NUMBER
PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION
NORTH ANAHEIM OVERHEAD WIDEN AND RETROFIT
LOG OF TEST BORINGS
GEOFON, Inc.
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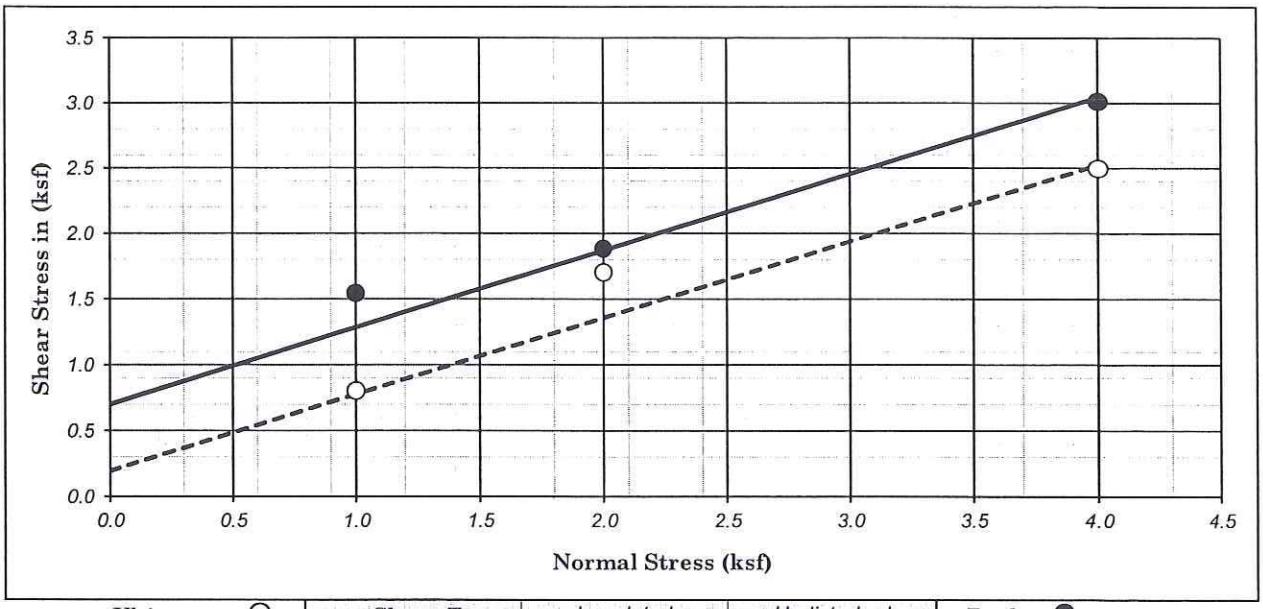
Appendix B

LABORATORY TEST RESULTS

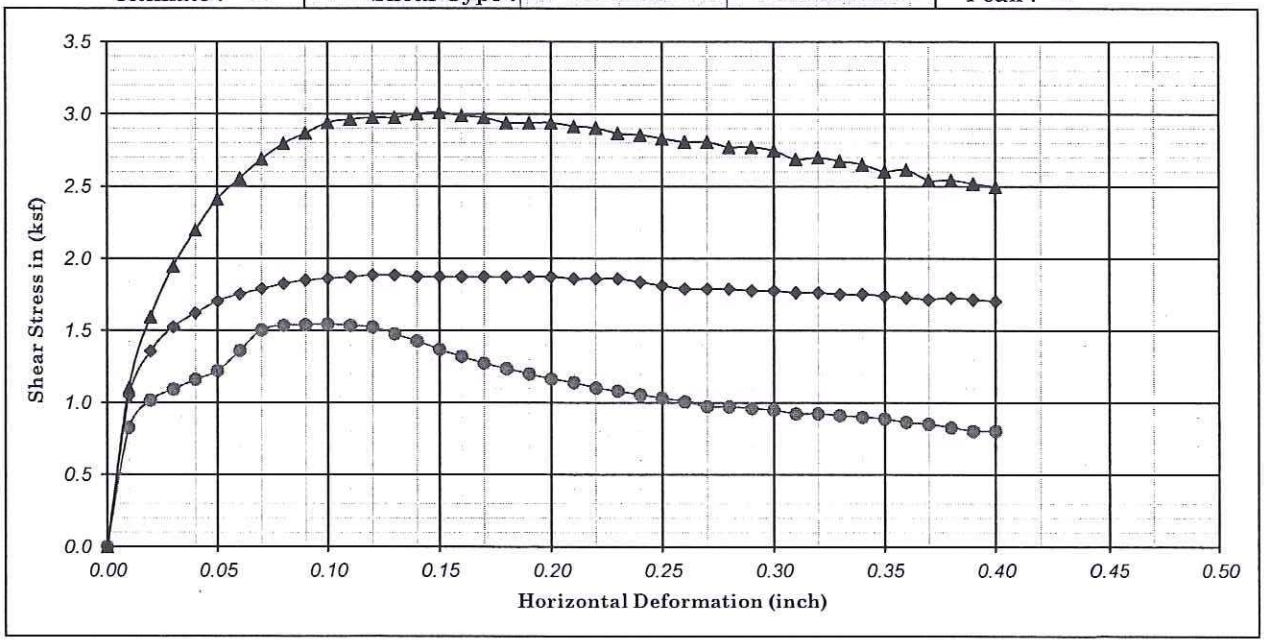
TABLE 1 SUMMARY OF LABORATORY TEST RESULTS FOR NORTH ANAHEIM OH

Project No. : *10-126* Project Name : RBF / SR-91 WB Widening

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-039	*D-1*	5	SM	8.3	139.2						4800	8.0	120	191
A-10-039	*S-2*	10	SM	16.4										
A-10-039	*D-3*	15	SP-SM to SC	10.9	136.0									
A-10-039	*S-4*	20	SM	13.1				8:60:32						
A-10-039	*D-5*	25	SM	3.1	115.0									
A-10-039	*S-6*	30	SM to SC	3.4										
A-10-039	*D-7*	35	SP	0.8	110.7									
A-10-039	*S-8*	40	SP-SM	3.6										
A-10-039	*D-9*	45	SP-SM	4.1	113.1									
A-10-039	*S-10*	50	SP-SM	6.3										
A-10-039	*D-11*	55	SM	5.6	113.6									
A-10-039	*S-12*	60	ML	15.1				0:48:52						
A-10-039	*D-13*	65	SM	10.5	134.4									
A-10-039	*S-14*	70	SM	12.3										
A-10-039	*D-15*	75	MH	28.7	120.9	1.75				67/34/33	760	7.9	40	253
A-10-039	*S-16*	80	SP	3.6										
A-10-039	*D-17*	85	SP-SM	2.3	114.5									
A-10-039	*S-18*	90	SP-SM	3.5										
A-10-039	*D-19*	85	SM to SP-SM	8.8	130.9									
A-10-039	*S-20*	100	SP-SM	3.5										
A-10-040	*S-1*	5	SM	8.3										
A-10-040	*D-2*	10	SP-SM	4.6	115.6									
A-10-040	*S-3*	15	SP-SM	4.4										
A-10-040	*D-4*	20	SM	8.4	130.1									
A-10-040	*S-5*	25	SM	7.8										
A-10-040	*D-6*	30	SM	11.7	134.4									
A-10-040	*S-7*	35	SP-SM	4.5										
A-10-040	*D-8*	40	SP	3.1	106.7									
A-10-040	*S-9*	45	SP	2.5										
A-10-040	*D-10*	50	SP	2.0	105.2									
A-10-040	*S-11*	55	SM	16.5										
A-10-040	*D-12*	60	SP-SM	1.9	107.2									
A-10-040	*S-13*	65	SP-SM	6.0										
A-10-040	*D-14*	70	SP	2.1	110.5									
A-10-040	*S-15*	75	SP	3.1										
A-10-040	*D-16*	80	SM to SP-SM	2.9	116.6									
A-10-040	*S-17*	85	SP-SM	5.1										
A-10-040	*D-18*	90	SP-SM to ML	15.9	124.6									
A-10-040	*S-19*	95	ML to SP-SM	19.3										
A-10-040	*D-20*	100	SP-SM	4.9	106.6									



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-039		Strength Intercept (C) :	0.98	(ksf)	Peak	0.41	(ksf)	Ultimate
Sample No. : D-3			46.92	(kPa)		19.54	(kPa)	
Depth (ft/m) : 15.0	0.00	Friction Angle (ϕ) :	30.33	Degree		30.17	Degree	

Description : Dark brown, CLAYEY SAND (SC) — Shear Rate (inch/minute) : 0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	18.16	117.85	18.55	0.43	1.00	47.88	1.54	73.93	0.80	38.50
◆	20.18	114.11	17.96	0.48	2.00	95.76	1.88	90.21	1.70	81.59
▲	17.41	114.75	18.06	0.47	4.00	191.52	3.01	144.21	2.50	119.51

Earth Mechanics, Inc.
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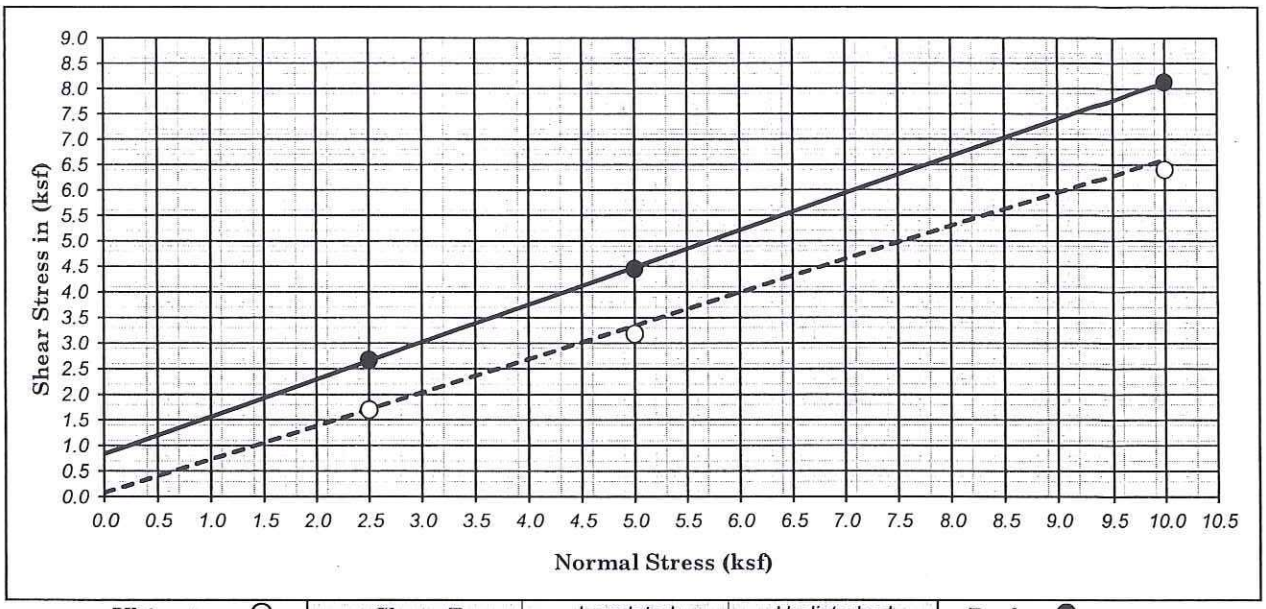
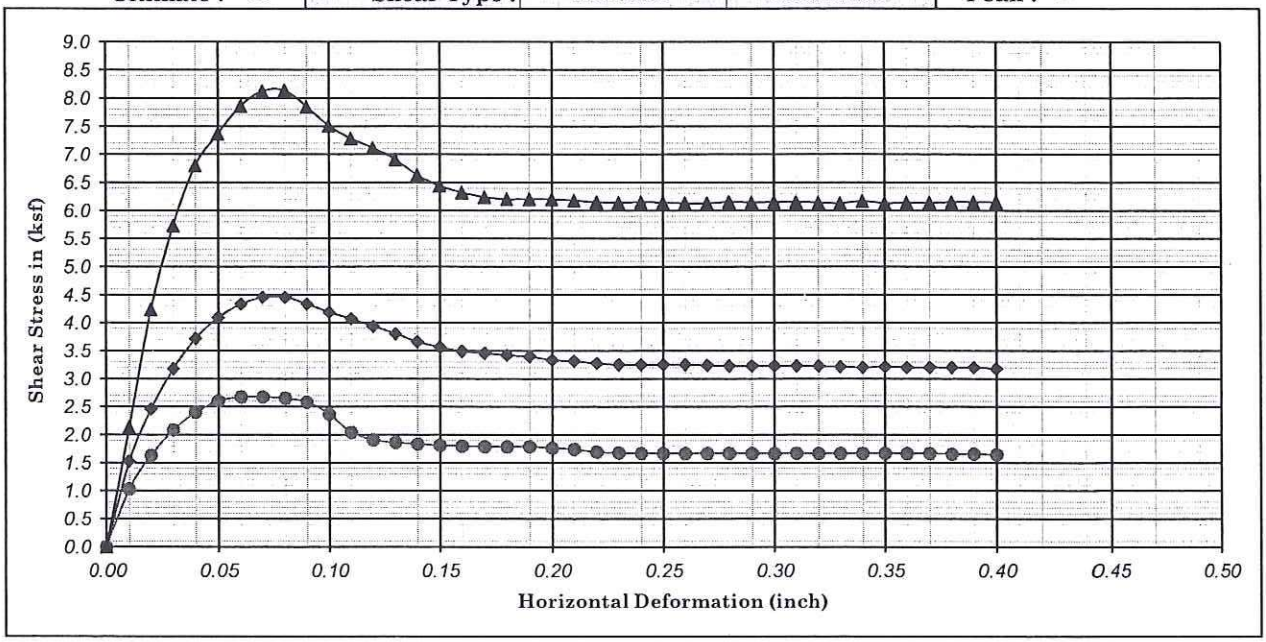
RBF/SR-91 WB Widening

DIRECT SHEAR TEST
(ASTM D-3080)

Project No. : 10-126 | Date : 02/09/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-039		Strength Intercept (C) :	0.83	(ksf)	Peak	0.09	(ksf)	Ultimate
Sample No. : D-13			39.96	(kPa)		4.31	(kPa)	
Depth (ft/m) : 65.0	0.00	Friction Angle (ϕ) :	36.10	Degree		33.10	Degree	
Description : Olive-brown, SILTY SAND (SM)					Shear Rate (inch/minute) :		0.02	

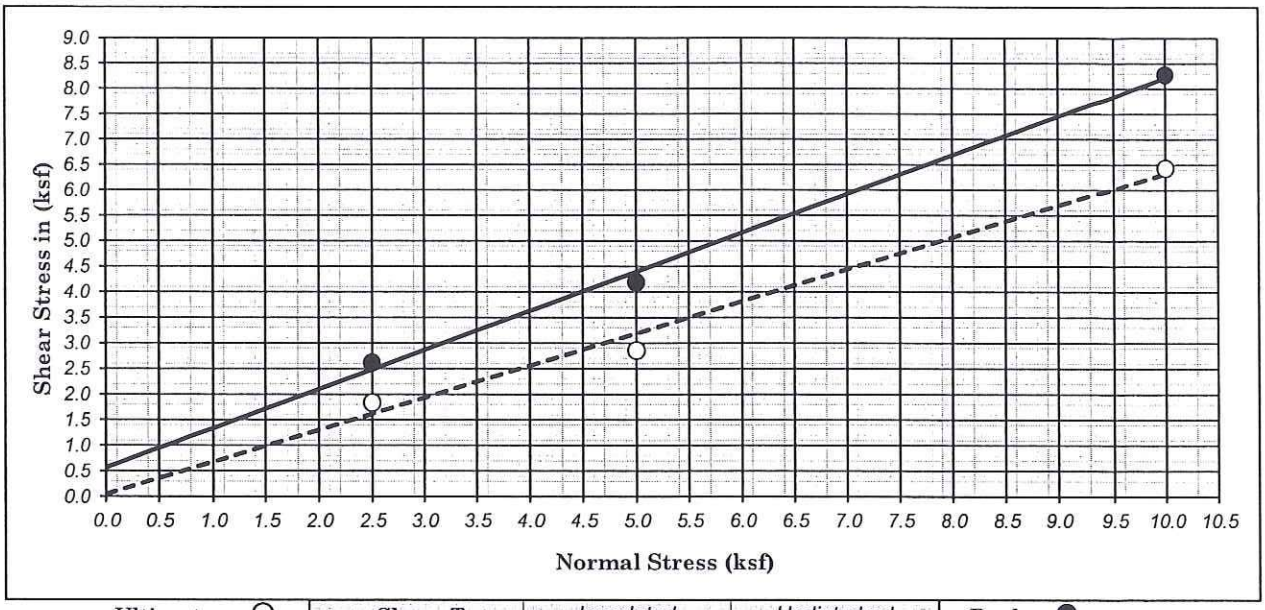
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	17.49	116.61	18.35	0.45	2.50	119.70	2.68	128.13	1.70	81.40
◆	17.58	117.17	18.44	0.44	5.00	239.40	4.45	213.16	3.18	152.26
▲	16.23	117.59	18.51	0.43	10.00	478.80	8.14	389.50	6.40	306.43

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

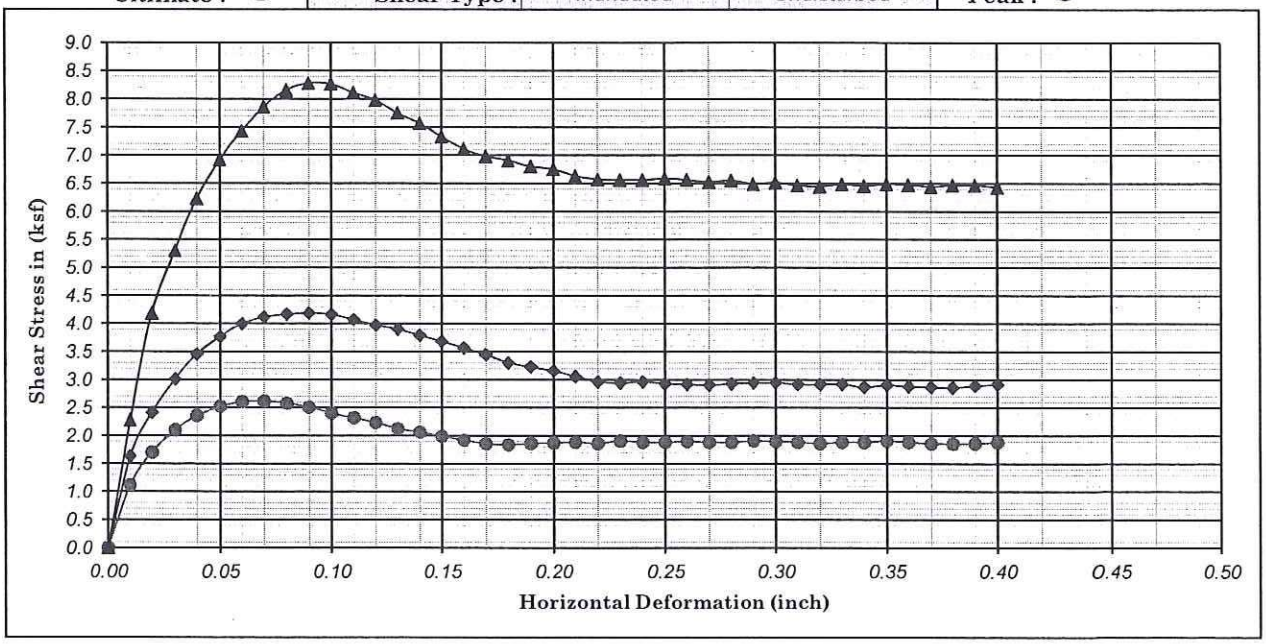
RBF/SR-91 WB Widening

DIRECT SHEAR TEST
(ASTM D-3080)

Project No. : 10-126 | Date : 02/12/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-040		Strength Intercept (C) :	0.57	(ksf)	Peak	0.05	(ksf)	Ultimate
Sample No. : D-8			27.32	(kPa)		2.32	(kPa)	
Depth (ft/m) : 40.0	0.00	Friction Angle (ϕ) :	37.38	Degree		32.10	Degree	
Description : Olive-brown, Poorly graded SAND (SP)					Shear Rate (inch/minute) :			0.02

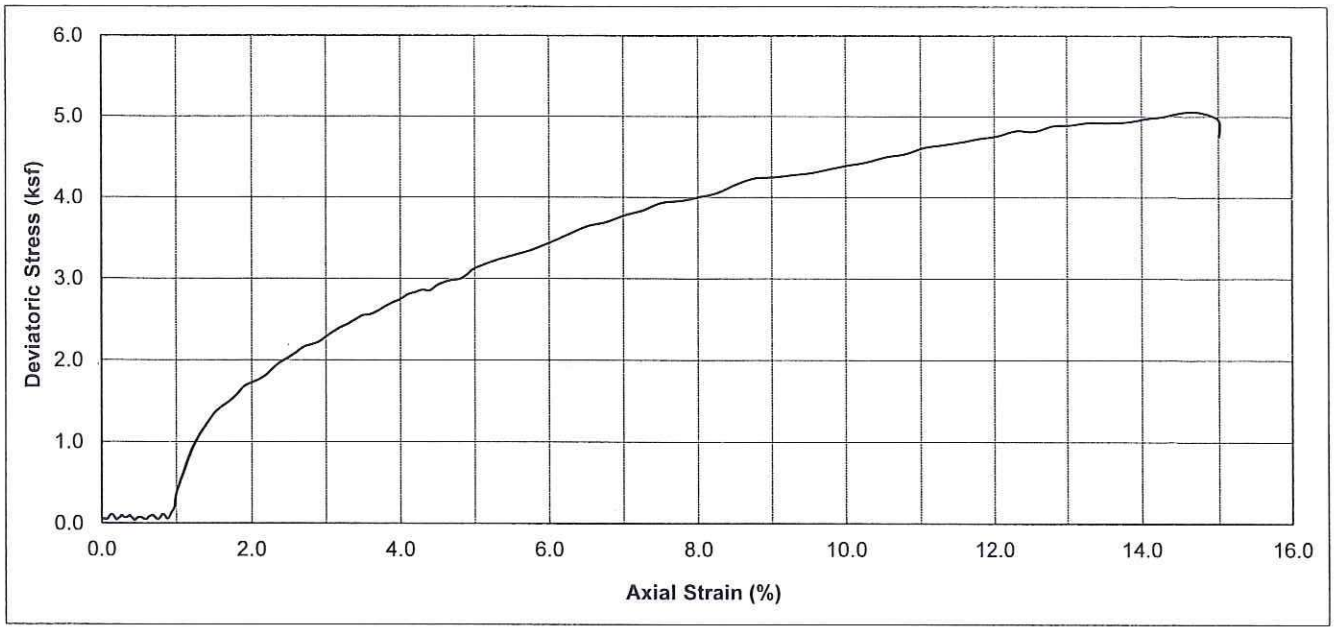
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	23.68	84.15	13.24	1.00	2.50	119.70	2.62	125.25	1.84	87.91
◆	23.44	86.93	13.68	0.94	5.00	239.40	4.19	200.52	2.86	136.75
▲	18.91	91.97	14.48	0.83	10.00	478.80	8.28	396.40	6.43	307.92

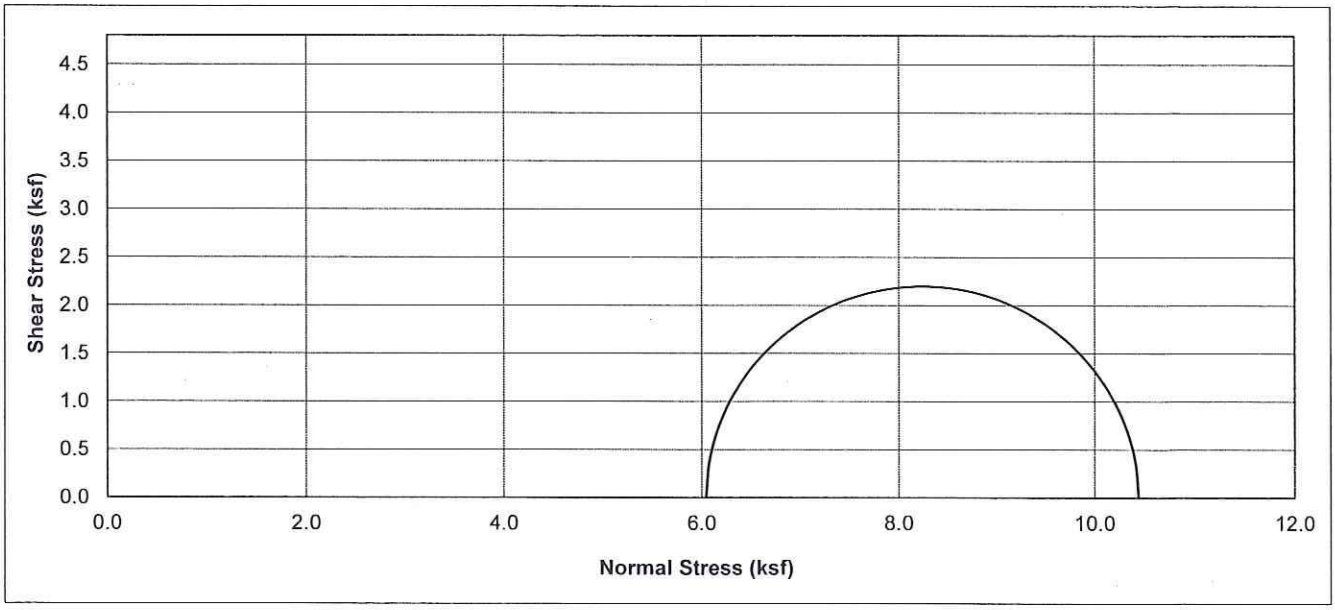
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

RBF/SR-91 WB Widening

DIRECT SHEAR TEST
(ASTM D-3080)

Project No. : 10-126 | Date : 02/12/11 | Figure No. :





Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-039	D-15	75	Olive Brown, Elastic SILT (MH)	92.9	28.75	6.04	4.39	95.5

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	**RBF/SR-91 WB Widening**
	UNCONSOLIDATED UNDRAINED TEST
Project No. : 10-126 **Date :** 02/08/11	**(ASTM D2850)** Figure No. :

Appendix C

DESIGN CALCULATIONS

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening
By: Ranjan Date: 3/21/11 Checked By: Lino Date: 3/24/11 Project No.: 10-26
Subject: Sheet: 1 of 1

N. Anaheim OH - Liquefaction Potential Analyses.

* Historical high ground water elevation of +120 feet was used

* Analysis was performed using the previous two soil borings (B-47 and B-52) and current two soil borings (A-10-039 and A-10-040).

⇒ Based on the analyses, liquefaction potential at the site is low

17660 Newhope Street, Suite E, Fountain Valley, CA 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

SR-91 Westbound Widening - N. Anaheim OH **EMI Project No. 10-126** Version - 12/05

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
$CRR\ r = CRR_{7.5} \times Cm \times K\ sigma$

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines (Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

$F_L = CRR\ r / CSR\ i$

A-10-039

Emean (%:	75		Present Ground El.	198.4	Borehole Dia. (in)	8	Tot. Unit Wt. (pcf)	78.4	=Design Water Table Depth	78.4	=Field Water Table Depth	Acc. max =	0.520	g							Earthq. M=	7.3
C_E	1.25		Future Ground El.	198.4	C_B	1.15	120	120	=Design Water El.	120	=Field Water El.										Cm=	1.07

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
5	193	64	SM	20.0	0.30	0.30	1.70	0.80	1.00	0.67	2	2	0.99	0.30	0.33	83	94	1.00	High N	0.00	LARGE	AboveWT
10	188	30	SM	15.0	0.60	0.60	1.32	0.85	1.20	1.00	1	1	0.98	0.60	0.33	58	63	1.00	High N	0.00	LARGE	AboveWT
15	183	48	SP-SM/SC	20.0	0.90	0.90	1.08	0.85	1.00	0.67	2	2	0.97	0.90	0.33	42	49	1.00	High N	0.00	LARGE	AboveWT
20	178	10	SM	32.0	1.20	1.20	0.93	0.95	1.20	1.00	1	1	0.95	1.20	0.32	15	23	0.97	0.25	0.26	0.82	AboveWT
25	173	80	SP-SM	10.0	1.50	1.50	0.83	0.95	1.00	0.67	2	2	0.94	1.50	0.32	61	63	0.93	High N	0.00	LARGE	AboveWT
30	168	21	SM/SC	25.0	1.80	1.80	0.76	1.00	1.20	1.00	1	1	0.93	1.80	0.31	28	35	0.89	High N	0.00	LARGE	AboveWT
35	163	37	SP	3.0	2.10	2.10	0.71	1.00	1.00	0.67	2	2	0.89	2.10	0.30	25	25	0.87	0.29	0.27	0.91	AboveWT
40	158	18	SP-SM	5.0	2.40	2.40	0.66	1.00	1.20	1.00	1	1	0.85	2.40	0.29	20	20	0.85	0.22	0.20	0.70	AboveWT
45	153	77	SP-SM	5.0	2.70	2.70	0.62	1.00	1.00	0.67	2	2	0.81	2.70	0.27	46	46	0.82	High N	0.00	LARGE	AboveWT
50	148	23	SP-SM	6.0	3.00	3.00	0.59	1.00	1.20	1.00	1	1	0.77	3.00	0.26	23	24	0.78	0.27	0.22	0.86	AboveWT
55	143	74	SM	15.0	3.30	3.30	0.56	1.00	1.00	0.67	2	2	0.73	3.30	0.25	40	44	0.76	High N	0.00	LARGE	AboveWT
60	138	12	ML	52.0	3.60	3.60	0.54	1.00	1.20	1.00	1	1	0.69	3.60	0.23	11	18	0.75	0.20	0.16	0.68	AboveWT
65	133	58	SM	30.0	3.90	3.90	0.52	1.00	1.00	0.67	2	2	0.64	3.90	0.22	29	38	0.73	High N	0.00	LARGE	AboveWT
70	128	22	MH	85.0	4.20	4.20	0.50	1.00	1.20	1.00	1	1	0.60	4.20	0.20	19	28	0.71	0.36	0.28	1.35	AboveWT
75	123	32	SP	4.0	4.50	4.50	0.48	1.00	1.00	0.67	2	2	0.56	4.50	0.19	15	15	0.70	0.16	0.12	0.62	AboveWT
80	118	36	SP-SM	6.0	4.80	4.75	0.47	1.00	1.20	1.00	1	1	0.55	4.75	0.19	29	29	0.68	0.42	0.31	1.66	no
85	113	98	SP-SM	6.0	5.10	4.89	0.46	1.00	1.00	0.67	2	2	0.54	4.89	0.19	43	44	0.68	High N	0.00	LARGE	high N
90	108	45	SP-SM	6.0	5.40	5.04	0.46	1.00	1.20	1.00	1	1	0.52	5.04	0.19	35	36	0.67	High N	0.00	LARGE	high N
95	103	59	SM/SP-SM	5.0	5.70	5.18	0.45	1.00	1.00	0.67	2	2	0.51	5.18	0.19	25	25	0.67	0.30	0.21	1.12	no
100	98.4	69	SP-SM	5.0	6.00	5.33	0.44	0.95	1.20	1.00	1	1	0.50	5.33	0.19	50	50	0.66	High N	0.00	LARGE	high N

SR-91 Westbound Widening - N. Anaheim OH **EMI Project No. 10-126** Version - 12/05

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines (Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

F_L = CRR r / CSR i

A-10-040

Emean (%)	75		Present Ground El.	201.2	Borehole Dia. (in)	8	Tot. Unit Wt. (pcf)	81.2	=Design Water Table Depth	81.2	=Field Water Table Depth	Acc. max =	0.520	g		Earthq. M=	7.3					
C_E	1.25		Future Ground El.	201.2	C_B	1.15	120	120	=Design Water El.	120	=Field Water El.					Cm=	1.07					

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
5	196	20	SM	20.0	0.30	0.30	1.70	0.80	1.20	1.00	1	1	0.99	0.30	0.33	47	54	1.00	High N	0.00	LARGE	AboveWT
10	191	63	SP-SM	10.0	0.60	0.60	1.32	0.85	1.00	0.67	2	2	0.98	0.60	0.33	68	70	1.00	High N	0.00	LARGE	AboveWT
15	186	43	SP-SM	10.0	0.90	0.90	1.08	0.85	1.20	1.00	1	1	0.97	0.90	0.33	68	70	1.00	High N	0.00	LARGE	AboveWT
20	181	81	SM	20.0	1.20	1.20	0.93	0.95	1.00	0.67	2	2	0.95	1.20	0.32	69	78	0.97	High N	0.00	LARGE	AboveWT
25	176	39	SM	20.0	1.50	1.50	0.83	0.95	1.20	1.00	1	1	0.94	1.50	0.32	53	61	0.93	High N	0.00	LARGE	AboveWT
30	171	63	SM	25.0	1.80	1.80	0.76	1.00	1.00	0.67	2	2	0.93	1.80	0.31	46	56	0.89	High N	0.00	LARGE	AboveWT
35	166	14	SP-SM	5.0	2.10	2.10	0.71	1.00	1.20	1.00	1	1	0.89	2.10	0.30	17	17	0.87	0.18	0.17	0.56	AboveWT
40	161	31	SP-SM	5.0	2.40	2.40	0.66	1.00	1.00	0.67	2	2	0.85	2.40	0.29	20	20	0.85	0.21	0.19	0.67	AboveWT
45	156	28	SP	3.0	2.70	2.70	0.62	1.00	1.20	1.00	1	1	0.81	2.70	0.27	30	30	0.82	High N	0.00	LARGE	AboveWT
50	151	84	SP	3.0	3.00	3.00	0.59	1.00	1.00	0.67	2	2	0.77	3.00	0.26	47	47	0.78	High N	0.00	LARGE	AboveWT
55	146	18	SM	20.0	3.30	3.30	0.56	1.00	1.20	1.00	1	1	0.73	3.30	0.25	17	22	0.76	0.25	0.20	0.83	AboveWT
60	141	81	SP-SM	5.0	3.60	3.60	0.54	1.00	1.00	0.67	2	2	0.69	3.60	0.23	42	42	0.75	High N	0.00	LARGE	AboveWT
65	136	26	SP-SM	7.0	3.90	3.90	0.52	1.00	1.20	1.00	1	1	0.64	3.90	0.22	23	24	0.73	0.27	0.21	0.95	AboveWT
70	131	75	SP	4.0	4.20	4.20	0.50	1.00	1.00	0.67	2	2	0.60	4.20	0.20	36	36	0.71	High N	0.00	LARGE	AboveWT
75	126	41	SP	3.0	4.50	4.50	0.48	1.00	1.20	1.00	1	1	0.56	4.50	0.19	34	34	0.70	High N	0.00	LARGE	AboveWT
80	121	69	SM/SP-SM	10.0	4.80	4.80	0.47	1.00	1.00	0.67	2	2	0.55	4.80	0.19	31	32	0.68	High N	0.00	LARGE	AboveWT
85	116	61	SP-SM	7.0	5.10	4.98	0.46	1.00	1.20	1.00	1	1	0.54	4.98	0.19	48	49	0.67	High N	0.00	LARGE	high N
90	111	53	SP-SM	10.0	5.40	5.13	0.45	1.00	1.00	0.67	2	2	0.52	5.13	0.19	23	24	0.67	0.28	0.20	1.06	no
96.2	105	42	SP-SM	4.0	5.77	5.30	0.44	0.95	1.20	1.00	1	1	0.51	5.30	0.19	31	31	0.66	High N	0.00	LARGE	high N
100	101	80	SP-SM	4.0	6.00	5.41	0.44	0.95	1.00	0.67	2	2	0.50	5.41	0.19	32	32	0.66	High N	0.00	LARGE	high N

SR-91 Westbound Widening - N. Anaheim OH **EMI Project No. 10-126** Version - 12/05

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
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[1]C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

F_L = CRR r / CSR i

B-47

Emean (%):	60		Present Ground El.	201.3	Borehole Dia. (in)	5	Tot. Unit Wt. (pcf)	81.3	=Design Water Table Depth	81.3	=Field Water Table Depth	Acc. max =	0.520	g		Earthq. M=	7.3					
C_E	1.00		Future Ground El.	201.3	C_B	1.00		120	=Design Water El.	120	=Field Water El.					Cm=	1.07					

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
-		-		-	-	-	-				-		-	-	-	-	-	-	-		-	-
2.5	199	45	SP-SM	6.0	0.15	0.15	1.70	0.75	1.20	1.00	1	1	0.99	0.15	0.34	69	69	1.00	High N	0.00	LARGE	AboveWT
10	191	41	SM	15.0	0.60	0.60	1.32	0.85	1.20	1.00	1	1	0.98	0.60	0.33	55	60	1.00	High N	0.00	LARGE	AboveWT
20	181	44	SP	4.0	1.20	1.20	0.93	0.95	1.20	1.00	1	1	0.95	1.20	0.32	47	47	0.97	High N	0.00	LARGE	AboveWT
30	171	58	SM	15.0	1.80	1.80	0.76	1.00	1.20	1.00	1	1	0.93	1.80	0.31	53	58	0.89	High N	0.00	LARGE	AboveWT
40	161	24	SP	4.0	2.40	2.40	0.66	1.00	1.20	1.00	1	1	0.85	2.40	0.29	19	19	0.85	0.20	0.18	0.64	AboveWT
50	151	53	SP	4.0	3.00	3.00	0.59	1.00	1.20	1.00	1	1	0.77	3.00	0.26	38	38	0.78	High N	0.00	LARGE	AboveWT
60	141	48	SP-SM	6.0	3.60	3.60	0.54	1.00	1.20	1.00	1	1	0.69	3.60	0.23	31	31	0.75	High N	0.00	LARGE	AboveWT
70	131	68	SP	4.0	4.20	4.20	0.50	1.00	1.20	1.00	1	1	0.60	4.20	0.20	41	41	0.71	High N	0.00	LARGE	AboveWT
80	121	35	CL	35.0	4.80	4.80	0.47	1.00	1.20	1.00	1	1	0.55	4.80	0.19	20	29	0.68	0.39	0.28	1.53	AboveWT
90	111	37	ML	35.0	5.40	5.13	0.45	1.00	1.20	1.00	1	1	0.52	5.13	0.19	20	29	0.67	0.41	0.29	1.58	no

SR-91 Westbound Widening - N. Anaheim OH **EMI Project No. 10-126** Version - 12/05

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
^1C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

F_L = CRR r / CSR i

B-52

Emean (%)	60		Present Ground El.	198.3	Borehole Dia. (in)	5	Tot. Unit Wt. (pcf)	78.3	=Design Water Table Depth	78.3	=Field Water Table Depth	Acc. max =	0.520	g							Earthq. M=	7.3
C_E	1.00		Future Ground El.	198.3	C_B	1.00	120	120	=Design Water El.	120	=Field Water El.										Cm=	1.07

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.5	196	48	SP-SM	6.0	0.15	0.15	1.70	0.75	1.20	1.00	1	1	0.99	0.15	0.34	73	74	1.00	High N	0.00	LARGE	AboveWT
10	188	52	SP-SM	6.0	0.60	0.60	1.32	0.85	1.20	1.00	1	1	0.98	0.60	0.33	70	70	1.00	High N	0.00	LARGE	AboveWT
20	178	95	SP	4.0	1.20	1.20	0.93	0.95	1.20	1.00	1	1	0.95	1.20	0.32	101	101	0.97	High N	0.00	LARGE	AboveWT
30	168	100	SP-SM	6.0	1.80	1.80	0.76	1.00	1.20	1.00	1	1	0.93	1.80	0.31	91	92	0.89	High N	0.00	LARGE	AboveWT
40	158	100	SW	4.0	2.40	2.40	0.66	1.00	1.20	1.00	1	1	0.85	2.40	0.29	79	79	0.85	High N	0.00	LARGE	AboveWT
50	148	90	SW	4.0	3.00	3.00	0.59	1.00	1.20	1.00	1	1	0.77	3.00	0.26	64	64	0.78	High N	0.00	LARGE	AboveWT
60	138	41	SP-SM	6.0	3.60	3.60	0.54	1.00	1.20	1.00	1	1	0.69	3.60	0.23	26	27	0.75	0.33	0.26	1.14	AboveWT
70	128	102	SP	4.0	4.20	4.20	0.50	1.00	1.20	1.00	1	1	0.60	4.20	0.20	61	61	0.71	High N	0.00	LARGE	AboveWT
80	118	30	CL-ML	85.0	4.80	4.75	0.47	1.00	1.20	1.00	1	1	0.55	4.75	0.19	17	25	0.68	0.30	0.22	1.16	no
90	108	65	SW	4.0	5.40	5.03	0.46	1.00	1.20	1.00	1	1	0.52	5.03	0.19	36	36	0.67	High N	0.00	LARGE	high N

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening Project No.: 10-126
By: Ranjan Date: 3/21/11 Checked By: Lino Date: 3/24/11 Sheet: 1 of 10
Subject:

Axial Pile Calculations – Using SHAFT 6.0

North Anaheim OH (widen) – Abutments 1 and 5

Under Service-I Limit State,

Total load per pile = 70 kips = 35 tons

Total load per support = 186 kips = 93 tons

Pile Capacity Check

Use factor of safety (FOS) = 2.0

Per AASHTO, group reduction factor, η, = 1.0 (∵ 4-2ϕ spacing)

Ignore skin down to +170' for Abutments 1 and 5,

Required Q_s = Total load x FOS

= 35 x 2 = 70 tons

From SHAFT analyses,

Required pile length for Abut 1 = 33'

Required pile tip El. for Abut 1 = +188' – 33'

= +155'

Similarly, Required pile length for Abut 5 = 34'

Required pile tip El. for Abut 5 = +190 – 34'

= +156'

⇒ USE +155' SAME AS ABUT 1.

Group check

Nominal resistance of pile = 70 tons

No. of piles/support = 3 [SATISFIED]

Total resistance = $3 \times 70 \times \frac{\eta}{1.0}$ = 210 tons > 186 tons

17660 Newhope Street, Suite E, Fountain Valley, CA 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

Project: SR-91 WB Widening Project No.: 10-126
By: Ranjan Date: 3/21/11 Checked By: Lino Date: 3/24/11 Sheet: 2 of 10
Subject:

Pile Group Settlement Calculations - Abutments 1 and 5

Permissible Settlement under Service load = 1"

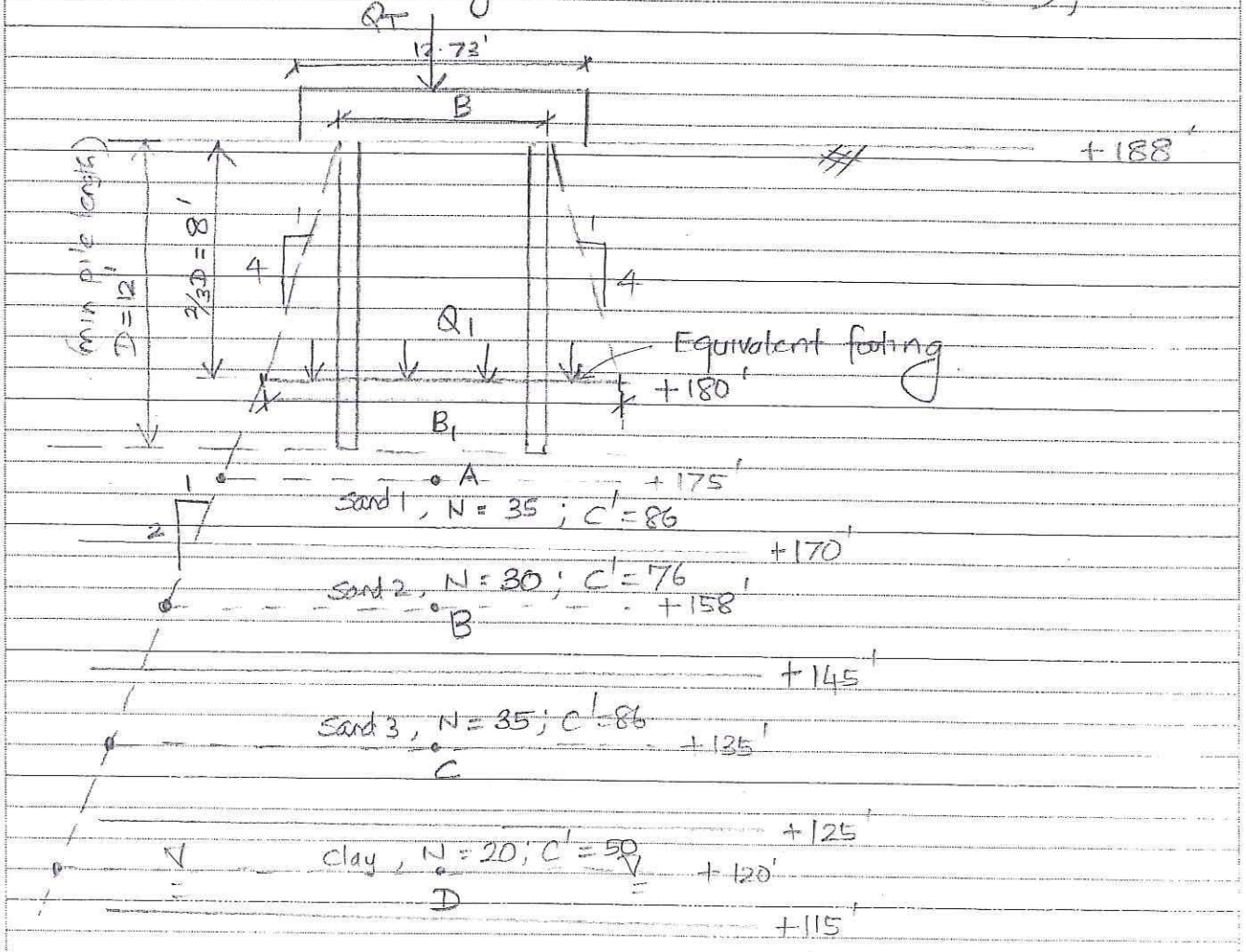
Total load per support (Q_T) = 186 kips

Based on Abutment pile layout,

$B = 9.66' + 1.33' = 11'$

$L = 3' + 1.33' = 4.33'$

Per AASHTO LRFD Figure 10.7.2.3.1-1 Case (d),



* Average N values were obtained using only current soil borings (Conservative)

Project: SR-91 WB Widening Project No.: 10-126
By: Ranjan Date: 3/21/11 Checked By: Lino Date: 3/24/11 Sheet: 3 of 10
Subject:

Assume a minimum pile length (D) = 12'

∴ 2/3 D = 8'

∴ Equivalent footing dimension $B_1 = 11' + 4' = 15'$

$L_1 = 4.33' + 4' = 8.33'$

∴ Stress at Equivalent footing $Q_1 = \frac{Q}{B_1 L_1}$

$= \frac{186}{15 \times 8.33} = 1.49$ ksf

* Layer between elevations +180' and +170' (Sand 1),

Avg N = 35

Per AASHTO Figure 10.6.2.4.2-1,

Bearing Capacity Index, C' = 86

@ point A,

Initial stress $\sigma_o' = 1.56$ ksf

Stress increase due to $Q_1 = \Delta\sigma_{v_1}' = \frac{186}{20' \times 13.33'} = 0.17$ ksf //

* Layer between elevations +170' and +145' (Sand 2),

Avg N = 30

C' = 76

$\sigma_o' = 3.6$ ksf

$\Delta\sigma_{v_2}' = \frac{186}{37' \times 30.33'} = 0.17$ ksf //

* Layer between elevations +145' and +125' (Sand 3),

Avg N = 35

C' = 86

$\sigma_o' = 6.36$ ksf, $\Delta\sigma_3' = \frac{186}{60' \times 53.33'} = 0.06$ ksf //

* Layer between elevations +125' and +115' (clay),

Avg N = 20

$C' = 50$ (from FHWA Fig 13)

$\sigma_o' = 8.16$ ksf ; $\Delta\sigma_1' = \frac{186}{75' \times 66.33'}$

$= 0.04$ ksf

Using AASHTO LRFD Eq^{n} 10.6.2.4.2-3,

$$\Delta H_i = H_i \frac{1}{C'} \log\left(\frac{\sigma_o' + \Delta\sigma_{v_i}'}{\sigma_o'}\right)$$

$$\Delta H_{TOTAL} = \Delta H_{sand_1} + \Delta H_{sand_2} + \Delta H_{sand_3} + \Delta H_{clay}$$

$$= \frac{10}{86}\log\left(\frac{1.56+0.7}{1.56}\right) + \frac{25}{76}\log\left(\frac{3.6+0.17}{3.6}\right) + \frac{20}{86}\log\left(\frac{6.36+0.05}{6.36}\right)$$

$$+ \frac{20}{50}\log\left(\frac{8.16+0.04}{8.16}\right)$$

$$= 0.23'' + 0.09'' + 0.02'' + 0.01''$$

$$= 0.35'' < 1''$$

$\Rightarrow$ No design tip for settlement at abutments 1 and 5 since a minimum pile length of 12' was used.

N. Anaheim OH - Bents 2, 3, and 4

Strength Limit State

Compression (Select Bent 3)

Compression per pile = 162 kips = 81. tons

∴ Nominal resistance = $\frac{81.}{0.7}$ = 116 tons

SELECT 120 tons //

∴ Required ultimate skin resistance = 120 tons

From SHAFT analyses,

Required pile length = 33'

∴ Required pile tip El. = +163' - 33' = +130' //

Tension (Select Bent 3)

Tension per pile = 23 kips = 11.5 tons

Nominal resistance = $\frac{11.5}{0.7}$ = 16.4 tons

∴ Required ultimate skin = 20 tons

Per Caltrans BDS (2003), Eq^n 4.6.5.1-2,

ultimate axial capacity for uplift

$Q_{ult} = 0.7 Q_s$

From SHAFT analyses,

Required pile length = 15'

Required pile tip El. = +163' - 15' = +148' //

GROUP CHECK - STRENGTH LIMIT

Compression load per support = 855 kips
= 427.5 tons

Nominal resistance per pile = 120 tons

No. of pile = 8

Per AASHTO LRFD,

η = 0.77 for 3D spacing

∴ Total nominal resistance = 120 × 8 × 0.77
= 739 tons.

Factored compression demand per support
= 427.5 / 0.7
= 611 tons

⇒ Total nominal resistance > Factored compression demand per support

SATISFIED

Project: SR-91 WB Widening Project No.: 10-026
By: Ranjan Date: 3/21/11 Checked By: Lino Date: 8/31/11 Sheet: 7 of 10
Subject: SP 8/31/11

BENTS 2, 3, and 4 - EXTREME LIMIT

COMPRESSION (Select Bent 3)

Compression per pile = 240 kips = 120 tons

Nominal resistance = $\frac{120}{1.0}$ = 120 tons

SELECT 120 tons //

Assume no end bearing,

∴ Required ultimate skin = 120 tons

From SHAFT analyses,

Required pile length = 33'

∴ Required pile tip El. = +163' − 33'

= +130' //

TENSION (Select Bent 3)

Tension per pile = 140 kips = 70 tons

Nominal resistance = $\frac{70}{1.0}$ = 70 tons

SELECT 70 tons //

∴ Required ultimate skin = 70 tons

Per Caltrans BDS 2003, Equation 4.6.5.1-2,

ultimate axial capacity for uplift $Q_{UT} = 0.7 Q_s$

From SHAFT analyses,

Required pile length = 30'

∴ Required pile tip El. = +163' − 30'

= +133' //

Project: SR-91 WB Widening Project No.: 10-26
By: Ranjan Date: 3/21/11 Checked By: Lino Date: 8/31/11 Sheet: 8 of 10
Subject: SP 8/31/11

GROUP CHECK - EXTREME LIMIT

Select Bent 4,

Compression load per support = 404 kips
= 202 tons

Factored compression load per support = 202 / 1
= 202 tons

Nominal resistance per pile = 120 tons.

No. of pile = 8

∴ Total nominal resistance = 120 × 8 × η
= 120 × 8 × 0.77
= 739 tons

⇒ Total nominal resistance > Factored compression load per support

SATISFIED

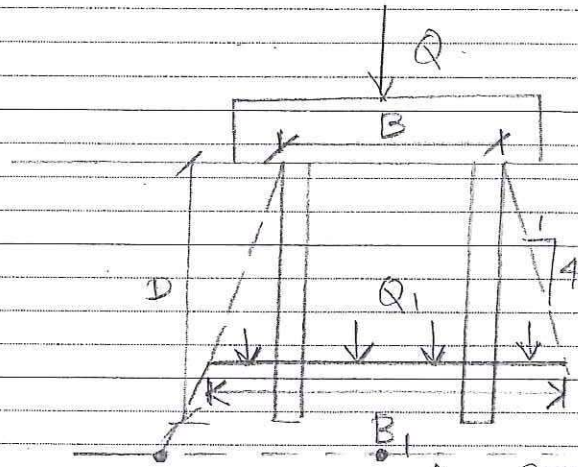
Project: SR-91 WB Widening Project No.: 10-126
By: Ranjan Date: 3/21/11 Checked By: Lino Date: 3/24/11 Sheet: 9 of 10
Subject:

SETTLEMENT CHECK - BENTS

Permissible Settlement under Service load = 1"

Select Bent 3,

Total load per support (Q) = 586 kips



$B = L = 8' + 1.33' = 9.33'$

Assume a minimum pile length $D = 12'$

$\therefore \frac{2}{3} D = 8'$

Equivalent footing dimension $B_1 = L_1 = 9.33' + 4' = 13.33'$

$Q_1 = \frac{595}{13.33^2} = 3.35$ ksf

Using $\Delta H_i = \frac{H_i}{C'} \log\left(\frac{\sigma_o' + \Delta\sigma_v'}{\sigma_o'}\right)$ AASHTO Eq^n 10.6.2.4.2-5

Project: SR-91 WB Widening Project No.: 10-126
By: Ranjan Date: 3/21/11 Checked By: Lino Date: 8/31/11 Sheet: 10 of 10
Subject: SP 8/31/11

Point	Layer	H (ft)	C'	σ_o' (ksf)	$\Delta\sigma_v'$ (ksf)	ΔH_i (in)
A	Sand 1	10	76	1.56	1.74	0.513
B	Sand 2	20	86	3.36	0.53	0.178
C	Clay	10	50	5.16	0.26	0.075
D	Sand 3	20	118	6.0	0.15	0.030

$\sum \Delta H_i = 0.8'' < 1''$

⇒ No design tip for settlement at bents 2, 3, and 4 since a minimum pile length of 12' was used.

DESIGN PILE TIP FOR LATERAL LOAD

Abutments & Bents - Using LPILE analyses, a 20-ft depth is adequate for lateral loading (i.e, 15 x diameter depth)

⇒ Required design pile tip for lateral load = +163' - 20'
= +143' //

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

SR-91 WB Widening Project - Abutment 1

TOTAL LOAD = 150.0 TONS

NUMBER OF LAYERS = 5

WATER TABLE DEPTH = 68.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00

SOIL INFORMATION

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.100E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.618E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.180E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.865E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.140E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.180E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.574E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.140E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.430E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.615E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.330E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.430E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.428E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.330E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.630E+02

LAYER NO 4----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-NC	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.200E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.630E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00

END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.200E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.730E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.347E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.730E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.100E+03

DRILLED SHAFT INFORMATION

DIAMETER OF STEM = 1.333 FT.
DIAMETER OF BASE = 1.333 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 18.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 2.010 SQ.IN.
ELASTIC MODULUS, Ec = 0.360E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
19.0	0.98	4.06	11.72	15.79	15.79	15.79	16.07
20.0	1.03	8.27	11.72	19.99	19.99	19.99	19.34
21.0	1.09	12.61	11.72	24.33	24.33	24.33	22.41
22.0	1.14	17.08	11.72	28.80	28.80	28.80	25.33
23.0	1.19	21.68	11.72	33.40	33.40	33.40	28.09
24.0	1.24	26.40	11.72	38.12	38.12	38.12	30.73
25.0	1.29	31.24	11.72	42.96	42.96	42.96	33.24
26.0	1.34	36.19	11.72	47.91	47.91	47.91	35.65
27.0	1.40	41.24	11.72	52.97	52.97	52.97	37.95
28.0	1.45	46.40	11.72	58.13	58.13	58.13	40.16
29.0	1.50	51.66	11.72	63.39	63.39	63.39	42.28
30.0	1.55	57.01	11.72	68.74	68.74	68.74	44.32
31.0	1.60	62.45	11.72	74.18	74.18	74.18	46.29
32.0	1.65	67.98	11.72	79.70	79.70	79.70	48.18
33.0	1.71	73.59	11.72	85.31	85.31	85.31	50.01
34.0	1.76	79.27	11.72	91.00	91.00	91.00	51.77
35.0	1.81	85.03	11.72	96.75	96.75	96.75	53.48
36.0	1.86	90.86	11.72	102.58	102.58	102.58	55.12
37.0	1.91	96.75	11.72	108.47	108.47	108.47	56.71
38.0	1.96	102.70	11.72	114.42	114.42	114.42	58.25
39.0	2.02	108.71	11.72	120.43	120.43	120.43	59.74
40.0	2.07	114.77	11.72	126.49	126.49	126.49	61.17
41.0	2.12	120.88	11.72	132.61	132.61	132.61	62.57
42.0	2.17	127.04	11.17	138.21	138.21	138.21	63.66
43.0	2.22	133.24	11.17	144.41	144.41	144.41	64.96
44.0	2.27	139.92	11.17	151.09 -	151.09	151.09	66.43

Required Qa = 70 tons

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.6646E-01	0.6018E-04	0.2443E-03	0.1000E-04
0.3323E+00	0.3009E-03	0.1222E-02	0.5000E-04
0.6646E+00	0.6018E-03	0.2443E-02	0.1000E-03
0.3422E+02	0.3091E-01	0.1222E+00	0.5000E-02
0.4946E+02	0.4569E-01	0.1833E+00	0.7500E-02
0.6279E+02	0.5953E-01	0.2443E+00	0.1000E-01
0.1113E+03	0.1204E+00	0.6109E+00	0.2500E-01
0.1432E+03	0.1787E+00	0.1222E+01	0.5000E-01
0.1575E+03	0.2194E+00	0.1833E+01	0.7500E-01
0.1648E+03	0.2530E+00	0.2429E+01	0.1000E+00
0.1713E+03	0.4118E+00	0.5525E+01	0.2500E+00
0.1738E+03	0.6656E+00	0.8363E+01	0.5000E+00
0.1750E+03	0.7923E+00	0.9672E+01	0.6250E+00
0.1762E+03	0.9506E+00	0.1116E+02	0.7813E+00
0.1764E+03	0.9694E+00	0.1133E+02	0.7998E+00

RESULT FROM UPPER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.1069E+00	0.8649E-04	0.3491E-03	0.1000E-04
0.5344E+00	0.4324E-03	0.1745E-02	0.5000E-04
0.1069E+01	0.8649E-03	0.3491E-02	0.1000E-03
0.5376E+02	0.4434E-01	0.1745E+00	0.5000E-02
0.7465E+02	0.6422E-01	0.2618E+00	0.7500E-02
0.9137E+02	0.8191E-01	0.3491E+00	0.1000E-01
0.1429E+03	0.1503E+00	0.8727E+00	0.2500E-01
0.1670E+03	0.2036E+00	0.1745E+01	0.5000E-01
0.1737E+03	0.2368E+00	0.2618E+01	0.7500E-01
0.1762E+03	0.2651E+00	0.3435E+01	0.1000E+00
0.1803E+03	0.4211E+00	0.7545E+01	0.2500E+00
0.1823E+03	0.6740E+00	0.9549E+01	0.5000E+00
0.1833E+03	0.8006E+00	0.1060E+02	0.6250E+00
0.1846E+03	0.9587E+00	0.1191E+02	0.7813E+00
0.1848E+03	0.9775E+00	0.1206E+02	0.7998E+00

RESULT FROM LOWER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.3599E-01	0.3889E-04	0.1396E-03	0.1000E-04
0.1800E+00	0.1944E-03	0.6981E-03	0.5000E-04
0.3599E+00	0.3889E-03	0.1396E-02	0.1000E-03
0.1851E+02	0.1976E-01	0.6981E-01	0.5000E-02
0.2753E+02	0.2962E-01	0.1047E+00	0.7500E-02
0.3608E+02	0.3922E-01	0.1396E+00	0.1000E-01
0.7584E+02	0.8893E-01	0.3491E+00	0.2500E-01
0.1161E+03	0.1516E+00	0.6981E+00	0.5000E-01
0.1399E+03	0.2009E+00	0.1047E+01	0.7500E-01
0.1530E+03	0.2405E+00	0.1424E+01	0.1000E+00
0.1624E+03	0.4024E+00	0.3505E+01	0.2500E+00
0.1654E+03	0.6571E+00	0.7177E+01	0.5000E+00
0.1666E+03	0.7841E+00	0.8747E+01	0.6250E+00
0.1679E+03	0.9424E+00	0.1041E+02	0.7813E+00
0.1680E+03	0.9612E+00	0.1061E+02	0.7998E+00

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SR-91 WB Widening Project - Abutment 5

TOTAL LOAD = 150.0 TONS

NUMBER OF LAYERS = 5

WATER TABLE DEPTH = 70.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00

SOIL INFORMATION

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.100E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.598E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.200E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.837E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.140E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.200E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.555E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.140E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.450E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.594E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.330E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.450E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.412E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.330E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.650E+02

LAYER NO 4----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.200E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.650E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00

END BEARING COEFFICIENT-NC	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.200E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.750E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.331E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.750E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.100E+03

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	= 1.333	FT.
DIAMETER OF BASE	= 1.333	FT.
END OF STEM TO BASE	= 0.000	FT.
ANGLE OF BELL	= 0.000	DEG.
IGNORED TOP PORTION	= 20.000	FT.
IGNORED BOTTOM PORTION	= 0.000	FT.
AREA OF ONE PERCENT STEEL	= 2.010	SQ.IN.
ELASTIC MODULUS, Ec	= 0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	= 0.000	CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
21.0	1.09	4.34	11.72	16.07	16.07	16.07	14.80
22.0	1.14	8.81	11.72	20.54	20.54	20.54	18.06
23.0	1.19	13.41	11.72	25.14	25.14	25.14	21.14
24.0	1.24	18.13	11.72	29.86	29.86	29.86	24.07
25.0	1.29	22.97	11.72	34.70	34.70	34.70	26.85
26.0	1.34	27.92	11.72	39.64	39.64	39.64	29.50
27.0	1.40	32.98	11.72	44.70	44.70	44.70	32.03
28.0	1.45	38.14	11.72	49.86	49.86	49.86	34.45
29.0	1.50	43.39	11.72	55.12	55.12	55.12	36.77
30.0	1.55	48.75	11.72	60.47	60.47	60.47	38.99
31.0	1.60	54.19	11.72	65.91	65.91	65.91	41.13
32.0	1.65	59.71	11.72	71.44	71.44	71.44	43.19
33.0	1.71	65.32	11.72	77.05	77.05	77.05	45.16
34.0	1.76	71.01	11.72	82.73	82.73	82.73	47.07
35.0	1.81	76.76	11.72	88.49	88.49	88.49	48.91
36.0	1.86	82.59	11.72	94.31	94.31	94.31	50.68
37.0	1.91	88.48	11.72	100.20	100.20	100.20	52.39
38.0	1.96	94.43	11.72	106.16	106.16	106.16	54.04
39.0	2.02	100.44	11.72	112.17	112.17	112.17	55.64
40.0	2.07	106.50	11.72	118.23	118.23	118.23	57.18
41.0	2.12	112.62	11.72	124.34	124.34	124.34	58.67
42.0	2.17	118.77	11.72	130.50	130.50	130.50	60.10
43.0	2.22	124.97	11.72	136.70	136.70	136.70	61.50
44.0	2.27	131.21	11.17	142.38	142.38	142.38	62.60
45.0	2.33	137.48	11.17	148.65	148.65	148.65	63.90
46.0	2.38	144.24	11.17	155.41	155.41	155.41	65.35

Required Q_S = 70 tons

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.7494E-01	0.6813E-04	0.2443E-03	0.1000E-04
0.3747E+00	0.3407E-03	0.1222E-02	0.5000E-04
0.7494E+00	0.6813E-03	0.2443E-02	0.1000E-03
0.3847E+02	0.3504E-01	0.1222E+00	0.5000E-02
0.5513E+02	0.5157E-01	0.1833E+00	0.7500E-02
0.6941E+02	0.6686E-01	0.2443E+00	0.1000E-01
0.1205E+03	0.1327E+00	0.6109E+00	0.2500E-01
0.1534E+03	0.1940E+00	0.1222E+01	0.5000E-01
0.1680E+03	0.2360E+00	0.1833E+01	0.7500E-01
0.1754E+03	0.2702E+00	0.2429E+01	0.1000E+00
0.1820E+03	0.4295E+00	0.5525E+01	0.2500E+00
0.1844E+03	0.6834E+00	0.8363E+01	0.5000E+00
0.1856E+03	0.8103E+00	0.9672E+01	0.6250E+00
0.1869E+03	0.9686E+00	0.1116E+02	0.7813E+00
0.1870E+03	0.9874E+00	0.1133E+02	0.7998E+00

RESULT FROM UPPER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.1224E+00	0.9969E-04	0.3491E-03	0.1000E-04
0.6118E+00	0.4985E-03	0.1745E-02	0.5000E-04
0.1224E+01	0.9969E-03	0.3491E-02	0.1000E-03
0.6075E+02	0.5103E-01	0.1745E+00	0.5000E-02
0.8296E+02	0.7313E-01	0.2618E+00	0.7500E-02
0.1005E+03	0.9253E-01	0.3491E+00	0.1000E-01
0.1535E+03	0.1658E+00	0.8727E+00	0.2500E-01
0.1780E+03	0.2212E+00	0.1745E+01	0.5000E-01
0.1848E+03	0.2549E+00	0.2618E+01	0.7500E-01
0.1873E+03	0.2834E+00	0.3435E+01	0.1000E+00
0.1914E+03	0.4397E+00	0.7545E+01	0.2500E+00
0.1934E+03	0.6927E+00	0.9549E+01	0.5000E+00
0.1944E+03	0.8193E+00	0.1060E+02	0.6250E+00
0.1957E+03	0.9776E+00	0.1191E+02	0.7813E+00
0.1959E+03	0.9964E+00	0.1206E+02	0.7998E+00

RESULT FROM LOWER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.3990E-01	0.4304E-04	0.1396E-03	0.1000E-04
0.1995E+00	0.2152E-03	0.6981E-03	0.5000E-04
0.3990E+00	0.4304E-03	0.1396E-02	0.1000E-03
0.2055E+02	0.2192E-01	0.6981E-01	0.5000E-02
0.3049E+02	0.3282E-01	0.1047E+00	0.7500E-02
0.3987E+02	0.4342E-01	0.1396E+00	0.1000E-01
0.8274E+02	0.9743E-01	0.3491E+00	0.2500E-01
0.1252E+03	0.1642E+00	0.6981E+00	0.5000E-01
0.1498E+03	0.2159E+00	0.1047E+01	0.7500E-01
0.1631E+03	0.2566E+00	0.1424E+01	0.1000E+00
0.1726E+03	0.4192E+00	0.3505E+01	0.2500E+00
0.1755E+03	0.6741E+00	0.7177E+01	0.5000E+00
0.1767E+03	0.8012E+00	0.8747E+01	0.6250E+00
0.1780E+03	0.9596E+00	0.1041E+02	0.7813E+00
0.1781E+03	0.9784E+00	0.1061E+02	0.7998E+00

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SR-91 WB Widening Project - Bents 2, 3, and 4

TOTAL LOAD = 200.0 TONS

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 43.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00

SOIL INFORMATION

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.140E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.865E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.140E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.180E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.927E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.330E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.180E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.668E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.330E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.380E+02

LAYER NO 3----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.200E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.380E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.200E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.480E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.565E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.480E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.454E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.600E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	=	1.333	FT.
DIAMETER OF BASE	=	1.333	FT.
END OF STEM TO BASE	=	0.000	FT.
ANGLE OF BELL	=	0.000	DEG.
IGNORED TOP PORTION	=	0.000	FT.
IGNORED BOTTOM PORTION	=	0.000	FT.
AREA OF ONE PERCENT STEEL	=	2.010	SQ.IN.
ELASTIC MODULUS, Ec	=	0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	=	0.000	CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
1.0	0.05	0.30	2.64	2.94	2.94	2.94	56.88
2.0	0.10	0.90	3.52	4.42	4.42	4.42	42.78
3.0	0.16	1.80	4.40	6.19	6.19	6.19	39.94
4.0	0.21	2.95	5.28	8.23	8.23	8.23	39.79
5.0	0.26	4.35	6.16	10.51	10.51	10.51	40.67
6.0	0.31	6.00	7.04	13.04	13.04	13.04	42.03
7.0	0.36	7.88	7.92	15.79	15.79	15.79	43.64
8.0	0.41	9.97	8.80	18.77	18.77	18.77	45.39
9.0	0.47	12.29	9.67	21.96	21.96	21.96	47.20
10.0	0.52	14.80	10.55	25.36	25.36	25.36	49.05
11.0	0.57	17.52	11.43	28.95	28.95	28.95	50.91
12.0	0.62	20.42	11.72	32.15	32.15	32.15	51.82
13.0	0.67	23.51	11.72	35.24	35.24	35.24	52.43
14.0	0.72	26.78	11.72	38.50	38.50	38.50	53.20
15.0	0.78	30.22	11.72	41.94	41.94	41.94	54.09
16.0	0.83	33.82	11.72	45.54	45.54	45.54	55.06
17.0	0.88	37.58	11.17	48.75	48.75	48.75	55.47
18.0	0.93	41.50	11.17	52.66	52.66	52.66	56.60
19.0	0.98	45.85	11.17	57.02	57.02	57.02	58.05
20.0	1.03	50.35	11.17	61.52	61.52	61.52	59.50
21.0	1.09	55.00	11.17	66.17	66.17	66.17	60.95
22.0	1.14	59.80	11.17	70.96	70.96	70.96	62.40
23.0	1.19	64.72	11.17	75.89	75.89	75.89	63.83
24.0	1.24	69.78	11.17	80.95	80.95	80.95	65.25
25.0	1.29	74.96	11.17	86.13	86.13	86.13	66.65
26.0	1.34	80.27	11.17	91.43	91.43	91.43	68.03
27.0	1.40	85.69	11.17	96.85	96.85	96.85	69.39
28.0	1.45	91.21	11.17	102.38	102.38	102.38	70.73
29.0	1.50	96.85	11.17	108.01	108.01	108.01	72.05
30.0	1.55	102.58	11.17	113.75	113.75	113.75	73.35
31.0	1.60	108.41	11.17	119.58	119.58	119.58	74.62
32.0	1.65	114.33	11.17	125.50	125.50	125.50	75.87
33.0	1.71	120.34	11.17	131.51	131.51	131.51	77.09
34.0	1.76	126.43	11.17	137.60	137.60	137.60	78.29
35.0	1.81	132.60	11.17	143.77	143.77	143.77	79.46
36.0	1.86	138.84	11.17	150.01	150.01	150.01	80.61
37.0	1.91	145.15	12.56	157.71	157.71	157.71	82.46
38.0	1.96	151.53	12.56	164.09	164.09	164.09	83.53
39.0	2.02	153.83	12.56	166.40	166.40	166.40	82.53
40.0	2.07	156.14	12.56	168.70	168.70	168.70	81.58
41.0	2.12	158.44	12.56	171.00	171.00	171.00	80.68
42.0	2.17	160.74	12.56	173.31	173.31	173.31	79.82
43.0	2.22	163.05	12.56	175.61	175.61	175.61	79.00
44.0	2.27	165.35	12.56	177.91	177.91	177.91	78.22
45.0	2.33	167.65	12.56	180.22	180.22	180.22	77.47
46.0	2.38	169.96	12.56	182.52	182.52	182.52	76.76
47.0	2.43	172.26	35.73	207.99	207.99	207.99	85.61

Extreem event - compression and strength limit - compression
Required Q_S = 120 tons

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.7764E-01	0.6659E-04	0.7818E-03	0.1000E-04
0.3882E+00	0.3329E-03	0.3909E-02	0.5000E-04
0.7764E+00	0.6659E-03	0.7818E-02	0.1000E-03
0.3891E+02	0.3365E-01	0.3909E+00	0.5000E-02
0.5581E+02	0.4960E-01	0.5864E+00	0.7500E-02
0.7028E+02	0.6438E-01	0.7818E+00	0.1000E-01
0.1184E+03	0.1243E+00	0.1955E+01	0.2500E-01
0.1495E+03	0.1816E+00	0.3909E+01	0.5000E-01
0.1624E+03	0.2205E+00	0.5864E+01	0.7500E-01
0.1693E+03	0.2537E+00	0.7773E+01	0.1000E+00
0.1803E+03	0.4202E+00	0.1768E+02	0.2500E+00
0.1878E+03	0.6823E+00	0.2676E+02	0.5000E+00
0.1919E+03	0.8137E+00	0.3095E+02	0.6250E+00
0.1965E+03	0.9773E+00	0.3571E+02	0.7813E+00
0.1970E+03	0.9967E+00	0.3627E+02	0.7998E+00

RESULT FROM UPPER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.

0.1322E+00	0.1010E-03	0.1117E-02	0.1000E-04
0.6608E+00	0.5048E-03	0.5584E-02	0.5000E-04
0.1322E+01	0.1010E-02	0.1117E-01	0.1000E-03
0.6330E+02	0.5040E-01	0.5584E+00	0.5000E-02
0.8617E+02	0.7222E-01	0.8377E+00	0.7500E-02
0.1040E+03	0.9130E-01	0.1117E+01	0.1000E-01
0.1518E+03	0.1558E+00	0.2792E+01	0.2500E-01
0.1711E+03	0.2032E+00	0.5584E+01	0.5000E-01
0.1786E+03	0.2378E+00	0.8377E+01	0.7500E-01
0.1821E+03	0.2680E+00	0.1099E+02	0.1000E+00
0.1941E+03	0.4369E+00	0.2414E+02	0.2500E+00
0.1997E+03	0.6958E+00	0.3055E+02	0.5000E+00
0.2030E+03	0.8260E+00	0.3390E+02	0.6250E+00
0.2072E+03	0.9888E+00	0.3809E+02	0.7813E+00
0.2077E+03	0.1008E+01	0.3859E+02	0.7998E+00

RESULT FROM LOWER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.3924E-01	0.4040E-04	0.4468E-03	0.1000E-04
0.1962E+00	0.2020E-03	0.2234E-02	0.5000E-04
0.3924E+00	0.4040E-03	0.4468E-02	0.1000E-03
0.1990E+02	0.2036E-01	0.2234E+00	0.5000E-02
0.2954E+02	0.3049E-01	0.3351E+00	0.7500E-02
0.3869E+02	0.4038E-01	0.4468E+00	0.1000E-01
0.8050E+02	0.9103E-01	0.1117E+01	0.2500E-01
0.1219E+03	0.1541E+00	0.2234E+01	0.5000E-01
0.1444E+03	0.2015E+00	0.3351E+01	0.7500E-01
0.1558E+03	0.2389E+00	0.4557E+01	0.1000E+00
0.1659E+03	0.4025E+00	0.1121E+02	0.2500E+00
0.1760E+03	0.6689E+00	0.2296E+02	0.5000E+00
0.1807E+03	0.8015E+00	0.2799E+02	0.6250E+00
0.1857E+03	0.9658E+00	0.3332E+02	0.7813E+00
0.1863E+03	0.9852E+00	0.3394E+02	0.7998E+00

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

SR-91 WB Widening Project - Bents 2, 3, and 4

TOTAL LOAD = 160.0 TONS

REDUCTION FACTOR APPLIED FOR UPLIFT FRICTION = 0.700

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 43.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00

SOIL INFORMATION

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.120E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.140E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.865E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.140E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.180E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.927E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.330E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.180E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.668E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.330E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.380E+02

LAYER NO 3----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.200E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.380E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.200E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.480E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.565E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.480E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.454E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.600E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	= 1.333	FT.
DIAMETER OF BASE	= 1.333	FT.
END OF STEM TO BASE	= 0.000	FT.
ANGLE OF BELL	= 0.000	DEG.
IGNORED TOP PORTION	= 0.000	FT.
IGNORED BOTTOM PORTION	= 0.000	FT.
AREA OF ONE PERCENT STEEL	= 2.010	SQ.IN.
ELASTIC MODULUS, Ec	= 0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	= 0.000	CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	WT (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
1.0	0.05	0.21	0.10	0.32	0.32	0.32	6.11
2.0	0.10	0.63	0.21	0.84	0.84	0.84	8.15
3.0	0.16	1.26	0.31	1.57	1.57	1.57	10.13
4.0	0.21	2.06	0.42	2.48	2.48	2.48	12.01
5.0	0.26	3.05	0.52	3.57	3.57	3.57	13.82
6.0	0.31	4.20	0.63	4.83	4.83	4.83	15.57
7.0	0.36	5.51	0.73	6.25	6.25	6.25	17.26
8.0	0.41	6.98	0.84	7.82	7.82	7.82	18.91
9.0	0.47	8.60	0.94	9.54	9.54	9.54	20.51
10.0	0.52	10.36	1.05	11.41	11.41	11.41	22.07
11.0	0.57	12.26	1.15	13.41	13.41	13.41	23.59
12.0	0.62	14.30	1.26	15.55	15.55	15.55	25.07
13.0	0.67	16.46	1.36	17.82	17.82	17.82	26.52
14.0	0.72	18.75	1.47	20.21	20.21	20.21	27.93
15.0	0.78	21.15	1.57	22.72	22.72	22.72	29.30
16.0	0.83	23.67	1.67	25.35	25.35	25.35	30.65
17.0	0.88	26.31	1.78	28.09	28.09	28.09	31.96
18.0	0.93	29.05	1.88	30.93	30.93	30.93	33.24
19.0	0.98	32.09	1.99	34.08	34.08	34.08	34.70
20.0	1.03	35.25	2.09	37.34	37.34	37.34	36.12
21.0	1.09	38.50	2.20	40.70	40.70	40.70	37.49
22.0	1.14	41.86	2.30	44.16	44.16	44.16	38.83
23.0	1.19	45.31	2.41	47.71	47.71	47.71	40.13
24.0	1.24	48.85	2.51	51.36	51.36	51.36	41.40
25.0	1.29	52.48	2.62	55.09	55.09	55.09	42.63
26.0	1.34	56.19	2.72	58.91	58.91	58.91	43.83
27.0	1.40	59.98	2.83	62.81	62.81	62.81	45.00
28.0	1.45	63.85	2.93	66.78	66.78	66.78	46.14
29.0	1.50	67.79	3.04	70.83	70.83	70.83	47.25
30.0	1.55	71.81	3.14	74.95	74.95	74.95	48.33
31.0	1.60	75.89	3.25	79.13	79.13	79.13	49.38
32.0	1.65	80.03	3.35	83.38	83.38	83.38	50.41
33.0	1.71	84.24	3.45	87.69	87.69	87.69	51.40
34.0	1.76	88.50	3.56	92.06	92.06	92.06	52.38
35.0	1.81	92.82	3.66	96.48	96.48	96.48	53.33
36.0	1.86	97.19	3.77	100.96	100.96	100.96	54.25
37.0	1.91	101.61	3.87	105.48	105.48	105.48	55.15
38.0	1.96	106.07	3.98	110.05	110.05	110.05	56.02
39.0	2.02	107.68	4.08	111.77	111.77	111.77	55.44
40.0	2.07	109.30	4.19	113.48	113.48	113.48	54.88
41.0	2.12	110.91	4.29	115.20	115.20	115.20	54.35
42.0	2.17	112.52	4.40	116.92	116.92	116.92	53.85
43.0	2.22	114.13	4.50	118.63	118.63	118.63	53.37
44.0	2.27	115.75	4.61	120.35	120.35	120.35	52.91
45.0	2.33	117.36	4.71	122.07	122.07	122.07	52.47
46.0	2.38	118.97	4.82	123.79	123.79	123.79	52.06
47.0	2.43	120.58	4.92	125.50	125.50	125.50	51.66
48.0	2.48	122.20	5.02	127.22	127.22	127.22	51.27
49.0	2.53	126.64	5.13	131.77	131.77	131.77	52.02
50.0	2.58	131.05	5.23	136.29	136.29	136.29	52.73
51.0	2.64	135.44	5.34	140.78	140.78	140.78	53.40
52.0	2.69	139.80	5.44	145.25	145.25	145.25	54.03
53.0	2.74	144.13	5.55	149.68	149.68	149.68	54.63
54.0	2.79	148.43	5.65	154.08	154.08	154.08	55.20
55.0	2.84	152.70	5.76	158.46	158.46	158.46	55.73
56.0	2.89	156.93	5.86	162.80	162.80	162.80	56.24

strength limit - Tension
Required Q_s = 20 tons

Required Q_s = 70 tons
Extreme limit - Tension

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.7410E-01	0.7228E-04	0.1283E-03	0.1000E-04
0.3705E+00	0.3614E-03	0.6413E-03	0.5000E-04
0.7410E+00	0.7228E-03	0.1283E-02	0.1000E-03
0.3673E+02	0.3633E-01	0.6413E-01	0.5000E-02
0.5224E+02	0.5332E-01	0.9620E-01	0.7500E-02
0.6523E+02	0.6885E-01	0.1283E+00	0.1000E-01
0.1067E+03	0.1302E+00	0.3207E+00	0.2500E-01
0.1327E+03	0.1879E+00	0.6413E+00	0.5000E-01
0.1425E+03	0.2257E+00	0.9620E+00	0.7500E-01

0.1474E+03	0.2579E+00	0.1275E+01	0.1000E+00
0.1502E+03	0.4128E+00	0.2900E+01	0.2500E+00
0.1504E+03	0.6639E+00	0.4390E+01	0.5000E+00
0.1510E+03	0.7901E+00	0.5077E+01	0.6250E+00
0.1516E+03	0.9476E+00	0.5858E+01	0.7813E+00
0.1517E+03	0.9663E+00	0.5950E+01	0.7998E+00

RESULT FROM UPPER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.1273E+00	0.1105E-03	0.1832E-03	0.1000E-04
0.6364E+00	0.5523E-03	0.9162E-03	0.5000E-04
0.1273E+01	0.1105E-02	0.1832E-02	0.1000E-03
0.5950E+02	0.5444E-01	0.9162E-01	0.5000E-02
0.8001E+02	0.7745E-01	0.1374E+00	0.7500E-02
0.9558E+02	0.9712E-01	0.1832E+00	0.1000E-01
0.1345E+03	0.1612E+00	0.4581E+00	0.2500E-01
0.1509E+03	0.2102E+00	0.9162E+00	0.5000E-01
0.1552E+03	0.2418E+00	0.1374E+01	0.7500E-01
0.1567E+03	0.2694E+00	0.1803E+01	0.1000E+00
0.1578E+03	0.4219E+00	0.3961E+01	0.2500E+00
0.1583E+03	0.6730E+00	0.5013E+01	0.5000E+00
0.1588E+03	0.7991E+00	0.5562E+01	0.6250E+00
0.1595E+03	0.9566E+00	0.6250E+01	0.7813E+00
0.1596E+03	0.9753E+00	0.6331E+01	0.7998E+00

RESULT FROM LOWER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.3709E-01	0.4347E-04	0.7329E-04	0.1000E-04
0.1855E+00	0.2174E-03	0.3665E-03	0.5000E-04
0.3709E+00	0.4347E-03	0.7330E-03	0.1000E-03
0.1874E+02	0.2187E-01	0.3665E-01	0.5000E-02
0.2774E+02	0.3271E-01	0.5497E-01	0.7500E-02
0.3620E+02	0.4324E-01	0.7329E-01	0.1000E-01
0.7406E+02	0.9639E-01	0.1832E+00	0.2500E-01
0.1100E+03	0.1608E+00	0.3665E+00	0.5000E-01
0.1287E+03	0.2087E+00	0.5497E+00	0.7500E-01
0.1379E+03	0.2461E+00	0.7476E+00	0.1000E+00
0.1420E+03	0.4029E+00	0.1840E+01	0.2500E+00
0.1426E+03	0.6548E+00	0.3767E+01	0.5000E+00
0.1432E+03	0.7811E+00	0.4592E+01	0.6250E+00
0.1437E+03	0.9386E+00	0.5467E+01	0.7813E+00
0.1438E+03	0.9573E+00	0.5569E+01	0.7998E+00

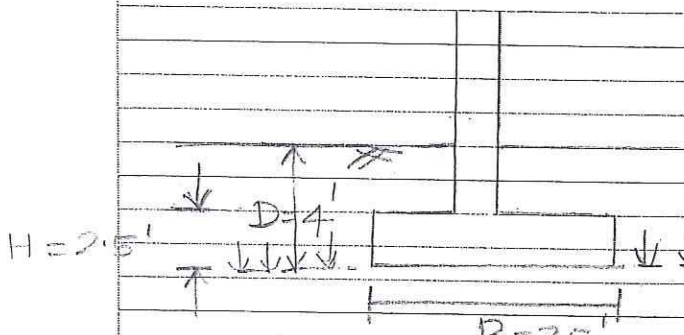
Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening Project No.: 10-126
By: Ranjan Date: 3/21/11 Checked By: Lino Date: 3/30/11 Sheet: 1 of 2
Subject:

Pier Protection wall - Adjacent to Bent 3

Per information, bottom of the wall footing is at +160.7 feet.

Width of the wall footing, B = 7.5'
Embedment of the wall footing, D = 4'



$q = \gamma D = 120 \times 4 = 480$ psf

+160.7'
$\phi = 32^\circ$; $c = 50$ psf
$\gamma = 120$ pcf

+145'
$\phi = 33^\circ$; $c = 50$ psf
$\gamma = 120$ pcf.

Per NAVFAC DM-7.2

$N_q = N_\gamma = 26$ for $\phi = 32^\circ$.

Ultimate bearing capacity $q_{ult} = \gamma D N_q + \frac{\gamma B}{2} N_\gamma$

$q_{ult} = (120 \times 4 \times 26) + \left(\frac{120 \times 7.5}{2} \times 26\right)$

$= 12,480 + 11,700$

$= 24,180$ psf

$q_{all} = \frac{q_{ult}}{FOS} = \frac{24,180}{3} = 8$ ksf

SELECT $q_{all} = 4$ KSF

17660 Newhope Street, Suite E, Fountain Valley, CA 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

Project: SR-91 WB Widening Project No.: 10-126
By: Ranjan Date: 3/21/11 Checked By: Lino Date: 3/22/11 Sheet: 2 of 2
Subject:

SETTLEMENT CHECK

Using $q_{all} = 4$ ksf ; B = 7.5' ; D = 4',

∴ The estimated total settlment is about 1.23" within a depth of 27 feet (i.e., 23 feet below footing bottom or 3B below footing bottom (See attached sheet).

⇒ Spread footing is feasible provided overexcavation and recompaction are performed. (Assuming the settlement in the overex. zone is negligible)

The allowble foundation settlement is 1-inch.

∴ Required mimimum overex. depth = 2 feet. //

Using $q_{all} = 3$ ksf ; B = 7.5' ; D = 4',

⇒ total settlement ≅ 1" ⇒ Use 1' overex. (See attached sheet) //

EARTH PRESSURE CALCULATIONS

Using NAVFAC DM-7.2,

$$K_p = \tan^2(45 + \Phi/2) = \tan^2(45 + 32/2)$$
$$= 3.25$$

∴ Passive equivalent fluid pressure $= K_p \cdot \delta$
$= 3.25 \times 120 = 390$ pcf //

BASE FRICTION:

Using NAVFAC DM-7.2, Table 1 (page 7.2-63),
Recommended frictional coefficient $\delta = 0.35 - 0.45$
SELECT $\delta = 0.4$ //

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17800 Newhope Street, Suite B, Fountain Valley, CA 92708
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Project: **SR-91 WB Widening Project** Project No. **10-126**
By GJG Date 3/21/2010 Check by Lino Date 3/30/11 Sheet

Settlement Calculation for Spread Footing - Pier Protection Wall

Footing Info

Footing Elevation= 160.5 ft = Embedded Depth = 4 ft
Load Width= 7.5 ft
Net Contact Stress = 4.0 ksf => Gross Contact Stress = 4.5 ksf

Check Settlement:
Method: AASHTO LRFD Bridge Design Spec - Hough's Method

Layer	Top Elev. (ft)	Bottom Elev. (ft)	Top Depth (ft)	Bottom Depth (ft)	Soil Type	γ' pcf	(N')	c'
1	164	145	0	19	SM	120	30	76
2	145	125	19	39	SM	120	35	86

Note: 1. c'= bearing capacity index
2. N'= average corrected SPT blowcount

Depth	Layer Thick. (ft)	Mid pt. depth (ft)	γ' kcf	σ_{vo}' (ksf)	depth to Equiv. Footing (ft)	$\Delta\sigma_v'$ (ksf)	σ_{vt} (ksf)	C	ΔS (in)	Total ΔS (in)	
0											
3	3	1.5	0.12	0.18	-2.5	0.00	0.18	76	0.00	0.00	
4	1	3.5	0.12	0.42	-0.5	0.00	0.42	76	0.00	0.00	Footing bottom
5	1	4.5	0.12	0.54	0.5	3.75	4.29	76	0.14	0.14	
6	1	5.5	0.12	0.66	1.5	3.33	3.99	76	0.12	0.27	bottom of overex.
7	1	6.5	0.12	0.78	2.5	3.00	3.78	76	0.11	0.37	
8	1	7.5	0.12	0.90	3.5	2.73	3.63	76	0.10	0.47	
10	2	9	0.12	1.08	5	2.40	3.48	76	0.16	0.63	
12	2	11	0.12	1.32	7	2.07	3.39	76	0.13	0.76	
13	1	12.5	0.12	1.50	8.5	1.88	3.38	76	0.06	0.81	
17	4	15	0.12	1.80	11	1.62	3.42	76	0.18	0.99	
19	2	18	0.12	2.16	14	1.40	3.56	76	0.07	1.06	
23	4	21	0.12	2.52	17	1.22	3.74	86	0.10	1.16	
27	4	25	0.12	3.00	21	1.05	4.05	86	0.07	1.23	

3B depth below footing bottom

total settlement

After 2-ft overex.,

⇒ new settlement = 1.23" − 0.27"
= 0.96" < 1"

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phone: (714)751-3826, Fax (714)751-3928

Project: **SR-91 WB Widening Project** Project No. **10-126**
By GJG Date 3/21/2010 Check by Lino Date 3/30/11 Sheet

Settlement Calculation for Spread Footing - Pier Protection Wall

Footing Info

Footing Elevation= 160.5 ft = Embedded Depth = 4 ft
Load Width= 7.5 ft
Net Contact Stress = 3.0 ksf => Gross Contact Stress = 3.5 ksf

Check Settlement:

Method: AASHTO LRFD Bridge Design Spec - Hough's Method

Layer	Top Elev. (ft)	Bottom Elev. (ft)	Top Depth (ft)	Bottom Depth (ft)	Soil Type	γ' pcf	(N')	c'
1	164	145	0	19	SM	120	30	76
2	145	125	19	39	SM	120	35	86

Note: 1. c'= bearing capacity index
2. N'= average corrected SPT blowcount

Depth	Layer Thick. (ft)	Mid pt. depth (ft)	γ' kcf	σ_{vo}' (ksf)	depth to Equiv. Footing (ft)	$\Delta\sigma_v'$ (ksf)	σ_{vt} (ksf)	C	ΔS (in)	Total ΔS (in)
0										
3	3	1.5	0.12	0.18	-2.5	0.00	0.18	76	0.00	0.00
4	1	3.5	0.12	0.42	-0.5	0.00	0.42	76	0.00	0.00
5	1	4.5	0.12	0.54	0.5	2.81	3.35	76	0.13	0.13
6	1	5.5	0.12	0.66	1.5	2.50	3.16	76	0.11	0.23
7	1	6.5	0.12	0.78	2.5	2.25	3.03	76	0.09	0.33
8	1	7.5	0.12	0.90	3.5	2.05	2.95	76	0.08	0.41
10	2	9	0.12	1.08	5	1.80	2.88	76	0.13	0.54
12	2	11	0.12	1.32	7	1.55	2.87	76	0.11	0.65
13	1	12.5	0.12	1.50	8.5	1.41	2.91	76	0.05	0.69
17	4	15	0.12	1.80	11	1.22	3.02	76	0.14	0.84
19	2	18	0.12	2.16	14	1.05	3.21	76	0.05	0.89
23	4	21	0.12	2.52	17	0.92	3.44	86	0.08	0.96
27	4	25	0.12	3.00	21	0.79	3.79	86	0.06	1.02

total settlement

⇒ 1' overex. required.

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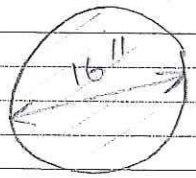
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening Project No.: 10-126
By: Ranjan Date: 3/21/11 Checked By: Lino Date: 3/24/11 Sheet: 1 of 1
Subject:

LATERAL PILE ANALYSES - N. ANAHEIM OH

* Select 20-ft depth for lateral tip estimation



CIDH

Area = 201.1 in^2

$I = \frac{\pi}{4} \times 8^4$

$= 3,220\ in^4$

$E = 3.6 \times 10^6$ psi

USE 50% EI & FREE-HEAD CONDITIONS

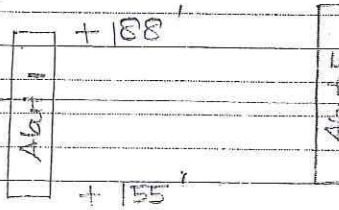
δ = 0.25", 0.5", 1", 3", and 5"

Group reduction factor (η) using Group 7.0,

$\eta = 0.9$ for Abutments

$\eta = 0.7$ for bents

Abutments



$\gamma = 120$ pcf
$\phi = 32$
$k = 65$ pci

$\gamma = 120$ pcf
$\phi = 32°$
$k = 65$ pci

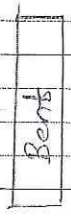
$\gamma = 120$ pcf
$\phi = 33°$
$k = 73$ pci

∇ = Su = 2000 psf
$\gamma' = 52.6$ pcf

∇ $\gamma = 115$ pcf
$\varepsilon_{50} = 0.005$

$\gamma' = 62.6$ pcf
$\phi = 38°$
$k = 100$ pci

Bents



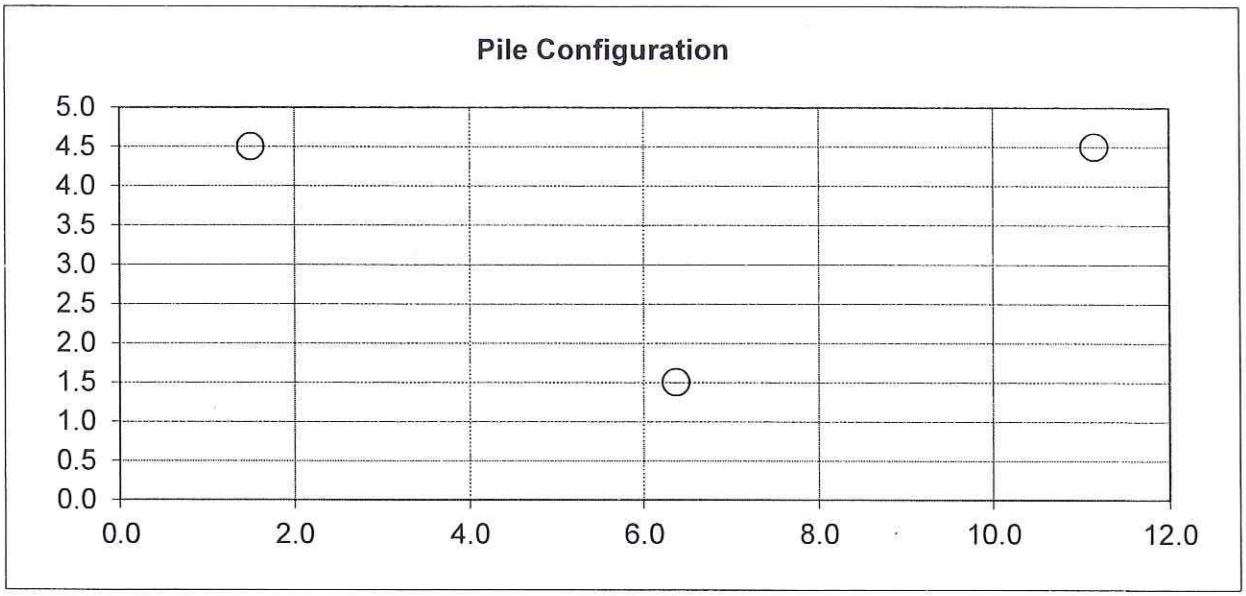
∇

17660 Newhope Street, Suite E, Fountain Valley, CA 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

Project: SR-91 WB Widening - N. Anaheim OH Abutments

By: Ranjan 3/22/2011

Calculation of Pile Group Efficiency (using formula in Group 7.0 Technical Manual)



Pile Dia.:	1.330
No. of Piles:	3

Group Efficiency	X-Dir (Trans)	Y-Dir (Long)
	0.922	0.972

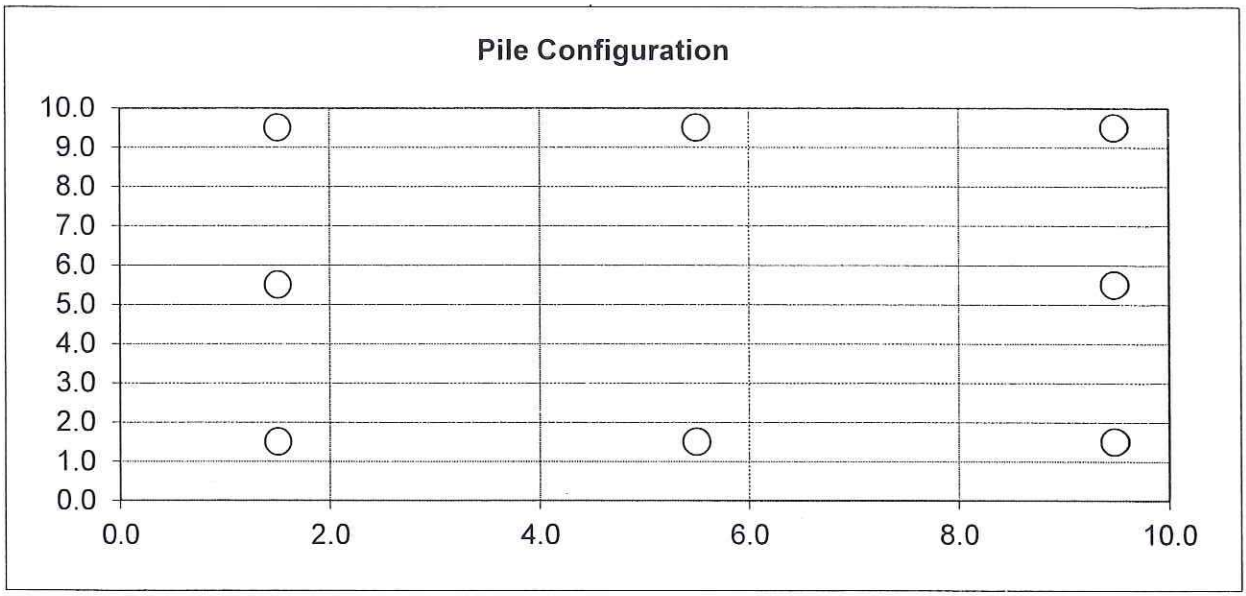
Pile No.	X (Transverse)	Y (Longitudinal)
1	1.500	4.50
2	6.365	1.50
3	11.167	4.50

Reduction Factors in X-dir	Reduction Factors in Y-dir
0.884	1.000
0.883	0.915
1.000	1.000

Project: SR-91 WB Widening - N. Anaheim OH Bents

By: Ranjan 3/22/2011

Calculation of Pile Group Efficiency (using formula in Group 7.0 Technical Manual)

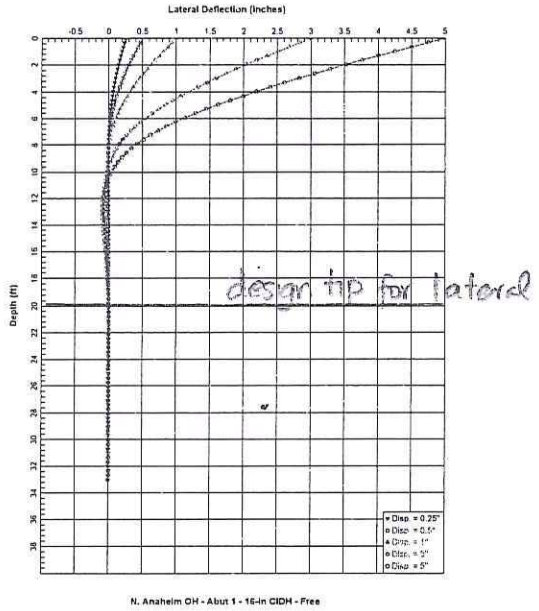


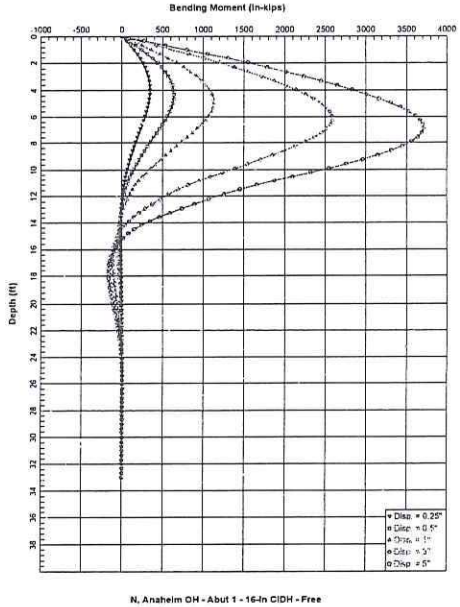
Pile Dia.:	1.330
No. of Piles:	8

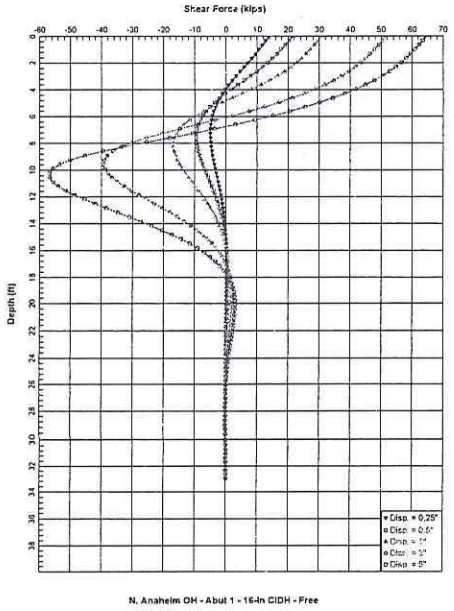
Group Efficiency	X-Dir (Trans)	Y-Dir (Long)
	0.726	0.726

Pile No.	X (Transverse)	Y (Longitudinal)
1	1.500	1.50
2	5.500	1.50
3	9.500	1.50
4	1.500	5.500
5	9.500	5.500
6	1.500	9.50
7	5.500	9.50
8	9.500	9.50

Reduction Factors in X-dir	Reduction Factors in Y-dir
0.638	0.638
0.624	0.685
0.867	0.638
0.685	0.624
0.866	0.624
0.638	0.867
0.624	0.866
0.867	0.867


Lateral Deflection (Inches)
Depth (ft)
design tip for lateral
Disp. = 0.25"
Disp. = 0.5"
Disp. = 1"
Disp. = 3"
Disp. = 5"
N. Anaheim OH - Abut 1 - 16-in CIDH - Free


Bending Moment (in-kips)
Depth (ft)
Disp. = 0.25"
Disp. = 0.5"
Disp. = 1"
Disp. = 3"
Disp. = 5"
N. Anaheim OH - Abut 1 - 16-in CIDH - Free


Shear Force (kips)
Depth (ft)
Disp. = 0.25"
Disp. = 0.5"
Disp. = 1"
Disp. = 3"
Disp. = 5"
N. Anaheim OH - Abut 1 - 16-in CIDH - Free

LPile Plus for Windows, Version 6.0 (6.0.09)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

(c) 1985-2010 by Ensoft, Inc.
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This program is licensed to:

Files Used for Analysis

Path to file locations: X:\Projects\2010\10-126 - RBF SR 91 Westbound Widening\Reports\Foundation Report\N. Anaheim OH\Analyses\LPILE\Abut 1\2-ft Overburden\
Name of input data file: 16-inch CIDH pile.lp6d
Name of output file: 16-inch CIDH pile.lp6o
Name of plot output file: 16-inch CIDH pile.lp6p
Name of runtime file: 16-inch CIDH pile.lp6r

Date and Time of Analysis

Date: March 23, 2011 Time: 16:32:23

Problem Title

Project Name: SR-91 WB Widening

Job Number: 10-126

Client:

Engineer: GJG

Description: 16-inch CIDH at N. Anaheim OH Abut 1

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	300	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections = 1

Total Pile Length = 33.00 ft

Depth of ground surface below top of pile = -2.00 ft

Slope angle of ground surface = 0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over
the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	16.0000000
2	33.000000	16.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	33.000 in
Top Width	=	16.000 in
Bottom Width	=	16.000 in
Top Area	=	201.061930 sq. in
Bottom Area	=	201.061930 sq. in
Moment of Inertia at Top	=	3.217E+03 inA4
Moment of Inertia at Bottom	=	3.217E+03 inA4
Elastic Modulus	=	1800000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 6 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = -2.000 ft
Distance from top of pile to bottom of layer = 18.000 ft
p-y subgrade modulus k for top of soil layer = 65.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 65.000 lbs/in**3

Layer 2 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 18.000 ft
Distance from top of pile to bottom of layer = 43.000 ft
p-y subgrade modulus k for top of soil layer = 65.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 65.000 lbs/in**3

Layer 3 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 43.000 ft
Distance from top of pile to bottom of layer = 63.000 ft
p-y subgrade modulus k for top of soil layer = 73.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 73.000 lbs/in**3

Layer 4 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 63.000 ft
Distance from top of pile to bottom of layer = 68.000 ft

Layer 5 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 68.000 ft
Distance from top of pile to bottom of layer = 73.000 ft

Layer 6 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 73.000 ft
Distance from top of pile to bottom of layer = 100.000 ft
p-y subgrade modulus k for top of soil layer = 100.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 100.000 lbs/in**3

(Depth of lowest layer extends 67.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 12 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	-2.00	120.00000
2	18.00	120.00000
3	18.00	120.00000
4	43.00	120.00000
5	43.00	120.00000
6	63.00	120.00000
7	63.00	115.00000
8	68.00	115.00000
9	68.00	52.60000
10	73.00	52.60000
11	73.00	62.60000
12	100.00	62.60000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. Subgr. pci
1	API Sand	-2.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
		18.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
2	API Sand	18.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
		43.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
3	API Sand	43.000	120.000	--	33.000	--	--	--	73.000	--	--	--	--	--
		63.000	120.000	--	33.000	--	--	--	73.000	--	--	--	--	--
4	Soft Clay	63.000	115.000	2000.000	--	--	--	0.00500	--	--	--	--	--	--
		68.000	115.000	2000.000	--	--	--	0.00500	--	--	--	--	--	--
5	Soft Clay	68.000	52.600	2000.000	--	--	--	0.00500	--	--	--	--	--	--
		73.000	52.600	2000.000	--	--	--	0.00500	--	--	--	--	--	--
6	API Sand	73.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--
		100.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.9000	1.0000
2	33.000	0.9000	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	70000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	70000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	70000.000
4	4	y =	3.000 in	M =	0.000 in-lbs	70000.000
5	4	y =	5.000 in	M =	0.000 in-lbs	70000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

---

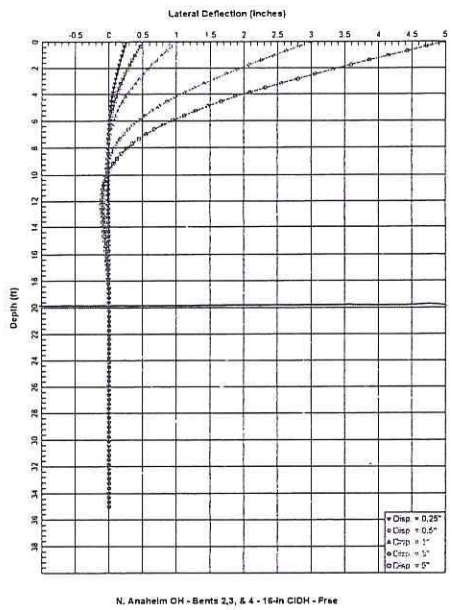
Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

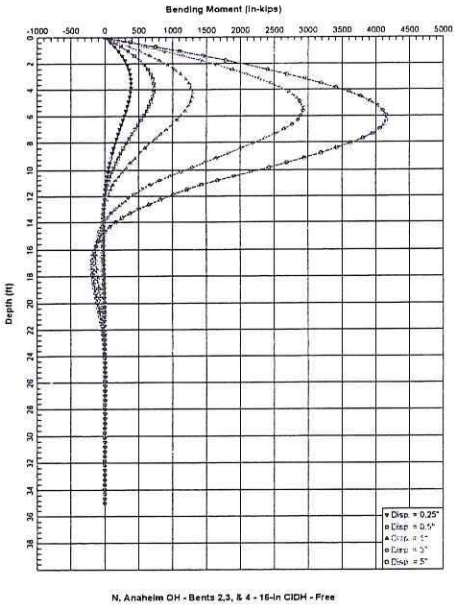
Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)		Condition 2 in-lb, rad., or in-lb/rad.		Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y =	0.2500	M =	0.000	70000.	0.25000000	343836.	13794.	0.00000000
2	4	y =	0.5000	M =	0.000	70000.	0.50000000	636955.	21482.	0.00000000
3	4	y =	1.0000	M =	0.000	70000.	1.00000000	1126995.	30838.	0.00000000
4	4	y =	3.0000	M =	0.000	70000.	3.00000000	2580522.	51558.	0.00000000
5	4	y =	5.0000	M =	0.000	70000.	5.00000000	3708901.	64633.	0.00000000

The analysis ended normally.

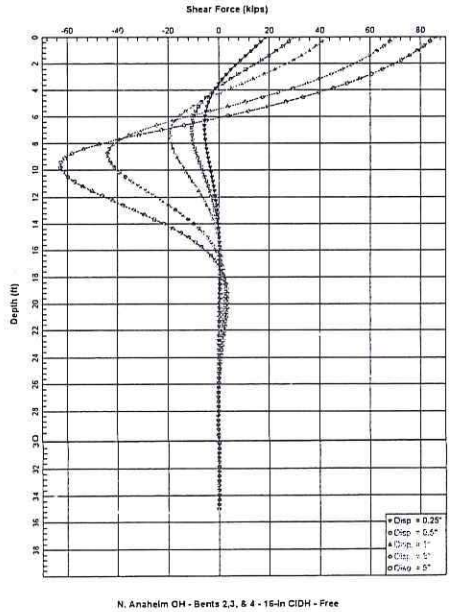


N. Anaheim OH - Bents 2,3, & 4 - 16-in CIDH - Free

design tip for lateral



N. Anaheim OH - Bents 2,3, & 4 - 16-in CIDH - Free



N. Anaheim OH - Bents 2,3, & 4 - 16-in CIDH - Free

LPile Plus for Windows, Version 6.0 (6.0.09)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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This program is licensed to:

Files Used for Analysis

Path to file locations: X:\Projects\2010\10-126 - RBF SR 91 Westbound Widening\Reports\Foundation Report\N. Anaheim OH\Analyses\LPILE\Bents 2 to 4\
Name of input data file: 16-inch CIDH pile.lp6d
Name of output file: 16-inch CIDH pile.lp6o
Name of plot output file: 16-inch CIDH pile.lp6p
Name of runtime file: 16-inch CIDH pile.lp6r

Date and Time of Analysis

Date: March 23, 2011 Time: 16:37:57

Problem Title

Project Name: SR-91 WB Widening

Job Number: 10-126

Client:

Engineer: GJG

Description: 16-inch CIDH at N. Anaheim OH Bents 2, 3, & 4

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	300	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections = 1

Total Pile Length = 35.00 ft

Depth of ground surface below top of pile = -5.00 ft

Slope angle of ground surface = 0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over
the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	16.0000000
2	35.000000	16.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	35.000 in
Top Width	=	16.000 in
Bottom Width	=	16.000 in
Top Area	=	201.061930 sq. in
Bottom Area	=	201.061930 sq. in
Moment of Inertia at Top	=	3.217E+03 in^4
Moment of Inertia at Bottom	=	3.217E+03 in^4
Elastic Modulus	=	1800000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 5 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = -5.000 ft
Distance from top of pile to bottom of layer = 18.000 ft
p-y subgrade modulus k for top of soil layer = 65.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 65.000 lbs/in**3

Layer 2 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 18.000 ft
Distance from top of pile to bottom of layer = 38.000 ft
p-y subgrade modulus k for top of soil layer = 73.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 73.000 lbs/in**3

Layer 3 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 38.000 ft
Distance from top of pile to bottom of layer = 43.000 ft

Layer 4 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 43.000 ft
Distance from top of pile to bottom of layer = 48.000 ft

Layer 5 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 48.000 ft

Distance from top of pile to bottom of layer = 100.000 ft
p-y subgrade modulus k for top of soil layer = 100.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 100.000 lbs/in**3

(Depth of lowest layer extends 65.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 10 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	-5.00	120.00000
2	18.00	120.00000
3	18.00	120.00000
4	38.00	120.00000
5	38.00	115.00000
6	43.00	115.00000
7	43.00	52.60000
8	48.00	52.60000
9	48.00	62.60000
10	100.00	62.60000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. Subgr. pci
1	API Sand	-5.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
		18.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
2	API Sand	18.000	120.000	--	33.000	--	--	--	73.000	--	--	--	--	--
		38.000	120.000	--	33.000	--	--	--	73.000	--	--	--	--	--
3	Soft Clay	38.000	115.000	2000.000	--	--	--	0.00500	--	--	--	--	--	--
		43.000	115.000	2000.000	--	--	--	0.00500	--	--	--	--	--	--
4	Soft Clay	43.000	52.600	2000.000	--	--	--	0.00500	--	--	--	--	--	--
		48.000	52.600	2000.000	--	--	--	0.00500	--	--	--	--	--	--
5	API Sand	48.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--
		100.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.7000	1.0000
2	35.000	0.7000	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	74000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	74000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	74000.000
4	4	y =	3.000 in	M =	0.000 in-lbs	74000.000
5	4	y =	5.000 in	M =	0.000 in-lbs	74000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

---

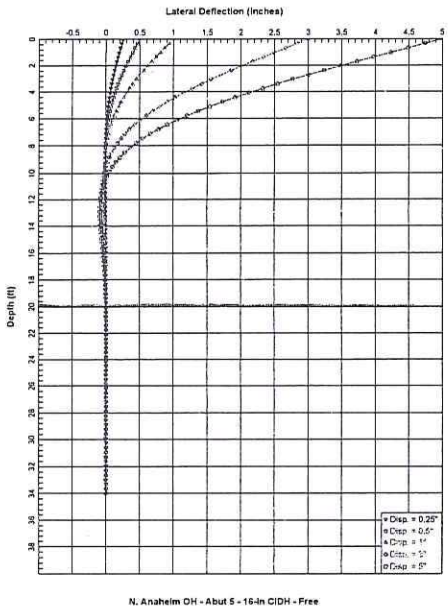
Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

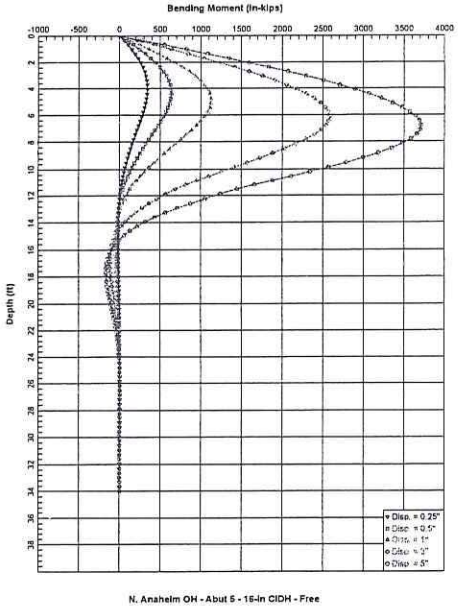
Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)	Condition 2 in-lb, rad., or in-lb/rad.	Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y = 0.2500	M = 0.000	74000.	0.25000000	387067.	18670.	0.00000000
2	4	y = 0.5000	M = 0.000	74000.	0.50000000	726460.	29859.	0.00000000
3	4	y = 1.0000	M = 0.000	74000.	1.00000000	1291495.	43137.	0.00000000
4	4	y = 3.0000	M = 0.000	74000.	3.00000000	2922363.	70004.	0.00000000
5	4	y = 5.0000	M = 0.000	74000.	5.00000000	4155229.	86031.	0.00000000

The analysis ended normally.

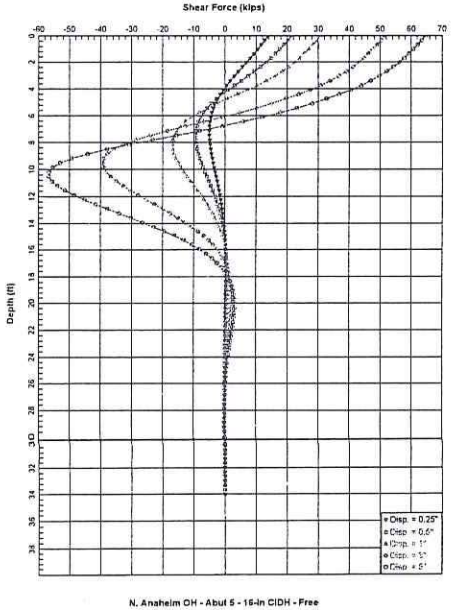


N. Anaheim OH - Abut 5 - 16-in CIDH - Free

design tip for lateral



N. Anaheim OH - Abut 5 - 16-in CIDH - Free



N. Anaheim OH - Abut 5 - 16-in CIDH - Free

LPile Plus for Windows, Version 6.0 (6.0.09)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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This program is licensed to:

Files Used for Analysis

Path to file locations: X:\Projects\2010\10-126 - RBF SR 91 Westbound Widening\Reports\Foundation Report\N. Anaheim OH\Analyses\LPILE\Abut 5\2-ft Overburden\
Name of input data file: 16-inch CIDH pile.lp6d
Name of output file: 16-inch CIDH pile.lp6o
Name of plot output file: 16-inch CIDH pile.lp6p
Name of runtime file: 16-inch CIDH pile.lp6r

Date and Time of Analysis

Date: March 23, 2011 Time: 16:36:13

Problem Title

Project Name: SR-91 WB Widening

Job Number: 10-126

Client:

Engineer: GJG

Description: 16-inch CIDH at N. Anaheim OH Abut 5

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	300	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections = 1

Total Pile Length = 34.00 ft

Depth of ground surface below top of pile = -2.00 ft

Slope angle of ground surface = 0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over
the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	16.0000000
2	34.000000	16.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	34.000 in
Top Width	=	16.000 in
Bottom Width	=	16.000 in
Top Area	=	201.061930 sq. in
Bottom Area	=	201.061930 sq. in
Moment of Inertia at Top	=	3.217E+03 in^4
Moment of Inertia at Bottom	=	3.217E+03 in^4
Elastic Modulus	=	1800000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 6 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = -2.000 ft
Distance from top of pile to bottom of layer = 20.000 ft
p-y subgrade modulus k for top of soil layer = 65.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 65.000 lbs/in**3

Layer 2 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 20.000 ft
Distance from top of pile to bottom of layer = 45.000 ft
p-y subgrade modulus k for top of soil layer = 65.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 65.000 lbs/in**3

Layer 3 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 45.000 ft
Distance from top of pile to bottom of layer = 65.000 ft
p-y subgrade modulus k for top of soil layer = 73.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 73.000 lbs/in**3

Layer 4 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 65.000 ft
Distance from top of pile to bottom of layer = 70.000 ft

Layer 5 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 70.000 ft
Distance from top of pile to bottom of layer = 75.000 ft

Layer 6 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 75.000 ft
Distance from top of pile to bottom of layer = 100.000 ft
p-y subgrade modulus k for top of soil layer = 100.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 100.000 lbs/in**3

(Depth of lowest layer extends 66.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 12 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	-2.00	120.00000
2	20.00	120.00000
3	20.00	120.00000
4	45.00	120.00000
5	45.00	120.00000
6	65.00	120.00000
7	65.00	115.00000
8	70.00	115.00000
9	70.00	52.60000
10	75.00	52.60000
11	75.00	62.60000
12	100.00	62.60000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. Subgr. pci
1	API Sand	-2.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
		20.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
2	API Sand	20.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
		45.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
3	API Sand	45.000	120.000	--	33.000	--	--	--	73.000	--	--	--	--	--
		65.000	120.000	--	33.000	--	--	--	73.000	--	--	--	--	--
4	Soft Clay	65.000	115.000	2000.000	--	--	--	0.00500	--	--	--	--	--	--
		70.000	115.000	2000.000	--	--	--	0.00500	--	--	--	--	--	--
5	Soft Clay	70.000	52.600	2000.000	--	--	--	0.00500	--	--	--	--	--	--
		75.000	52.600	2000.000	--	--	--	0.00500	--	--	--	--	--	--
6	API Sand	75.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--
		100.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.9000	1.0000
2	34.000	0.9000	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	70000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	70000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	70000.000
4	4	y =	3.000 in	M =	0.000 in-lbs	70000.000
5	4	y =	5.000 in	M =	0.000 in-lbs	70000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

---

Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)		Condition 2 in-lb, rad., or in-lb/rad.		Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y =	0.2500	M =	0.000	70000.	0.25000000	343531.	13793.	0.00000000
2	4	y =	0.5000	M =	0.000	70000.	0.50000000	636581.	21481.	0.00000000
3	4	y =	1.0000	M =	0.000	70000.	1.00000000	1126256.	30836.	0.00000000
4	4	y =	3.0000	M =	0.000	70000.	3.00000000	2581669.	51556.	0.00000000
5	4	y =	5.0000	M =	0.000	70000.	5.00000000	3709027.	64631.	0.00000000

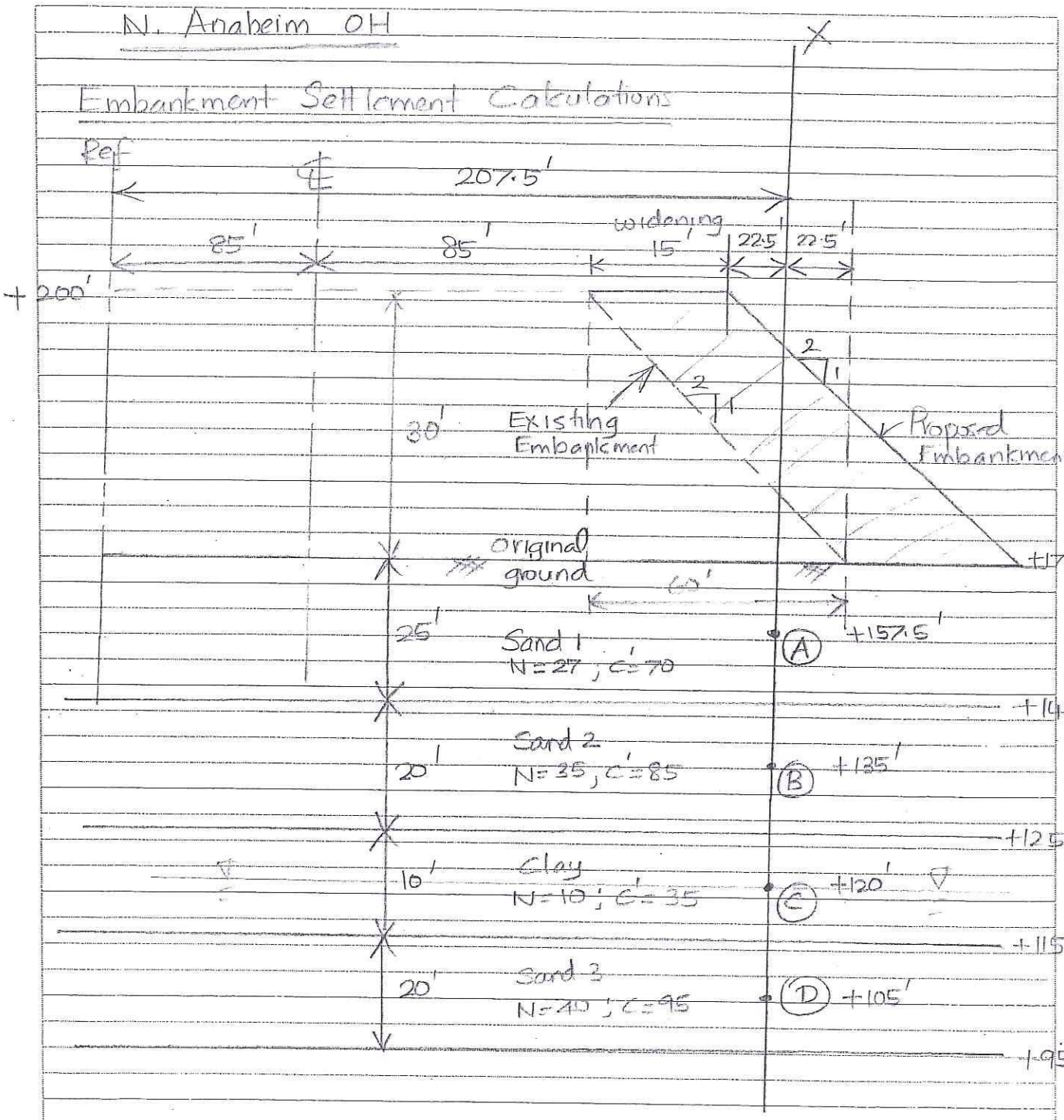
The analysis ended normally.

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening Project No.: 10-126
By: Ranjan Date: 3/21/11 Checked By: Lino Date: 3/24/11 Sheet: 1 of 3
Subject:

N. Anaheim OH

Embankment Settlement Calculations



17660 Newhope Street, Suite E, Fountain Valley, CA 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

Project: SR-91 WB Widening Project No.: 10-126
By: Ranjan Date: 3/21/11 Checked By: Lino Date: 3/24/11 Sheet: 2 of 3
Subject:

SAMPLE CALCULATION AT POINT A

Stress below original ground (σ_0') = $12.5' \times 120$ = 1.5 ksf

Stress increase due to existing embankment ($\Delta\sigma_1'$)

= 1.36 ksf (See attached sheet)

∴ Total initial stress $\sigma_1' = \sigma_0' + \Delta\sigma_1'$

= 1.5 + 1.36 = 2.86 ksf

Stress increase due to proposed embankment ($\Delta\sigma_2'$)

= 2.24 ksf (See attached sheet)

∴ Total final stress $\sigma_2' = \sigma_0 + \Delta\sigma_2'$

= 1.5 + 2.24 = 3.74 ksf

∴ Stress increase due to widening ($\Delta\sigma'$)

$= \sigma_2' - \sigma_1'$

= 3.74 − 2.86 = 0.88 ksf

For Sand 1 layer (between +170' and +145'),

Thickness H = 25'

Bearing Capacity Index, C' = 70 (∵ N = 27) (Per AASHTO)

Using AASHTO Eq^n 10.6.2.4.2-3,

$$\Delta H_i = \frac{H_i}{C'} \log\left(\frac{\sigma_1' + \Delta\sigma'}{\sigma_1'}\right)$$

$$\Delta H_A = \frac{25}{70} \log\left(\frac{2.86 + 0.88}{2.86}\right) \times 12'' = 0.5''$$

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening Project No.: 10-126
By: Ranjan Date: 3/21/11 Checked By: Lino Date: 3/24/11 Sheet: 3 of 3
Subject:

Point	layer name	Thickness H (ft)	σ_o' (ksf)	$\Delta\sigma_1'$ (ksf)	σ_1' (ksf)	$\Delta\sigma_2'$ (ksf)	$\Delta\sigma'$ (ksf)	C'	ΔH (in)
A	Sand 1	25	1.5	1.36	2.86	2.24	0.88	70	0.5
B	Sand 2	20	4.2	1.45	5.65	2.14	0.69	85	0.14
C	Clay	10	5.975	1.51	7.485	2.07	0.56	35	0.11
D	Sand 3	20	6.86	1.55	8.41	2.01	0.46	95	0.06

$\therefore$ Total Settlement @ X $= \underset{@A}{\Delta H} + \underset{@B}{\Delta H} + \underset{@C}{\Delta H} + \underset{@D}{\Delta H}$

$= 0.5'' + 0.14'' + 0.11'' + 0.06''$

$= 0.81''$

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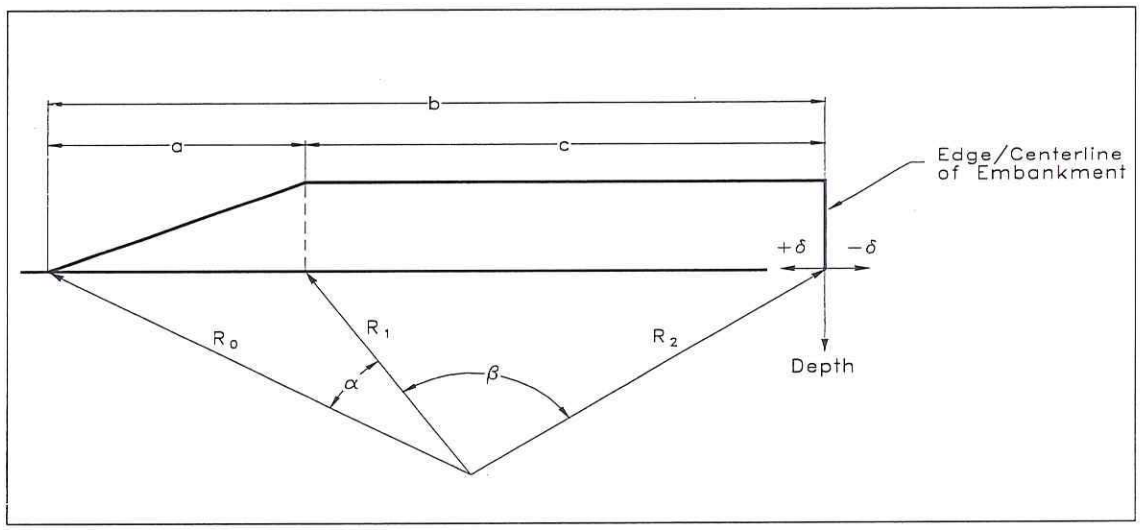
Stress at Various Points Below an Earth Embankment

Equation of Stress Given Below (Poulos & Davis P. 40):



Variables Defined in Adjacent Figure
Soil Unit Weight = 120 PCF

NOTE: ONLY CHANGE VARIABLES IN HIGHLIGHTED CELLS

Embankment Height =	30	a =	60
Embankment Width (Top)	185	b =	245
Side Slope Ratio (x:1) =	2.000	c =	185

Point X
Delta 207.5

Actual Depth (feet)	R2 (feet)	alpha (radians)	beta (radians)	SigmaZ (ksf)
12.5	208	2.31274	0.44693	**2.24**
35	210	1.3912	0.83236	**2.14**
50	213	1.06636	0.91149	**2.07**
65	217	0.85652	0.93398	**2.01**

Point X (Final)

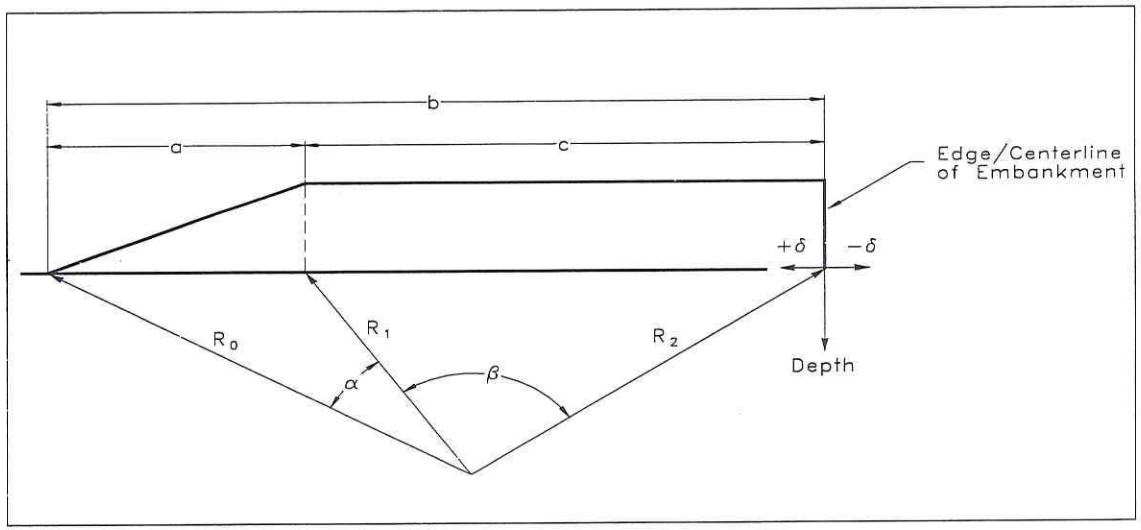
SigmaZ (ksf)
2.24
2.14
2.07
2.01

Future Fill - N.Anaheim Abuts

3/24/2011

Stress at Various Points Below an Earth Embankment

Equation of Stress Given Below (Poulos & Davis P. 40):



Variables Defined in Adjacent Figure
Soil Unit Weight = 120 PCF

NOTE: ONLY CHANGE VARIABLES IN HIGHLIGHTED CELLS

Embankment Height =	30	a =	60
Embankment Width (Top)	170	b =	230
Side Slope Ratio (x:1) =	2.000	c =	170

Point X
Delta 207.5

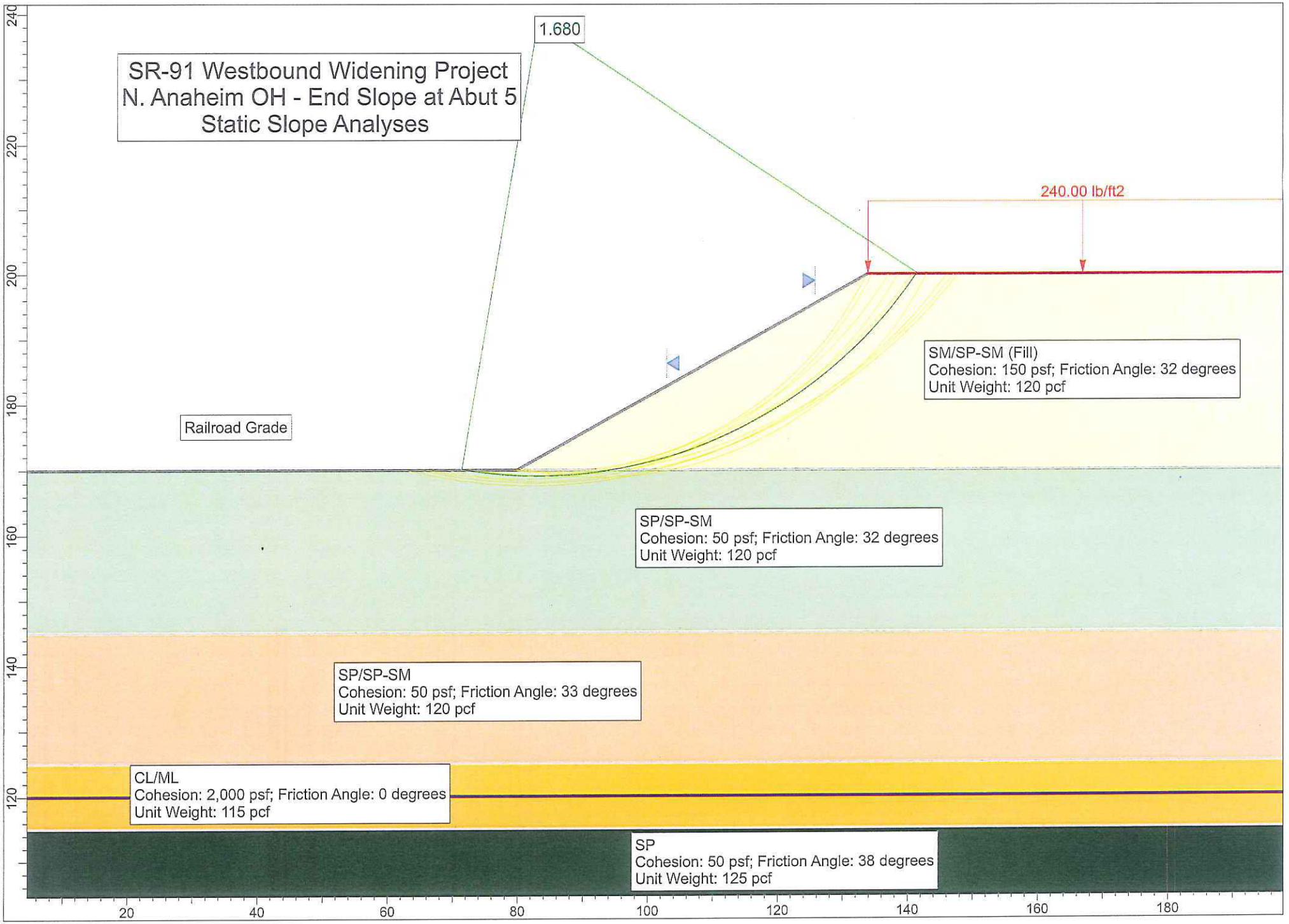
Actual Depth (feet)	R2 (feet)	alpha (radians)	beta (radians)	SigmaZ (ksf)
12.5	208	2.31274	0.26158	**1.36**
35	210	1.3912	0.58383	**1.45**
50	213	1.06636	0.69084	**1.51**
65	217	0.85652	0.74395	**1.55**

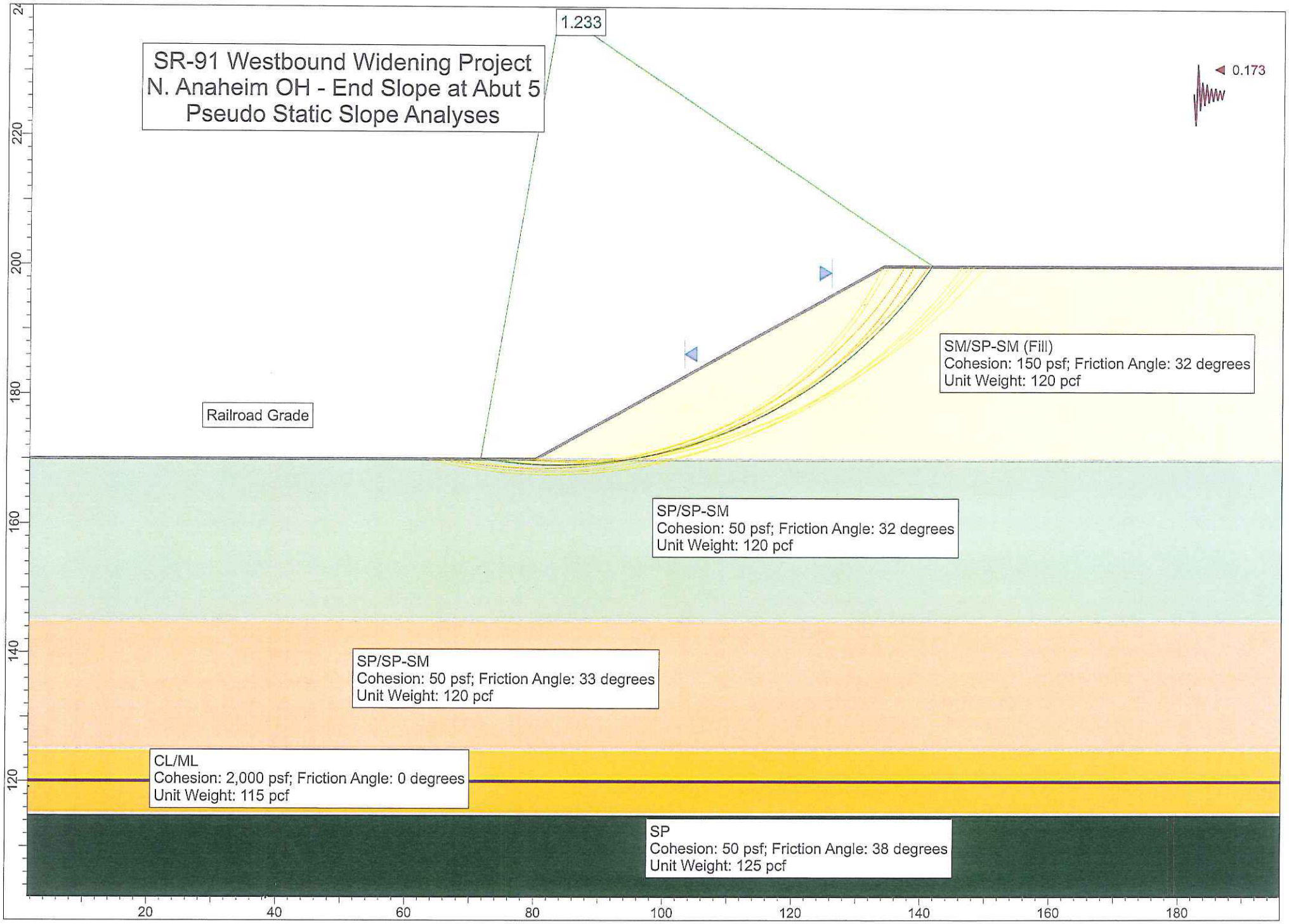
Point X (Final)

SigmaZ (ksf)
1.36
1.45
1.51
1.55

Existing Fill - N.Anaheim Abuts

3/24/2011

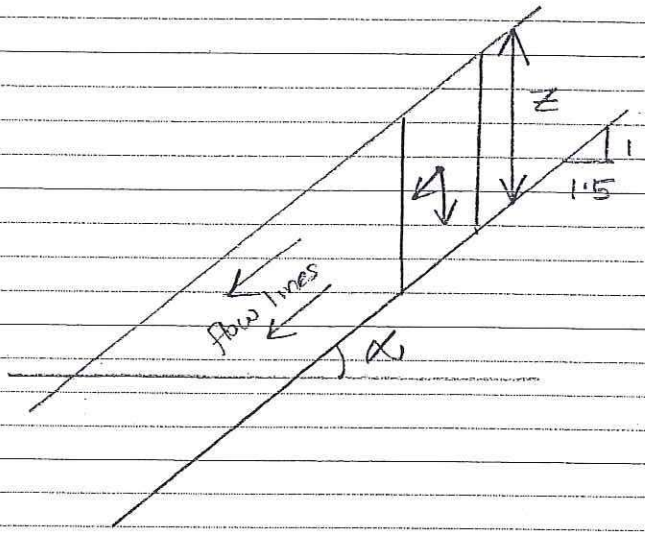

SR-91 Westbound Widening Project
N. Anaheim OH - End Slope at Abut 5
Static Slope Analyses
1.680
240.00 lb/ft2
SM/SP-SM (Fill)
Cohesion: 150 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
Railroad Grade
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 33 degrees
Unit Weight: 120 pcf
CL/ML
Cohesion: 2,000 psf; Friction Angle: 0 degrees
Unit Weight: 115 pcf
SP
Cohesion: 50 psf; Friction Angle: 38 degrees
Unit Weight: 125 pcf
240
220
200
180
160
140
120
20
40
60
80
100
120
140
160
180


SR-91 Westbound Widening Project
N. Anaheim OH - End Slope at Abut 5
Pseudo Static Slope Analyses
1.233
0.173
Railroad Grade
SM/SP-SM (Fill)
Cohesion: 150 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 33 degrees
Unit Weight: 120 pcf
CL/ML
Cohesion: 2,000 psf; Friction Angle: 0 degrees
Unit Weight: 115 pcf
SP
Cohesion: 50 psf; Friction Angle: 38 degrees
Unit Weight: 125 pcf
240
220
200
180
160
140
120
20
40
60
80
100
120
140
160
180

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening Project No.: 10-126
By: Ranjan Date: 3/21/11 Checked By: Lino Date: 3/24/11 Sheet: 1 of 1
Subject:

Surficial Slope Stability Analysis



For 1.5H : 1V Slope,

$\alpha = \tan^{-1}\left(\frac{1}{1.5}\right)$

$= 33.7^\circ$

Cosider the thickness of Slide $Z = 4$ ft

Assume $\gamma_t = 120$ pcf

$\gamma_b = 120 - 62.4$

$= 57.6$ pcf

Assume $\phi = 32^\circ$ & $C = 230$ psf

$$FOS = \frac{2Z\gamma_b \cos^2\alpha \tan\phi + 2C}{Z\gamma_t \sin 2\alpha}$$

$$= \frac{(2 \times 4' \times 57.6 \times \cos^2 33.7 \times \tan 32) + (2 \times 230)}{4' \times 120 \times \sin 67.4^\circ}$$

$$= 1.5$$

$\Rightarrow$ If Slope paving is not used for the 1.5H : 1V slopes, the upper 4-ft of slope face should have a minimum $\phi = 32^\circ$ & $C = 230$ psf //

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Appendix D

CALTRANS REVIEW COMMENTS AND EMI RESPONSES

State of California

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: LUQI YANG
Liaison Engineer

Date: May 2, 2011

File: 12-ORA-91 PM Various
EA 12-0C5701, 1200000079
Brookhurst Ave UC + 5Br.
No. 55-0280 + 5

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
Geotechnical Services
Office of Geotechnical Design – South 1

Subject: Foundation Report- Bridge No. 55-0216, 55-0218, 55-0245, 55-0279, 55-0280 & 55-852

Per your request, the Geotechnical Design South 1 - Branch B has reviewed the subject submittal, containing the following item:

1. Foundation Reports for No. 55-0216, 55-0218, 55-0245, 55-0279, 55-0280 & 55-852, Anaheim, Orange County, dated April 15, 2011.

Our office has no comments on above submitted item.

Should you have any questions, please contact Mushtaq Ahmed at (213) 620-2132.

Reviewed by: Date: 5/2/11

Mushtaq Ahmed, P.E.
Transportation Engineer-Civil
Office of Geotechnical Design – South 1
Branch B

Supervised by: Date: 5/2/11

Sam Sukiasian, G.E.
Chief Branch B
Office of Geotechnical Design – South 1

cc: OGDS1 – Nor. File, OGDS1- Sac. File, GS-Sac. File

REGISTERED CIVIL ENGINEER
MOHAMMAD MUSHTAQ AHMED
No. C056390
Exp.
STATE OF CALIFORNIA

FOUNDATION REPORT
EAST ST UC (Widen)
Bridge No. 55-0245

Earth Mechanics, Inc.

September 16, 2011

FOUNDATION REPORT

East Street Undercrossing (Widen)
Bridge No. 55-0245
Orange County, California
12-ORA-91, PM 4.26
Caltrans Project No. 12000000791 (EA 12-0C5701)
EMI Project No. 10-126
Date: September 16, 2011

EARTH MECHANICS, INC.

Geotechnical and Earthquake Engineering

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

September 16, 2011

EMI Project No. 10-126

RBF Consulting
14725 Alton Parkway
Irvine, California 92618

Attention: Mr. Steve Huff, P.E.

Subject: Foundation Report for East Street Undercrossing (Widen)
Bridge No. 55-0245
Orange County, California
12-ORA-91, PM 4.26
Caltrans Project No. 12000000791 (EA 12-0C5701)

Dear Mr. Huff:

Attached please find the Foundation Report for the subject bridge widening project. This report contains the findings and conclusions of our field investigation and laboratory testing program. This report also contains our recommendations for the design and construction of the bridge foundations.

An earlier version of this report dated April 15, 2011 was submitted to Caltrans for review. Caltrans prepared a memorandum dated May 2, 2011 indicating they have no comments. A copy of this Caltrans memorandum is included in Appendix D.

We appreciate the opportunity to provide geotechnical design services for this project. If you have any questions, please call us.

Sincerely,

EARTH MECHANICS, INC.

9/16/11

(Raja) S. Pirathiviraj, PE 71662
Senior Staff Engineer

9-16-11

Lino Cheang, GE 2345
Project Manager

SP/sp,lcc

17800 Newhope Street, Suite B, Fountain Valley, California 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

FOUNDATION REPORT

EAST STREET UNDERCROSSING (WIDEN)
BRIDGE NO. 55-0245
ORANGE COUNTY, CALIFORNIA
12-ORA-91, PM 4.26
CALTRANS PROJECT NO. 12000000791 (EA 12-0C5701)

Prepared for:

RBF Consulting
14725 Alton Parkway
Irvine, California 92618

Prepared By:

Earth Mechanics, Inc.
17800 Newhope Street, Suite B
Fountain Valley, California 92708

EMI Project No. 10-126

September 16, 2011

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Appendix C. Design Calculations
Appendix D. Caltrans Review Comments and EMI Responses

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE OF STUDY

This Foundation Report presents the findings and conclusions of a geotechnical investigation conducted by Earth Mechanics, Inc. (EMI). It presents foundation design and construction recommendations for the proposed widening of East Street Undercrossing (UC) in Orange County, California. A site location map is presented in Figure 1-1.

EMI is a subconsultant to RBF Consulting (RBF). The geotechnical services provided for this project included the following tasks:

- Collection and review of existing geotechnical information;
- Field exploration consisting of drilling and logging exploratory borings;
- Laboratory testing of selected bulk and relatively undisturbed soil samples;
- Engineering calculations and analysis to develop foundation design and construction recommendations; and
- Preparation of this report presenting our findings, conclusions, and recommendations.

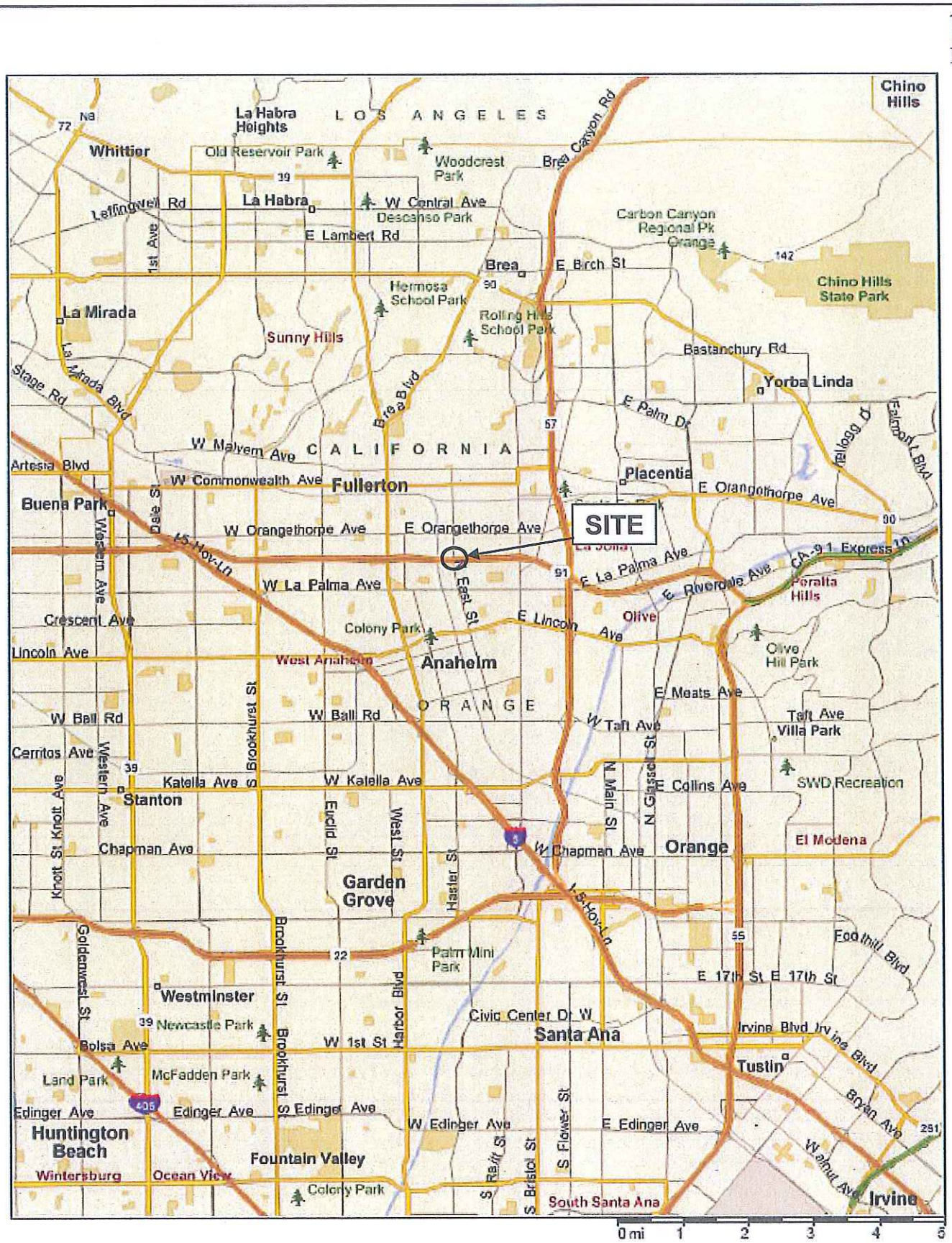
1.2 PROJECT DESCRIPTION

The California Department of Transportation (Caltrans), in cooperation with the Orange County Transportation Authority (OCTA) and the cities of Anaheim and Fullerton, proposes to widen the westbound State Route 91 (SR-91) from State Route 57 (SR-57) to Interstate 5 (I-5). SR-91 is a major east-west freeway facility that begins at the eastern junction with SR-60 in the city of Riverside in Riverside County, and continues west through Orange County to its terminus at the junction with Pacific Coast Highway 1 near the city of Hermosa Beach in Los Angeles County.

The proposed project limits cover a distance of 4.5 miles; however, actual improvements are limited to a total of 3.8 miles within the project area. The proposed project consists of widening six bridges. This foundation report addresses only the East Street UC.

The existing UC was constructed in November 1959, widened in February 1967, and widened and retrofitted in January 1997. The existing UC is a four-span precast, prestressed concrete structure with a total length of 135.5 feet and a width of 145.3 feet. The original UC and 1967 widening of UC were supported on 45-ton, 16-inch diameter Cast-In-Drilled-Hole (CIDH) piles with pile tip elevations of about 129 feet and 138 feet, respectively. The 1997 widening and retrofitting of UC were supported on 70-ton and 100-ton, 16-inch diameter CIDH piles at Abutments 1 and 5, and Bents 2 through 4, respectively; the specified pile tip elevations were 142 feet and 128 feet at abutments and bents, respectively.

The existing East Street UC will be widened by about 12-feet only in the north side in order to accommodate widening of the westbound SR-91.



East Street UC (Widen)	SITE LOCATION MAP
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 1-1
Project No. 10-126	Date: 03-15-11

2.0 FIELD INVESTIGATION AND LABORATORY TESTING

2.1 FIELD INVESTIGATION

As-built Log-of-Test-Borings (LOTB) sheets are included in Appendix A for the original construction and 1993 widening. Additional borings were not performed for the widening in February 1967.

One rotary-wash boring and three penetration borings were drilled between February and March 1955 for the original construction. The deepest boring was advanced to about elevation +99 feet. Existing grade at the borehole locations at the time of the investigation were between +169 feet and +171.4 feet, which is near the roadway surface of East Street.

Two rotary-wash borings and one cone penetration test (CPT) sounding were performed in January 1993. The deepest boring was advanced to about elevation +96 feet. Existing grades at the borehole locations at the time of the investigation were between elevations +187 feet and +193 feet, which are same as the freeway surface elevation.

To supplement the existing subsurface information, three soil borings were performed between December 7, 2010 and January 19, 2011. Boring information, including exploration number, stations, offsets, ground surface elevations, bottom of boring elevations and water level measurements are summarized in Table 2-1. Locations of the exploratory boring are shown on the LOTB sheets provided in Appendix A.

Table 2-1. Geotechnical Exploration Information

Boring No.	Station Line	Station	Approx. Offset (feet)	Approx. Ground Surface El. (feet)	Approx. Bottom of Boring El. (feet)	Approx. Groundwater El. (feet)
A-10-044	A Line	278+00	77 Lt	+193.0	+111.5	+113.3
A-10-045		279+05	77 Lt	+174.0	+92.6	+120.5
CPT-10-046		279+92	64 Lt	+189.5	+103.2	Not Measured

Exploratory borings were drilled using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers. Sampling was performed by alternating the Modified California Drive (MCD) sampler and Standard Penetration Test (SPT) sampler. The soil sampling interval is generally 5 feet.

Relatively undisturbed soil samples were obtained using a 3.25-inch outer diameter MCD sampler lined with brass rings. Each of these brass rings is 1-inch long with a 2.5-inch outside diameter. The SPT sampler (1.4-inch inside diameter) was also used to obtain soil samples. The MCD and SPT samplers were driven 18 inches into the ground or until refusal was encountered using a 140-lb hammer free falling from a height of 30 inches. The numbers of blows to advance the sampler each 6 inches of penetration was recorded. The numbers of blows for the final 12 inches or shorter of driving was recorded on the LOTB sheets.

The CPT sounding was performed using an electronic cone penetrometer in general accordance with current ASTM Standards (ASTM D5778 and ASTM D3441). The CPT equipment consisted of a cone penetrometer assembly mounted at the end of a series of hollow sounding rods. The cone penetrometer assembly consisted of a conical tip with a 60° apex angle and a projected cross sectional area of 1.55 in² (10 cm²) and a cylindrical friction sleeve with a surface area of 23.25 in² (150 cm²). The interior of the cone penetrometer is instrumented with strain gauges that allow simultaneous measurements of cone tip and friction sleeve resistance during penetration. The cone penetrometer assembly is continuously pushed into the soil by a set of hydraulic rams at a standard rate of 0.79 inch per second (20 mm per second) while the cone tip resistance and sleeve friction resistance are recorded every 1.967 inches (50 mm) and stored in digital form. A specially designed all-wheel drive 25-ton truck provides the required reaction weight for pushing the cone assembly and is also used to transport and house the testing equipment. The computer generated graphical logs include tip resistance, friction resistance, and friction ratio. Soil behavior type interpretations are based on guidelines by Robertson and Campanella (1989).

Charts published by Winterkorn and Fang (1975) can be used to determine a reduction factor used to convert blowcounts recorded using the MCD sampler into SPT blowcounts. Using those charts, we obtained a reduction factor of 0.5 which was used for this project.

2.2 LABORATORY TESTING

Soil samples considered representative of the subsurface conditions were tested to obtain or derive relevant physical and engineering soil properties. The following laboratory tests were conducted to supplement the observations recorded during the field investigation:

- In-situ Moisture Content and Unit Weight
- Percent Passing No. 200 Sieve
- Atterberg Limit
- Direct Shear
- Unconsolidated Undrained Triaxial
- Consolidation
- Minimum Resistivity, pH, Sulfate Content and Chloride Content

The laboratory tests were conducted in general accordance with California Test Methods or American Society for Testing and Materials (ASTM) Standards. Laboratory test results are included in Appendix B.

3.0 GEOLOGY AND SEISMICITY

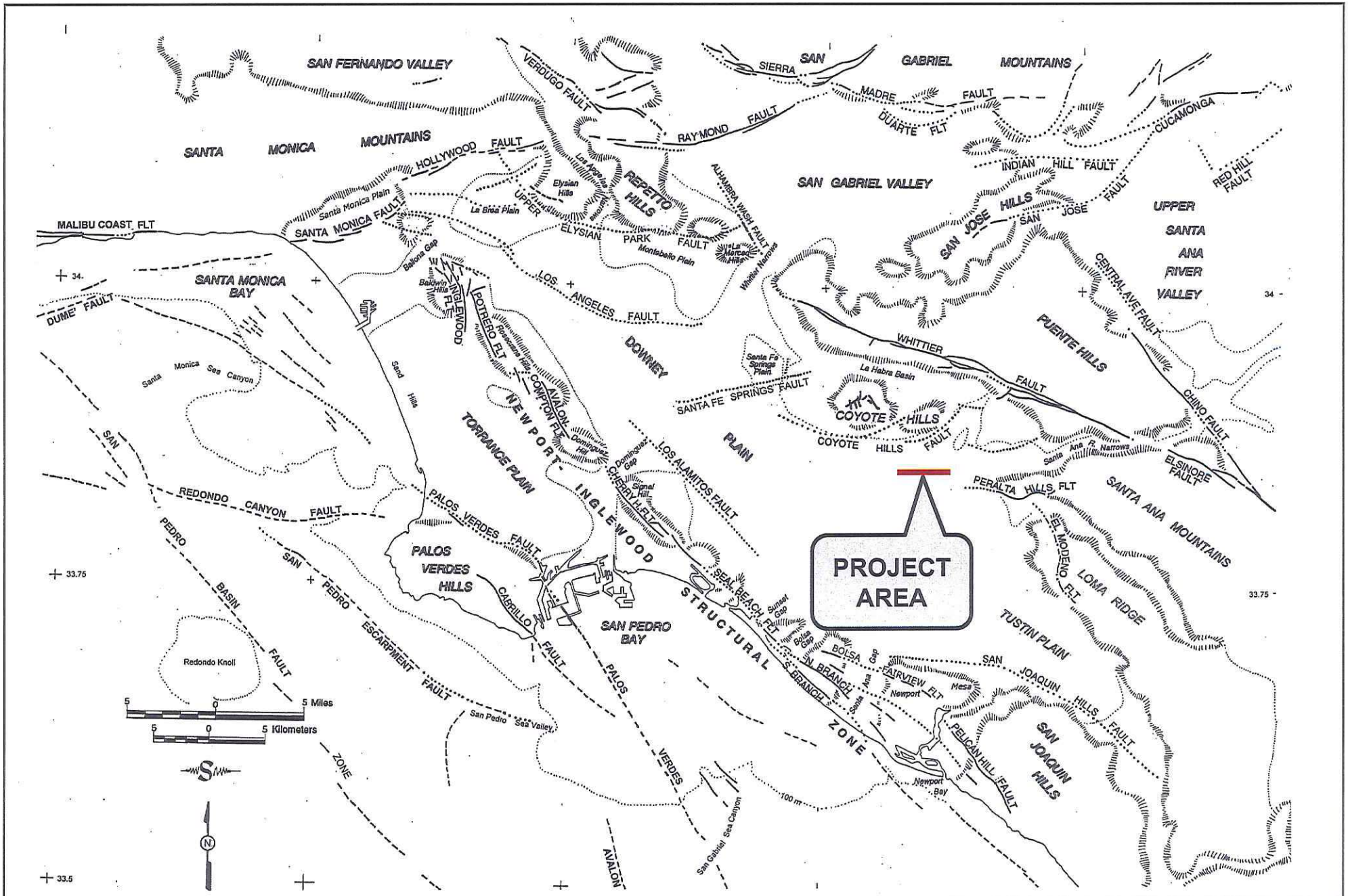
3.1 PHYSIOGRAPHY

The project area is in the east-central part of the Los Angeles Basin as shown in Figure 3-1 which comprises a transition zone between the Peninsular Ranges physiographic province on the east, and the Transverse Ranges physiographic province to the north. The Peninsular Ranges physiographic province comprises a northwest-southeast trending group of fault-bounded ranges such as Santa Ana Mountains, Puente Hills and San Joaquin Hills between the Salton Trough and the Pacific Ocean. The Transverse Ranges physiographic province comprises east-west trending ranges and valleys such as the Santa Monica Mountains, San Fernando Valley and San Gabriel Mountains. Valleys such as the Los Angeles Basin, the San Gabriel Valley and the Upper Santa Ana River Valley have characteristics compatible with both physiographic provinces and form a transition zone between the two provinces.

The Los Angeles Basin is essentially a large, relatively flat, low-lying and coastal plain surrounded by mountains on the north, east and southeast which rise abruptly to a few thousand feet above the plains. The western margin of the basin is bordered by the sea, the Palos Verdes Hills and the San Joaquin Hills. The floor of the basin gradually rises inland to a series of uplifted terrain along the margins of the surrounding mountains. This elevated marginal terrain includes the Santa Monica, La Brea, Montebello, Santa Fe Springs plains, and the Coyote Hills. The generally flat-lying nature and gradual inland rise of the Basin floor is disrupted by an alignment of northwest-southeast trending, low-elevation hills along the Newport-Inglewood Structural Zone (NISZ). The areas on either side of the NISZ are essentially flat and comprise the Downey-Tustin plain on the northeast and the Torrance Plain on the southwest. The site area is near the transition between the Downey and the Tustin plains.

3.2 GEOLOGIC STRUCTURE

The Los Angeles Basin is a deep structural basin comprising two major downward folds (synclines) separated by the NISZ uplift; the Paramount syncline is east of the NISZ under the Downey-Tustin Plain, and the Gardena syncline is west of the NISZ under the Torrance Plain. The Paramount syncline is the larger and deeper syncline with basement rocks as deep as about 30,000 feet (Yerkes et al, 1965). As described in the physiography section, the basin is rimmed by marginal elevated plains that rise about a hundred feet to as much as a couple hundred feet above the general level of the basin floor. These elevated plains and the Coyote Hills are underlain by fault-bounded, upward folds (anticlines) that are prolific oil fields. Most of the major faults associated with these folds are blind thrust faults and are shown on Figure 3-1 as dotted lines. The nearest faults to the project area are the blind thrust faults of the Puente Hills Blind Thrust Fault System and Compton-Los Alamitos Blind Fault System. Larger surface faults, such as the NISZ and the Elsinore Fault Zone (Whittier Section) lie to the southwest and northeast of the project site, respectively.



State Route 91 Westbound Widening Project

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

REGIONAL MAP OF ACTIVE FAULTS AND PHYSIOGRAPHY

Figure 3-1

Project No. 10-126

Date: 03-01-11

3.3 GEOLOGICAL HAZARDS

The only significant geological hazard at the site is earthquake shaking and perhaps local liquefaction. There are no known active surface faults within the project area so ground rupture is not a factor. The flat-lying nature of the area is not susceptible to landsliding. The site is too far from the ocean to be affected by tsunamis, and there are no large bodies of water within the site area that could generate a seiche. There are no volcanoes in the region.

As presented in Figure 3-2, the California Geological Survey (1997, 1998) shows designated project site is outside the liquefaction zone. Therefore, the liquefaction potential at the project site is low. The potential for liquefaction is discussed in detail in Section 5.2.

3.4 SEISMICITY

The project is in seismically active Southern California. The present-day seismotectonic stress field in the Los Angeles region is one of north-northeasterly compression. This is indicated by the geologic structures, by earthquake focal-mechanism solutions and by geodetic measurements. These data suggest crustal shortening of between 0.2 and 0.35 inches per year across the greater Los Angeles area (Argus et al., 1999).

Historical earthquake epicenter maps show widespread seismicity throughout the Los Angeles region. Earthquakes occur primarily as loose clusters along the NISZ, the southern margin of the Santa Monica Mountains, the margin between the Santa Susana-San Fernando Valley and the southern margin of the San Gabriel Mountains, and in the Coyote Hills-Puente Hills area.

The largest historical earthquakes within the Los Angeles Basin were the 1933 Long Beach (moment magnitude (M_W) of about 6.4), 1994 Northridge (M_W = 6.7), 1971 San Fernando (M_W = 6.7), 1987 Whittier (M_W = 5.9), and 2008 Chino Hills (M_W = 5.4). There have been no significant historical earthquakes in the immediate site area. There may have been a few random small events (M_W < 3.0). The nearest concentrated earthquake activity has been within the Puente Hills about 5 or 6 miles to the north of the site.

The 1933 Long Beach earthquake did not rupture the surface but is believed to have been associated with the NISZ (Benioff, 1938). Reevaluation of the seismic data by Hauksson and Gross (1991) relocated the 1933 earthquake hypocenter to a depth of about 6 miles below the Huntington Beach-Newport Beach city boundary.

The 1994 Northridge earthquake occurred on a southerly dipping subsurface fault which was unknown prior to the earthquake. The main shock occurred at a depth of about 12 miles. Earthquake aftershocks clearly defined the rupture surface dipping about 35 degrees southerly from a depth of about 1 or 2 miles to 14 miles. The causative fault was never identified with certainty.

The 1971 San Fernando earthquake involves surface rupture. The 1971 event occurred on a northerly dipping thrust fault that dips from the northern side of the San Fernando Valley to a depth of about 9 miles under the San Gabriel Mountains, and considered part of the Sierra Madre Fault System.

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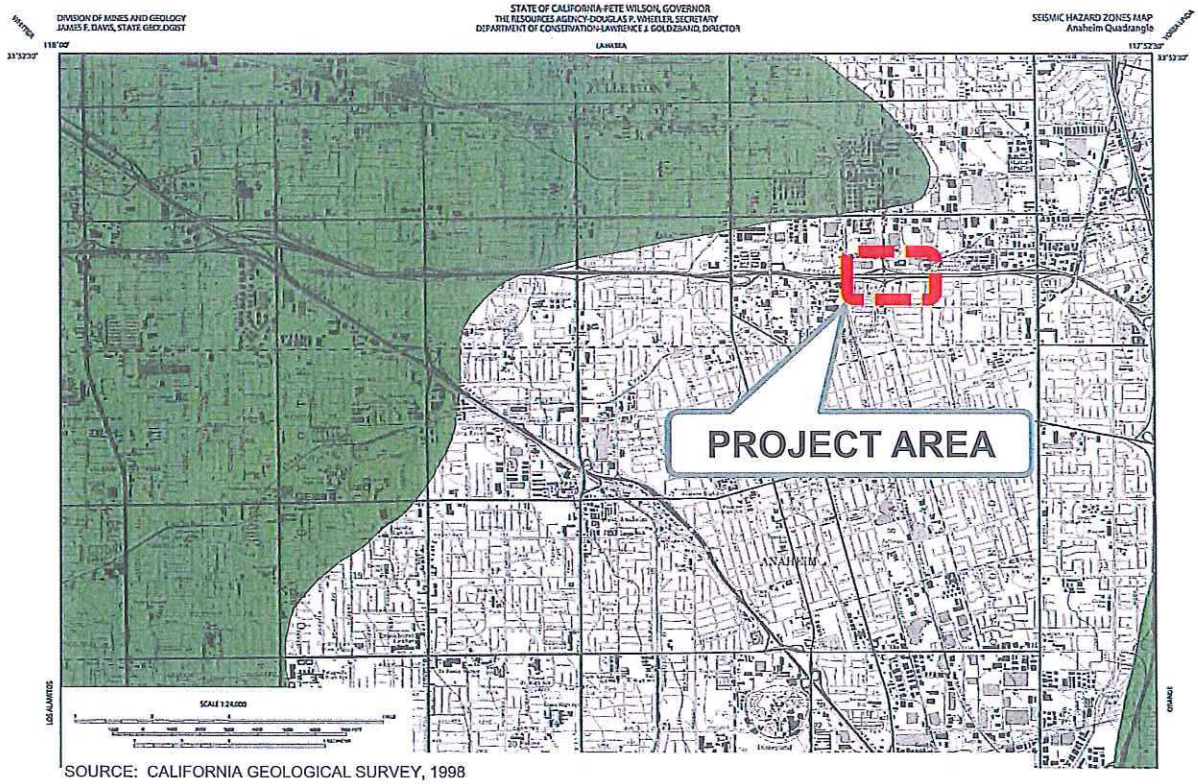


SOURCE: CALIFORNIA GEOLOGICAL SURVEY, 1998

MAP EXPLANATION

Zones of Required Investigation:

Liquefaction

Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

East Street UC (Widen)	MAP OF LIQUEFACTION POTENTIAL	
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering		Figure 3-2
	Project No. 10-126	Date: 03-01-11

The 1987 Whittier earthquake occurred on a subsurface fault dipping under the Puente Hills to about 10 miles beneath the San Gabriel Basin (Shaw and Shearer, 1999; Shaw et al., 2002). This event did not rupture the ground surface.

The 2008 Chino Hills event epicenter was in the Chino Hills area between the Elsinore-Fault-Zone Chino Section and Whittier Section. Preliminary data were inconclusive with regard to the causative fault. Detailed analysis by Shao and Hauksson (2009) indicated a rupture plane striking N71°W, dipping 62° northeast. This event did not rupture the ground surface.

Another significant earthquake was the 1812 earthquake which caused damage at the San Juan Capistrano Mission. The location and magnitude of the 1812 earthquake are unknown because of the sparse population at the time, but geological studies (Jacoby et al., 1987; Fumal et al., 1993; Weldon et al., 2004) postulate that it did not occur in the Capistrano area, but rather was a large ($M_W > 7.0$) distant event on the San Andreas fault in the Wrightwood area of the San Gabriel Mountains.

The earliest documented earthquake in the region was reported by the Portola´ expedition as they camped near the Santa Ana River in 1769. This event has been attributed by various geoscientists to just about every fault in the Los Angeles area but it could just as well have been a distant event that shook a wide area as did the 1971 San Fernando, the 1987 Whittier, and the 1994 Northridge events, as well as many other more-distant events such as 1992 Landers event.

4.0 SUBSURFACE CONDITIONS

4.1 SOIL CONDITIONS

The roadway elevation of the existing East Street is about +174 feet and the roadway elevation at the SR-91 level is +194 feet near Abutment 1 and +190 feet near Abutment 5. Based on the recent field investigation and as-built LOTB sheets, the site is underlain by interbedded silty sand, poorly graded sand, poorly graded sand with silt, sandy silt and sandy clay. The idealized soil profile and design strength parameters for foundation design are presented in Table 4-1.

Table 4-1. Idealized Soil Profile and Strength Parameters

Approximate Elevation (feet)	Predominant Soil Type	Equivalent SPT Blowcount* (blows/foot)	Total Unit Weight (pcf)	Friction Angle (degree)	Cohesion / Undrained Shear Strength (psf)
Abutments 1 and 5					
+193 to +152	Sand and Sand with Silt	12 to (38) Average = 24	120	32	100
+152 to +143	Lean Clay	6	115	-	1000
+143 to +128	Sand and Sand with Silt	23 to (47) Average = 35	120	34	100
+128 to +105	Sandy Silt and Sandy Clay with interbedded Silty Sand	13 to 19 Average = 15	120	-	1900
Bents 2 to 4					
+174 to +149	Sand and Sand with Silt	4 to (18) Average = 10	120	31	100
+149 to +144	Sandy Silt	6	115	-	1000
+144 to +129	Silty Sand and Sand with Silt	13 to (22) Average = 19	120	32	100
+129 to +104	Sandy Silt and Sandy Clay with interbedded Silty Sand	(7) to 10 Average = 9	115	-	1300
+104 to +93	Sand	(48) to (>100) Average = 66	120	36	50

* Values in ( ) are converted SPT blowcounts corrected for sampler size; correction factor from Modified California Drive sampler blowcounts to SPT blowcounts is 0.5.

The soil strength parameters are based on direct shear test results or unconsolidated-undrained triaxial test results or published correlations with SPT blowcounts (Lam and Martin, 1986). The design strength parameters of most of the idealized soil layers were based on direct shear or triaxial tests performed on similar soil layers across the borings except for the 2nd and 3rd

idealized layers at Abutments 1 and 5, and 2nd and 5th idealized layers at Bents 2 through 4; in these idealized soil layers, the strength parameters were based on published correlations with SPT blowcounts. It should be noted that the strength parameters obtained from the direct shear tests or triaxial tests are lower than those obtained using SPT correlations for the same idealized soil layers.

4.2 GROUNDWATER CONDITIONS

Groundwater was encountered between elevations +113.3 feet and +120.5 feet during the recent field investigation. Groundwater was not encountered in any of the borings drilled in 1993 and 1955 to the maximum depth explored at elevation +96 feet. Based on California Geological Survey (Division of Mines and Geology, 1997), the recorded highest historical groundwater at the project site is greater than 50 feet below the ground surface. The average ground surface elevation at the East Street grade is about +174 feet. Therefore, the CGS historical highest groundwater elevation would be deeper than +124 feet. Based on the measured and historical highest groundwater elevations, a groundwater elevation of +121 feet can be used for liquefaction assessment.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 SEISMIC DESIGN CRITERIA

To develop ARS curves in accordance with the 2009 Seismic Design Criteria (SDC) (Caltrans, 2009b and 2009d) procedures, we considered the following response spectra:

- Deterministic Criteria based on late-Quaternary faults in 2007 fault database (Caltrans, 2007a and 2007b and Shantz and Merriam, 2009);
- Probabilistic Criteria based on 5% in 50 years probability of exceedance ground motion; and
- Minimum Deterministic Spectrum based on a M_W= 6.5 strike-slip event occurring at a distance of 7.5 miles (12 km) from the site.

The design ARS curve is the envelope of the above spectra.

We used the Caltrans Deterministic Response Spectrum Spreadsheet as recommended by the 2009 SDC to develop the deterministic ARS curves. The spreadsheet uses the arithmetic average of two Next Generation Attenuation (NGA) relationships developed by Chiou-Youngs (2008) and Campbell-Bozorgnia (2008) with user-provided input parameters, including fault characteristics, site-to-fault distances and site condition parameters as presented in Table 5-1.

Table 5-1. Controlling Faults for Deterministic Response Spectrum

Controlling Fault	Fault ID	Maximum Moment Magnitude M_{max}	Site to Fault Distance R_{RUP} (miles)	Style of Fault	Fault Dip /Direction
Puente Hills Blind Thrust	240	7.3	8.6	Reverse	25° / North
Elsinore Fault Zone (Whittier Section)	241	7.6	10.2	Reverse Lateral Strike Slip	75° / Northeast

Results obtained from the spreadsheet were then verified with the Caltrans online web tool (Caltrans, 2009a). The spreadsheet method is recommended because the online web tool, though more user-friendly, does not include updates since 2007 in its calculation database and presently is not approved to develop spectra for final design.

The probabilistic response spectrum is based on data from the 2008 United States Geological Survey (USGS, 2008a) National Seismic Hazard Map for the 5% in 50 years probability of exceedance (975-year return period) ground motion. To develop the probabilistic spectrum, the Caltrans Probabilistic Response Spectrum Spreadsheet and the USGS Interactive Deaggregation Tool (USGS, 2008b) were used. Results obtained from both the spreadsheet and deaggregation tool were then verified with the Caltrans online web tool. Again, the spreadsheet and deaggregation tool are recommended because the online web tool, though more user-friendly, does not include updates since 2007 in its calculation database.

The resulting design ARS curve and the digitized coordinates are presented in Figure 5-1. A peak ground acceleration (PGA) of 0.52g is obtained from the design ARS curve.

5.2 LIQUEFACTION

Liquefaction analysis was performed using the available site-specific subsurface information and a historical high groundwater elevation of +121 feet. The liquefaction potential of the saturated, granular materials below the historical high groundwater table was evaluated using the procedures outlined by Seed et al. (1983), Seed and Harder (1990), and updated by NCEER (1997). Based on the analysis, granular materials susceptible to liquefaction were not encountered below the groundwater table. Therefore, the liquefaction potential at the bridge site is anticipated to be low. As a result, seismic settlement of onsite soils is also low.

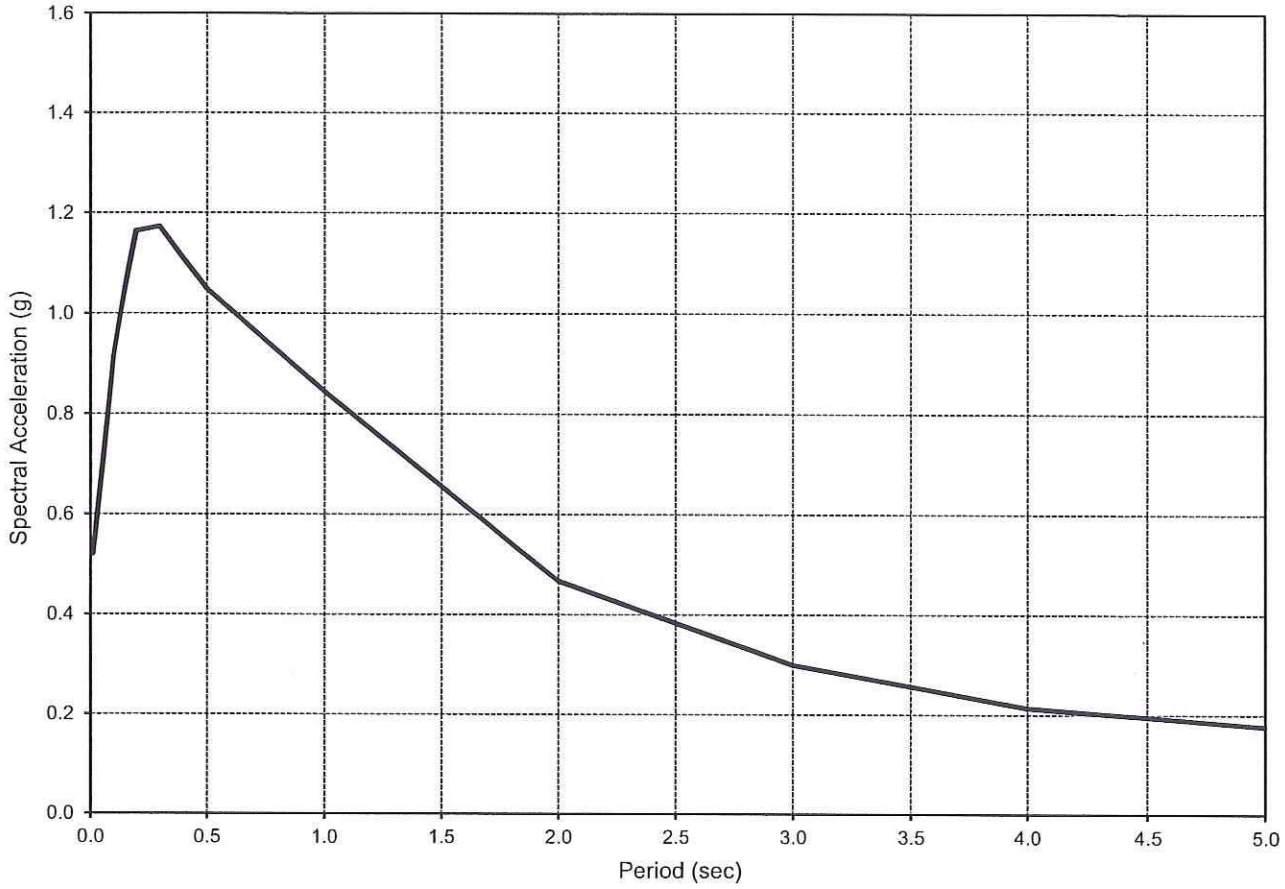
5.3 SOIL CORROSIVITY

Three soil samples were tested for pH, minimum resistivity, soluble chloride content and soluble sulfate content. The test results are summarized in Table 5-2. Minimum resistivities were between 760 and 17000 ohm-cm. The pH values were between 7.6 and 8.0. The soluble sulfate measurements were between 60 and 130 parts per million (ppm), and the soluble chloride measurements were between 153 and 322 ppm.

Table 5-2. Soil Corrosion Test Results

Boring	Station (Offset) / "Station Line"	Sample Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Soluble Sulfate Content (ppm)	Soluble Chloride Content (ppm)
A-10-044	278+00 (77 Lt) / A Line	45	CL	760	7.6	130	322
A-10-044	278+00 (77 Lt) / A Line	70	CL	810	7.8	70	255
A-10-045	279+05 (77 Lt) / A Line	10	SP-SM	17,000	8.0	60	153

Based on the Caltrans Corrosion Guidelines (2003b), soils are considered corrosive if the pH is 5.5 or less, or the chloride concentration is 500 ppm or greater, or the sulfate concentration is 2,000 ppm or greater. Based on the test results and the Caltrans criteria, the on-site soils are considered to be non-corrosive to bare metals and concrete.



Latitude = 33.8539 °
Longitude = -117.9591 °

Damping Ratio = 5%

Spectral Coordinates	
Period (sec)	Acc. (g)
0.010	0.520
0.100	0.915
0.200	1.164
0.300	1.173
0.500	1.049
1.000	0.844
2.000	0.467
3.000	0.299
4.000	0.214
5.000	0.176

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	East Street UC (Widen)	Design ARS Curve
	Project: 10-126 Date: 03/01/11	Figure 5-1

5.5 PILE FOUNDATION DESIGN

5.5.1 Foundation Type

According to the as-built plans, the 1967 widening and original East Street UC were supported on 16-inch diameter CIDH piles with a design capacity of 45 tons. The 1993 widening and retrofitting were supported on 16-inch diameter CIDH piles with design capacities of 70 tons and 100 tons at Abutments 1 and 5 and Bents 2 through 4, respectively.

We recommend matching the existing foundation type for the proposed bridge widening.

5.5.2 Foundation Data Provided by Structural Designers

Per Caltrans policy, LRFD Service-I Limit State load combinations and Working Stress Design (WSD) method provided in the Caltrans Bridge Design Specifications (2003a) are used for design of the abutment footing. The LRFD Service-I Limit State, Strength Limit State, and Extreme Event Limit State load combinations are used for the design of the bent footing.

The foundation design data sheet is presented in Table 5-3. Foundation loads were provided by the structural designers following the latest Caltrans Memo To Designers (Caltrans, 2008) and these loads are presented in Table 5-4.

Table 5-3. Foundation Design Data Sheet

Support No.	Design Method	Pile Type	Finished Grade Elevation (feet)	Cut-off Elevation (feet)	Pile Cap Size (feet)		Permissible Settlement under Service Load (inch)	Number of Pile per Support
					B	L		
Abut 1	WSD	16" CIDH	+187.0	+183.25	7.33	11.75	1	4
Bents 2, 3 and 4	LRFD	18" CIDH	+173.9	+168.00	12.50	12.50	1	9
Abut 5	WSD	16" CIDH	+184.5	+180.75	7.33	11.75	1	4

Table 5-4. Foundation Design Loads

Support No.	Service-I Limit State (kips)			Strength Limit State (Controlling Group, kips)				Extreme Event Limit State (Controlling Group, kips)			
	Total Load		Permanent Loads	Compression		Tension		Compression		Tension	
	Per Support	Max. Per Pile	Per Support	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile
Abut 1	225	75	160	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bents 2, 3 and 4	720	180	350	1100	225	0	0	350	275	N/A	200
Abut 5	225	75	160	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

5.5.3 Axial Pile Capacity

Abutments 1 and 5, and Bents 2 through 4 foundation design recommendations are presented in Table 5-5 and Table 5-6, respectively. The Pile Data Table for the contract plans is presented in Table 5-7. The minimum embedment and offset (from a slope face) of the footings should be based on Section 4.4.5.1 of Caltrans BDS dated August 2004.

A pile-group efficiency factor (GEF) of 0.65 is used for a center-to-center pile spacing of 2.5 times the pile diameter, and a GEF of 1.0 is used for a center-to-center spacing of 4.0 times the pile diameter or greater (Section 10.8.3.6.3, AASHTO, 2007). Linear interpolation can be used to determine the GEF for intermediate spacings. Based on the layout provided by the structural designers, GEF's of 0.77 and 0.87 were used for the abutments and bent piles, respectively.

The pile capacity calculations are presented in Appendix C. The pile capacity is also based on soil resistance only and may be further limited by the pile-head connection details and the strength of the pile materials.

Table 5-5. Abutments Foundation Design Recommendations

Support	Pile	Cut-off Elevation (feet)	LRFD Service-I Limit State Load per Support (kips)		LRFD Service-I Limit State Total Load per Pile (Compression) (kips)	Nominal Resistance (kips)	Design Tip Elevations (feet)	Specified Tip Elevation (feet)
			Total	Permanent				
Abut 1	16" CIDH	183.25	225	160	75	150	+145 (a) +161 (d)	+145
Abut 5	16" CIDH	180.75	225	160	75	150	+142 (a) +158 (d)	+142

Notes:
1. Design tip elevations are controlled by the following demands: (a) Compression and (d) Lateral Load.
2. There are no design tip elevations for Tension and Tolerable Settlement at Abutments 1 and 5.
3. The specified tip elevations for Abutments 1 and 5 shall not be raised above the design tip elevations for Lateral Load.

Table 5-6. Bent Foundation Design Recommendations

Support Location	Pile Type	Cut-off Elevation (feet)	Service-I Limit State Loads per Support (kips)	Total Permissible Support Settlement (inch)	Required Factored Nominal Resistance (kips)				Design Tip Elevations (feet)	Specified tip Elevation (feet)
					Strength Limit		Extreme Event			
					Comp. (ϕ=0.7)	Tension (ϕ=0.7)	Comp. (ϕ=1.0)	Tension (ϕ=1.0)		
Bents 2, 3 and 4	18" CIDH	168.00	720	1	225	0	275	200	+124 (a-I) +131 (a-II) +129 (b-II) +152 (c) +146 (d)	+124

Notes:
1. Design tip elevations are controlled by the following demands: (a-I) Compression (Strength Limit), (a-II) Compression (Extreme Event), (b-II) Tension (Extreme Event) (c) Settlement, and (d) Lateral Load.
2. There is no design tip elevation for Tension (Strength Limit) at Bents 2 through 4.
3. The Specified tip elevation for Bents 2 through 4 shall not be raised above the design tip elevations for Tension, Tolerable Settlement and Lateral Load.

Table 5-7. Pile Data Table

Location	Pile Type	Nominal Resistance (kips)		Design Tip Elevations (feet)	Specified Tip Elevation (feet)
		Compression	Tension		
Abutment 1	16" CIDH	150	0	+145 (a) +161 (d)	+145
Bents 2, 3 and 4	18" CIDH	330	200	+124 (a) +129 (b) +152 (c) +146 (d)	+124
Abutment 5	16" CIDH	150	0	+142 (a) +158 (d)	+142

Notes:

1. Design tip elevations are controlled by the following demands: (a) Compression, (b) Tension, (c) Settlement, and (d) Lateral Load.
2. There are no design tip elevations for Tension and Tolerable Settlement at Abutments 1 and 5.
3. The specified tip elevations for Abutments 1 and 5 shall not be raised above the design tip elevations for Lateral Load.
4. The specified tip elevations for Bents 2 through 4 shall not be raised above the design tip elevations for Tension, Tolerable Settlement and Lateral Load.

5.5.4 Lateral Pile Capacity

5.5.4.1 Lateral Pile Solutions

Results of lateral pile analysis in terms of pile-head shear and lateral deflection for a free-head condition are presented in Appendix C and summarized in Table 5-8. The maximum bending moment and the location of maximum moment are also presented. The solutions presented in Table 5-8 are entirely based on soil resistance and linear pile properties. Therefore, these values may be limited by the flexural strength (plastic moment) of the piles and pile-head connection details. Linear interpolation can be used for solutions between pile-head deflections of 0.25 and 5 inches. Based on the layout provided by the structural engineers, a group reduction factor of 0.8 and 0.74 was incorporated in the analysis for Abutments 1 and 5 and Bents 2 through 4, respectively.

Table 5-8. Lateral Pile Solutions

Support Location	Pile Head Deflection (in)	Pile Head shear (kips)	Maximum Moment (kip-in)	Depth to Max. Moment from Pile Top (ft)
Abutments 1 and 5 (16-inch CIDH)	¼	12.2	305	4.0
	½	19.4	552	4.5
	1	30.6	997	5.0
	2	44.1	1765	5.5
	5	66.5	3513	6.5
Bents 2, 3 and 4 (18-inch CIDH)	¼	16.0	417	4.1
	½	26.6	779	4.5
	1	43.8	1432	5.0
	2	63.1	2546	5.4
	5	93.6	5049	6.8

5.5.4.2 Lateral Load Resistance of Bent Pile Footing

Passive earth pressure at the bent pile cap can be used to resist a portion of the lateral loads transferred to the soil. For static design, the passive soil resistance against the embedded face of the bent pile cap should be neglected. Under earthquake loading, this ultimate passive soil resistance should be added to the pile group capacity to determine the total lateral resistance of the pile footing. At the bent location, the ultimate passive soil resistance against the pile footing is estimated to be equal to a maximum equivalent fluid pressure of 375 psf per foot of depth. Note that development of full passive earth pressure requires a lateral pile cap displacement equal to approximately 2 percent of the embedded height (measured from the nearest and lowest ground surface to the bottom of the pile cap). For displacement magnitudes smaller than what is required to mobilize full resistance, the actual resistance magnitude should be determined by linearly interpolating between zero and the full resistance.

5.6 EMBANKMENTS SETTLEMENT AND SLOPE STABILITY

5.6.1 Settlement and Settlement Period

Fill will need to be placed to construct the approaches to the bridge widening. Up to 19 feet of sliver fill will be placed to construct the approaches to Abutments 1 and 5. Based on the onsite soil type, calculated ground subsidence at Abutments 1 and 5 is estimated to be less than 2 inches. Since the onsite soils are primarily coarse-grained materials, soil settlement should occur relatively quickly, and a settlement period for pile construction is not required.

5.6.2 Slope Stability

Global stability analyses were conducted for both static and pseudo-static conditions for the bridge approach embankment slopes. The analysis was performed using the computer program SLIDE 5.0 (Rocscience, 2006). The soil strength parameters in Table 4-1 were used in the static and pseudo-static analysis and the results are presented in Appendix C.

The calculated factor of safety for a deep-seated failure is greater than the minimum required 1.5 under static condition with a 2-foot soil surcharge to represent traffic loading. Slope stability analysis under pseudo-static condition was performed using a seismic coefficient equal to 0.17g (which is the smaller of either one-third the horizontal peak ground acceleration or 0.2g) in accordance with guidelines provided in Section 3.10 of the Caltrans Guidelines for Structures Foundation Reports (Caltrans, 2009c). Analysis indicates that the calculated factor of safety is greater than the required minimum of 1.1 under pseudo-static condition.

For embankment slopes with a gradient of 2H:1V or flatter, surficial stability should not be a design concern. If slope paving is proposed for embankment slopes with a gradient of 1.5H:1V, then surficial stability is also not a design concern. If slope paving is not used for the 1.5H:1V slopes, it is recommended that the upper 4 feet of any new 1.5H:1V slope face be covered with materials with a minimum internal friction angle of 32 degrees and a minimum cohesion of 230 psf. This select material should be properly keyed and benched into the sloping ground. In all cases, proper maintenance with erosion protection and drainage control in accordance with Section 21 of Caltrans Standard Specifications (Caltrans, 2010b) are also recommended.

5.6.3 Structure Approach Slabs

Selection of the approach type (if required) will be performed by the structural designer following the flowchart in Caltrans Memo to Designers 5-3, Attachment A, dated May 1996 (Caltrans, 1996).

5.7 BRIDGE ABUTMENT WALL DESIGN

5.7.1 Abutment Earth Pressures

If abutment walls are free to move laterally at the top, a static active lateral earth pressure of 36 psf per foot of depth is recommended for a free draining, level and compacted backfill. If lateral movement at the top of abutment walls is restrained, the lateral earth pressure for a free draining, level and compacted backfill should follow Section 5.5.5.11 of the Caltrans BDS dated August 2004. For this condition, we recommend a coefficient of active lateral earth pressure of 0.3, a coefficient of at-rest lateral earth pressure of 0.46 and a soil unit weight of 120 lb/ft^3. If applicable, a uniform lateral pressure of at least 72 psf due to vehicle loads, equivalent to a vertical pressure produced by at least 2 feet of earth, should be added to the above lateral earth pressure.

5.7.2 Passive Resistance of Abutment Backfill

Under seismic loading, an ultimate passive earth pressure of 5 ksf may be used for the approach backfill and abutment walls with a height equal to or greater than 5.5 feet. For abutment walls with heights less than 5.5 feet, the passive pressure may be calculated proportionally (e.g., for a 4-foot high wall, the passive pressure is [4/5.5]x 5 ksf = 3.64 ksf. The horizontal movement at which the maximum passive pressure is expected to be fully mobilized can be determined following the procedure outlined in Section 7.8.1 of the Caltrans SDC (2009d).

6.0 CONSTRUCTION RECOMMENDATIONS

6.1 EARTHWORK

Earthwork should be performed in accordance with Caltrans Standard Specifications, Section 19 (Caltrans, 2010b). Appropriate measures should be taken to prevent damage to adjacent structures and utilities. Any design and construction of temporary sloping, sheeting, or shoring should be made the contractor's responsibility. It should be noted that it is the responsibility of the contractor to oversee the safety of the workers in the field during construction. The contractor shall conform to all applicable occupational and health standards, rules, regulations, and orders established by the State of California. In addition, other State, County, or Municipal regulations may supersede the recommendations presented in this section. If a trench shoring design and safety plan is required, the geotechnical consultant should review the plan to confirm that recommendations presented in this report have been applied to the design.

During the recent field investigation conducted between December 7, 2010 and January 19, 2011, groundwater was encountered between elevations 113.3 feet and 120.5 feet. As shown on the as-built LOTB sheets in Appendix A, groundwater was not encountered in 1993 and 1955 down to an elevation of 96 feet. Using the above groundwater measurements, Groundwater is not anticipated to be encountered during footing construction at the abutments and bents. However, groundwater level can fluctuate due to seasonal rainfall amount, local irrigation and groundwater recharge program and other man-made conditions. If groundwater is encountered during construction, it should be controlled in accordance with Section 19-3.03D of the Caltrans Standard Specifications (2010b).

6.2 PILE CONSTRUCTION

Construction of CIDH piles should follow Section 49-4.03B, "Drilled Holes" of the Caltrans Standard Specifications (2010b). The Contractor should be required to drill the bottom of the shaft boring with a clean-out bucket to ensure adequate removal of loose soils. Both clean-out and concrete placement should be addressed in the specifications. The shaft borings should be inspected and approved by the Resident Engineer prior to installation of reinforcement. Per latest Caltrans requirement, 3-inch of concrete cover over reinforcement should be provided to improve the construction of the CIDH piles.

The onsite fill and alluvial soils generally range from loose to very dense coarse grained materials, and these materials are susceptible to caving. If caving occurs, a temporary casing can be used. The casing should have an inside diameter larger than or equal to the pile diameter and should be placed tight in the hole. Vibratory hammers or oversized drilling are not allowed for casing installation. In the event that any boring becomes bell-shaped and cannot be advanced due to severe caving, all loose material should be removed from the bottom of the boring and the caved region filled with a low strength sand-cement slurry. Drilling may continue when the slurry has reached its initial set.

6.3 BACKDRAIN AND BACKFILL REQUIREMENTS FOR ABUTMENT WALLS

Expansive soils should not be placed as part of the embankment within the limits of a bridge abutment as shown in Figure 6-1. Materials placed behind abutment walls should be low-expansive soil with an Expansion Index (EI) less than 50 and Sand Equivalent (SE) of more than 20. The low-expansive material requirement should be supplemental to the abutment structure and pervious backfill requirement as described in Caltrans Standard Plans (2010a) and Caltrans Standard Specifications (2010b) under Sections 19-3.03E and 19-3.03G, respectively.

Backfill should be compacted in accordance with Section 19-5 of the Caltrans Standard Specifications (2010b). Backfill should be placed in loose lifts not exceeding 8 inches in thickness, moisture-conditioned to near optimum moisture content, and compacted to at least 95 percent relative compaction. The relative compaction should be based on the maximum density determined by California Test Method 216. Jetting or flooding to compact backfill is not recommended. Heavy compaction equipment, such as vibratory rollers, dozers, or loaders, should not be used adjacent to the abutment walls in order to avoid damaging the walls due to large lateral earth pressures.

Backdrains should be installed behind abutment walls to relieve hydrostatic pressure. Backdrains should be constructed in accordance with Bridge Detail 3-1 on Sheet B0-3 per Caltrans Standard Plans (2010a) or the geocomposite drain alternative per Section 6 of the Caltrans Bridge Design Details (1992).

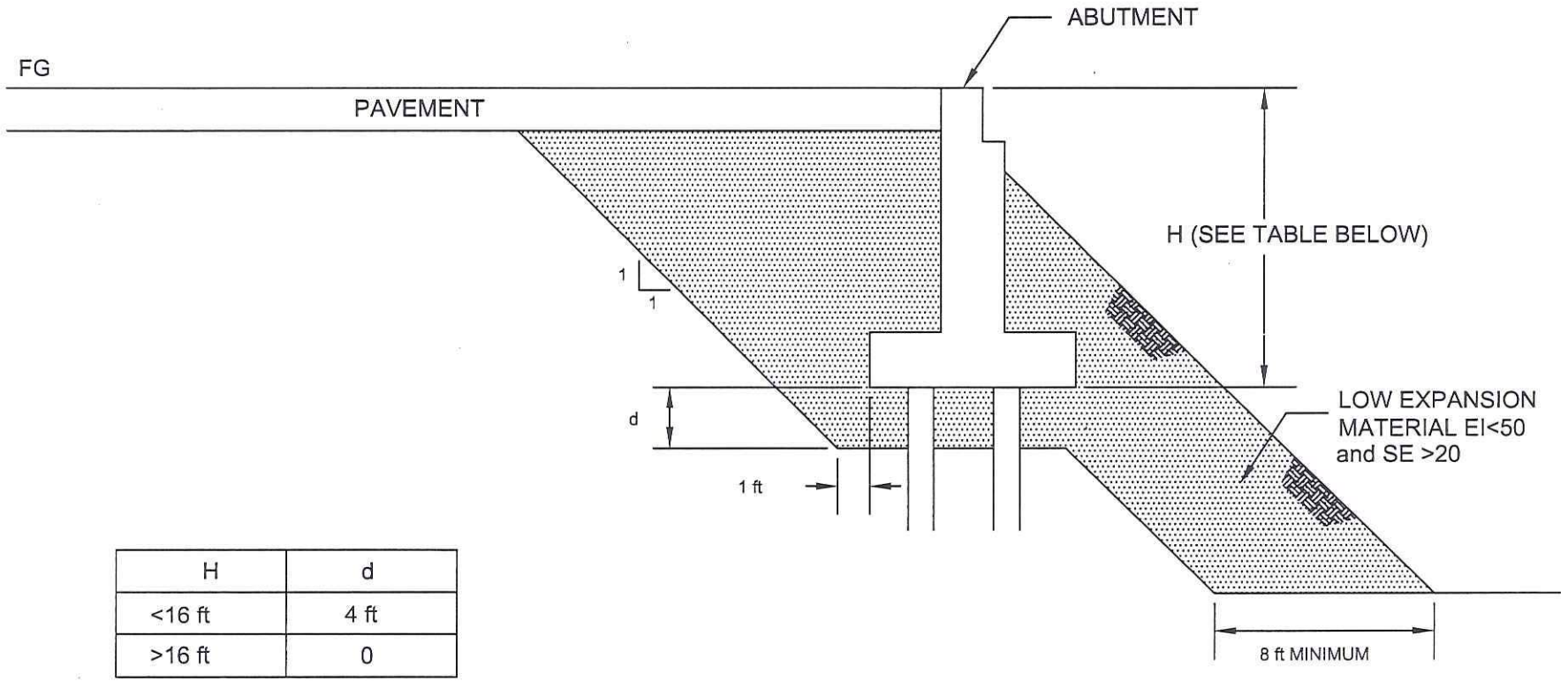
6.4 REVIEW OF CONSTRUCTION PLANS

Recommendations contained in this report are based on preliminary plans. The geotechnical consultant should review the final construction plans and specifications in order to confirm that the general intent of the recommendations contained in this report have been incorporated into the final construction documents. Recommendations contained in this report may require modification or additional recommendations may be necessary based on the final design.

6.5 GEOTECHNICAL OBSERVATION AND TESTING

It is recommended that inspections and testing be performed by the geotechnical consultant during the following stages of construction:

- Grading operations, including excavations and placement of compacted fill
- Shoring installation
- Footing excavations and pile constructions
- Backdrain installation and backfilling of bridge abutment walls
- Removal or installation of support of buried utilities or structures
- When any unusual subsurface conditions are encountered



H	d
<16 ft	4 ft
>16 ft	0

EXPANSION INDEX TO BE DETERMINED BY ASTM D4829
SAND EQUIVALENT TO BE DETERMINED BY CALIFORNIA TEST METHOD 217

NO SCALE

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

East Street UC (Widen)

Project No. 10-126 | Date: 03-10-11

Low Expansion Material
In Bridge Embankment

Figure 6-1

7.0 LIMITATIONS

This report is intended for the use of OCTA, RBF and Caltrans for the widening of East Street UC. This report is based on the project as described and the information obtained from the exploratory borings at the approximate locations indicated on the attached plans. The findings and recommendations contained in this report are based on the results of the field investigation, laboratory tests, and engineering analyses. In addition, soils and subsurface conditions encountered in the exploratory borings are presumed to be representative of the project site. However, subsurface conditions and characteristics of soils between exploratory borings can vary. The findings reflect an interpretation of the direct evidence obtained. The recommendations presented in this report are based on the assumption that an appropriate level of quality control and quality assurance (inspections and tests) will be provided during construction. EMI should be notified of any pertinent changes in the project plans or if subsurface conditions are found to vary from those described herein. Such changes or variations may require a re-evaluation of the recommendations contained in this report.

The data, opinions, and recommendations contained in this report are applicable to the specific design element(s) and location(s) which is (are) the subject of this report. They have no applicability to any other design elements or to any other locations and any and all subsequent users accept any and all liability resulting from any use or reuse of the data, opinions, and recommendations without the prior written consent of EMI.

EMI has no responsibility for construction means, methods, techniques, sequences, or procedures; for safety precautions or programs in connection with the construction; for the acts or omissions of the CONTRACTOR or any other person performing any of the construction; or for the failure of any worker to carry out the construction in accordance with the Final Construction Drawings and Specifications.

Services performed by EMI have been conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, expressed or implied, and no warranty or guarantee is included or intended.

8.0 REFERENCES

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Appendix A

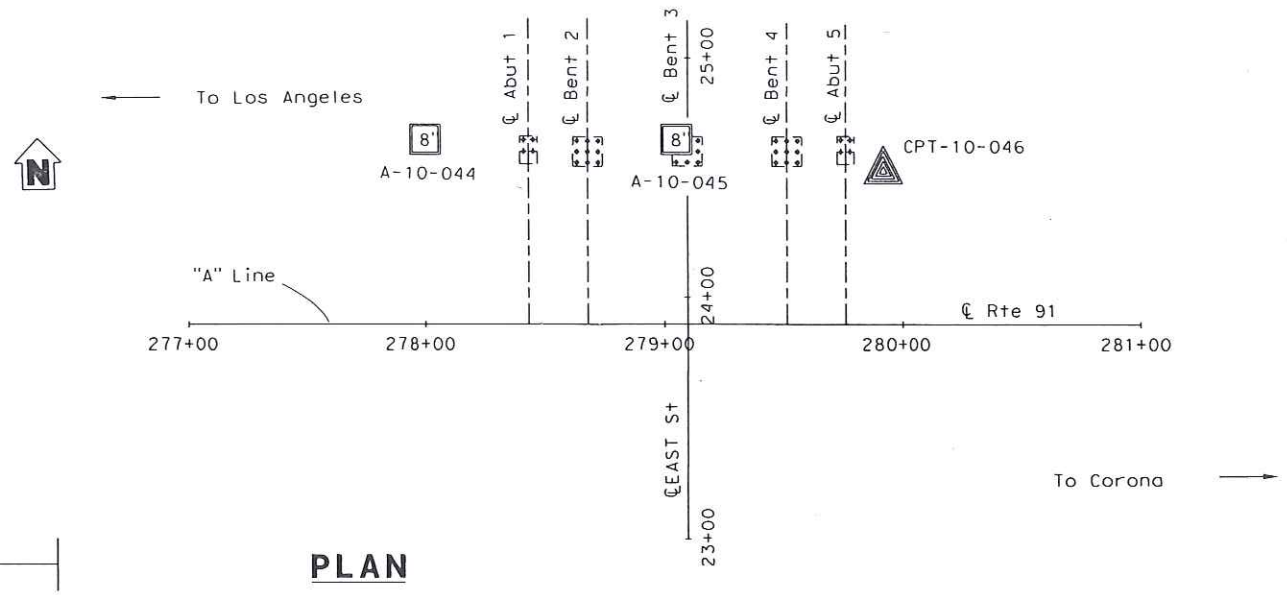
LOG OF TEST BORINGS SHEETS

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER — DATE 09/16/11

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

PLANS APPROVAL DATE

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

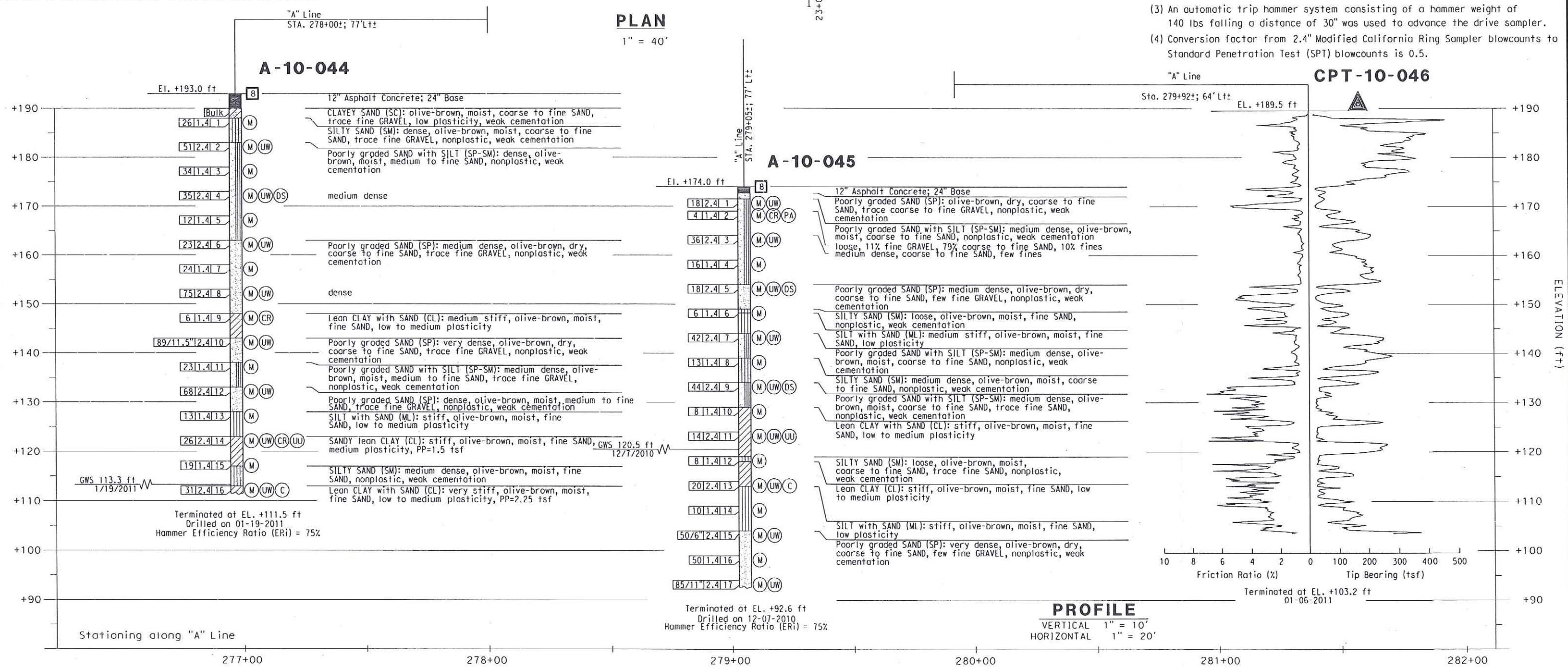
EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).
(2) 2.4" samples were taken using a California Modified Sampler.
(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.
(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.

PLAN

1" = 40'



PROFILE

VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. 55-0245	EAST STREET UC (WIDEN)
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011		PROJECT ENGINEER	POST MILES 4.3	LOG OF TEST BORINGS 1 OF 5

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

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FOUNTAIN VALLEY, CA 92708

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

CEMENTATION

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

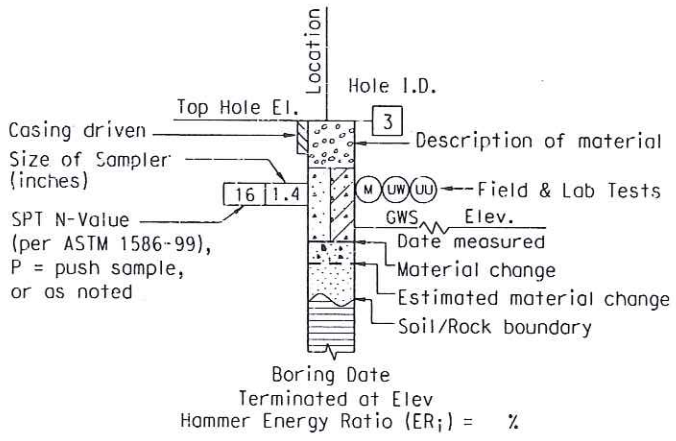
BOREHOLE IDENTIFICATION

Symbol	Hole Type	Description
Size	A	Auger Boring (hollow or solid stem bucket)
Size	R RW RC P	Rotary drilled boring (conventional) Rotary drilled with self-casing wire-line Rotary core with continuously-sampled, self-casing wire-line Rotary percussion boring (air)
Size	R	Rotary drilled diamond core
Size	HD HA	Hand driven (1-inch soil tube) Hand Auger
	D	Dynamic Cone Penetration Boring
	CPT	Cone Penetration Test (ASTM D 5778)
	O	Other (note on LOTB)

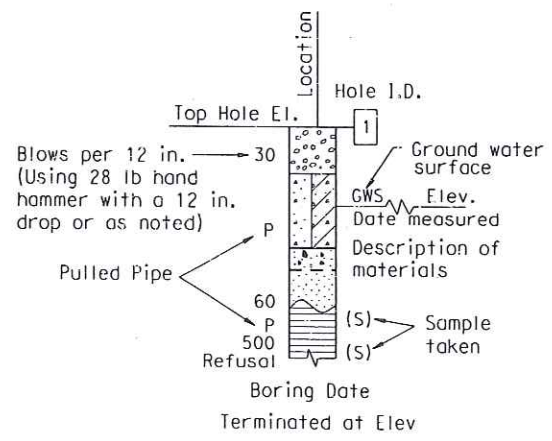
Note: Size in inches.

CONSISTENCY OF COHESIVE SOILS

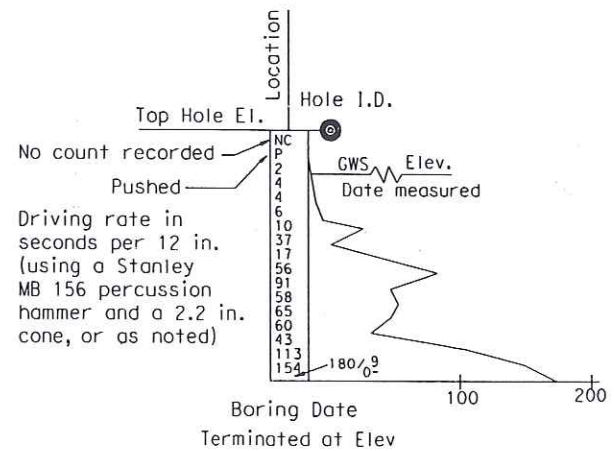
Description	Shear Strength (tsf)	Pocket Penetrometer Measurement, PP, (tsf)	Torvane Measurement, TV, (tsf)	Vane Shear Measurement, VS, (tsf)
Very Soft	Less than 0.12	Less than 0.25	Less than 0.12	Less than 0.12
Soft	0.12 - 0.25	0.25 - 0.5	0.12 - 0.25	0.12 - 0.25
Medium Stiff	0.25 - 0.5	0.5 - 1	0.25 - 0.5	0.25 - 0.5
Stiff	0.5 - 1	1 - 2	0.5 - 1	0.5 - 1
Very Stiff	1 - 2	2 - 4	1 - 2	1 - 2
Hard	Greater than 2	Greater than 4	Greater than 2	Greater than 2



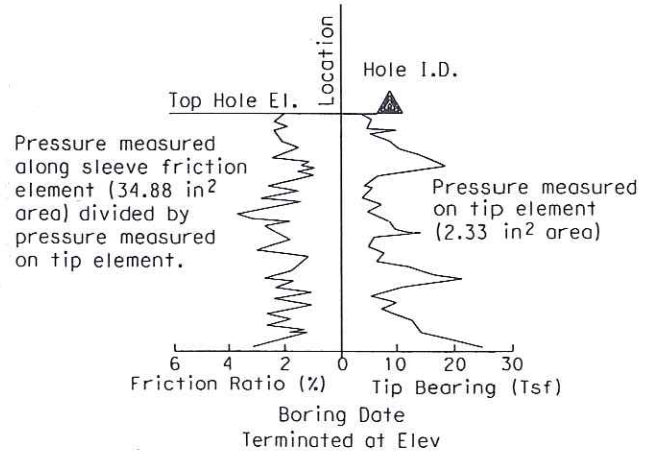
ROTARY BORING



HAND BORING



DYNAMIC CONE PENETRATION BORING



CONE PENETRATION TEST (CPT) BORING

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. 55-0245	EAST STREET UC (WIDEN)
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011		PROJECT ENGINEER	POST MILES 4.3	LOG OF TEST BORINGS 2 OF 5

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

GROUP SYMBOLS AND NAMES

Graphic/Symbol	Group Names	Graphic/Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND	CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
GP	Poorly-graded GRAVEL Poorly-graded GRAVEL with SAND		
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND	CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GP-GM	Poorly-graded GRAVEL with SILT Poorly-graded GRAVEL with SILT and SAND	ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
GP-GC	Poorly-graded GRAVEL with CLAY (or SILTY CLAY) Poorly-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GM	SILTY GRAVEL SILTY GRAVEL with SAND	OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND		
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND	OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL		
SP	Poorly-graded SAND Poorly-graded SAND with GRAVEL	CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL		
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
SP-SM	Poorly-graded SAND with SILT Poorly-graded SAND with SILT and GRAVEL		
SP-SC	Poorly-graded SAND with CLAY (or SILTY CLAY) Poorly-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
SM	SILTY SAND SILTY SAND with GRAVEL		
SC	CLAYEY SAND CLAYEY SAND with GRAVEL	OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY ORGANIC elastic SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL		
PT	PEAT	OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND
	COBBLES COBBLES and BOULDERS BOULDERS		

FIELD AND LABORATORY TESTING

- (C) Consolidation (ASTM D 2435)
- (CL) Collapse Potential (ASTM D 5333)
- (CP) Compaction Curve (CTM 216)
- (CR) Corrosivity Testing (CTM 643, CTM 422, CTM 417)
- (CU) Consolidated Undrained Triaxial (ASTM D 4767)
- (DS) Direct Shear (ASTM D 3080)
- (EI) Expansion Index (ASTM D 4829)
- (M) Moisture Content (ASTM D 2216)
- (OC) Organic Content-% (ASTM D 2974)
- (P) Permeability (CTM 220)
- (PA) Particle Size Analysis (ASTM D 422)
- (PI) Plasticity Index (AASHTO T 90)
Liquid Limit (AASHTO T 89)
- (PL) Point Load Index (ASTM D 5731)
- (PM) Pressure Meter
- (R) R-Value (CTM 301)
- (SE) Sand Equivalent (CTM 217)
- (SG) Specific Gravity (AASHTO T 100)
- (SL) Shrinkage Limit (ASTM D 427)
- (SW) Swell Potential (ASTM D 4546)
- (UC) Unconfined Compression-Soil (ASTM D 2166)
Unconfined Compression-Rock (ASTM D 2938)
- (UU) Unconsolidated Undrained Triaxial (ASTM D 2850)
- (UW) Unit Weight (ASTM D 4767)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER — DATE 09/16/11

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

PLANS APPROVAL DATE

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550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

APPARENT DENSITY OF COHESIONLESS SOILS

Description	SPT N_{60} (Blows / 12 in.)
Very Loose	0 - 5
Loose	5 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Greater than 50

MOISTURE

Description	Criteria
Dry	No discernable moisture
Moist	Moisture present, but no free water
Wet	Visible free water

PERCENT OR PROPORTION OF SOILS

Description	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5% - 10%
Little	15% - 25%
Some	30% - 45%
Mostly	50% - 100%

PARTICLE SIZE

Description		Size (in.)
Boulder		Greater than 12
Cobble		3 - 12
Gravel	Coarse	3/4 - 3
	Fine	1/5 - 3/4
Sand	Coarse	1/16 - 1/5
	Medium	1/64 - 1/16
	Fine	1/300 - 1/64
Silt and Clay		Less than 1/300

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie FIELD INVESTIGATION BY:	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER
SIGN OFF DATE	CHECKED BY	S. Pirathiviraj	DATE: 12/2010,1/2011		

BRIDGE NO. 55-0245 | POST MILES 4.3

EAST STREET UC (WIDEN)

LOG OF TEST BORINGS 3 OF 5

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

FED. ROAD DIV. NO.	STATE	PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
7	CAL.				

DIST.	COUNTY	ROUTE	SECTION	SHEET NO.	TOTAL SHEETS
07	Ora	91	3.4/4.6	206	323

JULY 1 1968

accompany plans dated April 19, 1965

DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES

As-Built Log of Test Borings sheet is considered an informational document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date confirm that this is a true and accurate copy of the original document. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.

DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
12	ORA	91	0.9/5.4		

GEOTECHNICAL PROFESSIONAL — DATE 09/16/11

EAST STREET UC (WIDEN)

LOG OF TEST BORINGS 4 OF 5

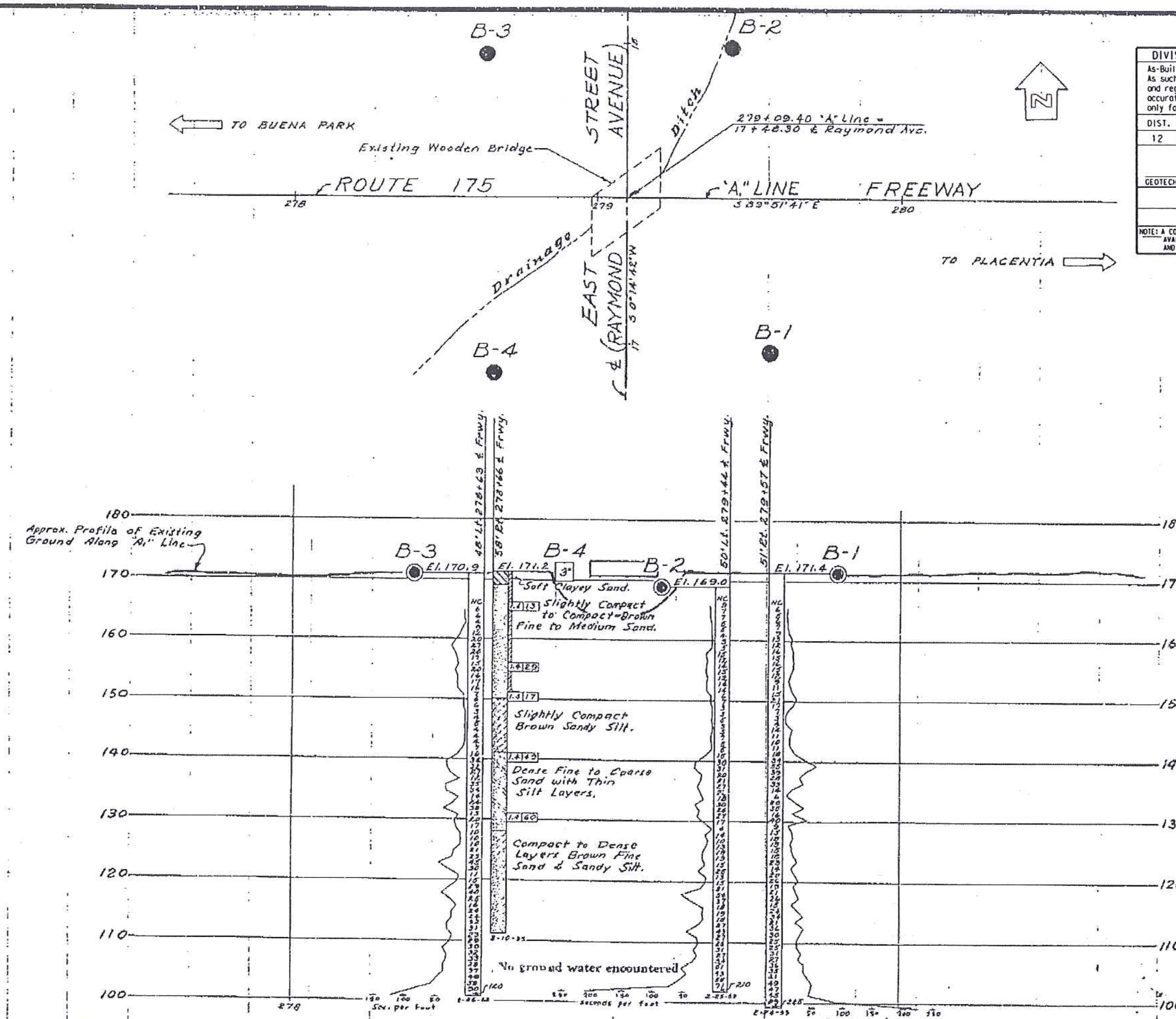
NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

BRIDGE No.	Sheet	of
55-0245	1	1

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

AS BUILT PLANS
Contract No 07-037424
Date Completed 2-17-67
Document No 70000022



INFORMATION ON ACTUAL FOUNDATION CONDITIONS ENCOUNTERED IS ON FILE IN BRIDGE GEOLOGY SECTION

Test Boring by Bridge Dept.

B.M. 27-B-54
Brass Cap in 6" P.C.C. Mon. 19' Lt. Sta. 16+30 East St.
2' off PP. #92613E, Bur. 19'
Elev. 170.00'

B.M. 26b-B-54
Chisl. Knob in S.E. Corner R.R. Signal Switch Box 98' Lt. Sta. 17+40 S.P.R.R. Tracks.
Elev. 170.96'

SHEET	OF
8	8

CLASSIFICATION OF MATERIAL BASED ON STANDARD GRADE SIZE LIMITS

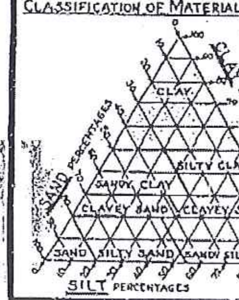


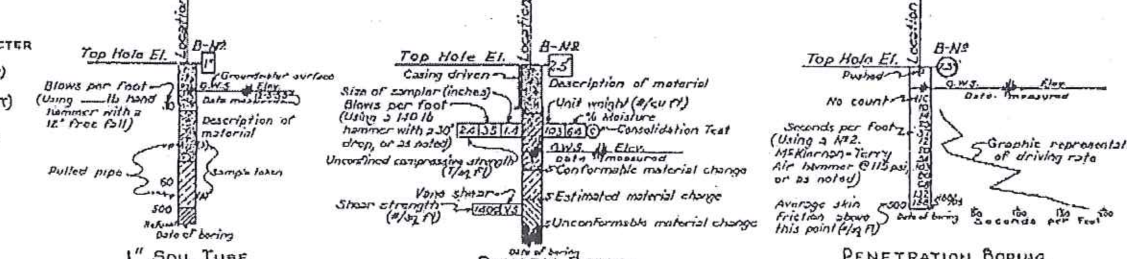
Diagram showing the basis for estimates of grade size distribution used in determination of class names.
If gravel is present in appreciable amounts the term "gravelly" may be added to the class name, viz. "gravelly sand." The terms "coarse", "medium" and "fine" when used to describe sand, silt and gravel refer to standard grade size limits.

LEGEND OF EARTH MATERIALS

- Gravel
- Sand
- Silt
- Clay
- Sandy Clay or Clayey Sand
- Sandy Silt or Silty Sand
- Silty Clay or Clayey Silt
- Peat and/or Organic Matter
- Fill Material
- Igneous Rock
- Sedimentary Rock
- Metamorphic Rock

LEGEND OF BORING OPERATIONS

- Plan of any boring
- Penetrometer
- 2½" Cone Penetrometer
- Sampler boring (dry)
- Rotary boring (wet)
- Auger boring (dry)
- Jet boring
- Core boring
- Test pit



NOTES

The contractor's attention is directed to Section 2, Article (c) of the Standard Specifications and to the Special Provisions accompanying this set of plans.

Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

EAST STREET UNDERCROSSING

LOG OF TEST BORINGS

SCALE Horiz. 1" = 20' Vert. 1" = 10' | BRIDGE 55-245 ½ | FILE E-55 | DRAWING 55245-7

FIELD STUDY	J. McCurdy
DRAWN	M. H. Bromberg 3-25-55
CHECKED	J. Mansky 3-25-55

Approval Recommended by

BRIDGE DEPARTMENT

206

145

Bx 101

DIST.	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
12	Ora	91	2.8/5.0	503	615

GEOTECHNICAL PROFESSIONAL — 12/15/93

1-20-97
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — THOMAS D. SWANTKO — NO. O.E. 813 — EXP. 12/31/97 — STATE OF CALIFORNIA

GEOFON, Inc.
5552 Cerritos Avenue, Suite B
Cypress, California 90630
Job Number 92-337

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES

As-Built Log of Test Borings sheet is considered an informational document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date confirm that this is a true and accurate copy of the original document. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.

DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
12	ORA	91	0.9/5.4		

09/16/11
GEOTECHNICAL PROFESSIONAL — DATE

EAST STREET UC (WIDEN)

LOG OF TEST BORINGS 5 OF 5

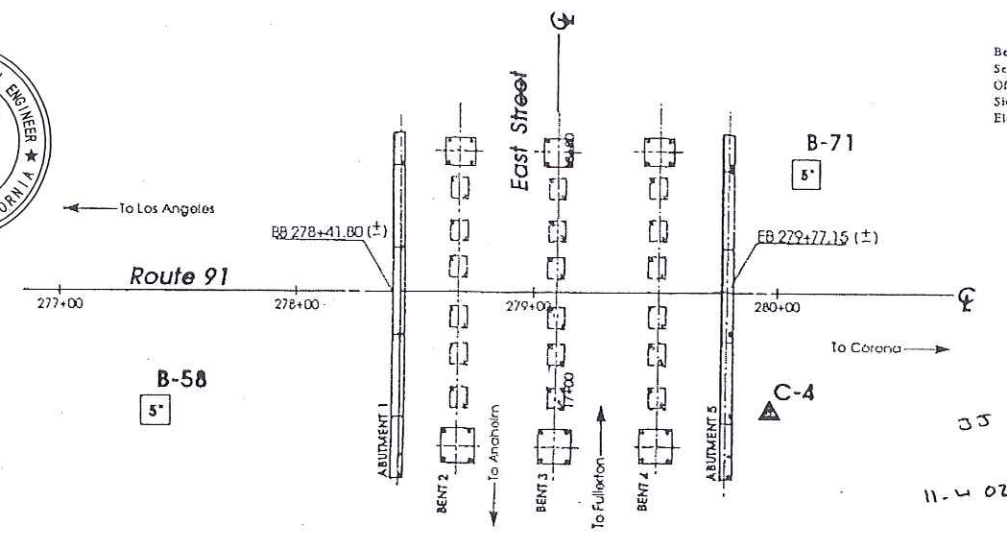
NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

UNIT: 2295
PROJECT NUMBER & PHASE: 1200000791

BRIDGE No.	Sheet	of
55-0245	1	1

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

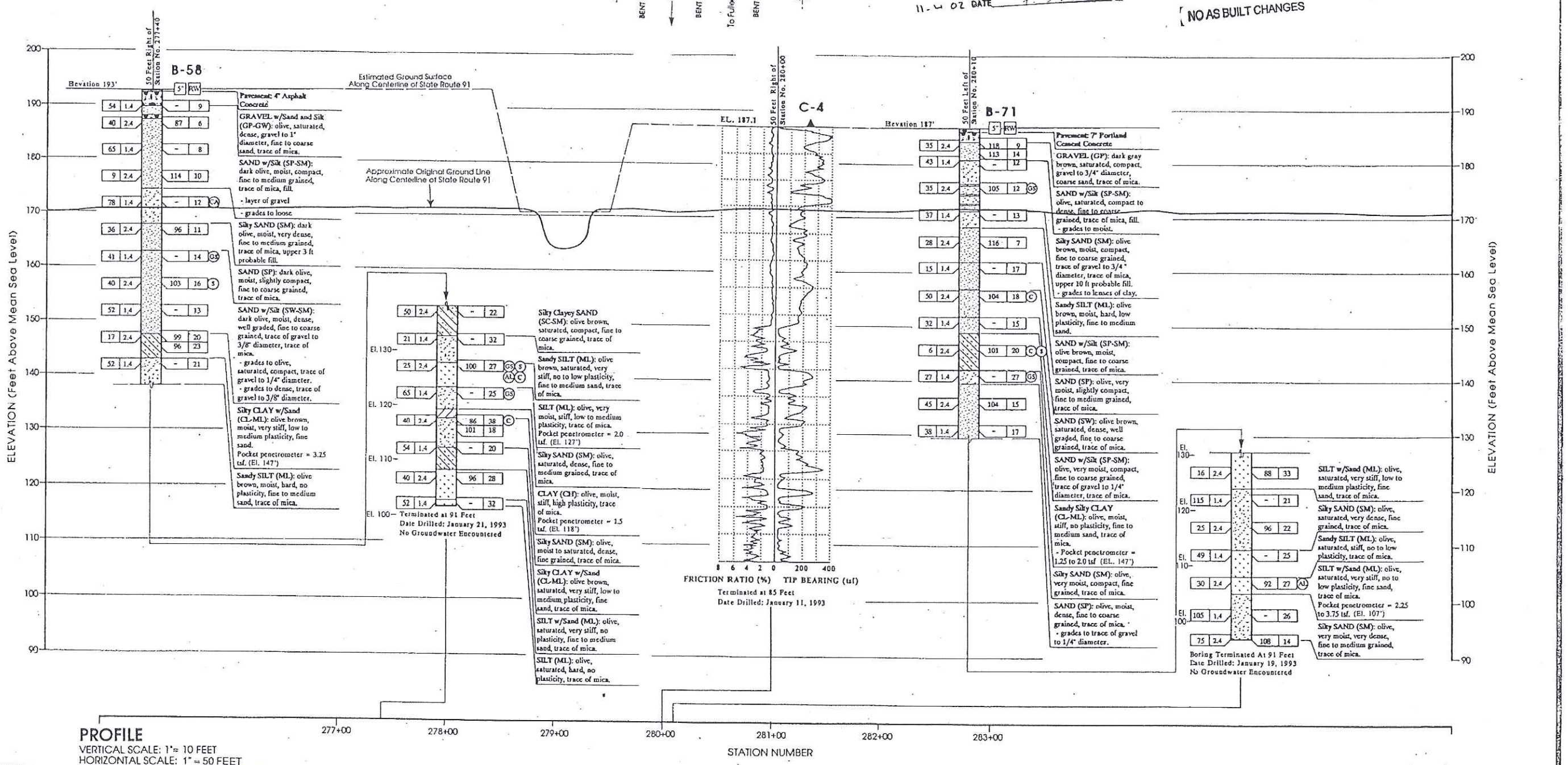
Bench Mark: 288-C-72 (PM 4.4)
Set R.S. Nail on Top of Headwall, 175 Feet West of Beginning of Westbound Off-Ramp to Raymond Avenue, 15 Feet North of Edge of Shoulder on North Side of Fwy.
Elevation: 176.48 Feet



AS BUILT
JS CORRECTIONS BY DMH
CONTRACT NO. 12012V9
11-402 DATE 7.5.00

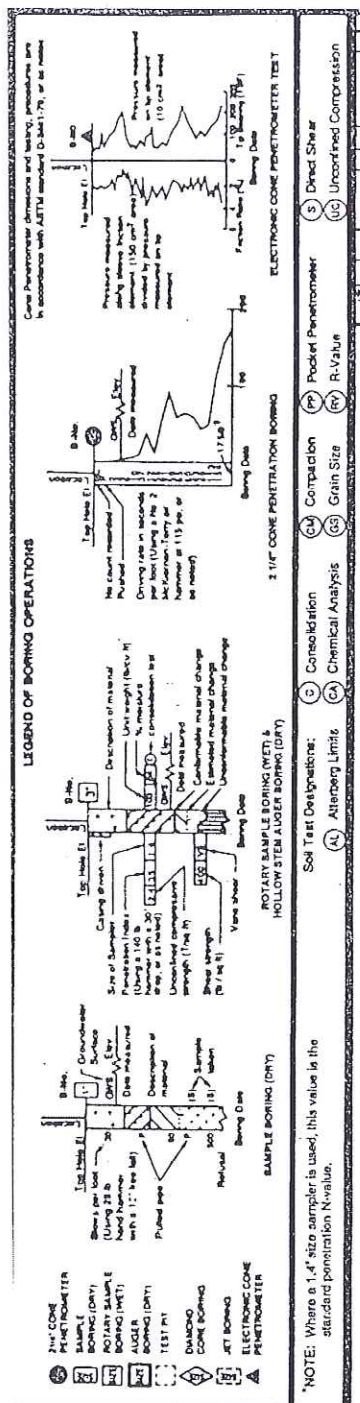
North
PLAN
SCALE: 1"= 40 FEET

NO AS BUILT CHANGES



PROFILE
VERTICAL SCALE: 1"= 10 FEET
HORIZONTAL SCALE: 1" = 50 FEET

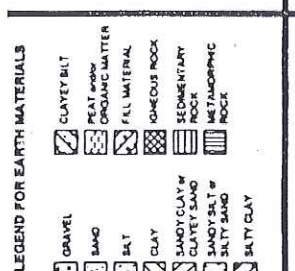
LEGEND OF BORING OPERATIONS



Soil Test Designations:
(C) Consolidation (CM) Compaction (DS) Direct Shear (UC) Unconfined Compression (PP) Pocket Penetrometer (RV) R-Value (GS) Grain Size (CA) Chemical Analysis (AL) Atterberg Limits

*NOTE: Where a 1.4" wide sampler is used, this value is the standard penetration N-value.

LEGEND FOR EARTH MATERIALS



CONSISTENCY CLASSIFICATION FOR SOILS
According to the Standard Penetration Test

Penetration Index (Blows/Ft.)	Granular	Cohesive	
0-4	Very Loose	Very Soft	
5-9	Loose	Soft	
10-19	Slightly Compact	Stiff	
20-34	Compact	Very Stiff	
35-69	Dense	Hard	
>70	Very Dense	Very Hard	

NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

DESIGN OVERSIGHT: BE NGUYEN	DRAWN BY: H. LEE	S. MOHAMMAD, J. CUNNEEN — FIELD INVESTIGATOR	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	D. K. HAGHIGHI — PROJECT ENGINEER	BRIDGE NO. 55-245
SIGN OFF DATE: 7-22-96	CHECKED BY: D. CORDS	SEE EXPLORATION — DATE			POST MILE 4.26

EAST STREET UNDERCROSSING WIDEN AND RETROFIT

LOG OF TEST BORINGS

ORIGINAL SCALE IN INCHES

CU12200

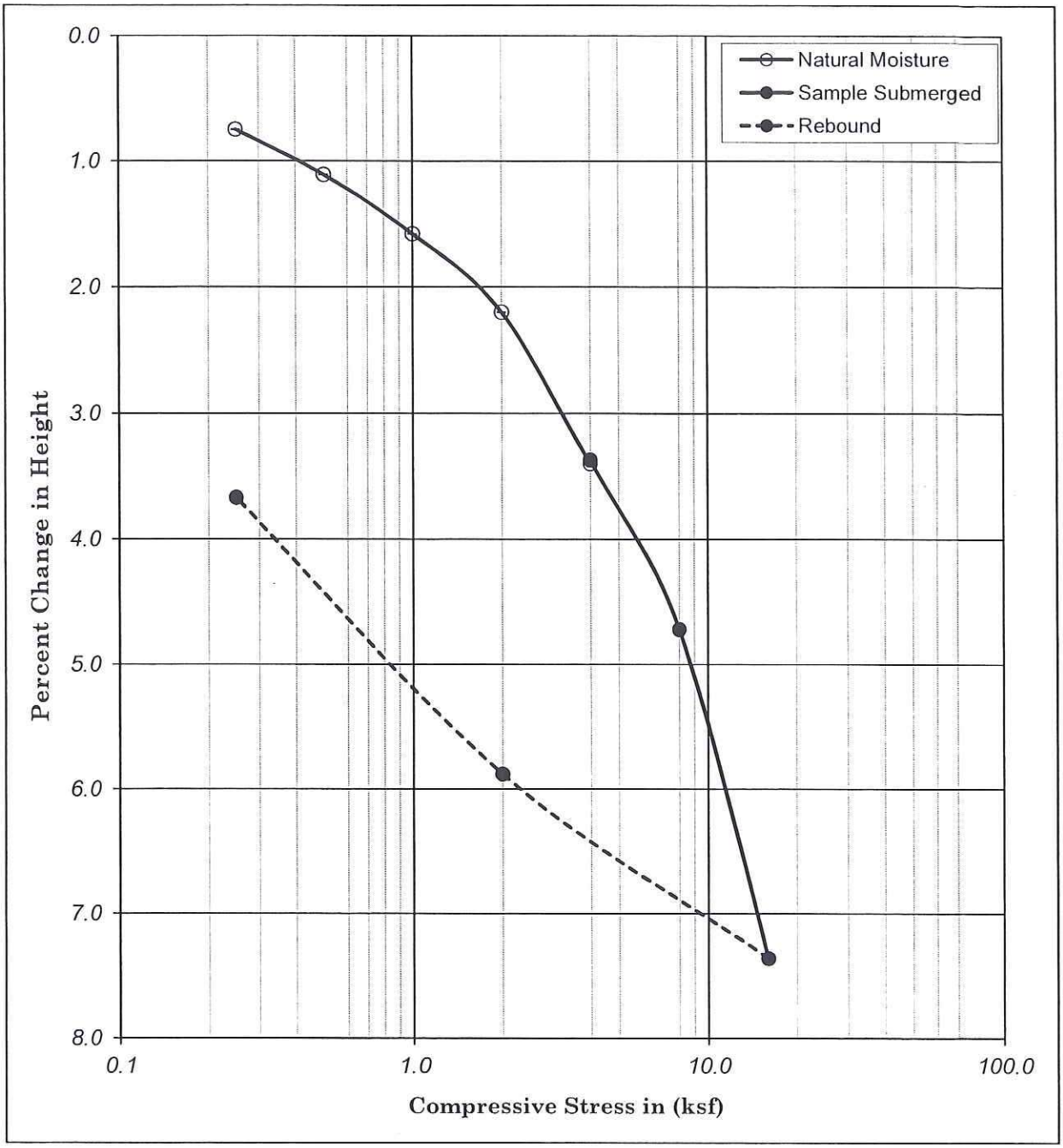
Appendix B

LABORATORY TEST RESULTS

TABLE B-1 SUMMARY OF LABORATORY TEST RESULTS

Project No. : *10-126* Project Name : East Street UC (Widen)

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-044	*S-1*	5	SM	11.6										
A-10-044	*D-2*	10	SP-SM	6.1	131.8									
A-10-044	*S-3*	15	SP-SM	6.8										
A-10-044	*D-4*	20	SP-SM	2.0	109.3									
A-10-044	*S-5*	25	SP-SM	2.1										
A-10-044	*D-6*	30	SP	1.1	104.4									
A-10-044	*S-7*	35	SP	4.2										
A-10-044	*D-8*	40	SP	1.7	111.1									
A-10-044	*S-9*	45	CL	30.0						36/22/14	760	7.6	130	322
A-10-044	*D-10*	50	SP	3.1	110.9									
A-10-044	*S-11*	55	SP-SM	5.0										
A-10-044	*D-12*	60	SP	3.6	117.6									
A-10-044	*S-13*	65	ML	31.0										
A-10-044	*D-14*	70	CL	19.6	126.7	1.5					810	7.8	70	255
A-10-044	*S-15*	75	CL to SM	23.6										
A-10-044	*D-16*	80	CL	34.1	119.2	2.25								
A-10-045	*D-1*	5	SP-SM	3.0	109.3									
A-10-045	*S-2*	10	SP-SM	5.3				11:79:10			17000	8.0	60	153
A-10-045	*D-3*	15	SP-SM	1.9	109.2									
A-10-045	*S-4*	15	SP-SM	4.8										
A-10-045	*D-5*	20	SP	1.8	103.2									
A-10-045	*S-6*	25	SM to ML	33.9										
A-10-045	*D-7*	30	SP-SM	17.0	115.7									
A-10-045	*S-8*	35	SM	12.5										
A-10-045	*D-9*	40	SP-SM	5.7	111.3									
A-10-045	*S-10*	45	CL	29.7										
A-10-045	*D-11*	50	CL	29.8	121.1									
A-10-045	*S-12*	55	SM to CL	19.2										
A-10-045	*D-13*	60	CL	31.8	118.6									
A-10-045	*S-14*	65	ML	28.2										
A-10-045	*D-15*	70	SP	2.9	109.2									
A-10-045	*S-16*	75	SP	3.8										
A-10-045	*D-17*	80	SP	12.4	121.7									



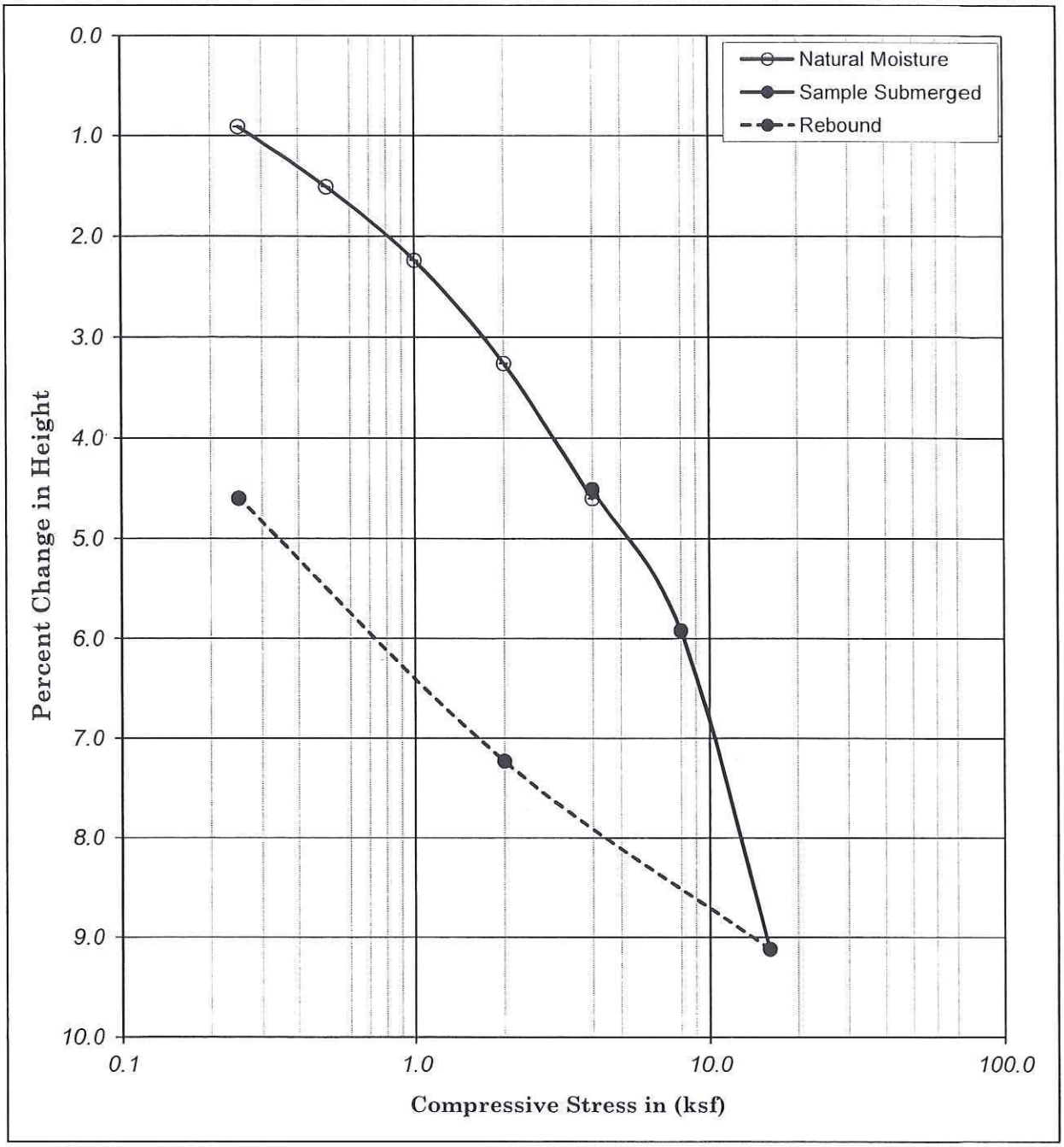
Boring No. : A-10-044			Liquid Limit :	-		Moisture Content (%)	Dry Density (pcf)	Dry Density (kN/m³)	Percent Saturation	Void Ratio
Sample No. : D-16			Plastic Limit :	-						
Depth	(ft) : 80.0	81.5	Plastic Index :	-	Initial	32.32	91.58	14.41	103.82	0.84
	(m) : 24.40	24.86	Specific Gravity :	2.70	Final	31.66	95.09	14.97	110.63	0.77
Description : Olive-brown, Lean CLAY with SAND (CL)										

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

East Street UC (Widen)

Project No. : 10-126 02/24/11

CONSOLIDATION TEST
(ASTM D-2435 / CT-219)



Boring No.	: A-10-045		Liquid Limit :	-		Moisture Content (%)	Dry Density (pcf)	Dry Density (kN/m³)	Percent Saturation	Void Ratio
Sample No.	: D-13		Plastic Limit :	-						
Depth (ft)	: 60.0	61.5	Plastic Index :	-	Initial	32.22	91.36	14.38	102.95	0.84
Depth (m)	: 18.30	18.76	Specific Gravity :	2.70	Final	30.48	95.78	15.08	108.29	0.76
Description : Olive-brown, Lean CLAY (CL)										

Earth Mechanics, Inc.
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East Street UC (Widen)

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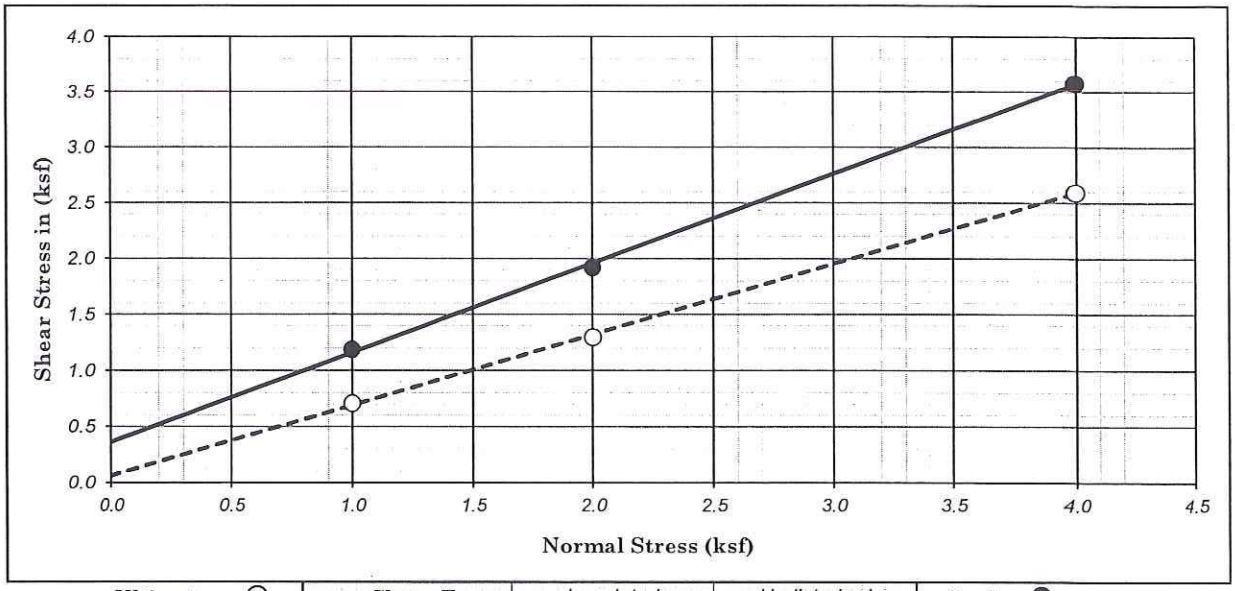
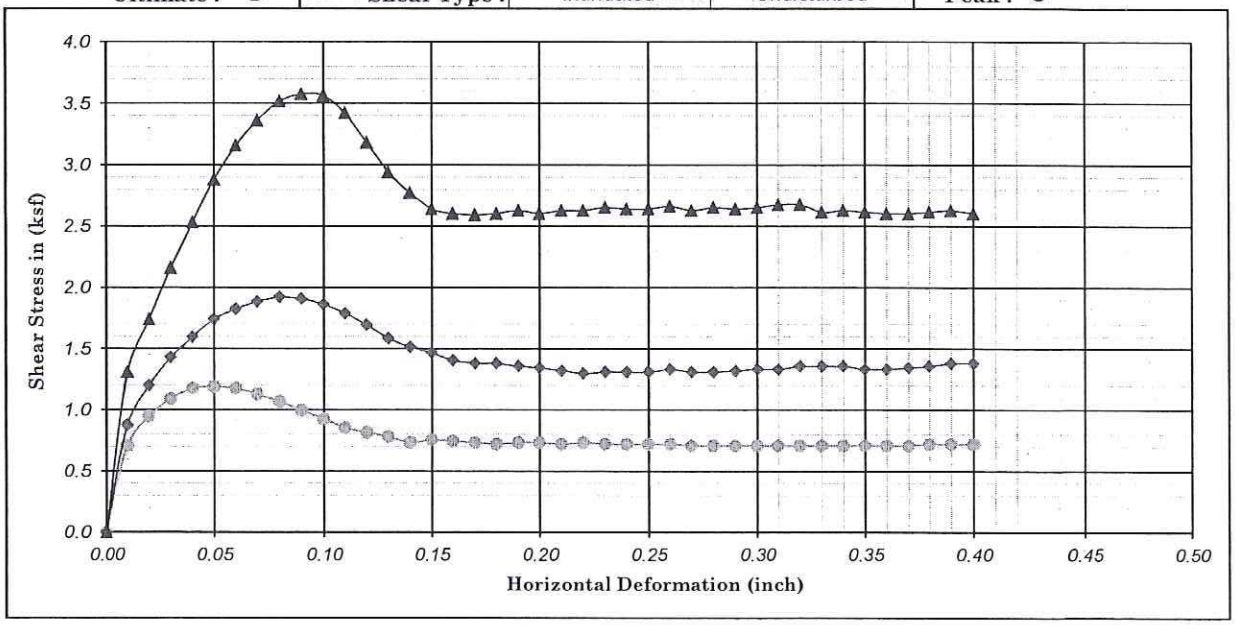
CONSOLIDATION TEST
(ASTM D-2435 / CT-219)



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-044		Strength Intercept (C) :	0.36	(ksf)	Peak	0.06	(ksf)	Ultimate
Sample No. : D-4			17.24	(kPa)		2.87	(kPa)	
Depth (ft/m) : 20.0	0.00	Friction Angle (ϕ) :	38.68	Degree		32.25	Degree	
Description : Olive-brown, Poorly graded SAND with SILT (SP-SM)					Shear Rate (inch/minute) :		0.02	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	17.67	96.23	15.15	0.75	1.00	47.88	1.19	56.88	0.71	33.90
◆	17.31	97.48	15.34	0.73	2.00	95.76	1.92	91.93	1.30	62.05
▲	18.82	93.50	14.72	0.80	4.00	191.52	3.58	171.22	2.59	124.10

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

East Street UC (Widen)

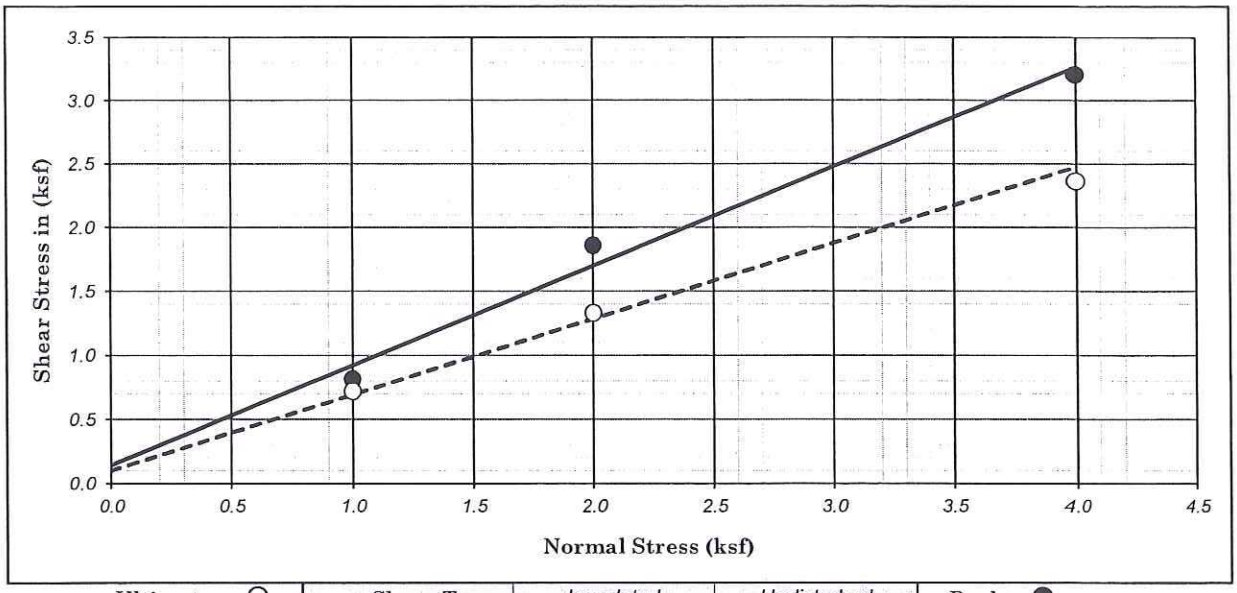
SR-91 WB Widening Project

DIRECT SHEAR TEST (ASTM D-3080)

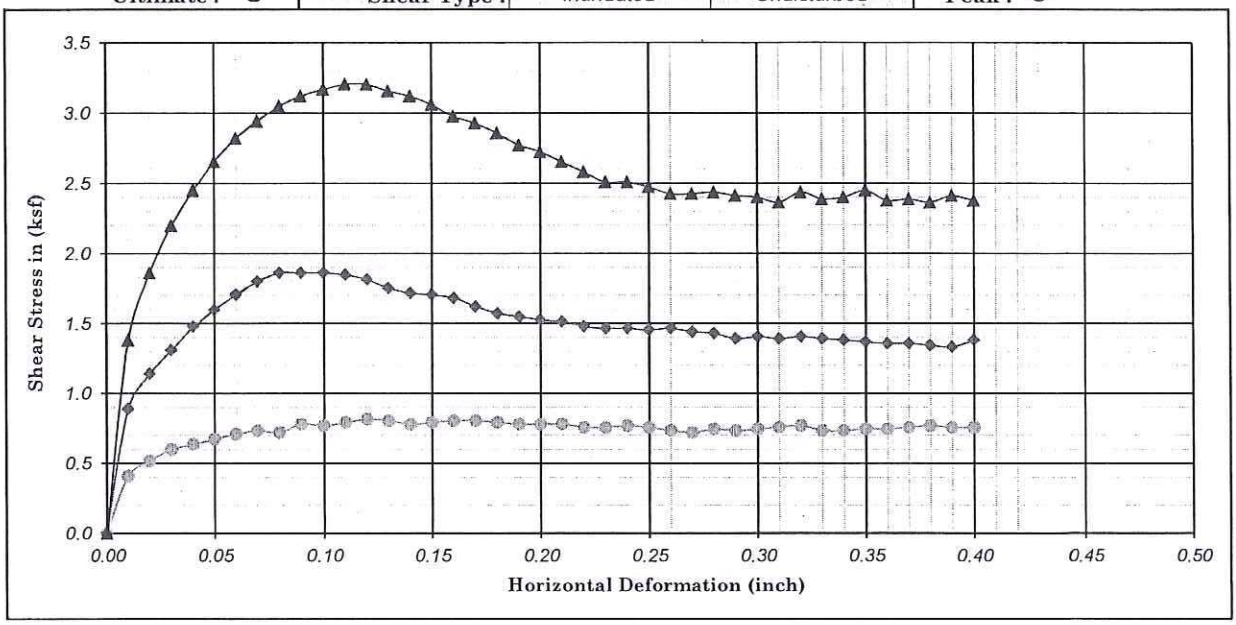
Project No. : 10-126

Date : 02/14/11

Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-045		Strength Intercept (C) :	0.14	(ksf)	Peak	0.10	(ksf)	Ultimate
Sample No. : D-5			6.89	(kPa)		4.79	(kPa)	
Depth (ft/m) : 20.0	0.00	Friction Angle (ϕ) :	37.89	Degree		30.65	Degree	

Description : Olive-brown, Poorly graded SAND (SP) — Shear Rate (inch/minute) : 0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	20.92	86.79	13.66	0.94	1.00	47.88	0.82	39.07	0.72	34.47
◆	20.76	85.34	13.43	0.98	2.00	95.76	1.86	89.06	1.33	63.78
▲	21.14	86.77	13.66	0.94	4.00	191.52	3.20	153.41	2.36	113.19

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

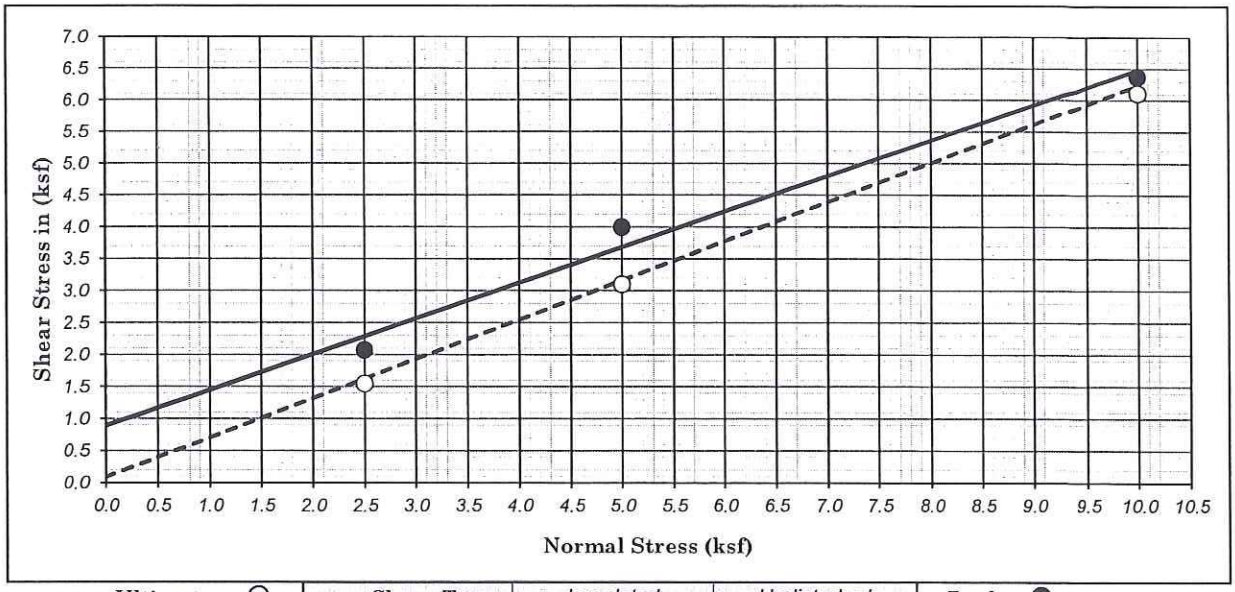
East Street UC (Widen)

SR-91 WB Widening Project

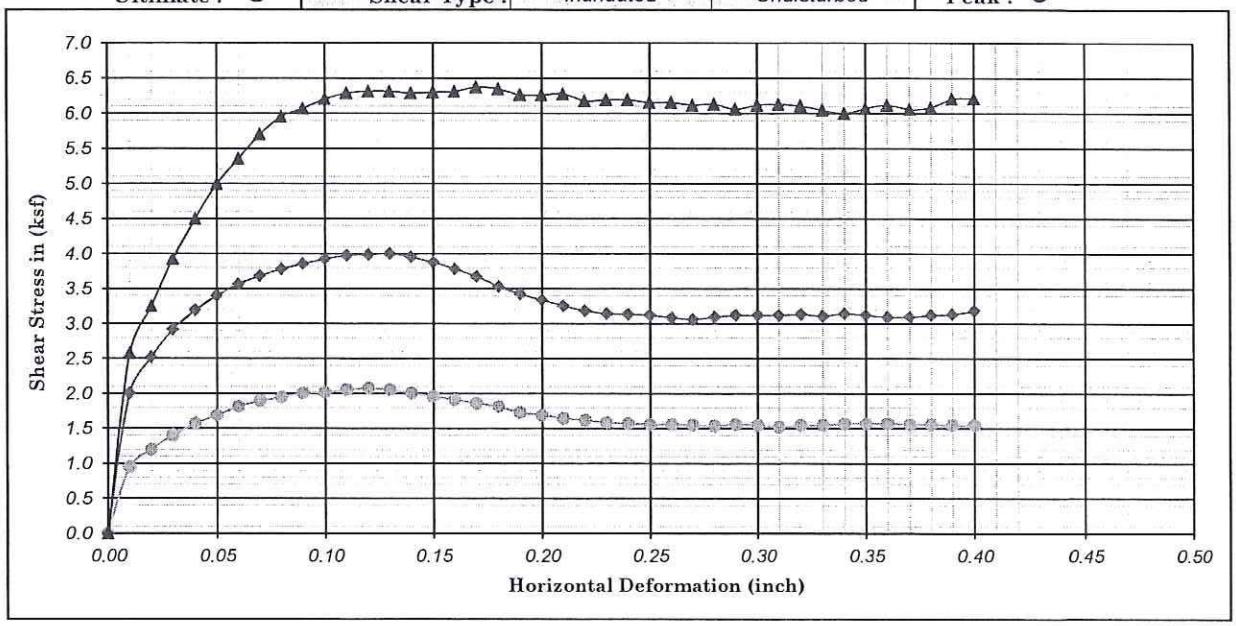
DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126 | Date : 02/14/11

Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-045		Strength Intercept (C) :	0.89	(ksf)	Peak	0.05	(ksf)	Ultimate
Sample No. : D-9			42.54	(kPa)		2.15	(kPa)	
Depth (ft/m) : 40.0	0.00	Friction Angle (ϕ) :	29.19	Degree		31.26	Degree	
Description : Olive-brown, Poorly graded SAND with SILT (SP-SM)					Shear Rate (inch/minute) :		0.02	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	23.28	82.92	13.05	1.03	2.50	119.70	2.08	99.40	1.55	74.21
◆	21.94	84.66	13.33	0.99	5.00	239.40	4.00	191.33	3.10	148.43
▲	21.88	88.41	13.92	0.91	10.00	478.80	6.37	305.04	6.11	292.55

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

East Street UC (Widen)

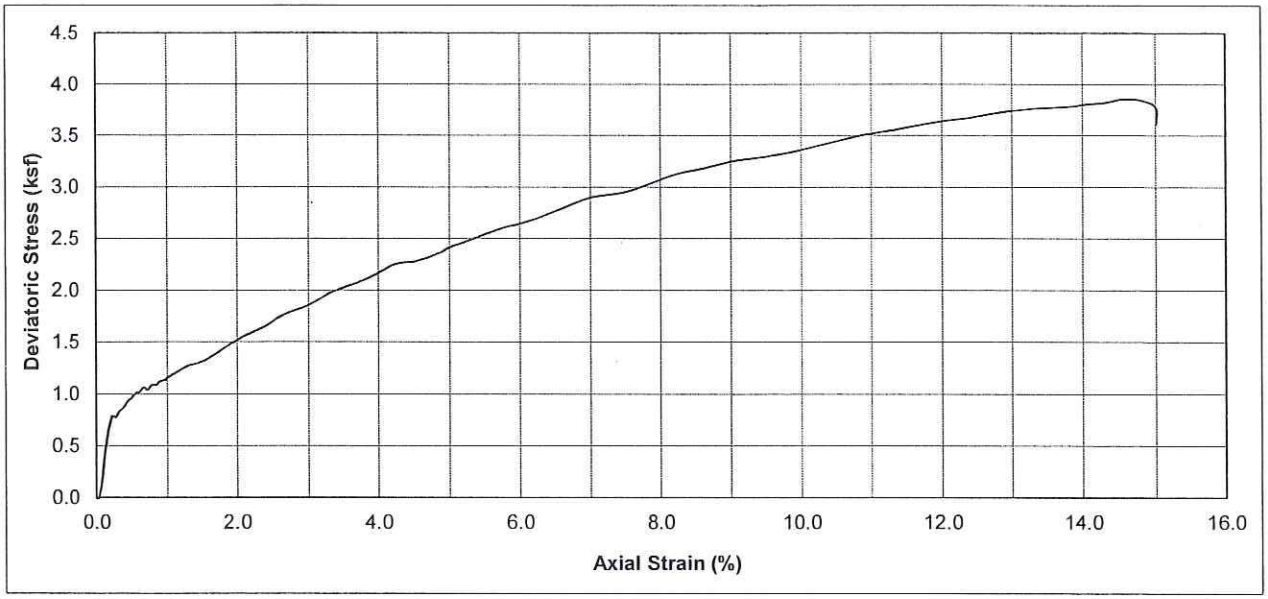
SR-91 WB Widening Project

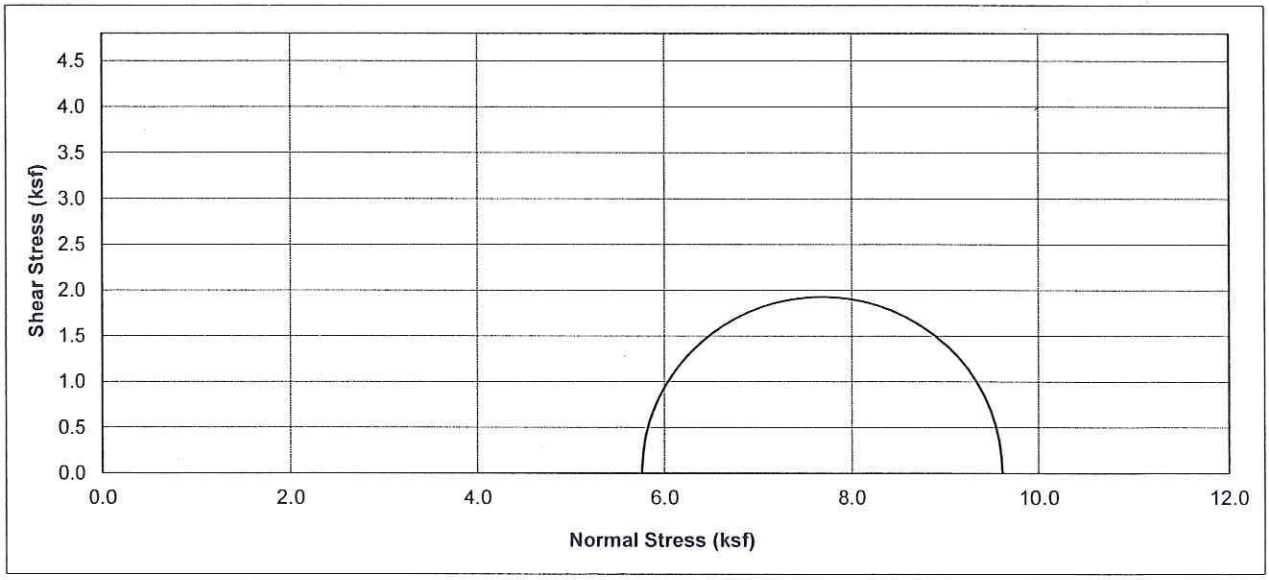
DIRECT SHEAR TEST (ASTM D-3080)

Project No. : 10-126

Date : 02/14/11

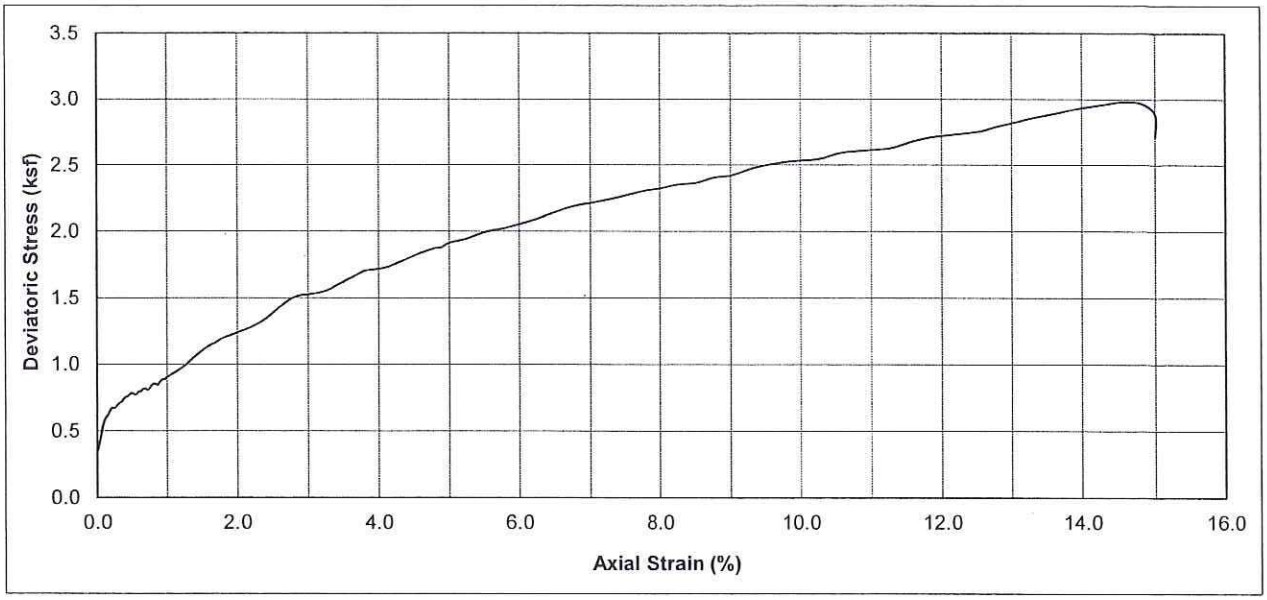
Figure No. :

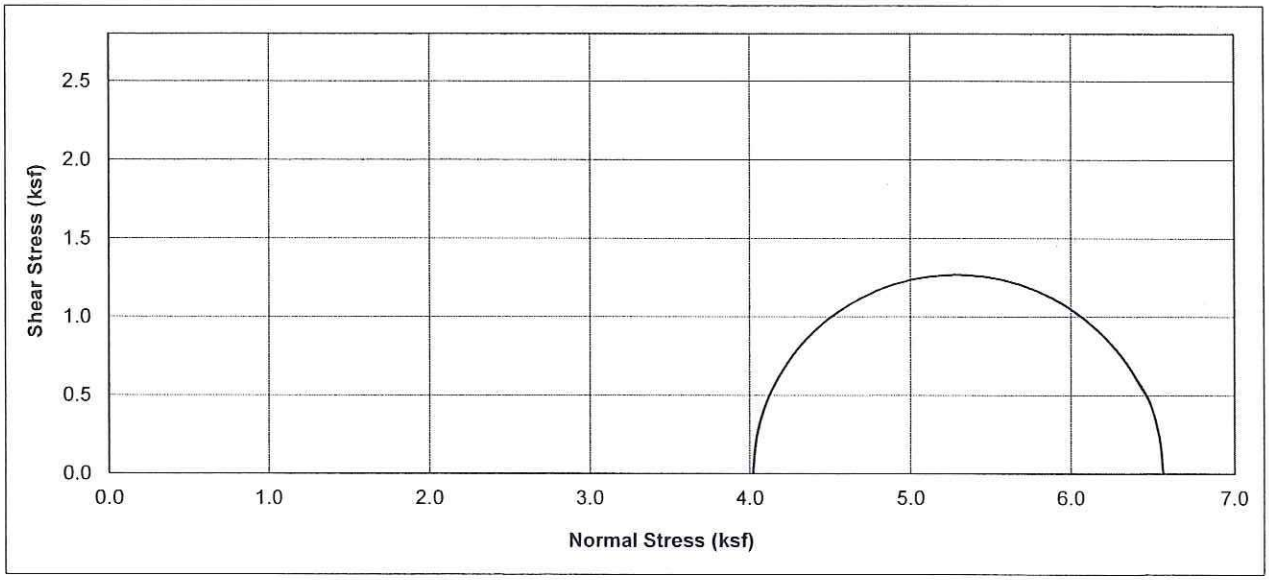




Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-044	D-14	70	Olive-brown , SANDY Lean CLAY (CL)	105.9	19.56	5.75	3.36	89.4

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	East Street UC (Widen)
	UNCONSOLIDATED UNDRAINED TEST (ASTM D2850)
Project No. : 10-126 Date : 02/08/11	Figure No. :





Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-045	D-11	50	Olive-brown , Lean CLAY with SAND (CL)	93.9	29.79	4.02	2.54	101.4

Earth Mechanics, Inc.	East Street UC (Widen)
Geotechnical and Earthquake Engineering	UNCONSOLIDATED UNDRAINED TEST
Project No. : 10-126 / Date : 02/08/11	(ASTM D2850) Figure No. :

Appendix C

DESIGN CALCULATIONS

East Street Undercrossing (Widen) SP 10-126
LIQUEFACTION ANALYSIS; ACC. = 0.52 g 21-Mar-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
$^{1}C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-044

Emean (%)	75	Sur.=	psf	193	=top of ground el.	Borehole Diamet	8							121	=water table El.		acc. max =	0.52	g		Earthq. M=	7.3		
C_E	1.25					C_B	1.15														Cm=	1.07		

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
188	193	5	0.30	0.30	5.00	1.83	0.75	1.20	1.00	120	1	1	26	0.99	0.33	61	20.0	70	1.00	high N	high N	LARGE	AboveWT
183	188	5	0.60	0.60	10.00	1.29	0.75	1.00	0.60	120	2	2	51	0.98	0.33	43	7.0	43	1.00	high N	high N	LARGE	AboveWT
178	183	5	0.90	0.90	15.00	1.05	0.85	1.20	1.00	120	1	1	34	0.97	0.33	53	8.0	54	1.00	high N	high N	LARGE	AboveWT
173	178	5	1.20	1.20	20.00	0.91	0.85	1.00	0.60	120	2	2	35	0.95	0.32	23	5.0	23	0.97	0.26	0.27	0.84	AboveWT
168	173	5	1.50	1.50	25.00	0.82	0.95	1.20	1.00	120	1	1	12	0.94	0.32	16	5.0	16	0.93	0.17	0.17	0.54	AboveWT
163	168	5	1.80	1.80	30.00	0.75	0.95	1.00	0.60	120	2	2	23	0.93	0.31	14	3.0	14	0.89	0.15	0.14	0.46	AboveWT
158	163	5	2.10	2.10	35.00	0.69	1.00	1.20	1.00	120	1	1	24	0.89	0.30	29	3.0	29	0.87	0.36	0.34	1.12	AboveWT
153	158	5	2.40	2.40	40.00	0.65	1.00	1.00	0.60	120	2	2	75	0.85	0.29	42	3.0	42	0.85	high N	high N	LARGE	AboveWT
148	153	5	2.70	2.70	45.00	0.61	1.00	1.20	1.00	120	1	1	6	0.81	0.27	6	80.0	13	0.82	0.14	0.12	0.44	AboveWT
143	148	5	3.00	3.00	50.00	0.58	1.00	1.00	0.60	120	2	2	100	0.77	0.26	50	3.0	50	0.78	high N	high N	LARGE	AboveWT
138	143	5	3.30	3.30	55.00	0.55	1.00	1.20	1.00	120	1	1	23	0.73	0.25	22	5.0	22	0.76	0.24	0.19	0.79	AboveWT
133	138	5	3.60	3.60	60.00	0.53	1.00	1.00	0.60	120	2	2	68	0.69	0.23	31	4.0	31	0.75	high N	high N	LARGE	AboveWT
128	133	5	3.90	3.90	65.00	0.51	1.00	1.20	1.00	120	1	1	13	0.64	0.22	11	80.0	19	0.73	0.20	0.16	0.72	AboveWT
123	128	5	4.20	4.20	70.00	0.49	1.00	1.00	0.60	120	2	2	26	0.60	0.20	11	70.0	18	0.71	0.20	0.15	0.73	AboveWT
118	123	5	4.50	4.34	75.00	0.48	1.00	1.20	1.00	120	1	1	19	0.56	0.20	16	65.0	24	0.71	0.27	0.20	1.02	fines
113	118	5	4.80	4.49	80.00	0.47	1.00	1.00	0.60	120	2	2	31	0.55	0.20	13	65.0	20	0.70	0.22	0.16	0.82	fines

East Street Undercrossing (Widen)
LIQUEFACTION ANALYSIS; ACC. = 0.52 g

SP 10-126
21-Mar-11

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al (1985), Seed and Harder (1990), updated NCEER (1997)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
^1C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

where: rd = stress reduction factor (Robertson and Wride (1996), Marcuson (USArmy Eng), per NCEER (1997))
g = acceleration of gravity

The resisting cyclic stress ratio (CSR r) is equal to:

CSR r = CSR x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
CSR = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F sub L is:

F sub L = CSR r / CSR i

A-10-045

Emean (%) 75 Sur.= psf 174 =top of ground el. Borehole Diamet 8 121 =water table El. acc. max = 0.52 g Earthq. M= 7.3
C_E 1.25 C_B 1.15 Cm= 1.07

ELEVATION BASE OF LAYER (ft.)	TOP OF LAYER ELEVATION (ft.)	LAYER THICKNESS L (ft.)	TOTAL OVERBUR. PRESS. (tsf)	EFFEC. OVERBUR. PRESS. (tsf)	DEPTH BELOW SURFACE (ft)	C_N	C_R	C_S	C_{ST}	TOTAL UNIT WEIGHT (pcf)	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	FIELD BLOW COUNT N	STRESS REDUC. COEFF. rd	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT Nc	EST. PERCENT OF FINES (%)	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Cor Mag Corr	FACTOR OF SAFETY (F sub L)	WILL IT LIQUEFY?
171.5	174	2.5	0.15	0.15	2.50	2.00	0.75	1.20	1.00	120	1	1	18	0.99	0.34	47	4.0	47	1.00	high N	high N	LARGE	AboveWT
169	171.5	2.5	0.30	0.30	5.00	1.83	0.75	1.00	0.60	120	2	2	4	0.99	0.33	5	10.0	6	1.00	0.07	0.07	0.22	AboveWT
164	169	5	0.60	0.60	10.00	1.29	0.75	1.20	1.00	120	1	1	36	0.98	0.33	60	10.0	62	1.00	high N	high N	LARGE	AboveWT
159	164	5	0.90	0.90	15.00	1.05	0.85	1.00	0.60	120	2	2	16	0.97	0.33	12	10.0	14	1.00	0.15	0.16	0.48	AboveWT
154	159	5	1.20	1.20	20.00	0.91	0.85	1.20	1.00	120	1	1	18	0.95	0.32	24	3.0	24	0.97	0.27	0.28	0.87	AboveWT
149	154	5	1.50	1.50	25.00	0.82	0.95	1.00	0.60	120	2	2	6	0.94	0.32	4	20.0	8	0.93	0.09	0.09	0.28	AboveWT
144	149	5	1.80	1.80	30.00	0.75	0.95	1.20	1.00	120	1	1	42	0.93	0.31	51	4.0	51	0.89	high N	high N	LARGE	AboveWT
139	144	5	2.10	2.10	35.00	0.69	1.00	1.00	0.60	120	2	2	13	0.89	0.30	8	30.0	14	0.87	0.15	0.14	0.46	AboveWT
134	139	5	2.40	2.40	40.00	0.65	1.00	1.20	1.00	120	1	1	44	0.85	0.29	49	3.0	49	0.85	high N	high N	LARGE	AboveWT
129	134	5	2.70	2.70	45.00	0.61	1.00	1.00	0.60	120	2	2	8	0.81	0.27	4	85.0	10	0.82	0.11	0.10	0.35	AboveWT
124	129	5	3.00	3.00	50.00	0.58	1.00	1.20	1.00	120	1	1	14	0.77	0.26	14	75.0	22	0.78	0.24	0.20	0.76	AboveWT
119	124	5	3.30	3.14	55.00	0.56	1.00	1.00	0.60	120	2	2	8	0.73	0.26	4	18.0	7	0.77	0.08	0.07	0.27	yes
114	119	5	3.60	3.29	60.00	0.55	1.00	1.20	1.00	120	1	1	20	0.69	0.25	19	90.0	28	0.76	0.34	0.28	1.09	fines
109	114	5	3.90	3.43	65.00	0.54	1.00	1.00	0.60	120	2	2	10	0.64	0.25	5	80.0	11	0.76	0.11	0.09	0.38	fines
104	109	5	4.20	3.58	70.00	0.53	1.00	1.20	1.00	120	1	1	100	0.60	0.24	91	4.0	91	0.75	high N	high N	LARGE	high N
99	104	5	4.50	3.72	75.00	0.52	1.00	1.00	0.60	120	2	2	50	0.56	0.23	22	4.0	22	0.74	0.24	0.19	0.84	yes
94	99	5	4.80	3.86	80.00	0.51	1.00	1.20	1.00	120	1	1	100	0.55	0.23	88	4.0	88	0.73	high N	high N	LARGE	high N

CI East St UC (Widen) Sounding: CPT-10-046

PGA: 0.52 Mag 7.3 Gwdepth 68.5 Ground EL 189.5 Note: Units are tons/cf, tons/sf, and feet

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	CQ2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
0.66	188.8	18.76	0.005	0.06	0.04	0.04	472.74	0.02	0.89	5.12	92.44	1.55	Sand	Sand	Sand	92.44	1.55	1.00	92.44	0.15	0.34	1.00	FALSE	0.00	Above WT
0.82	188.7	16.33	0.018	0.06	0.05	0.05	330.91	0.11	0.99	4.60	72.19	1.63	Sand	Sand	Sand	72.19	1.63	1.00	72.19	0.11	0.34	1.00	FALSE	0.00	Above WT
0.98	188.5	36.94	0.045	0.06	0.06	0.06	627.23	0.12	0.74	4.21	149.38	1.33	Sand	Sand	Sand	149.38	1.33	1.00	149.38	0.39	0.34	1.00	FALSE	0.00	Above WT
1.15	188.4	58.88	0.404	0.06	0.07	0.07	852.33	0.69	1.19	3.88	219.80	1.55	Sand	Sand	Sand	219.80	1.55	1.00	219.80	1.07	0.34	1.00	FALSE	0.00	Above WT
1.31	188.2	68.59	0.739	0.06	0.08	0.08	871.65	1.08	1.36	3.64	239.90	1.66	Sand	Sand	Sand	239.90	1.66	1.01	242.53	1.41	0.34	1.00	FALSE	0.00	Above WT
1.48	188.0	80.54	0.866	0.06	0.09	0.09	905.98	1.08	1.35	3.42	265.03	1.63	Sand	Sand	Sand	265.03	1.63	1.00	265.03	1.81	0.34	1.00	FALSE	0.00	Above WT
1.64	187.9	319.29	2.453	0.06	0.10	0.10	3243.82	0.77	1.11	3.25	998.09	1.20	Sand	Sand	Sand	998.09	1.20	1.00	998.09	92.55	0.34	1.00	FALSE	0.00	Above WT
1.80	187.7	458.55	3.764	0.06	0.11	0.11	4244.83	0.82	1.15	3.10	1368.23	1.18	Sand	Sand	Sand	1368.23	1.18	1.00	1368.23	238.29	0.34	1.00	FALSE	0.00	Above WT
1.97	187.5	451.36	4.510	0.06	0.12	0.12	3817.61	1.00	1.22	2.97	1287.35	1.27	Sand	Sand	Sand	1287.35	1.27	1.00	1287.35	198.50	0.34	1.00	FALSE	0.00	Above WT
2.13	187.4	345.14	3.835	0.06	0.13	0.13	2699.63	1.11	1.27	2.85	946.70	1.36	Sand	Sand	Sand	946.70	1.36	1.00	946.70	78.99	0.34	1.00	FALSE	0.00	Above WT
2.30	187.2	325.20	4.040	0.06	0.14	0.14	2355.52	1.24	1.32	2.75	858.41	1.42	Sand	Sand	Sand	858.41	1.42	1.00	858.41	58.91	0.34	0.99	FALSE	0.00	Above WT
2.46	187.0	255.89	4.447	0.06	0.15	0.15	1732.67	1.74	1.48	2.65	653.12	1.60	Sand	Sand	Sand	653.12	1.60	1.00	653.12	25.99	0.34	0.99	FALSE	0.00	Above WT
2.62	186.9	194.08	3.664	0.06	0.16	0.16	1233.67	1.89	1.54	2.57	480.02	1.69	Sand	Sand	Sand	480.02	1.69	1.03	495.42	11.39	0.34	0.99	FALSE	0.00	Above WT
2.79	186.7	155.13	4.017	0.06	0.17	0.17	925.70	2.59	1.71	2.49	371.79	1.87	Sand	Sand	Sand	371.79	1.87	1.16	430.37	7.49	0.34	0.99	FALSE	0.00	Above WT
2.95	186.6	107.76	3.849	0.06	0.18	0.18	607.81	3.58	1.90	2.42	251.16	2.07	Sand	Sand	Sand	251.16	2.07	1.41	352.94	4.17	0.34	0.99	FALSE	0.00	Above WT
3.12	186.4	123.32	2.181	0.06	0.19	0.19	657.76	1.77	1.61	2.36	279.49	1.79	Sand	Sand	Sand	279.49	1.79	1.10	307.26	2.78	0.34	0.99	FALSE	0.00	Above WT
3.28	186.2	176.77	1.737	0.06	0.20	0.20	897.22	0.98	1.32	2.30	390.73	1.50	Sand	Sand	Sand	390.73	1.50	1.00	390.73	5.63	0.34	0.99	FALSE	0.00	Above WT
3.44	186.1	200.02	1.780	0.06	0.21	0.21	968.09	0.89	1.27	2.24	431.72	1.44	Sand	Sand	Sand	431.72	1.44	1.00	431.72	7.56	0.34	0.99	FALSE	0.00	Above WT
3.61	185.9	175.91	1.773	0.06	0.22	0.22	811.14	1.01	1.35	2.19	370.63	1.52	Sand	Sand	Sand	370.63	1.52	1.00	370.63	4.81	0.34	0.99	FALSE	0.00	Above WT
3.77	185.7	189.90	1.679	0.06	0.23	0.23	838.52	0.89	1.29	2.14	391.53	1.46	Sand	Sand	Sand	391.53	1.46	1.00	391.53	5.66	0.34	0.99	FALSE	0.00	Above WT
3.94	185.6	197.52	1.609	0.06	0.24	0.24	834.53	0.82	1.26	2.10	398.36	1.43	Sand	Sand	Sand	398.36	1.43	1.00	398.36	5.96	0.33	0.99	FALSE	0.00	Above WT
4.10	185.4	203.40	1.735	0.06	0.25	0.25	825.83	0.85	1.28	2.06	402.13	1.44	Sand	Sand	Sand	402.13	1.44	1.00	402.13	6.13	0.33	0.99	FALSE	0.00	Above WT
4.27	185.2	279.50	3.668	0.06	0.26	0.26	1089.94	1.31	1.41	2.01	541.47	1.53	Sand	Sand	Sand	541.47	1.53	1.00	541.47	14.84	0.33	0.99	FALSE	0.00	Above WT
4.43	185.1	361.07	3.867	0.06	0.27	0.27	1357.43	1.07	1.29	1.98	686.75	1.40	Sand	Sand	Sand	686.75	1.40	1.00	686.75	30.20	0.33	0.99	FALSE	0.00	Above WT
4.59	184.9	394.32	4.597	0.06	0.28	0.28	1430.81	1.17	1.32	1.94	736.80	1.42	Sand	Sand	Sand	736.80	1.42	1.00	736.80	37.28	0.33	0.99	FALSE	0.00	Above WT
4.76	184.7	391.94	3.629	0.06	0.29	0.29	1371.34	0.93	1.23	1.91	719.16	1.34	Sand	Sand	Sand	719.16	1.34	1.00	719.16	34.67	0.33	0.99	FALSE	0.00	Above WT
4.92	184.6	352.08	4.184	0.06	0.30	0.30	1191.68	1.19	1.35	1.88	635.43	1.46	Sand	Sand	Sand	635.43	1.46	1.00	635.43	23.94	0.33	0.99	FALSE	0.00	Above WT
5.09	184.4	356.02	4.024	0.06	0.31	0.31	1164.75	1.13	1.34	1.85	631.72	1.44	Sand	Sand	Sand	631.72	1.44	1.00	631.72	23.53	0.33	0.99	FALSE	0.00	Above WT
5.25	184.3	344.00	3.362	0.06	0.32	0.32	1091.06	0.98	1.29	1.82	601.02	1.39	Sand	Sand	Sand	601.02	1.39	1.00	601.02	20.27	0.33	0.99	FALSE	0.00	Above WT
5.41	184.1	333.77	3.405	0.06	0.32	0.32	1027.25	1.02	1.31	1.79	574.46	1.42	Sand	Sand	Sand	574.46	1.42	1.00	574.46	17.71	0.33	0.99	FALSE	0.00	Above WT
5.58	183.9	341.04	3.467	0.06	0.33	0.33	1017.64	1.02	1.31	1.76	577.96	1.42	Sand	Sand	Sand	577.96	1.42	1.00	577.96	18.03	0.33	0.99	FALSE	0.00	Above WT
5.74	183.8	345.27	3.543	0.06	0.34	0.34	1001.53	1.03	1.32	1.74	576.91	1.42	Sand	Sand	Sand	576.91	1.42	1.00	576.91	17.94	0.33	0.99	FALSE	0.00	Above WT
5.91	183.6	345.38	3.326	0.06	0.35	0.35	973.00	0.96	1.30	1.71	568.74	1.40	Sand	Sand	Sand	568.74	1.40	1.00	568.74	17.19	0.33	0.99	FALSE	0.00	Above WT
6.07	183.4	322.60	2.876	0.06	0.36	0.36	884.78	0.89	1.28	1.69	524.18	1.39	Sand	Sand	Sand	524.18	1.39	1.00	524.18	13.47	0.33	0.99	FALSE	0.00	Above WT
6.23	183.3	322.27	2.411	0.06	0.37	0.37	861.15	0.75	1.22	1.67	516.87	1.33	Sand	Sand	Sand	516.87	1.33	1.00	516.87	12.92	0.33	0.99	FALSE	0.00	Above WT
6.40	183.1	316.00	2.156	0.06	0.38	0.38	821.92	0.68	1.19	1.65	500.04	1.31	Sand	Sand	Sand	500.04	1.31	1.00	500.04	11.71	0.33	0.99	FALSE	0.00	Above WT
6.56	182.9	287.66	1.798	0.06	0.39	0.39	729.84	0.63	1.18	1.63	449.61	1.30	Sand	Sand	Sand	449.61	1.30	1.00	449.61	8.53	0.33	0.98	FALSE	0.00	Above WT
6.73	182.8	275.57	1.689	0.06	0.40	0.40	681.44	0.61	1.19	1.60	425.24	1.31	Sand	Sand	Sand	425.24	1.31	1.00	425.24	7.23	0.33	0.98	FALSE	0.00	Above WT
6.89	182.6	256.82	1.663	0.06	0.41	0.41	620.24	0.65	1.23	1.59	391.68	1.35	Sand	Sand	Sand	391.68	1.35	1.00	391.68	5.67	0.33	0.98	FALSE	0.00	Above WT
7.05	182.5	242.92	1.799	0.06	0.42	0.42	573.28	0.74	1.30	1.57	366.25	1.42	Sand	Sand	Sand	366.25	1.42	1.00	366.25	4.65	0.33	0.98	FALSE	0.00	Above WT
7.22	182.3	263.27	2.001	0.06	0.43	0.43	606.73	0.76	1.30	1.55	392.23	1.41	Sand	Sand	Sand	392.23	1.41	1.00	392.23	5.69	0.33	0.98	FALSE	0.00	Above WT
7.38	182.1	306.83	2.315	0.06	0.44	0.44	691.93	0.76	1.27	1.53	452.14	1.37	Sand	Sand	Sand	452.14	1.37	1.00	452.14	8.68	0.33	0.98	FALSE	0.00	Above WT
7.55	182.0	322.31	2.514	0.06	0.45	0.45	710.50	0.78	1.27	1.52	469.58	1.37	Sand	Sand	Sand	469.58	1.37	1.00	469.58	9.71	0.33	0.98	FALSE	0.00	Above WT
7.71	181.8	316.92	2.156	0.06	0.46	0.46	684.08	0.68	1.23	1.50	456.91	1.33	Sand	Sand	Sand	456.91	1.33	1.00	456.91	8.95	0.33	0.98	FALSE	0.00	Above WT
7.87	181.6	305.31	2.241	0.06	0.47	0.47	645.57	0.73	1.27	1.48	435.67	1.37	Sand	Sand	Sand	435.67	1.37	1.00	435.67	7.77	0.33	0.98	FALSE	0.00	Above WT
8.04	181.5	262.00	2.205	0.06	0.48	0.48	583.58	0.78	1.32	1.47	398.13	1.41	Sand	Sand	Sand	398.13	1.41	1.00	398.13	5.95	0.33	0.98	FALSE	0.00	Above WT
8.20	181.3	279.98	3.333	0.06	0.49	0.49	568.07	1.19	1.48	1.45	391.41	1.57	Sand	Sand	Sand	391.41	1.57	1.00	391.41	5.66	0.33	0.98	FALSE	0.00	Above WT
8.37	181.1	287.67	7.106	0.06	0.50	0.50	571.82	2.47	1.76	1.44	398.05	1.83	Sand	Sand	Sand	398.05	1.83	1.13	450.43	8.58	0.33	0.98	FALSE	0.00	Above WT
8.53	181.0	323.27	6.292	0.06	0.51	0.51	630.63	1.95	1.65	1.43	443.10	1.72	Sand	Sand	Sand	443.10	1.72	1.05	465.81	9.48	0.33	0.98	FALSE	0.00	Above WT
8.69	180.8	234.79	4.356	0.06	0.52	0.52	449.31	1.86	1.70	1.41	318.84	1.78	Sand	Sand	Sand	318.84	1.78	1.09	347.26	3.97	0.33	0.98	FALSE	0.00	Above WT
8.86	180.6	250.73	2.727	0.06	0.53	0.53	470.65	1.09	1.49	1.40	337.21	1.57	Sand	Sand	Sand	337.21	1.57	1.00	337.21	3.65	0.33	0.98	FALSE	0.00	Above WT
9.02	180.5	295.89	2.958	0.06	0.54	0.54	545.73	1.00	1.42	1.39	394.40	1.50	Sand	Sand	Sand	394.40	1.50	1.00	394.40	5.79	0.33	0.98	FALSE	0.00	Above WT
9.19	180.3	312.14	3.205	0.06	0.55	0.55	565.09	1.03	1.43	1.37	412.19	1.50	Sand	Sand	Sand	412.19	1.50	1.00	412.19	6.59	0.33	0.98	FALSE	0.00	Above WT
9.35	180.2	326.48	3.112	0.06	0.56	0.56	580.96	0.95	1.39	1.36	427.42	1.46	Sand	Sand	Sand	427.42	1.46	1.00	427.42	7.34	0.33	0.98	FALSE	0.00	Above WT
9.51	180.0	347.38	3.114	0.06	0.57	0.57	607.80	0.90	1.36	1.35	450.94	1.43	Sand	Sand	Sand	450.94	1.43	1.00	450.94	8.61	0.33	0.98	FALSE	0.00	Above WT
9.68	179.8	363.16	3.065	0.06	0.58	0.58	624.28	0.85	1.33	1.34	467.27	1.40	Sand	Sand	Sand	467.27	1.40	1.00	467.27	9.57	0.33	0.98	FALSE	0.00	Above WT
9.84	179.7	341.04	2.967	0.06	0.59	0.59	576.64	0.87	1.36	1.33	435.23	1.43	Sand	Sand	Sand	435.23	1.43	1.00	435.23	7.75	0.33	0.98	FALSE	0.00	Above WT
10.01	179.5	290.19	3.380	0.06	0.60	0.60	482.17	1.17	1.51	1.32	367.18	1.57	Sand	Sand	Sand	367.18	1.57	1.00	367.18	4.68	0.33	0.98	FALSE	0.00	Above WT
10.17	179.3	226.88	3.420	0.06	0.61	0.61	370.61	1.51	1.66	1.31	284.80	1.73	Sand	Sand	Sand	284.80	1.73	1.06	301.15	2.62	0.33	0.98	FALSE	0.00	Above WT
10.33	179.2	205.70	3.379	0.06	0.62	0.62	330.88	1.65	1.72	1.30	256.21	1.79	Sand	Sand	Sand	256.21	1.79	1.10	281.02	2.14	0.33	0.98	FALSE	0.00	Above WT
10.50	179.0	198.38	3.511	0.06	0.63	0.63	313.89	1.78	1.76	1.28	245.08	1.82	Sand	Sand	Sand	245.08	1.82	1.12	275.60	2.03	0.33	0.98	FALSE	0.00	Above WT
10.66	178.8	177.46	2.971	0.06	0.64	0.64	276.45	1.68	1.77	1.28	217.59	1.84	Sand	Sand	Sand	217.59	1.84	1.13	246.73	1.48	0.33	0.98	FALSE	0.00	Above WT
10.83	178.7	193.28	2.615	0.06	0.65	0.65	296.45	1.36	1.68	1.27	235.12	1.74	Sand	Sand	Sand	235.12	1.74	1.07	250.78	1.55	0.33	0.97	FALSE	0.00	Above WT
10.99	178.5	189.59	1.840	0.06	0.66	0.66	286.52	0.97	1.58	1.26	228.94	1.64	Sand	Sand	Sand	228.94	1.64	1.00	228.25	1.19	0.33	0.97	FALSE	0.00	Above WT
11.15	178.4	184.07	1.630	0.06	0.67	0.67	274.14	0.89	1.56	1.25	220.68	1.62	Sand	Sand	Sand	220.68	1.62	1.00	220.68	1.08	0.33	0.97	FALSE	0.00	Above WT
11.32	178.2	192.91	1.852	0.06	0.68	0.68	283.03	0.96	1.58	1.24	229.53	1.64	Sand	Sand	Sand	229.53	1.64	1.00	229.53	1.20	0.33	0.97	FALSE	0.00	Above WT
11.48	178.0	191.93	1.882	0.06	0.69	0.69	277.64	0.98	1.59	1.23	226.77	1.65	Sand	Sand	Sand	226.77	1.65	1.00	227.06	1.17	0.33	0.97	FALSE	0.00	Above WT
11.65	177.9	244.02	2.533	0.06	0.70	0.70	348.10	1.04	1.55	1.22	286.20	1.60	Sand	Sand	Sand	286.20	1.60	1.00	286.20	2.26	0.33	0.97	FALSE	0.00	Above WT
11.81	177.7	296.53	2.650	0.06	0.71	0.71	417.47	0.90	1.45	1.21	345.42	1.50	Sand	Sand	Sand	345.42	1.50	1.00	345.42	3.91	0.33	0.97	FALSE	0.00	Above WT
11.98	177.5	323.46	2.654	0.06	0.72	0.72	449.03	0.82	1.40	1.20	374.13	1.45	Sand	Sand	Sand	374.13	1.45	1.00	374.13	4.95	0.33	0.97	FALSE	0.00	Above WT
12.14	177.4	333.49	2.259	0.06	0.73	0.73	456.84	0.68	1.33	1.19	383.16	1.38	Sand	Sand	Sand	383.16	1.38	1.00	383.16	5.31	0.33	0.97	FALSE	0.00	Above WT
12.30	177.2	338.69	2.530	0.06	0.74	0.74	457.93	0.75	1.36	1.19	386.60	1.41	Sand	Sand	Sand	386.60	1.41	1.00	386.60	5.45	0.33	0.97	FALSE	0.00	Above WT
12.47	177.0	340.29	2.794	0.06	0.75	0.75	453.81	0.82	1.40	1.18	385.77	1.44	Sand	Sand	Sand	385.77	1.44	1.00	385.77	5.42	0.33	0.97	FALSE	0.00	Above WT
12.63	176.9	303.59	2.893	0.06	0.76	0.76	399.62	0.96	1.48	1.17	341.97	1.52	Sand	Sand	Sand	341.97	1.52	1.00	341.97	3.80	0.33	0.97	FALSE	0.00	Above WT
12.80	176.7	284.00	3.064	0.06	0.77	0.77	368.79	1.08	1.55	1.16	317.78	1.58	Sand	Sand	Sand	317.78	1.58	1.00	317.78	3.06	0.33	0.97	FALSE	0.00	Above WT
12.96	176.5	266.91	3.044	0.06	0.78	0.78	342.25	1.14	1.58	1.16	296.80	1.62	Sand	Sand	Sand	296.80	1.62	1.00	296.80	2.51	0.33	0.97	FALSE	0.00	Above WT
13.12	176.4	256.97	2.803	0.06	0.79	0.79	325.44	1.09	1.58	1.15	284.00	1.62	Sand	Sand	Sand	284.00	1.62	1.00	284.00	2.21	0.33	0.97	FALSE	0.00	Above WT
13.29	176.2	261.38	2.512	0.06	0.80	0.80	326.79	0.96	1.54	1.14	287.02	1.57	Sand	Sand	Sand	287.02	1.57	1.00	287.02	2.28	0.33	0.97	FALSE	0.00	Above WT
13.45	176.1	261.51	1.881	0.06	0.81	0.81	323.05	0.72	1.44	1.14	285.45	1.48	Sand	Sand	Sand	285.45	1.48	1.00	285.45	2.24	0.33	0.97	FALSE	0.00	Above WT
13.62	175.9	248.67	2.011	0.06	0.82	0.82	304.52	0.81	1.50	1.13	270.82	1.53	Sand	Sand	Sand	270.82	1.53	1.00	270.82	1.93	0.33	0.97	FALSE	0.00	Above WT
13.78	175.7	208.72	1.556	0.06	0.83	0.83	251.44	0.75	1.53	1.12	225.09	1.56	Sand	Sand	Sand	225.09	1.56	1.00	225.09	1.14	0.33	0.97	FALSE	0.00	Above WT
13.94	175.6	181.08	1.627	0.06	0.84	0.84	215.50	0.90	1.64	1.12	194.15	1.67	Sand	Sand	Sand	194.15	1.67	1.02	197.12	0.79	0.33	0.97	FALSE	0.00	Above WT

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Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
14.11	175.4	176.03	1.503	0.06	0.85	0.85	206.93	0.86	1.63	1.11	187.60	1.66	Sand	Sand	Sand	187.60	1.66	1.01	189.84	0.72	0.33	0.97	FALSE	0.00	Above WT
14.27	175.2	145.24	1.306	0.06	0.86	0.86	168.63	0.90	1.71	1.10	153.92	1.74	Sand	Sand	Sand	153.92	1.74	1.07	163.95	0.49	0.33	0.97	FALSE	0.00	Above WT
14.44	175.1	128.39	1.490	0.06	0.87	0.87	147.19	1.17	1.83	1.10	135.26	1.86	Sand	Sand	Sand	135.26	1.86	1.15	155.71	0.43	0.33	0.97	FALSE	0.00	Above WT
14.60	174.9	131.29	1.615	0.06	0.88	0.88	148.87	1.24	1.85	1.09	137.55	1.87	Sand	Sand	Sand	137.55	1.87	1.16	159.81	0.46	0.33	0.97	FALSE	0.00	Above WT
14.76	174.7	149.26	1.426	0.06	0.89	0.89	167.54	0.96	1.73	1.08	155.53	1.76	Sand	Sand	Sand	155.53	1.76	1.08	167.21	0.51	0.33	0.97	FALSE	0.00	Above WT
14.93	174.6	153.95	1.014	0.06	0.90	0.90	170.86	0.66	1.62	1.08	159.50	1.64	Sand	Sand	Sand	159.50	1.64	1.00	158.90	0.45	0.33	0.97	FALSE	0.00	Above WT
15.09	174.4	117.44	0.695	0.06	0.91	0.91	128.71	0.60	1.69	1.07	121.03	1.71	Sand	Sand	Sand	121.03	1.71	1.04	126.22	0.27	0.33	0.96	FALSE	0.00	Above WT
15.26	174.2	110.54	0.564	0.06	0.92	0.92	119.73	0.51	1.67	1.07	113.28	1.69	Sand	Sand	Sand	113.28	1.69	1.03	117.16	0.23	0.33	0.96	FALSE	0.00	Above WT
15.42	174.1	72.52	0.538	0.06	0.93	0.93	77.38	0.75	1.92	1.06	73.93	1.94	Sand	Sand	Sand	73.93	1.94	1.23	90.87	0.15	0.33	0.96	FALSE	0.00	Above WT
15.58	173.9	39.14	0.582	0.06	0.93	0.93	40.87	1.52	2.33	1.05	39.70	2.34	Sand	Sand	Sand	39.70	2.34	2.08	82.54	0.13	0.33	0.96	FALSE	0.00	Above WT
15.75	173.8	25.31	0.705	0.06	0.95	0.95	25.78	2.89	2.66	Clay	Clay	Clay	Clay	Clay	Clay	25.78	2.66	3.70	95.41	0.16	0.33	0.96	FALSE	0.00	Above WT
15.91	173.6	21.52	0.914	0.06	0.95	0.95	21.54	4.44	2.84	Clay	Clay	Clay	Clay	Clay	Clay	21.54	2.84	5.12	110.22	0.20	0.33	0.96	FALSE	0.00	Above WT
16.08	173.4	23.93	0.994	0.06	0.96	0.96	23.80	4.33	2.80	Clay	Clay	Clay	Clay	Clay	Clay	23.80	2.80	4.77	113.43	0.22	0.33	0.96	FALSE	0.00	Above WT
16.24	173.3	37.79	0.881	0.06	0.97	0.97	37.78	2.39	2.48	1.03	37.54	2.48	Sand	Sand	Sand	37.54	2.48	2.67	100.16	0.17	0.33	0.96	FALSE	0.00	Above WT
16.40	173.1	52.60	0.787	0.06	0.98	0.98	52.46	1.52	2.24	1.03	52.00	2.25	Sand	Sand	Sand	52.00	2.25	1.79	92.94	0.15	0.33	0.96	FALSE	0.00	Above WT
16.57	172.9	56.81	0.602	0.06	0.99	0.99	56.14	1.08	2.13	1.02	55.67	2.13	Sand	Sand	Sand	55.87	2.13	1.51	84.50	0.14	0.32	0.96	FALSE	0.00	Above WT
16.73	172.8	55.34	0.604	0.06	1.00	1.00	54.13	1.11	2.15	1.02	54.16	2.15	Sand	Sand	Sand	54.16	2.15	1.55	83.96	0.14	0.32	0.96	FALSE	0.00	Above WT
16.90	172.6	47.89	0.604	0.06	1.01	1.01	46.23	1.29	2.24	1.01	46.63	2.24	Sand	Sand	Sand	46.63	2.24	1.77	82.48	0.13	0.32	0.96	FALSE	0.00	Above WT
17.06	172.4	39.70	0.713	0.06	1.02	1.02	37.78	1.84	2.41	1.01	38.48	2.40	Sand	Sand	Sand	38.48	2.40	2.31	88.96	0.15	0.32	0.96	FALSE	0.00	Above WT
17.22	172.3	34.03	0.940	0.06	1.03	1.03	31.94	2.85	2.58	1.00	32.83	2.57	Sand	Sand	Sand	32.83	2.57	3.17	103.98	0.18	0.32	0.96	FALSE	0.00	Above WT
17.39	172.1	34.36	0.996	0.06	1.04	1.04	31.93	2.99	2.60	1.00	32.98	2.59	Sand	Sand	Sand	32.98	2.59	3.24	106.83	0.19	0.32	0.96	FALSE	0.00	Above WT
17.55	172.0	41.57	0.863	0.06	1.05	1.05	38.48	2.13	2.44	0.99	39.72	2.43	Sand	Sand	Sand	39.72	2.43	2.43	96.65	0.16	0.32	0.96	FALSE	0.00	Above WT
17.72	171.8	48.35	0.402	0.06	1.06	1.06	44.48	0.85	2.15	0.99	45.98	2.14	Sand	Sand	Sand	45.98	2.14	1.54	70.61	0.11	0.32	0.96	FALSE	0.00	Above WT
17.88	171.6	52.88	0.249	0.06	1.07	1.07	48.29	0.48	2.00	0.98	50.06	1.99	Sand	Sand	Sand	50.06	1.99	1.28	64.26	0.10	0.32	0.96	FALSE	0.00	Above WT
18.04	171.5	53.02	0.285	0.06	1.08	1.08	47.98	0.55	2.03	0.98	49.97	2.01	Sand	Sand	Sand	49.97	2.01	1.32	65.95	0.11	0.32	0.96	FALSE	0.00	Above WT
18.21	171.3	49.24	0.288	0.06	1.09	1.09	44.07	0.60	2.08	0.98	46.19	2.06	Sand	Sand	Sand	46.19	2.06	1.39	64.21	0.10	0.32	0.96	FALSE	0.00	Above WT
18.37	171.1	45.42	0.285	0.06	1.10	1.10	40.21	0.64	2.13	0.97	42.42	2.11	Sand	Sand	Sand	42.42	2.11	1.47	62.50	0.10	0.32	0.96	FALSE	0.00	Above WT
18.54	171.0	41.29	0.385	0.06	1.11	1.11	36.12	0.96	2.26	0.97	38.39	2.24	Sand	Sand	Sand	38.39	2.24	1.76	67.53	0.11	0.32	0.96	FALSE	0.00	Above WT
18.70	170.8	34.90	0.528	0.06	1.12	1.12	30.11	1.56	2.44	0.96	32.31	2.42	Sand	Sand	Sand	32.31	2.42	2.38	77.01	0.12	0.32	0.96	FALSE	0.00	Above WT
18.86	170.6	30.49	0.851	0.06	1.13	1.13	25.94	2.90	2.66	Clay	Clay	Clay	Clay	Clay	Clay	25.94	2.66	3.69	95.73	0.16	0.32	0.96	FALSE	0.00	Above WT
19.03	170.5	26.55	1.017	0.06	1.14	1.14	22.25	4.00	2.80	Clay	Clay	Clay	Clay	Clay	Clay	22.25	2.80	4.76	106.02	0.19	0.32	0.96	FALSE	0.00	Above WT
19.19	170.3	24.95	1.055	0.06	1.15	1.15	20.67	4.43	2.85	Clay	Clay	Clay	Clay	Clay	Clay	20.67	2.85	5.23	108.14	0.20	0.32	0.96	FALSE	0.00	Above WT
19.36	170.1	21.48	1.144	0.06	1.16	1.16	17.49	5.63	2.97	Clay	Clay	Clay	Clay	Clay	Clay	17.49	2.97	6.46	112.94	0.21	0.32	0.95	FALSE	0.00	Above WT
19.52	170.0	22.58	1.161	0.06	1.17	1.17	18.28	5.42	2.95	Clay	Clay	Clay	Clay	Clay	Clay	18.28	2.95	6.19	113.14	0.21	0.32	0.95	FALSE	0.00	Above WT
19.69	169.8	23.35	1.206	0.06	1.18	1.18	18.76	5.44	2.94	Clay	Clay	Clay	Clay	Clay	Clay	18.76	2.94	6.11	114.68	0.22	0.32	0.95	FALSE	0.00	Above WT
19.85	169.7	28.73	1.122	0.06	1.19	1.19	23.12	4.07	2.79	Clay	Clay	Clay	Clay	Clay	Clay	23.12	2.79	4.70	108.67	0.20	0.32	0.95	FALSE	0.00	Above WT
20.01	169.5	42.53	0.978	0.06	1.20	1.20	34.42	2.37	2.51	0.93	38.06	2.47	Sand	Sand	Sand	38.06	2.47	2.63	100.13	0.17	0.32	0.95	FALSE	0.00	Above WT
20.18	169.3	73.57	0.622	0.06	1.21	1.21	59.76	0.86	2.05	0.93	65.56	2.02	Sand	Sand	Sand	65.56	2.02	1.32	86.66	0.14	0.32	0.95	FALSE	0.00	Above WT
20.34	169.2	93.47	0.559	0.06	1.22	1.22	75.59	0.61	1.88	0.92	82.97	1.85	Sand	Sand	Sand	82.97	1.85	1.14	94.79	0.16	0.32	0.95	FALSE	0.00	Above WT
20.51	169.0	107.00	0.518	0.06	1.23	1.23	85.95	0.49	1.78	0.92	94.58	1.75	Sand	Sand	Sand	94.58	1.75	1.07	101.31	0.18	0.32	0.95	FALSE	0.00	Above WT
20.67	168.8	104.53	0.459	0.06	1.24	1.24	83.28	0.44	1.78	0.92	92.04	1.74	Sand	Sand	Sand	92.04	1.74	1.06	97.88	0.17	0.32	0.95	FALSE	0.00	Above WT
20.83	168.7	92.05	0.393	0.06	1.25	1.25	72.65	0.43	1.82	0.91	80.74	1.78	Sand	Sand	Sand	80.74	1.78	1.09	88.32	0.14	0.32	0.95	FALSE	0.00	Above WT
21.00	168.5	77.18	0.376	0.06	1.26	1.26	60.25	0.50	1.92	0.91	67.42	1.88	Sand	Sand	Sand	67.42	1.88	1.17	78.86	0.13	0.32	0.95	FALSE	0.00	Above WT
21.16	168.3	64.64	0.386	0.06	1.27	1.27	49.91	0.61	2.04	0.91	56.25	1.99	Sand	Sand	Sand	56.25	1.99	1.29	72.52	0.12	0.32	0.95	FALSE	0.00	Above WT
21.33	168.2	59.64	0.602	0.06	1.28	1.28	45.60	1.03	2.19	0.90	51.70	2.15	Sand	Sand	Sand	51.70	2.15	1.55	79.89	0.13	0.32	0.95	FALSE	0.00	Above WT
21.49	168.0	62.38	0.528	0.06	1.29	1.29	47.38	0.86	2.14	0.90	53.87	2.09	Sand	Sand	Sand	53.87	2.09	1.43	77.26	0.12	0.32	0.95	FALSE	0.00	Above WT
21.65	167.9	65.85	0.462	0.06	1.30	1.30	49.69	0.72	2.07	0.89	56.65	2.03	Sand	Sand	Sand	56.65	2.03	1.33	75.60	0.12	0.32	0.95	FALSE	0.00	Above WT
21.82	167.7	71.47	0.475	0.06	1.31	1.31	53.59	0.68	2.03	0.89	61.25	1.98	Sand	Sand	Sand	61.25	1.98	1.28	78.37	0.12	0.32	0.95	FALSE	0.00	Above WT
21.98	167.5	84.78	0.929	0.06	1.32	1.32	63.29	1.11	2.09	0.89	72.39	2.05	Sand	Sand	Sand	72.39	2.05	1.37	99.12	0.17	0.32	0.95	FALSE	0.00	Above WT
22.15	167.4	119.67	1.160	0.06	1.33	1.33	89.05	0.98	1.94	0.88	101.79	1.90	Sand	Sand	Sand	101.79	1.90	1.19	120.91	0.24	0.32	0.95	FALSE	0.00	Above WT
22.31	167.2	127.58	1.193	0.06	1.34	1.34	94.31	0.95	1.91	0.88	108.13	1.87	Sand	Sand	Sand	108.13	1.87	1.16	125.49	0.26	0.32	0.95	FALSE	0.00	Above WT
22.47	167.0	153.06	0.926	0.06	1.35	1.35	112.53	0.61	1.74	0.88	129.26	1.69	Sand	Sand	Sand	129.26	1.69	1.03	133.29	0.30	0.32	0.95	FALSE	0.00	Above WT
22.64	166.9	157.03	0.879	0.06	1.36	1.36	114.60	0.56	1.71	0.87	132.11	1.66	Sand	Sand	Sand	132.11	1.66	1.01	133.74	0.30	0.32	0.95	FALSE	0.00	Above WT
22.80	166.7	145.23	0.862	0.06	1.37	1.37	105.16	0.60	1.76	0.87	121.76	1.71	Sand	Sand	Sand	121.76	1.71	1.04	126.91	0.27	0.32	0.95	FALSE	0.00	Above WT
22.97	166.5	124.91	0.780	0.06	1.38	1.38	89.63	0.63	1.83	0.87	104.33	1.77	Sand	Sand	Sand	104.33	1.77	1.09	113.54	0.22	0.32	0.95	FALSE	0.00	Above WT
23.13	166.4	93.69	0.547	0.06	1.39	1.39	66.51	0.59	1.92	0.87	77.99	1.86	Sand	Sand	Sand	77.99	1.86	1.16	90.24	0.15	0.32	0.95	FALSE	0.00	Above WT
23.29	166.2	65.33	0.431	0.06	1.40	1.40	45.75	0.67	2.09	0.86	54.19	2.03	Sand	Sand	Sand	54.19	2.03	1.34	72.55	0.12	0.32	0.95	FALSE	0.00	Above WT
23.46	166.0	43.10	0.573	0.06	1.41	1.41	29.62	1.37	2.42	0.86	35.62	2.35	Sand	Sand	Sand	35.62	2.35	2.12	75.57	0.12	0.32	0.95	FALSE	0.00	Above WT
23.62	165.9	36.06	0.663	0.06	1.42	1.42	25.86	1.81	2.53	0.86	31.35	2.47	Sand	Sand	Sand	31.35	2.47	2.60	81.50	0.13	0.32	0.94	FALSE	0.00	Above WT
23.79	165.7	57.21	0.731	0.06	1.43	1.43	39.08	1.31	2.31	0.85	46.96	2.24	Sand	Sand	Sand	46.96	2.24	1.77	83.27	0.13	0.32	0.94	FALSE	0.00	Above WT
23.95	165.6	115.25	0.706	0.06	1.44	1.44	79.20	0.62	1.87	0.85	94.27	1.81	Sand	Sand	Sand	94.27	1.81	1.11	104.76	0.19	0.32	0.94	FALSE	0.00	Above WT
24.11	165.4	150.71	0.726	0.06	1.45	1.45	103.18	0.49	1.72	0.85	122.87	1.65	Sand	Sand	Sand	122.87	1.65	1.00	123.45	0.25	0.32	0.94	FALSE	0.00	Above WT
24.28	165.2	167.22	0.908	0.06	1.46	1.46	113.79	0.55	1.71	0.84	135.85	1.65	Sand	Sand	Sand	135.85	1.65	1.00	135.83	0.31	0.32	0.94	FALSE	0.00	Above WT
24.44	165.1	170.47	1.030	0.06	1.47	1.47	115.25	0.61	1.73	0.84	138.04	1.67	Sand	Sand	Sand	138.04	1.67	1.02	140.15	0.34	0.32	0.94	FALSE	0.00	Above WT
24.61	164.9	158.11	1.060	0.06	1.48	1.48	106.08	0.68	1.79	0.84	127.59	1.72	Sand	Sand	Sand	127.59	1.72	1.05	134.28	0.31	0.32	0.94	FALSE	0.00	Above WT
24.77	164.7	162.13	1.059	0.06	1.49	1.49	108.09	0.66	1.77	0.84	130.41	1.71	Sand	Sand	Sand	130.41	1.71	1.04	135.98	0.31	0.32	0.94	FALSE	0.00	Above WT
24.93	164.6	180.73	1.386	0.06	1.50	1.50	119.82	0.77	1.78	0.83	144.90	1.72	Sand	Sand	Sand	144.90	1.72	1.05	151.86	0.41	0.32	0.94	FALSE	0.00	Above WT
25.10	164.4	195.74	1.484	0.06	1.51	1.51	128.97	0.76	1.75	0.83	156.40	1.69	Sand	Sand	Sand	156.40	1.69	1.03	160.90	0.47	0.32	0.94	FALSE	0.00	Above WT
25.26	164.2	209.57	1.377	0.06	1.52	1.52	137.28	0.66	1.69	0.83	166.92	1.62	Sand	Sand	Sand	166.92	1.62	1.00	166.92	0.51	0.32	0.94	FALSE	0.00	Above WT
25.43	164.1	208.96	1.311	0.06	1.53	1.53	135.95	0.63	1.68	0.83	165.88	1.61	Sand	Sand	Sand	165.88	1.61	1.00	165.88	0.50	0.32	0.94	FALSE	0.00	Above WT
25.59	163.9	208.74	1.229	0.06	1.54	1.54	134.95	0.59	1.67	0.82	165.19	1.60	Sand	Sand	Sand	165.19	1.60	1.00	165.19	0.50	0.32	0.94	FALSE	0.00	Above WT
25.75	163.8	205.08	1.159	0.06	1.55	1.55	131.74	0.57	1.67	0.82	161.79	1.59	Sand	Sand	Sand	161.79	1.59	1.00	161.79	0.47	0.32	0.94	FALSE	0.00	Above WT
25.92	163.6	200.65	1.109	0.06	1.56	1.56	128.02	0.56	1.67	0.82	157.77	1.60	Sand	Sand	Sand	157.77	1.60	1.00	157.77	0.45	0.32	0.94	FALSE	0.00	Above WT
26.08	163.4	190.08	1.015	0.06	1.56	1.56	120.47	0.54	1.68	0.82	149.00	1.61	Sand	Sand	Sand	149.00	1.61	1.00	149.00	0.39	0.32	0.94	FALSE	0.00	Above WT
26.25	163.3	176.00	0.947	0.06	1.58	1.58	110.75	0.54	1.72	0.81	137.52	1.64	Sand	Sand	Sand	137.52	1.64	1.00	137.52	0.32	0.32	0.94	FALSE	0.00	Above WT
26.41	163.1	147.22	0.798	0.06	1.58	1.58	91.91	0.55	1.79	0.81	114.68	1.71	Sand	Sand	Sand	114.68	1.71	1.04	119.46	0.24	0.32	0.94	FALSE	0.00	Above WT
26.57	162.9	123.70	0.632	0.06	1.59	1.59	76.59	0.52	1.84	0.81	96.07	1.76	Sand	Sand	Sand	96.07	1.76	1.08	103.36	0.18	0.32	0.94	FALSE	0.00	Above WT
26.74	162.8	107.15	0.503	0.06	1.60	1.60	65.79	0.48	1.88	0.81	82.95	1.79	Sand	Sand	Sand	82.95	1.79	1.10	91.35	0.15	0.32	0.94	FALSE	0.00	Above WT
26.90	162.6	96.09	0.396	0.06	1.61	1.61	58.54	0.42	1.90	0.80	74.17	1.81	Sand	Sand	Sand	74.17	1.81	1.11	82.52	0.13	0.32	0.94	FALSE	0.00	Above WT
27.07	162.4	86.95	0.302	0.06	1.62	1.62	52.53	0.35	1.91	0.80	66.90	1.82	Sand	Sand	Sand	66.90	1.82	1.12	74.79	0.12	0.32	0.94	FALSE	0.00	Above WT
27.23	162.3	79.48	0.341	0.06	1.63	1.63	47.65	0.44	1.99	0.80	60.97	1.89	Sand	Sand	Sand	60.97	1.89	1.18	72.06	0.11	0.32	0.94	FALSE	0.00	Above WT
27.40	162.1	81.39	0.402	0.06	1.64	1.64	48.51	0.50	2.01	0.80	62.24	1.91	Sand	Sand	Sand	62.24	1.91	1.20	74.79	0.12	0.32	0.94	FALSE	0.00	Above WT
27.56	161.9	83.43	0.442	0.06	1.65	1.65	49.45	0.54	2.02	0.79	63.62	1.92	Sand	Sand	Sand	63.62	1.92	1.21	76.83	0.12	0.32	0.94	FALSE	0.00	Above WT
27.72	161.8	88.01	0.412	0.06	1.66	1.66	51.92	0.48	1.97	0.79	66.92	1.87	Sand	Sand	Sand	66.92	1.87	1.17	77.99	0.12	0.32	0.94	FALSE	0.00	Above WT
27.89	161.6	97.83	0.481	0.06	1.67	1.67	57.46	0.50	1.94	0.79	74.16	1.84	Sand	Sand	Sand	74.16	1.84	1.14	84.61	0.14	0.32	0.93	FALSE	0.00	Above WT
28.05	161.5	107.07	0.535	0.06	1.68	1.68	62.62	0.51	1.91	0.79	80.93	1.82	Sand	Sand	Sand	80.93	1.82	1.12	90.50	0.15	0.32	0.93	FALSE	0.00	Above WT

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Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
28.22	161.3	113.26	0.432	0.06	1.69	1.69	65.89	0.39	1.84	0.78	85.35	1.74	Sand	Sand	Sand	85.35	1.74	1.06	90.75	0.15	0.32	0.93	FALSE	0.00	Above WT
28.36	161.1	110.23	0.439	0.06	1.70	1.70	63.73	0.40	1.86	0.78	82.83	1.76	Sand	Sand	Sand	82.83	1.76	1.08	89.23	0.15	0.32	0.93	FALSE	0.00	Above WT
28.54	161.0	96.96	0.514	0.06	1.71	1.71	55.62	0.54	1.97	0.78	72.66	1.87	Sand	Sand	Sand	72.66	1.87	1.16	84.37	0.14	0.32	0.93	FALSE	0.00	Above WT
28.71	160.6	80.57	0.641	0.06	1.72	1.72	45.77	0.81	2.13	0.78	60.20	2.03	Sand	Sand	Sand	60.20	2.03	1.35	81.04	0.13	0.32	0.93	FALSE	0.00	Above WT
28.87	160.6	69.91	0.753	0.06	1.73	1.73	39.36	1.10	2.26	0.77	52.09	2.16	Sand	Sand	Sand	52.09	2.16	1.58	82.10	0.13	0.32	0.93	FALSE	0.00	Above WT
29.04	160.5	93.68	0.789	0.06	1.74	1.74	52.76	0.86	2.09	0.77	69.59	1.99	Sand	Sand	Sand	69.59	1.99	1.29	90.00	0.15	0.32	0.93	FALSE	0.00	Above WT
29.20	160.3	117.72	0.610	0.06	1.75	1.75	66.19	0.53	1.90	0.77	87.21	1.80	Sand	Sand	Sand	87.21	1.80	1.10	96.23	0.16	0.31	0.93	FALSE	0.00	Above WT
29.36	160.1	129.65	0.555	0.06	1.76	1.76	72.60	0.43	1.82	0.77	95.79	1.72	Sand	Sand	Sand	95.79	1.72	1.05	100.57	0.17	0.31	0.93	FALSE	0.00	Above WT
29.53	160.0	145.83	0.649	0.06	1.77	1.77	81.31	0.45	1.79	0.77	107.43	1.68	Sand	Sand	Sand	107.43	1.68	1.03	110.28	0.20	0.31	0.93	FALSE	0.00	Above WT
29.69	159.8	160.35	0.693	0.06	1.78	1.78	89.01	0.44	1.75	0.76	117.81	1.64	Sand	Sand	Sand	117.81	1.64	1.00	117.55	0.23	0.31	0.93	FALSE	0.00	Above WT
29.86	159.6	157.54	0.735	0.06	1.79	1.79	86.93	0.47	1.77	0.76	115.41	1.67	Sand	Sand	Sand	115.41	1.67	1.02	117.23	0.23	0.31	0.93	FALSE	0.00	Above WT
30.02	159.5	160.29	0.855	0.06	1.80	1.80	87.99	0.54	1.80	0.76	117.11	1.69	Sand	Sand	Sand	117.11	1.69	1.03	121.07	0.25	0.31	0.93	FALSE	0.00	Above WT
30.18	159.3	173.30	0.998	0.06	1.81	1.81	94.70	0.58	1.79	0.76	126.28	1.69	Sand	Sand	Sand	126.28	1.69	1.03	129.88	0.28	0.31	0.93	FALSE	0.00	Above WT
30.35	159.2	190.14	1.161	0.06	1.82	1.82	103.42	0.62	1.77	0.76	138.17	1.67	Sand	Sand	Sand	138.17	1.67	1.02	140.53	0.34	0.31	0.93	FALSE	0.00	Above WT
30.51	159.0	192.78	1.189	0.06	1.83	1.83	104.31	0.62	1.77	0.75	139.72	1.67	Sand	Sand	Sand	139.72	1.67	1.02	141.99	0.35	0.31	0.93	FALSE	0.00	Above WT
30.68	158.8	188.79	1.184	0.06	1.84	1.84	101.56	0.63	1.78	0.75	136.45	1.68	Sand	Sand	Sand	136.45	1.68	1.02	139.86	0.33	0.31	0.92	FALSE	0.00	Above WT
30.84	158.7	177.30	1.278	0.06	1.85	1.85	94.82	0.73	1.84	0.75	127.81	1.74	Sand	Sand	Sand	127.81	1.74	1.07	136.17	0.31	0.31	0.92	FALSE	0.00	Above WT
31.00	158.5	186.72	1.448	0.06	1.86	1.86	99.39	0.78	1.85	0.75	134.25	1.74	Sand	Sand	Sand	134.25	1.74	1.07	143.33	0.35	0.31	0.92	FALSE	0.00	Above WT
31.17	158.3	194.41	1.546	0.06	1.87	1.87	102.95	0.80	1.84	0.75	139.40	1.74	Sand	Sand	Sand	139.40	1.74	1.06	148.29	0.38	0.31	0.92	FALSE	0.00	Above WT
31.33	158.2	195.99	1.393	0.06	1.88	1.88	103.26	0.72	1.81	0.74	140.17	1.71	Sand	Sand	Sand	140.17	1.71	1.04	146.01	0.37	0.31	0.92	FALSE	0.00	Above WT
31.50	158.0	185.69	0.981	0.06	1.89	1.89	97.25	0.53	1.76	0.74	132.45	1.65	Sand	Sand	Sand	132.45	1.65	1.00	132.66	0.30	0.31	0.92	FALSE	0.00	Above WT
31.66	157.8	184.10	1.179	0.06	1.90	1.90	95.92	0.65	1.81	0.74	130.98	1.70	Sand	Sand	Sand	130.98	1.70	1.04	136.02	0.31	0.31	0.92	FALSE	0.00	Above WT
31.82	157.7	194.72	1.307	0.06	1.91	1.91	100.99	0.68	1.80	0.74	138.19	1.69	Sand	Sand	Sand	138.19	1.69	1.03	142.93	0.35	0.31	0.91	FALSE	0.00	Above WT
31.99	157.5	217.25	1.478	0.06	1.92	1.92	112.19	0.69	1.77	0.74	153.77	1.66	Sand	Sand	Sand	153.77	1.66	1.01	155.60	0.43	0.31	0.91	FALSE	0.00	Above WT
32.15	157.4	212.02	1.392	0.06	1.93	1.93	108.91	0.66	1.77	0.73	149.69	1.66	Sand	Sand	Sand	149.69	1.66	1.01	151.40	0.40	0.31	0.91	FALSE	0.00	Above WT
32.32	157.2	208.66	1.419	0.06	1.94	1.94	106.60	0.69	1.79	0.73	146.93	1.68	Sand	Sand	Sand	146.93	1.68	1.02	150.25	0.40	0.31	0.91	FALSE	0.00	Above WT
32.48	157.0	211.24	1.354	0.06	1.95	1.95	107.39	0.65	1.77	0.73	148.38	1.66	Sand	Sand	Sand	148.38	1.66	1.01	149.71	0.39	0.31	0.91	FALSE	0.00	Above WT
32.64	156.9	212.45	1.306	0.06	1.96	1.96	107.48	0.62	1.76	0.73	148.86	1.65	Sand	Sand	Sand	148.86	1.65	1.00	148.91	0.39	0.31	0.91	FALSE	0.00	Above WT
32.81	156.7	218.76	1.300	0.06	1.97	1.97	110.12	0.60	1.74	0.73	152.89	1.63	Sand	Sand	Sand	152.89	1.63	1.00	152.89	0.41	0.31	0.91	FALSE	0.00	Above WT
32.97	156.5	216.65	1.305	0.06	1.98	1.98	108.52	0.61	1.75	0.73	151.05	1.64	Sand	Sand	Sand	151.05	1.64	1.00	151.05	0.40	0.31	0.91	FALSE	0.00	Above WT
33.14	156.4	203.81	1.316	0.06	1.99	1.99	101.50	0.65	1.79	0.72	141.73	1.68	Sand	Sand	Sand	141.73	1.68	1.02	144.75	0.36	0.31	0.90	FALSE	0.00	Above WT
33.30	156.2	182.35	1.336	0.06	2.00	2.00	90.27	0.74	1.87	0.72	126.50	1.75	Sand	Sand	Sand	126.50	1.75	1.07	135.47	0.31	0.31	0.90	FALSE	0.00	Above WT
33.46	156.0	171.83	1.326	0.06	2.01	2.01	84.59	0.78	1.90	0.72	118.92	1.78	Sand	Sand	Sand	118.92	1.78	1.10	130.24	0.29	0.30	0.90	FALSE	0.00	Above WT
33.63	155.9	173.05	1.310	0.06	2.02	2.02	84.76	0.77	1.90	0.72	119.46	1.78	Sand	Sand	Sand	119.46	1.78	1.09	130.27	0.29	0.30	0.90	FALSE	0.00	Above WT
33.79	155.7	179.05	1.224	0.06	2.03	2.03	87.32	0.69	1.86	0.72	123.31	1.74	Sand	Sand	Sand	123.31	1.74	1.06	131.24	0.29	0.30	0.90	FALSE	0.00	Above WT
33.96	155.5	182.84	1.169	0.06	2.04	2.04	88.73	0.65	1.84	0.71	125.60	1.72	Sand	Sand	Sand	125.60	1.72	1.05	131.64	0.29	0.30	0.90	FALSE	0.00	Above WT
34.12	155.4	187.23	1.128	0.06	2.05	2.05	90.46	0.61	1.82	0.71	128.32	1.69	Sand	Sand	Sand	128.32	1.69	1.03	132.50	0.30	0.30	0.90	FALSE	0.00	Above WT
34.28	155.2	196.73	1.209	0.06	2.06	2.06	94.65	0.62	1.81	0.71	134.51	1.68	Sand	Sand	Sand	134.51	1.68	1.02	137.86	0.32	0.30	0.89	FALSE	0.00	Above WT
34.45	155.1	219.62	1.309	0.06	2.07	2.07	105.25	0.60	1.76	0.71	149.79	1.64	Sand	Sand	Sand	149.79	1.64	1.00	149.79	0.39	0.30	0.89	FALSE	0.00	Above WT
34.61	154.9	239.94	1.441	0.06	2.08	2.08	114.54	0.61	1.73	0.71	163.27	1.61	Sand	Sand	Sand	163.27	1.61	1.00	163.27	0.48	0.30	0.89	FALSE	0.00	Above WT
34.78	154.7	242.84	1.325	0.06	2.09	2.09	115.37	0.55	1.70	0.71	164.84	1.58	Sand	Sand	Sand	164.84	1.58	1.00	164.84	0.50	0.30	0.89	FALSE	0.00	Above WT
34.94	154.6	235.52	1.350	0.06	2.10	2.10	111.34	0.58	1.73	0.70	159.50	1.60	Sand	Sand	Sand	159.50	1.60	1.00	159.50	0.46	0.30	0.89	FALSE	0.00	Above WT
35.10	154.4	216.06	1.161	0.06	2.11	2.11	101.59	0.54	1.75	0.70	145.99	1.62	Sand	Sand	Sand	145.99	1.62	1.00	145.99	0.37	0.30	0.89	FALSE	0.00	Above WT
35.27	154.2	173.02	1.011	0.06	2.12	2.12	80.76	0.59	1.85	0.70	116.63	1.72	Sand	Sand	Sand	116.63	1.72	1.05	122.49	0.25	0.30	0.89	FALSE	0.00	Above WT
35.43	154.1	115.14	0.870	0.06	2.13	2.13	53.16	0.77	2.07	0.70	77.44	1.93	Sand	Sand	Sand	77.44	1.93	1.22	94.32	0.16	0.30	0.89	FALSE	0.00	Above WT
35.60	153.9	62.64	1.041	0.06	2.14	2.14	28.33	1.72	2.49	0.70	42.03	2.35	Sand	Sand	Sand	42.03	2.35	2.12	89.26	0.15	0.30	0.88	FALSE	0.00	Above WT
35.76	153.7	37.59	1.172	0.06	2.15	2.15	16.52	3.31	2.85	Clay	Clay	Clay	Clay	Clay	Clay	16.52	2.85	5.19	85.66	0.14	0.30	0.88	FALSE	0.00	Above WT
35.93	153.6	25.47	1.039	0.06	2.16	2.16	10.81	4.46	3.07	Clay	Clay	Clay	Clay	Clay	Clay	10.81	3.07	7.56	81.79	0.13	0.30	0.88	FALSE	0.00	Above WT
36.09	153.4	28.55	0.890	0.06	2.17	2.17	12.18	3.37	2.96	Clay	Clay	Clay	Clay	Clay	Clay	12.18	2.96	6.27	76.42	0.12	0.30	0.88	FALSE	0.00	Above WT
36.25	153.3	73.04	1.050	0.06	2.18	2.18	32.58	1.48	2.40	0.69	48.56	2.26	Sand	Sand	Sand	48.56	2.26	1.83	88.95	0.15	0.30	0.88	FALSE	0.00	Above WT
36.42	153.1	116.43	1.043	0.06	2.19	2.19	52.28	0.91	2.11	0.69	77.23	1.97	Sand	Sand	Sand	77.23	1.97	1.27	97.89	0.17	0.30	0.88	FALSE	0.00	Above WT
36.58	152.9	129.01	1.021	0.06	2.19	2.19	57.76	0.80	2.05	0.69	85.39	1.91	Sand	Sand	Sand	85.39	1.91	1.19	102.04	0.18	0.30	0.88	FALSE	0.00	Above WT
36.75	152.8	137.70	1.120	0.06	2.21	2.21	61.45	0.83	2.03	0.69	90.93	1.89	Sand	Sand	Sand	90.93	1.89	1.18	107.38	0.20	0.30	0.87	FALSE	0.00	Above WT
36.91	152.6	130.05	1.044	0.06	2.21	2.21	57.72	0.82	2.05	0.69	85.69	1.91	Sand	Sand	Sand	85.69	1.91	1.20	102.61	0.18	0.30	0.87	FALSE	0.00	Above WT
37.07	152.4	102.61	1.043	0.06	2.22	2.22	45.13	1.04	2.20	0.68	67.47	2.05	Sand	Sand	Sand	67.47	2.05	1.38	93.00	0.15	0.29	0.87	FALSE	0.00	Above WT
37.24	152.3	69.95	1.119	0.06	2.23	2.23	30.31	1.65	2.45	0.68	45.89	2.31	Sand	Sand	Sand	45.89	2.31	1.98	90.98	0.15	0.29	0.87	FALSE	0.00	Above WT
37.40	152.1	50.15	1.382	0.06	2.24	2.24	21.35	2.88	2.72	Clay	Clay	Clay	Clay	Clay	Clay	21.35	2.72	4.15	88.66	0.14	0.29	0.87	FALSE	0.00	Above WT
37.57	151.9	36.99	1.429	0.06	2.25	2.25	15.41	4.11	2.93	Clay	Clay	Clay	Clay	Clay	Clay	15.41	2.93	5.98	92.10	0.15	0.29	0.87	FALSE	0.00	Above WT
37.73	151.8	27.34	1.294	0.06	2.26	2.26	11.08	5.16	3.10	Clay	Clay	Clay	Clay	Clay	Clay	11.08	3.10	7.94	87.98	0.14	0.29	0.87	FALSE	0.00	Above WT
37.89	151.6	23.53	1.074	0.06	2.27	2.27	9.35	5.05	3.15	Clay	Clay	Clay	Clay	Clay	Clay	9.35	3.15	8.62	80.59	0.13	0.29	0.87	FALSE	0.00	Above WT
38.06	151.4	22.15	1.071	0.06	2.28	2.28	8.70	5.39	3.20	Clay	Clay	Clay	Clay	Clay	Clay	8.70	3.20	9.19	79.94	0.13	0.29	0.86	FALSE	0.00	Above WT
38.22	151.3	23.44	1.033	0.06	2.29	2.29	9.22	4.88	3.15	Clay	Clay	Clay	Clay	Clay	Clay	9.22	3.15	8.56	78.96	0.13	0.29	0.86	FALSE	0.00	Above WT
38.39	151.1	23.34	1.161	0.06	2.30	2.30	9.13	5.52	3.19	Clay	Clay	Clay	Clay	Clay	Clay	9.13	3.19	9.05	82.62	0.13	0.29	0.86	FALSE	0.00	Above WT
38.55	151.0	25.18	1.253	0.06	2.31	2.31	9.89	5.48	3.16	Clay	Clay	Clay	Clay	Clay	Clay	9.89	3.16	8.65	85.56	0.14	0.29	0.86	FALSE	0.00	Above WT
38.71	150.8	31.39	1.301	0.06	2.32	2.32	12.52	4.48	3.02	Clay	Clay	Clay	Clay	Clay	Clay	12.52	3.02	6.99	87.43	0.14	0.29	0.86	FALSE	0.00	Above WT
38.88	150.6	36.99	1.435	0.06	2.33	2.33	14.86	4.14	2.94	Clay	Clay	Clay	Clay	Clay	Clay	14.86	2.94	6.12	90.95	0.15	0.29	0.86	FALSE	0.00	Above WT
39.04	150.5	42.59	1.406	0.06	2.34	2.34	17.18	3.49	2.85	Clay	Clay	Clay	Clay	Clay	Clay	17.18	2.85	5.20	89.28	0.15	0.29	0.86	FALSE	0.00	Above WT
39.21	150.3	53.71	1.190	0.06	2.35	2.35	21.83	2.32	2.66	Clay	Clay	Clay	Clay	Clay	Clay	21.83	2.66	3.69	80.45	0.13	0.29	0.85	FALSE	0.00	Above WT
39.37	150.1	72.13	1.031	0.06	2.36	2.36	29.54	1.48	2.44	0.66	46.02	2.28	Sand	Sand	Sand	46.02	2.28	1.89	86.76	0.14	0.29	0.85	FALSE	0.00	Above WT
39.53	150.0	96.12	1.023	0.06	2.37	2.37	39.53	1.09	2.26	0.66	61.20	2.10	Sand	Sand	Sand	61.20	2.10	1.46	89.17	0.15	0.29	0.85	FALSE	0.00	Above WT
39.70	149.8	112.50	1.319	0.06	2.38	2.38	46.23	1.20	2.22	0.66	71.48	2.07	Sand	Sand	Sand	71.48	2.07	1.41	100.61	0.17	0.29	0.85	FALSE	0.00	Above WT
39.86	149.6	113.35	1.446	0.06	2.39	2.39	46.40	1.30	2.24	0.66	71.87	2.09	Sand	Sand	Sand	71.87	2.09	1.44	103.80	0.18	0.29	0.85	FALSE	0.00	Above WT
40.03	149.5	86.19	1.658	0.06	2.40	2.40	34.89	2.22	2.48	0.66	54.53	2.34	Sand	Sand	Sand	54.53	2.34	2.07	112.85	0.21	0.29	0.85	FALSE	0.00	Above WT
40.19	149.3	47.64	1.954	0.06	2.41	2.41	18.76	4.32	2.88	Clay	Clay	Clay	Clay	Clay	Clay	18.76	2.88	5.46	102.47	0.18	0.29	0.85	FALSE	0.00	Above WT
40.35	149.2	41.25	1.737	0.06	2.42	2.42	16.04	4.47	2.94	Clay	Clay	Clay	Clay	Clay	Clay	16.04	2.94	6.07	97.43	0.17	0.29	0.85	FALSE	0.00	Above WT
40.52	149.0	52.39	1.711	0.06	2.43	2.43	20.55	3.43	2.78	Clay	Clay	Clay	Clay	Clay	Clay	20.55	2.78	4.62	95.00	0.16	0.29	0.84	FALSE	0.00	Above WT
40.68	148.8	59.37	1.640	0.06	2.44	2.44	23.32	2.88	2.69	Clay	Clay	Clay	Clay	Clay	Clay	23.32	2.69	3.93	91.63	0.15	0.28	0.84	FALSE	0.00	Above WT
40.85	148.7	68.10	1.667	0.06	2.45	2.45	26.78	2.54	2.61	Clay	Clay	Clay	Clay	Clay	Clay	26.78	2.61	3.39	90.69	0.15	0.28	0.84	FALSE	0.00	Above WT
41.01	148.5	90.06	1.861	0.06	2.46	2.46	35.60	2.12	2.46	0.65	56.30	2.31	Sand	Sand	Sand	56.30	2.31	1.99	112.14	0.21	0.28	0.84	FALSE	0.00	Above WT
41.17	148.3	119.21	2.042	0.06	2.47	2.47	47.26	1.75	2.32	0.65	74.38	2.17	Sand	Sand	Sand	74.38	2.17	1.59	118.20	0.23	0.28	0.84	FALSE	0.00	Above WT
41.34	148.2	131.32	2.175	0.06	2.48	2.48	51.94	1.69	2.27	0.65	81.76	2.13	Sand	Sand	Sand	81.76	2.13	1.50	122.98	0.25	0.28	0.84	FALSE	0.00	Above WT
41.50	148.0	134.09	2.302	0.06	2.49	2.49	52.85	1.75	2.28	0.65	83.33	2.13	Sand	Sand	Sand	83.33	2.13	1.51	126.08	0.27	0.28	0.84	FALSE	0.00	Above WT
41.67	147.8	131.35	2.156	0.06	2.50	2.50	51.54	1.67	2.27	0.64	81.46	2.12	Sand	Sand	Sand	81.46	2.12	1.50	122.31	0.25	0.28	0.83	FALSE	0.00	Above WT
41.83	147.7	120.95	1.978	0.06	2.51	2.51	47.19	1.67	2.30	0.64	74.86	2.15	Sand	Sand	Sand	74.86	2.15	1.56	116.45	0.23	0.28	0.83	FALSE	0.00	Above WT
41.99	147.5	112.12	1.700	0.06	2.52	2.52	43.50	1.55	2.31	0.64	69.27	2.16	Sand	Sand	Sand	69.27	2.16	1.56	108.32	0.20	0.28	0.83	FALSE	0.00	Above WT
42.16	147.3	88.20	1.702	0.06	2.53	2.53	33.87	1.99	2.46	0.64	54.38	2.31	Sand	Sand	Sand	54.38	2.31	1.97	106.87	0.19	0.28	0.83	FALSE	0.00	Above WT

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Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
42.32	147.2	61.47	1.856	0.06	2.54	2.54	23.21	3.15	2.72	Clay	Clay	Clay	Clay	Clay	23.21	2.72	4.12	95.61	0.16	0.28	0.83	FALSE	0.00	Above WT
42.49	147.0	43.99	1.602	0.06	2.55	2.55	16.26	3.87	2.89	Clay	Clay	Clay	Clay	Clay	16.26	2.89	5.63	91.51	0.15	0.28	0.83	FALSE	0.00	Above WT
42.65	146.9	45.10	1.433	0.06	2.56	2.56	16.62	3.37	2.85	Clay	Clay	Clay	Clay	Clay	16.62	2.85	5.21	86.61	0.14	0.28	0.83	FALSE	0.00	Above WT
42.81	146.7	78.67	1.402	0.06	2.57	2.57	29.63	1.64	2.49	0.64	48.13	2.32	Sand	Sand	48.13	2.32	2.03	97.64	0.17	0.28	0.83	FALSE	0.00	Above WT
42.98	146.5	88.69	1.370	0.06	2.58	2.58	33.39	1.59	2.41	0.64	54.16	2.24	Sand	Sand	54.16	2.24	1.78	96.49	0.16	0.28	0.82	FALSE	0.00	Above WT
43.14	146.4	91.21	1.416	0.06	2.59	2.59	34.24	1.60	2.40	0.63	55.59	2.24	Sand	Sand	55.59	2.24	1.76	97.91	0.17	0.28	0.82	FALSE	0.00	Above WT
43.31	146.2	81.54	1.360	0.06	2.60	2.60	30.38	1.72	2.46	0.63	49.60	2.30	Sand	Sand	49.60	2.30	1.93	95.94	0.16	0.28	0.82	FALSE	0.00	Above WT
43.47	146.0	74.85	1.555	0.06	2.61	2.61	27.70	2.15	2.55	0.63	45.45	2.39	Sand	Sand	45.45	2.39	2.26	102.69	0.18	0.28	0.82	FALSE	0.00	Above WT
43.64	145.9	54.81	1.837	0.06	2.62	2.62	19.93	3.52	2.80	Clay	Clay	Clay	Clay	Clay	19.93	2.80	4.77	95.09	0.16	0.28	0.82	FALSE	0.00	Above WT
43.80	145.7	30.37	1.345	0.06	2.63	2.63	10.56	4.85	3.10	Clay	Clay	Clay	Clay	Clay	10.56	3.10	7.94	83.82	0.13	0.28	0.82	FALSE	0.00	Above WT
43.96	145.5	29.02	1.039	0.06	2.64	2.64	10.00	3.94	3.07	Clay	Clay	Clay	Clay	Clay	10.00	3.07	7.50	75.01	0.12	0.28	0.82	FALSE	0.00	Above WT
44.13	145.4	133.57	0.966	0.06	2.65	2.65	49.45	0.74	2.08	0.63	80.49	1.91	Sand	Sand	80.49	1.91	1.19	96.11	0.16	0.28	0.81	FALSE	0.00	Above WT
44.29	145.2	136.13	0.825	0.06	2.66	2.66	50.23	0.62	2.04	0.63	81.89	1.86	Sand	Sand	81.89	1.86	1.15	94.19	0.16	0.27	0.81	FALSE	0.00	Above WT
44.46	145.0	109.83	1.069	0.06	2.67	2.67	40.17	1.00	2.23	0.62	65.94	2.05	Sand	Sand	65.94	2.05	1.37	90.62	0.15	0.27	0.81	FALSE	0.00	Above WT
44.62	144.9	103.40	1.056	0.06	2.68	2.68	37.62	1.05	2.26	0.62	61.97	2.09	Sand	Sand	61.97	2.09	1.43	88.68	0.14	0.27	0.81	FALSE	0.00	Above WT
44.78	144.7	101.07	1.179	0.06	2.69	2.69	36.62	1.20	2.31	0.62	60.46	2.13	Sand	Sand	60.46	2.13	1.51	91.42	0.15	0.27	0.81	FALSE	0.00	Above WT
44.95	144.6	90.75	0.965	0.06	2.70	2.70	32.65	1.10	2.33	0.62	54.19	2.14	Sand	Sand	54.19	2.14	1.54	83.57	0.13	0.27	0.81	FALSE	0.00	Above WT
45.11	144.4	82.58	1.540	0.06	2.71	2.71	29.51	1.93	2.50	0.62	49.22	2.33	Sand	Sand	49.22	2.33	2.05	100.73	0.18	0.27	0.81	FALSE	0.00	Above WT
45.28	144.2	72.27	1.819	0.06	2.72	2.72	25.60	2.61	2.63	Clay	Clay	Clay	Clay	Clay	25.60	2.63	3.53	90.47	0.15	0.27	0.81	FALSE	0.00	Above WT
45.44	144.1	86.09	1.905	0.06	2.73	2.73	30.58	2.28	2.54	0.62	51.13	2.37	Sand	Sand	51.13	2.37	2.18	111.28	0.21	0.27	0.80	FALSE	0.00	Above WT
45.60	143.9	144.30	1.880	0.06	2.74	2.74	51.74	1.33	2.21	0.62	85.54	2.04	Sand	Sand	85.54	2.04	1.36	116.22	0.23	0.27	0.80	FALSE	0.00	Above WT
45.77	143.7	177.64	1.551	0.06	2.75	2.75	63.69	0.89	2.03	0.62	105.11	1.86	Sand	Sand	105.11	1.86	1.15	121.27	0.25	0.27	0.80	FALSE	0.00	Above WT
45.93	143.6	204.50	1.817	0.06	2.76	2.76	73.21	0.90	1.99	0.61	120.80	1.82	Sand	Sand	120.80	1.82	1.12	135.31	0.31	0.27	0.80	FALSE	0.00	Above WT
46.10	143.4	222.79	2.092	0.06	2.77	2.77	79.55	0.95	1.97	0.61	131.36	1.81	Sand	Sand	131.36	1.81	1.11	145.96	0.37	0.27	0.80	FALSE	0.00	Above WT
46.26	143.2	248.86	2.316	0.06	2.78	2.78	88.66	0.94	1.93	0.61	146.47	1.77	Sand	Sand	146.47	1.77	1.08	158.77	0.45	0.27	0.80	FALSE	0.00	Above WT
46.42	143.1	251.05	2.311	0.06	2.79	2.79	89.14	0.93	1.93	0.61	147.51	1.76	Sand	Sand	147.51	1.76	1.08	159.33	0.46	0.27	0.80	FALSE	0.00	Above WT
46.59	142.9	246.96	2.293	0.06	2.80	2.80	87.35	0.94	1.94	0.61	144.84	1.77	Sand	Sand	144.84	1.77	1.09	157.30	0.44	0.27	0.79	FALSE	0.00	Above WT
46.75	142.8	250.04	2.303	0.06	2.81	2.81	88.14	0.93	1.93	0.61	146.40	1.77	Sand	Sand	146.40	1.77	1.08	158.39	0.45	0.27	0.79	FALSE	0.00	Above WT
46.92	142.6	237.36	2.330	0.06	2.82	2.82	83.31	0.99	1.97	0.61	138.72	1.80	Sand	Sand	138.72	1.80	1.11	153.65	0.42	0.27	0.79	FALSE	0.00	Above WT
47.08	142.4	230.56	2.421	0.06	2.82	2.82	80.62	1.06	2.00	0.61	134.52	1.83	Sand	Sand	134.52	1.83	1.13	152.01	0.41	0.27	0.79	FALSE	0.00	Above WT
47.24	142.3	236.26	2.408	0.06	2.83	2.83	82.35	1.03	1.98	0.61	137.61	1.81	Sand	Sand	137.61	1.81	1.12	153.81	0.42	0.27	0.79	FALSE	0.00	Above WT
47.41	142.1	232.93	2.365	0.06	2.84	2.84	80.88	1.03	1.99	0.60	135.42	1.82	Sand	Sand	135.42	1.82	1.12	151.78	0.41	0.27	0.79	FALSE	0.00	Above WT
47.57	141.9	215.45	2.088	0.06	2.85	2.85	74.49	0.98	2.01	0.60	125.05	1.83	Sand	Sand	125.05	1.83	1.13	141.34	0.34	0.27	0.79	FALSE	0.00	Above WT
47.74	141.8	185.71	1.520	0.06	2.86	2.86	63.83	0.83	2.02	0.60	107.60	1.84	Sand	Sand	107.60	1.84	1.13	121.93	0.25	0.27	0.79	FALSE	0.00	Above WT
47.90	141.6	150.96	1.111	0.06	2.87	2.87	51.53	0.75	2.07	0.60	87.32	1.88	Sand	Sand	87.32	1.88	1.17	102.27	0.18	0.27	0.78	FALSE	0.00	Above WT
48.06	141.4	125.64	0.876	0.06	2.88	2.88	42.57	0.71	2.13	0.60	72.55	1.93	Sand	Sand	72.55	1.93	1.22	88.74	0.14	0.26	0.78	FALSE	0.00	Above WT
48.23	141.3	115.08	0.868	0.06	2.89	2.89	38.77	0.77	2.18	0.60	66.34	1.99	Sand	Sand	66.34	1.99	1.28	85.09	0.14	0.26	0.78	FALSE	0.00	Above WT
48.39	141.1	132.43	1.070	0.06	2.90	2.90	44.61	0.83	2.15	0.60	76.21	1.95	Sand	Sand	76.21	1.95	1.24	94.75	0.16	0.26	0.78	FALSE	0.00	Above WT
48.56	140.9	163.36	1.534	0.06	2.91	2.91	55.07	0.96	2.10	0.60	93.85	1.92	Sand	Sand	93.85	1.92	1.21	113.33	0.22	0.26	0.78	FALSE	0.00	Above WT
48.72	140.8	193.46	1.860	0.06	2.92	2.92	65.18	0.98	2.05	0.60	110.95	1.87	Sand	Sand	110.95	1.87	1.16	128.81	0.28	0.26	0.78	FALSE	0.00	Above WT
48.88	140.6	196.44	1.991	0.06	2.93	2.93	65.98	1.03	2.06	0.60	112.48	1.88	Sand	Sand	112.48	1.88	1.17	131.61	0.29	0.26	0.78	FALSE	0.00	Above WT
49.05	140.5	185.48	2.238	0.06	2.94	2.94	62.02	1.23	2.13	0.59	106.02	1.95	Sand	Sand	106.02	1.95	1.24	131.34	0.29	0.26	0.77	FALSE	0.00	Above WT
49.21	140.3	205.21	2.488	0.06	2.95	2.95	68.50	1.23	2.09	0.59	117.11	1.92	Sand	Sand	117.11	1.92	1.21	141.29	0.34	0.26	0.77	FALSE	0.00	Above WT
49.38	140.1	220.18	2.710	0.06	2.96	2.96	73.31	1.25	2.08	0.59	125.43	1.90	Sand	Sand	125.43	1.90	1.19	149.23	0.39	0.26	0.77	FALSE	0.00	Above WT
49.54	140.0	238.45	2.431	0.06	2.97	2.97	79.22	1.03	2.00	0.59	135.62	1.82	Sand	Sand	135.62	1.82	1.12	152.08	0.41	0.26	0.77	FALSE	0.00	Above WT
49.70	139.8	247.12	2.434	0.06	2.98	2.98	81.87	1.00	1.98	0.59	140.33	1.80	Sand	Sand	140.33	1.80	1.11	155.15	0.43	0.26	0.77	FALSE	0.00	Above WT
49.87	139.6	264.68	2.351	0.06	2.99	2.99	87.46	0.90	1.93	0.59	150.04	1.75	Sand	Sand	150.04	1.75	1.07	160.45	0.46	0.26	0.77	FALSE	0.00	Above WT
50.03	139.5	277.97	2.370	0.06	3.00	3.00	91.60	0.86	1.90	0.59	157.32	1.72	Sand	Sand	157.32	1.72	1.05	165.33	0.50	0.26	0.77	FALSE	0.00	Above WT
50.20	139.3	271.20	2.422	0.06	3.01	3.01	89.04	0.90	1.92	0.59	153.23	1.74	Sand	Sand	153.23	1.74	1.07	163.31	0.49	0.26	0.77	FALSE	0.00	Above WT
50.36	139.1	257.01	2.250	0.06	3.02	3.02	84.06	0.89	1.94	0.59	144.98	1.75	Sand	Sand	144.98	1.75	1.07	155.73	0.43	0.26	0.76	FALSE	0.00	Above WT
50.52	139.0	236.66	2.014	0.06	3.03	3.03	77.07	0.86	1.96	0.59	133.29	1.77	Sand	Sand	133.29	1.77	1.09	144.97	0.36	0.26	0.76	FALSE	0.00	Above WT
50.69	138.8	217.90	1.947	0.06	3.04	3.04	70.64	0.91	2.00	0.58	122.52	1.82	Sand	Sand	122.52	1.82	1.12	136.97	0.32	0.26	0.76	FALSE	0.00	Above WT
50.85	138.7	199.66	1.838	0.06	3.05	3.05	64.44	0.94	2.04	0.58	112.09	1.85	Sand	Sand	112.09	1.85	1.15	128.68	0.28	0.26	0.76	FALSE	0.00	Above WT
51.02	138.5	189.03	1.860	0.06	3.06	3.06	60.75	1.00	2.08	0.58	105.94	1.89	Sand	Sand	105.94	1.89	1.18	125.08	0.26	0.26	0.76	FALSE	0.00	Above WT
51.18	138.3	188.57	1.961	0.06	3.07	3.07	60.41	1.06	2.10	0.58	105.52	1.91	Sand	Sand	105.52	1.91	1.20	126.26	0.27	0.26	0.76	FALSE	0.00	Above WT
51.35	138.2	192.55	1.764	0.06	3.08	3.08	61.50	0.93	2.06	0.58	107.57	1.87	Sand	Sand	107.57	1.87	1.16	124.62	0.26	0.26	0.76	FALSE	0.00	Above WT
51.51	138.0	186.15	1.437	0.06	3.09	3.09	59.23	0.79	2.03	0.58	103.83	1.83	Sand	Sand	103.83	1.83	1.13	117.41	0.23	0.26	0.75	FALSE	0.00	Above WT
51.67	137.8	174.51	1.275	0.06	3.10	3.10	55.29	0.74	2.04	0.58	97.19	1.84	Sand	Sand	97.19	1.84	1.14	110.57	0.21	0.25	0.75	FALSE	0.00	Above WT
51.84	137.7	155.44	1.097	0.06	3.11	3.11	48.97	0.72	2.08	0.58	86.42	1.87	Sand	Sand	86.42	1.87	1.17	100.71	0.17	0.25	0.75	FALSE	0.00	Above WT
52.00	137.5	117.30	1.234	0.06	3.12	3.12	36.60	1.08	2.28	0.58	65.12	2.08	Sand	Sand	65.12	2.08	1.42	92.16	0.15	0.25	0.75	FALSE	0.00	Above WT
52.17	137.3	86.92	1.378	0.06	3.13	3.13	26.77	1.64	2.50	0.58	48.17	2.29	Sand	Sand	48.17	2.29	1.93	92.76	0.15	0.25	0.75	FALSE	0.00	Above WT
52.33	137.2	66.80	1.511	0.06	3.14	3.14	20.28	2.37	2.69	Clay	Clay	Clay	Clay	Clay	20.28	2.69	3.91	79.22	0.13	0.25	0.75	FALSE	0.00	Above WT
52.49	137.0	57.93	1.793	0.06	3.15	3.15	17.39	3.27	2.83	Clay	Clay	Clay	Clay	Clay	17.39	2.83	5.00	87.01	0.14	0.25	0.75	FALSE	0.00	Above WT
52.66	136.8	46.29	1.464	0.06	3.16	3.16	13.65	3.39	2.92	Clay	Clay	Clay	Clay	Clay	13.65	2.92	5.88	80.27	0.13	0.25	0.75	FALSE	0.00	Above WT
52.82	136.7	77.14	1.344	0.06	3.17	3.17	23.34	1.82	2.57	0.57	42.49	2.36	Sand	Sand	42.49	2.36	2.16	91.97	0.15	0.25	0.74	FALSE	0.00	Above WT
52.99	136.5	187.47	1.359	0.06	3.18	3.18	57.96	0.74	2.02	0.57	103.10	1.82	Sand	Sand	103.10	1.82	1.12	115.46	0.22	0.25	0.74	FALSE	0.00	Above WT
53.15	136.4	231.89	1.540	0.06	3.19	3.19	71.72	0.67	1.92	0.57	127.33	1.72	Sand	Sand	127.33	1.72	1.05	133.96	0.30	0.25	0.74	FALSE	0.00	Above WT
53.31	136.2	233.72	1.869	0.06	3.20	3.20	72.07	0.81	1.97	0.57	128.14	1.77	Sand	Sand	128.14	1.77	1.08	139.02	0.33	0.25	0.74	FALSE	0.00	Above WT
53.48	136.0	223.59	2.050	0.06	3.21	3.21	68.68	0.93	2.02	0.57	122.40	1.82	Sand	Sand	122.40	1.82	1.12	137.54	0.32	0.25	0.74	FALSE	0.00	Above WT
53.64	135.9	212.75	1.774	0.06	3.22	3.22	65.10	0.85	2.02	0.57	116.29	1.81	Sand	Sand	116.29	1.81	1.12	129.87	0.28	0.25	0.74	FALSE	0.00	Above WT
53.81	135.7	187.86	1.485	0.06	3.23	3.23	57.19	0.80	2.05	0.57	102.52	1.84	Sand	Sand	102.52	1.84	1.14	116.79	0.23	0.25	0.74	FALSE	0.00	Above WT
53.97	135.5	151.47	1.160	0.06	3.24	3.24	45.78	0.78	2.12	0.57	82.54	1.91	Sand	Sand	82.54	1.91	1.20	99.01	0.17	0.25	0.73	FALSE	0.00	Above WT
54.13	135.4	113.67	1.204	0.06	3.25	3.25	34.00	1.09	2.31	0.57	61.85	2.10	Sand	Sand	61.85	2.10	1.45	89.70	0.15	0.25	0.73	FALSE	0.00	Above WT
54.30	135.2	67.91	1.618	0.06	3.26	3.26	19.84	2.50	2.71	Clay	Clay	Clay	Clay	Clay	19.84	2.71	4.06	80.60	0.13	0.25	0.73	FALSE	0.00	Above WT
54.46	135.0	36.77	1.543	0.06	3.27	3.27	10.25	4.61	3.10	Clay	Clay	Clay	Clay	Clay	10.25	3.10	7.89	80.94	0.13	0.25	0.73	FALSE	0.00	Above WT
54.63	134.9	27.57	1.024	0.06	3.28	3.28	7.41	4.22	3.19	Clay	Clay	Clay	Clay	Clay	7.41	3.19	9.09	67.34	0.11	0.25	0.73	FALSE	0.00	Above WT
54.79	134.7	57.21	1.147	0.06	3.29	3.29	16.40	2.13	2.74	Clay	Clay	Clay	Clay	Clay	16.40	2.74	4.26	69.85	0.11	0.25	0.73	FALSE	0.00	Above WT
54.95	134.6	93.26	1.351	0.06	3.30	3.30	27.29	1.50	2.47	0.56	50.36	2.25	Sand	Sand	50.36	2.25	1.81	90.98	0.15	0.25	0.73	FALSE	0.00	Above WT
55.12	134.4	109.03	1.172	0.06	3.31	3.31	31.97	1.11	2.34	0.56	58.79	2.12	Sand	Sand	58.79	2.12	1.49	87.66	0.14	0.25	0.73	FALSE	0.00	Above WT
55.28	134.2	123.00	1.357	0.06	3.32	3.32	36.08	1.13	2.30	0.56	66.23	2.08	Sand	Sand	66.23	2.08	1.43	94.48	0.16	0.24	0.72	FALSE	0.00	Above WT
55.45	134.1	151.11	1.507	0.06	3.33	3.33	44.42	1.02	2.20	0.56	81.24	1.99	Sand	Sand	81.24	1.99	1.28	104.14	0.19	0.24	0.72	FALSE	0.00	Above WT
55.61	133.9	165.95	1.755	0.06	3.34	3.34	48.74	1.08	2.18	0.56	89.09	1.97	Sand	Sand	89.09	1.97	1.26	112.50	0.21	0.24	0.72	FALSE	0.00	Above WT
55.77	133.7	162.43	1.630	0.06	3.35	3.35	47.54	1.02	2.17	0.56	87.07	1.96	Sand	Sand	87.07	1.96	1.26	109.30	0.20	0.24	0.72	FALSE	0.00	Above WT
55.94	133.6	134.35	1.799	0.06	3.36	3.36	39.03	1.37	2.32	0.56	71.91	2.11	Sand	Sand	71.91	2.11	1.47	105.75	0.19	0.24	0.72	FALSE	0.00	Above WT
56.10	133.4	88.19	2.382	0.06	3.37	3.37	25.20	2.81	2.66	Clay	Clay	Clay	Clay	Clay	25.20	2.66	3.70	93.19	0.16	0.24	0.72	FALSE	0.00	Above WT
56.27	133.2	46.37	2.411	0.06	3.38	3.38	12.73	5.61	3.08	Clay	Clay	Clay	Clay	Clay	12.73	3.08	7.65	97.36	0.17	0.24	0.72	FALSE	0.00	Above WT

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	CPT-[illegible]246	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
56.43	133.1	34.63	1.942	0.06	3.39	3.39	9.23	6.22	3.21	Clay	Clay	Clay	Clay	Clay	Clay	9.23	3.21	9.44	87.15	0.14	0.24	0.71	FALSE	0.00	Above WT
56.59	132.9	33.16	1.846	0.06	3.40	3.40	8.77	6.20	3.23	Clay	Clay	Clay	Clay	Clay	Clay	8.77	3.23	9.68	84.88	0.14	0.24	0.71	FALSE	0.00	Above WT
56.76	132.7	35.01	1.763	0.06	3.41	3.41	9.28	5.58	3.18	Clay	Clay	Clay	Clay	Clay	Clay	9.28	3.18	9.01	83.61	0.13	0.24	0.71	FALSE	0.00	Above WT
56.92	132.6	34.49	1.729	0.06	3.42	3.42	9.10	5.56	3.19	Clay	Clay	Clay	Clay	Clay	Clay	9.10	3.19	9.09	82.74	0.13	0.24	0.71	FALSE	0.00	Above WT
57.09	132.4	32.44	1.887	0.06	3.43	3.43	8.47	6.50	3.26	Clay	Clay	Clay	Clay	Clay	Clay	8.47	3.26	10.04	85.04	0.14	0.24	0.71	FALSE	0.00	Above WT
57.25	132.3	39.83	2.438	0.06	3.44	3.44	10.60	6.70	3.19	Clay	Clay	Clay	Clay	Clay	Clay	10.60	3.19	9.08	96.24	0.16	0.24	0.71	FALSE	0.00	Above WT
57.41	132.1	61.51	3.605	0.06	3.44	3.44	16.86	6.21	3.01	Clay	Clay	Clay	Clay	Clay	Clay	16.86	3.01	6.90	116.34	0.23	0.24	0.71	FALSE	0.00	Above WT
57.58	131.9	71.02	4.370	0.06	3.45	3.45	19.56	6.47	2.98	Clay	Clay	Clay	Clay	Clay	Clay	19.56	2.98	6.51	127.24	0.27	0.24	0.71	FALSE	0.00	Above WT
57.74	131.8	53.75	3.777	0.06	3.46	3.46	14.51	7.51	3.12	Clay	Clay	Clay	Clay	Clay	Clay	14.51	3.12	8.15	118.28	0.23	0.24	0.70	FALSE	0.00	Above WT
57.91	131.6	52.66	2.317	0.06	3.47	3.47	14.16	4.71	2.99	Clay	Clay	Clay	Clay	Clay	Clay	14.16	2.99	6.67	94.47	0.16	0.24	0.70	FALSE	0.00	Above WT
58.07	131.4	67.63	2.389	0.06	3.48	3.48	18.41	3.72	2.84	Clay	Clay	Clay	Clay	Clay	Clay	18.41	2.84	5.14	94.65	0.16	0.24	0.70	FALSE	0.00	Above WT
58.23	131.3	75.03	2.200	0.06	3.49	3.49	20.48	3.07	2.75	Clay	Clay	Clay	Clay	Clay	Clay	20.48	2.75	4.40	90.00	0.15	0.24	0.70	FALSE	0.00	Above WT
58.40	131.1	55.95	2.174	0.06	3.50	3.50	14.97	4.14	2.94	Clay	Clay	Clay	Clay	Clay	Clay	14.97	2.94	6.10	91.28	0.15	0.24	0.70	FALSE	0.00	Above WT
58.56	130.9	33.95	1.839	0.06	3.51	3.51	8.66	6.04	3.23	Clay	Clay	Clay	Clay	Clay	Clay	8.66	3.23	9.64	83.51	0.13	0.24	0.70	FALSE	0.00	Above WT
58.73	130.8	25.26	1.171	0.06	3.52	3.52	6.17	5.39	3.32	Clay	Clay	Clay	Clay	Clay	Clay	6.17	3.32	10.95	67.54	0.11	0.24	0.70	FALSE	0.00	Above WT
58.89	130.6	23.27	0.986	0.06	3.53	3.53	5.59	5.00	3.33	Clay	Clay	Clay	Clay	Clay	Clay	5.59	3.33	11.20	62.56	0.10	0.23	0.69	FALSE	0.00	Above WT
59.06	130.4	24.26	0.954	0.06	3.54	3.54	5.85	4.60	3.29	Clay	Clay	Clay	Clay	Clay	Clay	5.85	3.29	10.63	62.15	0.10	0.23	0.69	FALSE	0.00	Above WT
59.22	130.3	26.73	0.916	0.06	3.55	3.55	6.52	3.95	3.22	Clay	Clay	Clay	Clay	Clay	Clay	6.52	3.22	9.50	61.94	0.10	0.23	0.69	FALSE	0.00	Above WT
59.38	130.1	22.35	0.839	0.06	3.56	3.56	5.27	4.46	3.32	Clay	Clay	Clay	Clay	Clay	Clay	5.27	3.32	11.08	58.45	0.10	0.23	0.69	FALSE	0.00	Above WT
59.55	130.0	21.46	0.736	0.06	3.57	3.57	5.01	4.12	3.32	Clay	Clay	Clay	Clay	Clay	Clay	5.01	3.32	11.07	55.42	0.10	0.23	0.69	FALSE	0.00	Above WT
59.71	129.8	24.16	0.751	0.06	3.58	3.58	5.74	3.65	3.24	Clay	Clay	Clay	Clay	Clay	Clay	5.74	3.24	9.88	56.74	0.10	0.23	0.69	FALSE	0.00	Above WT
59.88	129.6	25.23	1.007	0.06	3.59	3.59	6.02	4.65	3.29	Clay	Clay	Clay	Clay	Clay	Clay	6.02	3.29	10.51	63.29	0.10	0.23	0.69	FALSE	0.00	Above WT
60.04	129.5	29.24	1.100	0.06	3.60	3.60	7.12	4.29	3.21	Clay	Clay	Clay	Clay	Clay	Clay	7.12	3.21	9.35	66.52	0.11	0.23	0.69	FALSE	0.00	Above WT
60.20	129.3	24.91	0.914	0.06	3.61	3.61	5.90	4.29	3.27	Clay	Clay	Clay	Clay	Clay	Clay	5.90	3.27	10.32	60.84	0.10	0.23	0.68	FALSE	0.00	Above WT
60.37	129.1	21.97	0.772	0.06	3.62	3.62	5.07	4.21	3.32	Clay	Clay	Clay	Clay	Clay	Clay	5.07	3.32	11.09	56.15	0.10	0.23	0.68	FALSE	0.00	Above WT
60.53	129.0	21.04	1.110	0.06	3.63	3.63	4.79	6.38	3.45	Clay	Clay	Clay	Clay	Clay	Clay	4.79	3.45	13.13	62.95	0.10	0.23	0.68	FALSE	0.00	Above WT
60.70	128.8	28.96	1.336	0.06	3.64	3.64	6.95	5.28	3.27	Clay	Clay	Clay	Clay	Clay	Clay	6.95	3.27	10.23	71.11	0.11	0.23	0.68	FALSE	0.00	Above WT
60.86	128.6	40.41	1.234	0.06	3.65	3.65	10.07	3.36	3.02	Clay	Clay	Clay	Clay	Clay	Clay	10.07	3.02	7.00	70.43	0.11	0.23	0.68	FALSE	0.00	Above WT
61.02	128.5	38.75	1.651	0.06	3.66	3.66	9.58	4.70	3.13	Clay	Clay	Clay	Clay	Clay	Clay	9.58	3.13	8.26	79.18	0.13	0.23	0.68	FALSE	0.00	Above WT
61.19	128.3	33.38	2.181	0.06	3.67	3.67	8.09	7.34	3.30	Clay	Clay	Clay	Clay	Clay	Clay	8.09	3.30	10.77	87.17	0.14	0.23	0.68	FALSE	0.00	Above WT
61.35	128.2	61.87	2.630	0.06	3.68	3.68	15.81	4.52	2.95	Clay	Clay	Clay	Clay	Clay	Clay	15.81	2.95	6.15	97.28	0.17	0.23	0.67	FALSE	0.00	Above WT
61.52	128.0	78.20	3.259	0.06	3.69	3.69	20.19	4.37	2.85	Clay	Clay	Clay	Clay	Clay	Clay	20.19	2.85	5.27	106.36	0.19	0.23	0.67	FALSE	0.00	Above WT
61.68	127.8	71.70	3.420	0.06	3.70	3.70	18.37	5.03	2.93	Clay	Clay	Clay	Clay	Clay	Clay	18.37	2.93	5.95	109.33	0.20	0.23	0.67	FALSE	0.00	Above WT
61.84	127.7	57.25	3.379	0.06	3.71	3.71	14.43	6.31	3.07	Clay	Clay	Clay	Clay	Clay	Clay	14.43	3.07	7.55	108.91	0.20	0.23	0.67	FALSE	0.00	Above WT
62.01	127.5	62.44	3.005	0.06	3.72	3.72	15.78	5.12	2.98	Clay	Clay	Clay	Clay	Clay	Clay	15.78	2.98	6.53	103.02	0.18	0.23	0.67	FALSE	0.00	Above WT
62.17	127.3	86.99	2.812	0.06	3.73	3.73	22.32	3.38	2.75	Clay	Clay	Clay	Clay	Clay	Clay	22.32	2.75	4.37	97.48	0.17	0.23	0.67	FALSE	0.00	Above WT
62.34	127.2	93.67	2.606	0.06	3.74	3.74	24.04	2.90	2.68	Clay	Clay	Clay	Clay	Clay	Clay	24.04	2.68	3.87	92.98	0.15	0.23	0.67	FALSE	0.00	Above WT
62.50	127.0	88.82	3.085	0.06	3.75	3.75	22.69	3.63	2.76	Clay	Clay	Clay	Clay	Clay	Clay	22.69	2.76	4.48	101.68	0.18	0.22	0.67	FALSE	0.00	Above WT
62.66	126.8	81.98	3.696	0.06	3.76	3.76	20.81	4.73	2.87	Clay	Clay	Clay	Clay	Clay	Clay	20.81	2.87	5.38	111.97	0.21	0.22	0.66	FALSE	0.00	Above WT
62.83	126.7	79.29	4.261	0.06	3.77	3.77	20.03	5.64	2.93	Clay	Clay	Clay	Clay	Clay	Clay	20.03	2.93	6.00	120.27	0.24	0.22	0.66	FALSE	0.00	Above WT
62.99	126.5	126.40	4.172	0.06	3.78	3.78	32.44	3.40	2.63	Clay	Clay	Clay	Clay	Clay	Clay	32.44	2.63	3.50	113.62	0.22	0.22	0.66	FALSE	0.00	Above WT
63.16	126.3	176.08	3.668	0.06	3.79	3.79	45.46	2.13	2.38	0.52	88.69	2.17	Sand	Sand	Sand	88.69	2.17	1.60	141.81	0.35	0.22	0.66	FALSE	0.00	Above WT
63.32	126.2	220.18	2.920	0.06	3.80	3.80	56.95	1.35	2.18	0.52	110.77	1.96	Sand	Sand	Sand	110.77	1.96	1.26	139.02	0.33	0.22	0.66	FALSE	0.00	Above WT
63.48	126.0	247.25	2.654	0.06	3.81	3.81	63.92	1.09	2.09	0.52	124.23	1.86	Sand	Sand	Sand	124.23	1.86	1.16	143.69	0.36	0.22	0.66	FALSE	0.00	Above WT
63.65	125.9	234.73	2.567	0.06	3.82	3.82	60.46	1.11	2.11	0.52	117.78	1.89	Sand	Sand	Sand	117.78	1.89	1.18	138.58	0.33	0.22	0.66	FALSE	0.00	Above WT
63.81	125.7	203.17	2.551	0.06	3.83	3.83	52.07	1.28	2.20	0.52	101.82	1.97	Sand	Sand	Sand	101.82	1.97	1.27	129.13	0.28	0.22	0.65	FALSE	0.00	Above WT
63.98	125.5	162.49	2.406	0.06	3.84	3.84	41.33	1.52	2.32	0.52	81.32	2.10	Sand	Sand	Sand	81.32	2.10	1.45	117.80	0.23	0.22	0.65	FALSE	0.00	Above WT
64.14	125.4	92.19	2.163	0.06	3.85	3.85	22.96	2.45	2.65	Clay	Clay	Clay	Clay	Clay	Clay	22.96	2.65	3.67	84.14	0.14	0.22	0.65	FALSE	0.00	Above WT
64.30	125.2	39.91	1.737	0.06	3.86	3.86	9.34	4.82	3.14	Clay	Clay	Clay	Clay	Clay	Clay	9.34	3.14	8.46	79.01	0.13	0.22	0.65	FALSE	0.00	Above WT
64.47	125.0	32.19	1.378	0.06	3.87	3.87	7.32	4.86	3.23	Clay	Clay	Clay	Clay	Clay	Clay	7.32	3.23	9.66	70.70	0.11	0.22	0.65	FALSE	0.00	Above WT
64.63	124.9	26.13	1.087	0.06	3.88	3.88	5.74	4.89	3.32	Clay	Clay	Clay	Clay	Clay	Clay	5.74	3.32	10.96	62.90	0.10	0.22	0.65	FALSE	0.00	Above WT
64.80	124.7	26.30	0.869	0.06	3.89	3.89	5.76	3.88	3.26	Clay	Clay	Clay	Clay	Clay	Clay	5.76	3.26	10.07	58.06	0.10	0.22	0.65	FALSE	0.00	Above WT
64.96	124.5	26.30	0.850	0.06	3.90	3.90	5.75	3.79	3.25	Clay	Clay	Clay	Clay	Clay	Clay	5.75	3.25	10.01	57.55	0.10	0.22	0.65	FALSE	0.00	Above WT
65.12	124.4	25.39	0.801	0.06	3.91	3.91	5.50	3.73	3.27	Clay	Clay	Clay	Clay	Clay	Clay	5.50	3.27	10.19	56.03	0.10	0.22	0.64	FALSE	0.00	Above WT
65.29	124.2	24.42	0.823	0.06	3.92	3.92	5.23	4.01	3.30	Clay	Clay	Clay	Clay	Clay	Clay	5.23	3.30	10.73	56.14	0.10	0.22	0.64	FALSE	0.00	Above WT
65.45	124.1	24.86	0.977	0.06	3.93	3.93	5.33	4.67	3.33	Clay	Clay	Clay	Clay	Clay	Clay	5.33	3.33	11.20	59.69	0.10	0.22	0.64	FALSE	0.00	Above WT
65.62	123.9	28.49	1.073	0.06	3.94	3.94	6.24	4.37	3.26	Clay	Clay	Clay	Clay	Clay	Clay	6.24	3.26	10.09	62.91	0.10	0.22	0.64	FALSE	0.00	Above WT
65.78	123.7	29.06	1.044	0.06	3.95	3.95	6.36	4.16	3.24	Clay	Clay	Clay	Clay	Clay	Clay	6.36	3.24	9.80	62.38	0.10	0.22	0.64	FALSE	0.00	Above WT
65.94	123.6	25.31	0.970	0.06	3.96	3.96	5.40	4.54	3.32	Clay	Clay	Clay	Clay	Clay	Clay	5.40	3.32	11.02	59.49	0.10	0.22	0.64	FALSE	0.00	Above WT
66.11	123.4	23.70	0.891	0.06	3.97	3.97	4.97	4.51	3.35	Clay	Clay	Clay	Clay	Clay	Clay	4.97	3.35	11.46	57.01	0.10	0.21	0.64	FALSE	0.00	Above WT
66.27	123.2	23.49	0.828	0.06	3.98	3.98	4.91	4.24	3.34	Clay	Clay	Clay	Clay	Clay	Clay	4.91	3.34	11.30	55.46	0.10	0.21	0.63	FALSE	0.00	Above WT
66.44	123.1	23.23	1.026	0.06	3.99	3.99	4.83	5.33	3.40	Clay	Clay	Clay	Clay	Clay	Clay	4.83	3.40	12.31	59.43	0.10	0.21	0.63	FALSE	0.00	Above WT
66.60	122.9	23.54	1.575	0.06	4.00	4.00	4.89	8.06	3.50	Clay	Clay	Clay	Clay	Clay	Clay	4.89	3.50	14.10	68.94	0.11	0.21	0.63	FALSE	0.00	Above WT
66.77	122.7	40.32	2.211	0.06	4.01	4.01	9.06	6.09	3.21	Clay	Clay	Clay	Clay	Clay	Clay	9.06	3.21	9.45	85.66	0.14	0.21	0.63	FALSE	0.00	Above WT
66.93	122.6	46.32	2.211	0.06	4.02	4.02	10.53	5.23	3.12	Clay	Clay	Clay	Clay	Clay	Clay	10.53	3.12	8.20	86.43	0.14	0.21	0.63	FALSE	0.00	Above WT
67.09	122.4	33.68	1.075	0.06	4.03	4.03	7.37	3.63	3.15	Clay	Clay	Clay	Clay	Clay	Clay	7.37	3.15	8.61	63.41	0.10	0.21	0.63	FALSE	0.00	Above WT
67.26	122.2	23.53	1.621	0.06	4.04	4.04	4.83	8.32	3.51	Clay	Clay	Clay	Clay	Clay	Clay	4.83	3.51	14.33	69.21	0.11	0.21	0.63	FALSE	0.00	Above WT
67.42	122.1	73.84	1.854	0.06	4.05	4.05	17.25	2.66	2.77	Clay	Clay	Clay	Clay	Clay	Clay	17.25	2.77	4.56	78.69	0.13	0.21	0.63	FALSE	0.00	Above WT
67.59	121.9	177.97	2.304	0.06	4.06	4.06	42.88	1.32	2.28	0.51	86.66	2.04	Sand	Sand	Sand	86.66	2.04	1.35	117.09	0.23	0.21	0.62	FALSE	0.00	Above WT
67.75	121.8	234.83	1.888	0.06	4.07	4.07	56.77	0.82	2.06	0.51	114.21	1.81	Sand	Sand	Sand	114.21	1.81	1.11	127.28	0.27	0.21	0.62	FALSE	0.00	Above WT
67.91	121.6	261.51	1.982	0.06	4.07	4.07	63.18	0.77	2.00	0.51	127.04	1.76	Sand	Sand	Sand	127.04	1.76	1.08	136.82	0.32	0.21	0.62	FALSE	0.00	Above WT
68.08	121.4	260.87	2.094	0.06	4.08	4.08	62.86	0.82	2.02	0.50	126.57	1.77	Sand	Sand	Sand	126.57	1.77	1.09	137.81	0.32	0.21	0.62	FALSE	0.00	Above WT
68.24	121.3	254.34	2.329	0.06	4.09	4.09	61.12	0.93	2.06	0.50	123.25	1.82	Sand	Sand	Sand	123.25	1.82	1.12	138.31	0.33	0.21	0.62	FALSE	0.00	Above WT
68.41	121.1	245.16	2.652	0.06	4.10	4.10	58.73	1.10	2.12	0.50	118.66	1.88	Sand	Sand	Sand	118.66	1.88	1.17	139.03	0.33	0.21	0.62	FALSE	0.00	Above WT
68.57	120.9	238.30	2.904	0.06	4.11	4.11	56.95	1.24	2.16	0.50	115.23	1.93	Sand	Sand	Sand	115.23	1.93	1.21	139.91	0.33	0.21	0.62	FALSE	0.00	liq
68.73	120.8	237.38	2.866	0.06	4.12	4.12	56.66	1.23	2.16	0.50	114.72	1.92	Sand	Sand	Sand	114.72	1.92	1.21	139.14	0.33	0.21	0.61	FALSE	0.00	liq
68.90	120.6	244.73	2.479	0.06	4.13	4.12	58.37	1.03	2.10	0.50	118.21	1.86	Sand	Sand	Sand	118.21	1.86	1.16	136.69	0.32	0.21	0.61	FALSE	0.00	liq
69.06	120.4	243.46	2.006	0.06	4.14	4.13	58.00	0.84	2.05	0.50	117.54	1.81	Sand	Sand	Sand	117.54	1.81	1.11	130.71	0.29	0.21	0.61	FALSE	0.00	liq
69.23	120.3	234.36	1.745	0.06	4.15	4.13	55.72	0.76	2.04	0.50	113.07	1.79	Sand	Sand	Sand	113.07	1.79	1.10	124.58	0.26	0.21	0.61	FALSE	0.00	liq
69.39	120.1	215.01	1.525	0.06	4.16	4.14	50.98	0.72	2.07	0.50	103.67	1.81	Sand	Sand	Sand	103.67	1.81	1.11	115.57	0.22	0.21	0.61	FALSE	0.00	liq
69.55	120.0	193.60	1.330	0.06	4.17	4.14	45.75	0.70	2.10	0.50	93.30	1.84	Sand	Sand	Sand	93.30	1.84	1.14	106.12	0.19	0.21	0.61	FALSE	0.00	liq
69.72	119.8	161.15	1.637	0.06	4.18	4.15	37.87	1.04	2.26	0.50	77.61	2.01	Sand	Sand	Sand	77.61	2.01	1.31	101.67	0.18	0.21	0.61	FALSE	0.00	liq
69.88	119.6	94.17	1.946	0.06	4.19	4.15	21.68	2.16	2.64	Clay	Clay	Clay	Clay	Clay	Clay	21.68	2.64	3.58	77.70	0.12	0.21	0.61	FALSE	0.00	Clay
70.05	119.5	47.29	1.421	0.06	4.20	4.15	10.37	3.30	3.01	Clay	Clay	Clay	Clay	Clay	Clay	10.37	3.01	6.83	70.80	0.11	0.21	0.60	FALSE	0.00	Clay
70.21	119.3	32.89	0.751	0.06	4.21	4.16	6.89	2.62	3.10	Clay	Clay	Clay	Clay	Clay	Clay	6.89	3.10	7.92	54.61	0.10	0.21	0.60	FALSE	0.00	Clay
70.37	119.1	32.21	0.358	0.06	4.22	4.16	6.72	1.28	2.96	Clay	Clay	Clay	Clay	Clay	Clay	6.72	2.96	6.28	42.20	0.09	0.21	0.60	FALSE	0.00	Clay

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Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
70.54	119.0	31.79	0.335	0.06	4.23	4.17	6.61	1.22	2.95	Clay	Clay	Clay	Clay	Clay	6.61	2.95	6.24	41.27	0.08	0.21	0.60	FALSE	0.00	Clay
70.70	118.8	30.13	0.336	0.06	4.24	4.17	6.20	1.30	2.99	Clay	Clay	Clay	Clay	Clay	6.20	2.99	6.65	41.22	0.08	0.21	0.60	FALSE	0.00	Clay
70.87	118.6	27.95	0.365	0.06	4.25	4.18	5.67	1.54	3.06	Clay	Clay	Clay	Clay	Clay	5.67	3.06	7.43	42.11	0.09	0.21	0.60	FALSE	0.00	Clay
71.03	118.5	27.84	0.679	0.06	4.26	4.18	5.64	2.88	3.20	Clay	Clay	Clay	Clay	Clay	5.64	3.20	9.19	51.80	0.09	0.21	0.60	FALSE	0.00	Clay
71.19	118.3	33.99	0.569	0.06	4.27	4.19	7.10	1.92	3.02	Clay	Clay	Clay	Clay	Clay	7.10	3.02	6.96	49.40	0.09	0.20	0.59	FALSE	0.00	Clay
71.36	118.1	28.66	0.692	0.06	4.28	4.19	5.81	2.84	3.18	Clay	Clay	Clay	Clay	Clay	5.81	3.18	8.99	52.26	0.09	0.20	0.59	FALSE	0.00	Clay
71.52	118.0	29.45	0.692	0.06	4.29	4.20	5.99	2.75	3.16	Clay	Clay	Clay	Clay	Clay	5.99	3.16	8.74	52.38	0.09	0.20	0.59	FALSE	0.00	Clay
71.69	117.8	28.26	0.667	0.06	4.30	4.20	5.70	2.78	3.18	Clay	Clay	Clay	Clay	Clay	5.70	3.18	9.03	51.47	0.09	0.20	0.59	FALSE	0.00	Clay
71.85	117.7	25.61	0.795	0.06	4.31	4.21	5.06	3.73	3.30	Clay	Clay	Clay	Clay	Clay	5.06	3.30	10.65	53.90	0.09	0.20	0.59	FALSE	0.00	Clay
72.01	117.5	24.61	1.635	0.06	4.32	4.21	4.82	8.06	3.51	Clay	Clay	Clay	Clay	Clay	4.82	3.51	14.19	68.37	0.11	0.20	0.59	FALSE	0.00	Clay
72.18	117.3	49.57	2.131	0.06	4.33	4.22	10.73	4.71	3.09	Clay	Clay	Clay	Clay	Clay	10.73	3.09	7.77	83.41	0.13	0.20	0.59	FALSE	0.00	Clay
72.34	117.2	82.71	2.622	0.06	4.34	4.22	18.57	3.35	2.81	Clay	Clay	Clay	Clay	Clay	18.57	2.81	4.86	90.21	0.15	0.20	0.59	FALSE	0.00	Clay
72.51	117.0	98.40	2.704	0.06	4.35	4.23	22.25	2.86	2.71	Clay	Clay	Clay	Clay	Clay	22.25	2.71	4.04	89.93	0.15	0.20	0.58	FALSE	0.00	Clay
72.67	116.8	97.27	2.791	0.06	4.36	4.23	21.96	3.00	2.72	Clay	Clay	Clay	Clay	Clay	21.96	2.72	4.16	91.42	0.15	0.20	0.58	FALSE	0.00	Clay
72.83	116.7	97.33	2.849	0.06	4.37	4.24	21.95	3.06	2.73	Clay	Clay	Clay	Clay	Clay	21.95	2.73	4.21	92.31	0.15	0.20	0.58	FALSE	0.00	Clay
73.00	116.5	71.32	2.763	0.06	4.38	4.24	15.79	4.13	2.92	Clay	Clay	Clay	Clay	Clay	15.79	2.92	5.90	93.19	0.16	0.20	0.58	FALSE	0.00	Clay
73.16	116.3	43.04	1.989	0.06	4.39	4.25	9.10	5.15	3.17	Clay	Clay	Clay	Clay	Clay	9.10	3.17	8.81	80.18	0.13	0.20	0.58	FALSE	0.00	Clay
73.33	116.2	29.75	1.961	0.06	4.40	4.25	5.96	7.73	3.42	Clay	Clay	Clay	Clay	Clay	5.96	3.42	12.69	75.70	0.12	0.20	0.58	FALSE	0.00	Clay
73.49	116.0	59.64	2.476	0.06	4.41	4.25	12.98	4.48	3.01	Clay	Clay	Clay	Clay	Clay	12.98	3.01	6.85	88.92	0.15	0.20	0.58	FALSE	0.00	Clay
73.65	115.9	111.36	3.100	0.06	4.42	4.26	25.11	2.90	2.67	Clay	Clay	Clay	Clay	Clay	25.11	2.67	3.77	94.55	0.16	0.20	0.57	FALSE	0.00	Clay
73.82	115.7	138.00	3.281	0.06	4.43	4.26	31.32	2.46	2.55	0.49	65.53	2.31	Sand	Sand	Sand	65.53	2.31	1.97	129.41	0.28	0.20	0.57	FALSE	0.00	liq
73.98	115.5	144.09	3.484	0.06	4.44	4.27	32.71	2.49	2.54	0.49	68.38	2.30	Sand	Sand	Sand	68.38	2.30	1.95	133.17	0.30	0.20	0.57	FALSE	0.00	liq
74.15	115.4	146.01	3.218	0.06	4.45	4.27	33.12	2.27	2.51	0.49	69.26	2.27	Sand	Sand	Sand	69.26	2.27	1.85	128.02	0.28	0.20	0.57	FALSE	0.00	liq
74.31	115.2	146.48	2.880	0.06	4.46	4.28	33.19	2.03	2.48	0.49	69.44	2.23	Sand	Sand	Sand	69.44	2.23	1.75	121.51	0.25	0.20	0.57	FALSE	0.00	liq
74.48	115.0	117.94	2.848	0.06	4.47	4.28	26.49	2.51	2.61	Clay	Clay	Clay	Clay	Clay	26.49	2.61	3.39	89.80	0.15	0.20	0.57	FALSE	0.00	Clay
74.64	114.9	65.46	2.888	0.06	4.48	4.29	14.22	4.74	2.99	Clay	Clay	Clay	Clay	Clay	14.22	2.99	6.67	94.88	0.16	0.20	0.57	FALSE	0.00	Clay
74.80	114.7	38.66	2.214	0.06	4.49	4.29	7.96	6.48	3.28	Clay	Clay	Clay	Clay	Clay	7.96	3.28	10.34	82.30	0.13	0.20	0.57	FALSE	0.00	Clay
74.97	114.5	28.09	1.552	0.06	4.50	4.30	5.49	6.58	3.41	Clay	Clay	Clay	Clay	Clay	5.49	3.41	12.45	68.35	0.11	0.20	0.56	FALSE	0.00	Clay
75.13	114.4	26.56	1.266	0.06	4.51	4.30	5.13	5.74	3.40	Clay	Clay	Clay	Clay	Clay	5.13	3.40	12.27	62.87	0.10	0.20	0.56	FALSE	0.00	Clay
75.30	114.2	25.34	1.357	0.06	4.52	4.31	4.83	6.52	3.45	Clay	Clay	Clay	Clay	Clay	4.83	3.45	13.18	63.70	0.10	0.20	0.56	FALSE	0.00	Clay
75.46	114.0	27.46	1.420	0.06	4.53	4.31	5.32	6.19	3.40	Clay	Clay	Clay	Clay	Clay	5.32	3.40	12.37	65.81	0.11	0.20	0.56	FALSE	0.00	Clay
75.62	113.9	38.56	0.800	0.06	4.54	4.32	7.88	2.35	3.03	Clay	Clay	Clay	Clay	Clay	7.88	3.03	7.03	55.45	0.10	0.20	0.56	FALSE	0.00	Clay
75.79	113.7	46.38	1.020	0.06	4.55	4.32	9.68	2.44	2.96	Clay	Clay	Clay	Clay	Clay	9.68	2.96	6.29	60.93	0.10	0.20	0.56	FALSE	0.00	Clay
75.95	113.6	32.18	1.298	0.06	4.56	4.33	6.39	4.70	3.27	Clay	Clay	Clay	Clay	Clay	6.39	3.27	10.23	65.33	0.11	0.20	0.56	FALSE	0.00	Clay
76.12	113.4	26.37	1.125	0.06	4.57	4.33	5.03	5.16	3.38	Clay	Clay	Clay	Clay	Clay	5.03	3.38	11.93	60.04	0.10	0.20	0.56	FALSE	0.00	Clay
76.28	113.2	24.77	0.926	0.06	4.58	4.34	4.66	4.59	3.37	Clay	Clay	Clay	Clay	Clay	4.66	3.37	11.91	55.47	0.10	0.20	0.56	FALSE	0.00	Clay
76.44	113.1	24.96	1.425	0.06	4.59	4.34	4.69	6.99	3.48	Clay	Clay	Clay	Clay	Clay	4.69	3.48	13.68	64.23	0.10	0.20	0.56	FALSE	0.00	Clay
76.61	112.9	50.58	1.778	0.06	4.60	4.35	10.58	3.87	3.04	Clay	Clay	Clay	Clay	Clay	10.58	3.04	7.21	76.30	0.12	0.20	0.56	FALSE	0.00	Clay
76.77	112.7	101.80	2.531	0.06	4.61	4.35	22.34	2.60	2.68	Clay	Clay	Clay	Clay	Clay	22.34	2.68	3.84	85.82	0.14	0.20	0.56	FALSE	0.00	Clay
76.94	112.6	55.25	2.030	0.06	4.62	4.35	11.63	4.01	3.02	Clay	Clay	Clay	Clay	Clay	11.63	3.02	6.94	80.70	0.13	0.20	0.56	FALSE	0.00	Clay
77.10	112.4	33.14	1.315	0.06	4.63	4.36	6.54	4.61	3.25	Clay	Clay	Clay	Clay	Clay	6.54	3.25	10.04	65.65	0.11	0.20	0.56	FALSE	0.00	Clay
77.26	112.2	29.67	0.845	0.06	4.64	4.36	5.74	3.38	3.23	Clay	Clay	Clay	Clay	Clay	5.74	3.23	9.62	55.18	0.10	0.20	0.56	FALSE	0.00	Clay
77.43	112.1	31.21	1.225	0.06	4.65	4.37	6.08	4.61	3.28	Clay	Clay	Clay	Clay	Clay	6.08	3.28	10.43	63.39	0.10	0.20	0.56	FALSE	0.00	Clay
77.59	111.9	39.96	1.896	0.06	4.66	4.37	8.07	5.37	3.22	Clay	Clay	Clay	Clay	Clay	8.07	3.22	9.54	76.99	0.12	0.20	0.55	FALSE	0.00	Clay
77.76	111.7	47.22	2.010	0.06	4.67	4.38	9.72	4.72	3.12	Clay	Clay	Clay	Clay	Clay	9.72	3.12	8.21	79.82	0.13	0.20	0.55	FALSE	0.00	Clay
77.92	111.6	50.14	1.592	0.06	4.68	4.38	10.37	3.50	3.02	Clay	Clay	Clay	Clay	Clay	10.37	3.02	7.00	72.59	0.12	0.20	0.55	FALSE	0.00	Clay
78.08	111.4	37.38	1.345	0.06	4.68	4.39	7.45	4.11	3.18	Clay	Clay	Clay	Clay	Clay	7.45	3.18	8.97	66.87	0.11	0.20	0.55	FALSE	0.00	Clay
78.25	111.3	29.44	1.213	0.06	4.70	4.39	5.63	4.90	3.32	Clay	Clay	Clay	Clay	Clay	5.63	3.32	11.08	62.40	0.10	0.20	0.55	FALSE	0.00	Clay
78.41	111.1	26.07	1.072	0.06	4.70	4.40	4.86	5.02	3.38	Clay	Clay	Clay	Clay	Clay	4.86	3.38	12.02	58.42	0.10	0.20	0.55	FALSE	0.00	Clay
78.58	110.9	26.07	1.023	0.06	4.71	4.40	4.85	4.79	3.37	Clay	Clay	Clay	Clay	Clay	4.85	3.37	11.85	57.46	0.10	0.20	0.55	FALSE	0.00	Clay
78.74	110.8	33.56	1.882	0.06	4.72	4.41	6.54	6.53	3.34	Clay	Clay	Clay	Clay	Clay	6.54	3.34	11.41	74.68	0.12	0.20	0.55	FALSE	0.00	Clay
78.90	110.6	55.78	2.717	0.06	4.73	4.41	11.57	5.32	3.10	Clay	Clay	Clay	Clay	Clay	11.57	3.10	7.86	90.99	0.15	0.20	0.55	FALSE	0.00	Clay
79.07	110.4	89.64	3.059	0.06	4.74	4.42	19.22	3.60	2.82	Clay	Clay	Clay	Clay	Clay	19.22	2.82	4.93	94.80	0.16	0.20	0.55	FALSE	0.00	Clay
79.23	110.3	99.98	3.443	0.06	4.75	4.42	21.54	3.62	2.78	Clay	Clay	Clay	Clay	Clay	21.54	2.78	4.62	99.42	0.17	0.20	0.55	FALSE	0.00	Clay
79.40	110.1	116.36	3.814	0.06	4.76	4.43	25.21	3.42	2.71	Clay	Clay	Clay	Clay	Clay	25.21	2.71	4.08	102.93	0.18	0.20	0.55	FALSE	0.00	Clay
79.56	109.9	149.95	3.965	0.06	4.77	4.43	32.77	2.73	2.56	0.48	69.85	2.32	Sand	Sand	Sand	69.85	2.32	2.02	140.95	0.34	0.20	0.55	FALSE	0.00	liq
79.72	109.8	116.23	3.893	0.06	4.78	4.44	25.13	3.49	2.72	Clay	Clay	Clay	Clay	Clay	25.13	2.72	4.14	103.94	0.18	0.20	0.55	FALSE	0.00	Clay
79.89	109.6	57.79	3.306	0.06	4.79	4.44	11.94	6.24	3.13	Clay	Clay	Clay	Clay	Clay	11.94	3.13	8.29	98.94	0.17	0.20	0.55	FALSE	0.00	Clay
80.05	109.5	39.76	2.023	0.06	4.80	4.44	7.86	5.79	3.25	Clay	Clay	Clay	Clay	Clay	7.86	3.25	9.95	78.27	0.12	0.20	0.55	FALSE	0.00	Clay
80.22	109.3	28.08	1.781	0.06	4.81	4.45	5.23	7.66	3.46	Clay	Clay	Clay	Clay	Clay	5.23	3.46	13.43	70.24	0.11	0.20	0.55	FALSE	0.00	Clay
80.38	109.1	40.31	2.421	0.06	4.82	4.45	7.97	6.82	3.29	Clay	Clay	Clay	Clay	Clay	7.97	3.29	10.55	84.02	0.14	0.20	0.55	FALSE	0.00	Clay
80.54	109.0	82.13	3.192	0.06	4.83	4.46	17.33	4.13	2.89	Clay	Clay	Clay	Clay	Clay	17.33	2.89	5.59	96.99	0.16	0.20	0.55	FALSE	0.00	Clay
80.71	108.8	119.31	3.515	0.06	4.84	4.46	25.64	3.07	2.68	Clay	Clay	Clay	Clay	Clay	25.64	2.68	3.83	98.14	0.17	0.20	0.55	FALSE	0.00	Clay
80.87	108.6	111.98	3.436	0.06	4.85	4.47	23.97	3.21	2.71	Clay	Clay	Clay	Clay	Clay	23.97	2.71	4.08	97.72	0.17	0.20	0.55	FALSE	0.00	Clay
81.04	108.5	111.40	3.225	0.06	4.86	4.47	23.81	3.03	2.70	Clay	Clay	Clay	Clay	Clay	23.81	2.70	3.98	94.67	0.16	0.20	0.55	FALSE	0.00	Clay
81.20	108.3	111.15	3.255	0.06	4.87	4.48	23.73	3.06	2.70	Clay	Clay	Clay	Clay	Clay	23.73	2.70	4.01	95.10	0.16	0.20	0.55	FALSE	0.00	Clay
81.36	108.1	128.17	3.762	0.06	4.88	4.48	27.50	3.05	2.65	Clay	Clay	Clay	Clay	Clay	27.50	2.65	3.65	100.51	0.17	0.20	0.55	FALSE	0.00	Clay
81.53	108.0	148.30	4.130	0.06	4.89	4.49	31.95	2.86	2.59	0.48	68.64	2.34	Sand	Sand	Sand	68.64	2.34	2.09	143.70	0.36	0.20	0.55	FALSE	0.00	liq
81.69	107.8	162.86	4.089	0.06	4.90	4.49	35.16	2.59	2.52	0.48	75.34	2.28	Sand	Sand	Sand	75.34	2.28	1.89	142.42	0.35	0.20	0.54	FALSE	0.00	liq
81.86	107.6	157.90	4.164	0.06	4.91	4.50	34.02	2.72	2.55	0.48	73.01	2.31	Sand	Sand	Sand	73.01	2.31	1.97	143.80	0.36	0.20	0.54	FALSE	0.00	liq
82.02	107.5	163.26	4.519	0.06	4.92	4.50	35.17	2.85	2.55	0.48	75.45	2.31	Sand	Sand	Sand	75.45	2.31	1.99	149.83	0.39	0.20	0.54	FALSE	0.00	liq
82.19	107.3	177.12	4.794	0.06	4.93	4.51	38.20	2.78	2.52	0.48	81.81	2.28	Sand	Sand	Sand	81.81	2.28	1.88	154.18	0.42	0.20	0.54	FALSE	0.00	liq
82.35	107.2	172.56	4.677	0.06	4.94	4.51	37.15	2.79	2.53	0.48	79.66	2.29	Sand	Sand	Sand	79.66	2.29	1.91	152.24	0.41	0.20	0.54	FALSE	0.00	liq
82.51	107.0	157.42	4.551	0.06	4.95	4.52	33.76	2.99	2.58	0.48	72.64	2.34	Sand	Sand	Sand	72.64	2.34	2.07	150.57	0.40	0.20	0.54	FALSE	0.00	liq
82.68	106.8	143.63	4.044	0.06	4.96	4.52	30.67	2.92	2.60	Clay	Clay	Clay	Clay	Clay	30.67	2.60	3.34	102.47	0.18	0.20	0.54	FALSE	0.00	Clay
82.84	106.7	137.96	3.674	0.06	4.97	4.53	29.38	2.76	2.60	Clay	Clay	Clay	Clay	Clay	29.38	2.60	3.34	98.01	0.17	0.20	0.54	FALSE	0.00	Clay
83.01	106.5	133.76	3.386	0.06	4.98	4.53	28.42	2.63	2.60	0.48	61.62	2.35	Sand	Sand	Sand	61.62	2.35	2.11	130.13	0.28	0.20	0.54	FALSE	0.00	liq
83.17	106.3	133.30	3.297	0.06	4.99	4.54	28.29	2.57	2.59	0.48	61.38	2.34	Sand	Sand	Sand	61.38	2.34	2.09	128.35	0.28	0.20	0.54	FALSE	0.00	liq
83.33	106.2	125.13	3.548	0.06	5.00	4.54	26.46	2.95	2.66	Clay	Clay	Clay	Clay	Clay	26.46	2.66	3.68	97.39	0.17	0.20	0.54	FALSE	0.00	Clay
83.50	106.0	85.19	3.715	0.06	5.01	4.55	17.64	4.63	2.92	Clay	Clay	Clay	Clay	Clay	17.64	2.92	5.85	103.23	0.18	0.20	0.54	FALSE	0.00	Clay
83.66	105.8	59.34	3.129	0.06	5.02	4.55	11.94	5.76	3.11	Clay	Clay	Clay	Clay	Clay	11.94	3.11	8.00	95.57	0.16	0.20	0.54	FALSE	0.00	Clay
83.83	105.7	75.72	3.295	0.06	5.03	4.55	15.52	4.66	2.96	Clay	Clay	Clay	Clay	Clay	15.52	2.96	6.31	97.90	0.17	0.20	0.54	FALSE	0.00	Clay
83.99	105.5	101.82	3.490	0.06	5.04	4.56	21.23	3.61	2.78	Clay	Clay	Clay	Clay	Clay	21.23	2.78	4.65	98.70	0.17	0.20	0.54	FALSE	0.00	Clay
84.15	105.4	147.87	3.790	0.06	5.05	4.56	31.29	2.65	2.57	0.48	67.87	2.32	Sand	Sand	Sand	67.87	2.32	2.02	136.92	0.32	0.20	0.54	FALSE	0.00	liq
84.32	105.2	188.59	3.686	0.06	5.06	4.57	40.17	2.01	2.41	0.48	86.52	2.16	Sand	Sand	Sand	86.52	2.16	1.58	136.34	0.32	0.20	0.54	FALSE	0.00	liq
84.48	105.0	164.85	3.271	0.06	5.07	4.57	34.94	2.05	2.46	0.48	75.59	2.21	Sand	Sand	Sand	75.59	2.21	1.69	127.57	0.27	0.20	0.54	FALSE	0.00	liq

Depth (ft)	Elevation	qc tip	fs	Unit Wt	Total OB	Eff OB	Q	F	Ic1	CQ1	qc1n,1	Ic2	CPT-10246	qc1n,2	Ic3	qc1N	Ic	Kc	(qc1n)CS	CRR7.5	CSR	rd	MSF	FOS	Liquefaction
84.65	104.9	123.46	3.226	0.06	5.08	4.58	25.86	2.73	2.64	Clay	Clay	Clay	Clay	Clay	Clay	25.86	2.64	3.59	92.70	0.15	0.20	0.54	FALSE	0.00	Clay
84.81	104.7	106.91	3.587	0.06	5.09	4.58	22.22	3.52	2.76	Clay	Clay	Clay	Clay	Clay	Clay	22.22	2.76	4.47	99.37	0.17	0.20	0.54	FALSE	0.00	Clay
84.97	104.5	123.62	3.554	0.06	5.10	4.59	25.84	3.00	2.67	Clay	Clay	Clay	Clay	Clay	Clay	25.84	2.67	3.76	97.24	0.17	0.20	0.54	FALSE	0.00	Clay
85.14	104.4	122.31	3.922	0.06	5.11	4.59	25.52	3.35	2.70	Clay	Clay	Clay	Clay	Clay	Clay	25.52	2.70	4.01	102.33	0.18	0.20	0.54	FALSE	0.00	Clay
85.30	104.2	132.09	4.529	0.06	5.12	4.60	27.62	3.57	2.69	Clay	Clay	Clay	Clay	Clay	Clay	27.62	2.69	3.95	109.14	0.20	0.20	0.54	FALSE	0.00	Clay
85.47	104.0	203.33	5.057	0.06	5.13	4.60	43.07	2.55	2.45	0.48	92.94	2.21	Sand	Sand	Sand	92.94	2.21	1.70	158.16	0.45	0.20	0.54	FALSE	0.00	liq
85.63	103.9	321.56	5.330	0.06	5.14	4.61	68.69	1.68	2.18	0.48	146.91	1.95	Sand	Sand	Sand	146.91	1.95	1.24	181.63	0.64	0.20	0.54	FALSE	0.00	liq
85.79	103.7	375.13	3.424	0.06	5.15	4.61	80.23	0.93	1.96	0.47	171.30	1.71	Sand	Sand	Sand	171.30	1.71	1.05	179.33	0.62	0.20	0.53	FALSE	0.00	liq
85.96	103.5	279.93	3.557	0.06	5.16	4.62	59.52	1.29	2.16	0.47	127.76	1.91	Sand	Sand	Sand	127.76	1.91	1.19	152.65	0.41	0.20	0.53	FALSE	0.00	liq

Earth Mechanics, Inc.
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Project SR-91 WB Widening - East of UC **Project No.** 10-126

By SP **Date** 08-30-11 **Checked By** LCC **Date** 8/31/11 **Sheet** ____ **of** ____

Abutments 1 and 5

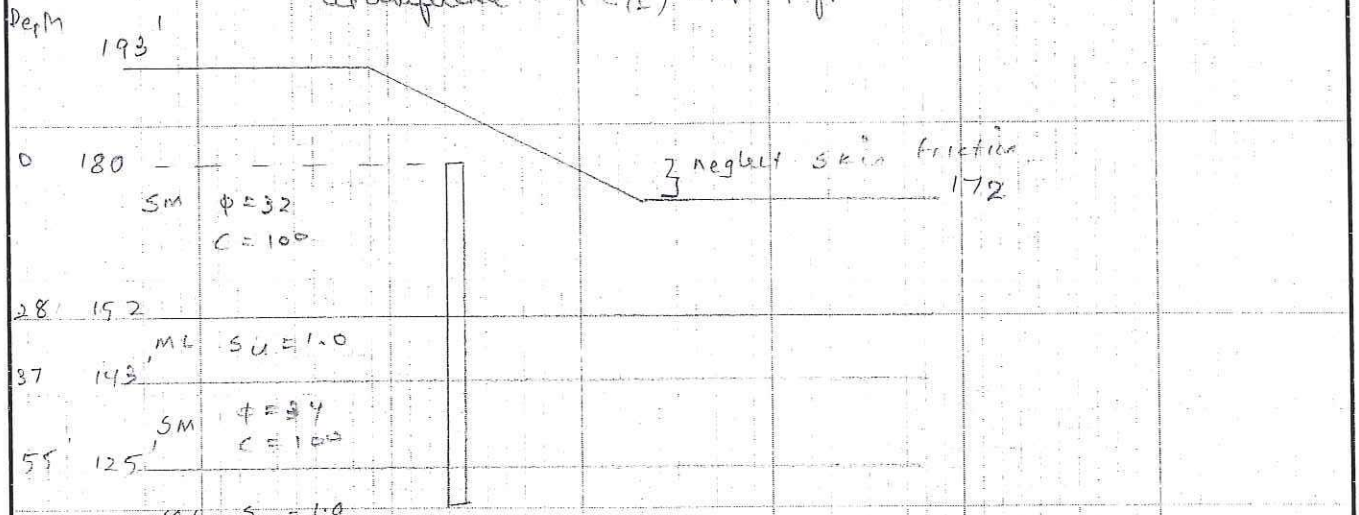
16-inch diameter CIDH piles

Area = $\frac{\pi}{4} 16^2 = 201 in^2$

$I = \frac{\pi}{64} 16^4 = 3217 in^4$; $I_{cracked} = 1608 in^4$

$E = 57000\sqrt{3250} = 3.2 \times 10^6$ lb/in²

Circumference = $\pi\left(\frac{16}{12}\right) = 4.19$ ft



maximum load per pile = 75 kips

Nominal resistance = 75 x 2 = 150 kips

Total load per support = 225 kips

Nominal resistance per support = 225 x 2 = 450 kips

from analysis

at 38 ft, pile capacity = 153 kips

pile tip elevation for compression = 183 - 38 = 145' for Abut 1

= 180 - 38 = 142' for Abut 5

Group efficiency factor = 0.77 for 3d pile spacing

Available group nominal resistance = 153 x 4 x 0.77

= 471 kips > 450 kips

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Project SR-91 WB widening - East of LC **Project No.** 10-126

By SP **Date** 03-16-11 **Checked By** LCC **Date** 3/18/11 **Sheet** ___ **of** ___

The available nominal resistance for a pile group exceeds the required group nominal resistance

pile tip elevation for compression
= 145 ft for Abut 1
= 142 ft for Abut 2

Lateral capacity

group reduction factor = 0.8

pile tip elevation for lateral = 183 - 22 = 161' for Abut 1
= 180 - 22 = 158' for Abut 5

SKIN FRICTION FOR DRILLED SHAFT IN BOTH COHESIONLESS AND COHESIVE SOILS USING REESE AND O'NEILL'S METHOD (1999)

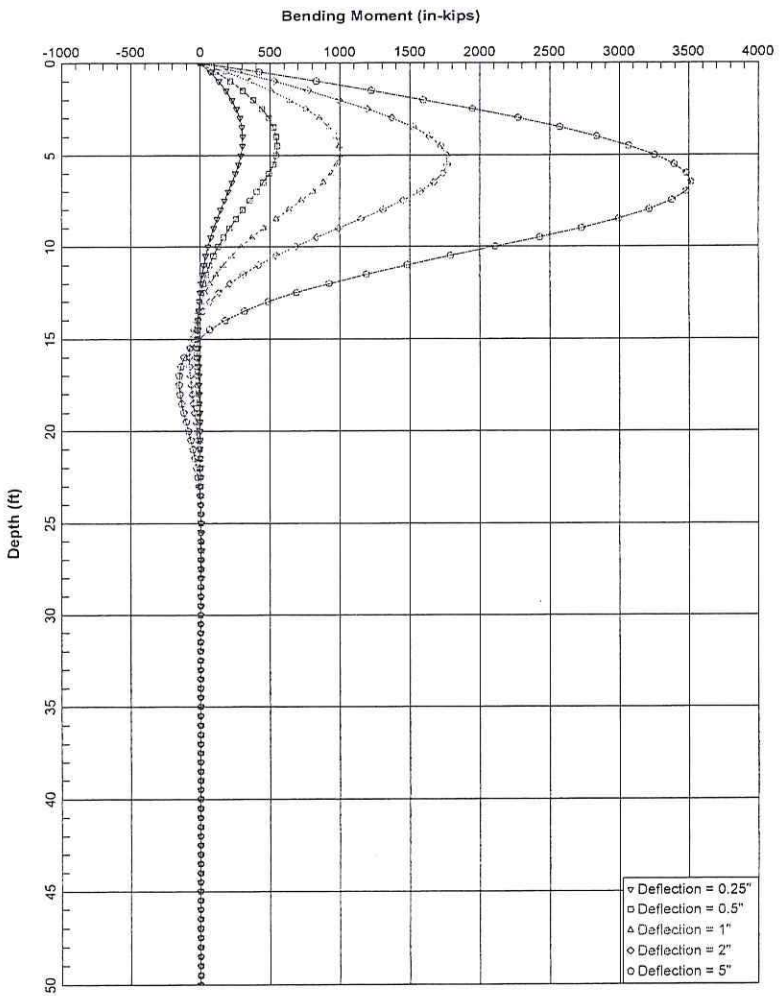
PROJECT: East St UC
ITEM: 16-inch Diameter CIDH Existing Pile
PROJECT NO.: 10-126
Abutments 1 and 5
DONE BY: SP DATE: 03/16/11
CHECKED BY: DATE:

D_s => 1.33 ft Hw => 59.0 ft Hg => 0.0 ft
p = 4.19 ft Ho => 0.0 ft Hf => 0.0 ft

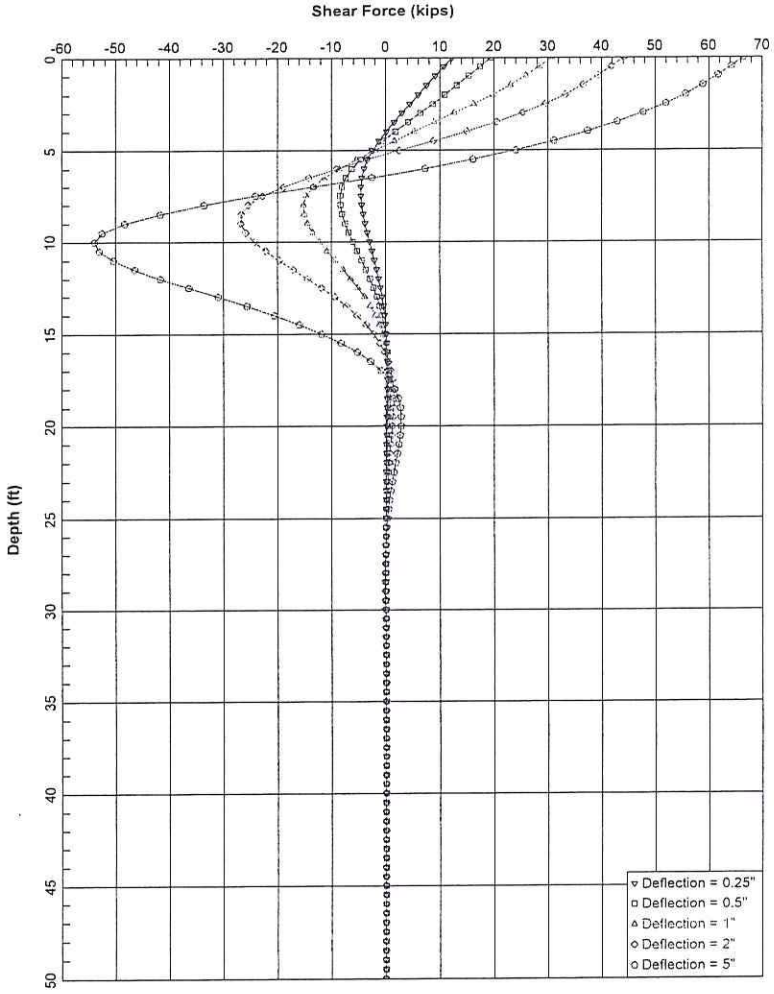
Hw is the depth to water table.
Hg is the depth to ground surface used in calculation.
Ho is the depth to location starting initial overburden pressure
Hf is the depth to location starting accumulation of skin frictio
bottom of footing = 180 feet

Soil Layer =>	from Top	to Bottom =>	γ (pcf)=>	γ' (pcf)=	c' (ksf) =>	ϕ' =>	
(1)	0	9	60	0.0	0.00	32	SM
(2)	9	28	120	57.6	0.00	32	SM
(3)	28	37	115	52.6	1.00	0	ML
(4)	37	55	120	57.6	0.00	34	SM

Sublayer No.	Depth, z (ft)	z_i (ft)	New Depth (ft)	Soil Unit Weight (pcf)	Overburden Pressure (psf)	c' (ksf)	β	f_i^s (ksf)	ΔQ_s^s (kips)	Q_s^s (kips)	f_i^c (ksf)	ΔQ_s^c (kips)	Q_s^c (kips)	Q_s (kips)
0	0.0	0.0	0.0	60.0	0									
1	0.0	0.0	0.0	60.0	0	0.0				0.0			0.0	0.0
2	1.0	0.5	0.5	60.0	30	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
3	2.0	1.5	1.5	60.0	90	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
4	3.0	2.5	2.5	60.0	150	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
5	4.0	3.5	3.5	60.0	210	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
6	5.0	4.5	4.5	60.0	270	0.0	1.20	0.00	0.0	0.0	0.00	0.0	0.0	0.0
7	6.0	5.5	5.5	60.0	330	0.0	1.18	0.00	0.0	0.0	0.00	0.0	0.0	0.0
8	7.0	6.5	6.5	60.0	390	0.0	1.16	0.00	0.0	0.0	0.00	0.0	0.0	0.0
9	8.0	7.5	7.5	60.0	450	0.0	1.13	0.00	0.0	0.0	0.00	0.0	0.0	0.0
10	9.0	8.5	8.5	60.0	510	0.0	1.11	0.00	0.0	0.0	0.00	0.0	0.0	0.0
11	10.0	9.5	9.5	120.0	630	0.0	1.08	0.68	2.9	2.9	0.00	0.0	0.0	2.9
12	11.0	10.5	10.5	120.0	750	0.0	1.06	0.80	3.3	6.2	0.00	0.0	0.0	6.2
13	12.0	11.5	11.5	120.0	870	0.0	1.04	0.91	3.8	10.0	0.00	0.0	0.0	10.0
14	13.0	12.5	12.5	120.0	990	0.0	1.02	1.01	4.2	14.2	0.00	0.0	0.0	14.2
15	14.0	13.5	13.5	120.0	1110	0.0	1.00	1.11	4.7	18.9	0.00	0.0	0.0	18.9
16	15.0	14.5	14.5	120.0	1230	0.0	0.99	1.21	5.1	24.0	0.00	0.0	0.0	24.0
17	16.0	15.5	15.5	120.0	1350	0.0	0.97	1.31	5.5	29.5	0.00	0.0	0.0	29.5
18	17.0	16.5	16.5	120.0	1470	0.0	0.95	1.40	5.9	35.3	0.00	0.0	0.0	35.3
19	18.0	17.5	17.5	120.0	1590	0.0	0.94	1.49	6.2	41.6	0.00	0.0	0.0	41.6
20	19.0	18.5	18.5	120.0	1710	0.0	0.92	1.57	6.6	48.1	0.00	0.0	0.0	48.1
21	20.0	19.5	19.5	120.0	1830	0.0	0.90	1.65	6.9	55.1	0.00	0.0	0.0	55.1
22	21.0	20.5	20.5	120.0	1950	0.0	0.89	1.73	7.3	62.3	0.00	0.0	0.0	62.3
23	22.0	21.5	21.5	120.0	2070	0.0	0.87	1.81	7.6	69.9	0.00	0.0	0.0	69.9
24	23.0	22.5	22.5	120.0	2190	0.0	0.86	1.88	7.9	77.8	0.00	0.0	0.0	77.8
25	24.0	23.5	23.5	120.0	2310	0.0	0.85	1.95	8.2	86.0	0.00	0.0	0.0	86.0
26	25.0	24.5	24.5	120.0	2430	0.0	0.83	2.02	8.5	94.4	0.00	0.0	0.0	94.4
27	26.0	25.5	25.5	120.0	2550	0.0	0.82	2.09	8.7	103.2	0.00	0.0	0.0	103.2
28	27.0	26.5	26.5	120.0	2670	0.0	0.81	2.15	9.0	112.2	0.00	0.0	0.0	112.2
29	28.0	27.5	27.5	120.0	2790	0.0	0.79	2.21	9.3	121.4	0.00	0.0	0.0	121.4
30	29.0	28.5	28.5	115.0	2905	1.0	0.78	0.00	0.0	121.4	0.55	2.3	2.3	123.8
31	30.0	29.5	29.5	115.0	3020	1.0	0.77	0.00	0.0	121.4	0.55	2.3	4.6	126.1
32	31.0	30.5	30.5	115.0	3135	1.0	0.75	0.00	0.0	121.4	0.55	2.3	6.9	128.4
33	32.0	31.5	31.5	115.0	3250	1.0	0.74	0.00	0.0	121.4	0.55	2.3	9.2	130.7
34	33.0	32.5	32.5	115.0	3365	1.0	0.73	0.00	0.0	121.4	0.55	2.3	11.5	133.0
35	34.0	33.5	33.5	115.0	3480	1.0	0.72	0.00	0.0	121.4	0.55	2.3	13.8	135.3
36	35.0	34.5	34.5	115.0	3595	1.0	0.71	0.00	0.0	121.4	0.55	2.3	16.1	137.6
37	36.0	35.5	35.5	115.0	3710	1.0	0.70	0.00	0.0	121.4	0.55	2.3	18.4	139.9
38	37.0	36.5	36.5	115.0	3825	1.0	0.68	0.00	0.0	121.4	0.55	2.3	20.7	142.2
39	38.0	37.5	37.5	120.0	3945	0.0	0.67	2.66	11.1	132.6	0.00	0.0	20.7	153.3
40	39.0	38.5	38.5	120.0	4065	0.0	0.66	2.69	11.3	143.8	0.00	0.0	20.7	164.6
41	40.0	39.5	39.5	120.0	4185	0.0	0.65	2.73	11.4	155.3	0.00	0.0	20.7	176.0
42	41.0	40.5	40.5	120.0	4305	0.0	0.64	2.76	11.6	166.8	0.00	0.0	20.7	187.6
43	42.0	41.5	41.5	120.0	4425	0.0	0.63	2.79	11.7	178.5	0.00	0.0	20.7	199.2



East Street Undercrossing (Widen) 16-inch CIDH at Abutments (Freehead)



East Street Undercrossing (Widen) 16-inch CIDH at Abutments (Freehead)

LPile Plus for Windows, Version 6.0 (6.0.09)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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Earth Mechanics, Inc.
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Files Used for Analysis

Path to file locations: X:\Projects\2010\10-126 - RBF SR 91 Westbound Widening\Reports\Foundation Report\East St UC\Analysis\03 Lateral Capacity\
Name of input data file: East St UC 16-inch CIDH (Abutments).lp6d
Name of output file: East St UC 16-inch CIDH (Abutments).lp6o
Name of plot output file: East St UC 16-inch CIDH (Abutments).lp6p
Name of runtime file: East St UC 16-inch CIDH (Abutments).lp6r

Date and Time of Analysis

Date: March 21, 2011 Time: 11:26:43

Problem Title

Project Name:
Job Number:
Client:
Engineer:
Description:

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections = 1

Total Pile Length = 50.00 ft

Depth of ground surface below top of pile = -3.00 ft

Slope angle of ground surface = 0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	16.0000000
2	50.000000	16.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	50.000 in
Top Width	=	16.000 in
Bottom Width	=	16.000 in
Top Area	=	201.000000 sq. in
Bottom Area	=	201.000000 sq. in
Moment of Inertia at Top	=	1.608E+03 in^4
Moment of Inertia at Bottom	=	1.608E+03 in^4
Elastic Modulus	=	3200000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	-3.000 ft
Distance from top of pile to bottom of layer	=	28.000 ft
p-y subgrade modulus k for top of soil layer	=	65.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	65.000 lbs/in**3

Layer 2 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	28.000 ft
Distance from top of pile to bottom of layer	=	37.000 ft

Layer 3 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	37.000 ft
Distance from top of pile to bottom of layer	=	55.000 ft
p-y subgrade modulus k for top of soil layer	=	100.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	100.000 lbs/in**3

Layer 4 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	55.000 ft
Distance from top of pile to bottom of layer	=	60.000 ft

(Depth of lowest layer extends 10.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 8 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	-3.00	120.00000
2	28.00	120.00000
3	28.00	115.00000
4	37.00	115.00000
5	37.00	120.00000
6	55.00	120.00000
7	55.00	120.00000
8	60.00	120.00000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. Subgr. pci
1	Sand (Reese, et al.)	-3.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
		28.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
2	Soft Clay	28.000	115.000	1000.000	--	--	--	0.00700	--	--	--	--	--	--
		37.000	115.000	1000.000	--	--	--	0.00700	--	--	--	--	--	--
3	Sand (Reese, et al.)	37.000	120.000	--	34.000	--	--	--	100.000	--	--	--	--	--
		55.000	120.000	--	34.000	--	--	--	100.000	--	--	--	--	--
4	Soft Clay	55.000	120.000	1900.000	--	--	--	0.00500	--	--	--	--	--	--
		60.000	120.000	1900.000	--	--	--	0.00500	--	--	--	--	--	--

---

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.8000	1.0000
2	50.000	0.8000	1.0000

Loading Type

---

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	75000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	75000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	75000.000
4	4	y =	2.000 in	M =	0.000 in-lbs	75000.000
5	4	y =	5.000 in	M =	0.000 in-lbs	75000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

---

Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)		Condition 2 in-lb, rad., or in-lb/rad.		Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y =	0.2500	M =	0.000	75000.	0.25000000	304829.	12198.	0.00000000
2	4	y =	0.5000	M =	0.000	75000.	0.50000000	552237.	19374.	0.00000000
3	4	y =	1.0000	M =	0.000	75000.	1.00000000	997493.	30629.	0.00000000
4	4	y =	2.0000	M =	0.000	75000.	2.00000000	1765405.	44099.	0.00000000
5	4	y =	5.0000	M =	0.000	75000.	5.00000000	3513130.	66519.	0.00000000

The analysis ended normally.

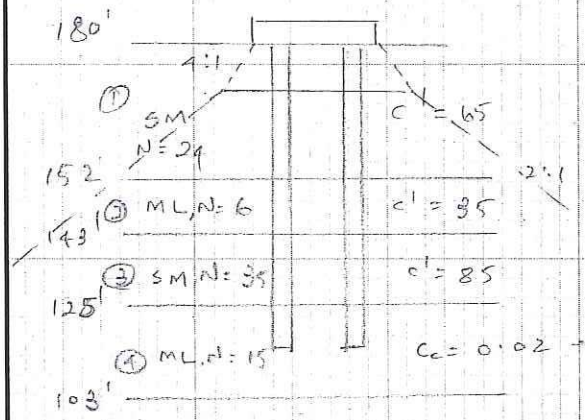
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
(714) 751-3826, Fax (714) 751-3928

Project SR-91 WB widening - East of UC **Project No.** 10-126

By SP **Date** 08-30-11 **Checked By** KCC **Date** 8/31/11 **Sheet** ____ **of** ____

Abutment settlements



Total load = 225 kips
permanent load = 160 kips
pile cap = 7.3' x 11.75'

consider pile length D = 12'

$2D/3 = 8'$

Equivalent footing = $(7.3 + \frac{8}{4}\times 2) \times (11.75 + \frac{8}{4}\times 2)$

= 11.3' x 15.75'

$q = \frac{225}{11.3 \times 15.75} = 1.3$ ksf for immediate settlement

$= \frac{160}{11.3 \times 15.75} = 0.9$ ksf for consolidation settlement

Immediate settlement

	$\bar{\sigma}_o$	$\Delta\sigma$	settlement
①	$13 \times 120 = 1.56$	$\frac{225}{(11.3+5)(15.8+5)} = 0.65$	$10 \times \frac{1}{65} \log\left(\frac{1.56+0.65}{1.56}\right) = 0.3$
①	$23 \times 120 = 2.76$	$\frac{225}{(11.3+15)(15.8+15)} = 0.27$	$10 \times \frac{1}{65} \log\left(\frac{2.76+0.27}{2.76}\right) = 0.1$
②	$36 \times 120 + 4.5 \times 115 = 3.88$	$\frac{225}{(11.3+24.5)(15.8+24.5)} = 0.15$	$9 \times \frac{1}{85} \log\left(\frac{3.88+0.15}{3.88}\right) = 0.1$
③	$37 \times 120 + 9 \times 115 = 5.48$	$\frac{225}{(11.3+32)(15.8+32)} = 0.11$	$18 \times \frac{1}{85} \log\left(\frac{5.48+0.11}{5.48}\right) = 0.02$

0.52"

consolidation settlement is negligible < 0.1"

pile length is less than 12 feet & settlement is less than 0.5"
no applicable pile length for settlement for Abutments 1 & 5

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Project SR-91 WB widening - East St UC **Project No.** 10-126

By SP **Date** 08/30/11 **Checked By** LCC **Date** 8/31/11 **Sheet** ____ **of** ____

Bents 2, 3 and 4

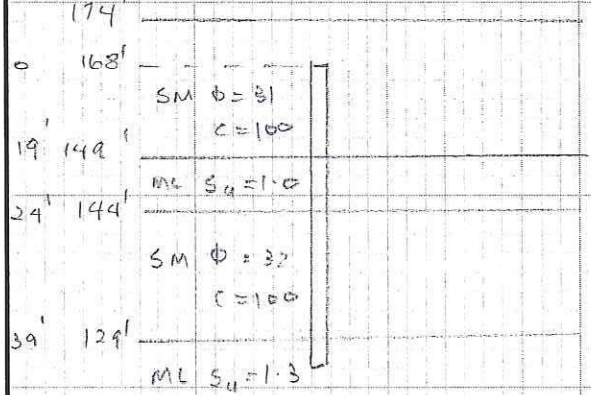
18" diameter C10H piles

$Area = \frac{\pi}{4} \times 18^2 = 254\ in^2$

$I = \frac{\pi}{64} \times 18^4 = 5158\ in^4$; $I_{cracked} = 257\ in^4$.

$\pi D = \pi \frac{18}{12} = 4.71\ ft$

Depth



Nominal resistance per pile

Strength limit state = 225/0.7 = 321.5 kips

consider 330 kips

Extreme event limit state = 275/1.0 = 275 kips

consider 280 kips

Tension = 200 kips

Nominal resistance per support

Strength limit state = 1100/0.7 = 1571 kips

Extreme event limit state = 350 kips

for pile spacing of 3.4 d

group efficiency factor = 0.87 for axial demand

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Project SR-91 WB widening - East St UC **Project No.** 10-126

By SP **Date** 08-30-11 **Checked By** LCC **Date** 8/31/11 **Sheet** ____ **of** ____

from analysis

strength limit state

at depth of 44 ft, pile capacity = 330.1 kips > 330 kips

pile tip elevation for compression = 168 - 44
= 124 feet.

Available group nominal resistance = 9 x 0.87 x 330
= 2584 kips > 1571 kips.

Available group nominal resistance exceeds the required nominal resistance for strength limit state.

pile tip elevation for compression = 124 feet for strength limit state.

Extreme event limit state

at depth of 37' pile capacity = 284.7 kips > 280 kips

pile tip elevation for compression = 168 - 37
= 131 feet.

Available group nominal resistance = 9 x 0.87 x 284.7
= 2229 kips > 350 kips

Available group nominal resistance exceeds the required nominal resistance for extreme event limit state.

pile tip elevation for compression = 131 feet for extreme event limit state.

at depth of 39 feet, tension capacity = 2/3 x 313
= 209 kips > 200 kips

pile tip elevation for tension = 168 - 39
= 129 feet for extreme event limit state

pile tip elevation for lateral load = 168 - 22 = 146 feet.

SKIN FRICTION FOR DRILLED SHAFT IN BOTH COHESIONLESS AND COHESIVE SOILS USING REESE AND O'NEILL'S METHOD (1999)

PROJECT: East St UC
ITEM: 18-inch Diameter CIDH Existing Pile
Bents 2, 3 and 4

PROJECT NO.: 10-126
DONE BY: SP DATE: 03/16/11
CHECKED BY: DATE:

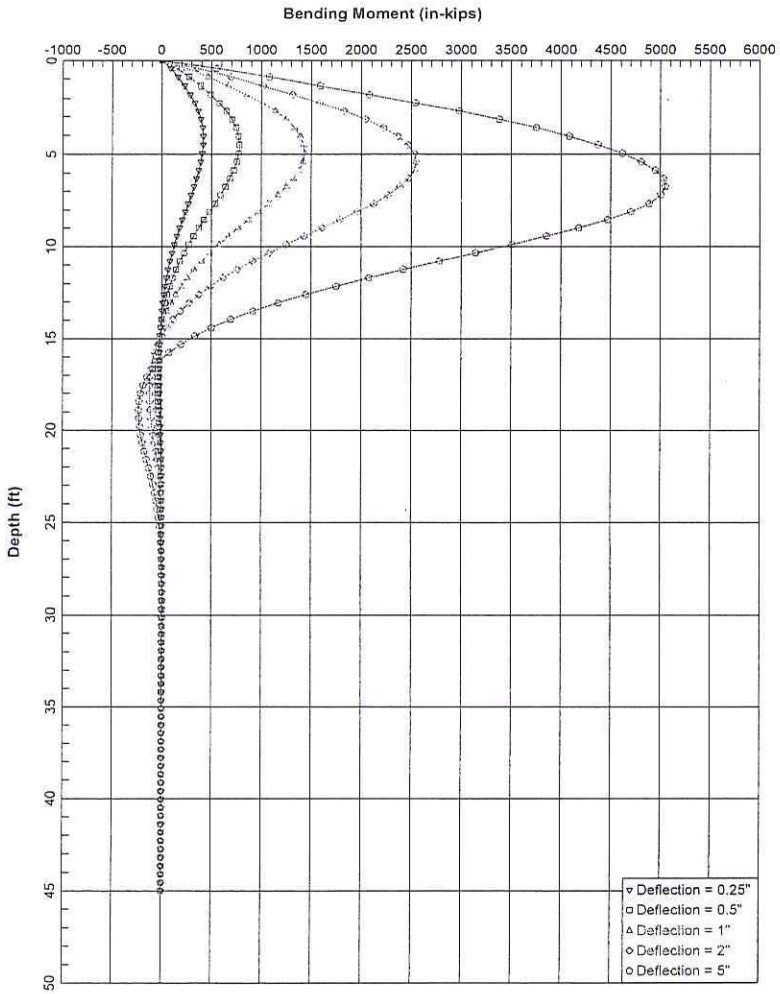
D_s => 1.50 ft Hw => 47.0 ft Hg => 0.0 ft
p = 4.71 ft Ho => 0.0 ft Hf => 0.0 ft

Hw is the depth to water table.
Hg is the depth to ground surface used in calculation.
Ho is the depth to location starting initial overburden pressure
Hf is the depth to location starting accumulation of skin frictio
bottom of footing = 168 feet

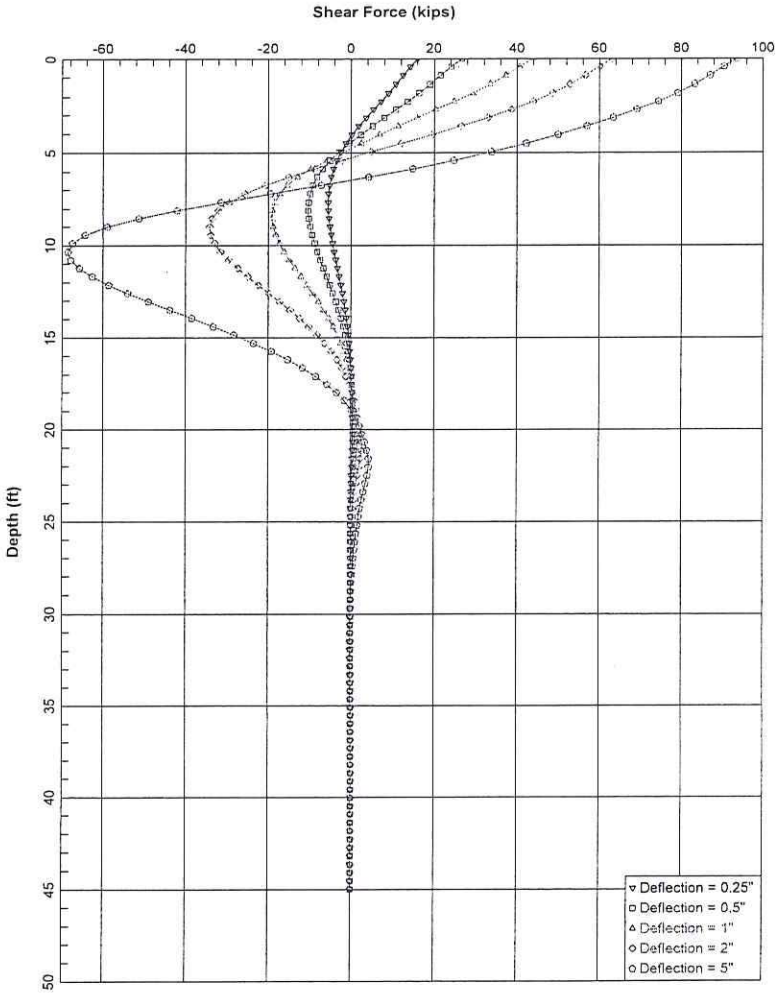
Soil Layer =>	from Top	to Bottom =>	γ (pcf)=>	γ' (pcf)=	c' (ksf) =>	ϕ' =>	
(1)	0	19	120	57.6	0.00	31	SM
(2)	19	24	115	52.6	1.00	0	ML
(3)	24	39	120	57.6	0.00	32	SM
(4)	39	64	115	52.6	1.30	0	ML

Sublayer No.	Depth, z (ft)	z_i (ft)	New Depth (ft)	Soil Unit Weight (pcf)	Overburden Pressure (psf)	c' (ksf)	β	f_i^s (ksf)	ΔQ_s^s (kips)	Q_s^s (kips)	f_i^c (ksf)	ΔQ_s^c (kips)	Q_s^c (kips)	Q_s (kips)
0	0.0	0.0	0.0	120.0	0					0.0			0.0	0.0
1	0.0	0.0	0.0	120.0	0	0.0								
2	1.0	0.5	0.5	120.0	60	0.0	1.20	0.07	0.3	0.3	0.00	0.0	0.0	0.3
3	2.0	1.5	1.5	120.0	180	0.0	1.20	0.22	1.0	1.4	0.00	0.0	0.0	1.4
4	3.0	2.5	2.5	120.0	300	0.0	1.20	0.36	1.7	3.1	0.00	0.0	0.0	3.1
5	4.0	3.5	3.5	120.0	420	0.0	1.20	0.50	2.4	5.4	0.00	0.0	0.0	5.4
6	5.0	4.5	4.5	120.0	540	0.0	1.20	0.65	3.1	8.5	0.00	0.0	0.0	8.5
7	6.0	5.5	5.5	120.0	660	0.0	1.18	0.78	3.7	12.2	0.00	0.0	0.0	12.2
8	7.0	6.5	6.5	120.0	780	0.0	1.16	0.90	4.2	16.4	0.00	0.0	0.0	16.4
9	8.0	7.5	7.5	120.0	900	0.0	1.13	1.02	4.8	21.2	0.00	0.0	0.0	21.2
10	9.0	8.5	8.5	120.0	1020	0.0	1.11	1.13	5.3	26.5	0.00	0.0	0.0	26.5
11	10.0	9.5	9.5	120.0	1140	0.0	1.08	1.24	5.8	32.3	0.00	0.0	0.0	32.3
12	11.0	10.5	10.5	120.0	1260	0.0	1.06	1.34	6.3	38.7	0.00	0.0	0.0	38.7
13	12.0	11.5	11.5	120.0	1380	0.0	1.04	1.44	6.8	45.4	0.00	0.0	0.0	45.4
14	13.0	12.5	12.5	120.0	1500	0.0	1.02	1.53	7.2	52.7	0.00	0.0	0.0	52.7
15	14.0	13.5	13.5	120.0	1620	0.0	1.00	1.63	7.7	60.3	0.00	0.0	0.0	60.3
16	15.0	14.5	14.5	120.0	1740	0.0	0.99	1.72	8.1	68.4	0.00	0.0	0.0	68.4
17	16.0	15.5	15.5	120.0	1860	0.0	0.97	1.80	8.5	76.9	0.00	0.0	0.0	76.9
18	17.0	16.5	16.5	120.0	1980	0.0	0.95	1.88	8.9	85.8	0.00	0.0	0.0	85.8
19	18.0	17.5	17.5	120.0	2100	0.0	0.94	1.96	9.3	95.0	0.00	0.0	0.0	95.0
20	19.0	18.5	18.5	120.0	2220	0.0	0.92	2.04	9.6	104.7	0.00	0.0	0.0	104.7
21	20.0	19.5	19.5	115.0	2335	1.0	0.90	0.00	0.0	104.7	0.55	2.6	2.6	107.2
22	21.0	20.5	20.5	115.0	2450	1.0	0.89	0.00	0.0	104.7	0.55	2.6	5.2	109.8
23	22.0	21.5	21.5	115.0	2565	1.0	0.87	0.00	0.0	104.7	0.55	2.6	7.8	112.4
24	23.0	22.5	22.5	115.0	2680	1.0	0.86	0.00	0.0	104.7	0.55	2.6	10.4	115.0
25	24.0	23.5	23.5	115.0	2795	1.0	0.85	0.00	0.0	104.7	0.55	2.6	13.0	117.6
26	25.0	24.5	24.5	120.0	2915	0.0	0.83	2.42	11.4	116.1	0.00	0.0	13.0	129.0
27	26.0	25.5	25.5	120.0	3035	0.0	0.82	2.48	11.7	127.8	0.00	0.0	13.0	140.7
28	27.0	26.5	26.5	120.0	3155	0.0	0.81	2.54	12.0	139.7	0.00	0.0	13.0	152.7
29	28.0	27.5	27.5	120.0	3275	0.0	0.79	2.59	12.2	152.0	0.00	0.0	13.0	164.9
30	29.0	28.5	28.5	120.0	3395	0.0	0.78	2.65	12.5	164.4	0.00	0.0	13.0	177.4
31	30.0	29.5	29.5	120.0	3515	0.0	0.77	2.70	12.7	177.1	0.00	0.0	13.0	190.1
32	31.0	30.5	30.5	120.0	3635	0.0	0.75	2.74	12.9	190.1	0.00	0.0	13.0	203.0
33	32.0	31.5	31.5	120.0	3755	0.0	0.74	2.79	13.1	203.2	0.00	0.0	13.0	216.2
34	33.0	32.5	32.5	120.0	3875	0.0	0.73	2.83	13.3	216.5	0.00	0.0	13.0	229.5
35	34.0	33.5	33.5	120.0	3995	0.0	0.72	2.87	13.5	230.1	0.00	0.0	13.0	243.0
36	35.0	34.5	34.5	120.0	4115	0.0	0.71	2.91	13.7	243.8	0.00	0.0	13.0	256.7
37	36.0	35.5	35.5	120.0	4235	0.0	0.70	2.95	13.9	257.7	0.00	0.0	13.0	270.6
38	37.0	36.5	36.5	120.0	4355	0.0	0.68	2.98	14.0	271.7	0.00	0.0	13.0	284.7
39	38.0	37.5	37.5	120.0	4475	0.0	0.67	3.01	14.2	285.9	0.00	0.0	13.0	298.9
40	39.0	38.5	38.5	120.0	4595	0.0	0.66	3.04	14.3	300.2	0.00	0.0	13.0	313.2
41	40.0	39.5	39.5	115.0	4710	1.3	0.65	0.00	0.0	300.2	0.72	3.4	16.3	316.6
42	41.0	40.5	40.5	115.0	4825	1.3	0.64	0.00	0.0	300.2	0.72	3.4	19.7	319.9
43	42.0	41.5	41.5	115.0	4940	1.3	0.63	0.00	0.0	300.2	0.72	3.4	23.1	323.3

Sublayer No.	Depth, z (ft)	z_i (ft)	New Depth (ft)	Soil Unit Weight (pcf)	Overburden Pressure (psf)	c' (ksf)	β	f_i^s (ksf)	ΔQ_s^s (kips)	Q_s^s (kips)	f_i^c (ksf)	ΔQ_s^c (kips)	Q_s^c (kips)	Q_s (kips)
44	43.0	42.5	42.5	115.0	5055	1.3	0.62	0.00	0.0	300.2	0.72	3.4	26.4	326.7
45	44.0	43.5	43.5	115.0	5170	1.3	0.61	0.00	0.0	300.2	0.72	3.4	29.8	330.1
46	45.0	44.5	44.5	115.0	5285	1.3	0.60	0.00	0.0	300.2	0.72	3.4	33.2	333.4
47	46.0	45.5	45.5	115.0	5400	1.3	0.59	0.00	0.0	300.2	0.72	3.4	36.5	336.8
48	47.0	46.5	46.5	115.0	5515	1.3	0.58	0.00	0.0	300.2	0.72	3.4	39.9	340.2
49	48.0	47.5	47.5	52.6	5568	1.3	0.57	0.00	0.0	300.2	0.72	3.4	43.3	343.5
50	49.0	48.5	48.5	52.6	5620	1.3	0.56	0.00	0.0	300.2	0.72	3.4	46.7	346.9
51	50.0	49.5	49.5	52.6	5673	1.3	0.55	0.00	0.0	300.2	0.72	3.4	50.0	350.3
52	51.0	50.5	50.5	52.6	5725	1.3	0.54	0.00	0.0	300.2	0.72	3.4	53.4	353.6
53	52.0	51.5	51.5	52.6	5778	1.3	0.53	0.00	0.0	300.2	0.72	3.4	56.8	357.0
54	53.0	52.5	52.5	52.6	5831	1.3	0.52	0.00	0.0	300.2	0.72	3.4	60.1	360.4
55	54.0	53.5	53.5	52.6	5883	1.3	0.51	0.00	0.0	300.2	0.72	3.4	63.5	363.7
56	55.0	54.5	54.5	52.6	5936	1.3	0.50	0.00	0.0	300.2	0.72	3.4	66.9	367.1
57	56.0	55.5	55.5	52.6	5988	1.3	0.49	0.00	0.0	300.2	0.72	3.4	70.2	370.5
58	57.0	56.5	56.5	52.6	6041	1.3	0.49	0.00	0.0	300.2	0.72	3.4	73.6	373.9
59	58.0	57.5	57.5	52.6	6094	1.3	0.48	0.00	0.0	300.2	0.72	3.4	77.0	377.2
60	59.0	58.5	58.5	52.6	6146	1.3	0.47	0.00	0.0	300.2	0.72	3.4	80.3	380.6
61	60.0	59.5	59.5	52.6	6199	1.3	0.46	0.00	0.0	300.2	0.72	3.4	83.7	384.0



East Street Undercrossing (Widen) 16-inch CIDH at Bents (Freehead)



East Street Undercrossing (Widen) 16-inch CIDH at Bents (Freehead)

```
================================================================================

                LPile Plus for Windows, Version 6.0 (6.0.09)

              Analysis of Individual Piles and Drilled Shafts
            Subjected to Lateral Loading Using the p-y Method

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                           All Rights Reserved

================================================================================

This program is licensed to:

Earth Mechanics, Inc.
Earth Mechanics, Inc.

--------------------------------------------------------------------------------
                            Files Used for Analysis
--------------------------------------------------------------------------------

Path to file locations:      X:\Projects\2010\10-126 - RBF SR 91 Westbound Widening\Reports\Foundation Report\East St UC\Analysis\03 Lateral Capacity\
Name of input data file:     East St UC 18-inch CIDH (Bents).lp6d
Name of output file:         East St UC 18-inch CIDH (Bents).lp6o
Name of plot output file:    East St UC 18-inch CIDH (Bents).lp6p
Name of runtime file:        East St UC 18-inch CIDH (Bents).lp6r

--------------------------------------------------------------------------------
                           Date and Time of Analysis
--------------------------------------------------------------------------------

              Date:  March 21, 2011     Time:  11:31:42

--------------------------------------------------------------------------------
                                Problem Title
--------------------------------------------------------------------------------

Project Name:

Job Number:

Client:

Engineer:

Description:



--------------------------------------------------------------------------------
                              Program Options
--------------------------------------------------------------------------------

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
  Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum
  bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:
- Number of pile increments                    =          100
- Maximum number of iterations allowed         =          100
- Deflection tolerance for convergence         =   1.0000E-05  in
```

- Maximum allowable deflection = 100.0000 in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections = 1

Total Pile Length = 45.00 ft

Depth of ground surface below top of pile = -5.00 ft

Slope angle of ground surface = 0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	18.0000000
2	45.000000	18.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	45.000 in
Top Width	=	18.000 in
Bottom Width	=	18.000 in
Top Area	=	254.000000 sq. in
Bottom Area	=	254.000000 sq. in
Moment of Inertia at Top	=	2.576E+03 in^4
Moment of Inertia at Bottom	=	2.576E+03 in^4
Elastic Modulus	=	3200000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = -5.000 ft
Distance from top of pile to bottom of layer = 19.000 ft
p-y subgrade modulus k for top of soil layer = 50.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 50.000 lbs/in**3

Layer 2 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 19.000 ft
Distance from top of pile to bottom of layer = 24.000 ft

Layer 3 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 24.000 ft
Distance from top of pile to bottom of layer = 39.000 ft
p-y subgrade modulus k for top of soil layer = 70.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 70.000 lbs/in**3

Layer 4 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 39.000 ft
Distance from top of pile to bottom of layer = 47.000 ft

(Depth of lowest layer extends 2.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 8 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	-5.00	120.00000
2	19.00	120.00000
3	19.00	115.00000
4	24.00	115.00000
5	24.00	120.00000
6	39.00	120.00000
7	39.00	120.00000
8	47.00	120.00000

Summary of Soil Properties

Layer Subgr. Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. pci
1	Sand (Reese, et al.)	-5.000	120.000	--	31.000	--	--	--	50.000	--	--	--	--	--
		19.000	120.000	--	31.000	--	--	--	50.000	--	--	--	--	--
2	Soft Clay	19.000	115.000	1000.000	--	--	--	0.00700	--	--	--	--	--	--
		24.000	115.000	1000.000	--	--	--	0.00700	--	--	--	--	--	--
3	Sand (Reese, et al.)	24.000	120.000	--	32.000	--	--	--	70.000	--	--	--	--	--
		39.000	120.000	--	32.000	--	--	--	70.000	--	--	--	--	--
4	Soft Clay	39.000	120.000	1300.000	--	--	--	0.00500	--	--	--	--	--	--
		47.000	120.000	1300.000	--	--	--	0.00500	--	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.7400	1.0000
2	45.000	0.7400	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	150000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	150000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	150000.000
4	4	y =	2.000 in	M =	0.000 in-lbs	150000.000
5	4	y =	5.000 in	M =	0.000 in-lbs	150000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)		Condition 2 in-lb, rad., or in-lb/rad.		Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y =	0.2500	M =	0.000	150000.	0.25000000	417446.	15968.	0.00000000
2	4	y =	0.5000	M =	0.000	150000.	0.50000000	778790.	26585.	0.00000000
3	4	y =	1.0000	M =	0.000	150000.	1.00000000	1431586.	43768.	0.00000000
4	4	y =	2.0000	M =	0.000	150000.	2.00000000	2545690.	63102.	0.00000000
5	4	y =	5.0000	M =	0.000	150000.	5.00000000	5049454.	93559.	0.00000000

Summary of Warning Messages

The following warning was reported 154 times

**** Warning ****

An unreasonable input value for shear strength has been specified for a soil defined using the soft clay criteria. The input value is greater than 8.68 psi (1,250 psf). You should check your input data for correctness.

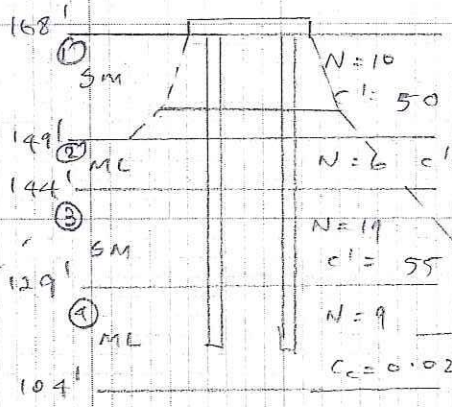
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
(714) 751-3826, Fax (714) 751-3928

Project SR-91 WB widening - East St UC **Project No.** 10-126

By SP **Date** 03-16-11 **Checked By** LCC **Date** 3/18/11 **Sheet** ____ **of** ____

Bents settlement



Total load = 720 kips
permanent load = 350 kips
pile cap = 12.5' x 12.5'

consider pile length D = 16'

$2P/3 = 10.7'$

Equivalent Footing = $(12.5 + \frac{10.7}{4} \times 2) \times (12.5 + \frac{10.7}{4} \times 2)$

= 17.8' x 17.8'

$q = \frac{720}{17.8 \times 17.8} = 2.3$ ksf for immediate settlement

$= \frac{350}{17.8 \times 17.8} = 1.1$ ksf for consolidation settlement

Immediate settlement

	σ_{vo}	$\Delta\sigma$	Settlement
①	$14.9 \times 120 = 1.79$	$\frac{720}{(17.8+4.2)^2} = 1.49$	$8.3 \times \frac{1}{50} \log\left(\frac{1.79+1.49}{1.79}\right) = 0.52$
②	$19 \times 120 + 2.5 \times 115 = 2.57$	$\frac{720}{(17.8+10.8)^2} = 0.88$	$5 \times \frac{1}{35} \log\left(\frac{2.57+0.88}{2.57}\right) = 0.22$
③	$26.5 \times 120 + 5 \times 115 = 3.76$	$\frac{720}{(17.8+20.8)^2} = 0.48$	$15 \times \frac{1}{55} \log\left(\frac{3.76+0.48}{3.76}\right) = 0.17$
①	$34 \times 120 + 9 \times 115 = 5.1$	$\frac{720}{(17.8+32.3)} = 0.29$	$8 \times \frac{1}{50} \log\left(\frac{5.1+0.29}{5.1}\right) = \frac{0.05}{0.96}$"

consolidation settlement = $17 \times 0.02 \log\left(\frac{6+0.18}{6}\right) = 0.05$"

Total settlement = 1.01".

pile tip elevation for settlement = 168 - 16
= 152 feet

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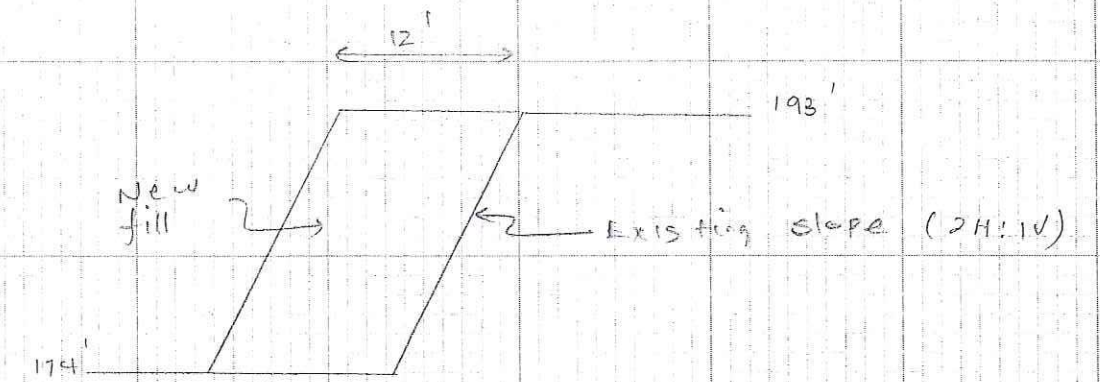
Project SR91 WB widening - East st UC **Project No.** 10-126

By SP **Date** 03-17-11 **Checked By** KC **Date** 11/18/11 **Sheet** ____ **of** ____

Approach Embankment settlement



① SM $c' = 65$

148'

② ML $c' = 35$

143'

③ SM $c' = 85$

125'

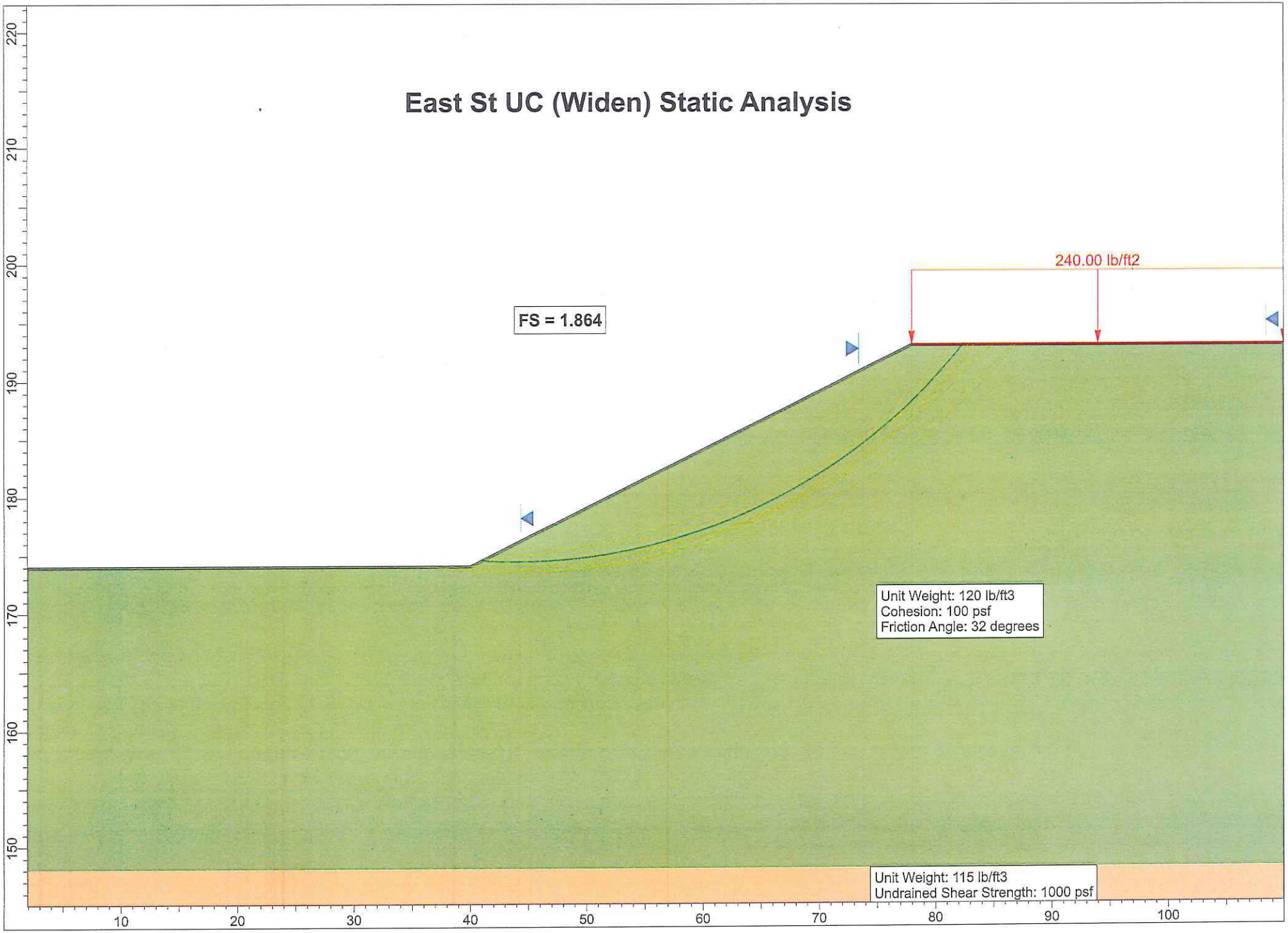
④ ML $C_c = 0.02$

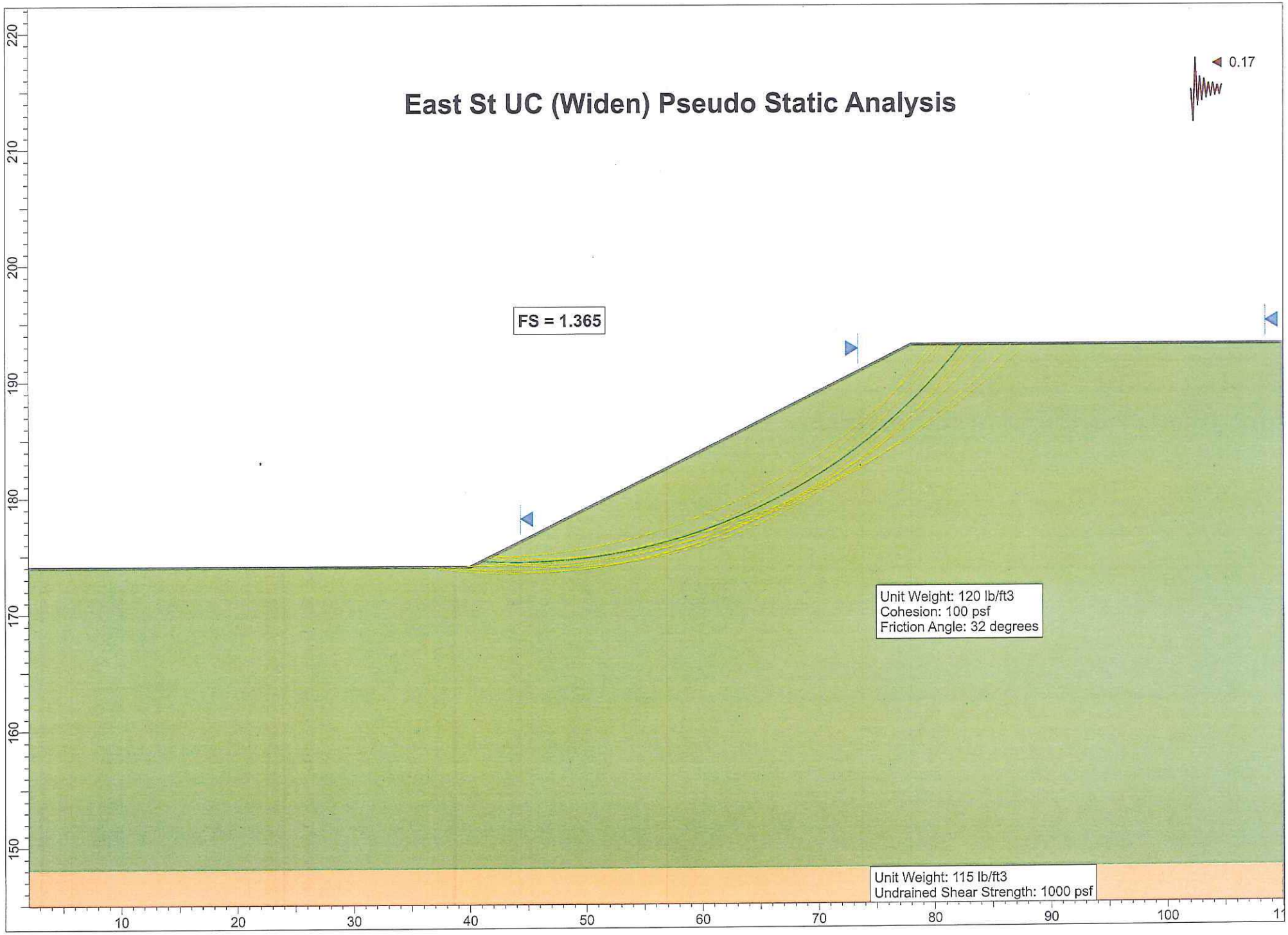
121'

103'

pwl to new fill $q = 19 \times 120 = 2.3$ ksf

	σ_{vo}	$\Delta\sigma$	settlement
①	$6 \times 120 = 0.72$	$2.3 \times 0.8 = 1.84$	$12 \times \frac{1}{65} \log\left(\frac{0.72 + 1.84}{0.72}\right) = 1.22$
②	$19 \times 120 = 2.28$	$2.3 \times 0.4 = 0.92$	$14 \times \frac{1}{65} \log\left(\frac{2.28 + 0.92}{2.28}\right) = 0.38$
③	$26 \times 120 + 2.5 \times 115 = 3.4$	$2.3 \times 0.25 = 0.58$	$5 \times \frac{1}{85} \log\left(\frac{3.4 + 0.58}{3.4}\right) = 0.12$
④	$35 \times 120 + 5 \times 115 = 4.78$	$2.3 \times 0.2 = 0.46$	$18 \times \frac{1}{85} \log\left(\frac{4.78 + 0.46}{4.78}\right) = 0.1$
⑤	$46 \times 120 + 5 \times 115 = 6.1$	$2.3 \times 0.15 = 0.35$	$4 \times \frac{1}{50} \log\left(\frac{6.1 + 0.35}{6.1}\right) = 0.02$
⑥	$48 \times 120 + 5 \times 115 + 9 \times 57.6 = 6.85$	$2.3 \times 0.1 = 0.23$	$18 \times 0.02 \log\left(\frac{6.85 + 0.23}{6.85}\right) = 0.06$
			1.911


East St UC (Widen) Static Analysis
240.00 lb/ft2
FS = 1.864
Unit Weight: 120 lb/ft3
Cohesion: 100 psf
Friction Angle: 32 degrees
Unit Weight: 115 lb/ft3
Undrained Shear Strength: 1000 psf
220
210
200
190
180
170
160
150
10
20
30
40
50
60
70
80
90
100


East St UC (Widen) Pseudo Static Analysis
0.17
FS = 1.365
Unit Weight: 120 lb/ft3
Cohesion: 100 psf
Friction Angle: 32 degrees
Unit Weight: 115 lb/ft3
Undrained Shear Strength: 1000 psf
220
210
200
190
180
170
160
150
10
20
30
40
50
60
70
80
90
100

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Project SD-91 WB widening - East St UC **Project No.** 10-126

By SP **Date** 03-17-11 **Checked By** LCA **Date** 11/18/11 **Sheet** ____ **of** ____

Surficial stability

for a 1.5 : 1 slope

$\beta = \tan^{-1}\left(\frac{1}{1.5}\right) = 33.7^\circ$

consider thickness of slide $h = 4$ ft

consider $\delta = 120$ pcf

$\phi = 32^\circ$

$c = 230$ psf

$$\text{factor of safety} = \frac{c + h\gamma' \cos^2\beta \tan\phi}{h\gamma \sin\beta \cos\beta}$$

$$= \frac{230 + 4(120 - 62.4)\cos^2 33.7 \tan 32}{4 \times 120 \sin 33.7 \cos 33.7}$$

$$= 1.5$$

Appendix D

CALTRANS REVIEW COMMENTS AND EMI RESPONSES

State of California

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: LUQI YANG
Liaison Engineer

Date: May 2, 2011

File: 12-ORA-91 PM Various
EA 12-0C5701, 1200000079
Brookhurst Ave UC + 5Br.
No. 55-0280 + 5

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
Geotechnical Services
Office of Geotechnical Design – South 1

Subject: Foundation Report- Bridge No. 55-0216, 55-0218, 55-0245, 55-0279, 55-0280 & 55-852

Per your request, the Geotechnical Design South 1 - Branch B has reviewed the subject submittal, containing the following item:

1. Foundation Reports for No. 55-0216, 55-0218, 55-0245, 55-0279, 55-0280 & 55-852, Anaheim, Orange County, dated April 15, 2011.

Our office has no comments on above submitted item.

Should you have any questions, please contact Mushtaq Ahmed at (213) 620-2132.

Reviewed by: Date: 5/2/11

Mushtaq Ahmed, P.E.
Transportation Engineer-Civil
Office of Geotechnical Design – South 1
Branch B

Supervised by: Date: 5/2/11

Sam Sukiasian, G.E.
Chief Branch B
Office of Geotechnical Design – South 1

cc: OGDS1 – Nor. File, OGDS1- Sac. File, GS-Sac. File

REGISTERED CIVIL ENGINEER
MOHAMMAD MUSHTAQ AHMED
No. C056390
Exp. 6-30-11
STATE OF CALIFORNIA

FOUNDATION REPORT
ACACIA ST UC (Widen)
Bridge No. 55-0218

Earth Mechanics, Inc.

September 16, 2011

FOUNDATION REPORT

Acacia Street Undercrossing (Widen)
Bridge No. 55-0218
Orange County, California
12-ORA-91, PM 4.8
Caltrans Project No. 12000000791 (EA 12-0C5701)
EMI Project No. 10-126
Date: September 16, 2011

EARTH MECHANICS, INC.

Geotechnical and Earthquake Engineering

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

September 16, 2011

EMI Project No. 10-126

RBF Consulting
14725 Alton Parkway
Irvine, California 92618

Attention: Mr. Steve Huff, P.E.

Subject: Foundation Report for Acacia Street Undercrossing (Widen)
Bridge No. 55-0218
Anaheim, Orange County, California
12-Ora-91, PM 4.8
Caltrans Project No. 12000000791 (EA 12-0C5701)

Dear Mr. Huff:

Attached please find the Foundation Report for the subject bridge widening project. This report contains the findings and conclusions of our field investigation and laboratory testing program. This report also contains our recommendations for the design and construction of the bridge foundations.

An earlier version of this report dated April 15, 2011 was submitted to Caltrans for review. Caltrans prepared a memorandum dated May 2, 2011 indicating they have no comments. A copy of this Caltrans memorandum is included in Appendix D.

We appreciate the opportunity to provide geotechnical design services for this project. If you have any questions, please call us.

Sincerely,

EARTH MECHANICS, INC.

09-16-11

9-16-11

(Ranjan) G. J. Gunaranjan, PE 71758
Senior Staff Engineer

Lino Cheang, GE 2345
Project Manager

GJG/gjg,lcc

FOUNDATION REPORT

ACACIA STREET UNDERCROSSING (WIDEN)
BRIDGE NO. 55-0218
ANAHEIM, ORANGE COUNTY, CALIFORNIA
12-ORA-91, PM 4.8
CALTRANS PROJECT NO. 12000000791 (EA 12-0C5701)

Prepared for:

RBF Consulting
14725 Alton Parkway
Irvine, California 92618

Prepared By:

Earth Mechanics, Inc.
17800 Newhope Street, Suite B
Fountain Valley, California 92708

EMI Project No. 10-126

September 16, 2011

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1.0 INTRODUCTION

1.1 Purpose and Scope of Study

This Foundation Report presents the findings and conclusions of a geotechnical investigation conducted by Earth Mechanics, Inc. (EMI). It presents foundation design and construction recommendations for the proposed widening of the Acacia Street Undercrossing (UC) in the City of Anaheim, County of Orange, California. A site location map is presented in Figure 1-1.

EMI is a subconsultant to RBF Consulting (RBF). The geotechnical services provided for this project included the following tasks:

- Collection and review of existing geotechnical information;
- Field exploration consisting of drilling and logging exploratory borings and Cone Penetration Test (CPT) sounding;
- Laboratory testing of selected bulk and relatively undisturbed soil samples;
- Engineering calculations and analysis to develop foundation design and construction recommendations; and
- Preparation of this report presenting our findings, conclusions, and recommendations.

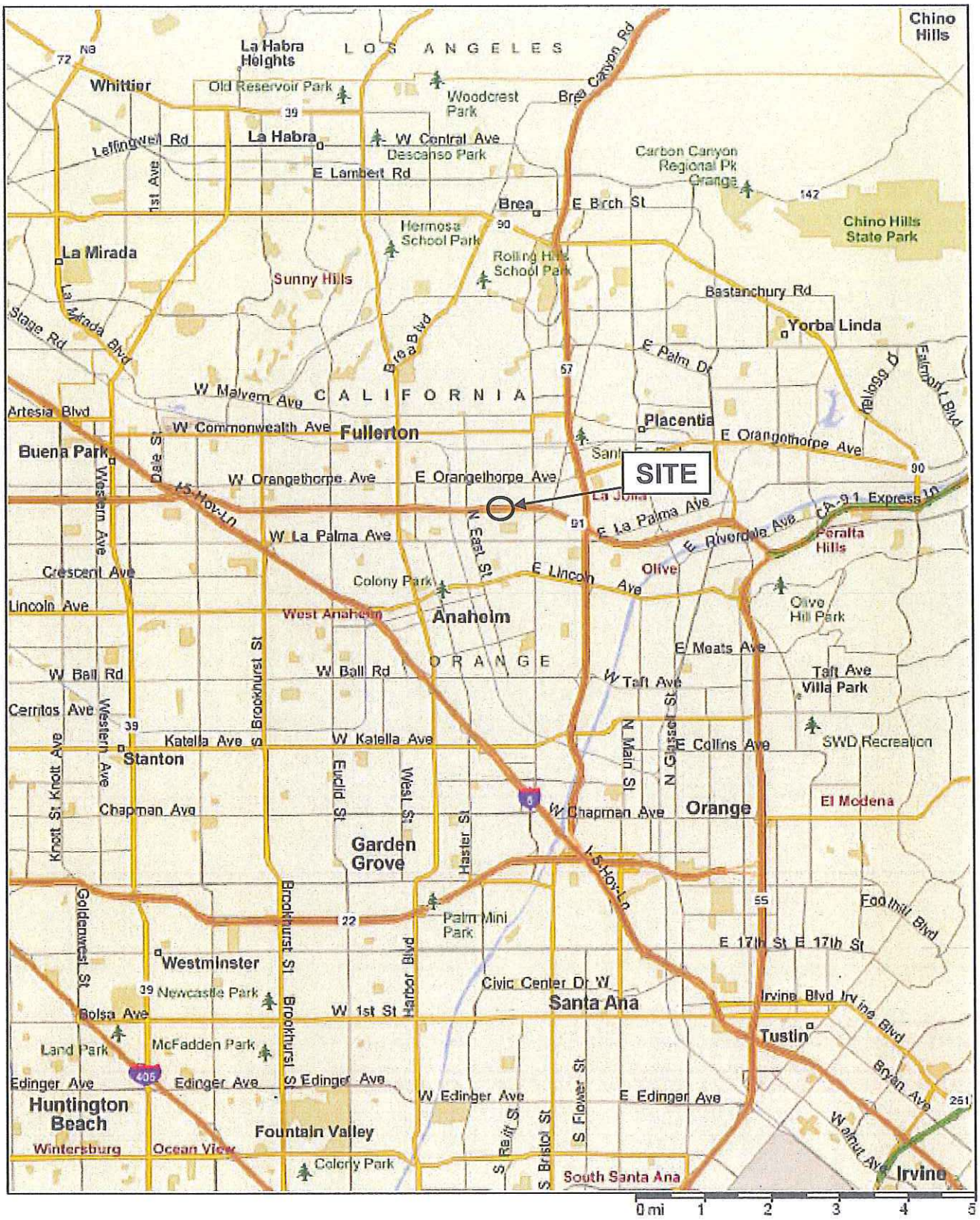
1.2 Project Description

The California Department of Transportation (Caltrans), in cooperation with the Orange County Transportation Authority (OCTA) and the cities of Anaheim and Fullerton, proposes to widen the westbound State Route 91 (SR-91) from State Route 57 (SR-57) to Interstate 5 (I-5). SR-91 is a major east-west freeway facility that begins at the eastern junction with SR-60 in the city of Riverside in Riverside County, and continues west through Orange County to its terminus at the junction with Pacific Coast Highway 1 near the city of Hermosa Beach in Los Angeles County.

The proposed project limits cover a distance of 4.5 miles; however, actual improvements are limited to a total of 3.8 miles within the project area. The proposed project consists of widening six bridges. The subject foundation report addresses only the Acacia Street UC (Bridge No. 55-0218).

The existing Acacia Street UC will be widened by about 12 feet only on the north side in order to accommodate widening of the westbound SR-91. The proposed widened Acacia Street UC is a three-span structure supported on seat type abutments (Abutments 1 & 4) and one-column bents (Bents 2 and 3). The new bridge deck will be approximately 169 feet wide and the bridge length is about 121.6 feet.

A new retaining wall (RW 305) is also proposed on the north side of the widened Abutment 1 and Bent 2 to retain the new abutment end slope. This retaining wall is needed because the end slope is close to an existing residential block wall.



Acacia Street UC (Widen)	SITE LOCATION MAP
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 1-1
Project No. 10-126	Date: 03-21-11

1.3 Existing Bridge Information

The existing UC was originally constructed in November 1959, widened in February 1967, and widened and retrofitted in July 2000. Based on the as-built plans, the original UC is supported on 45-ton, driven concrete piles and the 1967 widened portion is supported on 45-ton, 16-inch diameter Cast-In-Drilled-Hole (CIDH) piles. Foundation type of the widening and retrofitting in 2000 consists of 16-inch diameter CIDH piles with design loadings of 70 tons and 100 tons at abutments and bents, respectively.

As-built pile tip elevations for the original bridge is near +134 feet. For the 1967 widening, the as-built pile tip elevation is also near +134 feet. The specified pile tip elevations for the 2000 widening and retrofitting are +146 and +133 feet at the abutments and bents, respectively.

2.0 FIELD INVESTIGATION AND LABORATORY TESTING

2.1 Existing Information

The as-built Logs-of-Test-Borings (LOTB) sheets for the previous widening and retrofitting of the existing Acacia Street UC were reviewed as part of the preparation of this report. Copies of these LOTB sheets are provided in Appendix A.

For the widening and retrofitting in 2000, two rotary-wash borings and one CPT sounding were performed in January 1993. The deepest boring was advanced to about elevation +107 feet. Existing grades at the borehole locations at the time of the investigation were between elevations +198.1 and +198.7 feet, which are near the freeway surface elevation.

As-Built LOTB sheet of the original UC was used for the widening in February 1967.

For the original UC construction in 1959, two 1-inch soil-tube borings were drilled in August 1954. The deepest boring was advanced to about elevation +134 feet. Existing grade at the borehole locations at the time of the investigation was between +179.4 and +179.6 feet, which is near the roadway surface elevation of Acacia Street.

2.2 Field Investigation

To supplement the existing subsurface information, two soil borings and one CPT sounding were performed by EMI between December, 2010 and January, 2011. Exploration information, including Boring/CPT number, stations, offsets, ground surface elevations, bottom elevations and water level measurements are summarized in Table 2-1. Locations of the geotechnical exploration are also shown on the LOTB sheet provided in Appendix A.

Table 2-1. Geotechnical Exploration Information

Boring / CPT No.	Station Line	Approx. Station	Approx. Offset (feet)	Approx. Ground Surface El. (feet)	Approx. Exploration Bottom El. (feet)	Water Level El. (feet)
A-10-054	"A" Line	305+43	95 Lt	+181.0	+99.5	+128
A-10-055		306+48	76 Lt	+200.5	+129.3	Not Encountered
CPT-10-053		304+43	73 Lt	+200.0	+140.6	Not Measured

2.2.1 Soil Borings

Boring A-10-054 was drilled on Acacia Street, in between the proposed Bents 2 and 3, and Boring A-10-055 was drilled on the SR-91 freeway shoulder, east of Abutment 4.

Exploratory borings were drilled by 2R Drilling under subcontract with EMI using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers. The sampling interval is

usually 5 feet. Sampling was performed by alternating the Modified California Drive (MCD) sampler and Standard Penetration Test (SPT) sampler.

Relatively undisturbed drive samples were obtained using a 3.25-inch outer diameter MCD sampler lined with brass rings. Each of these brass rings is 1-inch long with a 2.5-inch outside diameter. The MCD sampler was driven into the ground using successive blows of a 140-lb hammer falling a distance of 30 inches. The numbers of blow to advance the sampler each 6 inches of penetration or less were recorded. The numbers of blow for the final 12 inches or shorter of driving are shown on the LOTB sheet.

The SPT sampler (1.4-inch inside diameter) was also used to obtain soil samples. The SPT sampler was driven into the ground using a 140-lb hammer falling from a height of 30 inches. The numbers of blow to advance the sampler each 6 inches of penetration or less were recorded. The blow counts required to drive the sampler for the last 12 inches or less were recorded as the Standard Penetration Resistance (N-value) on the LOTB sheet.

Charts published by Winterkorn and Fang (1975) can be used to determine a reduction factor used to convert blowcounts recorded using the California Drive sampler into SPT blowcounts. Using those charts, we obtained a reduction factor of 0.5 and this one-half reduction factor was used for this project.

2.2.2 CPT Sounding

The sounding CPT-10-053 was performed on the SR-91 freeway shoulder, west of Abutment 1.

The CPT sounding was performed by Middle Earth Geo Testing, Inc. under subcontract with EMI using an electronic cone penetrometer in general accordance with the current ASTM Standards (ASTM D5778 and ASTM D3441). The CPT equipment consisted of a cone penetrometer assembly mounted at the end of a series of hollow sounding rods. The cone penetrometer assembly consisted of a conical tip with a 60° apex angle and a projected cross sectional area of 1.55 in^2 (10 cm^2) and a cylindrical friction sleeve with a surface area of 23.25 in^2 (150 cm^2). The interior of the cone penetrometer is instrumented with strain gauges that allow simultaneous measurements of cone tip and friction sleeve resistance during penetration. The cone penetrometer assembly is continuously pushed into the soil by a set of hydraulic rams at a standard rate of 0.79 inch per second (20 mm per second) while the cone tip resistance and sleeve friction resistance are recorded every 1.967 inches (50 mm) and stored in digital form. A specially designed all-wheel drive 25-ton truck provides the required reaction weight for pushing the cone assembly and is also used to transport and house the test equipment. The computer generated graphical logs include cone resistance, friction resistance, and friction ratio. Soil behavior type interpretations are based on guidelines by Robertson and Campanella (1989).

2.3 Laboratory Testing

Soil samples considered representative of the subsurface conditions were tested to obtain or derive relevant physical and engineering soil properties. The following laboratory tests were conducted to supplement the observations recorded during the field investigation:

- In-situ Moisture Content and Unit Weight

- Percent Passing No. 200 Sieve
- Atterberg Limits
- Direct Shear
- Unconsolidated Undrained Triaxial
- Pocket Penetrometer
- Compaction
- R-Value
- Minimum Resistivity, pH, Sulfate Content and Chloride Content

The laboratory tests were conducted in general accordance with California Test Methods or American Society for Testing and Materials (ASTM) Standards. Laboratory test results are included in Appendix B.

Compaction and R-value tests are noted on the LOTB in Appendix A. These tests were conducted for the pavement design; these test results were not used in preparation of the recommendations included in this report and therefore, it was omitted from Appendix B.

3.0 GEOLOGY AND SEISMICITY

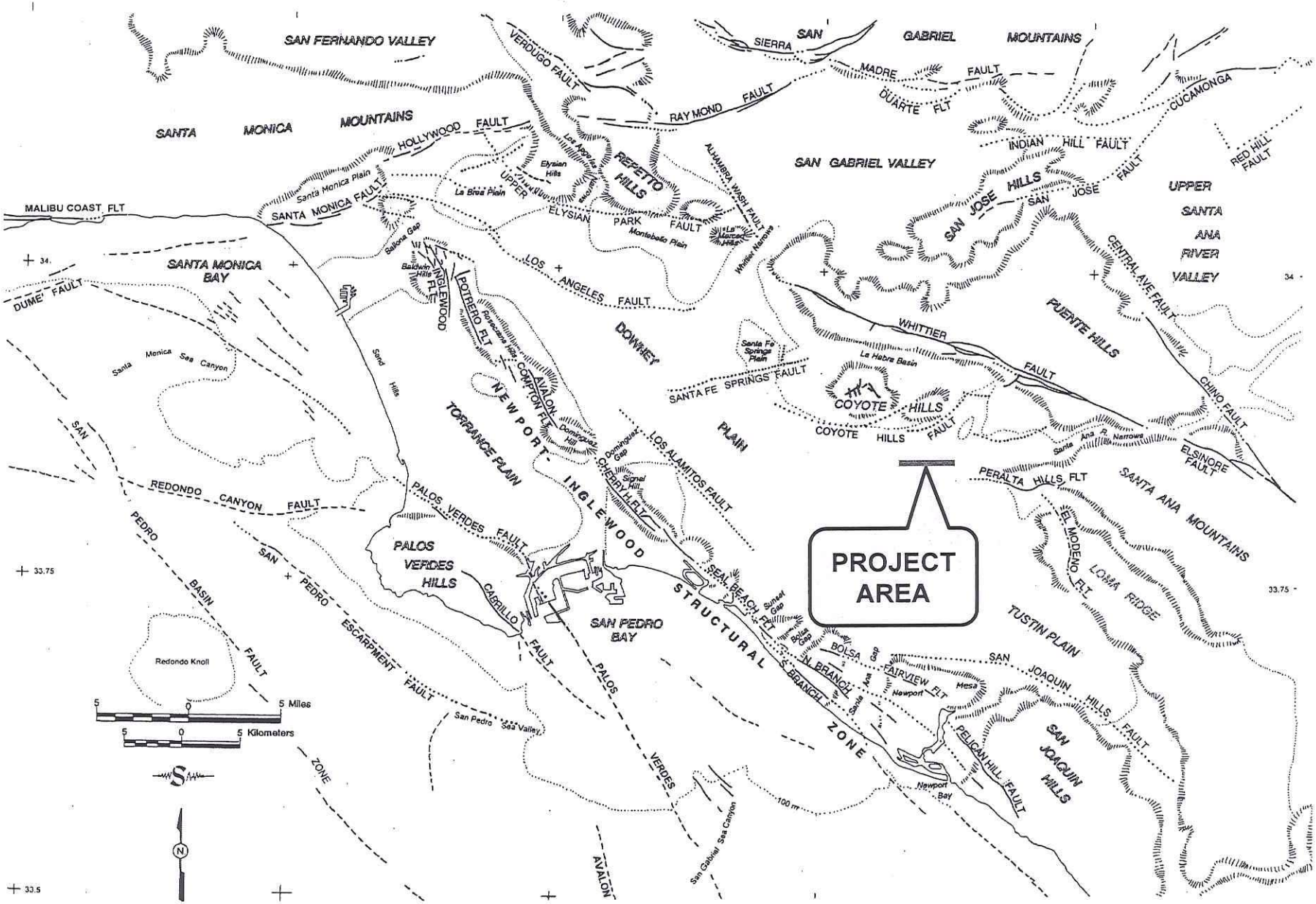
3.1 Physiography

The project area is in the east-central part of the Los Angeles Basin as shown in Figure 3-1 which comprises a transition zone between the Peninsular Ranges physiographic province on the east, and the Transverse Ranges physiographic province to the north. The Peninsular Ranges physiographic province comprises a northwest-southeast trending group of fault-bounded ranges such as Santa Ana Mountains, Puente Hills and San Joaquin Hills between the Salton Trough and the Pacific Ocean. The Transverse Ranges physiographic province comprises east-west trending ranges and valleys such as the Santa Monica Mountains, San Fernando Valley and San Gabriel Mountains. Valleys such as the Los Angeles Basin, the San Gabriel Valley and the Upper Santa Ana River Valley have characteristics compatible with both physiographic provinces and form a transition zone between the two provinces.

The Los Angeles Basin is essentially a large, relatively flat, low-lying and coastal plain surrounded by mountains on the north, east and southeast which rise abruptly to a few thousand feet above the plains. The western margin of the basin is bordered by the sea, the Palos Verdes Hills and the San Joaquin Hills. The floor of the basin gradually rises inland to a series of uplifted terrain along the margins of the surrounding mountains. This elevated marginal terrain includes the Santa Monica, La Brea, Montebello, Santa Fe Springs plains, and the Coyote Hills. The generally flat-lying nature and gradual inland rise of the Basin floor is disrupted by an alignment of northwest-southeast trending, low-elevation hills along the Newport-Inglewood Structural Zone (NISZ). The areas on either side of the NISZ are essentially flat and comprise the Downey-Tustin plain on the northeast and the Torrance Plain on the southwest. The site area is near the transition between the Downey and the Tustin plains.

3.2 Geologic Structure

The Los Angeles Basin is a deep structural basin comprising two major downward folds (synclines) separated by the NISZ uplift; the Paramount syncline is east of the NISZ under the Downey-Tustin Plain, and the Gardena syncline is west of the NISZ under the Torrance Plain. The Paramount syncline is the larger and deeper syncline with basement rocks as deep as about 30,000 feet (Yerkes et al, 1965). As described in the physiography section, the basin is rimmed by marginal elevated plains that rise about a hundred feet to as much as a couple hundred feet above the general level of the basin floor. These elevated plains and the Coyote Hills are underlain by fault-bounded, upward folds (anticlines) that are prolific oil fields. Most of the major faults associated with these folds are blind thrust faults and are shown on Figure 3-1 as dotted lines. The nearest faults to the project area are the blind thrust faults of the Puente Hills Blind Thrust Fault System and Compton-Los Alamitos Blind Fault System. Larger surface faults, such as the NISZ and the Elsinore Fault Zone (Whittier Section) lie to the southwest and northeast of the project site, respectively.



State Route 91 Westbound Widening Project

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

REGIONAL MAP OF ACTIVE FAULTS AND PHYSIOGRAPHY

Figure 3-1

Project No. 10-126

Date: 03-21-11

3.3 Geological Hazards

The only significant geological hazard at the site is earthquake shaking and perhaps local liquefaction. There are no known active surface faults within the project area so ground rupture is not a factor. The flat-lying nature of the area is not susceptible to landsliding. The site is too far from the ocean to be affected by tsunamis, and there are no large bodies of water within the site area that could generate a seiche. There are no volcanoes in the region.

As presented in Figure 3-2, the California Geological Survey (1997, 1998) shows designated project site is outside the liquefaction zone. Therefore, the liquefaction potential at the project site is low. The potential for liquefaction is discussed in detail in Section 5.2.

3.4 Seismicity

The project is in seismically active Southern California. The present-day seismotectonic stress field in the Los Angeles region is one of north-northeasterly compression. This is indicated by the geologic structures, by earthquake focal-mechanism solutions and by geodetic measurements. These data suggest crustal shortening of between 0.2 and 0.35 inches per year across the greater Los Angeles area (Argus et al., 1999).

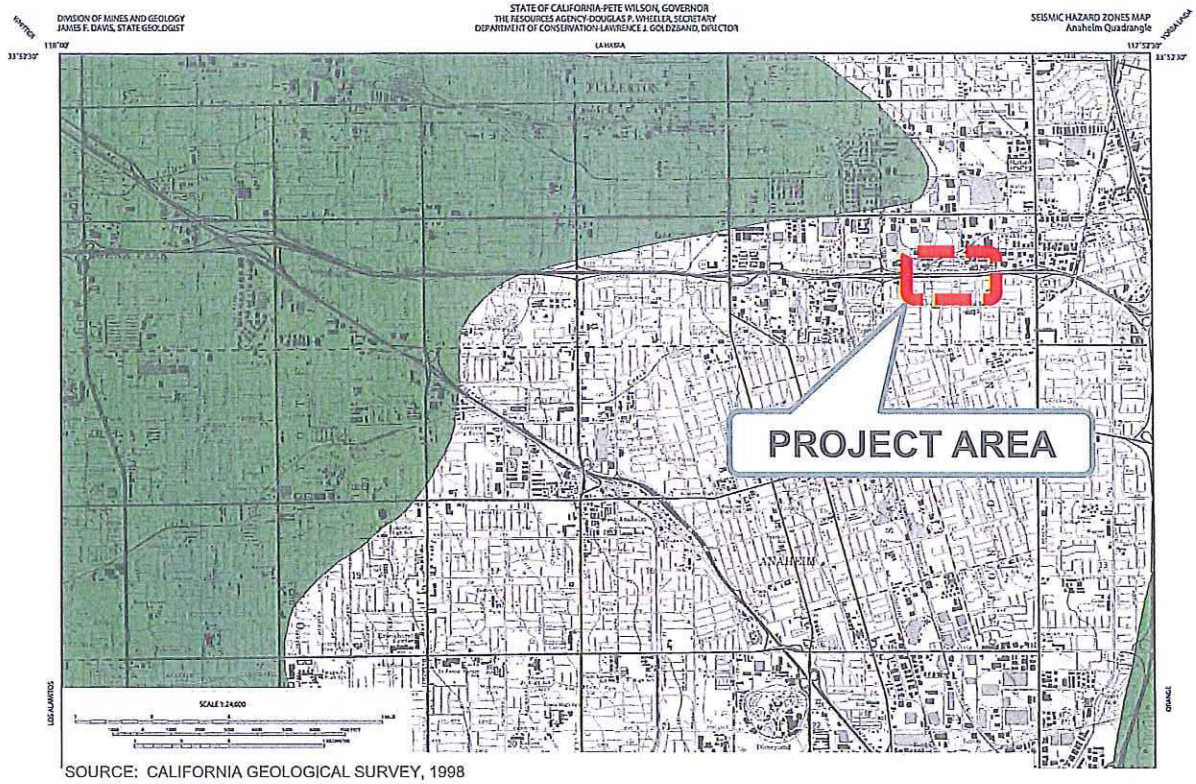
Historical earthquake epicenter maps show widespread seismicity throughout the Los Angeles region. Earthquakes occur primarily as loose clusters along the NISZ, the southern margin of the Santa Monica Mountains, the margin between the Santa Susana-San Fernando Valley and the southern margin of the San Gabriel Mountains, and in the Coyote Hills-Puente Hills area.

The largest historical earthquakes within the Los Angeles Basin were the 1933 Long Beach (moment magnitude (M_W) of about 6.4), 1994 Northridge (M_W = 6.7), 1971 San Fernando (M_W = 6.7), 1987 Whittier (M_W = 5.9), and 2008 Chino Hills (M_W = 5.4). There have been no significant historical earthquakes in the immediate site area. There may have been a few random small events (M_W < 3.0). The nearest concentrated earthquake activity has been within the Puente Hills about 5 or 6 miles to the north of the site.

The 1933 Long Beach earthquake did not rupture the surface but is believed to have been associated with the NISZ (Benioff, 1938). Reevaluation of the seismic data by Hauksson and Gross (1991) relocated the 1933 earthquake hypocenter to a depth of about 6 miles below the Huntington Beach-Newport Beach city boundary.

The 1994 Northridge earthquake occurred on a southerly dipping subsurface fault which was unknown prior to the earthquake. The main shock occurred at a depth of about 12 miles. Earthquake aftershocks clearly defined the rupture surface dipping about 35 degrees southerly from a depth of about 1 or 2 miles to 14 miles. The causative fault was never identified with certainty.

The 1971 San Fernando earthquake involves surface rupture. The 1971 event occurred on a northerly dipping thrust fault that dips from the northern side of the San Fernando Valley to a depth of about 9 miles under the San Gabriel Mountains, and considered part of the Sierra Madre Fault System.



SOURCE: CALIFORNIA GEOLOGICAL SURVEY, 1998

MAP EXPLANATION

Zones of Required Investigation:

Liquefaction

Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Acacia Street UC (Widen)	MAP OF LIQUEFACTION POTENTIAL	
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering		Figure 3-2
	Project No. 10-126	Date: 03-21-11

The 1987 Whittier earthquake occurred on a subsurface fault dipping under the Puente Hills to about 10 miles beneath the San Gabriel Basin (Shaw and Shearer, 1999; Shaw et al., 2002). This event did not rupture the ground surface.

The 2008 Chino Hills event epicenter was in the Chino Hills area between the Elsinore-Fault-Zone Chino Section and Whittier Section. Preliminary data were inconclusive with regard to the causative fault. Detailed analysis by Shao and Hauksson (2009) indicated a rupture plane striking N71°W, dipping 62° northeast. This event did not rupture the ground surface.

Another significant earthquake was the 1812 earthquake which caused damage at the San Juan Capistrano Mission. The location and magnitude of the 1812 earthquake are unknown because of the sparse population at the time, but geological studies (Jacoby et al., 1987; Fumal et al., 1993; Weldon et al., 2004) postulate that it did not occur in the Capistrano area, but rather was a large (M_W > 7.0) distant event on the San Andreas fault in the Wrightwood area of the San Gabriel Mountains.

The earliest documented earthquake in the region was reported by the Portola′ expedition as they camped near the Santa Ana River in 1769. This event has been attributed by various geoscientists to just about every fault in the Los Angeles area but it could just as well have been a distant event that shook a wide area as did the 1971 San Fernando, the 1987 Whittier, and the 1994 Northridge events, as well as many other more-distant events such as 1992 Landers event.

4.0 SUBSURFACE CONDITIONS

4.1 Soil Conditions

The proposed approach elevation is about +200 feet and the existing ground surface elevation at Acacia Street is about +180 feet. Based on the recent and previous field investigations, the site materials are typically fill and alluvium. The upper 70 feet or so materials are predominately loose to dense sand and silty sand with traces of fine gravelly sands. This top soil layer is underlain by a 10 to 20-foot thick stratum of interbedded layers of very stiff to hard sandy silt, silt with sand, elastic silt, and lean clay followed by a very dense poorly graded sand layer down to the boring termination depth.

The idealized soil profile and design strength parameters for foundation design are presented in Table 4-1.

Table 4-1. Idealized Soil Profile and Strength Parameters

Approximate Elevation (feet)	Predominant Soil Type	Equivalent SPT Blowcount* (blows/foot)	Total Unit Weight (pcf)	Friction Angle (degree)	Cohesion/ Undrained Shear Strength (psf)
+200 to +178	Fill	-	120	32	150
+178 to +150	Sand and Sand with Silt	9 to 68 Average = 30	120	32	50
+150 to +128	Sand and Sand with Silt	(19) to >100 Average = 48	120	36	50
+128 to +110	Silt with Sand to Lean Clay	(14) to 39 Average = 23	115	-	2,500
Below +110	Sand	(43) to >100 Average = 72	125	38	50

* Values in ( ) are converted SPT blowcounts corrected for sampler size; correction factor from California sampler blowcounts to SPT blowcounts is 0.5.

In Table 4-1, the soil strength parameters are based on direct shear test results or published correlations with SPT blowcounts (Lam and Martin, 1986). Direct shear tests were performed on soil samples obtained within the first and second idealized soil layers. The design strength parameters of these layers were based on the ultimate shear strength parameters obtained from the direct shear tests. The unconsolidated-undrained triaxial test results were used for the fourth idealized soil layer. Design strength parameters of the remaining idealized soil layers are based on correlation with SPT blowcounts. It should be noted that the strength parameters obtained from the direct shear and unconsolidated undrained triaxial tests are lower than those obtained using SPT correlations for the same idealized soil layers.

4.2 Groundwater Conditions

Groundwater was encountered at about elevation +128 feet in one of the borings drilled in December 2010. Groundwater was also encountered at about elevation +129.5 feet in one of the

borings drilled in January 1993. Based on California Geological Survey (Division of Mines and Geology, 1997), the recorded highest historical groundwater at the project site is greater than 50 feet below the ground surface. The average ground surface elevation at the Acacia Street grade is about +180 feet. Therefore, the CGS historical highest groundwater elevation would be deeper than +130 feet. Based on the measured and historical highest groundwater elevations, a groundwater elevation of +130 feet can be used for liquefaction analysis.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Seismic Design Criteria

To develop ARS curves in accordance with the 2009 Seismic Design Criteria (SDC) (Caltrans, 2009b and 2009d) procedures, we considered the following response spectra:

- Deterministic Criteria based on late-Quaternary faults in 2007 fault database (Caltrans, 2007a and 2007b and Shantz and Merriam, 2009);
- Probabilistic Criteria based on 5% in 50 years probability of exceedance ground motion; and
- Minimum Deterministic Spectrum based on a M_W= 6.5 strike-slip event occurring at a distance of 7.5 miles (12 km) from the site.

The design ARS curve is the envelope of the above spectra.

We used the Caltrans Deterministic Response Spectrum Spreadsheet as recommended by the 2009 SDC to develop the deterministic ARS curves. The spreadsheet uses the arithmetic average of two Next Generation Attenuation (NGA) relationships developed by Chiou-Youngs (2008) and Campbell-Bozorgnia (2008) with user-provided input parameters, including fault characteristics, site-to-fault distances and site condition parameters as presented in Table 5-1.

Table 5-1. Controlling Faults for Deterministic Response Spectrum

Controlling Fault	Fault ID	Maximum Moment Magnitude M_{max}	Site to Fault Distance R_{RUP} (miles)	Style of Fault	Fault Dip /Direction
Puente Hills Blind Thrust	240	7.3	8.6	Reverse	25° / North
Peralta Hills Fault	146	6.2	3.6	Reverse	50° / Southeast
Elsinore Fault Zone (Whittier Section)	241	7.6	9.6	Reverse Lateral Strike Slip	75° / Northeast

Results obtained from the spreadsheet were then verified with the Caltrans online web tool (Caltrans, 2009a). The spreadsheet method is recommended because the online web tool, though more user-friendly, does not include updates since 2007 in its calculation database and presently is not approved to develop spectra for final design.

The probabilistic response spectrum is based on data from the 2008 United States Geological Survey (USGS, 2008a) National Seismic Hazard Map for the 5% in 50 years probability of exceedance (975-year return period) ground motion. To develop the probabilistic spectrum, the Caltrans Probabilistic Response Spectrum Spreadsheet and the USGS Interactive Deaggregation Tool (USGS, 2008b) were used. Results obtained from both the spreadsheet and deaggregation tool were then verified with the Caltrans online web tool. Again, the spreadsheet and deaggregation tool are recommended because the online web tool, though more user-friendly, does not include updates since 2007 in its calculation database.

The resulting design ARS curve and the digitized coordinates are presented in Figure 5-1. A peak ground acceleration (PGA) of 0.52g is obtained from the design ARS curve.

5.2 Liquefaction

Liquefaction analysis was performed using the available site-specific subsurface information and historical high groundwater elevation of +130 feet. The liquefaction potential of the saturated, granular materials below the design water table was evaluated using the procedures outlined by Seed et al. (1985), Seed and Harder (1990), and updated by NCEER (1997) and Youd et al., (2001).

Liquefaction analyses were performed using subsurface information obtained from four soil borings. Out of these four soil borings, our Boring A-10-054 shows a layer of potentially liquefiable materials between elevations +121 and +116 feet. This soil layer is not continuous and is not expected to have any impact on foundation performance. Therefore, we conclude that the liquefaction potential at the site is low. Since liquefaction potential is low, seismically induced settlement should be negligible.

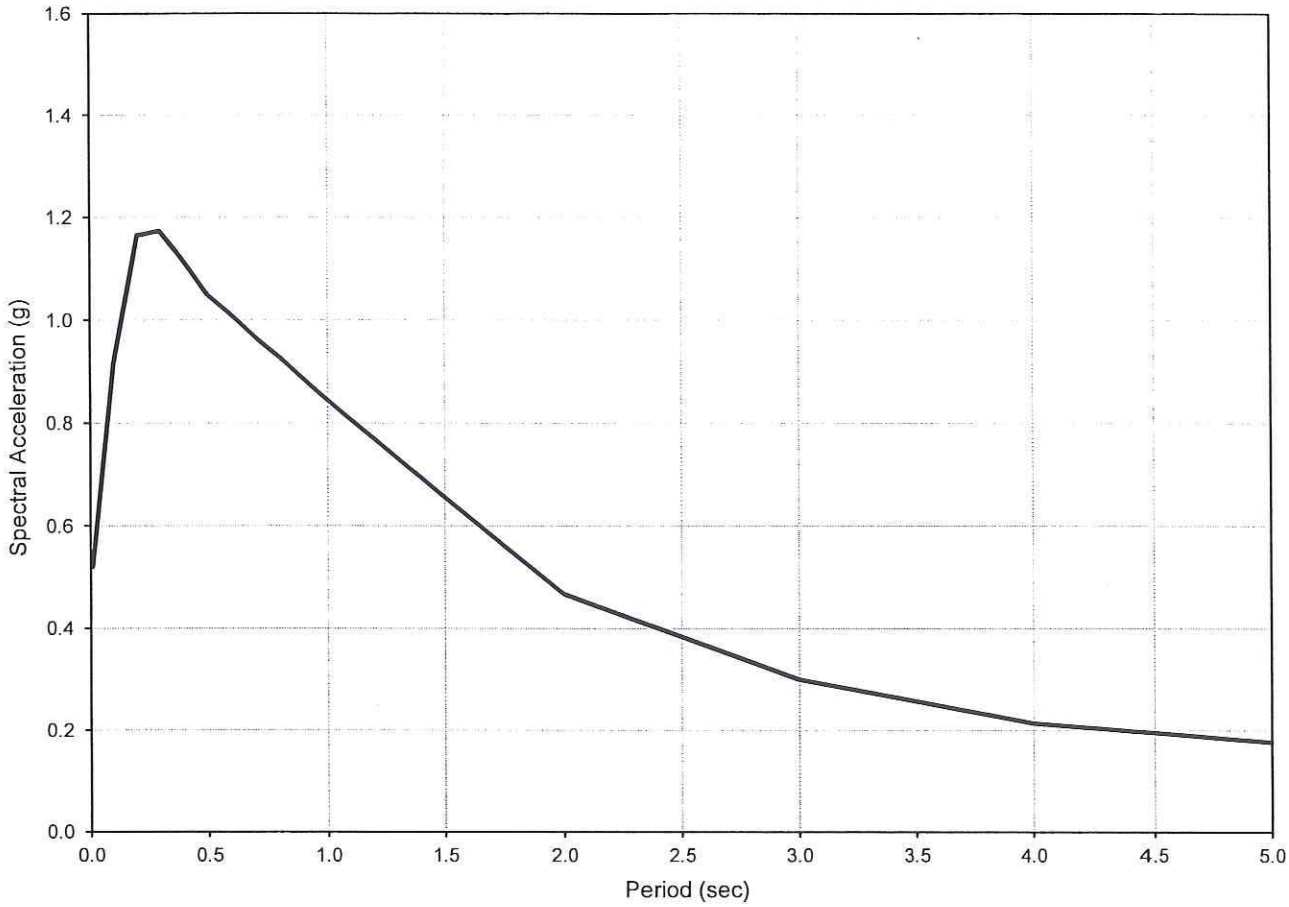
5.3 Soil Corrosivity

Three soil samples were tested for pH, minimum resistivity, soluble chloride content, and soluble sulfate content. The test results are summarized in Table 5-2. Minimum resistivities were between 2,100 and 29,000 ohm-cm. The pH values were between 7.2 and 7.8. The soluble sulfate measurements ranged from 60 to 110 parts per million (ppm), and the soluble chloride measurements ranged from 108 to 293 ppm.

Table 5-2. Soil Corrosion Test Results

Boring	Station (Offset) / "Station Line"	Sample Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Soluble Sulfate Content (ppm)	Soluble Chloride Content (ppm)
A-10-054	305+43 (95' Lt) / "A" Line	5	SP-SM	29,000	7.7	60	108
		25	SC	3,500	7.8	110	189
		65	CL to ML	2,100	7.2	70	293

Based on the Caltrans Corrosion Guidelines (2003b), soils are considered corrosive if the pH is 5.5 or less, or the chloride concentration is 500 ppm or greater, or the sulfate concentration is 2,000 ppm or greater. Based on the test results and the Caltrans criteria, the on-site soils are considered to be non-corrosive to bare metals and concrete.



Latitude = 33.8539 °
Longitude = -117.9591 °

Damping Ratio = 5%

Spectral Coordinates	
Period (sec)	Acc. (g)
0.010	0.520
0.100	0.915
0.200	1.164
0.300	1.173
0.500	1.049
1.000	0.844
2.000	0.467
3.000	0.299
4.000	0.214
5.000	0.176

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Acacia Street UC (Widen)	Design ARS Curve
	Project: 10-126 Date: 03/01/11	Figure 5-1

5.4 Pile Foundation Design

5.4.1 Foundation Type

According to the as-built plans, foundation type of the previous widenings of Acacia Street UC consists of CIDH piles except the original UC is supported on driven concrete piles. We recommend matching the existing foundation type of the previous widenings for the proposed bridge widening.

The minimum embedment and offset (from a slope face) of the footings should be based on Section 4.4.5.1 of Caltrans BDS dated August 2004.

5.4.2 Foundation Data Provided by Structural Designers

Per Caltrans policy, LRFD Service-I Limit State load combinations and Working Stress Design (WSD) method provided in the Caltrans Bridge Design Specifications (2003a) are used for design of the abutment footing. The LRFD Service-I Limit State, Strength Limit State, and Extreme Event Limit State load combinations are used for the design of the bent footing.

The foundation design data sheet is presented in Table 5-3. Foundation loads were provided by the structural designers following the latest Caltrans Memo To Designers (Caltrans, 2008) and these loads are presented in Table 5-4.

Table 5-3. Foundation Design Data Sheet

Support No.	Design Method	Pile Type	Finished Grade Elevation (feet)	Cut-off Elevation (feet)	Pile Cap Size (feet)		Permissible Settlement under Service Load (inch)	Number of Pile per Support
					B	L		
Abut 1	WSD	16" CIDH	195.0	188.25	6.33	13.00	1	3
Bent 2	LRFD	16" CIDH	184.0	173.45	11.33	11.33	1	8
Bent 3	LRFD	16" CIDH	184.0	173.45	11.33	11.33	1	8
Abut 4	WSD	16" CIDH	192.5	191.35	6.33	13.00	1	3

Table 5-4. Foundation Design Loads

Support No.	Service-I Limit State (kips)			Strength Limit State (Controlling Group, kips)				Extreme Event Limit State (Controlling Group, kips)			
	Total Load		Permanent Loads	Compression		Tension		Compression		Tension	
	Per Support	Max. Per Pile	Per Support	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile
Abut 1	182	80	100	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bent 2	492	N/A	363	689	145	0	30	373	240	0	140
Bent 3	492	N/A	363	689	145	0	30	373	240	0	140
Abut 4	156	76	121	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

5.4.3 Axial Pile Capacity

Abutments 1 and 4, and Bents 2 and 3 foundation design recommendations are presented in Table 5-5 and Table 5-6, respectively. The Pile Data Table for the contract plans is presented in Table 5-7.

A pile-group efficiency factor (GEF) of 0.65 is used for a center-to-center pile spacing of 2.5 times the pile diameter, and a GEF of 1.0 is used for a center-to-center spacing of 4.0 times the pile diameter or greater (Section 10.8.3.6.3, AASHTO, 2007). Linear interpolation can be used to determine the GEF for intermediate spacing. Based on the layout provided by the structural designers, GEF's of 1.0 and 0.77 were used for the abutments and bents piles, respectively.

Axial capacity of a single CIDH pile is estimated using the computer program SHAFT Version 6.0 (Ensoft, 2007). The pile capacity calculations are presented in Appendix C. The pile capacity is also based on soil resistance only and may be further limited by the pile-head connection details and the strength of the pile materials.

Table 5-5. Abutments Foundation Design Recommendations

Support	Pile	Cut-off Elevation (feet)	LRFD Service-I Limit State Load per Support (kips)		LRFD Service-I Limit State Total Load per Pile (Compression) (kips)	Nominal Resistance (kips)	Design Tip Elevations (feet)	Specified Tip Elevation (feet)
			Total	Permanent				
Abut 1	16" CIDH	188.25	182	100	80	160	+152 (a) +168 (d)	+152
Abut 4	16" CIDH	191.35	156	121	76	160	+154 (a) +171 (d)	+154

Notes:
1. Design tip elevations are controlled by the following demands: (a) Compression, (c) Settlement, and (d) Lateral Load.
2. There are no design tip elevations for Tension and Settlement at Abutments 1 and 4.
3. The specified tip elevation for Abutments 1 and 4 shall not be raised above the design tip elevation for Lateral Load.

Table 5-6. Bents Foundation Design Recommendations

Support Location	Pile Type	Cut-off Elevation (feet)	Service-I Limit State Loads per Support (kips)	Total Permissible Support Settlement (inch)	Required Factored Nominal Resistance (kips)				Design Tip Elevations (feet)	Specified tip Elevation (feet)
					Strength Limit		Extreme Event			
					Comp. (ϕ=0.7)	Tension (ϕ=0.7)	Comp. (ϕ=1.0)	Tension (ϕ=1.0)		
Bent 2	16" CIDH	173.45	492	1	145	30	240	140	+138 (a-I) +150 (b-I) +136 (a-II) +140 (b-II) +153 (d)	+136
Bent 3	16" CIDH	173.45	492	1	145	30	240	140	+138 (a-I) +150 (b-I) +136 (a-II) +140 (b-II) +153 (d)	+136

Notes:
1. Design tip elevations are controlled by the following demands: (a-I) Compression (Strength Limit), (b-I) Tension (Strength Limit), (a-II) Compression (Extreme Event), (b-II) Tension (Extreme Event), (c) Settlement, and (d) Lateral Load.
2. There is no design tip elevation for Settlement at Bents 2 and 3.
3. The Specified tip elevation for Bents 2 and 3 shall not be raised above the design tip elevations for Tension and Lateral Load.

Table 5-7. Pile Data Table

Location	Pile Type	Nominal Resistance (kips)		Design Tip Elevations (feet)	Specified Tip Elevation (feet)
		Compression	Tension		
Abut 1	16" CIDH	160	0	+152 (a) +168 (d)	+152
Bent 2	16" CIDH	240	140	+136 (a) +140 (b) +153 (d)	+136
Bent 3	16" CIDH	240	140	+136 (a) +140 (b) +153 (d)	+136
Abut 4	16" CIDH	160	0	+154 (a) +171 (d)	+154

Notes:
1. Design tip elevations are controlled by the following demands: (a) Compression, (b) Tension, (c) Settlement, and (d) Lateral Load.
2. There is no design tip elevation for Tension at Abutments 1 and 4.
3. There is no design tip elevation for Settlement at Abutments 1 and 4, and Bents 2 and 3.
4. The specified tip elevations shall not be raised above the design tip elevation for Tension and Lateral Load.

5.4.4 Lateral Pile Capacity

5.4.4.1 Lateral Pile Solutions

Lateral pile capacity analyses were performed using the computer program LPILE (Ensoft, 2010). Results of lateral pile analysis in terms of pile-head shear and lateral deflection for a free-head condition are presented for abutments and bents in Table 5-8 and Table 5-9, respectively. The maximum bending moment and the location of maximum moment are also presented.

Based on the layout provided by the structural designers and the procedures outlined in the Ensoft Group 7.0 software Technical Manual (Ensoft, 2006), group reduction factors (P-Multipliers in the LPILE input) of 0.9 and 0.7 are incorporated in the analyses for the abutment and bent piles, respectively.

The solutions presented in Table 5-8 and Table 5-9 are entirely based on soil resistance and linear pile properties. Therefore, these values may be limited by the flexural strength (plastic moment) of the piles and pile-head connection details. Linear interpolation can be used for solutions between pile-head deflections of 0.25 and 5 inches.

Table 5-8. Lateral Pile Solutions for Abutments 1 & 4

Support Location	Pile Head Deflection (in)	Pile Head Shear (k)	Maximum Moment (k-in)	Depth to Max. Moment from Pile Top (feet)
Abutments 1 & 4 (16-in CIDH)	¼	13.8	344	3.9
	½	21.4	637	4.4
	1	30.7	1,128	4.9
	3	51.3	2,584	6.2
	5	64.2	3,714	6.8

Table 5-9. Lateral Pile Solutions for Bents 2 & 3

Support Location	Pile Head Deflection (in)	Pile Head Shear (k)	Maximum Moment (k-in)	Depth to Max. Moment from Pile Top (feet)
Bents 2 & 3 (16-in CIDH)	¼	18.7	386	3.6
	½	30.0	725	4.0
	1	43.3	1,290	4.3
	3	70.4	2,917	5.6
	5	86.7	4,147	6.3

5.4.4.2 Lateral Load Resistance of Bent Pile Footing

Passive earth pressure at the bent pile cap can be used to resist a portion of the lateral loads transferred to the soil. For static design, the passive soil resistance against the embedded face of the bent pile cap should be neglected. Under earthquake loading, this ultimate passive soil resistance should be added to the pile group capacity to determine the total lateral resistance of the pile footing. At the bent location, the ultimate passive soil resistance against the pile footing is estimated to be equal to a maximum equivalent fluid pressure of 360 psf per foot of depth. Note that development of full passive earth pressure requires a lateral pile cap displacement equal to approximately 2 percent of the embedded height (measured from the nearest and lowest ground surface to the bottom of the pile cap). For displacement magnitudes smaller than what is required to mobilize full resistance, the actual resistance magnitude should be determined by linearly interpolating between zero and the full resistance.

5.5 Embankments Settlement and Slope Stability

5.5.1 Settlement and Settlement Period

Embankment fill will need to be placed to construct the approaches to the bridge widening. Up to 19 feet of embankment fill, approximately 12 feet wide at the crest with 2H:1V side slopes, will be placed to construct the approaches to Abutments 1 and 4 and ground subsidence at Abutments 1 and 4 is estimated to be about 1 inch. Since the onsite soils are primarily coarse-grained materials, soil settlement should occur relatively quickly, and a settlement period for pile construction is not required.

5.5.2 Slope Stability

Global stability analyses were conducted for both static and pseudo-static conditions for the bridge approach embankment slopes. The analysis was performed using the computer program SLIDE 5.0 (Rocscience, 2006). The soil strength parameters in Table 4-1 were used in the static and pseudo-static analysis and the results are presented in Appendix C.

The calculated factor of safety is greater than the minimum required 1.5 under static condition with a 2-foot soil surcharge to represent traffic loading. Slope stability analysis under pseudo-static condition was performed using a seismic coefficient equal to 0.173g (which is the smaller of either one-third the horizontal peak ground acceleration or 0.2g) in accordance with guidelines provided in Section 3.10 of the Caltrans Guidelines for Structures Foundation Reports (Caltrans, 2009c). Analysis indicates that the calculated factor of safety is greater than the required minimum of 1.1 under pseudo-static condition.

For embankment slopes with a gradient of 2H:1V or flatter, surficial stability should not be a design concern. If slope paving is proposed for embankment slopes with a gradient of 1.5H:1V, then surficial stability is also not a design concern. If slope paving is not used for the 1.5H:1V slopes, it is recommended that the upper 4 feet of any new 1.5H:1V slope face be covered with materials with a minimum internal friction angle of 32 degrees and a minimum cohesion of 230 psf. This select material should be properly keyed and benched into the sloping ground. In all cases, proper maintenance with erosion protection and drainage control in accordance with Section 21 of Caltrans Standard Specifications (Caltrans, 2010b) are also recommended.

5.5.3 Structure Approach Slabs

Selection of the approach type (if required) will be performed by the structural designer following the flowchart in Caltrans Memo to Designers 5-3, Attachment A, dated May 1996 (Caltrans, 1996).

5.6 Bridge Abutment Wall Design

5.6.1 Abutment Earth Pressures

If abutment walls are free to move laterally at the top, a static active lateral earth pressure of 36 psf per foot of depth is recommended for a free draining, level and compacted backfill. If lateral movement at the top of abutment walls is restrained, the lateral earth pressure for a free draining,

level and compacted backfill should follow Section 5.5.5.11 of the Caltrans BDS dated August 2004. For this condition, we recommend a coefficient of active lateral earth pressure of 0.3, a coefficient of at-rest lateral earth pressure of 0.46 and a soil unit weight of 120 lb/ft^3. If applicable, a uniform lateral pressure of at least 72 psf due to vehicle loads, equivalent to a vertical pressure produced by at least 2 feet of earth, should be added to the above lateral earth pressure.

5.6.2 Passive Resistance of Abutment Backfill

Under seismic loading, an ultimate passive earth pressure of 5 ksf may be used for the approach backfill and abutment walls with a height equal to or greater than 5.5 feet. For abutment walls with heights less than 5.5 feet, the passive pressure may be calculated proportionally (e.g., for a 4-foot high wall, the passive pressure is [4/5.5]x 5 ksf = 3.64 ksf. The horizontal movement at which the maximum passive pressure is expected to be fully mobilized can be determined following the procedure outlined in Section 7.8.1 of the Caltrans SDC (2009d).

5.7 Retaining Wall 305

A retaining wall is proposed on the north side of the widened Abutment 1 and Bent 2 to retain the abutment end slope. This wall is proposed to be a Caltrans Standard Type 1 retaining wall (Caltrans, 2010a). Due to the close proximity to the Abutment-1 footing, a portion of the retaining wall is supported on piles; the remaining portion of the wall is supported on a shallow foundation. The pertinent information of the retaining wall is presented in Table 5-10.

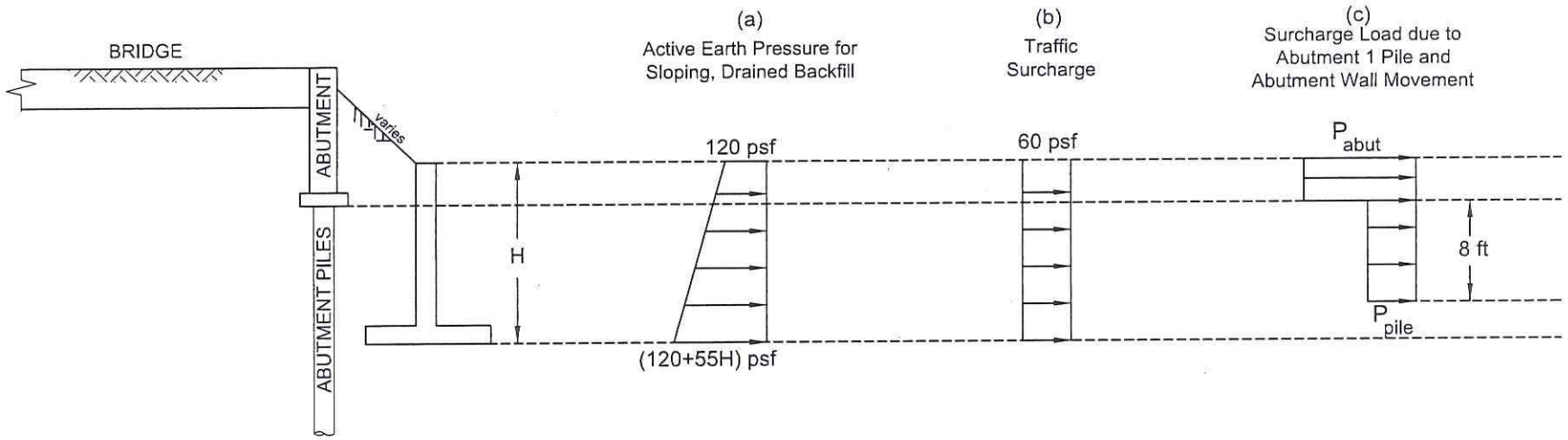
Table 5-10. Retaining Wall 305 Pertinent Data

Wall Footing Type	Location (A Line Stations)		Length (ft)	Retaining Wall Height (ft)	Approx. Bottom of Footing Elevation (ft)	Backfill Slope Condition
	Begin Wall	End Wall				
16-inch CIDH	304+91.41 97 Lt	305+06.41 97 Lt	15	10	+178.15	Varies
Shallow Footing	305+06.41 97 Lt	305+24.43 97 Lt	18	4 and 8	+178.57	Varies

5.7.1 Lateral Earth Pressure

For retaining wall design between Wall LOL Stations 10+00 and 10+15, the lateral earth pressure diagram is presented in Figure 5-2 and includes lateral earth pressure from sloping and drained backfill, Abutment-1 pile and abutment wall transverse movement, and traffic surcharge.

For retaining wall design between Wall LOL Station 10+15 and end of wall, Caltrans Standard Plans for Type 1 retaining walls (Caltrans, 2010a) can be used.



For 0.25" Abutment Pile Head Deflection P_{abut} = 45 psf

P_{pile} = 24 psf

For 1.0" Abutment Pile Head Deflection P_{abut} = 180 psf

P_{pile} = 45 psf

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Acacia Street UC (Widen) Retaining Wall 305	Lateral Earth Pressure Diagram for Retaining Wall 305
	Project No. 10-126 / Date: 09-06-11	Figure 5-2

5.7.2 Pile Foundation

Pile footings are recommended between Wall LOL Stations 10+00 and 10+15. Per Caltrans policy, the LRFD Service Limit State I load and Strength and Extreme Event Limit State load combinations are used for the design of Caltrans Standard Type 1 retaining walls on pile footings. Foundation loads for the Caltrans Standard Type 1 retaining wall are provided by the structural designers and presented in Table 5-11.

Table 5-11. Pile Foundation Design Loads for Retaining Wall 305

Wall Height (feet)	Footing Width (feet)	Min. Embed. Depth (feet)	Pile	Service-I Limit State Loads per Pile (kips)	Foundation Loads per Pile (kips)			
					Strength Limit State		Extreme Event Limit State	
					Compression	Tension	Compression	Tension
10	7.75	2.83	16" CIDH	35.1	51.9	5.2	31.4	0

Foundation design recommendations are presented in Table 5-12. The Pile Data Table for the contract plans is presented in Table 5-13.

Based on the pile layout provided by the structural designers, an axial pile-group efficiency factor of 0.77 was used for the analysis. The pile capacity is also based on soil resistance only and may be further limited by the pile-head connection details and the strength of the pile materials.

Table 5-12. Pile Foundation Design Recommendations for Retaining Wall 305

Wall LOL Station	Wall Height (feet)	Pile Type	Bottom of Footing El. (feet)	Service-I Limit State Loads per Pile (kips)	Total Wall Settlement (inch)	Required Factored Nominal Resistance (kips)				Design Tip El. (feet)	Specified tip El. (feet)
						Strength Limit		Extreme Event			
						Comp. (ϕ=0.7)	Tension (ϕ=0.7)	Comp. (ϕ=1.0)	Tension (ϕ=1.0)		
10+00 to 10+15	10	16" CIDH	+178.15	35.1	1	51.9	5.2	31.4	0	+153 (a-I) +168 (b-I) +161 (a-II) +161 (d)	+153

Notes:
1. Design tip elevations are controlled by the following demands: (a-I) Compression (Strength Limit), (b-I) Tension (Strength Limit), (a-II) Compression (Extreme Event) and (d) Lateral Load.
2. There are no design tip elevations for Tolerable Settlement.
3. The specified tip elevations shall not be raised above the design tip elevation for Tension and Lateral Load.

Table 5-13. Pile Data Table for Retaining Wall 305

Wall LOL Station	Wall Height (feet)	Pile Type	Nominal Resistance (kips)		Design Tip Elevations (feet)	Specified Tip Elevation (feet)
			Compression	Tension		
10+00 to 10+15	10	16" CIDH	80	10	+153 (a) +168 (b) +161 (d)	+153

Notes:
1. Design tip elevations are controlled by the following demands: (a) Compression, (b) Tension and (d) Lateral Load.
2. There are no design tip elevations for Tolerable Settlement.
3. The specified tip elevations shall not be raised above the design tip elevation for Tension and Lateral Load.

Results of lateral pile analysis in terms of pile-head shear and lateral deflection for a free-head condition are presented in Appendix C and summarized in Table 5-14. The maximum bending moment and the location of maximum moment are also presented. The solutions presented in Table 5-14 are entirely based on soil resistance and linear pile properties. Therefore, these values may be limited by the flexural strength (plastic moment) of the piles and pile-head connection details. Based on the pile layout provided by the structural designers, a group efficiency factor of 0.9 was used for the lateral solutions. The structural designer should compare the lateral pile demands with the results in Table 5-14 to determine whether the wall deflections are within tolerable limits.

Table 5-14. Lateral Pile Solutions for Retaining Wall 305

Support Location	Pile Head Deflection (inch)	Pile Head Shear (kips)	Maximum Moment (kip-in)	Depth to Max. Moment from Pile Top (feet)
Wall LOL Station 10+00 to 10+15	¼	10.9	233	3.4
	½	16.8	428	3.6
	1	23.6	752	4.2
	3	38.3	1703	5.5
	5	47.3	2438	6.0

5.7.3 Shallow Foundation

Shallow footings are recommended between Wall LOL Stations 10+15 and end of wall. Settlement and bearing capacity calculations are presented in Appendix C. Using the footing width shown in the Caltrans Standard Plan (2010a), the allowable bearing capacity is 2.2 ksf and 1.8 ksf for 8 feet and 4 feet wall heights for free draining sloping backfill, respectively. In order to provide uniform bearing material, at least 1-foot of overexcavation and recompaction are recommended for soils below the footing bottom.

The minimum embedment and offset (from a slope face) of the footings should be based on Section 4.4.5.1 of Caltrans Bridge Design Specifications (2003a).

The horizontal limits of the overexcavation should begin one foot from each edge of the footing bottom and extending downward at a 45-degree imaginary plane until the plane intersects the recommended minimum excavation depth of 1 feet. In some areas, the 45-degree imaginary plane would intersect temporary shoring. In this case only, the horizontal limit of the overexcavation should begin from the edge of the footing bottom and extending out a minimum of 1 foot and down until the plane intersects the recommended excavation depths. Onsite soils or Caltrans Structure Backfill should be used for backfilling with a minimum relative compaction of 95% of maximum density as determined by Caltrans Test Method 216. The overexcavation bottom should be proof rolled prior to backfilling. Further, the overexcavation bottom should be inspected by a qualified geotechnical engineer or technician to confirm the presence of an unyielding and competent surface.

6.0 CONSTRUCTION RECOMMENDATIONS

6.1 Earthwork

Earthwork should be performed in accordance with Caltrans Standard Specifications, Section 19 (Caltrans, 2010b). Appropriate measures should be taken to prevent damage to adjacent structures and utilities. Any design and construction of temporary sloping, sheeting, or shoring should be made the contractor's responsibility. It should be noted that it is the responsibility of the contractor to oversee the safety of the workers in the field during construction. The contractor shall conform to all applicable occupational and health standards, rules, regulations, and orders established by the State of California. In addition, other State, County, or Municipal regulations may supersede the recommendations presented in this section. If a trench shoring design and safety plan is required, the geotechnical consultant should review the plan to confirm that recommendations presented in this report have been applied to the design.

During the recent field investigation conducted on December, 2010 and January, 2011, groundwater was encountered at about elevation +128 feet in one of the borings. Groundwater was also encountered at about elevation +129.5 feet in one of the borings drilled in January 1993. Using the above groundwater measurements, groundwater is not anticipated to be encountered during pile and footing construction at the abutments and bents. However, groundwater level can fluctuate due to seasonal rainfall amount, local irrigation and groundwater recharge program, and other man-made conditions. If groundwater is encountered during footing construction, it should be controlled in accordance with Section 19-3.03D of the Caltrans Standard Specifications (2010b).

6.2 Pile Construction

Construction of CIDH piles should follow Section 49-4.03B, "Drilled Holes" of the Caltrans Standard Specifications (2010b). The Contractor should be required to drill the bottom of the shaft boring with a clean-out bucket to ensure adequate removal of loose soils. Both clean-out and concrete placement should be addressed in the specifications. The shaft borings should be inspected and approved by the Resident Engineer prior to installation of reinforcement. Per latest Caltrans requirement, 3-inch of concrete cover over reinforcement should be provided to improve the construction of the CIDH piles.

The onsite fill and alluvial soils generally range from loose to very dense coarse grained materials, and these materials are susceptible to caving. If caving occurs, a temporary casing can be used. The casing should have an inside diameter larger than or equal to the pile diameter and should be placed tight in the hole. Vibratory hammers or oversized drilling are not allowed for casing installation. In the event that any boring becomes bell-shaped and cannot be advanced due to severe caving, all loose material should be removed from the bottom of the boring and the caved region filled with a low strength sand-cement slurry. Drilling may continue when the slurry has reached its initial set.

6.3 Backdrain and Backfill Requirements For Abutment Walls

Expansive soils should not be placed as part of the embankment within the limits of a bridge abutment as shown in Figure 6-1. Materials placed behind abutment walls should be low-expansive soil with an Expansion Index (EI) less than 50 and Sand Equivalent (SE) of more than 20. The low-expansive material requirement should be supplemental to the abutment structure and pervious backfill requirement as described in Caltrans Standard Plans (2010a) and Caltrans Standard Specifications (2010b) under Sections 19-3.03E and 19-3.03G, respectively.

Backfill should be compacted in accordance with Section 19-5 of the Caltrans Standard Specifications (2010b). Backfill should be placed in loose lifts not exceeding 8 inches in thickness, moisture-conditioned to near optimum moisture content, and compacted to at least 95 percent relative compaction. The relative compaction should be based on the maximum density determined by California Test Method 216. Jetting or flooding to compact backfill is not recommended. Heavy compaction equipment, such as vibratory rollers, dozers, or loaders, should not be used adjacent to the abutment walls in order to avoid damaging the walls due to large lateral earth pressures.

Backdrains should be installed behind abutment walls to relieve hydrostatic pressure. Backdrains should be constructed in accordance with Bridge Detail 3-1 on Sheet B0-3 per Caltrans Standard Plans (2010a) or the geocomposite drain alternative per Section 6 of the Caltrans Bridge Design Details (1992).

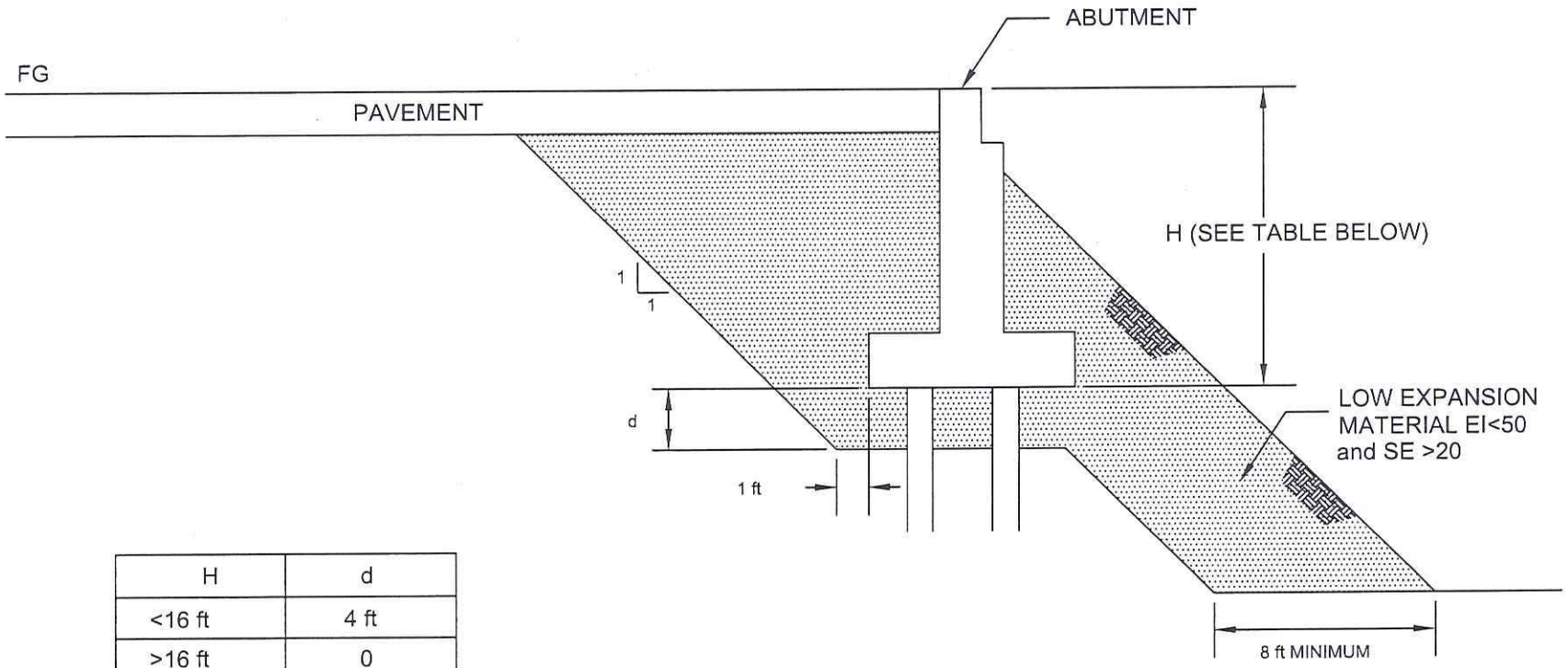
6.4 Review of Construction Plans

Recommendations contained in this report are based on preliminary plans. The geotechnical consultant should review the final construction plans and specifications in order to confirm that the general intent of the recommendations contained in this report have been incorporated into the final construction documents. Recommendations contained in this report may require modification or additional recommendations may be necessary based on the final design.

6.5 Geotechnical Observation and Testing

It is recommended that inspections and testing be performed by the geotechnical consultant during the following stages of construction:

- Grading operations, including excavations and placement of compacted fill
- Shoring installation
- Footing excavations and pile constructions
- Backdrain installation and backfilling of bridge abutment walls
- Removal or installation of support of buried utilities or structures
- When any unusual subsurface conditions are encountered



H	d
<16 ft	4 ft
>16 ft	0

EXPANSION INDEX TO BE DETERMINED BY ASTM D4829
SAND EQUIVALENT TO BE DETERMINED BY CALIFORNIA TEST METHOD 217

NO SCALE

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

Acacia Street UC (Widen)

Project No. 10-126 | Date: 03-10-11

Low Expansion Material
In Bridge Embankment

Figure 6-1

7.0 LIMITATIONS

This report is intended for the use of RBF, OCTA, and Caltrans for widening of Acacia Street UC. This report is based on the project as described and the information obtained from the exploratory borings and CPT sounding at the approximate locations indicated on the attached plans. The findings and recommendations contained in this report are based on the results of the field investigation, laboratory tests, and engineering analyses. In addition, soils and subsurface conditions encountered in the exploratory borings are presumed to be representative of the project site. However, subsurface conditions and characteristics of soils between exploratory borings and CPT sounding can vary. The findings reflect an interpretation of the direct evidence obtained. The recommendations presented in this report are based on the assumption that an appropriate level of quality control and quality assurance (inspections and tests) will be provided during construction. EMI should be notified of any pertinent changes in the project plans or if subsurface conditions are found to vary from those described herein. Such changes or variations may require a re-evaluation of the recommendations contained in this report.

The data, opinions, and recommendations contained in this report are applicable to the specific design element(s) and location(s) which is (are) the subject of this report. They have no applicability to any other design elements or to any other locations and any and all subsequent users accept any and all liability resulting from any use or reuse of the data, opinions, and recommendations without the prior written consent of EMI.

EMI has no responsibility for construction means, methods, techniques, sequences, or procedures; for safety precautions or programs in connection with the construction; for the acts or omissions of the CONTRACTOR or any other person performing any of the construction; or for the failure of any worker to carry out the construction in accordance with the Final Construction Drawings and Specifications.

Services performed by EMI have been conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, expressed or implied, and no warranty or guarantee is included or intended.

8.0 REFERENCES

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Appendix A

LOG OF TEST BORINGS SHEETS

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4	28	32

REGISTERED ENGINEER — DATE 09/16/11

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

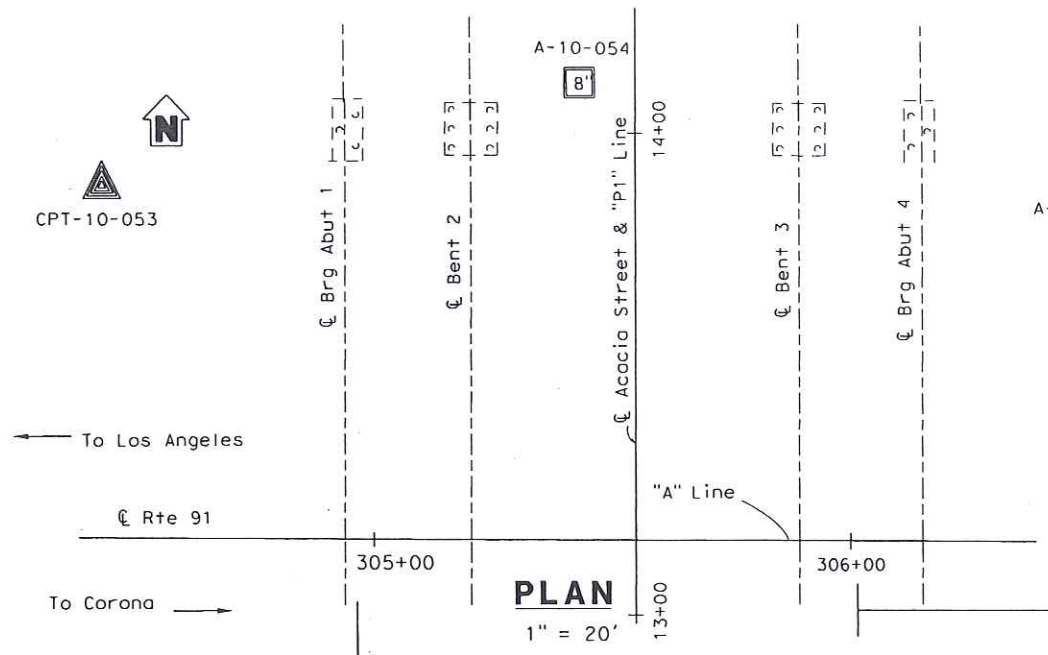
EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¼" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



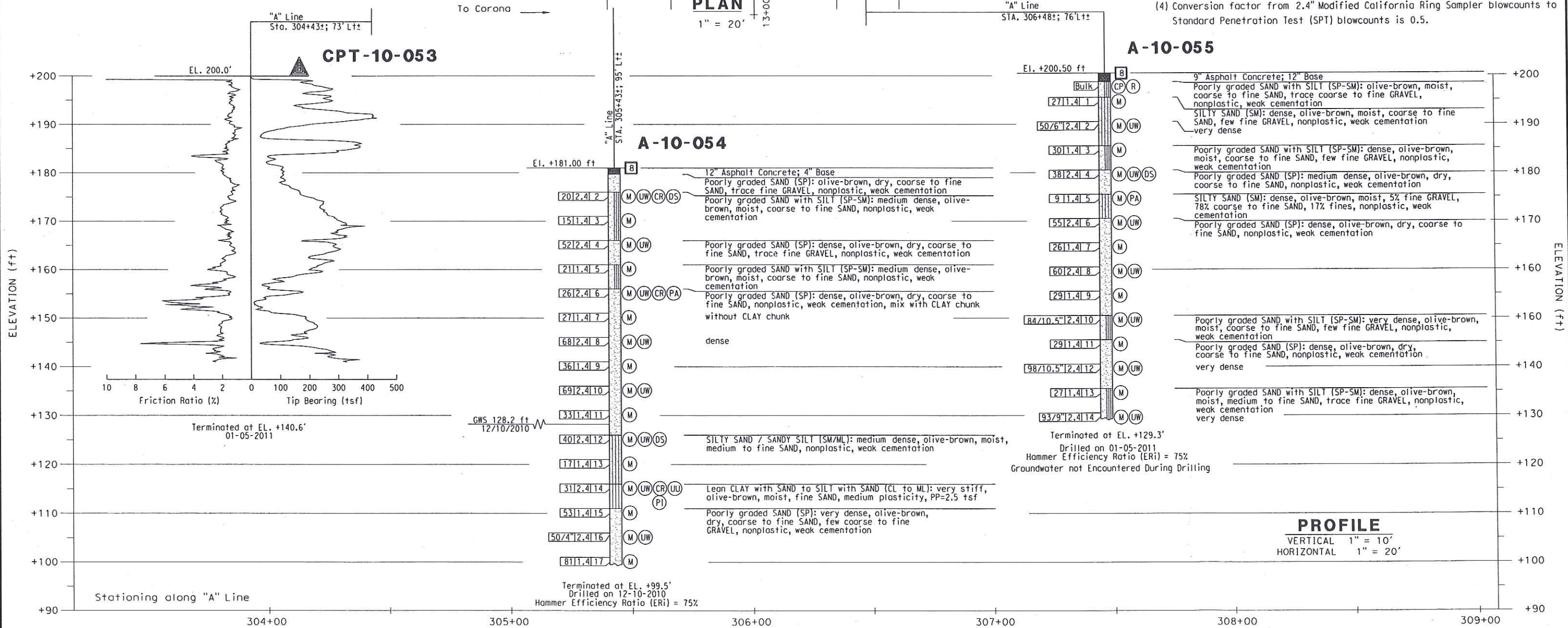
NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).

(2) 2.4" samples were taken using a California Modified Sampler.

(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.



PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

TIME PLOTTED => $TIME
DATE PLOTTED => $DATE
USERNAME => $USER

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. 55-0218
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011			PROJECT ENGINEER	POST MILES 4.8

ACACIA STREET UC (WIDEN)

LOG OF TEST BORINGS 1 OF 5

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

SHEET 28 OF 32

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4	29	32

REGISTERED ENGINEER — DATE 09/16/11

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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FOUNTAIN VALLEY, CA 92708

CEMENTATION

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

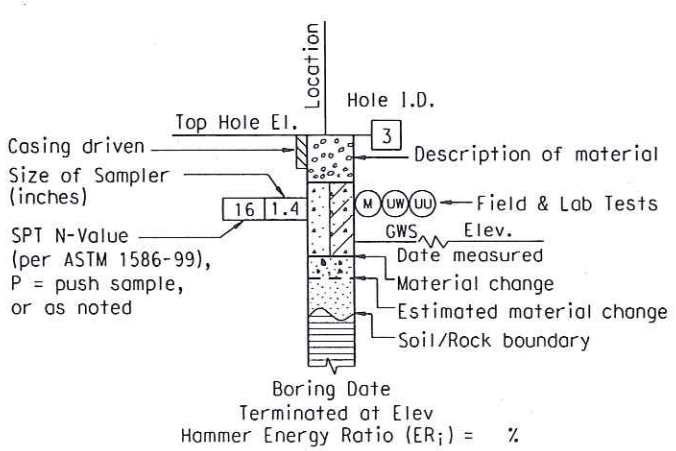
BOREHOLE IDENTIFICATION

Symbol	Hole Type	Description
Size	A	Auger Boring (hollow or solid stem bucket)
Size	R RW RC P	Rotary drilled boring (conventional) Rotary drilled with self-casing wire-line Rotary core with continuously-sampled, self-casing wire-line Rotary percussion boring (air)
Size	R	Rotary drilled diamond core
Size	HD HA	Hand driven (1-inch soil tube) Hand Auger
●	D	Dynamic Cone Penetration Boring
▲	CPT	Cone Penetration Test (ASTM D 5778)
[ ]	O	Other (note on LOTB)

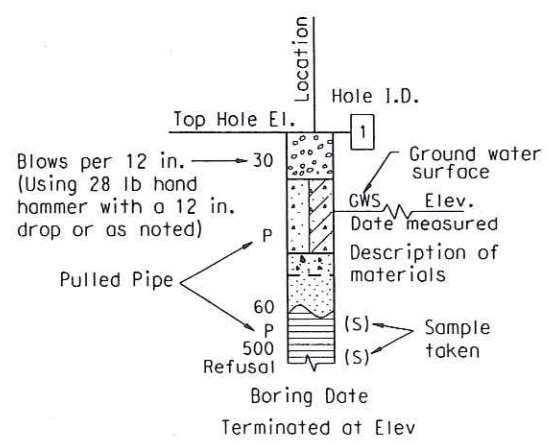
Note: Size in inches.

CONSISTENCY OF COHESIVE SOILS

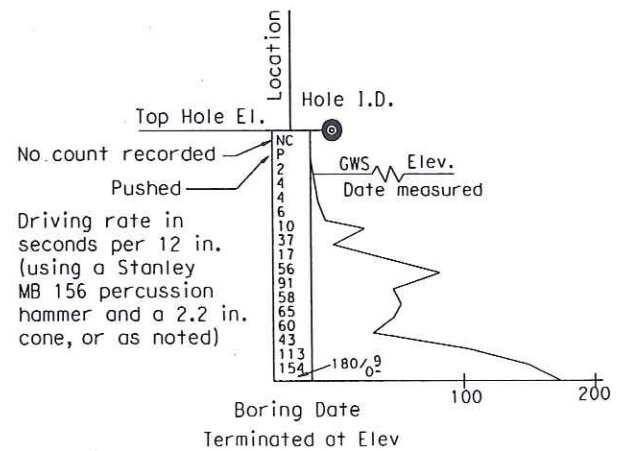
Description	Shear Strength (tsf)	Pocket Penetrometer Measurement, PP, (tsf)	Torvane Measurement, TV, (tsf)	Vane Shear Measurement, VS, (tsf)
Very Soft	Less than 0.12	Less than 0.25	Less than 0.12	Less than 0.12
Soft	0.12 - 0.25	0.25 - 0.5	0.12 - 0.25	0.12 - 0.25
Medium Stiff	0.25 - 0.5	0.5 - 1	0.25 - 0.5	0.25 - 0.5
Stiff	0.5 - 1	1 - 2	0.5 - 1	0.5 - 1
Very Stiff	1 - 2	2 - 4	1 - 2	1 - 2
Hard	Greater than 2	Greater than 4	Greater than 2	Greater than 2



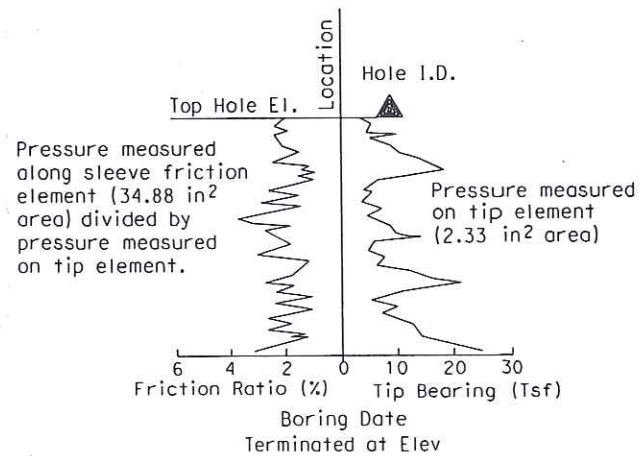
ROTARY BORING



HAND BORING



DYNAMIC CONE PENETRATION BORING



CONE PENETRATION TEST (CPT) BORING

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. 55-0218 / POST MILES 4.8	ACACIA STREET UC (WIDEN)
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011			UNIT: 2295 PROJECT NUMBER & PHASE: 12000000791	DISREGARD PRINTS BEARING EARLIER REVISION DATES →	LOG OF TEST BORINGS 2 OF 5

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

REVISION DATES | SHEET 29 | OF 32

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

GROUP SYMBOLS AND NAMES

Graphic/Symbol	Group Names	Graphic/Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND	CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
GP	Poorly-graded GRAVEL Poorly-graded GRAVEL with SAND		
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND	CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GP-GM	Poorly-graded GRAVEL with SILT Poorly-graded GRAVEL with SILT and SAND	ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
GP-GC	Poorly-graded GRAVEL with CLAY (or SILTY CLAY) Poorly-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GM	SILTY GRAVEL SILTY GRAVEL with SAND	OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND		
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND	OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL		
SP	Poorly-graded SAND Poorly-graded SAND with GRAVEL	CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL		
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
SP-SM	Poorly-graded SAND with SILT Poorly-graded SAND with SILT and GRAVEL		
SP-SC	Poorly-graded SAND with CLAY (or SILTY CLAY) Poorly-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
SM	SILTY SAND SILTY SAND with GRAVEL		
SC	CLAYEY SAND CLAYEY SAND with GRAVEL	OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY ORGANIC elastic SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL		
PT	PEAT	OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND
	COBBLES COBBLES and BOULDERS BOULDERS		

FIELD AND LABORATORY TESTING

- (C) Consolidation (ASTM D 2435)
- (CL) Collapse Potential (ASTM D 5333)
- (CP) Compaction Curve (CTM 216)
- (CR) Corrosivity Testing (CTM 643, CTM 422, CTM 417)
- (CU) Consolidated Undrained Triaxial (ASTM D 4767)
- (DS) Direct Shear (ASTM D 3080)
- (EI) Expansion Index (ASTM D 4829)
- (M) Moisture Content (ASTM D 2216)
- (OC) Organic Content-% (ASTM D 2974)
- (P) Permeability (CTM 220)
- (PA) Particle Size Analysis (ASTM D 422)
- (PI) Plasticity Index (AASHTO T 90) Liquid Limit (AASHTO T 89)
- (PL) Point Load Index (ASTM D 5731)
- (PM) Pressure Meter
- (R) R-Value (CTM 301)
- (SE) Sand Equivalent (CTM 217)
- (SG) Specific Gravity (AASHTO T 100)
- (SL) Shrinkage Limit (ASTM D 427)
- (SW) Swell Potential (ASTM D 4546)
- (UC) Unconfined Compression-Soil (ASTM D 2166) Unconfined Compression-Rock (ASTM D 2938)
- (UU) Unconsolidated Undrained Triaxial (ASTM D 2850)
- (UW) Unit Weight (ASTM D 4767)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4	30	32

REGISTERED ENGINEER — 09/16/11 DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

APPARENT DENSITY OF COHESIONLESS SOILS

Description	SPT N_{60} (Blows / 12 in.)
Very Loose	0 - 5
Loose	5 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Greater than 50

MOISTURE

Description	Criteria
Dry	No discernable moisture
Moist	Moisture present, but no free water
Wet	Visible free water

PERCENT OR PROPORTION OF SOILS

Description	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5% - 10%
Little	15% - 25%
Some	30% - 45%
Mostly	50% - 100%

PARTICLE SIZE

Description		Size (in.)
Boulder		Greater than 12
Cobble		3 - 12
Gravel	Coarse	3/4 - 3
	Fine	1/5 - 3/4
Sand	Coarse	1/16 - 1/5
	Medium	1/64 - 1/16
	Fine	1/300 - 1/64
Silt and Clay		Less than 1/300

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj, PROJECT ENGINEER
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011		

BRIDGE NO. 55-0218 | POST MILES 4.8

ACACIA STREET UC (WIDEN)

LOG OF TEST BORINGS 3 OF 5

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295 PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES

SHEET 30 OF 32

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST.	COUNTY	ROUTE	POST MILES	TOTAL PROJECT	Sheet No.	Total Sheets
12	ORA	-91	0.9/5.4		31	32

GEOTECHNICAL PROFESSIONAL — DATE 09/16/11

ACACIA STREET UC (WIDEN)

LOG OF TEST BORINGS 4 OF 5

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

UNIT: 2295
PROJECT NUMBER & PHASE: 1200000791

BRIDGE No.	Sheet	of
55-0218	31	32

DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES

As-Built Log of Test Borings sheet is considered an informational document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date confirm that this is a true and accurate copy of the original document. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.

REGISTERED PROFESSIONAL ENGINEER
S. PIRATHIVIRAJ
NO. C71662
EXP. 12/31/11
CIVIL
STATE OF CALIFORNIA

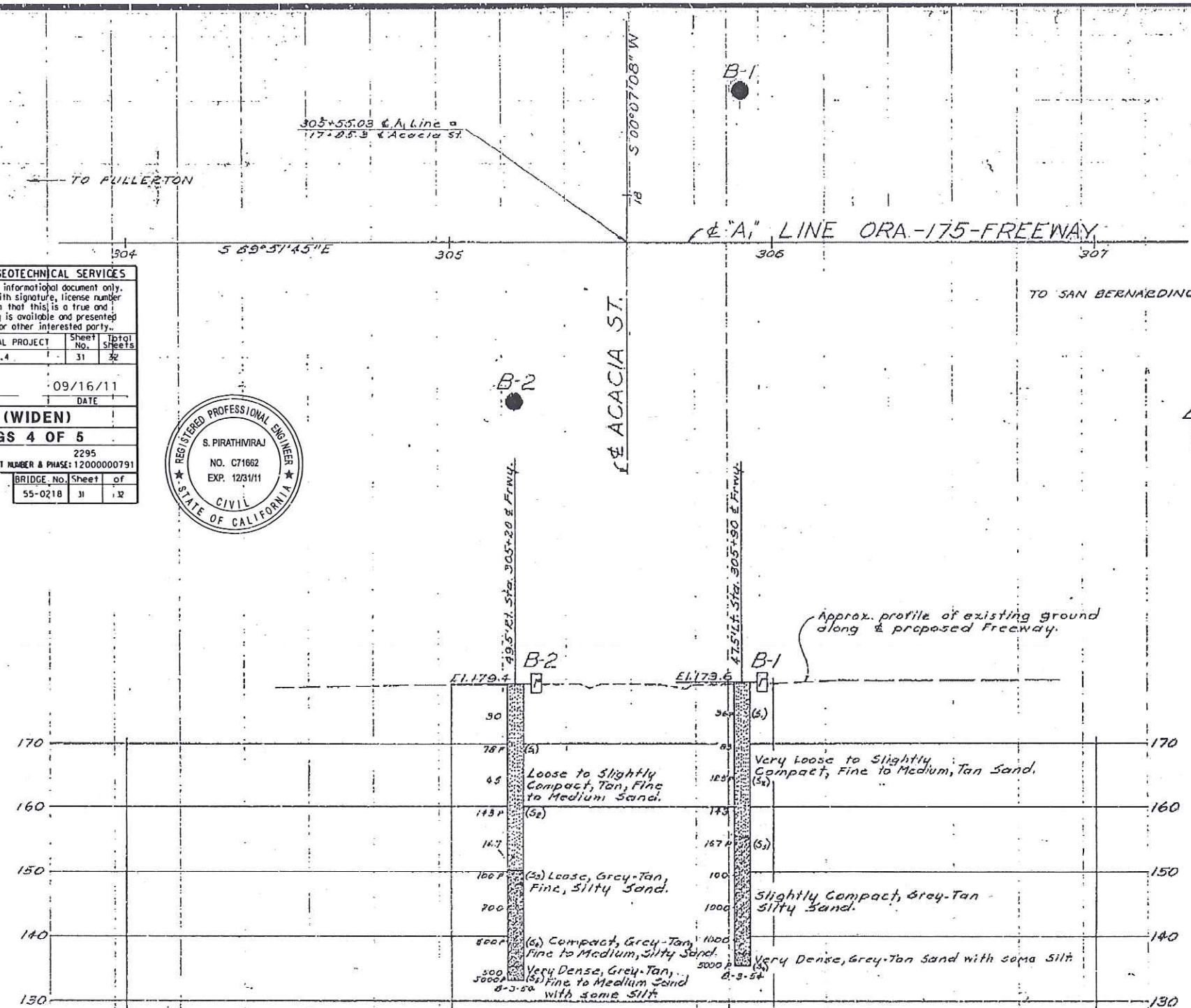
DIST.	COUNTY	ROUTE	POST MILES	TOTAL PROJECT	Sheet No.	Total Sheets
07	Ora	91	3.6/4.6	214323		

JULY 1 1 1958

To accompany plans dated April 19, 1965

AS BUILT PLANS
Contract No. 07-037424
Date Completed 2-17-67
Document No. 7000020222

Test Boring By Bridge Dept.



No ground water encountered

B.M. 30-B-54, ELEV. = 180.00'
Chisl. knob End OF Demler Egg Room Driveway Curb 22'± Rt. of Sta. 23+18 Acacia St.

B.M. 29-B-54, ELEV.=174.58'
Brass Cap in 8" P.C.C. Mon. 275'± Rt. Sta. 290+28, 2ª E.P.R.=103039 E. Buried 1ª!

INFORMATION ON ACTUAL FOUNDATION CONDITIONS ENCOUNTERED IS ON FILE IN BRIDGE GEOLOGY SECTION

SHEET	OF
8	12

CLASSIFICATION OF MATERIAL BASED ON STANDARD GRADE SIZE LIMITS

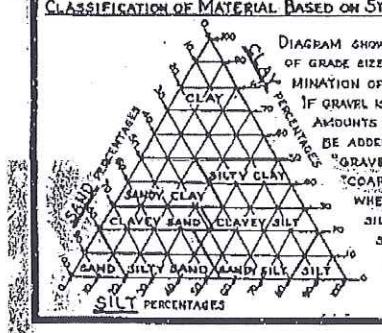


DIAGRAM SHOWING THE BASIS FOR ESTIMATES OF GRADE SIZE DISTRIBUTION USED IN DETERMINATION OF CLASS NAMES.

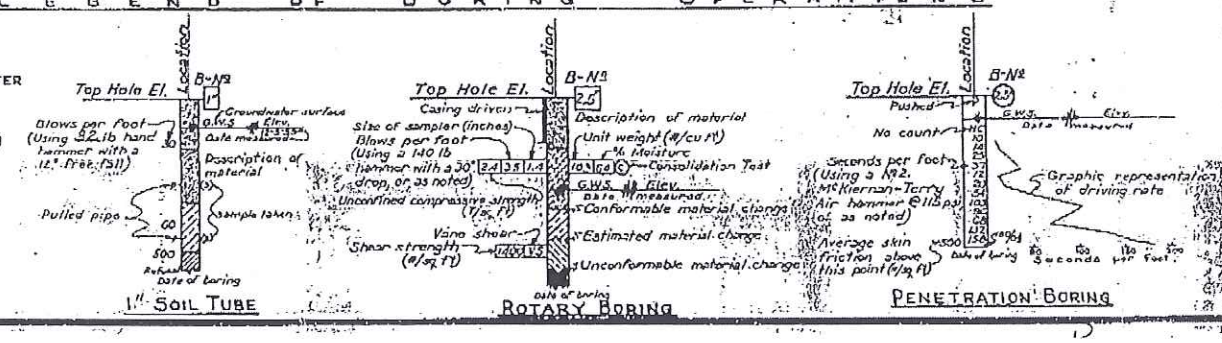
IF GRAVEL IS PRESENT IN APPRECIABLE AMOUNTS THE TERM "GRAVELLY" MAY BE ADDED TO THE CLASS NAME, VIZ. "GRAVELLY SAND". THE TERMS "COARSE", "MEDIUM" AND "FINE" WHEN USED TO DESCRIBE SAND, SILT AND GRAVEL REFER TO STANDARD GRADE SIZE LIMITS.

LEGEND OF EARTH MATERIALS

- GRAVEL
- SAND
- SILT
- CLAY
- SANDY CLAY OR CLAYEY SAND
- SANDY SILT OR SILTY SAND
- SILTY CLAY OR CLAYEY SILT
- PEAT AND/OR ORGANIC MATTER
- FILL MATERIAL
- IGNEOUS ROCK
- SEDIMENTARY ROCK
- METAMORPHIC ROCK

LEGEND OF BORING OPERATIONS

- PLAN OF ANY BORING
- PENETROMETER
- 2½" CONE PENETROMETER
- SAMPLER BORING (DRY)
- ROTARY BORING (WET)
- AUGER BORING (DRY)
- JET BORING
- CORE BORING
- TEST PIT



NOTES

The contractor's attention is directed to Section 2, Article (c) of the Standard Specifications and to the Special Provisions accompanying this set of plans.

Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

ACACIA STREET U.C.

LOG OF TEST BORINGS

SCALE: Horiz. 1" = 20' Vert. 1" = 10' | BRIDGE 55-218 L/R | FILE E-55 | DRAWING 55218-11

DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES					
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DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
12	ORA	91	0.9/5.4	32	32

GEOTECHNICAL PROFESSIONAL — 09/16/11 DATE

ACACIA STREET UC (WIDEN)

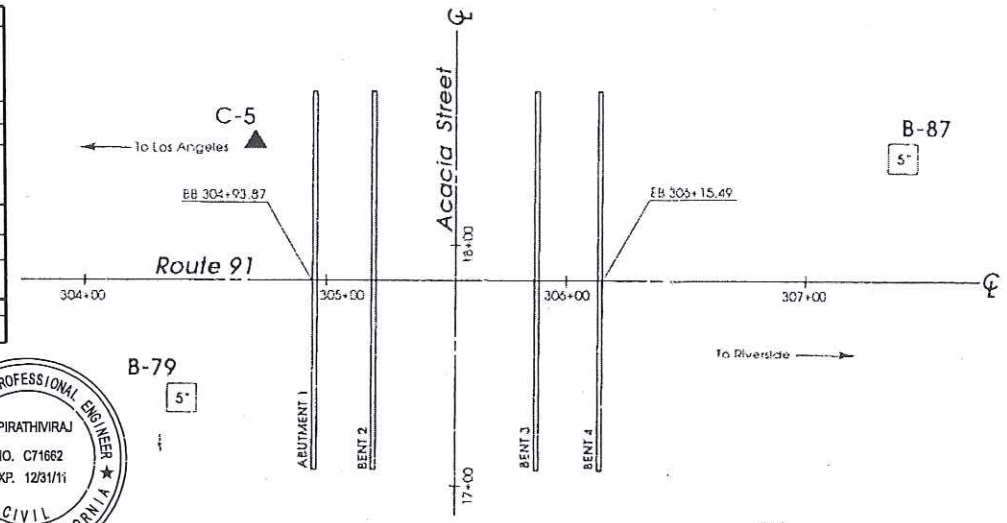
LOG OF TEST BORINGS 5 OF 5

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

BRIDGE No.	Sheet	of
55-0218	32	32

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA



Bench Mark: 310-C-72 (PM 4.85)
Set R.S. Nail on Top of Headwall at Station 310 on North Side of Fwy. 30 Feet North of Edge of Shoulder
Elevation: 184.14 Feet

North
PLAN
SCALE: 1"= 40 FEET

DIST.	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
12	Ora	91	2.8/5.0	577	615

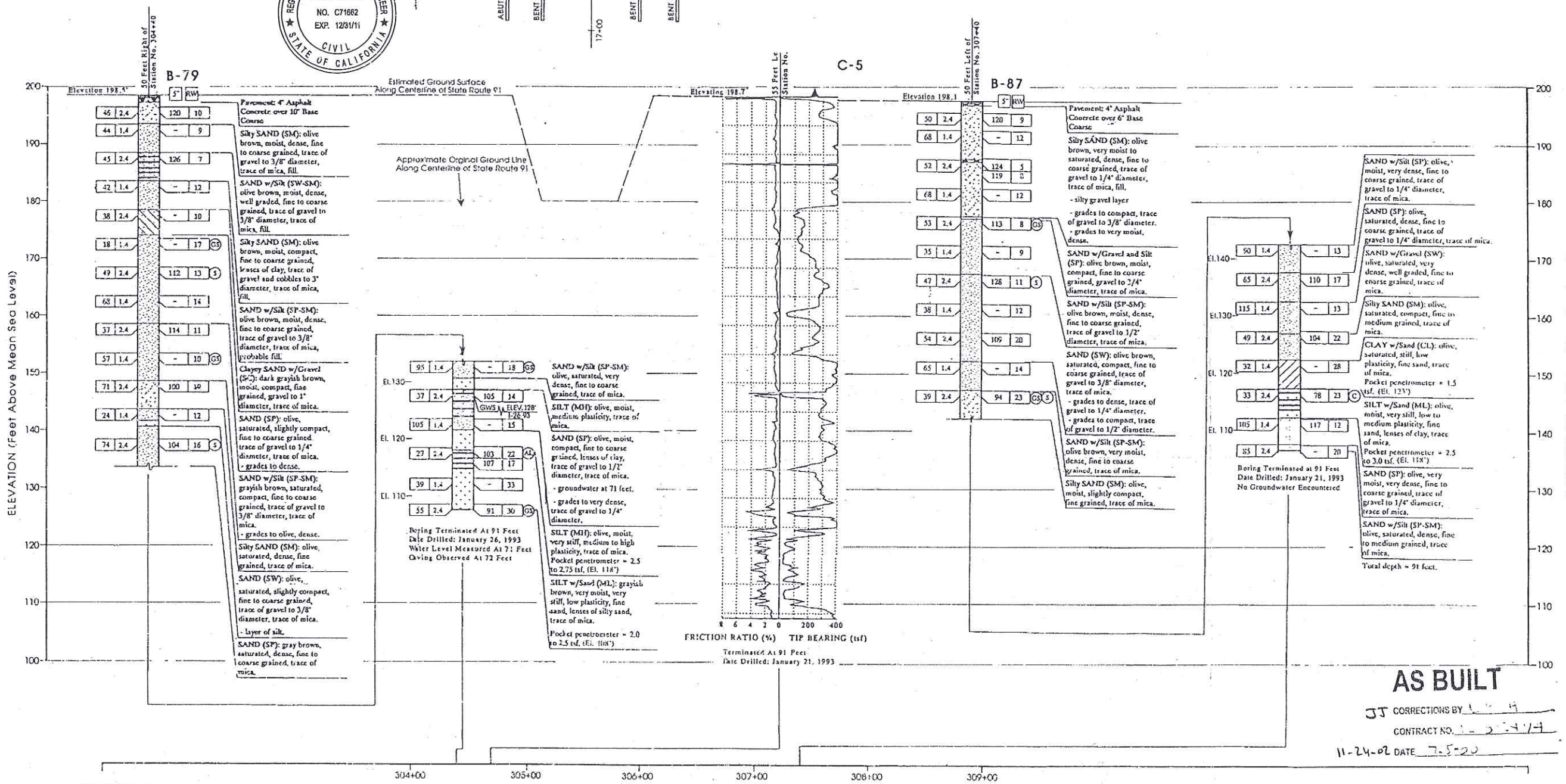
GEOTECHNICAL PROFESSIONAL

1-20-97
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — THOMAS D. SWANTKO — NO. GE 813 — EXP. 12/31/97 — STATE OF CALIFORNIA

GEOFON, Inc.
3552 Cerritos Avenue, Suite B
Cypress, California 90630
Job Number 92-337

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.



PROFILE
VERTICAL SCALE: 1"= 10 FEET
HORIZONTAL SCALE: 1" = 50 FEET

AS BUILT
JT CORRECTIONS BY
CONTRACT NO.
11-24-98 DATE

NO AS BUILT CHANGES

LEGEND OF BORING OPERATIONS

Soil Test Designations: (G) Consolidation, (CA) Chemical Analysis, (AL) Atterberg Limits, (S) Direct Shear, (UC) Unconfined Compression, (R) Pocket Penetrometer, (RV) R-Value, (C) Compaction, (GS) Grain Size

LEGEND FOR EARTH MATERIALS: GRAVEL, SAND, SILT, CLAY, SANDY SILT, PEAT, MISC. ORGANIC MATTER, FILL MATERIAL, COHESIVE ROCK, SEDIMENTARY ROCK, METAMORPHIC ROCK, SANDY CLAY or CLAYEY SAND, SANDY SILT or SILTY SAND, SILTY CLAY

CONSISTENCY CLASSIFICATION FOR SOILS
According to the Standard Penetration Test

Penetration Index (Blows/Ft.)	Granular	Cohesive
0-4	Very Loose	Very Soft
5-9	Loose	Soft
10-19	Slightly Compact	Stiff
20-34	Compact	Very Stiff
35-69	Dense	Hard
>70	Very Dense	Very Hard

NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

*NOTE: Where a 1.4" size sampler is used, this value is the standard penetration N-value.

DESIGN OVERSIGHT: BE NGUYEN — SIGN OFF DATE: 7-24-96	DRAWN BY: H. LEE	S. MOHAMMAD, J. CUNNEEN — FIELD INVESTIGATOR: SEE EXPLORATION — DATE	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	D. K. HAGHIGHI — PROJECT ENGINEER
	CHECKED BY: D. CORDS			

BRIDGE NO.	ACACIA STREET UNDERCROSSING WIDEN AND RETROFIT
55-218	LOG OF TEST BORINGS
POST MILE 4.8	

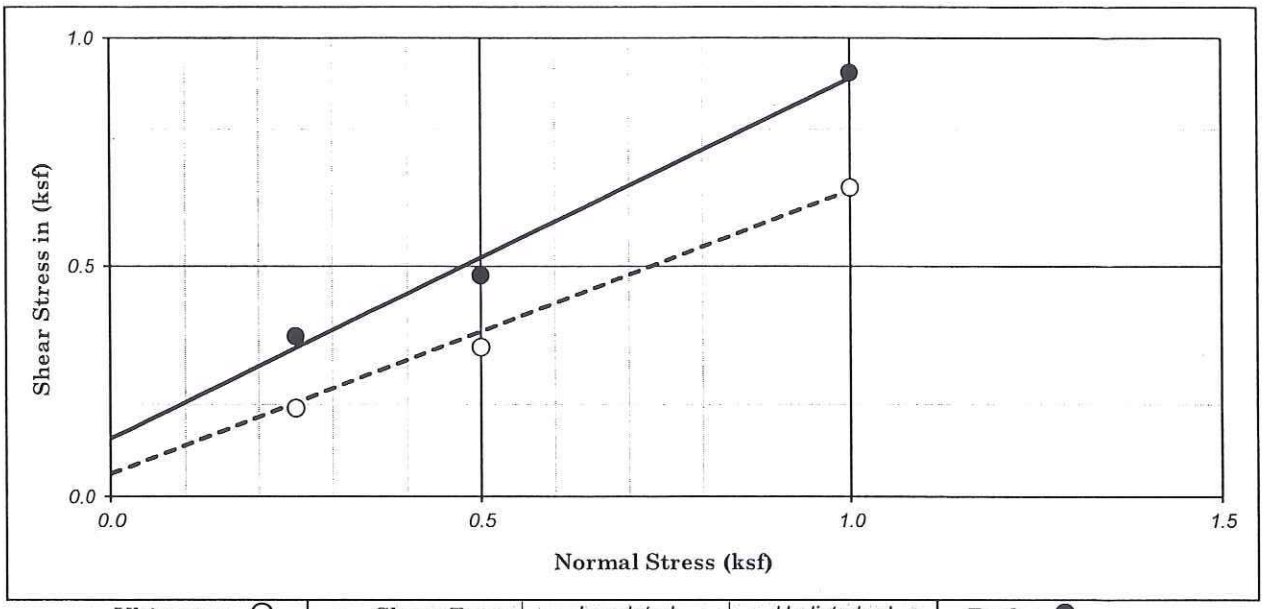
Appendix B

LABORATORY TEST RESULTS

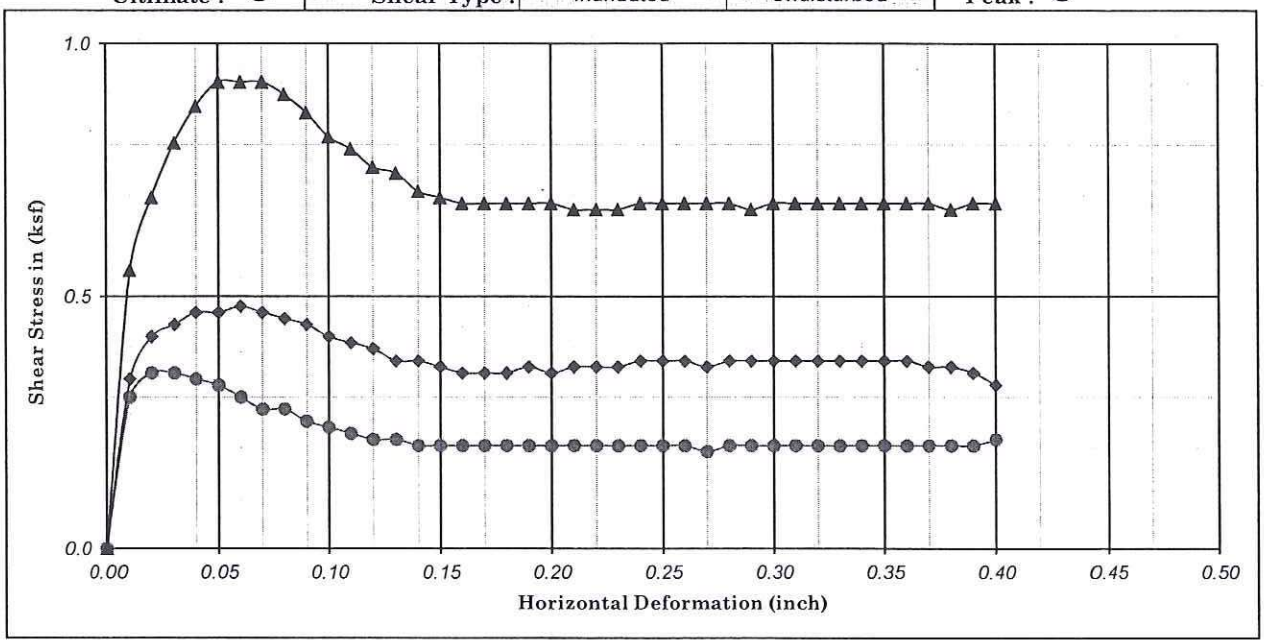
TABLE 1 SUMMARY OF LABORATORY TEST RESULTS FOR ACACIA STREET UC (WIDEN)

Project No. : *10-126* Project Name : RBF / SR-91 WB Widening

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-054	*D-2*	5	SP-SM	2.6	104.3						29000	7.7	60	108
A-10-054	*S-3*	10	SP-SM	4.2										
A-10-054	*D-4*	15	SP	1.9	111.4									
A-10-054	*S-5*	20	SP-SM	3.6										
A-10-054	*D-6*	25	SP/CL	12.8	126.4			0:71:29			3500	7.8	110	189
A-10-054	*S-7*	30	SP	1.8										
A-10-054	*D-8*	35	SP	1.6	106.0									
A-10-054	*S-9*	40	SP	4.7										
A-10-054	*D-10*	45	SP	2.5	109.1									
A-10-054	*S-11*	50	SP	6.0										
A-10-054	*D-12*	55	SM/ML	24.4	120.5									
A-10-054	*S-13*	60	SM	17.7										
A-10-054	*D-14*	65	ML	30.0	118.3	2.5				48/34/14	2100	7.2	70	293
A-10-054	*S-15*	70	SP	5.1										
A-10-054	*D-16*	75	SP	3.9										
A-10-054	*S-17*	80	SP	3.4	114.3									
A-10-055	*S-1*	5	SM	9.9										
A-10-055	*D-2*	10	SM	5.1	123.6									
A-10-055	*S-3*	15	SP-SM	2.5										
A-10-055	*D-4*	20	SP	2.2	113.4									
A-10-055	*S-5*	25	SM	6.4				5:78:17						
A-10-055	*D-6*	30	SP	2.4	105.9									
A-10-055	*S-7*	35	SP	2.3										
A-10-055	*D-8*	40	SP	2.6	109.8									
A-10-055	*S-9*	45	SP	4.1										
A-10-055	*D-10*	50	SP-SM	3.6	112.1									
A-10-055	*S-11*	55	SP	2.9										
A-10-055	*D-12*	60	SP	1.9	114.4									
A-10-055	*S-13*	65	SP-SM	6.4										
A-10-055	*D-14*	70	SP-SM	3.6	113.0									



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-054		Strength Intercept (C) :	0.13	(ksf)	Peak	0.05	(ksf)	Ultimate	
Sample No. : D-2			6.03	(kPa)		2.39	(kPa)		
Depth (ft/m) : 5.0	0.00	Friction Angle (ϕ) :	38.14	Degree		31.63	Degree		
Description : Light olive-brown, Poorly graded SAND with SILT (SP-SM)					Shear Rate (inch/minute) :			0.02	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	22.48	83.52	13.15	1.02	0.25	11.97	0.35	16.66	0.19	9.19
◆	22.46	83.31	13.11	1.02	0.50	23.94	0.48	22.98	0.32	15.51
▲	22.83	82.50	12.99	1.04	1.00	47.88	0.92	44.24	0.67	32.18

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

RBF/SR-91 WB Widening

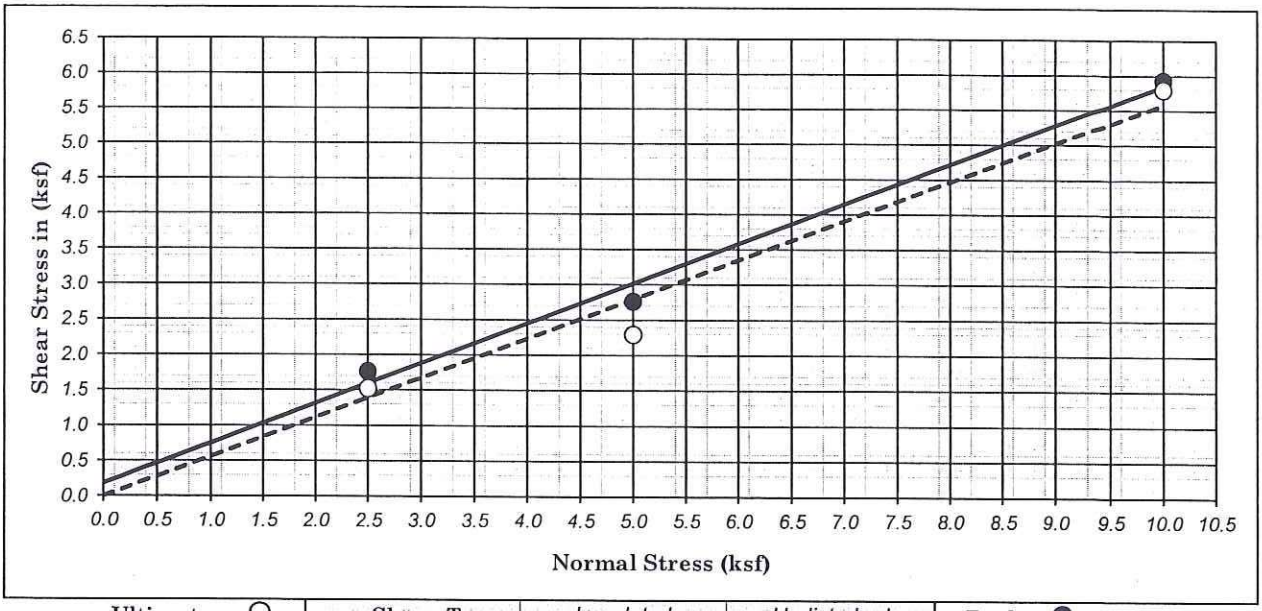
DIRECT SHEAR TEST

(ASTM D-3080)

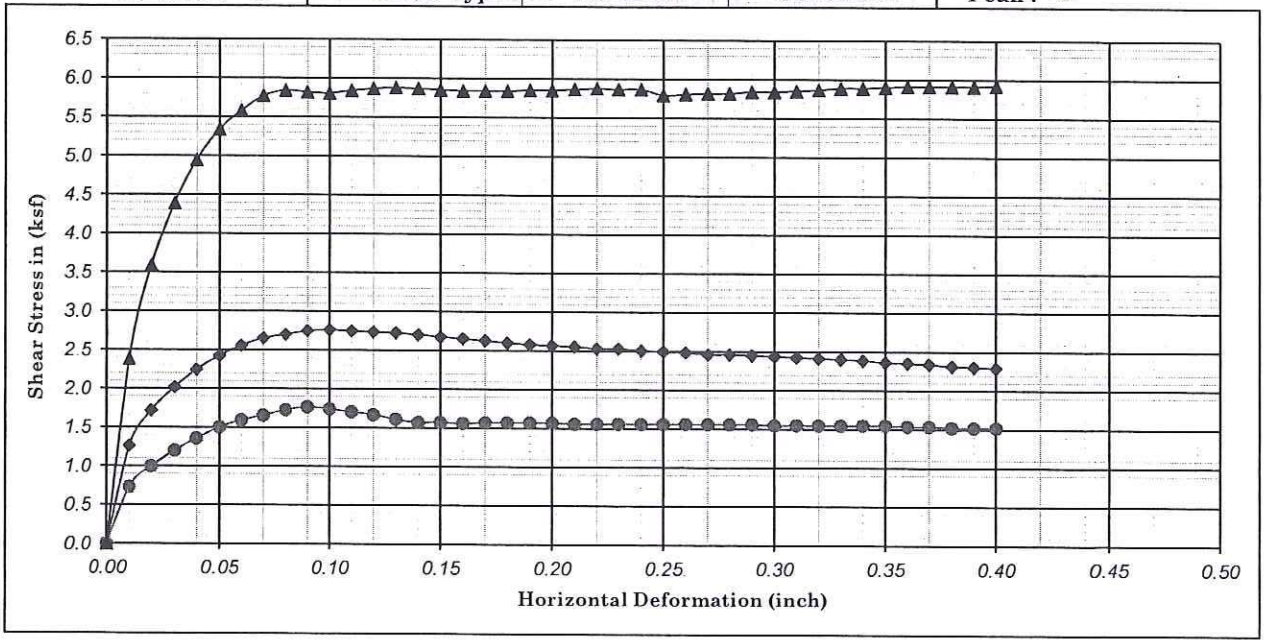
Project No. : 10-126

Date : 02/15/11

Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-054		Strength Intercept (C) :	0.18	(ksf)	Peak	0.00	(ksf)	Ultimate
Sample No. : D-12			8.64	(kPa)		0.00	(kPa)	
Depth (ft/m) : 55.0	0.00	Friction Angle (ϕ) :	29.52	Degree		29.16	Degree	

Description : Dark olive-brown, SILTY SAND / SANDY SILT (SM/ML) Shear Rate (inch/minute) : 0.02

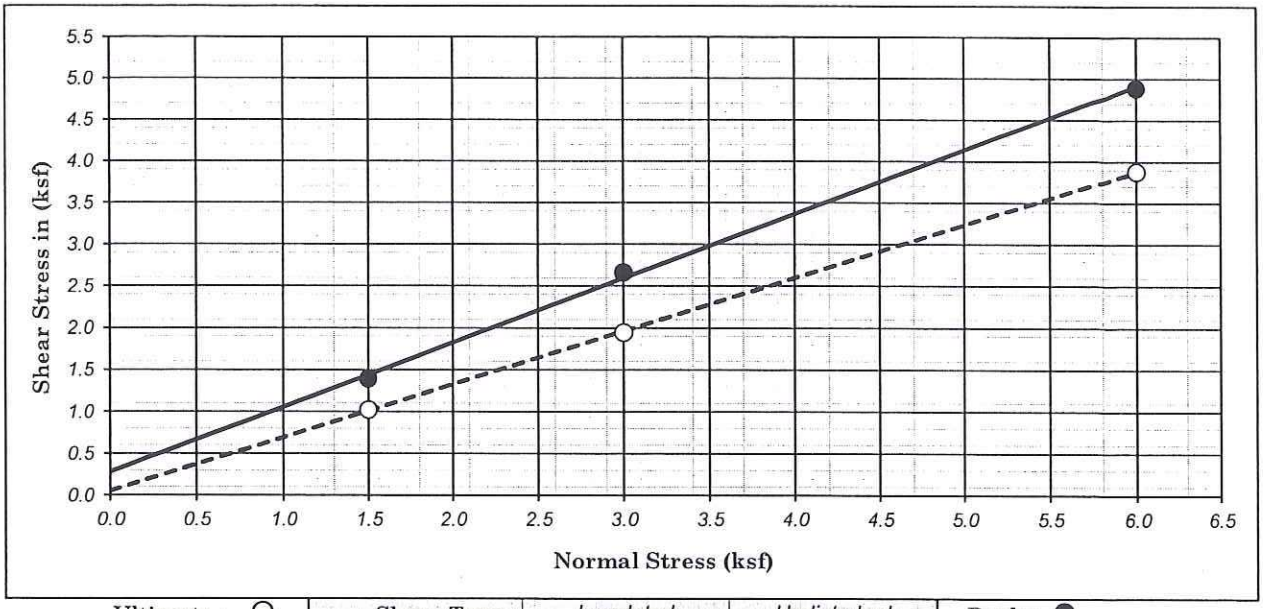
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	34.48	89.57	14.10	0.88	2.50	119.70	1.76	84.46	1.52	72.97
◆	36.46	88.46	13.92	0.91	5.00	239.40	2.76	132.15	2.29	109.74
▲	28.04	97.56	15.36	0.73	10.00	478.80	5.93	283.78	5.80	277.46

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

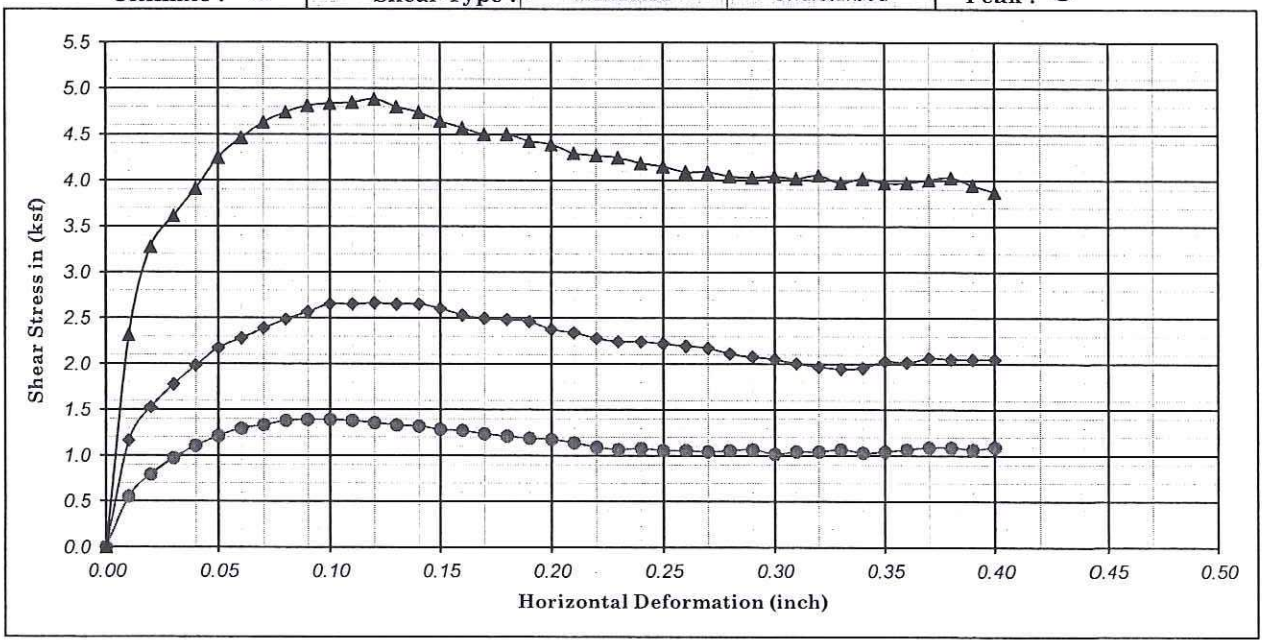
RBF/SR-91 WB Widening

DIRECT SHEAR TEST
(ASTM D-3080)

Project No. : 10-126 | Date : 02/15/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-055	Strength Intercept (C) :	0.28	(ksf)	Peak	0.05	(ksf)	Ultimate		
Sample No. : D-4		13.50	(kPa)		2.59	(kPa)			
Depth (ft/m) : 20.0 | 0.00	Friction Angle (ϕ) :	37.63	Degree		32.46	Degree			
Description : Light yellowish brown, Poorly graded SAND (SP)					Shear Rate (inch/minute) :		0.02		

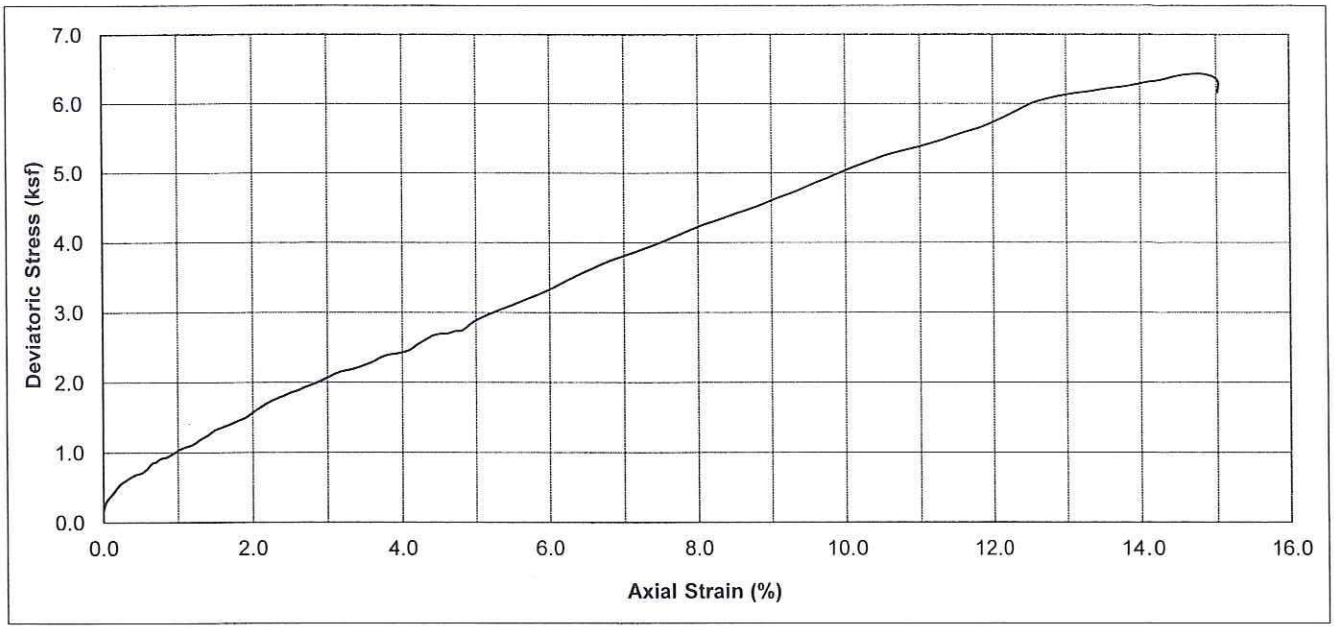
SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	17.03	94.93	14.94	0.78	1.50	71.82	1.39	66.65	1.02	48.84
◆	16.41	97.96	15.42	0.72	3.00	143.64	2.66	127.55	1.94	93.08
▲	11.19	101.59	15.99	0.66	6.00	287.28	4.88	233.85	3.88	185.58

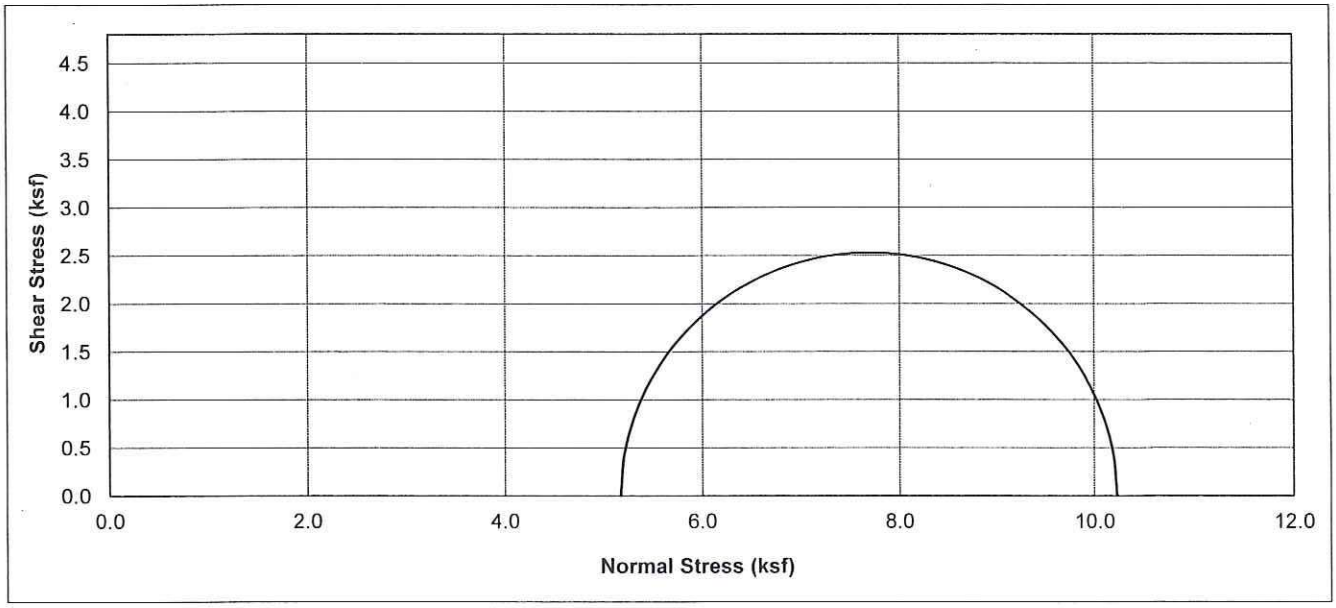
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

RBF/SR-91 WB Widening

DIRECT SHEAR TEST
(ASTM D-3080)

Project No. : 10-126 | Date : 02/15/11 | Figure No. :





Boring No.	Sample No.	Depth (ft)	Soil Type	Dry Density (pcf)	Moisture Content (%)	Conf. Stress (ksf)	10% Axial Strain Dev. Stress (ksf)	Initial Saturation (%)
A-10-054	D-14	65	Olive Br. , LEAN CLAY to SILT with SAND (CL to ML)	90.0	30.04	5.17	5.06	92.9

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	RBF/SR-91 WB Widening
	UNCONSOLIDATED UNDRAINED TEST
Project No. : 10-126 Date : 02/09/11	(ASTM D2850) Figure No. :

Appendix C

DESIGN CALCULATIONS

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening Project No.: 10-26
By: Ranjan Date: 3/21/11 Checked By: Lino Date: 3/23/11 Sheet: 1 of 1
Subject:

Acacia Street UC - Liquefaction Potential Analyses

* Historical high ground water elevation of +130 feet was used

* Analysis was performed using the previous two soil borings (B-79 and B-87) and the current two soil borings (A-10-054 and A-10-055) and one CPT sounding (CPT-10-053).

⇒ Boring A-10-055 and CPT sounding CPT-10-053 deepest depths are located above the historical high groundwater elevation (+130 ft).

∴ liquefaction potential was not performed for these explorations

⇒ Based on the analysis using remaining explorations, only one boring A-10-054 shows a layer of potentially liquefiable materials between elevations +121 and +116 feet.

∴ liquefaction potential at the site is low since this liquefiable soil layer is not continuous. //

17660 Newhope Street, Suite E, Fountain Valley, CA 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

SR-91 Westbound Widening - Acacia Street UC **EMI Project No. 10-126** Version - 12/05

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
^1C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

F_L = CRR r / CSR i

A-10-054

Emean (%)	75		Present Ground El.	181	Borehole Dia. (in)	8	Tot. Unit Wt. (pcf)	51.0	=Design Water Table Depth	52.8	=Field Water Table Depth	Acc. max =	0.520	g		Earthq. M=	7.3				
C_E	1.25		Future Ground El.	181	C_B	1.15	120	130	=Design Water El.	128.2	=Field Water El.					Cm=	1.07				

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
5	176	20	SP-SM	6.0	0.30	0.30	1.70	0.80	1.00	0.67	2	2	0.99	0.30	0.33	26	26	1.00	0.32	0.34	1.02	AboveWT
10	171	15	SP-SM	6.0	0.60	0.60	1.32	0.85	1.20	1.00	1	1	0.98	0.60	0.33	29	29	1.00	0.42	0.45	1.36	AboveWT
15	166	52	SP	4.0	0.90	0.90	1.08	0.85	1.00	0.67	2	2	0.97	0.90	0.33	46	46	1.00	High N	0.00	LARGE	AboveWT
20	161	21	SP-SM	6.0	1.20	1.20	0.93	0.95	1.20	1.00	1	1	0.95	1.20	0.32	32	32	0.97	High N	0.00	LARGE	AboveWT
25	156	26	SC	29.0	1.50	1.50	0.83	0.95	1.00	0.67	2	2	0.94	1.50	0.32	20	27	0.93	0.35	0.34	1.08	AboveWT
30	151	27	SP	4.0	1.80	1.80	0.76	1.00	1.20	1.00	1	1	0.93	1.80	0.31	35	35	0.89	High N	0.00	LARGE	AboveWT
35	146	68	SP	4.0	2.10	2.10	0.71	1.00	1.00	0.67	2	2	0.89	2.10	0.30	46	46	0.87	High N	0.00	LARGE	AboveWT
40	141	36	SP	4.0	2.40	2.40	0.66	1.00	1.20	1.00	1	1	0.85	2.40	0.29	41	41	0.85	High N	0.00	LARGE	AboveWT
45	136	69	SP	4.0	2.70	2.70	0.62	1.00	1.00	0.67	2	2	0.81	2.70	0.27	41	41	0.82	High N	0.00	LARGE	AboveWT
50	131	33	SP	4.0	3.00	3.00	0.59	1.00	1.20	1.00	1	1	0.77	3.00	0.26	34	34	0.78	High N	0.00	LARGE	AboveWT
55	126	40	SM/ML	50.0	3.30	3.23	0.57	1.00	1.00	0.67	2	2	0.73	3.18	0.26	22	31	0.77	High N	0.00	LARGE	high N
60	121	17	SM	45.0	3.60	3.38	0.56	1.00	1.20	1.00	1	1	0.69	3.32	0.25	16	25	0.76	0.28	0.23	0.92	yes
65	116	31	CL/ML	75.0	3.90	3.52	0.54	1.00	1.00	0.67	2	2	0.64	3.46	0.25	16	24	0.75	0.28	0.23	0.92	fines
70	111	53	SP	4.0	4.20	3.66	0.53	1.00	1.20	1.00	1	1	0.60	3.61	0.24	49	49	0.75	High N	0.00	LARGE	high N
75	106	80	SP	4.0	4.50	3.81	0.52	1.00	1.00	0.67	2	2	0.56	3.75	0.23	40	40	0.74	High N	0.00	LARGE	high N
80	101	81	SP	4.0	4.80	3.95	0.51	1.00	1.20	1.00	1	1	0.55	3.90	0.23	72	72	0.73	High N	0.00	LARGE	high N

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
$'C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
$CRR\ r = CRR_{7.5} \times Cm \times K\ sigma$

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

$F_L = CRR\ r / CSR\ i$

B-79

Emean (%)	60			Present Ground El.	200.8	Borehole Dia. (in)	5	Tot. Unit Wt. (pcf)	70.8	=Design Water Table Depth	71.0	=Field Water Table Depth	Acc. max	0.520	g			Earthq. M=	7.3		
C_E	1.00			Future Ground El.	200.8	C_B	1.00	120	130	=Design Water El.	129.8	=Field Water El.						Cm=	1.07		

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
5	196	44	SW-SM	6.0	0.30	0.30	1.70	0.80	1.20	1.00	1	1	0.99	0.30	0.33	72	72	1.00	High N	0.00	LARGE	AboveWT
15	186	42	SP-SM	6.0	0.90	0.90	1.08	0.85	1.20	1.00	1	1	0.97	0.90	0.33	46	46	1.00	High N	0.00	LARGE	AboveWT
25	176	18	SP	4.0	1.50	1.50	0.83	0.95	1.20	1.00	1	1	0.94	1.50	0.32	17	17	0.93	0.18	0.18	0.57	AboveWT
35	166	68	SP	4.0	2.10	2.10	0.71	1.00	1.20	1.00	1	1	0.89	2.10	0.30	58	58	0.87	High N	0.00	LARGE	AboveWT
45	156	57	SP-SM	6.0	2.70	2.70	0.62	1.00	1.20	1.00	1	1	0.81	2.70	0.27	43	43	0.82	High N	0.00	LARGE	AboveWT
55	146	24	SW	4.0	3.30	3.30	0.56	1.00	1.20	1.00	1	1	0.73	3.30	0.25	16	16	0.76	0.17	0.14	0.57	AboveWT
65	136	95	SP-SM	6.0	3.90	3.90	0.52	1.00	1.20	1.00	1	1	0.64	3.90	0.22	59	59	0.73	High N	0.00	LARGE	AboveWT
75	126	105	SP	4.0	4.50	4.38	0.49	1.00	1.20	1.00	1	1	0.56	4.37	0.20	62	62	0.70	High N	0.00	LARGE	high N
85	116	39	ML	85.0	5.10	4.66	0.47	1.00	1.20	1.00	1	1	0.54	4.66	0.20	22	32	0.69	High N	0.00	LARGE	high N

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
^1C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground accelaration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
$CRR\ r = CRR_{7.5} \times Cm \times K\ sigma$

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

$F_L = CRR\ r / CSR\ i$

B-87

Emean (%)	60			Present Ground El.	200.4	Borehole Dia. (in)	5	Tot. Unit Wt. (pcf)	70.4	=Design Water Table Depth	70.4	=Field Water Table Depth	Acc. max =	0.520	g			Earthq. M=	7.3			
C_E	1.00			Future Ground El.	200.4	C_B	1.00	120	130	=Design Water El.	130	=Field Water El.						Cm=	1.07			

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	195	68	SM	15.0	0.30	0.30	1.70	0.80	1.20	1.00	1	1	0.99	0.30	0.33	111	119	1.00	High N	0.00	LARGE	AboveWT
15	185	68	SM	15.0	0.90	0.90	1.08	0.85	1.20	1.00	1	1	0.97	0.90	0.33	75	81	1.00	High N	0.00	LARGE	AboveWT
25	175	35	SP-SM	6.0	1.50	1.50	0.83	0.95	1.20	1.00	1	1	0.94	1.50	0.32	33	33	0.93	High N	0.00	LARGE	AboveWT
35	165	38	SW	6.0	2.10	2.10	0.71	1.00	1.20	1.00	1	1	0.89	2.10	0.30	32	32	0.87	High N	0.00	LARGE	AboveWT
45	155	65	SP-SM	6.0	2.70	2.70	0.62	1.00	1.20	1.00	1	1	0.81	2.70	0.27	49	49	0.82	High N	0.00	LARGE	AboveWT
55	145	90	SP-SM	6.0	3.30	3.30	0.56	1.00	1.20	1.00	1	1	0.73	3.30	0.25	61	61	0.76	High N	0.00	LARGE	AboveWT
65	135	115	SW	6.0	3.90	3.90	0.52	1.00	1.20	1.00	1	1	0.64	3.90	0.22	71	72	0.73	High N	0.00	LARGE	AboveWT
75	125	32	CL	85.0	4.50	4.36	0.49	1.00	1.20	1.00	1	1	0.56	4.36	0.20	19	28	0.71	0.35	0.27	1.36	no
85	115	105	SP	4.0	5.10	4.64	0.47	1.00	1.20	1.00	1	1	0.54	4.64	0.20	60	60	0.69	High N	0.00	LARGE	high N

Project: SR-91 WB Widening Project No.: 10-26
By: Ranjan Date: 3/14/11 Checked By: Lino Date: 3/21/11 Sheet: 1 of 9
Subject:

Axial pile Calculation - Using SIMFET 6.0

Acacia St UC (Widen) - Abutment 1

Under Service-1 Limit State,

Total load per pile = 80 kips = 40 ton.
Total load per support = 182 kips = 91 ton

Pile Capacity Check (FOS = 2 for Q_s)

Group reduction factor η = 1.0 (∵ 4.5 ϕ spacing) (Per Article)

Due to excavation for RW, ignore skin down to El. +175' for Abuts 1 & 4.

Required Q_s = Total load X FOS (=2)
= 40 X 2 = 80 tons

From SIMFET analysis,
Required pile length = 36'
Required pile top El. = +188' − 36'
= +152' //

Similarly, for Abut 4, Required Q_s = 80 tons
Required pile top El. = +191' − 37'
= +154' //

Group check - Nominal resistance = 80 tons
Total resistance = 3 X 80 X 1 = 240 tons > 182 Tons

Pile Group Settlement Calculations - Abut 1

Permissible Settlement under service load = 1"

Total load per support (Q_T) = 182 kips

Based on Abutment 1 pile layout,

B = 11.33' & L = 4.66'

Per AASHTO LRFD Figure 10.7.2.3.1-1, Case d),

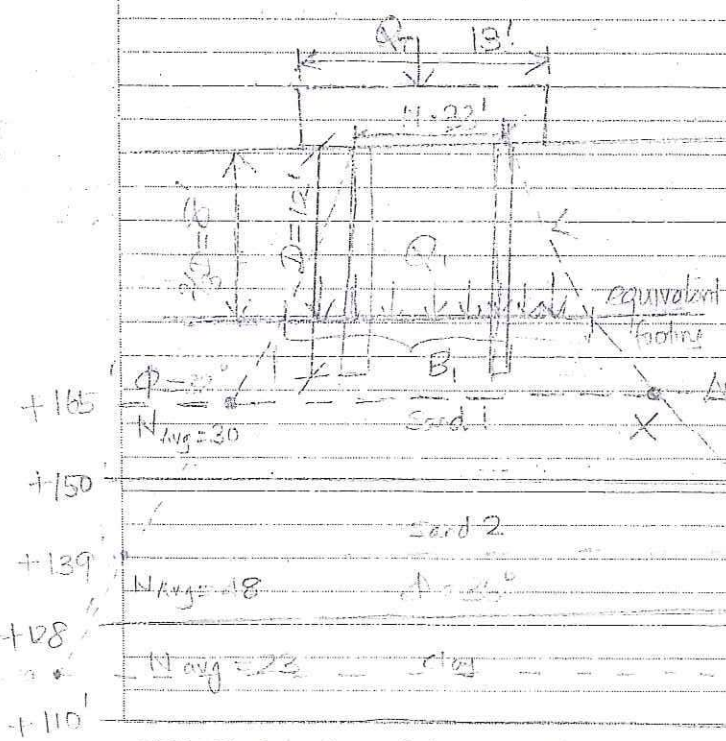
Equivalent footing is located at 2/3 of pile length (D)

Assume the minimum pile length (D) = 12'

∴ 2/3 D = 8'

∴ Equivalent footing dimensions B_1 = 11.33' + 4' = 15.33'

L_1 = 4.66' + 4' = 8.66'



Stress @ Equivalent footing

$Q_1 = \frac{182}{15.33 \times 8.66} = 1.37$ ksf

For layer between +180' and +150' (Sand 1)

Avg N = 30

Per AASHTO Figure 10.6.2.4.2-1,

C' = 175

@ X, Stress increase due to Q_1,

$\Delta\sigma_{v_1} = \frac{182}{(20.33 \times 23.66)} = 0.254$ ksf

For layer between +150' and +128' (Sand 2) ;

$N_{avg} = 35$

Using AASHTO fig. 10.6.2.4.2-1,

$\Rightarrow C' = 85$

Stress increase @ Y due to Q_1,

$\Delta\sigma_{v_2}' = \frac{182}{56.33 \times 49.66} = 0.07$ ksf //

Using AASHTO LRFD eq' 10.6.2.4.2-3,

$$\Delta H_{Sand_1} = H \times \frac{1}{C'} \log\left(\frac{\sigma_0' + \Delta\sigma_v'}{\sigma_0'}\right)$$

$$= \frac{30}{75} \log\left(\frac{2.76 + 0.254}{2.76}\right) + \frac{22}{85} \log\left(\frac{5.88 + 0.07}{5.88}\right)$$

$= 0.183'' + 0.016''$

$= 0.199''$ Select $0.2''$ //

Initial stress σ_0,

@ X, $\sigma_0 = 23 \times 120 = 2.76$ ksf

@ Y, $\sigma_0 = 49 \times 120 = 5.88$ ksf

@ Z, $\sigma_0 = (58 \times 120) + (2 \times 57.6) + (9 \times 52.6) = 7.6$ ksf

For clay layer between +128' and +110' ;

$N' = N \times C_N = 23 \times 0.49 = 11$

$\Rightarrow C' = 35$ from FHWA fig 13

$$\Delta H_{clay} = \frac{18}{35} \log\left(\frac{7.6 + 0.04}{7.6}\right)$$

$= 0.015''$ Select $0.025''$ //

@ Z,

Stress increase due to Q_1

$\Delta\sigma_{v_1}' = \frac{182}{76.33 \times 69.66} = 0.04$ ksf

Total Settlement = $\Delta H_{sand} + \Delta H_{clay}$

$= 0.2 + 0.025$

$= 0.225'' < 1''$ //

$\Rightarrow$ No design tip for settlement at Abut 1 and 4 since a minimum pile length of 12' was selected.

Project: SR-91 WB Widening Project No.: 10-26
By: Ranjan Date: 8/14/11 Checked By: Lino Date: 8/31/11 Sheet: 4 of 9
Subject: 8/31/11

For Bents 2 & 3 - Strength limit

COMPRESSION

Compression per pile = 145 kips = 72.5 tons

Nominal resistance = $\frac{72.5}{0.7}$

= 104 tons SELECT 110 tons

Assume no end bearing,

Required ultimate skin = 110 tons

From SHAFT, Required pile length = 35 ft

Required pile TD El. = +173' - 35'

= +138 ft //

TENSION

Tension per pile = 30 kips = 15.0 tons

Nominal resistance = $\frac{15.0}{0.7}$ = 21.4 tons

Required ultimate skin = 20 tons

Per Caltrans BDS (2003), Equation 4.6.5.1-2,

The ultimate axial capacity (Q_{ult}) for uplift loading,

$Q_{ult} = 0.7 Q_s$

Per SHAFT, Required pile length = 23 ft

Required pile tip El. = +173' - 23'

= +150 ft //

17660 Newhope Street, Suite E, Fountain Valley, CA 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

Project: SR-91 WB Widening Project No.: 10-26
By: Ranjan Date: 8/14/11 Checked By: Lino Date: 8/31/11 Sheet: 5 of 9
Subject: 8/31/11

Group check

Under strength limit, Compression load / support = 689 kips
= 345 tons

Nominal resistance per pile = 110 tons

Nominal resistance for group = 110 × 8 × η

∴ η = 0.77 for 3D spacing (AASHTO LRFD)

Total nominal resistance = 110 × 8 × 0.77 = 678 ton

Factored Compression Demand / support = 345 / 0.7 = 192 ton < Total Nominal Resistance

[CAUSE 6]

Project: SR-91 WB Widening Project No.: 10-26
By: Ranjan Date: 8/15'11 Checked By: Lino Date: 8/31/11 Sheet: 6 of 9
Subject: 8/31/11

Bents 2 & 3 - Extreme limit

COMPRESSION

Compression per pile = 240 kips
= 120 tons

Nominal resistance = $\frac{120}{1.0}$ = 120 tons

Select 120 tons //

Required ultimate skin = 120 tons (∵ Assume no end bearing)

From SHAFT, Required pile length = 37'

Required pile tip El. = +173' - 37'
= +136 ft //

TENSION

Tension per pile = 140 kips = 70 tons

Nominal resistance = $\frac{70}{1.0}$ = 70 ton

Select 70 tons //

Required ultimate skin = 70 tons

Per Caltrans BDS, Equation 4.6.5.1-2, an earth pressure coefficient factor of 0.7 was applied,

Per SHAFT, Required pile length = 33

Required pile tip El. = +173' - 33'
= +140 ft //

Project: SR-91 WB Widening Project No.: 10-26
By: Ranjan Date: 3/15'11 Checked By: Lino Date: 8/31/11 Sheet: 7 of 9
Subject: 8/31/11

Group Check

Under Extreme Limit,

Compression load / support = 373 kips = 187 tons

Factored Compression load / support = $\frac{187}{1}$ = 187 tons

Nominal resistance per pile = 120 tons

Total nominal resistance of pile group = 120 × 8 × η
= 120 × 8 × 0.77
= 739 ton

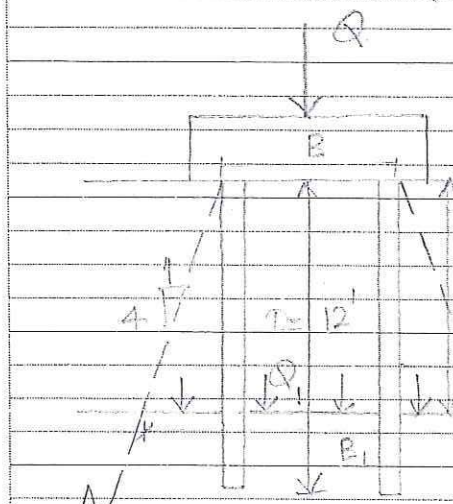
Total nominal resistance of pile group > Factored compression load / support

Satisfied

Settlement Check – Bents

Permissible Settlement under Service load = 1"

Total load per support = 492 kips (Q)



$B_1 = L_1 = 11.33$

$Q_1 = \frac{492}{11.33^2} = 3.83$ ksf

For layer between +165' and +150';

$N_1 = 30$

$= 75$

@A, $\Delta\sigma_{v_1}' = \frac{492}{18.33^2} = 1.46$ ksf

$\sigma_0' = 1.8$ ksf

For layer between +150' and +128';

$N_{1,60} = 35$

$c' = 85$

@B, $\Delta\sigma_{v_2}' = 0.25$ ksf

$\sigma_0' = 4.08$ ksf

For layer between +128' and +110';

$N' = 11$

$c' = 35$

@C, $\Delta\sigma_{v_3}' = 0.16$ ksf ; $\sigma_0' = 5.75$ ksf

Project: SR-91 WB Widening Project No.: 10-26
By: Ranjan Date: 8/15/11 Checked By: Lino Date: 8/31/11 Sheet: 7 of 9
Subject: 8/31/11

Using AASHTO LRFD eq^n.

$$\Delta H_{sand} = \frac{H}{C'} \log\left(\frac{\sigma_o' + \Delta\sigma_v'}{\sigma_o'}\right)$$

$$= \frac{15}{75} \log\left(\frac{1.8 + 1.46}{1.8}\right) + \frac{32}{85} \log\left(\frac{4.08 + 0.35}{4.08}\right)$$

$$= 0.62'' + 0.11''$$

$$= 0.73''$$

$$\Delta H_{clay} = \frac{18}{35} \log\left(\frac{5.75 + 0.16}{5.75}\right)$$

$$= 0.07''$$

Total Settlement = $\Delta H_{sand} + \Delta H_{clay}$

$$= 0.73'' + 0.07''$$

$$= 0.80'' < 1''$$

⇒ No design tip for settlement at Bents 2 & 3 since a minimum pile length of 12' was selected.

DESIGN LATERAL TIP ELEVATION

For abutments & bents, using LPILE analyses, a 20-ft depth is adequate for lateral movement. (15 diameter)

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
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SR-91 WB Widening Project - Abutment 1

TOTAL LOAD = 150.0 TONS

NUMBER OF LAYERS = 5

WATER TABLE DEPTH = 58.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00

SOIL INFORMATION

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.100E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.715E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.100E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.787E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.110E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.100E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.490E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.110E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.380E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.668E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.380E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.454E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.600E+02

LAYER NO 4----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.250E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.600E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.250E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.780E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.308E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.780E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.100E+03

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	=	1.333	FT.
DIAMETER OF BASE	=	1.333	FT.

END OF STEM TO BASE	=	0.000 FT.
ANGLE OF BELL	=	0.000 DEG.
IGNORED TOP PORTION	=	13.000 FT.
IGNORED BOTTOM PORTION	=	0.000 FT.
AREA OF ONE PERCENT STEEL	=	2.010 SQ.IN.
ELASTIC MODULUS, Ec	=	0.360E+07 LB/SQ IN
VOLUME OF UNDERREAM	=	0.000 CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
14.0	0.72	2.57	9.21	11.78	11.78	11.78	16.28
15.0	0.78	5.27	9.21	14.48	14.48	14.48	18.67
16.0	0.83	8.10	9.21	17.31	17.31	17.31	20.93
17.0	0.88	11.05	9.21	20.27	20.27	20.27	23.06
18.0	0.93	14.13	9.21	23.34	23.34	23.34	25.09
19.0	0.98	17.32	9.21	26.53	26.53	26.53	27.01
20.0	1.03	20.62	9.21	29.84	29.84	29.84	28.86
21.0	1.09	24.04	9.21	33.25	33.25	33.25	30.63
22.0	1.14	27.55	9.21	36.76	36.76	36.76	32.32
23.0	1.19	31.16	9.21	40.38	40.38	40.38	33.96
24.0	1.24	34.87	9.21	44.08	44.08	44.08	35.53
25.0	1.29	38.67	9.21	47.89	47.89	47.89	37.05
26.0	1.34	42.56	9.21	51.77	51.77	51.77	38.52
27.0	1.40	46.54	9.21	55.75	55.75	55.75	39.94
28.0	1.45	50.59	9.21	59.80	59.80	59.80	41.32
29.0	1.50	54.72	9.21	63.93	63.93	63.93	42.65
30.0	1.55	58.93	9.21	68.14	68.14	68.14	43.94
31.0	1.60	63.20	9.21	72.41	72.41	72.41	45.19
32.0	1.65	67.54	9.21	76.75	76.75	76.75	46.40
33.0	1.71	71.95	9.21	81.16	81.16	81.16	47.58
34.0	1.76	76.41	9.21	85.63	85.63	85.63	48.72
35.0	1.81	80.94	9.21	90.15	90.15	90.15	49.83
36.0	1.86	85.52	9.21	94.73	94.73	94.73	50.90
37.0	1.91	90.14	22.33	112.48	112.48	112.48	58.81
38.0	1.96	94.82	22.33	117.16	117.16	117.16	59.64
39.0	2.02	101.26	22.33	123.59	123.59	123.59	61.30
40.0	2.07	107.75	22.33	130.09	130.09	130.09	62.91
41.0	2.12	114.30	22.33	136.64	136.64	136.64	64.47
42.0	2.17	120.90	22.33	143.24	143.24	143.24	65.97
43.0	2.22	127.54	22.33	149.88	149.88	149.88	67.43
44.0	2.27	134.23	22.33	156.56	156.56	156.56	68.83

Required Q_S = 80 tons

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.5403E-01	0.5251E-04	0.4887E-03	0.1000E-04
0.2702E+00	0.2625E-03	0.2443E-02	0.5000E-04
0.5403E+00	0.5251E-03	0.4887E-02	0.1000E-03
0.2762E+02	0.2674E-01	0.2443E+00	0.5000E-02
0.4023E+02	0.3970E-01	0.3665E+00	0.7500E-02
0.5151E+02	0.5202E-01	0.4887E+00	0.1000E-01
0.9366E+02	0.1077E+00	0.1222E+01	0.2500E-01
0.1226E+03	0.1636E+00	0.2443E+01	0.5000E-01
0.1359E+03	0.2037E+00	0.3665E+01	0.7500E-01
0.1431E+03	0.2375E+00	0.4859E+01	0.1000E+00
0.1524E+03	0.4003E+00	0.1105E+02	0.2500E+00
0.1578E+03	0.6584E+00	0.1673E+02	0.5000E+00
0.1603E+03	0.7870E+00	0.1934E+02	0.6250E+00
0.1631E+03	0.9475E+00	0.2232E+02	0.7813E+00
0.1634E+03	0.9665E+00	0.2267E+02	0.7998E+00

@ length 35 ft, Q_S = 80.9 tons (just 0.9 tons greater than required)

⇒ Conservatively, shaft length of 36 ft was selected.

(the ultimate Q_S = 85 tons > Required Q_S = 80 tons)

RESULT FROM UPPER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.8566E-01	0.7402E-04	0.6981E-03	0.1000E-04
0.4283E+00	0.3701E-03	0.3491E-02	0.5000E-04
0.8566E+00	0.7402E-03	0.6981E-02	0.1000E-03
0.4313E+02	0.3773E-01	0.3491E+00	0.5000E-02
0.6078E+02	0.5512E-01	0.5236E+00	0.7500E-02
0.7519E+02	0.7083E-01	0.6981E+00	0.1000E-01
0.1212E+03	0.1342E+00	0.1745E+01	0.2500E-01
0.1440E+03	0.1866E+00	0.3491E+01	0.5000E-01
0.1510E+03	0.2205E+00	0.5236E+01	0.7500E-01
0.1541E+03	0.2498E+00	0.6870E+01	0.1000E+00
0.1624E+03	0.4118E+00	0.1509E+02	0.2500E+00
0.1664E+03	0.6677E+00	0.1910E+02	0.5000E+00
0.1685E+03	0.7957E+00	0.2119E+02	0.6250E+00
0.1711E+03	0.9558E+00	0.2381E+02	0.7813E+00
0.1714E+03	0.9748E+00	0.2412E+02	0.7998E+00

RESULT FROM LOWER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.2972E-01	0.3477E-04	0.2793E-03	0.1000E-04
0.1486E+00	0.1738E-03	0.1396E-02	0.5000E-04
0.2972E+00	0.3477E-03	0.2793E-02	0.1000E-03
0.1515E+02	0.1756E-01	0.1396E+00	0.5000E-02
0.2260E+02	0.2635E-01	0.2094E+00	0.7500E-02
0.2972E+02	0.3496E-01	0.2793E+00	0.1000E-01
0.6332E+02	0.8018E-01	0.6981E+00	0.2500E-01
0.9831E+02	0.1387E+00	0.1396E+01	0.5000E-01
0.1196E+03	0.1859E+00	0.2094E+01	0.7500E-01
0.1317E+03	0.2247E+00	0.2848E+01	0.1000E+00
0.1425E+03	0.3889E+00	0.7009E+01	0.2500E+00
0.1492E+03	0.6490E+00	0.1435E+02	0.5000E+00
0.1521E+03	0.7783E+00	0.1749E+02	0.6250E+00
0.1551E+03	0.9391E+00	0.2083E+02	0.7813E+00
0.1554E+03	0.9582E+00	0.2122E+02	0.7998E+00

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

SR-91 WB Widening Project - Abutment 4

TOTAL LOAD = 150.0 TONS

NUMBER OF LAYERS = 5

WATER TABLE DEPTH = 61.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00

SOIL INFORMATION

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.100E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.676E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.130E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.743E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.110E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.130E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.466E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.110E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.410E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.636E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.410E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.428E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.630E+02

LAYER NO 4----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.250E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.630E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.250E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.730E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.347E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.730E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.100E+03

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	=	1.333 FT.
DIAMETER OF BASE	=	1.333 FT.

END OF STEM TO BASE	=	0.000	FT.
ANGLE OF BELL	=	0.000	DEG.
IGNORED TOP PORTION	=	16.000	FT.
IGNORED BOTTOM PORTION	=	0.000	FT.
AREA OF ONE PERCENT STEEL	=	2.010	SQ.IN.
ELASTIC MODULUS, Ec	=	0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	=	0.000	CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
17.0	0.88	2.96	9.21	12.17	12.17	12.17	13.85
18.0	0.93	6.03	9.21	15.24	15.24	15.24	16.38
19.0	0.98	9.22	9.21	18.43	18.43	18.43	18.77
20.0	1.03	12.53	9.21	21.74	21.74	21.74	21.03
21.0	1.09	15.94	9.21	25.15	25.15	25.15	23.17
22.0	1.14	19.45	9.21	28.66	28.66	28.66	25.20
23.0	1.19	23.06	9.21	32.28	32.28	32.28	27.15
24.0	1.24	26.77	9.21	35.99	35.99	35.99	29.01
25.0	1.29	30.57	9.21	39.79	39.79	39.79	30.79
26.0	1.34	34.46	9.21	43.68	43.68	43.68	32.50
27.0	1.40	38.44	9.21	47.65	47.65	47.65	34.14
28.0	1.45	42.49	9.21	51.70	51.70	51.70	35.72
29.0	1.50	46.62	9.21	55.83	55.83	55.83	37.24
30.0	1.55	50.83	9.21	60.04	60.04	60.04	38.71
31.0	1.60	55.10	9.21	64.31	64.31	64.31	40.13
32.0	1.65	59.44	9.21	68.66	68.66	68.66	41.50
33.0	1.71	63.85	9.21	73.06	73.06	73.06	42.83
34.0	1.76	68.32	9.21	77.53	77.53	77.53	44.11
35.0	1.81	72.84	9.21	82.05	82.05	82.05	45.35
36.0	1.86	77.42	9.21	86.63	86.63	86.63	46.55
37.0	1.91	82.05	9.21	91.26	91.26	91.26	47.71
38.0	1.96	86.72	9.21	95.93	95.93	95.93	48.84
39.0	2.02	91.44	9.21	100.66	100.66	100.66	49.92
40.0	2.07	96.21	22.33	118.54	118.54	118.54	57.33
41.0	2.12	101.01	22.33	123.34	123.34	123.34	58.20
42.0	2.17	107.61	22.33	129.94	129.94	129.94	59.85
43.0	2.22	114.25	22.33	136.58	136.58	136.58	61.45
44.0	2.27	120.93	22.33	143.27	143.27	143.27	62.99
45.0	2.33	127.66	22.33	149.99	149.99	149.99	64.48
46.0	2.38	134.41	22.33	156.75	156.75	156.75	65.92

Required Q_S = 80 tons

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.5906E-01	0.5776E-04	0.4887E-03	0.1000E-04
0.2953E+00	0.2888E-03	0.2443E-02	0.5000E-04
0.5906E+00	0.5776E-03	0.4887E-02	0.1000E-03
0.3018E+02	0.2947E-01	0.2443E+00	0.5000E-02
0.4377E+02	0.4367E-01	0.3665E+00	0.7500E-02
0.5568E+02	0.5697E-01	0.4887E+00	0.1000E-01
0.9951E+02	0.1162E+00	0.1222E+01	0.2500E-01
0.1290E+03	0.1743E+00	0.2443E+01	0.5000E-01
0.1426E+03	0.2154E+00	0.3665E+01	0.7500E-01
0.1498E+03	0.2496E+00	0.4859E+01	0.1000E+00
0.1591E+03	0.4131E+00	0.1105E+02	0.2500E+00
0.1645E+03	0.6715E+00	0.1673E+02	0.5000E+00
0.1669E+03	0.8003E+00	0.1934E+02	0.6250E+00
0.1697E+03	0.9609E+00	0.2232E+02	0.7813E+00
0.1701E+03	0.9800E+00	0.2267E+02	0.7998E+00

RESULT FROM UPPER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.9474E-01	0.8261E-04	0.6981E-03	0.1000E-04
0.4737E+00	0.4131E-03	0.3491E-02	0.5000E-04
0.9474E+00	0.8261E-03	0.6981E-02	0.1000E-03
0.4737E+02	0.4208E-01	0.3491E+00	0.5000E-02
0.6608E+02	0.6113E-01	0.5236E+00	0.7500E-02
0.8112E+02	0.7817E-01	0.6981E+00	0.1000E-01
0.1281E+03	0.1451E+00	0.1745E+01	0.2500E-01
0.1510E+03	0.1990E+00	0.3491E+01	0.5000E-01
0.1580E+03	0.2333E+00	0.5236E+01	0.7500E-01
0.1611E+03	0.2628E+00	0.6870E+01	0.1000E+00
0.1693E+03	0.4254E+00	0.1509E+02	0.2500E+00
0.1733E+03	0.6815E+00	0.1910E+02	0.5000E+00
0.1754E+03	0.8097E+00	0.2119E+02	0.6250E+00
0.1780E+03	0.9699E+00	0.2381E+02	0.7813E+00
0.1784E+03	0.9890E+00	0.2412E+02	0.7998E+00

RESULT FROM LOWER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.3207E-01	0.3755E-04	0.2793E-03	0.1000E-04
0.1603E+00	0.1878E-03	0.1396E-02	0.5000E-04
0.3207E+00	0.3755E-03	0.2793E-02	0.1000E-03
0.1639E+02	0.1901E-01	0.1396E+00	0.5000E-02
0.2439E+02	0.2849E-01	0.2094E+00	0.7500E-02
0.3201E+02	0.3776E-01	0.2793E+00	0.1000E-01
0.6761E+02	0.8600E-01	0.6981E+00	0.2500E-01
0.1041E+03	0.1475E+00	0.1396E+01	0.5000E-01
0.1259E+03	0.1963E+00	0.2094E+01	0.7500E-01
0.1381E+03	0.2360E+00	0.2848E+01	0.1000E+00
0.1489E+03	0.4009E+00	0.7009E+01	0.2500E+00
0.1556E+03	0.6615E+00	0.1435E+02	0.5000E+00
0.1584E+03	0.7910E+00	0.1749E+02	0.6250E+00
0.1614E+03	0.9520E+00	0.2083E+02	0.7813E+00
0.1618E+03	0.9711E+00	0.2122E+02	0.7998E+00

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
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SR-91 WB Widening Project - Bents 2 and 3

TOTAL LOAD = 250.0 TONS

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 43.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00

SOIL INFORMATION

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.100E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.568E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.230E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.853E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.230E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.594E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.450E+02

LAYER NO 3----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.250E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.450E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.250E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.630E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.428E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.630E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.100E+03

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	=	1.333 FT.
DIAMETER OF BASE	=	1.333 FT.
END OF STEM TO BASE	=	0.000 FT.
ANGLE OF BELL	=	0.000 DEG.
IGNORED TOP PORTION	=	0.000 FT.
IGNORED BOTTOM PORTION	=	0.000 FT.
AREA OF ONE PERCENT STEEL	=	2.010 SQ.IN.
ELASTIC MODULUS, Ec	=	0.360E+07 LB/SQ IN
VOLUME OF UNDERREAM	=	0.000 CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
1.0	0.05	0.23	1.88	2.11	2.11	2.11	40.88
2.0	0.10	0.67	2.51	3.18	3.18	3.18	30.76
3.0	0.16	1.30	3.14	4.44	4.44	4.44	28.66
4.0	0.21	2.13	3.77	5.90	5.90	5.90	28.52
5.0	0.26	3.13	4.40	7.53	7.53	7.53	29.13
6.0	0.31	4.31	5.03	9.33	9.33	9.33	30.09
7.0	0.36	5.65	5.65	11.30	11.30	11.30	31.23
8.0	0.41	7.15	6.28	13.43	13.43	13.43	32.47
9.0	0.47	8.80	6.91	15.71	15.71	15.71	33.76
10.0	0.52	10.59	7.54	18.13	18.13	18.13	35.08
11.0	0.57	12.53	8.17	20.70	20.70	20.70	36.40
12.0	0.62	14.61	8.37	22.98	22.98	22.38	37.05
13.0	0.67	16.82	8.37	25.19	25.19	25.19	37.48
14.0	0.72	19.15	8.37	27.52	27.52	27.52	38.03
15.0	0.78	21.60	8.37	29.98	29.98	29.98	38.06
16.0	0.83	24.18	8.37	32.55	32.55	32.55	39.36
17.0	0.88	26.86	8.37	35.24	35.24	35.24	40.10
18.0	0.93	29.66	8.37	38.04	38.04	38.04	40.88
19.0	0.98	32.56	8.37	40.94	40.94	40.94	41.68
20.0	1.03	35.57	8.37	43.94	43.94	43.94	42.50
21.0	1.09	38.67	8.37	47.04	47.04	47.04	43.33
22.0	1.14	41.86	22.33	64.20	64.20	64.20	56.45
23.0	1.19	45.15	22.33	67.48	67.48	67.48	56.76
24.0	1.24	50.20	22.33	72.54	72.54	72.54	58.47
25.0	1.29	55.39	22.33	77.72	77.72	77.72	60.14
26.0	1.34	60.69	22.33	83.02	83.02	83.02	61.77
27.0	1.40	66.11	22.33	88.44	88.44	88.44	63.37
28.0	1.45	71.64	22.33	93.97	93.97	93.97	64.92
29.0	1.50	77.27	22.33	99.60	99.60	99.60	66.44
30.0	1.55	83.00	22.33	105.34	105.34	105.34	67.92
31.0	1.60	88.83	22.33	111.17	111.17	111.17	69.37
32.0	1.65	94.75	22.33	117.09	117.09	117.09	70.78
33.0	1.71	100.76	22.33	123.10	123.10	123.10	72.16
34.0	1.76	106.85	22.33	129.19	129.19	129.19	73.50
35.0	1.81	113.02	22.33	135.36	135.36	135.36	74.81
36.0	1.86	119.26	22.33	141.60	141.60	141.60	76.09
37.0	1.91	125.58	22.33	147.91	147.91	147.91	77.33
38.0	1.96	131.95	22.33	154.29	154.29	154.29	78.54
39.0	2.02	138.39	22.33	160.73	160.73	160.73	79.72
40.0	2.07	144.89	22.33	167.22	167.22	167.22	80.87
41.0	2.12	151.43	22.33	173.77	173.77	173.77	81.99
42.0	2.17	158.03	22.33	180.37	180.37	180.37	83.07
43.0	2.22	164.67	22.33	187.01	187.01	187.01	84.13
44.0	2.27	171.28	15.70	186.98	186.98	186.98	82.21
45.0	2.33	177.85	15.70	193.55	193.55	193.55	83.20
46.0	2.38	180.73	15.70	196.43	196.43	196.43	82.60
47.0	2.43	183.61	15.70	199.31	199.31	199.31	82.03
48.0	2.48	186.48	15.70	202.19	202.19	202.19	81.48
49.0	2.53	189.36	15.70	205.07	205.07	205.07	80.96
50.0	2.58	192.24	15.70	207.95	207.95	207.95	80.45
51.0	2.64	195.12	15.70	210.83	210.83	210.83	79.97
52.0	2.69	198.00	15.70	213.70	213.70	213.70	79.50
53.0	2.74	200.88	15.70	216.58	216.58	216.58	79.05
54.0	2.79	203.76	15.70	219.46	219.46	219.46	78.62
55.0	2.84	206.64	15.70	222.34	222.34	222.34	78.20
56.0	2.89	209.52	15.70	225.22	225.22	225.22	77.80
57.0	2.95	212.40	15.70	228.10	228.10	228.10	77.41
58.0	3.00	215.28	15.70	230.98	230.98	230.98	77.04
59.0	3.05	218.16	15.70	233.86	233.86	233.86	76.68
60.0	3.10	221.04	15.70	236.74	236.74	236.74	76.33
61.0	3.15	223.92	15.70	239.62	239.62	239.62	75.99
62.0	3.21	226.80	35.73	262.53	262.53	262.53	81.91

Strength limit
Required Q_s = 110 ton

Extreme limit
Required Q_s = 120 ton

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.1690E+00	0.1572E-03	0.7818E-03	0.1000E-04
0.8451E+00	0.7862E-03	0.3909E-02	0.5000E-04
0.1690E+01	0.1572E-02	0.7818E-02	0.1000E-03
0.7574E+02	0.7603E-01	0.3909E+00	0.5000E-02
0.1013E+03	0.1070E+00	0.5864E+00	0.7500E-02
0.1213E+03	0.1334E+00	0.7818E+00	0.1000E-01
0.1747E+03	0.2186E+00	0.1955E+01	0.2500E-01
0.2066E+03	0.2902E+00	0.3909E+01	0.5000E-01

0.2165E+03	0.3299E+00	0.5864E+01	0.7500E-01
0.2220E+03	0.3640E+00	0.7773E+01	0.1000E+00
0.2301E+03	0.5311E+00	0.1768E+02	0.2500E+00
0.2359E+03	0.7942E+00	0.2676E+02	0.5000E+00
0.2405E+03	0.9277E+00	0.3095E+02	0.6250E+00
0.2445E+03	0.1094E+01	0.3571E+02	0.7813E+00
0.2450E+03	0.1113E+01	0.3627E+02	0.7998E+00

RESULT FROM UPPER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.3320E+00	0.2787E-03	0.1117E-02	0.1000E-04
0.1660E+01	0.1394E-02	0.5584E-02	0.5000E-04
0.3320E+01	0.2787E-02	0.1117E-01	0.1000E-03
0.1208E+03	0.1211E+00	0.5584E-00	0.5000E-02
0.1502E+03	0.1611E+00	0.8377E+00	0.7500E-02
0.1713E+03	0.1924E+00	0.1117E+01	0.1000E-01
0.2129E+03	0.2694E+00	0.2792E+01	0.2500E-01
0.2273E+03	0.3178E+00	0.5584E+01	0.5000E-01
0.2334E+03	0.3537E+00	0.8377E+01	0.7500E-01
0.2365E+03	0.3849E+00	0.1099E+02	0.1000E+00
0.2466E+03	0.5567E+00	0.2414E+02	0.2500E+00
0.2513E+03	0.8167E+00	0.3055E+02	0.5000E+00
0.2547E+03	0.9486E+00	0.3390E+02	0.6250E+00
0.2588E+03	0.1113E+01	0.3809E+02	0.7813E+00
0.2593E+03	0.1133E+01	0.3859E+02	0.7998E+00

RESULT FROM LOWER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.7214E-01	0.7837E-04	0.4468E-03	0.1000E-04
0.3607E+00	0.3919E-03	0.2234E-02	0.5000E-04
0.7214E+00	0.7837E-03	0.4468E-02	0.1000E-03
0.3604E+02	0.3949E-01	0.2234E+00	0.5000E-02
0.5223E+02	0.5838E-01	0.3351E+00	0.7500E-02
0.6675E+02	0.7616E-01	0.4468E+00	0.1000E-01
0.1268E+03	0.1594E+00	0.1117E+01	0.2500E-01
0.1762E+03	0.2485E+00	0.2234E+01	0.5000E-01
0.1978E+03	0.3036E+00	0.3351E+01	0.7500E-01
0.2069E+03	0.3423E+00	0.4557E+01	0.1000E+00
0.2119E+03	0.5025E+00	0.1121E+02	0.2500E+00
0.2205E+03	0.7718E+00	0.2296E+02	0.5000E+00
0.2253E+03	0.9068E+00	0.2799E+02	0.6250E+00
0.2302E+03	0.1074E+01	0.3332E+02	0.7813E+00
0.2308E+03	0.1093E+01	0.3394E+02	0.7998E+00

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
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SR-91 WB Widening Project - Bents 2 and 3

TOTAL LOAD = 110.0 TONS

REDUCTION FACTOR APPLIED FOR UPLIFT FRICTION = 0.700

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 43.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00

SOIL INFORMATION

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.100E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.568E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.100E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.230E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.853E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.230E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.594E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.450E+02

LAYER NO 3----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.250E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.450E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.250E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.630E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.428E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.630E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.100E+03

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	= 1.333	FT.
DIAMETER OF BASE	= 1.333	FT.
END OF STEM TO BASE	= 0.000	FT.
ANGLE OF BELL	= 0.000	DEG.
IGNORED TOP PORTION	= 0.000	FT.
IGNORED BOTTOM PORTION	= 0.000	FT.
AREA OF ONE PERCENT STEEL	= 2.010	SQ.IN.
PLASTIC MODULUS, EC	= 0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	= 0.000	CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
Q5D = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;

QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	WT (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
1.0	0.05	0.16	0.10	0.26	0.26	0.25	5.12
2.0	0.10	0.47	0.21	0.68	0.68	0.68	6.51
3.0	0.16	0.91	0.31	1.23	1.23	1.23	7.91
4.0	0.21	1.49	0.42	1.91	1.91	1.91	9.23
5.0	0.26	2.19	0.52	2.72	2.72	2.72	10.53
6.0	0.31	3.01	0.63	3.64	3.64	3.64	11.75
7.0	0.36	3.95	0.73	4.69	4.69	4.69	12.95
8.0	0.41	5.00	0.84	5.84	5.84	5.84	14.12
9.0	0.47	6.16	0.94	7.10	7.10	7.10	15.26
10.0	0.52	7.42	1.05	8.46	8.46	8.46	16.37
11.0	0.57	8.77	1.15	9.93	9.93	9.93	17.45
12.0	0.62	10.23	1.26	11.48	11.48	11.48	18.51
13.0	0.67	11.77	1.36	13.13	13.13	13.13	19.54
14.0	0.72	13.40	1.47	14.87	14.87	14.87	20.55
15.0	0.78	15.12	1.57	16.69	16.69	16.69	21.53
16.0	0.83	16.92	1.67	18.60	18.60	18.60	22.49
17.0	0.88	18.81	1.78	20.59	20.59	20.59	23.42
18.0	0.93	20.76	1.88	22.65	22.65	22.65	24.34
19.0	0.98	22.79	1.99	24.78	24.78	24.78	25.23
20.0	1.03	24.90	2.09	26.99	26.99	26.99	26.10
21.0	1.09	27.07	2.20	29.26	29.26	29.26	26.96
22.0	1.14	29.30	2.30	31.61	31.61	31.61	27.79
23.0	1.19	31.60	2.41	34.01	34.01	34.01	28.60
24.0	1.24	35.14	2.51	37.66	37.66	37.66	30.35
25.0	1.29	38.77	2.62	41.39	41.39	41.39	32.03
26.0	1.34	42.48	2.72	45.20	45.20	45.20	33.63
27.0	1.40	46.28	2.83	49.10	49.10	49.10	35.18
28.0	1.45	50.15	2.93	53.08	53.08	53.08	36.67
29.0	1.50	54.09	3.04	57.12	57.12	57.12	38.10
30.0	1.55	58.10	3.14	61.24	61.24	61.24	39.49
31.0	1.60	62.18	3.25	65.43	65.43	65.43	40.83
32.0	1.65	66.33	3.35	69.68	69.68	69.68	42.12
33.0	1.71	70.53	3.45	73.99	73.99	73.99	43.37
34.0	1.76	74.80	3.56	78.36	78.36	78.36	44.58
35.0	1.81	79.11	3.66	82.78	82.78	82.78	45.75
36.0	1.86	83.48	3.77	87.25	87.25	87.25	46.89
37.0	1.91	87.90	3.87	91.78	91.78	91.78	47.98
38.0	1.96	92.37	3.98	96.34	96.34	96.34	49.05
39.0	2.02	96.87	4.08	100.96	100.96	100.96	50.08
40.0	2.07	101.42	4.19	105.61	105.61	105.61	51.07
41.0	2.12	106.00	4.29	110.30	110.30	110.30	52.04

Strength limit
Required Q_s = 30 tons

Required Q_s = 70 tons
Extreme Event

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.3081E-01	0.3462E-04	0.9391E-04	0.1000E-04
0.1540E+00	0.1731E-03	0.4695E-03	0.5000E-04
0.3081E+00	0.3462E-03	0.9391E-03	0.1000E-03
0.1559E+02	0.1741E-01	0.4695E-01	0.5000E-02
0.2320E+02	0.2611E-01	0.7043E-01	0.7500E-02
0.3037E+02	0.3461E-01	0.9391E-01	0.1000E-01
0.6011E+02	0.7634E-01	0.2348E+00	0.2500E-01
0.8175E+02	0.1223E+00	0.4695E+00	0.5000E-01
0.9189E+02	0.1573E+00	0.7043E+00	0.7500E-01
0.9727E+02	0.1880E+00	0.9337E+00	0.1000E+00
0.1013E+03	0.3428E+00	0.2123E+01	0.2500E+00
0.1022E+03	0.5941E+00	0.3214E+01	0.5000E+00
0.1026E+03	0.7197E+00	0.3717E+01	0.6250E+00
0.1031E+03	0.8766E+00	0.4289E+01	0.7813E+00
0.1031E+03	0.8952E+00	0.4356E+01	0.7998E+00

RESULT FROM UPPER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.4623E-01	0.4559E-04	0.1342E-03	0.1000E-04
0.2311E+00	0.2280E-03	0.6708E-03	0.5000E-04
0.4623E+00	0.4559E-03	0.1342E-02	0.1000E-03

0.2344E+02	0.2304E-01	0.6708E-01	0.5000E-02
0.3435E+02	0.3435E-01	0.1006E+00	0.7500E-02
0.4422E+02	0.4518E-01	0.1342E+00	0.1000E-01
0.7957E+02	0.9353E-01	0.3354E+00	0.2500E-01
0.9784E+02	0.1379E+00	0.6708E+00	0.5000E-01
0.1029E+03	0.1683E+00	0.1006E+01	0.7500E-01
0.1043E+03	0.1954E+00	0.1320E+01	0.1000E+00
0.1062E+03	0.3476E+00	0.2900E+01	0.2500E+00
0.1070E+03	0.5985E+00	0.3670E+01	0.5000E+00
0.1074E+03	0.7241E+00	0.4072E+01	0.6250E+00
0.1079E+03	0.8811E+00	0.4576E+01	0.7813E+00
0.1080E+03	0.8997E+00	0.4635E+01	0.7998E+00

RESULT FROM LOWER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.1803E-01	0.2499E-04	0.5366E-04	0.1000E-04
0.9014E-01	0.1250E-03	0.2683E-03	0.5000E-04
0.1803E+00	0.2499E-03	0.5366E-03	0.1000E-03
0.9055E+01	0.1251E-01	0.2683E-01	0.5000E-02
0.1362E+02	0.1880E-01	0.4025E-01	0.7500E-02
0.1807E+02	0.2506E-01	0.5366E-01	0.1000E-01
0.4006E+02	0.5912E-01	0.1342E+00	0.2500E-01
0.6420E+02	0.1059E+00	0.2683E+00	0.5000E-01
0.8017E+02	0.1459E+00	0.4025E+00	0.7500E-01
0.8906E+02	0.1805E+00	0.5474E+00	0.1000E+00
0.9643E+02	0.3380E+00	0.1347E+01	0.2500E+00
0.9743E+02	0.5855E+00	0.2758E+01	0.5000E+00
0.9785E+02	0.7152E+00	0.3362E+01	0.6250E+00
0.9825E+02	0.8721E+00	0.4003E+01	0.7813E+00
0.9829E+02	0.8907E+00	0.4077E+01	0.7998E+00

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening Project No.: 10-26
By: Ranjan Date: 3/15/11 Checked By: Lino Date: 3/21/11 Sheet: 1 of 1
Subject:

Lateral pile Analysis

* Lateral tip selected @ 20' depth (12, 15x dia. depth)

Acacia St. UC -

Area = 201.1 in²

$I = \pi/4 \times 8^4$

$= 3,220 \text{ in}^4$

CISM

$E = 3.6 \times 10^6$ psi

USE 50% EI & Free head conditions

δ = 0.25", 0.5", 1", 2", 5"

Abuts 1 & 4

Bents 2 & 3

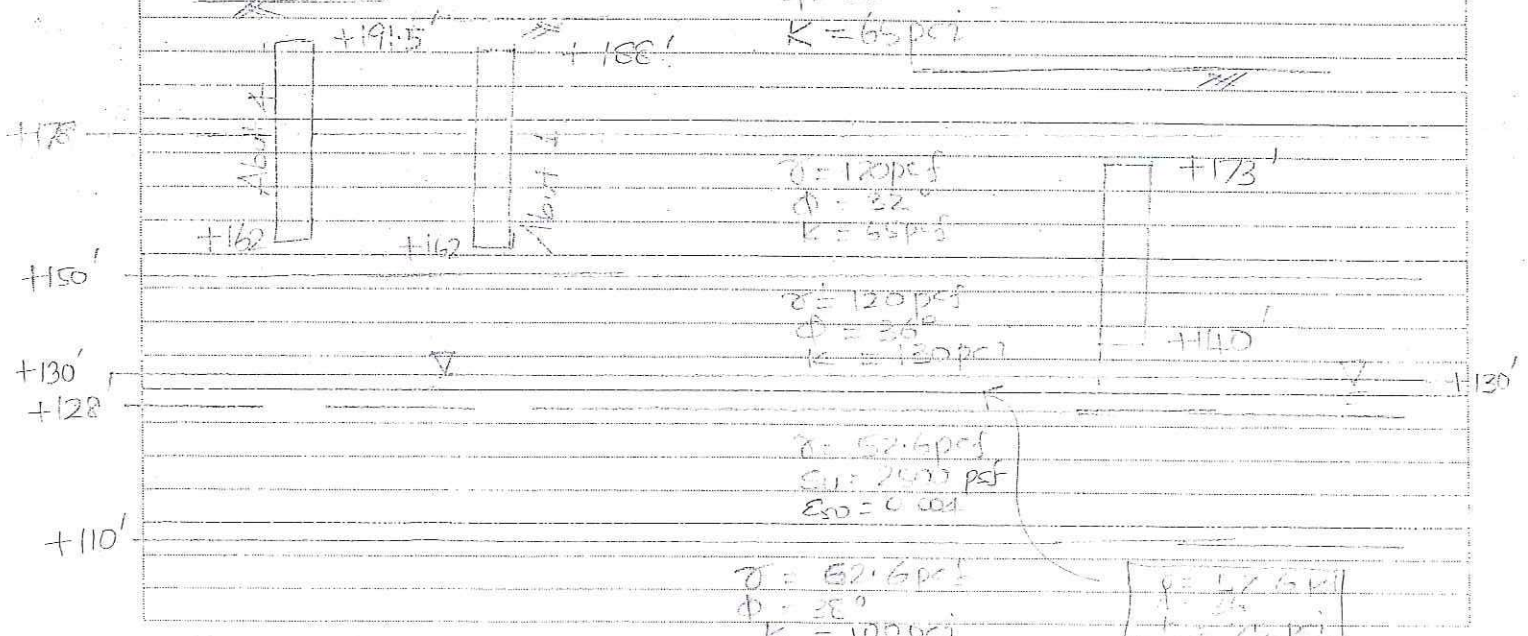
Group 7 ⇒ η = 0.9

η = 0.7

γ = 120 pcf

φ = 32°

K = 65 pcf

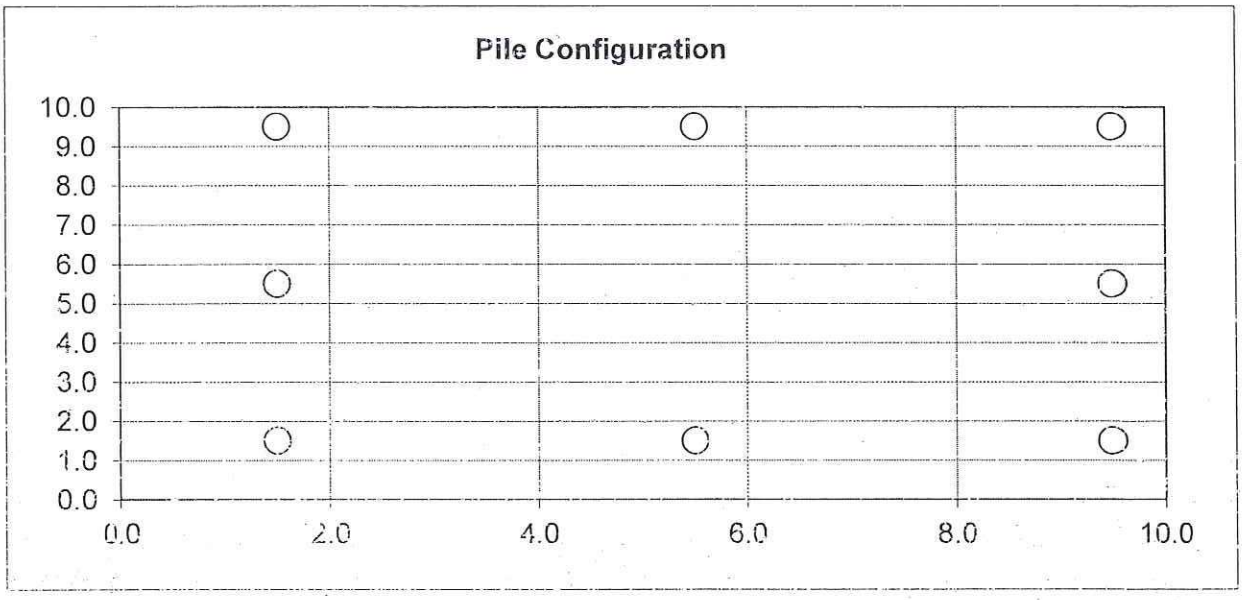


17660 Newhope Street, Suite E, Fountain Valley, CA 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

Project: SR-91 WB Widening

By: Ranjan 3/15/2011

Calculation of Pile Group Efficiency (using formula in Group 7.0 Technical Manual)



Pile Dia.: 1.330

No. of Piles: 8

Group Efficiency	X-Dir (Trans)	Y-Dir (Long)
	0.726	0.726

Pile No.	X (Transverse)	Y (Longitudinal)
1	1.500	1.50
2	5.500	1.50
3	9.500	1.50
4	1.500	5.500
5	9.500	5.500
6	1.500	9.50
7	5.500	9.50
8	9.500	9.50

Reduction Factors in X-dir	Reduction Factors in Y-dir
0.638	0.638
0.624	0.685
0.867	0.638
0.685	0.624
0.866	0.624
0.638	0.867
0.624	0.866
0.867	0.867

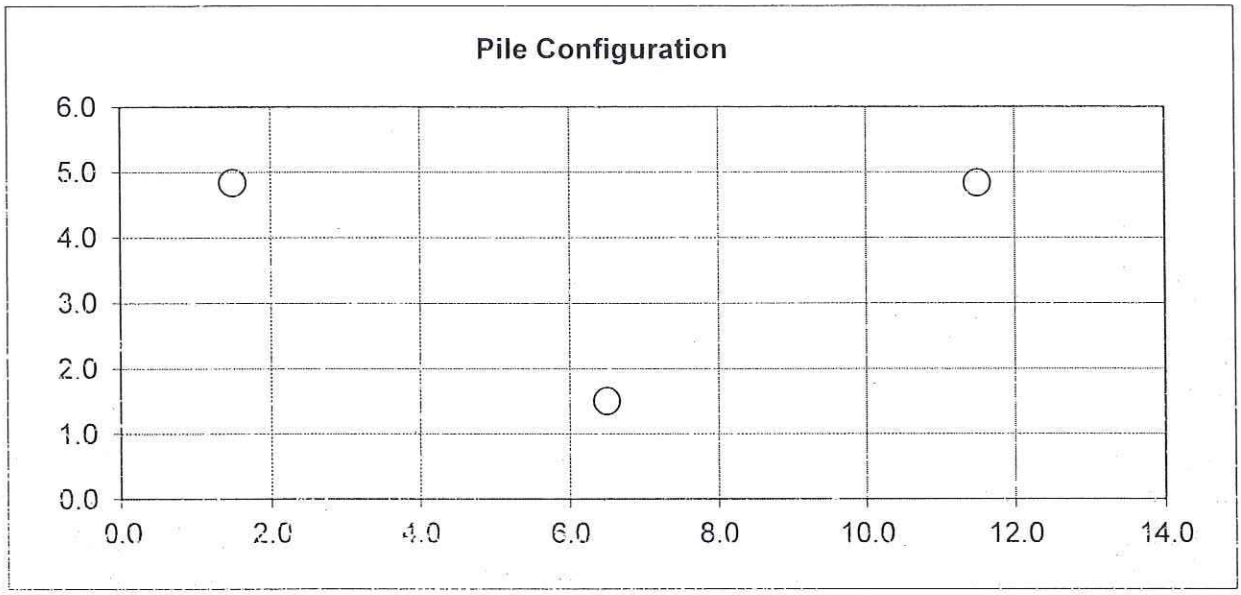
⇒ Select 0.7

Acacia Book 2 & 3

Project: SR-91 WB Widening

By: Ranjan 3/15/2011

Calculation of Pile Group Efficiency (using formula in Group 7.0 Technical Manual)



Pile Dia.: 1.330

No. of Piles: 3

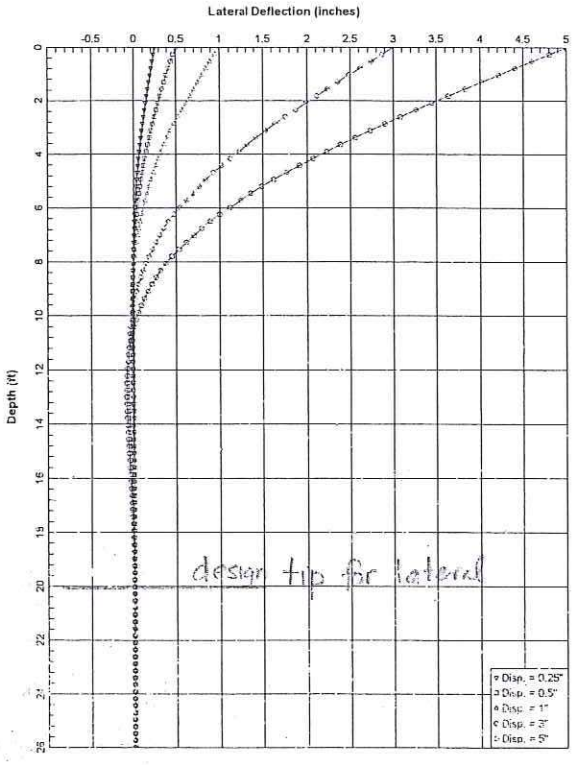
Group Efficiency	X-Dir (Trans)	Y-Dir (Long)
	0.933	0.972

Pile No.	X (Transverse)	Y (Longitudinal)
1	1.500	4.83
2	6.500	1.50
3	11.500	4.83

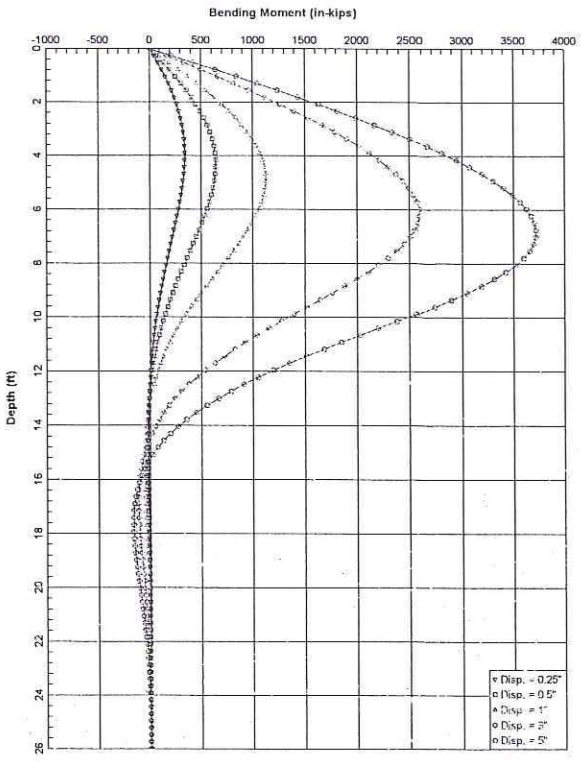
Reduction Factors in X-dir	Reduction Factors in Y-dir
0.900	1.000
0.900	0.915
1.000	1.000

⇒ Select 0.9

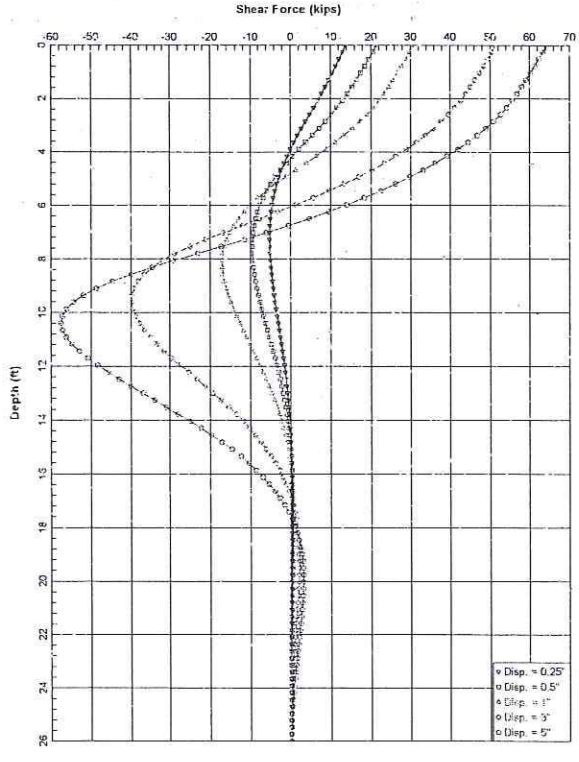
Acacia Abut 1 & 4



Acacia UC - Abut 1 - 16-in CIDH - Free



Acacia UC - Abut 1 - 16-in CIDH - Free



Acacia UC - Abut 1 - 16-in CIDH - Free

LPile Plus for Windows, Version 6.0 (6.0.09)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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This program is licensed to:

Files Used for Analysis

Path to file locations: X:\Projects\2010\10-126 - RBF SR 91 Westbound Widening\Reports\Foundation Report\Acacia Street UC\Analyses\LPILE\Abut 1\2-ft Overburden\
Name of input data file: 16-inch CIDH pile.lp6d
Name of output file: 16-inch CIDH pile.lp6o
Name of plot output file: 16-inch CIDH pile.lp6p
Name of runtime file: 16-inch CIDH pile.lp6r

Date and Time of Analysis

Date: March 23, 2011 Time: 9:25:32

Problem Title

Project Name: SR-91 WB Widening

Job Number: 10-126

Client:

Engineer: GJG

Description: 16-inch CIDH at Acacia Abut 1

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	300	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections = 1

Total Pile Length = 26.00 ft

Depth of ground surface below top of pile = -2.00 ft

Slope angle of ground surface = 0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	16.0000000
2	26.000000	16.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	26.000 in
Top Width	=	16.000 in
Bottom Width	=	16.000 in
Top Area	=	201.061930 sq in
Bottom Area	=	201.061930 sq. in
Moment of Inertia at Top	=	3.217E+03 in^4
Moment of Inertia at Bottom	=	3.217E+03 in^4
Elastic Modulus	=	1800000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 6 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = -2.000 ft
Distance from top of pile to bottom of layer = 10.000 ft
p-y subgrade modulus k for top of soil layer = 65.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 65.000 lbs/in**3

Layer 2 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 10.000 ft
Distance from top of pile to bottom of layer = 38.000 ft
p-y subgrade modulus k for top of soil layer = 65.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 65.000 lbs/in**3

Layer 3 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 38.000 ft
Distance from top of pile to bottom of layer = 58.000 ft
p-y subgrade modulus k for top of soil layer = 130.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 130.000 lbs/in**3

Layer 4 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer	=	58.000 ft
Distance from top of pile to bottom of layer	=	60.000 ft
p-y subgrade modulus k for top of soil layer	=	75.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	75.000 lbs/in**3

Layer 5 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	60.000 ft
Distance from top of pile to bottom of layer	=	78.000 ft

Layer 6 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer	=	78.000 ft
Distance from top of pile to bottom of layer	=	100.000 ft
p-y subgrade modulus k for top of soil layer	=	100.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	100.000 lbs/in**3

(Depth of lowest layer extends 74.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 12 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	-2.00	120.00000
2	10.00	120.00000
3	10.00	120.00000
4	38.00	120.00000
5	38.00	120.00000
6	58.00	120.00000
7	58.00	57.60000
8	60.00	57.60000
9	60.00	52.60000
10	78.00	52.60000
11	78.00	62.60000
12	100.00	62.60000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. Subgr. pci
1	API Sand	-2.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
		10.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
2	API Sand	10.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
		38.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
3	API Sand	38.000	120.000	--	36.000	--	--	--	130.000	--	--	--	--	--
		58.000	120.000	--	36.000	--	--	--	130.000	--	--	--	--	--
4	API Sand	58.000	57.600	--	36.000	--	--	--	75.000	--	--	--	--	--
		60.000	57.600	--	36.000	--	--	--	75.000	--	--	--	--	--
5	Soft Clay	60.000	52.600	2500.000	--	--	--	0.00400	--	--	--	--	--	--
		78.000	52.600	2500.000	--	--	--	0.00400	--	--	--	--	--	--
6	API Sand	78.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--
		100.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.9000	1.0000
2	26.000	0.9000	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	80000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	80000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	80000.000
4	4	y =	3.000 in	M =	0.000 in-lbs	80000.000
5	4	y =	5.000 in	M =	0.000 in-lbs	80000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

---

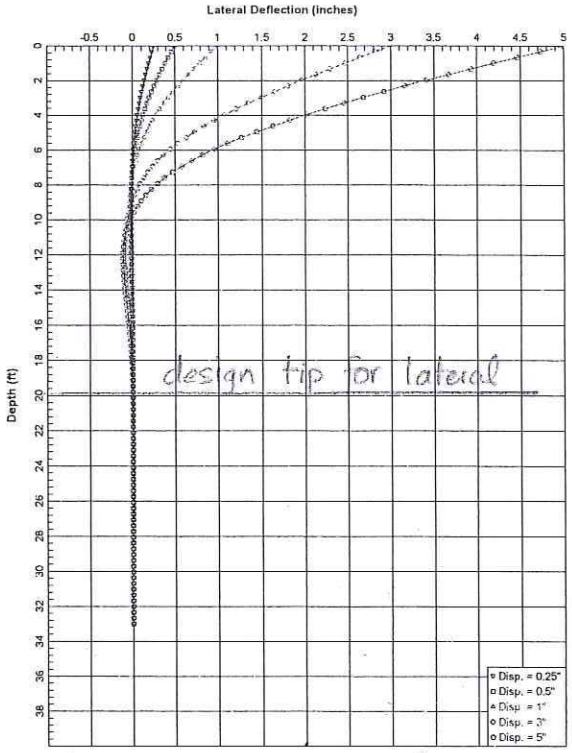
Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

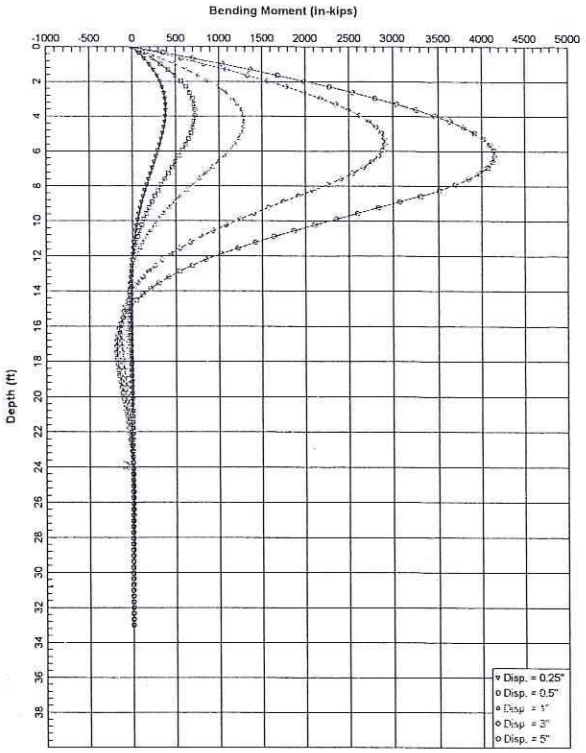
Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)		Condition 2 in-lb, rad., or in-lb/rad.		Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y = 0.2500	M =	0.000		80000.	0.25000000	344376.	13767.	0.00000000
2	4	y = 0.5000	M =	0.000		80000.	0.50000000	637763.	21431.	0.00000000
3	4	y = 1.0000	M =	0.000		80000.	1.00000000	1129368.	30743.	0.00000000
4	4	y = 3.0000	M =	0.000		80000.	3.00000000	2586653.	51299.	0.00000000
5	4	y = 5.0000	M =	0.000		80000.	5.00000000	3716712.	64224.	0.00000000

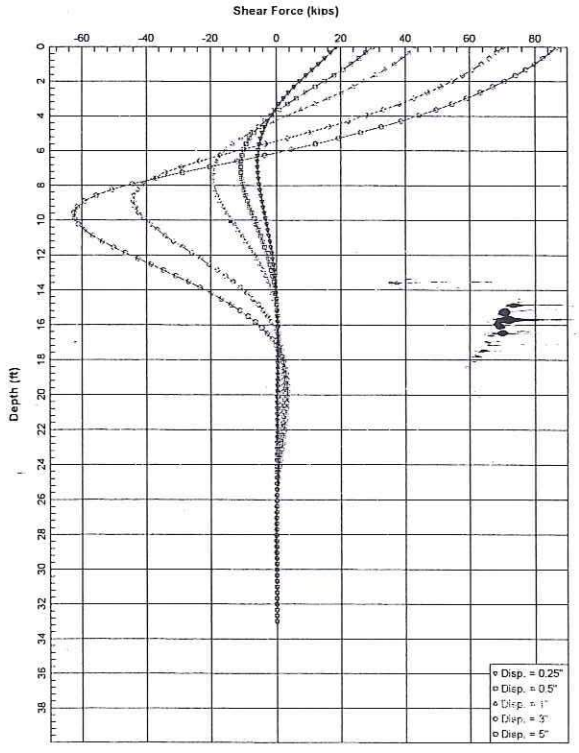
The analysis ended normally.



Acacia UC - Bents 2 & 3 - 16-in CIDH - Free



Acacia UC - Bents 2 & 3 - 16-in CIDH - Free



Acacia UC - Bents 2 & 3 - 16-in CIDH - Free

LPile Plus for Windows, Version 6.0 (6.0.09)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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This program is licensed to:

Files Used for Analysis

Path to file locations: X:\Projects\2010\10-126 - RBF SR 91 Westbound Widening\Reports\Foundation Report\Acacia Street UC\Analyses\LPILE\Bents 2 and 3\
Name of input data file: 16-inch CIDH pile.lp6d
Name of output file: 16-inch CIDH pile.lp6o
Name of plot output file: 16-inch CIDH pile.lp6p
Name of runtime file: 16-inch CIDH pile.lp6r

Date and Time of Analysis

Date: March 23, 2011 Time: 9:35:03

Problem Title

Project Name: SR-91 WB Widening

Job Number: 10-126

Client:

Engineer: GJG

Description: 16-inch CIDH at Acacia Bents 2 & 3

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	300	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections = 1

Total Pile Length = 33.00 ft

Depth of ground surface below top of pile = -5.00 ft

Slope angle of ground surface = 0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over
the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	16.0000000
2	33.000000	16.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	33.000 in
Top Width	=	16.000 in
Bottom Width	=	16.000 in
Top Area	=	201.061930 sq. in
Bottom Area	=	201.061930 sq. in
Moment of Inertia at Top	=	3.217E+03 in^4
Moment of Inertia at Bottom	=	3.217E+03 in^4
Elastic Modulus	=	1800000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 5 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = -5.000 ft
Distance from top of pile to bottom of layer = 23.000 ft
p-y subgrade modulus k for top of soil layer = 65.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 65.000 lbs/in**3

Layer 2 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 23.000 ft
Distance from top of pile to bottom of layer = 43.000 ft
p-y subgrade modulus k for top of soil layer = 130.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 130.000 lbs/in**3

Layer 3 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 43.000 ft
Distance from top of pile to bottom of layer = 45.000 ft
p-y subgrade modulus k for top of soil layer = 75.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 75.000 lbs/in**3

Layer 4 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 45.000 ft
Distance from top of pile to bottom of layer = 63.000 ft

Layer 5 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 63.000 ft
Distance from top of pile to bottom of layer = 100.000 ft
p-y subgrade modulus k for top of soil layer = 100.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 100.000 lbs/in**3

(Depth of lowest layer extends 67.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 10 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	-5.00	120.00000
2	23.00	120.00000
3	23.00	120.00000
4	43.00	120.00000
5	43.00	57.60000
6	45.00	57.60000
7	45.00	52.60000
8	63.00	52.60000
9	63.00	62.60000
10	100.00	62.60000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. Subgr. pci
1	API Sand	-5.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
		23.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
2	API Sand	23.000	120.000	--	36.000	--	--	--	130.000	--	--	--	--	--
		43.000	120.000	--	36.000	--	--	--	130.000	--	--	--	--	--
3	API Sand	43.000	57.600	--	36.000	--	--	--	75.000	--	--	--	--	--
		45.000	57.600	--	36.000	--	--	--	75.000	--	--	--	--	--
4	Soft Clay	45.000	52.600	2500.000	--	--	--	0.00400	--	--	--	--	--	--
		63.000	52.600	2500.000	--	--	--	0.00400	--	--	--	--	--	--
5	API Sand	63.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--
		100.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.7000	1.0000
2	33.000	0.7000	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	60000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	60000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	60000.000
4	4	y =	3.000 in	M =	0.000 in-lbs	60000.000
5	4	y =	5.000 in	M =	0.000 in-lbs	60000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

---

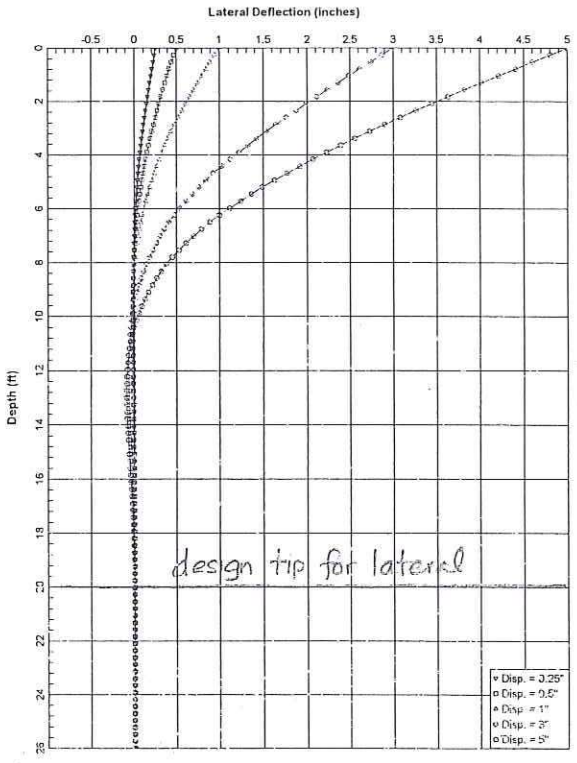
Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

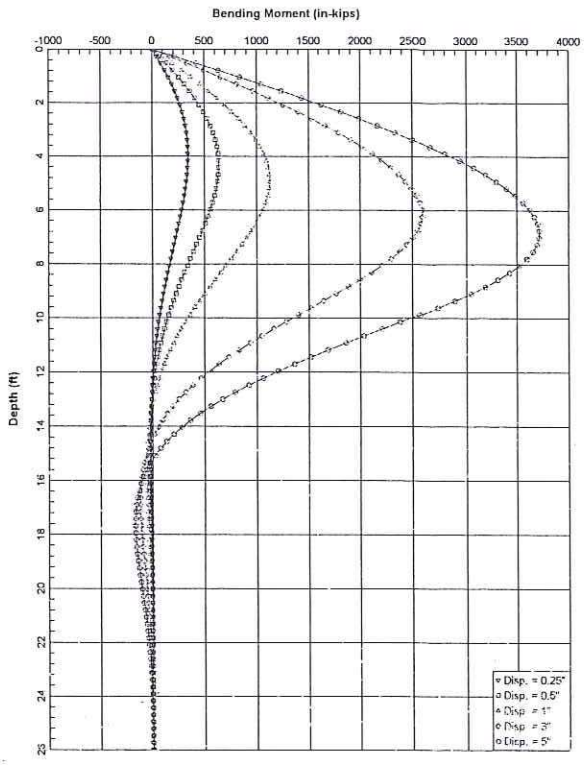
Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)	Condition 2 in-lb, rad., or in-lb/rad.	Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y = 0.2500	M = 0.000	60000.	0.25000000	386487.	18722.	0.00000000
2	4	y = 0.5000	M = 0.000	60000.	0.50000000	724647.	29958.	0.00000000
3	4	y = 1.0000	M = 0.000	60000.	1.00000000	1290376.	43316.	0.00000000
4	4	y = 3.0000	M = 0.000	60000.	3.00000000	2916795.	70445.	0.00000000
5	4	y = 5.0000	M = 0.000	60000.	5.00000000	4147062.	86699.	0.00000000

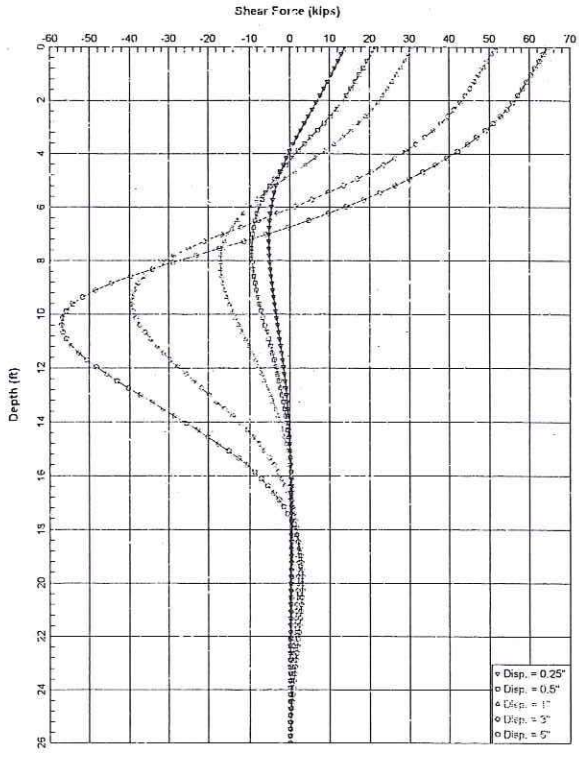
The analysis ended normally.



Acacia UC - Abut 4 - 16-in CIDH - Free



Acacia UC - Abut 4 - 16-in CIDH - Free



Acacia UC - Abut 4 - 16-in CIDH - Free

==========

Pile Plus for Windows, Version 6.0 (6.0.03)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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==========

This program is licensed to:

Files Used for Analysis

Path to file locations: X:\Projects\2010\10-126 - RBF SR 91 Westbound Widening\Reports\Foundation Report\Acacia Street UC\Analyses\LPILE\Abut 4\2-ft Overburden\
Name of input data file: 16-inch CIDH pile.lp6d
Name of output file: 16-inch CIDH pile.lp6o
Name of plot output file: 16-inch CIDH pile.lp6p
Name of runtime file: 16-inch CIDH pile.lp6r

Date and Time of Analysis

Date: March 23, 2011 Time: 9:33:31

Problem Title

Project Name: SR-91 WB Widening

Job Number: 10-126

Client:

Engineer: GJG

Description: 16-inch CIDH at Acacia Abut 4

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	300	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:

- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections = 1

Total Pile Length = 26.00 ft

Depth of ground surface below top of pile = -2.00 ft

Slope angle of ground surface = 0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	16.0000000
2	26.000000	16.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	26.000 in
Top Width	=	16.000 in
Bottom Width	=	16.000 in
Top Area	=	201.061930 sq. in
Bottom Area	=	201.061930 sq. in
Moment of Inertia at Top	=	3.217E+03 in^4
Moment of Inertia at Bottom	=	3.217E+03 in^4
Elastic Modulus	=	1800000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees.
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 6 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = -2.000 ft
Distance from top of pile to bottom of layer = 13.500 ft
p-y subgrade modulus k for top of soil layer = 65.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 65.000 lbs/in**3

Layer 2 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 13.500 ft
Distance from top of pile to bottom of layer = 41.500 ft
p-y subgrade modulus k for top of soil layer = 65.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 65.000 lbs/in**3

Layer 3 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 41.500 ft
Distance from top of pile to bottom of layer = 61.500 ft
p-y subgrade modulus k for top of soil layer = 130.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 130.000 lbs/in**3

Layer 4 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 61.500 ft
Distance from top of pile to bottom of layer = 63.500 ft
p-y subgrade modulus k for top of soil layer = 75.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 75.000 lbs/in**3

Layer 5 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer = 63.500 ft
Distance from top of pile to bottom of layer = 81.500 ft

Layer 6 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 81.500 ft
Distance from top of pile to bottom of layer = 100.000 ft
p-y subgrade modulus k for top of soil layer = 100.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 100.000 lbs/in**3

(Depth of lowest layer extends 74.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 12 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	-2.00	120.00000
2	13.50	120.00000
3	13.50	120.00000
4	41.50	120.00000
5	41.50	120.00000
6	61.50	120.00000
7	61.50	57.60000
8	63.50	57.60000
9	63.50	52.60000
10	81.50	52.60000
11	81.50	62.60000
12	100.00	62.60000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. Subgr. pci
1	API Sand	-2.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
		13.500	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
2	API Sand	13.500	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
		41.500	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
3	API Sand	41.500	120.000	--	36.000	--	--	--	130.000	--	--	--	--	--
		61.500	120.000	--	36.000	--	--	--	130.000	--	--	--	--	--
4	API Sand	61.500	57.600	--	36.000	--	--	--	75.000	--	--	--	--	--
		63.500	57.600	--	36.000	--	--	--	75.000	--	--	--	--	--
5	Soft Clay	63.500	52.600	2500.000	--	--	--	0.00400	--	--	--	--	--	--
		81.500	52.600	2500.000	--	--	--	0.00400	--	--	--	--	--	--
6	API Sand	81.500	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--
		100.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 7 points

Point No.	Depth X ft	p-mult	y-mult

1	0.000	0.9000	1.000
2	26.000	0.9000	1.000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Load, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	76000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	76000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	76000.000
4	4	y =	3.000 in	M =	0.000 in-lbs	76000.000
5	4	y =	5.000 in	M =	0.000 in-lbs	76000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

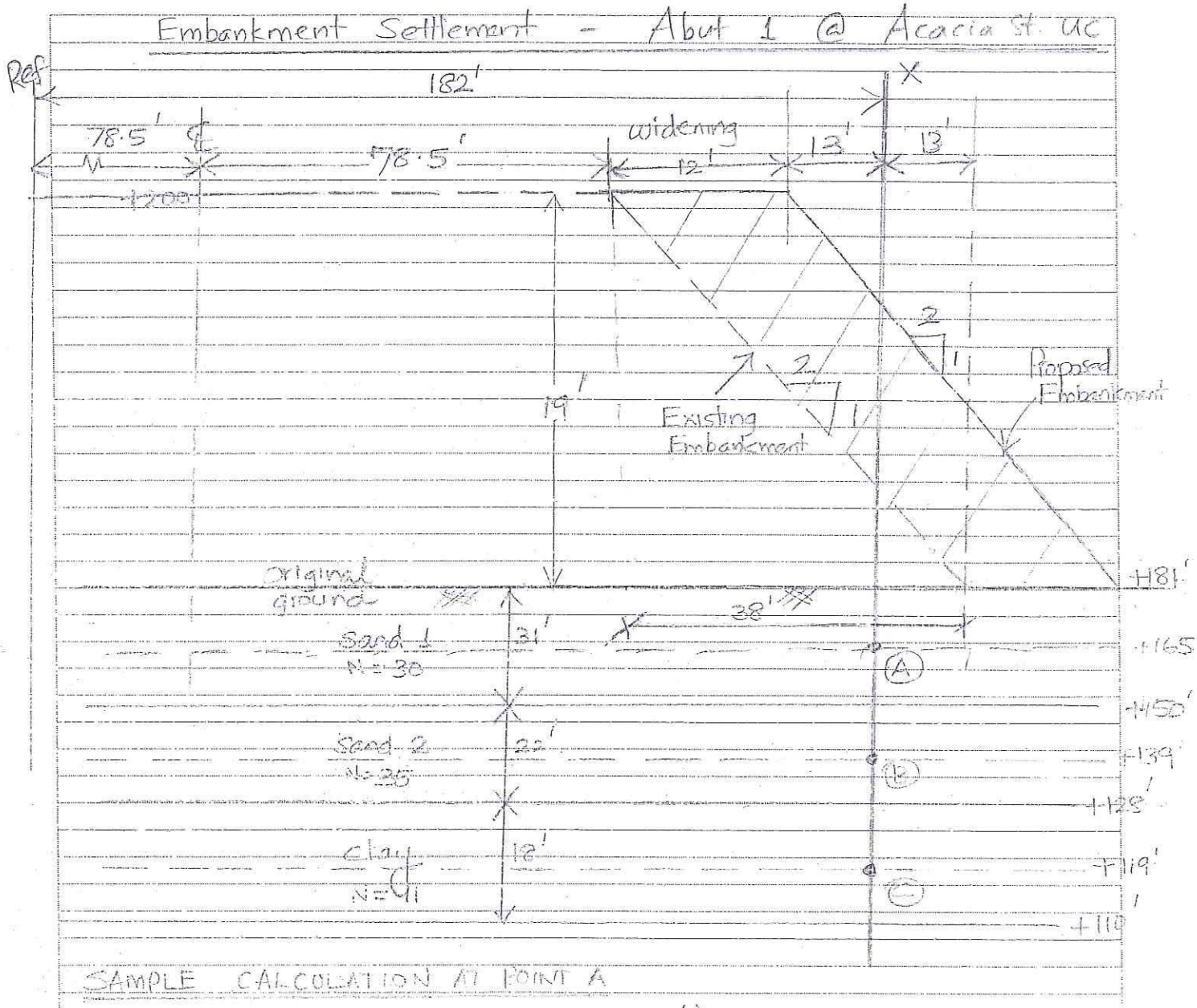
Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)		Condition 2 in-lb, rad., or in-lb/rad.		Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y =	0.2500	M =	0.000	76000.	0.25000000	343975.	13775.	0.00000000
2	4	y =	0.5000	M =	0.000	76000.	0.50000000	636954.	21445.	0.00000000
3	4	y =	1.0000	M =	0.000	76000.	1.00000000	1127878.	30772.	0.00000000
4	4	y =	3.0000	M =	0.000	76000.	3.00000000	2584155.	51400.	0.00000000
5	4	y =	5.0000	M =	0.000	76000.	5.00000000	3713782.	64335.	0.00000000

The analysis ended normally.

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening Project No.: 10-126
By: Ranjan Date: 3/17/11 Checked By: Lino Date: 3/22/11 Sheet: 1 of 2
Subject:

Embankment Settlement - Abut 1 @ Acacia St. UC



SAMPLE CALCULATION AT POINT A

Stress below original ground (σ_o') = 16 × 120 = 1.92 ksf

Stress increase due to existing embankment ($\Delta\sigma_1'$)
= 0.83 ksf (see attached sheet)

∴ Total initial stress σ_1' = σ_o' + $\Delta\sigma_1'$
= 1.92 + 0.83
= 2.75 ksf

Stress increase due to proposed embankment ($\Delta\sigma_2'$) (see attached sheet)
= 1.45 ksf

∴ Total final stress σ_2' = σ_o' + $\Delta\sigma_2'$ = 1.92 + 1.45 = 3.37 ksf

17660 Newhope Street, Suite E, Fountain Valley, CA 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

Project: SR-91 WB Widening Project No.: 10-126
By: Ranjan Date: 3/17/11 Checked By: Lino Date: 3/22/11 Sheet: 2 of 2
Subject:

∴ Stress increase due to widening ($\Delta\sigma'$) = $\sigma_2' - \sigma_1'$
= 3.37 − 2.75
= 0.62 ksf

For layer between El. +181' and El. +150' (ie, Sand 1 layer);
Thickness (H) = 31 ft.

Using AASHTO Figure 10.6.2.4.2-1,
Bearing Capacity Index (C') for SM = 175

Using AASHTO Equation 10.6.2.4.2-3,

$$\Delta H = \frac{H}{C'} \log\left(\frac{\sigma_1' + \Delta\sigma'}{\sigma_1'}\right)$$

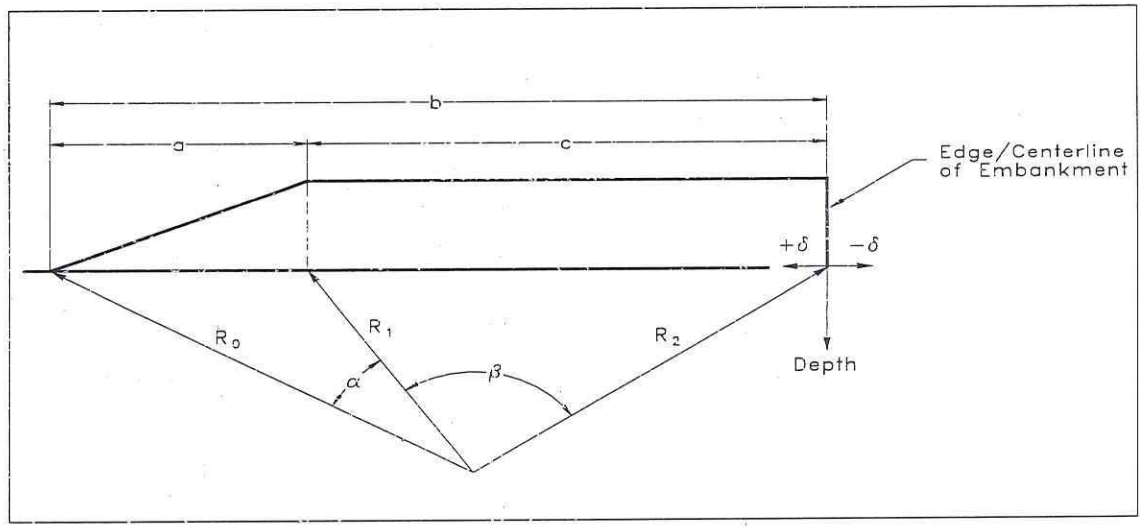
$$\Delta H_{Sand\,1} = \frac{31}{175} \log\left(\frac{2.75 + 0.62}{2.75}\right) \times 12 = 0.44''$$

Point	Layer name	Layer Thick (H)	σ_o'	$\Delta\sigma_1'$	σ_1'	$\Delta\sigma_2'$	$\Delta\sigma'$	C'	ΔH
A	Sand 1	31'	1.92 ksf	0.83 ksf	2.75 ksf	1.45 ksf	0.62 ksf	175	0.44"
B	Sand 2	22'	5.04 ksf	0.95 ksf	5.99 ksf	1.32 ksf	0.27 ksf	85	0.08"
C	Clay	18'	6.57 ksf	0.99 ksf	7.69 ksf	1.25 ksf	0.26 ksf	25	0.09"

Total Settlement at X = $\Delta H_{@A} + \Delta H_{@B} + \Delta H_{@C}$
= 0.44" + 0.08" + 0.09"
= 0.61"

Stress at Various Points Below an Earth Embankment

Equation of Stress Given Below (Poulos & Davis P. 40):



Variables Defined in Adjacent Figure
Soil Unit Weight = 120 PCF

NOTE: ONLY CHANGE VARIABLES IN HIGHLIGHTED CELLS

Embankment Height =	19	a =	38
Embankment Width (Top)	157	b =	195
Side Slope Ratio (x:1) =	2.000	c =	157

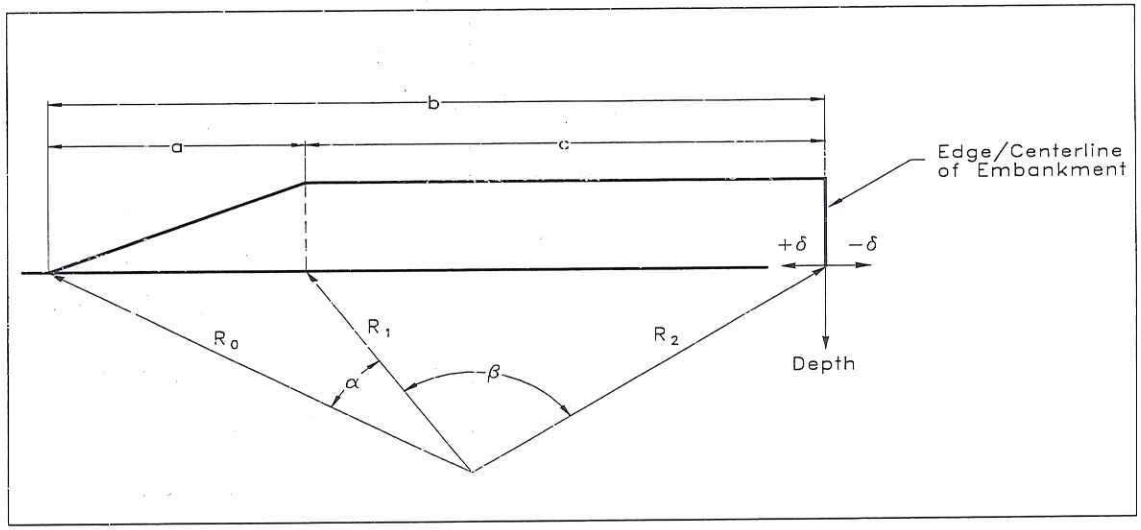
	Point X
Delta	182

Actual Depth (feet)	R2 (feet)	alpha (radians)	beta (radians)	SigmaZ (ksf)
16	183	1.6838	0.48163	**0.83**
42	187	0.83708	0.80709	**0.95**
62	192	0.58997	0.85918	**0.99**

Point X (Final)
SigmaZ (ksf)
0.83
0.95
0.99

Stress at Various Points Below an Earth Embankment

Equation of Stress Given Below (Poulos & Davis P. 40):



Variables Defined in Adjacent Figure
Soil Unit Weight = 120 PCF

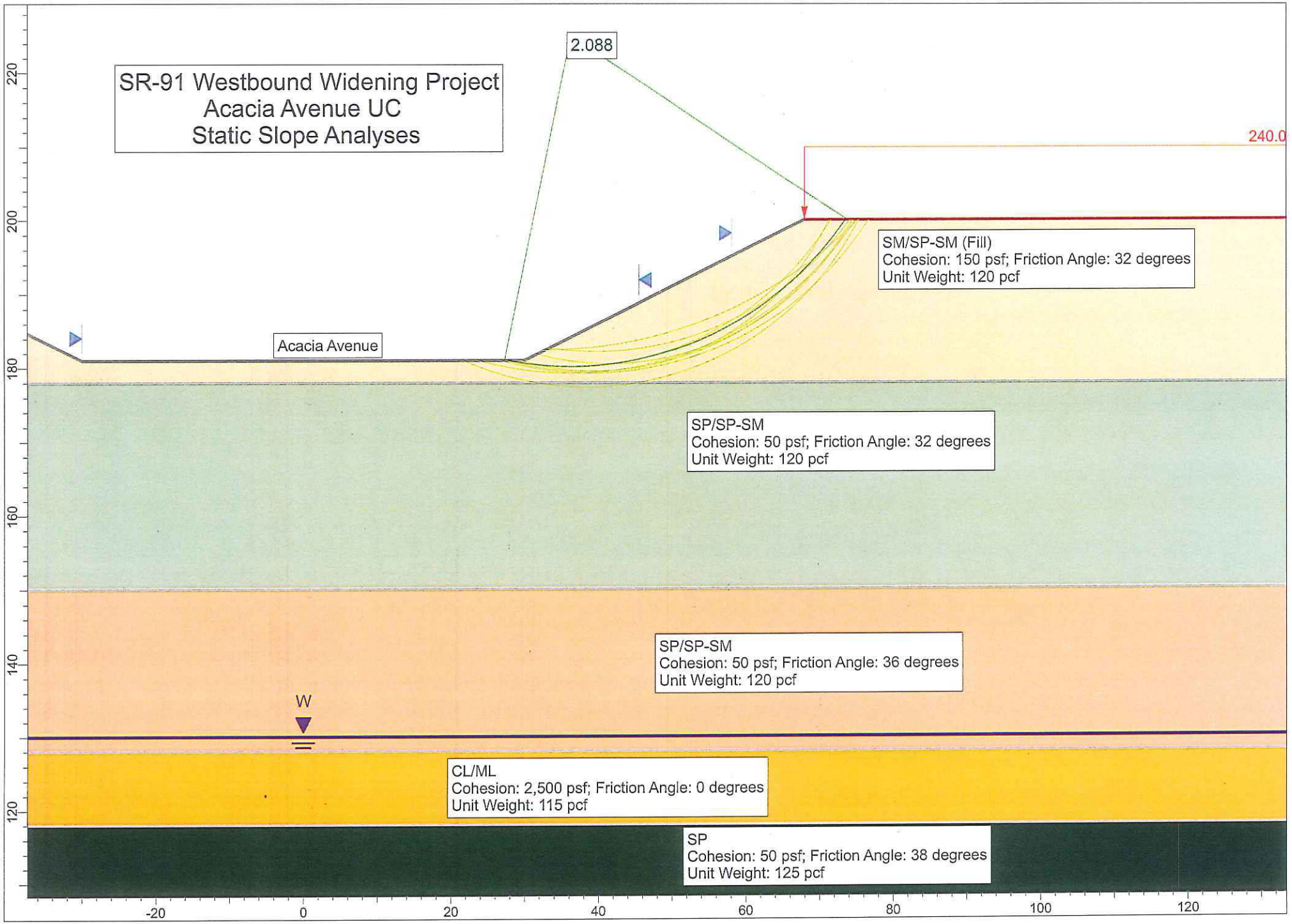
NOTE: ONLY CHANGE VARIABLES IN HIGHLIGHTED CELLS

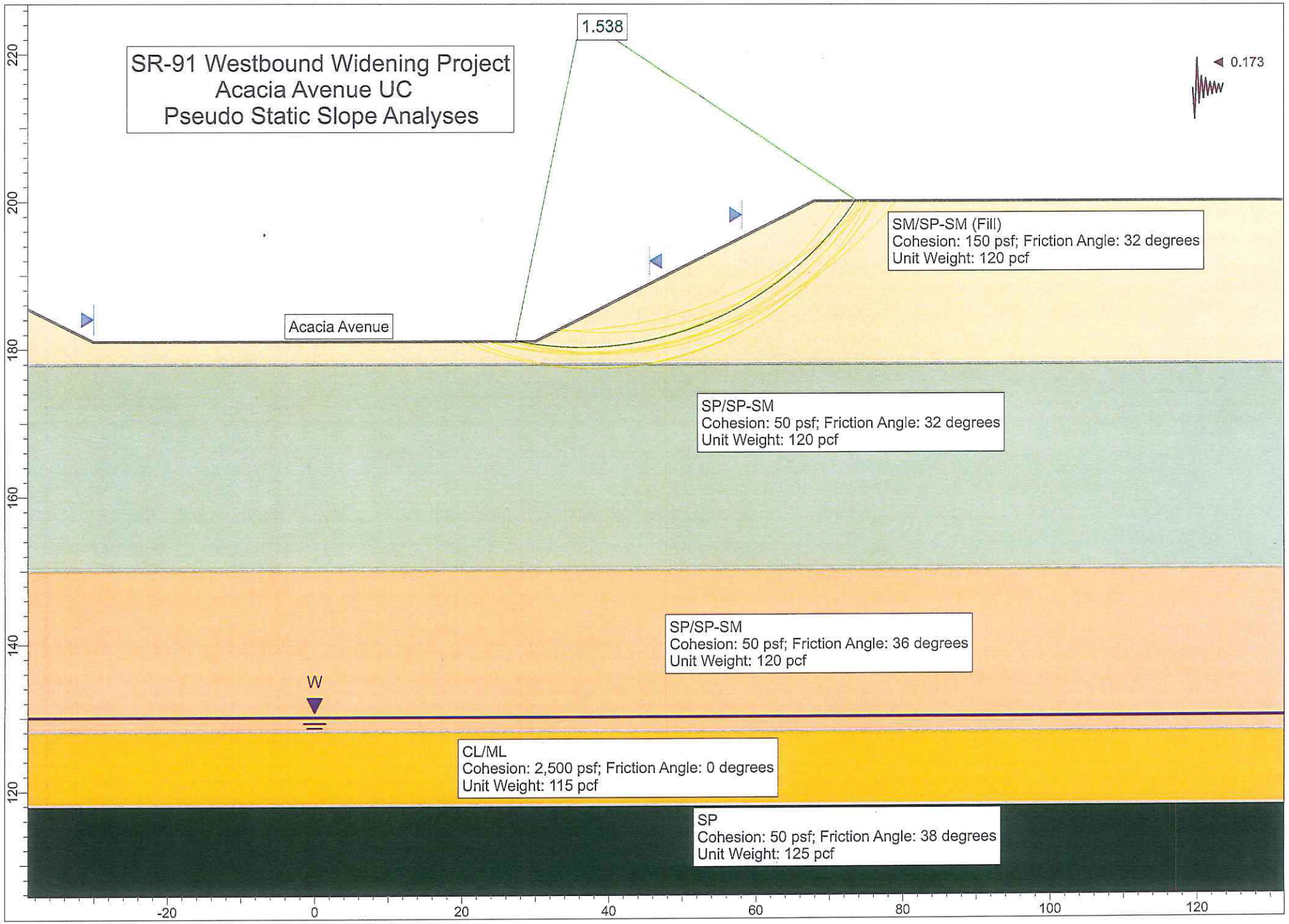
Embankment Height =	19	a =	38
Embankment Width (Top)	169	b =	207
Side Slope Ratio (x:1) =	2.000	c =	169

	Point X
Delta	182

Actual Depth (feet)	R2 (feet)	alpha (radians)	beta (radians)	SigmaZ (ksf)
16	183	1.6838	0.80079	**1.45**
42	187	0.83708	1.04383	**1.32**
62	192	0.58997	1.03578	**1.25**

Point X (Final)
SigmaZ (ksf)
1.45
1.32
1.25

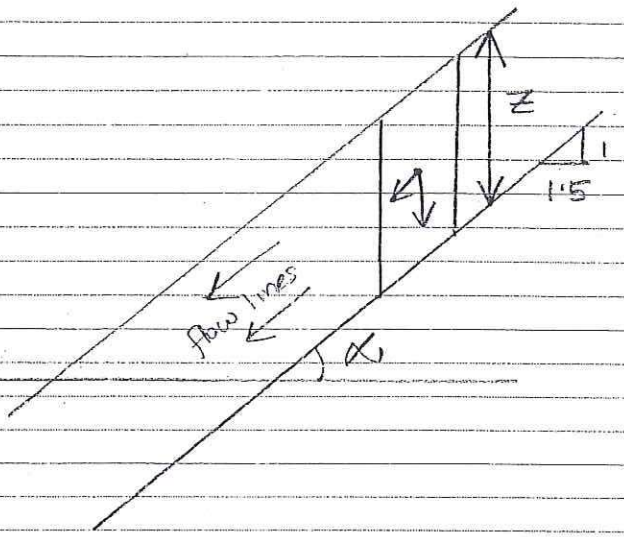

SR-91 Westbound Widening Project
Acacia Avenue UC
Static Slope Analyses
2.088
240.0
Acacia Avenue
SM/SP-SM (Fill)
Cohesion: 150 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 36 degrees
Unit Weight: 120 pcf
W
CL/ML
Cohesion: 2,500 psf; Friction Angle: 0 degrees
Unit Weight: 115 pcf
SP
Cohesion: 50 psf; Friction Angle: 38 degrees
Unit Weight: 125 pcf
220
200
180
160
140
120
-20
0
20
40
60
80
100
120


SR-91 Westbound Widening Project
Acacia Avenue UC
Pseudo Static Slope Analyses
1.538
0.173
SM/SP-SM (Fill)
Cohesion: 150 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
Acacia Avenue
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 36 degrees
Unit Weight: 120 pcf
W
CL/ML
Cohesion: 2,500 psf; Friction Angle: 0 degrees
Unit Weight: 115 pcf
SP
Cohesion: 50 psf; Friction Angle: 38 degrees
Unit Weight: 125 pcf
220
200
180
160
140
120
-20
0
20
40
60
80
100
120

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening Project No.: 10-126
By: Ranjan Date: 3/17/11 Checked By: Lino Date: Sheet: 1 of 1
Subject:

Surficial Slope Stability Analysis



For 1.5H : 1V Slope,

$\alpha = \tan^{-1}\left(\frac{1}{1.5}\right)$

$= 33.7^\circ$

Cosider the thickness of slide $Z = 4$ ft

Assume $\gamma_t = 120$ pcf

$\gamma_b = 120 - 62.4$

$= 57.6$ pcf

Assume $\phi = 32^\circ$ & $C = 230$ psf

$$\therefore FOS = \frac{2Z\gamma_b \cos^2\alpha \tan\phi + 2C}{Z\gamma_t \sin 2\alpha}$$

$$= \frac{(2 \times 4' \times 57.6 \times \cos^2 33.7 \times \tan 32) + (2 \times 230)}{4' \times 120 \times \sin 67.4^\circ}$$

$= 1.5$

⇒ If Slope paving is not used for the 1.5H : 1V slopes, the upper 4-ft of slope face should have a minimum $\phi = 32^\circ$ & $C = 230$ psf //

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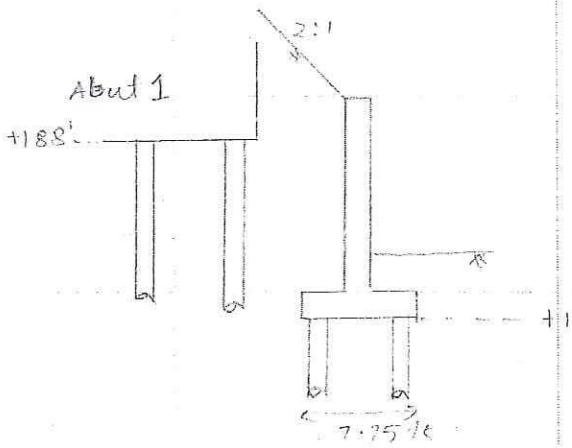
Project Arguin St UC - Retaining wall 305 **Project No.** 10-126

By SP **Date** 09/02/11 **Checked By** _____ **Date** _____ **Sheet** ____ **of** ____

From wall LOC Station 10+00 to 10+15



wall wt = 10 k/ft

pile spacing = 3d

Group reduction factor = 0.77

16" diameter CIDH piles

Nominal resistance compression

strength limit state = $\frac{51.9}{0.7}$ = 74 kips

consider 80 kips

extreme event = $\frac{31.9}{1.0}$ = 31.9 kips

consider 40 kips

Nominal resistance tension

strength limit state = 5.2/0.7 = 7.4 kips

consider 10 kips

from the analysis - strength limit state

at depth 25 ft pile capacity = 111.5 x 0.77 = 85.8 kips > 80 kips

pile tip elevation for strength limit state = 178-25 (compression) = 153 ft

for tension at 10 ft

tension capacity = 14.3 x 0.77 = 11 kips > 10 kips

pile tip elevation for strength limit state = 178-10 (tension) = 168 ft

Extreme event compression

at depth 17 ft pile capacity = 56.2 x 0.77 = 43.2 kips > 40 kips

pile tip elevation for extreme event = 178-17 = 161 ft (compression)

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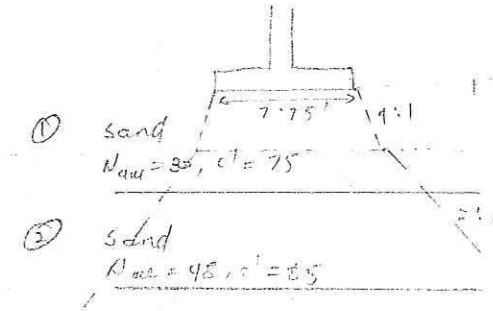
Project Acacia St UC - Retaining wall 305 **Project No.** 10-126

By SP **Date** 09/02/11 **Checked By** _____ **Date** _____ **Sheet** ____ **of** ____

settlement (wall col sta 10+00 to 10+15)

Service load = 35.1 x 7 = 245.7 kips



consider pile length of 120'

$\frac{2}{3} = 8$ ft

Equivalent footing = $(7.75 + \frac{8}{4} \times 2) \times (15 + \frac{8}{4} \times 2)$

= 9.75' x 17'

$q = \frac{245.7}{9.75 \times 17} = 1.5$ ksf

	G_s	$\Delta\sigma$	settlement
①	$1.8 \times 120 = 2.16$	$\frac{245.7}{(9.75+10)(17+10)} = 1.46$	$20 \times \frac{1}{75} \log\left(\frac{2.16+0.46}{2.16}\right) = 0.07$
②	$3.9 \times 120 = 4.68$	$\frac{245.7}{(9.75+81)(17+81)} = 0.13$	$22 \times \frac{1}{85} \log\left(\frac{4.68+0.13}{4.68}\right) = 0.05$
			0.32"

Settlement is less than 1" for pile length of 120 ft.

Therefore, there is no pile tip elevation for settlement

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

SR-91 WB Widening Project - RW 305 at Abutment - compression

TOTAL LOAD = 150.0 TONS

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 48.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00

SOIL INFORMATION

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.110E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.110E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.576E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.110E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.280E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.785E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.280E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.545E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.500E+02

LAYER NO 3----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-NC	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.250E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.500E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-NC	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.250E+04

INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.680E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.387E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.680E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.100E+03

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	=	1.333 FT.
DIAMETER OF BASE	=	1.333 FT.
END OF STEM TO BASE	=	0.000 FT.
ANGLE OF BELL	=	0.000 DEG.
IGNORED TOP PORTION	=	3.000 FT.
IGNORED BOTTOM PORTION	=	0.000 FT.
AREA OF ONE PERCENT STEEL	=	2.010 SQ.IN.
ELASTIC MODULUS, EC	=	0.360E+07 LB/SQ IN
VOLUME OF UNDERREAM	=	0.000 CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
4.0	0.21	0.91	4.15	5.05	5.05	5.05	24.44
5.0	0.26	2.01	4.84	6.85	6.85	6.85	26.49
6.0	0.31	3.30	5.53	8.83	8.83	8.83	28.48
7.0	0.36	4.78	6.22	11.00	11.00	11.00	30.39
8.0	0.41	6.43	6.91	13.34	13.34	13.34	32.25
9.0	0.47	8.24	7.60	15.84	15.84	15.84	34.06
10.0	0.52	10.22	8.29	18.51	18.51	18.51	35.81
11.0	0.57	12.35	8.98	21.34	21.34	21.34	37.52
12.0	0.62	14.64	9.21	23.85	23.85	23.85	38.44
13.0	0.67	17.06	9.21	26.28	26.28	26.28	39.10
14.0	0.72	19.63	9.21	28.84	28.84	28.84	39.85
15.0	0.78	22.33	9.21	31.54	31.54	31.54	40.68
16.0	0.83	25.16	9.21	34.37	34.37	34.37	41.56
17.0	0.88	28.12	9.21	37.33	37.33	37.33	42.48
18.0	0.93	31.19	9.21	40.41	40.41	40.41	43.42
19.0	0.98	34.38	9.21	43.60	43.60	43.60	44.38
20.0	1.03	37.69	9.21	46.90	46.90	46.90	45.36
21.0	1.09	41.10	9.21	50.31	50.31	50.31	46.34
22.0	1.14	44.61	9.21	53.83	53.83	53.83	47.33
23.0	1.19	48.23	9.21	57.44	57.44	57.44	48.31
24.0	1.24	51.94	9.21	61.15	61.15	61.15	49.29
25.0	1.29	55.74	9.21	64.95	64.95	64.95	50.26
26.0	1.34	59.63	9.21	68.84	68.84	68.84	51.22
27.0	1.40	63.60	22.33	85.93	85.93	85.93	61.57
28.0	1.45	67.65	22.33	89.99	89.99	89.99	62.17
29.0	1.50	73.29	22.33	95.62	95.62	95.62	63.78
30.0	1.55	79.02	22.33	101.35	101.35	101.35	65.36
31.0	1.60	84.85	22.33	107.18	107.18	107.18	66.88
32.0	1.65	90.77	22.33	113.11	113.11	113.11	68.37
33.0	1.71	96.78	22.33	119.11	119.11	119.11	69.82
34.0	1.76	102.87	22.33	125.20	125.20	125.20	71.24
35.0	1.81	109.04	22.33	131.37	131.37	131.37	72.61

Nominal resistance
Extreme event

Nominal resistance
Strength limit

36.0	1.86	115.28	22.33	137.61	137.61	137.61	73.95
37.0	1.91	121.59	22.33	143.93	143.93	143.93	75.25
38.0	1.96	127.97	22.33	150.30	150.30	150.30	76.51

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.4043E-01	0.3906E-04	0.4887E-03	0.1000E-04
0.2021E+00	0.1953E-03	0.2443E-02	0.5000E-04
0.4043E+00	0.3906E-03	0.4887E-02	0.1000E-03
0.2057E+02	0.1972E-01	0.2443E+00	0.5000E-02
0.3042E+02	0.2952E-01	0.3669E+00	0.7500E-02
0.3955E+02	0.3900E-01	0.4887E+00	0.1000E-01
0.7614E+02	0.8457E-01	0.1222E+01	0.2500E-01
0.1027E+03	0.1338E+00	0.2443E+01	0.5000E-01
0.1153E+03	0.1709E+00	0.3665E+01	0.7500E-01
0.1223E+03	0.2031E+00	0.4859E+01	0.1000E+00
0.1316E+03	0.3642E+00	0.1105E+02	0.2500E+00
0.1371E+03	0.6211E+00	0.1673E+02	0.5000E+00
0.1396E+03	0.7493E+00	0.1934E+02	0.6250E+00
0.1424E+03	0.9092E+00	0.2237E+02	0.7813E+00
0.1427E+03	0.9282E+00	0.2267E+02	0.7998E+00

RESULT FROM UPPER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.6181E-01	0.5256E-04	0.6931E-03	0.1000E-04
0.3093E+00	0.2628E-03	0.3491E-02	0.5000E-04
0.6181E+00	0.5256E-03	0.6931E-02	0.1000E-03
0.3136E+02	0.2666E-01	0.3491E+00	0.5000E-02
0.4549E+02	0.3954E-01	0.5236E+00	0.7500E-02
0.5783E+02	0.5168E-01	0.6981E+00	0.1000E-01
0.1002E+03	0.1044E+00	0.1745E+01	0.2500E-01
0.1224E+03	0.1519E+00	0.3491E+01	0.5000E-01
0.1293E+03	0.1843E+00	0.5236E+01	0.7500E-01
0.1325E+03	0.2131E+00	0.6870E+01	0.1000E+00
0.1407E+03	0.3734E+00	0.1509E+02	0.2500E+00
0.1447E+03	0.6285E+00	0.1910E+02	0.5000E+00
0.1468E+03	0.7561E+00	0.2119E+02	0.6250E+00
0.1494E+03	0.9157E+00	0.2331E+02	0.7813E+00
0.1497E+03	0.9346E+00	0.2412E+02	0.7998E+00

RESULT FROM LOWER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.2315E-01	0.2744E-04	0.2793E-03	0.1000E-04
0.1157E+00	0.1372E-03	0.1396E-02	0.5000E-04
0.2315E+00	0.2744E-03	0.2793E-02	0.1000E-03
0.1168E+02	0.1377E-01	0.1396E+00	0.5000E-02
0.1755E+02	0.2065E-01	0.2094E+00	0.7500E-02
0.2320E+02	0.2755E-01	0.2793E+00	0.1000E-01
0.5086E+02	0.6452E-01	0.6981E+00	0.2500E-01
0.8087E+02	0.1146E+00	0.1396E+01	0.5000E-01
0.1003E+03	0.1568E+00	0.2094E+01	0.7500E-01
0.1118E+03	0.1929E+00	0.2848E+01	0.1000E+00
0.1236E+03	0.3549E+00	0.7009E+01	0.2500E+00
0.1294E+03	0.6137E+00	0.1435E+02	0.5000E+00
0.1323E+03	0.7425E+00	0.1749E+02	0.6250E+00
0.1354E+03	0.9027E+00	0.2033E+02	0.7813E+00
0.1357E+03	0.9217E+00	0.2122E+02	0.7998E+00

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM
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SR-91 WB Widening Project - RW 3C5 Tension Capacity

TOTAL LOAD = 150.0 TONS

REDUCTION FACTOR APPLIED FOR UPLIFT FRICTION = 0.700

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 48.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 2.00

SOIL INFORMATION

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.110E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.110E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.570E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.110E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.230E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.780E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.360E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.280E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.545E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.500E+02

LAYER NO 3----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.250E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.500E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.250E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.115E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.680E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.387E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.680E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.100E+03

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	=	1.330 FT.
DIAMETER OF BASE	=	1.333 FT.
END OF STEM TO BASE	=	0.000 FT.
ANGLE OF BELL	=	0.000 DEG.
IGNORED TOP PORTION	=	3.000 FT.
IGNORED BOTTOM PORTION	=	0.000 FT.
AREA OF ONE PERCENT STEEL	=	1.010 SQ.IN.
ELASTIC MODULUS, Ec	=	0.360E+07 LB/SQ IN
VOLUME OF UNDERREAM	=	0.000 CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY),
QU = TOTAL ULTIMATE RESISTANCE;
QAD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QAN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	WT (TONS)	QU (TONS)	QAD (TONS)	QAN (TONS)	QU/VOLUME (TONS/CU.YDS)
4.0	0.24	0.63	0.42	1.05	1.05	1.05	5.09
5.0	0.26	1.41	0.52	1.93	1.93	1.93	7.47
6.0	0.31	2.31	0.63	2.94	2.94	2.94	9.48
7.0	0.36	3.34	0.73	4.08	4.08	4.08	11.27
8.0	0.41	4.50	0.84	5.34	5.34	5.34	12.90
9.0	0.47	5.77	0.94	6.71	6.71	6.71	14.43
10.0	0.52	7.15	1.05	8.20	8.20	8.20	15.86
11.0	0.57	8.65	1.15	9.80	9.80	9.80	17.23
12.0	0.62	10.25	1.26	11.50	11.50	11.50	18.54
13.0	0.67	11.94	1.36	13.31	13.31	13.31	19.80
14.0	0.72	13.74	1.47	15.21	15.21	15.21	21.01
15.0	0.78	15.63	1.57	17.20	17.20	17.20	22.18
16.0	0.83	17.61	1.67	19.29	19.29	19.29	23.32
17.0	0.88	19.68	1.78	21.45	21.46	21.46	24.42
18.0	0.93	21.84	1.88	23.72	23.72	23.72	25.49
19.0	0.98	24.07	1.99	26.06	26.06	26.06	26.53
20.0	1.03	26.38	2.09	28.48	28.48	28.48	27.54
21.0	1.09	28.77	2.20	30.97	30.97	30.97	28.53
22.0	1.14	31.23	2.30	33.53	33.53	33.53	29.48
23.0	1.19	33.76	2.41	36.17	36.17	36.17	30.42
24.0	1.24	36.36	2.51	38.87	38.87	38.87	31.33
25.0	1.29	39.02	2.62	41.63	41.63	41.63	32.21
26.0	1.34	41.74	2.72	44.46	44.46	44.46	33.08
27.0	1.40	44.52	2.83	47.35	47.35	47.35	33.92
28.0	1.45	47.36	2.93	50.29	50.29	50.29	34.74
29.0	1.50	51.30	3.04	54.34	54.34	54.34	36.24
30.0	1.55	55.31	3.14	58.45	58.45	58.45	37.69
31.0	1.60	59.39	3.25	62.64	62.64	62.64	39.09

32.0	1.65	63.54	3.25	66.65	66.65	[illegible]	[illegible]
33.0	1.71	67.75	3.45	71.20	71.20	[illegible]	[illegible]
34.0	1.76	72.01	3.56	75.57	75.57	[illegible]	[illegible]
35.0	1.81	76.33	3.66	79.99	79.99	[illegible]	[illegible]
36.0	1.86	80.70	3.77	84.46	84.46	[illegible]	[illegible]
37.0	1.91	85.11	3.87	88.98	88.98	[illegible]	[illegible]
38.0	1.96	89.58	3.98	93.56	93.56	[illegible]	[illegible]
39.0	2.02	94.09	4.08	98.19	98.19	[illegible]	[illegible]
40.0	2.07	98.63	4.19	102.87	102.87	[illegible]	[illegible]
41.0	2.12	103.22	4.29	107.61	107.61	[illegible]	[illegible]
42.0	2.17	107.83	4.40	112.23	112.23	[illegible]	[illegible]
43.0	2.22	112.48	4.50	116.98	116.98	[illegible]	[illegible]
44.0	2.27	117.16	4.62	121.77	121.77	[illegible]	[illegible]
45.0	2.33	121.87	4.71	126.58	126.58	[illegible]	[illegible]
46.0	2.38	126.60	4.82	131.41	131.41	[illegible]	[illegible]
47.0	2.43	131.35	4.92	136.27	136.27	[illegible]	[illegible]
48.0	2.48	136.11	5.02	141.14	141.14	[illegible]	[illegible]
49.0	2.53	140.85	5.13	145.98	145.98	[illegible]	[illegible]
50.0	2.58	145.54	5.23	150.75	150.75	[illegible]	[illegible]

RESULT FROM TREND (AVERAGED) LINE

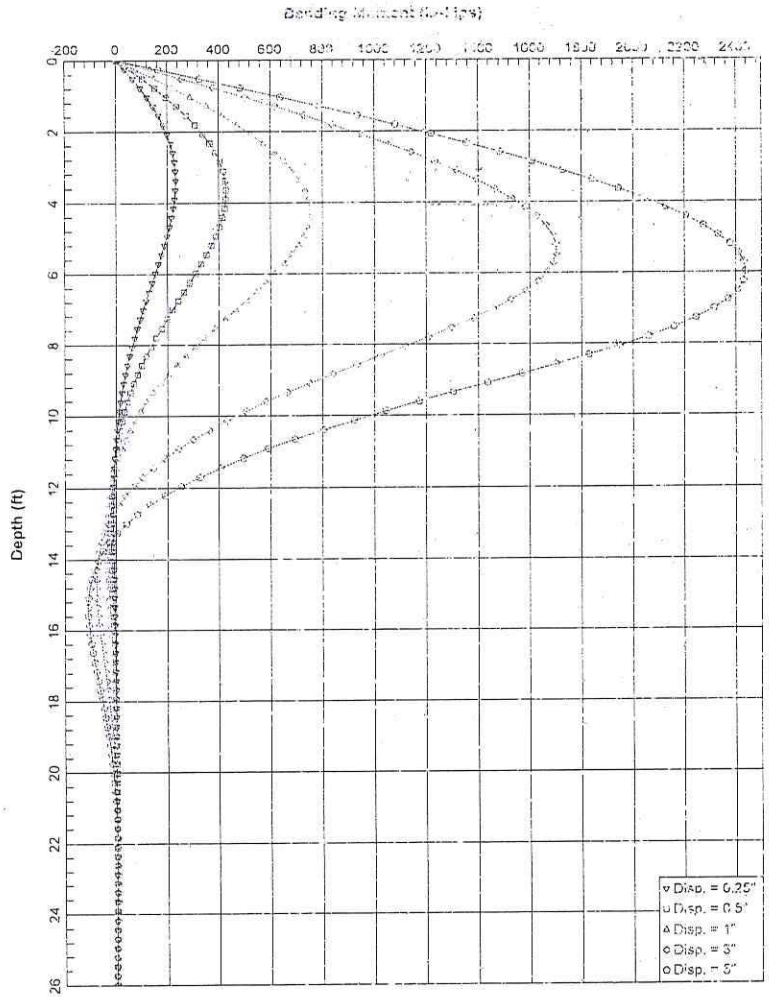
TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD [illegible]	TIP [illegible] IN.
0.5417E-01	0.5741E-04	0.1656E-03	0.1000E-04
0.2709E+00	0.2871E-03	0.5728E+03	0.5000E-04
0.5417E+00	0.5741E-03	0.1145E-02	0.1000E-03
0.2727E+02	0.2900E-01	0.5728E-02	0.5000E-02
0.3558E+02	0.4301E-01	0.8956E-01	0.7500E-02
0.5040E+02	0.5625E-01	0.1145E-01	0.1000E-01
0.9077E+02	0.1153E+00	0.2865E+00	0.2500E-01
0.1176E+03	0.1725E+00	0.5728E+00	0.5000E-01
0.1297E+03	0.2126E+00	0.8592E+00	0.7500E-01
0.1359E+03	0.2458E+00	0.1139E+01	0.1000E+00
0.1404E+03	0.4025E+00	0.2858E+01	0.2500E+00
0.1414E+03	0.6544E+00	0.5920E+01	0.5000E+00
0.1413E+03	0.7803E+00	0.4285E+01	0.6250E+00
0.1424E+03	0.9375E+00	0.9231E+01	0.7813E+00
0.1425E+03	0.9562E+00	0.9315E+01	0.7998E+00

RESULT FROM UPPER-BOUND LINE

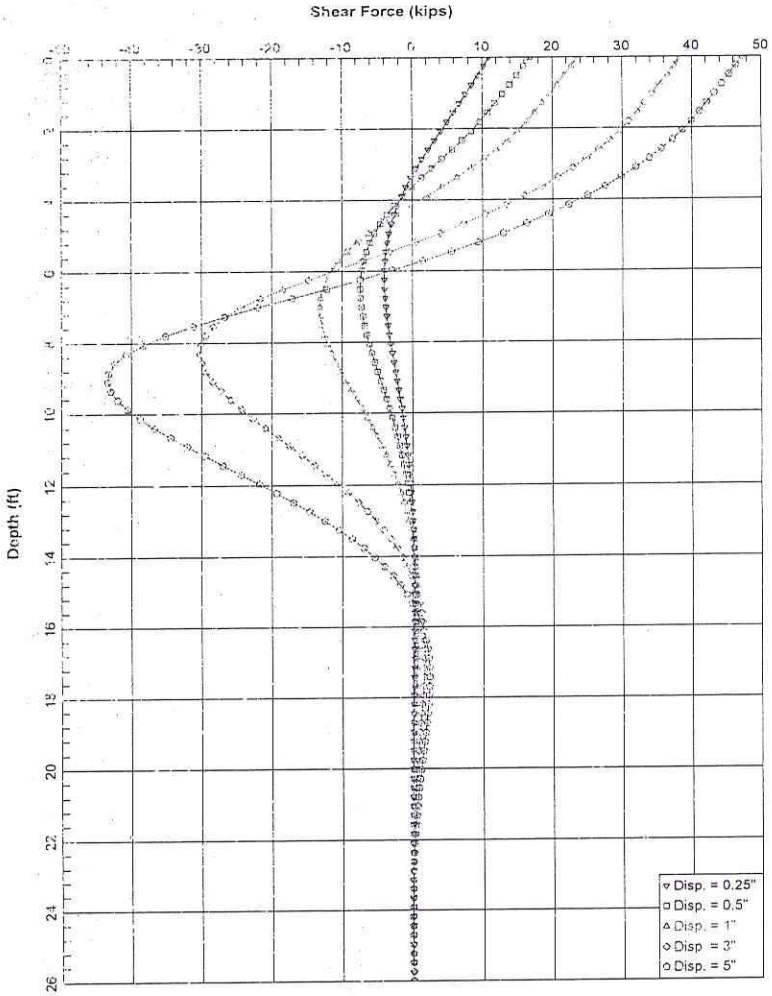
TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP [illegible] IN.
0.8684E-01	0.8198E-04	0.1636E-03	0.1000E-04
0.4342E+00	0.4099E-03	0.8180E-03	0.5000E-04
0.8684E+00	0.8198E-03	0.1636E-02	0.1000E-03
0.4261E+02	0.4121E-01	0.8180E-01	0.5000E-02
0.5960E+02	0.6004E-01	0.1227E+00	0.7500E-02
0.7333E+02	0.7695E-01	0.1636E+00	0.1000E-01
0.1171E+03	0.1440E+00	0.4090E+00	0.2500E-01
0.1377E+03	0.1966E+00	0.8180E+00	0.5000E-01
0.1433E+03	0.2293E+00	0.1227E+01	0.7500E-01
0.1452E+03	0.2571E+00	0.1636E+01	0.1000E+00
0.1471E+03	0.4102E+00	0.3636E+01	0.2500E+00
0.1480E+03	0.6618E+00	0.4475E+01	0.5000E+00
0.1481E+03	0.7876E+00	0.4966E+01	0.6250E+00
0.1491E+03	0.9449E+00	0.5530E+01	0.7813E+00
0.1492E+03	0.9636E+00	0.5693E+01	0.7998E+00

RESULT FROM LOWER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.2948E-01	0.3744E-04	0.6544E-04	0.1000E-04
0.1474E+00	0.1872E-03	0.3272E-03	0.5000E-04
0.2948E+00	0.3744E-03	0.6544E-03	0.1000E-03
0.1490E+02	0.1883E-01	0.3272E-01	0.5000E-02
0.2219E+02	0.2823E-01	0.4908E-01	0.7500E-02
0.2917E+02	0.3746E-01	0.6544E-01	0.1000E-01
0.6172E+02	0.8543E-01	0.1636E+00	0.2500E-01
0.9507E+02	0.1465E+00	0.3272E+00	0.5000E-01
0.1151E+03	0.1950E+00	0.4908E+00	0.7500E-01
0.1262E+03	0.2342E+00	0.6675E+00	0.1000E+00
0.1337E+03	0.3948E+00	0.1543E+01	0.2500E+00
0.1348E+03	0.6470E+00	0.3364E+01	0.5000E+00
0.1353E+03	0.7729E+00	0.4120E+01	0.6250E+00
0.1358E+03	0.9301E+00	0.4821E+01	0.7813E+00
0.1358E+03	0.9488E+00	0.4972E+01	0.7998E+00



Acacia UC - RW 305 - 16-in CIDH - Free



Acacia UC - RW 305 - 16-in CIDH - Free

LPile Plus for Windows, Version 6.0 (6.0.03)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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This program is licensed to:

Earth Mechanics, Inc.
Earth Mechanics, Inc.

Files Used for Analysis

Path to file locations: X:\Projects\2010\10-126 - RBF, SR 91 Westbound Widening\Reports\Foundation Report\04 Acacia Street UC\Analyses\LPILE\RW305\
Name of input data file: 16-inch CIDH pile RW 305.lp6d
Name of output file: 16-inch CIDH pile RW 305.lp6o
Name of plot output file: 16-inch CIDH pile RW 305.lp6p
Name of runtime file: 16-inch CIDH pile RW 305.lp6r

Date and Time of Analysis

Date: September 6, 2011 Time: 10:07:05

Problem Title

Project Name: SR-91 WB Widening

Job Number: 10-126

Client:

Engineer: GJG

Description: 16-inch CIDH at Acacia Abut 1

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	300	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections	=	1
Total Pile Length	=	26.00 ft
Depth of ground surface below top of pile	=	-2.00 ft

Slope angle of ground surface = 0.00 deg

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over
the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	16.0000000
2	26.000000	16.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	26.000 in
Top Width	=	16.000 in
Bottom Width	=	16.000 in
Top Area	=	201.000000 sq. in
Bottom Area	=	201.000000 sq. in
Moment of Inertia at Top	=	1.608E+03 in^4
Moment of Inertia at Bottom	=	1.608E+03 in^4
Elastic Modulus	=	1800000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 5 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer	=	-2.000 ft
Distance from top of pile to bottom of layer	=	28.000 ft
p-y subgrade modulus k for top of soil layer	=	65.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	65.000 lbs/in**3

Layer 2 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer	=	28.000 ft
Distance from top of pile to bottom of layer	=	43.000 ft
p-y subgrade modulus k for top of soil layer	=	130.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	130.000 lbs/in**3

Layer 3 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer	=	43.000 ft
Distance from top of pile to bottom of layer	=	50.000 ft
p-y subgrade modulus k for top of soil layer	=	75.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	75.000 lbs/in**3

Layer 4 is soft clay, p-y criteria by Matlock, 1970

Distance from top of pile to top of layer	=	50.000 ft
Distance from top of pile to bottom of layer	=	68.000 ft

Layer 5 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer	=	68.000 ft
Distance from top of pile to bottom of layer	=	100.000 ft
p-y subgrade modulus k for top of soil layer	=	100.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	100.000 lbs/in**3

(Depth of lowest layer extends 74.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 10 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	-2.00	120.00000
2	28.00	120.00000
3	28.00	120.00000
4	43.00	120.00000
5	43.00	57.60000
6	50.00	57.60000
7	50.00	52.60000
8	68.00	52.60000
9	68.00	62.60000
10	100.00	62.60000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. Subgr. pci
1	API Sand	-2.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
		28.000	120.000	--	32.000	--	--	--	65.000	--	--	--	--	--
2	API Sand	28.000	120.000	--	36.000	--	--	--	130.000	--	--	--	--	--
		43.000	120.000	--	36.000	--	--	--	130.000	--	--	--	--	--
3	API Sand	43.000	57.600	--	36.000	--	--	--	75.000	--	--	--	--	--
		50.000	57.600	--	36.000	--	--	--	75.000	--	--	--	--	--
4	Soft Clay	50.000	52.600	2500.000	--	--	--	0.00400	--	--	--	--	--	--
		68.000	52.600	2500.000	--	--	--	0.00400	--	--	--	--	--	--
5	API Sand	68.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--
		100.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.9000	1.0000
2	26.000	0.9000	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	80000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	80000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	80000.000
4	4	y =	3.000 in	M =	0.000 in-lbs	80000.000
5	4	y =	5.000 in	M =	0.000 in-lbs	80000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)	Condition 2 in-lb, rad., or in-lb/rad.	Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y = 0.2500	M = 0.000	80000.	0.25000000	232882.	10927.	0.00000000
2	4	y = 0.5000	M = 0.000	80000.	0.50000000	428421.	16796.	0.00000000
3	4	y = 1.0000	M = 0.000	80000.	1.00000000	751783.	23626.	0.00000000
4	4	y = 3.0000	M = 0.000	80000.	3.00000000	1702534.	38273.	0.00000000
5	4	y = 5.0000	M = 0.000	80000.	5.00000000	2438240.	47280.	0.00000000

The analysis ended normally.

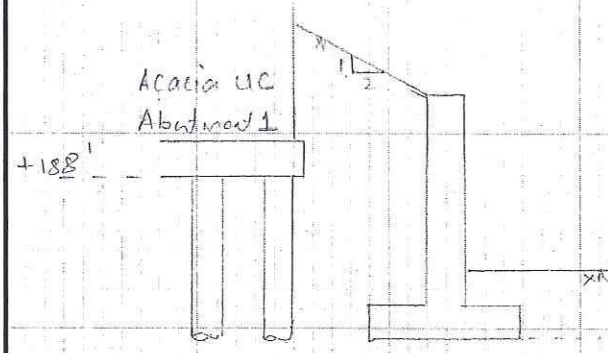
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
(714) 751-3826, Fax (714) 751-3928

Project SR-91 wb widening - Retaining wall 305 **Project No.** 10-156

By SP **Date** 09-2-11 **Checked By** _____ **Date** _____ **Sheet** ____ **of** ____

from wall loc station 10+15 to end of wall



Caltrans std type 1 retaining wall.

Maximum wall H = 8 ft

footing width : 6.5 ft.

Bearing capacity - strength limit state

$$q_u = cN_{cm} + \bar{c}N_{cm} + \tfrac{1}{2}\gamma B N_{\gamma m}$$

$N_{cm} = N_c s_c i_c$; $N_{qm} = N_q s_q i_q d_q$; $N_{\gamma m} = N_\gamma s_\gamma i_\gamma$

Shape factors $s_c = s_q = s_\gamma = 1$

Load inclination factors $i_c = i_q = i_\gamma = 1$

Footing depth $D_f = 1.5 + 1.33 = 2.83$ ft

depth factor $d_q = 1.2$

for $\Phi = 32$, $N_c = 35.5$, $N_q = 23.2$ $N_\gamma = 30.2$

$q_u = 100 \times 35.5 + 120 \times 2.83 \times 23.2 \times 1.2 + \frac{1}{2} \times 120 \times 6.5 \times 30.2$

$= 24.8$ ksf

$q_{all} = 11.2$ ksf ; resistance factor = 0.45

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

17800 Newhope Street, Suite B, Fountain Valley, CA 92708
(714) 751-3826, Fax (714) 751-3928

Project Acacia St UC - Retaining wall 305 Project No. 10-126

By SP Date 09-02-11 Checked By _____ Date _____ Sheet ____ of ____

Settlement

consider 2.2 ksf bearing pressure

	σ_{vo}	$\Delta\sigma_v$	settlement
①	$7.8 \times 120 = 0.94$	$2.2 \times 0.6 = 1.32$	$10 \times \frac{1}{75} \log\left(\frac{0.94+1.32}{0.94}\right) = 0.61$
	$21.8 \times 120 = 2.62$	$2.2 \times 0.3 = 0.66$	$18 \times \frac{1}{75} \log\left(\frac{2.62+0.66}{2.62}\right) = 0.28$
②	$36 \times 120 = 4.3$	$2.2 \times 0.15 = 0.33$	$10 \times \frac{1}{85} \log\left(\frac{4.3+0.33}{4.3}\right) = 0.1$
			$0.99''$

service limit state bearing capacity = 2.2 ksf with 1 foot of overexcavation

Appendix D

CALTRANS REVIEW COMMENTS AND EMI RESPONSES

State of California

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: LUQI YANG
Liaison Engineer

Date: May 2, 2011

File: 12-ORA-91 PM Various
EA 12-0C5701, 1200000079
Brookhurst Ave UC + 5Br.
No. 55-0280 + 5

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
Geotechnical Services
Office of Geotechnical Design – South 1

Subject: Foundation Report- Bridge No. 55-0216, 55-0218, 55-0245, 55-0279, 55-0280 & 55-852

Per your request, the Geotechnical Design South 1 - Branch B has reviewed the subject submittal, containing the following item:

1. Foundation Reports for No. 55-0216, 55-0218, 55-0245, 55-0279, 55-0280 & 55-852, Anaheim, Orange County, dated April 15, 2011.

Our office has no comments on above submitted item.

Should you have any questions, please contact Mushtaq Ahmed at (213) 620-2132.

Reviewed by: Date: 5/2/11

Mushtaq Ahmed, P.E.
Transportation Engineer-Civil
Office of Geotechnical Design – South 1
Branch B

Supervised by: Date: 5/2/11

Sam Sukiasian, G.E.
Chief Branch B
Office of Geotechnical Design – South 1

cc: OGDS1 – Nor. File, OGDS1- Sac. File, GS-Sac. File

REGISTERED CIVIL ENGINEER
MOHAMMAD MUSHTAQ AHMED
No. C056390
Exp.
STATE OF CALIFORNIA

FOUNDATION REPORT
STATE COLLEGE BLVD UC (Widen)
Bridge No. 55-0852

Earth Mechanics, Inc.

September 16, 2011

FOUNDATION REPORT

State College Boulevard Undercrossing (Widen)
Bridge No. 55-0852
Orange County, California
12-ORA-91, PM 5.3
Caltrans Project No. 12000000791 (EA 12-0C5701)
EMI Project No. 10-126
Date: September 16, 2011

EARTH MECHANICS, INC.

Geotechnical and Earthquake Engineering

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

September 16, 2011

EMI Project No. 10-126

RBF Consulting
14725 Alton Parkway
Irvine, California 92618

Attention: Mr. Steve Huff, P.E.

Subject: Foundation Report for State College Boulevard Undercrossing (Widen)
Bridge No. 55-0852
Anaheim, Orange County, California
12-Ora-91, PM 5.3
Caltrans Project No. 12000000791 (EA 12-0C5701)

Dear Mr. Huff:

Attached please find the Foundation Report for the subject bridge widening project. This report contains the findings and conclusions of our field investigation and laboratory testing program. This report also contains our recommendations for the design and construction of the bridge foundations.

An earlier version of this report dated April 15, 2011 was submitted to Caltrans for review. Caltrans prepared a memorandum dated May 2, 2011 indicating they have no comments. A copy of this Caltrans memorandum is included in Appendix D.

We appreciate the opportunity to provide geotechnical design services for this project. If you have any questions, please call us.

Sincerely,

EARTH MECHANICS, INC.

REGISTERED PROFESSIONAL ENGINEER
GNANAPRAGASAM J. GUNARANJAN
No. C71758
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FOUNDATION REPORT

STATE COLLEGE BOULEVARD UNDERCROSSING (WIDEN)
BRIDGE NO. 55-0852
ANAHEIM, ORANGE COUNTY, CALIFORNIA
12-ORA-91, PM 5.3
CALTRANS PROJECT NO. 12000000791 (EA 12-0C5701)

Prepared for:

RBF Consulting
14725 Alton Parkway
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Earth Mechanics, Inc.
17800 Newhope Street, Suite B
Fountain Valley, California 92708

EMI Project No. 10-126

September 16, 2011

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Appendix D. Caltrans Review Comments and EMI Responses

1.0 INTRODUCTION

1.1 Purpose and Scope of Study

This Foundation Report presents the findings and conclusions of a geotechnical investigation conducted by Earth Mechanics, Inc. (EMI). It presents foundation design and construction recommendations for the proposed widening of the State College Boulevard Undercrossing (UC) in the City of Anaheim, County of Orange, California. A site location map is presented in Figure 1-1.

EMI is a subconsultant to RBF Consulting (RBF). The geotechnical services provided for this project included the following tasks:

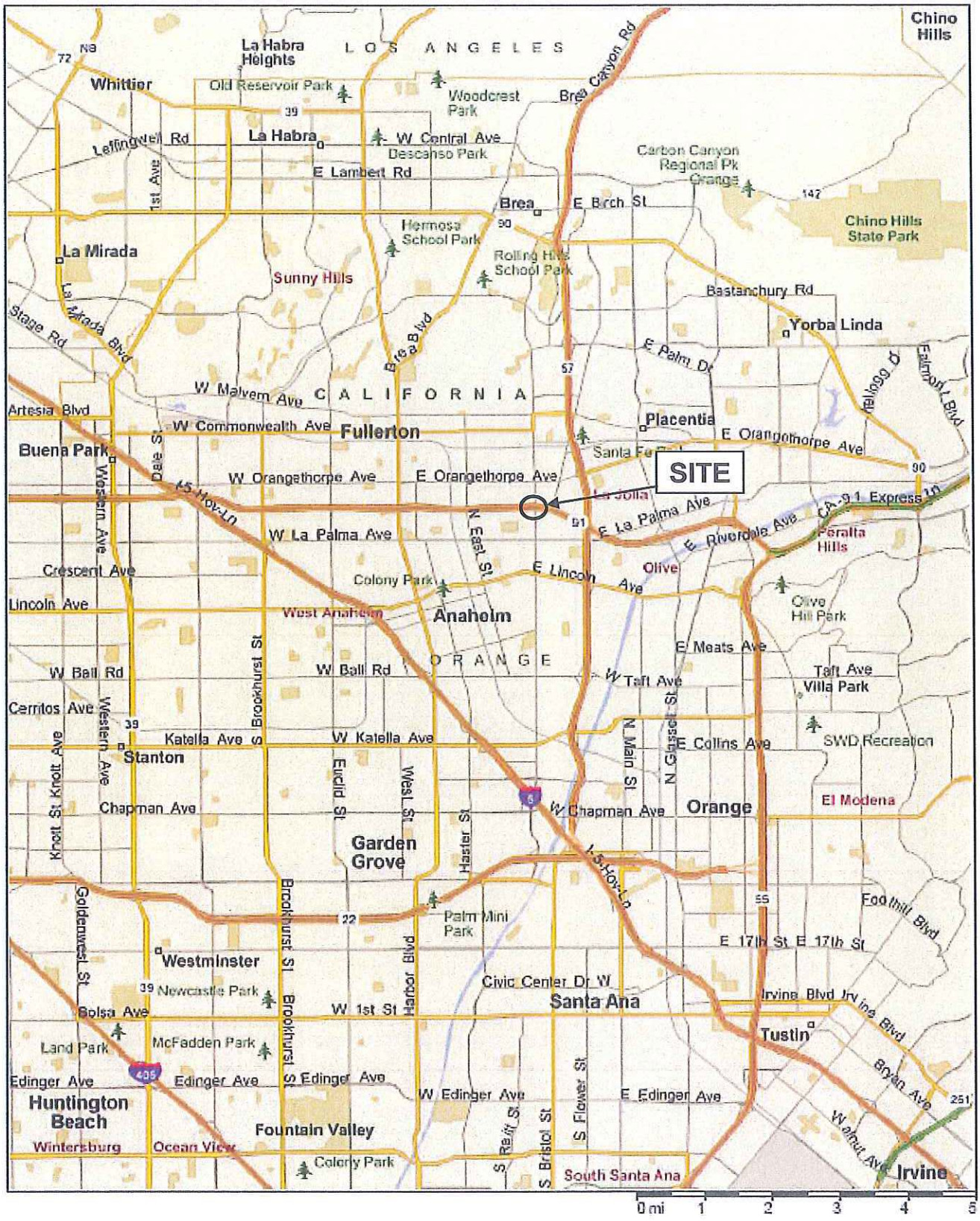
- Collection and review of existing geotechnical information;
- Field exploration consisting of drilling and logging exploratory borings and Cone Penetration Test (CPT) sounding;
- Laboratory testing of selected bulk and relatively undisturbed soil samples;
- Engineering calculations and analysis to develop foundation design and construction recommendations; and
- Preparation of this report presenting our findings, conclusions, and recommendations.

1.2 Project Description

The California Department of Transportation (Caltrans), in cooperation with the Orange County Transportation Authority (OCTA) and the cities of Anaheim and Fullerton, proposes to widen the westbound State Route 91 (SR-91) from State Route 57 (SR-57) to Interstate 5 (I-5). SR-91 is a major east-west freeway facility that begins at the eastern junction with SR-60 in the city of Riverside in Riverside County, and continues west through Orange County to its terminus at the junction with Pacific Coast Highway 1 near the city of Hermosa Beach in Los Angeles County.

The proposed project limits cover a distance of 4.5 miles; however, actual improvements are limited to a total of 3.8 miles within the project area. The proposed project consists of widening six bridges. The subject foundation report addresses only the State College Boulevard UC (Bridge No. 55-0852).

The existing State College Boulevard UC will be widened by about 14 feet only on the north side in order to accommodate widening of the westbound SR-91. The proposed widened State College Boulevard UC is a two-span structure supported on seat-type abutments (Abutments 1 & 3) and a single-column bent (Bent 2). The new bridge deck will be approximately 186 feet wide and the bridge length is about 145 feet.



State College Boulevard UC (Widen)	SITE LOCATION MAP
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 1-1
Project No. 10-126	Date: 03-21-11

1.3 Existing Bridge Information

This UC was originally constructed in 1959 and widened in 1967. The UC was replaced with a two-span structure in 2000. Based on the as-built plans, the replaced UC is supported on 16-inch diameter CIDH piles with design loadings of 45 tons and 70 tons at abutments and bent, respectively. The specified pile tip elevations are +140 and +150 feet at the abutments and bent, respectively.

2.0 FIELD INVESTIGATION AND LABORATORY TESTING

2.1 Existing Information

The as-built Logs-of-Test-Borings (LOTB) sheets for the 1959 original construction and 2000 replacement were reviewed as part of the preparation of this report. Copies of these LOTB sheets are provided in Appendix A.

For the 2000 replacement structure, two hollow-stem auger borings were performed in February 1993. The deepest boring was advanced to about elevation +113 feet. Existing grade at the borehole locations at the time of the investigation was between elevations +188.2 and +187.9 feet, which are near the roadway surface elevation of State College Boulevard.

As-Built LOTB sheet of the original UC was used for the widening in February 1967.

For the original UC construction in 1959, two 1-inch soil-tube borings were drilled in August 1954. The deepest boring was advanced to about elevation +140 feet. Existing grade at the borehole locations at the time of the investigation was between +188.0 and +188.6 feet, which is near the roadway surface elevation of State College Boulevard.

2.2 Field Investigation

To supplement the existing subsurface information, two soil borings and one CPT sounding were performed by EMI between December, 2010 and January, 2011. Exploration information, including Boring/CPT number, stations, offsets, ground surface elevations, bottom elevations and water level measurements are summarized in Table 2-1. Locations of the geotechnical exploration are also shown on the LOTB sheet provided in Appendix A.

Table 2-1. Geotechnical Exploration Information

Boring / CPT No.	Station Line	Approx. Station	Approx. Offset (feet)	Approx. Ground Surface El. (feet)	Approx. Exploration Bottom El. (feet)	Approx. Ground Water Level El. (feet)
A-10-063	"A" Line	332+01	90 Lt	+190.2	+109.7	Not Encountered
A-10-064		333+13	76 Lt	+210.0	+128.6	Not Encountered
CPT-10-062		330+80	69 Lt	+208.7	+162.6	Not Measured

2.2.1 Soil Borings

Boring A-10-063 was drilled on State College Boulevard, adjacent to Bent 2, and Boring A-10-064 was drilled on the SR-91 freeway shoulder, east of Abutment 3.

Exploratory borings were drilled by 2R Drilling under subcontract with EMI using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers. The sampling interval is

usually 5 feet. Sampling was performed by alternating the Modified California Drive (MCD) sampler and Standard Penetration Test (SPT) sampler.

Relatively undisturbed drive samples were obtained using a 3.25-inch outer diameter MCD sampler lined with brass rings. Each of these brass rings is 1-inch long with a 2.5-inch outside diameter. The MCD sampler was driven into the ground using successive blows of a 140-lb hammer falling a distance of 30 inches. The numbers of blow to advance the sampler each 6 inches of penetration or less were recorded. The numbers of blow for the final 12 inches or shorter of driving are shown on the LOTB sheet.

The SPT sampler (1.4-inch inside diameter) was also used to obtain soil samples. The SPT sampler was driven into the ground using a 140-lb hammer falling from a height of 30 inches. The numbers of blow to advance the sampler each 6 inches of penetration or less were recorded. The blow counts required to drive the sampler for the last 12 inches or less were recorded as the Standard Penetration Resistance (N-value) on the LOTB sheet.

Charts published by Winterkorn and Fang (1975) can be used to determine a reduction factor used to convert blowcounts recorded using the California Drive sampler into SPT blowcounts. Using those charts, we obtained a reduction factor of 0.5 and this one-half reduction factor was used for this project.

2.2.2 CPT Sounding

The sounding CPT-10-062 was performed on the SR-91 freeway shoulder, west of Abutment 1.

The CPT sounding was performed by Middle Earth Geo Testing, Inc. under subcontract with EMI using an electronic cone penetrometer in general accordance with the current ASTM Standards (ASTM D5778 and ASTM D3441). The CPT equipment consisted of a cone penetrometer assembly mounted at the end of a series of hollow sounding rods. The cone penetrometer assembly consisted of a conical tip with a 60° apex angle and a projected cross sectional area of 1.55 in² (10 cm²) and a cylindrical friction sleeve with a surface area of 23.25 in² (150 cm²). The interior of the cone penetrometer is instrumented with strain gauges that allow simultaneous measurements of cone tip and friction sleeve resistance during penetration. The cone penetrometer assembly is continuously pushed into the soil by a set of hydraulic rams at a standard rate of 0.79 inch per second (20 mm per second) while the cone tip resistance and sleeve friction resistance are recorded every 1.967 inches (50 mm) and stored in digital form. A specially designed all-wheel drive 25-ton truck provides the required reaction weight for pushing the cone assembly and is also used to transport and house the test equipment. The computer generated graphical logs include cone resistance, friction resistance, and friction ratio. Soil behavior type interpretations are based on guidelines by Robertson and Campanella (1989).

2.3 Laboratory Testing

Soil samples considered representative of the subsurface conditions were tested to obtain or derive relevant physical and engineering soil properties. The following laboratory tests were conducted to supplement the observations recorded during the field investigation:

- In-situ Moisture Content and Unit Weight
- Percent Passing No. 200 Sieve
- Direct Shear
- R-Value
- Minimum Resistivity, pH, Sulfate Content and Chloride Content

The laboratory tests were conducted in general accordance with California Test Methods or American Society for Testing and Materials (ASTM) Standards. Laboratory test results are included in Appendix B.

An R-value test is noted on the LOTB in Appendix A. This test was conducted for the pavement design; this test result was not used in preparation of the recommendations included in this report and therefore, it was omitted from Appendix B.

3.0 GEOLOGY AND SEISMICITY

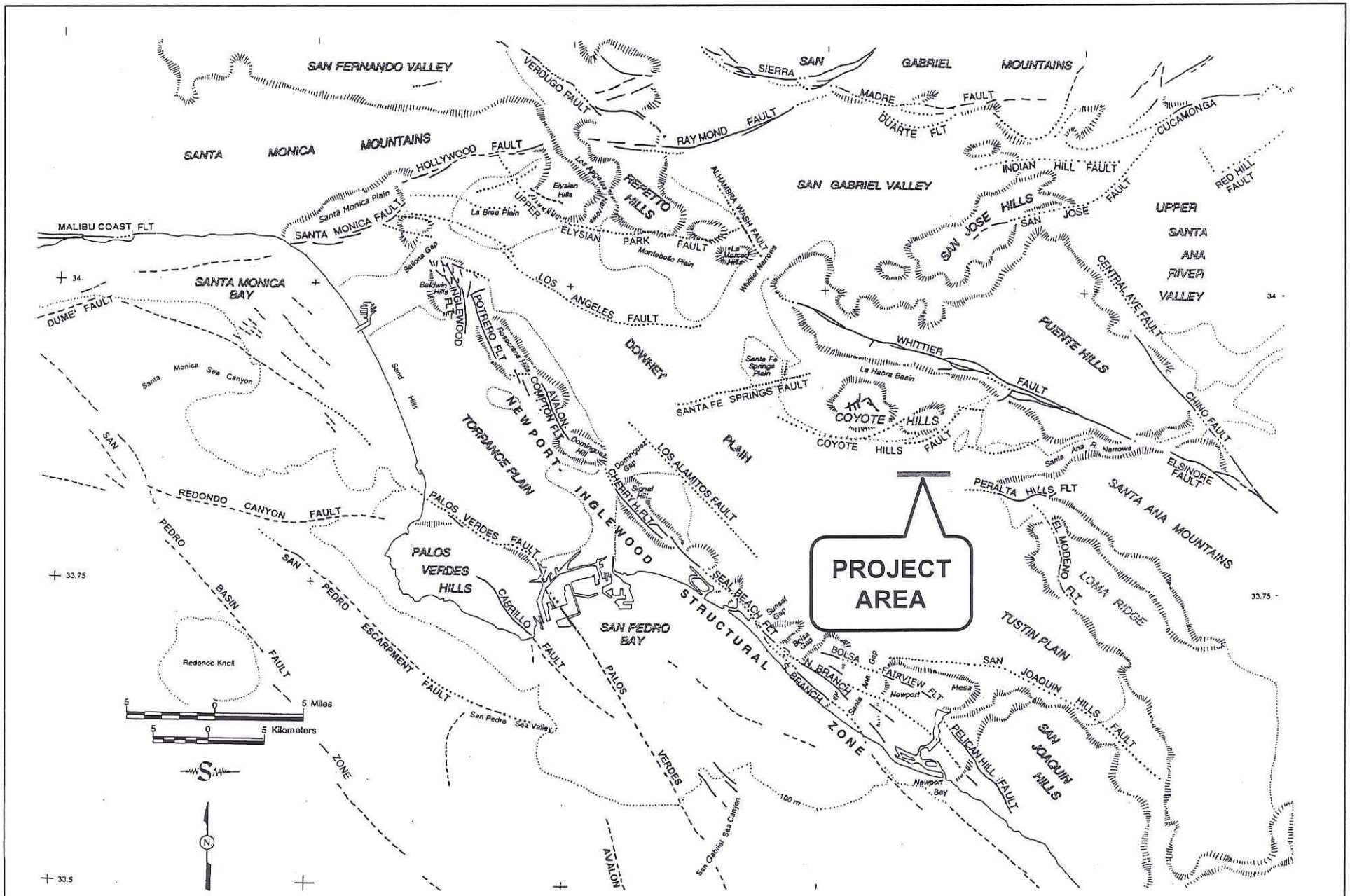
3.1 Physiography

The project area is in the east-central part of the Los Angeles Basin as shown in Figure 3-1 which comprises a transition zone between the Peninsular Ranges physiographic province on the east, and the Transverse Ranges physiographic province to the north. The Peninsular Ranges physiographic province comprises a northwest-southeast trending group of fault-bounded ranges such as Santa Ana Mountains, Puente Hills and San Joaquin Hills between the Salton Trough and the Pacific Ocean. The Transverse Ranges physiographic province comprises east-west trending ranges and valleys such as the Santa Monica Mountains, San Fernando Valley and San Gabriel Mountains. Valleys such as the Los Angeles Basin, the San Gabriel Valley and the Upper Santa Ana River Valley have characteristics compatible with both physiographic provinces and form a transition zone between the two provinces.

The Los Angeles Basin is essentially a large, relatively flat, low-lying and coastal plain surrounded by mountains on the north, east and southeast which rise abruptly to a few thousand feet above the plains. The western margin of the basin is bordered by the sea, the Palos Verdes Hills and the San Joaquin Hills. The floor of the basin gradually rises inland to a series of uplifted terrain along the margins of the surrounding mountains. This elevated marginal terrain includes the Santa Monica, La Brea, Montebello, Santa Fe Springs plains, and the Coyote Hills. The generally flat-lying nature and gradual inland rise of the Basin floor is disrupted by an alignment of northwest-southeast trending, low-elevation hills along the Newport-Inglewood Structural Zone (NISZ). The areas on either side of the NISZ are essentially flat and comprise the Downey-Tustin plain on the northeast and the Torrance Plain on the southwest. The site area is near the transition between the Downey and the Tustin plains.

3.2 Geologic Structure

The Los Angeles Basin is a deep structural basin comprising two major downward folds (synclines) separated by the NISZ uplift; the Paramount syncline is east of the NISZ under the Downey-Tustin Plain, and the Gardena syncline is west of the NISZ under the Torrance Plain. The Paramount syncline is the larger and deeper syncline with basement rocks as deep as about 30,000 feet (Yerkes et al, 1965). As described in the physiography section, the basin is rimmed by marginal elevated plains that rise about a hundred feet to as much as a couple hundred feet above the general level of the basin floor. These elevated plains and the Coyote Hills are underlain by fault-bounded, upward folds (anticlines) that are prolific oil fields. Most of the major faults associated with these folds are blind thrust faults and are shown on Figure 3-1 as dotted lines. The nearest faults to the project area are the blind thrust faults of the Puente Hills Blind Thrust Fault System and Compton-Los Alamitos Blind Fault System. Larger surface faults, such as the NISZ and the Elsinore Fault Zone (Whittier Section) lie to the southwest and northeast of the project site, respectively.



State Route 91 Westbound Widening Project

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

REGIONAL MAP OF ACTIVE FAULTS AND PHYSIOGRAPHY

Figure 3-1

Project No. 10-126

Date: 03-21-11

3.3 Geological Hazards

The only significant geological hazard at the site is earthquake shaking and perhaps local liquefaction. There are no known active surface faults within the project area so ground rupture is not a factor. The flat-lying nature of the area is not susceptible to landsliding. The site is too far from the ocean to be affected by tsunamis, and there are no large bodies of water within the site area that could generate a seiche. There are no volcanoes in the region.

As presented in Figure 3-2, the California Geological Survey (1997, 1998) shows designated project site is outside the liquefaction zone. Therefore, the liquefaction potential at the project site is low. The potential for liquefaction is discussed in detail in Section 5.2.

3.4 Seismicity

The project is in seismically active Southern California. The present-day seismotectonic stress field in the Los Angeles region is one of north-northeasterly compression. This is indicated by the geologic structures, by earthquake focal-mechanism solutions and by geodetic measurements. These data suggest crustal shortening of between 0.2 and 0.35 inches per year across the greater Los Angeles area (Argus et al., 1999).

Historical earthquake epicenter maps show widespread seismicity throughout the Los Angeles region. Earthquakes occur primarily as loose clusters along the NISZ, the southern margin of the Santa Monica Mountains, the margin between the Santa Susana-San Fernando Valley and the southern margin of the San Gabriel Mountains, and in the Coyote Hills-Puente Hills area.

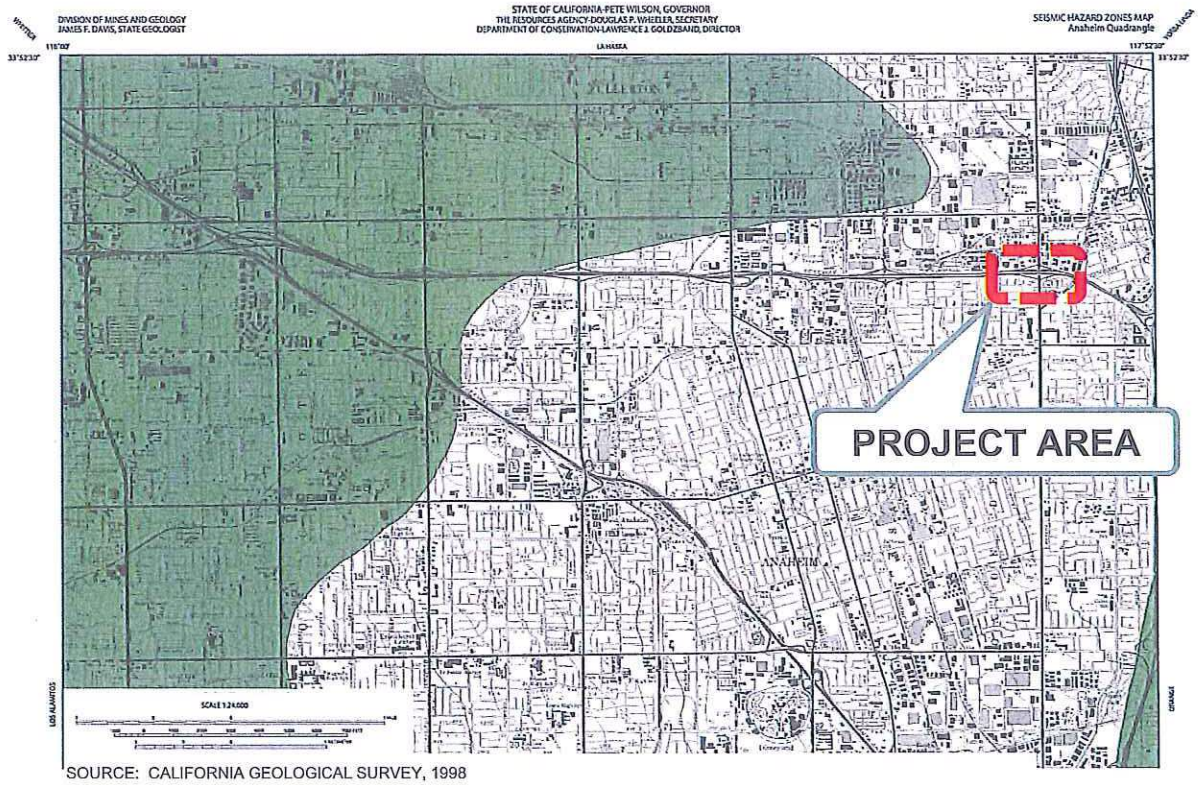
The largest historical earthquakes within the Los Angeles Basin were the 1933 Long Beach (moment magnitude (M_W) of about 6.4), 1994 Northridge (M_W = 6.7), 1971 San Fernando (M_W = 6.7), 1987 Whittier (M_W = 5.9), and 2008 Chino Hills (M_W = 5.4). There have been no significant historical earthquakes in the immediate site area. There may have been a few random small events (M_W < 3.0). The nearest concentrated earthquake activity has been within the Puente Hills about 5 or 6 miles to the north of the site.

The 1933 Long Beach earthquake did not rupture the surface but is believed to have been associated with the NISZ (Benioff, 1938). Reevaluation of the seismic data by Hauksson and Gross (1991) relocated the 1933 earthquake hypocenter to a depth of about 6 miles below the Huntington Beach-Newport Beach city boundary.

The 1994 Northridge earthquake occurred on a southerly dipping subsurface fault which was unknown prior to the earthquake. The main shock occurred at a depth of about 12 miles. Earthquake aftershocks clearly defined the rupture surface dipping about 35 degrees southerly from a depth of about 1 or 2 miles to 14 miles. The causative fault was never identified with certainty.

The 1971 San Fernando earthquake involves surface rupture. The 1971 event occurred on a northerly dipping thrust fault that dips from the northern side of the San Fernando Valley to a depth of about 9 miles under the San Gabriel Mountains, and considered part of the Sierra Madre Fault System.

N



SOURCE: CALIFORNIA GEOLOGICAL SURVEY, 1998

MAP EXPLANATION

Zones of Required Investigation:

Liquefaction

Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

State College Boulevard UC (Widen)	MAP OF LIQUEFACTION POTENTIAL	
Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	Figure 3-2	
	Project No. 10-126	Date: 03-21-11

The 1987 Whittier earthquake occurred on a subsurface fault dipping under the Puente Hills to about 10 miles beneath the San Gabriel Basin (Shaw and Shearer, 1999; Shaw et al., 2002). This event did not rupture the ground surface.

The 2008 Chino Hills event epicenter was in the Chino Hills area between the Elsinore-Fault-Zone Chino Section and Whittier Section. Preliminary data were inconclusive with regard to the causative fault. Detailed analysis by Shao and Hauksson (2009) indicated a rupture plane striking N71°W, dipping 62° northeast. This event did not rupture the ground surface.

Another significant earthquake was the 1812 earthquake which caused damage at the San Juan Capistrano Mission. The location and magnitude of the 1812 earthquake are unknown because of the sparse population at the time, but geological studies (Jacoby et al., 1987; Fumal et al., 1993; Weldon et al., 2004) postulate that it did not occur in the Capistrano area, but rather was a large (M_W > 7.0) distant event on the San Andreas fault in the Wrightwood area of the San Gabriel Mountains.

The earliest documented earthquake in the region was reported by the Portola´ expedition as they camped near the Santa Ana River in 1769. This event has been attributed by various geoscientists to just about every fault in the Los Angeles area but it could just as well have been a distant event that shook a wide area as did the 1971 San Fernando, the 1987 Whittier, and the 1994 Northridge events, as well as many other more-distant events such as 1992 Landers event.

4.0 SUBSURFACE CONDITIONS

4.1 Soil Conditions

The proposed approach elevation is about +210 feet and the existing ground surface elevation at State College Boulevard is about +188 feet. Based on the recent and previous field investigations, the site materials are typically fill and alluvium; consist of predominantly sand with silt and silty sand with traces of fine gravelly sands and thin isolated layers of lean clay, silty clay, and clayey silt. The consistency of upper 85 feet or so materials vary between loose to medium dense followed by a very dense consistency down to the boring termination depth.

The idealized soil profile and design strength parameters for foundation design are presented in Table 4-1.

Table 4-1. Idealized Soil Profile and Strength Parameters

Approximate Elevation (feet)	Predominant Soil Type	Equivalent SPT Blowcount* (blows/foot)	Total Unit Weight (pcf)	Friction Angle (degree)	Cohesion (psf)
+210 to +188	Fill	-	120	32	150
+188 to +180	Sand and Sand with Silt	5 to (20) Average = 11	120	30	100
+180 to +155	Sand and Sand with Silt	16 to (47) Average = 28	120	33	50
+155 to +125	Sand with Silt and Silty Sand	(32) to 78 Average = 45	120	34	0
Below +125	Sand and Sand with Silt	49 to (80) Average = 69	125	38	50

* Values in ( ) are converted SPT blowcounts corrected for sampler size; correction factor from California sampler blowcounts to SPT blowcounts is 0.5.

In Table 4-1, the soil strength parameters are based on direct shear test results or published correlations with SPT blowcounts (Lam and Martin, 1986). Direct shear tests were performed on soil samples obtained within the second, third, and fourth idealized soil layers. The design strength parameters of these layers were based on the ultimate shear strength parameters obtained from the direct shear tests. Design strength parameters of the remaining idealized soil layers are based on correlation with SPT blowcounts. It should be noted that the strength parameters obtained from the direct shear tests are lower than those obtained using SPT correlations for the same idealized soil layers.

4.2 Groundwater Conditions

Groundwater was not encountered in any of the as-built or current borings. Based on California Geological Survey (Division of Mines and Geology, 1997), the recorded highest historical groundwater at the project site is greater than 50 feet below the ground surface. The average ground surface elevation at the State College Boulevard roadway surface is about +188 feet. Therefore, the CGS historical highest groundwater elevation would be deeper than +138 feet. We used a historical highest groundwater elevation of +138 feet for liquefaction analysis.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Seismic Design Criteria

To develop ARS curves in accordance with the 2009 Seismic Design Criteria (SDC) (Caltrans, 2009b and 2009d) procedures, we considered the following response spectra:

- Deterministic Criteria based on late-Quaternary faults in 2007 fault database (Caltrans, 2007a and 2007b and Shantz and Merriam, 2009);
- Probabilistic Criteria based on 5% in 50 years probability of exceedance ground motion; and
- Minimum Deterministic Spectrum based on a M_w= 6.5 strike-slip event occurring at a distance of 7.5 miles (12 km) from the site.

The design ARS curve is the envelope of the above spectra.

We used the Caltrans Deterministic Response Spectrum Spreadsheet as recommended by the 2009 SDC to develop the deterministic ARS curves. The spreadsheet uses the arithmetic average of two Next Generation Attenuation (NGA) relationships developed by Chiou-Youngs (2008) and Campbell-Bozorgnia (2008) with user-provided input parameters, including fault characteristics, site-to-fault distances and site condition parameters as presented in Table 5-1.

Table 5-1. Controlling Faults for Deterministic Response Spectrum

Controlling Fault	Fault ID	Maximum Moment Magnitude M_{max}	Site to Fault Distance R_{RUP} (miles)	Style of Fault	Fault Dip /Direction
Puente Hills Blind Thrust	240	7.3	8.5	Reverse	25° / North
Peralta Hills Fault	146	6.2	3.5	Reverse	50° / Southeast
Elsinore Fault Zone (Whittier Section)	241	7.6	9.4	Reverse Lateral Strike Slip	75° / Northeast

Results obtained from the spreadsheet were then verified with the Caltrans online web tool (Caltrans, 2009a). The spreadsheet method is recommended because the online web tool, though more user-friendly, does not include updates since 2007 in its calculation database and presently is not approved to develop spectra for final design.

The probabilistic response spectrum is based on data from the 2008 United States Geological Survey (USGS, 2008a) National Seismic Hazard Map for the 5% in 50 years probability of exceedance (975-year return period) ground motion. To develop the probabilistic spectrum, the Caltrans Probabilistic Response Spectrum Spreadsheet and the USGS Interactive Deaggregation Tool (USGS, 2008b) were used. Results obtained from both the spreadsheet and deaggregation tool were then verified with the Caltrans online web tool. Again, the spreadsheet and deaggregation tool are recommended because the online web tool, though more user-friendly, does not include updates since 2007 in its calculation database.

The resulting design ARS curve and the digitized coordinates are presented in Figure 5-1. A peak ground acceleration (PGA) of 0.52g is obtained from the design ARS curve.

5.2 Liquefaction

Liquefaction analysis was performed using the available site-specific subsurface information and a historical high groundwater elevation of +138 feet. The liquefaction potential of the saturated, granular materials below the design water table was evaluated using the procedures outlined by Seed et al. (1985), Seed and Harder (1990), and updated by NCEER (1997) and Youd et al., (2001).

Using the subsurface information obtained from four soil borings, results of the analysis indicate that granular materials susceptible to liquefaction were not encountered below the groundwater table. Therefore, the liquefaction potential at the bridge site is anticipated to be low. Since liquefaction potential is low, seismically induced settlement should be negligible.

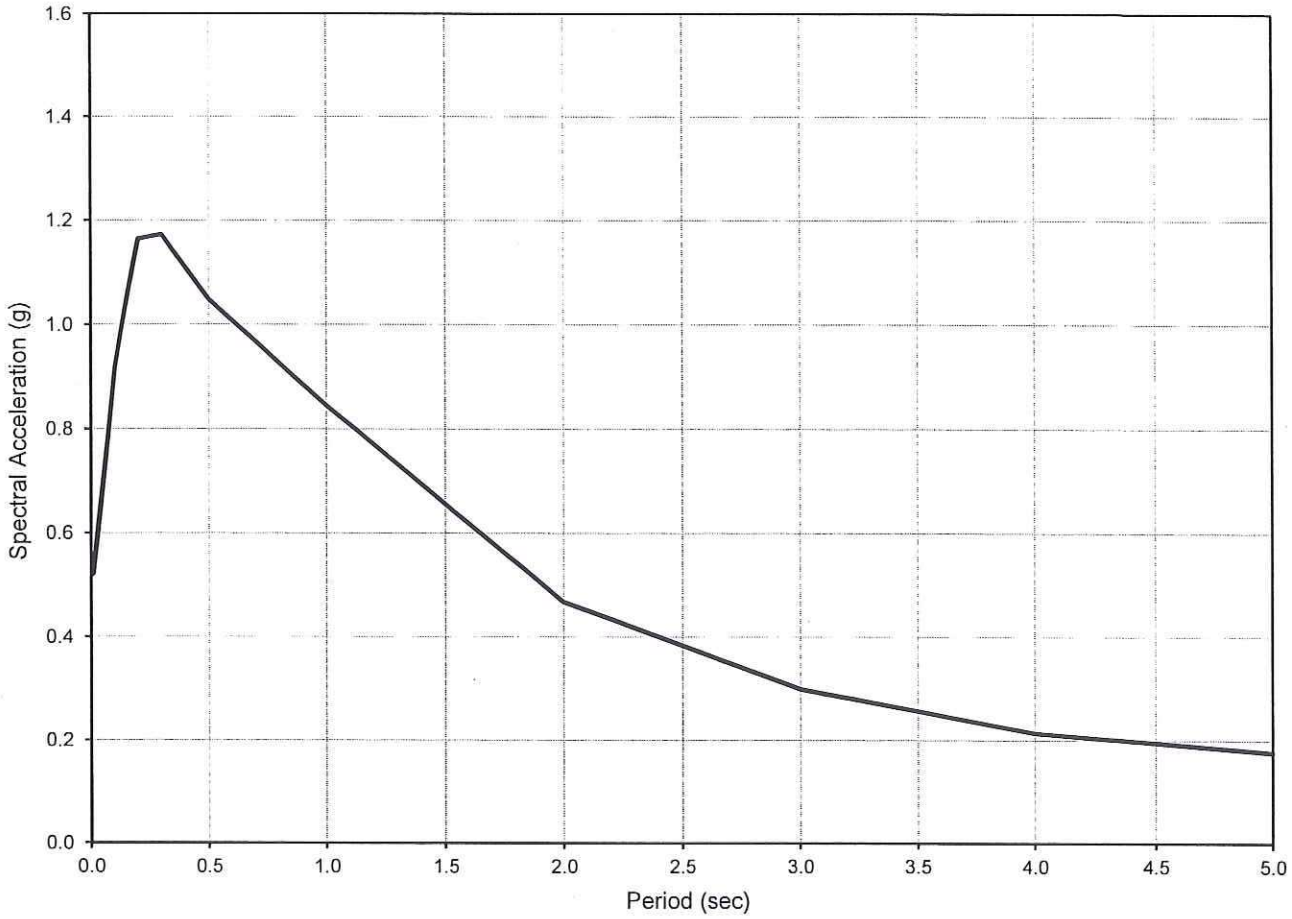
5.3 Soil Corrosivity

Two soil samples were tested for pH, minimum resistivity, soluble chloride content, and soluble sulfate content. The test results are summarized in Table 5-2. Minimum resistivities were 2,000 and 13,000 ohm-cm. The pH value was 7.8. The soluble sulfate measurement was 10 parts per million (ppm), and the soluble chloride measurements were 158 and 217 ppm.

Table 5-2. Soil Corrosion Test Results

Boring	Station (Offset) / "Station Line"	Sample Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Soluble Sulfate Content (ppm)	Soluble Chloride Content (ppm)
A-10-063	332+01 (90' Lt) / "A" Line	35	SP-SM	13,000	7.8	10	158
A-10-064	333+13 (76' Lt) / "A" Line	5	SM/SC	2,000	7.8	10	217

Based on the Caltrans Corrosion Guidelines (2003b), soils are considered corrosive if the pH is 5.5 or less, or the chloride concentration is 500 ppm or greater, or the sulfate concentration is 2,000 ppm or greater. Based on the test results and the Caltrans criteria, the on-site soils are considered to be non-corrosive to bare metals and concrete.



Latitude = 33.8539 °
Longitude = -117.9591 °

Damping Ratio = 5%

Spectral Coordinates	
Period (sec)	Acc. (g)
0.010	0.520
0.100	0.915
0.200	1.164
0.300	1.173
0.500	1.049
1.000	0.844
2.000	0.467
3.000	0.299
4.000	0.214
5.000	0.176

Earth Mechanics, Inc. Geotechnical and Earthquake Engineering	**State College Boulevard UC (Widen)**	**Design ARS Curve**
	Project: 10-126 **Date: 03/01/11**	**Figure 5-1**

5.4 Pile Foundation Design

5.4.1 Foundation Type

According to the as-built plans, foundation type of the existing State College Boulevard UC consists of CIDH piles. We recommend matching the foundation type of the existing UC for the proposed bridge widening.

The minimum embedment and offset (from a slope face) of the footings should be based on Section 4.4.5.1 of Caltrans BDS dated August 2004.

5.4.2 Foundation Data Provided by Structural Designers

Per Caltrans policy, LRFD Service-I Limit State load combinations and Working Stress Design (WSD) method provided in the Caltrans Bridge Design Specifications (2003a) are used for design of the abutment footing. The LRFD Service-I Limit State, Strength Limit State, and Extreme Event Limit State load combinations are used for the design of the bent footing.

The foundation design data sheet is presented in Table 5-3. Foundation loads were provided by the structural designers following the latest Caltrans Memo To Designers (Caltrans, 2008) and these loads are presented in Table 5-4.

Table 5-3. Foundation Design Data Sheet

Support No.	Design Method	Pile Type	Finished Grade Elevation (feet)	Cut-off Elevation (feet)	Pile Cap Size (feet)		Permissible Settlement under Service Load (inch)	Number of Pile per Support
					B	L		
Abut 1	WSD	16" CIDH	189.56	183 55	15.05	13.00	1	12
Bent 2	LRFD	16" CIDH	190.46	184.65	15.00	11.00	1	12
Abut 3	WSD	16" CIDH	189.69	183.55	15..05	13.00	1	12

Table 5-4. Foundation Design Loads

Support No.	Service-I Limit State (kips)			Strength Limit State (Controlling Group, kips)				Extreme Event Limit State (Controlling Group, kips)			
	Total Load		Permanent Loads	Compression		Tension		Compression		Tension	
	Per Support	Max. Per Pile	Per Support	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile
Abut 1	756 4	85	652	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bent 2	738 5	N/A	550	1045.8	87.0	N/A	N/A	622.5	131.0	N/A	65 0
Abut 3	756.4	85	652	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

5.4.3 Axial Pile Capacity

Abutments 1 and 3 and Bent 2 foundation design recommendations are presented in Table 5-5 and Table 5-6, respectively. The Pile Data Table for the contract plans is presented in Table 5-7. The abutment pile nominal resistance in Table 5-7 is controlled by the Service-I Limit State "Load per Pile" and a geotechnical factor of safety of 2.0. The bent pile nominal resistance in Table 5-7 is controlled by the Strength Limit State "Per Support, Compression" load.

A pile-group efficiency factor (GEF) of 0.65 is used for a center-to-center pile spacing of 2.5 times the pile diameter, and a GEF of 1.0 is used for a center-to-center spacing of 4.0 times the pile diameter or greater (Section 10.8.3.6.3, AASHTO, 2007). Linear interpolation can be used to determine the GEF for intermediate spacing. Based on the layout provided by the structural designers, a GEF of 0.77 was used for the abutments and bent piles.

Axial capacity of a single CIDH pile is estimated using the computer program SHAFT Version 6.0 (Ensoft, 2007). The pile capacity calculations are presented in Appendix C. The pile capacity is also based on soil resistance only and may be further limited by the pile-head connection details and the strength of the pile materials.

Table 5-5. Abutments Foundation Design Recommendations

Support	Pile	Cut-off Elevation (feet)	LRFD Service-I Limit State Load per Support (kips)		LRFD Service-I Limit State Total Load per Pile (Compression) (kips)	Nominal Resistance (kips)	Design Tip Elevations (feet)	Specified Tip Elevation (feet)
			Total	Permanent				
Abut 1	16" CIDH	183.55	756.4	652.0	85	170	+153 (a) +158 (d)	+153
Abut 3	16" CIDH	183.55	756.4	652.0	85	170	+153 (a) +158 (d)	+153

Notes:
1. Design tip elevations are controlled by the following demands: (a) Compression, (c) Settlement, and (d) Lateral Load.
2. There are no design tip elevations for Tension and Settlement at Abutments 1 and 3.
3. The specified tip elevation for Abutments 1 and 3 shall not be raised above the design tip elevation for Lateral Load.

Table 5-6. Bent Foundation Design Recommendations

Support Location	Pile Type	Cut-off Elevation (feet)	Service-I Limit State Loads per Support (kips)	Total Permissible Support Settlement (inch)	Required Factored Nominal Resistance (kips)				Design Tip Elevations (feet)	Specified tip Elevation (feet)
					Strength Limit		Extreme Event			
					Comp. (ϕ=0.7)	Tension (ϕ=0.7)	Comp. (ϕ=1.0)	Tension (ϕ=1.0)		
Bent 2	16" CIDH	184.65	738.5	1	87	N/A	131	65	+153 (a-I) +157 (a-II) +160 (b-II) +159 (d)	+153

Notes:
1. Design tip elevations are controlled by the following demands: (a-I) Compression (Strength Limit), (a-II) Compression (Extreme Event), (b-II) Tension (Extreme Event), (c) Settlement, and (d) Lateral Load.
2. There is no design tip elevation for Settlement at Bent 2.
3. The Specified tip elevation for Bent 2 shall not be raised above the design tip elevations for Tension and Lateral Load.

Table 5-7. Pile Data Table

Location	Pile Type	Nominal Resistance (kips)		Design Tip Elevations (feet)	Specified Tip Elevation (feet)
		Compression	Tension		
Abut 1	16" CIDH	170	0	+153 (a) +158 (d)	+153
Bent 2	16" CIDH	180	80	+153 (a) +160 (b) +159 (d)	+153
Abut 3	16" CIDH	170	0	+153 (a) +158 (d)	+153

Notes:
1. Design tip elevations are controlled by the following demands: (a) Compression, (b) Tension, (c) Settlement, and (d) Lateral Load.
2. There is no design tip elevation for Tension at Abutments 1 and 3.
3. There is no design tip elevation for Settlement at Abutments 1 and 3 and Bent 2.
4. The specified tip elevations shall not be raised above the design tip elevation for Tension and Lateral Load.

5.4.4 Lateral Pile Capacity

5.4.4.1 Lateral Pile Solutions

Lateral pile capacity analyses were performed using the computer program LPILE (Ensoft, 2010). Results of lateral pile analysis in terms of pile-head shear and lateral deflection for a free-head condition are presented for abutments and bents in Table 5-8 and Table 5-9, respectively. The maximum bending moment and the location of maximum moment are also presented.

Based on the layout provided by the structural designers and the procedures outlined in the Ensoft Group 7.0 software Technical Manual (Ensoft, 2006), group reduction factors (P-Multipliers in the LPILE input) of 0.6 and 0.62 are incorporated in the analyses for the abutment and bent piles, respectively.

The solutions presented in Table 5-8 and Table 5-9 are entirely based on soil resistance and linear pile properties. Therefore, these values may be limited by the flexural strength (plastic moment) of the piles and pile-head connection details. Linear interpolation can be used for solutions between pile-head deflections of 0.25 and 5 inches.

Table 5-8. Lateral Pile Solutions for Abutments 1 & 3

Support Location	Pile Head Deflection (in)	Pile Head Shear (k)	Maximum Moment (k-in)	Depth to Max. Moment from Pile Top (feet)
Abutments 1 & 3 (16-in CIDH)	¼	16.0	367	3.8
	½	27.5	709	4.1
	1	42.0	1,300	4.3
	3	70.3	2,989	5.4
	5	86.8	4,252	6.2

Table 5-9. Lateral Pile Solutions for Bent 2

Support Location	Pile Head Deflection (in)	Pile Head Shear (k)	Maximum Moment (k-in)	Depth to Max. Moment from Pile Top (feet)
Bent 2 (16-in CIDH)	¼	16.0	353	3.9
	½	27.1	684	4.2
	1	41.4	1,272	4.5
	3	70.2	2,993	5.6
	5	86.8	4,276	6.2

5.4.4.2 Lateral Load Resistance of Bent Pile Footing

Passive earth pressure at the bent pile cap can be used to resist a portion of the lateral loads transferred to the soil. For static design, the passive soil resistance against the embedded face of the bent pile cap should be neglected. Under earthquake loading, this ultimate passive soil resistance should be added to the pile group capacity to determine the total lateral resistance of the pile footing. At the bent location, the ultimate passive soil resistance against the pile footing is estimated to be equal to a maximum equivalent fluid pressure of 360 psf per foot of depth. Note that development of full passive earth pressure requires a lateral pile cap displacement equal to approximately 2 percent of the embedded height (measured from the nearest and lowest ground surface to the bottom of the pile cap). For displacement magnitudes smaller than what is required to mobilize full resistance, the actual resistance magnitude should be determined by linearly interpolating between zero and the full resistance.

5.5 Embankments Settlement and Slope Stability

5.5.1 Settlement and Settlement Period

Embankment fill will need to be placed to construct the approaches to the bridge widening. Up to 22 feet of embankment fill, approximately 15 feet wide at the crest with 2H:1V side slopes, will be placed to construct the approaches to Abutments 1 and 3. The resulting ground subsidence at Abutments 1 and 3 is estimated to be about 1 inch. Since the onsite soils are primarily coarse-

grained materials, soil settlement should occur relatively quickly, and a settlement period for pile construction is not required.

5.5.2 Slope Stability

Global stability analyses were conducted for both static and pseudo-static conditions for the bridge approach embankment slopes. The analysis was performed using the computer program SLIDE 5.0 (Rocscience, 2006). The soil strength parameters in Table 4-1 were used in the static and pseudo-static analysis and the results are presented in Appendix C.

The calculated factor of safety is greater than the minimum required 1.5 under static condition with a 2-foot soil surcharge to represent traffic loading. Slope stability analysis under pseudo-static condition was performed using a seismic coefficient equal to 0.173g (which is the smaller of either one-third the horizontal peak ground acceleration or 0.2g) in accordance with guidelines provided in Section 3.10 of the Caltrans Guidelines for Structures Foundation Reports (Caltrans, 2009c). Analysis indicates that the calculated factor of safety is greater than the required minimum of 1.1 under pseudo-static condition.

For embankment slopes with a gradient of 2H:1V or flatter, surficial stability should not be a design concern. If slope paving is proposed for embankment slopes with a gradient of 1.5H:1V, then surficial stability is also not a design concern. If slope paving is not used for the 1.5H:1V slopes, it is recommended that the upper 4 feet of any new 1.5H:1V slope face be covered with materials with a minimum internal friction angle of 32 degrees and a minimum cohesion of 230 psf. This select material should be properly keyed and benched into the sloping ground. In all cases, proper maintenance with erosion protection and drainage control in accordance with Section 21 of Caltrans Standard Specifications (Caltrans, 2010b) are also recommended.

5.5.3 Structure Approach Slabs

Selection of the approach type (if required) will be performed by the structural designer following the flowchart in Caltrans Memo to Designers 5-3, Attachment A, dated May 1996 (Caltrans, 1996).

5.6 Bridge Abutment Wall Design

5.6.1 Abutment Earth Pressures

If abutment walls are free to move laterally at the top, a static active lateral earth pressure of 36 psf per foot of depth is recommended for a free draining, level and compacted backfill. If lateral movement at the top of abutment walls is restrained, the lateral earth pressure for a free draining, level and compacted backfill should follow Section 5.5.5.11 of the Caltrans BDS dated August 2004. For this condition, we recommend a coefficient of active lateral earth pressure of 0.3, a coefficient of at-rest lateral earth pressure of 0.46 and a soil unit weight of 120 lb/ft^3. If applicable, a uniform lateral pressure of at least 72 psf due to vehicle loads, equivalent to a vertical pressure produced by at least 2 feet of earth, should be added to the above lateral earth pressure.

5.6.2 Passive Resistance of Abutment Backfill

Under seismic loading, an ultimate passive earth pressure of 5 ksf may be used for the approach backfill and abutment walls with a height equal to or greater than 5.5 feet. For abutment walls with heights less than 5.5 feet, the passive pressure may be calculated proportionally (e.g., for a 4-foot high wall, the passive pressure is [4/5.5]x 5 ksf = 3.64 ksf. The horizontal movement at which the maximum passive pressure is expected to be fully mobilized can be determined following the procedure outlined in Section 7.8.1 of the Caltrans SDC (2009d).

6.0 CONSTRUCTION RECOMMENDATIONS

6.1 Earthwork

Earthwork should be performed in accordance with Caltrans Standard Specifications, Section 19 (Caltrans, 2010b). Appropriate measures should be taken to prevent damage to adjacent structures and utilities. Any design and construction of temporary sloping, sheeting, or shoring should be made the contractor's responsibility. It should be noted that it is the responsibility of the contractor to oversee the safety of the workers in the field during construction. The contractor shall conform to all applicable occupational and health standards, rules, regulations, and orders established by the State of California. In addition, other State, County, or Municipal regulations may supersede the recommendations presented in this section. If a trench shoring design and safety plan is required, the geotechnical consultant should review the plan to confirm that recommendations presented in this report have been applied to the design.

Groundwater was not encountered in any of the as-built or current borings down to elevation +109.7 feet. Therefore, groundwater is not anticipated to be encountered during pile and footing construction at the abutments and bent. However, groundwater level can fluctuate due to seasonal rainfall amount, local irrigation and groundwater recharge program, and other man-made conditions. If groundwater is encountered during footing construction, it should be controlled in accordance with Section 19-3.03D of the Caltrans Standard Specifications (2010b).

6.2 Pile Construction

Construction of CIDH piles should follow Section 49-4.03B, "Drilled Holes" of the Caltrans Standard Specifications (2010b). The Contractor should be required to drill the bottom of the shaft boring with a clean-out bucket to ensure adequate removal of loose soils. Both clean-out and concrete placement should be addressed in the specifications. The shaft borings should be inspected and approved by the Resident Engineer prior to installation of reinforcement. Per latest Caltrans requirement, 3-inch of concrete cover over reinforcement should be provided to improve the construction of the CIDH piles.

The onsite fill and alluvial soils generally range from loose to very dense coarse grained materials, and these materials are susceptible to caving. If caving occurs, a temporary casing can be used. The casing should have an inside diameter larger than or equal to the pile diameter and should be placed tight in the hole. Vibratory hammers or oversized drilling are not allowed for casing installation. In the event that any boring becomes bell-shaped and cannot be advanced due to severe caving, all loose material should be removed from the bottom of the boring and the caved region filled with a low strength sand-cement slurry. Drilling may continue when the slurry has reached its initial set.

6.3 Backdrain and Backfill Requirements For Abutment Walls

Expansive soils should not be placed as part of the embankment within the limits of a bridge abutment as shown in Figure 6-1. Materials placed behind abutment walls should be low-expansive soil with an Expansion Index (EI) less than 50 and Sand Equivalent (SE) of more than 20. The low-expansive material requirement should be supplemental to the abutment structure and pervious backfill requirement as described in Caltrans Standard Plans (2010a) and Caltrans Standard Specifications (2010b) under Sections 19-3.03E and 19-3.03G, respectively.

Backfill should be compacted in accordance with Section 19-5 of the Caltrans Standard Specifications (2010b). Backfill should be placed in loose lifts not exceeding 8 inches in thickness, moisture-conditioned to near optimum moisture content, and compacted to at least 95 percent relative compaction. The relative compaction should be based on the maximum density determined by California Test Method 216. Jetting or flooding to compact backfill is not recommended. Heavy compaction equipment, such as vibratory rollers, dozers, or loaders, should not be used adjacent to the abutment walls in order to avoid damaging the walls due to large lateral earth pressures.

Backdrains should be installed behind abutment walls to relieve hydrostatic pressure. Backdrains should be constructed in accordance with Bridge Detail 3-1 on Sheet B0-3 per Caltrans Standard Plans (2010a) or the geocomposite drain alternative per Section 6 of the Caltrans Bridge Design Details (1992).

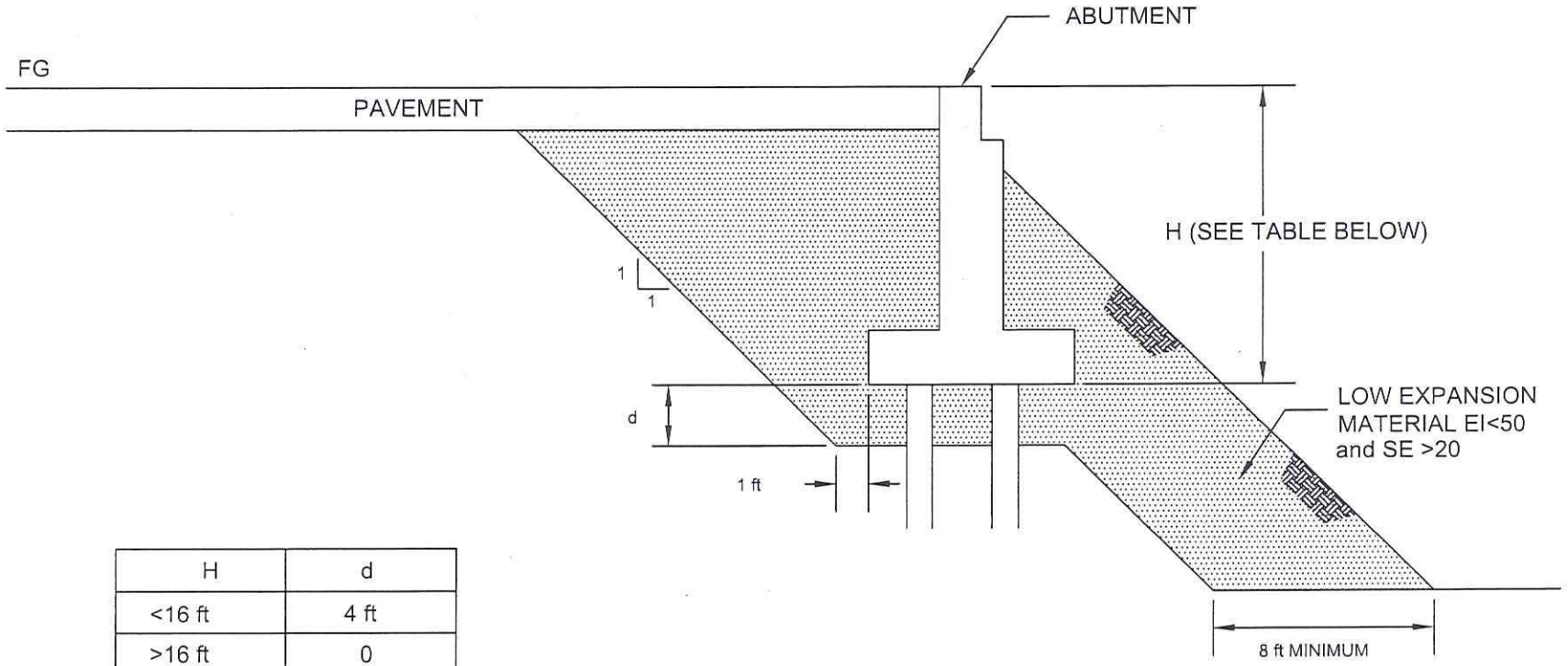
6.4 Review of Construction Plans

Recommendations contained in this report are based on preliminary plans. The geotechnical consultant should review the final construction plans and specifications in order to confirm that the general intent of the recommendations contained in this report have been incorporated into the final construction documents. Recommendations contained in this report may require modification or additional recommendations may be necessary based on the final design.

6.5 Geotechnical Observation and Testing

It is recommended that inspections and testing be performed by the geotechnical consultant during the following stages of construction:

- Grading operations, including excavations and placement of compacted fill
- Shoring installation
- Footing excavations and pile constructions
- Backdrain installation and backfilling of bridge abutment walls
- Removal or installation of support of buried utilities or structures
- When any unusual subsurface conditions are encountered



H	d
<16 ft	4 ft
>16 ft	0

EXPANSION INDEX TO BE DETERMINED BY ASTM D4829
SAND EQUIVALENT TO BE DETERMINED BY CALIFORNIA TEST METHOD 217

NO SCALE

Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

State College Boulevard UC (Widen)

Project No. 10-126 | Date: 03-10-11

Low Expansion Material
In Bridge Embankment

Figure 6-1

7.0 LIMITATIONS

This report is intended for the use of RBF, OCTA, and Caltrans for widening of State College Boulevard UC. This report is based on the project as described and the information obtained from the exploratory borings and CPT sounding at the approximate locations indicated on the attached plans. The findings and recommendations contained in this report are based on the results of the field investigation, laboratory tests, and engineering analyses. In addition, soils and subsurface conditions encountered in the exploratory borings and CPT sounding are presumed to be representative of the project site. However, subsurface conditions and characteristics of soils between exploratory borings and CPT sounding can vary. The findings reflect an interpretation of the direct evidence obtained. The recommendations presented in this report are based on the assumption that an appropriate level of quality control and quality assurance (inspections and tests) will be provided during construction. EMI should be notified of any pertinent changes in the project plans or if subsurface conditions are found to vary from those described herein. Such changes or variations may require a re-evaluation of the recommendations contained in this report.

The data, opinions, and recommendations contained in this report are applicable to the specific design element(s) and location(s) which is (are) the subject of this report. They have no applicability to any other design elements or to any other locations and any and all subsequent users accept any and all liability resulting from any use or reuse of the data, opinions, and recommendations without the prior written consent of EMI.

EMI has no responsibility for construction means, methods, techniques, sequences, or procedures; for safety precautions or programs in connection with the construction; for the acts or omissions of the CONTRACTOR or any other person performing any of the construction; or for the failure of any worker to carry out the construction in accordance with the Final Construction Drawings and Specifications.

Services performed by EMI have been conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, expressed or implied, and no warranty or guarantee is included or intended.

8.0 REFERENCES

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Appendix A

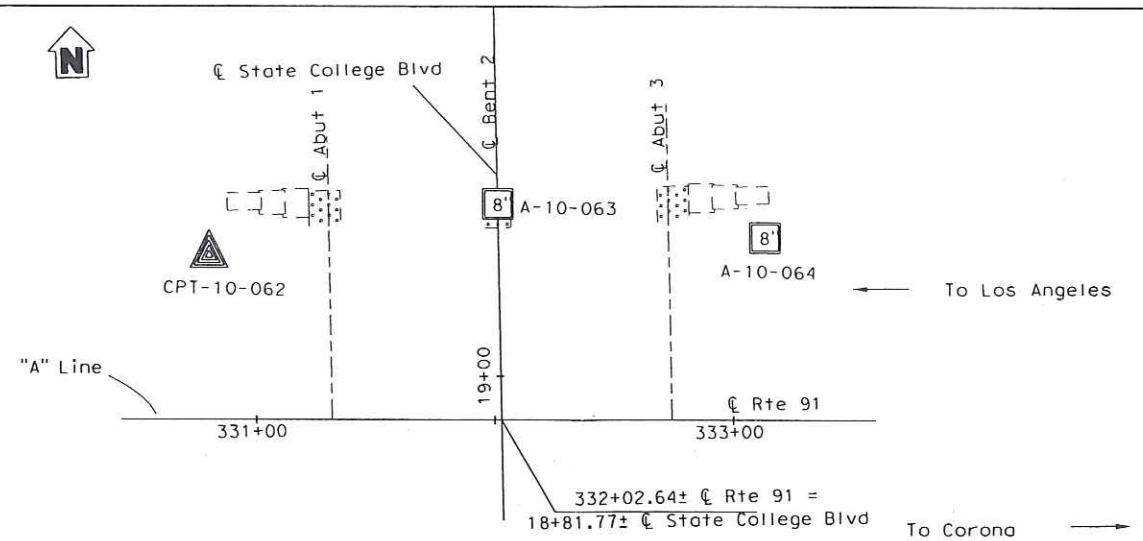
LOG OF TEST BORINGS SHEETS

BENCH MARK

Designation: 1G-164-05 Elev = 109.804
Described by OCS 2005 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "1G-164-05", set in the Nothwesterly Corner of a 4.5 ft. by 11.0 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Magnolia Avenue and Buckingham Street, 200 ft. ± from the centerline of Buckingham and 47 ft. Easterly of the centerline of Magnolia. Monument is set level with the Sidewalk

Designation: 2F-25-04 Elev = 162.700
Described by OCS 2004 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2F-25-04", set in the Nothwesterly Corner of a 7.5 ft. by 4.5 ft. Concrete Catch Basin. Monument is located in the Northeasterly Corner of the intersection of Harbor Boulevard and the Eastbound 91 Freeway On-Ramp, 39 ft. Northerly of the centerline of the On-Ramp and 40 ft. Easterly of the centerline of Harbor Boulevard. Monument is set level with the Sidewalk

Designation: 2D-35-86 Elev = 188.576
Described by OCS 2003 - Found 3¾" OCS Aluminum Benchmark Disk Stamped "2D-35-86", set in the Nothwesterly Corner of a 7 ft. by 14 ft. Concrete Catch Basin. Monument is located in the Southeasterly Corner of the intersection of Placentia Avenue and State College Boulevard, 38 ft. Easterly of the centerline of State College and 70.5 ft. Southerly of the centerline of Placentia. Monument is set level with the Sidewalk



DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER — DATE 09/16/11

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

NOTES:

(1) This LOTB sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification and Presentation Manual (June 2010).

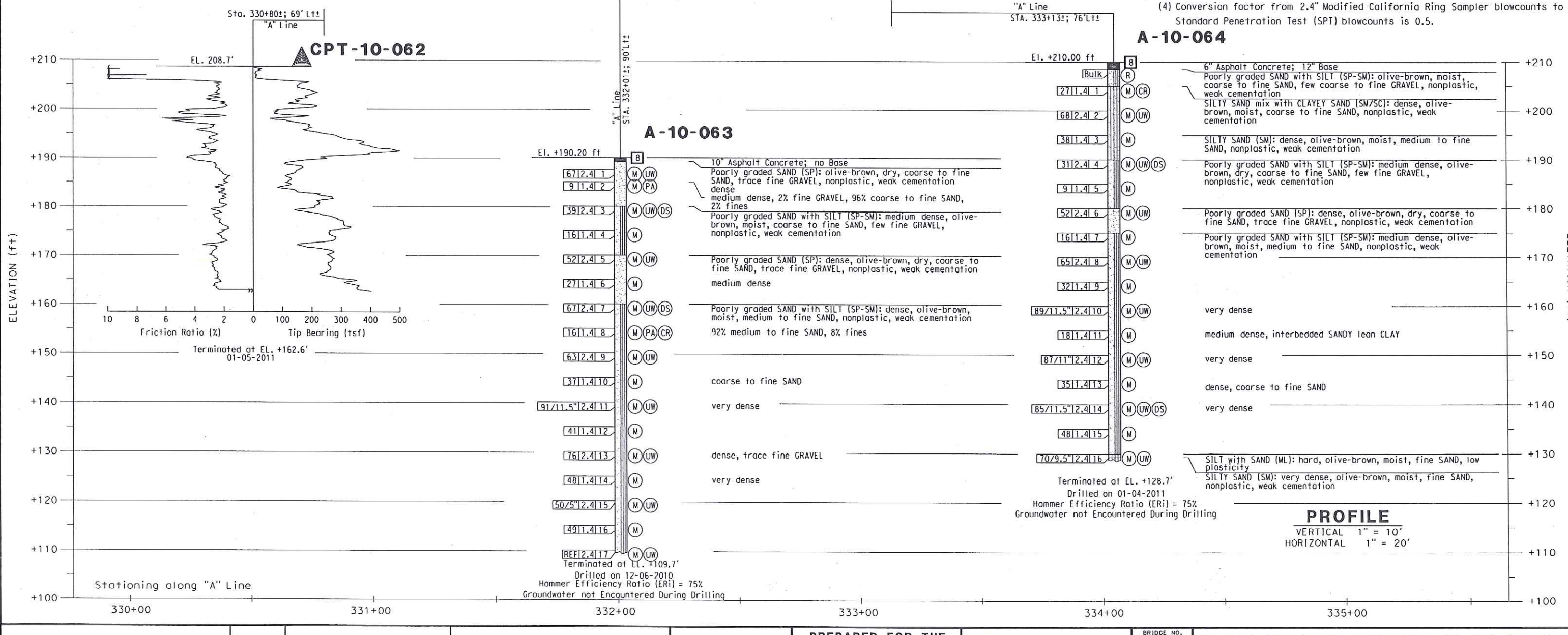
(2) 2.4" samples were taken using a California Modified Sampler.

(3) An automatic trip hammer system consisting of a hammer weight of 140 lbs falling a distance of 30" was used to advance the drive sampler.

(4) Conversion factor from 2.4" Modified California Ring Sampler blowcounts to Standard Penetration Test (SPT) blowcounts is 0.5.

PLAN

1" = 40'



PROFILE
VERTICAL 1" = 10'
HORIZONTAL 1" = 20'

TIME PLOTTED => $TIME
DATE PLOTTED => $DATE
USERNAME => $USER

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj	BRIDGE NO. 55-0852	STATE COLLEGE BOULEVARD UC (WIDEN)
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011		PROJECT ENGINEER	POST MILES 5.3	LOG OF TEST BORINGS 1 OF 5

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER — DATE 09/16/11

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

CEMENTATION

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

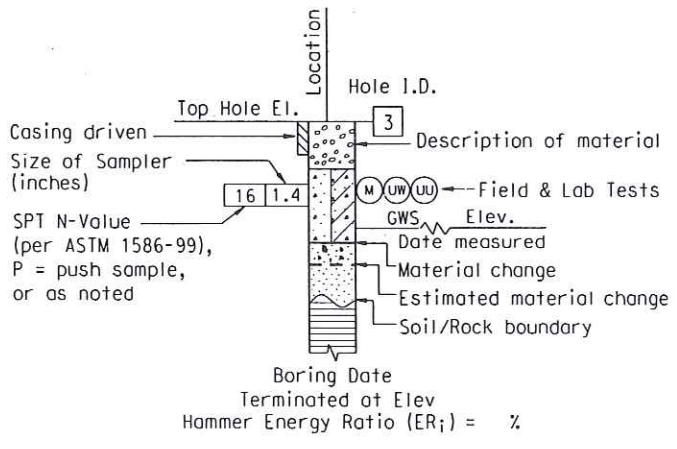
BOREHOLE IDENTIFICATION

Symbol	Hole Type	Description
Size	A	Auger Boring (hollow or solid stem bucket)
Size	R RW RC P	Rotary drilled boring (conventional) Rotary drilled with self-casing wire-line Rotary core with continuously-sampled, self-casing wire-line Rotary percussion boring (air)
Size	R	Rotary drilled diamond core
Size	HD HA	Hand driven (1-inch soil tube) Hand Auger
●	D	Dynamic Cone Penetration Boring
▲	CPT	Cone Penetration Test (ASTM D 5778)
[ ]	O	Other (note on LOTB)

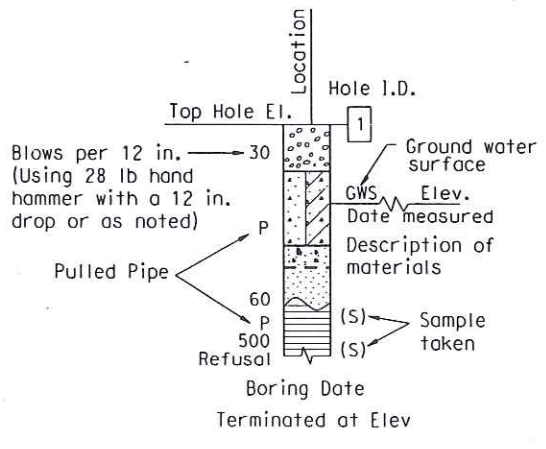
Note: Size in inches.

CONSISTENCY OF COHESIVE SOILS

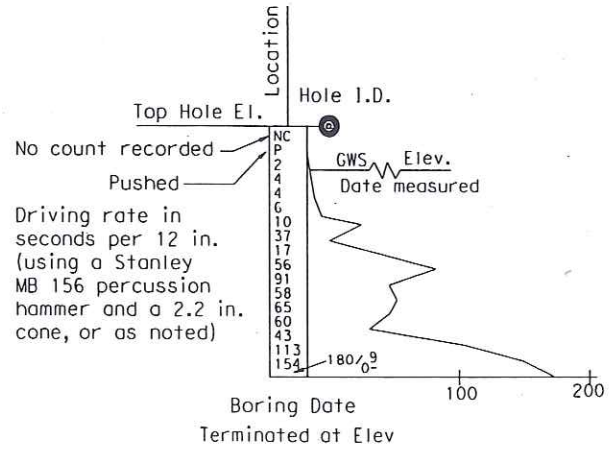
Description	Shear Strength (tsf)	Pocket Penetrometer Measurement, PP, (tsf)	Torvane Measurement, TV, (tsf)	Vane Shear Measurement, VS, (tsf)
Very Soft	Less than 0.12	Less than 0.25	Less than 0.12	Less than 0.12
Soft	0.12 - 0.25	0.25 - 0.5	0.12 - 0.25	0.12 - 0.25
Medium Stiff	0.25 - 0.5	0.5 - 1	0.25 - 0.5	0.25 - 0.5
Stiff	0.5 - 1	1 - 2	0.5 - 1	0.5 - 1
Very Stiff	1 - 2	2 - 4	1 - 2	1 - 2
Hard	Greater than 2	Greater than 4	Greater than 2	Greater than 2



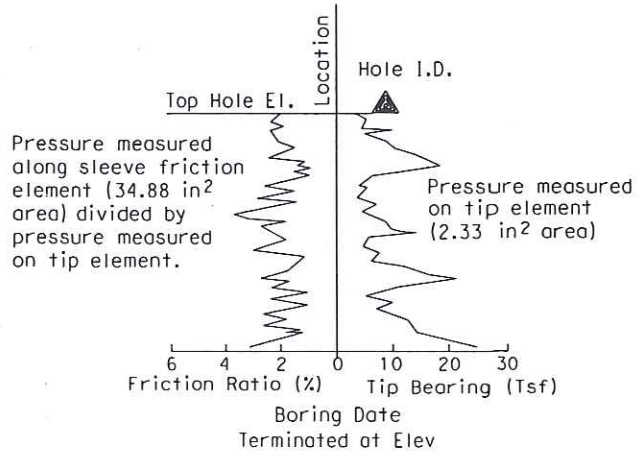
ROTARY BORING



HAND BORING



DYNAMIC CONE PENETRATION BORING



CONE PENETRATION TEST (CPT) BORING

DESIGN OVERSIGHT	DRAWN BY	J. Fang	R. Jie		PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. Pirathiviraj PROJECT ENGINEER	BRIDGE NO. 55-0852	STATE COLLEGE BOULEVARD UC (WIDEN)
SIGN OFF DATE	CHECKED BY	G. J. Gunaranjan	FIELD INVESTIGATION BY: DATE: 12/2010,1/2011				POST MILES 5.3	LOG OF TEST BORINGS 2 OF 5

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES →

REVISION DATES | SHEET | OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

GROUP SYMBOLS AND NAMES

Graphic/Symbol	Group Names	Graphic/Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND	CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
GP	Poorly-graded GRAVEL Poorly-graded GRAVEL with SAND		
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND	CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GP-GM	Poorly-graded GRAVEL with SILT Poorly-graded GRAVEL with SILT and SAND	ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
GP-GC	Poorly-graded GRAVEL with CLAY (or SILTY CLAY) Poorly-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GM	SILTY GRAVEL SILTY GRAVEL with SAND	OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND		
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND	OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL		
SP	Poorly-graded SAND Poorly-graded SAND with GRAVEL	CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL		
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
SP-SM	Poorly-graded SAND with SILT Poorly-graded SAND with SILT and GRAVEL		
SP-SC	Poorly-graded SAND with CLAY (or SILTY CLAY) Poorly-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
SM	SILTY SAND SILTY SAND with GRAVEL		
SC	CLAYEY SAND CLAYEY SAND with GRAVEL	OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY ORGANIC elastic SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL		
PT	PEAT	OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND
	COBBLES COBBLES and BOULDERS BOULDERS		

FIELD AND LABORATORY TESTING

- (C) Consolidation (ASTM D 2435)
- (CL) Collapse Potential (ASTM D 5333)
- (CP) Compaction Curve (CTM 216)
- (CR) Corrosivity Testing (CTM 643, CTM 422, CTM 417)
- (CU) Consolidated Undrained Triaxial (ASTM D 4767)
- (DS) Direct Shear (ASTM D 3080)
- (EI) Expansion Index (ASTM D 4829)
- (M) Moisture Content (ASTM D 2216)
- (OC) Organic Content-% (ASTM D 2974)
- (P) Permeability (CTM 220)
- (PA) Particle Size Analysis (ASTM D 422)
- (PI) Plasticity Index (AASHTO T 90) Liquid Limit (AASHTO T 89)
- (PL) Point Load Index (ASTM D 5731)
- (PM) Pressure Meter
- (R) R-Value (CTM 301)
- (SE) Sand Equivalent (CTM 217)
- (SG) Specific Gravity (AASHTO T 100)
- (SL) Shrinkage Limit (ASTM D 427)
- (SW) Swell Potential (ASTM D 4546)
- (UC) Unconfined Compression-Soil (ASTM D 2166) Unconfined Compression-Rock (ASTM D 2938)
- (UU) Unconsolidated Undrained Triaxial (ASTM D 2850)
- (UW) Unit Weight (ASTM D 4767)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
12	ORA	91	0.9/5.4		

REGISTERED ENGINEER — 09/16/11 DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

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ORANGE COUNTY TRANSPORTATION AUTHORITY
550 S. MAIN STREET
ORANGE, CA 92863-1584

EARTH MECHANICS, INC.
17800 NEWHOPE STREET, SUITE B
FOUNTAIN VALLEY, CA 92708

APPARENT DENSITY OF COHESIONLESS SOILS

Description	SPT N_{60} (Blows / 12 in.)
Very Loose	0 - 5
Loose	5 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Greater than 50

MOISTURE

Description	Criteria
Dry	No discernable moisture
Moist	Moisture present, but no free water
Wet	Visible free water

PERCENT OR PROPORTION OF SOILS

Description	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5% - 10%
Little	15% - 25%
Some	30% - 45%
Mostly	50% - 100%

PARTICLE SIZE

Description		Size (in.)
Boulder		Greater than 12
Cobble		3 - 12
Gravel	Coarse	3/4 - 3
	Fine	1/5 - 3/4
Sand	Coarse	1/16 - 1/5
	Medium	1/64 - 1/16
	Fine	1/300 - 1/64
Silt and Clay		Less than 1/300

DESIGN OVERSIGHT — SIGN OFF DATE

DRAWN BY: J. Fong — CHECKED BY: G. J. Gunaranjan

R. Jie — FIELD INVESTIGATION BY:

DATE: 12/2010,1/2011

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

S. Pirathiviraj — PROJECT ENGINEER

BRIDGE NO. 55-0852 — POST MILES 5.3

STATE COLLEGE BOULEVARD UC (WIDEN)

LOG OF TEST BORINGS 3 OF 5

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

SHEET OF

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

8-26-96
TO ACCOMPANY PLANS DATED

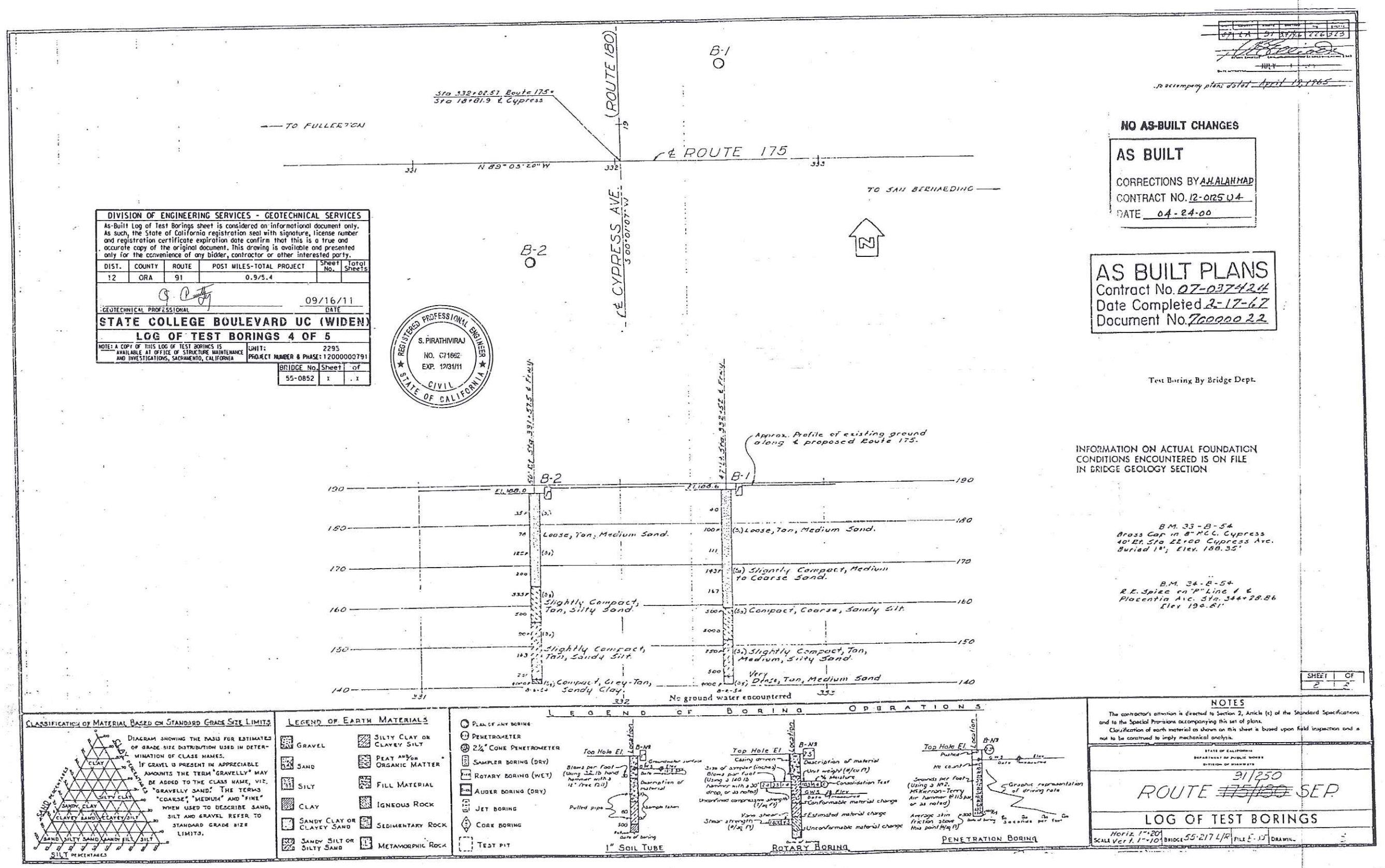
DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
12	Ora	57, 91	15.6/16.6, 5.0/6.7	677	852

To accompany plans dated April 19, 1965

NO AS-BUILT CHANGES

AS BUILT
CORRECTIONS BY A.H. ALAHMAD
CONTRACT NO. 12-0125U4
DATE 04-24-00

AS BUILT PLANS
Contract No. 07-037424
Date Completed 2-17-67
Document No. 7000022



INFORMATION ON ACTUAL FOUNDATION CONDITIONS ENCOUNTERED IS ON FILE IN BRIDGE GEOLOGY SECTION

B.M. 33-B-54
Brass Cap in 8" N.C.L. Cypress
40' Rt. Sta. 22+00 Cypress Ave.
Buried 1'; Elev. 188.35'

B.M. 34-B-54
R.E. Spike in "P" Line ℄ Placentia Ave. Sta. 344+28.86
Elev. 190.81'

DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES

As-Built Log of Test Borings sheet is considered an informational document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date confirm that this is a true and accurate copy of the original document. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.

DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
12	ORA	91	0.9/5.4		

GEOTECHNICAL PROFESSIONAL — DATE 09/16/11

STATE COLLEGE BOULEVARD UC (WIDEN)

LOG OF TEST BORINGS 4 OF 5

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

UNIT: 2295
PROJECT NUMBER & PHASE: 12000000791

BRIDGE No.	Sheet	of
55-0852	1	1

REGISTERED PROFESSIONAL ENGINEER
S. PIRATHIVIRAJ
NO. C71662
EXP. 12/31/11
CIVIL
STATE OF CALIFORNIA

CLASSIFICATION OF MATERIAL BASED ON STANDARD GRADE SIZE LIMITS

Diagram showing the basis for estimates of grade size distribution used in determination of class names. If gravel is present in appreciable amounts the term "gravelly" may be added to the class name, viz. "gravelly sand". The terms "coarse", "medium" and "fine" when used to describe sand, silt and gravel refer to standard grade size limits.

LEGEND OF EARTH MATERIALS

- Gravel
- Sand
- Silt
- Clay
- Sandy Clay or Clayey Sand
- Sandy Silt or Silty Sand
- Silty Clay or Clayey Silt
- Peat and/or Organic Matter
- Fill Material
- Igneous Rock
- Sedimentary Rock
- Metamorphic Rock

LEGEND OF BORING OPERATIONS

- Plan of any boring
- Penetrometer
- 2½" Cone Penetrometer
- Sampler boring (dry)
- Rotary boring (wet)
- Auger boring (dry)
- Jet boring
- Core boring
- Test pit

NOTES

The contractor's attention is directed to Section 2, Article (c) of the Standard Specifications and to the Special Provisions accompanying this set of plans.
Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

31/250
ROUTE ~~57/30~~ SEP

LOG OF TEST BORINGS

Horiz. 1"=20'
Scale Vert. 1"=10'
BRIDGE 55-217 L/R
FILE E-15
DRAWN

Test Boring By Bridge Dept.

SHEET	OF
2	2

DESIGN	BY V.Lee / D.Kuang	CHECKED F.Agha Mohammadi	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	Daniel J. Novak PROJECT ENGINEER	BRIDGE No. 55-0852
DETAILS	BY V.Ramirez	CHECKED F.Agha Mohammadi			POST MILE 5.3
QUANTITIES	BY G.Takara	CHECKED J.Fujita		CU 12209	

Be Nguyen
DESIGN OVERSIGHT
3-14-96
SIGNOFF DATE

NOTE:
ADDITIONAL AS-BUILT FOUNDATION DATA MAY BE AVAILABLE AT THE OFFICE OF TRANSPORTATION MATERIALS AND RESEARCH 5900 FOLSOM BOULEVARD, SACRAMENTO, CALIFORNIA 95819

ORIGINAL SCALE IN INCHES

STATE COLLEGE BLVD UC (REPLACE)
AS-BUILT LOG OF TEST BORINGS

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) 5/30/95 2/29/96

SHEET	OF
24	24

Generated by MicroStation

DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES					
As-Built Log of Test Borings sheet is considered an informational document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date confirm that this is a true and accurate copy of the original document. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.					
DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
12	ORA	91	0.9/5.4		
GEOTECHNICAL PROFESSIONAL				DATE	
				09/16/11	
STATE COLLEGE BOULEVARD UC (WIDEN)					
LOG OF TEST BORINGS 5 OF 5					
NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA			UNIT: 2295		
			PROJECT NUMBER & PHASE: 12000000791		
BRIDGE No.			Sheet	of	
55-0852			1	1	

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
12	Ora	57, 91	15.6/16.6, 5.0/6.7	676	852

REGISTERED PROFESSIONAL ENGINEER

8-26-96
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — LING CHEAH — No. C 41401 — Exp. 9-30-99 — CIVIL — STATE OF CALIFORNIA

EARTH MECHANICS, INC.
Geotechnical & Earthquake Engineering
17660 NEWHOPE STREET, SUITE E ● FOUNTAIN VALLEY, CA. 92708
Phone (714) 751-3826

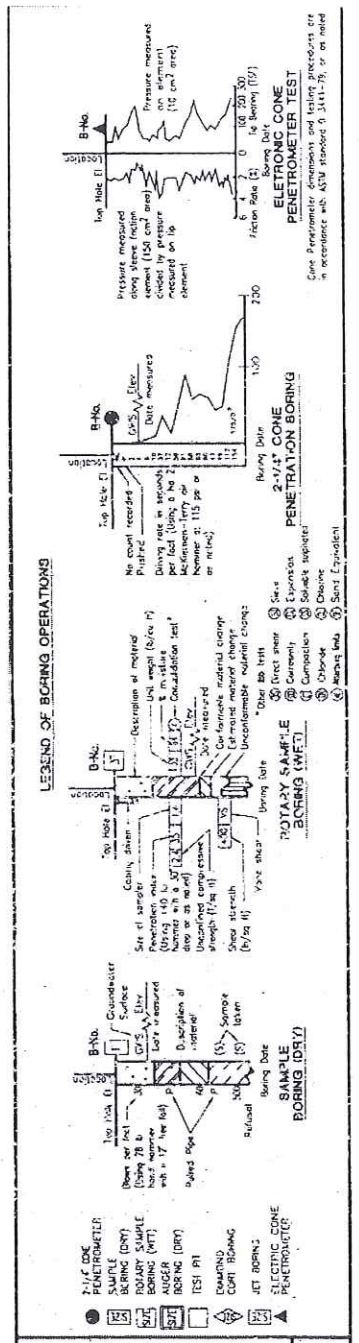
THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

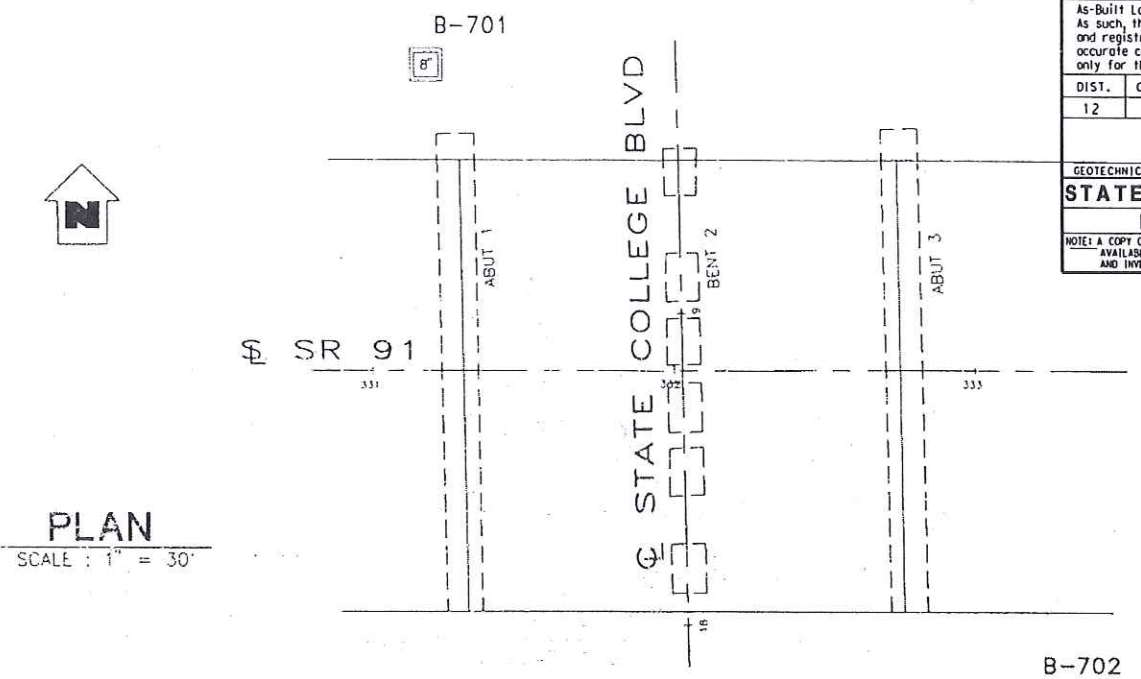
NO AS-BUILT CHANGES

AS BUILT
CORRECTIONS BY A.M.ALAHMAD
CONTRACT NO. 12-0251U4
DATE 04-24-00

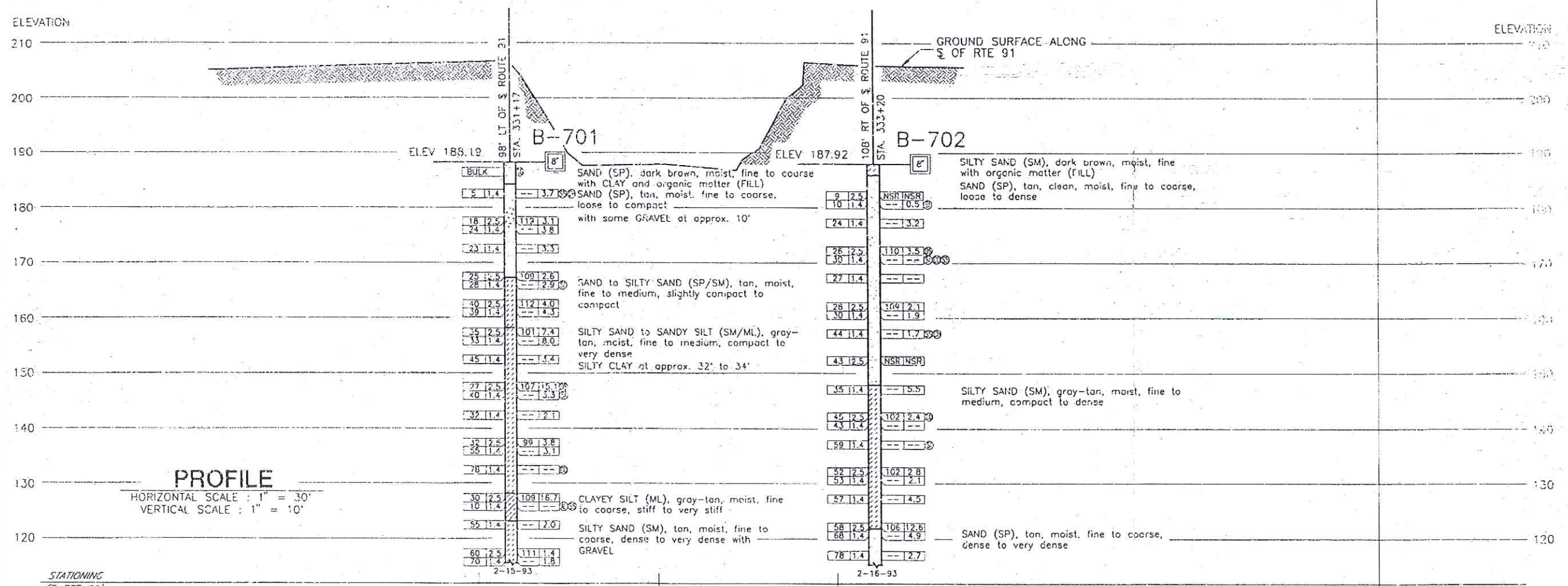
REGISTERED PROFESSIONAL ENGINEER — S. PIRATHIVIRAJ — NO. C71662 — EXP. 12/31/11 — CIVIL — STATE OF CALIFORNIA

NOTES:
1. NO GROUNDWATER ENCOUNTERED.
2. ELEVATIONS BASED ON SURVEY BY COAST SURVEYING, INC.
3. BORINGS LOGGED BY ENRIQUE RIUTORT, STAFF ENGINEER.
4. BENCHMARK - 57/91-B-88(PM 15.9) -3.5 IN. DIA. CADT STA. MARK DISK SET IN EPOXY ON TOP OF PCC SIDEWALK ON THE NE'LY CORNER OF THE MIRALOMA AVE. BRIDGE OVER RTE-57 FWY, ABOUT 150 FT. E'LY OF ℄ OF RTE-57, 36 FT N'LY OF ℄ OF MIRALOMA. ELEV 229.40
5. NSR INDICATES NO SAMPLE RECOVERY





PLAN
SCALE : 1" = 30'



PROFILE
HORIZONTAL SCALE : 1" = 30'
VERTICAL SCALE : 1" = 10'

JOB No. 192-077 PLATE I

BE NGUYEN	DRAWN BY	JOE MAGLIATO	E.A. RIUTORT	M&T AGRA	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DANIEL J. NOVAK	BRIDGE NO. 55-0852
DESIGN OVERSIGHT	CHECK BY	E.A. RIUTORT	FIELD INVESTIGATOR	Geotechnical and Environmental Services		PROJECT ENGINEER	POST MILE 5.3
SIGN OFF DATE 3.14.96			DATE 2-16-93			CU 12209 EA 0125U1	STATE COLLEGE BLVD UC (REPLACE) LOG OF TEST BORINGS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) 8-21-96 9-23-96

SHEET 23 OF 24

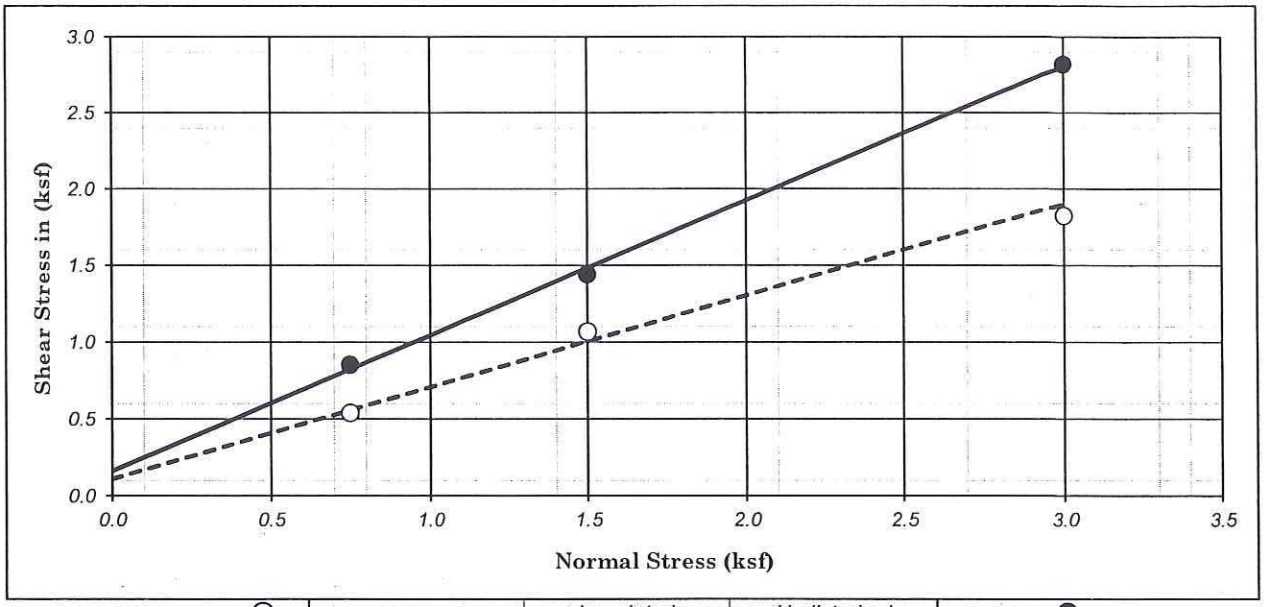
Appendix B

LABORATORY TEST RESULTS

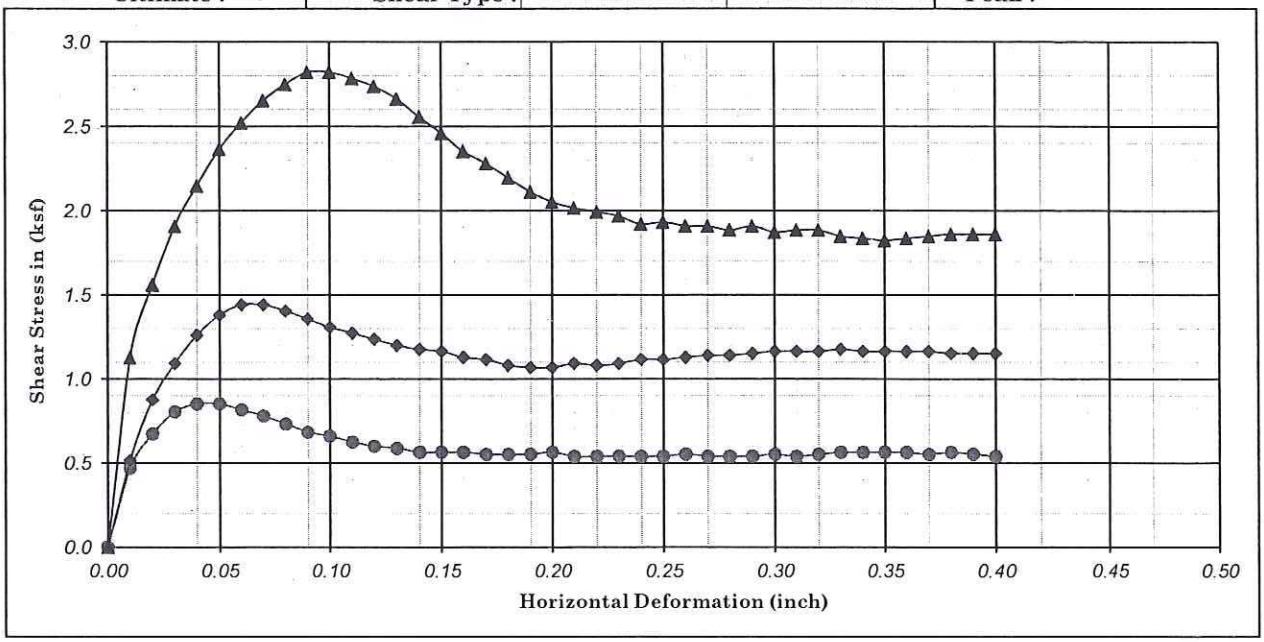
TABLE 1 SUMMARY OF LABORATORY TEST RESULTS FOR STATE COLLEGE BLVD. UC

Project No. : *10-126* Project Name : RBF / SR-91 WB Widening

Boring No.	Sample No.	Sample Depth (ft)	Soil Identification (group symbol) ASTM D2488/D2487	Moisture Content ASTM D2216 (%)	Total Unit Weight ASTM D2937 (pcf)	Pocket Penetrometer (tsf)	Torvane Shear (tsf)	Grain Size Distribution GR:SA:FI (%)	Sand Equivalent (CT-217)	Atterberg Limits ASTM D4318 (LL/PL/PI)	Soil-Minimum Resisivity CT-532 (ohm-cm)	Soil- pH CT-532	Soil-Soluble Sulfate Content CT-417 (ppm)	Soil-Moisture Free Chloride Content CT-422 (ppm)
A-10-063	*D-1*	2.5	SP-SM	2.6	114.9									
A-10-063	*S-2*	5	SP	1.7				2:96:2						
A-10-063	*D-3*	10	SP-SM	1.8	113.3									
A-10-063	*S-4*	15	SP-SM	2.6										
A-10-063	*D-5*	20	SP	3.4	108.1									
A-10-063	*S-6*	25	SP-SM	2.8										
A-10-063	*D-7*	30	SP-SM	4.8	112.4									
A-10-063	*S-8*	35	SP-SM	5.2				0:92:8			13000	7.8	10	158
A-10-063	*D-9*	40	SP-SM	2.6	109.4									
A-10-063	*S-10*	45	SP-SM	2.0										
A-10-063	*D-11*	50	SP-SM	2.7	117.4									
A-10-063	*S-12*	55	SP-SM	3.2										
A-10-063	*D-13*	60	SP-SM	1.8	115.7									
A-10-063	*S-14*	65	SP-SM	2.9										
A-10-063	*D-15*	70	SP-SM	3.1	103.7									
A-10-063	*S-16*	75	SP-SM	4.0										
A-10-063	*D-17*	80	SP-SM	3.5	108.0									
A-10-064	*S-1*	5	SM/SC	8.0							2000	7.8	10	217
A-10-064	*D-2*	10	SC to SM	13.1	134.3									
A-10-064	*S-3*	15	SM	6.5										
A-10-064	*D-4*	20	SP-SM	2.7	111.8									
A-10-064	*S-5*	25	SP-SM	2.8										
A-10-064	*D-6*	30	SP	1.3	110.0									
A-10-064	*S-7*	35	SP-SM	5.0										
A-10-064	*D-8*	40	SP-SM	3.7	105.6									
A-10-064	*S-9*	45	SP-SM	5.2										
A-10-064	*D-10*	50	SP-SM	4.4	113.5									
A-10-064	*S-11*	55	SP-SM	8.2										
A-10-064	*D-12*	60	SP-SM	1.7	105.1									
A-10-064	*S-13*	65	SP-SM	4.4										
A-10-064	*D-14*	70	SP-SM	3.0	105.9									
A-10-064	*S-15*	75	SP-SM	3.6										
A-10-064	*D-16*	80	ML to SM	15.7	121.4									



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-063		Strength Intercept (C) :	0.16	(ksf)	Peak	0.16	(ksf)	Ultimate
Sample No. : D-3			7.76	(kPa)		7.76	(kPa)	
Depth (ft/m) : 10.0	0.00	Friction Angle (ϕ) :	41.38	Degree		30.82	Degree	
Description : Light yellowish brown, Poorly graded SAND with SILT (SP-SM)						Shear Rate (inch/minute) :		0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	17.41	95.73	15.07	0.76	0.75	35.91	0.85	40.79	0.54	25.86
◆	19.31	94.89	14.93	0.78	1.50	71.82	1.44	68.95	1.07	51.14
▲	18.90	93.74	14.75	0.80	3.00	143.64	2.82	135.02	1.82	87.33
					0.00	0.00	0.16	7.76	0.11	
					3.0	143.64	2.81	134.32	1.90	

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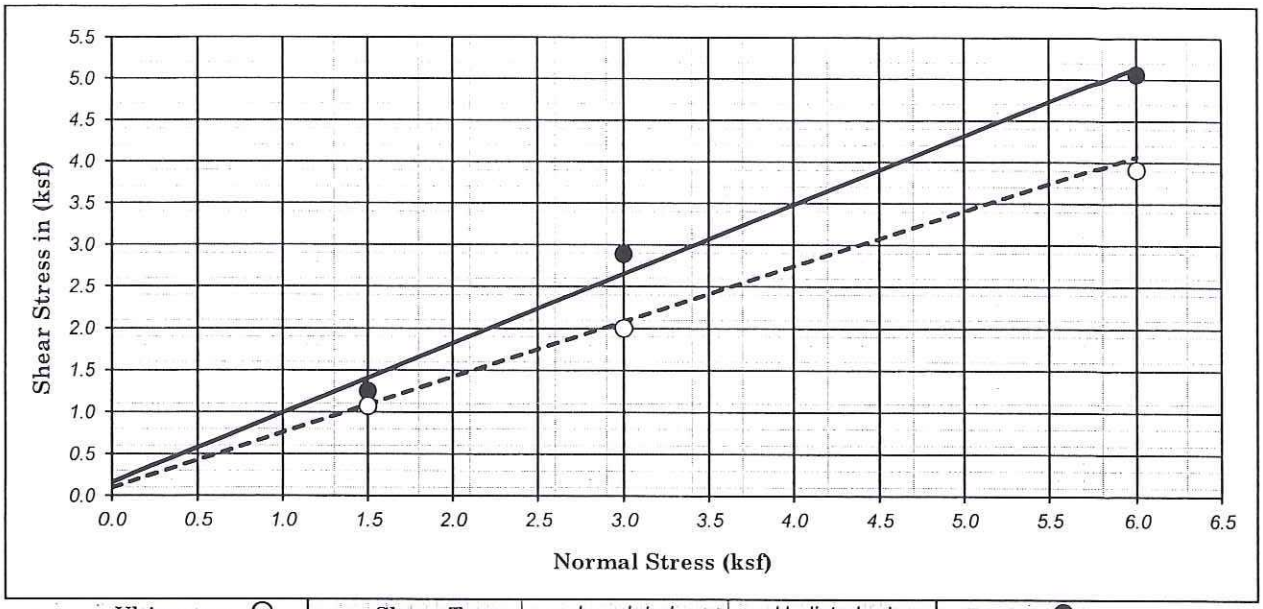
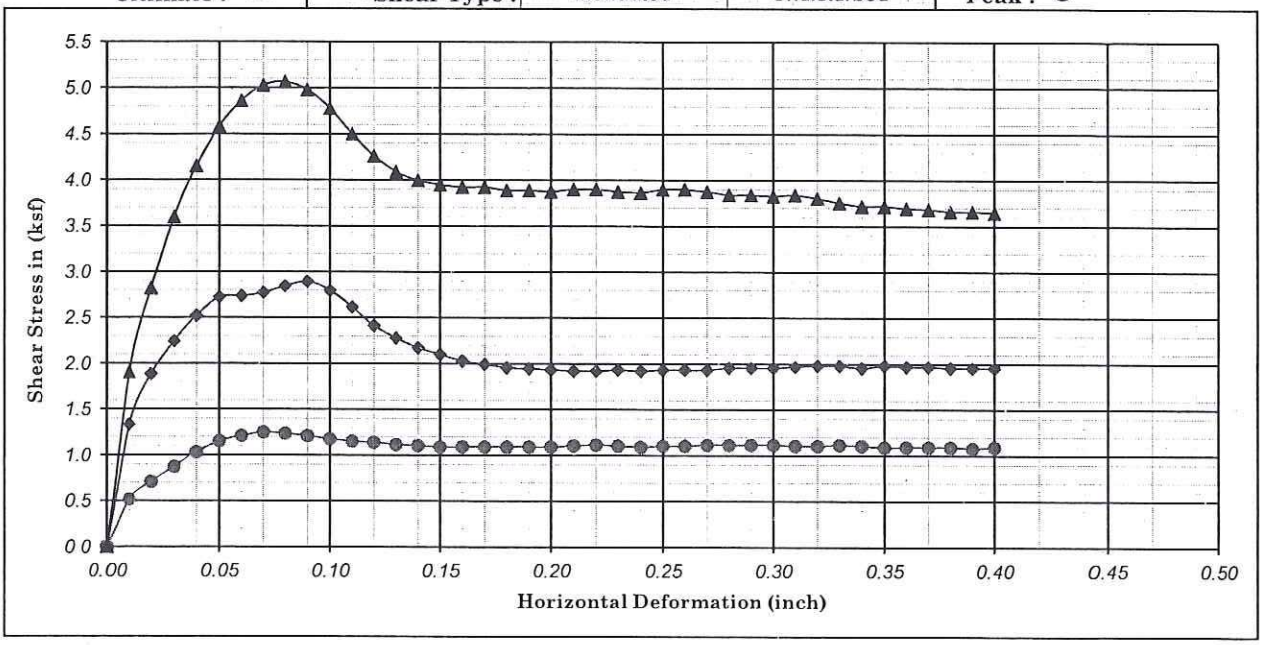
DIRECT SHEAR TEST
(ASTM D-3080)

Project No. : 10-126 | Date : 02/16/11 | Figure No. :



Ultimate : ○ | Shear Type : Inundated | Undisturbed | Peak : ●



Boring No. : A-10-063		Strength Intercept (C) :	0.16	(ksf)	Peak	0.10	(ksf)	Ultimate
Sample No. : D-7			7.76	(kPa)		4.57	(kPa)	
Depth (ft/m) : 30.0	0.00	Friction Angle (ϕ) :	39.70	Degree		33.51	Degree	

Description : Light yellowish brown, Poorly graded SAND with SILT (SP-SM) — Shear Rate (inch/minute) : 0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	22.18	91.04	14.33	0.85	1.50	71.82	1.25	59.75	1.07	51.23
◆	20.89	93.74	14.75	0.80	3.00	143.64	2.89	138.47	2.00	95.76
▲	20.21	93.57	14.73	0.80	6.00	287.28	5.06	242.46	3.91	187.21

Earth Mechanics, Inc.
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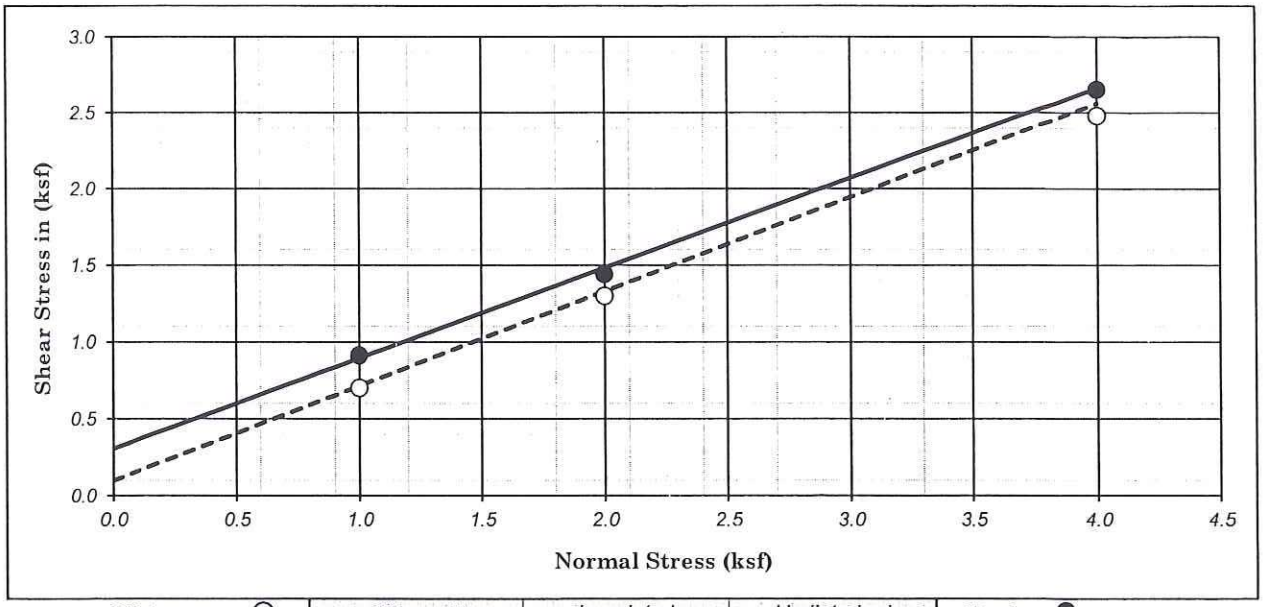
RBF/SR-91 WB Widening

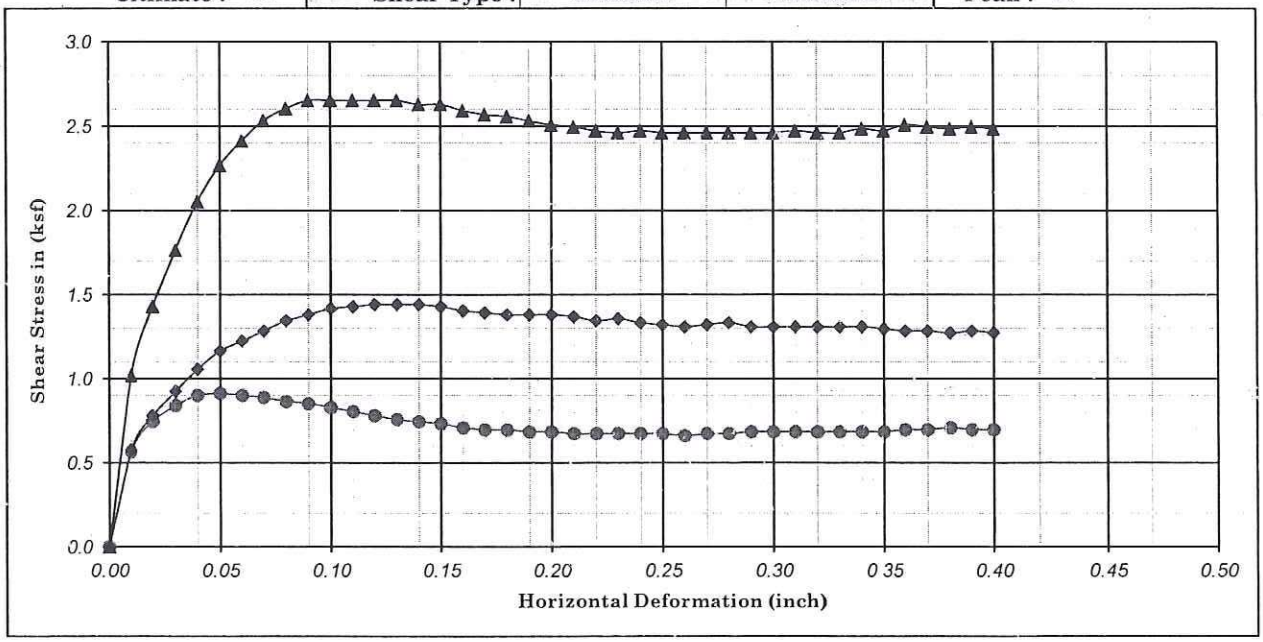
DIRECT SHEAR TEST

(ASTM D-3080)

Project No. : 10-126 | Date : 02/15/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-064		Strength Intercept (C) :	0.31	(ksf)	Peak	0.10	(ksf)	Ultimate
Sample No. : D-4			14.65	(kPa)		4.69	(kPa)	
Depth (ft/m) : 20.0	0.00	Friction Angle (ϕ) :	30.48	Degree		31.61	Degree	

Description : Olive-brown, Poorly graded SAND with SILT (SP-SM) Shear Rate (inch/minute) : 0.02

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	16.83	101.45	15.97	0.66	1.00	47.88	0.91	43.67	0.70	33.52
◆	17.68	100.03	15.75	0.69	2.00	95.76	1.44	68.95	1.30	62.24
▲	17.91	97.44	15.34	0.73	4.00	191.52	2.65	126.98	2.48	118.74

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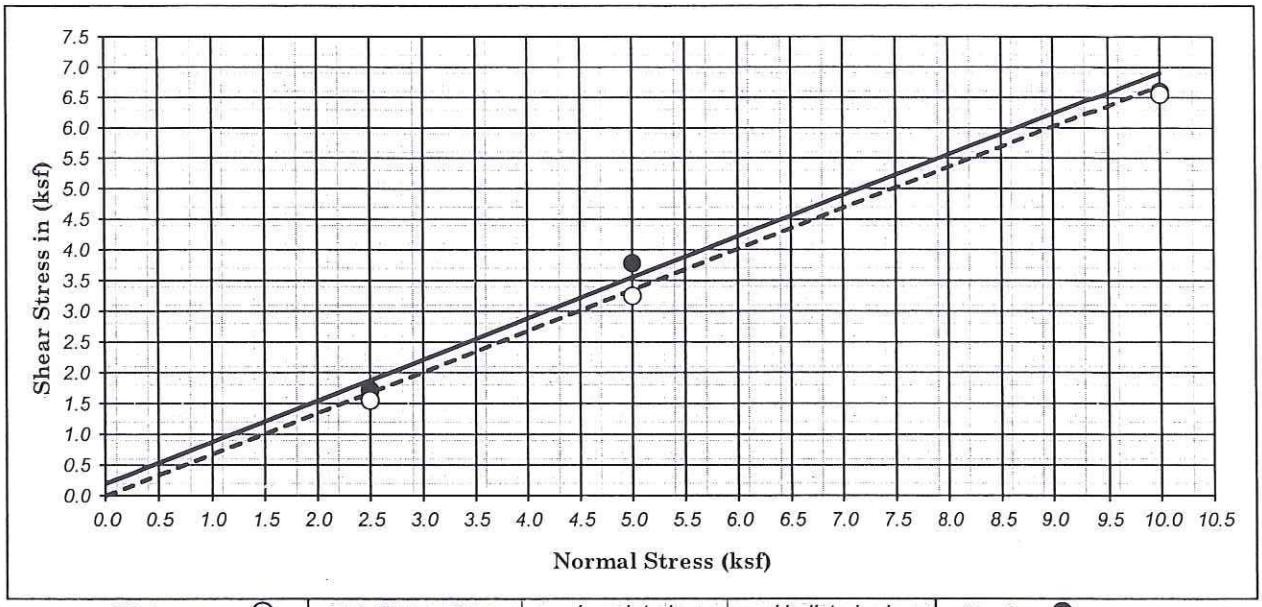
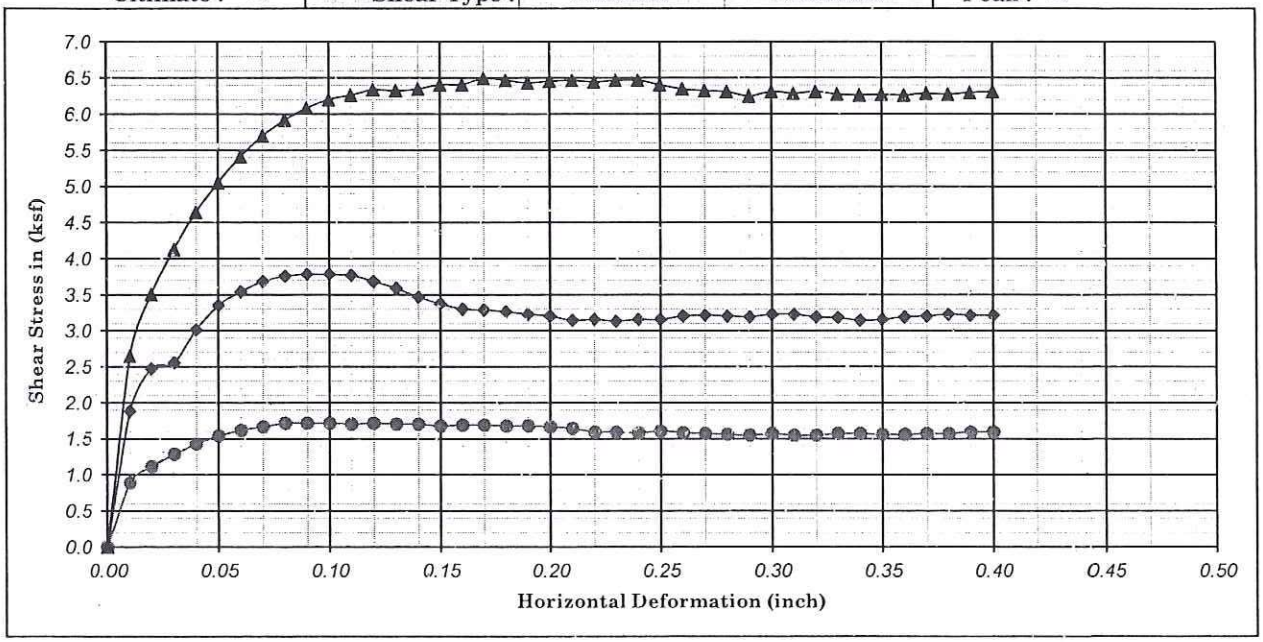
DIRECT SHEAR TEST
(ASTM D-3080)

Project No. : 10-126 | Date : 02/16/11 | Figure No. :



Ultimate : ○	Shear Type :	Inundated	Undisturbed	Peak : ●



Boring No. : A-10-064		Strength Intercept (C) :	0.31	(ksf)	Peak	0.00	(ksf)	Ultimate	
Sample No. : D-14			14.65	(kPa)		0.00	(kPa)		
Depth (ft/m) : 70.0	0.00	Friction Angle (ϕ) :	33.82	Degree		33.78	Degree		
Description : Light yellowish brown, Poorly graded SAND with SILT (SP-SM)						Shear Rate (inch/minute) :		0.02	

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	DRY DENSITY (kN/m^3)	VOID RATIO	NORMAL STRESS (ksf)	NORMAL STRESS (kPa)	PEAK STRESS (ksf)	PEAK STRESS (kPa)	ULTIMATE STRESS (ksf)	ULTIMATE STRESS (kPa)
●	22.86	89.10	14.02	0.89	2.50	119.70	1.72	82.15	1.55	74.12
◆	21.87	90.06	14.18	0.87	5.00	239.40	3.78	180.99	3.25	155.61
▲	22.40	87.19	13.72	0.93	10.00	478.80	6.60	316.01	6.55	313.61

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DIRECT SHEAR TEST

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Figure No. :

Appendix C

DESIGN CALCULATIONS

Earth Mechanics, Inc.
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Project: SR-91 WB Widening - State College Blvd. UC. Project No.: 10-126
By: Ranjan Date: 3/23/11 Checked By: Lino Date: 3/30/11 Sheet: 1 of 1
Subject:

State College Blvd. UC - Liquefaction Potential Analyses

* Historical high ground water elevation of +128 feet was used.

* Analysis was performed using the previous two soil borings (B-701 and B-702) and current two soil borings (A-10-063 and A-10-064).

=> Based on the analyses,
Liquefaction potential at the site is low.

17660 Newhope Street, Suite E, Fountain Valley, CA 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

SR-91 Westbound Widening - State College Blvd. UC **EMI Project No. 10-126** Version - 12/05

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
$^{1}C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

F_L = CRR r / CSR i

A-10-063

Emean (%)	75			Present Ground El.	190.2	Borehole Dia. (in)	8	Tot. Unit Wt. (pcf)	52.2	=Design Water Table Depth	52.2	=Field Water Table Depth	Acc. max =	0.520	g			Earthq. M=	7.3			
C_E	1.25			Future Ground El.	190.2	C_B	1.15	120	138	=Design Water El.	138	=Field Water El.						Cm=	1.07			

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
2.5	188	67	SP-SM	7.0	0.15	0.15	1.70	0.75	1.00	0.67	2	2	0 99	0.15	0.34	82	83	1.00	High N	0.00	LARGE	AboveWT
5	185	9	SP	2.0	0.30	0.30	1.70	0.80	1.20	1.00	1	1	0.99	0.30	0.33	21	21	1.00	0.23	0.25	0.74	AboveWT
10	180	39	SP-SM	7.0	0.60	0.60	1 32	0.85	1.00	0.67	2	2	0.98	0.60	0.33	42	42	1.00	High N	0.00	LARGE	AboveWT
15	175	16	SP-SM	7.0	0.90	0.90	1.08	0.85	1.20	1.00	1	1	0.97	0.90	0.33	25	26	1.00	0.30	0.33	1.00	AboveWT
20	170	52	SP	4.0	1.20	1.20	0.93	0.95	1.00	0.67	2	2	0.95	1.20	0.32	44	44	0.97	High N	0.00	LARGE	AboveWT
25	165	27	SP-SM	7.0	1.50	1.50	0.83	0.95	1.20	1.00	1	1	0.94	1.50	0.32	37	37	0.93	High N	0.00	LARGE	AboveWT
30	160	67	SP-SM	7.0	1.80	1.80	0.76	1.00	1.00	0.67	2	2	0.93	1.80	0.31	49	49	0.89	High N	0.00	LARGE	AboveWT
35	155	16	SP-SM	7.0	2.10	2.10	0.71	1.00	1.20	1.00	1	1	0.89	2.10	0.30	19	20	0.87	0.21	0.20	0.66	AboveWT
40	150	63	SP-SM	7.0	2.40	2.40	0.66	1.00	1.00	0.67	2	2	0.85	2.40	0.29	40	40	0.85	High N	0.00	LARGE	AboveWT
45	145	37	SP-SM	7.0	2.70	2.70	0.62	1.00	1.20	1.00	1	1	0.81	2.70	0.27	40	40	0.82	High N	0.00	LARGE	AboveWT
50	140	91	SP-SM	7.0	3 00	3.00	0.59	1.00	1.00	0.67	2	2	0.77	3.00	0.26	51	52	0.78	High N	0.00	LARGE	AboveWT
55	135	41	SP-SM	7.0	3.30	3.21	0.57	1.00	1.20	1.00	1	1	0.73	3.21	0.25	40	41	0.77	High N	0.00	LARGE	high N
60	130	76	SP-SM	7.0	3.60	3.36	0.56	1.00	1.00	0.67	2	2	0.69	3.36	0.25	41	41	0.76	High N	0.00	LARGE	high N
65	125	48	SP-SM	7.0	3.90	3.50	0.55	1.00	1.20	1.00	1	1	0.64	3.50	0.24	45	46	0.75	High N	0.00	LARGE	high N
70	120	80	SP-SM	7.0	4.20	3.64	0.54	1.00	1.00	0.67	2	2	0.60	3.64	0.24	41	41	0.74	High N	0.00	LARGE	high N
75	115	49	SP-SM	7.0	4.50	3.79	0.52	1.00	1.20	1.00	1	1	0.56	3.79	0.23	44	45	0.74	High N	0.00	LARGE	high N
80	110	80	SP-SM	7.0	4.80	3.93	0.52	1.00	1.00	0.67	2	2	0.55	3.93	0.23	39	40	0.73	High N	0.00	LARGE	high N

SR-91 Westbound Widening - State College Blvd. UC **EMI Project No. 10-126** Version - 12/05

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
[1]C_N = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
$CRR\ r = CRR_{7.5} \times Cm \times K\ sigma$

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines (Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

$F_L = CRR\ r / CSR\ i$

A-10-064

Emean (%:	75			Present Ground El.	210	Borehole Dia. (in)	8	Tot. Unit Wt. (pcf)	72.0	=Design Water Table Depth	72.0	=Field Water Table Depth	Acc. max :	0.520	g			Earthq. M=	7.3		
C_E	1.25			Future Ground El.	210	C_B	1.15	120	138	=Design Water El.	138	=Field Water El.						Cm=	1.07		

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
-		-		-	-	-	-				-		-	-	-	-	-	-	-		-	-
5	205	27	SM/SC	25.0	0.30	0.30	1.70	0.80	1.20	1.00	1	1	0.99	0.30	0.33	63	75	1.00	High N	0.00	LARGE	AboveWT
10	200	68	SC/SM	25.0	0.60	0.60	1.32	0.85	1.00	0.67	2	2	0.98	0.60	0.33	73	86	1.00	High N	0.00	LARGE	AboveWT
15	195	38	SM	25.0	0.90	0.90	1.08	0.85	1.20	1.00	1	1	0.97	0.90	0.33	60	71	1.00	High N	0.00	LARGE	AboveWT
20	190	31	SP-SM	10.0	1.20	1.20	0.93	0.95	1.00	0.67	2	2	0.95	1.20	0.32	26	28	0.97	0.36	0.38	1.17	AboveWT
25	185	9	SP-SM	10.0	1.50	1.50	0.83	0.95	1.20	1.00	1	1	0.94	1.50	0.32	12	13	0.93	0.14	0.14	0.45	AboveWT
30	180	52	SP	4.0	1.80	1.80	0.76	1.00	1.00	0.67	2	2	0.93	1.80	0.31	38	38	0.89	High N	0.00	LARGE	AboveWT
35	175	16	SP-SM	6.0	2.10	2.10	0.71	1.00	1.20	1.00	1	1	0.89	2.10	0.30	19	20	0.87	0.21	0.20	0.65	AboveWT
40	170	65	SP-SM	6.0	2.40	2.40	0.66	1.00	1.00	0.67	2	2	0.85	2.40	0.29	41	41	0.85	High N	0.00	LARGE	AboveWT
45	165	32	SP-SM	6.0	2.70	2.70	0.62	1.00	1.20	1.00	1	1	0.81	2.70	0.27	34	35	0.82	High N	0.00	LARGE	AboveWT
50	160	89	SP-SM	9.0	3.00	3.00	0.59	1.00	1.00	0.67	2	2	0.77	3.00	0.26	50	52	0.78	High N	0.00	LARGE	AboveWT
55	155	18	SP-SM	9.0	3.30	3.30	0.56	1.00	1.20	1.00	1	1	0.73	3.30	0.25	17	18	0.76	0.20	0.16	0.65	AboveWT
60	150	87	SP-SM	6.0	3.60	3.60	0.54	1.00	1.00	0.67	2	2	0.69	3.60	0.23	45	45	0.75	High N	0.00	LARGE	AboveWT
65	145	35	SP-SM	6.0	3.90	3.90	0.52	1.00	1.20	1.00	1	1	0.64	3.90	0.22	31	31	0.73	High N	0.00	LARGE	AboveWT
70	140	85	SP-SM	6.0	4.20	4.20	0.50	1.00	1.00	0.67	2	2	0.60	4.20	0.20	41	41	0.71	High N	0.00	LARGE	AboveWT
75	135	48	SP-SM	6.0	4.50	4.41	0.49	1.00	1.20	1.00	1	1	0.56	4.41	0.19	40	41	0.70	High N	0.00	LARGE	high N
80	130	80	ML/SM	30.0	4.80	4.55	0.48	1.00	1.00	0.67	2	2	0.55	4.55	0.20	37	47	0.69	High N	0.00	LARGE	high N

SR-91 Westbound Widening - State College Blvd. UC **EMI Project No. 10-126** Version - 12/05

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
$^{1}C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines
(Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

F_L = CRR r / CSR i

B-701

Emean (%)	70			Present Ground El.	188.19	Borehole Dia. (in)	8	Tot. Unit Wt. (pcf)	50.2	=Design Water Table Depth	50.2	=Field Water Table Depth	Acc. max =	0.520	g		Earthq. M=	7.3				
C_E	1.17			Future Ground El.	188.19	C_B	1.15	120	138	=Design Water El.	138	=Field Water El.					Cm=	1.07				

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
5	183	5	SP	4.0	0.30	0.30	1.70	0.80	1.20	1.00	1	1	0.99	0.30	0.33	11	11	1.00	0.12	0.13	0.39	AboveWT
11.5	177	24	SP	4.0	0.69	0.69	1.23	0.85	1.20	1.00	1	1	0.97	0.69	0.33	40	40	1.00	High N	0.00	LARGE	AboveWT
15	173	23	SP	4.0	0.90	0.90	1.08	0.85	1.20	1.00	1	1	0.97	0.90	0.33	34	34	1.00	High N	0.00	LARGE	AboveWT
21.5	167	28	SP-SM	6.0	1.29	1.29	0.90	0.95	1.20	1.00	1	1	0.95	1.29	0.32	39	39	0.96	High N	0.00	LARGE	AboveWT
26.5	162	39	SP-SM	6.0	1.59	1.59	0.81	1.00	1.20	1.00	1	1	0.94	1.59	0.32	51	51	0.92	High N	0.00	LARGE	AboveWT
31.5	157	33	SM/ML	50.0	1.89	1.89	0.74	1.00	1.20	1.00	1	1	0.92	1.89	0.31	39	52	0.88	High N	0.00	LARGE	AboveWT
35	153	45	SM/ML	50.0	2.10	2.10	0.71	1.00	1.20	1.00	1	1	0.89	2.10	0.30	51	66	0.87	High N	0.00	LARGE	AboveWT
41.5	147	40	SM/ML	50.0	2.49	2.49	0.65	1.00	1.20	1.00	1	1	0.84	2.49	0.28	42	55	0.84	High N	0.00	LARGE	AboveWT
45	143	32	SM/ML	50.0	2.70	2.70	0.62	1.00	1.20	1.00	1	1	0.81	2.70	0.27	32	43	0.82	High N	0.00	LARGE	AboveWT
51.5	137	55	SM/ML	50.0	3.09	3.05	0.59	1.00	1.20	1.00	1	1	0.75	3.05	0.26	52	67	0.78	High N	0.00	LARGE	high N
55	133	78	SM/ML	50.0	3.30	3.15	0.58	1.00	1.20	1.00	1	1	0.73	3.15	0.26	72	92	0.77	High N	0.00	LARGE	high N
61.5	127	10	ML	80.0	3.69	3.34	0.56	1.00	1.20	1.00	1	1	0.67	3.34	0.25	9	16	0.76	0.17	0.14	0.55	fines
65	123	55	SM	15.0	3.90	3.44	0.55	1.00	1.20	1.00	1	1	0.64	3.44	0.25	49	54	0.76	High N	0.00	LARGE	high N
71.5	117	70	SM	15.0	4.29	3.63	0.54	1.00	1.20	1.00	1	1	0.59	3.63	0.24	60	66	0.75	High N	0.00	LARGE	high N

SR-91 Westbound Widening - State College Blvd. UC **EMI Project No. 10-126** Version - 12/05

LIQUEFACTION ANALYSIS, M = 7.3 ; ACC. = 0.52 g

Liquefaction analysis is performed following Seed's Procedure, outlined by Seed et al. (1985), Seed and Harder (1990), updated NCEER (1997), Martin et al. (1999) and Youd et al. (2001)

Emean/E60 = Energy Ratio to correct to standard 60% Energy
Surcharge = Any surcharge on top of the ground (psf)
acc. max = maximum peak acceleration at the ground surface (g's)
$^{1}C_N$ = square root of (100 kPa or 1.04427 tsf/effective overburden)
The induced cyclic stress ratio (CSR i) by a given peak ground acceleration (acc. max) is:

CSR i = 0.65 x acc max. x total normal stress x rd / (effective normal stress x g)

The resisting cyclic stress ratio (CRR r) is equal to:
CRR r = $CRR_{7.5}$ x Cm x K sigma

where: Cm = Earthquake Magnitude Correction Factor (Blake, NCEER Table 3, Eq.4)
K sigma = Normalized resistance factor (Fig. 14 from NCEER Liquefaction workshop, Harder Boulanger)
$CRR_{7.5}$ = Resisting Cyclic Stress Ratio. It is a function of the content of fines (Figure 2, NCEER Workshop, after Seed et al 1985))

Factor of Safety, F_L is:

F_L = CRR r / CSR i

B-702

Emean (%)	70		Present Ground El.	187.92	Borehole Dia. (in)	8	Tot. Unit Wt. (pcf)	49.9	=Design Water Table Depth	49.9	=Field Water Table Depth	Acc. max =	0.520	g					Earthq. M=	7.3	
C_E	1.17		Future Ground El.	187.92	C_B	1.15	120	138	=Design Water El.	138	=Field Water El.								Cm=	1.07	

DEPTH OF SOIL SAMPLE (ft.)	EL. (ft.)	FIELD BLOW COUNT N	SOIL TYPE	EST. PERCENT OF FINES (%)	DESIGN TOTAL OVERBUR. PRESS. (tsf)	PRESENT EFFEC. OVERBUR. PRESS. (tsf)	C_N	C_R	C_S	C_{ST}	SAMPLER TYPE 1=SPT 2=CA.MOD	SAMPLER LINED 1=UNLINED 2=LINED	STRESS REDUC. COEFF. rd	DESIGN EFFEC. OVERBUR. PRESS. (tsf)	INDUCED CYCLIC STRESS RATIO	CORRECT BLOW COUNT N160	(N1)60cs	K sigma	RESIST. CYCLIC STRESS RATIO M=7.5	RESIST. CYCLIC STRESS RATIO Overburd Corr Mag Corr	FACTOR OF SAFETY (F_L)	WILL IT LIQUEFY?
-		-		-	-	-	-				-		-	-	-	-	-	-	-		-	-
6.5	181	10	SP	4.0	0.39	0.39	1.64	0.80	1.20	1.00	1	1	0.98	0.39	0.33	21	21	1.00	0.23	0.25	0.74	AboveWT
10	178	24	SP	4.0	0.60	0.60	1.32	0.85	1.20	1.00	1	1	0.98	0.60	0.33	43	43	1.00	High N	0.00	LARGE	AboveWT
16.5	171	30	SP	4.0	0.99	0.99	1.03	0.95	1.20	1.00	1	1	0.96	0.99	0.32	47	47	1.00	High N	0.00	LARGE	AboveWT
20	168	27	SP	4.0	1.20	1.20	0.93	0.95	1.20	1.00	1	1	0.95	1.20	0.32	39	39	0.97	High N	0.00	LARGE	AboveWT
26.5	161	30	SP	4.0	1.59	1.59	0.81	1.00	1.20	1.00	1	1	0.94	1.59	0.32	39	39	0.92	High N	0.00	LARGE	AboveWT
30	158	44	SP	4.0	1.80	1.80	0.76	1.00	1.20	1.00	1	1	0.93	1.80	0.31	54	54	0.89	High N	0.00	LARGE	AboveWT
40	148	35	SM	15.0	2.40	2.40	0.66	1.00	1.20	1.00	1	1	0.85	2.40	0.29	37	41	0.85	High N	0.00	LARGE	AboveWT
46.5	141	43	SM	15.0	2.79	2.79	0.61	1.00	1.20	1.00	1	1	0.80	2.79	0.27	42	47	0.82	High N	0.00	LARGE	AboveWT
50	138	59	SM	15.0	3.00	3.00	0.59	1.00	1.20	1.00	1	1	0.77	3.00	0.26	56	61	0.80	High N	0.00	LARGE	high N
56.5	131	53	SM	15.0	3.39	3.18	0.57	1.00	1.20	1.00	1	1	0.71	3.18	0.26	49	54	0.77	High N	0.00	LARGE	high N
60	128	57	SM	15.0	3.60	3.29	0.56	1.00	1.20	1.00	1	1	0.69	3.29	0.25	52	57	0.76	High N	0.00	LARGE	high N
66.5	121	68	SP	4.0	3.99	3.47	0.55	1.00	1.20	1.00	1	1	0.63	3.47	0.25	60	60	0.75	High N	0.00	LARGE	high N
70	118	78	SP	4.0	4.20	3.57	0.54	1.00	1.20	1.00	1	1	0.60	3.57	0.24	68	68	0.75	High N	0.00	LARGE	high N

Project: SR-91 WB Widening - State College Blvd. UC. Project No.: 10-126
By: Ranjan Date: 3/23/11 Checked By: Lino Date: 8/31/11 Sheet: 1 of 7
Subject: SP 8/31/11

Axial pile Calculations - Using SHAFT 6.0

State College Blvd. UC (Widen) - Abutments 1 and 3

Under Service-I Limit State,

Total load per pile = 85 kips = 42.5 tons

Total load per support = 756.4 kips = 378.2 tons

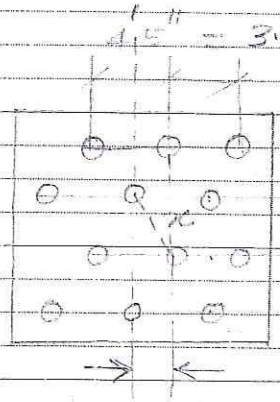
Pile Capacity Check

Use factor of Safety (FOS) = 2.0

Per AASHTO,

group reduction factor, $\eta = 0.77$
for 3ϕ spacing

Ignore skin down to +180' for Abutments 1 and 3.



$2c = \sqrt{2.21^2 + 3.33^2} = 4'$
$= 3\phi$

∴ Required Q_c = Total load x FOS
= 42.5 x 2
= 85 tons

From SHAFT analyses,

Required pile length for Abut 1 = 27'

Required pile tip El. for Abut 1 = +183' - 30'
= +153 feet //

Similarly, Required pile tip El. for Abut 3 = +153 feet //

GROUP CHECK

Nominal resistance of pile = 85 tons

No. of piles per support = 12

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Group reduction factor, η = 0.77 (@ 3D spacing)

∴ Total resistance per support = 85 × 12 × 0.77
= 785 tons

But Total load per support = 756.4 tons

⇒ Total resistance > Total load

SATISFIED

Pile Group Settlement Calculations - Abutments 1 and 3

Permissible Settlement under Service load = 1"

Total load per support (Q_T) = 745.4 kips

Based on Abutment layout,

B = (3.33 × 3) + 1.33' = 11.33'

L = (4.5" × 2) + 2.25" + 1.33' = 12.35'

Assume a minimum pile length (D) = 12'

∴ 2/3 D = 8'

∴ Equivalent footing dimension B_1 = 11.33' + 4'
= 15.33'

L_1 = 12.35' + 4'
= 16.35'

Stress @ equivalent footing $Q_1 = \frac{Q}{B_1 L_1} = \frac{756.4}{15.33 \times 16.35}$

= 3.02 ksf

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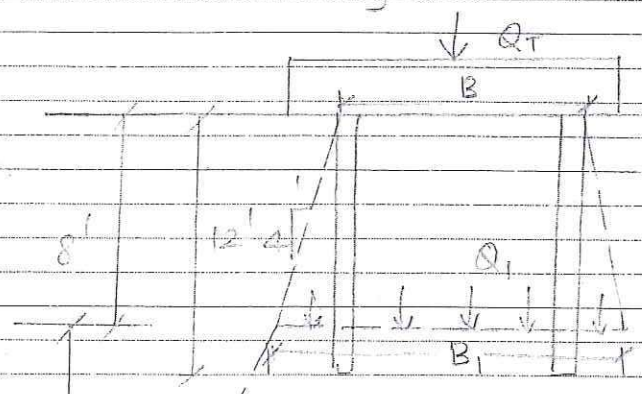
For AASHTO LRFD Figure 10.7.2.3.1-1 Case (d),



Using $\Delta H_i = \frac{H_i}{C_i'} \log\left(\frac{\sigma_0' + \Delta\sigma_{v_i}'}{\sigma_0'}\right)$ AASHTO Eq 10.5.2.4.1-3

σ_0' = initial stress

$\Delta\sigma_{v_i}'$ = stress increase due to Q_1

Layer	Mid point	H (ft)	C'	σ_0' (ksf)	$\Delta\sigma_{v_i}$ (ksf)	ΔH_i (in)	
Sand 1	A	20	67	2.16	1.14	0.66	
Sand 2	B	30	86	5.16	0.3	0.11	
Sand 3	C	25	140	6.72	0.13	0.02	
					$\Sigma\Delta H_i$ =	0.79"	< 1"

⇒ No design tip for settlement at abutments 1 and 3

Project: SR-91 WB Widening - State College Blvd. UC. Project No.: 10-126
By: Ranjan Date: 3/23/11 Checked By: Lino Date: 8/3/11 Sheet: 1 of 7
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State College Blvd. UC - Bent 2

Strength Limit State

Compression

Compression per pile = 87 kips = 43.5 tons

∴ Nominal resistance = $\frac{43.5}{0.7}$ = 62 tons

SELECT 70 tons //

∴ Required ultimate skin Q_s = 70 tons (Assume no end bearing for SHAFT analyses.)

∴ Required pile tip El. = +184' − 27' = +157' //

[Ignored skin down to El. +180']

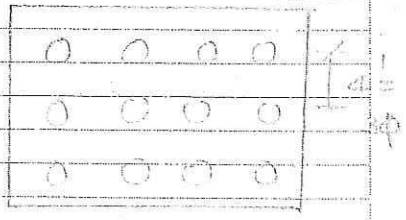
Group Check - Strength Limit

Compression load per support = 1046 kips = 523 tons

Nomimal resistance per pile = 70 tons

No. of piles per support = 12

Per AASHTO LRFD, η = 0.77 for 2d spacing



∴ Total resistance per support

= 70 × 12 × 0.77 = 646 tons

Factored compression load per support = $\frac{523}{0.7}$ = 747 tons

Factored compression load > Total resistance per support

∴ New compression per pile = 747 / (12 × 0.77)

= 81 tons

SELECT 90 tons //

⇒ New Required pile tip El. = +184' − 31' = +153' //

EXTREME LIMIT - BENT 2

Compression

Compression per pile = 131.0 kips = 65.5 tons

∴ Nominal resistance = $\frac{65.5}{1.0}$ = 65.5 tons

SELECT 70 tons //

∴ Required skin Q_s = 70 tons (∵ No end bearing)

Per SHAFT, Required pile tip El. = +184' - 27' = +157' //

[Ignored skin down to El. +180']

Group Check

Compression load per support = 623 kips = 311.5 tons

Factored compression load per support = $\frac{311.5}{1.0}$ = 311.5 tons

Nominal resistance per pile = 70 tons

No. of piles = 12

∴ Total resistance per support = 70 x 12 x 0.77 = 646 tons

⇒ Total resistance > Factored compression load, [SATISFIED] //

Tension

Tension per pile = 65 kips = 32.5 tons

Nominal resistance = $\frac{32.5}{1.0}$ = 32.5 tons SELECT 40 tons //

∴ Required Q_s = 40 tons

Per Caltrans BDS 2003 Eq^n 4.6.5.1-2,
ultimate axial capacity for uplift (Q_{ult}) = 0.7 Q_s

Per SHAFT, Required pile tip El. = +184' - 24' = +160' //

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

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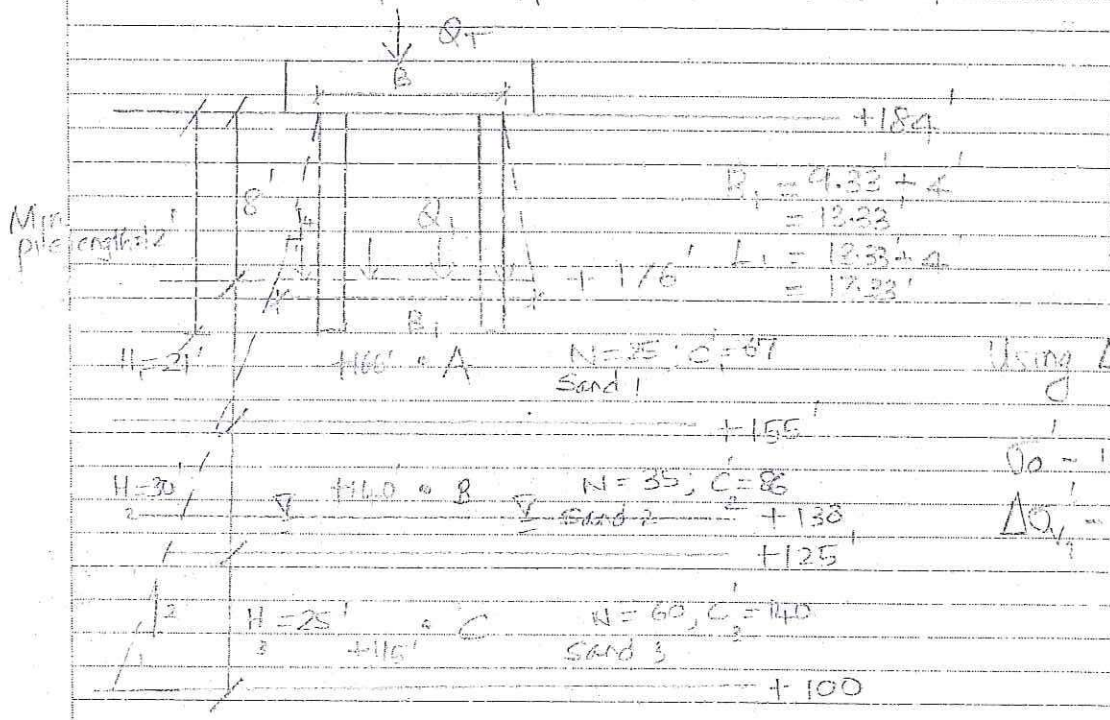
SETTLEMENT CHECK - BENT 2

Permissible Settlement under Service load = 1"

Total load per support (Q_T) = 739 kips



Using $\Delta H_i = \frac{H_i}{C_i'} \log\left(\frac{\sigma_o' + \Delta\sigma_{v_i}'}{\sigma_o'}\right)$

σ_o' = initial stress

$\Delta\sigma_{v_i}'$ = stress increase due to Q_1

Layer	Midpoint	H_i (ft)	C_i'	σ_o' (ksf)	$\Delta\sigma_{v_i}'$ (ksf)	ΔH_i (in)
Sand 1	A	21	87	2.16	1.159	0.7
Sand 2	B	30	86	5.28	0.3	0.1
Sand 3	C	25	140	6.72	0.13	0.02

$\sum \Delta H_i = 0.82" < 1"$

=> No design tip for settlement at Bent 2 since a minimum pile length of 12' was used.

17660 Newhope Street, Suite E, Fountain Valley, CA 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

Project: SR-91 WB Widening - State College Blvd. UC. Project No.: 10-126
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Subject:

DESIGN PILE TIP FOR LATERAL LOAD

Based on LPILE analyses,

a 25-ft depth is adequate for lateral loading.

i.e., 19 x diameter depth

⇒ Required pile tip EL. for Abutments 1 & 3

$= +182' - 25'$

$= +158'$ //

⇒ Required pile tip for Bent 2

$= +182' - 25'$

$= +159'$ //

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 6 (C)COPYRIGHT ENSOFT,INC.1989,1995,1998,2001,2003,2007

SR-91 WB Widening Project - Abutment 1

TOTAL LOAD = 150.0 TONS

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 45.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00

SOIL INFORMATION

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.500E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.500E+01
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.422E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.500E+01
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.300E+01

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.110E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.130E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.300E+01

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.681E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.130E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.280E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.786E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.280E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.472E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.580E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.472E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.580E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.250E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.100E+03

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	= 1.333	FT.
DIAMETER OF BASE	= 1.333	FT.
END OF STEM TO BASE	= 0.000	FT.
ANGLE OF BELL	= 0.000	DEG.
IGNORED TOP PORTION	= 3.000	FT.
IGNORED BOTTOM PORTION	= 0.000	FT.
AREA OF ONE PERCENT STEEL	= 2.010	SQ.IN.
ELASTIC MODULUS, Ec	= 0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	= 0.000	CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
4.0	0.21	1.07	4.90	5.97	5.97	5.97	28.88
5.0	0.26	2.38	5.72	8.09	8.09	8.09	31.31
6.0	0.31	3.90	6.53	10.44	10.44	10.44	33.65
7.0	0.36	5.65	7.35	13.00	13.00	13.00	35.92
8.0	0.41	7.59	8.17	15.76	15.76	15.76	38.11
9.0	0.47	9.74	8.98	18.72	18.72	18.72	40.25
10.0	0.52	12.08	9.80	21.88	21.88	21.88	42.32
11.0	0.57	14.60	10.62	25.22	25.22	25.22	44.35
12.0	0.62	17.30	10.89	28.18	28.18	28.18	45.43
13.0	0.67	20.17	10.89	31.05	31.05	31.05	46.21
14.0	0.72	23.20	10.89	34.09	34.09	34.09	47.10
15.0	0.78	26.39	10.89	37.28	37.28	37.28	48.08
16.0	0.83	29.74	10.89	40.62	40.62	40.62	49.12
17.0	0.88	33.23	10.89	44.12	44.12	44.12	50.20
18.0	0.93	36.86	10.89	47.75	47.75	47.75	51.32
19.0	0.98	40.64	10.89	51.52	51.52	51.52	52.46
20.0	1.03	44.54	10.89	55.43	55.43	55.43	53.61
21.0	1.09	48.57	10.89	59.46	59.46	59.46	54.77
22.0	1.14	52.72	10.89	63.61	63.61	63.61	55.93
23.0	1.19	57.00	10.89	67.88	67.88	67.88	57.09
24.0	1.24	61.38	10.89	72.27	72.27	72.27	58.25
25.0	1.29	65.87	10.89	76.76	76.76	76.76	59.39
26.0	1.34	70.47	10.89	81.35	81.35	81.35	60.53
27.0	1.40	75.16	14.89	90.05	90.05	90.05	64.52
28.0	1.45	79.95	14.89	94.84	94.84	94.84	65.52
29.0	1.50	85.59	14.89	100.48	100.48	100.48	67.02
30.0	1.55	91.32	14.89	106.21	106.21	106.21	68.49
31.0	1.60	97.15	14.89	112.04	112.04	112.04	69.91
32.0	1.65	103.07	14.89	117.96	117.96	117.96	71.31
33.0	1.71	109.08	14.89	123.97	123.97	123.97	72.67
34.0	1.76	115.17	14.89	130.06	130.06	130.06	74.00
35.0	1.81	121.34	14.89	136.23	136.23	136.23	75.29
36.0	1.86	127.58	14.89	142.47	142.47	142.47	76.56
37.0	1.91	133.89	14.89	148.78	148.78	148.78	77.79
38.0	1.96	140.27	14.89	155.16	155.16	155.16	78.99

Required Q_s = 85 tons for Abut 1 & 3.

@ 29' depth, Q_s = 85.5 tons

⇒ Conservatively, select the depth of 30' that has Q_s = 91.2 tons

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.4580E-01	0.4162E-04	0.3258E-03	0.1000E-04
0.2290E+00	0.2081E-03	0.1629E-02	0.5000E-04
0.4580E+00	0.4162E-03	0.3258E-02	0.1000E-03
0.2333E+02	0.2105E-01	0.1629E+00	0.5000E-02
0.3439E+02	0.3146E-01	0.2443E+00	0.7500E-02
0.4455E+02	0.4149E-01	0.3258E+00	0.1000E-01
0.8437E+02	0.8889E-01	0.8145E+00	0.2500E-01
0.1124E+03	0.1389E+00	0.1629E+01	0.5000E-01
0.1255E+03	0.1761E+00	0.2443E+01	0.7500E-01
0.1324E+03	0.2081E+00	0.3239E+01	0.1000E+00
0.1399E+03	0.3667E+00	0.7367E+01	0.2500E+00
0.1434E+03	0.6212E+00	0.1115E+02	0.5000E+00
0.1450E+03	0.7483E+00	0.1290E+02	0.6250E+00
0.1468E+03	0.9069E+00	0.1488E+02	0.7813E+00
0.1470E+03	0.9258E+00	0.1511E+02	0.7998E+00

RESULT FROM UPPER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN
0.7073E-01	0.5665E-04	0.4654E-03	0.1000E-04
0.3537E+00	0.2833E-03	0.2327E-02	0.5000E-04
0.7073E+00	0.5665E-03	0.4654E-02	0.1000E-03
0.3583E+02	0.2876E-01	0.2327E+00	0.5000E-02
0.5168E+02	0.4254E-01	0.3491E+00	0.7500E-02
0.6527E+02	0.5540E-01	0.4654E+00	0.1000E-01
0.1106E+03	0.1100E+00	0.1164E+01	0.2500E-01
0.1333E+03	0.1576E+00	0.2327E+01	0.5000E-01

0.1399E+03	0.1895E+00	0.3491E+01	0.7500E-01
0.1426E+03	0.2176E+00	0.4580E+01	0.1000E+00
0.1481E+03	0.3745E+00	0.1006E+02	0.2500E+00
0.1508E+03	0.6279E+00	0.1273E+02	0.5000E+00
0.1522E+03	0.7547E+00	0.1413E+02	0.6250E+00
0.1539E+03	0.9131E+00	0.1587E+02	0.7813E+00
0.1541E+03	0.9319E+00	0.1608E+02	0.7998E+00

RESULT FROM LOWER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.2595E-01	0.2884E-04	0.1862E-03	0.1000E-04
0.1298E+00	0.1442E-03	0.9308E-03	0.5000E-04
0.2595E+00	0.2884E-03	0.1862E-02	0.1000E-03
0.1313E+02	0.1449E-01	0.9308E-01	0.5000E-02
0.1969E+02	0.2177E-01	0.1396E+00	0.7500E-02
0.2599E+02	0.2896E-01	0.1862E+00	0.1000E-01
0.5652E+02	0.6747E-01	0.4654E+00	0.2500E-01
0.8919E+02	0.1190E+00	0.9308E+00	0.5000E-01
0.1100E+03	0.1620E+00	0.1396E+01	0.7500E-01
0.1219E+03	0.1983E+00	0.1899E+01	0.1000E+00
0.1316E+03	0.3588E+00	0.4673E+01	0.2500E+00
0.1360E+03	0.6145E+00	0.9569E+01	0.5000E+00
0.1378E+03	0.7420E+00	0.1166E+02	0.6250E+00
0.1397E+03	0.9008E+00	0.1389E+02	0.7813E+00
0.1400E+03	0.9196E+00	0.1415E+02	0.7998E+00

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
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SR-91 WB Widening Project - Bent 2

TOTAL LOAD = 200.0 TONS

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 46.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00

SOIL INFORMATION

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.500E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.500E+01
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.410E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.500E+01
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.400E+01

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COFFFICIENT- BETA	= 0.107E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.130E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.400E+01

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.670E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.130E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.290E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.773E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.340E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.290E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.463E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.340E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.590E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.463E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.590E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.255E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.850E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	= 1.333	FT.
DIAMETER OF BASE	= 1.333	FT.
END OF STEM TO BASE	= 0.000	FT.
ANGLE OF BELL	= 0.000	DEG.
IGNORED TOP PORTION	= 4.000	FT.
IGNORED BOTTOM PORTION	= 0.000	FT.
AREA OF ONE PERCENT STEEL	= 2.010	SQ.IN.
ELASTIC MODULUS, Ec	= 0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	= 0.000	CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
5.0	0.26	1.30	5.72	7.02	7.02	7.02	27.17
6.0	0.31	2.83	6.53	9.37	9.37	9.37	30.20
7.0	0.36	4.57	7.35	11.93	11.93	11.93	32.96
8.0	0.41	6.52	8.17	14.69	14.69	14.69	35.52
9.0	0.47	8.67	8.98	17.65	17.65	17.65	37.94
10.0	0.52	11.01	9.80	20.81	20.81	20.81	40.25
11.0	0.57	13.53	10.62	24.14	24.14	24.14	42.46
12.0	0.62	16.23	10.89	27.11	27.11	27.11	43.71
13.0	0.67	19.09	10.89	29.98	29.98	29.98	44.61
14.0	0.72	22.13	10.89	33.01	33.01	33.01	45.62
15.0	0.78	25.32	10.89	36.21	36.21	36.21	46.69
16.0	0.83	28.67	10.89	39.55	39.55	39.55	47.82
17.0	0.88	32.16	10.89	43.04	43.04	43.04	48.98
18.0	0.93	35.79	10.89	46.68	46.68	46.68	50.17
19.0	0.98	39.57	10.89	50.45	50.45	50.45	51.37
20.0	1.03	43.47	10.89	54.36	54.36	54.36	52.57
21.0	1.09	47.50	10.89	58.39	58.39	58.39	53.78
22.0	1.14	51.65	10.89	62.54	62.54	62.54	54.99
23.0	1.19	55.92	10.89	66.81	66.81	66.81	56.19
24.0	1.24	60.31	10.89	71.19	71.19	71.19	57.38
25.0	1.29	64.80	10.89	75.69	75.69	75.69	58.56
26.0	1.34	69.40	10.89	80.28	80.28	80.28	59.73
27.0	1.40	74.09	10.89	84.98	84.98	84.98	60.88
28.0	1.45	78.88	28.47	107.36	107.36	107.36	74.17
29.0	1.50	83.76	28.47	112.24	112.24	112.24	74.87
30.0	1.55	89.50	28.47	117.97	117.97	117.97	76.07
31.0	1.60	95.33	28.47	123.80	123.80	123.80	77.25
32.0	1.65	101.25	28.47	129.72	129.72	129.72	78.42
33.0	1.71	107.26	28.47	135.73	135.73	135.73	79.56
34.0	1.76	113.35	28.47	141.82	141.82	141.82	80.69
35.0	1.81	119.52	28.47	147.99	147.99	147.99	81.79
36.0	1.86	125.76	28.47	154.23	154.23	154.23	82.88
37.0	1.91	132.07	28.47	160.54	160.54	160.54	83.94
38.0	1.96	138.45	28.47	166.92	166.92	166.92	84.97
39.0	2.02	144.89	28.47	173.36	173.36	173.36	85.99
40.0	2.07	151.38	28.47	179.85	179.85	179.85	86.98
41.0	2.12	157.93	28.47	186.40	186.40	186.40	87.95
42.0	2.17	164.53	28.47	193.00	193.00	193.00	88.89
43.0	2.22	171.17	28.47	199.64	199.64	199.64	89.81
44.0	2.27	177.85	28.47	206.33	206.33	206.33	90.71

Required Q_s = 170 tons
Extreme limit - Compression

Strength limit - Compression
Required Q_s = 90 tons

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.7206E-01	0.6379E-04	0.6230E-03	0.1000E-04
0.3603E+00	0.3189E-03	0.3115E-02	0.5000E-04
0.7206E+00	0.6379E-03	0.6230E-02	0.1000E-03
0.3629E+02	0.3232E-01	0.3115E+00	0.5000E-02
0.5220E+02	0.4770E-01	0.4673E+00	0.7500E-02
0.6601E+02	0.6210E-01	0.6230E+00	0.1000E-01
0.1158E+03	0.1250E+00	0.1558E+01	0.2500E-01
0.1489E+03	0.1855E+00	0.3115E+01	0.5000E-01
0.1642E+03	0.2279E+00	0.4673E+01	0.7500E-01
0.1723E+03	0.2629E+00	0.6194E+01	0.1000E+00
0.1836E+03	0.4286E+00	0.1409E+02	0.2500E+00
0.1905E+03	0.6889E+00	0.2132E+02	0.5000E+00
0.1936E+03	0.8186E+00	0.2466E+02	0.6250E+00
0.1972E+03	0.9802E+00	0.2845E+02	0.7813E+00
0.1976E+03	0.9994E+00	0.2890E+02	0.7998E+00

RESULT FROM UPPER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.1176E+00	0.9281E-04	0.8900E-03	0.1000E-04
0.5882E+00	0.4641E-03	0.4450E-02	0.5000E-04
0.1176E+01	0.9281E-03	0.8900E-02	0.1000E-03

0.5720E+02	0.4666E-01	0.4450E+00	0.5000E-02
0.7867E+02	0.6731E-01	0.6675E+00	0.7500E-02
0.9564E+02	0.8557E-01	0.8900E+00	0.1000E-01
0.1482E+03	0.1564E+00	0.2225E+01	0.2500E-01
0.1736E+03	0.2121E+00	0.4450E+01	0.5000E-01
0.1817E+03	0.2474E+00	0.6675E+01	0.7500E-01
0.1853E+03	0.2775E+00	0.8758E+01	0.1000E+00
0.1958E+03	0.4428E+00	0.1924E+02	0.2500E+00
0.2009E+03	0.7002E+00	0.2435E+02	0.5000E+00
0.2036E+03	0.8291E+00	0.2702E+02	0.6250E+00
0.2069E+03	0.9902E+00	0.3035E+02	0.7813E+00
0.2073E+03	0.1009E+01	0.3075E+02	0.7998E+00

RESULT FROM LOWER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.3837E-01	0.4062E-04	0.3560E-03	0.1000E-04
0.1918E+00	0.2031E-03	0.1780E-02	0.5000E-04
0.3837E+00	0.4062E-03	0.3560E-02	0.1000E-03
0.1949E+02	0.2049E-01	0.1780E+00	0.5000E-02
0.2893E+02	0.3070E-01	0.2670E+00	0.7500E-02
0.3790E+02	0.4066E-01	0.3560E+00	0.1000E-01
0.7919E+02	0.9197E-01	0.8900E+00	0.2500E-01
0.1208E+03	0.1565E+00	0.1780E+01	0.5000E-01
0.1452E+03	0.2072E+00	0.2670E+01	0.7500E-01
0.1588E+03	0.2479E+00	0.3631E+01	0.1000E+00
0.1713E+03	0.4145E+00	0.8936E+01	0.2500E+00
0.1800E+03	0.6776E+00	0.1830E+02	0.5000E+00
0.1837E+03	0.8081E+00	0.2230E+02	0.6250E+00
0.1875E+03	0.9702E+00	0.2655E+02	0.7813E+00
0.1880E+03	0.9894E+00	0.2705E+02	0.7998E+00

Strength-Tension.sfo

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
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SR-91 WB Widening Project - Bent 2

TOTAL LOAD = 150.0 TONS

REDUCTION FACTOR APPLIED FOR UPLIFT FRICTION = 0.700

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 46.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 1.00

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 1.00

SOIL INFORMATION

LAYER NO 1----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.500E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.500E+01
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.410E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.500E+01
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.400E+01

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.107E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.130E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.400E+01

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.670E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.130E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.290E+02

LAYER NO 3----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.773E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.340E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.290E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.463E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.340E+02
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.590E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.463E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11

DEPTH, FT = 0.590E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.255E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.380E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.100E+11
DEPTH, FT = 0.850E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM = 1.333 FT.
DIAMETER OF BASE = 1.333 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 4.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 2.010 SQ.IN.
ELASTIC MODULUS, Ec = 0.360E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED TO THE ULTIMATE SIDE RESISTANCE AND THE ULTIMATE BASE RESISTANCE.

LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	WT (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
5.0	0.26	0.91	0.52	1.44	1.44	1.44	5.56
6.0	0.31	1.98	0.63	2.61	2.61	2.61	8.42
7.0	0.36	3.20	0.73	3.94	3.94	3.94	10.88
8.0	0.41	4.57	0.84	5.40	5.40	5.40	13.07
9.0	0.47	6.07	0.94	7.01	7.01	7.01	15.07
10.0	0.52	7.70	1.05	8.75	8.75	8.75	16.93
11.0	0.57	9.47	1.15	10.62	10.62	10.62	18.68
12.0	0.62	11.36	1.26	12.61	12.61	12.61	20.33
13.0	0.67	13.37	1.36	14.73	14.73	14.73	21.91
14.0	0.72	15.49	1.47	16.95	16.95	16.95	23.43
15.0	0.78	17.72	1.57	19.29	19.29	19.29	24.88
16.0	0.83	20.07	1.67	21.74	21.74	21.74	26.29
17.0	0.88	22.51	1.78	24.29	24.29	24.29	27.64
18.0	0.93	25.06	1.88	26.94	26.94	26.94	28.95
19.0	0.98	27.70	1.99	29.68	29.68	29.68	30.22
20.0	1.03	30.43	2.09	32.52	32.52	32.52	31.46
21.0	1.09	33.25	2.20	35.45	35.45	35.45	32.65
22.0	1.14	36.16	2.30	38.46	38.46	38.46	33.82
23.0	1.19	39.15	2.41	41.55	41.55	41.55	34.95
24.0	1.24	42.22	2.51	44.73	44.73	44.73	36.05
25.0	1.29	45.36	2.62	47.98	47.98	47.98	37.12
26.0	1.34	48.58	2.72	51.30	51.30	51.30	38.17
27.0	1.40	51.86	2.83	54.69	54.69	54.69	39.18
28.0	1.45	55.22	2.93	58.15	58.15	58.15	40.17
29.0	1.50	58.63	3.04	61.67	61.67	61.67	41.14
30.0	1.55	62.65	3.14	65.79	65.79	65.79	42.42
31.0	1.60	66.73	3.25	69.97	69.97	69.97	43.67
32.0	1.65	70.87	3.35	74.22	74.22	74.22	44.87
33.0	1.71	75.08	3.45	78.53	78.53	78.53	46.04
34.0	1.76	79.34	3.56	82.90	82.90	82.90	47.17
35.0	1.81	83.66	3.66	87.32	87.32	87.32	48.26
36.0	1.86	88.03	3.77	91.80	91.80	91.80	49.33
37.0	1.91	92.45	3.87	96.32	96.32	96.32	50.36
38.0	1.96	96.91	3.98	100.89	100.89	100.89	51.36
39.0	2.02	101.42	4.08	105.50	105.50	105.50	52.33
40.0	2.07	105.97	4.19	110.15	110.15	110.15	53.27
41.0	2.12	110.55	4.29	114.84	114.84	114.84	54.18
42.0	2.17	115.17	4.40	119.57	119.57	119.57	55.07
43.0	2.22	119.82	4.50	124.32	124.32	124.32	55.93
44.0	2.27	124.50	4.61	129.10	129.10	129.10	56.76
45.0	2.33	129.20	4.71	133.91	133.91	133.91	57.57
46.0	2.38	133.93	4.82	138.75	138.75	138.75	58.35
47.0	2.43	138.63	4.92	143.55	143.55	143.55	59.08
48.0	2.48	143.29	5.02	148.32	148.32	148.32	59.77
49.0	2.53	147.92	5.13	153.05	153.05	153.05	60.42

Extreme limit - Tension
Required Qs = 40 tons

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.5618E-01	0.5674E-04	0.1122E-03	0.1000E-04
0.2809E+00	0.2837E-03	0.5612E-03	0.5000E-04
0.5618E+00	0.5674E-03	0.1122E-02	0.1000E-03
0.2832E+02	0.2868E-01	0.5612E-01	0.5000E-02
0.4106E+02	0.4251E-01	0.8417E-01	0.7500E-02
0.5231E+02	0.5558E-01	0.1122E+00	0.1000E-01
0.9350E+02	0.1137E+00	0.2806E+00	0.2500E-01
0.1207E+03	0.1701E+00	0.5612E+00	0.5000E-01
0.1329E+03	0.2098E+00	0.8417E+00	0.7500E-01
0.1390E+03	0.2427E+00	0.1116E+01	0.1000E+00
0.1435E+03	0.3992E+00	0.2538E+01	0.2500E+00
0.1445E+03	0.6510E+00	0.3841E+01	0.5000E+00
0.1450E+03	0.7769E+00	0.4442E+01	0.6250E+00
0.1455E+03	0.9341E+00	0.5126E+01	0.7813E+00
0.1456E+03	0.9527E+00	0.5206E+01	0.7998E+00

RESULT FROM UPPER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.9036E-01	0.8111E-04	0.1603E-03	0.1000E-04
0.4518E+00	0.4055E-03	0.8017E-03	0.5000E-04
0.9036E+00	0.8111E-03	0.1603E-02	0.1000E-03
0.4440E+02	0.4080E-01	0.8017E-01	0.5000E-02
0.6198E+02	0.5938E-01	0.1202E+00	0.7500E-02
0.7612E+02	0.7604E-01	0.1603E+00	0.1000E-01
0.1203E+03	0.1417E+00	0.4008E+00	0.2500E-01
0.1411E+03	0.1936E+00	0.8017E+00	0.5000E-01
0.1466E+03	0.2260E+00	0.1202E+01	0.7500E-01
0.1484E+03	0.2537E+00	0.1578E+01	0.1000E+00
0.1503E+03	0.4068E+00	0.3466E+01	0.2500E+00
0.1512E+03	0.6583E+00	0.4386E+01	0.5000E+00
0.1517E+03	0.7841E+00	0.4867E+01	0.6250E+00
0.1523E+03	0.9413E+00	0.5468E+01	0.7813E+00
0.1524E+03	0.9599E+00	0.5540E+01	0.7998E+00

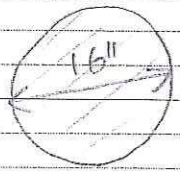
RESULT FROM LOWER-BOUND LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.3045E-01	0.3699E-04	0.6413E-04	0.1000E-04
0.1522E+00	0.1850E-03	0.3207E-03	0.5000E-04
0.3045E+00	0.3699E-03	0.6413E-03	0.1000E-03
0.1541E+02	0.1861E-01	0.3207E-01	0.5000E-02
0.2295E+02	0.2791E-01	0.4810E-01	0.7500E-02
0.3013E+02	0.3701E-01	0.6413E-01	0.1000E-01
0.6361E+02	0.8436E-01	0.1603E+00	0.2500E-01
0.9777E+02	0.1447E+00	0.3207E+00	0.5000E-01
0.1181E+03	0.1927E+00	0.4810E+00	0.7500E-01
0.1293E+03	0.2315E+00	0.6542E+00	0.1000E+00
0.1367E+03	0.3917E+00	0.1610E+01	0.2500E+00
0.1378E+03	0.6438E+00	0.3296E+01	0.5000E+00
0.1383E+03	0.7697E+00	0.4018E+01	0.6250E+00
0.1387E+03	0.9269E+00	0.4784E+01	0.7813E+00
0.1387E+03	0.9455E+00	0.4873E+01	0.7998E+00

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening - State College Blvd. UC. Project No.: 10-126
By: Ranjan Date: 3/23/11 Checked By: Lino Date: _____ Sheet: 1 of 1
Subject:

LATERAL PILE ANALYSES - STATE COLLEGE BLVD. UC



CTDH

Area = 201.1 in^2

$I = \pi/4 \times 8^4 = 3220\ in^4$

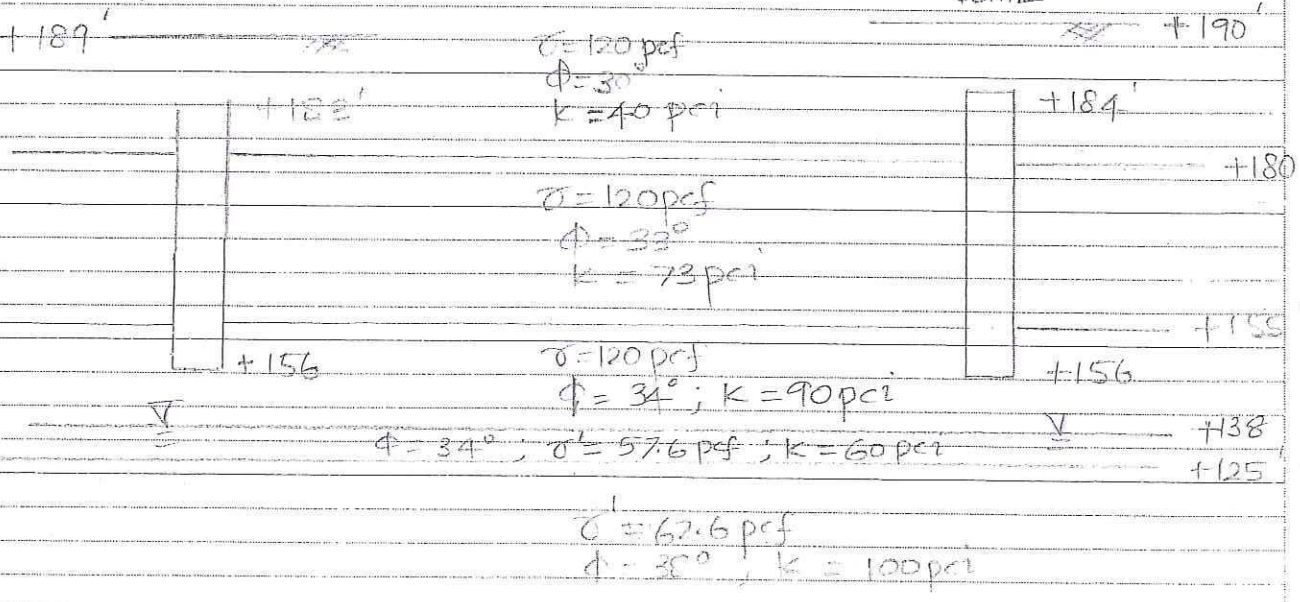
$E = 3.6 \times 10^6$ psi

USE 50% EI & FREE-HEAD CONDITIONS

δ = 0.25", 0.5", 1", 3", and 5"

Using Group 7.0, group reduction factor(η) for

Abutments = 0.60
Bent 2 = 0.62

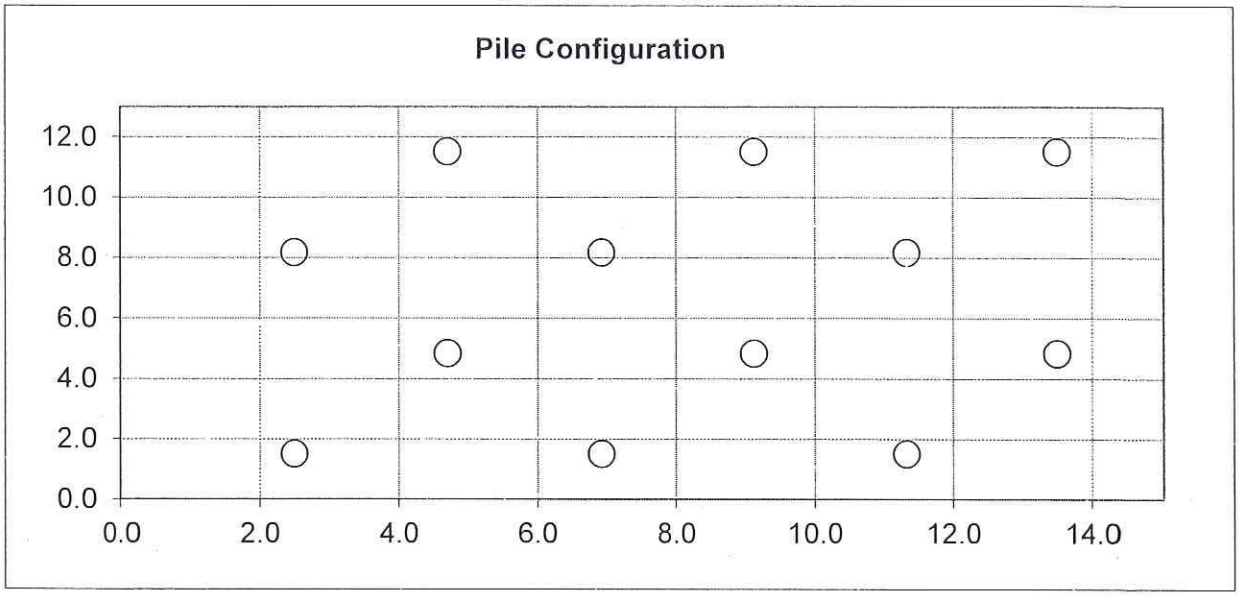


17660 Newhope Street, Suite E, Fountain Valley, CA 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

Project: SR-91 WB Widening - State College Blvd. UC Abutments

By: Ranjan 3/25/2011

Calculation of Pile Group Efficiency (using formula in Group 7.0 Technical Manual)



Pile Dia.:	1.330
No. of Piles:	12

Group Efficiency	X-Dir (Trans)	Y-Dir (Long)
	0.601	0.611

Pile No.	X (Transverse)	Y (Longitudinal)
1	2.500	1.50
2	6.920	1.50
3	11.330	1.50
4	4.710	4.83
5	9.130	4.83
6	13.500	4.83
7	2.500	8.16
8	6.920	8.16
9	11.330	8.16
10	4.710	11.50
11	9.130	11.50
12	13.500	11.50

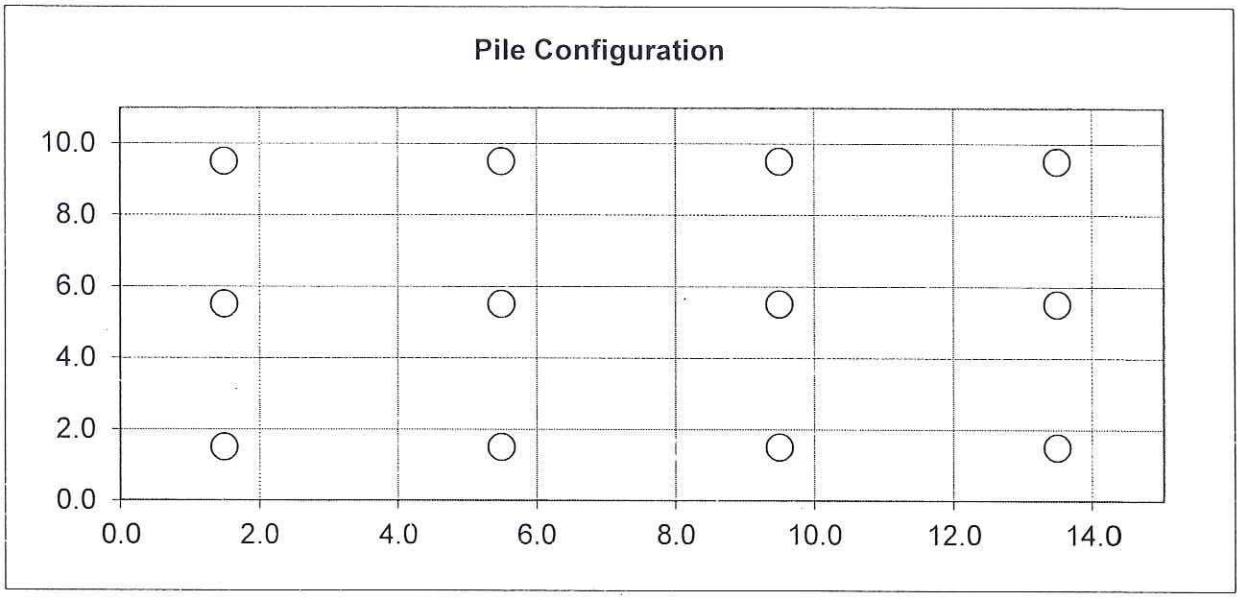
Reduction Factors in X-dir	Reduction Factors in Y-dir
0.603	0.645
0.543	0.476
0.777	0.510
0.427	0.446
0.470	0.411
0.823	0.594
0.495	0.703
0.415	0.502
0.633	0.518
0.561	0.836
0.579	0.802
0.887	0.892

SELECT $\eta = 0.6$

Project: SR-91 WB Widening - State College Blvd. UC Bent

By: Ranjan 3/25/2011

Calculation of Pile Group Efficiency (using formula in Group 7.0 Technical Manual)



Pile Dia.: 1.330

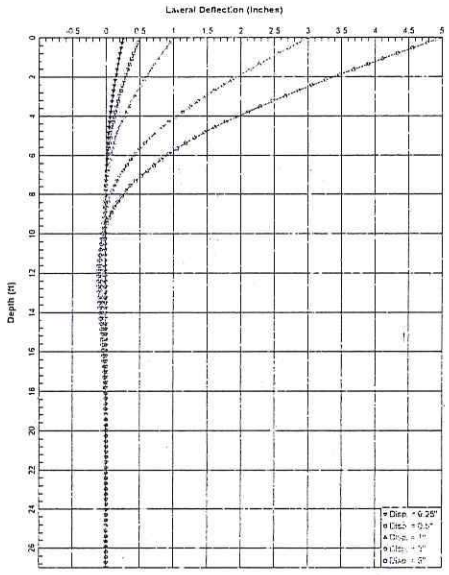
No. of Piles: 12

Group Efficiency	X-Dir (Trans)	Y-Dir (Long)
	0.620	0.640

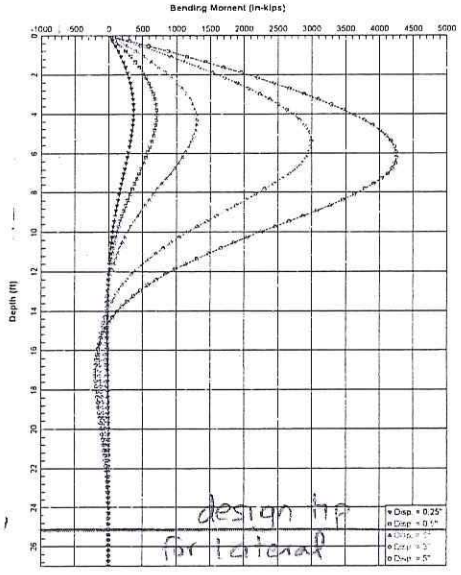
Pile No.	X (Transverse)	Y (Longitudinal)
1	1.500	1.50
2	5.500	1.50
3	9.500	1.50
4	13.500	1.50
5	1.500	5.50
6	5.500	5.50
7	9.500	5.50
8	13.500	5.50
9	1.500	9.50
10	5.500	9.50
11	9.500	9.50
12	13.500	9.50

Reduction Factors in X-dir	Reduction Factors in Y-dir
0.587	0.587
0.547	0.499
0.581	0.499
0.867	0.587
0.500	0.581
0.466	0.497
0.498	0.497
0.807	0.581
0.587	0.867
0.547	0.807
0.581	0.807
0.867	0.867

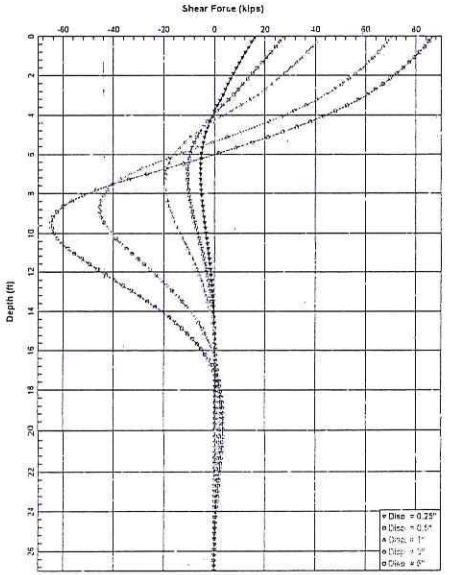
SELECT $\eta = 0.62$



State College Blvd, UC - Abuts 1 & 3 - 16-in CIDH - Free



State College Blvd, UC - Abuts 1 & 3 - 16-in CIDH - Free



State College Blvd, UC - Abuts 1 & 3 - 16-in CIDH - Free

LPile Plus for Windows, Version 6.0 (6.0.09)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

(c) 1985-2010 by Ensoft, Inc.
All Rights Reserved

This program is licensed to:

Files Used for Analysis

Path to file locations: X:\Projects\2010\10-126 - RBF SR 91 Westbound Widening\Reports\Foundation Report\State College Blvd UC\Analyses\LPILE\Abuts 1 and 3\6-ft Overburden\
Name of input data file: 16-inch CIDH pile.lp6d
Name of output file: 16-inch CIDH pile.lp6o
Name of plot output file: 16-inch CIDH pile.lp6p
Name of runtime file: 16-inch CIDH pile.lp6r

Date and Time of Analysis

Date: March 29, 2011 Time: 10:09:32

Problem Title

Project Name: SR-91 WB Widening

Job Number: 10-126

Client:

Engineer: GJG

Description: 16-inch CIDH at State College Blvd. UC Abuts 1 & 3

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	300	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections	=	1
Total Pile Length	=	27.00 ft
Depth of ground surface below top of pile	=	-6.00 ft
Slope angle of ground surface	=	0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	16.0000000
2	27.000000	16.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	27.000 in
Top Width	=	16.000 in
Bottom Width	=	16.000 in
Top Area	=	201.061930 sq. in
Bottom Area	=	201.061930 sq. in
Moment of Inertia at Top	=	3.217E+03 in^4
Moment of Inertia at Bottom	=	3.217E+03 in^4
Elastic Modulus	=	1800000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 5 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer	=	-6.000 ft
Distance from top of pile to bottom of layer	=	3.000 ft
p-y subgrade modulus k for top of soil layer	=	45.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	45.000 lbs/in**3

Layer 2 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer	=	3.000 ft
Distance from top of pile to bottom of layer	=	28.000 ft
p-y subgrade modulus k for top of soil layer	=	73.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	73.000 lbs/in**3

Layer 3 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer	=	28.000 ft
Distance from top of pile to bottom of layer	=	45.000 ft
p-y subgrade modulus k for top of soil layer	=	90.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	90.000 lbs/in**3

Layer 4 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer	=	45.000 ft
Distance from top of pile to bottom of layer	=	58.000 ft
p-y subgrade modulus k for top of soil layer	=	60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer	=	60.000 lbs/in**3

Layer 5 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 58.000 ft
Distance from top of pile to bottom of layer = 100.000 ft
p-y subgrade modulus k for top of soil layer = 100.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 100.000 lbs/in**3

(Depth of lowest layer extends 73.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 10 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	-6.00	120.00000
2	3.00	120.00000
3	3.00	120.00000
4	28.00	120.00000
5	28.00	120.00000
6	45.00	120.00000
7	45.00	57.60000
8	58.00	57.60000
9	58.00	62.60000
10	100.00	62.60000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. Subgr. pci
1	API Sand	-6.000	120.000	--	30.000	--	--	--	45.000	--	--	--	--	--
		3.000	120.000	--	30.000	--	--	--	45.000	--	--	--	--	--
2	API Sand	3.000	120.000	--	33.000	--	--	--	73.000	--	--	--	--	--
		28.000	120.000	--	33.000	--	--	--	73.000	--	--	--	--	--
3	API Sand	28.000	120.000	--	34.000	--	--	--	90.000	--	--	--	--	--
		45.000	120.000	--	34.000	--	--	--	90.000	--	--	--	--	--
4	API Sand	45.000	57.600	--	34.000	--	--	--	60.000	--	--	--	--	--
		58.000	57.600	--	34.000	--	--	--	60.000	--	--	--	--	--
5	API Sand	58.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--
		100.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.6000	1.0000
2	27.000	0.6000	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	85000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	85000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	85000.000
4	4	y =	3.000 in	M =	0.000 in-lbs	85000.000

5 4 y = 5.000 in M = 0.000 in-lbs 85000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

---

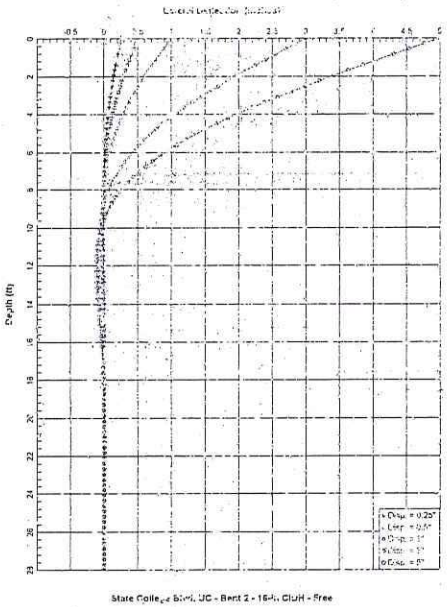
Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

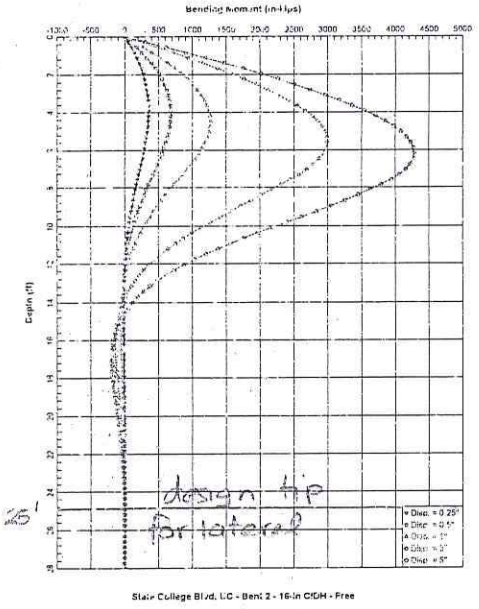
Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)	Condition 2 in-lb, rad., or in-lb/rad.	Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y = 0.2500	M = 0.000	85000.	0.25000000	357423.	14980.	0.00000000
2	4	y = 0.5000	M = 0.000	85000.	0.50000000	708825.	27461.	0.00000000
3	4	y = 1.0000	M = 0.000	85000.	1.00000000	1299543.	42030.	0.00000000
4	4	y = 3.0000	M = 0.000	85000.	3.00000000	2988902.	79229.	0.00000000
5	4	y = 5.0000	M = 0.000	85000.	5.00000000	4252153.	86781.	0.00000000

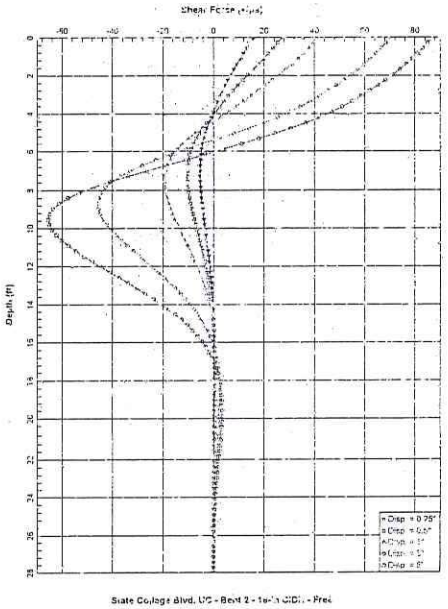
The analysis ended normally.



State College Blvd. UC - Bent 2 - 16-in CIDH - Free



State College Blvd. UC - Bent 2 - 16-in CIDH - Free



State College Blvd. UC - Bent 2 - 16-in CIDH - Free

LPile Plus for Windows, Version 6.0 (6.0 09)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

(c) 1985-2010 by Ensoft, Inc.
All Rights Reserved

This program is licensed to:

Files Used for Analysis

Path to file locations: X:\Projects\2010\10-126 - RBF SR 91 Westbound Widening\Reports\Foundation Report\State College Blvd UC\Analyses\LPILE\Bent 2\
Name of input data file: 16-inch CIDH pile.lp6d
Name of output file: 16-inch CIDH pile.lp6o
Name of plot output file: 16-inch CIDH pile.lp6p
Name of runtime file: 16-inch CIDH pile.lp6r

Date and Time of Analysis

Date: March 29, 2011 Time: 10:12:09

Problem Title

Project Name: SR-91 WB Widening

Job Number: 10-126

Client:

Engineer: GJG

Description: 16-inch CIDH at State College Blvd. UC Bent 2

Program Options

Units Used - US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes nonlinear bending stiffness and nominal Moment
Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis uses p-y multipliers for group action
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output summary table of values for pile-head deflection, maximum bending moment, and shear force only
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:

- Number of pile increments	=	100	
- Maximum number of iterations allowed	=	300	
- Deflection tolerance for convergence	=	1.0000E-05	in
- Maximum allowable deflection	=	100.0000	in

Pile Response Output Options:
- Only summary tables of pile-head deflection, maximum bending moment, and maximum shear force are to be written to output report file.

Pile Structural Properties and Geometry

Total Number of Sections = 1

Total Pile Length = 28.00 ft

Depth of ground surface below top of pile = -6.00 ft

Slope angle of ground surface = 0.00 deg.

Pile dimensions used for p-y curve computations defined using 2 points.
p-y curves are computed using values of pile diameter interpolated over the length of the pile.

Point	Depth X ft	Pile Diameter in
1	0.00000	16.0000000
2	28.000000	16.0000000

Input Structural Properties:

Section No. 1:

Section Type	=	Elastic Pile
Cross-sectional Shape	=	Circular
Section Length	=	28.000 in
Top Width	=	16.000 in
Bottom Width	=	16.000 in
Top Area	=	201.061930 sq. in
Bottom Area	=	201.061930 sq. in
Moment of Inertia at Top	=	3.217E+03 in^4
Moment of Inertia at Bottom	=	3.217E+03 in^4
Elastic Modulus	=	1800000.000 lbs/in

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 5 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = -6.000 ft
Distance from top of pile to bottom of layer = 4.000 ft
p-y subgrade modulus k for top of soil layer = 45.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 45.000 lbs/in**3

Layer 2 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 4.000 ft
Distance from top of pile to bottom of layer = 29.000 ft
p-y subgrade modulus k for top of soil layer = 73.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 73.000 lbs/in**3

Layer 3 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 29.000 ft
Distance from top of pile to bottom of layer = 46.000 ft
p-y subgrade modulus k for top of soil layer = 90.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 90.000 lbs/in**3

Layer 4 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 46.000 ft
Distance from top of pile to bottom of layer = 59.000 ft
p-y subgrade modulus k for top of soil layer = 60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 60.000 lbs/in**3

Layer 5 is sand, p-y criteria by API RP-2A, 1987

Distance from top of pile to top of layer = 59.000 ft
Distance from top of pile to bottom of layer = 100.000 ft
p-y subgrade modulus k for top of soil layer = 100.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 100.000 lbs/in**3

(Depth of lowest layer extends 72.00 ft below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 10 points

Point No.	Depth X ft	Eff. Unit Weight pcf
1	-6.00	120.00000
2	4.00	120.00000
3	4.00	120.00000
4	29.00	120.00000
5	29.00	120.00000
6	46.00	120.00000
7	46.00	57.60000
8	59.00	57.60000
9	59.00	62.60000
10	100.00	62.60000

Summary of Soil Properties

Layer Num.	Soil Type (p-y Curve Criteria)	Depth ft	Eff. Unit Wt., pcf	Cohesion psf	Friction Ang., deg.	qu psi	RQD percent	Epsilon 50	kpy pci	Rock Emass psi	krm	Test Type	Test Prop.	Elas. Subgr. pci
1	API Sand	-6.000	120.000	--	30.000	--	--	--	45.000	--	--	--	--	--
		4.000	120.000	--	30.000	--	--	--	45.000	--	--	--	--	--
2	API Sand	4.000	120.000	--	33.000	--	--	--	73.000	--	--	--	--	--
		29.000	120.000	--	33.000	--	--	--	73.000	--	--	--	--	--
3	API Sand	29.000	120.000	--	34.000	--	--	--	90.000	--	--	--	--	--
		46.000	120.000	--	34.000	--	--	--	90.000	--	--	--	--	--
4	API Sand	46.000	57.600	--	34.000	--	--	--	60.000	--	--	--	--	--
		59.000	57.600	--	34.000	--	--	--	60.000	--	--	--	--	--
5	API Sand	59.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--
		100.000	62.600	--	38.000	--	--	--	100.000	--	--	--	--	--

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.6200	1.0000
2	28.000	0.6200	1.0000

Loading Type

p-y criteria for static loading was used for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 5

Load No.	Load Type	Condition 1		Condition 2		Axial Thrust Force, lbs
1	4	y =	0.250 in	M =	0.000 in-lbs	85000.000
2	4	y =	0.500 in	M =	0.000 in-lbs	85000.000
3	4	y =	1.000 in	M =	0.000 in-lbs	85000.000
4	4	y =	3.000 in	M =	0.000 in-lbs	85000.000

5 4 y = 5.000 in M = 0.000 in-lbs 85000.000

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust values were determined from pile-head loading conditions

Number of Sections = 1

Section No. 1:

Moment-Curvature properties derived from elastic section properties

---

Summary of Pile Response(s)

Definitions of Pile-Head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians

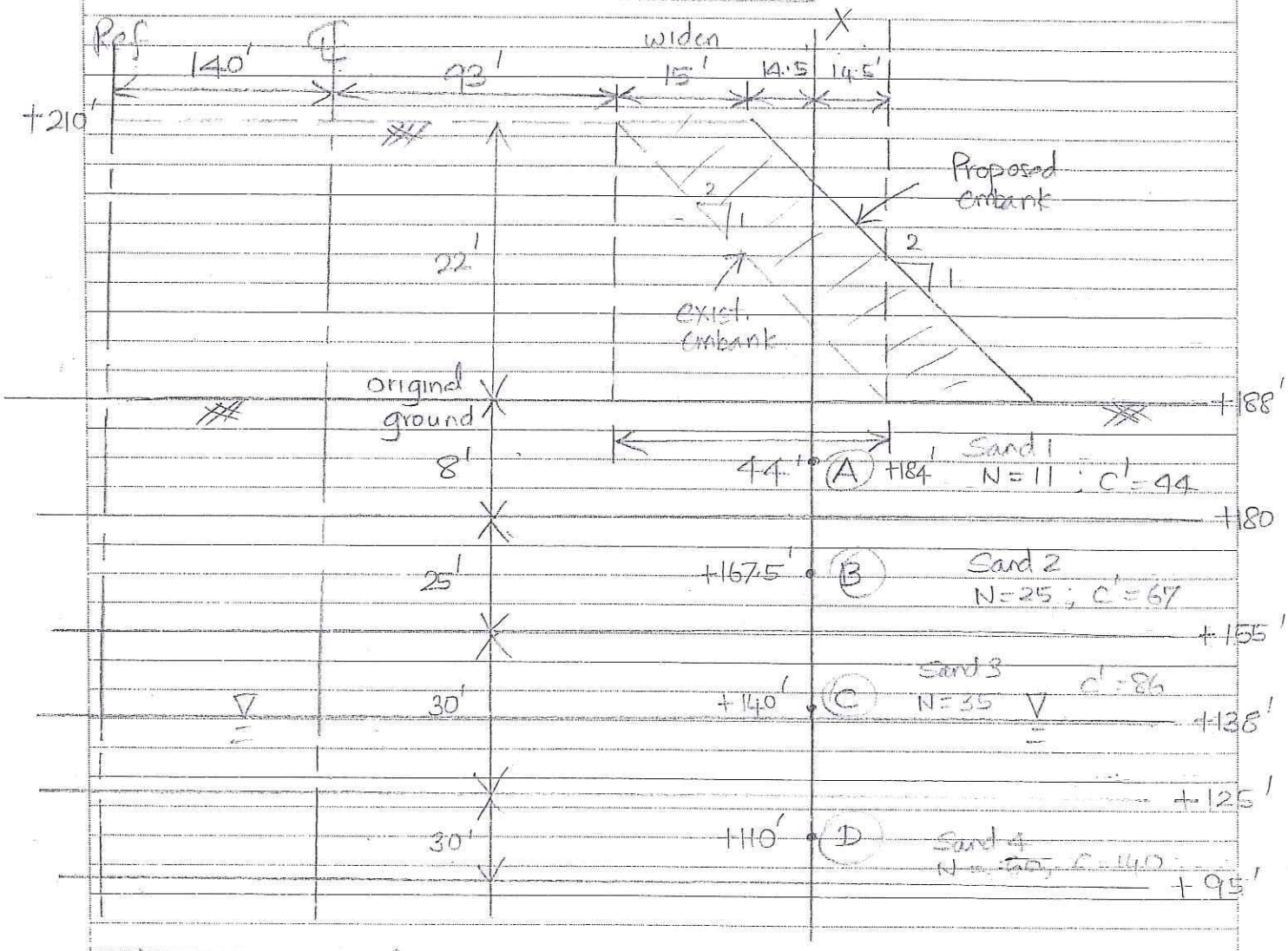
Load Case No.	Load Type No.	Condition 1 V(lbs) or y(inches)	Condition 2 in-lb, rad., or in-lb/rad.	Axial Load lbs	Pile-Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs	Pile-Head Rotation radians
1	4	y = 0.2500	M = 0.000	85000.	0.25000000	352877.	15864.	0.00000000
2	4	y = 0.5000	M = 0.000	85000.	0.50000000	684018.	27118.	0.00000000
3	4	y = 1.0000	M = 0.000	85000.	1.00000000	1271530.	41420.	0.00000000
4	4	y = 3.0000	M = 0.000	85000.	3.00000000	2993326.	70208.	0.00000000
5	4	y = 5.0000	M = 0.000	85000.	5.00000000	4276456.	86838.	0.00000000

The analysis ended normally.

Project: SR-91 WB Widening - State College Blvd. UC. Project No.: 10-126
By: Ranjan Date: 3/23/11 Checked By: Lino Date: 3/30/11 Sheet: 1 of 2
Subject:

STATE COLLEGE BLVD. UC

Embankment Settlement Calculations



Using AASHTO Eq^n 10.6.2.4.2-3,

$$\Delta H_i = \frac{H_i}{C_i} \log\left(\frac{\sigma_i' + \Delta\sigma'}{\sigma_i'}\right)$$

σ_0' - stress below original ground

$\Delta\sigma_1'$ - stress increase due to existing embankment

$\therefore$ Total Initial stress $\sigma_i' = \sigma_0 + \Delta\sigma_1'$

$\Delta\sigma_2'$ - stress increase due to proposed embankment

$\therefore$ stress increase due to widening ($\Delta\sigma'$) = $\Delta\sigma_2' - \Delta\sigma_1'$

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening - State College Blvd. UC. Project No.: 10-126
By: Ranjan Date: 3/23/11 Checked By: Lino Date: _____ Sheet: 2 of 2
Subject:

layer	Mid Point	Thick H (ft)	$\bar{\sigma}_o'$ (ksf)	$\Delta\sigma_1'$ (ksf)	$\bar{\sigma}_1'$ (ksf)	$\Delta\sigma_2'$ (ksf)	$\Delta\sigma'$ (ksf)	C'	ΔH_i (in.)
Sand 1	A	8	0.48	0.87	1.35	1.77	0.9	41	0.48
Sand 2	B	25	2.46	0.95	3.41	1.69	0.74	67	0.38
Sand 3	C	30	5.76	1.09	6.85	1.55	0.46	86	0.12
Sand 4	D	30	7.67	1.15	8.82	1.46	0.31	140	0.04

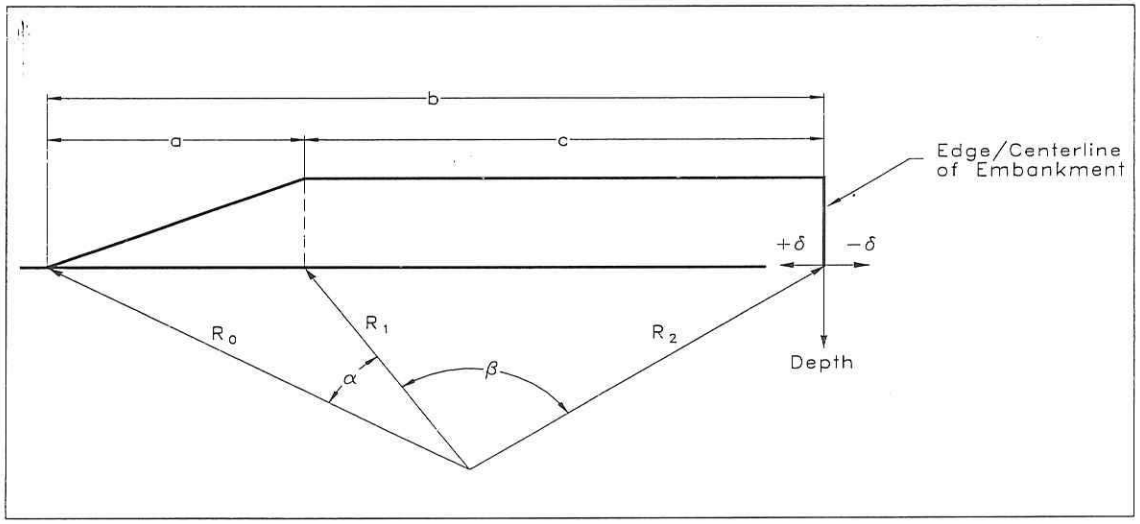
$\Sigma \Delta H_i = 1.02"$

$\Rightarrow$ Total Settlement of about 1 inch is estimated due to placement of widening fill. //

17660 Newhope Street, Suite E, Fountain Valley, CA 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

Stress at Various Points Below an Earth Embankment

Equation of Stress Given Below (Poulos & Davis P. 40):



Variables Defined in Adjacent Figure
Soil Unit Weight = 120 PCF

NOTE: ONLY CHANGE VARIABLES IN HIGHLIGHTED CELLS

Embankment Height =	22	a =	44
Embankment Width (Top)	233	b =	277
Side Slope Ratio (x:1) =	2.000	c =	233

Point X
Delta 262.5

Actual Depth (feet)	R2 (feet)	alpha (radians)	beta (radians)	SigmaZ (ksf)
4	263	2.73765	0.11953	**0.87**
20.5	263	1.57911	0.52937	**0.95**
48	267	0.84444	0.83886	**1.09**
78	274	0.54538	0.92039	**1.15**

$\Delta\sigma_1$

Point X (Final)

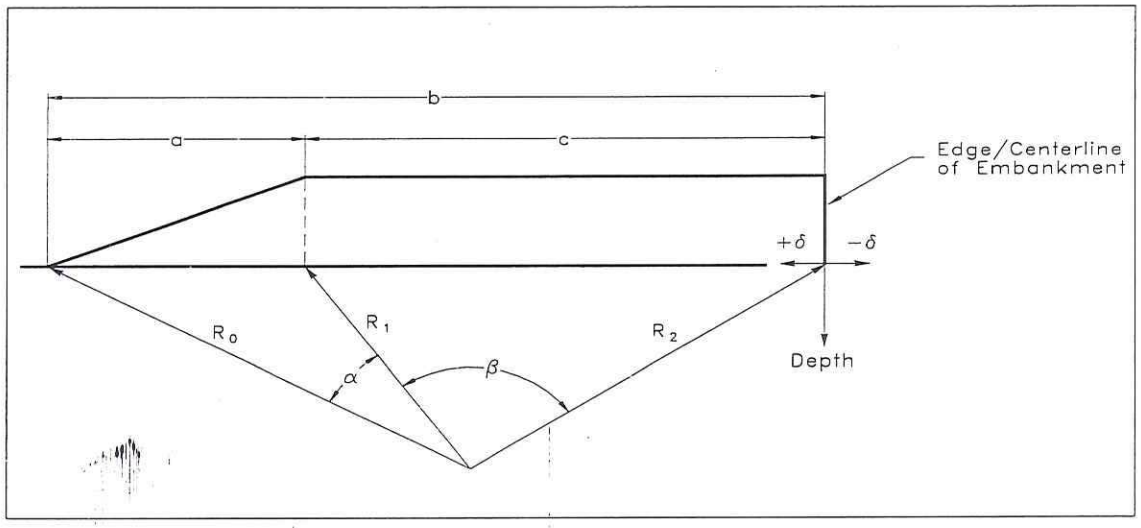
SigmaZ (ksf)
0.87
0.95
1.09
1.15

Existing Fill-State College Blv

3/29/2011

Stress at Various Points Below an Earth Embankment

Equation of Stress Given Below (Poulos & Davis P. 40):



Variables Defined in Adjacent Figure
Soil Unit Weight = 120 PCF

NOTE: ONLY CHANGE VARIABLES IN HIGHLIGHTED CELLS

Embankment Height =	22	a =	44
Embankment Width (Top)	248	b =	292
Side Slope Ratio (x:1) =	2.000	c =	248

Point X
Delta 262.5

Actual Depth (feet)	R2 (feet)	alpha (radians)	beta (radians)	SigmaZ (ksf)
4	263	2.73765	0.25393	**1.77**
20.5	263	1.57911	0.87724	**1.69**
48	267	0.84444	1.09657	**1.55**
78	274	0.54538	1.09816	**1.46**

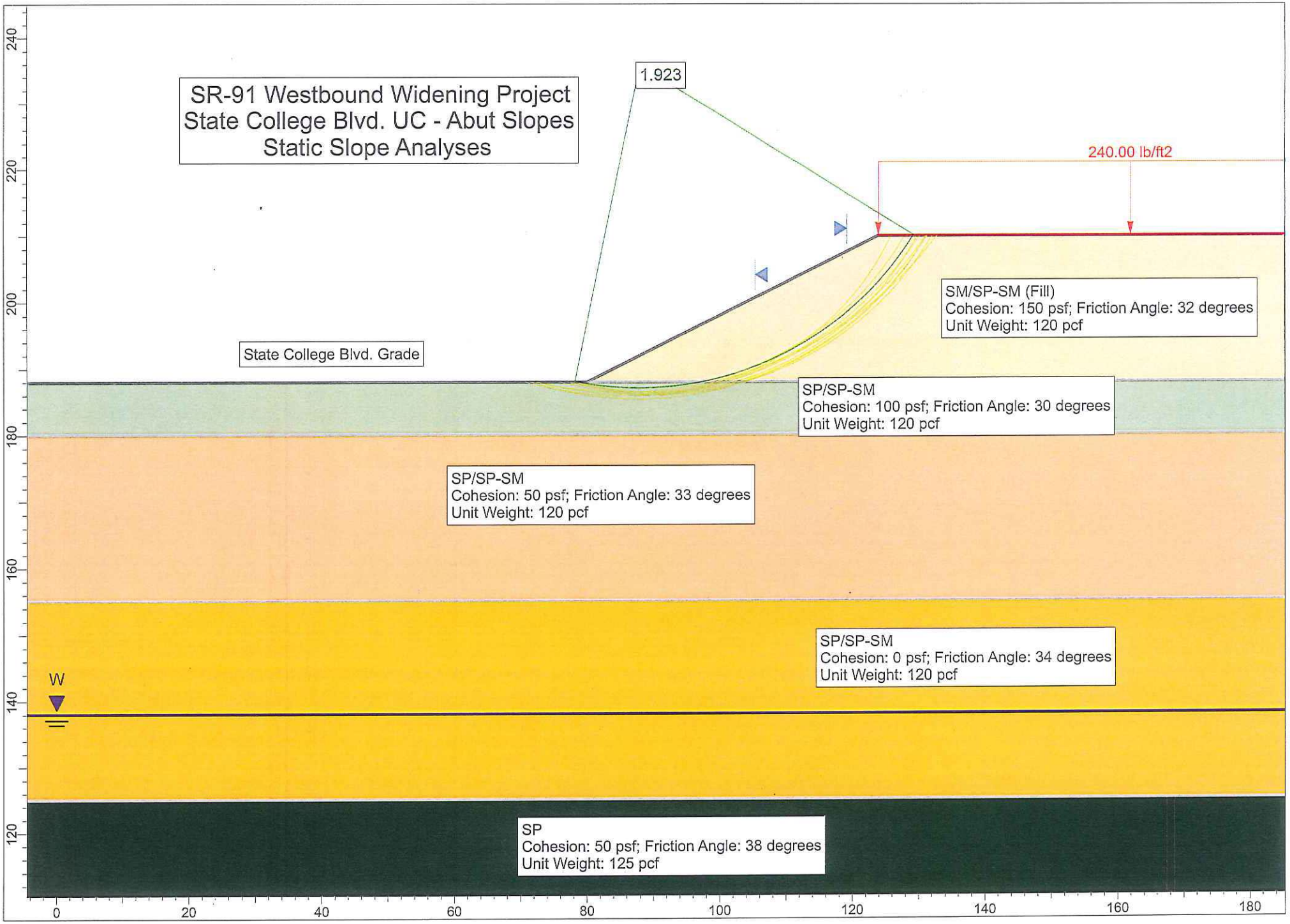
$\Delta\sigma_2$

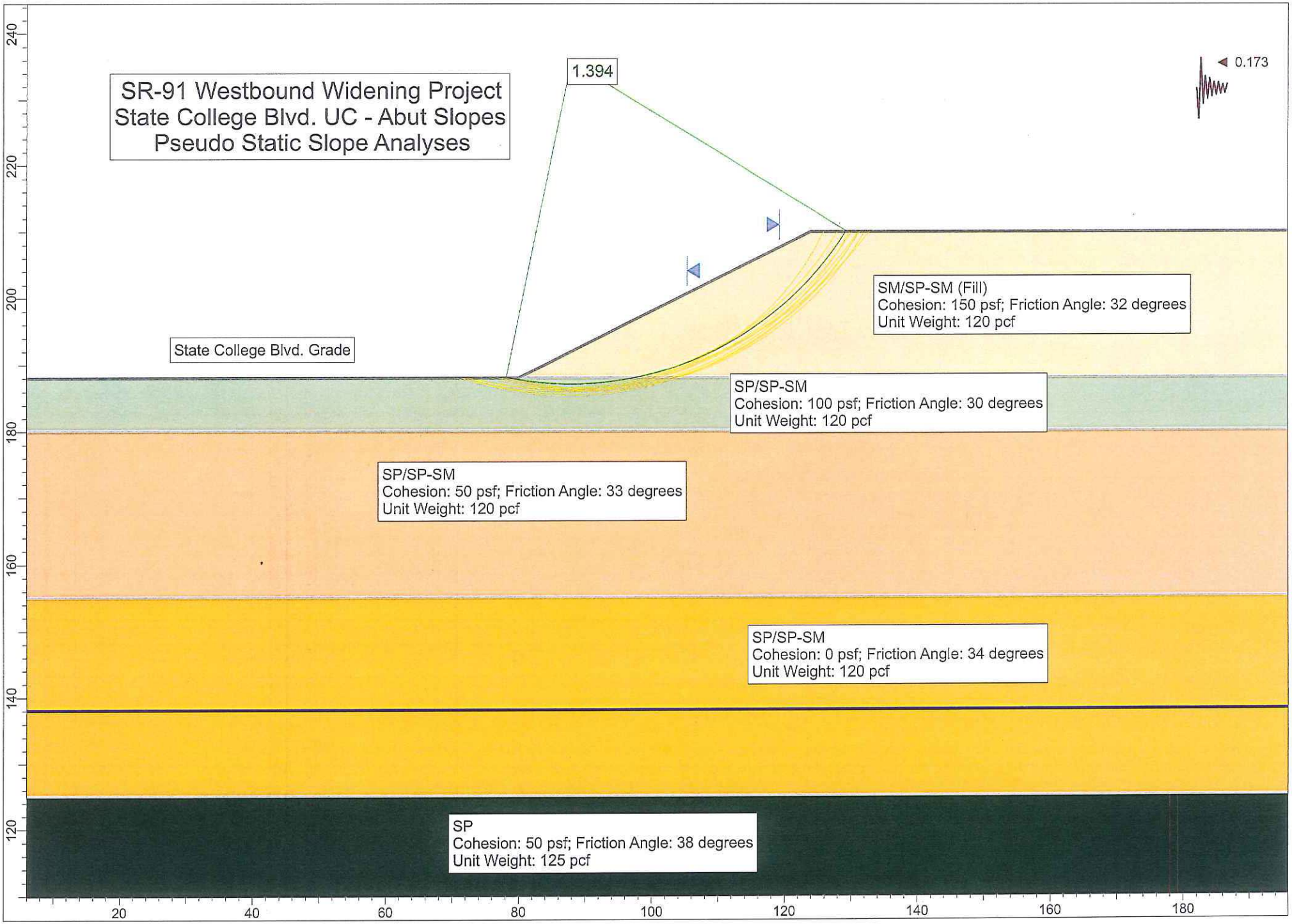
Point X (Final)

SigmaZ (ksf)
1.77
1.69
1.55
1.46

Future Fill -State College Blv

3/29/2011

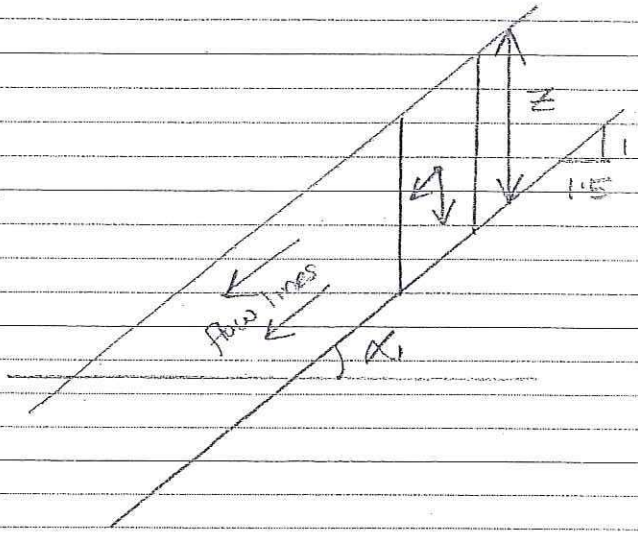

SR-91 Westbound Widening Project
State College Blvd. UC - Abut Slopes
Static Slope Analyses
1.923
240.00 lb/ft2
SM/SP-SM (Fill)
Cohesion: 150 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
State College Blvd. Grade
SP/SP-SM
Cohesion: 100 psf; Friction Angle: 30 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 33 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 0 psf; Friction Angle: 34 degrees
Unit Weight: 120 pcf
W
SP
Cohesion: 50 psf; Friction Angle: 38 degrees
Unit Weight: 125 pcf
240
220
200
180
160
140
120
0
20
40
60
80
100
120
140
160
180


SR-91 Westbound Widening Project
State College Blvd. UC - Abut Slopes
Pseudo Static Slope Analyses
1.394
0.173
State College Blvd. Grade
SM/SP-SM (Fill)
Cohesion: 150 psf; Friction Angle: 32 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 100 psf; Friction Angle: 30 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 50 psf; Friction Angle: 33 degrees
Unit Weight: 120 pcf
SP/SP-SM
Cohesion: 0 psf; Friction Angle: 34 degrees
Unit Weight: 120 pcf
SP
Cohesion: 50 psf; Friction Angle: 38 degrees
Unit Weight: 125 pcf
240
220
200
180
160
140
120
20
40
60
80
100
120
140
160
180

Earth Mechanics, Inc.
Geotechnical & Earthquake Engineering

Project: SR-91 WB Widening - State College Blvd. UC. Project No.: 10-126
By: Ranjan Date: 3/23/11 Checked By: Lino Date: 3/30/11 Sheet: 1 of 1
Subject:

Surficial Slope Stability Analysis



For 1.5H : 1V Slope,

$\alpha = \tan^{-1}\left(\frac{1}{1.5}\right)$

$= 33.7^\circ$

Cosider the thickness of Slide $Z = 4$ ft

Assume $\gamma_t = 120$ pcf

$\gamma_b = 120 - 62.4$

$= 57.6$ pcf

Assume $\phi = 32^\circ$ & $C = 230$ psf

$$\therefore FOS = \frac{2Z\gamma_b \cos^2\alpha \tan\phi + 2C}{Z\gamma_t \sin 2\alpha}$$

$$= \frac{(2 \times 4' \times 57.6 \times \cos^2 33.7 \times \tan 32) + (2 \times 230)}{4' \times 120 \times \sin 67.4^\circ}$$

$$= 1.5$$

$\Rightarrow$ If Slope paving is not used for the 1.5H : 1V Slopes, the upper 4-ft of slope-face should have a minimum $\phi = 32^\circ$ & $C = 230$ psf //

17660 Newhope Street, Suite E, Fountain Valley, CA 92708 Tel: (714) 751-3826 Fax: (714) 751-3928

Appendix D

CALTRANS REVIEW COMMENTS AND EMI RESONSES

State of California

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: LUQI YANG
Liaison Engineer

Date: May 2, 2011

File: 12-ORA-91 PM Various
EA 12-0C5701, 1200000079
Brookhurst Ave UC + 5Br.
No. 55-0280 + 5

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
Geotechnical Services
Office of Geotechnical Design – South 1

Subject: Foundation Report- Bridge No. 55-0216, 55-0218, 55-0245, 55-0279, 55-0280 & 55-852

Per your request, the Geotechnical Design South 1 - Branch B has reviewed the subject submittal, containing the following item:

1. Foundation Reports for No. 55-0216, 55-0218, 55-0245, 55-0279, 55-0280 & 55-852, Anaheim, Orange County, dated April 15, 2011.

Our office has no comments on above submitted item.

Should you have any questions, please contact Mushtaq Ahmed at (213) 620-2132.

Reviewed by: Date: 5/2/11

Mushtaq Ahmed, P.E.
Transportation Engineer-Civil
Office of Geotechnical Design – South 1
Branch B

Supervised by: Date: 5/2/11

Sam Sukiasian, G.E.
Chief Branch B
Office of Geotechnical Design – South 1

cc: OGDS1 – Nor. File, OGDS1- Sac. File, GS-Sac. File

REGISTERED CIVIL ENGINEER
MOHAMMAD MUSHTAQ AHMED
No. C056390
Exp. 6-30-11
STATE OF CALIFORNIA

PROJECT REPORT

AECOM

June 16, 2010

12-Ora-91
PM 0.9/5.4
EA 0C5700
May 2010

PROJECT REPORT

To Provide Project Approval

On Westbound Route 91 from Route 57 to Interstate 5

I have reviewed the right-of-way information contained in this Project Report and the R/W Data Sheet attached hereto, and find the data to be complete, current, and accurate:

6/2/10

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Right-of-Way Branch Chief, Project Coordination

APPROVAL RECOMMENDED:

6/2/10

Andrew Oshrin *Date*
Branch Chief, Design Branch D

6/1/10

Leo Chen *Date*
Project Manager

APPROVED:

6/16/10

Jim Beil, *Date*
Deputy District Director, Capital Outlay Program

12-Ora-91
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REGISTERED CIVIL ENGINEER CERTIFICATION

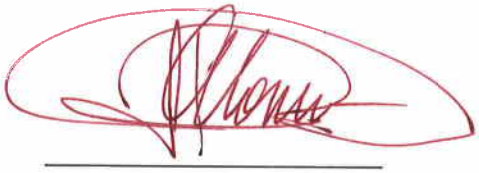
This Project Report has been prepared under the direction of the following registered civil engineer. The registered civil engineer attests to the technical information contained herein and the engineering data upon which recommendations, conclusions, and decisions are based.

5-24-10

Chris Bretall
REGISTERED CIVIL ENGINEER

Date

APPROVAL RECOMMENDED BY:



5/25/10

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Date

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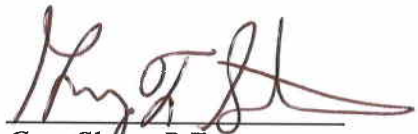

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1. INTRODUCTION

The California Department of Transportation (Department), in cooperation with the Orange County Transportation Authority (OCTA), and the cities of Anaheim and Fullerton, propose to widen westbound State Route 91 (SR-91) from State Route 57 (SR-57) to Interstate 5 (I-5). The proposed project is located in Orange County on SR-91 between SR-57 (to the east) and I-5 (to the west) and traverses through the city of Anaheim and the city of Fullerton. The proposed project limits cover a distance of 4.5 miles; however, actual improvements are limited to a total of 3.8 miles within the project area.

The proposed project is included in the Southern California Association of Governments (SCAG's) 2008 Regional Transportation Plan (RTP) as project 2M01126 and the 2008 cost-constrained Regional Transportation Improvement Program (RTIP) (project ID No. ORA000822). It is also included in OCTA's Long-Range RTP (LRTP), which was adopted by OCTA in July 2006. According to the 2008 RTIP, the proposed project is funded by the CARH3 program. In accordance with the Project Development Procedures Manual (PDPM), the project is designated as a Category 4A project because it requires the acquisition of additional right-of-way and increases traffic capacity.

The recommended Preferred Alternative (Alternative 2) consists of the mainline widening that connects the existing auxiliary lanes through each interchange and the addition of two-lane exit ramps and associated auxiliary lanes at the westbound exit ramps to Raymond Avenue, Lemon Street, Euclid Street and Brookhurst Road. The estimated right-of-way and construction costs of Alternative 2 are approximately $48.9 million, as shown in Attachment B.

2. RECOMMENDATION

It is recommended that Alternative 2 be selected for approval as the Preferred Alternative and the project proceed to the design phase. Throughout the progression of the Project Report all affected local agencies have been consulted with respect to the recommended plan, their views have been considered and the local agencies are in general accord with the plan as presented.

3. BACKGROUND

Project History

During the early-1990's, SR-91 consisted of three general purpose lanes in each direction within the project limits. In the mid-1990's, the freeway was reconstructed by adding one HOV lane in each direction and westbound auxiliary lanes which completely reconfigured the interchanges at Lemon Street and Harbor Boulevard. The SR-91/Lemon Street-Harbor Boulevard split diamond interchange segment was constructed to include one HOV lane plus four general purpose lanes in each direction. At the time the SR-91 was widened in the 1990's, the need for a wider facility (i.e., a westbound fourth continuous general purpose lane) was not considered urgent enough to prompt the construction of more than three westbound general purpose lanes. In October 1999, the SR-91 Route Concept Report was approved, identifying the ultimate corridor for SR-91 as a 10-lane facility (eight general purpose lanes and two HOV lanes).

A Project Study Report defining the project alternatives describing the alternatives was prepared by an independent consultant following Caltrans requirements. The PSR was reviewed by Caltrans District 12, Caltrans Headquarters and FHWA Area Reviewers and approved in June 2004.

Alternative 2 differs from the approved PSR at four off-ramps. The gore points of three of these ramps were shifted closer to their respective interchanges:

- Euclid Street
- Raymond Avenue
- State College Boulevard

The width of the proposed right-of-way acquisition was modified for the following off-ramp:

- Lemon Street

A detailed description of the modifications to each off-ramp is described below:

Euclid Street (Gore Point Shift of 68')

- Elimination of 6 temporary construction easements (TCEs)
- Elimination of one full property acquisition
- Reduction in the construction of approximately 530 LF of soundwall

Raymond Avenue (Gore Point Shift of 139')

- Elimination of approximately 5,100 SF of TCE
- Reduction in the construction of approximately 510 LF of retaining wall
- Addition of a right-turn pocket at the Raymond Avenue off-ramp

State College Boulevard (Gore Point Shift of 81')

- Elimination of the construction of a retaining wall (approximately 185 LF)

Lemon Street (Reduction in R/W Width from 23' to 10')

- Reduction of approximately 7,700 SF of R/W acquisition
- Elimination of the reduction of parking spaces in the adjacent parking lot
- Elimination of the reconstruction of an existing retail sign

The PSR identified a number of parcel areas outside the existing right-of-way limits that need to be acquired for Alternative 2. At this time none of the required right-of-way has been purchased. Alternative 2 will also impact aerial electric utilities requiring their permanent relocation.

Community Interaction

A public information meeting was held on May 21, 2008 at Woodcrest Elementary School in the City of Fullerton. The purpose of the meeting was to inform the public of the proposed project and the alternatives that were being evaluated. The meeting was attended by members of the Project Development Team (PDT) including OCTA, Caltrans and the Consultant team and by members of the local community. A total of 80 people signed the attendance sheet for this meeting.

The Initial Study with Proposed Mitigated Negative Declaration (IS/MND) was circulated for public comment from November 10 through December 14, 2009. A public hearing was held on December 2, 2009 from 5:00 p.m. to 8:00 p.m. at the Woodcrest Elementary School (455 West Baker Avenue, Fullerton, California). The comment period and public hearing were announced in a public notice (Notice of Intent to Adopt a Mitigated Declaration and Notice of Public Hearing) that was published in

several newspapers. The names of the newspapers where the notice was published are identified below, along with the date of publication. The public notice was also provided on the Department's website.

- *Orange County Register* (English language): November 10 and November 27, 2009
- *Fullerton News Tribune* (English language): November 12, 2009
- *Anaheim Bulletin* (English language): November 12, 2009
- *La Opinion* (Spanish language): November 10, 2009
- *Excelsior* (Spanish language): Week of November 13-19 and November 27-December 3, 2009

During the comment period (November 10 through December 14, 2009), the IS/MND was made available for review at the following locations:

California Department of Transportation
District 12
3347 Michelson Drive, Suite 100
Irvine, California 92612

Orange County Transportation Authority
550 South Main Street
Orange, California 92862

City of Anaheim City Hall
200 South Anaheim Boulevard
Anaheim, California 92805

City of Fullerton City Hall
303 West Commonwealth Avenue
Fullerton, California 92832

City of Anaheim Public Library
500 West Broadway
Anaheim, California 92805

City of Fullerton Public Library
353 West Commonwealth Avenue
Fullerton, California 92832

A total of 72 individuals signed in at the public hearing that was held on December 2, 2009. The public hearing format consisted of a combination of an open house session and a project presentation. During the open house session, participants had the opportunity to view project exhibits that presented the Build Alternatives and to ask the project team members questions regarding the proposed project. Project team members in attendance to answer questions included Department, OCTA, and OCTA consultant staff. Representatives from OCTA and their consultants provided a presentation that included: an overview of the project, including information on the alternatives under consideration, the purpose of the project, and project funding; a summary of environmental impacts; the next steps for the project; and the anticipated project schedule through construction. Two certified court reporters were present during the public hearing to take verbal comments from attendees. In addition, attendees were encouraged to submit their comments in writing or verbally to the court reporters during the public hearing, via mail, or via e-mail by the public circulation end date.

The agencies, utility providers, and individuals who commented are listed in the IS/MND. The method by which each comment correspondence was transmitted is included following each agency, utility provider, and individual listed.

From the various comment submittals, the most common issue raised was regarding anticipated right-of-way impacts (i.e., temporary and permanent acquisitions) associated with implementation of the identified Build Alternatives. Other common issues included the potential for impacts related to air quality and noise, both during construction and operation of the Build Alternatives.

Since the majority of the project occurs along the freeway mainline and ramps, the project, in general, does not include provisions for bicyclists or pedestrians. However, where the project interfaces with an accessible pedestrian route, appropriate accommodations will be provided as required by ADA.

Existing Facility

State Route 91 is a major east-west freeway facility that begins at the eastern junction with State Route 60 (SR-60) in the city of Riverside in Riverside County, and continues west through Orange County to its terminus at the junction with Pacific Coast Highway 1 near the city of Hermosa Beach in Los Angeles County. The route is used for commuter, goods movement and interregional travel, and provides important connections to Los Angeles County to the west and Riverside/San Bernardino Counties to the east. During the week, this route is a heavily used commuter route between residential (bedroom) communities of the Inland Empire (Riverside and San Bernardino Counties) and employment centers in Los Angeles and Orange Counties. On weekends, the route serves recreation trips between Los Angeles and Orange Counties, and the desert and mountain recreation areas to the east.

The proposed project is located in Orange County, on SR-91 between SR-57 (to the east) and I-5 (to the west) and traverses through the city of Anaheim and the city of Fullerton. Within Orange County, the SR-91 facility is an access-controlled, grade-separated freeway, and is classified by the Department as Other Freeway or Expressway. Within northern Orange County, SR-91 and State Route 22 are the two primary east-west freeways. The route is shown as a State Freeway in Orange County's Master Plan of Arterial Highways (OCTA 2007). This segment of SR-91 is within the National Highway System and the National Network for Surface Transportation Assistance Act (STAA) Trucks.

Within the limits of the proposed project, SR-91 has a varying number of existing general purpose lanes, auxiliary lanes, and a HOV lane with entry/exit allowed only at specific locations. The number of existing general purpose lanes, auxiliary lanes, and HOV lane locations, are outlined in Table 1-1.

Table 3-1. Existing Westbound SR-91 Lane Configuration

Segment	Lane Configuration	Description
From southbound SR-57 connector to State College Boulevard off-ramp	3 general-purpose lanes 1 auxiliary lane 1 HOV lane	At the eastern project limit, the southbound SR-57 connector ramp joins three westbound general purpose lanes as an auxiliary lane. That auxiliary lane tapers and ends prior to the State College Boulevard off-ramp.
From State College Boulevard on-ramp to Raymond Avenue off-ramp	3 general-purpose lanes 1 auxiliary lane 1 HOV lane	An auxiliary lane recommences at the State College Boulevard on-ramp and then tapers and ends prior to the Raymond Avenue off-ramp.
From Raymond Avenue on-ramp to Lemon Street off-ramp	4 general-purpose lanes 1 HOV lane	The on-ramp from Raymond Avenue joins SR-91 as the fourth continuous general purpose lane.
From Harbor Boulevard on-ramp to Euclid Street off-ramp	4 general-purpose lanes 1 HOV lane	This fourth lane extends west until the Euclid Street off-ramp. Between Raymond Avenue and Euclid Street, the Lemon Street off-ramp and Harbor Boulevard on-ramps diverge and merge, respectively, from the fourth lane.
From Euclid Street on-ramp to Brookhurst Road off-ramp	3 general-purpose lanes 1 auxiliary lane 1 HOV lane	Between Euclid Street and Brookhurst Road, an auxiliary lane is provided in addition to the three general purpose lanes.
From Brookhurst Road on-ramp to I-5 northbound connector	3 general-purpose lanes 1 auxiliary lane 1 HOV lane	The Brookhurst Road on-ramp joins westbound SR-91 as a fourth general purpose lane extending to the two-lane off-ramp to northbound I-5. At the I-5 ramp, the right (fourth) lane is dropped as one of the two ramp lanes with the second lane diverging from the third general purpose lane. Three lanes continue west towards Magnolia Avenue with a single-lane diverging off-ramp.

Bridges

The proposed project alignment is generally elevated on an embankment, at or near the elevations of the surrounding land, and crosses: (1) State College Boulevard, (2) Acacia Street, (3) Raymond Avenue, (4) the OCTA/Metrolink rail line at the North Anaheim Overhead (5) Lemon Street, (6) Harbor Boulevard, (7) Euclid Street, and (8) Brookhurst Road/Brookhurst Street (hereinafter referred to as Brookhurst Road). At the diverge with mainline SR-91, all interchanges are diamond interchanges with single lane on- and off-ramps, and off-ramps terminating at signalized intersections at the crossing arterial streets. However, Lemon/Harbor has been reconfigured as a split diamond interchange, and at Acacia Street there is no interchange.

Sound Walls and Retaining Walls

There are six segments of existing sound walls and retaining walls located in the following areas (from east to west):

- Beginning at the terminus of the southbound SR-57/westbound SR-91 on-ramp connector (south of East Miraloma Way) and ending at the North Placentia Avenue overcrossing;
- Beginning at the terminus of the North State College Boulevard on-ramp to westbound SR-91 (south of North Baxter Street) and ending at a segment of westbound SR-91 immediately south of Manhattan Avenue;
- Beginning at the Lemon Street overcrossing and ending at the Harbor Boulevard overcrossing;
- Beginning approximately 450 feet east of the terminus of the South Harbor Boulevard on-ramp to westbound SR-91 and ending at the off-ramp at South Euclid Street;
- Beginning at the westbound SR-91 on-ramp at South Euclid Street and ending at the off-ramp at South Brookhurst Road; and
- Beginning at the on-ramp at South Brookhurst Road and ending at the northbound I-5/westbound SR-91 connector at Magnolia Avenue.

Drainage Facilities

Existing drainage facilities located in the proposed project area include:

- Storm drain systems and inlets along the shoulders of the existing mainline;
- Drainage systems along the on- and off-ramps;
- Under-highway cross culverts;
- Houston Storm Channel, primarily a concrete open channel running along the north side of the freeway (however, between Euclid Street and Brookhurst Road segment of the SR-91 it becomes a reinforced concrete box culvert); and
- Carbon Creek, which traverses along the north side of the freeway west of East Burton Street and crosses SR-91 at Raymond Avenue as a reinforced concrete box culvert.

Nonstandard Design Features

There are three existing nonstandard design features that are not anticipated to be modified by the proposed improvements. These nonstandard geometric features are approved in a mandatory fact sheet. The nonstandard design features include:

- A nonstandard mainline left shoulder width between the existing HOV lane and the center concrete median barrier;
- Nonstandard vertical clearances at two existing undercrossings, State College Boulevard and Raymond Avenue; and
- Nonstandard freeway-to-freeway interchange spacing to local street interchanges.

4. NEED AND PURPOSE

A. PROBLEM, DEFICIENCIES, JUSTIFICATION

The Department, in cooperation with OCTA, and the cities of Anaheim and Fullerton, proposes to widen westbound SR-91 from SR-57 to I-5 in the cities of Anaheim and Fullerton, Orange County, California. The proposed project limits cover a distance of 4.5 miles; however, actual improvements are limited to a total of 3.8 miles within the project area. The total throughput capacity of westbound SR-91 is currently limited by the three general purpose lanes and one HOV lane that exist within the proposed project limits.

Bottleneck conditions that adversely affect traffic operations contribute to the congested conditions (i.e., traffic demand exceeds freeway capacity), and occur at two locations within the proposed project limits: at the junction of southbound SR-57 connector ramp and westbound SR-91, and near the off-ramp to Euclid Street.[1] At the first bottleneck location, through traffic from SR-57 must merge left prior to the State College Boulevard off-ramp. Likewise, westbound SR-91 traffic exiting at State College Boulevard must weave right to access the ramp. The length of the weaving section is just over 2,000 feet, and with the heavy through and ramp traffic volumes the weaving section operates at a poor LOS with vehicles in both the through and auxiliary lanes slowing to change lanes. The proposed project would partially address this condition by extending the weaving lane through the State College Boulevard interchange, eliminating the need for traffic entering from the southbound SR-57 connector ramp to merge left prior to the State College Boulevard off-ramp.

At the second bottleneck location, near the off-ramp to Euclid Street, the fourth general purpose lane ends at the ramp. Because the fourth lane extends from the Raymond Avenue on-ramp, a substantial volume of through traffic stays in the right lane until Euclid Street. At that point, vehicles must merge into the third mainline lane resulting in additional congestion on westbound SR-91. Build Alternative 2 addresses this bottleneck location by extending the fourth mainline lane through the Euclid Street and Brookhurst Road interchanges. The additional lane capacity achieved through connection of the auxiliary lanes through the interchanges would allow for improved traffic flow (improved LOS) and decreased Vehicle Hours of Delay (VHD).

Additionally, there are three existing nonstandard design features that are associated with the recommended Preferred Alternative and are not anticipated to be modified. These nonstandard geometric features are approved in a mandatory fact sheet.

The purpose of the proposed project is to reduce congestion, decrease travel times, and shorten the durations of peak traffic periods by increasing capacity and improving operational characteristics on the route within the proposed project limits, consistent with Department design standards. The objectives of the project are to:

- To provide congestion relief, decrease travel times, and shorten the durations of peak traffic periods in order to improve the mainline capacity and provide for continued goods movement along westbound SR-91 between SR-57 and I-5;
- To improve the operation of segments and ramp areas of westbound SR-91 between SR-57 and I-5 where current accident rates are higher than average; and

[1] A bottleneck condition can occur when certain segments of the highway have operational or geometric deficiencies which can cause a disruption, slow down, or stop in traffic flow.

- To help achieve the goals of the SCAG 2008 Regional Transportation Plan and OCTA 2006 Long-Range RTP.

Longer durations of congested operations may be expected to increase noise levels, reduce air quality, and interfere with goods movement in the vicinity of the proposed project area. Thus, the purpose of this project is to reduce congestion, decrease travel times, and shorten the durations of peak traffic periods by increasing capacity and improving operational characteristics on the route within the proposed project limits. Such improvements are consistent with state, regional, and local transportation plans.

B. REGIONAL & SYSTEM PLANNING

Federal and State Systems

This section of SR-91 is on the National Highway System and the National Network for Surface Transportation Assistance Act (STAA). This segment is not identified as a route for Subsystem of Highways for movement of Extra Legal Loads (SHELL) nor is it a Lifeline Route or designated State Scenic Highway.

State Planning

The Route Concept Report (RCR), dated October 1999, indicates that the route concept for this segment of SR-91 is planned for four mixed flow lanes plus one HOV lane in both the westbound and eastbound directions. The mainline route concept was completed in the eastbound direction through improvement projects that were constructed in the late 1990's. In the westbound direction only three general purpose lanes plus one HOV lane currently exists. The RCR recommends completion of the mainline route concept for this segment of SR-91 by construction of one additional general purpose lane in the westbound direction. Furthermore, the RCR shows that if no capital improvements are made that longer traffic delays will occur, congestion will not be reduced and levels of service will not be improved. Therefore, widening the westbound SR-91 through the existing interchanges of this segment of the freeway is consistent with the RCR. Currently there are several projects within the project limits that are programmed. Coordination with these projects will be required. See Table 4-1 below for a summary of these projects.

Table 4-1. Planned Projects on SR-91

EA	PM	Description	Location
0H029	0/10.3	Resurface Traveled Way of Mainline and Ramps. Resurface Deteriorated Shoulders	In La Palma, Buena Park, Anaheim, & Fullerton From LA Co Line/Lakeview Avenue Overcrossing
0J450	0/8.2	Convert HOV buffer to continuous ingress/egress access facility	In La Palma, Buena Park, Anaheim and Fullerton from LA/Orange County Border to 0.2 mile West of Tustin Avenue
0G330	9.1/15.6	General Purpose Lane Addition	In Anaheim Hills from SR-55 to SR-241
0C560	7.9/9.5	Provide Auxiliary Lane from NB SR-55 to Tustin Ave Off-Ramp	In Anaheim from 0.12 mi West of N Olive up to 0.12 mi of Tustin Ave OC

Regional Planning

The proposed project is included in the Southern California Association of Governments (SCAG's) 2008 Regional Transportation Plan (RTP) as project 2M01126 and the 2006 cost-constrained Regional Transportation Improvement Program (RTIP) (project ID No. ORA000822). It is also included in OCTA's Long-Range RTP, which was adopted by OCTA in December 2002. According to the 2008 RTIP, the proposed project is funded by the CARH3 program (Interchange- Modify/ Replace/ Reconfigure - Lane Addition[s]). Since the widening project is contained in the RTP, the improvements contemplated in this project are consistent with regional planning efforts.

Local Planning

CITY OF FULLERTON GENERAL PLAN

The City of Fullerton General Plan was updated in September of 1996 and last revised on October 5, 2004. The General Plan identifies the qualities, values and characteristics, which the City wishes to preserve, enhance and create. The Fullerton General Plan has nine elements, including the Land Use Element and Circulation Element.

Land Use Element

The Land Use Element designates the general distribution and intensity of uses for housing, commercial, office, downtown mixed-use, industrial, open space and recreation, and public/quasi-public facilities and services. In addition, the element has developed program strategies for Focus Areas where managed change is anticipated to occur.

Circulation Element

The Circulation Element is consistent with the Land Use Element and identifies the general location and configuration of existing and future streets and roadways, alternative modes of transportation, and bicycle routes. The Circulation Element identified SR-91 as an important link to the region. Issues of concern include operational conditions on the freeway as well as traffic conditions on City-controlled arterials, which connect to the freeway. Without proper planning the freeway and the arterial connections,

congestion on ramps leading to and from the freeway could result, along with increased diversion of freeway traffic to City streets.

CITY OF ANAHEIM GENERAL PLAN

The City of Anaheim General Plan was updated in September of 1996 and last revised on March 8, 2008. The General Plan identifies the qualities, values and characteristics, which the City wishes to preserve, enhance and create. The Anaheim General Plan has ten elements, including the Land Use Element and Circulation Element.

Land Use Element

The Land Use Element is a guide, or "blueprint," for Anaheim's future development. It designates the distribution and general location of land uses, such as residential, retail, industrial, open space, recreation, and public uses. The Land Use Element also addresses the permitted density and intensity of the various land use designations.

Circulation Element

The Circulation Element is consistent with the Land Use Element and identifies the general location and configuration of existing and future streets and roadways, alternative modes of transportation, and bicycle routes. The Circulation Element identified SR-91 as an important east-west freeway that is located at the northern edge of the City and provides regional access to Riverside County, San Bernardino County and points east, as well as regional access westerly to Los Angeles County. The Circulation Element identifies the proposed project as a proposed circulation improvement.

COMPATIBILITY WITH EXISTING LAND USES

The proposed improvements related to Alternative 2 are primarily within the existing right-of-way along SR-91, although there is potential of the full displacement of one residential parcel. No new land uses are proposed as part of this project. This alternative would be compatible with the existing land use patterns. The surrounding area is primarily built out with very few vacant parcels. The existing land uses in the vicinity are generally residential, commercial and industrial uses that would benefit from the proposed improvements. SCAG, the County of Orange, city of Fullerton and the city of Anaheim have given a high priority rating to this project. Traffic flow and circulation within the project vicinity could present a problem in the future if the corridor were not widened to accommodate additional anticipated traffic flow.

CONSISTENCY WITH PLANS AND POLICIES

The Circulation Elements of both cities General Plans support infrastructure improvements to promote efficient movement of people and goods, which is a primary component of the proposed project. The Fullerton and Anaheim General Plans identify SR-91 as an important link to the region. In addition, the Anaheim Circulation and Element identifies the proposed project as a proposed circulation improvement and both of the cities' general plans emphasize evaluating the overall circulation system as needed to enhance the highway network to respond to anticipated growth and mobility needs. The proposed project complies with these goals and would be consistent with the above identified plans and policies.

C. TRAFFIC

Current and Forecasted Traffic

Capacity and operating conditions along most sections of westbound SR-91 between SR-57 and I-5 during peak-hour travel times currently range between level of service (LOS D and F during the AM and PM peak hours. As indicated in Table 4-2, overall traffic volumes are forecast to increase by at least 18 percent through the year 2035, and all analyzed segments are predicted to operate at LOS F during peak-hour travel times. Capacity and operating conditions at the majority of interchange ramp connections to SR-91 within the proposed project limits are currently operating at an unacceptable LOS (i.e., LOS E or F). Peak hour LOS is expected to continue to degrade and the duration of the peak periods are expected to increase as the traffic demand volumes rise.

Table 4-2. Existing (2007) and Future (2035)
No-Build Westbound General Purpose Lane Operations

SR-91 Segment	# of Lanes	2007 Existing[1]						Future 2035 No-Build					
		AM Peak			PM Peak			AM Peak			PM Peak		
		Vol.	Vol./ lane	LOS	Vol.	Vol./ lane	LOS	Vol.	Vol./ lane	LOS	Vol.	Vol./ lane	LOS
SR-57 on-ramp to State College Blvd. off-ramp	3	6,985	2,328	F	6,780	2,260	E	10,714	3571	F	9,902	3,301	F
State College Blvd. on-ramp to Raymond Ave. off-ramp	3	6,947	2,316	F	7,030	2,343	F	11,462	3,821	F	10,186	3,395	F
Raymond Ave, on-ramp to Lemon St. off-ramp	4	7,502	1,876	D	7,847	1,962	D	11,187	2,797	F	9,869	2,467	F
Harbor Blvd. on-ramp to Euclid St. off-ramp	4	7,575	1,894	D	7,701	1,925	D	10,258	2,565	F	9,398	2,350	F
Euclid St. on-ramp to Brookhurst Rd. off-ramp	3	7,438	2,479	F	7,324	2,441	F	9,938	3,313	F	9,104	3,035	F
Brookhurst Rd. on-ramp to northbound I-5 off-ramp	3	7,152	2,384	F	6,624	2,208	E	9,861	3,287	F	8,763	2,921	F

Vol. (Volume) = Vehicles per Hour,
[1] High occupancy vehicle (HOV) volumes are not included in the general purpose lane volumes reported.

Extended peak period LOS F conditions on SR-91 are expected to result in increased traffic diversions onto the local arterial network to avoid increasing freeway delays, as well as increased truck density during non-peak hours. A comparison of the current (2007) and forecast (2035) capacity and operating conditions at each of the interchange ramp connections to SR-91 within the proposed project limits are provided in Table 4-3.

Table 4-3. Existing (2007) and Future (2035) No-Build Westbound Ramp Operations

Ramp Connection	Analysis	2007 Existing[1]				Future 2035 No-Build			
		AM Peak		PM Peak		AM Peak		PM Peak	
		Den.	LOS	Den.	LOS	Den.	LOS	Den.	LOS
State College Blvd. Off-Ramp	Weaving	36.7	E	37.4	E	61.4	F	52.4	F
State College Blvd. On-Ramp	Merge	33.6	F	35.8	F	60.3	F	51.9	F
Raymond Ave. Off-Ramp	Diverge	42.2	E	43.1	E	61.9	F	55.3	F
Raymond Ave. On-Ramp	Merge	40.9	F	43.7	F	59.4	F	54.0	F
Lemon St. Off-Ramp	Diverge	36.8	E	39.6	E	47.8	F	45.8	F
Harbor Blvd. On-Ramp	Merge	31.3	D	32.0	D	39.3	F	34.8	F
Euclid St. Off-Ramp	Diverge	47.9	F	48.9	F	60.9	F	58.5	F
Euclid St. On-Ramp	Merge	34.7	F	34.6	F	45.2	F	43.4	F
Brookhurst Rd. Off-Ramp	Diverge	44.2	F	45.0	F	58.5	F	54.9	F
Brookhurst Rd, On-Ramp	Weaving	42.5	F	36.4	E	51.5	F	42.5	F

Den. = Density in passenger car equivalents per mile per lane. Density shown is for the ramp influence area only.
[1] High occupancy vehicle (HOV) volumes are not included in the general purpose lane volumes reported.

Data and field observations provided in the Traffic Analysis Report prepared for the proposed project (Iteris 2008) indicate the lack of adequate mainline capacity on westbound SR-91 as the principal reason for poor operating LOS within the project limits. The total throughput capacity of westbound SR-91 is limited by the three general purpose lanes and one HOV lane that exist within the limits of the proposed project. This mainline constraint also has a negative effect on the merge and diverge LOS at the ramp connections as vehicles try to enter and exit overly congested mainline lanes. The limited westbound capacity also restricts the weaving section between Raymond Avenue and Lemon Street.

The operating conditions and LOS for the ramp merge and diverge locations along westbound SR-91 within the project limits for Buildout Year 2035 are summarized in Table 4-4. As previously discussed, because some locations that are today weave, merge, or diverge locations will be changed in Alternative 2 to another type of configuration, there are some locations where direct comparisons between the No Build and Build Alternative 2 conditions cannot quantitatively be made. For those locations a qualitative comparison will be made to describe the expected general change in operating conditions.

Alternative 2 provides an improvement in LOS conditions at the ramp junctions versus the No Build alternative. However, because of the high per-lane volumes in the mainline lanes in the ramp influence areas, a LOS F is expected at most of the ramp junctions. As traffic demand increases in the corridor upstream and downstream congestion will have a greater impact on operations at the adjacent ramps within the project limits. Upstream congestion can create pockets of lower volumes downstream of the congested point as traffic metered through the congested location. This can result in segments that appear to be operating well but only because of the upstream blockage. Conversely, congestion at downstream locations can result in backups that queue vehicles on the mainline. This can result in reduced traffic flow through several adjacent upstream interchanges. The additional mainline capacity added by Alternative 2 will help to address this condition on westbound SR-91.

Table 4-4: Forecasted Ramp Junction Traffic Demand and LOS in 2035
No Build and Build Alternative 2 Scenarios

Ramp Connection		Year 2035 Future Conditions								Density Change Versus No Build 2035			
		No Build Alternative				Build Alternative 2				AM Peak Hour		PM Peak Hour	
		AM Peak		PM Peak		AM Peak		PM Peak		Alt 2		Alt 2	
		Density pc/mi/ln	LOS	Density pc/mi/ln	LOS	Density pc/mi/ln	LOS	Density pc/mi/ln	LOS	Density	%	Density	%
State College Exit	Weaving Analysis	61.4	F	52.4	F	-	-	-	-	NA	-	NA	-
	Diverge Analysis	-	-	-	-	52.5	F	43.3	F	NA	-	NA	-
State College Entrance	Merge Analysis	60.3	F	51.9	F	46.9	F	42.4	F	-13.4	-22%	-9.5	-18%
Raymond Exit	Diverge Analysis	61.9	F	55.3	F	44.7	F	33.1	D	-17.2	-28%	-22.2	-40%
Raymond Entrance	Merge Analysis	59.4	F	54.0	F	-	-	-	-	NA	-	NA	-
Lemon Exit	Diverge Analysis	47.8	F	45.8	F	-	-	-	-	NA	-	NA	-
	Weaving Analysis	-	-	-	-	50.9	F	48.3	F	NA	-	NA	-
Harbor Entrance	Merge Analysis	39.3	F	34.8	F	43.4	F	37.7	F	4.1	10%	2.9	8%
Euclid Exit	Diverge Analysis	60.9	F	58.5	F	44.3	F	37.8	F	-16.6	-27%	-20.7	-35%
Euclid Entrance	Merge Analysis	45.2	F	43.4	F	46.5	F	42.3	F	1.3	3%	-1.1	-3%
Brookhurst Exit	Diverge Analysis	58.5	F	54.9	F	43.4	F	34.2	D	-15.1	-26%	-20.7	-38%
Brookhurst Entrance	Weaving Analysis	51.5	F	42.5	F	-	-	-	-	NA	-	NA	-
	Merge Analysis	-	-	-	-	37.9	F	28.3	D	NA	-	NA	-
I-5 NB Exit	Diverge Analysis	-	-	-	-	73.8	F	61.9	F	NA	-	NA	-

pc/mi/ln – passenger car equivalents per mi per lane
NA – not applicable

Transportation Demand

State Route 91 traffic volumes are expected to increase considerably within the next 30 years. A summary of existing average daily traffic and peak hour volumes, as well as forecasts of opening day and horizon year average daily traffic and peak hour volumes under No-Build condition, are provided in Table 4-5. The improvements proposed under Build Alternative 2 are expected to maintain the facility at an improved LOS over the No-Build condition.

Table 4-5. Baseline and Forecasted Average Daily Traffic Volumes (Westbound)

Freeway Segment	Year 2007 Existing Conditions Mainline/HOV	Year 2016 Opening Day Conditions Mainline/HOV	Year 2035 Horizon Year Conditions Mainline/HOV
SR-57 On-Ramp to State College Off-Ramp			
Average Daily Traffic	127,187/13,783	140,343/18,401	172,758/33,870
AM Peak Hour	6,985/1,293	8,015/1,658	10,714/2,801
PM Peak Hour	6,780/1,143	7,658/1,449	9,902/2,389
State College On-Ramp to Raymond Off-Ramp			
Average Daily Traffic	134,331/18,060	148,842/22,245	184,832/34,542
AM Peak Hour	6,947/1,744	8,160/2,090	11,462/3,060
PM Peak Hour	7,030/1,570	7,920/1,861	10,186/2,665
Raymond On-Ramp to Lemon Off Ramp			
Average Daily Traffic	119,639/19,540	134,493/22,178	172,188/28,975
AM Peak Hour	7,502/1,607	8,530/1,806	11,187/2,310
PM Peak Hour	7,847/1,421	8,447/1,644	9,869/2,236
Harbor On-Ramp to Euclid Off-Ramp			
Average Daily Traffic	118,710/18,154	130,109/23,627	157,897/41,208
AM Peak Hour	7,575/1,580	8,351/1,872	10,258/2,627
PM Peak Hour	7,701/1,392	8,210/1,670	9,398/2,453
Euclid On-Ramp to Brookhurst Off-Ramp			
Average Daily Traffic	118,700/15,665	128,780/21,507	152,960/41,992
AM Peak Hour	7,438/1,421	8,164/1,752	9,938/2,728
PM Peak Hour	7,324/1,252	7,855/1,564	9,104/2,499
Brookhurst On-Ramp to Northbound I-5 Off-Ramp			
Average Daily Traffic	105,760/23,240	120,572/25,155	159,011/29,733
AM Peak Hour	7,152/1,570	7,930/1,854	9,861/2,634
PM Peak Hour	6,624/1,376	7,248/1,622	8,763/2,294
Source: Iteris 2008			

A summary of forecast of opening day (year 2016), and forecast of horizon year (year 2035) traffic lane volumes, are provided in Tables 4-6 and 4-7. Forecast 2035 ramp operating conditions are summarized in Table 4-4. It is anticipated that construction of the project improvements would be completed no later than 2016.

While not directly analyzed in this study, the HOV lanes will continue to experience increasing volumes as traffic along the SR-91 corridor increases. For Year 2016 the HOV lane is still expected to be operating below its capacity. The projected HOV lane volumes are listed in Table 4-6; however, because the use of the lane is restricted to multi-occupant vehicles the per-lane volume of the HOV lane can vary from that of the adjacent general purpose lanes. If the HOV lanes were included in the LOS calculations

Table 4-6: Forecasted Mainline Traffic Demand and LOS in 2016 No Build and Build Alternative 2 Scenarios

Freeway Segments	2016 Future Year Freeway Segment Analysis																
	No Build Alternative									Build Alternative 2							
	# of Lanes	AM Peak				PM Peak				# of Lanes	AM Peak				PM Peak		
		HOV Vol.	ML Vol.	ML Vol. per Lane	LOS	HOV Vol.	ML Vol.	ML Vol. per Lane	LOS		HOV Vol.	ML Vol.	ML Vol. per Lane	LOS	HOV Vol.	ML Vol.	ML Vol. per Lane	LOS
SR 57 On-Ramp to State College Off-Ramp	3	1,658	8,015	2,672	F	1,449	7,658	2,553	F	4	1,659	8,175	2,044	E	1,441	7,793	1,948	D
State College On-Ramp to Raymond Off-Ramp	3	2,090	8,160	2,720	F	1,861	7,920	2,640	F	4	1,971	8,465	2,116	E	1,755	8,178	2,045	E
Raymond On-Ramp to Lemon Off-Ramp	4	1,806	8,530	2,133	E	1,644	8,447	2,112	E	4	1,834	8,658	2,165	E	1,597	8,658	2,165	E
Harbor On-Ramp to Euclid Off-Ramp	4	1,872	8,351	2,088	E	1,670	8,210	2,053	E	4	1,825	8,616	2,154	E	1,649	8,430	2,108	E
Euclid On-Ramp to Brookhurst Off-Ramp	3	1,752	8,164	2,721	F	1,564	7,855	2,618	F	4	1,688	8,494	2,124	E	1,520	8,132	2,033	D
Brookhurst On-Ramp to NB I-5 Off-Ramp	3	1,854	7,930	2,643	F	1,622	7,248	2,416	F	4	1,813	8,203	2,051	E	1,593	7,463	1,866	D

ML = Mainline
HOV = High Occupancy Vehicle

for the mainline lanes, some of the mainline traffic would have been assigned to the HOV lane by the analysis program and would have resulted in an under-estimation of mainline conditions. Therefore, the HOV volumes are provided for reference purposes, but are not included in the mainline LOS calculations.

As indicated in Table 4-6, the addition of the fourth general purpose lane on westbound SR-91 in Build Alternative 2 will improve traffic operations within the project limits over the No Build alternative. Even with the higher traffic volumes projected in Alternative 2 over the No Build alternative, the mainline lanes are still expected to operate with higher speeds and lower per lane densities than the No Build alternative. For Build Alternative 2, none of the project segments are projected to operate at LOS F during the peak hours.

The addition of the auxiliary lanes in Build Alternative 2 provides additional capacity and as a result attracts more traffic to the corridor than the No Build Alternative. Forecasted Year 2035 traffic conditions for westbound SR-91 within the project limits were calculated and are provided in Table 4-7 for the No Build and Alternative 2 scenarios.

As shown in Table 4-7, even with the addition of the fourth general purpose lane on westbound SR-91 the LOS will deteriorate to LOS F conditions along all of the mainline segments within the project limits under both scenarios. This is a result of the high forecast volumes projected for the corridor by the OCTAM model. While the per-lane volumes for Alternative 2 are projected to be less than the No Build conditions, Alternative 2 will have failing LOS conditions during the peak hours.

Table 4-7: Forecasted Mainline Traffic Demand and LOS in 2035
No Build and Build Alternative 2 Scenarios

Freeway Segments	2035 Future Year Freeway Segment Analysis																
	No Build Alternative									Build Alternative 2									
	# of Lanes	AM Peak				PM Peak				# of Lanes	AM Peak				PM Peak				
		HOV Vol.	ML Vol.	ML Vol. per Lane	LOS	HOV Vol.	ML Vol.	ML Vol. per Lane	LOS		HOV Vol.	ML Vol.	ML Vol. per Lane	LOS	HOV Vol.	ML Vol.	ML Vol. per Lane	LOS
SR 57 On-Ramp to State College Off-Ramp	3	2,801	10,714	3,571	F	2,389	9,902	3,301	F	4	2,807	11,395	2,849	F	2,349	10,485	2,621	F
State College On-Ramp to Raymond Off-Ramp	3	3,060	11,462	3,821	F	2,665	10,186	3,395	F	4	2,553	12,848	3,212	F	2,218	11,255	2,814	F
Raymond On-Ramp to Lemon Off-Ramp	4	2,310	11,187	2,797	F	2,236	9,869	2,467	F	4	2,424	11,716	2,929	F	2,045	10,658	2,665	F
Harbor On-Ramp to Euclid Off-Ramp	4	2,677	10,258	2,565	F	2,453	9,398	2,350	F	4	2,472	11,308	2,827	F	2,356	10,204	2,551	F
Euclid On-Ramp to Brookhurst Off-Ramp	3	2,728	9,938	3,313	F	2,499	9,104	3,035	F	4	2,429	11,241	2,810	F	2,291	10,143	2,536	F
Brookhurst On-Ramp to NB I-5 Off-Ramp	3	2,634	9,861	3,287	F	2,294	8,763	2,921	F	4	2,455	10,957	2,739	F	2,172	9,598	2,400	F

ML = Mainline
HOV = High Occupancy Vehicle

The OCTAM mainline traffic volume projections indicate that there will be an increase in traffic demand between the years 2016 and 2035 and that the numbers of hours during each day that poor operating conditions will be experienced will also increase without any capacity enhancements and other improvements to the transportation system. Using the current hourly distribution patterns of traffic throughout a typical weekday as a baseline an analysis was conducted to evaluate the number of hours during the day that poor LOS conditions would be expected for each of the future scenarios.

As shown in Figure 4-1, in 2007 there were about eight hours of a typical weekday where the mainline operating conditions are at LOS F. With no improvements, the number of hours where the roadway will experience LOS F conditions will increase to about 14 hours in 2016 and 16 hours in 2035. For Year 2016, Alternative 2 results in an improvement in LOS conditions with no hours expected to be operating at LOS F. As previously discussed, Alternative 2 also is projected to accommodate more vehicles during those hours as the auxiliary lanes will provide additional capacity.

For Year 2035, Alternative 2 will reduce the number of hours where LOS F conditions are expected to about 14 hours per day versus 16 without the added lane. The most notable difference between the No Build alternative and Alternative 2 by Year 2035 is the volume-to-capacity ratio is about 25 percent lower in Alternatives 2 than in the No Build alternative.

One of the most widely used measures of effectiveness for freeways is the Vehicle Hours traveled (VHT). VHT is an indication of total travel time that all vehicles spend within the project limits during a specific time period. VHT was calculated for the westbound SR-91 freeway within the project limits for all alternatives. The total vehicle miles traveled (VMT), vehicle hours traveled (VHT), and total delay for the No Build and Build Alternative 2 scenarios are summarized in Table 4-8.

It is important to note that the VHT, VMT, and delay values are only calculated for the westbound section of SR-91 within the project limits and does not include changes in those measures for other facilities in the area. Therefore, a diversion of traffic from a parallel facility to westbound SR-91 would not be accounted for in this analysis.

Table 4-8: Year 2035 VMT / VHT / Vehicle Hours of Delay for Westbound SR-91 Segment Between SR-57 and I-5

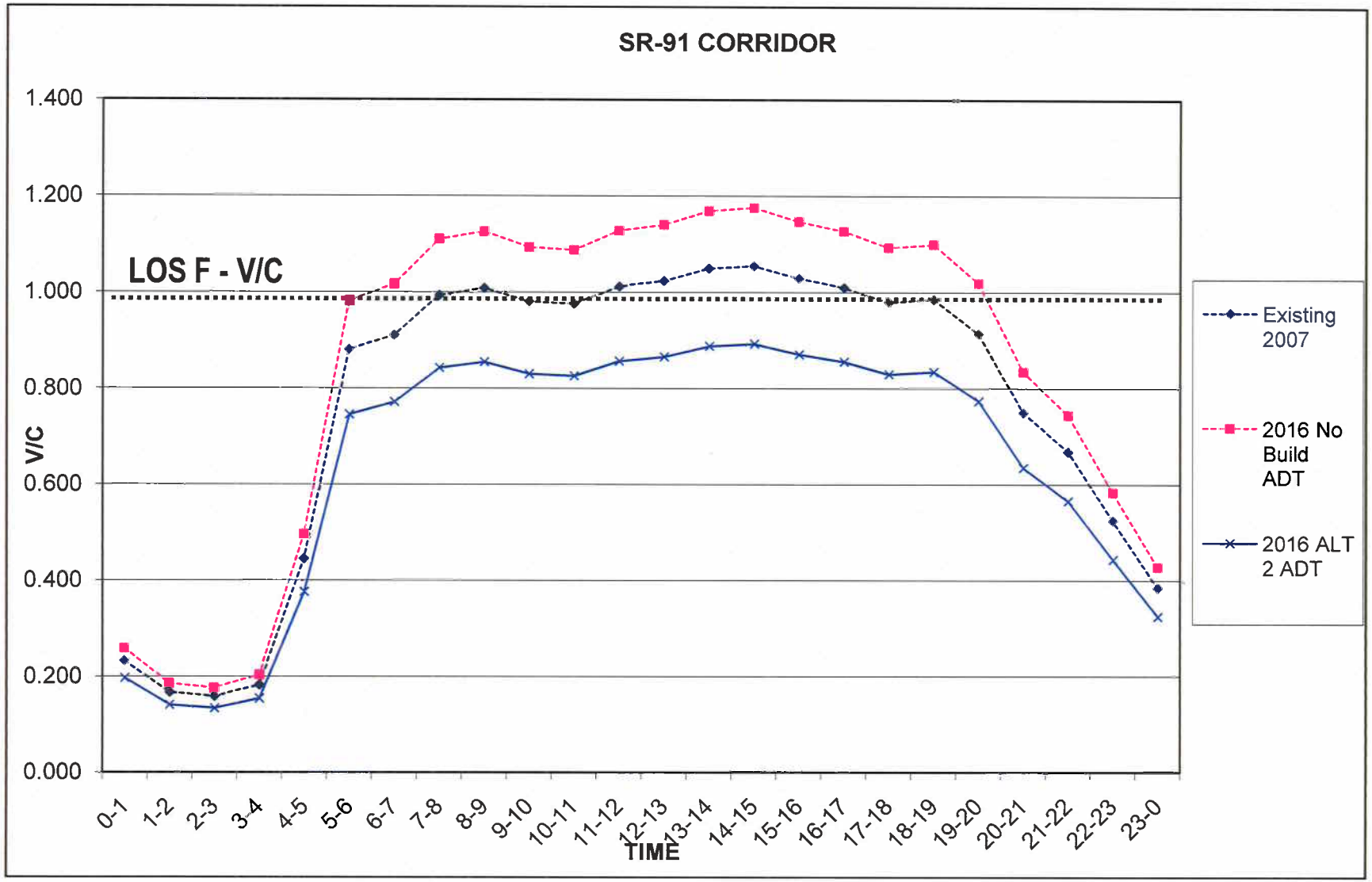
Vehicle Miles of Travel (VMT)						
	AM		PM		Daily	
Scenario	Miles	% Change	Miles	% Change	Miles	% Change
No Build	399,140		554,468		1,940,056	
Alternative 2	410,924	2.95%	566,318	2.14%	1,970,831	1.59%
Vehicle Hours of Travel (VHT)						
	AM		PM		Daily	
Scenario	Hours	% Change	Hours	% Change	Hours	% Change
No Build	13,839		19,088		50,839	
Alternative 2	12,727	-8.04%	18,088	-5.24%	48,250	-5.09%
Vehicle Hours of Delay (VHD)						
	AM		PM		Daily	
Scenario	Hours	% Change	Hours	% Change	Hours	% Change
No Build	7,677		10,519		20,854	
Alternative 2	6,378	-16.92%	9,338	-11.23%	17,791	-14.69%

Vehicle Miles Traveled is calculated by multiplying the total number of vehicles that use the subject section of roadway by the length of that road. For example, with the 4.5 mile project length if 1,000 vehicles travel on that section then the VMT would be 4,500 VMT (4.5 X 1,000 = 4,500). Since each of the alternatives has a different AM, PM, and daily traffic volume the VMT for each will be different. In this case Alternative 2 has the highest VMT as it accommodates the most traffic. The increase in VMT in Alternative 2 is between 2.14 percent and 2.95 percent during peak hours and about 1.59 percent over the entire day. Since the total number of cars in the entire system is held constant, the increase in VMT on westbound SR-91 means that fewer vehicles are traveling on other nearby facilities.

Vehicle Hours Traveled is calculated by summing all of the time each vehicle spends on westbound SR-91 within the project limits for each analysis period (AM peak hour, PM peak hour, or daily). A reduction in the VHT value indicates that traffic is moving faster along SR-91 within the project limits. As shown in Table 4-8, the VHT value for Alternative 2 is the lowest of the two alternatives even though the volume of traffic being accommodated on the facility is the highest.

The total delay value is the sum of the delay experienced by the vehicles on westbound SR-91 within the project limits. Delay is determined by calculating the difference between the freeflow speed through the facility and the congested speed during the analysis period. Alternative 2 produces the greatest reduction in delay on westbound SR-91 with a reduction of nearly 17 percent during the AM peak hour, over 11 percent in the PM peak hour, and over 14 percent over an entire weekday.

Figure 4-1: Hourly Distribution of Traffic and LOS F Threshold



Truck Traffic

The traffic data provided by Caltrans District 12 and the traffic data obtained from Caltrans website did not include truck volumes or percent truck data. Based on information contained in the 2006 Annual Average Daily Truck Traffic on the California State Highway System document prepared by Caltrans (dated December 2007), truck traffic (all axels) accounts for approximately seven to nine percent of the total daily traffic along SR-91 within the project limits. Due to heavy commuter traffic, the percent truck traffic is expected to be lower during A.M. and P.M. peak traffic periods. Based on field observations, it is estimated that the truck traffic is less than five percent of the total traffic on these ramps.

SR-91 is a key regional truck route in southern California and as such, any reduction in traffic congestion would be beneficial to goods movement within the region. Because most of the trucking activity takes place outside of the AM and PM peak hours of traffic, the impact to truck traffic is less pronounced than to auto traffic. However, because of the importance of the SR-91 corridor on goods movement in the region a reduction of congestion during all hours of the day is a substantial benefit.

Accident Data

The Caltrans Traffic Accident Surveillance and Analysis System (TASAS) provide detailed accident data for all highways in the State. District 12 provided accident data for westbound SR-91 between SR-57 and I-5 for the time period of July 1, 2004 through June 30, 2007. A summary of this accident data (both mainline and ramp segments) is provided in Table 4-9 and Table 4-10.

A review of the TASAS accident data revealed that rear-end accidents were the most common, followed by sideswipe accidents. Rear-end accidents are associated with a sudden attempt to stop when a roadway has exceeded traffic capacity and are typical in chokepoint areas. The sideswipe accidents can be attributed to lane weaving in congested areas. Most of the accidents within the project limits occur at the eastern end of the corridor where the confluence of several connecting ramps creates traffic that must weave and merge in a relatively short distance. The proposed improvement to add a general purpose lane is expected to improve traffic congestion within the project limits and would therefore help reduce accident attributed to traffic congestion.

Four fatalities and 245 injury accidents were recorded in the project area within the time period indicated. All of the fatalities and injuries occurred in the mainline segments of westbound SR-91 and none at the ramp junctions. A comparison of the actual rates versus the average accident data indicates that both fatality and injury accident rates are lower than the state average within the project limits, other than segments of the Harbor Boulevard to Raymond Avenue (PM 3.258 – 4.256) and the southbound SR-57 connector ramp to State College Boulevard (PM 5.258 – 6.119), where the actual rates are higher than the state average.

Table 4-9: Accident Data Rates for Westbound SR-91 Segments – I-5 to SR-57

36-Month Accident Rates

Location	Segment	36-Month Accident Rates*					
		Actual			Average		
		F	F+I	Total	F	F+I	Total
Magnolia Exit to I-5 Exit	PM R3.221L TO R4.084L	0.00	0.18	0.83	0.01	0.36	1.12
I-5 Exit to Brookhurst	PM 0.410 TO 1.232	0.00	0.16	0.68	0.01	0.53	1.71
Brookhurst to Euclid	PM 1.232 TO 2.234	0.00	0.21	0.65	0.01	0.56	1.81
Euclid to Harbor	PM 2.234 TO 3.258	0.01	0.24	0.93	0.01	0.43	1.38
Lemon to Raymond	PM 3.258 TO 4.256	0.01	0.33	1.52	0.01	0.43	1.35
Raymond to State College	PM 4.256 TO 5.258	0.01	0.32	1.47	0.01	0.51	1.63
State College to SR-57	PM 5.258 TO 6.119	0.01	0.46	1.97	0.01	0.49	1.57

Source: Caltrans TASAS Table B – Selective Accident Rate Calculation

12-Month Accident Rates

Location	Segment	12-Month Accident Rates*				Note
		Actual		Average		
		F+I	Total	F+I	Total	
Magnolia to I-5 Exit Ramp	PM R3.621 TO R3.821	0.11	1.42	0.22	0.73	Outside project limit
I-5 Exit Ramp to Brookhurst	PM R3.881 TO R4.081	0.22	0.66	0.22	0.72	
Euclid to Harbor	PM 3.065 TO 3.265	**0.50**	**1.72**	0.43	1.35	Improved by adding aux. lane
WB Off-Ramp to Lemon Street	PM 3.644	**1.40**	**2.44**	0.60	1.50	Improved by adding two-lane exit ramp
Lemon to Raymond	PM 4.105 TO 4.505	**0.55**	**2.55**	0.43	1.36	Improved by adding mainline lane
State College to SR-57	PM 5.258 TO 6.119	**0.61**	**1.92**	0.58	1.89	Improved by removing trap lane

Source: Caltrans TASAS Table C – Potential Investigation Locations
Accident rates are expressed as accidents per million vehicle miles traveled.

Of the 1,087 accidents only 81 occurred on or at the ramps (61 of those at the interchanges to be modified as part of the project). The type of accidents within the project limits mainly comprised of 691 rear end accidents (63.6%) and 214 sideswipe accidents (19.7%). Rear end accidents are more common in the study area because of the amount of congestion that exists during the peak periods. The majority of the "other" accidents consisted of vehicles hitting roadside objects. Approximately 30% of the accidents occurred between 4 PM and 7 PM with only about 13 percent occurring during the 6 AM to 9 AM commuter period.

Table 4-10: Accident Data for Westbound SR-91 Segments– I-5 to SR-57

36-Month Accident Characteristics - 07/01/04 to 06/30/07

Location	Segment	36-Month Number of Accidents				Type of Collision						Lighting					
		Total	Fatal (F)	Injuries (I)	F+I	Side-swipe	%	Read End	%	Other	%	Day	%	Night	%	Dusk Dawn	%
State College to SR 57	PM 5.258 TO 6.119	246	1	56	57	47	19.1%	179	72.8%	20	8.1%	163	66.3%	54	22.0%	29	11.8%
Raymond to State College	PM 4.256 TO 5.258	215	1	46	47	32	14.9%	163	75.8%	20	9.3%	183	85.1%	13	6.0%	19	8.8%
Lemon to Raymond	PM 3.258 TO 4.256	226	1	48	49	29	12.8%	158	69.9%	39	17.3%	173	76.5%	24	10.6%	29	12.8%
Euclid to Harbor	PM 2.234 TO 3.258	138	1	34	35	42	30.4%	71	51.4%	25	18.1%	97	70.3%	20	14.5%	21	15.2%
Brookhurst to Euclid	PM 1.232 TO 2.234	92	0	23	23	23	25.0%	49	53.3%	20	21.7%	57	62.0%	17	18.5%	18	19.6%
I-5 Exit to Brookhurst	PM 0.410 TO 1.232	73	0	17	17	19	26.0%	40	54.8%	14	19.2%	51	69.9%	14	19.2%	8	11.0%
Magnolia Exit to I-5 Exit	PM R3.221 TO R4.084	97	0	21	21	22	22.7%	31	32.0%	44	45.4%	70	72.2%	18	18.6%	9	9.3%
Totals		1087	4	245	249	214	19.7%	691	63.6%	182	16.7%	794	73.0%	160	14.7%	133	12.2%

Location	Segment	Facility Type				Time					
		Off Ramp	Ramp	On Ramp	Main line	AM Pk 6-9AM	%	PM Pk 4-7PM	%	Other	%
State College to SR 57	PM 5.258 TO 6.119	3	0	0	243	29	11.8%	80	32.5%	137	55.7%
Raymond to State College	PM 4.256 TO 5.258	5	2	1	207	36	16.7%	63	29.3%	116	54.0%
Lemon to Raymond	PM 3.258 TO 4.256	10	4	1	211	34	15.0%	74	32.7%	118	52.2%
Euclid to Harbor	PM 2.234 TO 3.258	7	4	1	126	16	11.6%	32	23.2%	90	65.2%
Brookhurst to Euclid	PM 1.232 TO 2.234	17	1	0	74	14	15.2%	18	19.6%	60	65.2%
I-5 Exit to Brookhurst	PM 0.410 TO 1.232	3	11	0	59	6	8.2%	25	34.2%	42	57.5%
Magnolia Exit to I-5 Exit	PM R3.221 TO R4.084	10	1	0	86	8	8.2%	35	36.1%	54	55.7%
Totals		55	23	3	1006	143	13.2%	327	30.1%	617	56.8%

Most of the accidents within the project limits occur at the eastern end of the corridor where the confluence of several connecting ramps creates traffic that must weave and merge in a relatively short distance. The proposed improvement to add a general purpose lane is expected to improve traffic congestion within the project limits and would therefore help reduce accident attributed to traffic congestion.

Four segments along SR-91 appear to have relatively high accident occurrences during the previous 12-month period as shown in Table 4-9. The higher than average accident rate between SR-57 and State College Boulevard should be reduced by the elimination of the trap lane condition between the interchanges.

Widening westbound SR-91 through the interchanges at State College Boulevard, Raymond Avenue, Euclid Street, and Brookhurst Road should reduce the higher than average accident rate on the freeway mainline lanes by increasing capacity and therefore reducing the occurrence of congestion-related accidents in these locations. The total accident rates at the Lemon Street exit ramp are approximately 63 percent higher than average and the fatal-plus-injury rate is 230 percent higher than average. The two-lane exit ramp should improve operations and reduce densities at the diverge point for this exit ramp.

The total accident rate on westbound SR-91 between the Harbor and Euclid ramps is about 27 percent higher than average. The auxiliary lane proposed in Alternative 2 will effectively add capacity within this segment of the project and improve operations, thereby reducing congestion. Accident rates at the Euclid Street exit ramp are also higher than average. Widening of the exit ramps to two lanes will reduce the length of the exit queues and will reduce the number of possible rear end collisions.

The total accident rate between the Raymond Avenue and Lemon Street is about 187 percent higher than average. The fatal plus injury accident rate is about 28 percent higher than average. The majority of the accidents on this segment of westbound SR-91 are mainline accidents. The addition of the fourth mainline lane will improve capacity along this segment of SR-91.

Four of the potential accident locations occur within the westbound segments of SR-91 between SR-57 and Euclid Street. Alternative 2 will provide mainline capacity within the project limits. However, the existing auxiliary lanes between the interchanges in this area are not as effective at addressing congestion as the two-lane exit ramps with auxiliary lanes proposed in Alternative 2. This is because the existing auxiliary lanes do not address high densities at the existing single lane exit ramps, which increases the potential for accidents. Alternative 2 will reduce densities at the exit ramps by providing additional capacity compared to the No Build alternative potentially reducing accident rates within the project limits.

5. ALTERNATIVES

A. VIABLE ALTERNATIVES

Three viable alternatives were studied: No Build, Build Alternative 1 and Build Alternative 2. Following public circulation of the Initial Study with Proposed Mitigated Negative Declaration (IS/MND) from November 10 to December 14, 2009, Build Alternative 2 was recommended as the Preferred Alternative for the proposed project. This recommendation was made by the Project Development Team (PDT), which consisted of staff from the Department, OCTA, the City of Anaheim, the City of Fullerton, and several project consulting firms, at a meeting on March 22, 2010. The PDT recommended Build Alternative 2 as the preferred alternative because it would better meet the objectives of the project, which are to: 1) provide congestion relief, decrease travel times, and shorten the durations of peak traffic periods

to improve through lane capacity and provide for continued goods movement along westbound SR-91 between SR-57 and I-5; and 2) help achieve the goals of the SCAG 2008 RTP and OCTA 2008 LRTP.

Both build alternatives would result in similar overall operating conditions; however, Build Alternative 1 would queue more vehicles on the on-ramps, while Build Alternative 2 would allow for more vehicles in the auxiliary lane and result in decreased VHD. Build Alternative 2 would provide the greatest reduction in corridor delay and vehicles hours of travel while allowing for an increase in vehicle miles traveled (VMT) within the proposed project limits.

Under Build Alternative 2, the provision of the auxiliary lane and the two-lane exit ramps provides additional capacity as compared to Build Alternative 1. Both Build Alternative 1 and Build Alternative 2 include the addition of the fourth mainline lane, therefore, the difference in operating conditions between the Build Alternatives and the No-Build Alternative are similar. However, Build Alternative 2 provides improved operations as compared to Build Alternative 1 for traffic that is exiting (diverging from) SR-91 because of the addition of the auxiliary lane and the second ramp lane. This is reflected in the projected operating conditions for exiting traffic at the majority of ramps along the proposed project alignment, which is predicted to be improved under Build Alternative 2 when compared to Build Alternative 1.

Build Alternative 2 also provides additional capacity with the addition of the auxiliary lanes and, as a result, it is predicted that Build Alternative 2 would attract more traffic to the corridor as a result than Build Alternative 1 or the No-Build Alternative. This additional volume would reduce the overall benefit, however, Build Alternative 2 would still result in an improved LOS at most ramps compared to Build Alternative 1 and would provide a substantial improvement over the No-Build Alternative.

Build Alternative 2 would include the addition of two-lane exit ramps and the construction of an auxiliary lane between interchanges. It is predicted that this would improve safety along the project alignment when compared to the single-lane exit ramps and auxiliary lanes that currently exist and would continue under the No-Build Alternative, and the single-lane exit ramps without auxiliary lanes, as proposed under Build Alternative 1. This is because the existing auxiliary lanes do not address high densities at the existing single-lane exit ramps, which increases the potential for accidents. It is anticipated that under Build Alternative 1 this would be exacerbated, as the existing auxiliary lanes would be eliminated. It is predicted that Build Alternative 2 would reduce densities at the exit ramps by providing additional capacity compared to Build Alternative 1 and the No-Build Alternative, thereby potentially reducing accident rates within the project limits and providing an improved merge/diverge condition.

As discussed above, it is predicted that Build Alternative 2, when compared to Build Alternative 1 and the No-Build Alternative, would: 1) provide the greatest overall improvement in LOS; 2) accommodate higher traffic volumes; and 3) provide better operations and safety. For the reasons enumerated above, Build Alternative 2 was recommended by the PDT as the Preferred Alternative.

Alternative 2 - Widen Through Existing Interchanges and Construct Auxiliary Lanes

Proposed Engineering Features

Alternative 2 meets the purpose and need of the project, therefore has been recommended as the Preferred Alternative. It provides additional traffic capacity through the provision of the auxiliary lane and the two-lane exit ramps; it improves operations for diverging (exiting) traffic at ramp junctions; it reduces the potential for accidents by decreasing traffic densities; and it improves the LOS conditions for both the mainline and ramp junctions. Overall, Alternative 2 provides the best improvement in LOS and accomplishes this while accommodating more traffic volume and providing better operational safety improvements.

Alternative 2 connects the existing westbound auxiliary lanes through each interchange. Within the eastern project limits, the southbound SR-57 to westbound SR-91 connector ramp auxiliary lane to the State College Boulevard off-ramp would be extended through the State College Boulevard interchange to the existing auxiliary lane between State College Boulevard and Raymond Avenue. Continuing west, the proposed fourth continuous general purpose lane would be widened through the Raymond Avenue interchange and connected with the existing number four general purpose lane through the Lemon Street-Harbor Boulevard split diamond interchange segment. West of the Lemon Street-Harbor Boulevard interchange, the existing number four general purpose lane that currently is required to exit at Euclid Street would be extended through the Euclid Street interchange and connected to the existing auxiliary lane between Euclid Street and Brookhurst Road. Continuing west, the proposed fourth continuous general purpose lane would be widened through the Brookhurst Road interchange and connected with the existing auxiliary lane downstream of the Brookhurst Road on-ramp. Additionally, Alternative 2 proposes to widen SR-91 between these interchanges to replace westbound auxiliary lanes and to provide two-lane ramp geometrics at the exit ramp diverge locations. A fourth auxiliary lane is also proposed in this alternative to be added between Raymond Avenue and Lemon Street where no auxiliary lane currently exists.

Build Alternative 2 includes all the modifications proposed in Build Alternative 1 as well as the following additional features:

Westbound Auxiliary Lane Improvements

- Auxiliary lane widening and two-lane westbound off-ramp widening to Raymond Avenue;
- Addition of single right-turn pocket lane on westbound off-ramp onto Raymond Avenue;
- Auxiliary lane widening and two-lane westbound off-ramp widening to Lemon Street, between approximately STA 244+65 and 251+60;
- Auxiliary lane widening and two-lane westbound off-ramp widening to Euclid Street, between approximately STA 183+00 and 198+60; and
- Auxiliary lane widening between Euclid Street and Brookhurst Road, and a two-lane westbound off-ramp widening to Brookhurst Road.

Ramp Improvements

As stated above, two-lane off-ramps and associated auxiliary lanes at the westbound off-ramps to Raymond Avenue, Lemon Street, Euclid Street, and Brookhurst Road. Alternative 2 also includes the construction of an exclusive right-turn lane on the Raymond Avenue off-ramp.

Bridges

The following additional bridge would be widened:

- Acacia Avenue Undercrossing (composite steel girders)

Sound Walls and Retaining Walls

In addition to the modifications identified in Build Alternative 1, the following sound wall and retaining wall modifications would be required under Build Alternative 2:

- Construction of a new retaining wall near the existing state right-of-way between Acacia Avenue and Raymond Avenue, between approximately STA 289+48 and 292+00.
- Demolition and reconstruction of a large a sound wall (supported on a retaining wall) west of Acacia Avenue extending from approximately STA 292+00 to 307+50 in order to widen between interchanges.
- Demolition and reconstruction of the a sound wall (supported on a retaining wall) east of Euclid Street, at the proposed new right-of-way between STA 182+80 (approximately 150 feet east of the South Woods Avenue terminus) and STA 198+50 (immediately west of the South Richman Avenue terminus). Retaining walls are proposed to minimize the number of parcels impacted and the amount of right-of-way required from affected properties.
- Existing sound walls would be tied together at STA 182+80, approximately 150 feet west of the South Woods Avenue terminus.
- Reconstruction of a sound wall (supported on a retaining wall) at the state right-of-way along the westbound Brookhurst Road off-ramp, between approximately STA 127+20 and STA 128+50.
- Reconstruction of a sound wall between approximately STA 313+85 and STA 316+70.

Drainage Improvements

Build Alternative 2 includes the modifications identified in Build Alternative 1. Also, due to the additional traffic loads from the proposed widening of the auxiliary lane between Euclid Street and Brookhurst Road, a large reinforced concrete box culvert (Houston Storm Channel) that exists along the north side of the freeway requires strengthening. Analysis of the increased traffic loading on the existing channel showed that the roof and wall do not have sufficient shear and moment capacity. The strengthening of the Houston Storm Channel would be accomplished by retrofitting the culvert with a concrete slab, side walls and providing additional transverse and longitudinal reinforcing steel bars.

Major Utilities

A permanent utility relocation would be required for an existing overhead electric utility located along the north right-of-way where new right-of-way is required to accommodate the proposed widening. Utility work would include the following:

- An existing 12-kilovolt overhead power line owned by Southern California Edison north of the proposed Euclid Street auxiliary lane would need to be permanently relocated outside of the new right-of-way.
- Protection of existing power lines would be required within the proposed TCEs at the beginning and end of the Euclid Street auxiliary lane, along the Euclid Street on-ramp and the Brookhurst Road off-ramp widening.

Nonstandard Mandatory Design Features

There are three existing nonstandard design features that are common to both build alternatives and not anticipated to be modified by the proposed improvements. These common nonstandard geometric features are approved in a mandatory fact sheet. The nonstandard design features include:

- A nonstandard mainline left shoulder width between the existing HOV lane and the center concrete median barrier;
- Nonstandard vertical clearances at two existing undercrossings, State College Boulevard, Raymond Avenue; and
- Nonstandard freeway-to-freeway interchange spacing to local street interchanges.

Refer to Table 5-1 for additional details regarding these nonstandard features.

Table 5-1. Exceptions to Department Design Standards

HDM Topic	Design Component	HDM Standard	Existing Condition	Alternative 1	Alternative 2
302.1	Left shoulder width	10'	2'	2'	2'
309.2	State College vertical clearance	15'	14'-11"	14'-11"	14'-11"
309.2	Raymond vertical clearance	15'	14'-11"	14'-11"	14'-11"
501.3	Lemon to Raymond interchange spacing	1 mi	0.76 mi	0.76 mi	0.76 mi
501.3	SR-57 to State College interchange spacing	2 mi	0.87 mi	0.87 mi	0.87 mi
501.3	I-5 to Brookhurst interchange spacing	2 mi	1.37 mi	1.37 mi	1.37 mi

Nonstandard Advisory Design Features

There are two existing nonstandard advisory design features that are common to both build alternatives and not anticipated to be modified by the proposed improvements. These common nonstandard geometric features will be addressed in an advisory fact sheet. The nonstandard design features include:

- A nonstandard embankment slope located on east and west of the North Anaheim Overhead; and
- Nonstandard horizontal clearance from the existing bridge columns at the State College Boulevard undercrossing in the north and southbound directions.

Refer to Table 5-2 for additional details regarding these nonstandard features.

Table 5-2. Exceptions to Department Advisory Design Standards

HDM Topic	Design Component	HDM Standard	Existing Condition	Alternative 1	Alternative 2
304.1	Embankment (fill) slopes adjacent to North Anaheim Overhead	4:1 or flatter	2:1	2:1	2:1
309.1	State College horizontal clearance	1'-6"	11" (SB) & 1'-2" (NB)	11" (SB) & 1'-2" (NB)	11" (SB) & 1'-2" (NB)

Cost Estimates

Estimated right-of-way and construction costs of the improvement for Alternative 2 is approximately $48.9 million as shown in Attachment B. The cost estimate does not include capital outlay support costs.

Right-of-Way Data

A Right-of-Way Data Sheet has been prepared for Alternative 2 and is included in Attachment D. The right-of-way costs for Alternative 2 are $3,303,000.

Alternative 1 - Widen Through Existing Interchanges and Eliminate Auxiliary Lanes

Proposed Engineering Features

Existing through-lane capacity would be increased from three general purpose lanes to four continuous general purpose lanes from southbound SR-57 to westbound SR-91 connector (PM 5.4) to the westbound SR-91 to northbound I-5 connector (PM 0.9). Elements that would be implemented under this build alternative are discussed in detail below.

Build Alternative 1 would connect the existing westbound auxiliary lanes through each interchange. Within the eastern project limits, the southbound SR-57 to westbound SR-91 connector ramp auxiliary lane to the State College Boulevard off-ramp would be extended through the State College Boulevard interchange to the existing auxiliary lane between State College Boulevard and Raymond Avenue. Continuing west, the proposed fourth continuous general purpose lane would be widened through the Raymond Avenue interchange and connected with the existing number four general purpose lane through the Lemon Street-Harbor Boulevard split diamond interchange segment. West of the Lemon Street-Harbor Boulevard interchange, the existing number four general purpose lane that currently is required to exit at Euclid Street would be extended through the Euclid Street interchange and connected to the existing auxiliary lane between Euclid Street and Brookhurst Road. Continuing west, the proposed fourth continuous general purpose lane would be widened through the Brookhurst Road interchange and connected with the existing auxiliary lane downstream of the Brookhurst Road on-ramp.

Alternative 1 does not meet the needs or purpose of this project. Although the alternative provides a relative improvement in LOS and traffic operations, it does not properly accommodate the higher traffic volumes forecasted for the project area. As a result, the Vehicle Miles Traveled (VMT), Vehicle Hours Traveled (VHT), and Vehicle Hours of Delay (VHD) do not satisfy the regional plans of OCTA. Additionally, the single lane exit ramps and removal of the auxiliary lanes pertaining to Alternative 1 does not adequately address exit ramp congestion. Therefore, accidents related to traffic maneuvers for exiting vehicles will escalate as future traffic congestion increases.

Bridges

The following bridges would be widened:

- State College Boulevard Undercrossing (pre-cast, pre-stressed concrete girders);
- Raymond Avenue Undercrossing (steel plate girders);
- North Anaheim Overhead (steel plate girders);
- Euclid Street Undercrossing (pre-cast, pre-stressed concrete slab); and
- Brookhurst Road Undercrossing (pre-cast, pre-stressed concrete slab).

In keeping with the Historic Agriculture/Orchard Theme identified by the Master Plan of Freeway and Transit Corridor Enhancements: Creating a Quality Environment Along Orange County's Transportation Corridors, bridge abutments or parapets would include imprinted patterns representative of agricultural orchards.

Sound Walls and Retaining Walls

The following sound wall and retaining wall modifications would be required under Build Alternative 1:

- Extension of an existing sound wall along the Euclid Street westbound on-ramp between approximately Station (STA) 158+00 and 160+70.
- Reconstruction of sound walls supported on a retaining wall in their current locations along the Brookhurst Road/SR-91 westbound on-ramp between approximately STA 106+10 and 111+30 and between STA 113+10 and 114+70.
- Walls would be constructed following the Historic Agriculture/Orchard Theme identified by the Master Plan of Freeway and Transit Corridor Enhancements for the project.

Drainage Facilities

Drainage work involved under the proposed project includes extensions of existing storm drain systems and construction of new inlets along the shoulders of the widened westbound SR-91, construction of drainage systems along ramp modifications and extensions of cross culverts to the north to accommodate westbound widening. Modifications to the Houston Storm Channel reinforced concrete box, concrete open channels, and appurtenant facilities would also be implemented. Specifically, drainage work would include the following:

- Removal of concrete ditch starting 200 feet east of State College Boulevard undercrossing, extending eastward for a length of 250 feet;
- Construction of 36-inch diameter reinforced concrete pipe (RCP) starting 200 feet east of Brookhurst Road undercrossing, extending eastward for a length of 6 feet;
- Construction of two 8-foot by 5-foot reinforced concrete boxes starting 50 feet west of South Orchard Avenue terminus, extending eastward for a length of 245 feet (STA 157+15 to 159+60);
- Construction of transition, reinforced concrete box to reinforced concrete trap, starting 100 feet east of South Orchard Avenue terminus, extending eastward for a length of 40 feet (STA 159+60 to 160+00);
- Construction of various sized RCP culverts and drainage inlets throughout the length of the project.

Electrical Work

Electrical work involved under the proposed project includes modification of existing ramp gore lighting and sign illumination systems. Existing traffic signals at the westbound ramp terminal intersections may require modifications depending on the specific improvements ultimately constructed at the interchanges. Any lighting that is installed as part of the project would follow the Master Plan of Freeway and Transit Corridor Enhancements. During the construction phase of the project temporary lighting, traffic monitoring stations, signals and fiber optics will be supplied where required in order to ensure proper traffic operations.

Nonstandard Mandatory Design Features

There are three existing nonstandard design features that are common to both build alternatives and not anticipated to be modified by the proposed improvements. These common nonstandard geometric features are approved in a mandatory fact sheet. The nonstandard design features include:

- A nonstandard mainline left shoulder width between the existing HOV lane and the center concrete median barrier;
- Nonstandard vertical clearances at two existing undercrossings, State College Boulevard and Raymond Avenue; and
- Nonstandard freeway-to-freeway interchange spacing to local street interchanges.

Refer to Table 5-3 for additional details regarding these nonstandard features.

Table 5-3. Exceptions to Department Mandatory Design Standards

HDM Topic	Design Component	HDM Standard	Existing Condition	Alternative 1	Alternative 2
302.1	Left shoulder width	10'	2'	2'	2'
309.2	State College vertical clearance	15'	14'-11"	14'-11"	14'-11"
309.2	Raymond vertical clearance	15'	14'-11"	14'-11"	14'-11"
501.3	Lemon to Raymond interchange spacing	1 mi	0.76 mi	0.76 mi	0.76 mi
501.3	SR-57 to State College interchange spacing	2 mi	0.87 mi	0.87 mi	0.87 mi
501.3	I-5 to Brookhurst interchange spacing	2 mi	1.37 mi	1.37 mi	1.37 mi

Nonstandard Advisory Design Features

There are two existing nonstandard advisory design features that are common to both build alternatives and not anticipated to be modified by the proposed improvements. These common nonstandard geometric features will be addressed in an advisory fact sheet. The nonstandard design features include:

- A nonstandard embankment slope located on east and west of the North Anaheim Overhead; and
- Nonstandard horizontal clearance from the existing bridge columns at the State College Boulevard undercrossing in the north and southbound directions.

Table 5-2. Exceptions to Department Advisory Design Standards

HDM Topic	Design Component	HDM Standard	Existing Condition	Alternative 1	Alternative 2
304.1	Embankment (fill) slopes adjacent to North Anaheim Overhead	4:1 or flatter	2:1	2:1	2:1
309.1	State College horizontal clearance	1'-6"	11" (SB) & 1'-2" (NB)	11" (SB) & 1'-2" (NB)	11" (SB) & 1'-2" (NB)

High Occupancy Vehicle (HOV) Lanes

The existing HOV lane that currently extends through the length of the project will be maintained. The HOV lane currently has restricted access with entry and exit allowed at only selected locations. As part of a future and separate project, Caltrans has proposed allowing continuous access to the HOV lane throughout this segment of SR-91. The timing of this project is unknown and is contingent on funding availability.

Ramp Metering

The existing ramp metering that currently exists at all the on-ramps within the project limits will be maintained. In order to ensure and maintain standard traffic operations, temporary ramp metering will be provided during construction where required.

California Highway Patrol (CHP) Enforcement Area

There is an existing California Highway Patrol (CHP) Enforcement Area between Brookhurst Street and Euclid Street from Station 125+00 to STA 167+10. This facility will remain and will not be modified as part of the proposed project.

Utility and Other Owner Involvement

Alternative 1 is not expected to have substantial impacts to existing utilities. The improvements proposed in Alternative 1 are primarily within the existing State right-of-way. Existing utilities in the arterials crossing under the freeway bridges at the interchanges may require protection; however, since they currently do not conflict with the undercrossing column bents and abutment footings in their existing configuration, new conflicts are not anticipated. These underground utilities should be potholed during design to accurately identify existing locations and to assess potential impacts definitively.

Railroad Involvement

The project will require railroad involvement at the OCTA/Metrolink railroad tracks for the proposed widening of the North Anaheim overhead structure, Bridge No. 55-216, over the OCTA/Metrolink railroad tracks and right-of-way. The proposed steel plate girder bridge widening will not require falsework over the active railroad tracks. Widening of the overhead structure may necessitate extension of the existing pier protection wall adjacent to any new columns in the OCTA/Metrolink right-of-way. The proposed improvements are expected to require a permanent easement from the railroad, a Construction and Maintenance Agreement and a Service Contract for flagging.

In addition, Metrolink has proposed a project (Anaheim Layover Facility) that will require construction under SR-91 at the North Anaheim Overhead. This project will not conflict with the widening of SR-91.

Highway Planting

Per the Department's Highway Planting General Policy, any highway planting within the State right-of-way that is damaged or removed by State highway construction activity, including irrigation modification and/or replacement, would be replaced as part of the project, where feasible. Trees and other vegetation would be replaced at a rate and size determined by the District Landscape Architect. Existing irrigation crossovers under roadways and ramps and inside bridge cells will be extended or replaced as needed.

Erosion Control

This project requires coverage under the State Water Resources Control Board Order No. 2009-0009-DWQ National Pollutant Discharge Elimination System General Permit No. CAS 000002 Waste Discharge Requirements For Discharges Of Storm Water Runoff Associated With Construction And Land Disturbance Activities (previously known as 99-08-DWQ, NPDES No. CAS 00002) General Construction Permit (GCP). The GCP requires that the applicant stabilize disturbed soil areas to protect against runoff after project is completed. Appropriate soil stabilization/slope protection measures will be incorporated into project to assure permit compliance.

Non-motorized and Pedestrian Facilities

ADA requirements will be applied to any pedestrian facility within the limits of the project and the facility will be upgraded to current standards via Caltrans criteria as required. However, pedestrian facilities located outside of the project limits will not be incorporated at this phase given that this would alter the area of the project's defined footprint.

Needed Roadway Rehabilitation and Upgrading

The proposed project scope and funding does not include the rehabilitation or upgrading of existing pavement.

Cost Estimates

Estimated right-of-way and construction costs of the improvement for Alternative 1 are approximately $25.5 million. The cost estimate does not include capital outlay support costs.

Right-of-Way Data

A Right-of-Way Data Sheet was been prepared for Alternative 1and was included in the Draft Project Report. The right-of-way costs for Alternative 1 are $732,000.

No Build Alternative

A no build option was considered as a baseline to measure and compare the proposed build alternatives. The no build alternative would maintain the existing three general purpose lanes, one HOV lane and auxiliary lanes through the east and west segments of westbound SR-91. Traffic modeling for the no build alternative reflects the current highway network augmented by any transportation network changes that are reasonably expected to be in place by the design year for this project, which is OCTA's conformed travel demand model network.

The No-Build Alternative proposes that no improvements be implemented at this time. Attachment A shows the typical cross sections of the No-Build Alternative. This alternative, however, would not preclude the construction of future improvements, including improvements that would be required for the SR-91 facility to become a 10-lane facility (eight general purpose lanes and two HOV lanes) as indicated in the approved 1999 Route Concept Report. The No-Build Alternative does nothing to address the existing and projected capacity deficiencies that are expected to degrade further. The lack of adequate capacity along this corridor is expected to have a negative impact on mobility, which would continue to worsen under the No-Build Alternative. In addition, the No-Build Alternative would not address the identified purpose and need for the project.

Effects of the No-Build Alternative would include:

- Maintenance of LOS F along the mainline and ramp areas currently experiencing LOS F conditions within the project limits, and the deterioration of LOS at all other areas to LOS F (within the project limits).

- Ramp queue lengths would increase and contribute to further congestion of mainline operations and extended VHD.

- Accident rates would be expected to increase as ramp queue lengths increase, extending into mainline lanes.

B. REJECTED ALTERNATIVES

Other alternatives considered but eliminated from further consideration are discussed below:

Transportation System Management

Transportation System Management (TSM) strategies consist of actions that increase the efficiency of existing facilities; they are actions that increase the number of vehicle trips a facility can carry without increasing the number of through lanes. Examples of TSM strategies include ramp metering, auxiliary lanes, turning lanes, reversible lanes and traffic signal coordination. Because TSM strategies currently are employed in the project area (HOV and auxiliary lanes), and traffic congestion is still prevalent in the project area, TSM measures alone would not address the existing capacity deficiency of the SR-91 facility.

Although Transportation System Management measures alone could not satisfy the purpose and need of the project, the following TSM measures have been incorporated into the proposed Build Alternatives for this project:

1. Maintain the TSM strategies that are currently in place on SR-91 such as ramp metering, changeable message signs and closed circuit television cameras.

2. Maintain/add system elements to enhance existing freeway surveillance coverage, such as the systemwide fiber optic communication system, to tie in all of the Traffic Management Center (TMC).

Transportation Demand Management

Transportation Demand Management (TDM) encourages automobile, public and private transit, ridesharing programs, and bicycle and pedestrian improvements as elements of a unified urban transportation system. TDM addresses traffic congestion by reducing travel demand rather than increasing transportation capacity and focuses on alternatives such as ride sharing, flextime, increased transit usage, walking, and bicycling. TDM focuses on regional strategies for reducing the number of vehicle trips and vehicle miles traveled as well as increasing vehicle occupancy. It facilitates higher vehicle occupancy or reduces traffic congestion by expanding the traveler's transportation choice in terms of travel method, travel time, travel route, travel costs, and the quality and convenience of the travel experience. Typical activity within this component is providing contract funds to regional agencies that are actively promoting ridesharing, maintaining rideshare databases and providing limited rideshare services to employers and individuals. Because TDM strategies currently are employed in the project area (OCTA bus and rail networks), and traffic congestion is still prevalent in the project area, TDM measures alone would not be adequate to meet the purpose of and need for the proposed project.

Multi-Modal Alternatives

Modal alternatives integrate multiple forms of transportation modes, such as pedestrian, bicycle, automobile, rail, and transit. Because a range of transportation options are currently available in the project area (OCTA bus and rail networks, and local street network with sidewalks), and traffic

congestion is still prevalent in the project area, multi-modal alternatives alone would not be adequate to meet the purpose of and need for the proposed project.

6. CONSIDERATIONS REQUIRING DISCUSSION

A. HAZARDOUS WASTE

An Initial Site Assessment (ISA) was prepared for the project in October 2008 (updated May 2010). The ISA indicated that there is one commercial site within the project between State College Boulevard and Acacia Avenue that has a potential for hazardous waste involvement (1403 Baxter Street). Since right-of-way will be required, a Phase II Hazardous Waste Investigation shall be performed for this property to assess for the presence of petroleum hydrocarbons and oxygenates. At this time the PDT has decided to defer the Phase II investigation until the PS&E phase which is scheduled to begin in the summer of 2010.

An Aerially Deposited Lead (ADL) investigation was prepared in March 2009. Material generated during the project may be reused according to Caltrans Soil Classification Y-1. The soil should be placed a minimum of 5 feet above the maximum groundwater table elevation and covered with at least 1 foot of non-hazardous soil, thereby eliminating disposal costs associated with hazardous material. A soil management plan shall be prepared during the PS&E design phase to 1) establish soil reuse criteria and a sampling plan for stockpiled materials, 2) describe the disposition of materials that do not satisfy the reuse criteria, and 3) specify guidelines for imported materials. Appropriate health and safety measures, including personal protection equipment (PPE) and dust control, should be implemented in order to limit exposure to workers at the site during the proposed construction.

B. VALUE ANALYSIS

A Value Analysis Study was performed on September 22 through 24, 2008 at the offices of OCTA. The purpose of the study was to review the project during the PA/ED phase and focus on additional design options that would help to finalize the scope of the project and identify cost savings that would help provide a fundable project and satisfy the local stakeholders.

A VA team was formed to carry out these objectives and included Caltrans District 12 staff, representatives from OCTA, AECOM and the VA facilitator, VMS. The VA team developed four design options for improvement of the project. The first option proposes to add continuous access to the existing HOV lane and reduce the buffer zone to save structural section cost. The second option proposes using rubberized AC in lieu of AC. The third option proposes several enhancements that can improve the design. The fourth option proposes to adjust signal synchronization and timing at Raymond Avenue during and after construction of the new right-turn lane. Options 1, 2 and 4 were not adopted, however they could be reconsidered for implementation during the PS&E phase if deemed appropriate.

The design features proposed in Option 3 that were adopted by the PDT and have been incorporated into the project. These include the following:

- Testing for aerially deposited lead (ADL) in the PA & ED design phase;
- Adding a retaining wall at the toe of the slope west of the OCTA/Metrolink rail line; and
- Adding of safety shape barrier to sound walls that will not be replaced.

C. RESOURCE CONSERVATION

The proposed project will retain the existing HOV lane in the westbound direction which will continue to contribute to energy/fuel conservation within the SR-91 corridor. Furthermore, the Value Analysis Study

identified an alternative to use rubberized asphalt concrete in lieu of standard asphalt. If adopted, this will promote the use of recycled tires and minimize the use of nonrenewable resources.

During the PS&E phase, other methods of conservation should be explored including the reuse of existing materials through salvaging or recycling (i.e., demolished concrete used for base material).

D. RIGHT-OF-WAY ISSUES

Right-of-Way Required

The proposed project will require acquisition of residential and commercial properties. Both permanent fee acquisitions and temporary construction easements (TCEs) will be required.

Alternative 2, requires acquisition affecting 53 properties (includes TCE's, permanent acquisitions, a permanent easement from Metrolink for the widening of the North Anaheim Overhead and one potential displacement). To accommodate the project's future right-of-way requirements, the property acquisitions will be subject to the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894), as amended by the Uniform Relocation Act Amendments of 1987, Title IV of the surface Transportation and Uniform Relocation Act of 1987 (Public Law 100-17, 101 Stat. 246-256).

In conjunction with the Anaheim Layover Facility project, a highway easement will be acquired from APN 267-051-20. This highway easement will be of sufficient width to accommodate the widening of the North Anaheim Overhead.

Relocation Impact Studies

A Draft Relocation Impact Report (DRIR) and a Final Relocation Impact Statement (FRIS) were prepared in August 2009 and May 2010, respectively, to study the impacts to any potential displacements. One property has been identified for potential displacement under Build Alternative 2. The identified replacement area(s) include(s) the neighborhoods surrounding the proposed displacement area. They are found within the same city (Fullerton) and can be characterized as having generally similar or better street usage, accessibility, composition, utilities, landscape, and proximity to transportation, shopping, health, and religious facilities.

E. ENVIRONMENTAL ISSUES

An Initial Study with Mitigated Negative Declaration (IS/MND) has been prepared in accordance with the California Environmental Quality Act (CEQA) and Department policies and procedures. As the lead agency under CEQA, the Department approved the IS/MND on May 20, 2010. This is based on the findings of the technical studies and environmental evaluations that have been conducted. These studies indicate that any potentially significant impact could be reduced to a level that would be considered less than significant when taking into consideration mitigation measures that have been identified for the proposed project. The IS/MND has been prepared in accordance with Caltrans' environmental procedures, as well as State environmental regulations and is the appropriate document for this proposal. The IS/MND is bound under separate cover and is listed as Attachment F.

Permanent, unavoidable impacts on jurisdictional waters will require compensatory mitigation. To mitigate for impacts on jurisdictional waters, permanent impacts to 0.38 acres of jurisdictional waters under Build Alternative 2, shall be compensated at a 1:1 ratio through onsite restoration and enhancement, or through a United States Army Corps of Engineers-approved mitigation bank or in-lieu

fee mitigation program. Although temporary impacts are not anticipated at this time, if temporary impacts occur, these areas will be restored to pre-project condition.

F. AIR QUALITY CONFORMITY

The proposed project is included in the Southern California Association of Governments (SCAG's) 2008 Regional Transportation Plan (RTP) as project 2M01126. The Southern California Association of Governments (SCAG) adopted the 2008 RTP on May 8, 2008 and the Federal Highway Administration (FHWA) and Federal Transit Agency (FTA) adopted the air quality conformity finding on June 5, 2008. The proposed project is also included in the cost-constrained 2008 Regional Transportation Improvement Program (RTIP) with amendments as project ID No. ORA000822 (Expense Authorization No. 0C5700), which was adopted by SCAG on July 17, 2008 and was found to be conforming by FHWA and FTA on November 17, 2008. The design concept and scope of the proposed project are consistent with the project description in the 2008 RTP and 2008 RTIP and the assumptions in SCAG's regional emissions analysis.

G. NOISE

There are existing sound walls at various locations throughout the project limits. For Alternative 2, existing sound walls that are not impacted by the proposed widening will be maintained in place. Sound walls that are impacted will be reconstructed to accommodate the proposed widening. Any noise barrier to be demolished must be replaced at the same height or higher at the new location. It is important to ensure the top of the wall is constructed at the same elevation as before or higher to maintain the effectiveness of providing noise reduction. A Noise Abatement Decision report (NADR) is not required for the project since the project falls under CEQA guidelines.

H. NPDES

The proposed project is within the jurisdiction of the Santa Ana Regional Water Quality Control Board (RWQCB) (Region 8), within the Coyote Creek/Carbon Creek WMA. The project site drains to Carbon Creek and the Houston Storm Channel, both tributaries to Coyote Creek and ultimately the San Gabriel River in Los Angeles County.

Construction of the project would require excavation, along with disturbances of soils and vegetation. Because the proposed project would disturb more than 1 acre of soil, a Notice Of Intent (NOI) will be required in compliance with the provisions of the State Water Resources Control Board Order No. 2009-0009-DWQ National Pollutant Discharge Elimination System General Permit No. CAS 000002 Waste Discharge Requirements For Discharges of Storm Water Runoff Associated With Construction and Land Disturbance Activities (previously known as 99-08-DWQ, NPDES No. CAS 00002) in addition to the requirements of the Department's NPDES, Statewide Storm Water Permit, Order No. 99-06-DWQ, NPDES NO. CAS 00003. NPDES General Construction Permit (GCP) coverage will be required prior to commencement of construction activities. As part of the GCP permit requirements, a SWPPP would be prepared and implemented to address construction related activities, equipment and materials that have the potential to impact water quality.

Construction Site BMPs included in SWPPP will follow the latest edition of the Storm Water Quality Handbooks, Storm Water Pollution Prevention Plan (SWPPP) and Water Pollution Control Program (WPCP) Preparation Manual to control and minimize impacts of construction related activities, materials and pollutants on water quality. Construction Site BMPs include but are not limited to temporary sediment control, temporary soil stabilization, scheduling, waste management, materials handling and other non-storm water BMPs.

This project must incorporate treatment BMPs to the maximum extent practicable (MEP) in compliance with the Department's NPDES Statewide Storm Water Permit. Department approved Treatment BMPs such as biofiltration strips/swales, infiltration basins (infiltration trenches), detention devices and media filters will be considered and implemented to MEP in accordance with the Department's Storm Water Quality Handbooks, Project Planning and Design Guide (PPDG 2007) to determine appropriate selection of treatment BMPs in the design of this project.

Design Pollution Prevention BMPs such as slope/surface protection systems, permanent soil stabilization, concentrated flow conveyance systems such as ditches, berms, dikes, swales, overside drains, flared end sections and outlet protection/dissipation devices will be included in project design in accordance with the Department's Storm Water Quality Handbooks, Project Planning and Design Guide (PPDG). In most cases these improvements will be similar to, or extension of, existing conveyance systems to minimize changes to existing drainage patterns.

Construction site dewatering must conform to the General Waste Discharge Requirements for Discharges to Surface Water that Pose an Insignificant (de minimus) Threat to Water Quality (Order No. R8-2009-0003 NPDES No. CAG 998001) and any subsequent permit.

The proposed Carbon Creek and Houston Storm Channel culvert extensions would require a Section 404 nationwide permit (NWP 14) from USACE, Streambed Alteration Agreement from CDFG, and Section 401 Water Quality Certification from the RWQCB for work within the jurisdictional limits of these waterways. Conditions for these permits would ensure that the proposed project minimizes potential erosion/sedimentation and habitat degradation impacts, as applicable, within Carbon Creek and Houston Storm Channel.

The Storm Water Data Report (SWDR) has been prepared and is included in Attachment E. The SWDR will be updated at the PS&E phase of this project to document project compliance with the Department's NPDES permit requirements.

I. TITLE VI CONSIDERATIONS

Minimal impacts to local street traffic are proposed for Alternative 2. The recommended improvements to the Raymond Avenue off-ramp extend to the local street intersection. In order to provide adequate pedestrian facilities for the aged or disabled, ramped curbs at this intersection shall be implemented. The proposed project complies with Title VI of the Civil Rights Act of 1964.

7. OTHER CONSIDERATIONS

Public Hearing Process

A public hearing was held on December 2, 2009 at Woodcrest Elementary School in the City of Fullerton for review and comment of the DED. The comments received from the hearing had a wide variation, ranging from the endorsement of the project to its disapproval, but the general tone of the comments centered around the what types direct effects the project will incur on the owner's property. Public circulation of the DED was executed between November 10 and December 14 of 2009. Following the public circulation, all comments were collected and responses generated and included in the final ED. No changes were made to the project design or mitigating features as a result of circulation of the DED and public hearing process.

Permits

Implementation of the proposed project would require permits or other approvals from the following public agencies, shown in Table 7-1.

Table 7-1. Required Permits and Approvals

Agency	Permit or Approval
Department, District 12	Lead Agency for California Environmental Quality Act (CEQA) compliance.
State Water Resources Control Board (SWRCB)	Clean Water Act (CWA) Section 402 coverage under the General Permit for Discharges of Storm Water Associated with Construction Activity.
Santa Ana Regional Water Quality Control Board (RWQCB), Santa Ana Region 8	CWA Section 401 Water Quality Certification for impacts to state and federal jurisdictional waters. General Waste Discharge Requirements for Discharges to Surface Waters that Pose an Insignificant (de minimus) Threat to Water Quality (Order No. R8-2009-0003, NPDES No. CAG998001), construction site dewatering, and any subsequent updates to this permit at the time of construction.
U.S. Army Corps of Engineers (USACE)	CWA Section 404 Nationwide Permit authorization for filling or dredging waters of the United States.
California Department of Fish and Game	Streambed Alteration Agreement (Fish & Game Code Section 1602).

Cooperative Agreements

A cooperative agreement (Agreement # 12-619) has been entered into between Caltrans and OCTA for design oversight. Acquisition and appraisal will be performed by Caltrans Right-of-Way staff. A separate agreement (Agreement # 12-619) has also been entered into between Caltrans and OCTA that addresses the right-of-way acquisition.

Transportation Management Plan for Use During Construction

The proposed improvements involve widening of westbound SR-91 and reconnection of the interchange ramps to the widened mainline freeway. The freeway widening associated with Alternative 2 includes pavement widening and bridge widening of five existing undercrossings and the widening of one existing overhead structure. All three existing general purpose lanes and the HOV lane will be maintained open throughout each phase of construction. Temporary K-railing will be used along the widening sections to screen the construction zone. Since the existing right shoulders require removal prior to construction of the widening, the existing HOV lane and the two inside general purpose lanes are anticipated to be re-striped from 12 feet wide each to 11 feet wide each, allowing for the 2-foot width of the K-railing plus 1-foot of space to construct the connections between existing pavement and the widening. The existing right general purpose lane will be shifted, but will be maintained at 12 feet wide for truck use during construction.

Where possible, ramp traffic will be temporarily shifted within the limits of existing ramp paving to allow for staged construction of the ramp improvements while maintaining entrance and exit ramp traffic through the construction zone. Reconstruction of the ramp connections may require short-term ramp closures to complete work. No two consecutive ramps will be closed during the same phase of

construction. If a ramp were required to be temporarily closed to complete the proposed improvements, a variety of detour routes would be available to maintain circulation with the adjacent arterial network. Orangethorpe Avenue to the north of SR-91 and La Palma Avenue to the south of SR-91 both parallel the freeway in an east-west direction within approximately ½ mile of SR-91.

More details related to the recommended TMP elements and the related budget should be developed during the PS&E phase of the project, which may include the following:

- Public Awareness Campaign
- Traffic Systems and Signing Designs
- Construction Zone Enforcement Enhancement Program (COZEEP)
- Traffic Management Plan
- Advanced Transportation Management System

In addition, the following items should be considered during the PS&E and construction phases of the project:

- Temporary detour plans should be prepared as needed during the PS&E stage in association with representatives from the Cities of Anaheim and Fullerton.
- The number of existing travel lanes should be maintained throughout the construction period.
- For short-term lane closures and ramp closures, Lane Closure Charts must be developed during the PS&E phase of the project. Lane Closure Special Provisions will need to be incorporated into the bid package.

Stage Construction

Alternative 2 is expected to be constructed in three primary construction stages:

Stage 1:
During Stage 1 the undercrossings and approach embankments would be widened. To complete this work, the westbound mainline general purpose and HOV lanes will be transitioned east of the project from four 12-foot lanes to one 11-foot HOV lane, two 11-foot general purpose lanes and one 12-foot outer right lane; providing approximately 2 feet of space for temporary concrete K-rail and working area on the inside of the K-rail. This results in no right shoulder along the K-rail during construction; however, if a narrow "shy distance" right shoulder is desired during construction, the existing HOV buffer could be reduced from 4 feet to 2 feet providing approximately 2 feet of right shoulder width through the construction zone. Widening through each of the four interchange areas could be completed concurrently during this stage, while maintaining all existing mainline lanes and ramp connections open during construction.

Stage 2:
During Stage 2 the ramp connection modifications would be constructed in the new ramp gore areas and down the ramps to the respective join lines with existing. Stage 2 would consist of four consecutive sub-stages.

Stage 2A would involve temporary closure of the State College Boulevard and Euclid Street exit ramps while the tie-in modifications are constructed. Ramp closures should be short-term and do not involve consecutive ramps nor ramps within the same project segment to minimize impacts to the traveling public.

Stage 2B would involve temporary closure of the State College Boulevard and Euclid Street entrance ramps while the tie-in modifications are constructed. Again, ramp closures should be short-term and are planned to minimize impacts to the traveling public.

Stage 2C would involve temporary closure of the Raymond Avenue and Brookhurst Road exit ramps while the tie-in modifications are constructed. Ramp closures should be short-term and impacts to the traveling public are minimized.

Stage 2D would complete the ramp tie-in connections by temporarily closing the Raymond Avenue and Brookhurst Road entrance ramps. Ramp closures should be short-term with impacts to the traveling public minimized.

To the extent possible, ramp modification tie-ins will be staged such that ramp closures can be kept to the absolute minimum duration necessary during Stage 2.

Stage 3:
During Stage 3 the auxiliary lanes between State College Boulevard and Raymond Avenue, Raymond Avenue and Lemon Street, Harbor Boulevard and Euclid Street and Euclid Street and Brookhurst Road would be constructed. To complete this work the mainline shifts established in Stage 1 would remain and temporary concrete K-rail would be placed within the existing auxiliary lanes between State College Boulevard and Raymond Avenue, Harbor Boulevard and Euclid Street and Euclid Street and Brookhurst Road. The existing 12-foot auxiliary lanes would provide space for a 8-foot right shoulder along the outside mainline lane, a 2-foot K-rail and 2 feet of working area on the inside of the K-rail. To complete Stage 3 between Raymond Avenue and Lemon Street, temporary concrete K-rail would be placed 2 feet inside of the existing edge of travel ramp to provide a working space of 2 feet while maintaining all existing westbound HOV and general purpose lanes open during construction.

Graffiti Control

This section of SR-91 is in a graffiti-prone area. Proposed aesthetic treatments for structural surfaces (bridge, retaining walls and sound walls) should be developed so that they are easily maintained and replaced. Surfaces should be graffiti resistant with washable surfaces.

8. PROGRAMMING

Programming

The proposed project is included in the Southern California Association of Governments (SCAG's) 2008 Regional Transportation Plan (RTP) as project 2M01126 and the 2008 cost-constrained Regional Transportation Improvement Program (RTIP) (project ID No. ORA000822). It is also included in OCTA's Long-Range RTP, which was adopted by OCTA in December 2002. According to the 2008 RTIP, the proposed project is funded by the CARH3 program (Interchange- Modify/ Replace/ Reconfigure - Lane Addition[s]). Since the widening project is contained in the RTP, the improvements contemplated in this project are consistent with regional planning efforts.

Schedule

The project design is scheduled to begin in June 2010 and be completed by February 2012. Right-of-way Certification is anticipated for June 20102 with project advertisement in August 2012. Construction is scheduled to start in November 20102 and be completed by November 2015.

Funding

Funds for the proposed project consist of 52 % Local Orange M2 - Freeway (ORAFWY2) funds (Renewed Orange County Measure M funds) and 48% Proposition 1B funds through the State Trade Corridor Improvement Fund (TCIF).

9. REVIEWS

The project has no federal funding; therefore a Federal Highway Administration (FHWA) review was not performed.

10. PROJECT PERSONNEL

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Project Manager

11. LIST OF ATTACHMENTS

Attachment A	Typical Cross Sections and Layouts
Attachment B	Cost Estimates
Attachment C	Structure Advance Planning Studies
Attachment D	Right-of-Way Data Sheets
Attachment E	Storm Water Data Report (Bound Separately)
Attachment F	Initial Study with Mitigated Negative Declaration, May 2010 (Bound Separately)