04-1G9404
Information Handout

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State Water Resources Control Board

Executive Office

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1001 I Street • Sacramento, California 95814 • (916) 341-5615
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Linda S. Adams
Secretary for Environmental Protection

Arnold Schwarzenegger
Governor

JUL 0 6 2009

Ms. Susan Miller
Contra Costa Transportation Authority
3478 Buskirk Ave., Suite 100
Pleasant Hill, CA 94523

Dear Ms. Miller:

CLEAN WATER ACT (CWA) SECTION 401 WATER QUALITY CERTIFICATION FOR THE STATE ROUTE 4 WIDENING PROJECT (PROJECT), CITIES OF PITTSBURG AND ANTIOCH, CONTRA COSTA COUNTY (CORPS FILE #2002-26746N)

On April 11, 2008, the San Francisco Bay Regional Water Quality Control Board (San Francisco Bay Water Board) received an application from the Contra Costa Transportation Authority (Authority) for CWA section 401 Water Quality Certification (Certification) for Phase 1 of the Project. San Francisco Bay Water Board staff reviewed the information submitted by the Authority describing the project activities and the proposed water quality protection measures.

On February 11, 2009, the project file was forwarded to the State Water Resources Control Board (State Water Board) because the project was expanded to include Phase 2, which extends into the jurisdiction of the Central Valley Regional Water Quality Control Board (Central Valley Water Board). The State Water Board issues or denies certifications that affect waters within multiple Regional Water Boards. State Water Board staff consulted with the San Francisco Bay Water Board and Central Valley Water Board, as well as the U.S. Army Corps of Engineers.

Pursuant to Title 23, section 3838 of the California Code of Regulations, I hereby make the Certification determination described in the Enclosure for these projects. Attachments A through D to the Enclosure are also a part of this Certification.

If you require further assistance, please contact Amna Hawatky, the staff person most knowledgeable on the subject, at (916) 341-5483 (ahawatky@waterboards.ca.gov). You may also contact Bill Orme, Chief of the 401 Certification and Wetlands Protection Unit, at (916) 341-5464 (borme@waterboards.ca.gov).

Sincerely,

Dorothy Rice

Dorothy Rice
Executive Director

Enclosure

cc: (See next page)

cc: (all with Enclosure)

Mr. Jan Novak
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U.S. Army Corps of Engineers
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Mr. Bruce H. Wolfe
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Ms. Pamela Creedon
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11020 Sun Center Drive, #200
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cc: (See continuation page)

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Linda S. Adams
Secretary for Environmental Protection

Arnold Schwarzenegger
Governor

ACTION ON REQUEST FOR CLEAN WATER ACT (CWA) SECTION 401 WATER QUALITY CERTIFICATION FOR THE STATE ROUTE 4 (SR4) WIDENING PROJECT, CONTRA COSTA COUNTY (Corps File No. 2002-26746N)

PROJECT: CWA Section 401 Certification SR4 Widening Project, Contra Costa County

APPLICANT: Ms. Susan Miller
Contra Costa Transportation Authority
3478 Buskirk Avenue, Suite 100
Pleasant Hill, CA 94523

This Order responds to your request for a 401 Water Quality Certification (Certification) for the Contra Costa County Transportation Authority's (Authority) SR4 Widening Project (Project). The Authority has applied for a U.S. Army Corps of Engineers (Corps) Individual Permit (Corps No. 2002-26746N) pursuant to section 404 of the CWA (33 U.S.C. 1344) for the proposed Project. The Authority has applied to the State Water Resources Control Board (State Water Board) for a Certification that the Project will not violate State water quality standards.

ACTION:

- ☒ Order for Standard Certification
- ☐ Order for Denial of Certification
- ☐ Order for an Amendment of a Technically Conditioned Certification
- ☐ Order for Waiver of Waste Discharge Requirements

PROJECT DESCRIPTION:

The Authority proposes to widen SR4 in the cities of Pittsburg and Antioch, through Contra Costa County. The Project is located 0.8 miles west of Loveridge Road, and approximately 0.7 miles east of Hillcrest Avenue. This Certification applies to the entirety of the Project from Loveridge Road to State Route 160.

The Project's purpose is to provide traffic congestion relief and meet future traffic demand through the year 2030. Widening activities consist of converting the existing four lane highway to an eight lane facility (three lanes plus a commuter lane). The Project has been designed with additional space within the SR4 median to accommodate the possibility of future public transit improvements.

The primary receiving waters in the Project area are Old Kirker Creek, Kirker Creek, the Los Medanos Wasteway, and West Antioch Creek. All drain to Suisun Bay, approximately four miles north of SR4. Work in jurisdictional waters includes:

- Replacement of a box culvert at Old Kirker Creek. The existing Old Kirker Creek concrete box culvert will be replaced with a higher capacity double box culvert and

extended approximately 38 feet upstream. Approximately 28 linear feet of riprap will be placed upstream of the new culvert;

- In-kind replacement and extension of box culverts at Kirker Creek and the Los Medanos Wasteway. Rock slope protection will be placed at the outlets and inlets of both culverts. Kirker Creek currently crosses beneath SR4 through a 72 inch concrete pipe and double box culvert, and daylights north of Loveridge Road; this system will be replaced in-kind and extended to the south by approximately 98 linear feet with an additional 82 linear feet of riprap; and
- Relocation of a 36 inch sanitary sewer line crossing Old Kirker Creek. The existing line crosses the creek south of the upstream end of the existing culvert and will be relocated south of the existing SR4 crossing.

Additional work includes:

- Widening of the Roosevelt Lane pedestrian undercrossing and the Cavallo Road undercrossings;
- Reconstruction of the Loveridge Road, Somersville Road, Contra Loma; Boulevard-L Street, Lone Tree Way- A Street, and Hillcrest Avenue interchanges. A sixth intersection at G street would be redesigned to accommodate a new SR4 overstructure;
- Replacement of the Century Boulevard undercrossing structure; and
- Shifting of SR4 frontage roads California Avenue and North Park Boulevard to the north to accommodate widening and interchange improvement activities.

STANDARD CONDITIONS:

1. This Certification action is subject to modification or revocation upon administrative or judicial review, including review and amendment pursuant to section 13330 of the California Water Code and Article 6 (commencing with section 3867) of Chapter 28, Title 23 of the California Code of Regulations.

2. This Certification action is not intended and shall not be construed to apply to any activity involving a hydroelectric facility requiring a Federal Energy Regulatory Commission (FERC) license or an amendment to a FERC license unless the pertinent certification application was filed pursuant to subsection 3855(b) of Chapter 28, Title 23 of the California Code of Regulations, and the application specifically identified that a FERC license or amendment to a FERC license for a hydroelectric facility was being sought.

3. This Certification is conditioned upon total payment of any fee required under Chapter 28, Title 23 of the California Code of Regulations and owed by the applicant.

ADDITIONAL CONDITIONS:

1. Best Management Practices (BMPs)

a. Appropriate BMPs shall be implemented throughout the project activities to help minimize sediment disturbance and suspension within the water. All BMP materials shall be on site and ready for use prior to project implementation. BMPs shall be in full compliance with all specifications governing the proper design, installation, operation, and maintenance of such management practices.

b. No equipment shall be operated in areas of flowing or standing water; no fueling, cleaning or maintenance of vehicles or equipment shall take place within jurisdictional waters or within any areas where an accidental discharge may occur.

c. Activities shall not cause turbidity increases in surface water to exceed:

(a) where natural turbidity is between 0 and 5 Nephelometric Turbidity Units (NTUs), increases shall not exceed 1 NTU;

(b) where natural turbidity is between 5 and 50 NTUs, increases shall not exceed 20 percent;

(c) where natural turbidity is between 50 and 100 NTUs, increases shall not exceed 10 NTUs;

(d) where natural turbidity is greater than 100 NTUs, increases shall not exceed 10 percent.

Except that these limits will be eased during in-water working periods to allow a turbidity increase of 15 NTU over background turbidity as measured in surface waters 300 feet downstream from the working area. In determining compliance with the above limits, appropriate averaging periods may be applied provided that beneficial uses will be fully protected.

d. Activities shall not cause settleable matter to exceed 0.1 ml/l in surface waters as measured in surface waters 300 feet downstream from the project.

e. In the event that project activities occur in surface waters, result in the deposition of soil materials, or create a visible plume, the following monitoring shall be conducted immediately upstream and 300 feet downstream of the work site and the results reported to the State Water Board:

Parameter	Unit	Type of Sample	Frequency of Sample
Turbidity	NTU	Grab	Every 4 hours during work in water
Settleable Material	ml/l	Grab	Same as above.

f. The Authority shall notify the State Water Board immediately if the above criteria are exceeded.

g. Dewatering and diversion activities shall be executed as described in the "Dewatering and Non-Storm Water Discharge Control Plan" revised May 9, 2009. Any deviation from the Project plans shall require State Water Board approval.

h. Stream diversion activities shall occur only between April 1st and October 15th.

i. Prior to dewatering and diversion activities, the Authority shall ensure a biologist is on site to ensure no sensitive aquatic species are stranded in areas of dewatering and diversion.

j. The Authority shall immediately remove stream diversion structures when diversion is no longer necessary. All diverted streams shall be returned to their original condition.

k. All on- and off-site biofiltration swales shall incorporate a soil amendment to enhance their infiltrative capacity and be maintained on a regular basis to ensure optimal treatment functionality.

l. The off-site stormwater treatment project shall be completed at or before Project completion.

m. No debris, soil, silt, sand, cement, concrete, or washings thereof, other construction related materials or wastes, oil or petroleum products or other organic or earthen material shall be allowed to enter into or be placed where it may be washed by rainfall or runoff into jurisdictional wetlands or waters. Upon completion of construction, all construction-related materials shall be removed from the work area and any areas adjacent to the work area.

n. Disturbance or removal of vegetation shall be minimized. The site shall be stabilized utilizing BMPs, including the successful reestablishment of native vegetation, to enhance wildlife habitat values, and to prevent and control erosion and sedimentation. Revegetation work is not confined to the period of April 1st to October 15, but must be completed in the same calendar year.

2. Monitoring Reports

a. Monitoring reports will be submitted by November 1st of each monitoring year to the 401 Program Managers of the State Water Board and the appropriate Regional Water Board(s) documenting work undertaken the previous year(s). The reports, at a minimum, shall include:

i. Names, titles, and affiliations of all persons who prepared the report and conducted field work;
ii. Copies of Corps permits, any special Conditions, and subsequent Letters of Memorandum;
iii. Analysis of all quantitative monitoring data;
iv. Electronic or color copies of all photo-documentation;
v. Maps showing the monitoring area, vegetation survey sites, and photo-documentation points; and
vi. Remedial action recommendations, as needed.

b. Monitoring reports shall be submitted for five years. Reports shall be directed to: Program Manager, Certification and Wetlands Program at the following State and appropriate Regional Water Board office(s):

State Water Resources Control Board
Division of Water Quality
1001 "I" Street, 15th Floor
Sacramento, CA 95814

San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612

Central Valley Regional Water Quality Control Board
Sacramento Office
11020 Sun Center Drive, Suite 200
Rancho Cordova, CA 95670-6114

c. The Authority shall notify the State Water Board within 24 hours of any noncompliance that may impact the beneficial uses of waters of the State. The notification shall include the volume and type of materials discharged and recovered, measures used to contain the discharge, and measures used to prevent future discharges.

ADMINISTRATIVE CONDITIONS:

1. The Authority shall submit to the State Water Board a Bill of Sale of 0.944 acres of seasonal freshwater wetland mitigation credits from Elsie Gridley Mitigation Bank.

2. The Authority shall adhere to the conditions imposed by the Project Individual Permit, issued to the Authority by the Corps.

3. A copy of the Storm Water Pollution Prevention Plan (SWPPP) shall be provided to the State Water Board at least 30 days prior to the start of construction. Except as expressly allowed in this Certification, the discharge, or creation of the potential for discharge, to waters of the State of any construction wastes and/or soil materials including cement, fresh concrete, or washings thereof, silts, clay, sand, oil or petroleum products and other organic materials to waters of the State is prohibited.

4. The Authority shall maintain a copy of this Certification and supporting documentation (Attachments) at the Project site during construction for review by site personnel and agencies. All personnel (employees, contractors, and subcontractors) performing work on the proposed project shall be adequately informed and trained regarding the conditions of this Certification.

5. The Authority shall grant State Water Board and Regional Water Board staff, or an authorized representative, upon presentation of credentials and other documents as may be required by law, permission to enter the project site at reasonable times, to ensure compliance with the terms and conditions of this Certification and/or to determine the impacts the project may have on the waters of the State.

6. In the event of any violation or threatened violation of the conditions of this Certification, the violation or threatened violation must be subject to any remedies, penalties, processes, or sanctions as provided for under State law.

7. The State Water Board reserves the right to suspend, cancel, or modify and reissue this Certification, after providing notice to the Authority and/or responsible Project Site Supervisor, if the State Water Board determines that the project fails to comply with any of the terms or conditions of the Certification.

8. Designs and details for all post construction BMPs shall be submitted to the State Water Board for review and approval. Post construction BMPs shall not be constructed until State Water Board staff has approved the designs for the BMPs.

9. The activity(ies) described in the 401 Certification application shall not result in the taking of any State endangered species, threatened species, or candidate species, or the habitat of such a species unless the activity is authorized by the California Department of Fish and Game pursuant to a permit, memorandum of understanding, or other document or program in accordance with Fish and Game Code sections 2081, 2081.1, or 2086.

10. All protective measures included in the Biological Opinion (#1-1-05-F-0158 and amendment issued on April 15, 2008) issued by the United States Fish and Wildlife Service on June 13, 2005 and the 1602 Lake and Streambed Alteration Agreement (#1600-2008-0217-3) issued by the California Department of Fish and Game on November 6, 2008 for this project will be implemented. All protective measures included in the 1602 Lake and Streambed Alteration Agreement for the Somersville to State Route 160 segment will be implemented. A copy of the 1602 Lake and Streambed Alteration Agreement for the Somersville to State Route 160 shall be provided to the State Water Board prior to any discharge to waters of the State.

11. Any significant modifications to the Mitigation and Monitoring Report, June 2009 (Attachment D) must be approved by the State Water Board before implementation.

12. This Certification does not obviate the need to obtain other permits that may be required by federal, state, or local authorities.

13. Failure to comply with any condition of this Certification shall constitute a violation of the CWA and the Porter-Cologne Water Quality Control Act. Any such certification previously granted shall immediately be revoked, and any or all discharges shall cease. The permittee may then be subject to administrative and/or civil liability pursuant to Water Code section 13385.

14. Certification is conditioned upon total payment of the full fee required in State regulations (23 CCR section 3833). State Water Board staff received two checks one on March 1, 2009 ($943.00) and another April 4, 2009 ($347.00) for fees associated with this Project.

STATE WATER BOARD CONTACT PERSON:

If you have any questions, please contact State Water Board Environmental Scientist Amna Hawatky at (916) 341-5483 (**ahawatky@waterboards.ca.gov**). You may also contact Bill Orme, Chief of the 401 Certification and Wetlands Protection Unit, at (916) 341-5464 (**borme@waterboards.ca.gov**).

WATER QUALITY CERTIFICATION:

I hereby issue an order certifying that any discharge from the referenced project will comply with the applicable provisions of Clean Water Act 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), if all of the conditions listed in the certification action are met. This discharge is also regulated pursuant to State Water Board Quality Order No. 2003-0017-DWQ, which authorizes this certification to serve as Waste Discharge Requirements pursuant to the Porter-Cologne Water Quality Control Act (Wat. Code, § 13000 et seq.).

Except insofar as may be modified by any preceding conditions, all certification actions are contingent on: (a) the discharge being limited and all proposed mitigation being completed in strict compliance with the Mitigation and Monitoring Report for Jurisdictional Waters of the U.S, Project Information Sheet (Attachment B), and (b) compliance with all applicable requirements of the Regional Water Board's Water Quality Control Plan.

Dorothy Rice, Executive Director
State Water Resources Control Board

7.06.09
Date

Attachments:
A. Signatory Requirements
B. Project Information Sheet
C. Project Impacts and Mitigation
D. Mitigation and Monitoring Report

2. US Army Corps of Engineers 404 Permit (Corridorwide)

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
1455 MARKET STREET
SAN FRANCISCO, CALIFORNIA 94103-1398

DEPARTMENT OF THE ARMY PERMIT

PERMITTEE: Ms. Susan Miller, Contra Costa Transportation Authority

PERMIT NO.: 2002-26746S

ISSUING OFFICE: San Francisco District, U.S. Army Corps of Engineers

NOTE: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate District or Division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below:

PROJECT DESCRIPTION: The Contra Costa Transit Authority (CCTA) is authorized through this Department of the Army permit to perform the following work:

A. Fill 0.048 acre (100 lineal feet) of wetland supported by sediment within a concrete lined Kirker Creek located between the existing highway and some unused railroad tracks on the south side of SR-4.

B. Fill 0.021 acre of wetland and 0.005 acre of waters of the U.S. by placing approximately 66 lineal feet of Old Kirker Creek on the south side of SR-4 into a culvert.

C. Fill 0.010 acre of wetland on the north side of SR-4 at the northwest edge of Loveridge Road at Old Kirker Creek.

D. Fill 0.022 acre (75 lineal feet) of waters of U.S. to extend culverts on both the north and south side of SR-4 at the Los Medanos Wasteway.

E. Fill 0.060 acre of wetlands and 0.066 acre of waters of the U.S. at the West Antioch Creek Complex, which will place approximately 1040 lineal feet of waters and combined wetland into new culverts.

The project is approximately 6.1 miles long. The work will widen the highway from two lanes in each direction to four lanes in each direction, one HOV lane and three mixed flow lanes. Auxiliary lanes, which span between on ramps to off ramps, have been designed into the project to allow for longer distance and safer merging of traffic. Five main intersections, Loveridge Road, Somersville, Contra Loma Boulevard-L Street, Lone Tree Way-A Street and Hillcrest Avenue, will be redesigned to accommodate the highway widening and to improve traffic flow. The G Street interchange, which currently has an eastbound exit ramp and westbound entrance ramp will be reconstructed to remove highway access and accommodate highway widening. The Cavallo Road Undercrossing and the Roosevelt Lane Pedestrian Undercrossing will be widened. (Refer to "State Route 4 (East) Widening Project: Loveridge Road To State Route 160", dated November 10, 2003.)

Because of funding and construction restrictions, the project will be built in four segments and some of the segments will be divided into phases. The work is planned to be completed over the next 10 years, as funding becomes available. Segment 1 is scheduled to be constructed first, beginning in 2009. The timing and order of Segment 2, Segment 3, and Segment 4 will be determined as funding becomes available. The segments and phases of construction are described below.

Segment 1: The Loveridge Road segment, between PM 23.7 and PM 25.8, is scheduled to be constructed first. It will tie into the previously completed SR-4 project, which ended in Pittsburg at approximately PM

24.2 (where Kirker Creek passes under SR-4). The Loveridge Road segment ends at PM 25.8, slightly east of the Los Medanos Wasteway. (For details of Segment 1, refer to "Project Plans for Construction on State Highway in Contra Costa County, in Pittsburg and Antioch from 0.9 KM West of Loveridge Road Overcrossing to 0.3 KM West of Somersville Road Undercrossing", and dated September 17, 2008).

Segment 2: The second segment, the Somersville Road Undercrossing segment, extends eastward from where the Loveridge Road segment ends and is between PM R25.61 and PM R26.62. (For details of the Somersville Road Undercrossing phase, refer to "Project Plans for Construction on State Highway in Contra Costa County, in Antioch and Pittsburg from 0.7 Mile West of Somersville Road Undercrossing to 0.5 Mile East of Somersville Road Undercrossing", dated July 15, 2008).

Segment 3: Segment 3 begins at PM 26.5 and ends at PM 27.5. The Contra Loma Boulevard-L Street Interchange will be rebuilt to accommodate widening of Contra Loma Boulevard and L Street to a four lane facility with room for left turn lanes. SR-4 will be widened and elevated 3 feet to allow more overhead over Contra Loma Boulevard-L Street, and the on and off ramps will be redesigned, adjacent to where West Antioch Creek crosses under SR-4.

The G Street Overcrossing will be reconstructed along with some of the local street intersections to accommodate SR-4 widening, improve local traffic flow and remove the on and off ramps so there will be no SR-4 access from G Street. (For details of Segment 3, refer to the project plans entitled "Project Plans for Construction of State Highway in Contra Costa County, in Antioch from 0.3 Mile West of Contra Loma Boulevard Undercrossing to 0.2 Mile East of G Street Overcrossing" and dated April 22, 2009.)

Segment 4: Segment 4 begins at the end of Segment 3 and extends to PM 29.7, near the SR4/Route 160 Interchange. Segment 4 is divided into 2 phases, which CCTA refers to as Phase 4a and Phase 4b. Phase 4a will rebuild the SR-4/Lone Tree Way-A Street Interchange and the Cavallo Road Undercrossing. Phase 4b will reconfigure the SR-4/Hillcrest Avenue Interchange and widen the highway to the end of the project limits. (For details of Segment 4A, see the project plans entitled "Project Plans for Construction on State Highway in Contra Costa County, in Antioch from 0.61 Miles West of "A" Street Undercrossing to 0.10 Miles East of Hillcrest Avenue Overcrossing" and dated January 16, 2009. For details of Segment 4B, see the project plans entitled "Project Plans for Construction on State Highway in Contra Costa County, in Antioch from 0.33 Miles West of Hillcrest Avenue Overcrossing to 0.98 Miles East of Hillcrest Avenue Overcrossing" and dated April 17, 2009.)

PROJECT LOCATION: This project is located in Pittsburg and Antioch in Contra Costa County, California. The project is on State Route 4 (SR-4) starting 0.84 mile west of Loveridge Road (Post Mile 23.7) and ending approximately 0.7 mile east of Hillcrest Avenue (Post Mile 29.7).

PERMIT CONDITIONS

GENERAL CONDITIONS:

1. The time limit for completing the work authorized ends on July 15, 2019. If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.

2. 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 4 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.

3. If you discover any previously unknown historic or archeological remains while accomplishing the activity

authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and State coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

4. If you sell the property associated with this permit, you must obtain the signature of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. If a conditioned water quality certification has been issued for your project, you must comply with the conditions specified in the certification as special conditions to this permit. For your convenience, a copy of the certification is attached if it contains such conditions.

6. 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 in accordance with the terms and conditions of your permit.

7. You understand and agree that, if future operations by the United States require the removal, relocation or other alteration of the structure or work authorized herein, 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, you 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.

SPECIAL CONDITIONS:

1. This Corps permit does not authorize you to take an endangered species. In order to legally take a listed species, you must have a separate authorization under the Endangered Species Act (ESA) (e.g., an ESA Section 10 permit or a Biological Opinion (BO) under ESA Section 7 with "incidental take" provisions with which you must comply). The enclosed U.S. Fish and Wildlife Service (FWS) BO dated June 13, 2005 (151422SWR04SR9275:ES) (as amended by Amendment to Biological Opinion for the State Route 4 Widening Project dated April 15, 2008 (Service File No. 1-1-05-F-0158)) contains mandatory terms and conditions to implement the reasonable and prudent measures that are associated with "incidental take" that is also specified in the BO. Your authorization under this Corps permit is conditional upon your compliance with all of the mandatory terms and conditions associated with incidental take authorized by the attached BO, whose terms and conditions are incorporated by reference in this permit. Failure to comply with the terms and conditions associated with incidental take of the BO, where a take of the listed species occurs, will constitute an unauthorized take and it will also constitute non-compliance with this Corps permit. The FWS is the appropriate authority to determine compliance with the terms and conditions of its BO and with the ESA.

2. CCTA will mitigate for the 0.139 acre of permanent wetland loss within the three segments of the project through the purchase of 0.14 acre of wetland credits from an approved wetland creation mitigation bank within the service area of the Contra Costa County SR-4 Widening Project.

3. CCTA may not begin construction on any part of the SR-4 project that will impact Corps jurisdiction until the Corps has received copies of receipts from the mitigation bank purchases (see Special Conditions 2 and above) and has approved these purchases in writing.

4. For permanent impact to 0.093 acre of other waters of the United States, CCTA shall use standard BMP (best management practices) erosion control standards on all disturbed ground associated with Corps jurisdiction, re-grade the soil surface to conform to existing grades, and plant the disturbed areas with an appropriate native species ground cover seed mix.

5. CCTA will provide the Corps with the final project plans for all project segments prior to start of work. CCTA will apply to the Corps for a permit modification before any work in waters of the U.S. if either of the following conditions arise: a) the final project plans for any segment are significantly different than the above permitted project description; or b) if impacts to waters of the U.S. are greater for any segment than described in the above permitted project description.

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. Section 403).
   (X) Section 404 of the Clean Water Act (33 U.S.C. Section 1344).
   ( ) Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. Section 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 Item 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 C.F.R. Section 325.7 or enforcement procedures such as those contained in 33 C.F.R. Sections 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 measures 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 C.F.R. Section 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

6. Extensions: General Condition 1 establishes a time limit for the completion of the activity authorized by this permit. Unless there are circumstances requiring either a prompt completion of the authorized activity or a reevaluation of the public interest decision, the Corps will normally give favorable consideration to a request for an extension of this time limit.

Your signature below, as permittee, indicates that you accept and agree to comply with the terms and conditions of this permit.

Adam J. Miller 7/24/2009

(PERMITTEE) (DATE)

This permit becomes effective when the Federal official, designated to act for the Secretary of the Army, has signed below.

Jane M. Hicks 7/24/09

Cr Laurence M. Farrell (DATE)
Lieutenant Colonel, U.S. Army
District Commander

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

(TRANSFEREE) (DATE)

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
1455 MARKET STREET
SAN FRANCISCO, CALIFORNIA 94103-1398

Regulatory Division

SUBJECT: File Number 2002-26746S

JUL 24 2009

Ms. Susan Miller
Contra Costa Transportation Authority
3478 Buskirk Avenue, Suite 100
Pleasant Hill, California 94523

Dear Ms. Miller:

Enclosed is your signed copy of a Department of the Army permit (Enclosure 1) to widen and improve State Route 4 (SR-4) in the cities of Pittsburg and Antioch, Contra Costa County, California. The project would widen SR-4 from the existing four lanes to eight lanes with one High-Occupancy Vehicle lane (HOV) in each direction. The project also includes redesign and reconstruction of the interchanges within the project limits and the addition of auxiliary lanes between on-ramps and off-ramps.

Please complete the appropriate parts of "Project Status" form (Enclosure 2), and return it to this office as your work progresses. You are responsible for ensuring that the contractor or workers executing the activity authorized herein are knowledgeable of the terms and conditions of this authorization.

Should you have any questions regarding this matter, please call Hal Durio of our Regulatory Division at 415-503-6785. Please address all correspondence to the Regulatory Division and refer to the File Number at the head of this letter. If you would like to provide comments on our permit review process, please complete the Customer Survey Form available online at http://per2.nwp.usace.army.mil/survey.html.

Sincerely,

Jane M. Hicks

for Laurence M. Farrell
Lieutenant Colonel, U.S. Army
Commanding

Enclosures

Copies Furnished (w/encl 1 only):

US FWS, Sacramento, CA
CA DFG, Yountville, CA
CA RWQCB, Oakland, CA

PROJECT STATUS

Please use the forms below to report the dates when you start and finish the work authorized by the enclosed permit. Also if you suspend work for an extended period of time, use the forms below to report the dates you suspended and resumedwork. The second copy is provided for your records. If you find that you cannot complete the work within the time granted by the permit, please apply for a time extension at least one month before your permit expires. If you materially change the plan or scope of the work, it will be necessary for you to submit new drawings and a request for a modification of your permit.

(cut as needed) ----------

Date:_____

NOTICE OF COMPLETION OF WORK under Department of the Army Permit No. 26746S
TO: District Engineer, US Army Corps of Engineers, RegulatoryDivision, 1455 Market Street, 16th Floor, San Francisco, CA 94103-1398

In compliance with the conditions of Permit No.26746S, this is to notify you that work was completed on _____.

Permittee: Ms. Susan Miller, Contra Costa Transportation Authority
Address: 3478 Buskirk Avenue, Suite 100, Pleasant Hill, CA 94523

(cut as needed) ----------

Date:_____

NOTICE OF RESUMPTION OF WORK under Department of the Army Permit No.26746S
TO: District Engineer, US Army Corps of Engineers, RegulatoryDivision, 1455 Market Street, 16th Floor, San Francisco, CA 94103-1398

In compliance with the conditions of Permit No.26746S, this is to notify you that work was completed on _____.

Permittee: Ms. Susan Miller, Contra Costa Transportation Authority
Address: 3478 Buskirk Avenue, Suite 100, Pleasant Hill, CA 94523

(cut as needed) ----------

Date:_____

NOTICE OF SUSPENSION OF WORK under Department of the Army Permit No.26746S
TO: District Engineer, US Army Corps of Engineers, RegulatoryDivision, 1455 Market Street, 16th Floor, San Francisco, CA 94103-1398

In compliance with the conditions of Permit No.26746S, this is to notify you that work was completed on _____.

Permittee: Ms. Susan Miller, Contra Costa Transportation Authority
Address: 3478 Buskirk Avenue, Suite 100, Pleasant Hill, CA 94523

(cut as needed) ----------

Date:_____

NOTICE OF COMMENCEMENT OF WORK under Department of the Army Permit No.26746S
TO: District Engineer, US Army Corps of Engineers, RegulatoryDivision, 1455 Market Street, 16th Floor, San Francisco, CA 94103-1398

In compliance with the conditions of Permit No.26746S, this is to notify you that work was completed on _____.

Permittee: Ms. Susan Miller, Contra Costa Transportation Authority
Address: 3478 Buskirk Avenue, Suite 100, Pleasant Hill, CA 94523

3. Foundation Report - A Street Undercrossing (Replacement) - At State Route 4 (Br. No. 28-0401 R/L) – Contra Costa County, CA

FINAL FOUNDATION REPORT
A STREET UNDERCROSSING (Replacement)
At State Route 4
(Bridge No. 28-0401L/R)
Contra Costa County, California
04-CC-4-R27.8 EA 2285F1

For

T. Y. Lin International
2010 Crow Canyon Place, Suite 350
San Ramon, CA 94583

PARIKH CONSULTANTS, INC.
1243 Alpine Road, Suite 110
Walnut Creek, California
(925) 933-6336

April, 2010 Job No. 206117.LNT

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FINAL FOUNDATION REPORT
A STREET UNDERCROSSING AT STATE ROUTE 4
LEFT AND RIGHT BRIDGES (BRIDGE NO. 28-0401L/R)
ANTIOCH, CONTRA COSTA COUNTY, CALIFORNIA
04-CC-4-R27.8 EA 2285F1

INTRODUCTION

This report presents the results of our geotechnical engineering investigation for the proposed new bridges along eastbound and westbound State Route 4 over A Street Undercrossing in Antioch, Contra Costa County, CA. Our work was performed generally in accordance with the scope of work as per our agreement. The general location of the site and its vicinity are shown on the Project Location Map, Plate 1.

The geotechnical recommendations presented in this report are intended for design input and are not intended to be used as specifications. These recommendations should not be used for direct bidding purposes.

PROPOSED CONSTRUCTION

Based on the preliminary plans provided by T. Y. Lin International, the proposed project consists of demolition of the existing left and right bridges for the A Street Undercrossing at State Route 4 in Antioch, Contra Costa County, California and replacement by new bridges. The new bridges will be two-span cast-in-place prestressed concrete box girder structures that will span over Lone Tree Way/A Street. Per the plans provided, the structures will be 200 feet long and 71 feet wide along the same alignment. The new bridges will accommodate four 12-foot lanes in each direction with 10-foot shoulders and concrete barriers. Abutments 1 and 3 will be open face abutments on fill. Support at Bent 2 will consist of four 7-ft diameter columns flared at the top. The abutments and the four columns in Bent 2 will all be supported on cast-in-drilled-hole (CIDH) piles.

PURPOSE AND SCOPE

The purpose of this investigation was to evaluate the general soil conditions at the project site, to evaluate their engineering properties, and to provide recommendations for foundation support of

the proposed project.

The scope of work performed for this investigation included a review of the readily available soils and geologic literature, obtaining representative soil samples and logging soil materials encountered in four drilled borings, laboratory testing of the collected samples, engineering analysis of the field and laboratory data, and preparation of this report. The basis for this investigation is the preliminary plans provided to us by T. Y. Lin International. We have presented the descriptive log of the boreholes in Appendix A.

Due to limitations inherent in geotechnical investigations, it is neither uncommon to encounter unforeseen variations in the soil conditions during construction nor is it practical to determine all such variations during an acceptable program of drilling and sampling for a project of this scope. Such variations, when encountered, generally require additional engineering services to attain a properly constructed project. We, therefore, recommend that a contingency fund be provided to accommodate any additional charges resulting from technical services that may be required during construction.

Our recommendations in this report are based on the above information. Any major deviation should be reported to this office for consideration.

SITE CONDITIONS

The project is located at the crossing of Lone Tree Way/A Street and State Route 4, in the City of Antioch, Contra Costa County. Per the As-Built drawings, the existing bridges (which will be demolished) were constructed in 1969. They are single span, cast-in-place prestressed concrete structures, 155 feet long and 41 feet wide, each carrying two 12-ft wide traffic lanes and have a 10-ft shoulder adjacent to the outer lane and a 5-ft shoulder adjacent to the inner lane. Railing (Type 9) barriers are present on the outside edges of the shoulders. The abutments are founded on 16-in.diameter 70 ton Cast-in-drilled-hole (CIDH) piles.

The existing bridge abutments are on approach fill. The top of the fill is at an approximate elevation of 69 feet, which is approximately 10 to 15 feet above adjacent ground. To accommodate

the wider new bridges, additional fill will be required, particularly on the south side.

FIELD EXPLORATION AND LABORATORY TESTING

Field Exploration

The exploration program was based on the proposed plans, discussions with design engineer, and readily available data of the existing undercrossing. Two (2) exploratory borings were drilled in September, 2006, one near each abutment. Borings were drilled from the top of the embankment to depths of approximately 100. Two additional borings were drilled in July, 2009, adjacent to the previous borings to depths of approximately 130 feet. The latter borings were drilled to gain pertinent additional information beyond 100-ft depth. The test borings were advanced with a truck-mounted drill rig, using the hollow stem auger drilling method. The boring locations are shown on the plan portion of the Log of Test Borings in Appendix A.

Selected samples were generally obtained from 3.0-inch O.D. & 2.5 inches I.D. (Modified California) samplers at various depths. Occasionally, 2.0-inch O.D. & 1.4-inch I.D. (Standard Penetration Test) sampler was used, particularly in the dense granular layers and hard clays below 70 feet. The samplers were driven in subsurface soils under the impact of a 140-lb hammer having a free fall of 30 inches. The blow counts are presented on the "Log of Test Borings". (When correlating standard penetration data in similar soils, the blow counts for the Modified California Sampler can be taken as roughly 1.6 times that for the Standard Penetration Test in similar soils). The samples were sealed and transported to our laboratory for further evaluation and testing. The field investigation was conducted under the supervision of our field engineer who logged the test borings and prepared the samples for subsequent laboratory testing and evaluation.

Laboratory Testing

Laboratory tests were performed on selected samples obtained during field exploration to determine the physical and engineering properties of the subsoils. Laboratory data of moisture contents, dry density, grain size distribution, Atterberg Limits and unconfined compression tests are presented on the Log of Test Borings. A detailed description of laboratory testing performed is presented in Appendix B.

Boring Logs

The bore logs presented in Appendix A were prepared from the field logs which were edited after visual re-examination of the soil samples in the laboratory and results of classification tests on selected soil samples as indicated on the logs. The abrupt stratum changes shown on these logs may be gradual and relatively minor changes in soil types within a stratum may not be noted on the logs due to field limitations. Appendix A also includes log of test borings available from as-built drawings for the existing undercrossing.

SUBSURFACE CONDITIONS

Subsurface conditions in both the borings drilled indicate predominantly lean clays and sandy clays with occasional layers of sandy soils to a depth of approximately 60 feet. The clays are generally very stiff to a depth of 30 feet, turning to hard clays below that depth. Very hard/very dense interbedded layers of sandstone and siltstone were encountered in all the four borings at depths of approximately 70 feet. The sandstones and siltstones are judged to belong to Tulare Formation (Pliocene). Four boring logs, drilled in 1957 are shown on the as-built drawings. The boring logs indicate predominantly silts and sandy silts with interbedded sand layers. The discrepancies between the current and As-built boring logs may be attributed to changes in soil classification over the years.

During field exploration in September, 2006, groundwater was encountered (during drilling) approximately at 63-ft depth (Elev. 5.6 feet) in boring AST-154 on the west end and approximately at 56.5-ft depth (Elev. 11.7 feet) in boring AST-155 on the east side of the bridge. During field exploration in July, 2009, groundwater was encountered (during drilling) approximately at 80-ft depth (Elev. -11.4 feet) in boring AST-154A on the west end and approximately at 60-ft depth (Elev. 8.2 feet) in boring AST-155A on the east side of the bridge. In boring 155A, groundwater rose approximately 20 feet (Elev. 28.2 feet) prior to grouting of the hole. However, the groundwater may vary with the passage of time due to seasonal groundwater fluctuation, surface and subsurface flows, ground surface run-off and other factors that may not be present at the time of investigation.

GEOLOGY

General geologic features pertaining to the site were evaluated with reference to the "Geologic Map of Quaternary Geology of Contra Costa County and Surrounding Areas, CA: Derived from Digital Database open-file 97-98" by E.J. Helley and R.W. Graymer 1997; Scale 1:100000. Based on the map, the site is located in an area covered by Pleistocene alluvial deposits (Qpaf). A geologic map of the general project area is shown on Plate 2. Description of the main geologic units is as follows:

> *Qpaf (Alluvial Fans and Fluvial Deposits (Pleistocene)) – Brown dense gravely and clayey sand or clayey gravel that fines upward to sandy clay. These deposits display various sorting and are located in most stream channels in the county. All Qpaf deposits can be related to modern stream courses. They are distinguished from younger alluvial fans and fluvial deposits by higher topographic position, greater degree of dissection, and stronger soil profile development. They are less permeable than Holocene deposits, and locally contain fresh water mollusks and extinct late Pleistocene vertebrate fossils. They are overlain by Holocene deposits on lower parts of the alluvial plain, and incised by channels that are partly filled with Holocene alluvium on higher parts of the alluvial plain. Maximum thickness is unknown but at least 50m (150 feet).*

Another map ('Preliminary geologic map emphasizing bedrock formations in Contra Costa County: A digital database', compiled by Graymer, Jones and Brabb (USGS Open File Report 94-622) was also considered for additional information for the bedrock. Bedrock (Tulare Formation) exposed at the surface is noted to the south of the site. The rock has a shallow dip towards the north and is therefore expected to underlie the hard Pleistocene clays at the site. Description of the rock is as follows:

> *Ttu (Tulare Formation (Pliocene) – Poorly consolidated, non-marine, gray to maroon siltstone, sandstone, and conglomerate. This formation contains tuff correlated with the Putah tuff.*

EARTHQUAKE CONSIDERATIONS

Seismic Sources

The project is located in a seismically active part of Northern California. Many faults exist in the area, which are capable of producing earthquakes which may cause strong ground shaking at the site.

Applicable major faults in the vicinity of the project site were identified and their associated maximum earthquake magnitudes were established using the In-Progress Seismic Hazard Map currently under development by Caltrans and the associated Data Base. The documents were supplied to us by Caltrans, with the understanding that the fault locations in the map and the associated magnitudes in the Data Base have essentially been finalized. Pertinent information is summarized below. The moment magnitudes noted in the table represent the largest earthquakes that could occur on the given fault based on the current understanding of the regional tectonic structure. A fault map of the project vicinity is shown on Plate 3.

Fault	Fault No.(1)	Fault Type	Distance from Site (miles)	Maximum Moment Magnitude
Vaca Fault Zone	14	RLSS(2)	3.4	6.9
Great Valley Fault 5	24	Reverse Fault	4.4	6.5
Greenville Fault Zone (Clayton Section)	351	RLSS	4.1	6.6
Concord Fault Zone (Ygnacio Valley Section)	341	RLSS	6.9	6.6

(1) Number of the Fault in the Data Base associated with the Caltrans In-Progress Seismic Hazard Map
(2) RLSS – Right-left Strike Slip Fault

Based on the Caltrans In-Progress Seismic Hazard Map and the attenuation relationship by Sadigh et al. (1997), the controlling fault is the Vaca Fault Zone (Fault No. 14 in the map), which is associated with a Maximum Moment Magnitude (Mmax) of 6.9. A peak bedrock acceleration (PBA) of 0.50g is anticipated at the site.

Seismic Hazards/Liquefaction Impact

Potential seismic hazards may arise from three sources: surface fault rupture, ground shaking and liquefaction. Since no active faults pass through the site, the potential for fault rupture is relatively low. Based on available geological and seismic information, the possibility of the site to experience strong ground shaking may be considered significant.

Liquefaction is a phenomenon in which saturated soils are subject to a temporary but essentially total loss of shear strength under the reversing, cyclic shear stresses associated with earthquake shaking. Submerged, cohesionless sands and silts of low relative density are the type of soils which usually are susceptible to liquefaction - the susceptibility increases with decreasing relative density (reflected by the number of blows to drive a sampler), and decreasing fines content. Accepted procedures for the assessment of liquefaction potential for cohesionless soils have evolved over the years through research and field observations (Youd et al, 2001). Recent research and field observations have shown that clays of low plasticity are also potentially liquefiable, based on the moisture content and plasticity characteristics of the clay. Procedures for the assessment of liquefaction potential for clay soils have also been established and have received general acceptance (Bray et. al., 2004).

Potential for liquefaction at the site is low, due to the predominant presence of stiff clay soils and the relatively low groundwater table.

FINDINGS AND RECOMMENDATIONS

General

Based on the findings of the investigation, it is our opinion that the site is feasible for the planned bridge structures provided the recommendations presented in this report are incorporated into the final design and construction.

This report was prepared specifically for the proposed bridge structures according to the plans provided to us. Normal construction procedures were assumed throughout our analysis and represent one of the bases of recommendations presented herein. Our design criteria have been based upon the materials encountered at the site. Therefore, we should be notified in the event that these conditions are changed, so as to modify or amend our recommendations.

Foundations

For the proposed structure, 24-inch diameter CIDH piles are recommended for foundation support at the two abutment locations and 84-inch CIDH piles are recommended for the column foundations for Bent 2.

Pile Design

Pertinent foundation design information was provided by T. Y. Lin International (Structural Engineers for the project), which are presented in the following tables (Foundation Design Data and Foundation Design Loads).

FOUNDATION DESIGN DATA – Left Bridge

Support No	Design Method	Pile Type	Finish Grade Elev. (ft)	Pile Cut-off Elev. (ft)	Pile Cap Size (ft)		Permissible Settlement (inch)	No. of Piles per Support
					B(2)	L(3)		
Abutment 1	WSD	24-in CIDH	62.33	54.75	10	72.5	0.5(1)	22
Bent 2	LRFD	84-in CIDH	44.00	42.00	N/A	N/A	0.5(1)	1
Abutment 3	WSD	24-in CIDH	61.83	54.25	10	72.5	0.5(1)	22

Note: (1) Per MTD – 3-1 (2) B = Width (3) L = Length

FOUNDATION LOADS – Left Bridge

Support No.	Service-I Limit State (kips)			Strength Limit State (Controlling Group, (kips)				Extreme Limit State (Controlling Group, kips)			
	Total Load		Permanent Loads	Compression		Tension		Compression		Tension	
	Per Supp.	Per Pile	Per Support	Per Supp.	Max. Per Pile	Per Supp.	Max. Per Pile	Per Supp.	Max. Per Pile	Per Supp.	Max. Per Pile
Abutment 1	2366	114(1) 142(4)	1821	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bent 2	1303	1303	907	2259	2259	0	0	1015	1015	0	0
Abutment 3	2366	114(1) 142(4)	1821	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Notes: (1) Group 1 Loading – 100% of allowable; (4) Group 4 Loading – 125% of allowable

FOUNDATION DESIGN DATA – Right Bridge

Support No	Design Method	Pile Type	Finish Grade Elev. (ft)	Pile Cut-off Elev. (ft)	Pile Cap Size (ft)		Permissible Settlement (inch)	No. of Piles per Support
					B(2)	L(3)		
Abutment 1	WSD	24-in CIDH	62.33	54.75	10	72.5	0.5(1)	22
Bent 2	LRFD	84-in CIDH	44.00	42.00	N/A	N/A	0.5(1)	1
Abutment 3	WSD	24-in CIDH	61.83	54.25	10	72.5	0.5(1)	22

Note: Per MTD – 3-1 (2) B = Width (3) L = Length

FOUNDATION LOADS – Right Bridge

Support No.	Service-I Limit State (kips)			Strength Limit State (Controlling Group, (kips)				Extreme Limit State (Controlling Group, kips)			
	Total Load		Permanent Loads	Compression		Tension		Compression		Tension	
	Per Supp.	Per Pile	Per Support	Per Supp.	Max. Per Pile	Per Supp.	Max. Per Pile	Per Supp.	Max. Per Pile	Per Supp.	Max. Per Pile
Abutment 1	2366	114(1) 142(4)	1821	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bent 2	1303	1303	907	2259	2259	0	0	1015	1015	0	0
Abutment 3	2366	114(1) 142(4)	1821	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Notes: (1) Group 1 Loading – 100% of allowable; (4) Group 4 Loading – 125% of allowable

Consistent with the current Caltrans requirements, Working Stress Design (WSD) was used for the abutment foundations and Load Resistance Factor Design (LRFD) was used for the foundations for Bent 2 for the two bridges.

The abutment foundations were evaluated for the foundation design data and loading conditions using Caltrans November 2003 Bridge Design Specifications for foundations, using Working Stress Design (WSD) methods. The Bent 2 foundations were evaluated for the foundation design data and loading conditions using AASHTO LRFD Bridge Design Specifications – 3rd Edition, with Interims Through 2006 and current Caltrans Amendments (v3.06.01). The actual load demands on the piles, based upon WSD and LRFD are presented in the table below for the two bridges.

LOAD DEMANDS – Left Bridge

Support No.	Design Method	Service Loads (kips)		Required Nominal Resistance (kips)				Required Nominal Resistance (kips)	
				Strength Limit		Extreme Limit			
		Comp.	Tens.	Comp. (ϕ=0.7)	Tens. (ϕ=0.7)	Comp. (ϕ=1.0)	Tens. (ϕ=1.0)	Comp.	Tens.
Abutment 1	WSD	114	0	N/A	N/A	N/A	N/A	228	0
Bent 2	LRFD	1303	0	3203	0	1015	0	3203	0
Abutment 3	WSD	114	0	N/A	N/A	N/A	N/A	228	0

LOAD DEMANDS – Right Bridge

Support No.	Design Method	Service Loads (kips)		Required Nominal Resistance (kips)				Required Nominal Resistance (kips)	
				Strength Limit		Extreme Limit			
		Comp.	Tens.	Comp. (ϕ=0.7)	Tens. (ϕ=0.7)	Comp. (ϕ=1.0)	Tens. (ϕ=1.0)	Comp.	Tens.
Abutment 1	WSD	114	0	N/A	N/A	N/A	N/A	228	0
Bent 2	LRFD	1303	0	3203	0	1105	0	3203	0
Abutment 3	WSD	114	0	N/A	N/A	N/A	N/A	228	0

Estimation of the pile capacities was made using the site-specific subsurface conditions for the loads computed above and other pertinent information provided by the Structural Engineer. The computer program SHAFT developed by Ensoft, Inc. was used for the computations. The program computes capacities for drilled shafts (CIDH piles) based on procedures proposed by O'Neil and Reese (1999). The procedures utilize an α factor (α=0.55) for "Clay" and a β factor for "Sand" where β is a function of depths below ground surface and independent of soil friction angle The SHAFT program also computes the pile settlement and associated mobilization of shaft and

end-bearing resistance, consistent with the O'Neil and Reese (1999) procedures.

The pile data table is presented below. Pile capacity computations (SHAFT output) are presented in Appendix C. End bearing was neglected in the estimation of axial pile capacities for all piles.

PILE DATA TABLE - Left Bridge

Location	Pile Type	Nominal Resistance (kips)		Cut-off Elev. (ft)	Design Tip Elev. (ft)[1]	Specified Tip Elev. (ft)	Nominal Driving Resistance (kips)
		Compression	Tension				
Abutment 1	24-in CIDH	230	0	54.75	34.0(a), 34.0(b)	34.0	N/A
Bent 2	84-in CIDH	3210	0	42.00	-18.5(a), -6.0(b)	-18.5	N/A
Abutment 3	24-in CIDH	230	0	54.25	29.0(a), 34.0(b)	29.0	N/A

Notes:
1. Design Tip Elevation is controlled by the following demands: (a) Compression; (b) Lateral Loads

PILE DATA TABLE - Right Bridge

Location	Pile Type	Nominal Resistance (kips)		Cut-off Elev. (ft)	Design Tip Elev. (ft)[1],	Specified Tip Elev. (ft)	Nominal Driving Resistance (kips)
		Compression	Tension				
Abutment 1[1]	24-in CIDH	230	0	54.75	34.0(a), 34.0(b)	34.0	N/A
Bent 2	84-in CIDH	3210	0	42.00	-18.5(a), -6.0(b)	-18.5	N/A
Abutment 3[1]	24-in CIDH	230	0	54.25	29.0(a), 34.0(b)	29.0	N/A

Notes:
1. Design Tip Elevation is controlled by the following demands: (a) Compression; (b) Lateral Load.

CIDH Pile Installation

Caltrans standard specification for "Cast-in-Place Concrete Piling" should be used for the construction of CIDH piles. Groundwater will be encountered during pile construction for the 84-inch Bent 2 piles and may also be encountered for the abutment piles. The construction of the CIDH piles should be in accordance with the Caltrans specifications, which include necessary

QA/QC procedures. It is prudent to make the contractor aware of these conditions so that he takes appropriate steps to comply with the standards and maintain the integrity of the CIDH piles. The use of temporary steel casing should be anticipated at all times to maintain the integrity of the piles, particularly when drilling through the embankment fill. It is also recommended that the specifications set certain to pre-qualify the potential contractors. This is particularly significant for the 68-ft long 84-inch diameter piles for Bent 2, which will require installation of a large diameter CIDH pile below groundwater.

All piles excavations should be observed by the geotechnical engineer or regulatory agency prior to the placement of reinforcement and concrete so that if conditions differ from those anticipated, appropriate recommendations can be made.

Lateral Pile Capacity

Lateral load analyses may be performed using the LPILE program to determine the behavior of the piles under lateral loading conditions. Geotechnical parameters recommended for use in the LPILE program are presented below. The following parameters are based on field borings and laboratory testing data. The elevation information is based on the topographic information provided to us.

Geotechnical Parameters for LPILE Analysis
Abutment 1 – Left and Right Bridge

Approx. Elev. (ft.)	Generalized Soil Profile	LPILE Soil Type	Probable Soil Strength	K (pci)	E_{50} (in/in)	Effect Unit Wt. (pci)
Above 45	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 24.31 psi	1000	.005	0.0723
35 to 45	Dense Silty Sand	8, API SAND	ϕ=35°	125	--	0.0752
20 to 35	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 24.31 psi	1000	.005	0.0723
5 to 20	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su 17.36 psi	1000	.005	0.0723
0 to 5	Very Stiff Sandy Silt	8, API SAND	ϕ=25°	125	--	0.0376
Below 5	Hard Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 27.78 psi	2000	.004	0.0376

Bent 2 – Left and Right Bridges

Approx. Elev. (ft.)	Generalized Soil Profile	LPILE Soil Type	Probable Soil Strength	K (pci)	E_{50} (in/in)	Effect Unit Wt. (pci)
Above 20	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 24.31 psi	1000	.00267	0.0723
4 to 20	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 24.31 psi	1000	.00267	0.0723
0 to 4	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 24.31 psi	1000	.00267	0.0376
Below 0	Hard Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 41.67 psi	2000	.00214	0.0376

Abutment 3 – Left and Right Bridges

Approx. Elev. (ft.)	Generalized Soil Profile	LPILE Soil Type	Probable Soil Strength	K (pci)	E_{50} (in/in)	Effect Unit Wt. (pci)
Above 40	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 17.36 psi	1000	.005	0.0723
20 to 40	Hard Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 27.78 psi	2000	.004	0.0723
5 to 20	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 17.36 psi	1000	.005	0.0723
3 to 5	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 17.36 psi	1000	.005	0.0376
Below 3	Very Dense Sand	8, API SAND	ϕ=40°	125	--	0.0405

Analyses were performed for the CIDH piles for the lateral loads provided by the designer. In all analyses, a 'pinned' pile head connection was assumed. The results are presented in the table below. Appropriate Group Reduction Factors were used in the analyses corresponding to the pile spacings, as noted in the table.

LATERAL LOAD (LPILE) ANALYSIS RESULTS

Support No.	CIDH Pile Diameter (inches)	Cut-off Elevation (ft)	Shear Load on top of Pile (kips)	Deflection on Top of Pile (inches)	Maximum Bending Moment	
					Magnitude (kip-ft)	At depth (ft)[1]
Abut 1	24	54.75	27	0.0478	55.1	4
			37	0.0973	86.1	5
			47	0.162	122.2	5
Bent 2[2]	84	42.00	72 (long)	0.0080	292.6	7
			73 (trans)	0.0119	320.0	8
			147 (long)	0.0369	685.3	9
			155 (trans)	0.0617	858.1	11
Abut 3	24	54.25	27	0.0753	67.1	5
			37	0.151	105.1	6
			47	0.255	148.0	6

Notes:

1. Depth measured from top of pile (bottom of footing)
2. Used Cracked Section: Moment of Inertia reduced by 50 percent.
3. Group factors of 0.6 used for Abutments corresponding to a pile spacing of 3 times the diameter, as recommended by Caltrans
4. For Bent 2, Group Factors based on GROUP 7.0 Program (0.80 for Longitudinal and 0.62 for Transverse)
5. Loads provided by Antonio Luo

Lateral Earth Pressures

Abutment retaining walls and wing walls should be designed to resist the following Applied Lateral Earth Pressures and live load. These values assume no hydrostatic pore pressure buildup behind the wall and are based on well-drained backfill behind the walls supported in native soil.

Applied Lateral Earth Pressure

Active Condition	36 pcf Equivalent Fluid Pressure (EFP) for engineered fill
At-Rest Condition	55 pcf Equivalent Fluid Pressure (EFP) for engineered fill
Passive Resistance	310 pcf EFP with a maximum value of 3100 psf. 5 ksf (ultimate) for seismic design of the abutment backwall (5.5 feet high or greater); for activated height less than 5.5 feet modify proportionally, i.e. 5 x (H/5.5) ksf. A minimum lateral wall movement of 2% of wall height to mobilize the full ultimate passive pressure is required.

Cantilever walls which are free to rotate at least 0.004 radians may be assumed flexible for the active condition. Walls that are not capable of this movement should be assumed rigid and designed for the at-rest condition. The effect of any surcharge (dead, live, or traffic load) should be added to the preceding lateral earth pressures. A coefficient of 0.3 may be used to determine the additional earth pressure resulting from the surcharge.

Seismic Design Criteria

The value of PBA for the project site was calculated from the distances to the applicable faults in the project vicinity using the Caltrans In-Progress Seismic Hazard Map and the attenuation relation by Sadigh et al. (1997). The computed PBA value was increased by 20%, also per Sadigh (1997), to account for the reverse fault effect, wherever applicable. The PBA computations based on Sadigh attenuation relation are presented in Appendix C. Based on the computations, the maximum PBA computed within the project limit is 0.5g.

Based on the available boring information in the vicinity of the project site, the subsurface soil

conditions at the project site generally matches the criteria for Soil Type D, as per Caltrans Seismic Design Criteria (Version 1.4, June 2006). Based on Caltrans Seismic Design Criteria and the above information, the seismic design criteria are as follows:

1.	Closest Distance to Fault	=	3.4 miles (5.5 km)
2.	PBA	=	0.5g
3.	Design ARS Curve	=	Caltrans Seismic Design Criteria June 2006 Version 1.4 Figure B.8 (Soil Profile Type D).

4. Design ARS Curve (see Plate 4): Curve based on Caltrans SDC (v. 1.4, 6/2006) for different structural periods. The curve is based on (Governing Fault – Vaca Fault Zone; Mmax =6.9) Figure B.8, PBA = 0.5g. The curve is modified for near fault effects as required by SDC.

A copy of the ARS Design Curve is included on Plate No. 4 of this report.

Grading

All grading operations should be performed in accordance with the project specifications and Caltrans Standard Specifications for Earthwork (Section 19). A representative from our office or regulatory agency should observe all excavated areas during grading and perform moisture and density tests on prepared subgrade and compacted fill material. Any fill material imported to the site should be non-expansive, relatively granular material having a Plasticity Index (P.I.) of less than 15. It should also be non-corrosive, free of deleterious material and should be reviewed by the Geotechnical Engineer.

Should there be any alterations of the proposed construction that will affect the stated bases of our recommendations, we should be informed so that we can review such changes and amend or submit additional recommendations. Our office should review the final grading plans prior to grading to see that the intent of our recommendations is included in the plans.

Engineered Fill Engineered fill should be non-expansive and consist of relatively granular material having a P.I. of less than 15. The fill shall also be free of organic and inorganic debris, rubble and any other deleterious material. The on-site soils may be used as engineered fill, provided they meet the above criteria.

Low Expansion Materials at Abutments As per Caltrans standards, "Low Expansion Material" should be used at the abutments for the project. A schematic drawing showing standard "Limits of Low Expansion Material at Abutments" per Caltrans requirements is shown on Plate 5. The material within this limit should have Sand Equivalent (SE) more than 20 as determined in accordance with California Test Method 217 and Expansion Index (EI) less than 50 as determined in accordance with ASTM D4829. In addition, as general requirements, fill material should be free of organic material and rocks or lumps greater than 4 inches in diameter, have a plastic index (PI) of less than 15, and compacted as per Caltrans Standard Specification.

Approach Embankment The maximum embankment fill thickness is anticipated to be approximately 10 to 15 feet at all the abutment locations. The approach embankments will have a 2(H): 1(V) slope on both sides. Under the bridge, paved slopes may be constructed at 1.5(H):1 (V) slope. The available boring data indicates that the subsurface soil conditions generally consist of stiff to very stiff clays. Based on the boring information, it appears that the consolidation settlement due to the placement of the embankment fill is anticipated to be relatively quick (during construction) and therefore insignificant. Standard Caltrans 30-day waiting period is considered adequate.

Corrosion

The corrosion investigations performed are in general accordance with the provisions of California Test Method 643. A summary of the corrosion test data is presented below.

Boring	Depth (ft)	PH	Resistivity (ohms-cm)	Sulfate (ppm)	Chloride (ppm)
AST-154	8	7.50	860	89.1	10.9

Based on the data, the site subsoil is non-corrosive per Caltrans corrosion design guidelines, and standard Type II modified or Type I-P (MS) modified cement may be used for the concrete substructures. The minimum cement factor and cover thickness should be per Caltrans Bridge Design Specifications (Section 8.22).

Plan Review

We recommend that final plans for foundations be reviewed by this office prior to construction so that the intent of our recommendations is included in the project plans and specifications and to further see that no misunderstandings or misinterpretations have occurred.

Construction Observation

To a degree, the performance of any structure is dependent upon construction procedures and quality. Hence, observation of foundation excavations, and pile installations should be carried out by the regulating agencies. If the subsurface conditions different from those forming the basis of our recommendations is encountered, this office should be informed in order to assess the need for design changes. Therefore, the recommendations presented in this report are contingent upon good quality control and these geotechnical observations during construction.

INVESTIGATION LIMITATIONS

Our services consist of professional opinions and recommendations made in accordance with generally accepted geotechnical engineering principles and practices and are based on our site reconnaissance and the assumption that the subsurface conditions do not deviate from observed conditions. All work done is in accordance with generally accepted geotechnical engineering principles and practices. No warranty, expressed or implied, of merchantability or fitness, is made or intended in connection with our work or by the furnishing of oral or written reports or findings.

The scope of our services did not include any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in structures, soil, surface water, groundwater or air, below or around this site. Unanticipated soil conditions are commonly encountered and cannot be fully determined by taking soil samples and excavating test borings; different soil conditions may require that additional expenditures be made during construction to attain a properly constructed project. Some contingency fund is thus recommended to accommodate these possible extra costs.

This report has been prepared for the proposed project as described earlier, to assist the engineer in the design of this project. In the event any changes in the design or location of the facilities are planned, or if any variations or undesirable conditions are encountered during construction, our conclusions and recommendations shall not be considered valid unless the changes or variations are reviewed and our recommendations modified or approved by us in writing.

This report is issued with the understanding that it is the designer's responsibility to ensure that the information and recommendations contained herein are incorporated into the project and that necessary steps are also taken to see that the recommendations are carried out in the field.

The findings in this report are valid as of the present date. However, changes in the subsurface conditions can occur with the passage of time, whether they are due to natural processes or to the works of man, on this or adjacent properties. In addition, changes in applicable or appropriate standards occur, whether they result from legislation or from the broadening of knowledge. Accordingly, the findings in this report might be invalidated, wholly or partially, by changes outside of our control.

Respectfully submitted,
PARIKH CONSULTANTS, INC.

Partha Sircar, Ph.D., P.E. C54619
Senior Engineer

Gary Parikh, G.E. 666
Project Manager

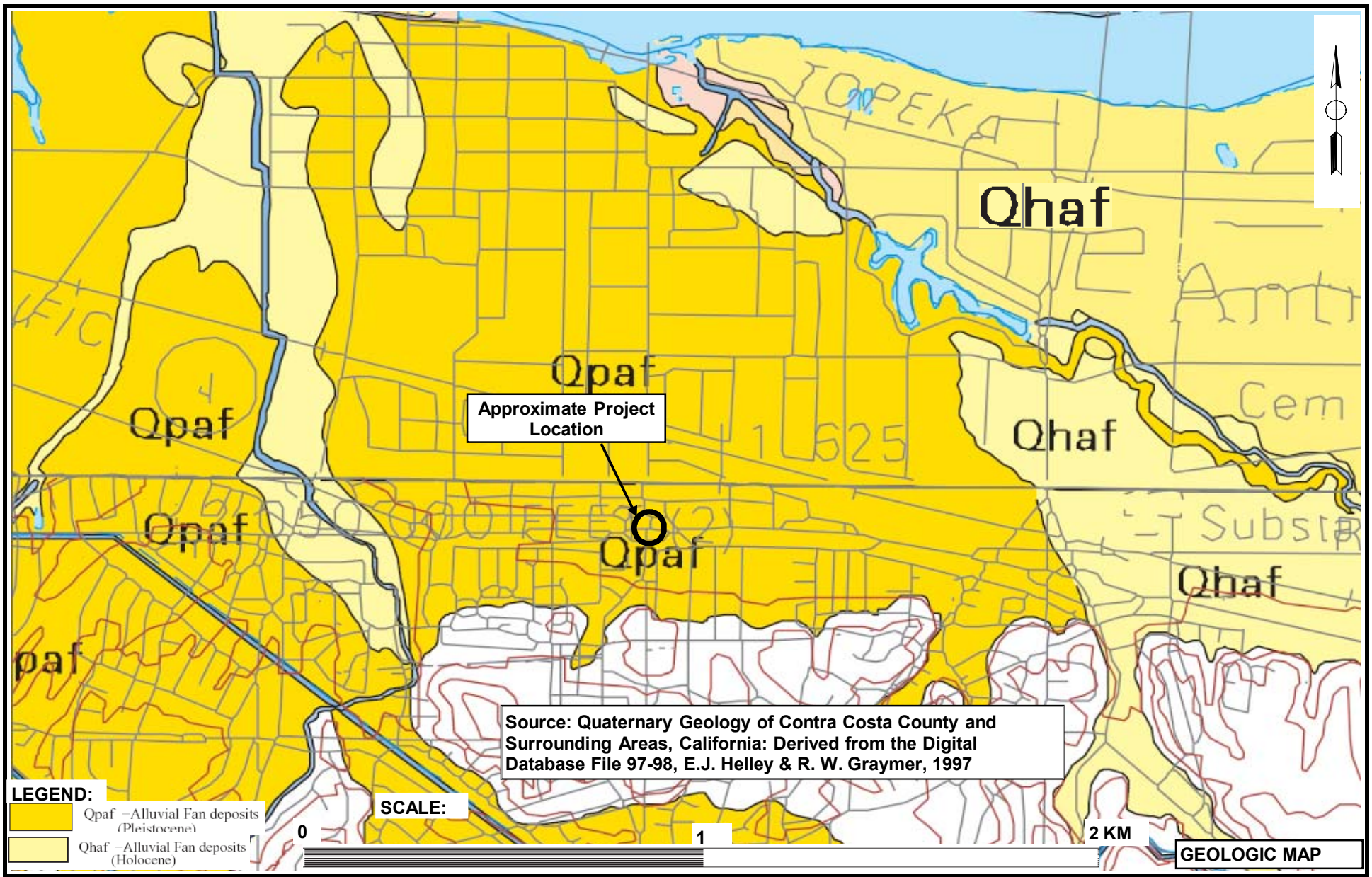
REGISTERED PROFESSIONAL ENGINEER
GAURANG R. PARIKH
No. 666
EXP. 12-31-11
GEOTECHNICAL
STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

A STREET UNDERCROSSING
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO.: 206117.AST

PLATE NO.: 1



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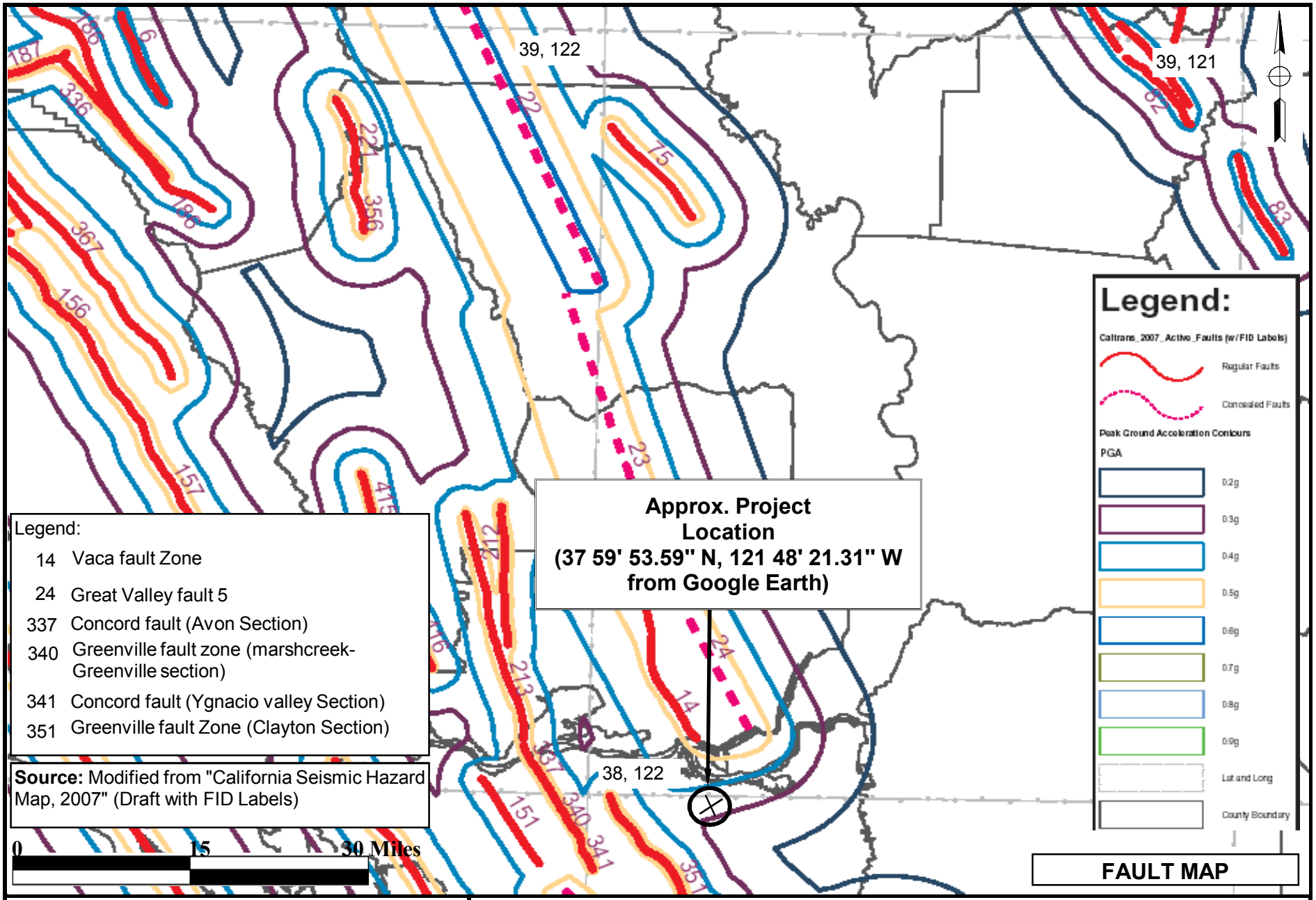
A STREET UNDERCROSSING
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO.: 206118.AST | **PLATE NO.: 3**



FAULT MAP

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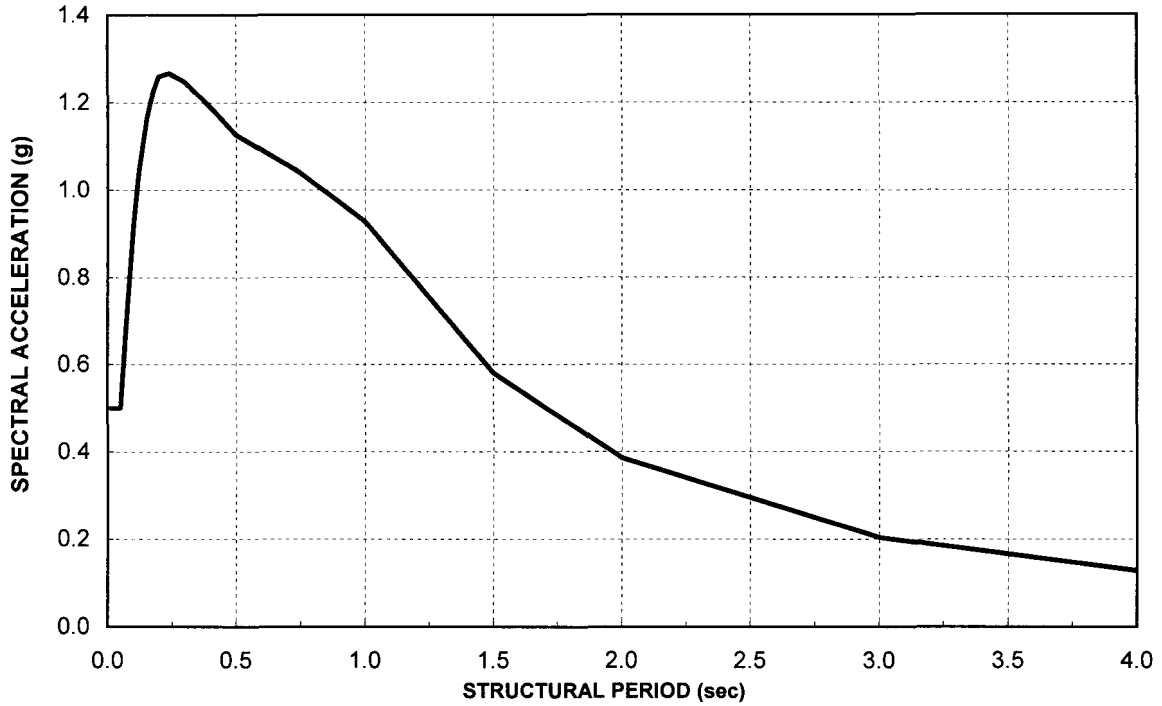
A Street Undercrossing



Spectral Data

Period (sec)	Spectral Accel. (g)
0.010	0.500
0.020	0.500
0.030	0.500
0.050	0.500
0.075	0.719
0.100	0.919
0.120	1.037
0.150	1.156
0.170	1.209
0.200	1.259
0.240	1.266
0.300	1.247
0.400	1.190
0.500	1.125
0.750	1.038
1.000	0.927
1.500	0.581
2.000	0.386
3.000	0.204
4.000	0.128

Caltrans SDC (v 1.4, June 2006), Figure B.8,
Governing Fault: Vaca Fault Zone
Fault Distance = 5.45 km (3.4 miles)
(Mw = 6.9, Soil Profile Type D, PBA = 0.5g)

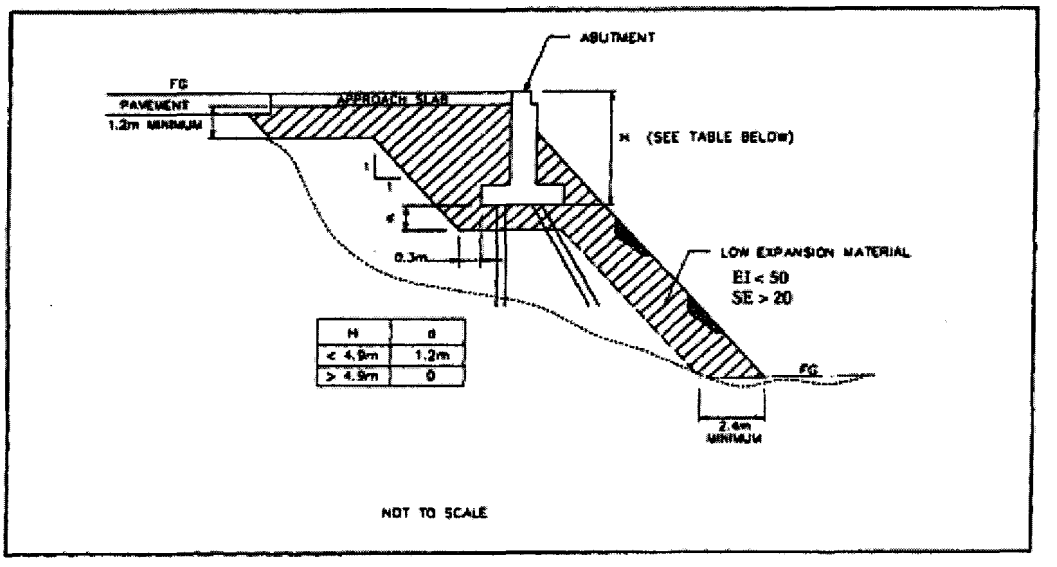
Notes:
(a) The new (in-progress) Caltrans Hazard Map and Data Base was used
(b) PBA was obtained by using Sadigh Attenuation Relationship:0.49g (rounded off to 0.5 g)
(c) The following modifications were then applied for near-fault effects:
(1) No change of Sa for structural periods $\leq$ 0.5 sec
(2) 20% increase of Sa for structural periods > 1 sec
(3) Linear interpolation for structural periods between 0.5 and 1 sec

EXPANSIVE SOIL EXCLUSION ZONE

GUIDELINE FOR DEFINING EXPANSIVE SOIL AND THE ZONE AROUND BRIDGE ABUTMENTS IN WHICH EXPANSIVE SOIL IS TO BE EXCLUDED (ALSO APPLICABLE TO WINGWALLS AND RETAINING WALLS).

Expansive soil materials shall not be placed as part of the embankment within the limits of a bridge abutment as shown in Figure 1 below for the full width of the embankment. Expansive soil materials for this requirement are defined as having either an Expansion Index (EI) greater than 50, (Expansion Index to be determined in accordance with ASTM D 4829) or a Sand Equivalent (SE) less than 20 (Sand Equivalent to be determined in accordance with California Test Method 217). This requirement is exclusive of the structure backfill and pervious backfill material requirements as shown on the plans and set forth in the Standard Specifications under Sections 19-3.06 and 19-3.065 respectively.

Figure 1 TYPICAL SECTION - EXPANSIVE SOIL EXCLUSION ZONE IN BRIDGE EMBANKMENT



H	a
< 4.9m	1.2m
> 4.9m	0

LOW EXPANSION MATERIAL

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A STREET UNDERCROSSING
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO.: 206117.AST | PLATE NO.: 5

APPENDIX B

APPENDIX B

LABORATORY TESTS

Classification Tests

The field classification of the samples was visually verified in the laboratory according to the Unified Soil Classification System. The results are presented on "Log of Test Borings", Appendix A.

Moisture-Density

The natural moisture contents and dry unit weights were determined for selected undisturbed samples of the soils in general accordance with ASTM Test Method D 2216-92. This information was used to classify and correlate the soils. The results are presented at the appropriate depths on the "Log of Test Borings", Appendix A.

Atterberg Limits

The Atterberg Limits were determined for selected samples of the fine-grained materials. These results were used to classify the soils, as well as to obtain an indication of the effective strength characteristics and expansion potential with variations in moisture content. The Atterberg Limits were determined in general accordance with ASTM Test Method D 4318-93. The results of these tests are presented on Plate B-2, "Plasticity Chart".

Grain Size Classification

Grain size classification tests (ASTM Test Method D422-63) were performed on selected samples of granular soil to aid in the classification. The results are presented on Plates B-3A and B-3B, "Grain Size Distribution Curves".

Hydrometer

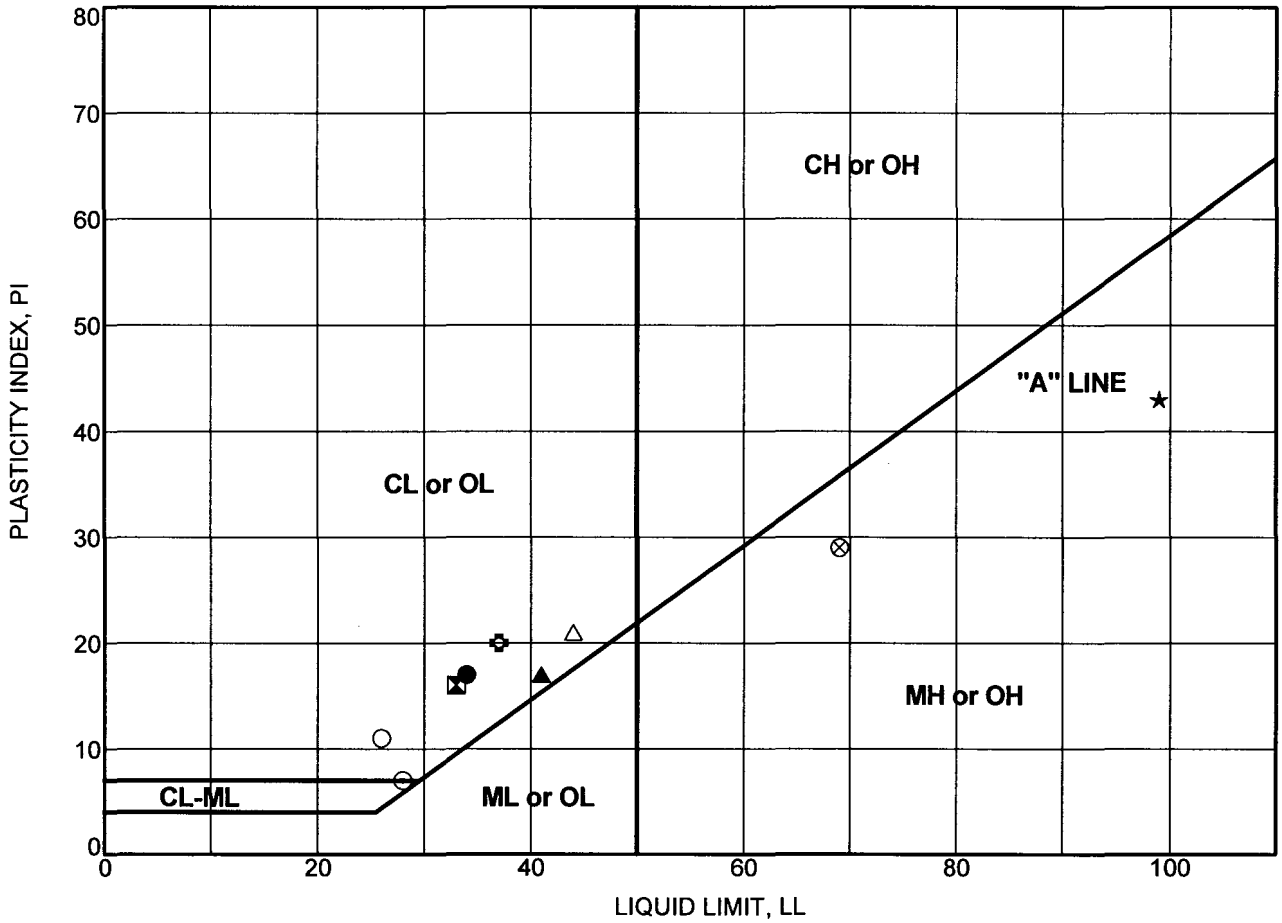
Hydrometer test (ASTM Test Method D 422) was performed on selected samples to aid in the classification. The result is presented on Plate B-4, " Grain Size Distribution Curves"

Unconfined Compression Tests

Strength tests were performed on selected undisturbed samples using unconfined compression machine. Unconfined compression tests were performed in general accordance with ASTM Test Method D 2166-91. The results are presented on "Log of Test Borings"

Corrosion Test

Corrosion test was performed on selected sample to determine the corrosion potential of the soils. The pH and minimum resistively test was performed according to California Test Method 643. The test was performed by Sunland Analytical. The test result is presented on Plate B-4.



PLASTICITY CHART

Boring Number	Sample Number	Depth (feet)	Test Symbol	Moisture Content (%)	LL	PL	PI	Description
AST-154	MC-2	8.0	●	16	34	17	17	LEAN CLAY (CL)
AST-154	MC-7	30.0	⊠	11	33	17	16	SILTY SAND (SM)
AST-154	MC-12	55.0	▲	25	41	24	17	LEAN CLAY (CL)
AST-154A	SPT-7	99.5	★	50	99	56	43	ELASTIC SILT (MH)
AST-155	MC-2	10.0	⊙	19	28	21	7	SILTY CLAY (CL-ML)
AST-155	MC-4	15.0	✿	15	37	17	20	SILT (ML)
AST-155	MC-11	50.0	○	24	26	15	11	LEAN CLAY (CL)
AST-155	MC-12	55.0	△	56	44	23	21	LEAN CLAY (CL)
AST-155A	SPT-8	109.5	⊗	62	69	40	29	SANDY ELASTIC SILT (MH)

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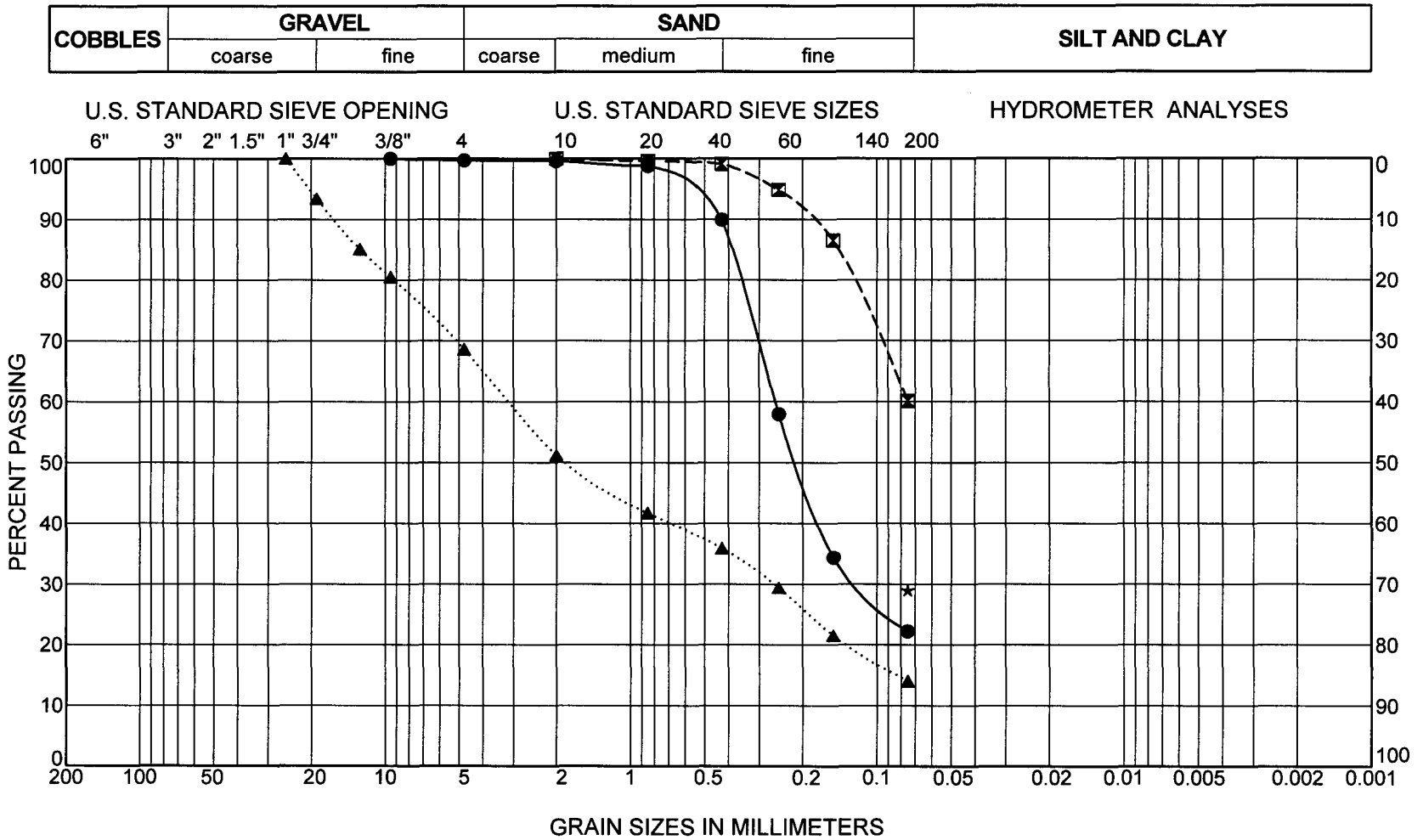
JOB NO: 206117.AST

PLATE NO: B-2

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
AST-154	MC-7	30.0	●	33	16	SILTY SAND (SM)
AST-154	SPT-14	65.0	⊠			SANDY SILT (ML)
AST-154A	SPT-8	89.5	▲			SILTY SAND WITH GRAVEL (SM)
AST-154A	SPT-9	109.5	★			SANDY SILT (ML)

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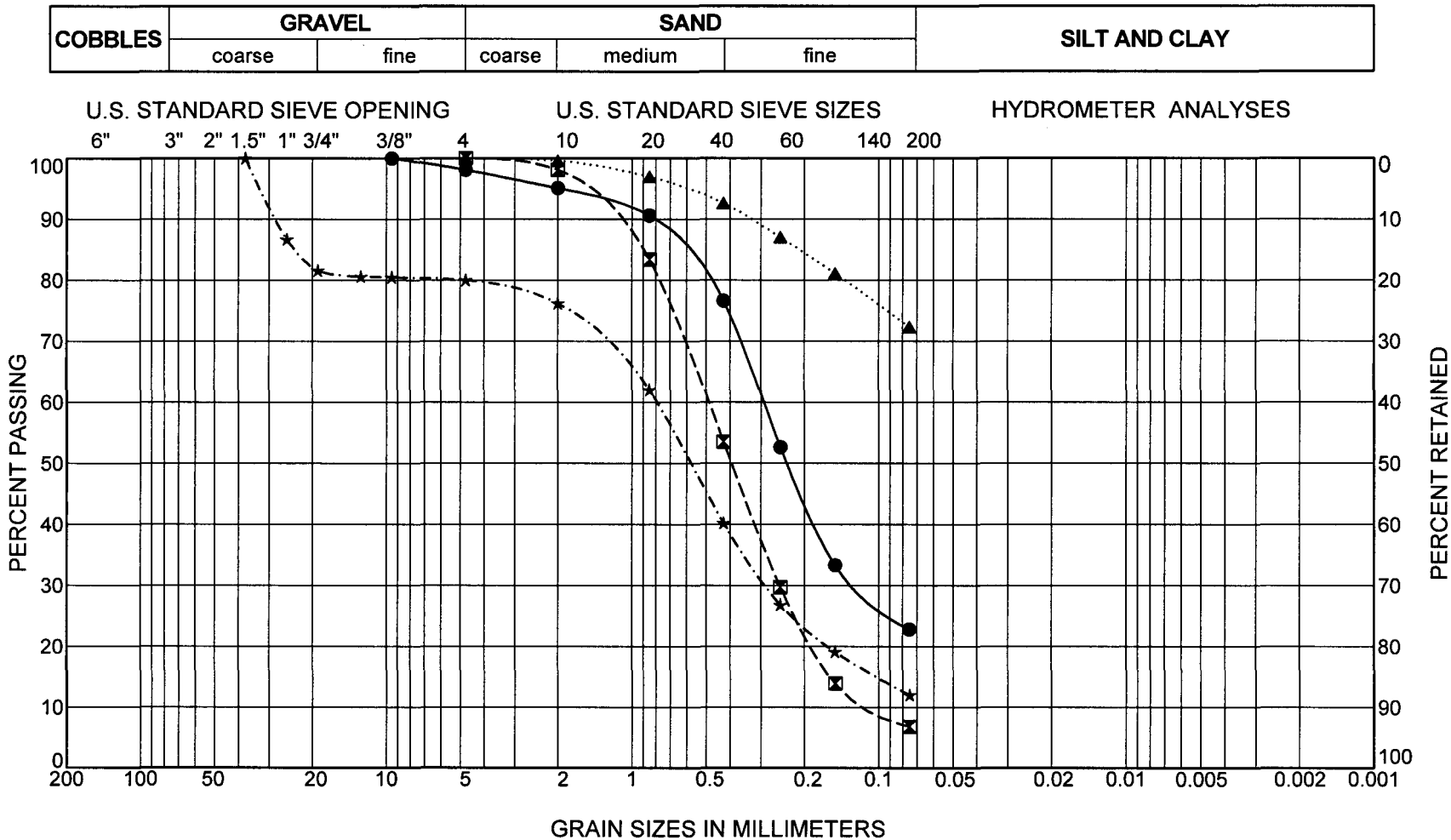
JOB NO: 206117.AST

A STREET UNDERCROSSING
CONTRA COSTA COUNTY, CALIFORNIA

PLATE NO: B-3A

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
AST-155	MC-6	25.0	●			CLAYEY SAND (SC)
AST-155	SPT-14	70.0	⊠			POORLY GRADED SAND WITH SILT (SP-SM)
AST-155A	SPT-7	99.5	▲			SILT WITH SAND (ML)
AST-155A	SPT-9	119.5	★			WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM)

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JOB NO: 206117.AST

A STREET UNDERCROSSING
CONTRA COSTA COUNTY, CALIFORNIA

PLATE NO: B-3B

Sunland Analytical

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 12/08/2006
Date Submitted 12/04/2006

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.AST/A ST.BDGE Site ID : AST 154 #2 @ 8'.
Thank you for your business.

* For future reference to this analysis please use SUN # 49465-98602.

EVALUATION FOR SOIL CORROSION

Soil pH	7.50		
Minimum Resistivity	0.86	ohm-cm (x1000)	
Chloride	10.9 ppm	00.00109	%
Sulfate	89.1 ppm	00.00891	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

APPENDIX C

Attenuation Relationships for Shallow Crustal Earthquakes (Sadigh, et al, 1997)

Fault = Vaca fault zone (RLSS Fault, Map NO: 14)

Mmax = 6.9 **Rrup = 5.48** **km**

M>=6.5 *ROCK SITE:*

C1 = -1.274 C2 = 1.1 C3 = 0 C4 = -2.1

C5 = -0.48451 C6 = 0.524 C7 = 0

A=C1+C2M+C3(8.5M)^2.5= 6.316

B=C4*Ln(Rrup+exp(C5+C6M))= -7.026

C=C7*Ln(Rrup+2)= 0

Ln(y) = A+B+C = -0.710

y = Exp(Ln(y)) = 0.49 **Peak Bed Rock Acceleration PBA = 0.490 - Use 0.5g**

Fault = Great valley fault 5 (Reverse Fault, Map No: 24)

Mmax = 6.5 **Rrup = 7.045** **km**

A= 5.876

B= -6.811

C= 0

Ln(y) = -0.935

y = 0.39 **Peak Bed Rock Acceleration PBA = 0.39g x 1.2 = 0.468g**

Fault = Greenville fault zone (Clayton section, RLSS Fault, Map No: 351)

Mmax = 6.6 **Rrup = 6.59** **km**

A= 5.986

B= -6.855

C= 0

Ln(y) = -0.869

y = 0.42 **Peak Bed Rock Acceleration PBA = 0.42g**

Fault = Concord fault zone (Ygnacio valley section, RLSS Fault, Map No: 341)

Mmax = 6.6 **Rrup = 11.136** **km**

A= 5.986

B= -7.191

C= 0

Ln(y) = -1.205

y = 0.30 **Peak Bed Rock Acceleration PBA = 0.3g**

AXIAL PILE CAPACITIES

(SHAFT Program)

SHAFT Runs SR Bypass – Lone Tree Way-A Street Undercrossing
Job No. 206117.LNT
Pile capacities computed using SHAFT program – Output follows
Note: Neglected End Bearing for Pile Capacity
Revised August 23, 2009

Abutment 1 (based on boring AST-154)

Left & Right Bridges – 24-in CIDH Pile

Ground Surface Elevation 62.0 (approx.)
Nominal Compression Load = 230 kips = 115 tons
Reqd. Shaft Length per SHAFT output = 26.5 ft
Recommended Penetration = 28.0 feet (absence of sand layer)
Reqd. Tip Elevation = 62.0-28.0 = 34.0

Abutment 3 (based on boring AST-155)

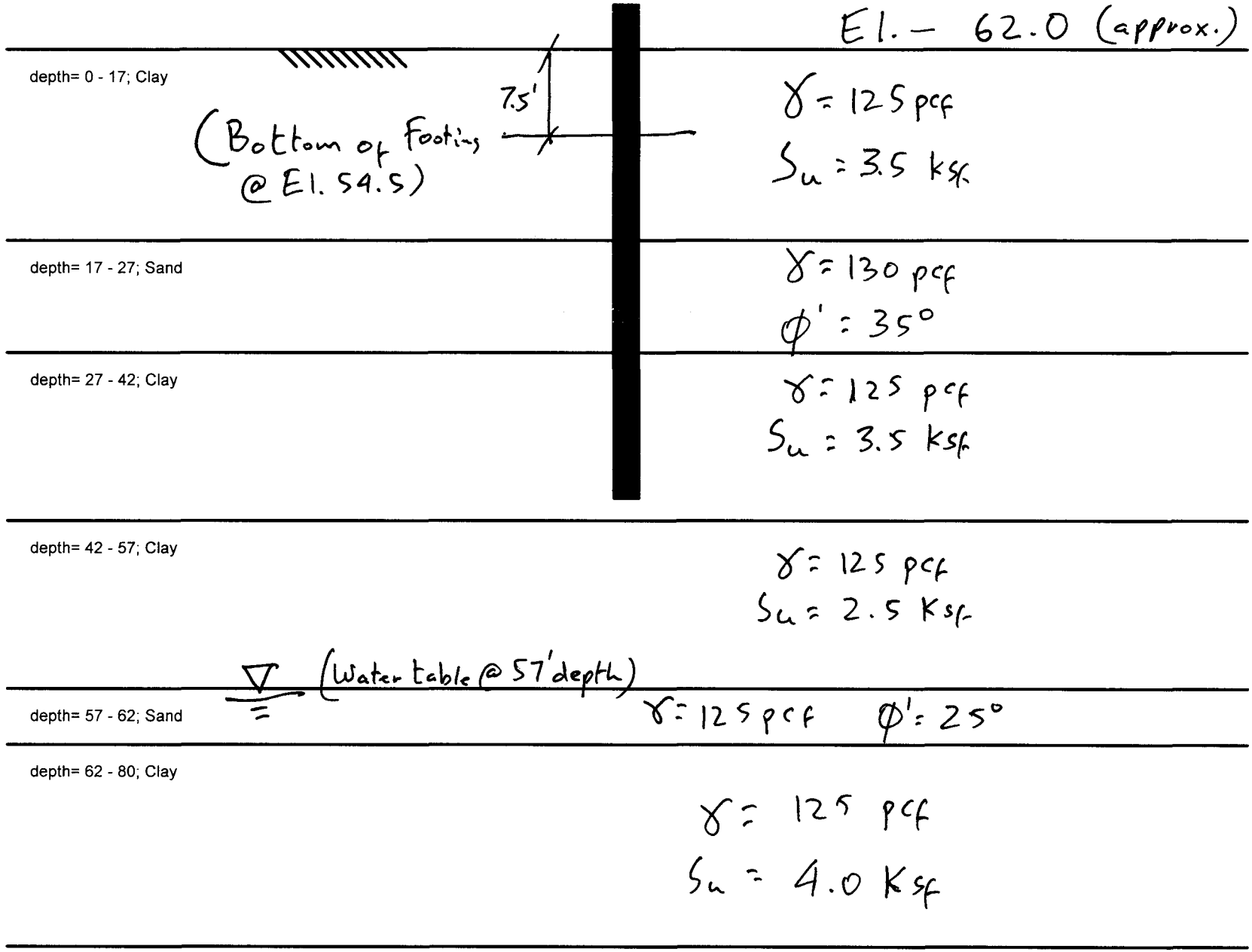
Left & Right Bridges – 24-in CIDH PIle

Ground Surface Elevation 62.0 (approx.)
Nominal Compression Load = 240 kips = 120 tons
Reqd. Shaft Lengthn per SHAFT output = 32.0 ft
Recommended Penetration = 33.0 feet
Reqd. Tip Elevation = 62.0 – 33.0 = 29.0

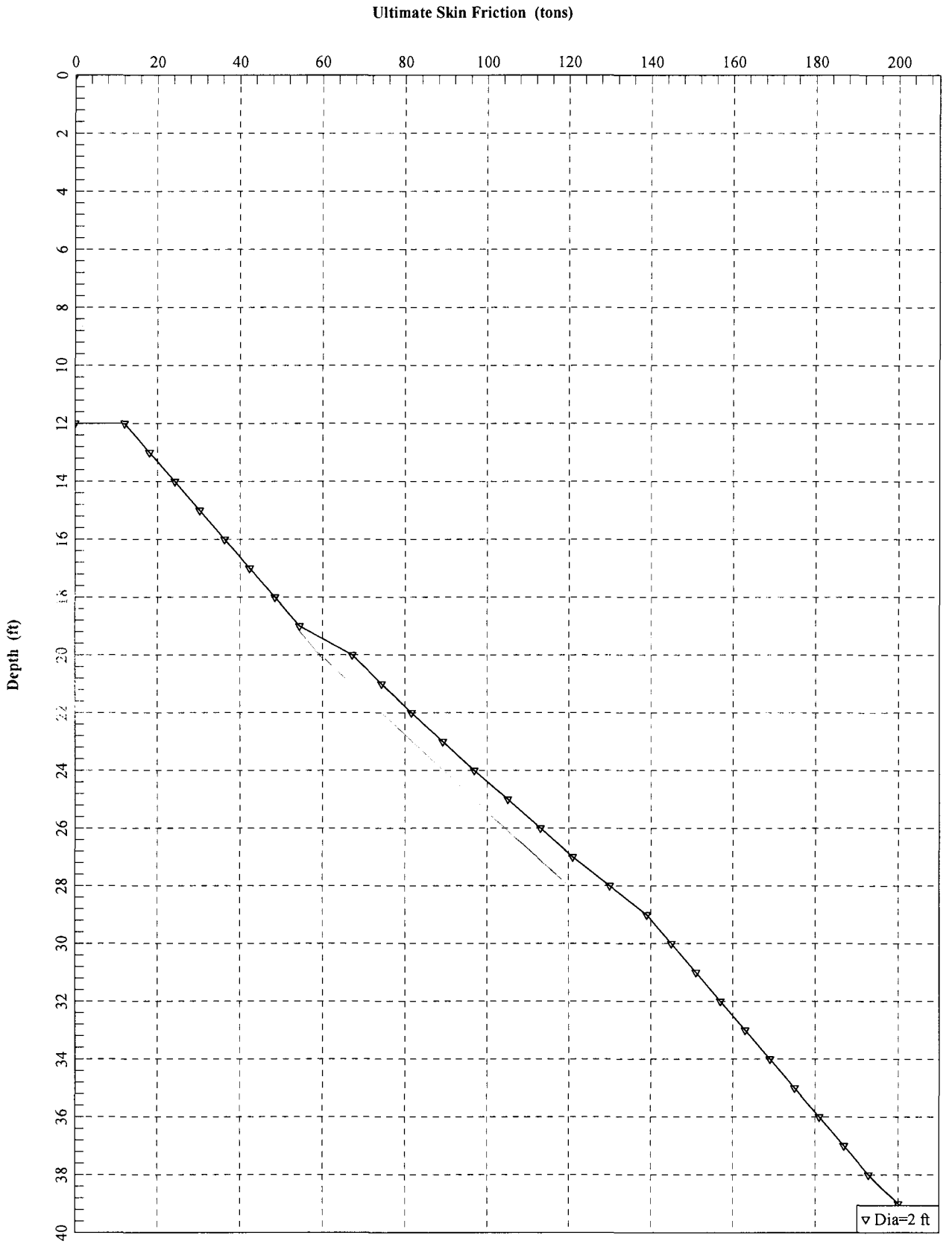
Bent 2 (based on borings AST-154 & AST-155)

84-in CIDH Pile
(Assumed Granular IGM at bottom)

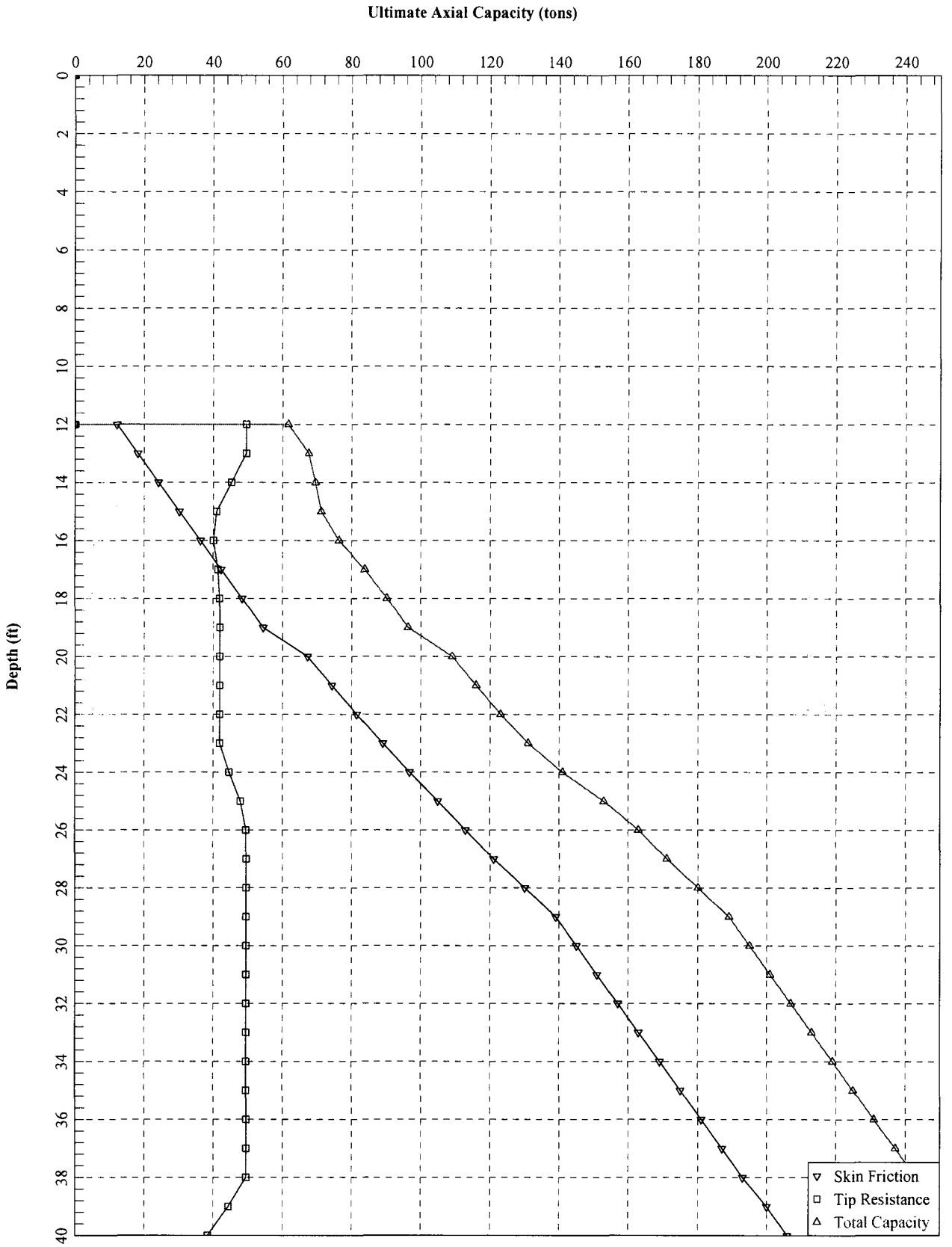
Ground Surface Elevation 44.0 (approx.)
Nominal Compression Load = 3210 kips = 1605 tons
Reqd. Shaft Length per SHAFT output = 62.5 ft
Recommended Penetration = 62.5 feet
Reqd. Tip Elevation = 44.0 –62.50 = -18.5



Abutment 1 - Left & Right Bridges



Lone Tree Way - A Street Undercrossing @ SR4 - Left & Right Bridges - Abutment 1 - 24-in CIDH Pile



Lone Tree Way - A Street Undercrossing @ SR4 - Left & Right Bridges - Abutment 1 - 24-in CIDH Pile

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 5.0 (C) COPYRIGHT ENSOFT,INC. 1989,1995,1998,2001,2003

A Street- SR4 - Abutment 1

PROPOSED DEPTH = 40.0 FT

NUMBER OF LAYERS = 6

WATER TABLE DEPTH = 57.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 2.50

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 3.00

SOIL INFORMATION

LAYER NO 1----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.350E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.350E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
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.	= 0.350E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.400E+04
DEPTH, FT	= 0.170E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.799E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.350E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.139E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.400E+04
DEPTH, FT	= 0.270E+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	= 0.350E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.270E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.350E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.420E+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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.420E+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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 5.0 (C) COPYRIGHT ENSOFT,INC. 1989,1995,1998,2001,2003

A Street- SR4 - Abutment 1

PROPOSED DEPTH = 40.0 FT

NUMBER OF LAYERS = 6

WATER TABLE DEPTH = 57.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 2.50

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 3.00

SOIL INFORMATION

LAYER NO 1----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.350E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.350E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
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.	= 0.350E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03

MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.400E+04
DEPTH, FT	= 0.170E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.799E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.350E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.400E+04
DEPTH, FT	= 0.270E+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	= 0.350E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.270E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.350E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.420E+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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.420E+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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04

DEPTH, FT = 0.570E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.481E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.250E+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 = 0.400E+04
DEPTH, FT = 0.570E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.437E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.250E+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 = 0.400E+04
DEPTH, FT = 0.620E+02

LAYER NO 6----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.640E+04
DEPTH, FT = 0.620E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.640E+04
DEPTH, FT = 0.800E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM = 2.000 FT.
DIAMETER OF BASE = 2.000 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 7.500 FT.
IGNORED BOTTOM PORTION = 2.000 FT.

AREA OF ONE PERCENT STEEL = 4.524 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.

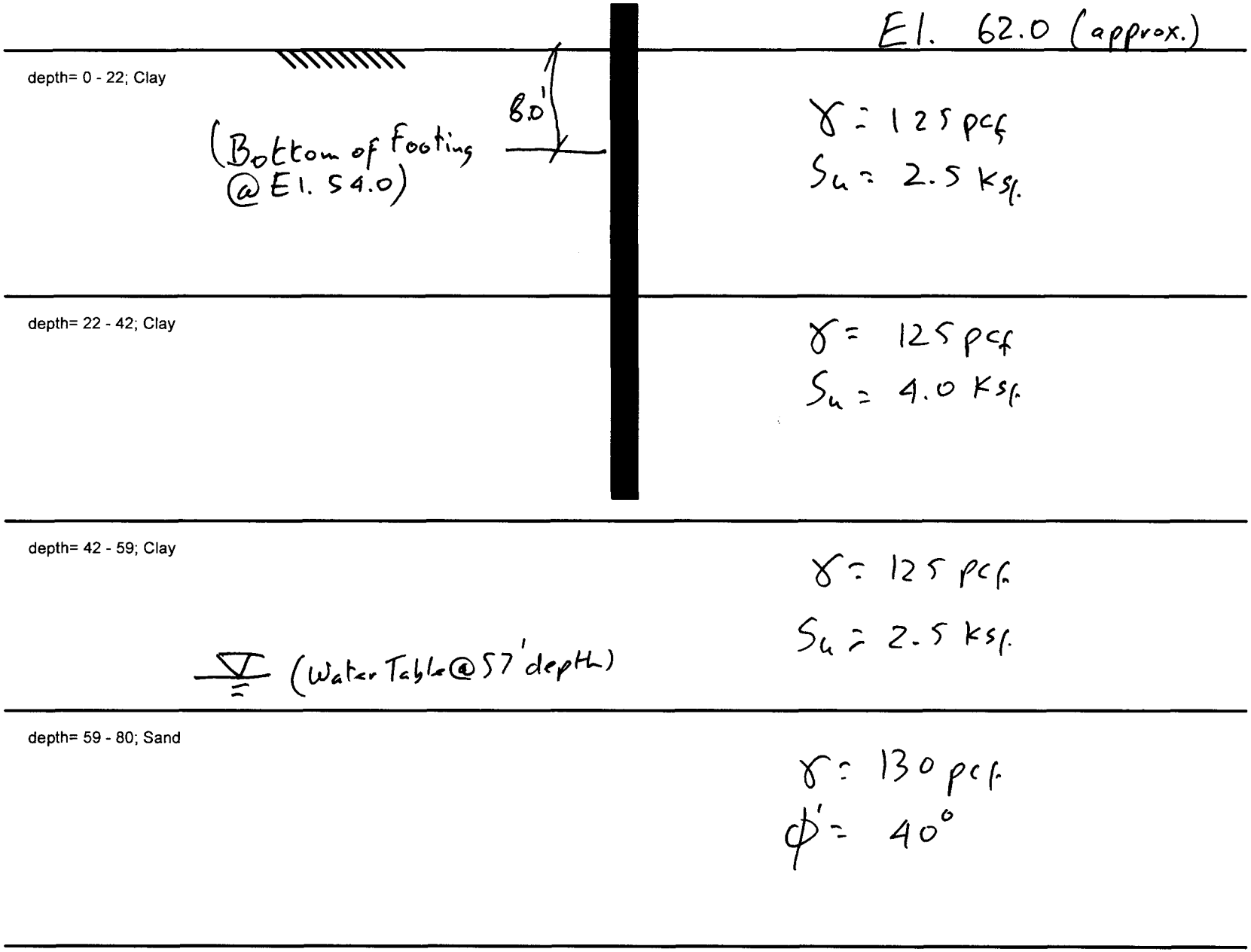
LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
11.0	1.28	6.05	49.49	55.53	22.54	18.91	43.38
12.0	1.40	12.10	49.49	61.58	28.59	21.33	44.10
13.0	1.51	18.15	49.49	67.63	34.64	23.75	44.71
14.0	1.63	24.19	45.28	69.47	39.29	24.77	42.64
15.0	1.75	30.24	40.98	71.22	43.90	25.76	40.80
16.0	1.86	36.29	40.10	76.39	49.66	27.88	41.03
17.0	1.98	42.34	41.45	83.79	56.16	30.75	42.35
18.0	2.09	48.39	41.90	90.29	62.35	33.32	43.10
19.0	2.21	54.44	41.90	96.33	68.40	35.74	43.57
20.0	2.33	67.24	41.90	109.13	81.20	40.86	46.89
21.0	2.44	74.25	41.90	116.14	88.21	43.66	47.53
22.0	2.56	81.50	41.90	123.40	95.47	46.57	48.20
23.0	2.68	89.00	41.90	130.90	102.97	49.57	48.91
24.0	2.79	96.73	44.61	141.34	111.60	53.56	50.61
25.0	2.91	104.68	47.86	152.54	120.63	57.82	52.43
26.0	3.03	112.84	49.49	162.33	129.34	61.63	53.65
27.0	3.14	121.21	49.49	170.69	137.70	64.98	54.33
28.0	3.26	129.77	49.49	179.25	146.26	68.40	55.01
29.0	3.37	138.52	49.49	188.00	155.01	71.90	55.71
30.0	3.49	144.57	49.49	194.05	161.06	74.32	55.58
31.0	3.61	150.62	49.49	200.10	167.11	76.74	55.47
32.0	3.72	156.66	49.49	206.15	173.16	79.16	55.36
33.0	3.84	162.71	49.49	212.20	179.21	81.58	55.26
34.0	3.96	168.76	49.49	218.25	185.26	84.00	55.16
35.0	4.07	174.81	49.49	224.29	191.30	86.42	55.07
36.0	4.19	180.86	49.49	230.34	197.35	88.84	54.98
37.0	4.31	186.91	49.49	236.39	203.40	91.26	54.90
38.0	4.42	192.95	49.49	242.44	209.45	93.68	54.82
39.0	4.54	199.00	44.44	243.44	213.81	94.41	53.64
40.0	4.65	205.05	38.38	243.43	217.84	94.81	52.30

RESULT FROM TREND (AVERAGED) LINE

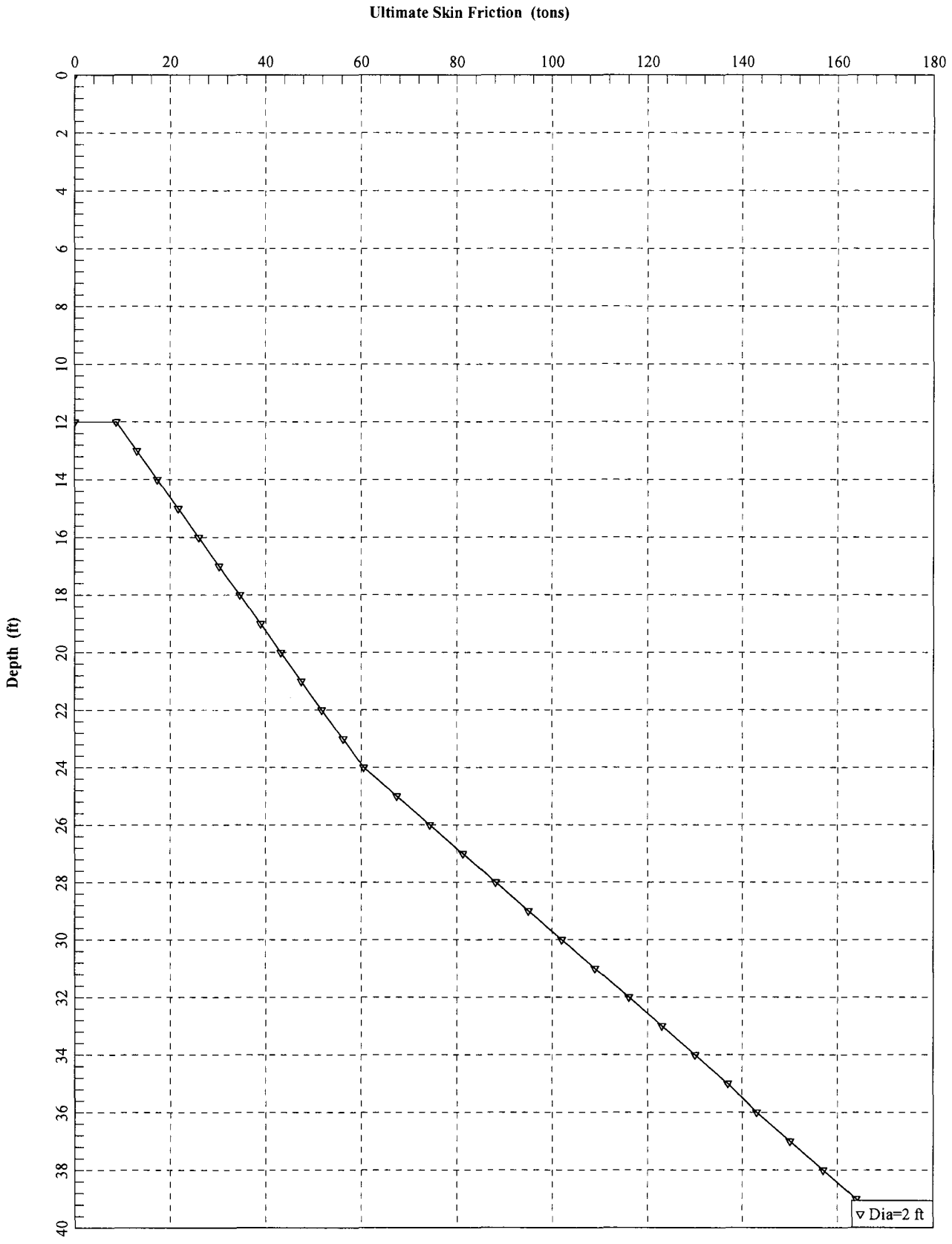
TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.5882E+00	0.2723E-03	0.1263E-01	0.1000E-03
0.5882E+01	0.2723E-02	0.1263E+00	0.1000E-02
0.1481E+02	0.6818E-02	0.3158E+00	0.2500E-02
0.2987E+02	0.1370E-01	0.6316E+00	0.5000E-02
0.4490E+02	0.2058E-01	0.9474E+00	0.7500E-02

A Street - Abut 1.sfo

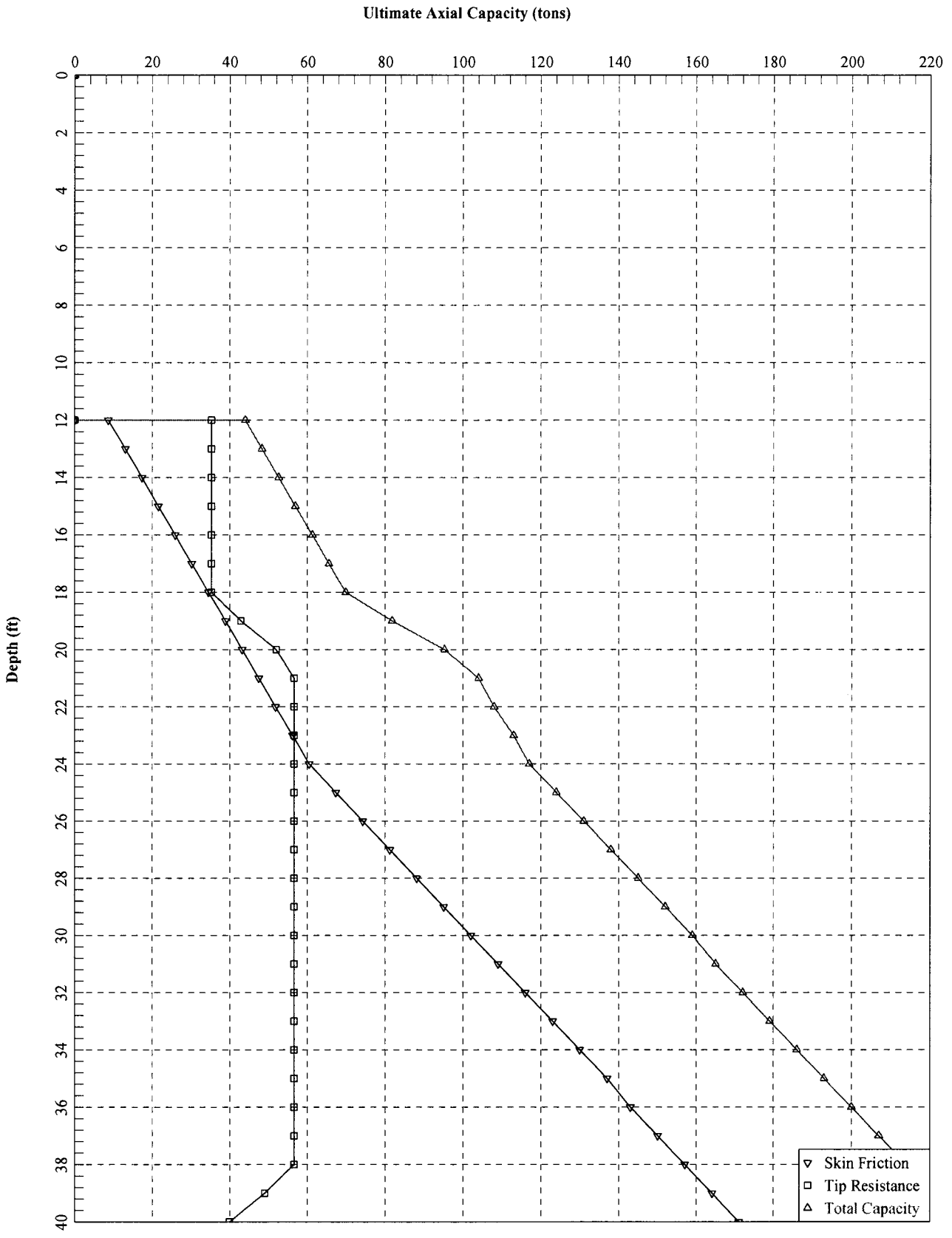
0.5987E+02	0.2746E-01	0.1263E+01	0.1000E-01
0.1228E+03	0.6361E-01	0.3158E+01	0.2500E-01
0.1740E+03	0.1066E+00	0.6316E+01	0.5000E-01
0.1977E+03	0.1418E+00	0.9474E+01	0.7500E-01
0.2085E+03	0.1711E+00	0.1263E+02	0.1000E+00
0.2264E+03	0.3300E+00	0.2194E+02	0.2500E+00
0.2210E+03	0.5804E+00	0.3056E+02	0.5000E+00
0.2251E+03	0.8329E+00	0.3478E+02	0.7500E+00
0.2268E+03	0.1084E+01	0.3659E+02	0.1000E+01
0.2278E+03	0.2485E+01	0.3803E+02	0.2400E+01



Abutment 3 - Left & Right Bridges



Lone Tree Way - A Street Undercrossing @ SR4 - Left & Right Bridges - Abutment 3 - 24-in CIDH Pile



Lone Tree Way - A Street Undercrossing @ SR4 - Left & Right Bridges - Abutment 3 - 24-in CIDH Pile

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 5.0 (C) COPYRIGHT ENSOFT,INC. 1989,1995,1998,2001,2003

A Street- SR4 - Abutment 3

PROPOSED DEPTH = 40.0 FT

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 57.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 2.50

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 3.00

SOIL INFORMATION

LAYER NO 1----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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.000E+00

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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.220E+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	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00

SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.220E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.420E+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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.420E+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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
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.	= 0.400E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.400E+04
DEPTH, FT	= 0.590E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.293E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.400E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.400E+04

DEPTH, FT = 0.800E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	=	2.000	FT.
DIAMETER OF BASE	=	2.000	FT.
END OF STEM TO BASE	=	0.000	FT.
ANGLE OF BELL	=	0.000	DEG.
IGNORED TOP PORTION	=	8.000	FT.
IGNORED BOTTOM PORTION	=	2.000	FT.
AREA OF ONE PERCENT STEEL	=	4.524	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.

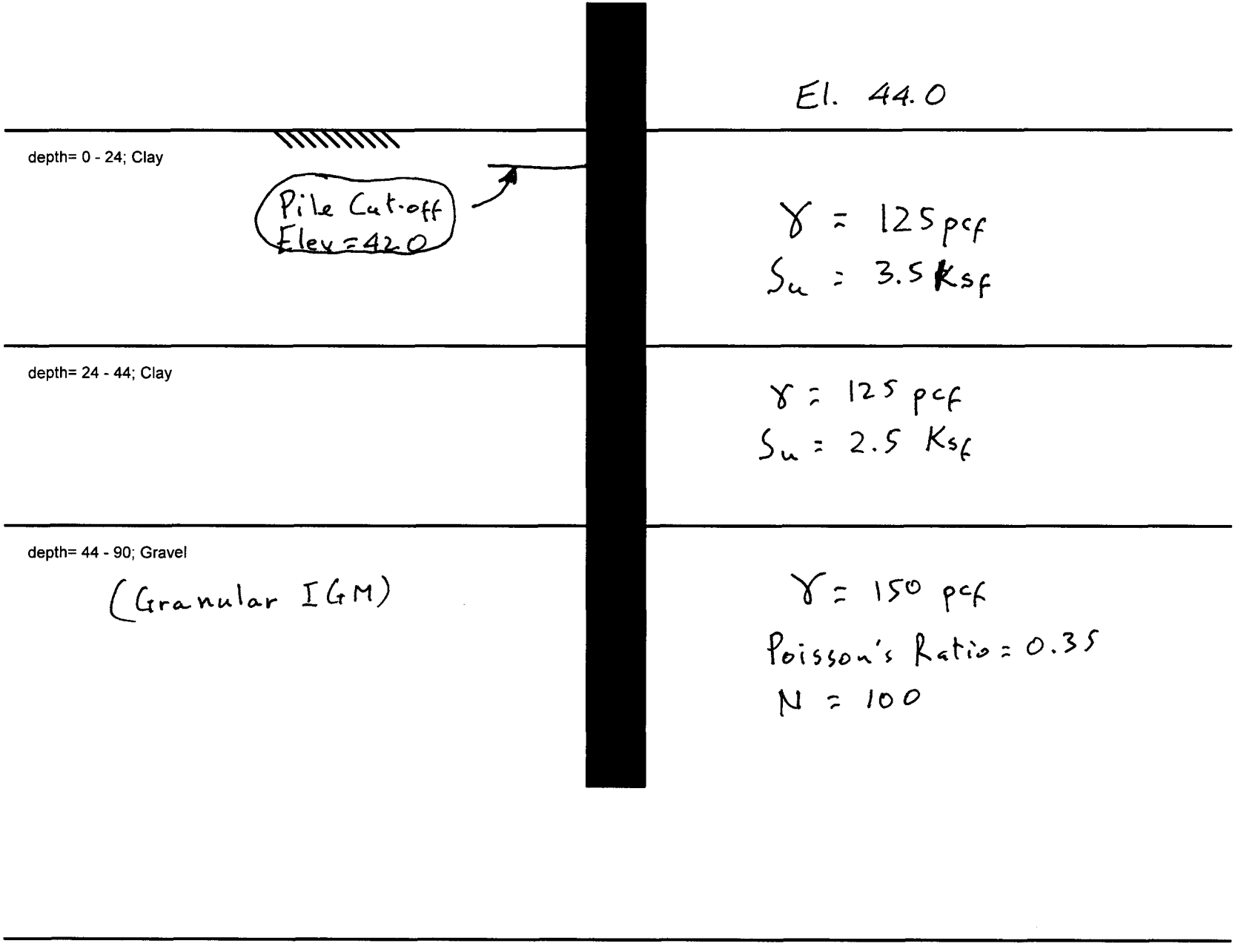
LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
11.0	1.28	4.32	35.35	39.67	16.10	13.51	30.99
12.0	1.40	8.64	35.35	43.99	20.42	15.24	31.50
13.0	1.51	12.96	35.35	48.31	24.74	16.97	31.93
14.0	1.63	17.28	35.35	52.63	29.06	18.69	32.30
15.0	1.75	21.60	35.35	56.95	33.38	20.42	32.63
16.0	1.86	25.92	35.35	61.27	37.70	22.15	32.91
17.0	1.98	30.24	35.35	65.59	42.02	23.88	33.15
18.0	2.09	34.56	35.35	69.91	46.34	25.61	33.38
19.0	2.21	38.88	42.92	81.80	53.19	29.86	37.00
20.0	2.33	43.20	52.01	95.21	60.54	34.62	40.91
21.0	2.44	47.52	56.56	104.08	66.37	37.86	42.59
22.0	2.56	51.84	56.56	108.40	70.70	39.59	42.34
23.0	2.68	56.16	56.56	112.72	75.02	41.32	42.11
24.0	2.79	60.48	56.56	117.04	79.34	43.05	41.91
25.0	2.91	67.40	56.56	123.95	86.25	45.81	42.61
26.0	3.03	74.31	56.56	130.86	93.16	48.58	43.25
27.0	3.14	81.22	56.56	137.78	100.07	51.34	43.85
28.0	3.26	88.13	56.56	144.69	106.99	54.11	44.41
29.0	3.37	95.05	56.56	151.60	113.90	56.87	44.92
30.0	3.49	101.96	56.56	158.51	120.81	59.64	45.41
31.0	3.61	108.87	56.56	165.43	127.72	62.40	45.86
32.0	3.72	115.78	56.56	172.34	134.63	65.17	46.28
33.0	3.84	122.70	56.56	179.25	141.55	67.93	46.68
34.0	3.96	129.61	56.56	186.16	148.46	70.70	47.05
35.0	4.07	136.52	56.56	193.08	155.37	73.46	47.40
36.0	4.19	143.43	56.56	199.99	162.28	76.22	47.74
37.0	4.31	150.34	56.56	206.90	169.20	78.99	48.05
38.0	4.42	157.26	56.56	213.81	176.11	81.75	48.35

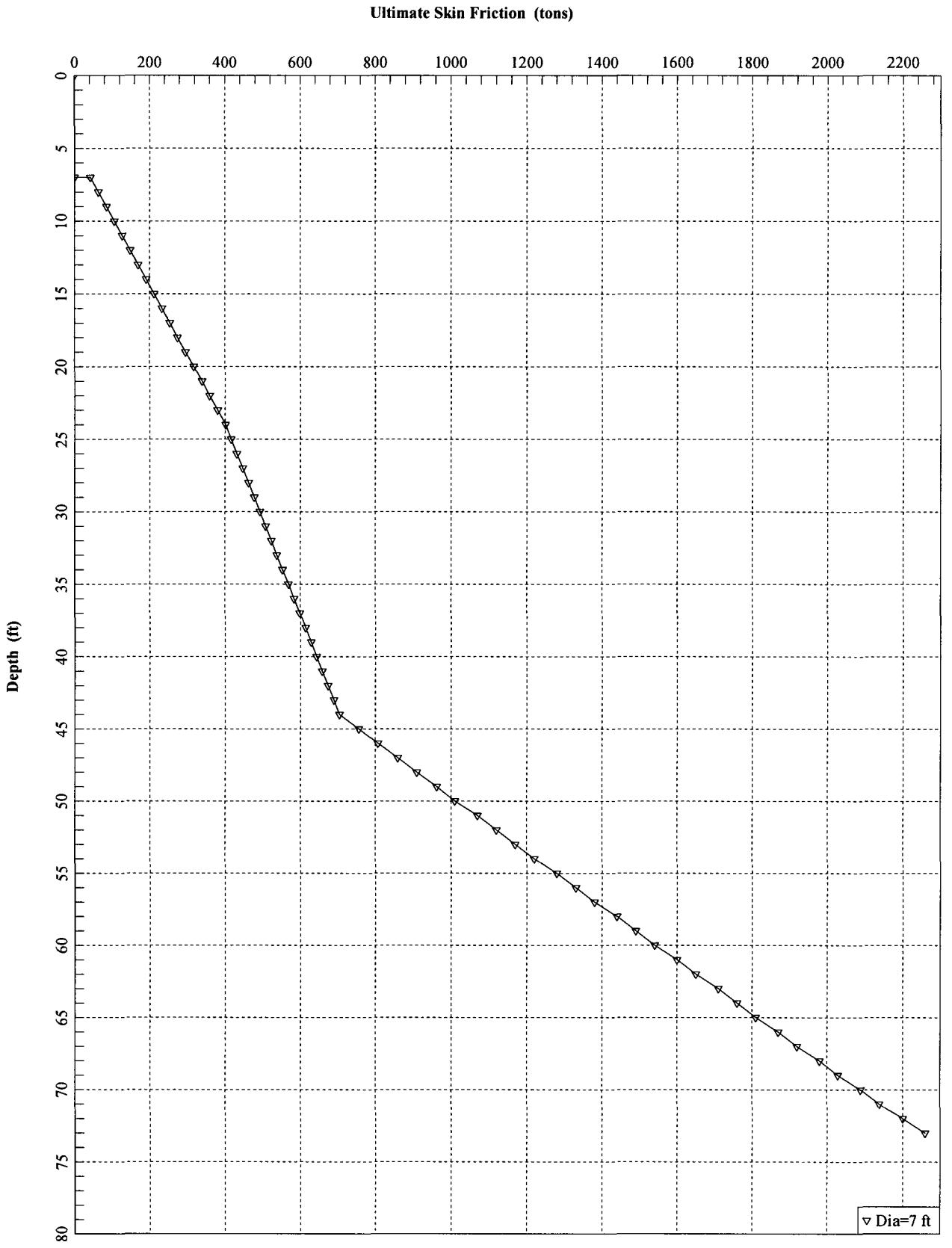
39.0	4.54	164.17	48.98	213.15	180.50	81.99	46.97
40.0	4.65	171.08	39.89	210.97	184.38	81.73	45.32

RESULT FROM TREND (AVERAGED) LINE

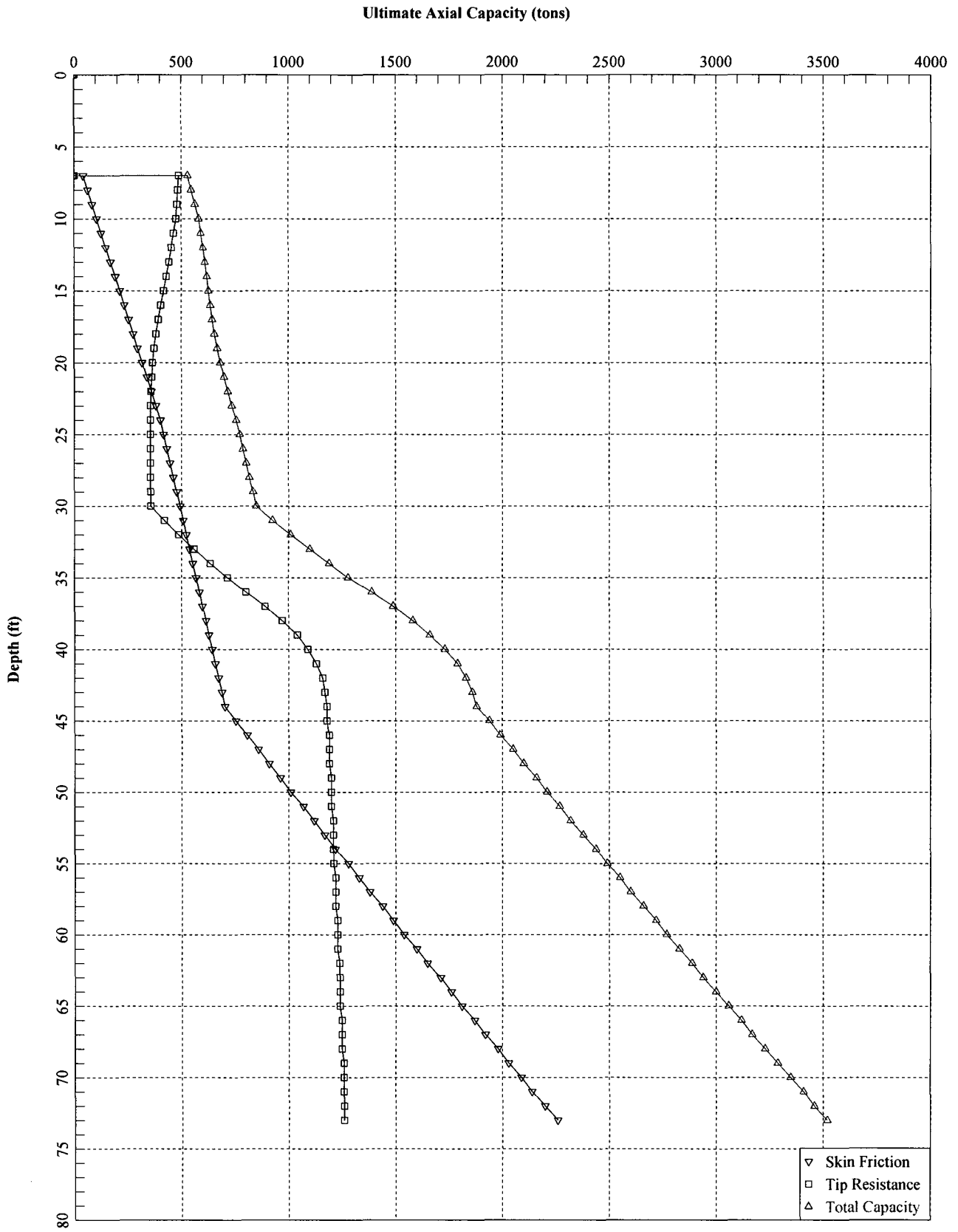
TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.5114E+00	0.2626E-03	0.5818E-02	0.1000E-03
0.5114E+01	0.2626E-02	0.5818E-01	0.1000E-02
0.1284E+02	0.6570E-02	0.1454E+00	0.2500E-02
0.2590E+02	0.1319E-01	0.2909E+00	0.5000E-02
0.3895E+02	0.1983E-01	0.4363E+00	0.7500E-02
0.5198E+02	0.2646E-01	0.5818E+00	0.1000E-01
0.1068E+03	0.6113E-01	0.1454E+01	0.2500E-01
0.1472E+03	0.1009E+00	0.2909E+01	0.5000E-01
0.1664E+03	0.1345E+00	0.4363E+01	0.7500E-01
0.1704E+03	0.1612E+00	0.5818E+01	0.1000E+00
0.1803E+03	0.3170E+00	0.1423E+02	0.2500E+00
0.1718E+03	0.5660E+00	0.2295E+02	0.5000E+00
0.1787E+03	0.8201E+00	0.2987E+02	0.7500E+00
0.1848E+03	0.1074E+01	0.3600E+02	0.1000E+01
0.2071E+03	0.2487E+01	0.5824E+02	0.2400E+01

Bent 2 - Left and Right Bridges
Granular IGM Bottom





Lone Tree Way - A Street UC @ SR4 - Left and Right Gridges - Bent 2 - 84-in. CIDH PIle - Granular IGM Bottom



Lone Tree Way - A Street UC @ SR4 - Left and Right Bridges - Bent 2 - 84-in. CIDH PIle - Granular IGM Bottom

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VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 5.0 (C) COPYRIGHT ENSOFT,INC. 1989,1995,1998,2001,2003

A Street Undercrossing - SR4 - Bent 2 - Granular Rock Bottom -7FT cidh

PROPOSED DEPTH =      73.0 FT
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NUMBER OF LAYERS =    3
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WATER TABLE DEPTH =      38.0 FT.
--------------------

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 2.50
--------------------------------------------------------
FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 3.00
--------------------------------------------------------

SOIL INFORMATION
----------------

LAYER NO 1----CLAY

  AT THE TOP

  STRENGTH REDUCTION FACTOR-ALPHA                    = 0.550E+00
  END BEARING COEFFICIENT-Nc                         = 0.900E+01
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                 = 0.350E+04
  INTERNAL FRICTION ANGLE, DEG.                      = 0.000E+00
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                         = 0.125E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.640E+04
  DEPTH, FT                                          = 0.000E+00

  AT THE BOTTOM

  STRENGTH REDUCTION FACTOR-ALPHA                    = 0.550E+00
  END BEARING COEFFICIENT-Nc                         = 0.900E+01
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                 = 0.350E+04
  INTERNAL FRICTION ANGLE, DEG.                      = 0.000E+00
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                         = 0.125E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.640E+04
  DEPTH, FT                                          = 0.240E+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                 = 0.250E+04
  INTERNAL FRICTION ANGLE, DEG.                      = 0.000E+00
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.000E+00
```

A Street Undercrossings - Bent 2 Granular Rock Bottom - 7FT cidh.sfo

```
  SOIL UNIT WEIGHT, LB/CU FT                         = 0.125E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.640E+04
  DEPTH, FT                                          = 0.240E+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                         = 0.125E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.640E+04
  DEPTH, FT                                          = 0.440E+02

LAYER NO  3----GRAVEL

  AT THE TOP

  ELASTIC MODULUS OF GRAVEL, LB/SQ IN                = 0.000E+00
  POISSION RATIO OF GRAVEL                           = 0.350E+00
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.100E+03
  SOIL UNIT WEIGHT, LB/CU FT                         = 0.150E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.100E+11
  DEPTH, FT                                          = 0.440E+02

  AT THE BOTTOM

  ELASTIC MODULUS OF GRAVEL, LB/SQ IN                = 0.000E+00
  POISSION RATIO OF GRAVEL                           = 0.350E+00
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.100E+03
  SOIL UNIT WEIGHT, LB/CU FT                         = 0.150E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.100E+11
  DEPTH, FT                                          = 0.900E+02

DRILLED SHAFT INFORMATION
-------------------------

 DIAMETER OF STEM          =    7.000  FT.
 DIAMETER OF BASE          =    7.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    5.000  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   55.425  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;
```

A Street Undercrossings - Bent 2 Granular Rock Bottom - 7FT cidh.sfo

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)
6.0	8.55	21.17	492.68	513.85	185.40	172.69	60.08
7.0	9.98	42.34	488.67	531.01	205.23	179.83	53.21
8.0	11.40	63.51	484.73	548.24	225.09	186.98	48.07
9.0	12.83	84.68	480.85	565.53	244.96	194.16	44.08
10.0	14.26	105.85	477.04	582.88	264.86	201.35	40.89
11.0	15.68	127.02	465.76	592.78	282.27	206.06	37.80
12.0	17.11	148.18	454.08	602.26	299.54	210.63	35.21
13.0	18.53	169.35	442.14	611.49	316.73	215.12	33.00
14.0	19.96	190.52	430.03	620.56	333.87	219.55	31.09
15.0	21.38	211.69	417.77	629.46	350.95	223.93	29.44
16.0	22.81	232.86	405.37	638.23	367.98	228.27	27.98
17.0	24.23	254.03	392.83	646.86	384.98	232.56	26.69
18.0	25.66	275.20	382.19	657.39	402.60	237.48	25.62
19.0	27.09	296.37	373.43	669.80	420.85	243.02	24.73
20.0	28.51	317.54	366.52	684.06	439.71	249.19	23.99
21.0	29.94	338.71	361.41	700.12	459.18	255.95	23.39
22.0	31.36	359.88	358.03	717.91	479.22	263.29	22.89
23.0	32.79	381.05	356.33	737.37	499.82	271.19	22.49
24.0	34.21	402.22	356.25	758.46	520.97	279.64	22.17
25.0	35.64	417.34	356.23	773.57	536.08	285.68	21.71
26.0	37.06	432.46	356.23	788.69	551.20	291.73	21.28
27.0	38.49	447.58	356.23	803.81	566.32	297.78	20.88
28.0	39.92	462.70	356.23	818.93	581.44	303.82	20.52
29.0	41.34	477.82	356.23	834.05	596.56	309.87	20.18
30.0	42.77	492.94	356.23	849.17	611.69	315.92	19.86
31.0	44.19	508.06	419.18	927.25	647.79	342.95	20.98
32.0	45.62	523.18	486.64	1009.82	685.39	371.48	22.14
33.0	47.04	538.30	558.61	1096.91	724.50	401.52	23.32
34.0	48.47	553.42	635.11	1188.53	765.13	433.07	24.52
35.0	49.89	568.54	716.16	1284.71	807.27	466.14	25.75
36.0	51.32	583.67	801.78	1385.44	850.93	500.73	27.00
37.0	52.74	598.79	891.98	1490.76	896.11	536.84	28.26
38.0	54.17	613.91	969.99	1583.89	937.24	568.89	29.24
39.0	55.60	629.03	1035.74	1664.77	974.28	596.86	29.94
40.0	57.02	644.15	1089.17	1733.32	1007.21	620.72	30.40
41.0	58.45	659.27	1130.22	1789.49	1036.01	640.45	30.62
42.0	59.87	674.39	1158.82	1833.21	1060.67	656.03	30.62
43.0	61.30	689.51	1174.92	1864.43	1081.15	667.44	30.42
44.0	62.72	704.63	1178.44	1883.07	1097.44	674.66	30.02
45.0	64.15	755.75	1181.91	1937.67	1149.72	696.27	30.21
46.0	65.57	807.05	1185.35	1992.41	1202.17	717.94	30.38
47.0	67.00	858.54	1188.75	2047.29	1254.79	739.66	30.56
48.0	68.43	910.19	1192.11	2102.30	1307.56	761.45	30.72
49.0	69.85	962.03	1195.43	2157.46	1360.51	783.29	30.89
50.0	71.28	1014.04	1198.72	2212.76	1413.61	805.19	31.04
51.0	72.70	1066.23	1201.97	2268.19	1466.88	827.15	31.20
52.0	74.13	1118.58	1205.18	2323.77	1520.31	849.16	31.35
53.0	75.55	1171.11	1208.37	2379.47	1573.90	871.23	31.49
54.0	76.98	1223.81	1211.51	2435.32	1627.64	893.36	31.64
55.0	78.40	1276.67	1214.63	2491.30	1681.55	915.54	31.77
56.0	79.83	1329.70	1217.71	2547.42	1735.61	937.79	31.91
57.0	81.26	1382.90	1220.77	2603.67	1789.82	960.08	32.04
58.0	82.68	1436.27	1223.79	2660.05	1844.20	982.44	32.17
59.0	84.11	1489.79	1226.78	2716.57	1898.72	1004.84	32.30
60.0	85.53	1543.48	1229.75	2773.23	1953.40	1027.31	32.42
61.0	86.96	1597.33	1232.68	2830.01	2008.23	1049.83	32.54

A Street Undercrossings - Bent 2 Granular Rock Bottom - 7FT cidh.sfo

62.0	88.38	1651.34	1235.59	2886.93	2063.21	1072.40	32.66
63.0	89.81	1705.51	1238.47	2943.98	2118.34	1095.03	32.78
64.0	91.23	1759.84	1241.32	3001.17	2173.62	1117.71	32.90
65.0	92.66	1814.33	1244.15	3058.48	2229.04	1140.45	33.01
66.0	94.09	1868.97	1246.96	3115.92	2284.62	1163.24	33.12
67.0	95.51	1923.77	1249.73	3173.50	2340.35	1186.08	33.23
68.0	96.94	1978.72	1252.49	3231.21	2396.22	1208.98	33.33
69.0	98.36	2033.83	1255.22	3289.04	2452.23	1231.94	33.44
70.0	99.79	2089.08	1257.92	3347.01	2508.39	1254.94	33.54
71.0	101.21	2144.50	1260.60	3405.10	2564.70	1278.00	33.64
72.0	102.64	2200.06	1263.26	3463.32	2621.15	1301.11	33.74
73.0	104.06	2255.77	1261.54	3517.31	2676.28	1322.82	33.80

LOAD SETTLEMENT RELATIONSHIP

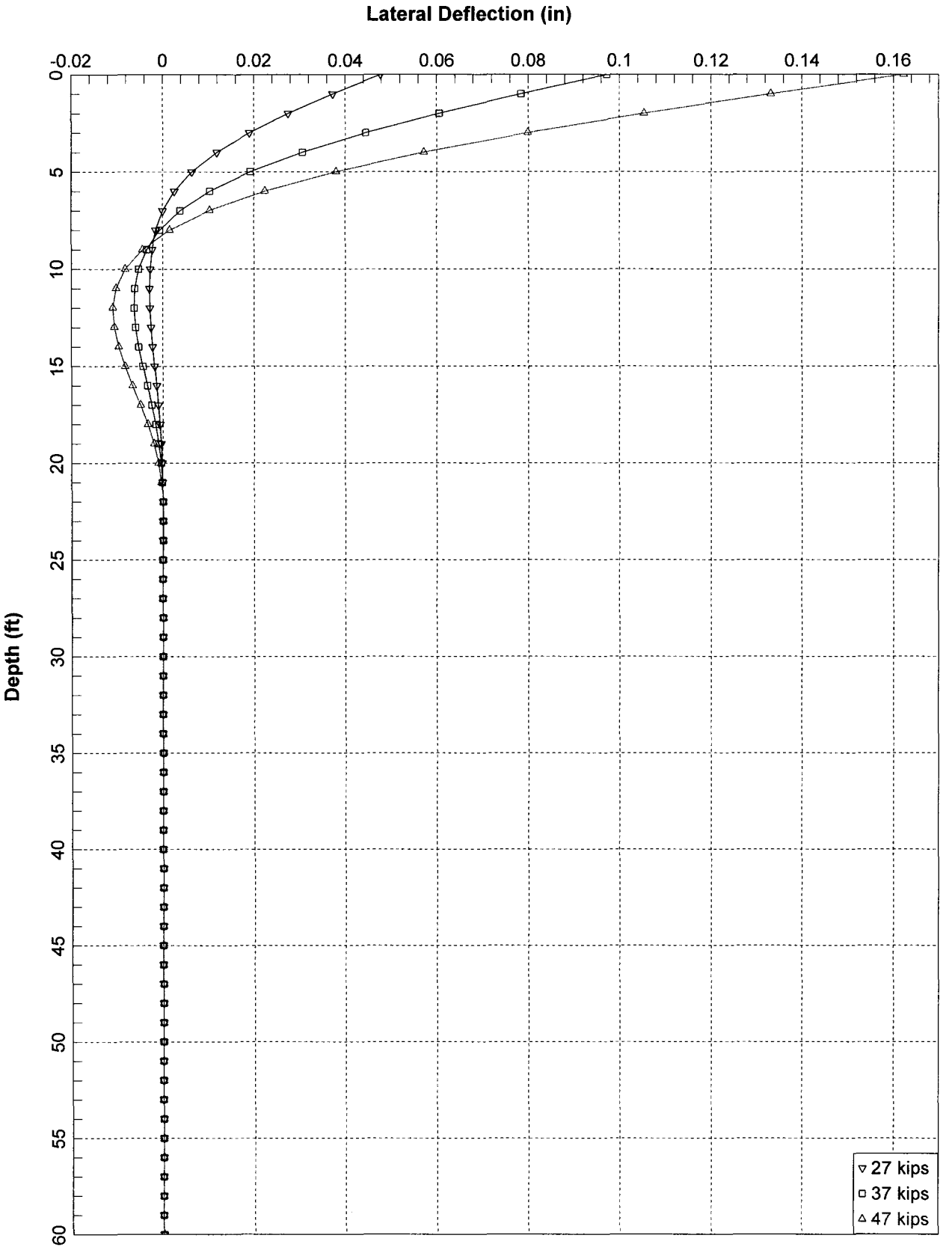
LOAD (TON)	SETTLEMENT (IN.)
0.238E+03	0.473E-01
0.476E+03	0.945E-01
0.714E+03	0.142E+00
0.952E+03	0.189E+00
0.119E+04	0.236E+00
0.143E+04	0.284E+00
0.167E+04	0.331E+00
0.190E+04	0.378E+00
0.214E+04	0.425E+00
0.238E+04	0.473E+00
0.265E+04	0.145E+01
0.293E+04	0.242E+01
0.320E+04	0.340E+01
0.348E+04	0.437E+01
0.348E+04	0.525E+01

PILE LATERAL LOAD BEHAVIOR
(LPILE Program)

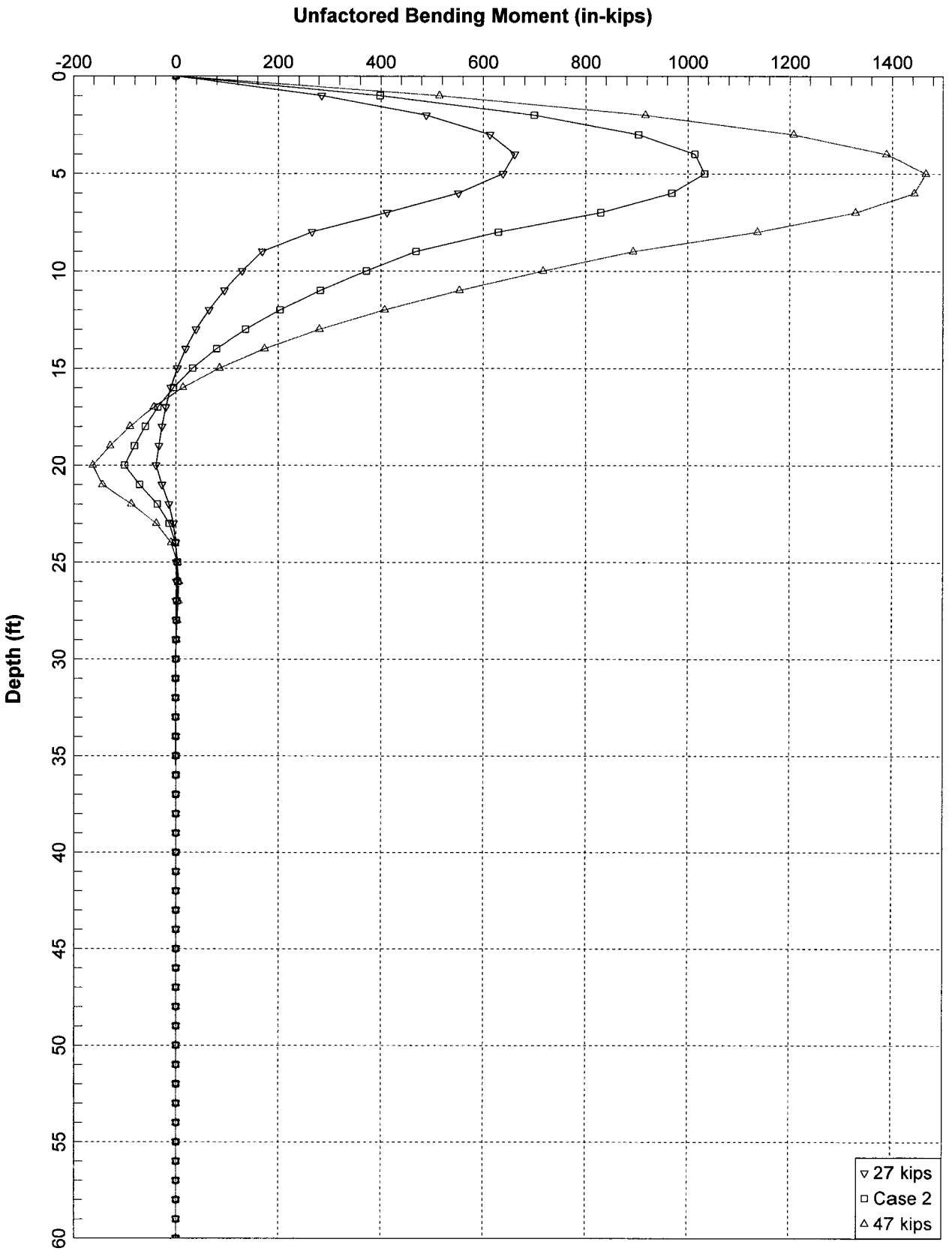
Abutment 1 - Left & Right Bridges
Profile based on boring AST-154
24-in. Diameter CIDH Pile
Area = 452.4 in^2 ; I = 16286 in^4

El. - 62.0

Depths -90 - 114 = Stiff Clay w/o free water	S_u = 3.5 ksf γ' = 125 pcf ϵ_{50} = 0.005
Depths 114 - 234 = API RP-2A Sand	ϕ' = 35° γ' = 130 pcf K = 90 lb/in.^{3}
Depths 234 - 414 = Stiff Clay w/o free water	S_u = 3.5 ksf γ' = 125 pcf ϵ_{50} = 0.005
Depths 414 - 594 = Stiff Clay w/o free water	S_u = 2.5 ksf γ' = 125 pcf ϵ_{50} = 0.005
Depths 594 - 654 = API RP-2A Sand	ϕ' = 25° γ' = 65 pcf K = 125 lb/in^3
Depths 654 - 990 = Stiff Clay w/o free water	S_u = 4.0 ksf γ' = 65 pcf ϵ_{50} = 0.004



Lone Tree Way - A Street UC @ SR4 - Left and Right Bridges - Abutment 1 - 24-in CIDH Pile



Lone Tree Way - A Street UC @ SR4 - Left & Right Bridges - Abutment 1 - 24-in. CIDH Pile

LPILE Plus for Windows, Version 5.0 (5.0.21)

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:

Gary Parikh
Parikh Consultants

Path to file locations: S:\Ongoing Projects\2006\206117 TYLIn Rte 4 Project\A St_Lone Tree\LPILE\
Name of input data file: A Street - Abutment 1.lpd
Name of output file: A Street - Abutment 1.lpo
Name of plot output file: A Street - Abutment 1.lpp
Name of runtime file: A Street - Abutment 1.lpr

Time and Date of Analysis

Date: August 23, 2009 Time: 18:23: 2

Problem Title

SR4 - A Street - Abutment 1 - 24-in CIDH Pile

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant 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 pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 60
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 720.00 in
Depth of ground surface below top of pile = -90.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	24.00000000	16286.0000	452.4000	3600000.
2	720.0000	24.00000000	16286.0000	452.4000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 6 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -90.000 in
Distance from top of pile to bottom of layer = 114.000 in

Layer 2 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 114.000 in
Distance from top of pile to bottom of layer = 234.000 in
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 3 is stiff clay without free water
Distance from top of pile to top of layer = 234.000 in
Distance from top of pile to bottom of layer = 414.000 in

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 414.000 in
Distance from top of pile to bottom of layer = 594.000 in

Layer 5 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 594.000 in
Distance from top of pile to bottom of layer = 654.000 in
p-y subgrade modulus k for top of soil layer = 125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 125.000 lbs/in**3

Layer 6 is stiff clay without free water
Distance from top of pile to top of layer = 654.000 in
Distance from top of pile to bottom of layer = 990.000 in

(Depth of lowest layer extends 270.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth is defined using 12 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-90.00	.07230
2	114.00	.07230
3	114.00	.07520
4	234.00	.07520
5	234.00	.07230
6	414.00	.07230
7	414.00	.07230
8	594.00	.07230
9	594.00	.03760
10	654.00	.03760
11	654.00	.03760
12	990.00	.03760

Shear Strength of Soils

Distribution of shear strength parameters with depth defined using 12 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-90.000	24.30000	.00	.00500	.0
2	114.000	24.30000	.00	.00500	.0
3	114.000	.00000	35.00	------	------
4	234.000	.00000	35.00	------	------
5	234.000	24.31000	.00	.00500	.0
6	414.000	24.31000	.00	.00500	.0
7	414.000	17.36000	.00	.00500	.0
8	594.000	17.36000	.00	.00500	.0
9	594.000	.00000	25.00	------	------
10	654.000	.00000	25.00	------	------
11	654.000	27.78000	.00	.00400	.0
12	990.000	27.78000	.00	.00400	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.6000	1.0000
2	720.000	.6000	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 3

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 27000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 37000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 47000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 27000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 200000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.047823	2.2601E-08	27000.0000	-.0008734	442.0866	-568.6070
12.000	.037342	285156.	20203.1240	-.0008442	652.1983	-564.2057
24.000	.027562	488927.	13514.9787	-.0007650	802.3425	-550.4852
36.000	.018982	613188.	7052.6786	-.0006522	893.9014	-526.5648
48.000	.011909	661322.	947.5436	-.0005218	929.3681	-490.9577
60.000	.006459	638434.	-4641.1992	-.0003888	912.5031	-440.4994
72.000	.002578	551799.	-9476.4157	-.0002670	848.6686	-365.3700
84.000	5.20E-05	412281.	-11939.4974	-.0001683	745.8674	-45.1436
96.000	-.001461	266059.	-10149.9383	-9.8886E-05	638.1270	343.4035
108.000	-.002321	169157.	-5687.2935	-5.4347E-05	566.7266	400.3707
120.000	-.002766	129825.	-3100.6471	-2.3750E-05	537.7457	30.7371
132.000	-.002891	94855.6618	-2712.1879	-7.5689E-07	511.9791	34.0061
144.000	-.002784	64736.3678	-2300.8700	1.5575E-05	489.7863	34.5468
156.000	-.002517	39560.0190	-1896.3558	2.6249E-05	471.2356	32.8722
168.000	-.002154	19097.8347	-1521.9990	3.2252E-05	456.1585	29.5206
180.000	-.001743	2877.2355	-1194.7283	3.4501E-05	444.2067	25.0245
192.000	-.001326	-9741.2479	-925.2389	3.3798E-05	449.2643	19.8904
204.000	-.000932	-19490.7278	-718.3589	3.0807E-05	456.4480	14.5896
216.000	-.000587	-27129.7336	-573.4685	2.6036E-05	462.0766	9.5588
228.000	-.000307	-33378.9424	-484.8608	1.9843E-05	466.6812	5.2091
240.000	-.000110	-38861.6403	270.1781	1.2450E-05	470.7210	120.6307
252.000	-8.59E-06	-26954.4300	1050.3500	5.7149E-06	461.9475	9.3980
264.000	2.69E-05	-13680.6725	930.2639	1.5564E-06	452.1670	-29.4123
276.000	2.88E-05	-4635.5674	565.0018	-3.1805E-07	445.5023	-31.4647
288.000	1.93E-05	-119.1026	249.8414	-8.0463E-07	442.1744	-21.0620
300.000	9.45E-06	1364.4882	61.4331	-6.7718E-07	443.0920	-10.3394
312.000	3.00E-06	1358.5421	-20.3001	-3.9851E-07	443.0877	-3.2828
324.000	-1.13E-07	879.1994	-39.2563	-1.6951E-07	442.7345	.1234721
336.000	-1.07E-06	417.2049	-31.5104	-3.6836E-08	442.3941	1.1675
348.000	-9.97E-07	123.1270	-17.9618	1.8461E-08	442.1774	1.0906
360.000	-6.24E-07	-13.9672	-7.3213	2.9632E-08	442.0969	.6828334
372.000	-2.86E-07	-52.7266	-1.3486	2.2806E-08	442.1255	.3126106
384.000	-7.68E-08	-46.4441	1.0314	1.2658E-08	442.1209	.0840561
396.000	1.80E-08	-28.0348	1.4174	5.0355E-09	442.1073	-.0197101
408.000	4.40E-08	-12.4499	1.0103	8.9244E-10	442.0958	-.0481510
420.000	3.94E-08	-3.7927	.5365161	-7.6978E-10	442.0894	-.0308074
432.000	2.55E-08	.4301667	.2319559	-1.1139E-09	442.0870	-.0199526
444.000	1.27E-08	1.7796	.0527004	-8.8775E-10	442.0880	-.0099233
456.000	4.24E-09	1.6992	-.0266900	-5.3173E-10	442.0879	-.0033084
468.000	-5.89E-11	1.1416	-.0462644	-2.4101E-10	442.0875	4.6042E-05
480.000	-1.55E-09	.5900478	-.0387274	-6.3793E-11	442.0871	.0012101
492.000	-1.59E-09	.2124565	-.0240141	1.8333E-11	442.0868	.0012421
504.000	-1.11E-09	.0136212	-.0113632	4.1469E-11	442.0867	.0008664
516.000	-5.95E-10	-.0604585	-.0033772	3.6676E-11	442.0867	.0004646
528.000	-2.29E-10	-.0676080	.0004829	2.3570E-11	442.0867	.0001788
540.000	-2.90E-11	-.0489812	.0016916	1.1639E-11	442.0867	2.2677E-05
552.000	5.05E-11	-.0270648	.0015911	3.8563E-12	442.0867	-3.9438E-05
564.000	6.35E-11	-.0108143	.0010567	-2.0172E-14	442.0867	-4.9624E-05
576.000	5.00E-11	-.0017044	.0005246	-1.3013E-12	442.0867	-3.9060E-05
588.000	3.23E-11	.0017817	.0001389	-1.2934E-12	442.0867	-2.5226E-05
600.000	1.90E-11	.0016344	-1.6435E-05	-9.4380E-13	442.0867	-6.5568E-07
612.000	9.64E-12	.0013918	-2.2422E-05	-6.3411E-13	442.0867	-3.4209E-07
624.000	3.74E-12	.0010993	-2.5291E-05	-3.7918E-13	442.0866	-1.3609E-07
636.000	5.40E-13	.0007866	-2.6228E-05	-1.8618E-13	442.0866	-2.0138E-08
648.000	-7.28E-13	.0004707	-2.6183E-05	-5.7512E-14	442.0866	2.7800E-08
660.000	-8.40E-13	.0001585	-1.9352E-05	6.8796E-15	442.0866	1.1105E-06
672.000	-5.63E-13	6.1957E-06	-8.2246E-06	2.3736E-14	442.0866	7.4410E-07
684.000	-2.70E-13	-3.8982E-05	-1.6147E-06	2.0381E-14	442.0866	3.5754E-07
696.000	-7.38E-14	-3.2655E-05	1.1158E-06	1.3050E-14	442.0866	9.7540E-08
708.000	4.27E-14	-1.2267E-05	1.3623E-06	8.4526E-15	442.0866	-5.6446E-08

720.000	1.29E-13	0.0000	0.0000	7.1973E-15	442.0866	-1.7061E-07

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection              =      .04782304 in
Computed slope at pile head       =     -.00087340
Maximum bending moment            =   661322.16260 lbs-in
Maximum shear force               =    27000.00000 lbs
Depth of maximum bending moment   =    48.00000000 in
Depth of maximum shear force      =        0.00000 in
Number of iterations              =             18
Number of zero deflection points  =              8
```

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

```
Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head  =       37000.000 lbs
Specified moment at pile head       =            .000 in-lbs
Specified axial load at pile head   =      200000.000 lbs
```

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.097287	-2.8252E-08	37000.0000	-.0015679	442.0866	-679.0408
12.000	.078471	398872.	28850.1157	-.0015271	735.9873	-679.2732
24.000	.060635	699733.	20752.1135	-.0014147	957.6703	-670.3938
36.000	.044518	903713.	12820.1587	-.0012506	1107.9691	-651.5987
48.000	.030621	1013420.	5180.4958	-.0010544	1188.8039	-621.6785
60.000	.019212	1033107.	-2020.4275	-.0008450	1203.3097	-578.4754
72.000	.010341	968985.	-8593.8201	-.0006401	1156.0633	-517.0900
84.000	.003850	829927.	-14221.8192	-.0004560	1053.6013	-420.9098
96.000	-.000602	629850.	-15102.4460	-.0003066	906.1789	274.1387
108.000	-.003508	468940.	-10795.9745	-.0001942	787.6155	443.6066
120.000	-.005262	371679.	-7783.4464	-.0001081	715.9506	58.4815
132.000	-.006103	282657.	-7001.8569	-4.1167E-05	650.3563	71.7834
144.000	-.006250	203832.	-6105.7892	8.6191E-06	592.2761	77.5612
156.000	-.005896	136076.	-5178.4652	4.3404E-05	542.3516	76.9928
168.000	-.005209	79340.5748	-4288.1950	6.5450E-05	500.5471	71.3855
180.000	-.004326	32845.4279	-3487.3450	7.6930E-05	466.2881	62.0895
192.000	-.003362	-4724.9725	-2812.1760	7.9808E-05	445.5681	50.4387
204.000	-.002410	-35029.8748	-2283.2195	7.5740E-05	467.8977	37.7207
216.000	-.001544	-59885.7915	-1905.8692	6.6026E-05	486.2122	25.1710
228.000	-.000826	-81087.6632	-1670.8933	5.1600E-05	501.8344	13.9916
240.000	-.000306	-100235.	421.8912	3.3043E-05	515.9427	334.8058
252.000	-3.26E-05	-71120.8822	2644.8598	1.5507E-05	494.4906	35.6890
264.000	6.61E-05	-36832.7101	2424.9719	4.4597E-06	469.2261	-72.3369
276.000	7.44E-05	-12942.9629	1502.5567	-6.3424E-07	451.6234	-81.3989
288.000	5.09E-05	-768.3043	680.0521	-2.0374E-06	442.6528	-55.6852
300.000	2.55E-05	3388.0676	178.4986	-1.7693E-06	444.5831	-27.9071
312.000	8.44E-06	3524.1551	-44.3372	-1.0619E-06	444.6833	-9.2322

324.000	2.40E-08	2329.0712	-99.8880	-4.6293E-07	443.8028	-.0262302
336.000	-2.67E-06	1129.0660	-82.5139	-1.0903E-07	442.9186	2.9219
348.000	-2.59E-06	349.2605	-47.9640	4.2255E-08	442.3440	2.8364
360.000	-1.66E-06	-22.2736	-20.0705	7.5718E-08	442.1031	1.8125
372.000	-7.76E-07	-132.7959	-4.1048	5.9849E-08	442.1845	.8484481
384.000	-2.20E-07	-121.0763	2.4330	3.3868E-08	442.1759	.2411923
396.000	3.73E-08	-74.5657	3.6357	1.3847E-08	442.1416	-.0407499
408.000	1.12E-07	-33.8864	2.6571	2.7478E-09	442.1116	-.1223454
420.000	1.03E-07	-10.8082	1.4393	-1.8261E-09	442.0946	-.0806182
432.000	6.80E-08	.6663563	.6368375	-2.8640E-09	442.0871	-.0531308
444.000	3.45E-08	4.4897	.1565208	-2.3363E-09	442.0900	-.0269220
456.000	1.19E-08	4.4341	-.0609760	-1.4231E-09	442.0899	-.0093275
468.000	3.08E-10	3.0331	-.1183852	-6.5892E-10	442.0889	-.0002407
480.000	-3.87E-09	1.5960	-.1016705	-1.8519E-10	442.0878	.0030265
492.000	-4.14E-09	.5939009	-.0641231	3.8916E-11	442.0871	.0032314
504.000	-2.94E-09	.0568462	-.0309535	1.0551E-10	442.0867	.0022968
516.000	-1.60E-09	-.1494906	-.0096533	9.6031E-11	442.0868	.0012532
528.000	-6.35E-10	-.1752930	.0008443	6.2793E-11	442.0868	.0004964
540.000	-9.72E-11	-.1295298	.0042780	3.1598E-11	442.0867	7.5903E-05
552.000	1.23E-10	-.0727730	.0041571	1.0895E-11	442.0867	-9.6049E-05
564.000	1.64E-10	-.0298116	.0028106	3.9711E-13	442.0867	-.0001284
576.000	1.32E-10	-.0053210	.0014194	-3.1983E-12	442.0867	-.0001035
588.000	8.76E-11	.0042690	.0003880	-3.3059E-12	442.0867	-6.8408E-05
600.000	5.31E-11	.0040061	-3.3510E-05	-2.4591E-12	442.0867	-1.8378E-06
612.000	2.86E-11	.0034766	-5.0615E-05	-1.6933E-12	442.0867	-1.0131E-06
624.000	1.25E-11	.0027994	-5.9423E-05	-1.0510E-12	442.0867	-4.5482E-07
636.000	3.33E-12	.0022555	-6.2896E-05	-5.5420E-13	442.0867	-1.2400E-07
648.000	-8.00E-13	.0012926	-6.3456E-05	-2.1157E-13	442.0866	3.0564E-08
660.000	-1.75E-12	.0005335	-4.9379E-05	-2.4687E-14	442.0866	2.3156E-06
672.000	-1.39E-12	.0001076	-2.4438E-05	4.0925E-14	442.0866	1.8412E-06
684.000	-7.70E-13	-5.3197E-05	-7.2869E-06	4.6495E-14	442.0866	1.0174E-06
696.000	-2.77E-13	-6.7489E-05	1.0145E-06	3.4144E-14	442.0866	3.6622E-07
708.000	4.98E-14	-2.9013E-05	2.8169E-06	2.4268E-14	442.0866	-6.5818E-08
720.000	3.05E-13	0.0000	0.0000	2.1299E-14	442.0866	-4.0366E-07

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

```
Pile-head deflection              =      .09728662 in
Computed slope at pile head       =     -.00156795
Maximum bending moment            =       1033107. lbs-in
Maximum shear force               =    37000.00000 lbs
Depth of maximum bending moment   =    60.00000000 in
Depth of maximum shear force      =        0.00000 in
Number of iterations              =             25
Number of zero deflection points  =              8
```

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 3

```
Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head  =       47000.000 lbs
Specified moment at pile head       =            .000 in-lbs
Specified axial load at pile head   =      200000.000 lbs
```


(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.162329	-1.1301E-08	47000.0000	-.0024243	442.0866	-771.7403
12.000	.133238	514253.	37717.3137	-.0023717	821.0033	-775.3741
24.000	.105409	916600.	28446.5345	-.0022252	1117.4639	-769.7557
36.000	.079832	1207651.	19304.0086	-.0020078	1331.9191	-753.9986
48.000	.057221	1389533.	10419.1233	-.0017421	1465.9354	-726.8156
60.000	.038023	1466072.	1941.8763	-.0014498	1522.3311	-686.0589
72.000	.022425	1443098.	-5938.8209	-.0011521	1505.4030	-627.3906
84.000	.010372	1329070.	-12937.2667	-.0008684	1421.3843	-539.0170
96.000	.001584	1136772.	-18276.2865	-.0006161	1279.6931	-350.8196
108.000	-.004413	893396.	-17562.1686	-.0004083	1100.3672	469.8393
120.000	-.008215	717239.	-14195.3501	-.0002435	970.5695	91.2971
132.000	-.010256	553877.	-12923.8611	-.0001134	850.1991	120.6177
144.000	-.010937	407611.	-11385.9204	-1.4991E-05	742.4262	135.7057
156.000	-.010616	280687.	-9740.0404	5.5448E-05	648.9047	138.6076
168.000	-.009606	173584.	-8118.5105	.0001019	569.9882	131.6474
180.000	-.008170	85352.9709	-6625.0748	.0001284	504.9772	117.2586
192.000	-.006524	13965.4801	-5334.3512	.0001386	452.3768	97.8620
204.000	-.004843	-43336.7359	-4292.4144	.0001356	474.0184	75.7941
216.000	-.003269	-89703.3144	-3517.9571	.0001220	508.1827	53.2821
228.000	-.001916	-128353.	-3003.4848	9.9663E-05	536.6610	32.4633
240.000	-.000877	-162265.	-610.6654	6.9922E-05	561.6485	366.3399
252.000	-.000238	-143345.	3146.7650	3.8647E-05	547.7073	259.8985
264.000	5.02E-05	-86928.4792	4376.9845	1.5081E-05	506.1381	-54.8619
276.000	.000124	-38369.5640	3231.4617	2.2586E-06	470.3585	-136.0586
288.000	.000104	-9384.2394	1730.1371	-2.6284E-06	449.0012	-114.1622
300.000	6.13E-05	3166.3430	642.8538	-3.2647E-06	444.4197	-67.0517
312.000	2.60E-05	6059.9233	69.8511	-2.3205E-06	446.5518	-28.4487
324.000	5.60E-06	4853.9084	-137.6085	-1.2036E-06	445.6632	-6.1279
336.000	-2.88E-06	2763.0977	-155.4677	-4.2409E-07	444.1226	3.1513
348.000	-4.58E-06	1124.7190	-106.5210	-2.6218E-08	442.9154	5.0065
360.000	-3.51E-06	206.7184	-53.4443	1.1004E-07	442.2390	3.8397
372.000	-1.94E-06	-158.4724	-17.7017	1.1498E-07	442.2034	2.1174
384.000	-7.51E-07	-218.6740	-.0709764	7.6379E-08	442.2478	.8210109
396.000	-1.02E-07	-160.5425	5.5278	3.7571E-08	442.2049	.1121246
408.000	1.51E-07	-86.1862	5.2081	1.2321E-08	442.1502	-.1654085
420.000	1.93E-07	-35.6064	3.3100	-1.4250E-10	442.1129	-.1509430
432.000	1.48E-07	-6.7450	1.7117	-4.4766E-09	442.0916	-.1154481
444.000	8.58E-08	5.4953	.6169191	-4.6045E-09	442.0907	-.0670116
456.000	3.73E-08	8.0832	.0401361	-3.2149E-09	442.0926	-.0291189
468.000	8.62E-09	6.4740	-.1749907	-1.7252E-09	442.0914	-.0067355
480.000	-4.13E-09	3.8917	-.1960469	-6.6438E-10	442.0895	.0032262
492.000	-7.32E-09	1.7721	-.1423648	-8.4768E-11	442.0880	.0057209
504.000	-6.16E-09	.4753568	-.0791468	1.4523E-10	442.0870	.0048155
516.000	-3.84E-09	-.1281570	-.0322660	1.8076E-10	442.0867	.0029980
528.000	-1.83E-09	-.2998939	-.0057191	1.3695E-10	442.0869	.0014265
540.000	-5.51E-10	-.2660739	.0054214	7.9034E-11	442.0868	.0004303
552.000	7.08E-11	-.1701593	.0076713	3.4391E-11	442.0868	-5.5329E-05
564.000	2.75E-10	-.0821284	.0060524	8.5721E-12	442.0867	-.0002145
576.000	2.77E-10	-.0249419	.0034693	-2.3852E-12	442.0867	-.0002160
588.000	2.17E-10	.0011462	.0011545	-4.8204E-12	442.0866	-.0001698
600.000	1.61E-10	.0027887	.0001025	-4.4177E-12	442.0867	-5.5635E-06
612.000	1.11E-10	.0036286	4.5476E-05	-3.7610E-12	442.0867	-3.9487E-06
624.000	7.06E-11	.0038982	6.3710E-06	-2.9907E-12	442.0867	-2.5689E-06
636.000	3.95E-11	.0037959	-1.7879E-05	-2.2033E-12	442.0867	-1.4728E-06
648.000	1.77E-11	.0034796	-3.0777E-05	-1.4587E-12	442.0867	-6.7682E-07
660.000	4.49E-12	.0030642	-7.0474E-05	-7.8906E-13	442.0867	-5.9392E-06
672.000	-1.21E-12	.0017921	-9.6492E-05	-2.9209E-13	442.0867	1.6028E-06
684.000	-2.52E-12	.0007498	-6.6915E-05	-3.1959E-14	442.0866	3.3268E-06

696.000	-1.98E-12	.0001862	-3.1254E-05	6.3834E-14	442.0866	2.6166E-06
708.000	-9.85E-13	-6.0286E-07	-7.7438E-06	8.2833E-14	442.0866	1.3018E-06
720.000	8.42E-15	0.0000	0.0000	8.2771E-14	442.0866	-1.1132E-08

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

```
Pile-head deflection              =      .16232943 in
Computed slope at pile head       =     -.00242429
Maximum bending moment            =        1466072. lbs-in
Maximum shear force               =    47000.00000 lbs
Depth of maximum bending moment   =    60.00000000 in
Depth of maximum shear force      =        0.00000 in
Number of iterations              =             28
Number of zero deflection points  =              8
```

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

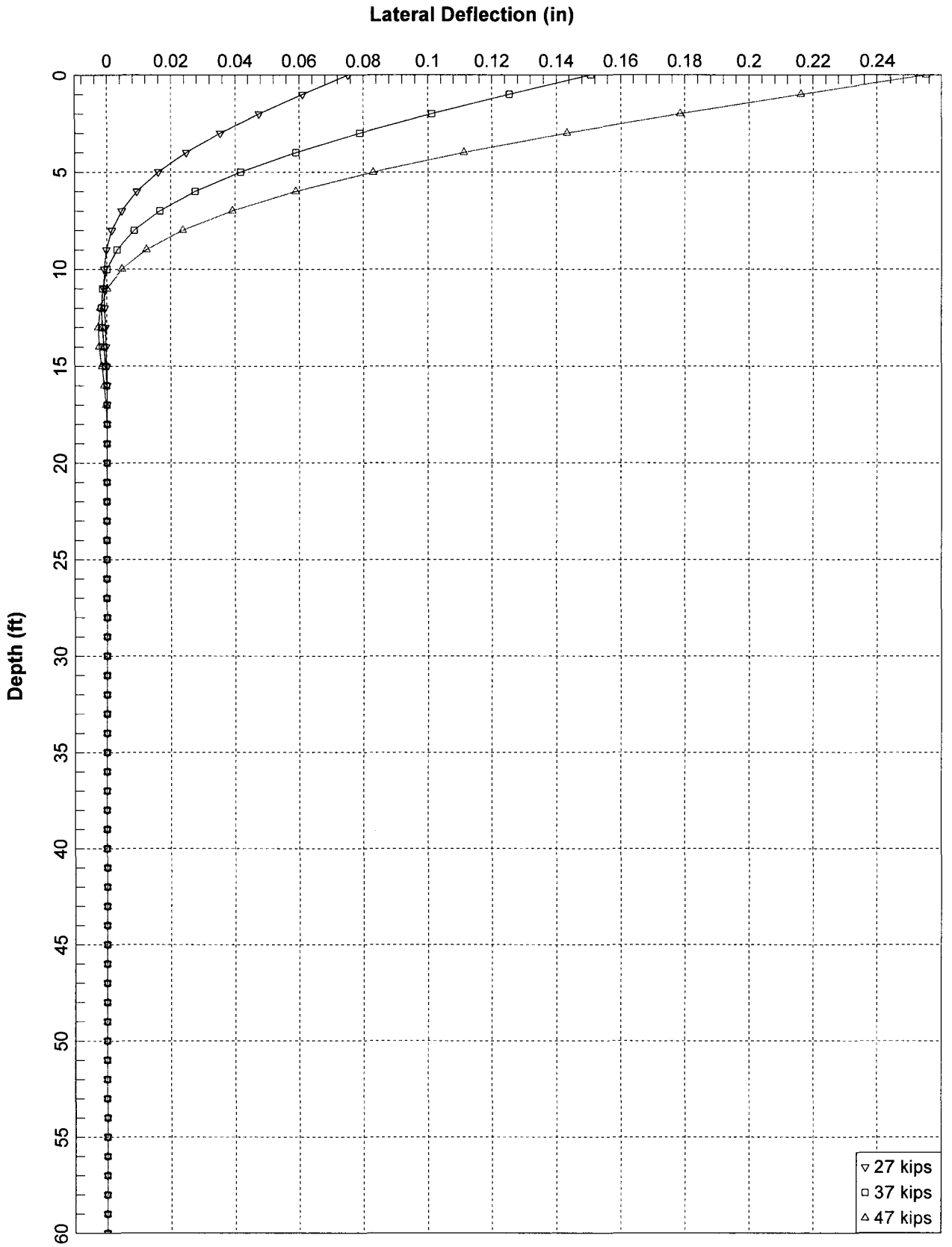
```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1		Pile-Head Condition 2		Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V=	27000.	M=	0.000	200000.	.0478230	661322.	27000.0000
1	V=	37000.	M=	0.000	200000.	.0972866	1033107.	37000.0000
1	V=	47000.	M=	0.000	200000.	.1623294	1466072.	47000.0000

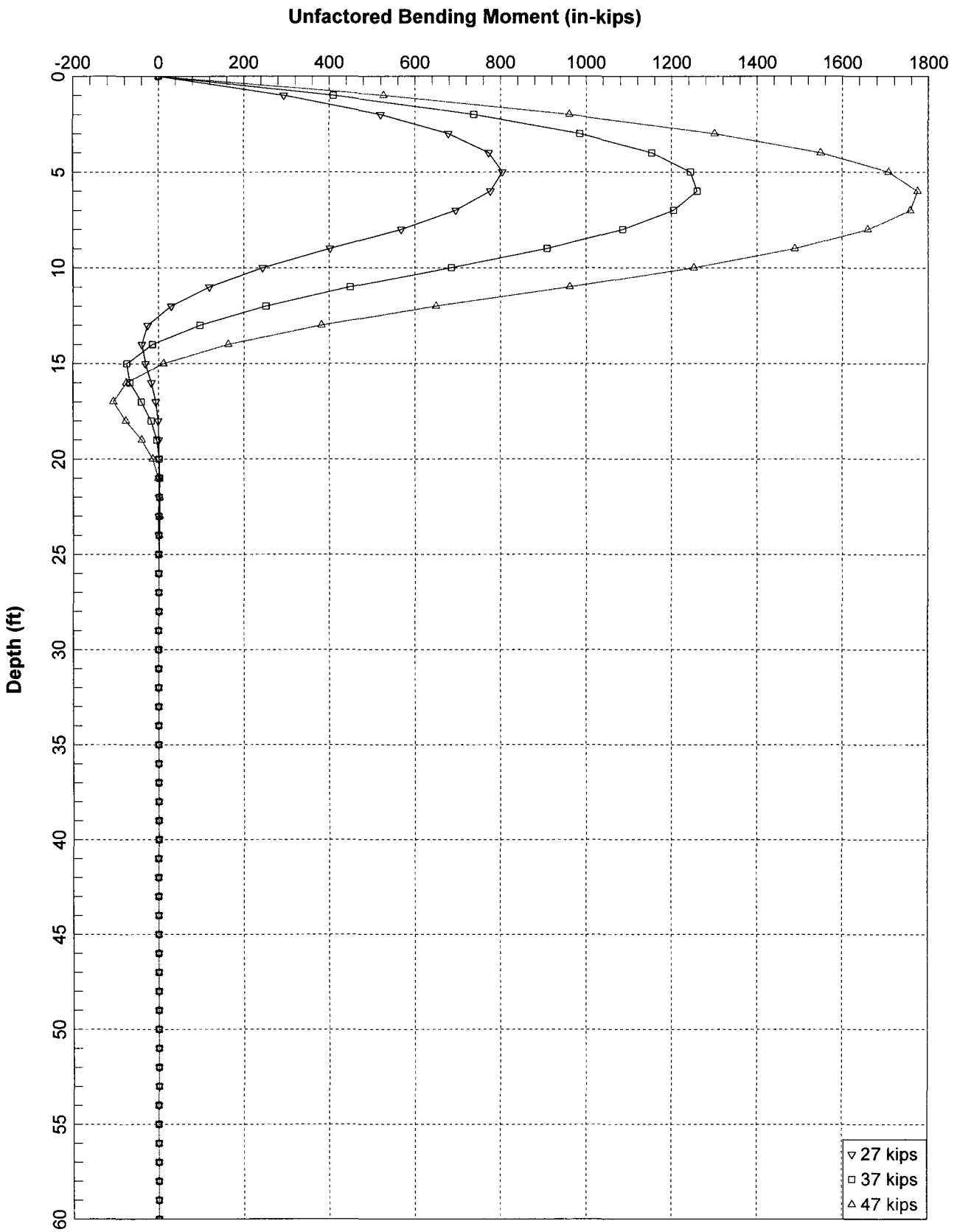
The analysis ended normally.

EL. 61.75 (approx.)

Depths -90 - 162 = Stiff Clay w/o free water	$S_u = 2.5$ ksf $\gamma' = 125$ pcf $\epsilon_{50} = 0.005$	
Depths 162 - 402 = Stiff Clay w/o free water	$S_u = 4.0$ ksf $\gamma' = 125$ pcf $\epsilon_{50} = 0.004$	
Depths 402 - 582 = Stiff Clay w/o free water	$S_u = 2.5$ ksf $\gamma' = 125$ pcf $\epsilon_{50} = 0.005$	
Depths 582 - 606 = Stiff Clay w/o free water	$S_u = 1.5$ ksf $\gamma' = 65$ pcf $\phi' = 40^\circ$ $\gamma' = 70$ pcf $K = 125$ lb/in.^{3}	$\epsilon_{50} = 0.007$



Lone Tree Way - A Street UC @ SR4 - Left and Right Bridges - Abutment 3 - 24-in CIDH Pile



Lone Tree Way - A Street UC @ SR4 - Left & Right Bridges - Abutment 3 - 24-in. CIDH Pile

LPILE Plus for Windows, Version 5.0 (5.0.21)

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:

Gary Parikh
Parikh Consultants

Path to file locations: S:\Ongoing Projects\2006\206117 TYLIn Rte 4 Project\A St_Lone Tree\LPILE\
Name of input data file: A Street - Abutment 3.lpd
Name of output file: A Street - Abutment 3.lpo
Name of plot output file: A Street - Abutment 3.lpp
Name of runtime file: A Street - Abutment 3.lpr

Time and Date of Analysis

Date: August 23, 2009 Time: 18:39:24

Problem Title

SR4 - A Street - Abutment 3 - 24-in CIDH Pile

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant 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 pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 60
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 720.00 in
Depth of ground surface below top of pile = -90.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	24.00000000	16286.0000	452.4000	3600000.
2	720.0000	24.00000000	16286.0000	452.4000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 5 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -90.000 in
Distance from top of pile to bottom of layer = 162.000 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 162.000 in
Distance from top of pile to bottom of layer = 402.000 in

Layer 3 is stiff clay without free water
Distance from top of pile to top of layer = 402.000 in
Distance from top of pile to bottom of layer = 582.000 in

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 582.000 in
Distance from top of pile to bottom of layer = 606.000 in

Layer 5 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 606.000 in
Distance from top of pile to bottom of layer = 978.000 in
p-y subgrade modulus k for top of soil layer = 125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 125.000 lbs/in**3

(Depth of lowest layer extends 258.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth

is defined using 10 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-90.00	.07230
2	162.00	.07230
3	162.00	.07230
4	402.00	.07230
5	402.00	.07230
6	582.00	.07230
7	582.00	.03760
8	606.00	.03760
9	606.00	.04050
10	978.00	.04050

Shear Strength of Soils

Distribution of shear strength parameters with depth defined using 10 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-90.000	17.36000	.00	.00500	.0
2	162.000	17.36000	.00	.00500	.0
3	162.000	27.77000	.00	.00400	.0
4	402.000	27.77000	.00	.00400	.0
5	402.000	17.36000	.00	.00500	.0
6	582.000	17.36000	.00	.00500	.0
7	582.000	10.42000	.00	.00700	.0
8	606.000	10.42000	.00	.00700	.0
9	606.000	.00000	40.00	------	------
10	978.000	.00000	40.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.6000	1.0000
2	720.000	.6000	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 3

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 27000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 37000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 47000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 27000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 200000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.075341	-5.6503E-09	27000.0000	-.0011858	442.0866	-464.5526
12.000	.061112	293398.	21416.3203	-.0011558	658.2710	-466.0607
24.000	.047602	519539.	15850.8776	-.0010726	824.8985	-461.5131
36.000	.035369	678968.	10379.0390	-.0009499	942.3699	-450.4600
48.000	.024804	773196.	5082.2774	-.0008013	1011.8002	-432.3336
60.000	.016137	804789.	50.1823	-.0006399	1035.0785	-406.3489

72.000	.009447	777472.	-4615.4164	-.0004779	1014.9506	-371.2509
84.000	.004667	696313.	-8789.9478	-.0003271	955.1503	-324.5044
96.000	.001597	568083.	-12287.0862	-.0001977	860.6669	-258.3520
108.000	-7.81E-05	402372.	-13513.7984	-9.8394E-05	738.5659	53.9000
120.000	-.000765	244224.	-11800.3571	-3.2223E-05	622.0383	231.6736
132.000	-.000851	119318.	-8930.3164	4.9808E-06	530.0035	246.6666
144.000	-.000645	29872.8185	-6020.9600	2.0249E-05	464.0978	238.2262
156.000	-.000366	-25282.3508	-2878.4107	2.0718E-05	460.7154	285.5320
168.000	-.000148	-39308.4871	-195.4720	1.4108E-05	471.0503	161.6244
180.000	-2.69E-05	-30041.3988	957.3179	7.0112E-06	464.2220	30.5072
192.000	2.03E-05	-16366.5112	996.9764	2.2619E-06	454.1460	-23.8975
204.000	2.74E-05	-6124.8226	653.7562	-3.9787E-08	446.5996	-33.3059
216.000	1.94E-05	-676.1706	307.6656	-7.3578E-07	442.5849	-24.3759
228.000	9.72E-06	1262.6842	85.6420	-6.7576E-07	443.0170	-12.6280
240.000	3.16E-06	1382.4814	-15.2011	-4.0506E-07	443.1053	-4.1791
252.000	-1.80E-10	899.8033	-40.2745	-1.7150E-07	442.7497	.0002373
264.000	-9.53E-07	416.7174	-32.7164	-3.6768E-08	442.3937	1.2394
276.000	-8.83E-07	114.7859	-18.1623	1.7624E-08	442.1712	1.1662
288.000	-5.30E-07	-19.2623	-6.9616	2.7400E-08	442.1008	.7005350
300.000	-2.25E-07	-52.4240	-.9743765	2.0064E-08	442.1253	.2973357
312.000	-4.86E-08	-42.7436	1.1953	1.0324E-08	442.1181	.0642707
324.000	2.28E-08	-23.7873	1.4004	3.5159E-09	442.1042	-.0300762
336.000	3.57E-08	-9.1502	.9366213	1.4512E-10	442.0934	-.0472251
348.000	2.62E-08	-1.3091	.4452008	-9.2526E-10	442.0876	-.0346783
360.000	1.35E-08	1.5390	.1298319	-9.0172E-10	442.0878	-.0178831
372.000	4.60E-09	1.8112	-.0139631	-5.5886E-10	442.0880	-.0060827
384.000	1.21E-10	1.2066	-.0514209	-2.5003E-10	442.0875	-.0001603
396.000	-1.40E-09	.5783205	-.0413050	-6.7363E-11	442.0871	.0018463
408.000	-1.50E-09	.2156118	-.0232180	1.3886E-11	442.0868	.0011682
420.000	-1.06E-09	.0210210	-.0112215	3.8102E-11	442.0867	.0008312
432.000	-5.81E-10	-.0530869	-.0035112	3.4739E-11	442.0867	.0004539
444.000	-2.30E-10	-.0634134	.0002913	2.2734E-11	442.0867	.0001799
456.000	-3.53E-11	-.0470039	.0015364	1.1435E-11	442.0867	2.7610E-05
468.000	4.41E-11	-.0265954	.0014951	3.9027E-12	442.0867	-3.4490E-05
480.000	5.83E-11	-.0111403	.0010148	4.0886E-14	442.0867	-4.5560E-05
492.000	4.51E-11	-.0022404	.0005299	-1.3285E-12	442.0867	-3.5256E-05
504.000	2.64E-11	.0015836	.0001944	-1.3957E-12	442.0867	-2.0653E-05
516.000	1.16E-11	.0024329	1.5992E-05	-9.8464E-13	442.0867	-9.0888E-06
528.000	2.81E-12	.0019722	-5.1695E-05	-5.3383E-13	442.0867	-2.1924E-06
540.000	-1.18E-12	.0011948	-5.9329E-05	-2.0973E-13	442.0866	9.1995E-07
552.000	-2.23E-12	.0005493	-4.3371E-05	-3.1245E-14	442.0866	1.7398E-06
564.000	-1.93E-12	.0001541	-2.3897E-05	4.0733E-14	442.0866	1.5058E-06
576.000	-1.25E-12	-2.4433E-05	-9.0058E-06	5.3998E-14	442.0866	9.7612E-07
588.000	-6.32E-13	-6.2345E-05	-1.5157E-06	4.5118E-14	442.0866	2.7224E-07
600.000	-1.67E-13	-6.1026E-05	5.4883E-07	3.2492E-14	442.0866	7.1853E-08
612.000	1.48E-13	-4.9329E-05	9.6012E-07	2.1199E-14	442.0866	-3.3043E-09
624.000	3.42E-13	-3.8085E-05	8.9271E-07	1.2253E-14	442.0866	-7.9310E-09
636.000	4.42E-13	-2.7963E-05	7.8120E-07	5.4939E-15	442.0866	-1.0654E-08
648.000	4.74E-13	-1.9362E-05	6.4624E-07	6.5077E-16	442.0866	-1.1841E-08
660.000	4.58E-13	-1.2457E-05	5.0407E-07	-2.6055E-15	442.0866	-1.1854E-08
672.000	4.11E-13	-7.2520E-06	3.6683E-07	-4.6224E-15	442.0866	-1.1019E-08
684.000	3.47E-13	-3.6306E-06	2.4307E-07	-5.7361E-15	442.0866	-9.6073E-09
696.000	2.74E-13	-1.3909E-06	1.3847E-07	-6.2500E-15	442.0866	-7.8247E-09
708.000	1.97E-13	-2.7722E-07	5.6669E-08	-6.4207E-15	442.0866	-5.8094E-09
720.000	1.20E-13	0.0000	0.0000	-6.4490E-15	442.0866	-3.6354E-09

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection = .07534145 in

Computed slope at pile head = -.00118582
Maximum bending moment = 804788.80112 lbs-in
Maximum shear force = 27000.00000 lbs
Depth of maximum bending moment = 60.00000000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 21
Number of zero deflection points = 8

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 37000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 200000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.150722	1.1301E-08	37000.0000	-.0021020	442.0866	-552.4695
12.000	.125498	409267.	30337.7759	-.0020601	743.6465	-557.9012
24.000	.101280	737995.	23646.1608	-.0019427	985.8630	-557.3679
36.000	.078874	986100.	16999.2757	-.0017662	1168.6737	-550.4462
48.000	.058890	1154456.	10476.7946	-.0015472	1292.7233	-536.6339
60.000	.041741	1244969.	4165.2186	-.0013016	1359.4164	-515.2954
72.000	.027651	1260669.	-1839.8259	-.0010452	1370.9842	-485.5454
84.000	.016656	1205831.	-7428.8903	-.0007928	1330.5778	-445.9654
96.000	.008623	1086181.	-12467.1222	-.0005582	1242.4164	-393.7399
108.000	.003258	909299.	-16754.4908	-.0003540	1112.0848	-320.8215
120.000	.000126	685772.	-19222.6289	-.0001908	947.3838	-90.5349
132.000	-.001321	448872.	-18114.1731	-7.4681E-05	772.8286	275.2775
144.000	-.001666	251391.	-14650.6871	-3.0181E-06	627.3187	301.9702
156.000	-.001393	97269.9023	-11076.6581	3.2663E-05	513.7580	293.7013
168.000	-.000882	-14605.7800	-7116.0914	4.1123E-05	452.8486	366.3931
180.000	-.000406	-73713.6789	-2152.4990	3.2084E-05	496.4010	460.8723
192.000	-.000112	-66419.7594	1402.2973	1.7743E-05	491.0267	131.5938
204.000	1.94E-05	-40143.7104	2050.4765	6.8379E-06	471.6657	-23.5639
216.000	5.21E-05	-17241.1447	1515.7222	9.6527E-07	454.7904	-65.5618
228.000	4.25E-05	-3771.0101	790.8095	-1.1851E-06	444.8652	-55.2570
240.000	2.37E-05	1743.9708	271.4832	-1.3925E-06	443.3717	-31.2974
252.000	9.12E-06	2751.2699	11.4134	-9.3247E-07	444.1139	-12.0476
264.000	1.31E-06	2022.3694	-71.2312	-4.4395E-07	443.5768	-1.7265
276.000	-1.54E-06	1043.8528	-69.4034	-1.3016E-07	442.8558	2.0312
288.000	-1.82E-06	357.3114	-42.8092	1.3229E-08	442.3499	2.4012
300.000	-1.22E-06	16.3693	-18.7319	5.1470E-08	442.0987	1.6117
312.000	-5.82E-07	-92.5018	-4.4481	4.3679E-08	442.1548	.7689819
324.000	-1.71E-07	-90.5941	1.5248	2.4941E-08	442.1534	.2265046
336.000	1.66E-08	-56.0253	2.7521	9.9367E-09	442.1279	-.0219630
348.000	6.71E-08	-24.5916	2.0887	1.6865E-09	442.1048	-.0886091
360.000	5.71E-08	-5.9055	1.1043	-1.4344E-09	442.0910	-.0754470
372.000	3.26E-08	1.9191	.3929249	-1.8424E-09	442.0881	-.0431196
384.000	1.29E-08	3.5336	.0320841	-1.2844E-09	442.0893	-.0170205
396.000	1.81E-09	2.6953	-.0843727	-6.4693E-10	442.0886	-.0023890
408.000	-2.65E-09	1.5117	-.0863078	-2.1640E-10	442.0878	.0020665
420.000	-3.39E-09	.6249653	-.0580404	2.2664E-12	442.0871	.0026448
432.000	-2.59E-09	.1187451	-.0300280	7.8376E-11	442.0867	.0020240

444.000	-1.50E-09	-.0960821	-.0108322	8.0695E-11	442.0867	.0011753
456.000	-6.54E-10	-.1416156	-.0007141	5.6370E-11	442.0868	.0005110
468.000	-1.52E-10	-.1134910	.0030628	3.0263E-11	442.0867	.0001185
480.000	7.21E-11	-.0682526	.0034354	1.1664E-11	442.0867	-5.6359E-05
492.000	1.28E-10	-.0310865	.0024960	1.4965E-12	442.0867	-.0001002
504.000	1.08E-10	-.0083568	.0013881	-2.5410E-12	442.0867	-8.4417E-05
516.000	6.73E-11	.0022310	.0005662	-3.1679E-12	442.0867	-5.2579E-05
528.000	3.20E-11	.0052463	.0001006	-2.4027E-12	442.0867	-2.5022E-05
540.000	9.64E-12	.0046560	-9.4753E-05	-1.3894E-12	442.0867	-7.5305E-06
552.000	-1.31E-12	.0029789	-.0001338	-6.0802E-13	442.0867	1.0271E-06
564.000	-4.95E-12	.0014483	-.0001044	-1.5494E-13	442.0867	3.8691E-06
576.000	-5.03E-12	.0004742	-5.7588E-05	4.1801E-14	442.0866	3.9322E-06
588.000	-3.95E-12	6.6022E-05	-2.3780E-05	9.7084E-14	442.0866	1.7025E-06
600.000	-2.70E-12	-9.7004E-05	-6.5724E-06	9.3913E-14	442.0866	1.1654E-06
612.000	-1.70E-12	-9.2167E-05	6.4661E-07	7.4554E-14	442.0866	3.7786E-08
624.000	-9.14E-13	-8.1843E-05	1.0005E-06	5.6746E-14	442.0866	2.1194E-08
636.000	-3.34E-13	-6.8428E-05	1.1759E-06	4.1368E-14	442.0866	8.0372E-09
648.000	7.87E-14	-5.3821E-05	1.2123E-06	2.8858E-14	442.0866	-1.9656E-09
660.000	3.59E-13	-3.9471E-05	1.1448E-06	1.9310E-14	442.0866	-9.2890E-09
672.000	5.42E-13	-2.6439E-05	1.0019E-06	1.2565E-14	442.0866	-1.4520E-08
684.000	6.60E-13	-1.5485E-05	8.0510E-07	8.2749E-15	442.0866	-1.8284E-08
696.000	7.41E-13	-7.1564E-06	5.6836E-07	5.9578E-15	442.0866	-2.1173E-08
708.000	8.03E-13	-1.8731E-06	2.9919E-07	5.0338E-15	442.0866	-2.3688E-08
720.000	8.62E-13	0.0000	0.0000	4.8421E-15	442.0866	-2.6177E-08

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

Pile-head deflection = .15072215 in
Computed slope at pile head = -.00210198
Maximum bending moment = 1260669. lbs-in
Maximum shear force = 37000.00000 lbs
Depth of maximum bending moment = 72.00000000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 22
Number of zero deflection points = 8

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 47000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 200000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.255181	2.2601E-08	47000.0000	-.0032441	442.0866	-630.1897
12.000	.216252	526412.	39383.7013	-.0031903	829.9626	-639.1934
24.000	.178615	960522.	31694.7688	-.0030381	1149.8274	-642.2953
36.000	.143337	1301670.	24006.4325	-.0028066	1401.1948	-639.0940

48.000	.111257	1550148.	16397.0752	-.0025147	1584.2810	-629.1322
60.000	.082984	1707270.	8951.1096	-.0021814	1700.0531	-611.8621
72.000	.058904	1775445.	1760.4505	-.0018250	1750.2866	-586.5811
84.000	.039184	1758281.	-5072.8076	-.0014633	1737.6393	-552.2953
96.000	.023783	1660722.	-11430.9056	-.0011134	1665.7551	-507.3877
108.000	.012462	1489284.	-17166.9337	-.0007911	1539.4343	-448.6170
120.000	.004797	1252513.	-22058.9530	-.0005105	1364.9746	-366.7196
132.000	.000210	962319.	-25192.4985	-.0002838	1151.1515	-155.5380
144.000	-.002015	649255.	-24225.7765	-.0001189	920.4769	316.6583
156.000	-.002644	381471.	-20257.5536	-1.3431E-05	723.1658	344.7121
168.000	-.002337	163138.	-15384.5666	4.2303E-05	562.2918	467.4524
180.000	-.001629	12038.6312	-9920.1699	6.0231E-05	450.9571	443.2804
192.000	-.000891	-75234.7270	-4889.5142	5.3763E-05	497.5218	395.1622
204.000	-.000339	-105568.	-46.4319	3.5260E-05	519.8721	412.0182
216.000	-4.52E-05	-76518.3433	2766.9960	1.6626E-05	498.4676	56.8865
228.000	6.03E-05	-39239.6728	2638.2146	4.7797E-06	470.9996	-78.3501
240.000	6.95E-05	-13224.1350	1617.2418	-5.8927E-07	451.8306	-91.8121
252.000	4.62E-05	-423.0412	700.3088	-1.9859E-06	442.3984	-61.0101
264.000	2.18E-05	3592.8086	161.2373	-1.6615E-06	444.7339	-28.8352
276.000	6.30E-06	3454.6294	-61.6947	-9.4028E-07	444.6321	-8.3202
288.000	-7.44E-07	2116.6489	-105.7156	-3.7013E-07	443.6463	.9833479
300.000	-2.59E-06	919.2307	-79.3100	-5.9450E-08	442.7640	3.4176
312.000	-2.17E-06	213.4954	-41.5926	5.6471E-08	442.2440	2.8686
324.000	-1.23E-06	-79.2622	-14.6201	7.0208E-08	442.1451	1.6268
336.000	-4.86E-07	-137.7233	-1.0062	4.8002E-08	442.1881	.6421835
348.000	-7.91E-08	-103.6423	3.4741	2.3301E-08	442.1630	.1045382
360.000	7.32E-08	-54.4569	3.5208	7.1218E-09	442.1268	-.0967515
372.000	9.18E-08	-19.1770	2.2124	-4.1373E-10	442.1008	-.1213094
384.000	6.33E-08	-1.3562	.9828039	-2.5150E-09	442.0876	-.0836312
396.000	3.14E-08	4.4223	.2317078	-2.2013E-09	442.0899	-.0415515
408.000	1.05E-08	4.2153	-.0666389	-1.3173E-09	442.0898	-.0081729
420.000	-1.69E-10	2.8293	-.1148840	-5.9638E-10	442.0887	.0001321
432.000	-3.85E-09	1.4610	-.0960406	-1.5732E-10	442.0877	.0030085
444.000	-3.94E-09	.5251184	-.0595000	4.5932E-11	442.0870	.0030816
456.000	-2.75E-09	.0327582	-.0281264	1.0302E-10	442.0867	.0021473
468.000	-1.47E-09	-.1504088	-.0083422	9.0984E-11	442.0868	.0011501
480.000	-5.65E-10	-.1678916	.0012069	5.8410E-11	442.0868	.0004414
492.000	-7.04E-11	-.1217234	.0041853	2.8771E-11	442.0867	5.4958E-05
504.000	1.25E-10	-.0671814	.0039272	9.3985E-12	442.0867	-9.7982E-05
516.000	1.55E-10	-.0275157	.0026118	-3.3353E-13	442.0867	-.0001213
528.000	1.17E-10	-.0048967	.0013339	-3.6505E-12	442.0867	-9.1728E-05
540.000	6.76E-11	.0045159	.0004667	-3.6895E-12	442.0867	-5.2809E-05
552.000	2.89E-11	.0063216	1.4507E-05	-2.5804E-12	442.0867	-2.2555E-05
564.000	5.67E-12	.0048764	-.0001474	-1.4344E-12	442.0867	-4.4296E-06
576.000	-5.55E-12	.0027909	-.0001479	-6.4978E-13	442.0867	4.3393E-06
588.000	-9.92E-12	.0013289	-9.6236E-05	-2.2817E-13	442.0866	4.2782E-06
600.000	-1.10E-11	.0004824	-4.2037E-05	-4.2803E-14	442.0866	4.7550E-06
612.000	-1.10E-11	.0003203	-1.2043E-05	3.9335E-14	442.0866	2.4405E-07
624.000	-1.01E-11	.0001931	-9.1755E-06	9.1875E-14	442.0866	2.3385E-07
636.000	-8.75E-12	9.9604E-05	-6.5085E-06	1.2183E-13	442.0866	2.1066E-07
648.000	-7.16E-12	3.6352E-05	-4.1708E-06	1.3575E-13	442.0866	1.7895E-07
660.000	-5.49E-12	-1.1476E-06	-2.2447E-06	1.3935E-13	442.0866	1.4208E-07
672.000	-3.82E-12	-1.8188E-05	-7.7859E-07	1.3737E-13	442.0866	1.0227E-07
684.000	-2.19E-12	-2.0493E-05	1.9912E-07	1.3341E-13	442.0866	6.0685E-08
696.000	-6.16E-13	-1.4050E-05	6.6892E-07	1.2988E-13	442.0866	1.7616E-08
708.000	9.25E-13	-5.0624E-06	6.1098E-07	1.2792E-13	442.0866	-2.7273E-08
720.000	2.45E-12	0.0000	0.0000	1.2740E-13	442.0866	-7.4558E-08

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

A Street - Abutment 3.lpo

```
Pile-head deflection              =       .25518129 in
Computed slope at pile head       =     -.00324414
Maximum bending moment            =       1775445. lbs-in
Maximum shear force               =    47000.00000 lbs
Depth of maximum bending moment   =    72.00000000 in
Depth of maximum shear force      =        0.00000 in
Number of iterations              =             23
Number of zero deflection points  =              8
```

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 27000.	M= 0.000	200000.	.0753415	804789.	27000.0000
1	V= 37000.	M= 0.000	200000.	.1507222	1260669.	37000.0000
1	V= 47000.	M= 0.000	200000.	.2551813	1775445.	47000.0000

The analysis ended normally.

Bent 2 - Left & Right Bridges

Based on borings AST-154A & AST-155A

84-in. Diameter CIDH Pile

$A = 5541.8\ in^2$; $I = 1221960\ in^4$

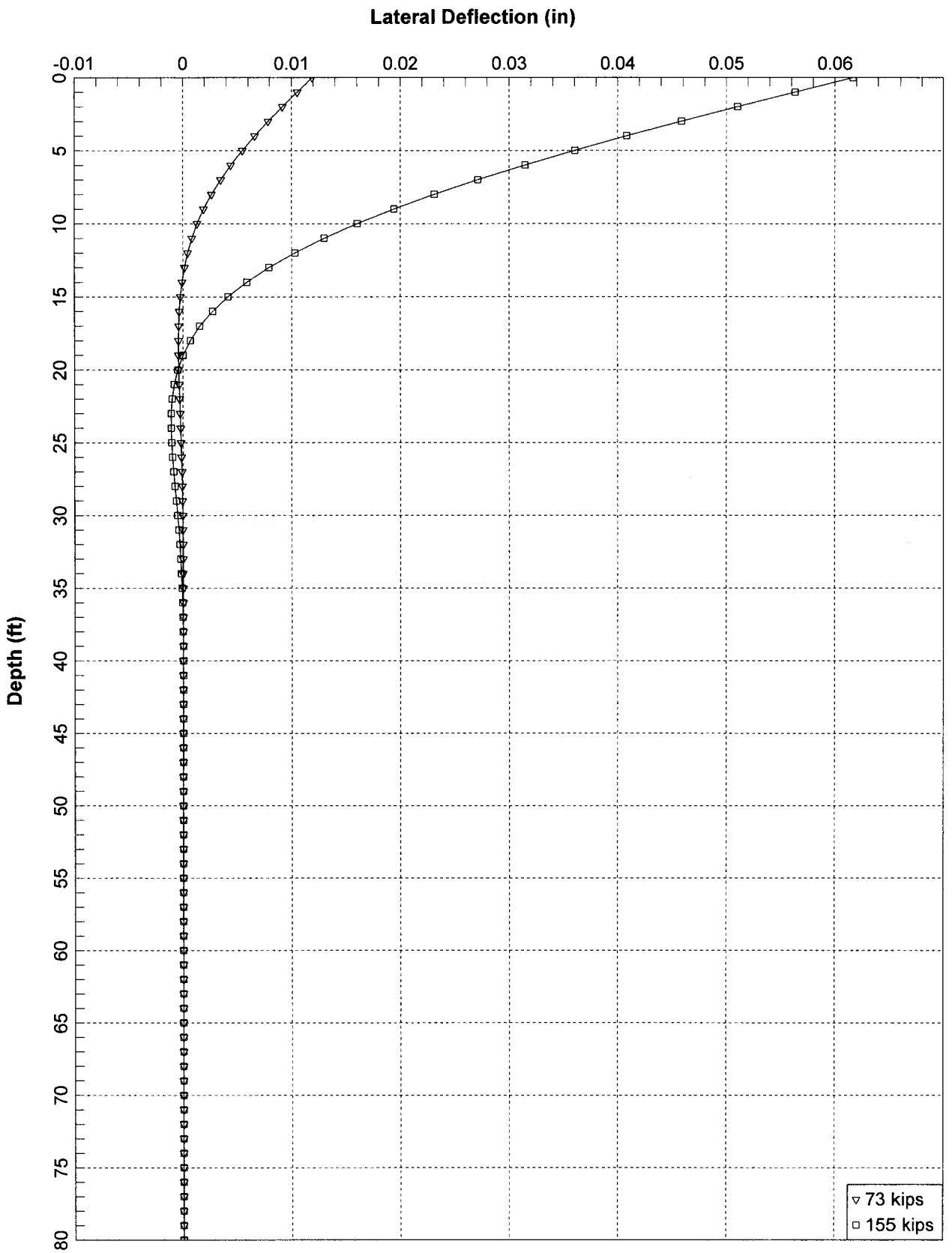
(Note: ϵ_{50} reduced for large diameter pile)

Transverse Loading

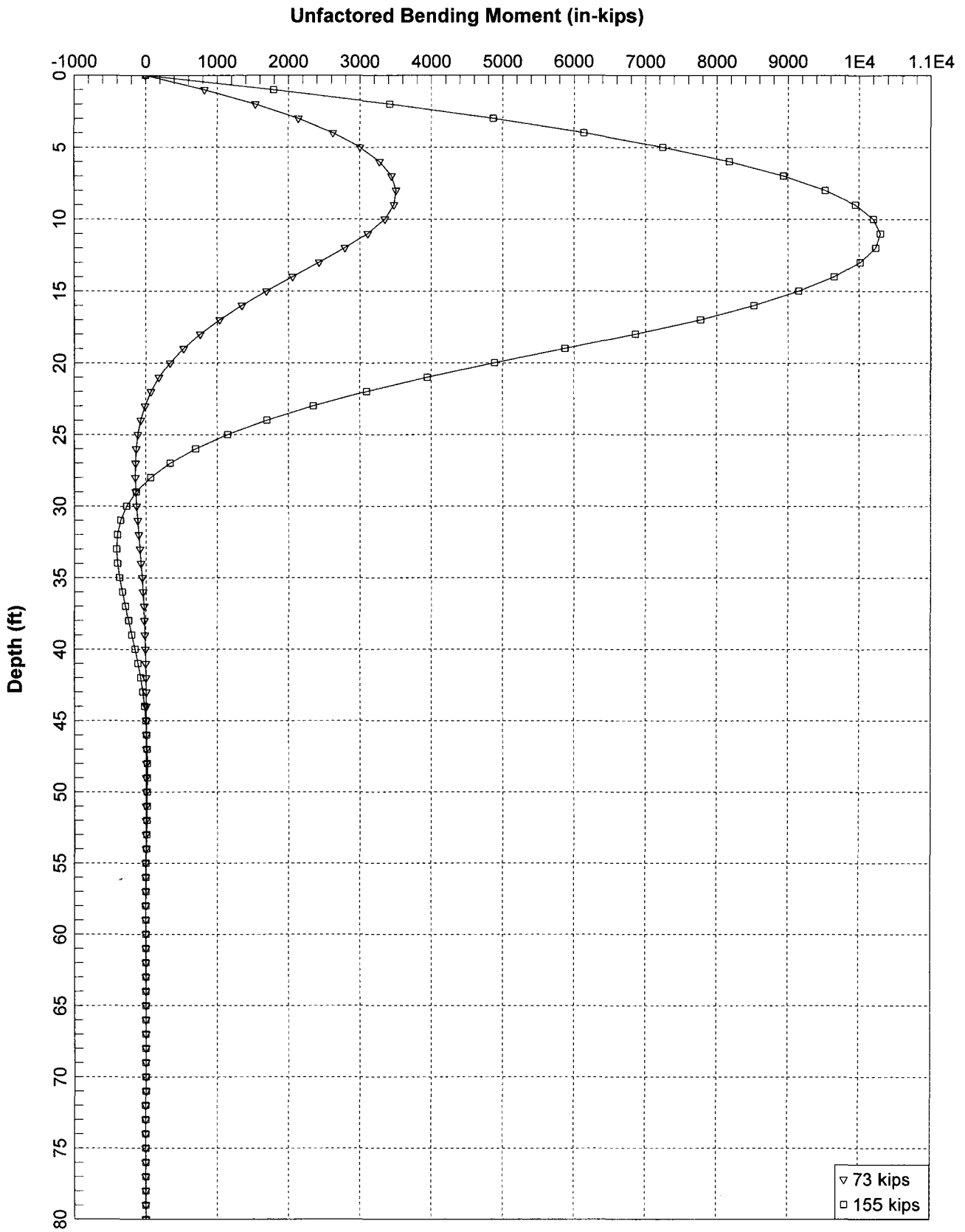
Group Reduction Factor = 0.62

EL. 44.0

Depths -24 - 264 = Stiff Clay w/o free water		$S_u = 3.5$ ksf $\gamma' = 125$ pcf $\epsilon_{50} = 0.00267$
Depths 264 - 456 = Stiff Clay w/o free water		$S_u = 2.5$ ksf $\gamma' = 125$ pcf $\epsilon_{50} = 0.00267$
Depths 456 - 504 = Stiff Clay w/o free water	$S_u = 2.5$ ksf	$\gamma' = 65$ pcf $\epsilon_{50} = 0.00267$
Depths 504 - 1200 = Stiff Clay w/o free water		$S_u = 8.0$ ksf $\gamma' = 125$ pcf $\epsilon_{50} = 0.0020$



Lone Tree Way - A Street UC @ SR4 - Left & Right Bridges - Bent 2 - 84-in CIDH Pile - Transverse



Lone TRee Way - A Street UC @ SR4 - Left & Right Bridges - Bent 2 - 84-in CIDH Pile - Transverse

LPILE Plus for Windows, Version 5.0 (5.0.21)

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:

Gary Parikh
Parikh Consultants

Path to file locations: S:\Ongoing Projects\2006\206117 TYLIn Rte 4 Project\A St_Lone Tree\LPILE\
Name of input data file: A Street - Bent 2--trans.lpd
Name of output file: A Street - Bent 2--trans.lpo
Name of plot output file: A Street - Bent 2--trans.lpp
Name of runtime file: A Street - Bent 2--trans.lpr

Time and Date of Analysis

Date: August 24, 2009 Time: 16:43:52

Problem Title

SR4 - A Street - Bent 2 - 84-in CIDH Pile - Transverse

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant 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 pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 80
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 960.00 in
Depth of ground surface below top of pile = -24.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	84.00000000	1221960.	5541.8000	3600000.
2	960.0000	84.00000000	1221960.	5541.8000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -24.000 in
Distance from top of pile to bottom of layer = 264.000 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 264.000 in
Distance from top of pile to bottom of layer = 456.000 in

Layer 3 is stiff clay without free water
Distance from top of pile to top of layer = 456.000 in
Distance from top of pile to bottom of layer = 504.000 in

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 504.000 in
Distance from top of pile to bottom of layer = 1200.000 in

(Depth of lowest layer extends 240.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth is defined using 8 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-24.00	.07230

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
2	264.00	.07230
3	264.00	.07230
4	456.00	.07230
5	456.00	.03760
6	504.00	.03760
7	504.00	.03760
8	1200.00	.03760

Shear Strength of Soils

Distribution of shear strength parameters with depth defined using 8 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-24.000	24.31000	.00	.00267	.0
2	264.000	24.31000	.00	.00267	.0
3	264.000	17.36000	.00	.00267	.0
4	456.000	17.36000	.00	.00267	.0
5	456.000	17.36000	.00	.00267	.0
6	504.000	17.36000	.00	.00267	.0
7	504.000	55.55000	.00	.00210	.0
8	1200.000	55.55000	.00	.00210	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.6200	1.0000
2	960.000	.6200	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 73000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 3280000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 155000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 3280000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

**** WARNING ****

An unreasonable input value for shear strength has been specified for layer 4 defined using the stiff clay without free water criteria. The input value is greater than 55.55 psi (8000 psf). You should check your input data for correctness.

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 73000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 3280000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.011916	-2.6497E-07	73000.0000	-.0001153	591.8655	-776.4427
12.000	.010532	824635.	63673.8357	-.0001142	620.2090	-777.9180
24.000	.009176	1537162.	54351.7041	-.0001110	644.6993	-775.7706
36.000	.007869	2137812.	45078.0242	-.0001060	665.3442	-769.8428
48.000	.006632	2627376.	35899.2618	-9.9465E-05	682.1710	-759.9510
60.000	.005482	3007224.	26864.3088	-9.1780E-05	695.2268	-745.8745
72.000	.004430	3279344.	18025.0382	-8.3206E-05	704.5798	-727.3373
84.000	.003485	3446375.	9437.1586	-7.4032E-05	710.3208	-703.9760
96.000	.002653	3511664.	1161.6146	-6.4542E-05	712.5649	-675.2813
108.000	.001936	3479335.	-6732.9515	-5.5007E-05	711.4537	-640.4797
120.000	.001333	3354403.	-15448.3830	-4.5686E-05	707.1597	-812.0922
132.000	.000839	3112170.	-23466.5469	-3.6866E-05	698.8339	-524.2684
144.000	.000448	2794108.	-28331.7374	-2.8811E-05	687.9018	-286.5967
156.000	.000148	2434476.	-30632.7892	-2.1679E-05	675.5409	-96.9120
168.000	-7.24E-05	2060628.	-30923.2791	-1.5548E-05	662.6913	48.4970
180.000	-.000225	1693542.	-29706.0306	-1.0428E-05	650.0742	154.3778
192.000	-.000323	1348504.	-27423.3533	-6.2785E-06	638.2149	226.0684

204.000	-.000376	1035875.	-24452.2086	-3.0264E-06	627.4695	269.1223
216.000	-.000395	761889.	-21103.4428	-5.7438E-07	618.0524	289.0053
228.000	-.000390	529438.	-17624.2372	1.1869E-06	610.0628	290.8623
240.000	-.000367	338814.	-14202.9668	2.3711E-06	603.5108	279.3494
252.000	-.000333	188380.	-10975.7362	3.0902E-06	598.3403	258.5224
264.000	-.000293	75153.1324	-8144.5145	3.4496E-06	594.4485	213.3479
276.000	-.000250	-7359.8024	-5901.2363	3.5421E-06	592.1184	160.5318
288.000	-.000208	-66755.3725	-4122.8138	3.4410E-06	594.1599	135.8720
300.000	-.000167	-106578.	-2637.8354	3.2046E-06	595.5287	111.6244
312.000	-.000131	-130316.	-1435.5579	2.8815E-06	596.3447	88.7552
324.000	-9.82E-05	-141258.	-495.4432	2.5111E-06	596.7207	67.9306
336.000	-7.04E-05	-142404.	209.5041	2.1242E-06	596.7600	49.5606
348.000	-4.73E-05	-136398.	709.9259	1.7439E-06	596.5536	33.8430
360.000	-2.86E-05	-125503.	1037.8261	1.3867E-06	596.1791	20.8070
372.000	-1.40E-05	-111599.	1224.7892	1.0633E-06	595.7012	10.3535
384.000	-3.04E-06	-96191.8177	1300.6602	7.7990E-07	595.1717	2.2917
396.000	4.74E-06	-80444.4286	1292.6333	5.3898E-07	594.6304	-3.6295
408.000	9.89E-06	-65211.0472	1224.6900	3.4032E-07	594.1068	-7.6944
420.000	1.29E-05	-51078.6573	1117.3254	1.8170E-07	593.6211	-10.1997
432.000	1.43E-05	-38409.5405	987.5012	5.9649E-08	593.1856	-11.4377
444.000	1.43E-05	-27383.3251	848.7688	-3.0088E-08	592.8067	-11.6844
456.000	1.35E-05	-18036.7199	708.9496	-9.2038E-08	592.4854	-11.6188
468.000	1.21E-05	-10361.2886	576.0361	-1.3077E-07	592.2216	-10.5334
480.000	1.04E-05	-4201.5603	458.0938	-1.5063E-07	592.0099	-9.1236
492.000	8.52E-06	644.8213	358.0020	-1.5548E-07	591.8876	-7.5584
504.000	6.66E-06	4402.7275	260.6481	-1.4860E-07	592.0168	-8.6673
516.000	4.95E-06	6912.0739	149.5144	-1.3317E-07	592.1030	-9.8550
528.000	3.47E-06	8001.5563	48.4071	-1.1283E-07	592.1405	-6.9962
540.000	2.24E-06	8082.7267	-21.1105	-9.0888E-08	592.1433	-4.5901
552.000	1.28E-06	7502.0583	-64.6368	-6.9632E-08	592.1233	-2.6643
564.000	5.71E-07	6536.9251	-87.8300	-5.0484E-08	592.0901	-1.2012
576.000	7.24E-08	5398.1125	-95.9628	-3.4205E-08	592.0510	-.1542339
588.000	-2.50E-07	4236.5107	-93.6531	-2.1064E-08	592.0111	.5391772
600.000	-4.33E-07	3152.0955	-84.7342	-1.0987E-08	591.9738	.9473111
612.000	-5.13E-07	2203.7547	-72.2274	-3.6817E-09	591.9412	1.1372
624.000	-5.22E-07	1418.9272	-58.3865	1.2594E-09	591.9142	1.1697
636.000	-4.83E-07	802.3805	-44.7854	4.2891E-09	591.8930	1.0772
648.000	-4.19E-07	343.7405	-32.4294	5.8523E-09	591.8773	.9621530
660.000	-3.43E-07	23.6136	-21.8724	6.3533E-09	591.8663	.7973486
672.000	-2.66E-07	-181.6976	-13.3294	6.1377E-09	591.8717	.6264934
684.000	-1.95E-07	-296.7742	-6.7772	5.4851E-09	591.8757	.4655359
696.000	-1.34E-07	-344.7819	-2.0396	4.6101E-09	591.8773	.3240536
708.000	-8.48E-08	-346.0887	1.1448	3.6678E-09	591.8774	.2066910
720.000	-4.64E-08	-317.5949	3.0719	2.7626E-09	591.8764	.1144968
732.000	-1.85E-08	-272.5795	4.0355	1.9576E-09	591.8748	.0460916
744.000	5.44E-10	-220.8976	4.3038	1.2846E-09	591.8731	-.0013719
756.000	1.23E-08	-169.3896	4.1068	7.5223E-10	591.8713	-.0314616
768.000	1.86E-08	-122.3938	3.6305	3.5426E-10	591.8697	-.0479194
780.000	2.08E-08	-82.2853	3.0173	7.5093E-11	591.8683	-.0542898
792.000	2.04E-08	-49.9857	2.3693	-1.0532E-10	591.8672	-.0536950
804.000	1.83E-08	-25.4128	1.7548	-2.0815E-10	591.8663	-.0487232
816.000	1.54E-08	-7.8534	1.2141	-2.5353E-10	591.8657	-.0414001
828.000	1.22E-08	3.7454	.7663890	-2.5913E-10	591.8656	-.0332172
840.000	9.19E-09	10.5604	.4159163	-2.3962E-10	591.8658	-.0251949
852.000	6.48E-09	13.7462	.1569789	-2.0646E-10	591.8659	-.0179614
864.000	4.23E-09	14.3441	-.0218129	-1.6815E-10	591.8660	-.0118373
876.000	2.45E-09	13.2359	-.1343290	-1.3053E-10	591.8659	-.0069154
888.000	1.10E-09	11.1305	-.1946087	-9.7300E-11	591.8658	-.0031312
900.000	1.12E-10	8.5730	-.2153289	-7.0426E-11	591.8658	-.0003222
912.000	-5.93E-10	5.9682	-.2069115	-5.0593E-11	591.8657	.0017251
924.000	-1.10E-09	3.6111	-.1771358	-3.7527E-11	591.8656	.0032375
936.000	-1.49E-09	1.7198	-.1311438	-3.0256E-11	591.8655	.0044278
948.000	-1.83E-09	.4660217	-.0717498	-2.7275E-11	591.8655	.0054712
960.000	-2.15E-09	0.0000	0.0000	-2.6639E-11	591.8655	.0064871

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection              =      .01191632 in
Computed slope at pile head       =     -.00011532
Maximum bending moment            =      3511664. lbs-in
Maximum shear force               =    73000.00000 lbs
Depth of maximum bending moment   =    96.00000000 in
Depth of maximum shear force      =       0.00000 in
Number of iterations              =            13
Number of zero deflection points  =             5
```

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 155000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 3280000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress p lbs/in**2	Soil Res p lbs/in
0.000	.061671	-2.5437E-06	155000.	-.0004454	591.8655	-1171.8671
12.000	.056327	1793156.	140866.	-.0004429	653.4980	-1183.7901
24.000	.051041	3415653.	126610.	-.0004358	709.2649	-1192.2361
36.000	.045867	4866102.	112274.	-.0004245	759.1183	-1197.0716
48.000	.040852	6143650.	97902.6942	-.0004095	803.0289	-1198.1551
60.000	.036038	7248004.	83541.7537	-.0003913	840.9866	-1195.3349
72.000	.031462	8179452.	69239.0720	-.0003702	873.0014	-1188.4454
84.000	.027153	8938885.	55044.5844	-.0003469	899.1039	-1177.3026
96.000	.023137	9527827.	41010.5824	-.0003217	919.3464	-1161.6978
108.000	.019433	9948462.	27192.0701	-.0002951	933.8041	-1141.3876
120.000	.016054	1.0204E+07	13647.2709	-.0002676	942.5758	-1116.0789
132.000	.013010	1.0297E+07	438.3659	-.0002397	945.7859	-1085.4052
144.000	.010302	1.0233E+07	-12367.3827	-.0002117	943.5859	-1048.8862
156.000	.007930	1.0017E+07	-24695.8423	-.0001840	936.1567	-1005.8571
168.000	.005885	9654843.	-36462.9803	-.0001572	923.7121	-955.3326
180.000	.004157	9154173.	-47569.3144	-.0001316	906.5036	-895.7231
192.000	.002728	8523536.	-57888.5615	-.0001074	884.8280	-824.1515
204.000	.001578	7773306.	-69612.2740	-8.5220E-05	859.0418	-1129.8006
216.000	.000683	6859550.	-79385.7530	-6.5262E-05	827.6351	-499.1125
228.000	1.17E-05	5873185.	-82432.9386	-4.7896E-05	793.7327	-8.7517
240.000	-.000467	4884930.	-80351.7657	-3.3222E-05	759.7654	355.6139
252.000	-.000786	3947358.	-74556.0918	-2.1176E-05	727.5401	610.3318
264.000	-.000975	3097250.	-66628.1230	-1.1567E-05	698.3211	710.9964
276.000	-.001063	2349194.	-58265.3771	-4.1389E-06	672.6096	682.7946
288.000	-.001074	1699207.	-49949.1477	1.3828E-06	650.2689	703.2436
300.000	-.001030	1150305.	-41608.4185	5.2693E-06	631.4026	686.8779
312.000	-.000948	700190.	-33624.0891	7.7933E-06	615.9317	643.8437
324.000	-.000843	342714.	-26263.4050	9.2157E-06	603.6449	582.9370

336.000	-.000727	69143.1456	-19696.5054	9.7775E-06	594.2420	511.5463
348.000	-.000608	-130772.	-14013.2094	9.6934E-06	596.3602	435.6697
360.000	-.000494	-267937.	-9239.2448	9.1496E-06	601.0747	359.9910
372.000	-.000389	-353234.	-5351.3312	8.3024E-06	604.0065	287.9946
384.000	-.000295	-397022.	-2290.7175	7.2791E-06	605.5115	222.1077
396.000	-.000214	-408785.	25.0594	6.1800E-06	605.9158	163.8551
408.000	-.000147	-396908.	1692.2922	5.0811E-06	605.5076	114.0170
420.000	-9.21E-05	-368569.	2813.0801	4.0370E-06	604.5336	72.7810
432.000	-4.97E-05	-329711.	3489.0655	3.0846E-06	603.1980	39.8832
444.000	-1.81E-05	-285075.	3816.7660	2.2461E-06	601.6638	14.7335
456.000	4.20E-06	-238286.	3883.5061	1.5323E-06	600.0556	-3.6102
468.000	1.87E-05	-191991.	3764.4698	9.4542E-07	598.4644	-16.2292
480.000	2.69E-05	-148013.	3525.4362	4.8168E-07	596.9528	-23.6097
492.000	3.03E-05	-107419.	3222.6876	1.3329E-07	595.5575	-26.8484
504.000	3.01E-05	-70678.9621	2826.6642	-1.0963E-07	594.2948	-39.1555
516.000	2.76E-05	-39570.0780	2261.7971	-2.6000E-07	593.2255	-54.9890
528.000	2.39E-05	-16375.3637	1642.9131	-3.3630E-07	592.4283	-48.1583
540.000	1.95E-05	-113.6899	1113.8542	-3.5879E-07	591.8694	-40.0182
552.000	1.52E-05	10385.3812	683.9752	-3.4478E-07	592.2224	-31.6283
564.000	1.13E-05	16328.8563	351.9351	-3.0835E-07	592.4267	-23.7117
576.000	7.84E-06	18856.0970	109.3953	-2.6036E-07	592.5136	-16.7116
588.000	5.03E-06	18974.8383	-55.9862	-2.0876E-07	592.5176	-10.8519
600.000	2.83E-06	17528.8626	-158.2563	-1.5897E-07	592.4679	-6.1931
612.000	1.21E-06	15189.2011	-211.5093	-1.1435E-07	592.3875	-2.6824
624.000	8.76E-08	12461.6398	-228.7821	-7.6631E-08	592.2938	-.1963705
636.000	-6.28E-07	9704.4631	-221.4036	-4.6398E-08	592.1990	1.4261
648.000	-1.03E-06	7151.6060	-198.6968	-2.3408E-08	592.1113	2.3583
660.000	-1.19E-06	4937.5815	-167.9383	-6.9192E-09	592.0352	2.7681
672.000	-1.19E-06	3121.6324	-134.4910	4.0730E-09	591.9728	2.8064
684.000	-1.09E-06	1709.4767	-102.0434	1.0662E-08	591.9242	2.6015
696.000	-9.36E-07	671.7526	-72.8978	1.3910E-08	591.8885	2.2561
708.000	-7.58E-07	-41.1644	-48.2706	1.4770E-08	591.8669	1.8484
720.000	-5.82E-07	-487.9037	-28.5750	1.4049E-08	591.8822	1.4342
732.000	-4.21E-07	-728.0704	-13.6705	1.2390E-08	591.8905	1.0499
744.000	-2.84E-07	-816.9722	-3.0703	1.0283E-08	591.8935	.7168063
756.000	-1.74E-07	-802.5661	3.8962	8.0738E-09	591.8930	.4442696
768.000	-9.06E-08	-724.0991	7.9617	5.9916E-09	591.8903	.2333140
780.000	-3.05E-08	-611.9571	9.8382	4.1693E-09	591.8865	.0794403
792.000	9.51E-09	-488.3100	10.1646	2.6686E-09	591.8822	-.0250391
804.000	3.35E-08	-368.2161	9.4791	1.5004E-09	591.8781	-.0892218
816.000	4.55E-08	-260.9306	8.2097	6.4226E-10	591.8744	-.1223428
828.000	4.90E-08	-171.2345	6.6780	5.2816E-11	591.8713	-.1329353
840.000	4.68E-08	-100.6626	5.1103	-3.1803E-10	591.8689	-.1283427
852.000	4.13E-08	-48.5613	3.6533	-5.2156E-10	591.8671	-.1144999
864.000	3.43E-08	-12.9427	2.3908	-6.0545E-10	591.8659	-.0959058
876.000	2.68E-08	8.8658	1.3611	-6.1101E-10	591.8658	-.0757235
888.000	1.96E-08	19.7712	.5710019	-5.7195E-10	591.8661	-.0559553
900.000	1.31E-08	22.6158	.0093455	-5.1414E-10	591.8662	-.0376541
912.000	7.27E-09	20.0359	-.3434455	-4.5596E-10	591.8661	-.0211444
924.000	2.12E-09	14.4090	-.5077522	-4.0898E-10	591.8660	-.0062400
936.000	-2.55E-09	7.8821	-.4998874	-3.7858E-10	591.8657	.0075508
948.000	-6.96E-09	2.4415	-.3296149	-3.6450E-10	591.8655	.0208280
960.000	-1.13E-08	0.0000	0.0000	-3.6117E-10	591.8655	.0341079

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

```
Pile-head deflection              =      .06167129 in
Computed slope at pile head       =     -.00044538
Maximum bending moment            =      10297064. lbs-in
```



```
Maximum shear force               =   155000.00000 lbs
Depth of maximum bending moment   =     132.00000 in
Depth of maximum shear force      =       0.00000 in
Number of iterations              =            15
Number of zero deflection points  =             5
```

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 73000.	M= 0.000	3280000.	.0119163	3511664.	73000.0000
1	V= 1.55E+05	M= 0.000	3280000.	.0616713	1.0297E+07	155000.

Bent 2 - Left & Right Bridges

Based on borings AST-154A & AST-155A

84-in. Diameter CIDH Pile

$A = 5541.8\ in^2$; $I = 1221960\ in^4$

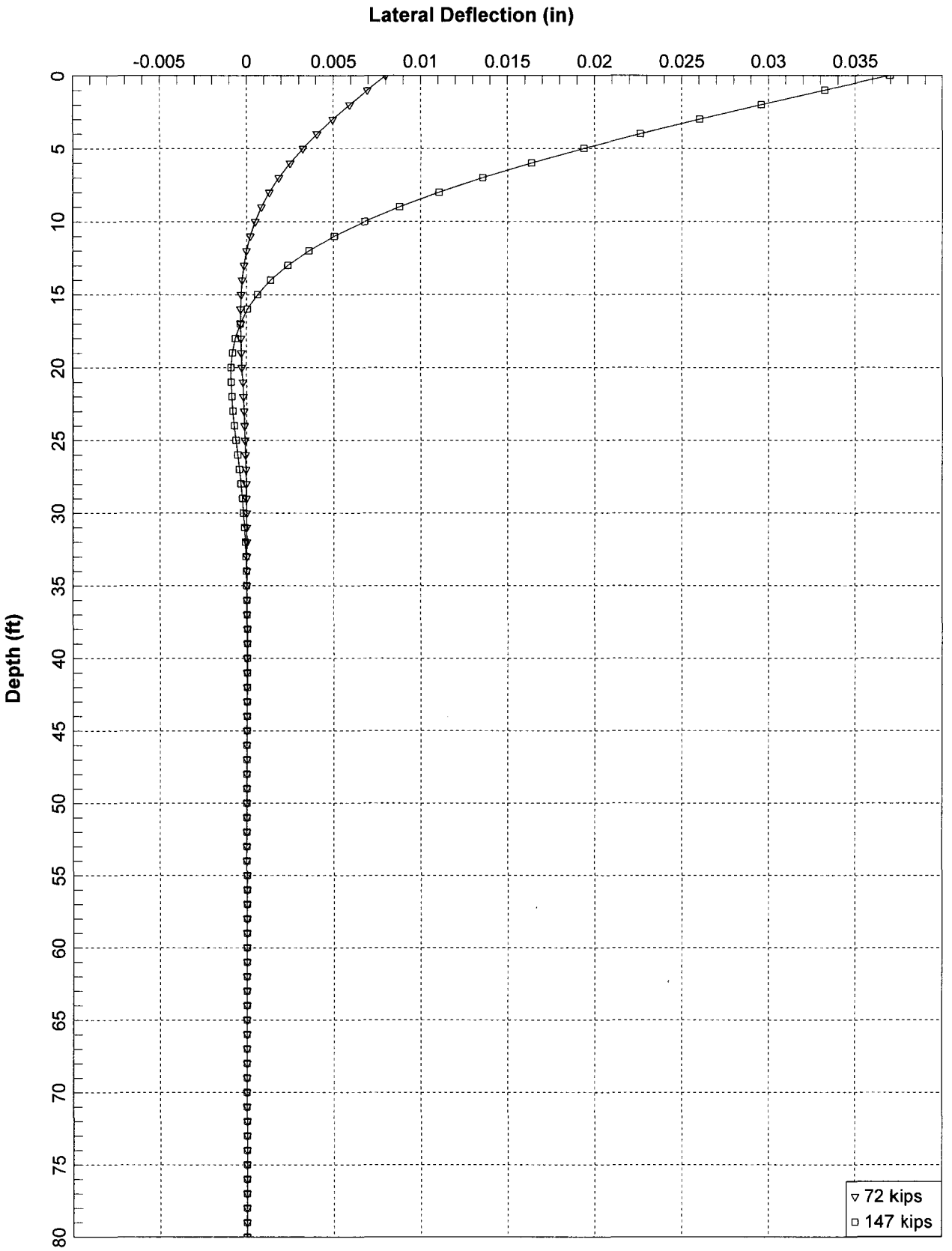
(Note: ϵ_{50} reduced for large diameter pile)

Longitudinal Loading

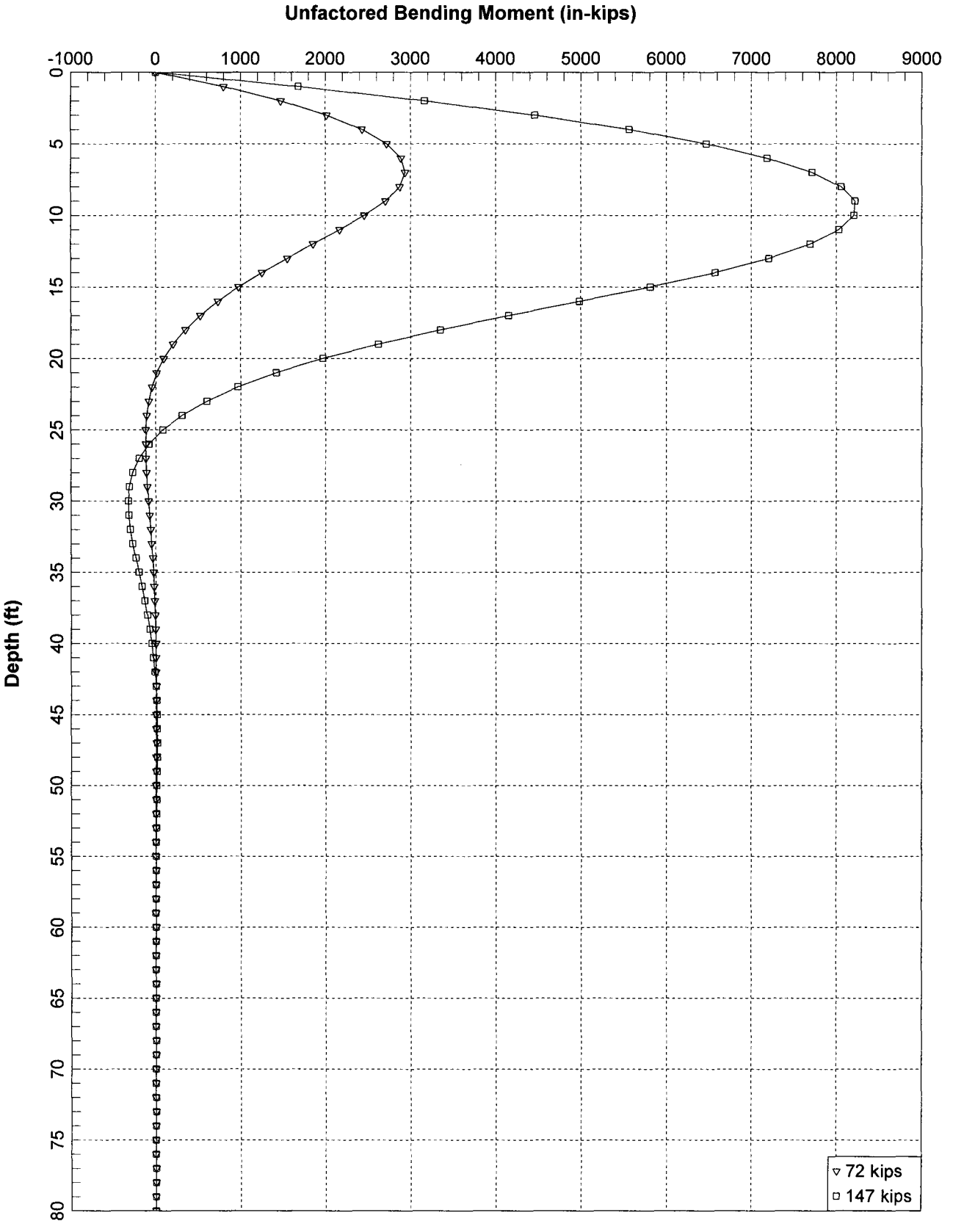
Group Reduction Factor = 0.80

EL. 44.0

Depths -24 - 264 = Stiff Clay w/o free water		$S_u = 3.5$ ksf $\gamma' = 125$ pcf $\epsilon_{50} = 0.00267$
Depths 264 - 456 = Stiff Clay w/o free water		$S_u = 2.5$ ksf $\gamma' = 125$ pcf $\epsilon_{50} = 0.00267$
Depths 456 - 504 = Stiff Clay w/o free water	$S_u = 2.5$ ksf	$\gamma' = 65$ pcf $\epsilon_{50} = 0.00267$
Depths 504 - 1200 = Stiff Clay w/o free water		$S_u = 8.0$ ksf $\gamma' = 125$ pcf $\epsilon_{50} = 0.0021$



Lone Tree Way - A Street UC @ SR4 - Left & Right Bridges - Bent 2 - 84-in CIDH Pile - Longitudinal



Lone TRee Way - A Street UC @ SR4 - Left & Right Bridges - Bent 2 - 84-in CIDH Pile - Longitudinal

LPILE Plus for Windows, Version 5.0 (5.0.21)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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Gary Parikh
Parikh Consultants

Path to file locations: S:\Ongoing Projects\2006\206117 TYLIn Rte 4 Project\A St_Lone Tree\LPILE\
Name of input data file: A Street - Bent 2--long.lpd
Name of output file: A Street - Bent 2--long.lpo
Name of plot output file: A Street - Bent 2--long.lpp
Name of runtime file: A Street - Bent 2--long.lpr

Time and Date of Analysis

Date: August 24, 2009 Time: 16:32:32

Problem Title

SR4 - A Street - Bent 2 - 84-in CIDH Pile - Longitudinal

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant 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 pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 80
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 960.00 in
Depth of ground surface below top of pile = -24.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	84.00000000	1221960.	5541.8000	3600000.
2	960.0000	84.00000000	1221960.	5541.8000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -24.000 in
Distance from top of pile to bottom of layer = 264.000 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 264.000 in
Distance from top of pile to bottom of layer = 456.000 in

Layer 3 is stiff clay without free water
Distance from top of pile to top of layer = 456.000 in
Distance from top of pile to bottom of layer = 504.000 in

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 504.000 in
Distance from top of pile to bottom of layer = 1200.000 in

(Depth of lowest layer extends 240.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth is defined using 8 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-24.00	.07230
2	264.00	.07230
3	264.00	.07230
4	456.00	.07230
5	456.00	.03760
6	504.00	.03760
7	504.00	.03760
8	1200.00	.03760

Shear Strength of Soils

Distribution of shear strength parameters with depth defined using 8 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-24.000	24.31000	.00	.00267	.0
2	264.000	24.31000	.00	.00267	.0
3	264.000	17.36000	.00	.00267	.0
4	456.000	17.36000	.00	.00267	.0
5	456.000	17.36000	.00	.00267	.0
6	504.000	17.36000	.00	.00267	.0
7	504.000	55.55000	.00	.00210	.0
8	1200.000	55.55000	.00	.00210	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.8000	1.0000
2	960.000	.8000	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 72000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 3280000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 147000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 3280000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

**** WARNING ****

An unreasonable input value for shear strength has been specified for layer 4 defined using the stiff clay without free water criteria. The input value is greater than 55.55 psi (8000 psf). You should check your input data for correctness.

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 72000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 3280000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.008002	3.7096E-07	72000.0000	-8.7110E-05	591.8655	-906.9355
12.000	.006957	802129.	61128.9433	-8.6016E-05	619.4354	-904.9073
24.000	.005938	1473866.	50312.7093	-8.2912E-05	642.5237	-897.7984
36.000	.004967	2016161.	39613.5108	-7.8151E-05	661.1629	-885.4013
48.000	.004062	2430742.	29096.3535	-7.2086E-05	675.4125	-867.4582
60.000	.003237	2720148.	18829.7998	-6.5061E-05	685.3597	-843.6341
72.000	.002501	2887779.	8887.2063	-5.7412E-05	691.1213	-813.4649
84.000	.001859	2937961.	-651.0960	-4.9466E-05	692.8461	-776.2522
96.000	.001313	2876047.	-9870.7271	-4.1536E-05	690.7181	-760.3530
108.000	.000862	2704333.	-17506.0442	-3.3925E-05	684.8161	-512.1998
120.000	.000499	2458572.	-22404.6776	-2.6883E-05	676.3691	-304.2391
132.000	.000217	2168737.	-25043.0579	-2.0572E-05	666.4071	-135.4910
144.000	5.57E-06	1859158.	-25877.3812	-1.5078E-05	655.7666	-3.5629
156.000	-.000145	1548867.	-25329.1214	-1.0430E-05	645.1016	94.9395
168.000	-.000245	1252080.	-23775.2243	-6.6094E-06	634.9007	164.0433
180.000	-.000304	978782.	-21542.4143	-3.5666E-06	625.5072	208.0917
192.000	-.000330	735343.	-18904.9811	-1.2287E-06	617.1399	231.4805

204.000	-.000333	525159.	-16085.3899	4.9055E-06	609.9157	238.4513
216.000	-.000319	349255.	-13257.0721	1.6832E-06	603.8697	232.9349
228.000	-.000293	206857.	-10548.7994	2.4417E-06	598.9753	218.4438
240.000	-.000260	95891.6648	-8050.1008	2.8546E-06	595.1614	198.0059
252.000	-.000224	13429.3767	-5817.2628	3.0037E-06	592.3270	174.1337
264.000	-.000188	-43959.0957	-3950.5202	2.9621E-06	593.3764	136.9900
276.000	-.000153	-81616.2838	-2538.8463	2.7908E-06	594.6707	98.2890
288.000	-.000121	-105111.	-1474.3290	2.5361E-06	595.4782	79.1306
300.000	-9.22E-05	-117200.	-630.7022	2.2329E-06	595.8937	61.4739
312.000	-6.73E-05	-120424.	12.4303	1.9088E-06	596.0045	45.7149
324.000	-4.64E-05	-117052.	479.1299	1.5849E-06	595.8886	32.0684
336.000	-2.93E-05	-109049.	795.1555	1.2765E-06	595.6136	20.6026
348.000	-1.57E-05	-98068.5127	986.3995	9.9402E-07	595.2362	11.2714
360.000	-5.42E-06	-85454.0342	1077.6997	7.4371E-07	594.8026	3.9452
372.000	2.11E-06	-72262.2650	1091.9918	5.2860E-07	594.3492	-1.5632
384.000	7.27E-06	-59287.8423	1049.7579	3.4917E-07	593.9032	-5.4758
396.000	1.05E-05	-47095.5625	968.7237	2.0407E-07	593.4842	-8.0299
408.000	1.22E-05	-36054.5381	863.7574	9.0663E-08	593.1047	-9.4644
420.000	1.27E-05	-26372.5226	746.9239	5.5171E-09	592.7719	-10.0078
432.000	1.23E-05	-18128.7998	627.6528	-5.5180E-08	592.4886	-9.8707
444.000	1.13E-05	-11304.5124	512.9820	-9.5324E-08	592.2540	-9.2411
456.000	1.00E-05	-5809.7274	405.9492	-1.1867E-07	592.0651	-8.5977
468.000	8.49E-06	-1552.3900	310.1137	-1.2871E-07	591.9188	-7.3749
480.000	6.92E-06	1643.1328	229.3944	-1.2858E-07	591.9219	-6.0783
492.000	5.41E-06	3963.1970	164.1276	-1.2094E-07	592.0017	-4.7995
504.000	4.02E-06	5591.7148	103.9358	-1.0791E-07	592.0577	-5.2325
516.000	2.82E-06	6466.1497	38.8777	-9.1460E-08	592.0877	-5.6105
528.000	1.83E-06	6531.9794	-16.9103	-7.3731E-08	592.0900	-3.6875
540.000	1.05E-06	6066.1059	-51.9143	-5.6548E-08	592.0740	-2.1465
552.000	4.69E-07	5290.4870	-70.6362	-4.1059E-08	592.0473	-.9738318
564.000	6.32E-08	4374.0684	-77.2766	-2.7877E-08	592.0158	-.1329020
576.000	-2.00E-07	3438.0422	-75.5202	-1.7222E-08	591.9836	.4256477
588.000	-3.50E-07	2562.9402	-68.4357	-9.0370E-09	591.9535	.7559289
600.000	-4.17E-07	1796.4167	-58.4283	-3.0911E-09	591.9272	.9111366
612.000	-4.24E-07	1160.9040	-47.3226	9.4247E-10	591.9054	.9398076
624.000	-3.94E-07	660.5990	-36.3818	3.4269E-09	591.8882	.8836715
636.000	-3.42E-07	287.4718	-26.4193	4.7200E-09	591.8753	.7767355
648.000	-2.81E-07	26.1635	-17.8873	5.1477E-09	591.8664	.6452676
660.000	-2.19E-07	-142.2290	-10.9654	4.9894E-09	591.8703	.5083834
672.000	-1.61E-07	-237.3990	-5.6412	4.4717E-09	591.8736	.3789917
684.000	-1.11E-07	-277.9687	-1.7778	3.7687E-09	591.8750	.2649050
696.000	-7.05E-08	-280.3622	.8315034	3.0072E-09	591.8751	.1699747
708.000	-3.90E-08	-258.2493	2.4223	2.2726E-09	591.8743	.0951529
720.000	-1.60E-08	-222.4067	3.2297	1.6170E-09	591.8731	.0394218
732.000	-2.25E-10	-180.8634	3.4696	1.0670E-09	591.8717	.0005618
744.000	9.62E-09	-139.2198	3.3275	6.3039E-10	591.8702	-.0242481
756.000	1.49E-08	-101.0530	2.9541	3.0268E-10	591.8689	-.0379887
768.000	1.69E-08	-68.3458	2.4652	7.1630E-11	591.8678	-.0434994
780.000	1.66E-08	-41.8951	1.9444	-7.8730E-11	591.8669	-.0432932
792.000	1.50E-08	-21.6741	1.4479	-1.6543E-10	591.8662	-.0394627
804.000	1.27E-08	-7.1334	1.0092	-2.0473E-10	591.8657	-.0336546
816.000	1.01E-08	2.5618	.6446950	-2.1096E-10	591.8655	-.0270890
828.000	7.59E-09	8.3559	.3585107	-1.9607E-10	591.8657	-.0206084
840.000	5.37E-09	11.1815	.1464204	-1.6942E-10	591.8658	-.0147400
852.000	3.52E-09	11.8833	-.0005972	-1.3796E-10	591.8659	-.0097629
864.000	2.06E-09	11.1780	-.0938062	-1.0651E-10	591.8658	-.0057719
876.000	9.67E-10	9.6404	-.1448416	-7.8115E-11	591.8658	-.0027340
888.000	1.88E-10	7.7080	-.1644618	-5.4453E-11	591.8657	-.0005360
900.000	-3.39E-10	5.6976	-.1618095	-3.6169E-11	591.8657	.0009781
912.000	-6.80E-10	3.8274	-.1440682	-2.3177E-11	591.8656	.0019788
924.000	-8.96E-10	2.2417	-.1164128	-1.4899E-11	591.8655	.0026304
936.000	-1.04E-09	1.0346	-.0821714	-1.0431E-11	591.8655	.0030765
948.000	-1.15E-09	.2704504	-.0431387	-8.6506E-12	591.8655	.0034290
960.000	-1.25E-09	0.0000	0.0000	-8.2817E-12	591.8655	.0037608

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection              =      .00800214 in
Computed slope at pile head       =     -.00008711
Maximum bending moment            =       2937961. lbs-in
Maximum shear force               =    72000.00000 lbs
Depth of maximum bending moment   =    84.00000000 in
Depth of maximum shear force      =       0.00000 in
Number of iterations              =            13
Number of zero deflection points  =             5
```

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 147000.00 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 3280000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. Y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress p lbs/in**2	Soil Res p lbs/in
0.000	.036977	1.6958E-06	147000.	-.0003099	591.8655	-1330.2187
12.000	.033258	1680420.	130987.	-.0003076	649.6232	-1338.6004
24.000	.029595	3167901.	114903.	-.0003009	700.7494	-1342.0315
36.000	.026036	4461790.	98809.2195	-.0002905	745.2217	-1340.3142
48.000	.022622	5562194.	82767.9449	-.0002769	783.0436	-1333.2316
60.000	.019391	6470015.	66845.3130	-.0002605	814.2464	-1320.5404
72.000	.016371	7186985.	51110.3014	-.0002418	838.8893	-1301.9615
84.000	.013587	7715700.	35635.5490	-.0002215	857.0618	-1277.1639
96.000	.011055	8059675.	20498.1264	-.0002000	868.8846	-1245.7399
108.000	.008787	8223398.	5780.7115	-.0001778	874.5119	-1207.1626
120.000	.006788	8212406.	-8426.5278	-.0001554	874.1341	-1160.7106
132.000	.005059	8033391.	-22022.7319	-.0001332	867.9812	-1105.3234
144.000	.003592	7694347.	-34890.4651	-.0001118	856.3279	-1039.2988
156.000	.002376	7204817.	-46883.6966	-9.1431E-05	839.5023	-959.5731
168.000	.001397	6576335.	-58260.2575	-7.2634E-05	817.9007	-936.5204
180.000	.000633	5812289.	-66483.9735	-5.5737E-05	791.6397	-434.0990
192.000	5.95E-05	4985108.	-69338.9291	-4.1010E-05	763.2086	-41.7270
204.000	-.000351	4151383.	-68081.5617	-2.8548E-05	734.5526	251.2882
216.000	-.000626	3353397.	-63829.1604	-1.8313E-05	707.1251	457.4454
228.000	-.000790	2620924.	-57544.2910	-1.0164E-05	681.9493	590.0329
240.000	-.000870	1973135.	-50030.3115	-3.8980E-06	659.6841	662.2971
252.000	-.000884	1420504.	-41935.7799	7.3069E-07	640.6896	686.7915
264.000	-.000852	966618.	-34087.6064	3.9866E-06	625.0891	621.2374
276.000	-.000788	602087.	-27322.5556	6.1262E-06	612.5598	506.2711
288.000	-.000705	310395.	-21516.3870	7.3707E-06	602.5340	461.4237
300.000	-.000611	85113.7670	-16301.3724	7.9102E-06	594.7909	407.7454
312.000	-.000515	-81460.9472	-11755.6867	7.9151E-06	594.6654	349.8689
324.000	-.000421	-197646.	-7907.7032	7.5345E-06	598.6587	291.4617

336.000	-.000334	-271839.	-4747.1381	6.8941E-06	601.2088	235.2992
348.000	-.000256	-312120.	-2235.1835	6.0976E-06	602.5933	183.3599
360.000	-.000188	-325963.	-313.4226	5.2273E-06	603.0691	136.9336
372.000	-.000131	-320053.	1088.5808	4.3462E-06	602.8660	96.7337
384.000	-8.37E-05	-300180.	2047.0375	3.5003E-06	602.1829	63.0091
396.000	-4.66E-05	-271200.	2638.9884	2.7209E-06	601.1869	35.6494
408.000	-1.84E-05	-237058.	2938.5652	2.0277E-06	600.0134	14.2801
420.000	2.09E-06	-200834.	3014.3240	1.4305E-06	598.7683	-1.6536
432.000	1.60E-05	-164827.	2927.5057	9.3173E-07	597.5307	-12.8161
444.000	2.45E-05	-130647.	2731.0607	5.2872E-07	596.3559	-19.9247
456.000	2.87E-05	-99323.0097	2463.8544	2.1506E-07	595.2793	-24.6097
468.000	2.96E-05	-71531.7856	2161.9122	-1.7972E-08	594.3241	-25.7140
480.000	2.82E-05	-47435.7011	1858.9385	-1.8024E-07	593.4959	-24.7816
492.000	2.53E-05	-26903.0738	1575.5801	-2.8163E-07	592.7901	-22.4448
504.000	2.15E-05	-9599.6087	1273.2965	-3.3142E-07	592.1954	-27.9358
516.000	1.73E-05	3682.1311	898.5996	-3.3949E-07	591.9920	-34.5137
528.000	1.33E-05	11993.5067	530.1323	-3.1811E-07	592.2777	-26.8975
540.000	9.70E-06	16430.3483	249.5911	-2.7934E-07	592.4302	-19.8593
552.000	6.62E-06	18005.6832	48.0327	-2.3237E-07	592.4843	-13.7337
564.000	4.12E-06	17601.4250	-86.4183	-1.8380E-07	592.4704	-8.6747
576.000	2.21E-06	15946.1138	-166.6897	-1.3805E-07	592.4135	-4.7038
588.000	8.12E-07	13611.7396	-205.4278	-9.7732E-08	592.3333	-1.7525
600.000	-1.38E-07	11023.5409	-214.1285	-6.4132E-08	592.2443	.3023987
612.000	-7.27E-07	8477.7040	-202.6471	-3.7533E-08	592.1568	1.6112
624.000	-1.04E-06	6162.9650	-178.9976	-1.7565E-08	592.0773	2.3304
636.000	-1.15E-06	4183.1451	-149.3612	-3.4532E-09	592.0092	2.6090
648.000	-1.12E-06	2578.5670	-118.2342	5.7693E-09	591.9541	2.5789
660.000	-1.01E-06	1345.0693	-88.6557	1.1121E-08	591.9117	2.3509
672.000	-8.55E-07	449.9546	-62.4723	1.3569E-08	591.8809	2.0130
684.000	-6.85E-07	-155.3338	-40.6058	1.3971E-08	591.8708	1.6314
696.000	-5.20E-07	-525.6843	-23.3021	1.3042E-08	591.8835	1.2525
708.000	-3.72E-07	-715.6114	-10.3481	1.1349E-08	591.8901	.9064555
720.000	-2.47E-07	-774.9321	-1.2500	9.3161E-09	591.8921	.6098893
732.000	-1.48E-07	-746.3455	4.6272	7.2412E-09	591.8911	.3696491
744.000	-7.36E-08	-664.4493	7.9581	5.3170E-09	591.8883	.1854936
756.000	-2.06E-08	-555.7707	9.3868	3.6527E-09	591.8846	.0526280
768.000	1.41E-08	-439.4540	9.4847	2.2953E-09	591.8806	-.0363005
780.000	3.44E-08	-328.3174	8.7288	1.2481E-09	591.8767	-.0896925
792.000	4.40E-08	-230.0613	7.4951	4.8651E-10	591.8734	-.1159254
804.000	4.61E-08	-148.4737	6.0636	-2.9787E-11	591.8706	-.1226596
816.000	4.33E-08	-84.5331	4.6289	-3.4759E-10	591.8684	-.1164463
828.000	3.78E-08	-37.3518	3.3149	-5.1383E-10	591.8667	-.1025646
840.000	3.10E-08	-4.9357	2.1894	-5.7151E-10	591.8656	-.0850210
852.000	2.41E-08	15.2379	1.2793	-5.5746E-10	591.8660	-.0666540
864.000	1.76E-08	25.8116	.5835960	-5.0147E-10	591.8663	-.0492983
876.000	1.20E-08	29.2836	.0839640	-4.2633E-10	591.8665	-.0339737
888.000	7.38E-09	27.8603	-.2463262	-3.4839E-10	591.8664	-.0210747
900.000	3.66E-09	23.3992	-.4360555	-2.7847E-10	591.8663	-.0105469
912.000	7.02E-10	17.4169	-.5115832	-2.2280E-10	591.8661	-.0020411
924.000	-1.69E-09	11.1388	-.4941053	-1.8385E-10	591.8658	.0049541
936.000	-3.71E-09	5.5728	-.3983782	-1.6106E-10	591.8657	.0110005
948.000	-5.55E-09	1.5904	-.2326979	-1.5129E-10	591.8655	.0166129
960.000	-7.34E-09	0.0000	0.0000	-1.4912E-10	591.8655	.0221700

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

```
Pile-head deflection              =      .03697665 in
Computed slope at pile head       =     -.00030985
Maximum bending moment            =       8223398. lbs-in
```



```
Maximum shear force               =   147000.00000 lbs
Depth of maximum bending moment   =      108.00000 in
Depth of maximum shear force      =       0.00000 in
Number of iterations              =            14
Number of zero deflection points  =             5
```

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 72000.	M= 0.000	3280000.	.0080021	2937961.	72000.0000
1	V= 1.47E+05	M= 0.000	3280000.	.0369767	8223398.	147000.

APPENDIX D

Office of Special Funded Projects
Comment & Response Form

General Project Information	Review Phase		Reviewer Information
Dist: _ EA: 228511 Project Name: Route 4 Widenining SEG 3A OSFP Liaison: O. Hor Phone: 916-227-8419 e-mail: overcomer_hor@dot.ca.gov	☐ PSR/PDS (Review No. _) ☐ APS/PSR (Review No. _) ☐ APS/PR (Review No. _) ☐ Type Selection	☒ 65% PS&E Unchecked Details ☐ PS&E (Review No. 1) ☐ Construction Support ☒ Other: Foundation Report	Reviewer Name: Ali Kaddoura Functional Unit: 327 Cost Center: 59 Phone Number: 510-286-4676 e-mail: ali_kaddoura@dot.ca.gov Date of Review: 02/11/09
	Structure Information (Use when necessary to document comments by individual structure) Structure Name: A Street UC Br No: 28-0401 L/R		

Consultant Information (to be filled in by Consultant)

Consultant Structure Lead (First and Last Name)	Structure Consultant Firm	Phone Number	e-mail	Response Date

#	Doc. (See Note 1)	Page, Section, or SSP	Review Comments	Consultant Responses	✓
1	FR A Street UC Bridge No. 28-0401L/R 65% PS&E		FR Prepared by Parikh Consultants Dated September 2008	No response required.	
2		Page 6	What is the reason behind using CIDH piles in lieu of as built driven piles for the abutments and bents?	Per as-built drawings, CIDH piles were used for the existing A Street Undercrossing. Text has been revised to indicate that.	
3		Appendix B	It appears that end bearing was used to calculate the pile tip elevations for the abutments. Caltrans policy neglects end bearing in the design.	No. End bearing was not used to calculate pile tip elevations for abutments.	
4		Appendix B	Unit weight of 139 pcf was used in the	Agreed. The input has been revised and the calculations	

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓ = Comment Resolved (for Reviewer's use)

		Abutment 1 Shaft Analyses	calculations in lieu of 130 pcf as shown on SHAFT program inputs and outputs.	have been reperformed.	
5	FR A Street UC Bridge No. 28-0401L/R 65% PS&E		(C3) Not approved (resubmittal to GS required)	No response required.	

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved (for Reviewer's use)

Office of Special Funded Projects
Comment & Response Form

General Project Information	Review Phase		Reviewer Information
Dist: _ EA: 228511 Project Name: Route 4 Widenining SEG 3A OSFP Liaison: O. Hor Phone: 916-227-8419 e-mail: overcomer_hor@dot.ca.gov	☐ PSR/PDS (Review No. _) ☐ APS/PSR (Review No. _) ☐ APS/PR (Review No. _) ☐ Type Selection	☐ 65% PS&E Unchecked Details ☐ PS&E (Review No. 1) ☐ Construction Support ☒ Other: Final Foundation Report	Reviewer Name: Ali Kaddoura Functional Unit: 327 Cost Center: 59 Phone Number: 510-286-4676 e-mail: ali_kaddoura@dot.ca.gov Date of Review: 11/03/09
	Structure Information (Use when necessary to document comments by individual structure) Structure Name: A Street UC (Replacement) Br No: 28-0401 L/R		

Consultant Information (to be filled in by Consultant)

Consultant Structure Lead (First and Last Name)	Structure Consultant Firm	Phone Number	e-mail	Response Date

#	Doc. (See Note 1)	Page, Section, or SSP	Review Comments	Consultant Responses	✓
1	Final FR A Street UC Replacement Bridge No. 28-0401L/R		FR Prepared by Parikh Consultants Dated September 2008	Not Required	
2		Page 2, **Purpose AND SCOPE**	For the statement" The scope of work performed...and preparation of this report." the **two** drilled borings, should corrected to **four** drilled borings. For the statement" It should be noted that recommendations for foundation support for the **left** bridge..." Why is the recommendation for the left bridge only and not for both bridges, **left and right**?	Agreed. Text will be revised. Agreed. Text will be revised to clarify.	

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved (for Reviewer's use)

3		Page6, **Seismic Sources**	In the table: - The distance between the site and Vaca Fault Zone is 5.4 miles not 3.4 miles. - The distance between the site and Great Valley Fault is 6.6 miles not 4.4 miles. Please correct and check all calculations based on these values.	Per e-mail from Hossein Salimi of Caltrans dated March 2, 2010, no further action on this comment is required.(See attached e-mail)	
4			Our previous comments have been addressed to our satisfaction.		
5	Final FR A Street UC Replacement Bridge No. 28-0401L/R		(C2) Approved subject to OSFP verification		

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved (for Reviewer's use)

Partha Sircar

From: "Hossain Salimi" <hossain_salimi@dot.ca.gov>
To: "Partha Sircar" <psircar@parikhnet.com>
Sent: Tuesday, March 02, 2010 10:53 AM
Attach: 228511GeoSeg 3A-1stPSE.pdf
Subject: Fw: SR4 Segment 3A bridges - Seismic

FYI

Hossain Salimi
Senior Materials and Research Engineer
Office of Geotechnical Design-West
(916) 227-7147
----- Forwarded by Hossain Salimi/HQ/Caltrans/CAGov on 03/02/2010 09:53 AM

Hossain Salimi/HQ/Caltrans/CAGov
02/25/2010 10:43 AM

To
Ali Kaddoura/D04/Caltrans/CAGov, Rifaat Nashed/HQ/Caltrans/CAGov
cc
Tim Pokrywka/D04/Caltrans/CAGov@DOT
Subject
Fw: SR4 Segment 3A bridges - Seismic

Gentlemen,

I am writing you in regards to the reports submitted by Parikh and our subsequent attached comments (Bridges under EA # 04-228511). Parikh had used the old 1996 Caltrans Seismic Hazard Map as well as the old Seismic Design Criteria (SDC) to produce the seismic recommendations. These bridges were type selected before the Department mandated changes to the SDC became official. In fact, their findings are more conservative compared to the new criteria. In light of this, I find it unreasonable for us to request changes to the seismic recommendations of these reports. I am satisfied with the findings in the reports and have no further comments. In the future, I will check the type selection date of each bridge to see if the changes to the new SDC are warranted.

Sincerely,

Hossain Salimi

Senior Materials and Research Engineer
Office of Geotechnical Design-West
(916) 227-7147
----- Forwarded by Hossain Salimi/HQ/Caltrans/CAGov on 02/25/2010 10:30 AM

"Partha Sircar"
<psircar@parikhne
t.com>
02/24/2010 10:13
AM

To
"Hossain Salimi"
<hossain_salimi@dot.ca.gov>
cc

Subject
SR4 Segment 3A bridges - Seismic

Hossein:

As I had discussed with you earlier, I have the same issues with the above bridges. Please call me to advise.

Partha Sircar
Parikh Consultanta
(408) - 452 -9000

----- Original Message -----
From: "Hossain Salimi" <hossain_salimi@dot.ca.gov>
To: "Rifaat Nashed" <rifaat_nashed@dot.ca.gov>; "Ali Kaddoura" <ali_kaddoura@dot.ca.gov>
Cc: "Partha Sircar" <psircar@parikhnet.com>; "Tim Pokrywka" <tim_pokrywka@dot.ca.gov>
Sent: Thursday, December 17, 2009 10:38 AM
Subject: Updated status of Somersville Rd UC replacement (04-228511)

>
> Hi Rifaat/Ali,
>
> I had a conversation with Mr. Sircar of Parikh subsequent to the e-mail I
> sent you. As it turns out, this project has been in the works for a long
> time, and the seismic analysis and design have already been completed
> using

> the old SDC. Therefore, Parikh is not required to take any further
> actions
> regarding my comments. Thank you all.
>
> Sincerely,
>
> Hossain Salimi
> Senior Materials and Research Engineer
> Office of Geotechnical Design-West
> (916) 227-7147
> ----- Forwarded by Hossain Salimi/HQ/Caltrans/CAGov on 12/17/2009 10:31
AM
> -----
>
> Hossain
> Salimi/HQ/Caltran
> s/CAGov To
> Rifaat Nashed/HQ/Caltrans/CAGov
> 11/30/2009 09:25 cc
> AM Tim Pokrywka/D04/Caltrans/CAGov@DOT
> Subject
> Somersville Rd UC replacement
> (04-228511)(Document link: Hossain
> Salimi)
>
>
>
>
>
>
>
>
>
> Hi Rifaat,
>
> I reviewed the attached documents you sent me on November 19, 2009
(Report
> containing Final Foundation Report from Parikh Consultants to Mark Thomas
> and Company Inc. for the proposed Somersville Road Undercrossing
> replacement) and have the following comments. I should note that the
> proposed bridge (28-0398L/R) is located on Route 4 and will replace the
> existing 2-span structure (28-0211R).
>
> 1. According to the report, Parikh is using the in-progress Seismic
Hazard
> Map (CSHM) . However, the distances as outlined in the table does not
> match our latest CSHM.
>
> 2. The Department has finalized the new ARS curves based on the new
> Seismic
> Design Criteria (SDC) and is now mandatory for use by both the Department
> personnel as well as our consultants effective September 30, 2009.
> However, Parikh is still using the ARS curve based on the 2001SDC which
> was

> based on Sadigh 1996 Attenuation Relationship models.
>
> To re-iterate, the Department has implemented the new SDC and the
> consultant shall re-submit the report using the now mandated seismic
> design
> criteria.
>
> Sincerely,
>
> Hossain Salimi
> Senior Materials and Research Engineer
> Office of Geotechnical Design-West
> (916) 227-7147
>
>
>
>
>
> Rifaat
> Nashed/HQ/Caltran
> s/CAGov To
> Hossain
> 11/19/2009 03:20 Salimi/HQ/Caltrans/CAGov@DOT
> PM cc
> Tim Pokrywka/D04/Caltrans/CAGov
> Subject
> Somerville Rd UC (Replacement)
>
>
>
>
>
>
>
>
>
> Hi Hossain
>
> Please find attached the Final Foundation Report for Somerville Road
> Undercrossing (Replacement) by PARIKH Consultant
>
> (See attached file: FR- Somerville Rd UC (Replacement).pdf)(See attached
> file: Appendix B- Lab Tests.pdf)(See attached file: Appendix C.pdf)
>
>
> Regards
>
> Rifaat Nashed
(See attached file: 228511GeoSeg 3A-1stPSE.pdf)

4. Foundation Report - Cavallo Road Undercrossing (Replacement) - At State Route 4 (Br. No. 28-0402 R/L) – Contra Costa County, CA

FINAL FOUNDATION REPORT
CAVALLO ROAD UNDERCROSSING (Replacement)
At State Route 4
(Bridge No. 28-0402L/R)
Contra Costa County, California
04-CC-4-R28.2 EA 2285F1

For

T. Y. Lin International
2010 Crow Canyon Place, Suite 350
San Ramon, CA 94583

PARIKH CONSULTANTS, INC.
1243 Alpine Road, Suite 110
Walnut Creek, California
(925) 933-6336

April 2010 Job No. 206117.CAV

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Appendix B Laboratory Test Data
Appendix C Calculations
Appendix D Caltrans Comments and Responses

FINAL FOUNDATION REPORT
CAVALLO ROAD UNDERCROSSING AT STATE ROUTE 4
(BRIDGE NO. 28-0402L/R)
ANTIOCH, CONTRA COSTA COUNTY, CALIFORNIA

04-CC-4-R28.2 EA 2285F1

INTRODUCTION

This report presents the results of our geotechnical engineering investigation for the proposed new bridges along eastbound State Route 4 over Cavallo Road in Antioch, Contra Costa County, CA. Our work was performed generally in accordance with the scope of work as per our agreement. The general location of the site and its vicinity are shown on the Project Location Map, Plate 1.

The geotechnical recommendations presented in this report are intended for design input and are not intended to be used as specifications. These recommendations should not be used for direct bidding purposes.

PROPOSED CONSTRUCTION

Based on the plans provided by T. Y. Lin International in their Type Selection Report, the proposed construction consists of demolition of the existing left and right bridges for the Cavallo Road Undercrossing at State Route 4 in Antioch, Contra Costa County, California and replacement by new bridges. The new bridges will be single span cast-in-place, prestressed concrete box girder structures, each 130 feet long and 83 feet wide. The bridges will accommodate five 12-foot lanes with two 10-foot shoulders. The superstructures will be supported on open face abutments in approach fill embankments. The abutments will be supported on 24-inch diameter cast-in-drilled-hole (CIDH) piles.

PURPOSE AND SCOPE

The purpose of this investigation was to evaluate the general soil conditions at the project site, to evaluate their engineering properties, and to provide recommendations for foundation support of the proposed project.

The scope of work performed for this investigation included a review of the readily available soils and geologic literature, obtaining representative soil samples and logging soil materials encountered in two drilled borings, laboratory testing of the collected samples, engineering analysis of the field and laboratory data, and preparation of this report. The basis for this investigation is the preliminary plans provided to us by T. Y. Lin International. We have presented the descriptive log of the borehole in Appendix A.

Due to limitations inherent in geotechnical investigations, it is neither uncommon to encounter unforeseen variations in the soil conditions during construction nor is it practical to determine all such variations during an acceptable program of drilling and sampling for a project of this scope. Such variations, when encountered, generally require additional engineering services to attain a properly constructed project. We, therefore, recommend that a contingency fund be provided to accommodate any additional charges resulting from technical services that may be required during construction.

Our recommendations in this report are based on the above information. Any major deviation should be reported to this office for consideration.

SITE CONDITIONS

The project is located at the crossing of Cavallo Road and State Route 4, in the City of Antioch, Contra Costa County. Per the As-Built drawings, the existing bridges (which will be demolished) were constructed in 1969. They are single span, cast-in-place prestressed concrete structures, 117 feet long and 39 feet wide, each carrying two 12-ft wide traffic lanes and have a 10-ft shoulder adjacent to the outer lane and a 5-ft shoulder adjacent to the inner lane. Railing (Type 9) barriers are present on the outside edges of the shoulders. The abutments are founded on spread footings. Design footing pressures of 1.5 tsf are noted in the as-built drawings.

The existing bridge abutments are on approach fill. The top of the fill is at an approximate elevation of 60 feet, which is approximately 10 to 15 feet above adjacent ground. To accommodate the wider new bridges, additional fill will be required on both sides of the existing bridges.

FIELD EXPLORATION AND LABORATORY TESTING

Field Exploration

The exploration program was based on the proposed plans, discussions with design engineer, and readily available data of the existing undercrossing. Two (2) exploratory borings were drilled in September, 2006, one near each abutment. Borings were drilled from the top of the embankment to depths of approximately 100 feet. The test borings were advanced with a truck-mounted drill rig, using the hollow stem auger drilling method. The boring locations are shown on the plan portion of the Log of Test Borings in Appendix A.

Selected samples were generally obtained from 3.0-inch O.D. & 2.5 inches I.D. (Modified California) samplers at various depths. Occasionally, 2.0-inch O.D. & 1.4-inch I.D. (Standard Penetration Test) sampler was used, particularly in the dense granular layers and hard clays below 70 feet. The samplers were driven in subsurface soils under the impact of a 140-lb hammer having a free fall of 30 inches. The blow counts are presented on the "Log of Test Borings". (When correlating standard penetration data in similar soils, the blow counts for the Modified California Sampler can be taken as roughly 1.6 times that for the Standard Penetration Test in similar soils). The samples were sealed and transported to our laboratory for further evaluation and testing. The field investigation was conducted under the supervision of our field engineer who logged the test borings and prepared the samples for subsequent laboratory testing and evaluation.

Laboratory Testing

Laboratory tests were performed on selected samples obtained during field exploration to determine the physical and engineering properties of the subsoils. Laboratory data of moisture contents, dry density, Atterberg Limits and unconfined compression tests are presented on the Log of Test Borings. A detailed description of laboratory testing performed is presented in Appendix B.

Boring Logs

The bore logs presented in Appendix A were prepared from the field logs which were edited after visual re-examination of the soil samples in the laboratory and results of classification tests on selected soil samples as indicated on the logs. The abrupt stratum changes shown on the log may be gradual and relatively minor changes in soil types within a stratum may not be noted on the log due to field limitations. Appendix A also includes log of test borings available from as-built drawings for the existing undercrossing.

SUBSURFACE CONDITIONS

Subsurface conditions in both the borings drilled indicate predominantly lean clays and sandy clays with occasional layers of sandy soils. The clays are generally very stiff to a depth of 30 feet, turning to hard clays below that depth. A layer of very dense poorly graded sand with silt and gravel, over 15 feet thick was encountered at a depth of approximately 70 feet in boring CAV-168 on the west end of the bridge. All other sandy layers encountered in the two borings were 10 feet thick or less. Below a depth of approximately 70 feet, very dense/very hard sand and clay layers were encountered, which were judged to belong to the Tulare Formation (Pliocene). A single boring log, drilled in 1957, is shown on the as-built plans. The boring log indicates predominantly silts with interbedded sand layers. The discrepancies between the current and As-built boring logs may be attributed to changes in soil classification over the years.

During field exploration, groundwater was encountered at elevations ranging from 4.5 feet to 5.5 feet in the two borings. However, the groundwater may vary with the passage of time due to seasonal groundwater fluctuation, surface and subsurface flows, ground surface run-off and other factors that may not be present at the time of investigation.

GEOLOGY

General geologic features pertaining to the site were evaluated with reference to the "Geologic Map of Quaternary Geology of Contra Costa County and Surrounding Areas, CA: Derived from Digital Database open-file 97-98" by E.J. Helley and R.W. Graymer 1997; Scale 1:100000. Based on the

map, the site is located in an area covered by Pleistocene alluvial deposits (Qpaf). A geologic map of the general project area is shown on Plate 2. Description of the main geologic units is as follows:

> *Qpaf (Alluvial Fans and Fluvial Deposits (Pleistocene)) – Brown dense gravely and clayey sand or clayey gravel that fines upward to sandy clay. These deposits display various sorting and are located in most stream channels in the county. All Qpaf deposits can be related to modern stream courses. They are distinguished from younger alluvial fans and fluvial deposits by higher topographic position, greater degree of dissection, and stronger soil profile development. They are less permeable than Holocene deposits, and locally contain fresh water mollusks and extinct late Pleistocene vertebrate fossils. They are overlain by Holocene deposits on lower parts of the alluvial plain, and incised by channels that are partly filled with Holocene alluvium on higher parts of the alluvial plain. Maximum thickness is unknown but at least 50m (150 feet).*

Another map ('Preliminary geologic map emphasizing bedrock formations in Contra Costa County: A digital database', compiled by Graymer, Jones and Brabb (USGS Open File Report 94-622) was also considered for additional information for the bedrock. Bedrock (Tulare Formation) exposed at the surface is noted to the south of the site. The rock has a shallow dip towards the north and is therefore expected to underlie the hard Pleistocene clays at the site. Description of the rock is as follows:

> *Ttu (Tulare Formation (Pliocene) – Poorly consolidated, non-marine, gray to maroon siltstone, sandstone, and conglomerate. This formation contains tuff correlated with the Putah tuff.*

EARTHQUAKE CONSIDERATIONS

Seismic Sources

The project is located in a seismically active part of Northern California. Many faults exist in the area, which are capable of producing earthquakes which may cause strong ground shaking at the site.

Applicable major faults in the vicinity of the project site were identified and their associated maximum earthquake magnitudes were established using the In-Progress Seismic Hazard Map currently under development by Caltrans and the associated Data Base. The documents were supplied to us by Caltrans, with the understanding that the fault locations in the map and the associated magnitudes in the Data Base have essentially been finalized. Pertinent information is summarized below. The moment magnitudes noted in the table represent the largest earthquakes that could occur on the given fault based on the current understanding of the regional tectonic structure. A fault map of the project vicinity is shown on Plate 3.

Fault	Fault No.(1)	Fault Type	Distance from Site (miles)	Maximum Moment Magnitude
Vaca Fault Zone	14	RLSS(2)	3.4	6.9
Great Valley Fault 5	24	Reverse Fault	4.4	6.5
Greenville Fault Zone (Clayton Section)	351	RLSS	4.1	6.6
Concord Fault Zone (Ygnacio Valley Section)	341	RLSS	6.9	6.6

(1) Number of the Fault in the Data Base associated with the Caltrans In-Progress Seismic Hazard Map
(2) RLSS – Right-Lateral Strike Slip Fault

Based on the Caltrans In-Progress Seismic Hazard Map and the attenuation relationship by Sadigh et al. (1997), the controlling fault is the Vaca Fault Zone (Fault No. 14 in the map), which is associated with a Maximum Moment Magnitude (Mmax) of 6.9. A peak bedrock acceleration (PBA) of 0.50g is anticipated at the site.

Seismic Hazards/Liquefaction Impact

Potential seismic hazards may arise from three sources: surface fault rupture, ground shaking and liquefaction. Since no active faults pass through the site, the potential for fault rupture is relatively low. Based on available geological and seismic information, the possibility of the site to experience strong ground shaking may be considered significant.

Liquefaction is a phenomenon in which saturated soils are subject to a temporary but essentially total loss of shear strength under the reversing, cyclic shear stresses associated with earthquake

shaking. Submerged, cohesionless sands and silts of low relative density are the type of soils which usually are susceptible to liquefaction - the susceptibility increases with decreasing relative density (reflected by the number of blows to drive a sampler), and decreasing fines content. Accepted procedures for the assessment of liquefaction potential for cohesionless soils have evolved over the years through research and field observations (Youd et al, 2001). Recent research and field observations have shown that clays of low plasticity are also potentially liquefiable, based on the moisture content and plasticity characteristics of the clay. Procedures for the assessment of liquefaction potential for clay soils have also been established and have received general acceptance. (Bray et. al., 2004).

Potential for liquefaction at the site is low, due to the predominant presence of stiff clay soils and the relatively low groundwater table.

FINDINGS AND RECOMMENDATIONS

General

Based on the findings of the investigation, it is our opinion that the site is feasible for the planned bridge structures provided the recommendations presented in this report are incorporated into the final design and construction.

This report was prepared specifically for the proposed bridge structures according to the plans provided to us. Normal construction procedures were assumed throughout our analysis and represent one of the bases of recommendations presented herein. Our design criteria have been based upon the materials encountered at the site. Therefore, we should be notified in the event that these conditions are changed, so as to modify or amend our recommendations.

Foundations

For the proposed structure, 24-inch diameter CIDH piles are recommended for foundation support at the two abutment locations.

Pile Design

Pertinent foundation design information was provided by T. Y. Lin International (Structural Engineers for the project), which are presented in the following tables (Foundation Design Data and Foundation Design Loads).

FOUNDATION DESIGN DATA - Left Bridge

Support No	Design Method	Pile Type	Finish Grade Elev. (ft)	Pile Cut-off Elev. (ft)	Pile Cap Size (ft)		Permissible Settlement (inch)	No. of Piles per Support
					B(2)	L(3)		
Abutment 1	WSD	24-in CIDH	53.08	45.75	10	85.25	0.5(1)	28
Abutment 2	WSD	24-in CIDH	52.40	45.25	10	85.25	0.5(1)	28

Notes: (1) Per MTD 3-1 (2) B = Width (3) L = Length

FOUNDATION LOADS – Left Bridge

Support No.	Service-I Limit State (kips)			Strength Limit State (Controlling Group, kips)				Extreme Limit State (Controlling Group, kips)			
	Total Load		Permanent Loads	Compression		Tension		Compression		Tension	
	Per Supp.	Per Pile	Per Support	Per Supp.	Max. Per Pile.	Per Supp.	Max. Per Pile	Per Supp.	Max. Per Pile	Per Supp.	Max. Per Pile
Abutment 1	3664	140(1) 159(4)	3188	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Abutment 2	3664	140(1) 159(4)	3188	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Notes: (1) Group 1 Loading – 100 % of allowable; (4) Group 4 Loading – 125% of allowable

FOUNDATION DESIGN DATA - Right Bridge

Support No	Design Method	Pile Type	Finish Grade Elev. (ft)	Pile Cut-off Elev. (ft)	Pile Cap Size (ft)		Permissible Settlement (inch)	No. of Piles per Support
					B(2)	L(3)		
Abutment 1	WSD	24-in CIDH	51.88	44.75	10	85.25	0.5(1)	28
Abutment 2	WSD	24-in CIDH	51.20	44.25	10	85.25	0.5(1)	28
Notes: (1) Per MTD 3-1 (2) B = Width (3) L = Length								

FOUNDATION LOADS – Right Bridge

Support No.	Service-I Limit State (kips)			Strength Limit State (Controlling Group, kips)				Extreme Limit State (Controlling Group, kips)			
	Total Load		Permanent Loads	Compression		Tension		Compression		Tension	
	Per Supp.	Per Pile	Per Support	Per Supp.	Max. Per Pile	Per Supp.	Max. Per Pile	Per Supp.	Max. Per Pile	Per Supp.	Max. Per Pile
Abutment 1	3631	138(1) 157(4)	3155	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Abutment 2	3631	138(1) 157(4)	3155	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Notes: (1) Group 1 Loading – 100 % of allowable; (4) Group 4 Loading – 125% of allowable											

Consistent with the current Caltrans requirements, Working Stress Design (WSD) was used for the abutment and wingwall foundations. The abutment and wingwall foundations were evaluated for the foundation design data and loading condition using Caltrans November 2003 Bridge Design Specifications for foundations, using Working Stress Design (WSD) methods. The actual load demands on the piles, based upon WSD are presented in the table below.

LOAD DEMANDS – Left Bridge

Support No.	Design Method	Service Loads (kips)		Required Nominal Resistance (kips)				Required Nominal Resistance (kips)	
				Strength Limit		Extreme Limit			
		Comp.	Tens.	Comp. (ϕ=0.7)	Tens. (ϕ=0.7)	Comp. (ϕ=1.0)	Tens. (ϕ=1.0)	Comp.	Tens.
Abutment 1	WSD	140	0	N/A	N/A	N/A	N/A	280	0
Abutment 2	WSD	140	0	N/A	N/A	N/A	N/A	280	0

LOAD DEMANDS – Right Bridge

Support No.	Design Method	Service Loads (kips)		Required Nominal Resistance (kips)				Required Nominal Resistance (kips)	
				Strength Limit		Extreme Limit			
		Comp.	Tens.	Comp. (ϕ=0.7)	Tens. (ϕ=0.7)	Comp. (ϕ=1.0)	Tens. (ϕ=1.0)	Comp.	Tens.
Abutment 1	WSD	138	0	N/A	N/A	N/A	N/A	276	0
Abutment 2	WSD	138	0	N/A	N/A	N/A	N/A	276	0

Estimation of the pile capacities was made using the site-specific subsurface conditions for the loads computed above and other pertinent information provided by the Structural Engineer. The computer program SHAFT developed by Ensoft, Inc. was used for the computations. The program computes capacities for drilled shafts (CIDH piles) based on procedures proposed by O'Neil and Reese (1999). The procedures utilize an α factor (α=0.55) for "Clay" and a β factor for "Sand" where β is a function of depths below ground surface and independent of soil friction angle The SHAFT program also computes the pile settlement and associated mobilization of shaft and end-bearing resistance, consistent with the O'Neil and Reese (1999) procedures. This feature is particularly useful for large diameter piles.

The pile data table is presented below. Pile capacity computations (SHAFT output) are presented in Appendix C. End bearing resistance was neglected in the estimation for pile capacities.

PILE DATA TABLE – Left Bridge

Location	Pile Type	Nominal Resistance (kips)		Cut-off Elev. (ft)	Design Tip Elev. (ft)[1]	Specified Tip Elev. (ft)
		Compression	Tension			
Abutment 1	24-in CIDH	280	0	45.75	17.0.0(a) 20.0 (b)	17.0
Abutment 2	24-in CIDH	280	0	45.25	21.0(a) 22.0 (b)	21.0

Notes:
1. Design Tip Elevation is controlled by the following demands: (a) Compression; (b) Lateral Loads (75 kips)

PILE DATA TABLE – Right Bridge

Location	Pile Type	Nominal Resistance (kips)		Cut-off Elev. (ft)	Design Tip Elev. (ft)[1]	Specified Tip Elev. (ft)
		Compression	Tension			
Abutment 1	24-in CIDH	280	0	44.75	16.0(a) 19.0 (b)	16.0
Abutment 2	24-in CIDH	280	0	44.25	20.0(a) 21.0 (b)	20.0

Notes:
1. Design Tip Elevation is controlled by the following demands: (a) Compression; (b) Lateral Loads (75 kips)

CIDH Pile Installation

Caltrans standard specification for "Cast-in-Place Concrete Piling" should be used for the construction of CIDH piles. Based on the boring logs, there is only a minor possibility for groundwater to be encountered during pile construction. The construction of the CIDH piles should be in accordance with the Caltrans specifications, which include necessary QA/QC procedures. It is prudent to make the contractor aware of these conditions so that he takes appropriate steps to comply with the standards and maintain the integrity of the CIDH piles. The use of temporary steel casing should be anticipated at all times to maintain the integrity of the piles. It is also recommended that the specifications set certain criteria to pre-qualify the potential contractors.

All piles excavations should be observed by the geotechnical engineer or regulatory agency prior to the placement of reinforcement and concrete so that if conditions differ from those anticipated, appropriate recommendations can be made.

Lateral Pile Capacity

Lateral load analyses may be performed using the LPILE program to determine the behavior of the piles under lateral loading conditions. Geotechnical parameters recommended for use in the LPILE program are presented below. The following parameters are based on field borings and laboratory testing data. The elevation information is based on the topographic information provided to us.

Geotechnical Parameters for LPILE Analysis

Abutment 1 – Left Bridge

Approx. Elev. (ft.)	Generalized Soil Profile	LPILE Soil Type	Probable Soil Strength	K (pci)	E_{50} (in/in)	Effect Unit Wt. (pci)
Above 30	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 17.36 psi	1000	.005	0.0723
10 to 30	Hard Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 27.78 psi	500	.004	0.0723
2 to 10	Dense Sand with Silt	8, API SAND	ϕ=35°	125	--	0.0752
2 to -8	Hard Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 27.78 psi	2000	.004	0.0376
Below -8	Very Dense Sand with Silt	8, API SAND	Cu = 280 psi	N/A	--	0.0405

Abutment 2 – Left Bridge

Approx. Elev. (ft.)	Generalized Soil Profile	LPILE Soil Type	Probable Soil Strength	K (pci)	E_{50} (in/in)	Effect. Unit Wt. (pci)
Above 40.5	Stiff to Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 13.89 psi	750	.006	0.0723
5.5 to 40.5	Hard Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 27.78 psi	2000	.004	0.0376
-7.5 to 5.5	Very Stiff Lean Clay	, STIFF CLAY w/o FREE WATER	Su = 17.36 psi	1000	.005	0.0376
Below -7.5	Hard Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 27.78 psi	2000	.004	0.0376

Abutment 1 – Right Bridge

Approx. Elev. (ft.)	Generalized Soil Profile	LPILE Soil Type	Probable Soil Strength	K (pci)	E_{50} (in/in)	Effect Unit Wt. (pci)
Above 29	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 17.36 psi	1000	.005	0.0723
9 to 29	Hard Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 27.78 psi	500	.004	0.0723
1 to 9	Dense Sand with Silt	8, API SAND	ϕ=35°	120	--	0.0752
-9 to 1	Hard Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 27.78 psi	2000	.004	0.0376
Below -9	Very Dense Sand with Silt	8, API SAND	Cu = 280 psi	N/A	--	0.0405

Abutment 2 – Right Bridge

Approx. Elev. (ft.)	Generalized Soil Profile	LPILE Soil Type	Probable Soil Strength	K (pci)	E_{50} (in/in)	Effect. Unit Wt. (pci)
Above 39.5	Stiff to Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 13.89 psi	750	.006	0.0723
4.5 to 39.5	Hard Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 27.78 psi	2000	.004	0.0376
-8.5 to 4.5	Very Stiff Lean Clay	, STIFF CLAY w/o FREE WATER	Su = 17.36 psi	1000	.005	0.0376
Below -8.5	Hard Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 27.78 psi	2000	.004	0.0376

Analyses were performed for the CIDH piles for the lateral loads provided by the designer. In all analyses, a 'pinned' pile head connection was assumed. The results are presented in the table below. Appropriate Group Reduction Factors were used in the analyses corresponding to the pile spacings, as noted in the table.

LATERAL LOAD (LPILE) ANALYSIS RESULTS

Support No.	CIDH Pile Diameter (inches)	Cut-off Elevation (ft)	Shear Load on top of Pile (kips)	Deflection on Top of Pile (inches)	Maximum Bending Moment	
					Magnitude (kip-ft)	At depth (ft)(1)
Left Bridge						
Abut 1	24	45.75	24	0.055	55.8	5
			34	0.121	91.2	5
			44	0.213	132.7	6
Abut 2	24	45.25	24	0.066	66.8	5
			34	0.133	107.6	6
			44	0.226	153.3	6
Right Bridge						
Abut 1	24	44.75	24	0.055	55.8	5
			34	0.121	91.2	5
			44	0.213	132.7	6
Abut 2	24	44.25	24	0.066	66.8	5
			34	0.133	107.6	6
			24	0.055	55.8	5

Notes:

(1) Depth measured from top of pile (bottom of footing)

(2) Group factors of 0.6 used for Abutments corresponding to a pile spacing of three times the diameter, consistent with Caltrans state-of-practice

(3) Loads provided by Antonio Luo

Lateral Earth Pressures

Abutment retaining walls and wing walls should be designed to resist the following Applied Lateral Earth Pressures and live load. These values assume no hydrostatic pore pressure buildup behind the wall and are based on well-drained backfill behind the walls supported in native soil.

Applied Lateral Earth Pressure

Active Condition	36 pcf Equivalent Fluid Pressure (EFP) for engineered fill
At-Rest Condition	55 pcf Equivalent Fluid Pressure (EFP) for engineered fill
Passive Resistance	310 pcf EFP with a maximum value of 3100 psf. 5 ksf (ultimate) for seismic design of the abutment backwall (5.5 feet high or greater); for activated height less than 5.5 feet modify proportionally, i.e. 5 x (H/5.5) ksf. A minimum lateral wall movement of 2% of wall height to mobilize the full ultimate passive pressure is required.

Cantilever walls which are free to rotate at least 0.004 radians may be assumed flexible for the active condition. Walls that are not capable of this movement should be assumed rigid and designed for the at-rest condition. The effect of any surcharge (dead, live, or traffic load) should be added to the preceding lateral earth pressures. A coefficient of 0.3 may be used to determine the additional earth pressure resulting from the surcharge.

Seismic Design Criteria

The value of PBA for the project site was calculated from the distances to the applicable faults in the project vicinity using the Caltrans In-Progress Seismic Hazard Map and the attenuation relation by Sadigh et al. (1997). The computed PBA value was increased by 20%, also per Sadigh (1997), to account for the reverse fault effect, wherever applicable. The PBA computations based on Sadigh attenuation relation are presented in Appendix C. Based on the computations; the maximum PBA computed within the project limit is 0.5g,

Based on the available boring information in the vicinity of the project site, the subsurface soil conditions at the project site generally matches the criteria for Soil Type D, as per Caltrans Seismic Design Criteria (Version 1.4, June 2006). Based on Caltrans Seismic Design Criteria and the above information, the seismic design criteria are as follows:

1.	Closest Distance to Fault	=	3.4 miles (5.5 km)
2.	PBA	=	0.5g
3.	Design ARS Curve	=	Caltrans Seismic Design Criteria June 2006 Version 1.4 Figure B.8 (Soil Profile Type D).

4. Design ARS Curve (see Plate 4): Curve based on Caltrans SDC (v. 1.4, 6/2006) for different structural periods. The curve is based on (Governing Fault – Vaca Fault Zone; Mmax =6.9) Figure B.8, PBA = 0.5g. The curve is modified for near fault effects as required by SDC.

A copy of the ARS Design Curve is included on Plate No. 4 of this report.

Grading

All grading operations should be performed in accordance with the project specifications and Caltrans Standard Specifications for Earthwork (Section 19). A representative from our office or regulatory agency should observe all excavated areas during grading and perform moisture and density tests on prepared subgrade and compacted fill material. Any fill material imported to the site should be non-expansive, relatively granular material having a Plasticity Index (P.I.) of less than 15. It should also be non-corrosive, free of deleterious material and should be reviewed by the Geotechnical Engineer. Should there be any alterations of the proposed construction that will affect the stated bases of our recommendations, we should be informed so that we can review such changes and amend or submit additional recommendations. Our office should review the final grading plans prior to grading to see that the intent of our recommendations is included in the plans.

Engineered Fill Engineered fill should be non-expansive and consist of relatively granular material having a P.I. of less than 15. The fill shall also be free of organic and inorganic debris, rubble and any other deleterious material. The on-site soils may be used as engineered fill, provided they meet the above criteria.

Low Expansion Materials at Abutments As per Caltrans standards, "Low Expansion Material" should be used at the abutments for the project. A schematic drawing showing standard "Limits of Low Expansion Material at Abutments" per Caltrans requirements is shown on Plate 5. The material within this limit should have Sand Equivalent (SE) more than 20 as determined in accordance with California Test Method 217 and Expansion Index (EI) less than 50 as determined in accordance with ASTM D4829. In addition, as general requirements, fill material should be free of organic material and rocks or lumps greater than 4 inches in diameter, have a plasticity index (PI) of less than 15, and compacted as per Caltrans Standard Specifications.

Approach Embankment. The maximum embankment fill thickness is anticipated to be approximately 10 feet at the two abutment locations. The approach embankment will have a 2(H): 1(V) slope on both sides. Under the bridge, paved slopes may be constructed at 1.5(H):1 (V) slope. The available boring data indicates that the subsurface soil conditions predominantly consist of stiff to very stiff clays below the fill. Based on the boring information, it appears that the consolidation settlement due to the placement of the embankment fill is anticipated to be relatively quick (during construction) and therefore insignificant. Standard Caltrans 30-day waiting period is considered adequate.

Corrosion

The corrosion investigations performed are in general accordance with the provisions of California Test Method 643. A summary of the corrosion test data is presented below.

Boring	Depth (ft)	PH	Resistivity (ohms-cm)	Sulfate (ppm)	Chloride (ppm)
CAV-168	8.5	7.61	1450	43.6	6.2

Based on the data, the site subsoil is non-corrosive per Caltrans corrosion design guidelines, and

standard Type II modified or Type I-P (MS) modified cement may be used for the concrete substructures. The minimum cement factor and cover thickness should be per Caltrans Bridge Design Specifications (Section 8.22).

Plan Review

We recommend that final plans for foundations be reviewed by this office prior to construction so that the intent of our recommendations is included in the project plans and specifications and to further see that no misunderstandings or misinterpretations have occurred.

Construction Observation

To a degree, the performance of any structure is dependent upon construction procedures and quality. Hence, observation of foundation excavations, and pile installations should be carried out by the regulating agencies. If the subsurface conditions different from those forming the basis of our recommendations is encountered this office should be informed in order to assess the need for design changes. Therefore, the recommendations presented in this report are contingent upon good quality control and these geotechnical observations during construction.

INVESTIGATION LIMITATIONS

Our services consist of professional opinions and recommendations made in accordance with generally accepted geotechnical engineering principles and practices and are based on our site reconnaissance and the assumption that the subsurface conditions do not deviate from observed conditions. All work done is in accordance with generally accepted geotechnical engineering principles and practices. No warranty, expressed or implied, of merchantability or fitness, is made or intended in connection with our work or by the furnishing of oral or written reports or findings. The scope of our services did not include any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in structures, soil, surface water, groundwater or air, below or around this site. Unanticipated soil conditions are commonly encountered and cannot be fully determined by taking soil samples and excavating test borings; different soil conditions may require that additional expenditures be made during construction to attain a

properly constructed project. Some contingency fund is thus recommended to accommodate these possible extra costs.

This report has been prepared for the proposed project as described earlier, to assist the engineer in the design of this project. In the event any changes in the design or location of the facilities are planned, or if any variations or undesirable conditions are encountered during construction, our conclusions and recommendations shall not be considered valid unless the changes or variations are reviewed and our recommendations modified or approved by us in writing.

This report is issued with the understanding that it is the designer's responsibility to ensure that the information and recommendations contained herein are incorporated into the project and that necessary steps are also taken to see that the recommendations are carried out in the field.

The findings in this report are valid as of the present date. However, changes in the subsurface conditions can occur with the passage of time, whether they are due to natural processes or to the

works of man, on this or adjacent properties. In addition, changes in applicable or appropriate standards occur, whether they result from legislation or from the broadening of knowledge. Accordingly, the findings in this report might be invalidated, wholly or partially, by changes outside of our control.

Respectfully submitted,
PARIKH CONSULTANTS, INC.

Partha Sircar, Ph.D., P.E. C54619
Senior Engineer

Gary Parikh, G.E. 666
Project Manager

No. 666
EXP. 12-31-11

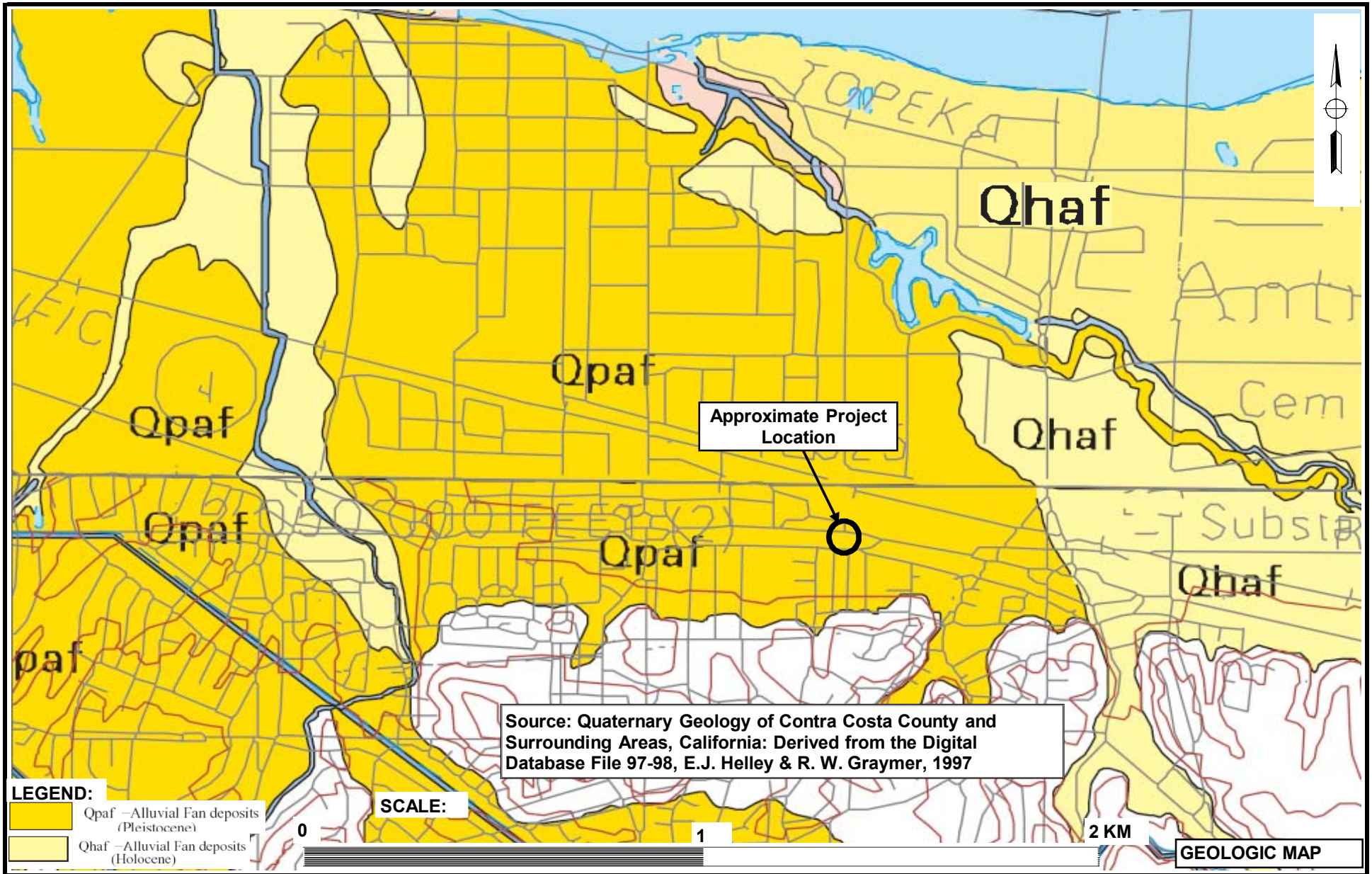
PROJECT VICINTY MAP

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

CAVALLO ROAD UNDERCROSSING
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO.: 206117.CAV

PLATE NO.: 1



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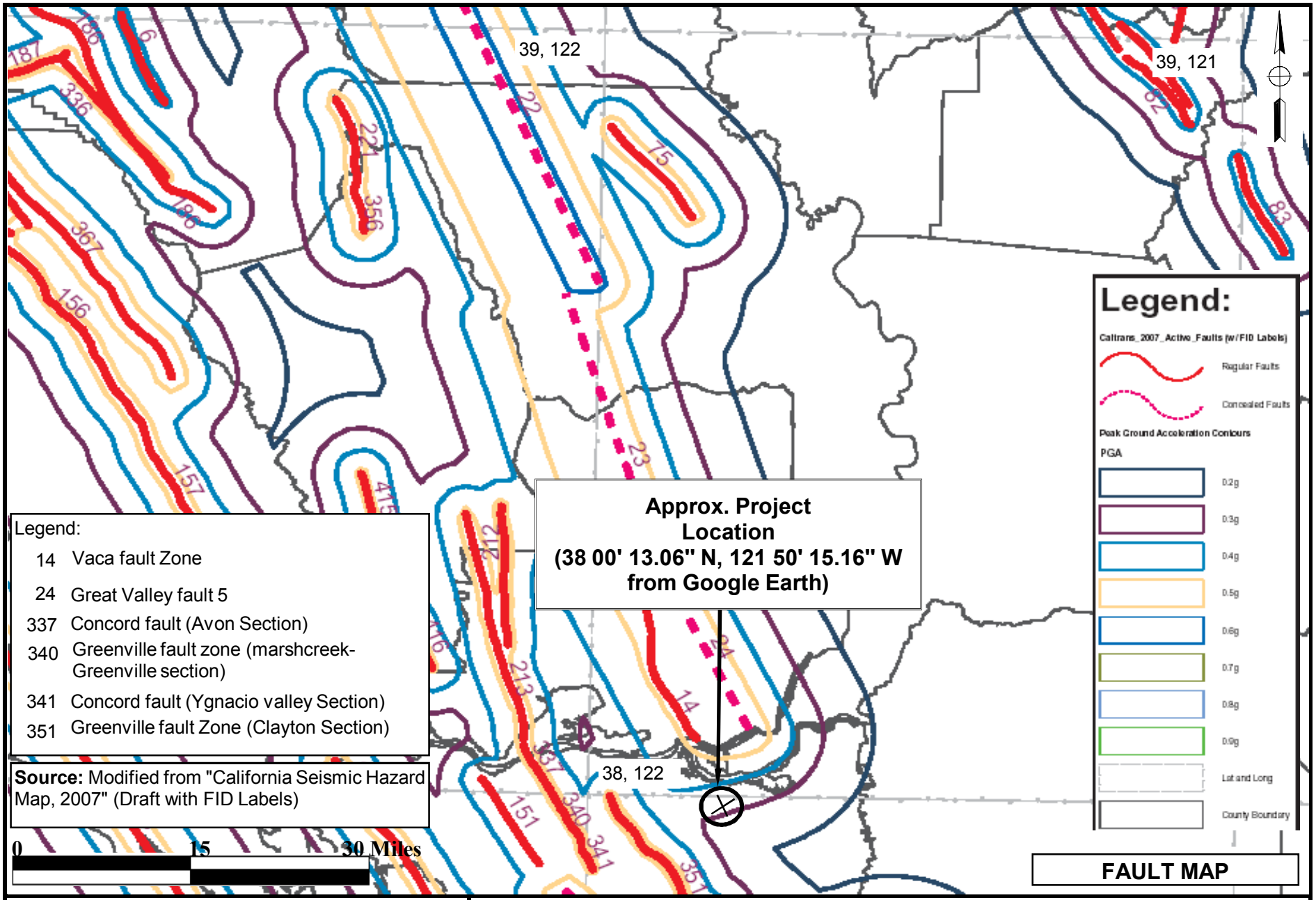
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

CAVALLO ROAD UNDERCROSSING
ANTIOCH, CALIFORNIA

JOB NO.: 206117.CAV

PLATE NO.: 2



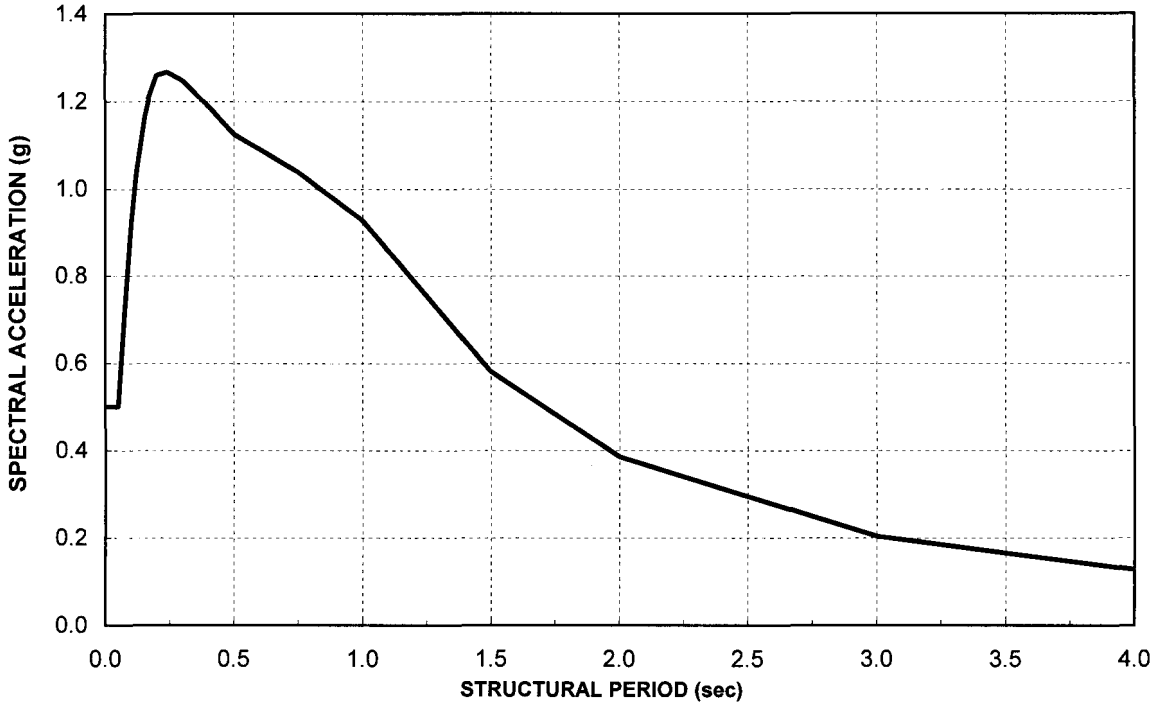
FAULT MAP

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

CAVALLO ROAD UNDERCROSSING
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO.: 206117.CAV | PLATE NO.: 3

Cavallo Road Undercrossing



Spectral Data

Period (sec)	Spectral Accel. (g)
0.010	0.500
0.020	0.500
0.030	0.500
0.050	0.500
0.075	0.719
0.100	0.919
0.120	1.037
0.150	1.156
0.170	1.209
0.200	1.259
0.240	1.266
0.300	1.247
0.400	1.190
0.500	1.125
0.750	1.038
1.000	0.927
1.500	0.581
2.000	0.386
3.000	0.204
4.000	0.128

Caltrans SDC (v 1.4, June 2006), Figure B.8,
Governing Fault: Vaca Fault Zone
Fault Distance = 5.45 km (3.4 miles)
(Mw = 6.9, Soil Profile Type D, PBA = 0.5g)

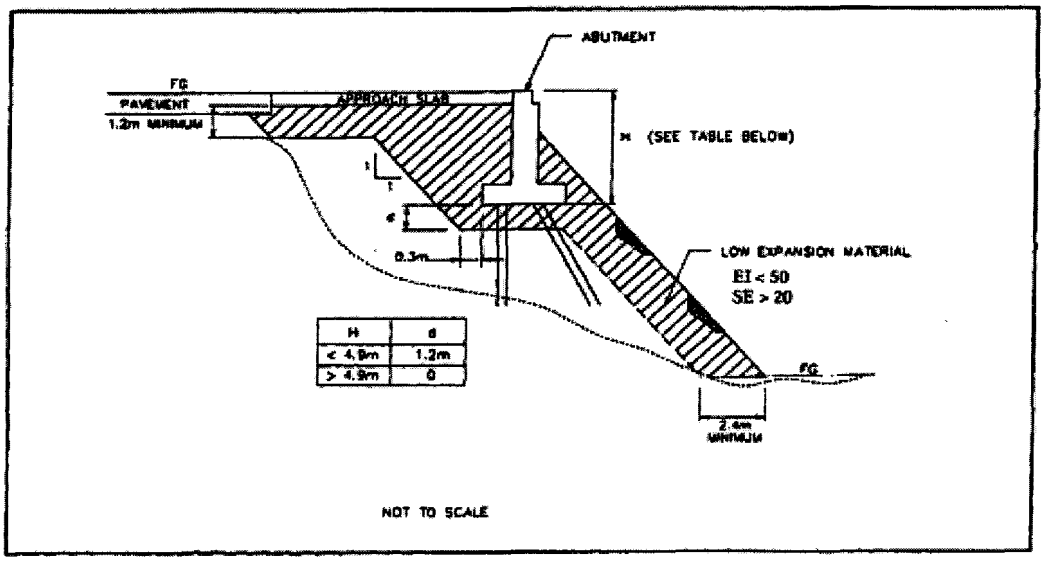
Notes:
(a) The new (in-progress) Caltrans Hazard Map and Data Base was used
(b) PBA was obtained by using Sadigh Attenuation Relationship: 0.49g (rounded off to 0.5 g)
(c) The following modifications were then applied for near-fault effects:
(1) No change of Sa for structural periods $\leq$ 0.5 sec
(2) 20% increase of Sa for structural periods > 1 sec
(3) Linear interpolation for structural periods between 0.5 and 1 sec

EXPANSIVE SOIL EXCLUSION ZONE

GUIDELINE FOR DEFINING EXPANSIVE SOIL AND THE ZONE AROUND BRIDGE ABUTMENTS IN WHICH EXPANSIVE SOIL IS TO BE EXCLUDED (ALSO APPLICABLE TO WINGWALLS AND RETAINING WALLS).

Expansive soil materials shall not be placed as part of the embankment within the limits of a bridge abutment as shown in Figure 1 below for the full width of the embankment. Expansive soil materials for this requirement are defined as having either an Expansion Index (EI) greater than 50, (Expansion Index to be determined in accordance with ASTM D 4829) or a Sand Equivalent (SE) less than 20 (Sand Equivalent to be determined in accordance with California Test Method 217). This requirement is exclusive of the structure backfill and pervious backfill material requirements as shown on the plans and set forth in the Standard Specifications under Sections 19-3.06 and 19-3.065 respectively.

Figure 1 TYPICAL SECTION - EXPANSIVE SOIL EXCLUSION ZONE IN BRIDGE EMBANKMENT



H	d
< 4.9m	1.2m
> 4.9m	0

LOW EXPANSION MATERIAL

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

CAVALLO ROAD UNDERCROSSING
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO.: 206117.CAV | PLATE NO.: 5

APPENDIX A

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

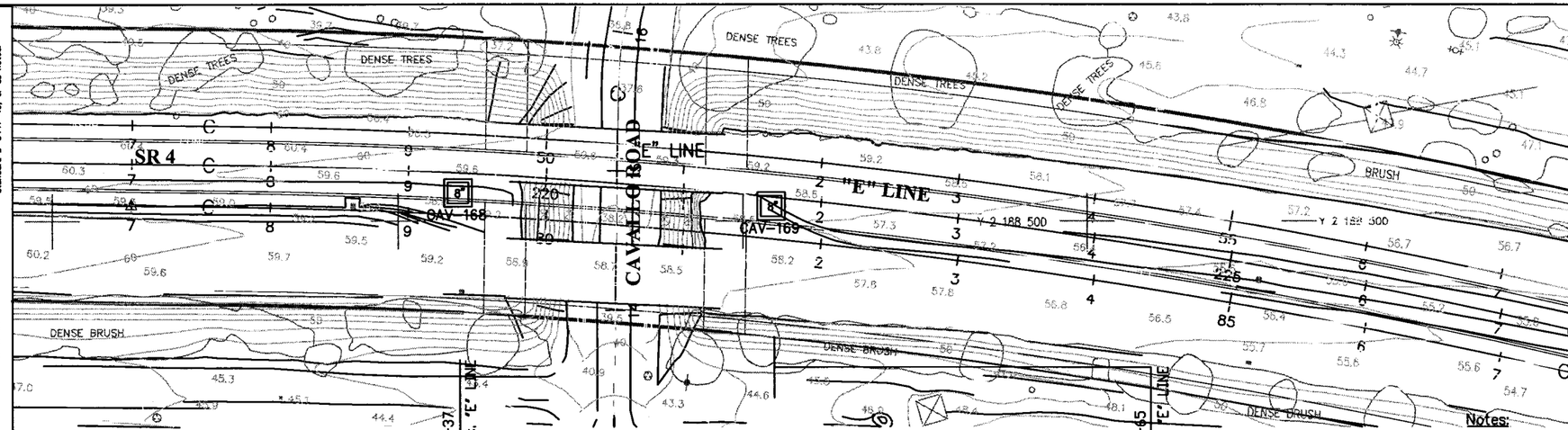
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE. 666 Exp. 12/31/09 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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.



PLAN
1"=50'

Notes:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)

PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ELEVATION (feet)

CAV-168

Sta 219+37, 12.8'± Rt. "E" LINE; Elev. 58.7 ft±; 8"

Blows	Hammer	Penetration (in)	Moisture (%)	Dry Density (pcf)	Soil Symbol	Description
23	2.5	1	111.9	16		LEAN CLAY (CL), stiff, grayish brown, moist
35	2.5	2	106.9	20	CA	--very stiff, brown
–	2.5	3	108.0	21	AL	--very stiff, bluish gray (LL=31, PI=11)
1.6 / 33	2.5	4	105.1	20	UC	--very stiff, bluish black
30	2.5	5	109.3	15	AL	--very stiff, brown (LL=39, PI=22)
90	2.5	6	108.1	10		SANDY LEAN CLAY (CL), hard, brown, dry
60	2.5	7	104.0	18		LEAN CLAY (CL), hard, brown, moist
41	2.5	8	101.9	4	SA	POORLY-GRADED SAND WITH SILT (SP-SM), medium dense, bluish brown, moist, fine-grained (+#4=0%, -#200=8%)
63	2.5	9	118.0	13		SANDY LEAN CLAY (CL), hard, brown, moist
43	2.5	10	111.9	18	SA	CLAYEY SAND (SC), medium dense, bluish brown, moist (+#4=1%, -#200=37%)
48	2.5	11	106.4	17	SA	POORLY-GRADED SAND (SP), dense, bluish brown, moist (+#4=0%, -#200=4%)
41	1.4	12	–	41		LEAN CLAY (CL), hard, brown, wet
50/6"	2.5	13	–	–		--(No Recovery)
50/5"	1.4	14	–	32	SA	POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM), very dense, bluish brown, wet (+#4=27%, -#200=6%)
60	1.4	15	–	38		--very dense
50/6"	1.4	16	–	31		--very dense
50/6"	1.4	17	–	24		--very dense, fine-grained
50/6"	1.4	18	–	47		LEAN CLAY (CL), hard, grayish brown, wet
72	2.5	19	90.8	32		--hard, bluish brown

GWS ▽ ELEV. = 5.2'± 9-7-06

9-7-06

CAV-169

Sta 221+65, 6.0'± Rt. "E" LINE; Elev. 58.5 ft±; 8"

Blows	Hammer	Penetration (in)	Moisture (%)	Dry Density (pcf)	Soil Symbol	Description
17	2.5	1	105.3	18		LEAN CLAY (CL), stiff, gray and brown, moist, medium plasticity
34	2.5	2	102.0	22	UC	LEAN CLAY WITH SAND (CL), very stiff, brown, moist, medium plasticity
2.6 / 25	2.5	3	108.6	19	AL	LEAN CLAY (CL), very stiff, brown and mottled gray, moist, medium plasticity (LL=35, PI=17)
18	2.5	4	108.2	15		--stiff, dark brown
62	2.5	5	104.5	10	SA	SILTY SAND (SM), very dense, yellowish brown, moist, fine-grained (+#4=1%, -#200=28%)
50/6"	2.5	6	99.7	16		LEAN CLAY (CL), hard, yellowish brown and mottled white, moist, medium plasticity
61	2.5	7	107.8	17		--hard
3.8 / 45	2.5	8	95.7	22	UC AL	--very stiff, gray and mottled brown (LL=44, PI=20)
76	2.5	9	111.2	12	SA	SANDY LEAN CLAY (CL), hard, gray and mottled red, moist, medium plasticity (+#4=0%, -#200=62%)
82	2.5	10	109.7	19		--hard, gray
80	2.5	11	102.3	24	SA	SANDY SILT (ML), hard, yellowish brown and gray, low plasticity, fine-grained sand (+#4=0%, -#200=57%)
19	1.4	12	–	56	SA	SILTY CLAY WITH SAND AND GRAVEL (CL-ML), very stiff, gray and brown, wet, low plasticity, gravel up to 3", medium to coarse grained sand, decomposed bedrock (+#4=0%, -#200=71%)
22	1.4	13	–	42	SA	SANDY SILTY CLAY WITH GRAVEL (CL-ML), very stiff, gray and brown, low plasticity, gravel up to 3", medium to coarse grained sand, decomposed bedrock (+#4=0%, -#200=58%)
50/5.5"	2.5	14	106.5	21		LEAN CLAY WITH SAND (CL), hard, gray, moist, medium to high plasticity, fine-grained sand
50/4"	2.5	15	83.2	26		POORLY-GRADED SAND WITH GRAVEL (SP), very dense, dark gray, wet, gravel up to 1", fine to medium grained
50/3"	2.5	16	82.8	37		LEAN CLAY (CL), hard, gray, moist, medium plasticity, trace decomposed bedrock
50/5.5"	2.5	17	96.8	27		LEAN CLAY WITH SAND (CL), hard, bluish gray, moist, medium plasticity, fine-grained sand

GWS ▽ ELEV. = 4.5'± 9-6-06

9-6-06

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

218+00 220+00 222+00 224+00

LEGEND OF BORING OPERATIONS

IN-SITU, LAB & FIELD TEST DESIGNATIONS

TYPES OF BORINGS

LEGEND OF EARTH MATERIALS (USCS) BASED ON ASTM D2487, D2488

CONSISTENCY CLASSIFICATION FOR SOILS According to the Standard Penetration Test (ASTM D-1586)

NOTE: Visual classifications of earth materials are based on field inspection and or a confirmed or revised with laboratory test results as necessary.

DESIGN OVERSIGHT

SIGN OFF DATE

DESIGN By: D. GOUTHIER
CHECKED By: P. SIRCAR

Field Investigation by: L. BHANGOO

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

P. SIRCAR
PROJECT ENGINEER

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04275
EA 228511

STRUCTURE NO. 28-0402 L/R
POST MILES (PM) 28.2

CAVALLO ROAD UNDERCROSSING (L/R)

LOG OF TEST BORINGS

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) 08/31/09

SHEET 1 OF 2

PLATE A-1

S:\ACAD\206117.CAV\LOTB.dwg, 1, 8/31/2009 1:36:22 PM, O.G

DIST.	COUNTY	ROUTE	KILOMETER POST–TOTAL PROJECT	Sheet No.	Total Sheets
04	CC	4			

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 CIVIL ENGINEER — DATE: 06-23-08

LOG OF TEST BORINGS

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

CU: 04275
EA: 228511

BRIDGE No. 28-6402L/R

Sheet 2 of 2

REGISTERED PROFESSIONAL ENGINEER — GARY PARIKH — No. G.E. 666 — Exp. 12/31/09 — GEOTECHNICAL — STATE OF CALIFORNIA

Revisions made to this Log of Test Borings from the original 1969 Log of Test Borings are the addition of the following table and notes:

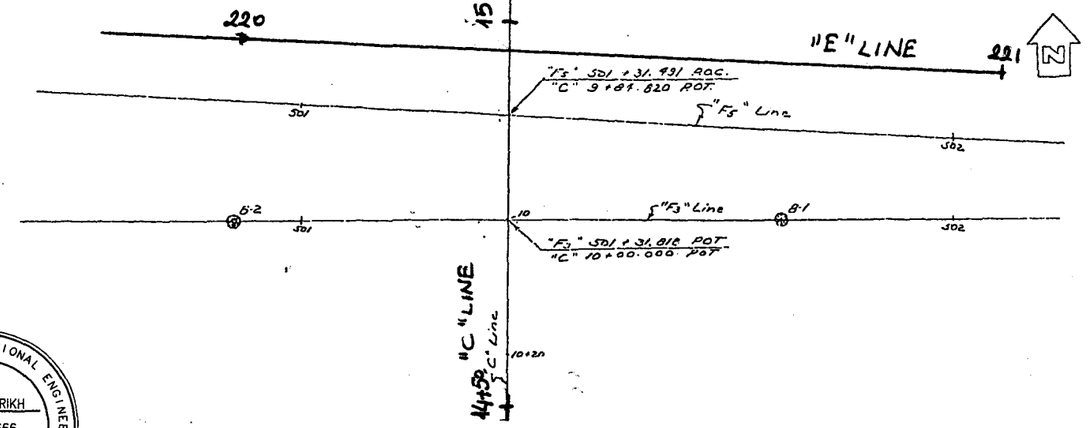
Boring	Station	Offset from "E" LINE
B-2	219+99	12 ft Rt
B-1	220+72	10 ft Rt

'F5' Line parallels 'E' Lines

'C' Line intersects 'E' Line at Station 220+36 ft

Notes:

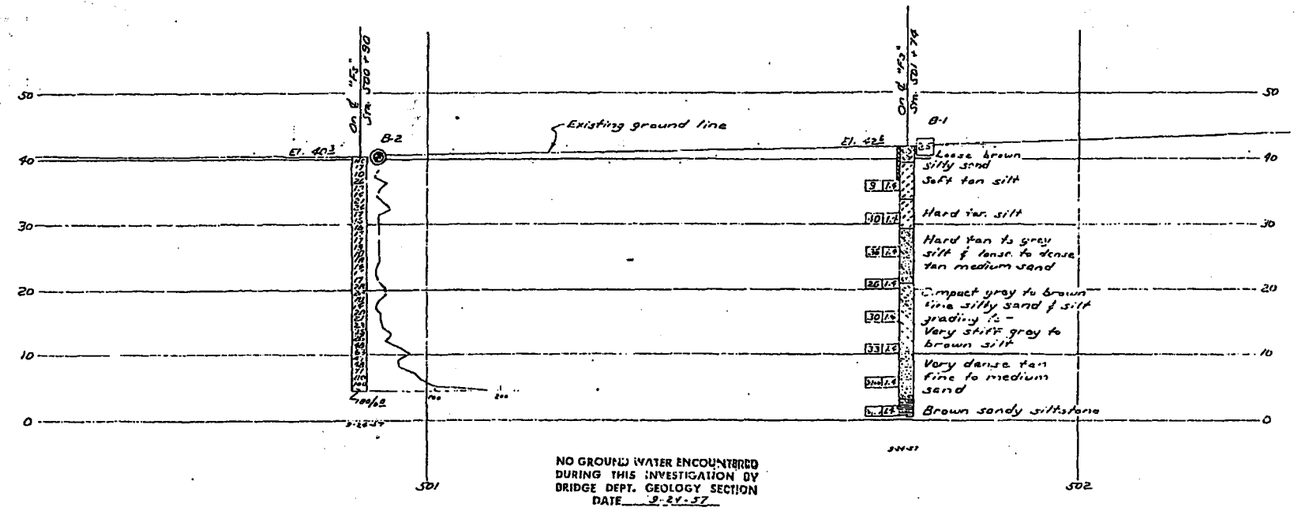
1. See the "Log of Test Borings" for stationing.
2. The Division of Structure Design produced the data presented in the table above. The data are the English locations for the As-Built Test Borings referenced to the proposed new structure location. This table is presented on the As-Built Log of Test Boring sheet for the convenience of any bidder, contractor or other interested party.



Dist.	County	Route	PM	Sheet No.	Total Sheets
04	CC	4	23.7/25.4 R.S.M/L.M.	204	315

Section Supervisor — April 4, 1962

BM #54 - "X" Cut into PCC base lattice tower N. side Tragallis Rd. 121' Rt. "F3" Sta. 498 + 99 ± Elev. 45 ±



NO GROUND WATER ENCOUNTERED DURING THIS INVESTIGATION BY BRIDGE DEPT. GEOLOGY SECTION
DATE 9-27-57

AS BUILT
CONTRACT No. ____
CONTRACT No. ____
DATE ____

CLASSIFICATION OF MATERIAL BASED ON STANDARD GRADE SIZE LIMITS

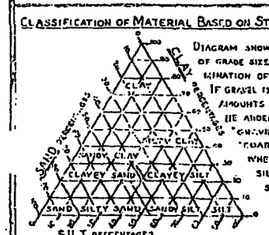


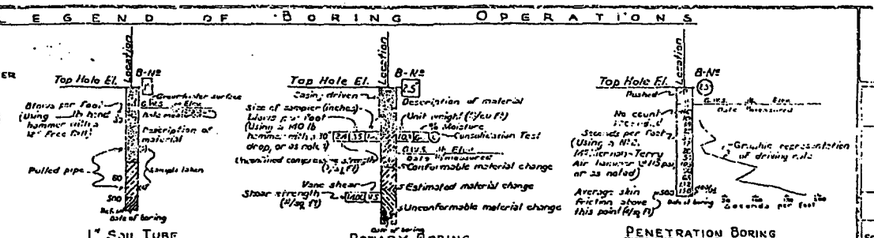
DIAGRAM SHOWING THE BASIS FOR ESTIMATES OF GRADE SIZE DISTRIBUTION USED IN DETERMINATION OF CLASS NAMES. IF GRAVEL IS PRESENT IN APPRECIABLE AMOUNTS THE TERM "GRAVELLY" MAY BE ADDED TO THE CLASS NAME, VIZ. "GRAVELLY SAND." THE TERMS "COARSE", "MEDIUM" AND "FINE" WHEN USED TO DESCRIBE SAND, SILT AND GRAVEL 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 — 70 11

CAVALLO ROAD UNDERCROSSING

LOG OF TEST BORINGS

SCALE 1" = 10' | BRIDGE 28-80 | FILE | DRAWING 2385-10

APPENDIX B

APPENDIX B

LABORATORY TESTS

Classification Tests

The field classification of the samples was visually verified in the laboratory according to the Unified Soil Classification System. The results are presented on "Log of Test Borings", Appendix A.

Moisture-Density

The natural moisture contents and dry unit weights were determined for selected undisturbed samples of the soils in general accordance with ASTM Test Method D 2216-92. This information was used to classify and correlate the soils. The results are presented at the appropriate depths on the "Log of Test Borings", Appendix A.

Atterberg Limits

The Atterberg Limits were determined for selected samples of the fine-grained materials. These results were used to classify the soils, as well as to obtain an indication of the effective strength characteristics and expansion potential with variations in moisture content. The Atterberg Limits were determined in general accordance with ASTM Test Method D 4318-93. The results of these tests are presented on Plate B-2, "Plasticity Chart".

Grain Size Classification

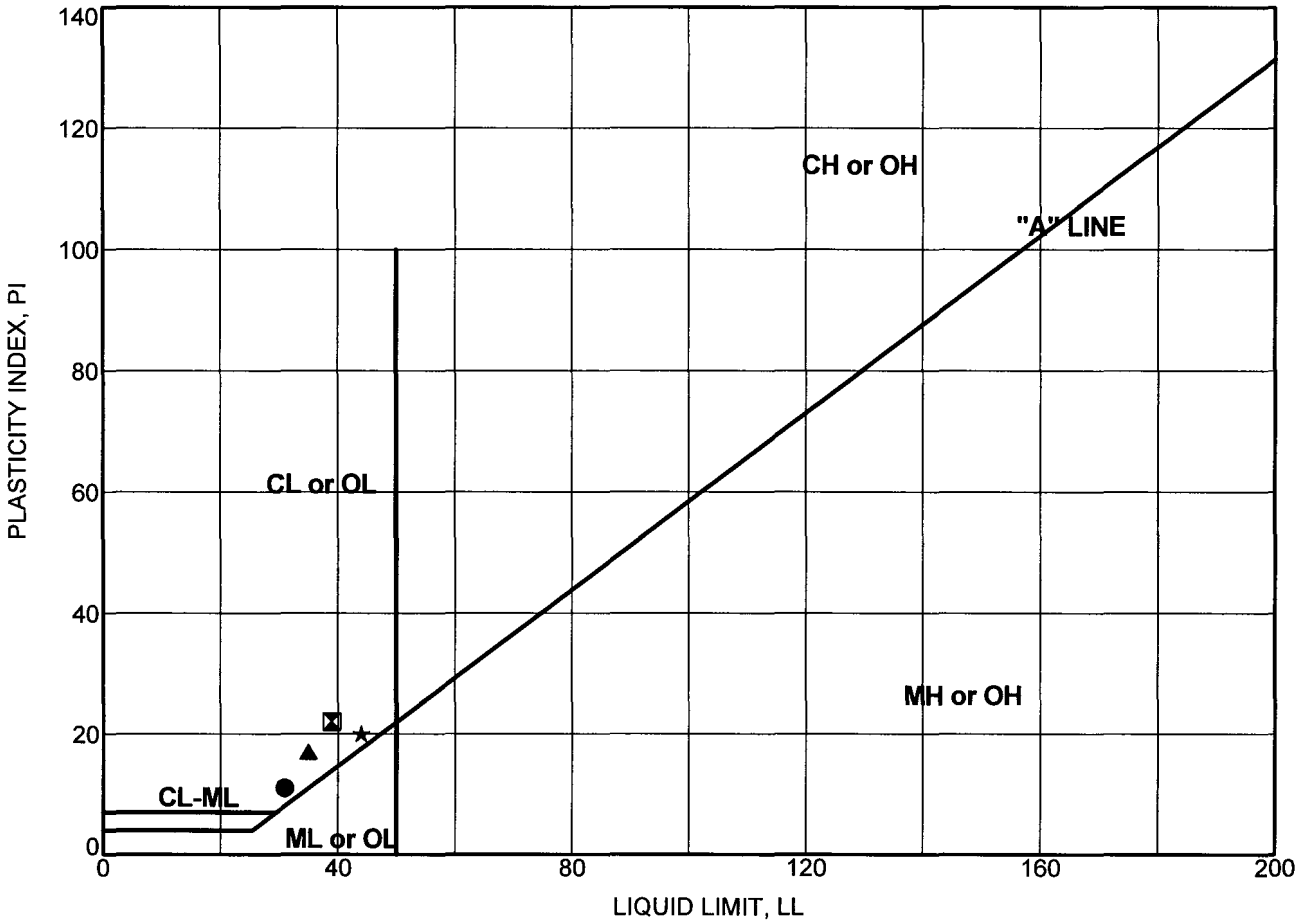
Grain size classification tests (ASTM Test Method D422-63) were performed on selected samples of granular soil to aid in the classification. The results are presented on Plates B-3A to B-3C, "Grain Size Distribution Curves".

Unconfined Compression Tests

Strength tests were performed on selected undisturbed samples using unconfined compression machine. Unconfined compression tests were performed in general accordance with ASTM Test Method D 2166-91. The results are presented on "Log of Test Borings"

Corrosion Test

Corrosion test was performed on selected sample to determine the corrosion potential of the soils. The pH and minimum resistively test was performed according to California Test Method 643. The test was performed by Sunland Analytical. The test result is presented on Plate B-4.



PLASTICITY CHART

Boring Number	Sample Number	Depth (feet)	Test Symbol	Moisture Content (%)	LL	PL	PI	Description
CAV-168	MC-3	14.5	●	21	31	20	11	LEAN CLAY (CL)
CAV-168	MC-5	25.0	⊠	15	39	17	22	LEAN CLAY (CL)
CAV-169	MC-3	10.0	▲	19	35	18	17	LEAN CLAY (CL)
CAV-169	MC-8	35.0	★	22	44	24	20	LEAN CLAY (CL)

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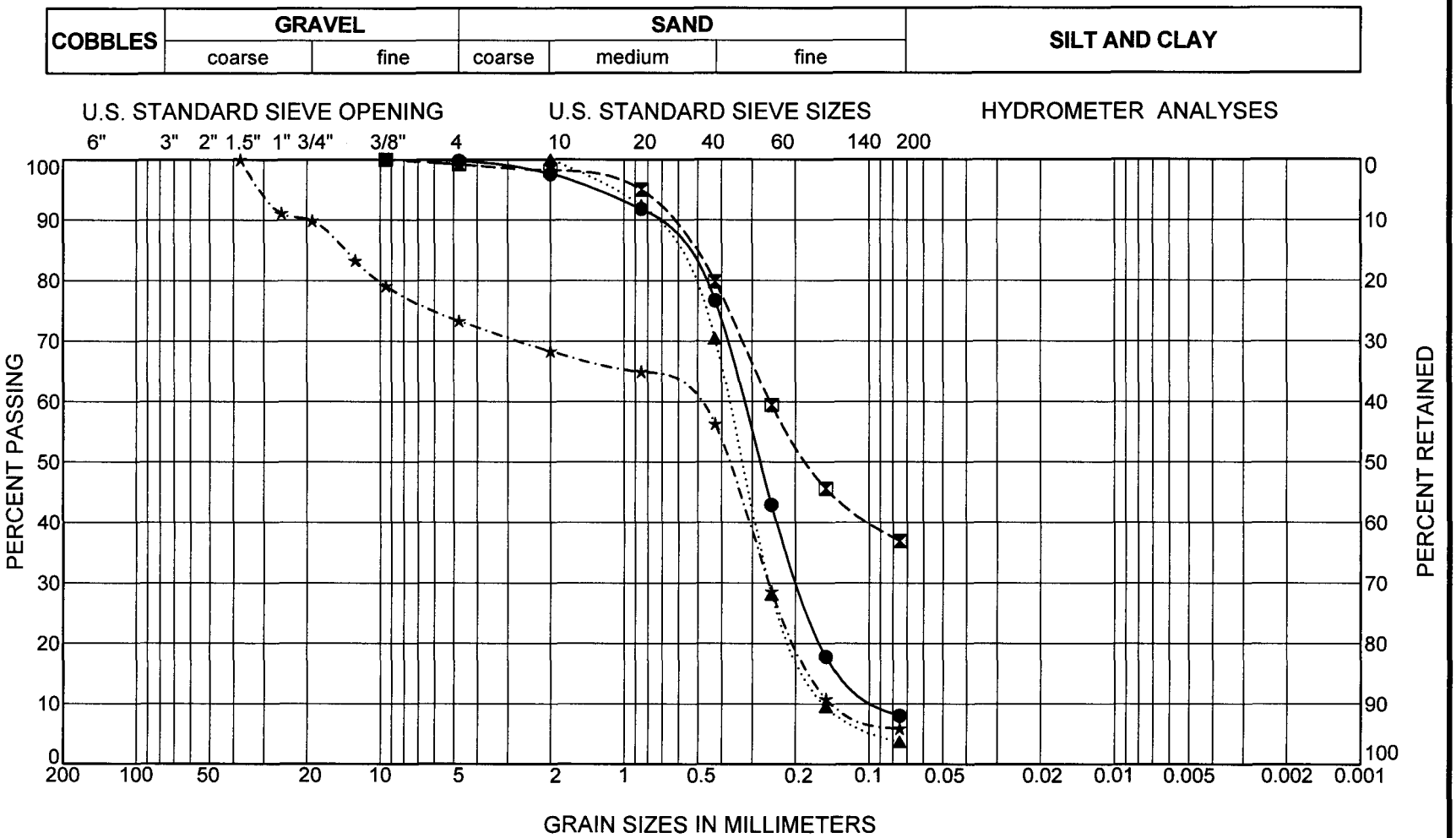
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

CAVALLO ROAD UNDERCROSSING
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.CAV

PLATE NO: B-2

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
CAV-168	MC-8	40.0	●			POORLY GRADED SAND WITH SILT (SP-SM)
CAV-168	MC-10	50.0	⊠			CLAYEY SAND (SC)
CAV-168	MC-11	55.0	▲			POORLY GRADED SAND (SP)
CAV-168	SPT-14	70.0	★			POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)

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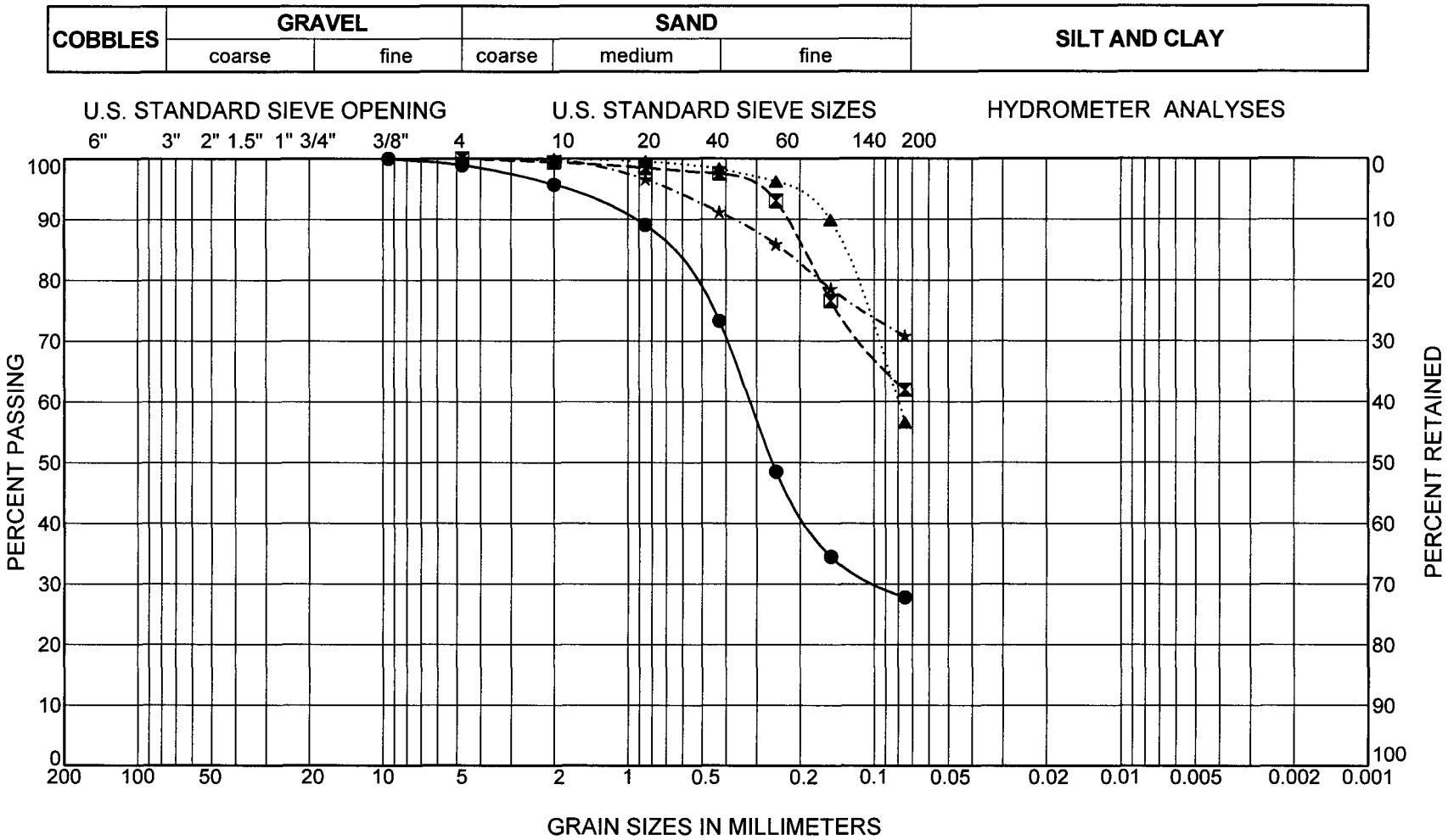
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

CAVALLO ROAD UNDERCROSSING
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.CAV

PLATE NO: B-3A

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
CAV-169	MC-5	20.0	●			SILTY SAND (SM)
CAV-169	MC-9	40.0	⊠			SANDY LEAN CLAY (CL)
CAV-169	MC-11	50.0	▲			SANDY SILT (ML)
CAV-169	SPT-12	55.0	★			SILTY CLAY WITH SAND (CL-ML)

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MATERIALS ENGINEERING

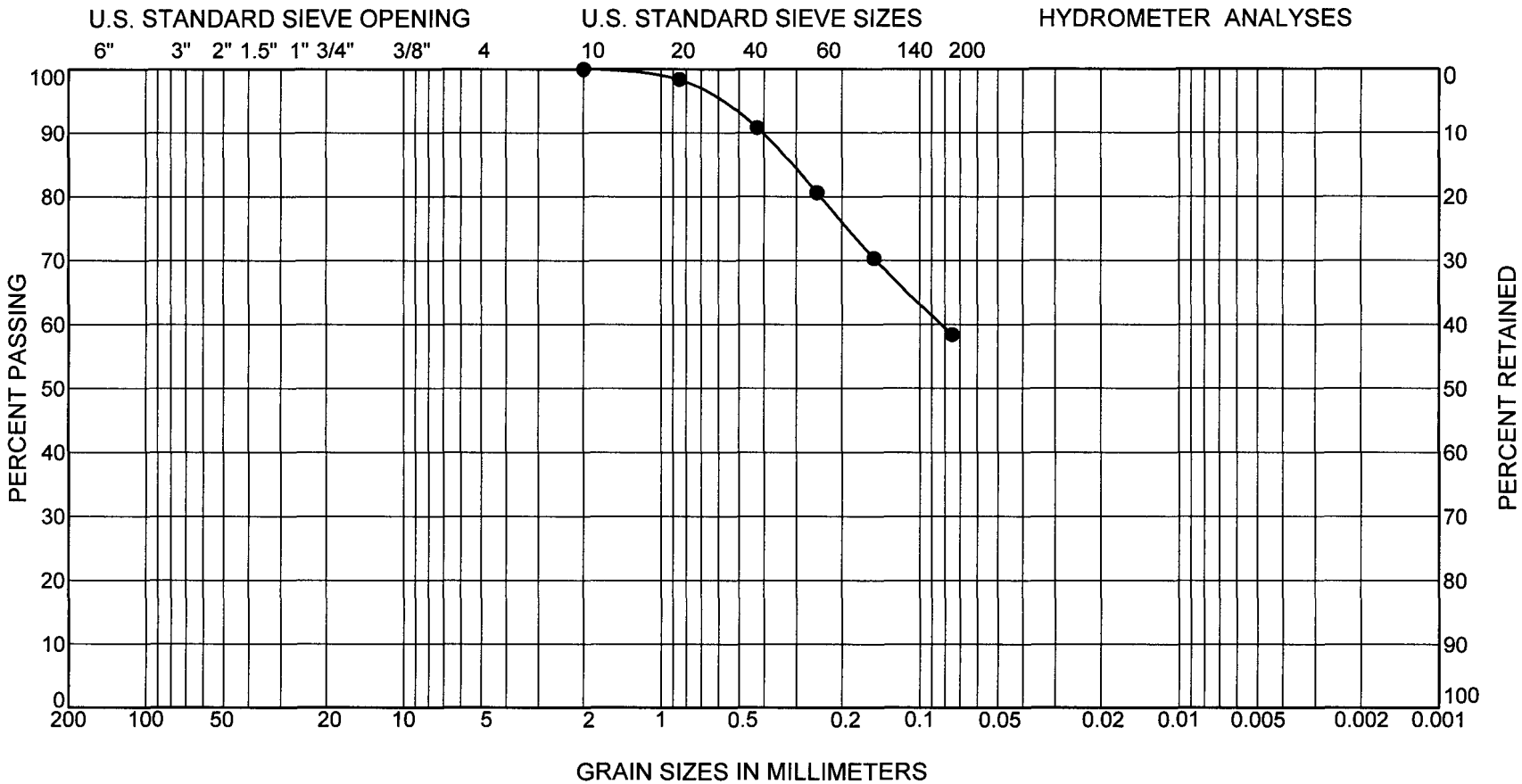
JOB NO: 206117.CAV

CAVALLO ROAD UNDERCROSSING
CONTRA COSTA COUNTY, CALIFORNIA

PLATE NO: B-3B

GRAIN SIZE DISTRIBUTION CURVES

COBBLES	GRAVEL		SAND			SILT AND CLAY
	coarse	fine	coarse	medium	fine	



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
CAV-169	SPT-13	60.0	●			SANDY SILTY CLAY (CL-ML)

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

JOB NO: 206117.CAV

CAVALLO ROAD UNDERCROSSING
CONTRA COSTA COUNTY, CALIFORNIA

PLATE NO: B-3C

Sunland Analytical

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 12/08/2006
Date Submitted 12/04/2006

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.CAV/CAVALO RD Site ID : CAV108 #2 @ 8.5. CAV162
Thank you for your business.

* For future reference to this analysis please use SUN # 49464-98601.

EVALUATION FOR SOIL CORROSION

Soil pH	7.61		
Minimum Resistivity	1.45	ohm-cm (x1000)	
Chloride	6.2 ppm	00.00062	%
Sulfate	43.6 ppm	00.00436	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

APPENDIX C

Attenuation Relationships for Shallow Crustal Earthquakes (Sadigh, et al, 1997)

Fault = Vaca fault zone (RLSS Fault, Map NO: 14)

Mmax = 6.9 **Rrup = 5.45** **km**

M>=6.5 *ROCK SITE:*

C1 = -1.274 C2 = 1.1 C3 = 0 C4 = -2.1

C5 = -0.48451 C6 = 0.524 C7 = 0

A=C1+C2M+C3(8.5M)^2.5= 6.316

B=C4*Ln(Rrup+exp(C5+C6M))= -7.024

C=C7*Ln(Rrup+2)= 0

Ln(y) = A+B+C = -0.708

y = Exp(Ln(y)) = 0.49 **Peak Bed Rock Acceleration PBA = 0.490 - Use 0.5g**

Fault = Great valley fault 5 (Reverse Fault, Map No: 24)

Mmax = 6.5 **Rrup = 7.045** **km**

A= 5.876

B= -6.811

C= 0

Ln(y) = -0.935

y = 0.39 **Peak Bed Rock Acceleration PBA = 0.39g x 1.2 = 0.468g**

Fault = Greenville fault zone (Clayton section, RLSS Fault, Map No: 351)

Mmax = 6.6 **Rrup = 6.59** **km**

A= 5.986

B= -6.855

C= 0

Ln(y) = -0.869

y = 0.42 **Peak Bed Rock Acceleration PBA = 0.42g**

Fault = Concord fault zone (Ygnacio valley section, RLSS Fault, Map No: 341)

Mmax = 6.6 **Rrup = 11.136** **km**

A= 5.986

B= -7.191

C= 0

Ln(y) = -1.205

y = 0.30 **Peak Bed Rock Acceleration PBA = 0.3g**

AXIAL PILE CAPACITIES

(SHAFT Program)

SHAFT Runs – 24-in. CIDH Pile
SR Bypass – Cavallo Road Undercrossing
Job No. 206117.CAV
Pile capacities computed using SHAFT program – Output follows

Note: Neglected End Bearing for Pile Capacity

Abutment 1 (based on boring CAV-168)

Left Bridge
Ground Surface Elevation = 53.0 (approx.)
Nominal Compression Load = 280 kips = 140 tons
Reqd. Shaft Length per SHAFT output = 36.0 ft
Recommended Penetration = 36.0 feet
Reqd. Tip Elevation = 53.0-36.0 = 17.0

Right Bridge
Ground Surface Elevation =52.0 (approx.)
Nominal Compression Load = 280 kips = 140 tons
Reqd. Shaft Length per SHAFT output = 36.0 ft
Recommended Penetration = 36 feet
Reqd. Tip Elevation = 52.0 – 36.0 = 16.0

Abutment 2 (based on boring CAV-169)

Left Bridge
Ground Surface Elevation = 52.5 (approx.)
Nominal Compression Load = 280 kips = 140 tons
Reqd. Shaft Lengthn per SHAFT output = 31.5 ft
Recommended Penetration = 31.5 feet
Reqd. Tip Elevation = 52.5 – 31.5 = 21.0

Right Bridge
Ground Surface Elevation = 51.5 (approx.)
Nominal Compression Load = 280 kips = 140 tons
Reqd. Shaft Lengthn per SHAFT output = 31.5 ft
Recommended Penetration = 31.5 feet
Reqd. Tip Elevation = 51.5 – 31.5 = 20.0

El. = 53.0 (approx.) - Left Bridge
= 52.0 (approx.) - Right Bridge

depth= 0 - 23; Clay

$\gamma = 125$ pcf

$S_u = 2.5$ ksf

depth= 23 - 43; Clay

$\gamma = 125$ pcf

$S_u = 4.0$ ksf

depth= 43 - 51; Sand

(at depth of 48 ft)

$\gamma = 130$ pcf

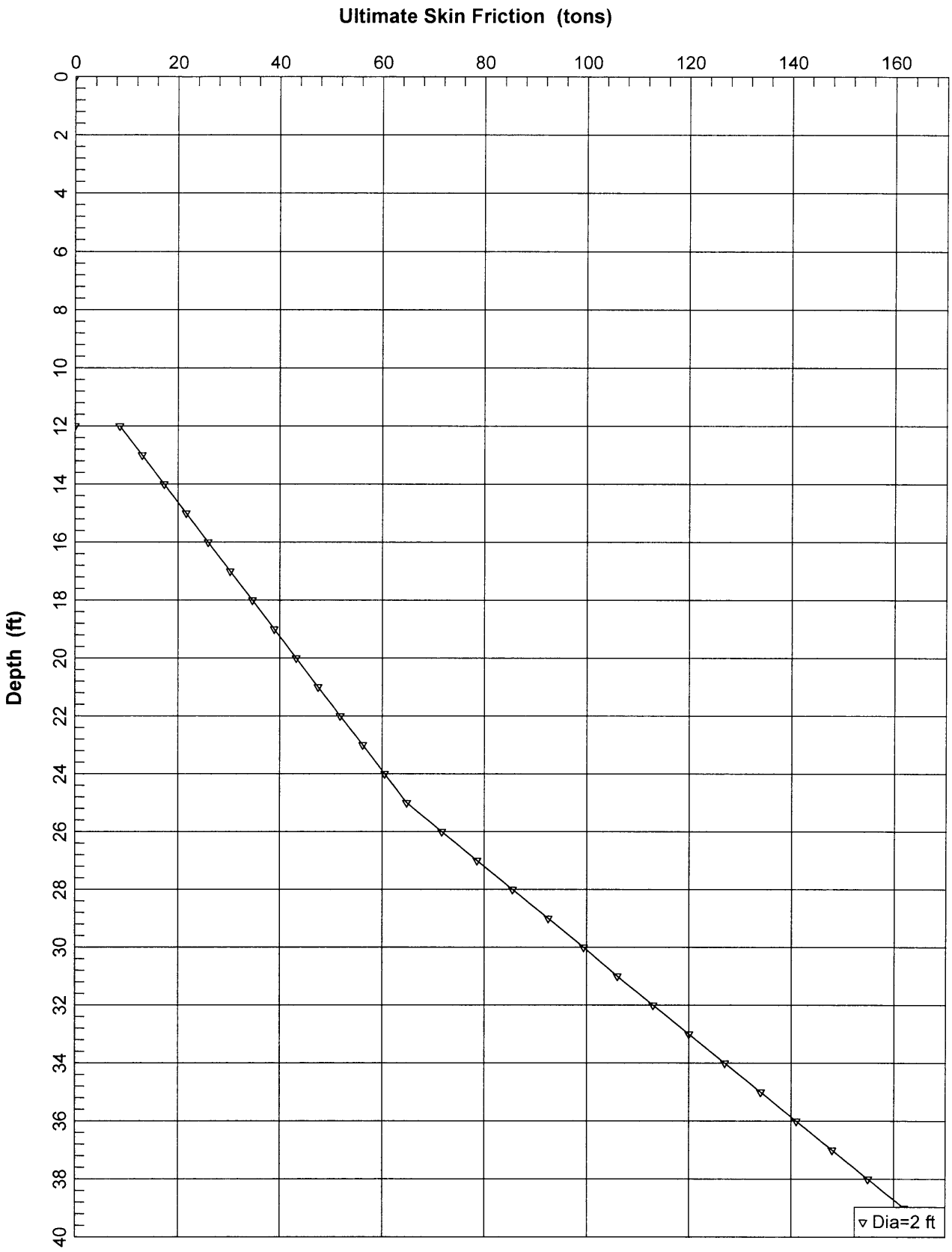
$\phi' = 35°$

depth= 51 - 61; Clay

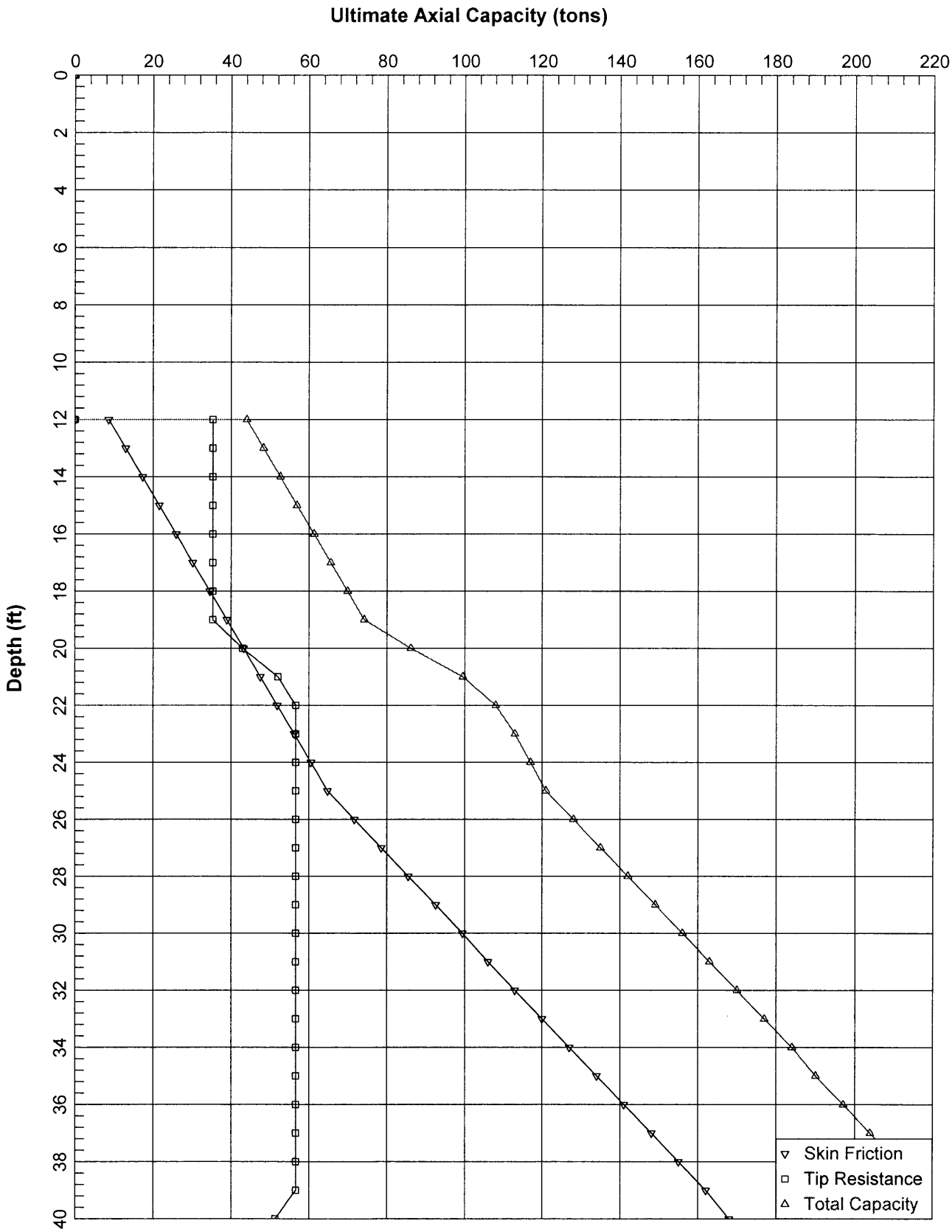
$\gamma = 125$ pcf

$S_u = 4.0$ ksf

Abutment 1 - Left and Right Bridge



Cavallo Road-Undercrossing @ SR4 - Abutment 1 - 24-in CIDH Pile



Cavallo Road @ SR4 - Abutment 1 - 24-in CIDH Pile

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 5.0 (C) COPYRIGHT ENSOFT,INC. 1989,1995,1998,2001,2003

Cavallo Roadt- SR4 - Abutment 1

PROPOSED DEPTH = 40.0 FT

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 48.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 2.50

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 3.00

SOIL INFORMATION

LAYER NO 1----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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.000E+00

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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.230E+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	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00

SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.230E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
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.	= 0.350E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.400E+04
DEPTH, FT	= 0.430E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.536E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.350E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.400E+04
DEPTH, FT	= 0.510E+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	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.510E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04

DEPTH, FT = 0.610E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	=	2.000	FT.
DIAMETER OF BASE	=	2.000	FT.
END OF STEM TO BASE	=	0.000	FT.
ANGLE OF BELL	=	0.000	DEG.
IGNORED TOP PORTION	=	8.000	FT.
IGNORED BOTTOM PORTION	=	2.000	FT.
AREA OF ONE PERCENT STEEL	=	4.524	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	1.28	4.32	35.35	39.67	16.10	13.51	30.99
12.0	1.40	8.64	35.35	43.99	20.42	15.24	31.50
13.0	1.51	12.96	35.35	48.31	24.74	16.97	31.93
14.0	1.63	17.28	35.35	52.63	29.06	18.69	32.30
15.0	1.75	21.60	35.35	56.95	33.38	20.42	32.63
16.0	1.86	25.92	35.35	61.27	37.70	22.15	32.91
17.0	1.98	30.24	35.35	65.59	42.02	23.88	33.15
18.0	2.09	34.56	35.35	69.91	46.34	25.61	33.38
19.0	2.21	38.88	35.35	74.23	50.66	27.34	33.57
20.0	2.33	43.20	42.92	86.12	57.51	31.59	37.00
21.0	2.44	47.52	52.01	99.53	64.86	36.35	40.73
22.0	2.56	51.84	56.56	108.40	70.70	39.59	42.34
23.0	2.68	56.16	56.56	112.72	75.02	41.32	42.11
24.0	2.79	60.48	56.56	117.04	79.34	43.05	41.91
25.0	2.91	64.80	56.56	121.36	83.66	44.77	41.72
26.0	3.03	71.72	56.56	128.27	90.57	47.54	42.40
27.0	3.14	78.63	56.56	135.18	97.48	50.30	43.03
28.0	3.26	85.54	56.56	142.10	104.39	53.07	43.61
29.0	3.37	92.45	56.56	149.01	111.31	55.83	44.15
30.0	3.49	99.37	56.56	155.92	118.22	58.60	44.66
31.0	3.61	106.28	56.56	162.83	125.13	61.36	45.14
32.0	3.72	113.19	56.56	169.75	132.04	64.13	45.58
33.0	3.84	120.10	56.56	176.66	138.95	66.89	46.00
34.0	3.96	127.02	56.56	183.57	145.87	69.66	46.40
35.0	4.07	133.93	56.56	190.48	152.78	72.42	46.77
36.0	4.19	140.84	56.56	197.40	159.69	75.19	47.12
37.0	4.31	147.75	56.56	204.31	166.60	77.95	47.45
38.0	4.42	154.66	56.56	211.22	173.52	80.72	47.77

Cavallo Road - Abut 1.sfo

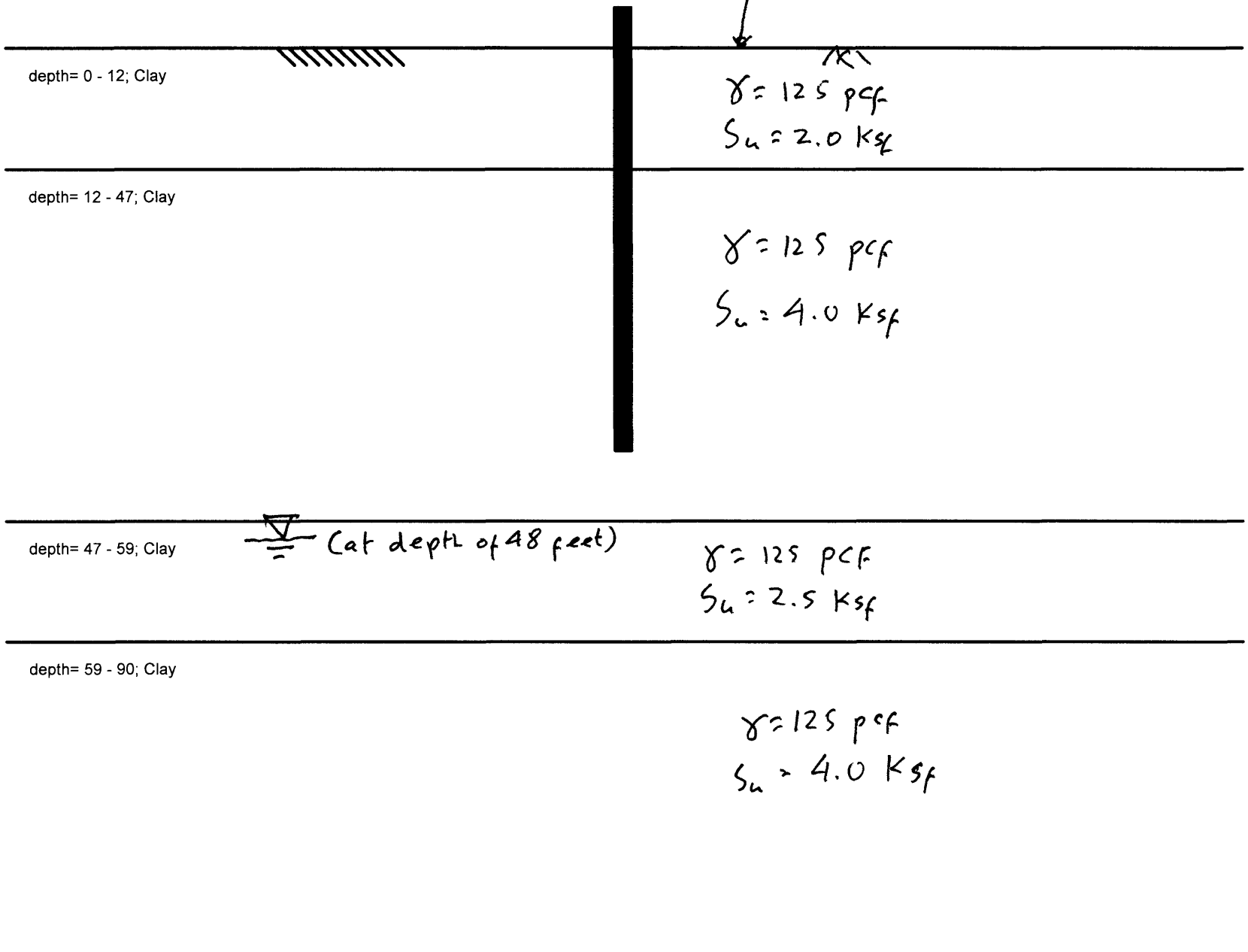
39.0	4.54	161.58	56.56	218.13	180.43	83.48	48.06
40.0	4.65	168.49	51.32	219.81	185.60	84.50	47.22

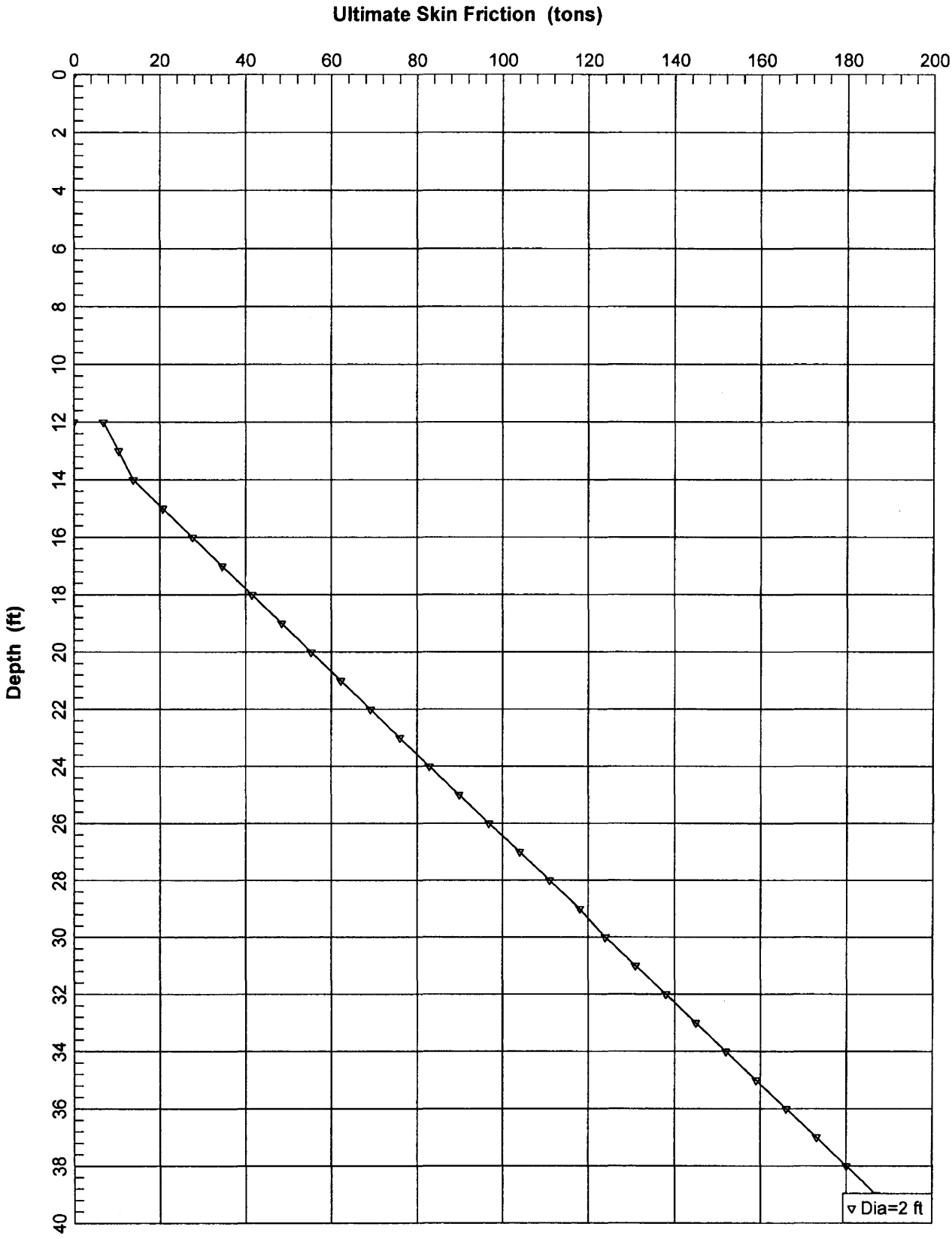
RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.5247E+00	0.2690E-03	0.1689E-01	0.1000E-03
0.5247E+01	0.2690E-02	0.1689E+00	0.1000E-02
0.1319E+02	0.6732E-02	0.4223E+00	0.2500E-02
0.2660E+02	0.1352E-01	0.8447E+00	0.5000E-02
0.3999E+02	0.2032E-01	0.1267E+01	0.7500E-02
0.5332E+02	0.2711E-01	0.1689E+01	0.1000E-01
0.1089E+03	0.6245E-01	0.4223E+01	0.2500E-01
0.1517E+03	0.1038E+00	0.8447E+01	0.5000E-01
0.1724E+03	0.1385E+00	0.1267E+02	0.7500E-01
0.1793E+03	0.1669E+00	0.1689E+02	0.1000E+00
0.1927E+03	0.3250E+00	0.2934E+02	0.2500E+00
0.1874E+03	0.5757E+00	0.4086E+02	0.5000E+00
0.1931E+03	0.8290E+00	0.4651E+02	0.7500E+00
0.1955E+03	0.1080E+01	0.4893E+02	0.1000E+01
0.1974E+03	0.2482E+01	0.5086E+02	0.2400E+01

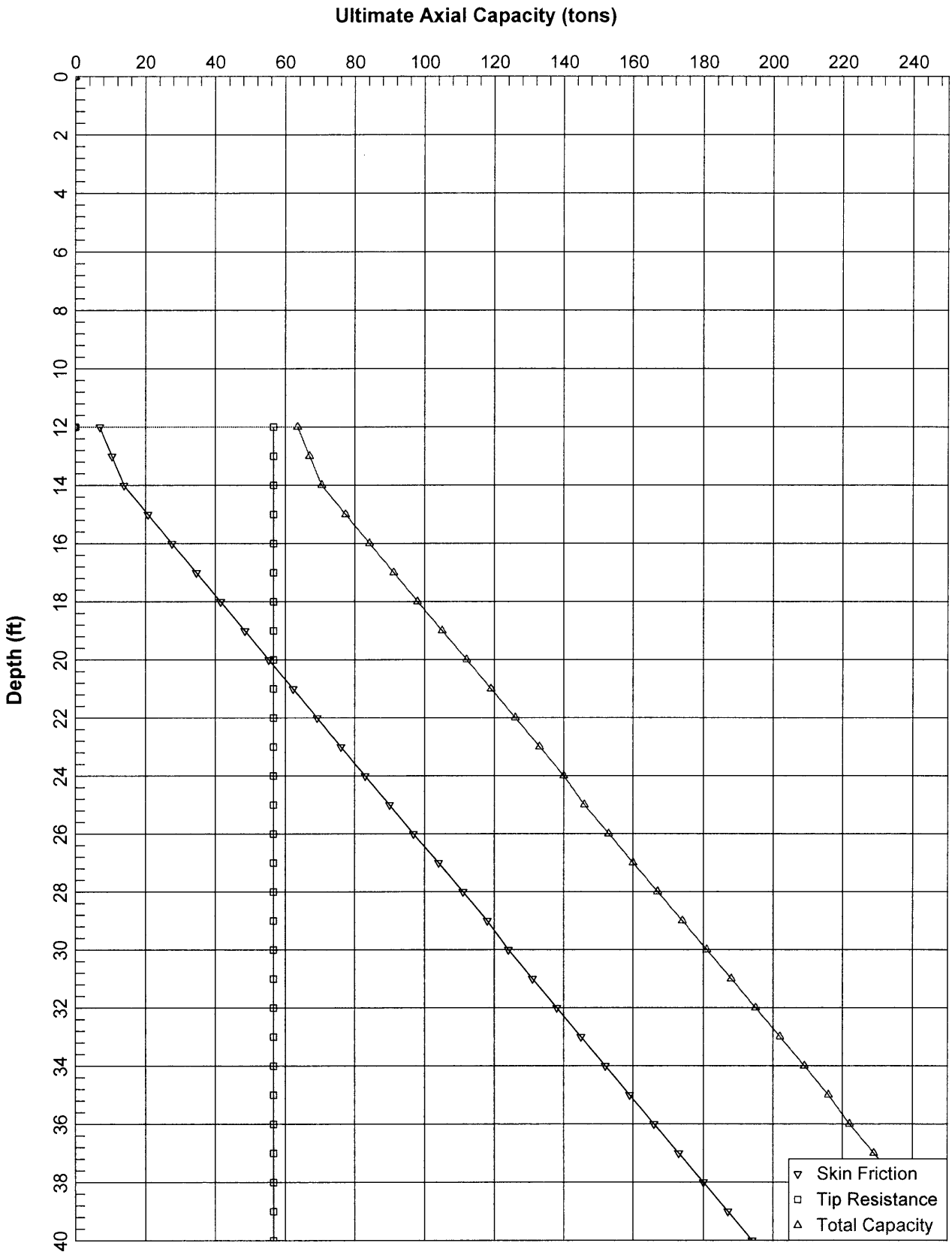
Abutment 2 - Left and Right Bridge

El. = 52.5 (approx.) - Left Bridge
= 51.5 (approx.) - Right Bridge





Cavallo Road-Undercrossing @ SR4 - Abutment 2 - 24-in CIDH Pile



Cavallo Road @ SR4 - Abutment 2 - 24-in CIDH Pile

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 5.0 (C) COPYRIGHT ENSOFT,INC. 1989,1995,1998,2001,2003

Cavallo Roadt- SR4 - Abutment 2

PROPOSED DEPTH = 40.0 FT

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 48.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 2.50

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 3.00

SOIL INFORMATION

LAYER NO 1----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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.000E+00

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	= 0.250E+04
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.120E+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	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00

Cavallo Road - Abut 2.sfo

SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.120E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.470E+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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.470E+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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.590E+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	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.590E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00

SOIL UNIT WEIGHT, LB/CU FT	=	0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	=	0.640E+04
DEPTH, FT	=	0.900E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	=	2.000	FT.
DIAMETER OF BASE	=	2.000	FT.
END OF STEM TO BASE	=	0.000	FT.
ANGLE OF BELL	=	0.000	DEG.
IGNORED TOP PORTION	=	8.000	FT.
IGNORED BOTTOM PORTION	=	2.000	FT.
AREA OF ONE PERCENT STEEL	=	4.524	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	1.28	3.46	56.56	60.01	22.31	20.23	46.88
12.0	1.40	6.91	56.56	63.47	25.76	21.62	45.45
13.0	1.51	10.37	56.56	66.92	29.22	23.00	44.24
14.0	1.63	13.82	56.56	70.38	32.68	24.38	43.20
15.0	1.75	20.74	56.56	77.29	39.59	27.15	44.28
16.0	1.86	27.65	56.56	84.21	46.50	29.91	45.22
17.0	1.98	34.56	56.56	91.12	53.41	32.68	46.06
18.0	2.09	41.47	56.56	98.03	60.33	35.44	46.80
19.0	2.21	48.39	56.56	104.94	67.24	38.21	47.46
20.0	2.33	55.30	56.56	111.86	74.15	40.97	48.06
21.0	2.44	62.21	56.56	118.77	81.06	43.74	48.60
22.0	2.56	69.12	56.56	125.68	87.98	46.50	49.09
23.0	2.68	76.04	56.56	132.59	94.89	49.27	49.54
24.0	2.79	82.95	56.56	139.50	101.80	52.03	49.95
25.0	2.91	89.86	56.56	146.42	108.71	54.80	50.33
26.0	3.03	96.77	56.56	153.33	115.63	57.56	50.68
27.0	3.14	103.69	56.56	160.24	122.54	60.33	51.00
28.0	3.26	110.60	56.56	167.15	129.45	63.09	51.30
29.0	3.37	117.51	56.56	174.07	136.36	65.86	51.58
30.0	3.49	124.42	56.56	180.98	143.28	68.62	51.84
31.0	3.61	131.34	56.56	187.89	150.19	71.39	52.08
32.0	3.72	138.25	56.56	194.80	157.10	74.15	52.31
33.0	3.84	145.16	56.56	201.72	164.01	76.92	52.53
34.0	3.96	152.07	56.56	208.63	170.92	79.68	52.73
35.0	4.07	158.99	56.56	215.54	177.84	82.45	52.92
36.0	4.19	165.90	56.56	222.45	184.75	85.21	53.10

Cavallo Road - Abut 2.sfo

37.0	4.31	172.81	56.56	229.37	191.66	87.98	53.27
38.0	4.42	179.72	56.56	236.28	198.57	90.74	53.43
39.0	4.54	186.63	56.56	243.19	205.49	93.51	53.58
40.0	4.65	193.55	56.56	250.10	212.40	96.27	53.73

RESULT FROM TREND (AVERAGED) LINE

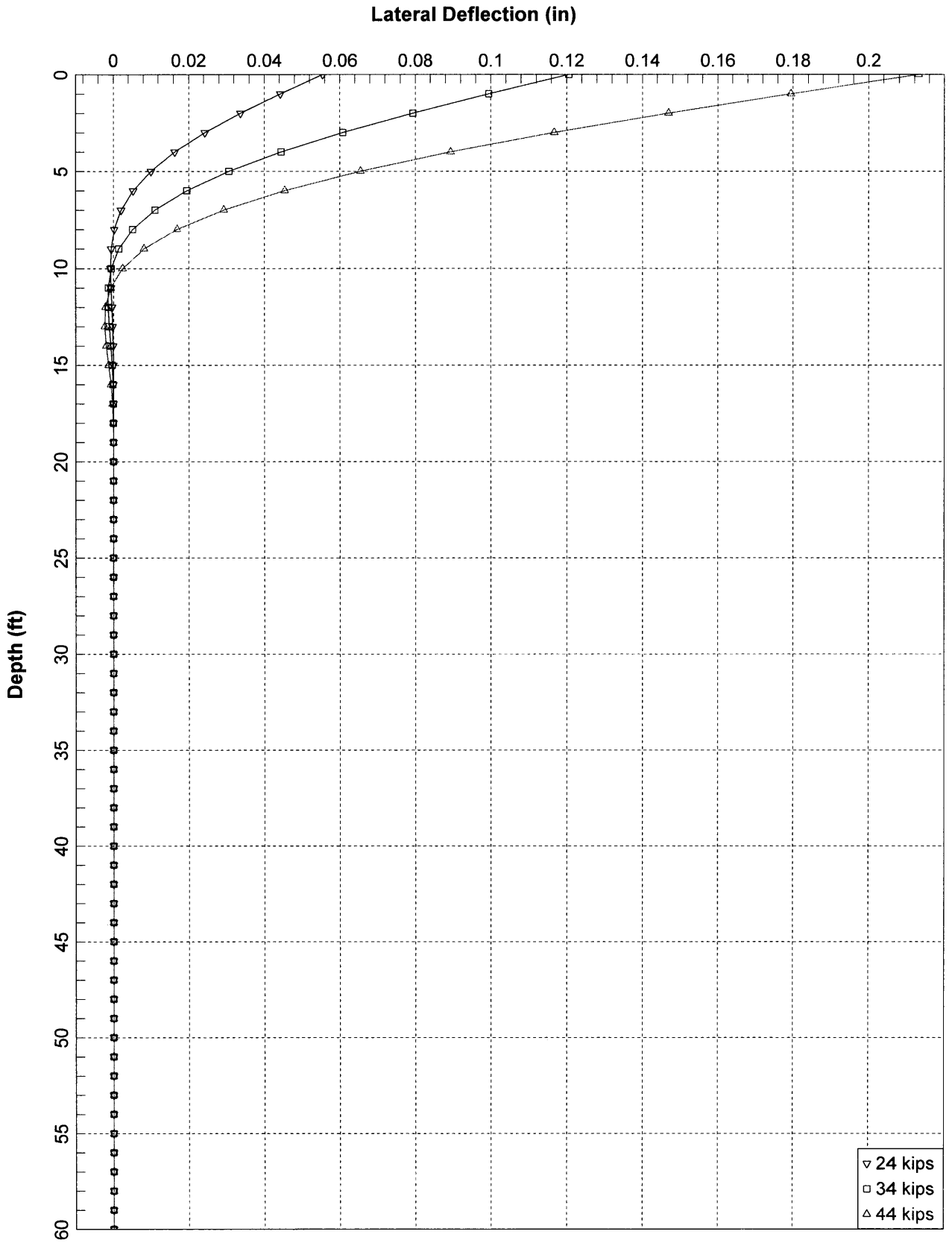
TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.5694E+00	0.2876E-03	0.1862E-01	0.1000E-03
0.5694E+01	0.2876E-02	0.1862E+00	0.1000E-02
0.1433E+02	0.7205E-02	0.4654E+00	0.2500E-02
0.2891E+02	0.1448E-01	0.9308E+00	0.5000E-02
0.4347E+02	0.2176E-01	0.1396E+01	0.7500E-02
0.5791E+02	0.2903E-01	0.1862E+01	0.1000E-01
0.1181E+03	0.6630E-01	0.4654E+01	0.2500E-01
0.1646E+03	0.1093E+00	0.9308E+01	0.5000E-01
0.1869E+03	0.1447E+00	0.1396E+02	0.7500E-01
0.1944E+03	0.1734E+00	0.1862E+02	0.1000E+00
0.2091E+03	0.3322E+00	0.3233E+02	0.2500E+00
0.2037E+03	0.5831E+00	0.4503E+02	0.5000E+00
0.2099E+03	0.8368E+00	0.5125E+02	0.7500E+00
0.2126E+03	0.1088E+01	0.5392E+02	0.1000E+01
0.2147E+03	0.2490E+01	0.5605E+02	0.2400E+01

PILE LATERAL LOAD BEHAVIOR
(LPILE Program)

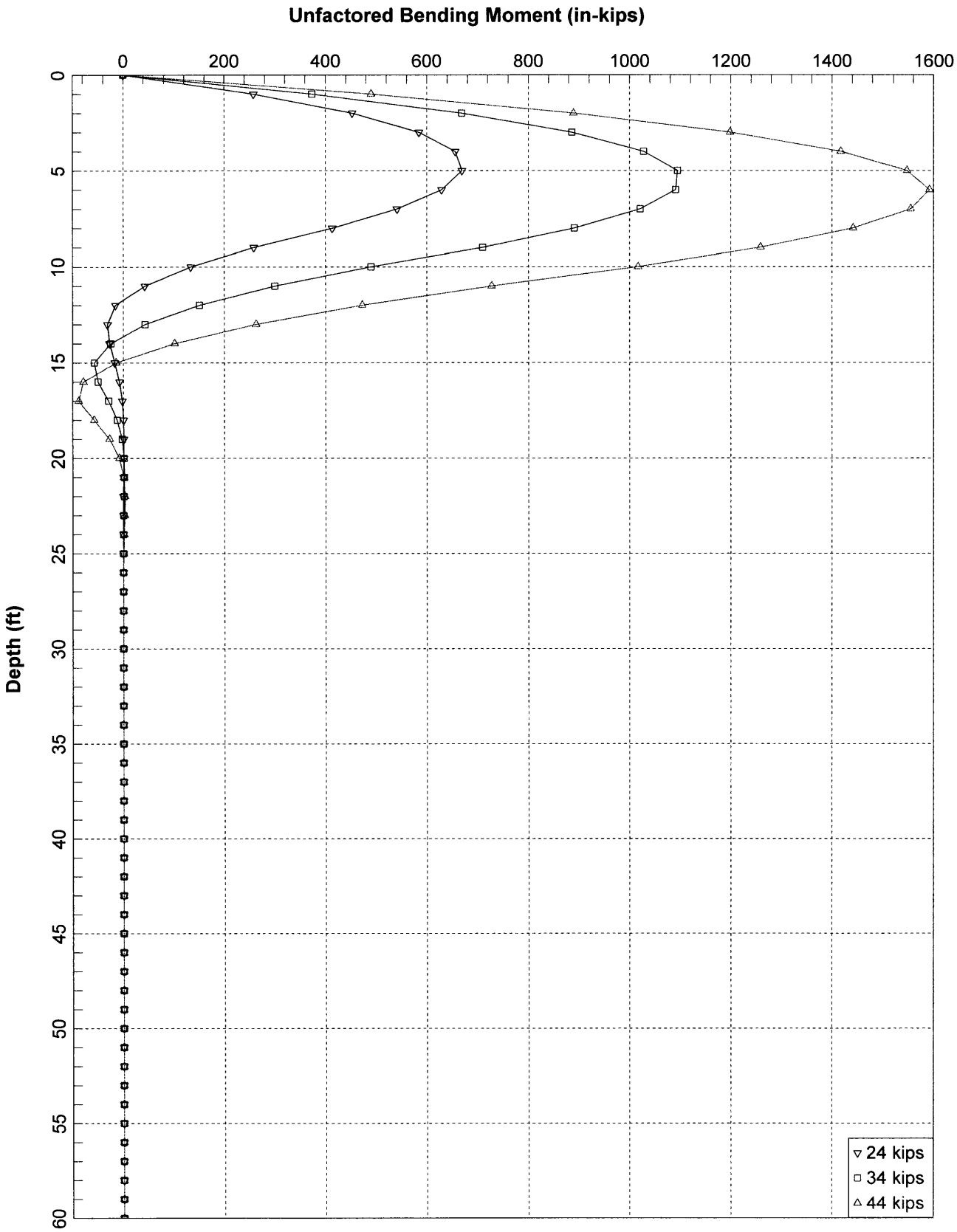
Abutment 1 – Left & Right Bridges
Profile based on boring CAV-168
24-in. Diameter CIDH Pile
Area = 452.4 in², I = 16286 in⁴

El. = 53.0 (approx.) - Left Bridge
= 52.0 (approx.) - Right Bridge

Depths -96 - 180 = Stiff Clay w/o free water	$S_u = 2.5$ ksf, $\gamma' = 125$ pcf, $\epsilon_{50} = 0.005$
Depths 180 - 420 = Stiff Clay w/o free water	$S_u = 4.0$ ksf, $\gamma' = 125$ pcf, $\epsilon_{50} = 0.004$
Depths 420 - 516 = API RP-2A Sand	$\phi' = 35°$, $\gamma' = 130$ pcf, $K = 125$ lb/in³
Depths 516 - 636 = Stiff Clay w/o free water	$S_u = 4.0$ ksf, $\gamma' = 65$ pcf, $\epsilon_{50} = 0.004$
Depths 636 - 924 = API RP-2A Sand	$\phi' = 40°$, $\gamma' = 70$ pcf, $K = 125$ lb/in³



Cavallo Road Undercrossing @ SR4 - Left & Right Bridges - Abutment 1 - 24-in. CIDH PIle



Cavallo Road Undercrossing @ SR4 - Left & Right Bridges - Abutment 1 - 24-in. CIDH PIle

LPILE Plus for Windows, Version 5.0 (5.0.21)

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:

Gary Parikh
Parikh Consultants

Path to file locations: S:\Ongoing Projects\2006\206117 TYLIn Rte 4 Project\Cavallo Rd\LPILE\
Name of input data file: Cavallo Road - Abutment 1.lpd
Name of output file: Cavallo Road - Abutment 1.lpo
Name of plot output file: Cavallo Road - Abutment 1.lpp
Name of runtime file: Cavallo Road - Abutment 1.lpr

Time and Date of Analysis

Date: August 24, 2009 Time: 19:26:10

Problem Title

eBARTCavallo Road Underpass - Abutment 1 - 24-in CIDH Pile

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant 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 pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 60
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 720.00 in
Depth of ground surface below top of pile = -96.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	24.00000000	16286.0000	452.4000	3600000.
2	720.0000	24.00000000	16286.0000	452.4000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 5 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -96.000 in
Distance from top of pile to bottom of layer = 180.000 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 180.000 in
Distance from top of pile to bottom of layer = 420.000 in

Layer 3 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 420.000 in
Distance from top of pile to bottom of layer = 516.000 in
p-y subgrade modulus k for top of soil layer = 125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 125.000 lbs/in**3

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 516.000 in
Distance from top of pile to bottom of layer = 636.000 in

Layer 5 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 636.000 in
Distance from top of pile to bottom of layer = 924.000 in
p-y subgrade modulus k for top of soil layer = 125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 125.000 lbs/in**3

(Depth of lowest layer extends 204.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth is defined using 10 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-96.00	.07230
2	180.00	.07230
3	180.00	.07230
4	420.00	.07230
5	420.00	.07520
6	516.00	.07520
7	516.00	.03760
8	636.00	.03760
9	636.00	.04050
10	924.00	.04050

Shear Strength of Soils

Distribution of shear strength parameters with depth defined using 10 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-96.000	17.36000	.00	.00500	.0
2	180.000	17.36000	.00	.00500	.0
3	180.000	27.78000	.00	.00400	.0
4	420.000	27.78000	.00	.00400	.0
5	420.000	.00000	35.00	------	------
6	516.000	.00000	35.00	------	------
7	516.000	27.78000	.00	.00400	.0
8	636.000	27.78000	.00	.00400	.0
9	636.000	.00000	40.00	------	------
10	924.000	.00000	40.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.6000	1.0000
2	720.000	.6000	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 3

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 24000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 34000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 44000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 24000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 200000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.055468	-2.8252E-08	24000.0000	-.0009300	442.0866	-442.6340
12.000	.044308	258362.	18693.9173	-.0009035	632.4555	-441.7131
24.000	.033783	452991.	13436.7189	-.0008307	775.8636	-434.4866
36.000	.024371	584831.	8307.0898	-.0007245	873.0072	-420.4516

48.000	.016395	655839.	3390.8364	-.0005976	925.3278	-398.9240
60.000	.010030	669079.	-1215.8461	-.0004620	935.0838	-368.8564
72.000	.005308	628876.	-5398.8097	-.0003291	905.4607	-328.3042
84.000	.002131	541088.	-9002.1039	-.0002094	840.7759	-272.2449
96.000	.000282	413831.	-11782.2893	-.0001117	747.0090	-191.1194
108.000	-.000550	258849.	-11672.5250	-4.2838E-05	632.8140	209.4134
120.000	-.000746	133896.	-9009.3427	-2.6453E-06	540.7448	234.4503
132.000	-.000613	42637.3082	-6215.2025	1.5421E-05	473.5031	231.2398
144.000	-.000376	-15343.3411	-3066.8313	1.8214E-05	453.3921	293.4888
156.000	-.000176	-31054.0689	-481.0210	1.3466E-05	464.9682	137.4796
168.000	-5.25E-05	-26952.4797	590.0902	7.5294E-06	461.9460	41.0389
180.000	4.72E-06	-16928.0446	808.8207	3.0388E-06	454.5597	-4.5839
192.000	2.04E-05	-7555.3687	628.0407	5.3323E-07	447.6537	-25.5461
204.000	1.75E-05	-1857.6264	338.7837	-4.3007E-07	443.4554	-22.6634
216.000	1.01E-05	577.5056	122.8897	-5.6108E-07	442.5122	-13.3190
228.000	4.05E-06	1094.4186	10.8352	-3.8998E-07	442.8930	-5.3567
240.000	7.17E-07	839.4225	-26.9906	-1.9207E-07	442.7052	-.9475484
252.000	-5.57E-07	447.5671	-28.2572	-6.0364E-08	442.4164	.7364495
264.000	-7.32E-07	161.5406	-18.0340	1.9707E-09	442.2057	.9674128
276.000	-5.10E-07	14.7422	-8.1859	2.0011E-08	442.0975	.6739318
288.000	-2.52E-07	-35.0173	-2.1468	1.7936E-08	442.1125	.3325900
300.000	-7.94E-08	-36.8667	.4783563	1.0580E-08	442.1138	.1049327
312.000	2.30E-09	-23.5876	1.0897	4.3930E-09	442.1040	-.0030363
324.000	2.60E-08	-10.7341	.8649500	8.8056E-10	442.0946	-.0344278
336.000	2.34E-08	-2.8330	.4725577	-5.0786E-10	442.0887	-.0309709
348.000	1.39E-08	.6097057	.1768331	-7.3539E-10	442.0871	-.0183165
360.000	5.78E-09	1.4145	.0210840	-5.2823E-10	442.0877	-.0076416
372.000	1.18E-09	1.1183	-.0341198	-2.6904E-10	442.0875	-.0015590
384.000	-6.76E-10	.5969416	-.0381148	-9.3507E-11	442.0871	.0008932
396.000	-1.06E-09	.2039514	-.0243113	-1.1546E-11	442.0868	.0014074
408.000	-9.53E-10	.0135250	-.0083102	1.0710E-11	442.0867	.0012595
420.000	-8.08E-10	.0044547	-.0006415	1.2550E-11	442.0867	1.8651E-05
432.000	-6.52E-10	-.0019321	-.0004358	1.2808E-11	442.0867	1.5633E-05
444.000	-5.00E-10	-.0060668	-.0002673	1.1990E-11	442.0867	1.2453E-05
456.000	-3.64E-10	-.0084053	-.0001363	1.0509E-11	442.0867	9.3848E-06
468.000	-2.48E-10	-.0093882	-4.0248E-05	8.6876E-12	442.0867	6.6220E-06
480.000	-1.55E-10	-.0094129	2.5205E-05	6.7635E-12	442.0867	4.2869E-06
492.000	-8.58E-11	-.0088157	6.5589E-05	4.8981E-12	442.0867	2.4437E-06
504.000	-3.78E-11	-.0078623	8.6921E-05	3.1913E-12	442.0867	1.1116E-06
516.000	-9.18E-12	-.0067449	.0001664	1.6964E-12	442.0867	1.2134E-05
528.000	2.89E-12	-.0038769	.0002163	6.0940E-13	442.0867	-3.8251E-06
540.000	5.45E-12	-.0015578	.0001501	5.3228E-14	442.0867	-7.1981E-06
552.000	4.17E-12	-.0002745	7.3841E-05	-1.3428E-13	442.0866	-5.5137E-06
564.000	2.22E-12	.0002150	2.3130E-05	-1.4036E-13	442.0866	-2.9382E-06
576.000	8.03E-13	.0002813	-8.6422E-07	-8.9569E-14	442.0866	-1.0608E-06
588.000	7.32E-14	.0001947	-7.8096E-06	-4.0852E-14	442.0866	-9.6754E-08
600.000	-1.78E-13	9.4089E-05	-6.9793E-06	-1.1296E-14	442.0866	2.3515E-07
612.000	-1.98E-13	2.7272E-05	-3.9989E-06	1.1243E-15	442.0866	2.6158E-07
624.000	-1.51E-13	-1.8906E-06	-1.2326E-06	3.7218E-15	442.0866	1.9948E-07
636.000	-1.09E-13	-2.3276E-06	-1.7547E-08	3.2901E-15	442.0866	3.0271E-09
648.000	-7.19E-14	-2.3275E-06	1.3041E-08	2.8137E-15	442.0866	2.0708E-09
660.000	-4.10E-14	-2.0281E-06	3.2775E-08	2.3680E-15	442.0866	1.2182E-09
672.000	-1.51E-14	-1.5523E-06	4.2858E-08	2.0015E-15	442.0866	4.6235E-10
684.000	6.99E-15	-1.0091E-06	4.3431E-08	1.7394E-15	442.0866	-3.6694E-10
696.000	2.66E-14	-5.1831E-07	3.6056E-08	1.5831E-15	442.0866	-8.6222E-10
708.000	4.50E-14	-1.5139E-07	2.1899E-08	1.5146E-15	442.0866	-1.4972E-09
720.000	6.30E-14	0.0000	0.0000	1.4991E-15	442.0866	-2.1526E-09

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:


```
Pile-head deflection              =      .05546803 in
Computed slope at pile head       =     -.00092996
Maximum bending moment            =   669079.32092 lbs-in
Maximum shear force               =    24000.00000 lbs
Depth of maximum bending moment   =    60.00000000 in
Depth of maximum shear force      =       0.00000 in
Number of iterations              =            18
Number of zero deflection points  =             8
```

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

```
Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head  =       34000.000 lbs
Specified moment at pile head       =            .000 in-lbs
Specified axial load at pile head   =      200000.000 lbs
```

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.120586	0.0000	34000.0000	-.0017559	442.0866	-537.4369
12.000	.099516	373519.	27531.1632	-.0017177	717.3061	-540.7026
24.000	.079362	668993.	21059.7949	-.0016110	935.0200	-537.8588
36.000	.060852	886687.	14661.7717	-.0014518	1095.4231	-528.4784
48.000	.044519	1027844.	8418.6428	-.0012559	1199.4320	-512.0431
60.000	.030711	1094762.	2419.1201	-.0010386	1248.7393	-487.8774
72.000	.019592	1090888.	-3238.1342	-.0008150	1245.8849	-454.9983
84.000	.011152	1020959.	-8438.4182	-.0005988	1194.3587	-411.7157
96.000	.005220	891241.	-13034.1602	-.0004031	1098.7787	-354.2413
108.000	.001477	710074.	-16770.7799	-.0002393	965.2898	-268.5286
120.000	-.000522	489890.	-17099.0479	-.0001165	803.0521	213.8173
132.000	-.001318	300256.	-14137.8363	-3.5611E-05	663.3239	279.7180
144.000	-.001377	150753.	-10703.8560	1.0544E-05	553.1660	292.6121
156.000	-.001065	43312.6368	-7301.3450	3.0405E-05	474.0007	274.4731
168.000	-.000647	-24625.0504	-4200.4546	3.2317E-05	460.2311	242.3420
180.000	-.000290	-57653.3946	-1058.5511	2.3897E-05	484.5674	281.3086
192.000	-7.38E-05	-50144.9822	1183.5126	1.2865E-05	479.0349	92.3687
204.000	1.90E-05	-29310.8444	1589.8814	4.7338E-06	463.6837	-24.6406
216.000	3.99E-05	-12010.5521	1125.9328	5.0509E-07	450.9364	-52.6842
228.000	3.12E-05	-2290.8808	562.6306	-9.5849E-07	443.7746	-41.1995
240.000	1.69E-05	1497.1835	181.7685	-1.0397E-06	443.1898	-22.2775
252.000	6.22E-06	2076.5526	-1.1932	-6.7398E-07	443.6167	-8.2161
264.000	6.78E-07	1471.7829	-55.8674	-3.1086E-07	443.1711	-.8962707
276.000	-1.24E-06	737.2272	-53.3727	-8.4792E-08	442.6299	1.6454
288.000	-1.36E-06	239.2458	-30.7385	1.5138E-08	442.2629	1.7936
300.000	-8.81E-07	-.5703117	-12.9858	3.9563E-08	442.0871	1.1652
312.000	-4.07E-07	-72.6036	-2.7637	3.2075E-08	442.1401	.5385322
324.000	-1.12E-07	-67.0527	1.3532	1.7783E-08	442.1361	.1476174
336.000	1.94E-08	-40.2118	2.0853	6.8058E-09	442.1163	-.0256098
348.000	5.17E-08	-17.0391	1.5219	9.4691E-10	442.0992	-.0682885
360.000	4.21E-08	-3.6915	.7782431	-1.1746E-09	442.0894	-.0556494
372.000	2.35E-08	1.6444	.2581921	-1.3841E-09	442.0879	-.0310258
384.000	8.88E-09	2.5117	.0015936	-9.5877E-10	442.0885	-.0117406
396.000	4.61E-10	1.6872	-.0725099	-5.2906E-10	442.0879	-.0006099
408.000	-3.82E-09	.7740459	-.0459108	-2.7718E-10	442.0872	.0050431

420.000	-6.19E-09	.5866982	-.0147942	-1.3793E-10	442.0871	.0001430
432.000	-7.13E-09	.4196479	-.0129107	-3.4940E-11	442.0870	.0001710
444.000	-7.03E-09	.2770083	-.0108352	3.6354E-11	442.0869	.0001750
456.000	-6.25E-09	.1594286	-.0088177	8.1018E-11	442.0868	.0001613
468.000	-5.09E-09	.0649941	-.0070357	1.0398E-10	442.0867	.0001357
480.000	-3.76E-09	-.0099279	-.0055993	1.0962E-10	442.0867	.0001037
492.000	-2.45E-09	-.0699162	-.0045578	1.0145E-10	442.0867	6.9922E-05
504.000	-1.32E-09	-.1198014	-.0039050	8.2034E-11	442.0867	3.8874E-05
516.000	-4.85E-10	-.1640299	.0001776	5.2987E-11	442.0868	.0006416
528.000	-5.10E-11	-.1157931	.0044311	2.4351E-11	442.0867	6.7350E-05
540.000	9.91E-11	-.0578010	.0040496	6.5856E-12	442.0867	-.0001309
552.000	1.07E-10	-.0186355	.0024145	-1.2367E-12	442.0867	-.0001416
564.000	6.94E-11	.0001531	.0010149	-3.1281E-12	442.0866	-9.1705E-05
576.000	3.20E-11	.0057360	.0002106	-2.5254E-12	442.0867	-4.2336E-05
588.000	8.77E-12	.0052198	-.0001129	-1.4042E-12	442.0867	-1.1589E-05
600.000	-1.67E-12	.0030323	-.0001692	-5.5975E-13	442.0867	2.2122E-06
612.000	-4.67E-12	.0011618	-.0001189	-1.3054E-13	442.0866	6.1687E-06
624.000	-4.81E-12	.0001791	-4.3776E-05	6.6847E-15	442.0866	6.3534E-06
636.000	-4.51E-12	.0001111	-4.9022E-06	3.6386E-14	442.0866	1.2564E-07
648.000	-3.93E-12	6.1253E-05	-3.4691E-06	5.4029E-14	442.0866	1.1321E-07
660.000	-3.21E-12	2.7630E-05	-2.2182E-06	6.3125E-14	442.0866	9.5269E-08
672.000	-2.42E-12	7.7126E-06	-1.2029E-06	6.6742E-14	442.0866	7.3954E-08
684.000	-1.61E-12	-1.5595E-06	-4.5545E-07	6.7372E-14	442.0866	5.0619E-08
696.000	-8.01E-13	-3.5417E-06	3.9585E-09	6.6850E-14	442.0866	2.5950E-08
708.000	-3.53E-15	-1.7854E-06	1.6083E-07	6.6304E-14	442.0866	1.9578E-10
720.000	7.90E-13	0.0000	0.0000	6.6122E-14	442.0866	-2.7001E-08

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

```
Pile-head deflection              =      .12058640 in
Computed slope at pile head       =     -.00175590
Maximum bending moment            =      1094762. lbs-in
Maximum shear force               =    34000.00000 lbs
Depth of maximum bending moment   =    60.00000000 in
Depth of maximum shear force      =       0.00000 in
Number of iterations              =            26
Number of zero deflection points  =             8
```

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 3

```
Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head  =       44000.000 lbs
Specified moment at pile head       =            .000 in-lbs
Specified axial load at pile head   =      200000.000 lbs
```

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.213138	3.3902E-08	44000.0000	-.0028057	442.0866	-619.6662
12.000	.179470	490118.	36522.5667	-.0027556	803.2197	-626.5726

24.000	.147004	889768.	28998.3925	-.0026144	1097.6940	-627.4564
36.000	.116725	1198628.	21502.1524	-.0024006	1325.2709	-621.9170
48.000	.089389	1417343.	14113.6944	-.0021329	1486.4264	-609.4927
60.000	.065534	1547595.	6919.0048	-.0018295	1582.3998	-589.6222
72.000	.045481	1592181.	11.8553	-.0015082	1615.2520	-561.5693
84.000	.029338	1555119.	-6503.0927	-.0011861	1587.9436	-524.2553
96.000	.017014	1441800.	-12503.5501	-.0008794	1504.4470	-475.8209
108.000	.008232	1259255.	-17831.3716	-.0006030	1369.9423	-412.1494
120.000	.002542	1016741.	-22216.8927	-.0003701	1191.2514	-318.7708
132.000	-.000650	727826.	-22725.1375	-.0001915	978.3699	234.0633
144.000	-.002055	472258.	-19380.2644	-6.8725E-05	790.0598	323.4155
156.000	-.002299	263029.	-15443.4233	6.5223E-06	635.8943	332.7246
168.000	-.001898	101584.	-11544.0681	4.3836E-05	516.9368	317.1679
180.000	-.001247	-14238.8063	-7511.3887	5.2775E-05	452.5782	354.9453
192.000	-.000632	-78942.5669	-3064.6236	4.3239E-05	500.2538	386.1822
204.000	-.000210	-87997.3167	879.6641	2.6154E-05	506.9256	271.1991
216.000	-3.84E-06	-57956.1694	2537.3477	1.1218E-05	484.7904	5.0815
228.000	5.96E-05	-27154.8181	2095.1741	2.5079E-06	462.0951	-78.7771
240.000	5.63E-05	-7684.0283	1175.6493	-1.0575E-06	447.7485	-74.4771
252.000	3.42E-05	1065.8397	457.4027	-1.7347E-06	442.8720	-45.2307
264.000	1.47E-05	3301.9643	69.3510	-1.2878E-06	444.5196	-19.4446
276.000	3.31E-06	2736.4452	-73.5869	-6.6980E-07	444.1029	-4.3784
288.000	-1.36E-06	1539.0944	-89.0337	-2.3225E-07	443.2207	1.8039
300.000	-2.26E-06	600.7501	-60.2733	-1.3266E-08	442.5293	2.9895
312.000	-1.68E-06	92.5988	-28.9878	5.7690E-08	442.1549	2.2247
324.000	-8.77E-07	-95.2342	-8.6831	5.7420E-08	442.1568	1.1594
336.000	-3.05E-07	-116.0707	.6922192	3.5796E-08	442.1722	.4031765
348.000	-1.80E-08	-78.7927	3.2541	1.5854E-08	442.1447	.0238057
360.000	7.55E-08	-38.0481	2.7984	3.8966E-09	442.1147	-.0997633
372.000	7.55E-08	-11.6506	1.6009	-1.1894E-09	442.0952	-.0998085
384.000	4.69E-08	.3801185	.6299061	-2.3428E-09	442.0869	-.0620298
396.000	1.93E-08	3.4784	.1048164	-1.9480E-09	442.0892	-.0254852
408.000	1.76E-10	2.9051	-.0494933	-1.2947E-09	442.0888	-.0002331
420.000	-1.18E-08	2.2968	-.0492582	-7.6236E-10	442.0883	.0002723
432.000	-1.81E-08	1.7265	-.0450160	-3.5063E-10	442.0879	.0004347
444.000	-2.02E-08	1.2181	-.0393897	-4.9291E-11	442.0875	.0005030
456.000	-1.93E-08	.7814083	-.0333846	1.5533E-10	442.0872	.0004979
468.000	-1.65E-08	.4160740	-.0277583	2.7788E-10	442.0870	.0004399
480.000	-1.26E-08	.1138759	-.0230275	3.3211E-10	442.0867	.0003486
492.000	-8.51E-09	-.1381804	-.0194813	3.2962E-10	442.0868	.0002424
504.000	-4.72E-09	-.3552580	-.0171937	2.7912E-10	442.0869	.0001388
516.000	-1.81E-09	-.5521702	-.0020045	1.8626E-10	442.0871	.0023927
528.000	-2.53E-10	-.4042603	.0143593	8.8382E-11	442.0869	.0003346
540.000	3.11E-10	-.2079709	.0139003	2.5728E-11	442.0868	-.0004111
552.000	3.64E-10	-.0707772	.0085441	-2.7983E-12	442.0867	-.0004816
564.000	2.44E-10	-.0028992	.0037205	-1.0338E-11	442.0867	-.0003223
576.000	1.16E-10	.0185654	.0008648	-8.7349E-12	442.0867	-.0001536
588.000	3.42E-11	.0178971	-.0003284	-5.0034E-12	442.0867	-4.5223E-05
600.000	-3.85E-12	.0107079	-.0005692	-2.0760E-12	442.0867	5.0883E-06
612.000	-1.56E-11	.0042461	-.0004149	-5.4567E-13	442.0867	2.0636E-05
624.000	-1.69E-11	.0007539	-.0001566	-3.3974E-14	442.0866	2.2399E-05
636.000	-1.64E-11	.0004868	-1.9506E-05	9.2994E-14	442.0866	4.5801E-07
648.000	-1.47E-11	.0002853	-1.4217E-05	1.7201E-13	442.0866	4.2348E-07
660.000	-1.23E-11	.0001447	-9.4863E-06	2.1602E-13	442.0866	3.6505E-07
672.000	-9.53E-12	5.6612E-05	-5.5475E-06	2.3662E-13	442.0866	2.9142E-07
684.000	-6.62E-12	1.0443E-05	-2.5485E-06	2.4348E-13	442.0866	2.0841E-07
696.000	-3.69E-12	-5.7201E-06	-5.8194E-07	2.4397E-13	442.0866	1.1935E-07
708.000	-7.65E-13	-4.6946E-06	2.8692E-07	2.4290E-13	442.0866	2.5463E-08
720.000	2.14E-12	0.0000	0.0000	2.4242E-13	442.0866	-7.3283E-08

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

```
Pile-head deflection              =      .21313841 in
Computed slope at pile head       =     -.00280574
Maximum bending moment            =      1592181. lbs-in
Maximum shear force               =    44000.00000 lbs
Depth of maximum bending moment   =    72.00000000 in
Depth of maximum shear force      =        0.00000 in
Number of iterations              =             28
Number of zero deflection points  =              8
```

Summary of Pile Response(s)

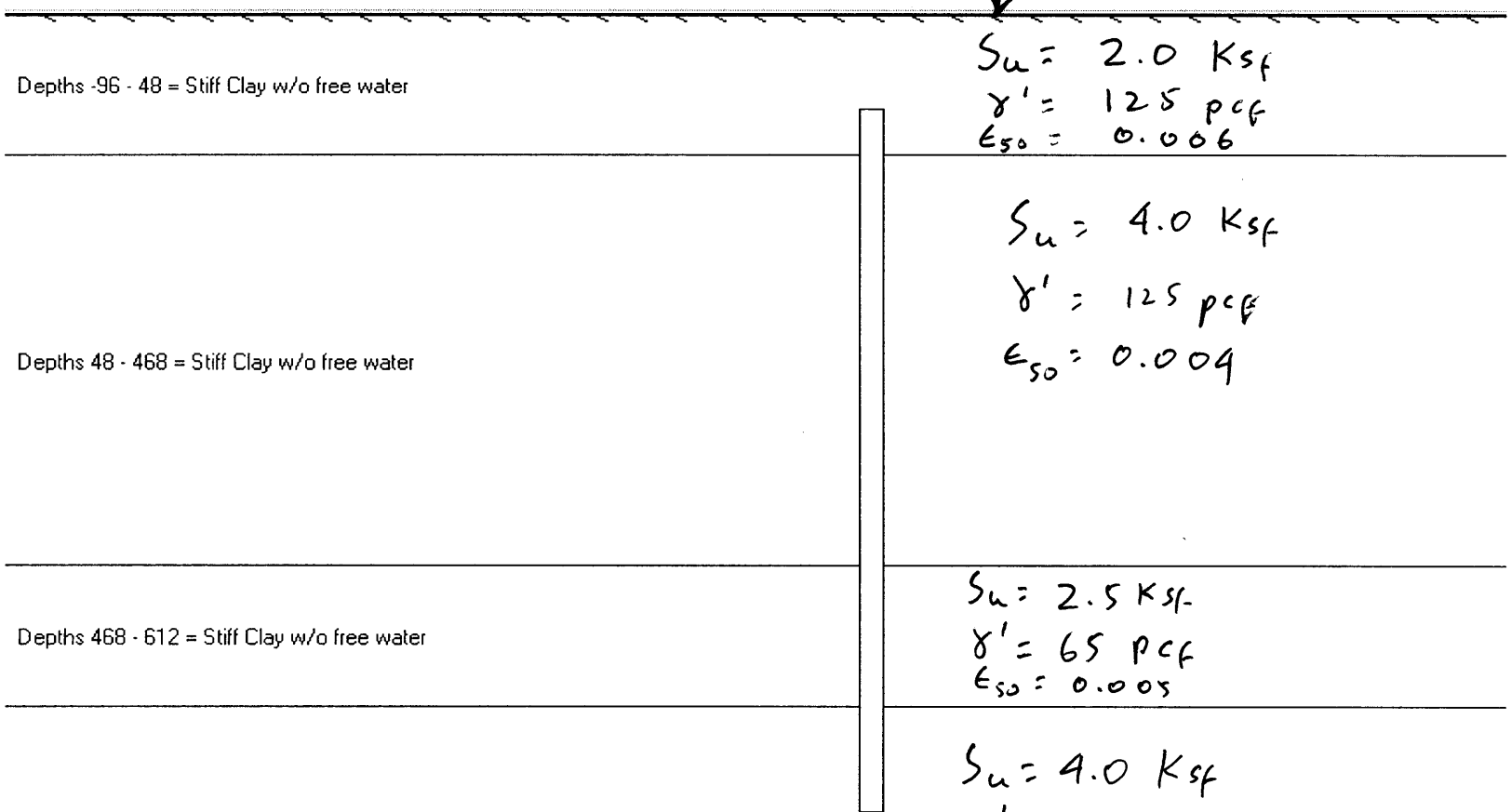
Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

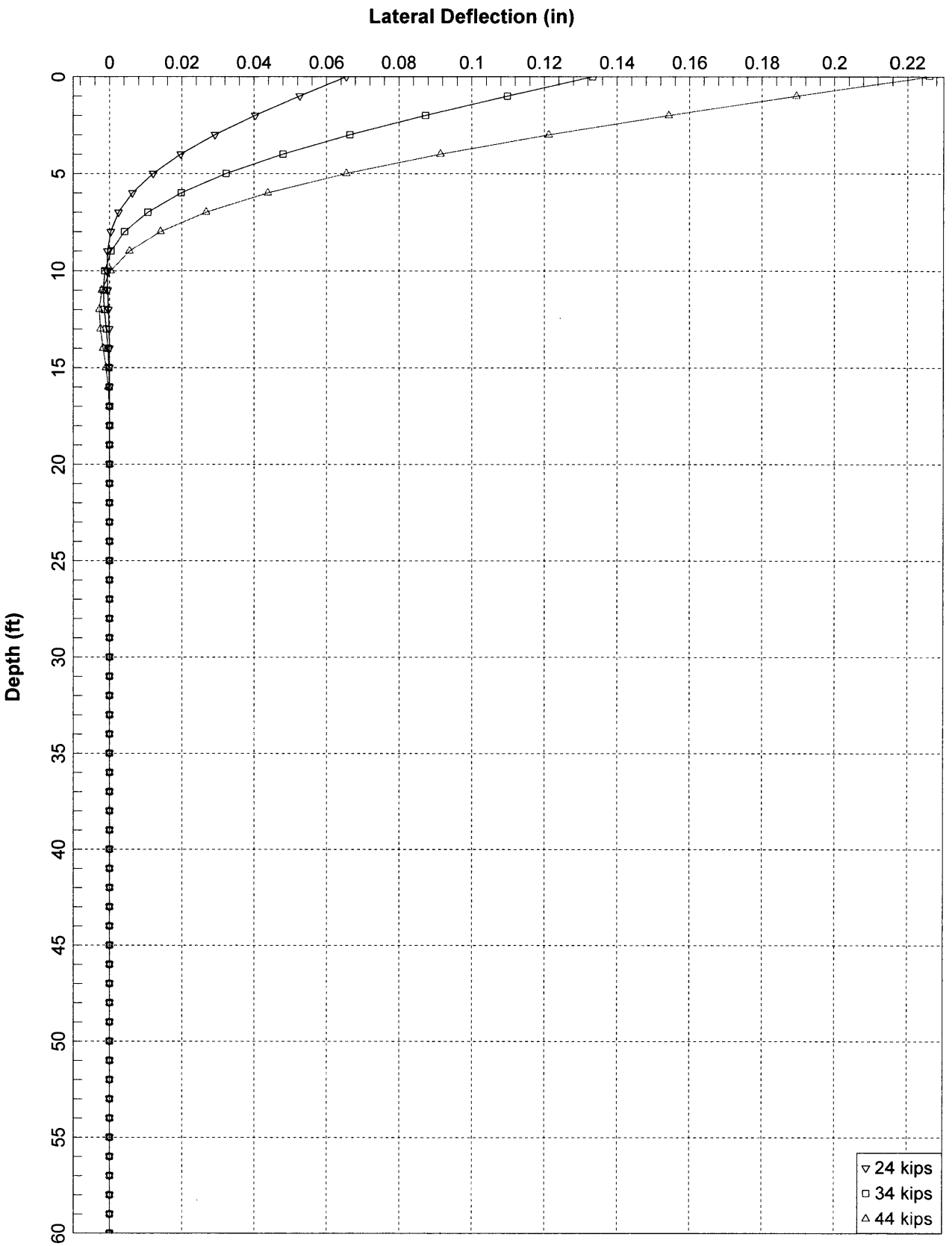
Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 24000.	M= 0.000	200000.	.0554680	669079.	24000.0000
1	V= 34000.	M= 0.000	200000.	.1205864	1094762.	34000.0000
1	V= 44000.	M= 0.000	200000.	.2131384	1592181.	44000.0000

The analysis ended normally.

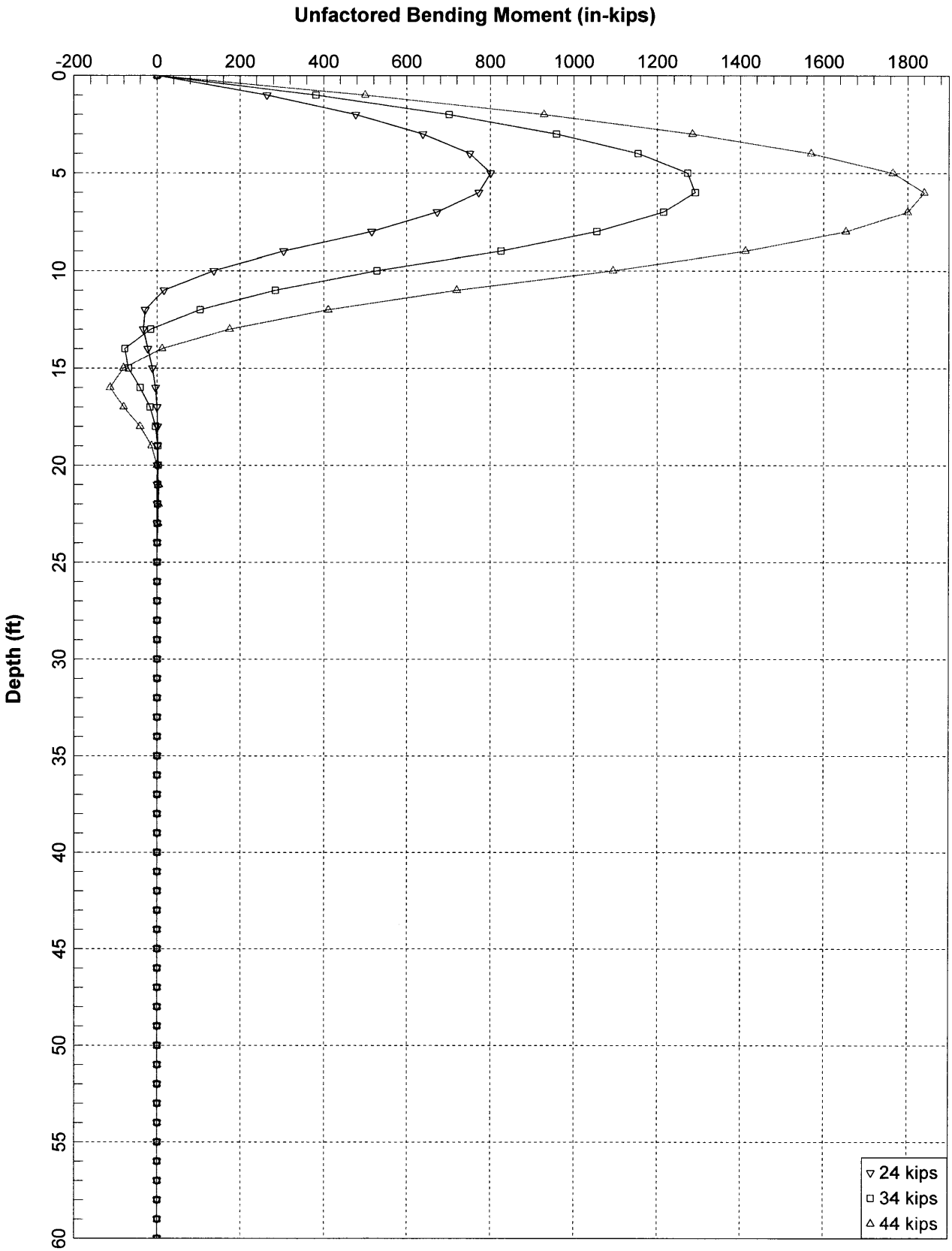
El. = 52.5 (Left Bridge)
51.5 (Right Bridge)



Abutment 2 – Left & Right Bridges
Profile based on boring CAV-169
24-in. Diameter CIDH Pile
Area = 452.4 in²; I = 16286 in⁴



Cavallo Road Undercrossing @ SR4 - Left and Right Bridges - Abutment 2 - 24-in. CIDH PIle



Cavallo Road Undercrossing @ SR4 - Left & Right Bridges - Abutment 2 - 24-in. CIDH PIle

==

LPILE Plus for Windows, Version 5.0 (5.0.21)

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:

Gary Parikh
Parikh Consultants

Path to file locations: S:\Ongoing Projects\2006\206117 TYLIn Rte 4 Project\Cavallo Rd\LPILE\
Name of input data file: Cavallo Road - Abutment 2.lpd
Name of output file: Cavallo Road - Abutment 2.lpo
Name of plot output file: Cavallo Road - Abutment 2.lpp
Name of runtime file: Cavallo Road - Abutment 2.lpr

Time and Date of Analysis

Date: August 24, 2009 Time: 19:14:21

Problem Title

SR4 - Cavallo Road Undercrossing- Abutment 2 - 24-in CIDH Pile

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant 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 pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 60
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 720.00 in
Depth of ground surface below top of pile = -96.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	24.00000000	16286.0000	452.4000	3600000.
2	720.0000	24.00000000	16286.0000	452.4000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -96.000 in
Distance from top of pile to bottom of layer = 48.000 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 48.000 in
Distance from top of pile to bottom of layer = 468.000 in

Layer 3 is stiff clay without free water
Distance from top of pile to top of layer = 468.000 in
Distance from top of pile to bottom of layer = 612.000 in

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 612.000 in
Distance from top of pile to bottom of layer = 972.000 in

(Depth of lowest layer extends 252.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 8 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-96.00	.07230
2	48.00	.07230
3	48.00	.07230
4	468.00	.07230
5	468.00	.03760
6	612.00	.03760
7	612.00	.03760
8	972.00	.03760

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 8 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-96.000	13.89000	.00	.00600	.0
2	48.000	13.89000	.00	.00600	.0
3	48.000	27.78000	.00	.00400	.0
4	468.000	27.78000	.00	.00400	.0
5	468.000	17.36000	.00	.00500	.0
6	612.000	17.36000	.00	.00500	.0
7	612.000	27.78000	.00	.00400	.0
8	972.000	27.78000	.00	.00400	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.6000	1.0000
2	720.000	.6000	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 3

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 24000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 34000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 44000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 24000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 200000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.065561	-2.2601E-08	24000.0000	-.0010766	442.0866	-359.3398
12.000	.052642	264711.	19687.0566	-.0010495	637.1336	-359.4841
24.000	.040373	477527.	15403.1469	-.0009735	793.9423	-354.5008
36.000	.029277	639060.	11213.1588	-.0008592	912.9645	-343.8305
48.000	.019751	750767.	6610.5155	-.0007170	995.2737	-423.2767
60.000	.012069	801154.	797.3779	-.0005582	1032.4001	-545.5796
72.000	.006355	772583.	-5400.8905	-.0003971	1011.3486	-487.4652
84.000	.002538	673439.	-10759.2756	-.0002492	938.2959	-405.5990
96.000	.000375	515557.	-15374.2424	-.0001275	821.9639	-363.5621
108.000	-.000522	305069.	-15772.1299	-4.3499E-05	666.8702	297.2475
120.000	-.000669	137234.	-12012.6992	1.7647E-06	543.2050	329.3243
132.000	-.000479	16755.4397	-6891.2876	1.7524E-05	454.4325	524.2443
144.000	-.000249	-28240.5925	-2053.6174	1.6348E-05	462.8951	282.0340
156.000	-8.70E-05	-32609.8501	252.6174	1.0121E-05	466.1145	102.3384
168.000	-5.60E-06	-22226.3560	907.5561	4.5092E-06	458.4637	6.8180
180.000	2.12E-05	-10850.1488	788.2236	1.1242E-06	450.0814	-26.7068

192.000	2.14E-05	-3314.3865	461.1885	-3.2534E-07	444.5288	-27.7991
204.000	1.34E-05	219.9380	188.0629	-6.4202E-07	442.2487	-17.7219
216.000	5.97E-06	1202.2052	34.3599	-4.9648E-07	442.9725	-7.8953
228.000	1.49E-06	1046.9576	-24.8423	-2.6631E-07	442.8581	-1.9717
240.000	-4.18E-07	607.2672	-33.3554	-9.7017E-08	442.5341	.5528888
252.000	-8.37E-07	246.8945	-23.4020	-9.6040E-09	442.2686	1.1060
264.000	-6.49E-07	45.6644	-11.6207	2.0336E-08	442.1203	.8575626
276.000	-3.49E-07	-32.0991	-3.7100	2.1724E-08	442.1103	.4608755
288.000	-1.27E-07	-43.4808	.0656067	1.3989E-08	442.1187	.1683987
300.000	-1.29E-08	-30.5917	1.1785	6.4089E-09	442.1092	.0170832
312.000	2.64E-08	-15.2276	1.0715	1.7199E-09	442.0979	-.0349159
324.000	2.84E-08	-4.8839	.6371368	-3.3827E-10	442.0902	-.0374782
336.000	1.83E-08	.0652967	.2671586	-8.3139E-10	442.0867	-.0241848
348.000	8.40E-09	1.5319	.0554295	-6.6794E-10	442.0878	-.0111034
360.000	2.27E-09	1.3988	-.0291620	-3.6802E-10	442.0877	-.0029952
372.000	-4.33E-10	.8337520	-.0437030	-1.3955E-10	442.0873	.0005717
384.000	-1.08E-09	.3506090	-.0316818	-1.8345E-11	442.0869	.0014318
396.000	-8.73E-10	.0734764	-.0161688	2.5055E-11	442.0867	.0011537
408.000	-4.82E-10	-.0375618	-.0054247	2.8730E-11	442.0867	.0006370
420.000	-1.83E-10	-.0568535	-.0001491	1.9068E-11	442.0867	.0002423
432.000	-2.43E-11	-.0412313	.0014971	9.0300E-12	442.0867	3.2102E-05
444.000	3.34E-11	-.0209662	.0014245	2.6649E-12	442.0867	-4.4201E-05
456.000	3.97E-11	-.0070557	.0008447	-2.0283E-13	442.0867	-5.2437E-05
468.000	2.86E-11	-.0006928	.0003513	-9.9580E-13	442.0866	-2.9793E-05
480.000	1.58E-11	.0013803	9.8620E-05	-9.2544E-13	442.0867	-1.2321E-05
492.000	6.36E-12	.0016785	-5.1194E-06	-6.1240E-13	442.0867	-4.9693E-06
504.000	1.07E-12	.0012604	-3.9968E-05	-3.1164E-13	442.0866	-8.3874E-07
516.000	-1.12E-12	.0007208	-3.9759E-05	-1.0889E-13	442.0866	8.7357E-07
528.000	-1.54E-12	.0003067	-2.7300E-05	-3.7396E-15	442.0866	1.2028E-06
540.000	-1.21E-12	6.5624E-05	-1.4421E-05	3.4362E-14	442.0866	9.4368E-07
552.000	-7.15E-13	-3.9583E-05	-5.4074E-06	3.7027E-14	442.0866	5.5860E-07
564.000	-3.19E-13	-6.4332E-05	-5.5900E-07	2.6392E-14	442.0866	2.4947E-07
576.000	-8.16E-14	-5.3126E-05	1.3205E-06	1.4372E-14	442.0866	6.3776E-08
588.000	2.56E-14	-3.2710E-05	1.5832E-06	5.5878E-15	442.0866	-1.9987E-08
600.000	5.25E-14	-1.5156E-05	1.2174E-06	6.8944E-16	442.0866	-4.0990E-08
612.000	4.21E-14	-3.4966E-06	7.0781E-07	-1.2194E-15	442.0866	-4.3933E-08
624.000	2.32E-14	1.8377E-06	2.6017E-07	-1.3891E-15	442.0866	-3.0673E-08
636.000	8.79E-15	2.7542E-06	6.4026E-09	-9.1922E-16	442.0866	-1.1622E-08
648.000	1.14E-15	1.9958E-06	-7.2402E-08	-4.3312E-16	442.0866	-1.5122E-09
660.000	-1.60E-15	1.0187E-06	-6.8766E-08	-1.2462E-16	442.0866	2.1181E-09
672.000	-1.85E-15	3.4602E-07	-4.1409E-08	1.5033E-17	442.0866	2.4414E-09
684.000	-1.24E-15	2.4769E-08	-1.6913E-08	5.2979E-17	442.0866	1.6412E-09
696.000	-5.75E-16	-6.0158E-08	-2.5021E-09	4.9357E-17	442.0866	7.6067E-10
708.000	-5.71E-17	-3.5518E-08	2.5145E-09	3.9566E-17	442.0866	7.5426E-11
720.000	3.74E-16	0.0000	0.0000	3.5931E-17	442.0866	-4.9451E-10

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection              =      .06556052 in
Computed slope at pile head       =     -.00107656
Maximum bending moment            =   801153.69925 lbs-in
Maximum shear force               =    24000.00000 lbs
Depth of maximum bending moment   =    60.00000000 in
Depth of maximum shear force      =       0.00000 in
Number of iterations              =            17
Number of zero deflection points  =            10
```


Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

```
Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head  =       34000.000 lbs
Specified moment at pile head       =            .000 in-lbs
Specified axial load at pile head   =      200000.000 lbs
```

(Zero moment for this load indicates free-head conditions)

Depth x in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.133348	-5.6503E-08	34000.0000	-.0019567	442.0866	-429.1092
12.000	.109867	381800.	28833.0183	-.0019177	723.4083	-432.0544
24.000	.087324	701197.	23661.4022	-.0018068	958.7492	-429.8816
36.000	.066504	958347.	18549.6677	-.0016370	1148.2245	-422.0741
48.000	.048036	1154247.	12845.9822	-.0014208	1292.5694	-528.5401
60.000	.032404	1273470.	5484.9667	-.0011724	1380.4166	-698.2958
72.000	.019900	1291513.	-2594.9609	-.0009099	1393.7113	-648.3588
84.000	.010568	1215558.	-9960.6590	-.0006533	1337.7456	-579.2576
96.000	.004221	1055593.	-16322.2461	-.0004209	1219.8786	-481.0070
108.000	.000467	825845.	-22040.3685	-.0002283	1050.5931	-472.0134
120.000	-.001259	527720.	-22558.2094	-8.9807E-05	830.9265	385.7066
132.000	-.001688	284879.	-17655.5289	-6.6477E-06	651.9936	431.4068
144.000	-.001418	104020.	-12495.3029	3.3151E-05	518.7314	428.6309
156.000	-.000893	-15167.6712	-7549.2788	4.2244E-05	453.2626	395.7065
168.000	-.000405	-77365.8106	-2219.5679	3.2774E-05	499.0920	492.5787
180.000	-.000106	-68594.6170	1538.6849	1.7837E-05	492.6292	133.7968
192.000	2.35E-05	-40522.9919	2157.9649	6.6704E-06	471.9452	-30.5835
204.000	5.38E-05	-16835.4779	1547.7549	8.0045E-07	454.4915	-71.1182
216.000	4.27E-05	-3380.7165	782.1268	-1.2684E-06	444.5777	-56.4865
228.000	2.34E-05	1941.6527	257.9327	-1.4157E-06	443.5173	-30.8792
240.000	8.76E-06	2816.4648	3.2046	-9.2876E-07	444.1619	-11.5755
252.000	1.07E-06	2023.0200	-74.7417	-4.3350E-07	443.5773	-1.4155
264.000	-1.65E-06	1024.7444	-70.1749	-1.2160E-07	442.8417	2.1767
276.000	-1.85E-06	339.4060	-42.4627	1.8005E-08	442.3367	2.4420
288.000	-1.21E-06	5.5523	-18.1777	5.3307E-08	442.0907	1.6055
300.000	-5.68E-07	-97.1137	-4.0392	4.3937E-08	442.1582	.7509289
312.000	-1.60E-07	-91.5983	1.7363	2.4625E-08	442.1541	.2116501
324.000	2.29E-08	-55.5602	2.8247	9.5648E-09	442.1276	-.0302531
336.000	6.94E-08	-23.8513	2.0925	1.4380E-09	442.1042	-.0917790
348.000	5.74E-08	-5.3469	1.0866	-1.5501E-09	442.0906	-.0758712
360.000	3.22E-08	2.2347	.3757543	-1.8686E-09	442.0883	-.0426044
372.000	1.26E-08	3.6802	.0205722	-1.2633E-09	442.0894	-.0165926
384.000	1.91E-09	2.7345	-.0941543	-6.0682E-10	442.0887	-.0025285
396.000	-2.01E-09	1.4234	-.0933766	-1.8132E-10	442.0877	.0026581
408.000	-2.44E-09	.4943122	-.0580857	1.4928E-11	442.0870	.0032237
420.000	-1.65E-09	.0292334	-.0256363	6.8506E-11	442.0867	.0021845
432.000	-7.95E-10	-.1212874	-.0062265	5.9086E-11	442.0867	.0010504
444.000	-2.35E-10	-.1204852	.0019369	3.4343E-11	442.0867	.0003101
456.000	2.95E-11	-.0749676	.0035632	1.4341E-11	442.0867	-3.9058E-05
468.000	1.10E-10	-.0350375	.0026433	3.0836E-12	442.0867	-.0001143
480.000	1.04E-10	-.0115443	.0014723	-1.6835E-12	442.0867	-8.0897E-05
492.000	6.92E-11	.0003053	.0006627	-2.8336E-12	442.0866	-5.4041E-05
504.000	3.55E-11	.0043730	.0001718	-2.3549E-12	442.0867	-2.7770E-05
516.000	1.27E-11	.0044395	-5.4172E-05	-1.4530E-12	442.0867	-9.8899E-06
528.000	6.76E-13	.0030798	-.0001167	-6.8350E-13	442.0867	-5.2792E-07
540.000	-3.74E-12	.0016425	-.0001023	-2.0023E-13	442.0867	2.9249E-06
552.000	-4.13E-12	.0006256	-6.5391E-05	3.1882E-14	442.0866	3.2262E-06

564.000	-2.98E-12	7.2980E-05	-3.2071E-05	1.0337E-13	442.0866	2.3271E-06
576.000	-1.65E-12	-.0001446	-1.0380E-05	9.6047E-14	442.0866	1.2880E-06
588.000	-6.74E-13	-.0001766	5.0665E-07	6.3178E-14	442.0866	5.2637E-07
600.000	-1.33E-13	-.0001327	4.2861E-06	3.1522E-14	442.0866	1.0354E-07
612.000	8.27E-14	-7.3883E-05	4.3897E-06	1.0378E-14	442.0866	-8.6276E-08
624.000	1.17E-13	-2.7426E-05	2.9477E-06	1.0623E-17	442.0866	-1.5405E-07
636.000	8.30E-14	-3.1391E-06	1.3651E-06	-3.1173E-15	442.0866	-1.0970E-07
648.000	4.17E-14	5.3522E-06	3.7597E-07	-2.8909E-15	442.0866	-5.5160E-08
660.000	1.36E-14	5.8980E-06	-6.2953E-08	-1.7395E-15	442.0866	-1.7994E-08
672.000	-1.88E-17	3.8497E-06	-1.7077E-07	-7.4199E-16	442.0866	2.4883E-11
684.000	-4.20E-15	1.8032E-06	-1.3734E-07	-1.6349E-16	442.0866	5.5452E-09
696.000	-3.94E-15	5.5422E-07	-7.2805E-08	7.7754E-17	442.0866	5.2115E-09
708.000	-2.33E-15	5.5467E-08	-2.3064E-08	1.4015E-16	442.0866	3.0786E-09
720.000	-5.79E-16	0.0000	0.0000	1.4582E-16	442.0866	7.6552E-10

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

```
Pile-head deflection              =      .13334827 in
Computed slope at pile head       =     -.00195673
Maximum bending moment            =       1291513. lbs-in
Maximum shear force               =    34000.00000 lbs
Depth of maximum bending moment   =    72.00000000 in
Depth of maximum shear force      =       0.00000 in
Number of iterations              =            19
Number of zero deflection points  =            10
```

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 3

```
Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head  =       44000.000 lbs
Specified moment at pile head       =            .000 in-lbs
Specified axial load at pile head   =      200000.000 lbs
```

(Zero moment for this load indicates free-head conditions)

Depth x in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.225984	2.2601E-08	44000.0000	-.0030399	442.0866	-489.5878
12.000	.189505	500045.	38091.7148	-.0029887	810.5347	-495.1263
24.000	.154255	928547.	32147.4815	-.0028425	1126.2672	-495.5792
36.000	.121285	1285229.	26231.1605	-.0026160	1389.0810	-490.4743
48.000	.091471	1570652.	19563.1711	-.0023237	1599.3885	-620.8573
60.000	.065516	1765899.	10842.1827	-.0019823	1743.2526	-832.6408
72.000	.043897	1840379.	1105.6461	-.0016132	1798.1314	-790.1153
84.000	.026799	1800178.	-8020.6570	-.0012406	1768.5102	-730.9352
96.000	.014122	1653838.	-16309.1422	-.0008872	1660.6828	-650.4790
108.000	.005507	1413017.	-23427.6445	-.0005733	1483.2387	-535.9380
120.000	.000363	1094326.	-28932.7877	-.0003167	1248.4183	-381.5858
132.000	-.002094	720150.	-28490.9387	-.0001310	972.7143	455.2273
144.000	-.002782	411173.	-22716.3341	-1.5244E-05	745.0508	507.2068
156.000	-.002460	175031.	-16614.5205	4.4747E-05	571.0548	509.7622

168.000	-.001708	12209.5180	-10665.8220	6.3908E-05	451.0830	481.6876
180.000	-.000926	-81255.2192	-5211.3930	5.6842E-05	501.9579	427.3839
192.000	-.000344	-113137.	34.4628	3.6949E-05	525.4491	446.9254
204.000	-3.93E-05	-80605.4659	3027.7173	1.7122E-05	501.4791	51.9504
216.000	6.72E-05	-40553.7253	2806.6944	4.7226E-06	471.9678	-88.7875
228.000	7.40E-05	-13267.4678	1686.7671	-7.8535E-07	451.8625	-97.8670
240.000	4.83E-05	-67.5459	716.3241	-2.1500E-06	442.1364	-63.8735
252.000	2.24E-05	3934.6298	155.1196	-1.7543E-06	444.9858	-29.6606
264.000	6.22E-06	3663.7443	-72.1737	-9.7667E-07	444.7862	-8.2216
276.000	-1.00E-06	2207.1480	-113.5654	-3.7586E-07	443.7129	1.3230
288.000	-2.80E-06	939.9782	-83.4152	-5.3791E-08	442.7793	3.7020
300.000	-2.29E-06	205.4406	-43.0264	6.3428E-08	442.2380	3.0294
312.000	-1.28E-06	-92.9591	-14.7106	7.4939E-08	442.1551	1.6899
324.000	-4.93E-07	-147.9728	-.6588854	5.0283E-08	442.1957	.6520845
336.000	-7.16E-08	-109.0137	3.8218	2.3984E-08	442.1670	.0947020
348.000	8.23E-08	-56.3639	3.7375	7.0593E-09	442.1282	-.1087654
360.000	9.78E-08	-19.3487	2.3094	-6.8889E-10	442.1009	-.1292463
372.000	6.58E-08	-.9354489	1.0124	-2.7647E-09	442.0873	-.0869113
384.000	3.14E-08	4.9631	.2417343	-2.3525E-09	442.0903	-.0415393
396.000	9.29E-09	4.8775	-.0811807	-1.3455E-09	442.0902	-.0122799
408.000	-8.66E-10	3.0212	-.1479919	-5.3717E-10	442.0889	.0011447
420.000	-3.60E-09	1.3282	-.1125581	-9.2058E-11	442.0876	.0047610
432.000	-3.08E-09	.3202249	-.0596018	7.6642E-11	442.0869	.0040651
444.000	-1.76E-09	-.1025728	-.0212337	9.8916E-11	442.0867	.0023296
456.000	-7.01E-10	-.1898578	-.0016934	6.8989E-11	442.0868	.0009271
468.000	-1.07E-10	-.1435449	.0045367	3.4870E-11	442.0868	.0001112
480.000	1.35E-10	-.0811431	.0045692	1.1876E-11	442.0867	-.0001058
492.000	1.78E-10	-.0339419	.0030982	9.8167E-14	442.0867	-.0001393
504.000	1.38E-10	-.0067959	.0016163	-4.0698E-12	442.0867	-.0001077
516.000	8.07E-11	.0048681	.0005921	-4.2661E-12	442.0867	-6.3014E-05
528.000	3.54E-11	.0074456	4.7884E-05	-3.0059E-12	442.0867	-2.7693E-05
540.000	8.52E-12	.0060317	-.0001582	-1.6267E-12	442.0867	-6.6570E-06
552.000	-3.59E-12	.0036563	-.0001813	-6.3523E-13	442.0867	2.8056E-06
564.000	-6.72E-12	.0016830	-.0001330	-8.8823E-14	442.0867	5.2529E-06
576.000	-5.72E-12	.0004654	-7.4629E-05	1.3104E-13	442.0866	4.4709E-06
588.000	-3.58E-12	-.0001087	-3.1027E-05	1.6754E-13	442.0866	2.7961E-06
600.000	-1.70E-12	-.0002801	-6.2725E-06	1.2775E-13	442.0866	1.3298E-06
612.000	-5.13E-13	-.0002599	4.9165E-06	7.2495E-14	442.0866	5.3508E-07
624.000	3.77E-14	-.0001624	7.8281E-06	2.9278E-14	442.0866	-4.9811E-08
636.000	1.90E-13	-7.2121E-05	6.0261E-06	5.2738E-15	442.0866	-2.5053E-07
648.000	1.64E-13	-1.7841E-05	3.2022E-06	-3.9327E-15	442.0866	-2.1711E-07
660.000	9.52E-14	5.1827E-06	1.1629E-06	-5.2281E-15	442.0866	-1.2577E-07
672.000	3.88E-14	1.0093E-05	1.0067E-07	-3.6649E-15	442.0866	-5.1259E-08
684.000	7.19E-15	7.6163E-06	-2.6394E-07	-1.8526E-15	442.0866	-9.5094E-09
696.000	-5.68E-15	3.7670E-06	-2.7591E-07	-6.8767E-16	442.0866	7.5132E-09
708.000	-9.31E-15	9.9770E-07	-1.5700E-07	-2.0007E-16	442.0866	1.2306E-08
720.000	-1.05E-14	0.0000	0.0000	-9.7967E-17	442.0866	1.3860E-08

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

```
Pile-head deflection              =      .22598394 in
Computed slope at pile head       =     -.00303990
Maximum bending moment            =       1840379. lbs-in
Maximum shear force               =    44000.00000 lbs
Depth of maximum bending moment   =    72.00000000 in
Depth of maximum shear force      =       0.00000 in
Number of iterations              =            21
Number of zero deflection points  =             9
```

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 24000.	M= 0.000	200000.	.0655605	801154.	24000.0000
1	V= 34000.	M= 0.000	200000.	.1333483	1291513.	34000.0000
1	V= 44000.	M= 0.000	200000.	.2259839	1840379.	44000.0000

The analysis ended normally.

APPENDIX D

Office of Special Funded Projects
Comment & Response Form

General Project Information	Review Phase		Reviewer Information
Dist: _ EA: 228511 Project Name: Route 4 Widenining SEG 3A OSFP Liaison: O. Hor Phone: 916-227-8419 e-mail: overcomer_hor@dot.ca.gov	☐ PSR/PDS (Review No. _) ☐ APS/PSR (Review No. _) ☐ APS/PR (Review No. _) ☐ Type Selection	☒ 65% PS&E Unchecked Details ☐ PS&E (Review No. 1) ☐ Construction Support ☒ Other: Foundation Report	Reviewer Name: Ali Kaddoura Functional Unit: 327 Cost Center: 59 Phone Number: 510-286-4676 e-mail: ali_kaddoura@dot.ca.gov Date of Review: 02/11/09
	Structure Information (Use when necessary to document comments by individual structure) Structure Name: Cavallo Rd. UC Br No: 28-0402R/L		

Consultant Information (to be filled in by Consultant)

Consultant Structure Lead (First and Last Name)	Structure Consultant Firm	Phone Number	e-mail	Response Date

#	Doc. (See Note 1)	Page, Section, or SSP	Review Comments	Consultant Responses	✓
1	FR Cavallo Rd UC Bridge No. 28-0402R/L 65% PS&E		FR Prepared by Parikh Consultants Dated September 2008	No response required.	
2		P 10, Pile Data Tables	Nominal Resistance units (kips) are missing	Agreed. Units have been added in the table.	
3			(C2) Approved subject to OSFP verification	No response required.	

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓ = Comment Resolved (for Reviewer's use)

Office of Special Funded Projects
Comment & Response Form

General Project Information	Review Phase		Reviewer Information
Dist: _ EA: 228511 Project Name: Route 4 Widenining SEG 3A OSFP Liaison: O. Hor Phone: 916-227-8419 e-mail: overcomer_hor@dot.ca.gov	☐ PSR/PDS (Review No. _) ☐ APS/PSR (Review No. _) ☐ APS/PR (Review No. _) ☐ Type Selection	☐ 65% PS&E Unchecked Details ☐ PS&E (Review No. 1) ☐ Construction Support ☒ Other: Final Foundation Report	Reviewer Name: Ali Kaddoura/R. Nashed Functional Unit: 327 Cost Center: 59 Phone Number: 510-286-4676 e-mail: ali_kaddoura@dot.ca.gov Date of Review: 11/02/09
	Structure Information (Use when necessary to document comments by individual structure) Structure Name: Cavallo Rd. UC Br No: 28-0402R/L		

Consultant Information (to be filled in by Consultant)

Consultant Structure Lead (First and Last Name)	Structure Consultant Firm	Phone Number	e-mail	Response Date

#	Doc. (See Note 1)	Page, Section, or SSP	Review Comments	Consultant Responses	✓
1	Final FR Cavallo Rd UC Bridge No. 28-0402R/L		Final FR Prepared by Parikh Consultants Dated August 2009	No response required.	
2		Page 6, **Seismic Sources**	In the table: – The distance between the site and Vaca Fault Zone is 5.5 miles not 3.4 miles. _ The distance between the site and Great Valley Fault is 6.6 miles not 4.4 miles. Please correct and check all calculations based on these values.	Per e-mail from Hossein Salimi of Caltrans dated March 2, 2010, no further action on this comment is required. (See attached e-mail)	

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓ = Comment Resolved (for Reviewer's use)

3			Our previous comments have been addressed to our satisfaction.		
4	Final FR Cavallo Rd UC Bridge No. 28-0402R/L		(C2) Approved subject to OSFP verification		

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved
(for Reviewer's use)

Partha Sircar

From: "Hossain Salimi" <hossain_salimi@dot.ca.gov>
To: "Partha Sircar" <psircar@parikhnet.com>
Sent: Tuesday, March 02, 2010 10:53 AM
Attach: 228511GeoSeg 3A-1stPSE.pdf
Subject: Fw: SR4 Segment 3A bridges - Seismic

FYI

Hossain Salimi
Senior Materials and Research Engineer
Office of Geotechnical Design-West
(916) 227-7147
----- Forwarded by Hossain Salimi/HQ/Caltrans/CAGov on 03/02/2010 09:53 AM

Hossain Salimi/HQ/Caltrans/CAGov
02/25/2010 10:43 AM

To
Ali Kaddoura/D04/Caltrans/CAGov, Rifaat Nashed/HQ/Caltrans/CAGov
cc
Tim Pokrywka/D04/Caltrans/CAGov@DOT
Subject
Fw: SR4 Segment 3A bridges - Seismic

Gentlemen,

I am writing you in regards to the reports submitted by Parikh and our subsequent attached comments (Bridges under EA # 04-228511). Parikh had used the old 1996 Caltrans Seismic Hazard Map as well as the old Seismic Design Criteria (SDC) to produce the seismic recommendations. These bridges were type selected before the Department mandated changes to the SDC became official. In fact, their findings are more conservative compared to the new criteria. In light of this, I find it unreasonable for us to request changes to the seismic recommendations of these reports. I am satisfied with the findings in the reports and have no further comments. In the future, I will check the type selection date of each bridge to see if the changes to the new SDC are warranted.

Sincerely,

Hossain Salimi

Senior Materials and Research Engineer
Office of Geotechnical Design-West
(916) 227-7147
----- Forwarded by Hossain Salimi/HQ/Caltrans/CAGov on 02/25/2010 10:30 AM

"Partha Sircar"
<psircar@parikhne
t.com>
02/24/2010 10:13
AM

To
"Hossain Salimi"
<hossain_salimi@dot.ca.gov>
cc

Subject
SR4 Segment 3A bridges - Seismic

Hossein:

As I had discussed with you earlier, I have the same issues with the above bridges. Please call me to advise.

Partha Sircar
Parikh Consultanta
(408) - 452 -9000

----- Original Message -----
From: "Hossain Salimi" <hossain_salimi@dot.ca.gov>
To: "Rifaat Nashed" <rifaat_nashed@dot.ca.gov>; "Ali Kaddoura" <ali_kaddoura@dot.ca.gov>
Cc: "Partha Sircar" <psircar@parikhnet.com>; "Tim Pokrywka" <tim_pokrywka@dot.ca.gov>
Sent: Thursday, December 17, 2009 10:38 AM
Subject: Updated status of Somersville Rd UC replacement (04-228511)

>
> Hi Rifaat/Ali,
>
> I had a conversation with Mr. Sircar of Parikh subsequent to the e-mail I
> sent you. As it turns out, this project has been in the works for a long
> time, and the seismic analysis and design have already been completed
> using

> the old SDC. Therefore, Parikh is not required to take any further
> actions
> regarding my comments. Thank you all.
>
> Sincerely,
>
> Hossain Salimi
> Senior Materials and Research Engineer
> Office of Geotechnical Design-West
> (916) 227-7147
> ----- Forwarded by Hossain Salimi/HQ/Caltrans/CAGov on 12/17/2009 10:31
AM
> -----
>
> Hossain
> Salimi/HQ/Caltran
> s/CAGov To
> Rifaat Nashed/HQ/Caltrans/CAGov
> 11/30/2009 09:25 cc
> AM Tim Pokrywka/D04/Caltrans/CAGov@DOT
> Subject
> Somersville Rd UC replacement
> (04-228511)(Document link: Hossain
> Salimi)
>
>
>
>
>
>
>
>
>
> Hi Rifaat,
>
> I reviewed the attached documents you sent me on November 19, 2009
(Report
> containing Final Foundation Report from Parikh Consultants to Mark Thomas
> and Company Inc. for the proposed Somersville Road Undercrossing
> replacement) and have the following comments. I should note that the
> proposed bridge (28-0398L/R) is located on Route 4 and will replace the
> existing 2-span structure (28-0211R).
>
> 1. According to the report, Parikh is using the in-progress Seismic
Hazard
> Map (CSHM) . However, the distances as outlined in the table does not
> match our latest CSHM.
>
> 2. The Department has finalized the new ARS curves based on the new
> Seismic
> Design Criteria (SDC) and is now mandatory for use by both the Department
> personnel as well as our consultants effective September 30, 2009.
> However, Parikh is still using the ARS curve based on the 2001SDC which
> was

> based on Sadigh 1996 Attenuation Relationship models.
>
> To re-iterate, the Department has implemented the new SDC and the
> consultant shall re-submit the report using the now mandated seismic
> design
> criteria.
>
> Sincerely,
>
> Hossain Salimi
> Senior Materials and Research Engineer
> Office of Geotechnical Design-West
> (916) 227-7147
>
>
>
>
> Rifaat
> Nashed/HQ/Caltran
> s/CAGov To
> Hossain
> 11/19/2009 03:20 Salimi/HQ/Caltrans/CAGov@DOT
> PM cc
> Tim Pokrywka/D04/Caltrans/CAGov
> Subject
> Somerville Rd UC (Replacement)
>
>
>
>
>
>
>
>
>
> Hi Hossain
>
> Please find attached the Final Foundation Report for Somerville Road
> Undercrossing (Replacement) by PARIKH Consultant
>
> (See attached file: FR- Somerville Rd UC (Replacement).pdf)(See attached
> file: Appendix B- Lab Tests.pdf)(See attached file: Appendix C.pdf)
>
>
> Regards
>
> Rifaat Nashed
(See attached file: 228511GeoSeg 3A-1stPSE.pdf)

5. Foundation Report - A Street Underpass - (Br. No. 28C0487) – East Contra Costa Transit Development (eBART) – Antioch, Contra Costa County, CA

FINAL FOUNDATION REPORT
A STREET UNDERPASS (BRIDGE NO. 28C0487)
EAST CONTRA COSTA TRANSIT DEVELOPMENT (eBART)
ANTIOCH, CONTRA COSTA COUNTY, CALIFORNIA

04-CC-4-R27.8 EA 2285F1

For

T. Y. Lin International
2010 Crow Canyon Place, Suite 350
San Ramon, CA 94583

PARIKH CONSULTANTS, INC.

1243 Alpine Road, Suite 110
Walnut Creek, California
(925) 933-6336

April 2010 Job No. 206117.EBS

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Appendix B Laboratory Test Data
Appendix C Calculations
Appendix D Caltrans Comments and Responses

FINAL FOUNDATION REPORT
A STREET UNDERPASS (BRIDGE NO. 28C0487)
EAST CONTRA COSTA TRANSIT DEVELOPMENT (eBART)
ANTIOCH, CONTRA COSTA COUNTY, CALIFORNIA

04-CC-4-R27.8 EA 2285F1

INTRODUCTION

This report presents the results of our geotechnical engineering investigation for the proposed new eBART underpass structure over A Street in Antioch, Contra Costa County, CA. Our work was performed generally in accordance with the scope of work as per our agreement. The general location of the site and its vicinity are shown on the Project Location Map, Plate 1.

The geotechnical recommendations presented in this report are intended for design input and are not intended to be used as specifications. These recommendations should not be used for direct bidding purposes.

PROPOSED CONSTRUCTION

The project plans are to construct a new underpass for eBART in the median between the eastbound and westbound bridges on Highway 4 crossing A Street-Lone Tree Way. The adjacent highway bridges are planned to be replaced under a different program. Per the plans provided by T. Y. Lin International, The new underpass will be two-span cast-in-place prestressed concrete box girder structure that will span over Lone Tree Way/A Street. Per the plans provided, the structures will be 200 feet long and 27 feet wide along the same alignment. The new underpass will accommodate two parallel railroad tracks. Abutments 1 and 3 will be open face abutments on fill. Support at Bent 2 will consist of two 4-ft diameter columns flared at the top. The abutments and the two columns in Bent 2 will all be supported on cast-in-drilled-hole (CIDH) piles.

PURPOSE AND SCOPE

The purpose of this investigation was to evaluate the general soil conditions at the project site, to evaluate their engineering properties, and to provide recommendations for foundation support of the proposed project.

The scope of work performed for this investigation included a review of the readily available soils and geologic literature, obtaining representative soil samples and logging soil materials encountered in four drilled borings, laboratory testing of the collected samples, engineering analysis of the field and laboratory data, and preparation of this report. The basis for this investigation is the preliminary plans provided to us by T. Y. Lin International. We have presented the descriptive log of the boreholes in Appendix A.

Due to limitations inherent in geotechnical investigations, it is neither uncommon to encounter unforeseen variations in the soil conditions during construction nor is it practical to determine all such variations during an acceptable program of drilling and sampling for a project of this scope. Such variations, when encountered, generally require additional engineering services to attain a properly constructed project. We, therefore, recommend that a contingency fund be provided to accommodate any additional charges resulting from technical services that may be required during construction.

Our recommendations in this report are based on the above information. Any major deviation should be reported to this office for consideration.

SITE CONDITIONS

The project is located at the crossing of Lone Tree Way/A Street and State Route 4, in the City of Antioch, Contra Costa County. Per the As-Built drawings, the existing bridges (which will be demolished) were constructed in 1969. They are single span, cast-in-place prestressed concrete structures, 155 feet long and 41 feet wide, each carrying two 12-ft wide traffic lanes and have a 10-ft shoulder adjacent to the outer lane and a 5-ft shoulder adjacent to the inner lane. The existing bridge abutments are on approach fill. The top of the fill is at an approximate elevation of 69 feet, which is approximately 10 to 15 feet above adjacent ground. The abutments are founded on 16-in.diameter 70 ton Cast-in-drilled-hole (CIDH) piles.

The existing bridge abutments are on approach fill. The top of the fill is at an approximate elevation of 69 feet, which is approximately 10 to 15 feet above adjacent ground. The abutments for the underpass will be on the approach fill.

FIELD EXPLORATION AND LABORATORY TESTING

Field Exploration

The exploration program was based on the proposed plans, discussions with design engineer, and readily available data of the existing undercrossing. Two (2) exploratory borings were drilled in September, 2006, one near each abutment as part of the highway widening project. These borings and the associated laboratory testing have been used here, as they are deemed applicable to the present. Borings were drilled from the top of the embankment to depths of approximately 100. Two additional borings were drilled in July, 2009, adjacent to the previous borings to depths of approximately 130 feet. The latter borings were drilled to gain pertinent additional information beyond 100-ft depth. The test borings were advanced with a truck-mounted drill rig, using the hollow stem auger drilling method. The boring locations are shown on the plan portion of the Log of Test Borings in Appendix A.

The test borings were advanced with a truck-mounted drill rig. The drilling was performed using hollow stem auger. Selected samples were obtained from 3.0-inch O.D. & 2.5 inches I.D. (Modified California) and 2.0-inch O.D. & 1.4-inch I.D. (Standard Penetration Test) samplers at various depths. The samplers were driven in subsurface soils under the impact of a 140 lb hammer having a free fall of 30 inches. The blow counts are presented on the "Log of Test Borings". When correlating standard penetration data in similar soils, the blow counts for the Modified California Sampler may be converted to equivalent SPT blow counts by multiplying a factor of 0.65 per Daniel (2003). The samples were sealed and transported to our laboratory for further evaluation and testing. The field investigation was conducted under the supervision of our field engineer who logged the test borings and prepared the samples for subsequent laboratory testing and evaluation.

Laboratory Testing

Laboratory tests were performed on selected samples obtained during field exploration to determine the physical and engineering properties of the subsoils. Laboratory data of moisture contents, dry density, grain size distribution, Atterberg Limits and unconfined compression tests are presented on the Log of Test Borings. A detailed description of laboratory testing performed is presented in Appendix B.

Boring Logs

The bore logs presented in Appendix A were prepared from the field logs which were edited after visual re-examination of the soil samples in the laboratory and results of classification tests on selected soil samples as indicated on the logs. The abrupt stratum changes shown on these logs may be gradual and relatively minor changes in soil types within a stratum may not be noted on the logs due to field limitations. Appendix A also includes log of test borings available from as-built drawings for the existing undercrossing.

SUBSURFACE CONDITIONS

Subsurface conditions in both the borings drilled indicate predominantly lean clays and sandy clays with occasional layers of sandy soils to a depth of approximately 60 feet. The clays are generally very stiff to a depth of 30 feet, turning to hard clays below that depth. Very hard/very dense interbedded layers of sandstone and siltstone were encountered in all the four borings at depths of approximately 70 feet. The sandstones and siltstones are judged to belong to Tulare Formation (Pliocene). Four boring logs, drilled in 1957 are shown on the as-built drawings. The boring logs indicate predominantly silts and sandy silts with interbedded sand layers. The discrepancies between the current and As-built boring logs may be attributed to changes in soil classification over the years.

During field exploration in September, 2006, groundwater was encountered (during drilling) approximately at 63-ft depth (Elev. 5.6 feet) in boring AST-154 on the west end and approximately at 56.5-ft depth (Elev. 11.7 feet) in boring AST-155 on the east side of the bridge. During field exploration in July, 2009, groundwater was encountered (during drilling) approximately at 80-ft depth (Elev. -11.4 feet) in boring AST-154A on the west end and approximately at 60-ft depth (Elev. 8.2 feet) in boring AST-155A on the east side of the bridge. In boring 155A, groundwater rose approximately 20 feet (Elev. 28.2 feet) prior to grouting of the hole. However, the groundwater may vary with the passage of time due to seasonal groundwater fluctuation, surface and subsurface flows, ground surface run-off and other factors that may not be present at the time of investigation.

GEOLOGY

General geologic features pertaining to the site were evaluated with reference to the "Geologic Map of Quaternary Geology of Contra Costa County and Surrounding Areas, CA: Derived from Digital Database open-file 97-98" by E.J. Helley and R.W. Graymer 1997; Scale 1:100000. Based on the map, the site is located in an area covered by Pleistocene alluvial deposits (Qpaf). A geologic map of the general project area is shown on Plate 2. Description of the main geologic units is as follows:

> *Qpaf (Alluvial Fans and Fluvial Deposits (Pleistocene)) – Brown dense gravely and clayey sand or clayey gravel that fines upward to sandy clay. These deposits display various sorting and are located in most stream channels in the county. All Qpaf deposits can be related to modern stream courses. They are distinguished from younger alluvial fans and fluvial deposits by higher topographic position, greater degree of dissection, and stronger soil profile development. They are less permeable than Holocene deposits, and locally contain fresh water mollusks and extinct late Pleistocene vertebrate fossils. They are overlain by Holocene deposits on lower parts of the alluvial plain, and incised by channels that are partly filled with Holocene alluvium on higher parts of the alluvial plain. Maximum thickness is unknown but at least 50m (150 feet).*

Another map ('Preliminary geologic map emphasizing bedrock formations in Contra Costa County: A digital database', compiled by Graymer, Jones and Brabb (USGS Open File Report 94-622) was also considered for additional information for the bedrock. Bedrock (Tulare Formation) exposed at the surface is noted to the south of the site. The rock has a shallow dip towards the north and is therefore expected to underlie the hard Pleistocene clays at the site. Description of the rock is as follows:

> *Ttu (Tulare Formation (Pliocene) – Poorly consolidated, non-marine, gray to maroon siltstone, sandstone, and conglomerate. This formation contains tuff correlated with the Putah tuff.*

EARTHQUAKE CONSIDERATIONS

Seismic Sources

The project is located in a seismically active part of Northern California. Many faults exist in the area, which are capable of producing earthquakes which may cause strong ground shaking at the site.

Applicable major faults in the vicinity of the project site were identified and their associated maximum earthquake magnitudes were established using the In-Progress Seismic Hazard Map currently under development by Caltrans and the associated Data Base. The documents were supplied to us by Caltrans, with the understanding that the fault locations in the map and the associated magnitudes in the Data Base have essentially been finalized. Pertinent information is summarized below. The moment magnitudes noted in the table represent the largest earthquakes that could occur on the given fault based on the current understanding of the regional tectonic structure. A fault map of the project vicinity is shown on Plate 3.

Fault	Fault No.(1)	Fault Type	Distance from Site (miles)	Maximum Moment Magnitude
Vaca Fault Zone	14	RLSS(2)	3.4	6.9
Great Valley Fault 5	24	Reverse Fault	4.4	6.5
Greenville Fault Zone (Clayton Section)	351	RLSS	4.1	6.6
Concord Fault Zone (Ygnacio Valley Section)	341	RLSS	6.9	6.6

(1) Number of the Fault in the Data Base associated with the Caltrans In-Progress Seismic Hazard Map
(2) RLSS – Right-Lateral Strike Slip Fault

Based on the Caltrans In-Progress Seismic Hazard Map and the attenuation relationship by Sadigh et al. (1997), the controlling fault is the Vaca Fault Zone (Fault No. 14 in the map), which is associated with a Maximum Moment Magnitude (Mmax) of 6.9. A peak bedrock acceleration (PBA) of 0.50g is anticipated at the site.

Seismic Hazards/Liquefaction Impact

Potential seismic hazards may arise from three sources: surface fault rupture, ground shaking and liquefaction. Since no active faults pass through the site, the potential for fault rupture is relatively low. Based on available geological and seismic information, the possibility of the site to experience strong ground shaking may be considered significant.

Liquefaction is a phenomenon in which saturated soils are subject to a temporary but essentially total loss of shear strength under the reversing, cyclic shear stresses associated with earthquake shaking. Submerged, cohesionless sands and silts of low relative density are the type of soils which usually are susceptible to liquefaction - the susceptibility increases with decreasing relative density (reflected by the number of blows to drive a sampler), and decreasing fines content. Accepted procedures for the assessment of liquefaction potential for cohesionless soils have evolved over the years through research and field observations (Youd et al, 2001). Recent research and field observations have shown that clays of low plasticity are also potentially liquefiable, based on the moisture content and plasticity characteristics of the clay. Procedures for the assessment of liquefaction potential for clay soils have also been established and have received general acceptance (Bray et. al., 2004).

Potential for liquefaction at the site is low, due to the predominant presence of stiff clay soils and the relatively low groundwater table.

FINDINGS AND RECOMMENDATIONS

General

Based on the findings of the investigation, it is our opinion that the site is feasible for the planned bridge structures provided the recommendations presented in this report are incorporated into the final design and construction.

This report was prepared specifically for the proposed bridge structures according to the plans provided to us. Normal construction procedures were assumed throughout our analysis and represent one of the bases of recommendations presented herein. Our design criteria have been based upon the materials encountered at the site. Therefore, we should be notified in the event that these conditions are changed, so as to modify or amend our recommendations.

Foundations

For the proposed structure, 24-inch diameter CIDH piles are recommended for foundation support at the two abutment locations and 84-inch CIDH piles are recommended for the column foundations for Bent 2.

Pile Design

Pertinent foundation design information was provided by T. Y. Lin International (Structural Engineers for the project), which are presented in the following tables (Foundation Design Data and Foundation Design Loads).

FOUNDATION DESIGN DATA

Support No	Design Method	Pile Type	Finish Grade Elev. (ft)	Pile Cut-off Elev. (ft)	Pile Cap Size (ft)		Permissible Settlement (inch)	No. of Piles per Support
					B(2)	L(3)		
Abutment 1	WSD	24-in CIDH	62.33	55.25	14	31.7	0.25(1)	14
Bent 2	LRFD	84-in CIDH	44.00	42.00	N/A	N/A	0.25(1)	1
Abutment 3	WSD	24-in CIDH	61.83	54.75	10	32.7	0.25(1)	14
Note: (1) Per MTD – 3-1 (2) B = Width (3) L = Length								

FOUNDATION LOADS

Support No.	Service-I Limit State (kips)			Strength Limit State (Controlling Group, (kips)				Extreme Limit State (Controlling Group, kips)			
	Total Load		Permanent Loads	Compression		Tension		Compression		Tension	
	Per Supp.	Per Pile	Per Support	Per Supp.	Max. Per Pile	Per Supp.	Max. Per Pile	Per Supp.	Max. Per Pile	Per Supp.	Max. Per Pile
Abutment 1	1914	152(1) 139(4)	1445	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bent 2	1600	1600	1212	2614	2614	360	360	2784	2784	0	0
Abutment 3	1914	152(1) 139(4)	1445	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Notes: (1) Group 1 Loading – 100% of allowable; (4) Group 4 Loading – 125% of allowable											

Consistent with the current Caltrans requirements, Working Stress Design (WSD) was used for the abutment foundations and Load Resistance Factor Design (LRFD) was used for the foundations for Bent 2 for the two bridges.

The abutment foundations were evaluated for the foundation design data and loading conditions using Caltrans November 2003 Bridge Design Specifications for foundations, using Working Stress Design (WSD) methods. The Bent 2 foundations were evaluated for the foundation design data and loading conditions using AASHTO LRFD Bridge Design Specifications – 3rd Edition, with Interims Through 2006 and current Caltrans Amendments (v3.06.01). The actual load demands on the piles, based upon WSD and LRFD are presented in the table below for the two bridges.

LOAD DEMANDS

Support No.	Design Method	Service Loads (kips)		Required Nominal Resistance (kips)				Required Nominal Resistance (kips)	
				Strength Limit		Extreme Limit			
		Comp.	Tens.	Comp. (ϕ=0.7)	Tens. (ϕ=0.7)	Comp. (ϕ=1.0)	Tens. (ϕ=1.0)	Comp.	Tens.
Abutment 1	WSD	152	0	N/A	N/A	N/A	N/A	304	0
Bent 2	LRFD	1600	0	3734	514	2784	0	3734	514
Abutment 3	WSD	152	0	N/A	N/A	N/A	N/A	304	0

Estimation of the pile capacities was made using the site-specific subsurface conditions for the loads computed above and other pertinent information provided by the Structural Engineer. The computer program SHAFT developed by Ensoft, Inc. was used for the computations. The program computes capacities for drilled shafts (CIDH piles) based on procedures proposed by O'Neil and Reese (1999). The procedures utilize an α factor (α=0.55) for "Clay" and a β factor for "Sand" where β is a function of depths below ground surface and independent of soil friction angle The SHAFT program also computes the pile settlement and associated mobilization of shaft and end-bearing resistance, consistent with the O'Neil and Reese (1999) procedures.

The pile data table is presented below. Pile capacity computations (SHAFT output) are presented in Appendix C. End bearing was neglected in the estimation of axial pile capacities for all piles.

PILE DATA TABLE

Location	Pile Type	Nominal Load (kips)		Finish Grade (ft)	Cut-off Elev. (ft)	Design Tip Elev. (ft)[1]	Specified Tip Elev. (ft)
		Compression	Tension				
Abutment 1	24-in CIDH	310	0	62.33	55.25	29.0(a), 34.0(b)	29.5
Bent 2	84-in CIDH	3740	520	44.00	42.00	-29.0(a) 12.0(b) -20.0(c)	-29.0
Abutment 3	24-in CIDH	310	0	61.83	54.75	24.0(a), 34.0(b)	24.0

1. Design Tip Elevation is controlled by the following demands: (a) Compression; (b) Lateral Loads.

CIDH Pile Installation

Caltrans standard specifications and standard special provisions (SSP) for "Cast-in-Place Concrete Piling" should be used for the construction of CIDH piles. It is possible that groundwater may be encountered during construction and "dry" condition as per the standard specifications Section 49-4 could not be maintained. The "wet" specifications are contained in Caltrans SSP.

Vertical inspection pipes for acceptance testing should be provided in all CIDH piles that are 24 inches in diameter or larger, except when the holes are dry or when the holes are dewatered without the use of temporary casing to control groundwater. The acceptance test should include Gamma-Gamma Logging and may also include crosshole sonic logging. Gamma-Gamma Logging should be performed in accordance with California Test 233 Standard (CT233) to check the homogeneity of CIDH piles. Details of the acceptance testing and Gamma-Gamma Logging are contained in Caltrans SSP and CT233.

It is prudent to make the contractor aware of these conditions so that he takes appropriate steps to comply with the standards and maintain the integrity of the CIDH piles. The use of temporary steel casing should be anticipated at all times to maintain the integrity of the piles. It is also

recommended that the specifications set certain criteria for qualifications and previous work experience requirements to pre-qualify the potential contractors. The intent is to help select qualified contractors to reduce construction issues.

All piles excavations should be observed by the geotechnical engineer or regulatory agency prior to the placement of reinforcement and concrete so that if conditions differ from those anticipated, appropriate recommendations can be made.

Lateral Pile Capacity

Lateral load analyses may be performed using the LPILE program to determine the behavior of the piles under lateral loading conditions. Geotechnical parameters recommended for use in the LPILE program are presented below. The following parameters are based on field borings and laboratory testing data. The elevation information is based on the topographic information provided to us.

Geotechnical Parameters for LPILE Analysis

Abutment 1

Approx. Elev. (ft.)	Generalized Soil Profile	LPILE Soil Type	Probable Soil Strength	K (pci)	E_{50} (in/in)	Effect Unit Wt. (pci)
Above 45	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 24.31 psi	1000	.005	0.0723
35 to 45	Dense Silty Sand	8, API SAND	ϕ=35°	125	--	0.0752
20 to 35	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 24.31 psi	1000	.005	0.0723
5 to 20	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su 17.36 psi	1000	.005	0.0723
0 to 5	Very Stiff Sandy Silt	8, API SAND	ϕ=25°	125	--	0.0376
Below 5	Hard Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 27.78 psi	2000	.004	0.0376

Bent 2

Approx. Elev. (ft.)	Generalized Soil Profile	LPILE Soil Type	Probable Soil Strength	K (pci)	E_{50} (in/in)	Effect Unit Wt. (pci)
Above 20	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 24.31 psi	1000	.00267	0.0723
4 to 20	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 24.31 psi	1000	.00267	0.0723
0 to 4	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 24.31 psi	1000	.00267	0.0376
Below 0	Hard Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 41.67 psi	2000	.00214	0.0376

Abutment 3

Approx. Elev. (ft.)	Generalized Soil Profile	LPILE Soil Type	Probable Soil Strength	K (pci)	E_{50} (in/in)	Effect Unit Wt. (pci)
Above 40	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 17.36 psi	1000	.005	0.0723
20 to 40	Hard Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 27.78 psi	2000	.004	0.0723
5 to 20	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 17.36 psi	1000	.005	0.0723
3 to 5	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 17.36 psi	1000	.005	0.0376
Below 3	Very Dense Sand	8, API SAND	ϕ=40°	125	--	0.0405

Analyses were performed for the CIDH piles for the lateral loads provided by the designer. In all analyses, a 'pinned' pile head connection was assumed. The results are presented in the table below. Appropriate Group Reduction Factors were used in the analyses corresponding to the pile spacings, as noted in the table.

LATERAL LOAD (LPILE) ANALYSIS RESULTS

Support No.	CIDH Pile Diameter (inches)	Cut-off Elevation (ft)	Shear Load on top of Pile (kips)	Deflection on Top of Pile (inches)	Maximum Bending Moment	
					Magnitude (kip-ft)	At depth (ft)[1]
Abut 1	24	54.75	31	0.065	66.9	4
			41	0.122	100.2	5
			51	0.194	136.7	5
Bent 2[2]	84	42.00	205 (Long.)	0.084	114.1	11
			205 (Trans.)	0.123	130.8	13
			890 (long.)	2.141	930.8	20
			485 (Trans>)	0.824	449.1	18
Abut 3	24	54.25	31	0.098	80.4	5
			41	0.181	120.2	6
			51	0.294	163.5	6

Notes:

1. Depth measured from top of pile (bottom of footing)
2. Used Cracked Section: Moment of Inertia reduced by 50 percent.
3. Group factors of 0.6 used for Abutments corresponding to a pile spacing of 3 times the diameter, as recommended by Caltrans
4. For Bent 2, Group Factors based on GROUP 7.0 Program (0.80 for Longitudinal and 0.62 for Transverse)
5. Loads provided by Antonio Luo

Lateral Earth Pressures

Abutment retaining walls and wing walls should be designed to resist the following Applied Lateral Earth Pressures and live load. These values assume no hydrostatic pore pressure buildup behind the wall and are based on well-drained backfill behind the walls supported in native soil.

Active Condition (flexible wall - wall free to rotate at least 0.4 percent of wall height

Structure Backfill: Equivalent Fluid Pressure (EFP) – 36 pcf (backfill having a friction angle $\varphi = 33.5°$ and a unit weight of 125 pcf)

Surcharge (dead or live load): 0.3 times surcharge load

At-Rest Condition (rigid wall - wall not free to rotate at least 0.4 percent of wall height

Structure Backfill:	Equivalent Fluid Pressure (EFP) – 55 pcf (backfill having a friction angle $\varphi = 33.5°$ and a unit weight of 125 pcf)
Surcharge (dead or live load):	0.5 times surcharge load

Passive Resistance for Seismic Design of Abutment Wall

Height of wall – 5.5 feet or higher:	5.0 ksf (ultimate)
Height of wall – less than 5.5 feet:	5.0 X (H/5.5) ksf (ultimate)

Seismic increment of Lateral Earth Pressure (based on BART Facilities Standards)

$11.7H^2$ (psf) per foot of wall, acting at 0.6H above the base
(The earth pressures are based on Mononobe-Okabe formulation. The accelerations used are half of the corresponding peak acceleration per BART Facilities Standards)

Seismic Design Criteria

The value of PBA for the project site was calculated from the distances to the applicable faults in the project vicinity using the Caltrans In-Progress Seismic Hazard Map and the attenuation relation by Sadigh et al. (1997). The computed PBA value was increased by 20%, also per Sadigh (1997), to account for the reverse fault effect, wherever applicable. The PBA computations based on Sadigh attenuation relation are presented in Appendix C. Based on the computations, the maximum PBA computed within the project limit is 0.5g,

Based on the available boring information in the vicinity of the project site, the subsurface soil conditions at the project site generally matches the criteria for Soil Type D, as per Caltrans Seismic Design Criteria (Version 1.4, June 2006). Based on Caltrans Seismic Design Criteria and the above information, the seismic design criteria are as follows:

1.	Closest Distance to Fault	=	3.4 miles (5.5 km)
2.	PBA	=	0.5g
3.	Design ARS Curve	=	Caltrans Seismic Design Criteria June 2006 Version 1.4 Figure B.8 (Soil Profile Type D).

4. Design ARS Curve (see Plate 4): Curve based on Caltrans SDC (v. 1.4, 6/2006) for different structural periods. The curve is based on (Governing Fault – Vaca Fault Zone; Mmax =6.9) Figure B.8, PBA = 0.5g. The curve is modified for near fault effects as required by SDC.

A copy of the ARS Design Curve is included on Plate No. 4 of this report.

Grading

All grading operations should be performed in accordance with the project specifications and Caltrans Standard Specifications for Earthwork (Section 19.

Engineered Fill Engineered fill should be non-expansive and consist of relatively granular material having a P.I. of less than 15. The fill shall also be free of organic and inorganic debris, rubble and any other deleterious material. The on-site soils may be used as engineered fill, provided they meet the above criteria.

Approach Embankment The maximum embankment fill thickness is anticipated to be approximately 10 to 15 feet at all the abutment locations. The approach embankments will have a 2(H): 1(V) slope on both sides. Under the bridge, paved slopes may be constructed at 1.5(H):1 (V) slope. The available boring data indicates that the subsurface soil conditions generally consist of stiff to very stiff clays. Based on the boring information, it appears that the consolidation settlement due to the placement of the embankment fill is anticipated to be relatively quick (during construction) and therefore insignificant. Standard Caltrans 30-day waiting period is considered

adequate.

Corrosion

The corrosion investigations performed are in general accordance with the provisions of California Test Method 643. A summary of the corrosion test data is presented below.

Boring	Depth (ft)	PH	Resistivity (ohms-cm)	Sulfate (ppm)	Chloride (ppm)
AST-154	8	7.50	860	89.1	10.9

Based on the data, the site subsoil is non-corrosive per Caltrans corrosion design guidelines, and standard Type II modified or Type I-P (MS) modified cement may be used for the concrete substructures. The minimum cement factor and cover thickness should be per Caltrans Bridge Design Specifications (Section 8.22).

Plan Review

We recommend that final plans for foundations be reviewed by this office prior to construction so that the intent of our recommendations is included in the project plans and specifications and to further see that no misunderstandings or misinterpretations have occurred.

Construction Observation

To a degree, the performance of any structure is dependent upon construction procedures and quality. Hence, observation of foundation excavations, and pile installations should be carried out by the regulating agencies. If the subsurface conditions different from those forming the basis of our recommendations is encountered, this office should be informed in order to assess the need for design changes. Therefore, the recommendations presented in this report are contingent upon good quality control and these geotechnical observations during construction.

INVESTIGATION LIMITATIONS

Our services consist of professional opinions and recommendations made in accordance with generally accepted geotechnical engineering principles and practices and are based on our site reconnaissance and the assumption that the subsurface conditions do not deviate from observed conditions. All work done is in accordance with generally accepted geotechnical engineering principles and practices. No warranty, expressed or implied, of merchantability or fitness, is made or intended in connection with our work or by the furnishing of oral or written reports or findings. The scope of our services did not include any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in structures, soil, surface water, groundwater or air, below or around this site. Unanticipated soil conditions are commonly encountered and cannot be fully determined by taking soil samples and excavating test borings; different soil conditions may require that additional expenditures be made during construction to attain a properly constructed project. Some contingency fund is thus recommended to accommodate these possible extra costs.

This report has been prepared for the proposed project as described earlier, to assist the engineer in the design of this project. In the event any changes in the design or location of the facilities are planned, or if any variations or undesirable conditions are encountered during construction, our conclusions and recommendations shall not be considered valid unless the changes or variations are reviewed and our recommendations modified or approved by us in writing.

This report is issued with the understanding that it is the designer's responsibility to ensure that the information and recommendations contained herein are incorporated into the project and that necessary steps are also taken to see that the recommendations are carried out in the field.

The findings in this report are valid as of the present date. However, changes in the subsurface conditions can occur with the passage of time, whether they are due to natural processes or to the works of man, on this or adjacent properties. In addition, changes in applicable or appropriate standards occur, whether they result from legislation or from the broadening of knowledge. Accordingly, the findings in this report might be invalidated, wholly or partially, by changes outside of our control.

Respectfully submitted,
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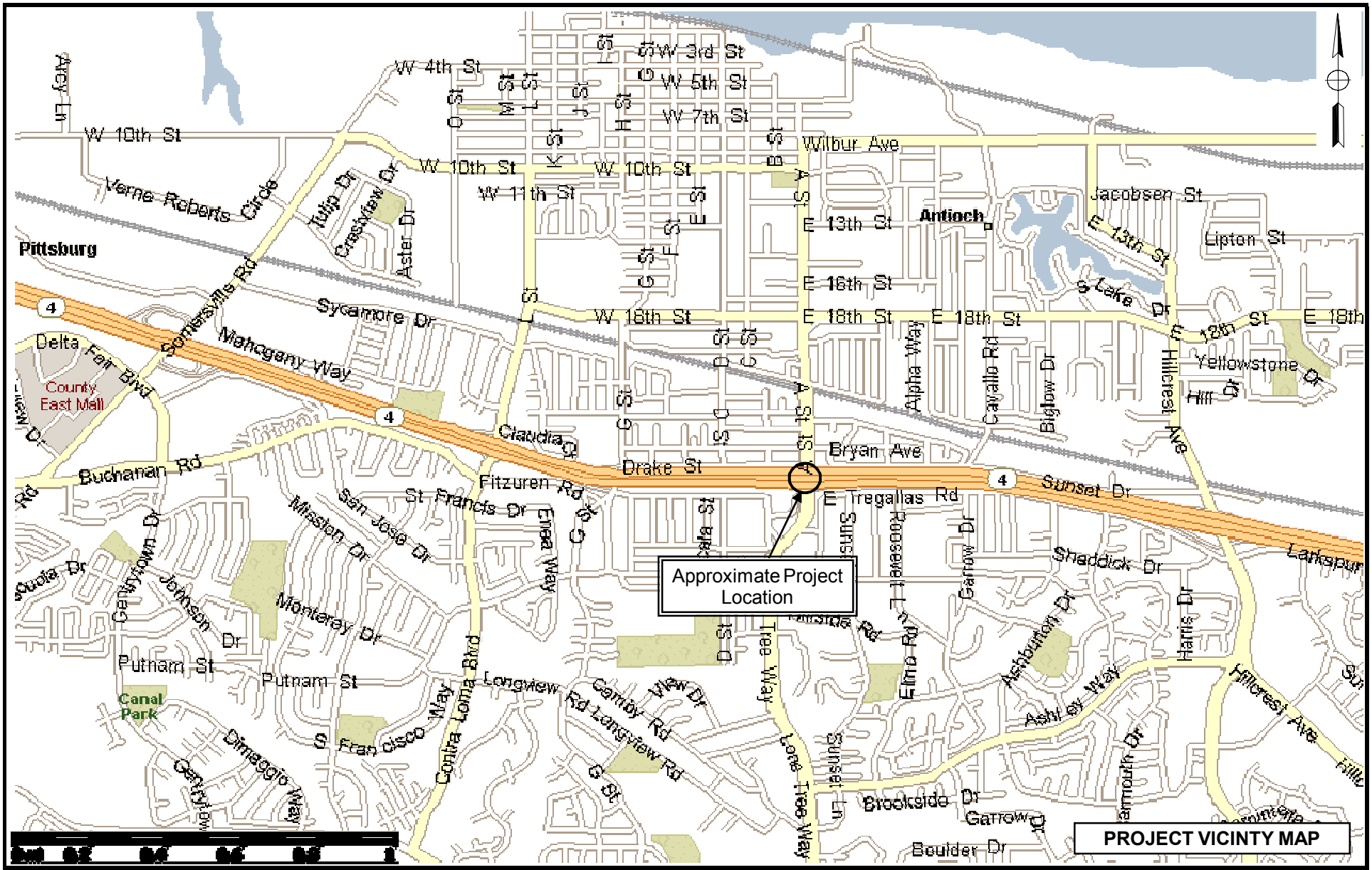
Gary Parikh, G.E. 666
Project Manager

REGISTERED PROFESSIONAL ENGINEER
GAURANG R. PARIKH
No. 666
EXP. 12-31-11
GEOTECHNICAL
STATE OF CALIFORNIA



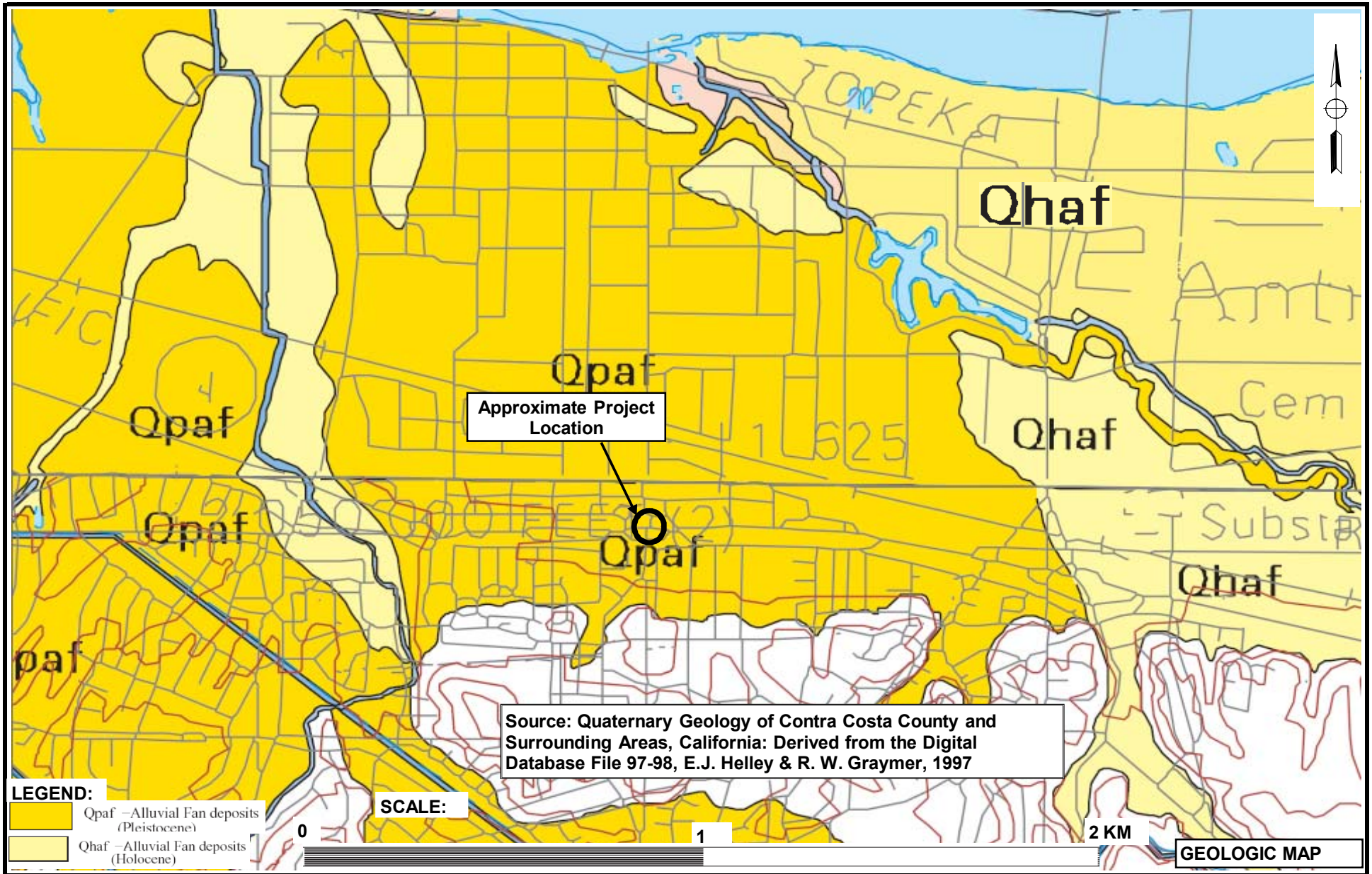
PROJECT VICINTY MAP

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

eBART A STREET UNDERPASS
ANTIOCH, CALIFORNIA

JOB NO.: 206117.EBS

PLATE NO.: 1

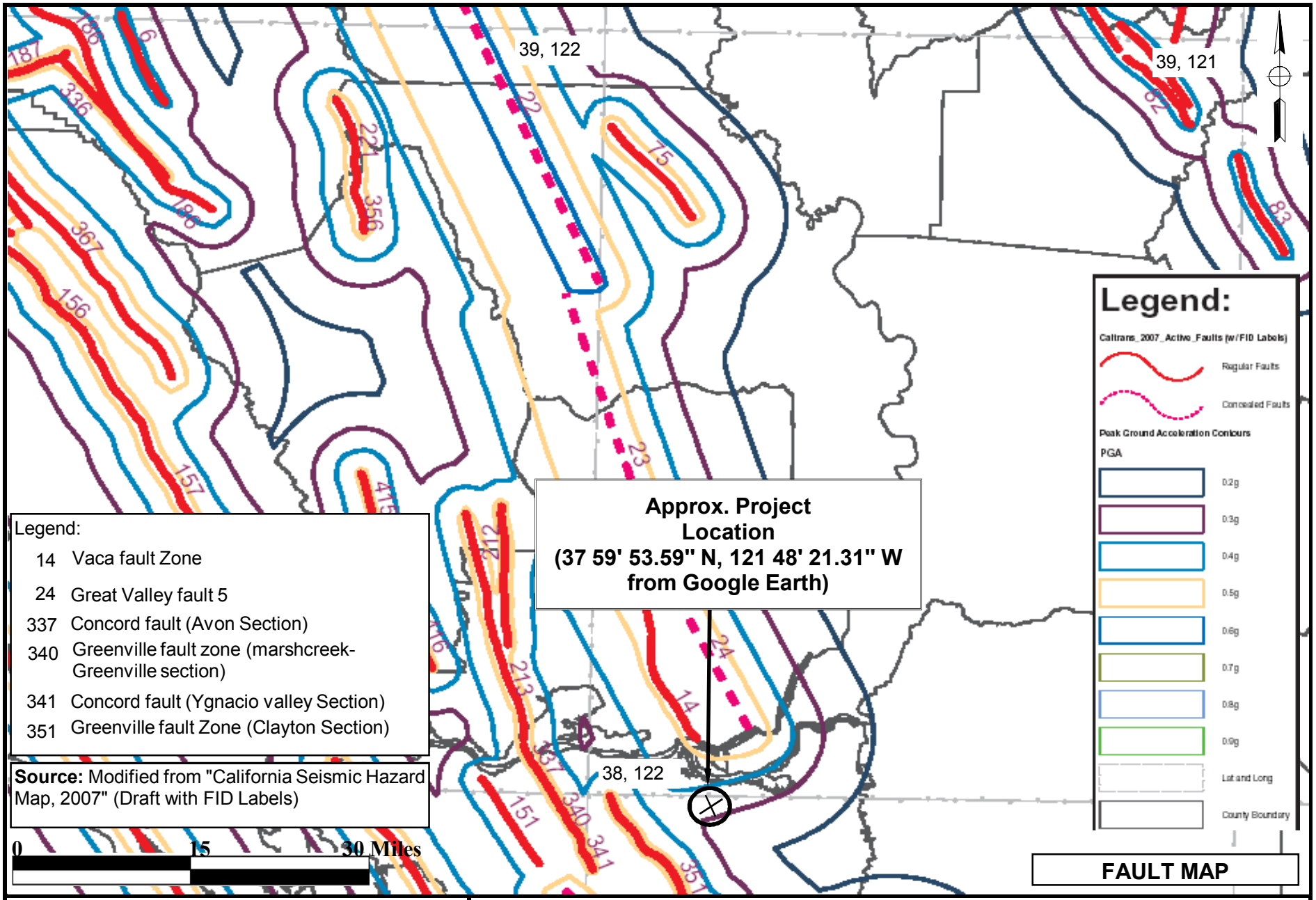


PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

eBART A STREET UNDERPASS
ANTIOCH, CALIFORNIA

JOB NO.: 206117.EBS

PLATE NO.: 2



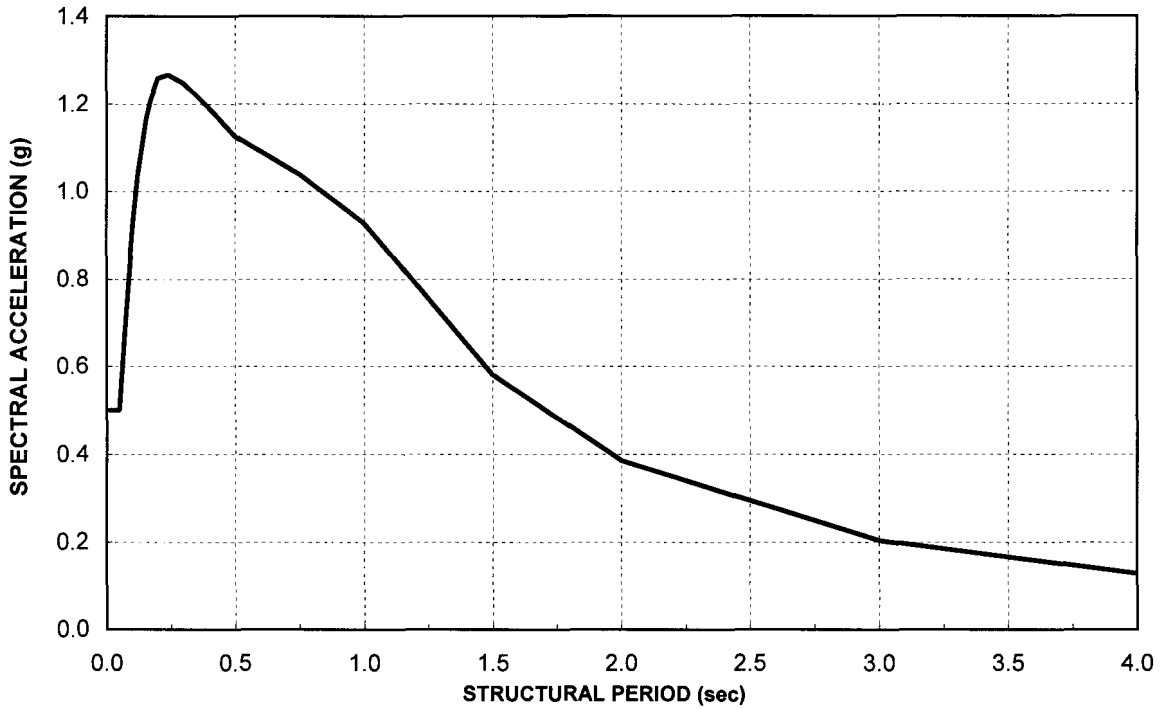
FAULT MAP

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

eBART A STREET UNDERPASS
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO.: 206117.EBS	PLATE NO.: 3

A Street Undercrossing



Spectral Data

Period (sec)	Spectral Accel. (g)
0.010	0.500
0.020	0.500
0.030	0.500
0.050	0.500
0.075	0.719
0.100	0.919
0.120	1.037
0.150	1.156
0.170	1.209
0.200	1.259
0.240	1.266
0.300	1.247
0.400	1.190
0.500	1.125
0.750	1.038
1.000	0.927
1.500	0.581
2.000	0.386
3.000	0.204
4.000	0.128

Caltrans SDC (v 1.4, June 2006), Figure B.8,
Governing Fault: Vaca Fault Zone
Fault Distance = 5.45 km (3.4 miles)
(Mw = 6.9, Soil Profile Type D, PBA = 0.5g)

Notes:
(a) The new (in-progress) Caltrans Hazard Map and Data Base was used
(b) PBA was obtained by using Sadigh Attenuation Relationship:0.49g (rounded off to 0.5 g)
(c) The following modifications were then applied for near-fault effects:
(1) No change of Sa for structural periods $\leq$ 0.5 sec
(2) 20% increase of Sa for structural periods > 1 sec
(3) Linear interpolation for structural periods between 0.5 and 1 sec

APPENDIX A

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	–		

REGISTERED ENGINEER-GEOTECHNICAL

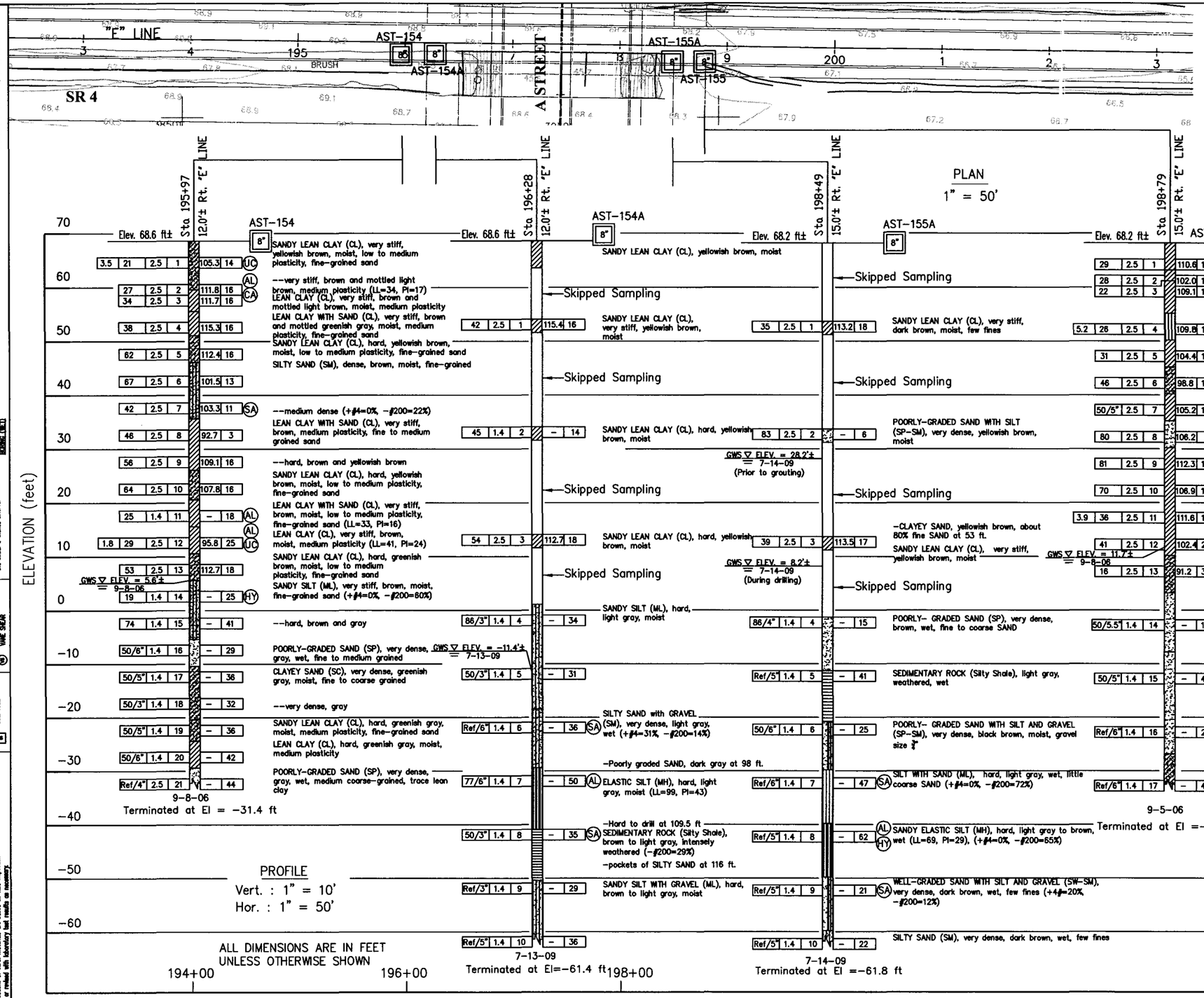
PLANS APPROVAL DATE

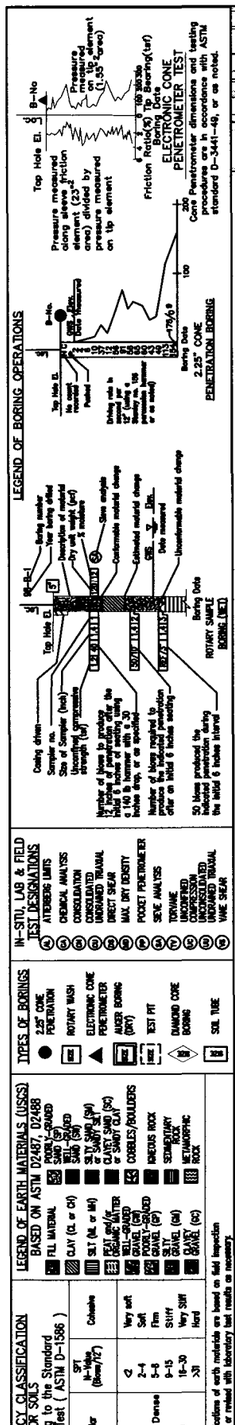
REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE 666 Exp. 12/31/09 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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.





DESIGN OVERSIGHT		DESIGN By: D. GOUTHIER	Field investigation by: L. BHANGOO	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	P. SIRCAR PROJECT ENGINEER	STRUCTURE NO. 28C0487	eBART A STREET UNDERPASS
SIGN OFF DATE		CHECKED By: P. SIRCAR				POST MILES (PM) 27.8	LOG OF TEST BORINGS 1 OF 2

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04275
EA 228511

DISREGARD PRINTS BEARING EARLIER REVISION DATES → 08/31/09

REVISION DATES (PRELIMINARY STAGE ONLY) | SHEET | OF

PLATE A-1

S:\ACAD\206117.EBS\LOTB- A STREET 08-31-09.dwg, A ST-154-154A (1), 8/31/2009 11:47:54 AM, O.G

Dist.	County	Route	Phase	Sheet No.	Total Sheets
04	CC	4	89	192	715

April 1 1969

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	KILOMETER POST–TOTAL PROJECT	Sheet No.	Total Sheets
04	CC	4			

REGISTERED CIVIL ENGINEER — DATE 06-23-08

LOG OF TEST BORINGS

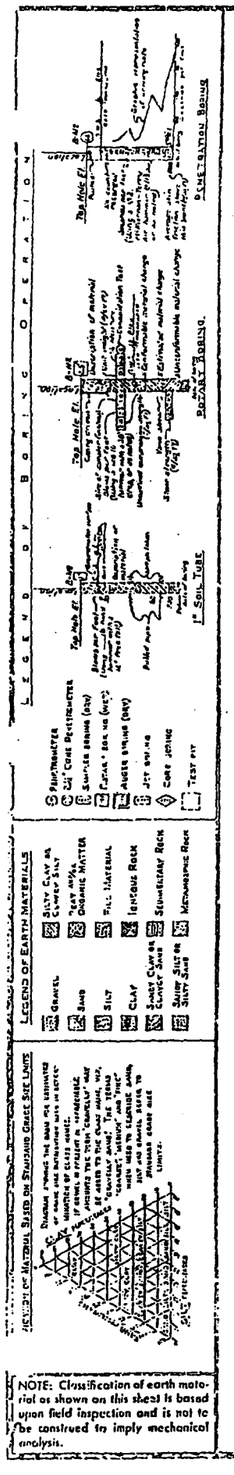
NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

CU: 04275
EA: 228511

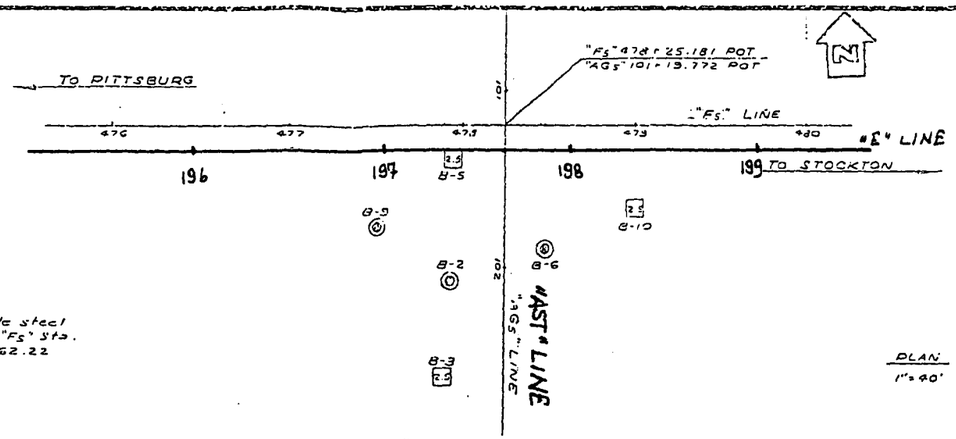
BRIDGE No. 28-0401

Sheet 2 of 3

REGISTERED PROFESSIONAL ENGINEER
GARY PARIKH
No. G.E. 666
Exp. 12/31/09
GEOTECHNICAL
STATE OF CALIFORNIA



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.



BM #51
Chiseled "a" on N side steel tower base 122' Rt "Fs" Sta. 478+87 Elev. 62.22

PLAN
1"=40'

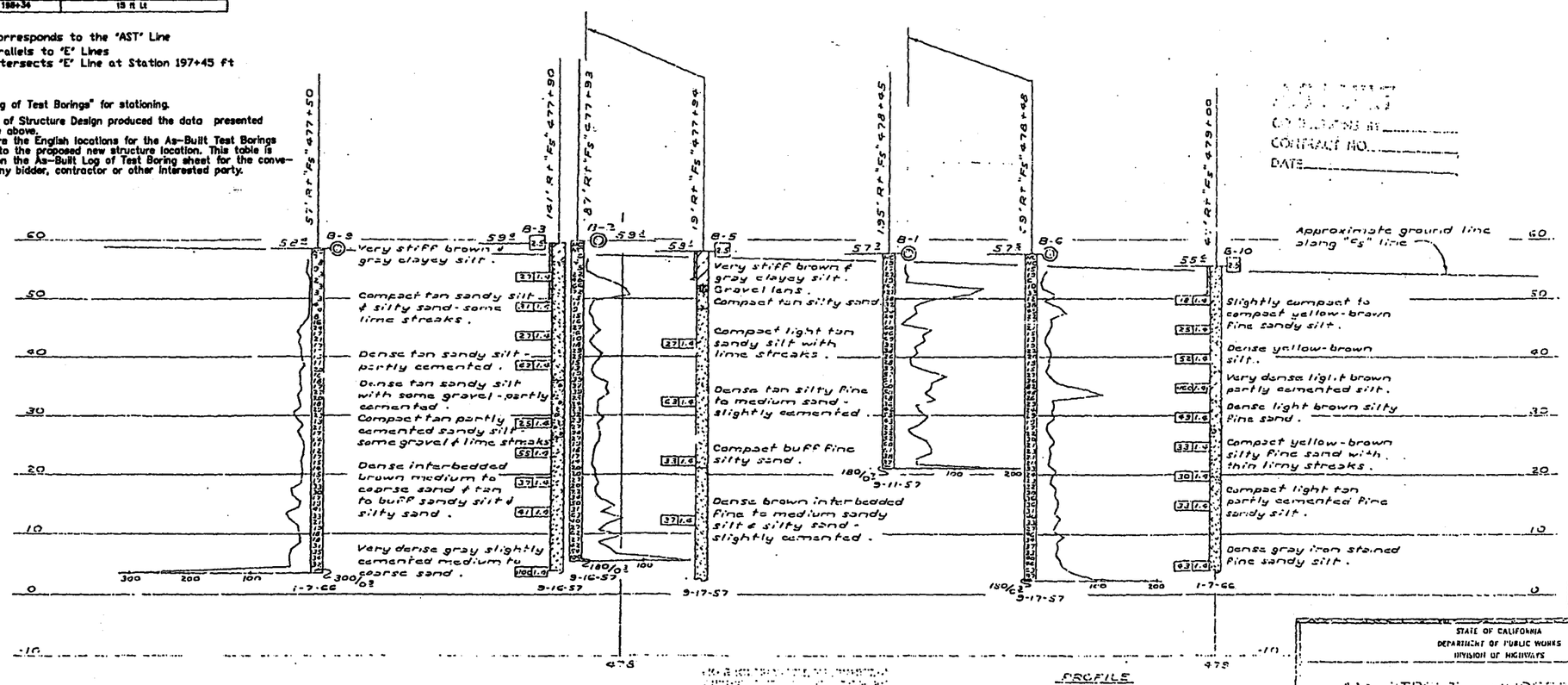
Revisions made to this Log of Test Borings from the original 1969 Log of Test Borings are the addition of the following table and notes:

Boring	Station	Offset from "E" LINE
B-9	196+94	20 ft Lt
B-3	197+30	56 ft Lt
B-2	197+34	36 ft Lt
B-5	197+40	3 ft Lt
B-1	197+82	80 ft Lt
B-6	197+88	26 ft Lt
B-10	198+34	15 ft Lt

'AGS' Line corresponds to the 'AST' Line
'FS' Line parallels to 'E' Lines
'AGS' Line intersects 'E' Line at Station 197+45 ft

Notes:

1. See the "Log of Test Borings" for stationing.
2. The Division of Structure Design produced the data presented in the table above.
   The data are the English locations for the As-Built Test Borings referenced to the proposed new structure location. This table is presented on the As-Built Log of Test Boring sheet for the convenience of any bidder, contractor or other interested party.



PROFILES
1"=10'

CONTRACT NO.
DATE

AS BUILT PLANS
Contract No. 04-159704
Date Completed
Document No. 4180621R

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

"A" STREET UNDERCROSSING

LOG OF TEST BORINGS

SHEET 10 OF 14

SCALE As Noted | BRIDGE 28-0401 | FILE | DRAWING 2886-14

PREL. DRAWING No. PB

Disregard points bearing center numbers

209

APPENDIX B

APPENDIX B

LABORATORY TESTS

Classification Tests

The field classification of the samples was visually verified in the laboratory according to the Unified Soil Classification System. The results are presented on "Log of Test Borings", Appendix A.

Moisture-Density

The natural moisture contents and dry unit weights were determined for selected undisturbed samples of the soils in general accordance with ASTM Test Method D 2216-92. This information was used to classify and correlate the soils. The results are presented at the appropriate depths on the "Log of Test Borings", Appendix A.

Atterberg Limits

The Atterberg Limits were determined for selected samples of the fine-grained materials. These results were used to classify the soils, as well as to obtain an indication of the effective strength characteristics and expansion potential with variations in moisture content. The Atterberg Limits were determined in general accordance with ASTM Test Method D 4318-93. The results of these tests are presented on Plate B-2, "Plasticity Chart".

Grain Size Classification

Grain size classification tests (ASTM Test Method D422-63) were performed on selected samples of granular soil to aid in the classification. The results are presented on Plates B-3A and B-3B, "Grain Size Distribution Curves".

Hydrometer

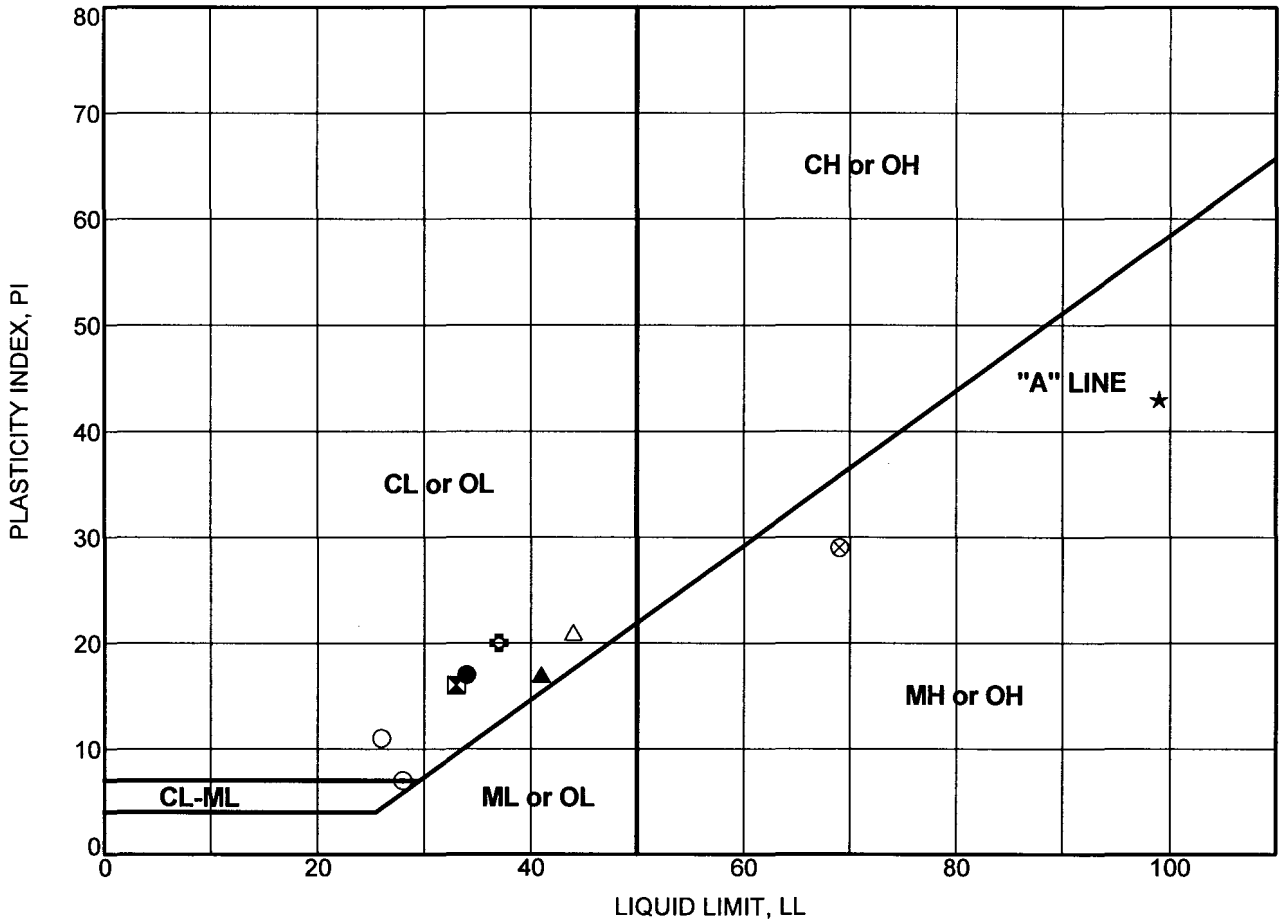
Hydrometer test (ASTM Test Method D 422) was performed on selected samples to aid in the classification. The result is presented on Plate B-4, " Grain Size Distribution Curves"

Unconfined Compression Tests

Strength tests were performed on selected undisturbed samples using unconfined compression machine. Unconfined compression tests were performed in general accordance with ASTM Test Method D 2166-91. The results are presented on "Log of Test Borings"

Corrosion Test

Corrosion test was performed on selected sample to determine the corrosion potential of the soils. The pH and minimum resistively test was performed according to California Test Method 643. The test was performed by Sunland Analytical. The test result is presented on Plate B-4.



PLASTICITY CHART

Boring Number	Sample Number	Depth (feet)	Test Symbol	Moisture Content (%)	LL	PL	PI	Description
AST-154	MC-2	8.0	●	16	34	17	17	LEAN CLAY (CL)
AST-154	MC-7	30.0	⊠	11	33	17	16	SILTY SAND (SM)
AST-154	MC-12	55.0	▲	25	41	24	17	LEAN CLAY (CL)
AST-154A	SPT-7	99.5	★	50	99	56	43	ELASTIC SILT (MH)
AST-155	MC-2	10.0	⊙	19	28	21	7	SILTY CLAY (CL-ML)
AST-155	MC-4	15.0	✿	15	37	17	20	SILT (ML)
AST-155	MC-11	50.0	○	24	26	15	11	LEAN CLAY (CL)
AST-155	MC-12	55.0	△	56	44	23	21	LEAN CLAY (CL)
AST-155A	SPT-8	109.5	⊗	62	69	40	29	SANDY ELASTIC SILT (MH)

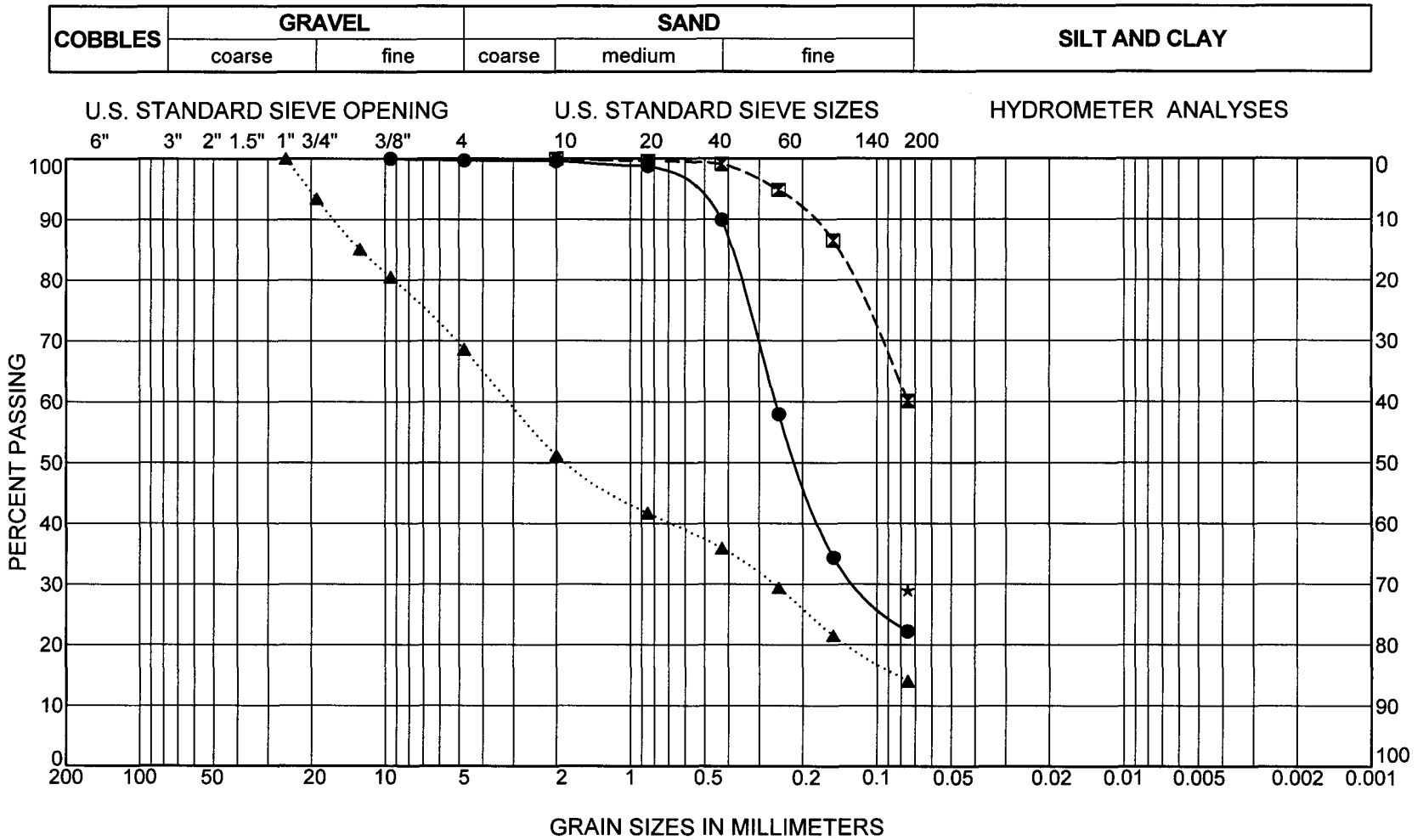
PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

A STREET UNDERCROSSING
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.AST

PLATE NO: B-2

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
AST-154	MC-7	30.0	●	33	16	SILTY SAND (SM)
AST-154	SPT-14	65.0	⊠			SANDY SILT (ML)
AST-154A	SPT-8	89.5	▲			SILTY SAND WITH GRAVEL (SM)
AST-154A	SPT-9	109.5	★			SANDY SILT (ML)

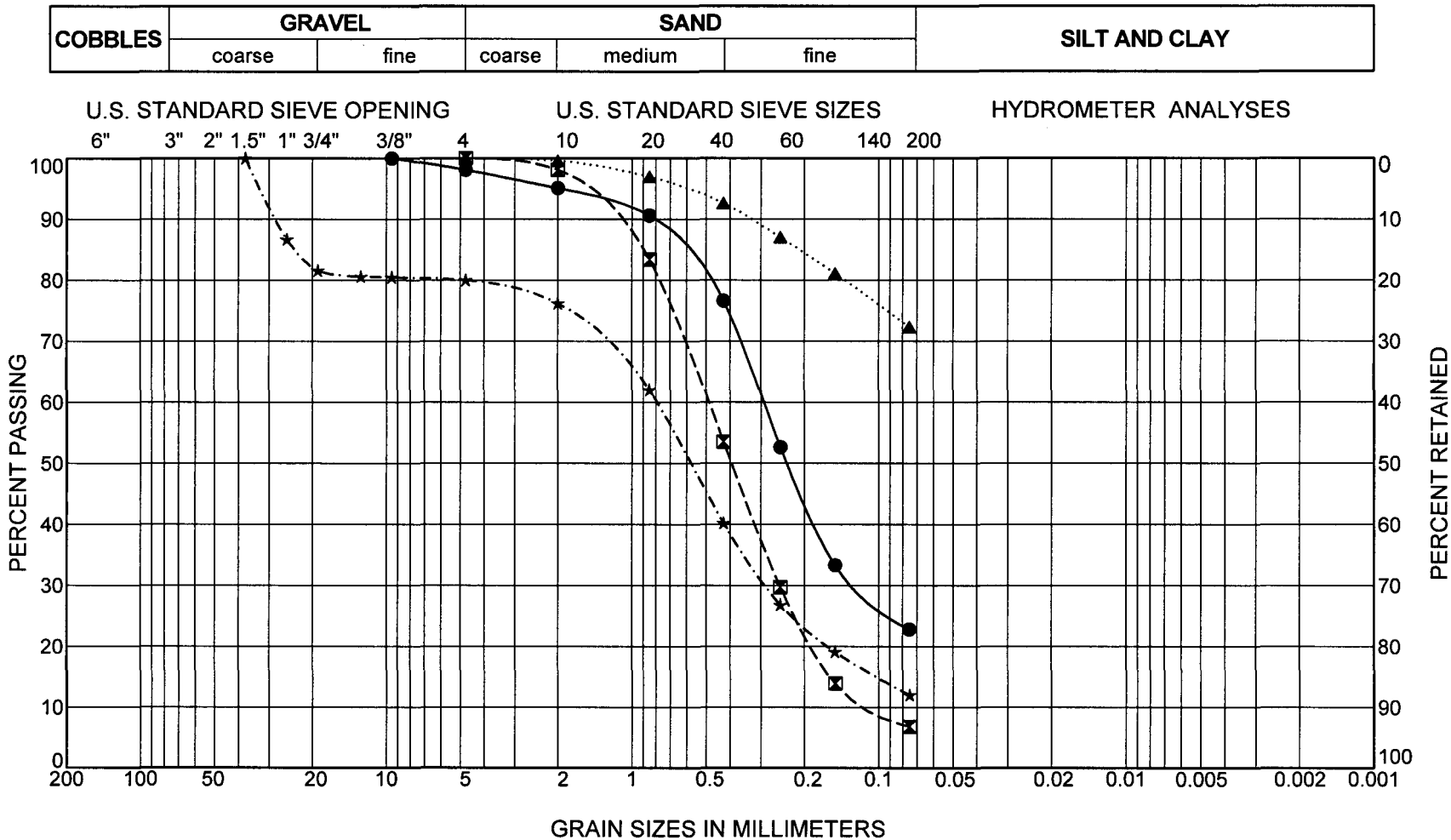
PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

JOB NO: 206117.AST

A STREET UNDERCROSSING
CONTRA COSTA COUNTY, CALIFORNIA

PLATE NO: B-3A

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
AST-155	MC-6	25.0	●			CLAYEY SAND (SC)
AST-155	SPT-14	70.0	⊠			POORLY GRADED SAND WITH SILT (SP-SM)
AST-155A	SPT-7	99.5	▲			SILT WITH SAND (ML)
AST-155A	SPT-9	119.5	★			WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM)

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

JOB NO: 206117.AST

A STREET UNDERCROSSING
CONTRA COSTA COUNTY, CALIFORNIA

PLATE NO: B-3B

Sunland Analytical

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 12/08/2006
Date Submitted 12/04/2006

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.AST/A ST.BDGE Site ID : AST 154 #2 @ 8'.
Thank you for your business.

* For future reference to this analysis please use SUN # 49465-98602.

EVALUATION FOR SOIL CORROSION

Soil pH	7.50		
Minimum Resistivity	0.86	ohm-cm (x1000)	
Chloride	10.9 ppm	00.00109	%
Sulfate	89.1 ppm	00.00891	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

APPENDIX C

Attenuation Relationships for Shallow Crustal Earthquakes (Sadigh, et al, 1997)

Fault = Vaca fault zone (RLSS Fault, Map NO: 14)

Mmax = 6.9 **Rrup = 5.48** **km**

M>=6.5 *ROCK SITE:*

C1 = -1.274 C2 = 1.1 C3 = 0 C4 = -2.1

C5 = -0.48451 C6 = 0.524 C7 = 0

A=C1+C2M+C3(8.5M)^2.5= 6.316

B=C4*Ln(Rrup+exp(C5+C6M))= -7.026

C=C7*Ln(Rrup+2)= 0

Ln(y) = A+B+C = -0.710

y = Exp(Ln(y)) = 0.49 **Peak Bed Rock Acceleration PBA = 0.490 - Use 0.5g**

Fault = Great valley fault 5 (Reverse Fault, Map No: 24)

Mmax = 6.5 **Rrup = 7.045** **km**

A= 5.876

B= -6.811

C= 0

Ln(y) = -0.935

y = 0.39 **Peak Bed Rock Acceleration PBA = 0.39g x 1.2 = 0.468g**

Fault = Greenville fault zone (Clayton section, RLSS Fault, Map No: 351)

Mmax = 6.6 **Rrup = 6.59** **km**

A= 5.986

B= -6.855

C= 0

Ln(y) = -0.869

y = 0.42 **Peak Bed Rock Acceleration PBA = 0.42g**

Fault = Concord fault zone (Ygnacio valley section, RLSS Fault, Map No: 341)

Mmax = 6.6 **Rrup = 11.136** **km**

A= 5.986

B= -7.191

C= 0

Ln(y) = -1.205

y = 0.30 **Peak Bed Rock Acceleration PBA = 0.3g**

AXIAL PILE CAPACITIES

(SHAFT Program)

SHAFT Runs SR Bypass – eBART - A Street Underpass
Pile capacities computed using SHAFT program – Output follows
(Revised on 08/17/09)

Abutment 1 (based on boring AST-154)

24-in CIDH Pile (Note: Neglected End Bearing for Pile Capacity)

Ground Surface Elevation 62.0 (approx.)
Nominal Compression Load = 310 kips = 155 tons
Reqd. Shaft Length per SHAFT output = 32.0 ft
Recommended Penetration = 33.0 feet (absence of sand layer)
Reqd. Tip Elevation = 62.0-33.0 = 29.0

Abutment 3 (based on boring AST-155)

24-in CIDH Pile (Note: Neglected End Bearing for Pile Capacity)

Ground Surface Elevation 62.0 (approx.)
Nominal Compression Load = 310 kips = 155 tons
Reqd. Shaft Length per SHAFT output = 38.0 ft
Recommended Penetration = 38.0 feet
Reqd. Tip Elevation = 62.0 – 38.0 = 24.0

Bent 2 (based on borings AST-154 & AST-155)

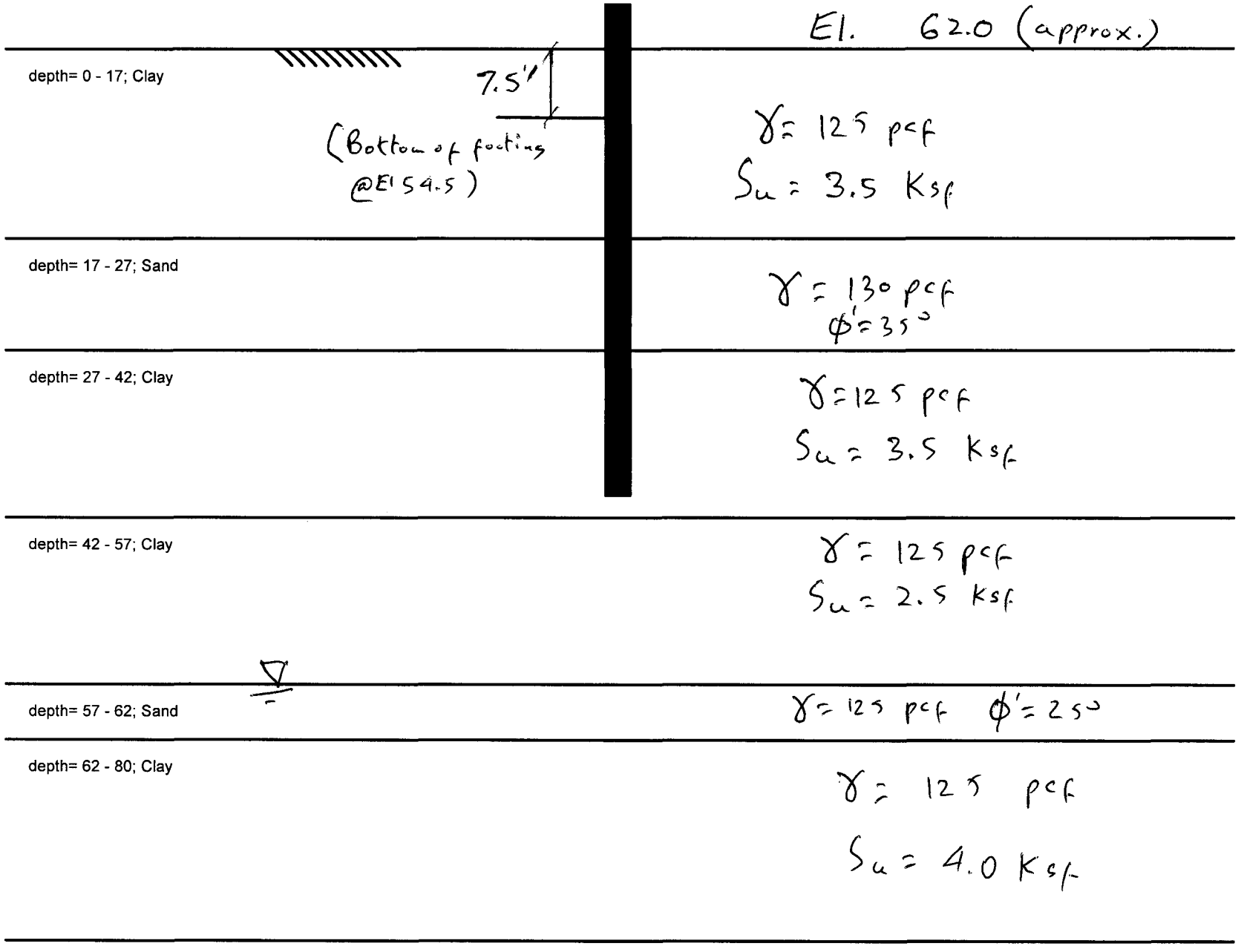
84-in CIDH Pile (Note: Neglected End Bearing for Pile Capacity)

(Assumed Granular IGM at bottom)

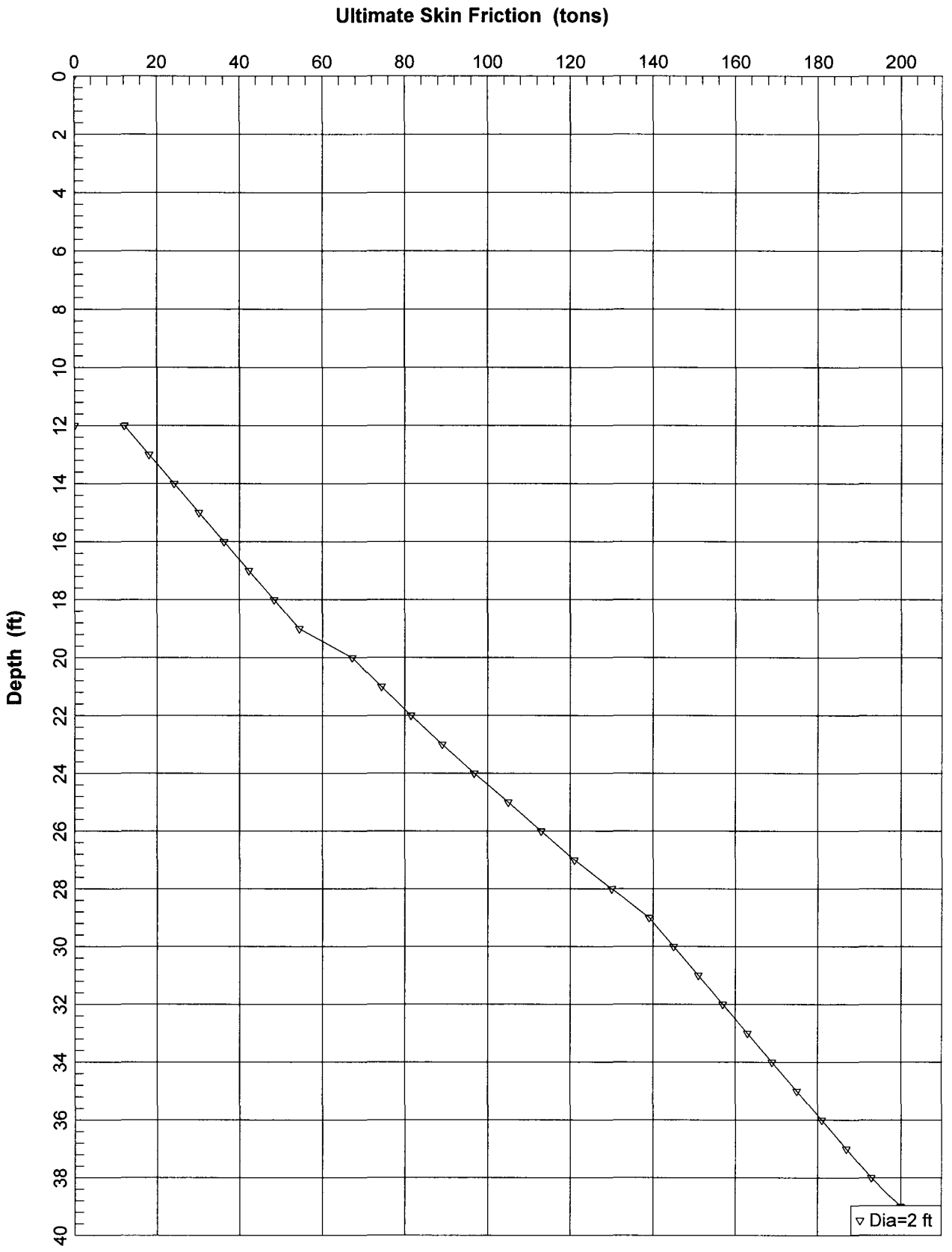
Ground Surface Elevation 44.0 (approx.)
Nominal Compression Load = 3740 kips = 1870 tons
Reqd. Shaft Length per SHAFT output = 66.0 ft
Recommended Penetration = 68.0 feet
Reqd. Tip Elevation = 44.0 - 68.0 .0 = -24.0 ----- Compression

Nominal Tension = 520 kips = 260 tons
Equivalent Skin Friction = 260/0.5 = 520 tons
Reqd. Shaft Length per SHAFT output = 32.0 ft
Reqd. Tip Elevation = 44.0 – 32.0 = 12.0.0 ------ Tension

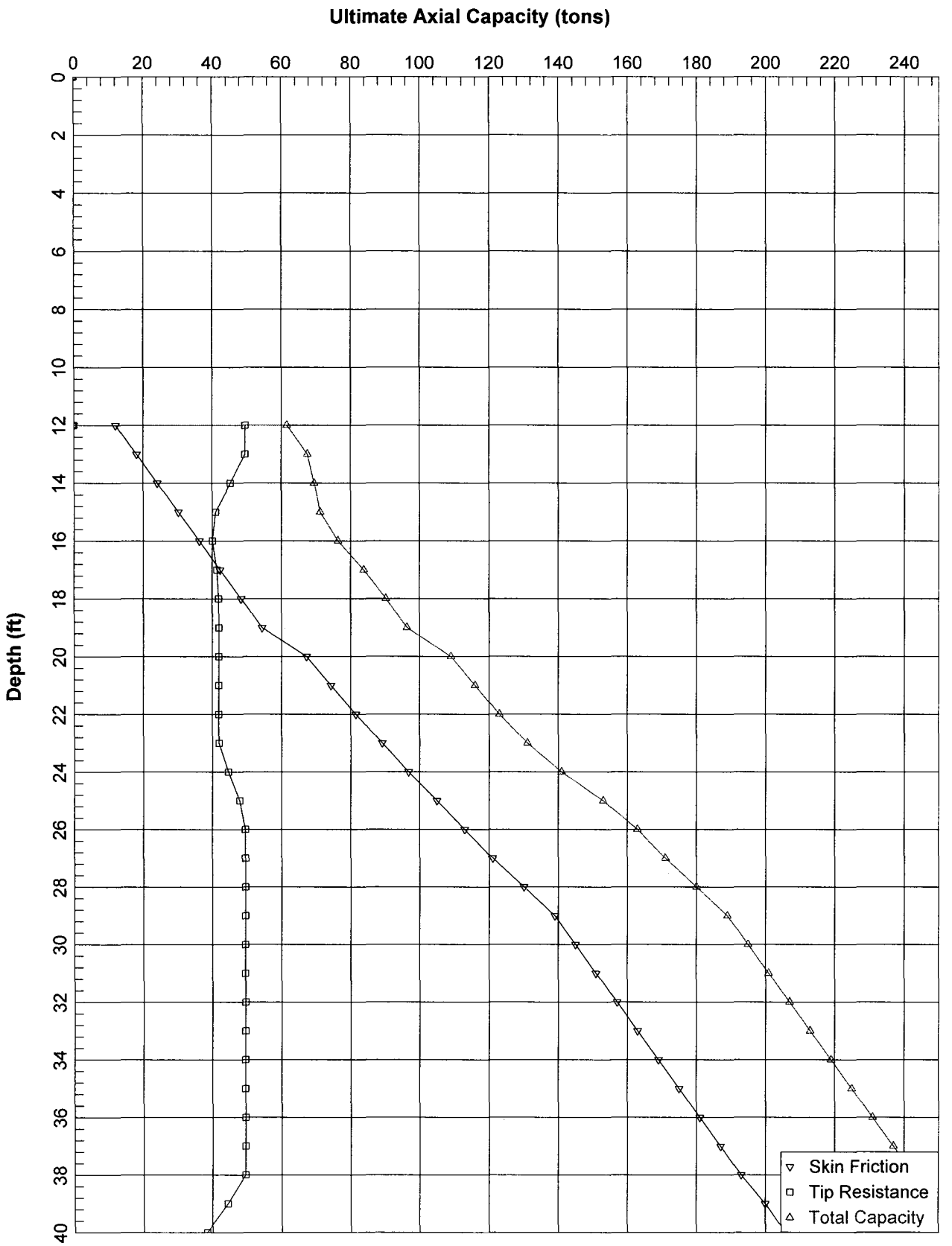
Reqd. Tip Elevation = 44.0.0 – 68.0 = -24.0 ------ Tension


El. 62.0 (approx.)
depth= 0 - 17; Clay
7.5'
(Bottom of footing @El 54.5)
γ = 125 pcf
Su = 3.5 Ksf
depth= 17 - 27; Sand
γ = 130 pcf
φ' = 35°
depth= 27 - 42; Clay
γ = 125 pcf
Su = 3.5 Ksf
depth= 42 - 57; Clay
γ = 125 pcf
Su = 2.5 ksf
depth= 57 - 62; Sand
γ = 125 pcf φ' = 25°
depth= 62 - 80; Clay
γ = 125 pcf
Su = 4.0 Ksf

Abutment 1



eBART A Street Underpass - Abutment 1 - 24-in CIDH Pile



eBART A Street Underpass - Abutment 1 - 24-in CIDH Pile

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 5.0 (C) COPYRIGHT ENSOFT,INC. 1989,1995,1998,2001,2003

A Street- SR4 - Abutment 1

PROPOSED DEPTH = 40.0 FT

NUMBER OF LAYERS = 6

WATER TABLE DEPTH = 57.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 2.50

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 3.00

SOIL INFORMATION

LAYER NO 1----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.350E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.350E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
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.	= 0.350E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03

MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.400E+04
DEPTH, FT	= 0.170E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.799E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.350E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.400E+04
DEPTH, FT	= 0.270E+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	= 0.350E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.270E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.350E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.420E+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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.420E+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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04

DEPTH, FT = 0.570E+02

LAYER NO 5----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA = 0.481E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.250E+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 = 0.400E+04
DEPTH, FT = 0.570E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA = 0.437E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.000E+00
INTERNAL FRICTION ANGLE, DEG. = 0.250E+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 = 0.400E+04
DEPTH, FT = 0.620E+02

LAYER NO 6----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.640E+04
DEPTH, FT = 0.620E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA = 0.550E+00
END BEARING COEFFICIENT-Nc = 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT = 0.400E+04
INTERNAL FRICTION ANGLE, DEG. = 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.640E+04
DEPTH, FT = 0.800E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM = 2.000 FT.
DIAMETER OF BASE = 2.000 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 7.500 FT.
IGNORED BOTTOM PORTION = 2.000 FT.

AREA OF ONE PERCENT STEEL = 4.524 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	1.28	6.05	49.49	55.53	22.54	18.91	43.38
12.0	1.40	12.10	49.49	61.58	28.59	21.33	44.10
13.0	1.51	18.15	49.49	67.63	34.64	23.75	44.71
14.0	1.63	24.19	45.28	69.47	39.29	24.77	42.64
15.0	1.75	30.24	40.98	71.22	43.90	25.76	40.80
16.0	1.86	36.29	40.10	76.39	49.66	27.88	41.03
17.0	1.98	42.34	41.45	83.79	56.16	30.75	42.35
18.0	2.09	48.39	41.90	90.29	62.35	33.32	43.10
19.0	2.21	54.44	41.90	96.33	68.40	35.74	43.57
20.0	2.33	67.24	41.90	109.13	81.20	40.86	46.89
21.0	2.44	74.25	41.90	116.14	88.21	43.66	47.53
22.0	2.56	81.50	41.90	123.40	95.47	46.57	48.20
23.0	2.68	89.00	41.90	130.90	102.97	49.57	48.91
24.0	2.79	96.73	44.61	141.34	111.60	53.56	50.61
25.0	2.91	104.68	47.86	152.54	120.63	57.82	52.43
26.0	3.03	112.84	49.49	162.33	129.34	61.63	53.65
27.0	3.14	121.21	49.49	170.69	137.70	64.98	54.33
28.0	3.26	129.77	49.49	179.25	146.26	68.40	55.01
29.0	3.37	138.52	49.49	188.00	155.01	71.90	55.71
30.0	3.49	144.57	49.49	194.05	161.06	74.32	55.58
31.0	3.61	150.62	49.49	200.10	167.11	76.74	55.47
32.0	3.72	156.66	49.49	206.15	173.16	79.16	55.36
33.0	3.84	162.71	49.49	212.20	179.21	81.58	55.26
34.0	3.96	168.76	49.49	218.25	185.26	84.00	55.16
35.0	4.07	174.81	49.49	224.29	191.30	86.42	55.07
36.0	4.19	180.86	49.49	230.34	197.35	88.84	54.98
37.0	4.31	186.91	49.49	236.39	203.40	91.26	54.90
38.0	4.42	192.95	49.49	242.44	209.45	93.68	54.82
39.0	4.54	199.00	44.44	243.44	213.81	94.41	53.64
40.0	4.65	205.05	38.38	243.43	217.84	94.81	52.30

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.5882E+00	0.2723E-03	0.1263E-01	0.1000E-03
0.5882E+01	0.2723E-02	0.1263E+00	0.1000E-02
0.1481E+02	0.6818E-02	0.3158E+00	0.2500E-02
0.2987E+02	0.1370E-01	0.6316E+00	0.5000E-02
0.4490E+02	0.2058E-01	0.9474E+00	0.7500E-02

A Street - Abut 1.sfo

0.5987E+02	0.2746E-01	0.1263E+01	0.1000E-01
0.1228E+03	0.6361E-01	0.3158E+01	0.2500E-01
0.1740E+03	0.1066E+00	0.6316E+01	0.5000E-01
0.1977E+03	0.1418E+00	0.9474E+01	0.7500E-01
0.2085E+03	0.1711E+00	0.1263E+02	0.1000E+00
0.2264E+03	0.3300E+00	0.2194E+02	0.2500E+00
0.2210E+03	0.5804E+00	0.3056E+02	0.5000E+00
0.2251E+03	0.8329E+00	0.3478E+02	0.7500E+00
0.2268E+03	0.1084E+01	0.3659E+02	0.1000E+01
0.2278E+03	0.2485E+01	0.3803E+02	0.2400E+01

El. 62.0 (approx.)

depth= 0 - 22; Clay

8.0

(Bottom of Footing @ El. 54.0)

$\gamma = 125$ pcf

$S_u = 2.5$ ksf

depth= 22 - 42; Clay

$\gamma = 125$ pcf

$S_u = 4.0$ ksf

depth= 42 - 59; Clay

$\gamma = 125$ pcf

$S_u = 2.5$ ksf

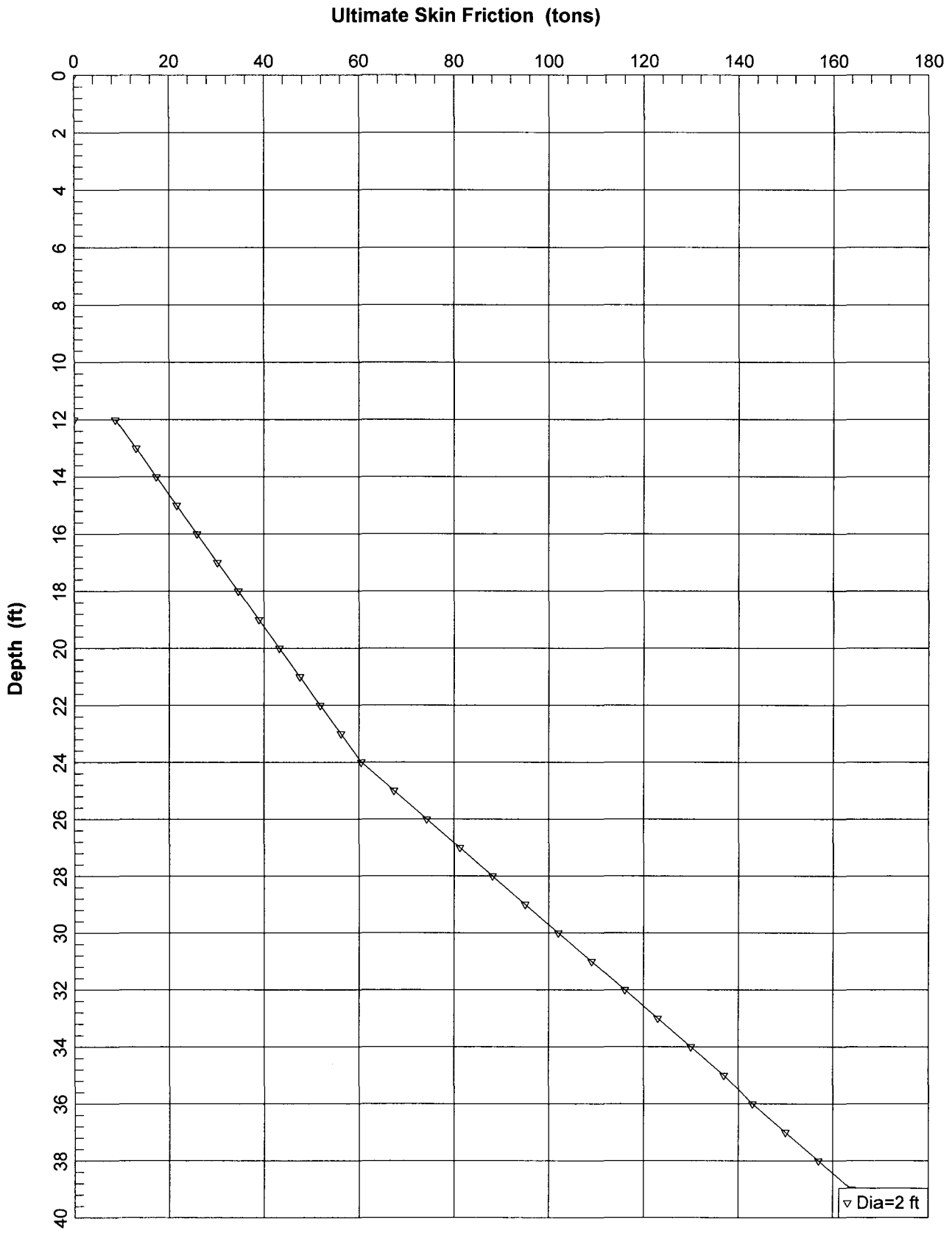
(Water Table @ 57' depth)

depth= 59 - 80; Sand

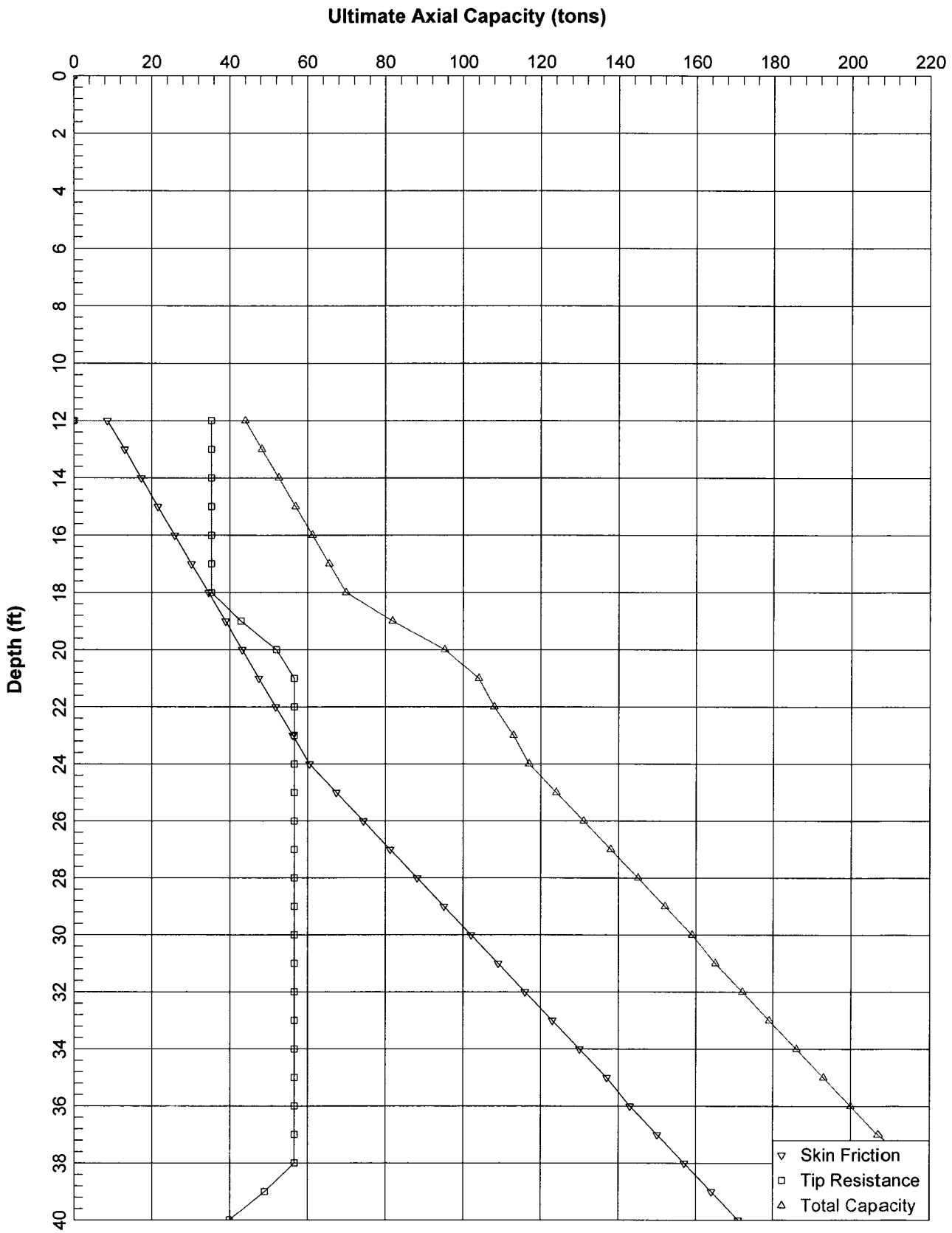
$\gamma = 130$ pcf

$\phi' = 40°$

Abutment 3



eBART A Street Underpass - Abutment 3 - 24-in CIDH Pile



eBART A Street Underpass - Abutment 3 - 24-in CIDH Pile

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 5.0 (C) COPYRIGHT ENSOFT,INC. 1989,1995,1998,2001,2003

eBART A Street Underpass SR4 - Abutment 3

PROPOSED DEPTH = 40.0 FT

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 57.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 2.50

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 3.00

SOIL INFORMATION

LAYER NO 1----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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.000E+00

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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.220E+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	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00

BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.220E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.420E+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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.420E+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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
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.	= 0.400E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.400E+04
DEPTH, FT	= 0.590E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.293E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.400E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00

SOIL UNIT WEIGHT, LB/CU FT = 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.400E+04
DEPTH, FT = 0.800E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM = 2.000 FT.
DIAMETER OF BASE = 2.000 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 8.000 FT.
IGNORED BOTTOM PORTION = 2.000 FT.
AREA OF ONE PERCENT STEEL = 4.524 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.

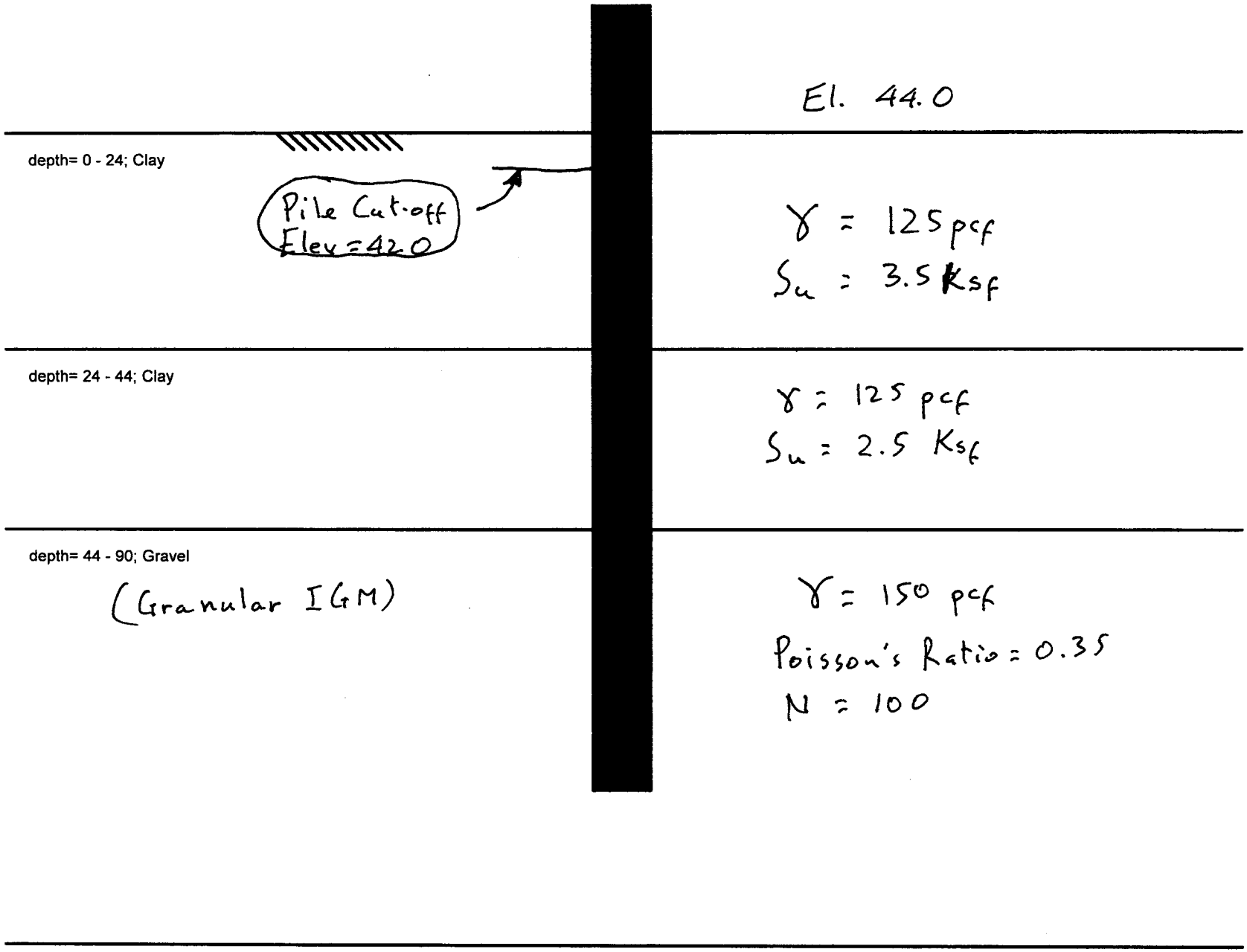
LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
11.0	1.28	4.32	35.35	39.67	16.10	13.51	30.99
12.0	1.40	8.64	35.35	43.99	20.42	15.24	31.50
13.0	1.51	12.96	35.35	48.31	24.74	16.97	31.93
14.0	1.63	17.28	35.35	52.63	29.06	18.69	32.30
15.0	1.75	21.60	35.35	56.95	33.38	20.42	32.63
16.0	1.86	25.92	35.35	61.27	37.70	22.15	32.91
17.0	1.98	30.24	35.35	65.59	42.02	23.88	33.15
18.0	2.09	34.56	35.35	69.91	46.34	25.61	33.38
19.0	2.21	38.88	42.92	81.80	53.19	29.86	37.00
20.0	2.33	43.20	52.01	95.21	60.54	34.62	40.91
21.0	2.44	47.52	56.56	104.08	66.37	37.86	42.59
22.0	2.56	51.84	56.56	108.40	70.70	39.59	42.34
23.0	2.68	56.16	56.56	112.72	75.02	41.32	42.11
24.0	2.79	60.48	56.56	117.04	79.34	43.05	41.91
25.0	2.91	67.40	56.56	123.95	86.25	45.81	42.61
26.0	3.03	74.31	56.56	130.86	93.16	48.58	43.25
27.0	3.14	81.22	56.56	137.78	100.07	51.34	43.85
28.0	3.26	88.13	56.56	144.69	106.99	54.11	44.41
29.0	3.37	95.05	56.56	151.60	113.90	56.87	44.92
30.0	3.49	101.96	56.56	158.51	120.81	59.64	45.41
31.0	3.61	108.87	56.56	165.43	127.72	62.40	45.86
32.0	3.72	115.78	56.56	172.34	134.63	65.17	46.28
33.0	3.84	122.70	56.56	179.25	141.55	67.93	46.68
34.0	3.96	129.61	56.56	186.16	148.46	70.70	47.05
35.0	4.07	136.52	56.56	193.08	155.37	73.46	47.40

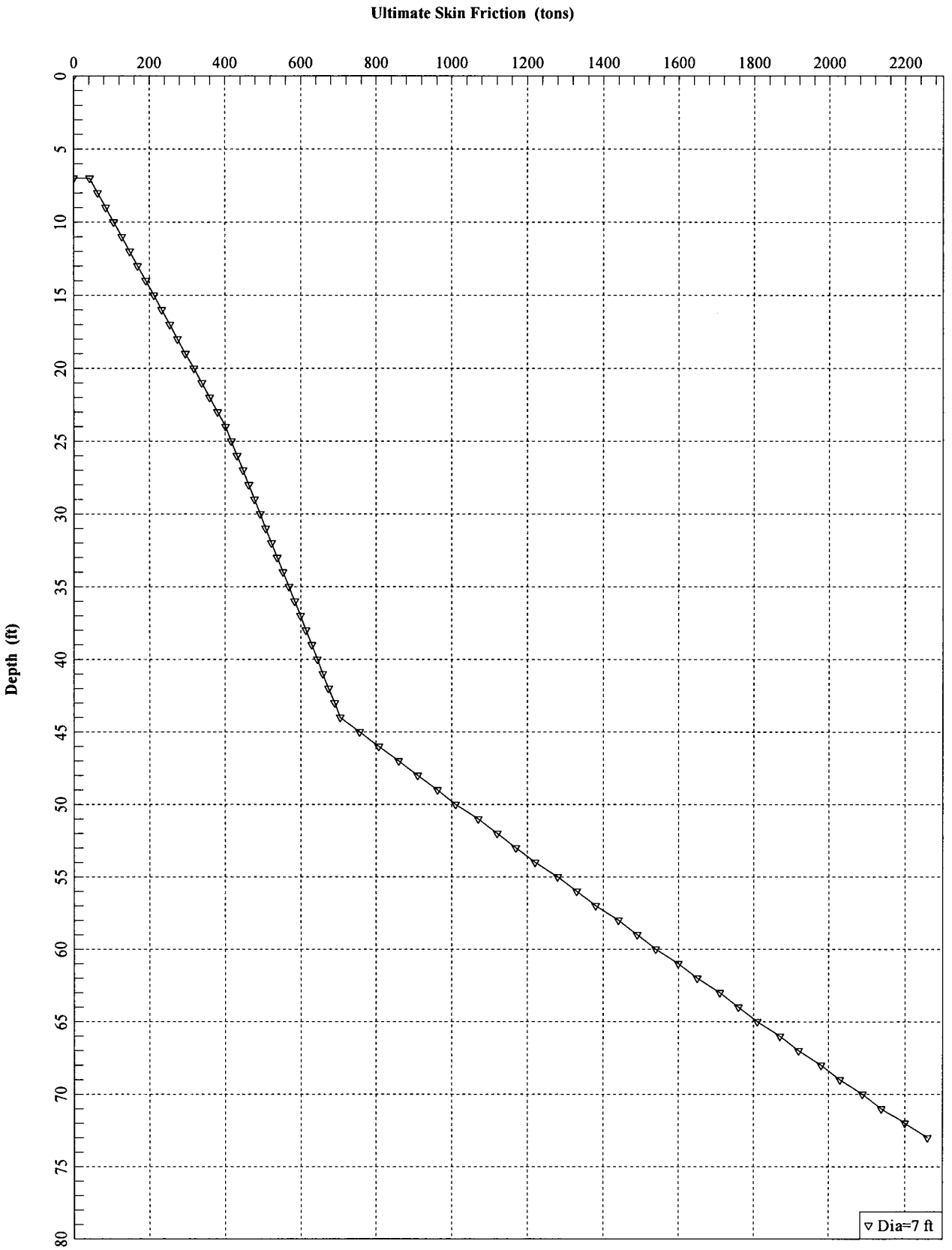
36.0	4.19	143.43	56.56	199.99	162.28	76.22	47.74
37.0	4.31	150.34	56.56	206.90	169.20	78.99	48.05
38.0	4.42	157.26	56.56	213.81	176.11	81.75	48.35
39.0	4.54	164.17	48.98	213.15	180.50	81.99	46.97
40.0	4.65	171.08	39.89	210.97	184.38	81.73	45.32

RESULT FROM TREND (AVERAGED) LINE

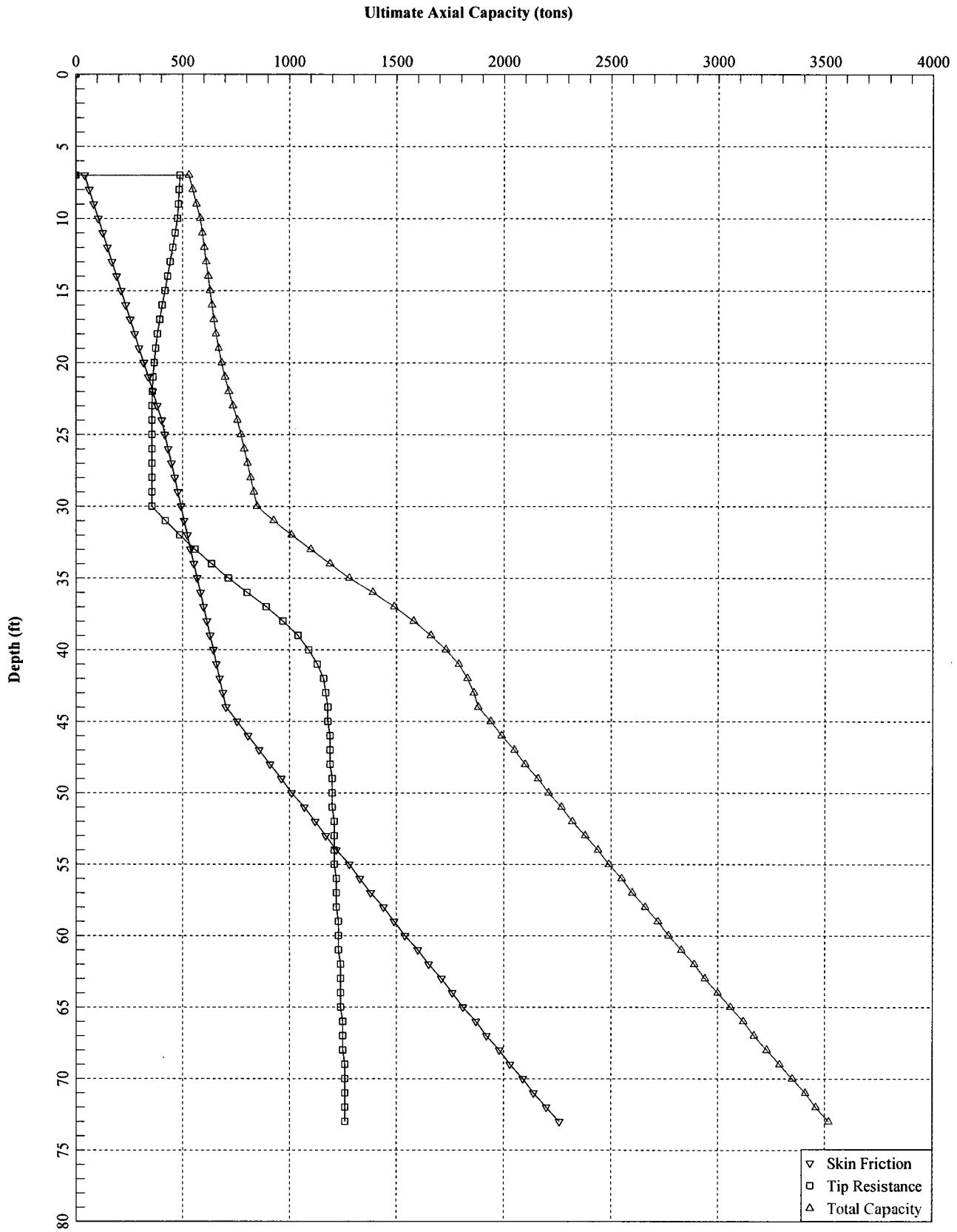
TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.5114E+00	0.2626E-03	0.5818E-02	0.1000E-03
0.5114E+01	0.2626E-02	0.5818E-01	0.1000E-02
0.1284E+02	0.6570E-02	0.1454E+00	0.2500E-02
0.2590E+02	0.1319E-01	0.2909E+00	0.5000E-02
0.3895E+02	0.1983E-01	0.4363E+00	0.7500E-02
0.5198E+02	0.2646E-01	0.5818E+00	0.1000E-01
0.1068E+03	0.6113E-01	0.1454E+01	0.2500E-01
0.1472E+03	0.1009E+00	0.2909E+01	0.5000E-01
0.1664E+03	0.1345E+00	0.4363E+01	0.7500E-01
0.1704E+03	0.1612E+00	0.5818E+01	0.1000E+00
0.1803E+03	0.3170E+00	0.1423E+02	0.2500E+00
0.1718E+03	0.5660E+00	0.2295E+02	0.5000E+00
0.1787E+03	0.8201E+00	0.2987E+02	0.7500E+00
0.1848E+03	0.1074E+01	0.3600E+02	0.1000E+01
0.2071E+03	0.2487E+01	0.5824E+02	0.2400E+01

Bent 2
Granular IGM Bottom





A Street Underpass - Bent 2 - 84-in. CIDH PIle - Granular IGM Bottom



A Street Underpass - Bent 2 - 84-in. CIDH PIle - Granular IGM Bottom

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VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 5.0 (C) COPYRIGHT ENSOFT,INC. 1989,1995,1998,2001,2003

eBART A Street Underpass - SR4 - Bent 2 - Granular Rock Bottom -7FT cidh

PROPOSED DEPTH =      73.0 FT
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NUMBER OF LAYERS =    3
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WATER TABLE DEPTH =      38.0 FT.
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FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 2.50
--------------------------------------------------------
FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 3.00
--------------------------------------------------------

SOIL INFORMATION
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LAYER NO 1----CLAY

  AT THE TOP

  STRENGTH REDUCTION FACTOR-ALPHA                  = 0.550E+00
  END BEARING COEFFICIENT-Nc                       = 0.900E+01
  UNDRAINED SHEAR STRENGTH, LB/SQ FT               = 0.350E+04
  INTERNAL FRICTION ANGLE, DEG.                    = 0.000E+00
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST    = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                       = 0.125E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT         = 0.640E+04
  DEPTH, FT                                        = 0.000E+00

  AT THE BOTTOM

  STRENGTH REDUCTION FACTOR-ALPHA                  = 0.550E+00
  END BEARING COEFFICIENT-Nc                       = 0.900E+01
  UNDRAINED SHEAR STRENGTH, LB/SQ FT               = 0.350E+04
  INTERNAL FRICTION ANGLE, DEG.                    = 0.000E+00
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST    = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                       = 0.125E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT         = 0.640E+04
  DEPTH, FT                                        = 0.240E+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               = 0.250E+04
  INTERNAL FRICTION ANGLE, DEG.                    = 0.000E+00
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST    = 0.000E+00
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A Street Underpass - Bent 2 Granular Rock Bottom - 7FT cidh.sfo

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  SOIL UNIT WEIGHT, LB/CU FT                       = 0.125E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT         = 0.640E+04
  DEPTH, FT                                        = 0.240E+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                       = 0.125E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT         = 0.640E+04
  DEPTH, FT                                        = 0.440E+02

LAYER NO  3----GRAVEL

  AT THE TOP

  ELASTIC MODULUS OF GRAVEL, LB/SQ IN              = 0.000E+00
  POISSION RATIO OF GRAVEL                         = 0.350E+00
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST    = 0.100E+03
  SOIL UNIT WEIGHT, LB/CU FT                       = 0.150E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT         = 0.100E+11
  DEPTH, FT                                        = 0.440E+02

  AT THE BOTTOM

  ELASTIC MODULUS OF GRAVEL, LB/SQ IN              = 0.000E+00
  POISSION RATIO OF GRAVEL                         = 0.350E+00
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST    = 0.100E+03
  SOIL UNIT WEIGHT, LB/CU FT                       = 0.150E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT         = 0.100E+11
  DEPTH, FT                                        = 0.900E+02

DRILLED SHAFT INFORMATION
-------------------------

 DIAMETER OF STEM          =    7.000  FT.
 DIAMETER OF BASE          =    7.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    5.000  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   55.425  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;
```

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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)
6.0	8.55	21.17	492.68	513.85	185.40	172.69	60.08
7.0	9.98	42.34	488.67	531.01	205.23	179.83	53.21
8.0	11.40	63.51	484.73	548.24	225.09	186.98	48.07
9.0	12.83	84.68	480.85	565.53	244.96	194.16	44.08
10.0	14.26	105.85	477.04	582.88	264.86	201.35	40.89
11.0	15.68	127.02	465.76	592.78	282.27	206.06	37.80
12.0	17.11	148.18	454.08	602.26	299.54	210.63	35.21
13.0	18.53	169.35	442.14	611.49	316.73	215.12	33.00
14.0	19.96	190.52	430.03	620.56	333.87	219.55	31.09
15.0	21.38	211.69	417.77	629.46	350.95	223.93	29.44
16.0	22.81	232.86	405.37	638.23	367.98	228.27	27.98
17.0	24.23	254.03	392.83	646.86	384.98	232.56	26.69
18.0	25.66	275.20	382.19	657.39	402.60	237.48	25.62
19.0	27.09	296.37	373.43	669.80	420.85	243.02	24.73
20.0	28.51	317.54	366.52	684.06	439.71	249.19	23.99
21.0	29.94	338.71	361.41	700.12	459.18	255.95	23.39
22.0	31.36	359.88	358.03	717.91	479.22	263.29	22.89
23.0	32.79	381.05	356.33	737.37	499.82	271.19	22.49
24.0	34.21	402.22	356.25	758.46	520.97	279.64	22.17
25.0	35.64	417.34	356.23	773.57	536.08	285.68	21.71
26.0	37.06	432.46	356.23	788.69	551.20	291.73	21.28
27.0	38.49	447.58	356.23	803.81	566.32	297.78	20.88
28.0	39.92	462.70	356.23	818.93	581.44	303.82	20.52
29.0	41.34	477.82	356.23	834.05	596.56	309.87	20.18
30.0	42.77	492.94	356.23	849.17	611.69	315.92	19.86
31.0	44.19	508.06	419.18	927.25	647.79	342.95	20.98
32.0	45.62	523.18	486.64	1009.82	685.39	371.48	22.14
33.0	47.04	538.30	558.61	1096.91	724.50	401.52	23.32
34.0	48.47	553.42	635.11	1188.53	765.13	433.07	24.52
35.0	49.89	568.54	716.16	1284.71	807.27	466.14	25.75
36.0	51.32	583.67	801.78	1385.44	850.93	500.73	27.00
37.0	52.74	598.79	891.98	1490.76	896.11	536.84	28.26
38.0	54.17	613.91	969.99	1583.89	937.24	568.89	29.24
39.0	55.60	629.03	1035.74	1664.77	974.28	596.86	29.94
40.0	57.02	644.15	1089.17	1733.32	1007.21	620.72	30.40
41.0	58.45	659.27	1130.22	1789.49	1036.01	640.45	30.62
42.0	59.87	674.39	1158.82	1833.21	1060.67	656.03	30.62
43.0	61.30	689.51	1174.92	1864.43	1081.15	667.44	30.42
44.0	62.72	704.63	1178.44	1883.07	1097.44	674.66	30.02
45.0	64.15	755.75	1181.91	1937.67	1149.72	696.27	30.21
46.0	65.57	807.05	1185.35	1992.41	1202.17	717.94	30.38
47.0	67.00	858.54	1188.75	2047.29	1254.79	739.66	30.56
48.0	68.43	910.19	1192.11	2102.30	1307.56	761.45	30.72
49.0	69.85	962.03	1195.43	2157.46	1360.51	783.29	30.89
50.0	71.28	1014.04	1198.72	2212.76	1413.61	805.19	31.04
51.0	72.70	1066.23	1201.97	2268.19	1466.88	827.15	31.20
52.0	74.13	1118.58	1205.18	2323.77	1520.31	849.16	31.35
53.0	75.55	1171.11	1208.37	2379.47	1573.90	871.23	31.49
54.0	76.98	1223.81	1211.51	2435.32	1627.64	893.36	31.64
55.0	78.40	1276.67	1214.63	2491.30	1681.55	915.54	31.77
56.0	79.83	1329.70	1217.71	2547.42	1735.61	937.79	31.91
57.0	81.26	1382.90	1220.77	2603.67	1789.82	960.08	32.04
58.0	82.68	1436.27	1223.79	2660.05	1844.20	982.44	32.17
59.0	84.11	1489.79	1226.78	2716.57	1898.72	1004.84	32.30
60.0	85.53	1543.48	1229.75	2773.23	1953.40	1027.31	32.42
61.0	86.96	1597.33	1232.68	2830.01	2008.23	1049.83	32.54

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62.0	88.38	1651.34	1235.59	2886.93	2063.21	1072.40	32.66
63.0	89.81	1705.51	1238.47	2943.98	2118.34	1095.03	32.78
64.0	91.23	1759.84	1241.32	3001.17	2173.62	1117.71	32.90
65.0	92.66	1814.33	1244.15	3058.48	2229.04	1140.45	33.01
66.0	94.09	1868.97	1246.96	3115.92	2284.62	1163.24	33.12
67.0	95.51	1923.77	1249.73	3173.50	2340.35	1186.08	33.23
68.0	96.94	1978.72	1252.49	3231.21	2396.22	1208.98	33.33
69.0	98.36	2033.83	1255.22	3289.04	2452.23	1231.94	33.44
70.0	99.79	2089.08	1257.92	3347.01	2508.39	1254.94	33.54
71.0	101.21	2144.50	1260.60	3405.10	2564.70	1278.00	33.64
72.0	102.64	2200.06	1263.26	3463.32	2621.15	1301.11	33.74
73.0	104.06	2255.77	1261.54	3517.31	2676.28	1322.82	33.80

LOAD SETTLEMENT RELATIONSHIP

LOAD (TON)	SETTLEMENT (IN.)
0.238E+03	0.473E-01
0.476E+03	0.945E-01
0.714E+03	0.142E+00
0.952E+03	0.189E+00
0.119E+04	0.236E+00
0.143E+04	0.284E+00
0.167E+04	0.331E+00
0.190E+04	0.378E+00
0.214E+04	0.425E+00
0.238E+04	0.473E+00
0.265E+04	0.145E+01
0.293E+04	0.242E+01
0.320E+04	0.340E+01
0.348E+04	0.437E+01
0.348E+04	0.525E+01

PILE LATERAL LOAD BEHAVIOR

(LPILE Analysis)

Abutment 1

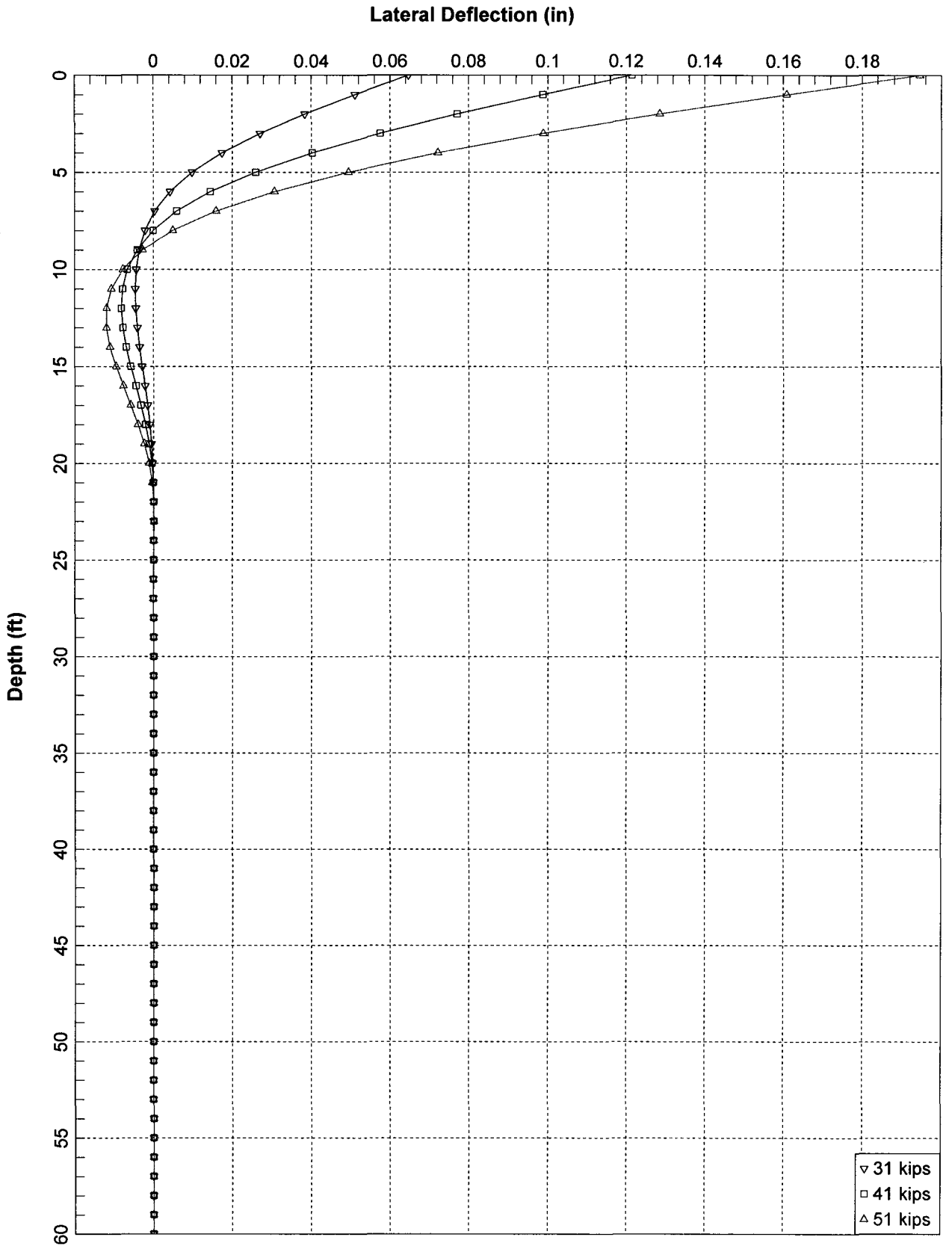
Profile based on boring AST-154

24-in. Diameter CIDH Pile

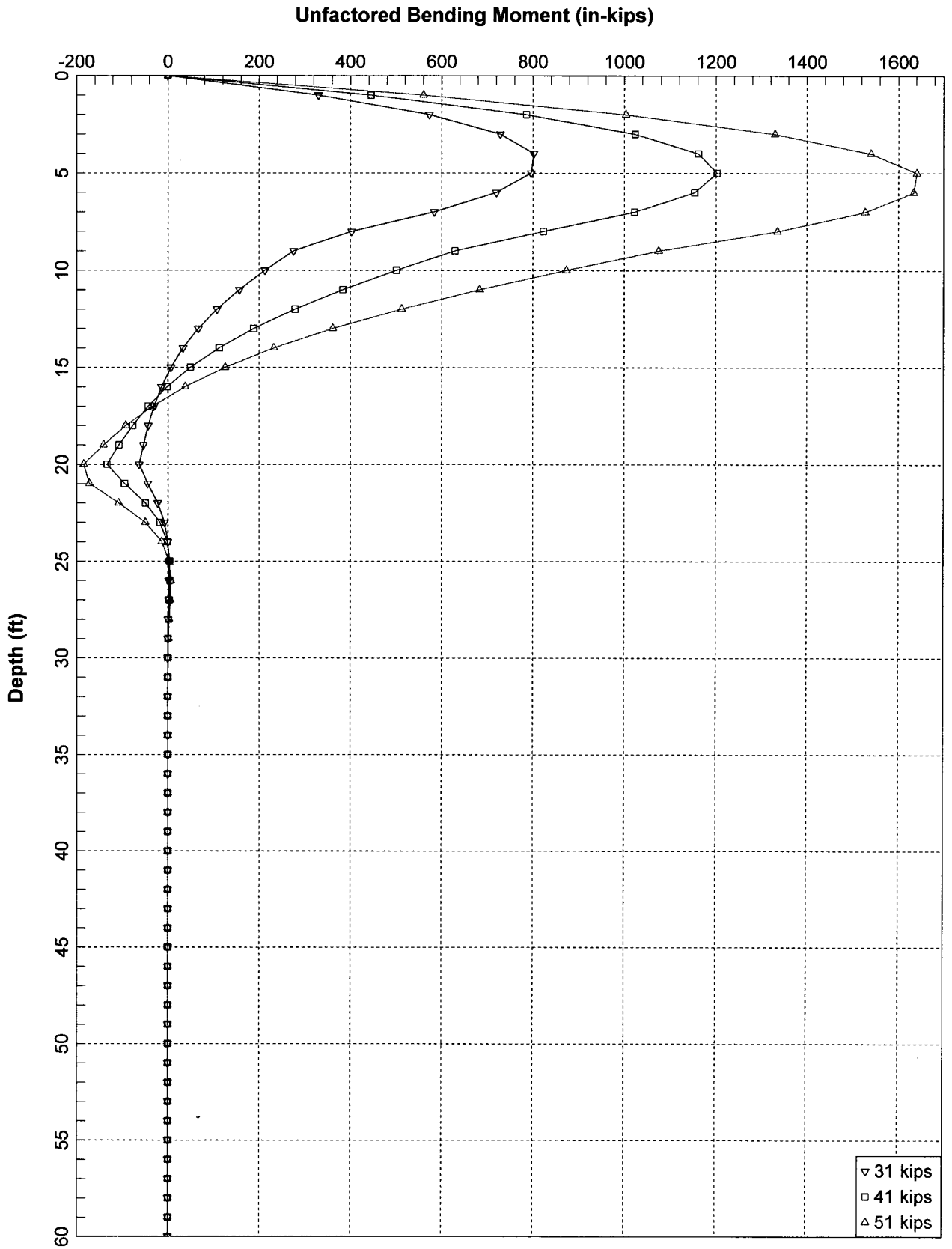
Area = 452.4 in^2 ; I = 16286 in^4

El. - 62.0

Depths -90 - 114 = Stiff Clay w/o free water	S_u = 3.5 Ksf γ' = 125 pcf ϵ_{50} = 0.005
Depths 114 - 234 = API RP-2A Sand	ϕ' = 35° γ' = 130 pcf K = 90 lb/in.^{3}
Depths 234 - 414 = Stiff Clay w/o free water	S_u = 3.5 ksf γ' = 125 pcf ϵ_{50} = 0.005
Depths 414 - 594 = Stiff Clay w/o free water	S_u = 2.5 Ksf γ' = 125 pcf ϵ_{50} = 0.005
Depths 594 - 654 = API RP-2A Sand	ϕ' = 25° γ' = 65 pcf K = 125 lb/in^3
Depths 654 - 990 = Stiff Clay w/o free water	S_u = 4.0 Ksf γ' = 65 pcf ϵ_{50} = 0.004



eBART A Street Underpass - Abutment 1 - 24-in. CIDH PIle



eBART A Street Underpass - Abutment 1 - 24-in. CIDH PIle

LPILE Plus for Windows, Version 5.0 (5.0.21)

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:

Gary Parikh
Parikh Consultants

Path to file locations: S:\Ongoing Projects\2006\206117 TYLIn Rte 4 Project\EBART PROJECT\A Street Underpass\LPILE\
Name of input data file: A Street - Abutment 1.lpd
Name of output file: A Street - Abutment 1.lpo
Name of plot output file: A Street - Abutment 1.lpp
Name of runtime file: A Street - Abutment 1.lpr

Time and Date of Analysis

Date: August 19, 2009 Time: 20: 4:48

Problem Title

SR4 - A Street - Abutment 1 - 24-in CIDH Pile

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant 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 pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 60
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 720.00 in
Depth of ground surface below top of pile = -90.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	24.00000000	16286.0000	452.4000	3600000.
2	720.0000	24.00000000	16286.0000	452.4000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 6 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -90.000 in
Distance from top of pile to bottom of layer = 114.000 in

Layer 2 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 114.000 in
Distance from top of pile to bottom of layer = 234.000 in
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 3 is stiff clay without free water
Distance from top of pile to top of layer = 234.000 in
Distance from top of pile to bottom of layer = 414.000 in

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 414.000 in
Distance from top of pile to bottom of layer = 594.000 in

Layer 5 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 594.000 in
Distance from top of pile to bottom of layer = 654.000 in
p-y subgrade modulus k for top of soil layer = 125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 125.000 lbs/in**3

Layer 6 is stiff clay without free water
Distance from top of pile to top of layer = 654.000 in
Distance from top of pile to bottom of layer = 990.000 in

(Depth of lowest layer extends 270.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth is defined using 12 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-90.00	.07230
2	114.00	.07230
3	114.00	.07520
4	234.00	.07520
5	234.00	.07230
6	414.00	.07230
7	414.00	.07230
8	594.00	.07230
9	594.00	.03760
10	654.00	.03760
11	654.00	.03760
12	990.00	.03760

Shear Strength of Soils

Distribution of shear strength parameters with depth defined using 12 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-90.000	24.30000	.00	.00500	.0
2	114.000	24.30000	.00	.00500	.0
3	114.000	.00000	35.00	------	------
4	234.000	.00000	35.00	------	------
5	234.000	24.31000	.00	.00500	.0
6	414.000	24.31000	.00	.00500	.0
7	414.000	17.36000	.00	.00500	.0
8	594.000	17.36000	.00	.00500	.0
9	594.000	.00000	25.00	------	------
10	654.000	.00000	25.00	------	------
11	654.000	27.78000	.00	.00400	.0
12	990.000	27.78000	.00	.00400	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.6000	1.0000
2	720.000	.6000	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 3

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 31000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 41000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 51000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 31000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 200000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.064765	-2.8252E-08	31000.0000	-.0011318	442.0866	-613.3672
12.000	.051183	330554.	23657.0983	-.0010980	685.6484	-610.4498
24.000	.038413	573041.	16405.8546	-.0010055	864.3197	-598.0909
36.000	.027050	729121.	9365.5887	-.0008723	979.3242	-575.2868
48.000	.017479	802002.	2671.7544	-.0007156	1033.0249	-540.3523
60.000	.009877	796678.	-3509.1457	-.0005520	1029.1020	-489.7978
72.000	.004232	720432.	-8929.0045	-.0003967	972.9216	-413.5120
84.000	.000356	584286.	-13264.6292	-.0002632	872.6054	-309.0921
96.000	-.002084	403344.	-12867.5800	-.0001621	739.2820	375.2670
108.000	-.003534	276242.	-7947.7370	-9.2561E-05	645.6298	444.7069
120.000	-.004306	213042.	-4992.3714	-4.2489E-05	599.0624	47.8540
132.000	-.004554	156629.	-4383.8642	-4.6574E-06	557.4954	53.5638
144.000	-.004418	107852.	-3733.5513	2.2409E-05	521.5551	54.8217
156.000	-.004016	66916.1790	-3089.9585	4.0294E-05	491.3924	52.4438
168.000	-.003451	33499.4902	-2491.5363	5.0571E-05	466.7701	47.2932
180.000	-.002803	6876.5704	-1966.4065	5.4702E-05	447.1535	40.2284
192.000	-.002138	-13956.8377	-1532.6142	5.3978E-05	452.3705	32.0703
204.000	-.001507	-30165.2648	-1198.6707	4.9463E-05	464.3133	23.5869
216.000	-.000951	-42962.3544	-964.1865	4.1979E-05	473.7426	15.4938
228.000	-.000500	-53507.2385	-820.4192	3.2106E-05	481.5123	8.4674
240.000	-.000180	-62806.5260	412.5697	2.0203E-05	488.3643	197.0307
252.000	-1.48E-05	-43702.5409	1691.9013	9.3033E-06	474.2880	16.1912
264.000	4.32E-05	-22245.5513	1505.6916	2.5544E-06	458.4778	-47.2262
276.000	4.65E-05	-7578.2034	917.0955	-4.9772E-07	447.6705	-50.8732
288.000	3.12E-05	-232.8696	406.9043	-1.2971E-06	442.2582	-34.1587
300.000	1.54E-05	2193.7269	101.0410	-1.0964E-06	443.7031	-16.8185
312.000	4.91E-06	2197.3780	-32.1056	-6.4704E-07	443.7057	-5.3726
324.000	-1.55E-07	1426.2993	-63.3248	-2.7620E-07	443.1376	.1693636
336.000	-1.72E-06	678.9084	-51.0343	-6.0760E-08	442.5869	1.8790
348.000	-1.61E-06	201.7672	-29.1723	2.9366E-08	442.2353	1.7646
360.000	-1.01E-06	-21.3689	-11.9363	4.7827E-08	442.1074	1.1081
372.000	-4.65E-07	-84.9342	-2.2345	3.6948E-08	442.1492	.5089183
384.000	-1.26E-07	-75.1735	1.6469	2.0563E-08	442.1420	.1379837
396.000	2.83E-08	-45.5062	2.2890	8.2134E-09	442.1202	-.0309711
408.000	7.10E-08	-20.2764	1.6372	1.4814E-09	442.1016	-.0776577
420.000	6.39E-08	-6.2194	.8719556	-1.2301E-09	442.0912	-.0498909
432.000	4.15E-08	.6564073	.3782540	-1.7994E-09	442.0871	-.0323926
444.000	2.07E-08	2.8673	.0869754	-1.4388E-09	442.0888	-.0161538
456.000	6.93E-09	2.7507	-.0424464	-8.6388E-10	442.0887	-.0054165
468.000	-5.50E-11	1.8528	-.0746879	-3.9277E-10	442.0880	4.2932E-05
480.000	-2.49E-09	.9600987	-.0627456	-1.0491E-10	442.0874	.0019475
492.000	-2.57E-09	.3473843	-.0390019	2.8896E-11	442.0869	.0020098
504.000	-1.80E-09	.0239156	-.0185087	6.6894E-11	442.0867	.0014057
516.000	-9.67E-10	-.0971458	-.0055407	5.9400E-11	442.0867	.0007557
528.000	-3.74E-10	-.1093452	.0007454	3.8268E-11	442.0867	.0002920
540.000	-4.89E-11	-.0794410	.0027265	1.8948E-11	442.0867	3.8174E-05
552.000	8.10E-11	-.0440007	.0025761	6.3155E-12	442.0867	-6.3242E-05
564.000	1.03E-10	-.0176457	.0017152	6.7329E-15	442.0867	-8.0233E-05
576.000	8.11E-11	-.0028356	.0008536	-2.0893E-12	442.0867	-6.3368E-05
588.000	5.26E-11	.0028509	.0002270	-2.0877E-12	442.0867	-4.1062E-05
600.000	3.10E-11	.0026231	-2.5784E-05	-1.5275E-12	442.0867	-1.0725E-06
612.000	1.59E-11	.0022394	-3.5606E-05	-1.0299E-12	442.0867	-5.6432E-07
624.000	6.29E-12	.0017735	-4.0366E-05	-6.1921E-13	442.0867	-2.2903E-07
636.000	1.04E-12	.0012736	-4.1973E-05	-3.0738E-13	442.0866	-3.8857E-08
648.000	-1.08E-12	.0007676	-4.1958E-05	-9.8486E-14	442.0866	4.1326E-08
660.000	-1.32E-12	.0002671	-3.1230E-05	7.4026E-15	442.0866	1.7468E-06
672.000	-9.05E-13	1.8039E-05	-1.3575E-05	3.6584E-14	442.0866	1.1957E-06
684.000	-4.43E-13	-5.8855E-05	-2.8831E-06	3.2407E-14	442.0866	5.8618E-07
696.000	-1.27E-13	-5.1310E-05	1.6401E-06	2.1133E-14	442.0866	1.6768E-07
708.000	6.37E-14	-1.9595E-05	2.1407E-06	1.3877E-14	442.0866	-8.4240E-08

720.000	2.06E-13	0.0000	0.0000	1.1872E-14	442.0866	-2.7254E-07

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection              =      .06476452 in
Computed slope at pile head       =     -.00113181
Maximum bending moment            =   802001.62946 lbs-in
Maximum shear force               =    31000.00000 lbs
Depth of maximum bending moment   =    48.00000000 in
Depth of maximum shear force      =       0.00000 in
Number of iterations              =            18
Number of zero deflection points  =             8
```

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 41000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 200000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.121541	-3.3902E-08	41000.0000	-.0018942	442.0866	-717.8958
12.000	.098811	444857.	32375.2925	-.0018486	769.8706	-719.5554
24.000	.077174	785880.	23785.6821	-.0017227	1021.1463	-712.0463
36.000	.057467	1023983.	15346.2694	-.0015375	1196.5870	-694.5225
48.000	.040275	1161571.	7184.7711	-.0013138	1297.9659	-665.7272
60.000	.025935	1202724.	-550.4584	-.0010718	1328.2884	-623.4777
72.000	.014550	1153505.	-7669.6799	-.0008307	1292.0225	-563.0593
84.000	.005998	1022639.	-13867.9279	-.0006080	1195.5967	-469.9821
96.000	-4.23E-05	823593.	-16458.8316	-.0004191	1048.9339	38.1648
108.000	-.004060	629638.	-13467.7142	-.0002704	906.0225	460.3548
120.000	-.006531	501665.	-10270.1073	-.0001546	811.7284	72.5797
132.000	-.007770	383898.	-9286.3386	-6.3960E-05	724.9537	91.3817
144.000	-.008066	279100.	-8137.5062	3.8900E-06	647.7359	100.0903
156.000	-.007677	188579.	-6935.5649	5.1751E-05	581.0371	100.2332
168.000	-.006824	112398.	-5773.0220	8.2552E-05	524.9051	93.5239
180.000	-.005695	49630.1266	-4721.3963	9.9134E-05	478.6556	81.7470
192.000	-.004445	-1390.9565	-3830.8458	.0001041	443.1115	66.6781
204.000	-.003198	-42809.7104	-3130.5288	9.9547E-05	473.6301	50.0414
216.000	-.002056	-77001.4739	-2629.2704	8.7286E-05	498.8236	33.5017
228.000	-.001103	-106331.	-2316.1409	6.8524E-05	520.4346	18.6866
240.000	-.000411	-132918.	493.7494	4.4040E-05	540.0243	449.6285
252.000	-4.58E-05	-94692.5794	3491.8893	2.0747E-05	511.8589	50.0615
264.000	8.69E-05	-49212.0125	3221.7733	6.0202E-06	478.3475	-95.0809
276.000	9.87E-05	-17398.9173	2003.2995	-7.9657E-07	454.9067	-107.9981
288.000	6.78E-05	-1129.0011	910.3084	-2.6927E-06	442.9185	-74.1671
300.000	3.41E-05	4461.4100	241.4903	-2.3516E-06	445.3739	-37.3026
312.000	1.14E-05	4678.0533	-56.8770	-1.4163E-06	445.5336	-12.4253

324.000	1.07E-07	3103.1594	-132.1316	-6.2002E-07	444.3731	-.1171488
336.000	-3.52E-06	1509.8717	-109.7149	-1.4794E-07	443.1992	3.8533
348.000	-3.44E-06	470.7117	-63.9941	5.4752E-08	442.4335	3.7669
360.000	-2.21E-06	-26.2502	-26.8984	1.0024E-07	442.1060	2.4158
372.000	-1.04E-06	-175.3308	-5.5929	7.9608E-08	442.2158	1.1352
384.000	-2.98E-07	-160.8617	3.1721	4.5203E-08	442.2052	.3256637
396.000	4.72E-08	-99.4179	4.8163	1.8566E-08	442.1599	-.0516264
408.000	1.48E-07	-45.3595	3.5358	3.7503E-09	442.1201	-.1617957
420.000	1.37E-07	-14.5774	1.9219	-2.3834E-09	442.0974	-.1071814
432.000	9.07E-08	.7777364	.8537002	-3.7957E-09	442.0872	-.0708532
444.000	4.61E-08	5.9296	.2124768	-3.1092E-09	442.0910	-.0360173
456.000	1.61E-08	5.8921	-.0789787	-1.8994E-09	442.0910	-.0125586
468.000	5.19E-10	4.0433	-.1567607	-8.8268E-10	442.0896	-.0004051
480.000	-5.11E-09	2.1341	-.1352473	-2.5051E-10	442.0882	.0039906
492.000	-5.49E-09	.7985217	-.0855532	4.9605E-11	442.0872	.0042917
504.000	-3.92E-09	.0805700	-.0414394	1.3957E-10	442.0867	.0030606
516.000	-2.14E-09	-.1966930	-.0130260	1.2769E-10	442.0868	.0016749
528.000	-8.53E-10	-.2326677	.0010236	8.3746E-11	442.0868	.0006667
540.000	-1.34E-10	-.1725278	.0056525	4.2279E-11	442.0868	.0001048
552.000	1.61E-10	-.0972102	.0055253	1.4675E-11	442.0867	-.0001260
564.000	2.18E-10	-.0399904	.0037473	6.3392E-13	442.0867	-.0001703
576.000	1.77E-10	-.0072769	.0018980	-4.2033E-12	442.0867	-.0001379
588.000	1.17E-10	.0055829	.0005216	-4.3767E-12	442.0867	-9.1512E-05
600.000	7.15E-11	.0052623	-4.2314E-05	-3.2668E-12	442.0867	-2.4721E-06
612.000	3.87E-11	.0045831	-6.5395E-05	-2.2592E-12	442.0867	-1.3747E-06
624.000	1.73E-11	.0037037	-7.7410E-05	-1.4112E-12	442.0867	-6.2792E-07
636.000	4.87E-12	.0027320	-8.2268E-05	-7.5258E-13	442.0867	-1.8165E-07
648.000	-8.04E-13	.0017328	-8.3173E-05	-2.9566E-13	442.0867	3.0699E-08
660.000	-2.22E-12	.0007373	-6.5352E-05	-4.2876E-14	442.0866	2.9396E-06
672.000	-1.83E-12	.0001646	-3.3177E-05	4.9419E-14	442.0866	2.4229E-06
684.000	-1.04E-12	-5.9228E-05	-1.0409E-05	6.0203E-14	442.0866	1.3718E-06
696.000	-3.88E-13	-8.5495E-05	9.0004E-07	4.5393E-14	442.0866	5.1302E-07
708.000	5.16E-14	-3.7845E-05	3.5688E-06	3.2771E-14	442.0866	-6.8218E-08
720.000	3.98E-13	0.0000	0.0000	2.8898E-14	442.0866	-5.2659E-07

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

```
Pile-head deflection              =      .12154111 in
Computed slope at pile head       =     -.00189416
Maximum bending moment            =     1202724. lbs-in
Maximum shear force               =    41000.00000 lbs
Depth of maximum bending moment   =    60.00000000 in
Depth of maximum shear force      =       0.00000 in
Number of iterations              =            20
Number of zero deflection points  =             8
```

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 51000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 200000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.194568	-2.2601E-08	51000.0000	-.0028056	442.0866	-807.4958
12.000	.160901	560594.	41278.1033	-.0027482	855.1484	-812.8204
24.000	.128611	1003866.	31547.1320	-.0025881	1181.7643	-809.0082
36.000	.098787	1330148.	21921.6184	-.0023492	1422.1783	-795.2441
48.000	.072229	1541261.	12527.7938	-.0020554	1577.7328	-770.3934
60.000	.049457	1640681.	3509.4460	-.0017298	1650.9881	-732.6646
72.000	.030715	1633791.	-4958.7962	-.0013947	1645.9113	-678.7091
84.000	.015985	1528364.	-12634.2744	-.0010711	1568.2298	-600.5373
96.000	.005010	1335709.	-19042.2353	-.0007780	1426.2761	-467.4562
108.000	-.002685	1075085.	-19358.1456	-.0005312	1234.2403	414.8045
120.000	-.007740	873664.	-16353.2280	-.0003318	1085.8275	86.0151
132.000	-.010649	684200.	-15085.7349	-.0001724	946.2250	125.2337
144.000	-.011877	512433.	-13450.0975	-4.9923E-05	819.6625	147.3725
156.000	-.011847	361637.	-11637.8097	3.9528E-05	708.5514	154.6755
168.000	-.010929	232936.	-9811.1392	.0001004	613.7209	149.7696
180.000	-.009438	125688.	-8099.7475	.0001371	534.6972	135.4623
192.000	-.007639	37884.3531	-6599.4281	.0001538	470.0009	114.5909
204.000	-.005746	-33436.6994	-5372.3050	.0001543	466.7238	89.9296
216.000	-.003936	-91791.4638	-4447.8108	.0001415	509.7213	64.1528
228.000	-.002352	-140863.	-3823.7976	.0001176	545.8787	39.8494
240.000	-.001113	-184127.	-1252.0693	8.4387E-05	577.7570	388.7720
252.000	-.000326	-171318.	3222.3415	4.8011E-05	568.3186	356.9632
264.000	3.94E-05	-170022.	5105.2419	1.9527E-05	520.9433	-43.1464
276.000	.000142	-48885.7804	3912.1306	3.5715E-06	478.1071	-155.7054
288.000	.000125	-13147.5707	2156.4031	-2.7768E-06	451.7742	-136.9158
300.000	7.57E-05	2881.2218	838.1044	-3.8274E-06	444.2096	-82.8006
312.000	3.33E-05	6985.3065	122.7392	-2.8177E-06	447.2336	-36.4269
324.000	8.06E-06	5840.4886	-148.7516	-1.5052E-06	446.3901	-8.8216
336.000	-2.83E-06	3422.4941	-183.1337	-5.5723E-07	444.6084	3.0912
348.000	-5.31E-06	1447.9541	-129.7366	-5.8798E-08	443.1535	5.8083
360.000	-4.24E-06	309.0979	-67.0771	1.2101E-07	442.3144	4.6349
372.000	-2.41E-06	-162.4775	-23.4808	1.3602E-07	442.2064	2.6311
384.000	-9.72E-07	-255.0950	-1.3114	9.3286E-08	442.2746	1.0638
396.000	-1.66E-07	-194.4001	6.1628	4.7285E-08	442.2299	.1819027
408.000	1.62E-07	-107.4156	6.1882	1.6398E-08	442.1658	-.1776708
420.000	2.27E-07	-45.9631	4.0568	7.0206E-10	442.1205	-.1775525
432.000	1.79E-07	-10.0555	2.1513	-5.0307E-09	442.0941	-.1400391
444.000	1.07E-07	5.6914	.8116360	-5.4773E-09	442.0908	-.0832323
456.000	4.78E-08	9.4501	.0881674	-3.9278E-09	442.0936	-.0373458
468.000	1.23E-08	7.8263	-.1934537	-2.1598E-09	442.0924	-.0095911
480.000	-4.03E-09	4.8176	-.2321172	-8.6582E-10	442.0902	.0031472
492.000	-8.50E-09	2.2597	-.1733825	-1.4155E-10	442.0883	.0066419
504.000	-7.43E-09	.6570781	-.0987244	1.5694E-10	442.0871	.0058011
516.000	-4.74E-09	-.1104747	-.0417210	2.1288E-10	442.0867	.0036995
528.000	-2.32E-09	-.3452474	-.0086649	1.6624E-10	442.0869	.0018099
540.000	-7.46E-10	-.3192312	.0056901	9.8241E-11	442.0869	.0005827
552.000	4.10E-11	-.2091556	.0089939	4.4167E-11	442.0868	-3.2035E-05
564.000	3.14E-10	-.1035905	.0073291	1.2161E-11	442.0867	-.0002454
576.000	3.33E-10	-.0333148	.0042964	-1.8493E-12	442.0867	-.0002600
588.000	2.70E-10	-.0004690	.0014716	-5.3067E-12	442.0866	-.0002107
600.000	2.06E-10	.0020296	.0001645	-5.1470E-12	442.0867	-7.1076E-06
612.000	1.46E-10	.0035037	9.0718E-05	-4.5807E-12	442.0867	-5.1894E-06
624.000	9.56E-11	.0042288	3.8716E-05	-3.7894E-12	442.0867	-3.4776E-06
636.000	5.53E-11	.0044511	5.4798E-06	-2.9011E-12	442.0867	-2.0618E-06
648.000	2.60E-11	.0043743	-1.2837E-05	-1.9980E-12	442.0867	-9.9097E-07
660.000	7.35E-12	.0041526	-7.7063E-05	-1.1253E-12	442.0867	-9.7134E-06
672.000	-1.06E-12	.0025301	-.0001270	-4.4144E-13	442.0867	1.3957E-06
684.000	-3.25E-12	.0011074	-9.2851E-05	-6.9182E-14	442.0866	4.2907E-06

696.000	-2.72E-12	.0003021	-4.5564E-05	7.5062E-14	442.0866	3.5904E-06
708.000	-1.44E-12	1.3549E-05	-1.2564E-05	1.0736E-13	442.0866	1.9095E-06
720.000	-1.40E-13	0.0000	0.0000	1.0875E-13	442.0866	1.8456E-07

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

```
Pile-head deflection              =      .19456832 in
Computed slope at pile head       =     -.00280558
Maximum bending moment            =       1640681. lbs-in
Maximum shear force               =    51000.00000 lbs
Depth of maximum bending moment   =    60.00000000 in
Depth of maximum shear force      =        0.00000 in
Number of iterations              =             27
Number of zero deflection points  =              8
```

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 31000.	M= 0.000	200000.	.0647645	802002.	31000.0000
1	V= 41000.	M= 0.000	200000.	.1215411	1202724.	41000.0000
1	V= 51000.	M= 0.000	200000.	.1945683	1640681.	51000.0000

The analysis ended normally.

Bent 2 - Underpass

Based on borings AST-154A & AST-155A

84-in. Diameter CIDH Pile

$A = 5541.8\ in^2$; $I = 1221960\ in^4$

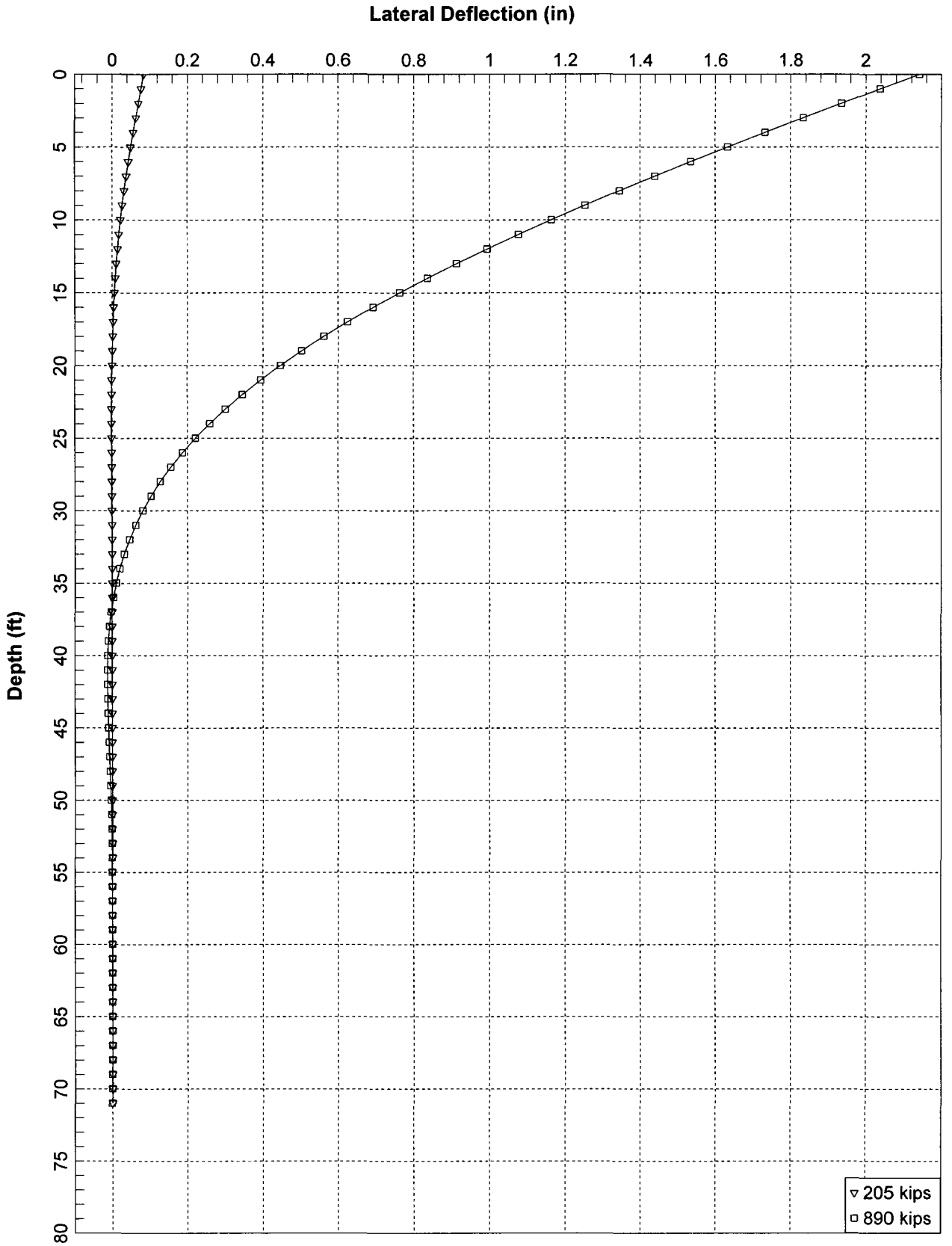
(Note: ϵ_{50} reduced for large diameter pile)

Longitudinal Loading

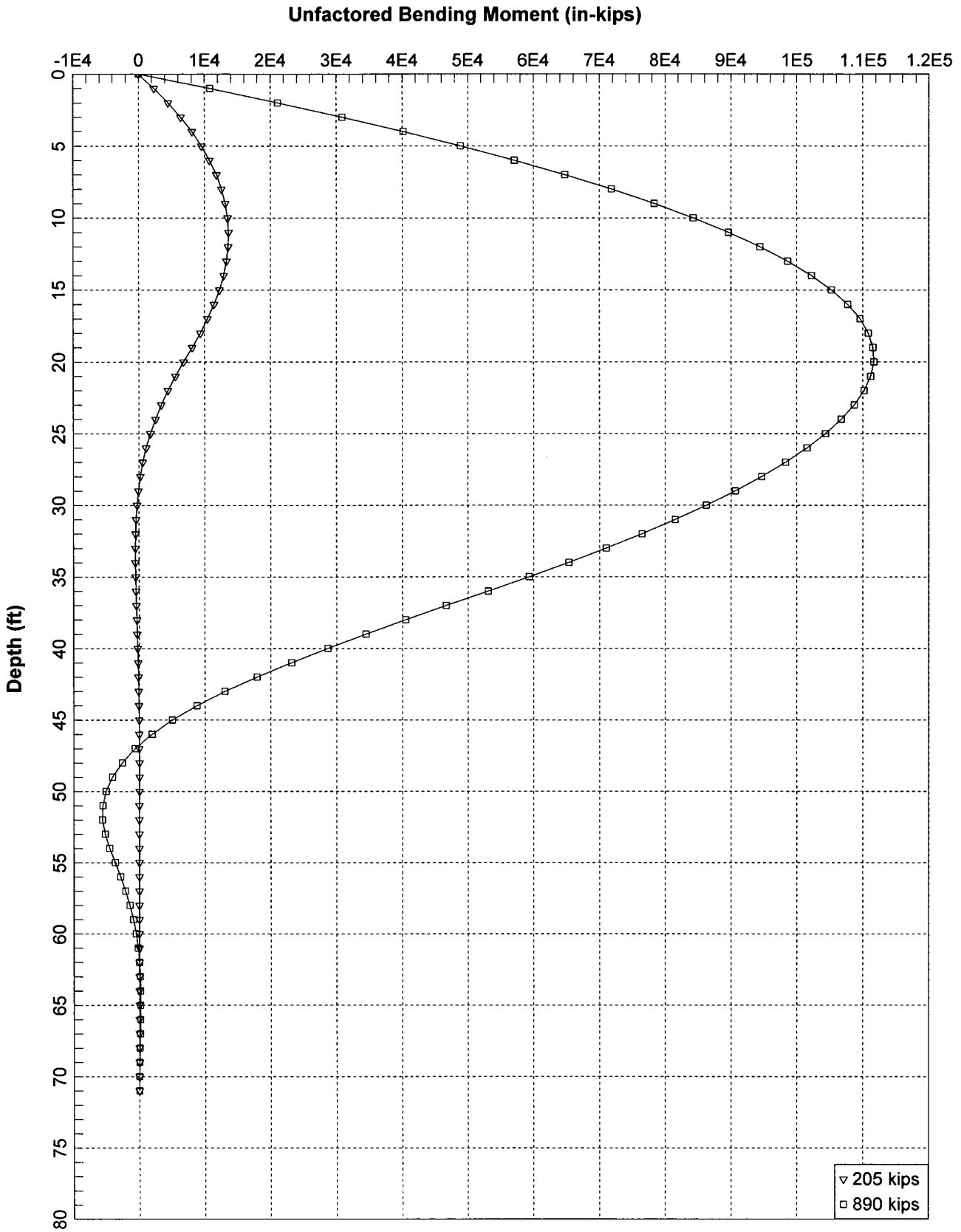
Group Reduction Factor = 0.75

EL. 44.0

Depths -24 - 264 = Stiff Clay w/o free water		$S_u = 3.5$ ksf $\gamma' = 125$ pcf $\epsilon_{50} = 0.00267$
Depths 264 - 456 = Stiff Clay w/o free water		$S_u = 2.5$ ksf $\gamma' = 125$ pcf $\epsilon_{50} = 0.00267$
Depths 456 - 504 = Stiff Clay w/o free water	$S_u = 2.5$ ksf	$\gamma' = 65$ pcf $\epsilon_{50} = 0.00267$
Depths 504 - 1200 = Stiff Clay w/o free water		$S_u = 8.0$ ksf $\gamma' = 125$ pcf $\epsilon_{50} = 0.00210$



eBART A Street Underpass - Bent 2 - 84-in. CIDH Pile - Longitudinal Loading



eBART A Street Underpass - Bent 2 - 84-in. CIDH Pile - Longitudinal Loading

LPILE Plus for Windows, Version 5.0 (5.0.21)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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Gary Parikh
Parikh Consultants

Path to file locations: S:\Ongoing Projects\2006\206117 TYLIn Rte 4 Project\EBART PROJECT\A Street Underpass\LPILE\
Name of input data file: A Street - Bent 2-84 in - long.lpd
Name of output file: A Street - Bent 2-84 in - long.lpo
Name of plot output file: A Street - Bent 2-84 in - long.lpp
Name of runtime file: A Street - Bent 2-84 in - long.lpr

Time and Date of Analysis

Date: August 30, 2009 Time: 16:56:18

Problem Title

eBART A Street Underpass - Bent 2 - 84-in CIDH Pile-LOngitudinal

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant 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 pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 71
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 852.00 in
Depth of ground surface below top of pile = -24.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	84.00000000	1221960.	5541.8000	3600000.
2	852.0000	84.00000000	1221960.	5541.8000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -24.000 in
Distance from top of pile to bottom of layer = 264.000 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 264.000 in
Distance from top of pile to bottom of layer = 432.000 in

Layer 3 is stiff clay without free water
Distance from top of pile to top of layer = 432.000 in
Distance from top of pile to bottom of layer = 504.000 in

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 504.000 in
Distance from top of pile to bottom of layer = 1200.000 in

(Depth of lowest layer extends 348.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 8 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-24.00	.07230
2	264.00	.07230
3	264.00	.07230
4	432.00	.07230
5	432.00	.03760
6	504.00	.03760
7	504.00	.03760
8	1200.00	.03760

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 8 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-24.000	24.31000	.00	.00270	.0
2	264.000	24.31000	.00	.00270	.0
3	264.000	17.36000	.00	.00270	.0
4	432.000	17.36000	.00	.00270	.0
5	432.000	17.36000	.00	.00270	.0
6	504.000	17.36000	.00	.00270	.0
7	504.000	55.55000	.00	.00210	.0
8	1200.000	55.55000	.00	.00210	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.7500	1.0000
2	876.000	.7500	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 205000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 1870000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 890000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 3740000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

**** WARNING ****

An unreasonable input value for shear strength has been specified for layer 4 defined using the stiff clay without free water criteria. The input value is greater than 55.55 psi (8000 psf). You should check your input data for correctness.

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 205000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 1870000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.084307	0.0000	205000.	-.0006005	337.4355	-1528.5480
12.000	.077101	2363419.	186561.	-.0005972	418.6686	-1544.6045
24.000	.069973	4504270.	167956.	-.0005879	492.2518	-1556.2214
36.000	.062992	6420750.	149239.	-.0005730	558.1231	-1563.2317
48.000	.056222	8111731.	130467.	-.0005532	616.2438	-1565.4592
60.000	.049717	9576790.	111698.	-.0005290	666.5994	-1562.7159
72.000	.043525	1.0816E+07	92993.1287	-.0005012	709.2002	-1554.7984
84.000	.037687	1.1831E+07	74415.4429	-.0004703	744.0829	-1541.4825
96.000	.032237	1.2623E+07	56031.4494	-.0004370	771.3113	-1522.5164
108.000	.027200	1.3195E+07	37910.6942	-.0004018	790.9776	-1497.6095
120.000	.022595	1.3551E+07	20126.5372	-.0003653	803.2038	-1466.4167
132.000	.018434	1.3695E+07	2756.9612	-.0003281	808.1435	-1428.5127
144.000	.014720	1.3632E+07	-14114.2139	-.0002908	805.9841	-1383.3499
156.000	.011454	1.3369E+07	-30395.4257	-.0002540	796.9493	-1330.1854
168.000	.008624	1.2914E+07	-45984.2106	-.0002182	781.3026	-1267.9454
180.000	.006218	1.2275E+07	-60761.5819	-.0001838	759.3532	-1194.9499
192.000	.004213	1.1464E+07	-74581.0199	-.0001514	731.4637	-1108.2898

204.000	.002583	1.0492E+07	-87243.6376	-.0001215	698.0646	-1002.1465
216.000	.001297	9375576.	-98932.0279	-9.4383E-05	659.6835	-945.9186
228.000	.000318	8122116.	-106028.	-7.0517E-05	616.6008	-236.8079
240.000	-.000395	6834059.	-105649.	-5.0118E-05	572.3290	300.1089
252.000	-.000885	5588800.	-99735.6347	-3.3174E-05	529.5281	685.3821
264.000	-.001191	4441893.	-90426.1297	-1.9493E-05	490.1078	866.2021
276.000	-.001353	3419447.	-80032.0513	-8.7706E-06	454.9653	866.1443
288.000	-.001402	2521517.	-69345.5723	-6.6752E-07	424.1026	914.9355
300.000	-.001369	1755184.	-58395.6553	5.1656E-06	397.7629	910.0507
312.000	-.001278	1119790.	-47742.7385	9.0869E-06	375.9238	865.4355
324.000	-.001150	608950.	-37790.2445	1.1445E-05	358.3657	793.3135
336.000	-.001003	212310.	-28805.9467	1.2565E-05	344.7328	704.0694
348.000	-.000849	-82956.5978	-20944.0869	1.2741E-05	340.2868	606.2405
360.000	-.000697	-290920.	-14267.0932	1.2231E-05	347.4347	506.5918
372.000	-.000555	-425916.	-8766.0284	1.1254E-05	352.0746	410.2524
384.000	-.000427	-501809.	-4379.1604	9.9883E-06	354.6832	320.8923
396.000	-.000316	-531464.	-1008.2740	8.5790E-06	355.7024	240.9221
408.000	-.000221	-526393.	1467.4615	7.1361E-06	355.5281	171.7005
420.000	-.000144	-496565.	3180.0936	5.7409E-06	354.5029	113.7382
432.000	-8.36E-05	-450328.	4280.1081	4.4494E-06	352.9137	69.5975
444.000	-3.76E-05	-394042.	4887.5218	3.2977E-06	350.9791	31.6381
456.000	-4.44E-06	-333176.	5100.0627	2.3059E-06	348.8871	3.7854
468.000	1.78E-05	-271744.	5030.9277	1.4808E-06	346.7756	-15.3079
480.000	3.11E-05	-212500.	4776.5969	8.2033E-07	344.7393	-27.0806
492.000	3.75E-05	-157143.	4416.2058	3.1617E-07	342.8366	-32.9846
504.000	3.87E-05	-106525.	3917.2438	-4.3457E-08	341.0969	-50.1757
516.000	3.64E-05	-63126.8644	3181.4954	-2.7485E-07	339.6052	-72.4490
528.000	3.21E-05	-30157.1494	2358.4071	-4.0208E-07	338.4720	-64.7324
540.000	2.68E-05	-6507.0489	1641.4964	-4.5209E-07	337.6591	-54.7527
552.000	2.12E-05	9259.0545	1048.7831	-4.4834E-07	337.7537	-44.0328
564.000	1.60E-05	18683.8659	582.7483	-4.1023E-07	338.0777	-33.6396
576.000	1.14E-05	23263.4257	235.3746	-3.5301E-07	338.2351	-24.2560
588.000	7.54E-06	24348.7004	-7.7023	-2.8807E-07	338.2724	-16.2569
600.000	4.48E-06	23091.4980	-163.9472	-2.2337E-07	338.2292	-9.7840
612.000	2.17E-06	20423.9929	-251.5297	-1.6402E-07	338.1375	-4.8131
624.000	5.41E-07	17062.1454	-287.6813	-1.1289E-07	338.0219	-1.2121
636.000	-5.85E-07	13524.7070	-287.6775	-7.1169E-08	337.9003	1.2128
648.000	-1.17E-06	10161.0786	-264.3165	-3.8863E-08	337.7847	2.6807
660.000	-1.47E-06	7182.8547	-227.7677	-1.5207E-08	337.6824	3.4107
672.000	-1.53E-06	4695.3365	-185.6776	9.9382E-10	337.5969	3.6043
684.000	-1.44E-06	2726.5486	-143.4383	1.1117E-08	337.5292	3.4356
696.000	-1.27E-06	1252.3196	-104.5425	1.6544E-08	337.4785	3.0470
708.000	-1.05E-06	216.7857	-70.9682	1.8547E-08	337.4429	2.5487
720.000	-8.20E-07	-451.7501	-43.5520	1.8227E-08	337.4510	2.0207
732.000	-6.09E-07	-829.2792	-22.3261	1.6480E-08	337.4640	1.5170
744.000	-4.25E-07	-988.3153	-6.8051	1.4001E-08	337.4695	1.0699
756.000	-2.73E-07	-993.2289	3.7840	1.1298E-08	337.4696	.6949605
768.000	-1.54E-07	-898.0074	10.3257	8.7184E-09	337.4664	.3953265
780.000	-6.36E-08	-745.8038	13.6911	6.4764E-09	337.4611	.1655708
792.000	1.89E-09	-569.7124	14.6547	4.6821E-09	337.4551	-.0049625
804.000	4.87E-08	-394.3008	13.8476	3.3673E-09	337.4490	-.1295616
816.000	8.27E-08	-237.5219	11.7376	2.5055E-09	337.4437	-.2220951
828.000	1.09E-07	-112.7101	8.6326	2.0278E-09	337.4394	-.2954137
840.000	1.31E-07	-30.4310	4.6997	1.8326E-09	337.4365	-.3600691
852.000	1.53E-07	0.0000	0.0000	1.7911E-09	337.4355	-.4232110

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection = .08430681 in

Computed slope at pile head = -.00060047
Maximum bending moment = 13694916. lbs-in
Maximum shear force = 205000.00000 lbs
Depth of maximum bending moment = 132.00000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 16
Number of zero deflection points = 4

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 890000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 3740000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress p lbs/in**2	Soil Res p lbs/in
0.000	2.141	-.0002713	890000.	-.0085833	674.8710	-3431.1693
12.000	2.038	1.0818E+07	848400.	-.0085686	1046.7025	-3502.0867
24.000	1.936	2.1131E+07	805976.	-.0085250	1401.1552	-3568.6333
36.000	1.834	3.0927E+07	762780.	-.0084540	1737.8563	-3630.6801
48.000	1.733	4.0196E+07	718868.	-.0083570	2056.4575	-3688.0983
60.000	1.633	4.8930E+07	674294.	-.0082354	2356.6356	-3740.7585
72.000	1.535	5.7119E+07	629119.	-.0080908	2638.0932	-3788.5308
84.000	1.439	6.4755E+07	583400.	-.0079245	2900.5594	-3831.2842
96.000	1.345	7.1831E+07	537199.	-.0077382	3143.7905	-3868.8865
108.000	1.253	7.8342E+07	490578.	-.0075334	3367.5705	-3901.2035
120.000	1.164	8.4282E+07	443602.	-.0073116	3571.7122	-3928.0990
132.000	1.078	8.9645E+07	396337.	-.0070744	3756.0574	-3949.4337
144.000	.994215	9.4429E+07	348850.	-.0068233	3920.4779	-3965.0649
156.000	.913881	9.8630E+07	301211.	-.0065600	4064.8763	-3974.8457
168.000	.836775	1.0225E+08	253490.	-.0062860	4189.1865	-3978.6239
180.000	.763016	1.0528E+08	205761.	-.0060030	4293.3745	-3976.2408
192.000	.692703	1.0772E+08	158098.	-.0057125	4377.4395	-3967.5296
204.000	.625917	1.0958E+08	110579.	-.0054161	4441.4141	-3952.3137
216.000	.562718	1.1086E+08	63282.8032	-.0051154	4485.3660	-3930.4040
228.000	.503147	1.1156E+08	16290.8070	-.0048120	4509.3981	-3901.5954
240.000	.447229	1.1169E+08	-30312.7424	-.0045075	4513.6501	-3865.6628
252.000	.394967	1.1124E+08	-76440.8467	-.0042035	4498.2993	-3822.3546
264.000	.346346	1.1023E+08	-120204.	-.0039014	4463.5620	-3471.5429
276.000	.301333	1.0871E+08	-158751.	-.0036028	4411.1787	-2952.9623
288.000	.259879	1.0674E+08	-193871.	-.0033089	4343.7225	-2900.3283
300.000	.221919	1.0435E+08	-228316.	-.0030210	4261.4622	-2840.5810
312.000	.187375	1.0153E+08	-262000.	-.0027402	4164.7036	-2773.2704
324.000	.156154	9.8307E+07	-294826.	-.0024676	4053.7916	-2697.8375
336.000	.128151	9.4680E+07	-326695.	-.0022044	3929.1133	-2613.5663
348.000	.103248	9.0664E+07	-357493.	-.0019516	3791.1008	-2519.5061
360.000	.081312	8.6275E+07	-387096.	-.0017103	3640.2368	-2414.3398
372.000	.062201	8.1528E+07	-415359.	-.0014814	3477.0601	-2296.1440
384.000	.045758	7.6440E+07	-442107.	-.0012660	3302.1758	-2161.9172
396.000	.031818	7.1031E+07	-467118.	-.0010648	3116.2695	-2006.5371
408.000	.020203	6.5324E+07	-490078.	-.0008788	2920.1332	-1820.0442
420.000	.010726	5.9348E+07	-510468.	-.0007088	2714.7138	-1578.3176
432.000	.003192	5.3137E+07	-527331.	-.0005554	2501.2329	-1232.2163

444.000	-.002603	4.6742E+07	-527625.	-.0004192	2281.4297	1183.2668
456.000	-.006868	4.0511E+07	-511371.	-.0003001	2067.2863	1525.6978
468.000	-.009807	3.4496E+07	-492097.	-.0001978	1860.5237	1686.6648
480.000	-.011616	2.8719E+07	-471301.	-.0001116	1661.9640	1779.2520
492.000	-.012486	2.3195E+07	-449636.	-4.0813E-05	1472.0897	1831.6611
504.000	-.012596	1.7931E+07	-422420.	1.5279E-05	1291.1835	2704.2302
516.000	-.012119	1.3055E+07	-381549.	5.7542E-05	1123.5863	4107.7031
528.000	-.011215	8768840.	-332389.	8.7308E-05	976.2648	4085.6719
540.000	-.010023	5069891.	-283708.	.0001062	849.1282	4027.7663
552.000	-.008666	1950319.	-235919.	.0001158	741.9054	3937.0785
564.000	-.007245	-602553.	-189403.	.0001176	695.5813	3815.4972
576.000	-.005844	-2605919.	-144526.	.0001132	764.4390	3663.9929
588.000	-.004528	-4081351.	-101646.	.0001041	815.1511	3482.6878
600.000	-.003346	-5054776.	-61126.0747	9.1639E-05	848.6087	3270.6978
612.000	-.002329	-5556602.	-23348.4384	7.7165E-05	865.8570	3025.5749
624.000	-.001494	-5622065.	14888.2966	6.1919E-05	868.1070	3347.2143
636.000	-.000843	-5204841.	46442.1527	4.7151E-05	853.7666	1911.7618
648.000	-.000362	-4511686.	62900.7417	3.3899E-05	829.9421	831.3364
660.000	-2.90E-05	-3698266.	68293.4730	2.2701E-05	801.9841	67.4521
672.000	.000183	-2874680.	66117.1072	1.3736E-05	773.6766	-430.1798
684.000	.000301	-2112688.	59242.3381	6.9335E-06	747.4862	-715.6151
696.000	.000349	-1453486.	49902.2730	2.0695E-06	724.8288	-841.0624
708.000	.000350	-915219.	39736.0143	-1.1612E-06	706.3280	-853.3140
720.000	.000321	-499718.	29865.2586	-3.0911E-06	692.0468	-791.8119
732.000	.000276	-198176.	20986.7089	-4.0430E-06	681.6825	-687.9464
744.000	.000224	4326.3664	13467.6980	-4.3074E-06	675.0197	-565.2221
756.000	.000173	125436.	7436.4647	-4.1304E-06	679.1823	-439.9834
768.000	.000125	183172.	2861.8605	-3.7095E-06	681.1668	-322.4506
780.000	8.37E-05	194453.	-380.1534	-3.1944E-06	681.5545	-217.8850
792.000	4.86E-05	174335.	-2454.0114	-2.6914E-06	680.8631	-127.7579
804.000	1.91E-05	135799.	-3525.6547	-2.2684E-06	679.5385	-50.8493
816.000	-5.87E-06	89923.2087	-3736.2294	-1.9605E-06	677.9617	15.7535
828.000	-2.79E-05	46305.1917	-3187.1801	-1.7747E-06	676.4625	75.7547
840.000	-4.85E-05	13590.1850	-1935.7149	-1.6930E-06	675.3381	132.8228
852.000	-6.86E-05	0.0000	0.0000	-1.6745E-06	674.8710	189.7963

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

Pile-head deflection = 2.14118244 in
Computed slope at pile head = -.00858331
Maximum bending moment = 1.116866E+08 lbs-in
Maximum shear force = 890000.00000 lbs
Depth of maximum bending moment = 240.00000 in
Depth of maximum shear force = 0.00000 in
Number of iterations = 35
Number of zero deflection points = 3

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in

Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 2.05E+05	M= 0.000	1870000.	.0843068	1.3695E+07	205000.
1	V= 8.90E+05	M= 0.000	3740000.	2.1412	1.1169E+08	890000.

Bent 2 - Underpass

Based on borings AST-154A & AST-155A

84-in. Diameter CIDH Pile

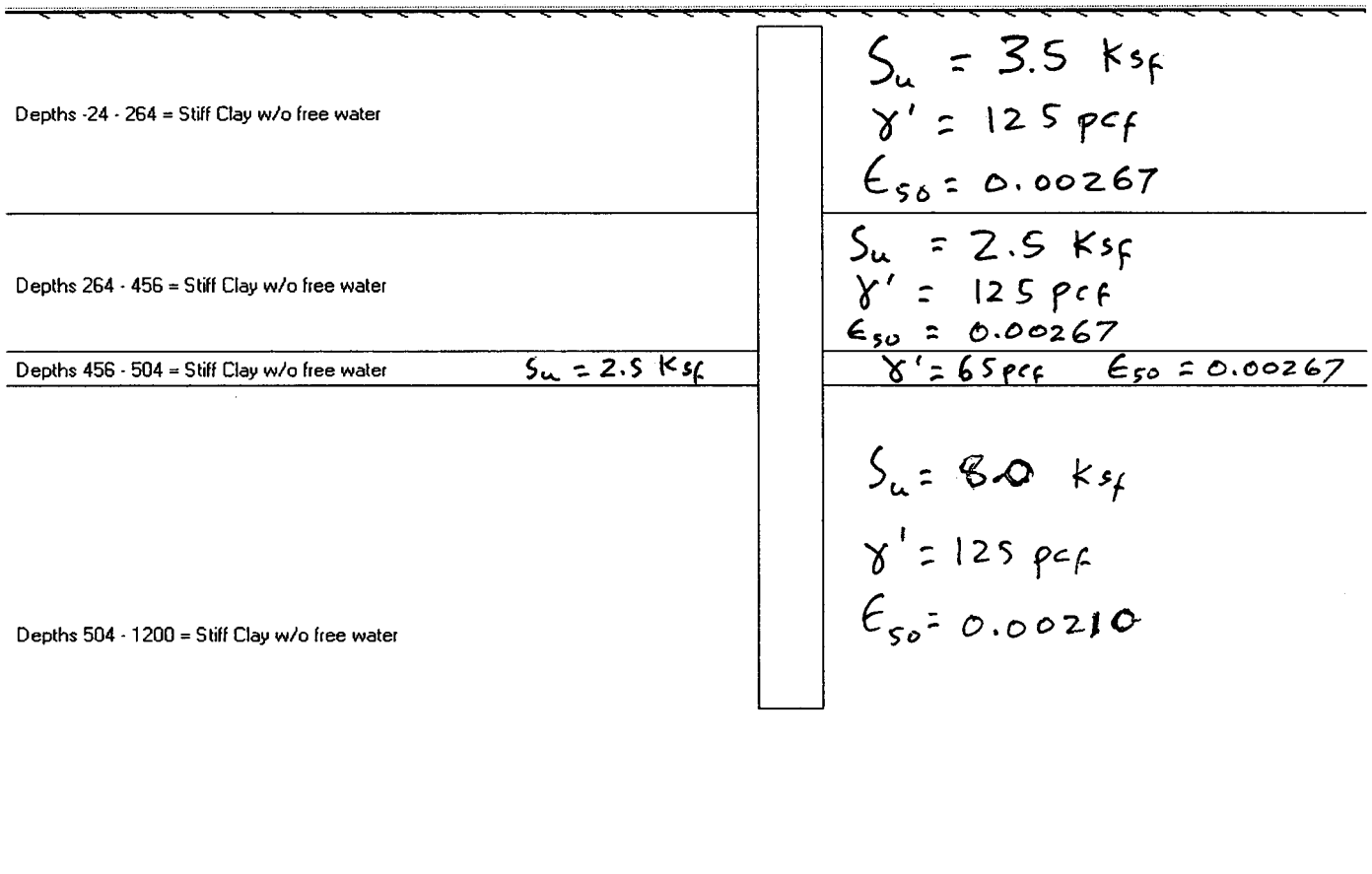
$A = 5541.8\ in^2$; $I = 1221960\ in^4$

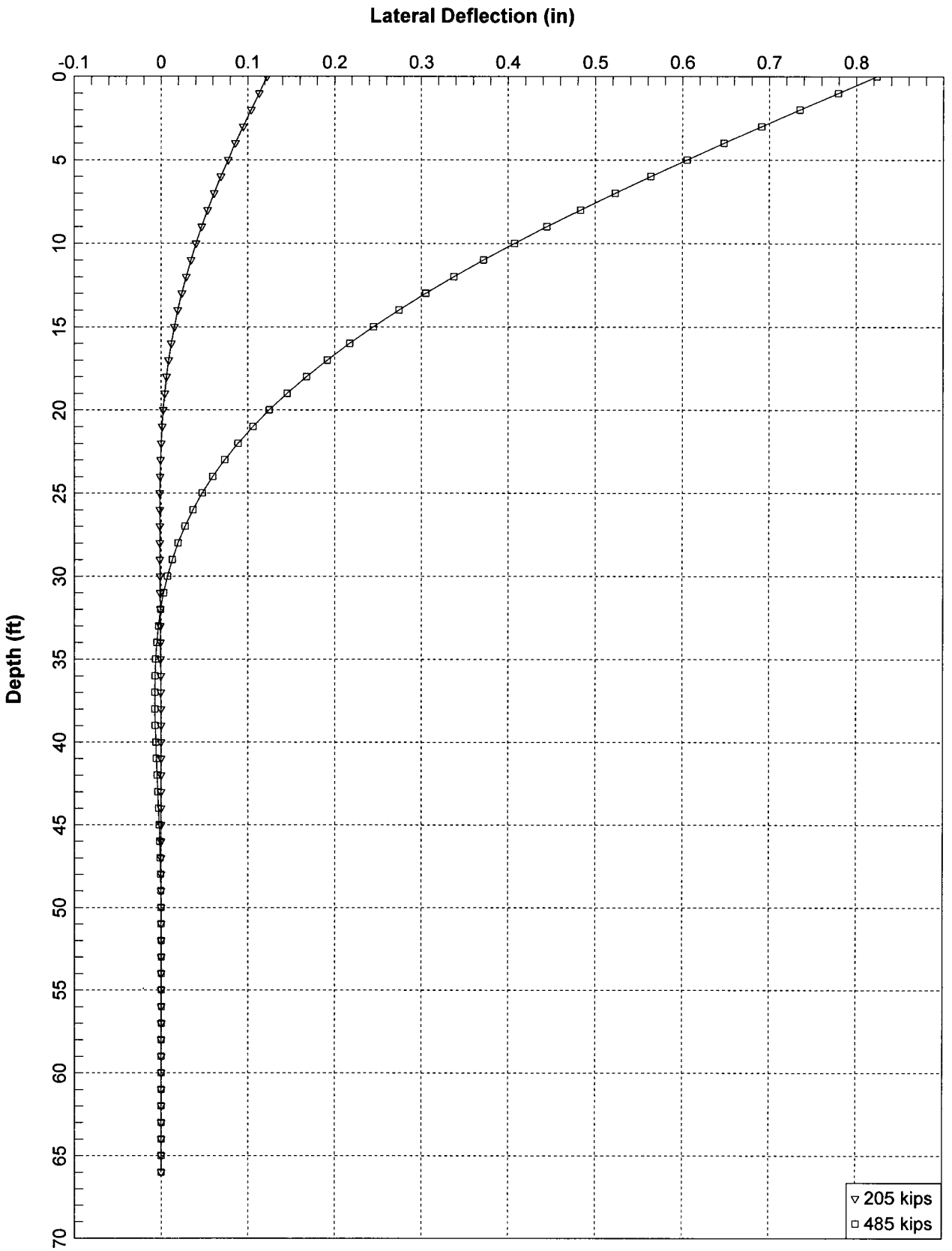
(Note: ϵ_{50} reduced for large diameter pile)

Transverse Loading

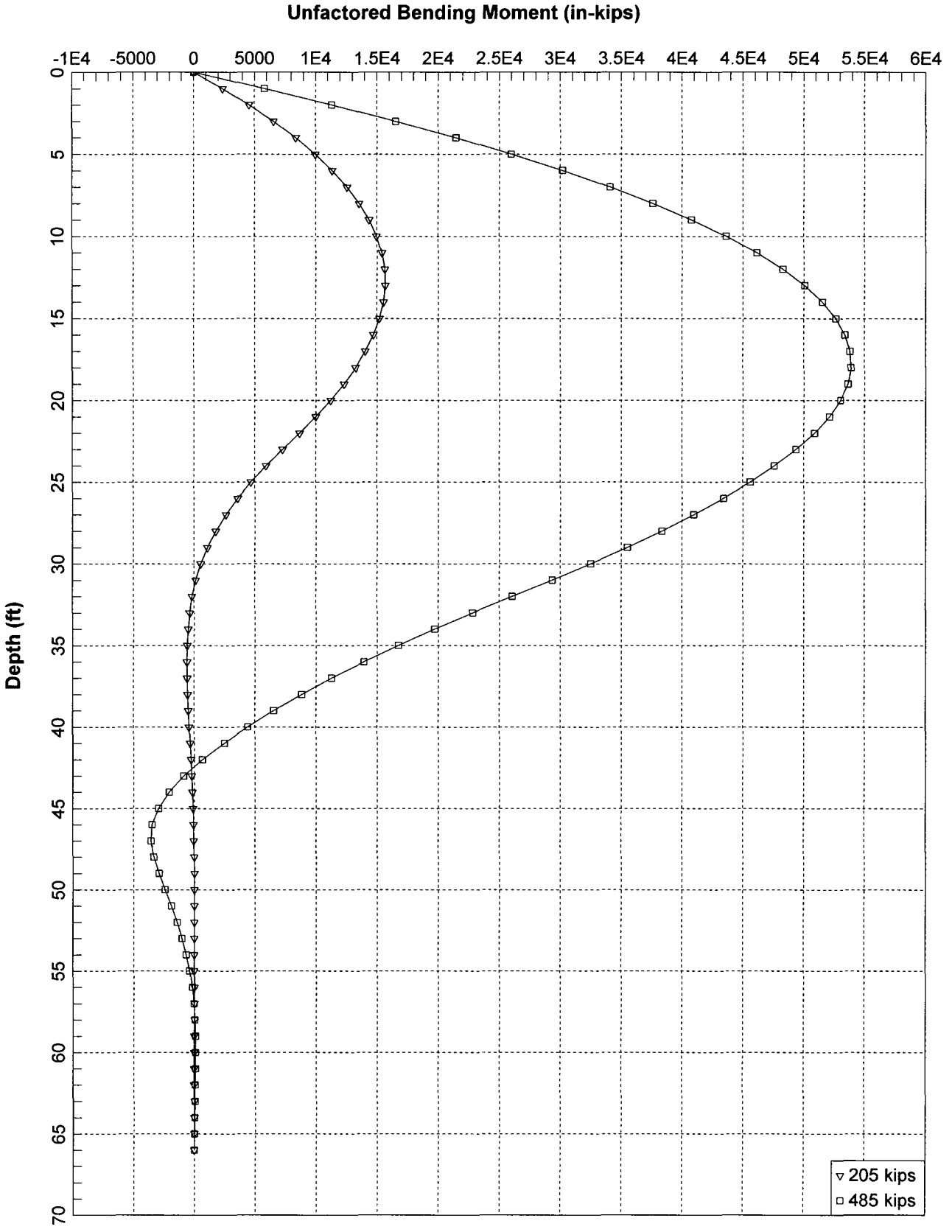
Group Reduction Factor = 0.59

EL. 44.0





eBART A Street Underpass - bent 2 - 84-in. CIDH Pile - Transverse Loading



eBART A Street Underpass - 84-in. CIDH PIle - Transverse Loading

LPILE Plus for Windows, Version 5.0 (5.0.21)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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Gary Parikh
Parikh Consultants

Path to file locations: S:\Ongoing Projects\2006\206117 TYLIn Rte 4 Project\EBART PROJECT\A Street Underpass\LPILE\
Name of input data file: A Street - Bent 2-84 in - trans.lpd
Name of output file: A Street - Bent 2-84 in - trans.lpo
Name of plot output file: A Street - Bent 2-84 in - trans.lpp
Name of runtime file: A Street - Bent 2-84 in - trans.lpr

Time and Date of Analysis

Date: August 13, 2009 Time: 17:33: 2

Problem Title

eBART A Street Underpass - Bent 2 - 84-in CIDH Pile-Transverse

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant 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 pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 66
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 792.00 in
Depth of ground surface below top of pile = -24.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	84.00000000	1221960.	5541.8000	3600000.
2	792.0000	84.00000000	1221960.	5541.8000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -24.000 in
Distance from top of pile to bottom of layer = 264.000 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 264.000 in
Distance from top of pile to bottom of layer = 432.000 in

Layer 3 is stiff clay without free water
Distance from top of pile to top of layer = 432.000 in
Distance from top of pile to bottom of layer = 504.000 in

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 504.000 in
Distance from top of pile to bottom of layer = 1200.000 in

(Depth of lowest layer extends 408.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 8 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-24.00	.07230

2	264.00	.07230
3	264.00	.07230
4	432.00	.07230
5	432.00	.03760
6	504.00	.03760
7	504.00	.03760
8	1200.00	.03760

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 8 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-24.000	24.31000	.00	.00270	.0
2	264.000	24.31000	.00	.00270	.0
3	264.000	17.36000	.00	.00270	.0
4	432.000	17.36000	.00	.00270	.0
5	432.000	17.36000	.00	.00270	.0
6	504.000	17.36000	.00	.00270	.0
7	504.000	55.55000	.00	.00210	.0
8	1200.000	55.55000	.00	.00210	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.5900	1.0000
2	816.000	.5900	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 205000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 1870000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 485000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 3740000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

**** WARNING ****

An unreasonable input value for shear strength has been specified for layer 4 defined using the stiff clay without free water criteria. The input value is greater than 55.55 psi (8000 psf). You should check your input data for correctness.

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 205000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 1870000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.122554	-1.6958E-06	205000.	-.0007724	337.4355	-1320.3094
12.000	.113285	2382270.	189052.	-.0007691	419.3165	-1337.7517
24.000	.104095	4571758.	172913.	-.0007596	494.5714	-1351.9965
36.000	.095054	6566278.	156624.	-.0007445	563.1251	-1362.9284
48.000	.086228	8364135.	140223.	-.0007241	624.9192	-1370.4277
60.000	.077676	9964138.	123755.	-.0006991	679.9129	-1374.3696
72.000	.069450	1.1366E+07	107261.	-.0006700	728.0833	-1374.6226
84.000	.061596	1.2568E+07	90786.7036	-.0006374	769.4263	-1371.0470
96.000	.054153	1.3573E+07	74379.4721	-.0006017	803.9568	-1363.4916
108.000	.047155	1.4381E+07	58087.7759	-.0005636	831.7104	-1351.7911
120.000	.040628	1.4993E+07	41962.4629	-.0005235	852.7430	-1335.7610
132.000	.034591	1.5411E+07	26056.7495	-.0004820	867.1329	-1315.1912
144.000	.029059	1.5640E+07	10426.5876	-.0004397	874.9809	-1289.8358
156.000	.024039	1.5681E+07	-4868.8203	-.0003970	876.4121	-1259.3989
168.000	.019532	1.5540E+07	-19766.2776	-.0003544	871.5770	-1223.5107
180.000	.015533	1.5223E+07	-34197.4776	-.0003124	860.6535	-1181.6893
192.000	.012033	1.4734E+07	-48087.2539	-.0002716	843.8493	-1133.2734

204.000	.009016	1.4081E+07	-61350.6749	-.0002323	821.4050	-1077.2968
216.000	.006459	1.3272E+07	-73887.8529	-.0001950	793.5991	-1012.2329
228.000	.004337	1.2316E+07	-85573.6939	-.0001601	760.7554	-935.4073
240.000	.002618	1.1225E+07	-96234.3916	-.0001280	723.2559	-841.3757
252.000	.001266	1.0012E+07	-107167.	-9.8985E-05	681.5686	-980.6621
264.000	.000242	8657616.	-114106.	-7.3520E-05	635.0064	-175.8774
276.000	-.000499	7277067.	-113245.	-5.1787E-05	587.5556	319.3370
288.000	-.001001	5942058.	-107409.	-3.3757E-05	541.6700	653.3342
300.000	-.001309	4700765.	-98267.0435	-1.9241E-05	499.0055	870.3368
312.000	-.001463	3584512.	-87100.8748	-7.9400E-06	460.6388	990.6913
324.000	-.001499	2610700.	-74953.2119	5.0984E-07	427.1679	1033.9192
336.000	-.001451	1785612.	-62641.2963	6.5061E-06	398.8088	1018.0667
348.000	-.001343	1107017.	-50777.2735	1.0451E-05	375.4848	959.2704
360.000	-.001200	566489.	-39792.5820	1.2734E-05	356.9063	871.5115
372.000	-.001038	151423.	-29964.3649	1.3713E-05	342.6401	766.5247
384.000	-.000871	-153272.	-21442.2349	1.3711E-05	342.7036	653.8303
396.000	-.000709	-363806.	-14274.0995	1.3005E-05	349.9399	540.8589
408.000	-.000558	-496434.	-8430.1004	1.1832E-05	354.4984	433.1409
420.000	-.000425	-566659.	-3824.0377	1.0382E-05	356.9121	334.5362
432.000	-.000309	-588676.	-271.8026	8.8063E-06	357.6689	257.5030
444.000	-.000213	-573578.	2350.6719	7.2211E-06	357.1499	179.5761
456.000	-.000136	-532584.	4122.9761	5.7123E-06	355.7410	115.8079
468.000	-7.61E-05	-474882.	5211.2913	4.3382E-06	353.7577	65.5779
480.000	-3.19E-05	-407708.	5771.1965	3.1344E-06	351.4488	27.7396
492.000	-9.11E-07	-336514.	5942.4493	2.1194E-06	349.0018	.8025268
504.000	1.90E-05	-265184.	5799.2916	1.2987E-06	346.5501	-24.6621
516.000	3.03E-05	-197390.	5290.1591	6.6778E-07	344.2200	-60.1933
528.000	3.50E-05	-138251.	4504.8542	2.0999E-07	342.1873	-70.6909
540.000	3.53E-05	-89282.6135	3647.5152	-1.0035E-07	340.5042	-72.1990
552.000	3.26E-05	-50705.7731	2808.3569	-2.9128E-07	339.1783	-67.6607
564.000	2.83E-05	-21868.9742	2045.4854	-3.9027E-07	338.1871	-59.4845
576.000	2.33E-05	-1596.6072	1391.3301	-4.2227E-07	337.4904	-49.5414
588.000	1.82E-05	11541.8994	858.8625	-4.0871E-07	337.8322	-39.2032
600.000	1.35E-05	19034.4358	447.2082	-3.6700E-07	338.0897	-29.4058
612.000	9.36E-06	22291.3679	146.4297	-3.1064E-07	338.2017	-20.7239
624.000	6.00E-06	22562.6893	-58.6069	-2.4946E-07	338.2110	-13.4488
636.000	3.38E-06	20895.9970	-185.2715	-1.9019E-07	338.1537	-7.6619
648.000	1.44E-06	18124.7094	-251.0414	-1.3696E-07	338.0585	-3.2997
660.000	8.98E-08	14877.1497	-272.0919	-9.1952E-08	337.9468	-.2086754
672.000	-7.70E-07	11598.6301	-262.4735	-5.5841E-08	337.8341	1.8117
684.000	-1.25E-06	8580.2922	-233.7453	-2.8318E-08	337.7304	2.9763
696.000	-1.45E-06	5990.0149	-194.9405	-8.4452E-09	337.6414	3.4912
708.000	-1.45E-06	3902.1002	-152.7563	5.0470E-09	337.5696	3.5395
720.000	-1.33E-06	2323.6363	-111.8793	1.3538E-08	337.5154	3.2733
732.000	-1.13E-06	1216.3894	-75.3750	1.8367E-08	337.4773	2.8107
744.000	-8.88E-07	513.8114	-45.0908	2.0727E-08	337.4532	2.2367
756.000	-6.31E-07	133.2805	-22.0324	2.1609E-08	337.4401	1.6064
768.000	-3.69E-07	-15.9353	-6.6899	2.1769E-08	337.4360	.9506599
780.000	-1.08E-07	-28.2550	.7045651	2.1709E-08	337.4365	.2817574
792.000	1.52E-07	0.0000	0.0000	2.1670E-08	337.4355	-.3991850

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection              =      .12255396 in
Computed slope at pile head       =     -.00077238
Maximum bending moment            =      15681142. lbs-in
Maximum shear force               =    205000.00000 lbs
Depth of maximum bending moment   =       156.00000 in
Depth of maximum shear force      =         0.00000 in
```


504.000	-.004658	676591.	-138301.	7.0005E-05	698.1261	1659.0391
516.000	-.003807	-866756.	-113831.	6.9746E-05	704.6623	2419.3171
528.000	-.002984	-2061616.	-85463.9583	6.5752E-05	745.7308	2308.5395
540.000	-.002229	-2923793.	-58557.0864	5.8952E-05	775.3647	2175.9392
552.000	-.001569	-3472277.	-25977.7365	5.0228E-05	794.2166	3253.9525
564.000	-.001023	-3551767.	6449.9772	4.0648E-05	796.9488	2150.6664
576.000	-.000594	-3321127.	26940.3386	3.1274E-05	789.0214	1264.3938
588.000	-.000273	-2908006.	38058.4633	2.2778E-05	774.8221	588.6270
600.000	-4.71E-05	-2409768.	42207.9017	1.5525E-05	757.6971	102.9461
612.000	9.97E-05	-1896410.	41501.0284	9.6515E-06	740.0525	-220.7583
624.000	.000185	-1414610.	37695.2692	5.1355E-06	723.4925	-413.5349
636.000	.000223	-992185.	32178.2378	1.8528E-06	708.9734	-505.9703
648.000	.000229	-642498.	25986.7120	-3.7676E-07	696.9543	-525.9506
660.000	.000214	-368470.	19846.7829	-1.7556E-06	687.5357	-497.3709
672.000	.000187	-166018.	14225.0958	-2.4846E-06	680.5772	-439.5770
684.000	.000154	-26844.5786	9383.6095	-2.7477E-06	675.7937	-367.3374
696.000	.000121	59435.4021	5432.5616	-2.7032E-06	676.9138	-291.1706
708.000	8.94E-05	103780.	2378.2339	-2.4806E-06	678.4380	-217.8840
720.000	6.14E-05	116736.	163.6260	-2.1799E-06	678.8833	-151.2173
732.000	3.71E-05	107902.	-1298.7435	-1.8735E-06	678.5797	-92.5110
744.000	1.64E-05	85733.9974	-2101.9440	-1.6094E-06	677.8177	-41.3558
756.000	-1.49E-06	57600.0326	-2327.2687	-1.4139E-06	676.8508	3.8017
768.000	-1.75E-05	30006.4578	-2033.8682	-1.2944E-06	675.9023	45.0984
780.000	-3.26E-05	8903.3808	-1254.9116	-1.2413E-06	675.1770	84.7277
792.000	-4.73E-05	0.0000	0.0000	-1.2292E-06	674.8710	124.4242

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

```
Pile-head deflection              =      .82389283 in
Computed slope at pile head       =     -.00370227
Maximum bending moment            =      53896122. lbs-in
Maximum shear force               =    485000.00000 lbs
Depth of maximum bending moment   =       216.00000 in
Depth of maximum shear force      =         0.00000 in
Number of iterations              =              29
Number of zero deflection points  =               3
```

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 2.05E+05 M=	0.000	1870000.	.1225540	1.5681E+07	205000.
1	V= 4.85E+05 M=	0.000	3740000.	.8238928	5.3896E+07	485000.


```
Number of iterations              =              19
Number of zero deflection points  =               4
```

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 485000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 3740000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.823893	-7.4616E-05	485000.	-.0037023	674.8710	-2125.8793
12.000	.779466	5833095.	459246.	-.0036943	875.3603	-2166.4944
24.000	.735229	1.1353E+07	433023.	-.0036709	1065.1022	-2203.9386
36.000	.691365	1.6555E+07	406371.	-.0036328	1243.8881	-2238.1125
48.000	.648042	2.1432E+07	379329.	-.0035810	1411.5269	-2268.9159
60.000	.605421	2.5980E+07	351938.	-.0035163	1567.8457	-2296.2478
72.000	.563650	3.0195E+07	324240.	-.0034397	1712.6901	-2320.0060
84.000	.522868	3.4071E+07	296280.	-.0033521	1845.9248	-2340.0862
96.000	.483201	3.7606E+07	268101.	-.0032543	1967.4340	-2356.3823
108.000	.444765	4.0798E+07	239750.	-.0031474	2077.1222	-2368.7850
120.000	.407664	4.3643E+07	211274.	-.0030322	2174.9146	-2377.1818
132.000	.371992	4.6140E+07	182722.	-.0029097	2260.7577	-2381.4558
144.000	.337831	4.8289E+07	154145.	-.0027809	2334.6198	-2381.4846
156.000	.305250	5.0089E+07	125593.	-.0026468	2396.4917	-2377.1395
168.000	.274309	5.1541E+07	97120.2618	-.0025081	2446.3874	-2368.2831
180.000	.245055	5.2645E+07	68781.9559	-.0023660	2484.3446	-2354.7679
192.000	.217524	5.3404E+07	40634.7500	-.0022214	2510.4255	-2336.4331
204.000	.191741	5.3820E+07	12737.5465	-.0020751	2524.7177	-2313.1008
216.000	.167721	5.3896E+07	-14848.4843	-.0019282	2527.3348	-2284.5710
228.000	.145464	5.3637E+07	-42059.5939	-.0017816	2518.4179	-2250.6139
240.000	.124963	5.3047E+07	-68829.0380	-.0016360	2498.1361	-2210.9601
252.000	.106199	5.2132E+07	-95086.5043	-.0014926	2466.6880	-2165.2843
264.000	.089141	5.0899E+07	-119749.	-.0013521	2424.3037	-1945.1758
276.000	.073749	4.9379E+07	-141224.	-.0012153	2372.0777	-1633.9185
288.000	.059974	4.7618E+07	-160516.	-.0010830	2311.5569	-1581.3947
300.000	.047757	4.5624E+07	-179136.	-.0009558	2243.0088	-1521.9997
312.000	.037034	4.3405E+07	-196996.	-.0008344	2166.7357	-1454.6622
324.000	.027732	4.0971E+07	-213991.	-.0007193	2083.0802	-1377.7507
336.000	.019771	3.8334E+07	-229988.	-.0006111	1992.4332	-1288.5727
348.000	.013064	3.5506E+07	-244813.	-.0005104	1895.2472	-1182.1486
360.000	.007520	3.2504E+07	-258190.	-.0004177	1792.0609	-1047.4486
372.000	.003040	2.9347E+07	-269572.	-.0003333	1683.5535	-849.4295
384.000	-.000479	2.6064E+07	-272509.	-.0002577	1570.7184	359.9366
396.000	-.003146	2.2830E+07	-265039.	-.0001910	1459.5552	884.9416
408.000	-.005064	1.9720E+07	-253652.	-.0001330	1352.6758	1012.9515
420.000	-.006338	1.6754E+07	-241044.	-8.3266E-05	1250.7270	1088.3782
432.000	-.007063	1.3943E+07	-227424.	-4.1398E-05	1154.0945	1181.6896
444.000	-.007331	1.1300E+07	-213095.	-6.9689E-06	1063.2521	1206.4586
456.000	-.007230	8829021.	-198560.	2.0485E-05	978.3333	1215.9329
468.000	-.006840	6532384.	-183989.	4.1437E-05	899.3956	1212.6738
480.000	-.006236	4409573.	-169524.	5.6361E-05	826.4324	1198.1632
492.000	-.005487	2458757.	-155295.	6.5729E-05	759.3809	1173.2700

APPENDIX D

Office of Special Funded Projects
Comment & Response Form

General Project Information	Review Phase	Reviewer Information
Dist: _ EA: 228511 Project Name: Route 4 Widenining SEG 3A OSFP Liaison: O. Hor Phone: 916-227-8419 e-mail: overcomer_hor@dot.ca.gov	☐ PSR/PDS (Review No. _) ☐ APS/PSR (Review No. _) ☐ APS/PR (Review No. _) ☐ Type Selection ☒ 65% PS&E Unchecked Details ☐ PS&E (Review No. 1) ☐ Construction Support ☒ Other: Foundation Report **Structure Information** (Use when necessary to document comments by individual structure) Structure Name: A Street UP Br No: 28-C0487	Reviewer Name: Ali Kaddoura Functional Unit: 327 Cost Center: 59 Phone Number: 510-286-4676 e-mail: ali_kaddoura@dot.ca.gov Date of Review: 03/09/09

Consultant Information (to be filled in by Consultant)

Consultant Structure Lead (First and Last Name)	Structure Consultant Firm	Phone Number	e-mail	Response Date

#	Doc. (See Note 1)	Page, Section, or SSP	Review Comments	Consultant Responses	✓
1	FR A Street UP Bridge No. 28-C0487 65% PS&E		Draft FR Prepared by Parikh Consultants Dated February 2009.	No response required.	
2			The report lacks the County, Route, and Postmile designation.	Agreed. The County, Route, and Postmile designation have been added in the revised report.	
3		Site Geology, page 4.	The overview of the site geology is given with reference to the geologic map, but there is no evaluation of historical geologic hazards and potential hazards (such as landslides, other slope failures, subsidence, earthquakes, or floods).	This report is a foundation reportfor the Underpass structure. There are no slopes or flood hazards.	
4		Page 6	In Table, "RLSS" stands for "right lateral strike slip" and not "right left strike slip.	Agreed. Text has been revised.	
5		Page 9 Load	The compression Strength Limit for Bent 2	The number noted is the required Nominal Resistance corresponding to the Strength Limit of 2326 kips, e.g.	

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved (for Reviewer's use)

		Demands Table	should be 2326 kips as per Foundation Loads Table on Page 8.	2326/0.7 = 3323 kips	
6		Appendix C, Bent 2 & Page 10 Table	In SHAFT program output: The Ultimate Side Resistance output was 1497 tons for a pile length of 72'. However, Pile Data Table Page 10 spcifies a nominal load of 1660 tons. That means the required load will not be reached at the pile length of 72'! Please explain.	In the 65pct. Report, a small portion of the end bearing was included in the Ultimate Capacity, within limitations of pile displacement. In the revised report, the soil profile has been revised and a new pile tip resistance has been developed. End bearing has been neglected in the new computation.	
7	A Street UP Bridge No. 28-C0487 65% PS&E		(C3) Not approved (resubmittal to GS required)	No response required.	

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved
(for Reviewer's use)

Office of Special Funded Projects
Comment & Response Form

General Project Information	Review Phase		Reviewer Information
Dist: _ EA: 228511 Project Name: Route 4 Widenining SEG 3A OSFP Liaison: O. Hor Phone: 916-227-8419 e-mail: overcomer_hor@dot.ca.gov	☐ PSR/PDS (Review No. _) ☐ APS/PSR (Review No. _) ☐ APS/PR (Review No. _) ☐ Type Selection	☐ 65% PS&E Unchecked Details ☐ PS&E (Review No. 1) ☐ Construction Support ☒ Other: Final Foundation Report	Reviewer Name: Ali Kaddoura/R. Nashed Functional Unit: 327 Cost Center: 59 Phone Number: 510-286-4676 e-mail: ali_kaddoura@dot.ca.gov Date of Review: 11/03/09
	Structure Information (Use when necessary to document comments by individual structure) Structure Name: A Street UP Br No: 28-C0487		

Consultant Information (to be filled in by Consultant)

Consultant Structure Lead (First and Last Name)	Structure Consultant Firm	Phone Number	e-mail	Response Date

#	Doc. (See Note 1)	Page, Section, or SSP	Review Comments	Consultant Responses	✓
1	Final FR A Street UP Bridge No. 28-C0487		Final FR Prepared by Parikh Consultants Dated August 2009.	No response required.	
2		Page 2, **Purpose AND SCOPE**	For the statement" The scope of work performed...and preparation of this report." the **two** drilled borings, should corrected to **four** drilled borings.	Agreed. Text will be revised.	
3		Page 2, **SITE CONDITIONS**	This section should be corrected to be applied to this bridge structure project (Br. No. 28C0487)	Agreed. Text will be revised to be applicable to Br. No. 28C0487.	
4		Page 6, **Seismic Sources**	In the table: - The distance between the site and Vaca Fault Zone is 5.4 miles not 3.4 miles. - The distance between the site and Great Valley Fault is 6.6 miles not 4.4 miles. Please correct and check all calculations based	Per e-mail from Hossein Salimi of Caltrans dated March 2, 2010, no further action on this comment is required. (See attached e-mail)	

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved (for Reviewer's use)

			on these values.		
5			Our previous comments have been addressed to our satisfaction.		
6	Final FR A Street UP Bridge No. 28-C0487		(C2) Approved subject to OSFP verification		

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved
(for Reviewer's use)

Partha Sircar

From: "Hossain Salimi" <hossain_salimi@dot.ca.gov>
To: "Partha Sircar" <psircar@parikhnet.com>
Sent: Tuesday, March 02, 2010 10:53 AM
Attach: 228511GeoSeg 3A-1stPSE.pdf
Subject: Fw: SR4 Segment 3A bridges - Seismic

FYI

Hossain Salimi
Senior Materials and Research Engineer
Office of Geotechnical Design-West
(916) 227-7147
----- Forwarded by Hossain Salimi/HQ/Caltrans/CAGov on 03/02/2010 09:53 AM

Hossain Salimi/HQ/Caltrans/CAGov
02/25/2010 10:43 AM

To
Ali Kaddoura/D04/Caltrans/CAGov, Rifaat Nashed/HQ/Caltrans/CAGov
cc
Tim Pokrywka/D04/Caltrans/CAGov@DOT
Subject
Fw: SR4 Segment 3A bridges - Seismic

Gentlemen,

I am writing you in regards to the reports submitted by Parikh and our subsequent attached comments (Bridges under EA # 04-228511). Parikh had used the old 1996 Caltrans Seismic Hazard Map as well as the old Seismic Design Criteria (SDC) to produce the seismic recommendations. These bridges were type selected before the Department mandated changes to the SDC became official. In fact, their findings are more conservative compared to the new criteria. In light of this, I find it unreasonable for us to request changes to the seismic recommendations of these reports. I am satisfied with the findings in the reports and have no further comments. In the future, I will check the type selection date of each bridge to see if the changes to the new SDC are warranted.

Sincerely,

Hossain Salimi

Senior Materials and Research Engineer
Office of Geotechnical Design-West
(916) 227-7147
----- Forwarded by Hossain Salimi/HQ/Caltrans/CAGov on 02/25/2010 10:30 AM

"Partha Sircar"
<psircar@parikhne
t.com>
02/24/2010 10:13
AM

To
"Hossain Salimi"
<hossain_salimi@dot.ca.gov>
cc

Subject
SR4 Segment 3A bridges - Seismic

Hossein:

As I had discussed with you earlier, I have the same issues with the above bridges. Please call me to advise.

Partha Sircar
Parikh Consultanta
(408) - 452 -9000

----- Original Message -----
From: "Hossain Salimi" <hossain_salimi@dot.ca.gov>
To: "Rifaat Nashed" <rifaat_nashed@dot.ca.gov>; "Ali Kaddoura" <ali_kaddoura@dot.ca.gov>
Cc: "Partha Sircar" <psircar@parikhnet.com>; "Tim Pokrywka" <tim_pokrywka@dot.ca.gov>
Sent: Thursday, December 17, 2009 10:38 AM
Subject: Updated status of Somersville Rd UC replacement (04-228511)

>
> Hi Rifaat/Ali,
>
> I had a conversation with Mr. Sircar of Parikh subsequent to the e-mail I
> sent you. As it turns out, this project has been in the works for a long
> time, and the seismic analysis and design have already been completed
> using

> the old SDC. Therefore, Parikh is not required to take any further
> actions
> regarding my comments. Thank you all.
>
> Sincerely,
>
> Hossain Salimi
> Senior Materials and Research Engineer
> Office of Geotechnical Design-West
> (916) 227-7147
> ----- Forwarded by Hossain Salimi/HQ/Caltrans/CAGov on 12/17/2009 10:31
AM
> -----
>
> Hossain
> Salimi/HQ/Caltran
> s/CAGov To
> Rifaat Nashed/HQ/Caltrans/CAGov
> 11/30/2009 09:25 cc
> AM Tim Pokrywka/D04/Caltrans/CAGov@DOT
> Subject
> Somersville Rd UC replacement
> (04-228511)(Document link: Hossain
> Salimi)
>
>
>
>
>
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>
>
>
> Hi Rifaat,
>
> I reviewed the attached documents you sent me on November 19, 2009
(Report
> containing Final Foundation Report from Parikh Consultants to Mark Thomas
> and Company Inc. for the proposed Somersville Road Undercrossing
> replacement) and have the following comments. I should note that the
> proposed bridge (28-0398L/R) is located on Route 4 and will replace the
> existing 2-span structure (28-0211R).
>
> 1. According to the report, Parikh is using the in-progress Seismic
Hazard
> Map (CSHM) . However, the distances as outlined in the table does not
> match our latest CSHM.
>
> 2. The Department has finalized the new ARS curves based on the new
> Seismic
> Design Criteria (SDC) and is now mandatory for use by both the Department
> personnel as well as our consultants effective September 30, 2009.
> However, Parikh is still using the ARS curve based on the 2001SDC which
> was

> based on Sadigh 1996 Attenuation Relationship models.
>
> To re-iterate, the Department has implemented the new SDC and the
> consultant shall re-submit the report using the now mandated seismic
> design
> criteria.
>
> Sincerely,
>
> Hossain Salimi
> Senior Materials and Research Engineer
> Office of Geotechnical Design-West
> (916) 227-7147
>
>
>
>
>
> Rifaat
> Nashed/HQ/Caltran
> s/CAGov To
> Hossain
> 11/19/2009 03:20 Salimi/HQ/Caltrans/CAGov@DOT
> PM cc
> Tim Pokrywka/D04/Caltrans/CAGov
> Subject
> Somerville Rd UC (Replacement)
>
>
>
>
>
>
>
>
>
> Hi Hossain
>
> Please find attached the Final Foundation Report for Somerville Road
> Undercrossing (Replacement) by PARIKH Consultant
>
> (See attached file: FR- Somerville Rd UC (Replacement).pdf)(See attached
> file: Appendix B- Lab Tests.pdf)(See attached file: Appendix C.pdf)
>
>
> Regards
>
> Rifaat Nashed
(See attached file: 228511GeoSeg 3A-1stPSE.pdf)

6. Foundation Report - Cavallo Road Underpass - (Br. No. 28C0488) – East Contra Costa Transit Development (eBART) – Antioch, Contra Costa County, CA

FINAL FOUNDATION REPORT
CAVALLO ROAD UNDERPASS (BRIDGE NO. 28C0488)
EAST CONTRA COSTA TRANSIT DEVELOPMENT (eBART)
ANTIOCH, CONTRA COSTA COUNTY, CALIFORNIA

04-CC-4-R28.2 EA 2285F1

For

T. Y. Lin International
2010 Crow Canyon Place, Suite 350
San Ramon, CA 94583

PARIKH CONSULTANTS, INC.

1243 Alpine Road, Suite 110
Walnut Creek, California
(925) 933-6336

April 2010 Job No. 206117.EBS

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Appendix C Calculations

Appendix D Caltrans Comments and Responses

FINAL FOUNDATION REPORT
CAVALLO ROAD UNDERPASS (BRIDGE NO. 28C0488)
EAST CONTRA COSTA TRANSIT DEVELOPMENT (eBART)
ANTIOCH, CONTRA COSTA COUNTY, CALIFORNIA

04-CC-4-R28.2 EA 2285F1

INTRODUCTION

This report presents the results of our geotechnical engineering investigation for the proposed new eBART underpass structure over Cavallo Road in Antioch, Contra Costa County, CA. Our work was performed generally in accordance with the scope of work as per our agreement. The general location of the site and its vicinity are shown on the Project Location Map, Plate 1.

The geotechnical recommendations presented in this report are intended for design input and are not intended to be used as specifications. These recommendations should not be used for direct bidding purposes.

PROPOSED CONSTRUCTION

The project plans are to construct a new underpass for eBART in the median between the eastbound and westbound bridges on Highway 4 crossing Cavallo Road. The adjacent highway bridges are planned to be replaced under a different program. Per the plans provided by T. Y. Lin International, the new underpass will be single span cast-in-place, prestressed concrete box girder structures, each 130 feet long and 28 feet wide. The underpass will accommodate two parallel railroad tracks. The superstructures will be supported on open face abutments in approach fill embankments. The abutments will be supported on 24-inch diameter cast-in-drilled-hole (CIDH) piles.

PURPOSE AND SCOPE

The purpose of this investigation was to evaluate the general soil conditions at the project site, to evaluate their engineering properties, and to provide recommendations for foundation support of the proposed project.

The scope of work performed for this investigation included a review of the readily available soils and geologic literature, obtaining representative soil samples and logging soil materials encountered in two drilled borings, laboratory testing of the collected samples, engineering analysis of the field and laboratory data, and preparation of this report. The basis for this investigation is the preliminary plans provided to us by T. Y. Lin International. We have presented the descriptive log of the borehole in Appendix A.

Due to limitations inherent in geotechnical investigations, it is neither uncommon to encounter unforeseen variations in the soil conditions during construction nor is it practical to determine all such variations during an acceptable program of drilling and sampling for a project of this scope. Such variations, when encountered, generally require additional engineering services to attain a properly constructed project. We, therefore, recommend that a contingency fund be provided to accommodate any additional charges resulting from technical services that may be required during construction.

Our recommendations in this report are based on the above information. Any major deviation should be reported to this office for consideration.

SITE CONDITIONS

The project is located at the crossing of Cavallo Road and State Route 4, in the City of Antioch, Contra Costa County. Per the As-Built drawings, the existing bridges (which will be demolished) were constructed in 1969. They are single span, cast-in-place prestressed concrete structures, 117 feet long and 39 feet wide, each carrying two 12-ft wide traffic lanes and have a 10-ft shoulder adjacent to the outer lane and a 5-ft shoulder adjacent to the inner lane. The existing bridge abutments are on approach fill. The top of the fill is at an approximate elevation of 60 feet, which is approximately 10 to 15 feet above adjacent ground. The abutments are founded on spread footings. Design footing pressures of 1.5 tsf are noted in the as-built drawings.

The existing bridge abutments are on approach fill. The top of the fill is at an approximate elevation of 60 feet, which is approximately 10 to 15 feet above adjacent ground. The abutments for the underpass will be on the approach fill.

FIELD EXPLORATION AND LABORATORY TESTING

Field Exploration

The exploration program was based on the proposed plans, discussions with design engineer, and readily available data of the existing undercrossing. Two (2) exploratory borings were drilled in September, 2006, one near each abutment as part of the highway widening project. These borings and the associated laboratory testing have been used here, as they are deemed applicable to the proposed project. Borings were drilled from the top of the embankment to depths of approximately 100 feet. The test borings were advanced with a truck-mounted drill rig, using the hollow stem auger drilling method. The boring locations are shown on the plan portion of the Log of Test Borings in Appendix A.

The test borings were advanced with a truck-mounted drill rig. The drilling was performed using hollow stem auger. Selected samples were obtained from 3.0-inch O.D. & 2.5 inches I.D. (Modified California) and 2.0-inch O.D. & 1.4-inch I.D. (Standard Penetration Test) samplers at various depths. The samplers were driven in subsurface soils under the impact of a 140 lb hammer having a free fall of 30 inches. The blow counts are presented on the "Log of Test Borings". When correlating standard penetration data in similar soils, the blow counts for the Modified California Sampler may be converted to equivalent SPT blow counts by multiplying a factor of 0.65 per Daniel (2003). The samples were sealed and transported to our laboratory for further evaluation and testing. The field investigation was conducted under the supervision of our field engineer who logged the test borings and prepared the samples for subsequent laboratory testing and evaluation.

Laboratory Testing

Laboratory tests were performed on selected samples obtained during field exploration to determine the physical and engineering properties of the subsoils. Laboratory data of moisture contents, dry density, Atterberg Limits and unconfined compression tests are presented on the Log of Test Borings. A detailed description of laboratory testing performed is presented in Appendix B.

Boring Logs

The bore logs presented in Appendix A were prepared from the field logs which were edited after visual re-examination of the soil samples in the laboratory and results of classification tests on selected soil samples as indicated on the logs. The abrupt stratum changes shown on the log may be gradual and relatively minor changes in soil types within a stratum may not be noted on the log due to field limitations. Appendix A also includes log of test borings available from as-built drawings for the existing undercrossing.

SUBSURFACE CONDITIONS

Subsurface conditions in both the borings drilled indicate predominantly lean clays and sandy clays with occasional layers of sandy soils. The clays are generally very stiff to a depth of 30 feet, turning to hard clays below that depth. A layer of very dense poorly graded sand with silt and gravel, over 15 feet thick was encountered at a depth of approximately 70 feet in boring CAV-168 on the west end of the bridge. All other sandy layers encountered in the two borings were 10 feet thick or less. Below a depth of approximately 70 feet, very dense/very hard sand and clay layers were encountered, which were judged to belong to the Tulare Formation (Pliocene). A single boring log, drilled in 1957, is shown on the as-built plans. The boring log indicates predominantly silts with interbedded sand layers. The discrepancies between the current and As-built boring logs may be attributed to changes in soil classification standards over the years.

During field exploration, groundwater was encountered at depths ranging from 53.5 feet to 54.0 feet (elevations ranging from 4.5 feet to 5.2 feet) in the two borings. However, the groundwater may vary with the passage of time due to seasonal groundwater fluctuation, surface and subsurface flows, ground surface run-off and other factors that may not be present at the time of investigation.

GEOLOGY

General geologic features pertaining to the site were evaluated with reference to the "Geologic Map of Quaternary Geology of Contra Costa County and Surrounding Areas, CA: Derived from Digital Database open-file 97-98" by E.J. Helley and R.W. Graymer 1997; Scale 1:100000. Based on the

map, the site is located in an area covered by Pleistocene alluvial deposits (Qpaf). A geologic map of the general project area is shown on Plate 2. Description of the main geologic units is as follows:

> *Qpaf (Alluvial Fans and Fluvial Deposits (Pleistocene)) – Brown dense gravely and clayey sand or clayey gravel that fines upward to sandy clay. These deposits display various sorting and are located in most stream channels in the county. All Qpaf deposits can be related to modern stream courses. They are distinguished from younger alluvial fans and fluvial deposits by higher topographic position, greater degree of dissection, and stronger soil profile development. They are less permeable than Holocene deposits, and locally contain fresh water mollusks and extinct late Pleistocene vertebrate fossils. They are overlain by Holocene deposits on lower parts of the alluvial plain, and incised by channels that are partly filled with Holocene alluvium on higher parts of the alluvial plain. Maximum thickness is unknown but at least 50m (150 feet).*

Another map ('Preliminary geologic map emphasizing bedrock formations in Contra Costa County: A digital database', compiled by Graymer, Jones and Brabb (USGS Open File Report 94-622) was also considered for additional information for the bedrock. Bedrock (Tulare Formation) exposed at the surface is noted to the south of the site. The rock has a shallow dip towards the north and is therefore expected to underlie the hard Pleistocene clays at the site. Description of the rock is as follows:

> *Ttu (Tulare Formation (Pliocene) – Poorly consolidated, non-marine, gray to maroon siltstone, sandstone, and conglomerate. This formation contains tuff correlated with the Putah tuff.*

EARTHQUAKE CONSIDERATIONS

Seismic Sources

The project is located in a seismically active part of Northern California. Many faults exist in the area, which are capable of producing earthquakes which may cause strong ground shaking at the site.

Applicable major faults in the vicinity of the project site were identified and their associated

maximum earthquake magnitudes were established using the In-Progress Seismic Hazard Map currently under development by Caltrans and the associated Data Base. The documents were supplied to us by Caltrans, with the understanding that the fault locations in the map and the associated magnitudes in the Data Base have essentially been finalized. Pertinent information is summarized below. The moment magnitudes noted in the table represent the largest earthquakes that could occur on the given fault based on the current understanding of the regional tectonic structure. A fault map of the project vicinity is shown on Plate 3.

Fault	Fault No.(1)	Fault Type	Distance from Site (miles)	Maximum Moment Magnitude
Vaca Fault Zone	14	RLSS(2)	3.4	6.9
Great Valley Fault 5	24	Reverse Fault	4.4	6.5
Greenville Fault Zone (Clayton Section)	351	RLSS	4.1	6.6
Concord Fault Zone (Ygnacio Valley Section)	341	RLSS	6.9	6.6

(1) Number of the Fault in the Data Base associated with the Caltrans In-Progress Seismic Hazard Map
(2) RLSS – Right-Lateral Strike Slip Fault

Based on the Caltrans In-Progress Seismic Hazard Map and the attenuation relationship by Sadigh et al. (1997), the controlling fault is the Vaca Fault Zone (Fault No. 14 in the map), which is associated with a Maximum Moment Magnitude (Mmax) of 6.9. A peak bedrock acceleration (PBA) of 0.50g is anticipated at the site.

Seismic Hazards/Liquefaction Impact

Potential seismic hazards may arise from three sources: surface fault rupture, ground shaking and liquefaction. Since no active faults pass through the site, the potential for fault rupture is relatively low. Based on available geological and seismic information, the possibility of the site to experience strong ground shaking may be considered significant.

Liquefaction is a phenomenon in which saturated soils are subject to a temporary but essentially total loss of shear strength under the reversing, cyclic shear stresses associated with earthquake shaking. Submerged, cohesionless sands and silts of low relative density are the type of soils

which usually are susceptible to liquefaction - the susceptibility increases with decreasing relative density (reflected by the number of blows to drive a sampler), and decreasing fines content. Accepted procedures for the assessment of liquefaction potential for cohesionless soils have evolved over the years through research and field observations (Youd et al, 2001). Recent research and field observations have shown that clays of low plasticity are also potentially liquefiable, based on the moisture content and plasticity characteristics of the clay. Procedures for the assessment of liquefaction potential for clay soils have also been established and have received general acceptance. (Bray et. al., 2004).

Potential for liquefaction at the site is low, due to the predominant presence of stiff clay soils and the relatively low groundwater table.

FINDINGS AND RECOMMENDATIONS

General

Based on the findings of the investigation, it is our opinion that the site is feasible for the planned bridge structures provided the recommendations presented in this report are incorporated into the final design and construction.

This report was prepared specifically for the proposed bridge structures according to the plans provided to us. Normal construction procedures were assumed throughout our analysis and represent one of the bases of recommendations presented herein. Our design criteria have been based upon the materials encountered at the site. Therefore, we should be notified in the event that these conditions are changed, so as to modify or amend our recommendations.

Foundations

For the proposed structure, 24-inch diameter CIDH piles are recommended for foundation support at the two abutment locations.

Pile Design

Pertinent foundation design information was provided by T. Y. Lin International (Structural Engineers for the project), which are presented in the following tables (Foundation Design Data and Foundation Design Loads).

FOUNDATION DESIGN DATA

Support No	Design Method	Pile Type	Finish Grade Elev. (ft)	Pile Cut-off Elev. (ft)	Pile Cap Size (ft)		Permissible Settlement (inch)	No. of Piles per Support
					B[2]	L[3]		
Abutment 1	WSD	24-in CIDH	52.48	45.50	14	35	0.25[1]	14
Abutment 2	WSD	24-in CIDH	51.80	44.75	14	35	0.25[1]	14
Notes: (1) Per MTD 3-1 (2) B = Width (3) L = Length								

FOUNDATION LOADS

Support No.	Service-I Limit State (kips)			Strength Limit State (Controlling Group, kips)				Extreme Limit State (Controlling Group, kips)			
	Total Load		Permanent Loads	Compression		Tension		Compression		Tension	
	Per Supp.	Per Pile	Per Support	Per Supp.	Max. Per Pile.	Per Supp.	Max. Per Pile	Per Supp.	Max. Per Pile	Per Supp.	Max. Per Pile
Abutment 1	2724	204[1] 219[4]	2261	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Abutment 2	2724	204[1] 219[4]	2261	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Notes: (1) Group 1 Loading – 100 % of allowable; (4) Group 4 Loading – 125% of allowable											

Consistent with the current Caltrans requirements, Working Stress Design (WSD) was used for the abutment and wingwall foundations. The abutment and wingwall foundations were evaluated for the foundation design data and loading condition using Caltrans November 2003 Bridge Design Specifications for foundations, using Working Stress Design (WSD) methods. The actual load demands on the piles, based upon WSD are presented in the table below.

LOAD DEMANDS

Support No.	Design Method	Service Loads (kips)		Required Nominal Resistance (kips)				Required Nominal Resistance (kips)	
				Strength Limit		Extreme Limit			
		Comp.	Tens.	Comp. (ϕ=0.7)	Tens. (ϕ=0.7)	Comp. (ϕ=1.0)	Tens. (ϕ=1.0)	Comp.	Tens.
Abutment 1	WSD	204	0	N/A	N/A	N/A	N/A	408	0
Abutment 2	WSD	204	0	N/A	N/A	N/A	N/A	408	0

Estimation of the pile capacities was made using the site-specific subsurface conditions for the loads computed above and other pertinent information provided by the Structural Engineer. The computer program SHAFT developed by Ensoft, Inc. was used for the computations. The program computes capacities for drilled shafts (CIDH piles) based on procedures proposed by O'Neil and Reese (1999). The procedures utilize an α factor (α=0.55) for "Clay" and a β factor for "Sand" where β is a function of depths below ground surface and independent of soil friction angle The SHAFT program also computes the pile settlement and associated mobilization of shaft and end-bearing resistance, consistent with the O'Neil and Reese (1999) procedures.

The pile data table is presented below. Pile capacity computations (SHAFT output) are presented in Appendix C. End bearing resistance was neglected in the estimation for pile capacities.

PILE DATA TABLE

Location	Pile Type	Nominal Resistance (kips)		Finish Grade (ft)	Cut-off Elev. (ft)	Design Tip Elev. (ft)[1]	Specified Tip Elev. (ft)
		Compression	Tension				
Abutment 1	24-in CIDH[2]	410	0	52.48	45.50	7.0(a) 20.0 (b)	7.0
Abutment 2	24-in CIDH[2]	410	0	51.80	44.75	10.0(a) 22.0 (b)	10.0

1. Design Tip Elevation is controlled by the following demands: (a) Compression; (b) Lateral Loads.
2. The required nominal resistances for the piles are 480 kips, which slightly exceed the Caltrans Standard Nominal Resistance of 400 kips for 24-in CIDH piles. The pile design may therefore need to be modified by the Structural Engineer as appropriate.

CIDH Pile Installation

Caltrans standard specifications and standard special provisions (SSP) for "Cast-in-Place Concrete Piling" should be used for the construction of CIDH piles. It is possible that groundwater may be encountered during construction and "dry" condition as per the standard specifications Section 49-4 could not be maintained. The "wet" specifications are contained in Caltrans SSP.

Vertical inspection pipes for acceptance testing should be provided in all CIDH piles that are 24 inches in diameter or larger, except when the holes are dry or when the holes are dewatered without the use of temporary casing to control groundwater. The acceptance test should include Gamma-Gamma Logging and may also include crosshole sonic logging. Gamma-Gamma Logging should be performed in accordance with California Test 233 Standard (CT233) to check the homogeneity of CIDH piles. Details of the acceptance testing and Gamma-Gamma Logging are contained in Caltrans SSP and CT233.

It is prudent to make the contractor aware of these conditions so that he takes appropriate steps to comply with the standards and maintain the integrity of the CIDH piles. The use of temporary steel casing should be anticipated at all times to maintain the integrity of the piles. It is also recommended that the specifications set certain criteria for qualifications and previous work experience requirements to pre-qualify the potential contractors. The intent is to help select qualified contractors to reduce construction issues.

All piles excavations should be observed by the geotechnical engineer or regulatory agency prior to the placement of reinforcement and concrete so that if conditions differ from those anticipated, appropriate recommendations can be made.

Lateral Pile Capacity

Lateral load analyses may be performed using the LPILE program to determine the behavior of the piles under lateral loading conditions. Geotechnical parameters recommended for use in the LPILE program are presented below. The following parameters are based on field borings and laboratory testing data. The elevation information is based on the topographic information provided to us.

Geotechnical Parameters for LPILE Analysis

Abutment 1

Approx. Elev. (ft.)	Generalized Soil Profile	LPILE Soil Type	Probable Soil Strength	K (pci)	E_{50} (in/in)	Effect Unit Wt. (pci)
Above 30	Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 17.36 psi	1000	.005	0.0723
10 to 30	Hard Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 27.78 psi	500	.004	0.0723
2 to 10	Dense Sand with Silt	8, API SAND	ϕ=35°	125	--	0.0752
2 to -8	Hard Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 27.78 psi	2000	.004	0.0376
Below -8	Very Dense Sand with Silt	8, API SAND	Cu = 280 psi	N/A	--	0.0405

Abutment 2

Approx. Elev. (ft.)	Generalized Soil Profile	LPILE Soil Type	Probable Soil Strength	K (pci)	E_{50} (in/in)	Effect. Unit Wt. (pci)
Above 40.5	Stiff to Very Stiff Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 13.89 psi	750	.006	0.0723
5.5 to 40.5	Hard Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 27.78 psi	2000	.004	0.0376
-7.5 to 5.5	Very Stiff Lean Clay	, STIFF CLAY w/o FREE WATER	Su = 17.36 psi	1000	.005	0.0376
Below -7.5	Hard Lean Clay	3, STIFF CLAY w/o FREE WATER	Su = 27.78 psi	2000	.004	0.0376

Analyses were performed for the CIDH piles for the lateral loads provided by the designer. In all analyses, a 'pinned' pile head connection was assumed. The results are presented in the table below. Appropriate Group Reduction Factors were used in the analyses corresponding to the pile spacings, as noted in the table.

LATERAL LOAD (LPILE) ANALYSIS RESULTS

Support No.	CIDH Pile Diameter (inches)	Cut-off Elevation (ft)	Shear Load on top of Pile (kips)	Deflection on Top of Pile (inches)	Maximum Bending Moment	
					Magnitude (kip-ft)	At depth (ft)(1)
Left Bridge						
Abut 1	24	45.75	36	0.137	99.0	6
			56	0.363	186.8	7
			76	0.708	289.2	8
Abut 2	24	45.25	36	0.151	116.2	6
			56	0.370	212.0	7
			76	0.687	321.2	7

Notes:

(1) Depth measured from top of pile (bottom of footing)

(2) Group factors of 0.6 used for Abutments corresponding to a pile spacing of three times the diameter, consistent with Caltrans state-of-practice

(3) Loads provided by Antonio Luo

Lateral Earth Pressures

Abutment retaining walls and wing walls should be designed to resist the following Applied Lateral Earth Pressures and live load. These values assume no hydrostatic pore pressure buildup behind the wall and are based on well-drained backfill behind the walls supported in native soil.

Active Condition (flexible wall - wall free to rotate at least 0.4 percent of wall height

Structure Backfill:	Equivalent Fluid Pressure (EFP) – 36 pcf (backfill having a friction angle $\varphi = 33.5°$ and a unit weight of 125 pcf)
Surcharge (dead or live load):	0.3 times surcharge load

At-Rest Condition (rigid wall - wall not free to rotate at least 0.4 percent of wall height

Structure Backfill:	Equivalent Fluid Pressure (EFP) – 55 pcf (backfill having a friction angle $\varphi = 33.5°$ and a unit weight of 125 pcf)
Surcharge (dead or live load):	0.5 times surcharge load

Passive Resistance for Seismic Design of Abutment Wall

Height of wall – 5.5 feet or higher: 5.0 ksf (ultimate)
Height of wall – less than 5.5 feet: 5.0 X (H/5.5) ksf (ultimate)

Seismic increment of Lateral Earth Pressure (based on BART Facilities Standards)

$11.7H^2$ (psf) per foot of wall, acting at 0.6H above the base
(The earth pressures are based on Mononobe-Okabe formulation. The accelerations used are half of the corresponding peak acceleration per BART Facilities Standards)

Seismic Design Criteria

The value of PBA for the project site was calculated from the distances to the applicable faults in the project vicinity using the Caltrans In-Progress Seismic Hazard Map and the attenuation relation by Sadigh et al. (1997). The computed PBA value was increased by 20%, also per Sadigh (1997), to account for the reverse fault effect, wherever applicable. The PBA computations based on Sadigh attenuation relation are presented in Appendix C. Based on the computations, the maximum PBA computed within the project limit is 0.5g,

Based on the available boring information in the vicinity of the project site, the subsurface soil conditions at the project site generally matches the criteria for Soil Type D, as per Caltrans Seismic Design Criteria (Version 1.4, June 2006). Based on Caltrans Seismic Design Criteria and the above information, the seismic design criteria are as follows:

1.	Closest Distance to Fault	=	3.4 miles (5.5 km)
2.	PBA	=	0.5g
3.	Design ARS Curve	=	Caltrans Seismic Design Criteria June 2006 Version 1.4 Figure B.8 (Soil Profile Type D).

4. Design ARS Curve (see Plate 4): Curve based on Caltrans SDC (v. 1.4, 6/2006) for different structural periods. The curve is based on (Governing Fault – Vaca Fault Zone; Mmax =6.9) Figure B.8, PBA = 0.5g. The curve is modified for near fault effects as required by SDC.

A copy of the ARS Design Curve is included on Plate No. 4 of this report.

Grading

All grading operations should be performed in accordance with the project specifications and Caltrans Standard Specifications for Earthwork (Section 19).

Engineered Fill Engineered fill should be non-expansive and consist of relatively granular material having a P.I. of less than 15. The fill shall also be free of organic and inorganic debris, rubble and any other deleterious material. The on-site soils may be used as engineered fill, provided they meet the above criteria.

Approach Embankment. The maximum embankment fill thickness is anticipated to be approximately 10 feet at the two abutment locations. The approach embankment will have a 2(H): 1(V) slope on both sides. Under the bridge, paved slopes may be constructed at 1.5(H):1 (V) slope. The available boring data indicates that the subsurface soil conditions predominantly consist of stiff to very stiff clays below the fill. Based on the boring information, it appears that the consolidation settlement due to the placement of the embankment fill is anticipated to be relatively quick (during construction) and therefore insignificant. Standard Caltrans 30-day waiting period is considered adequate.

Corrosion

The corrosion investigations performed are in general accordance with the provisions of California Test Method 643. A summary of the corrosion test data is presented below.

Boring	Depth (ft)	PH	Resistivity (ohms-cm)	Sulfate (ppm)	Chloride (ppm)
CAV-168	8.5	7.61	1450	43.6	6.2

Based on the data, the site subsoil is non-corrosive per Caltrans corrosion design guidelines, and standard Type II modified or Type I-P (MS) modified cement may be used for the concrete substructures. The minimum cement factor and cover thickness should be per Caltrans Bridge Design Specifications (Section 8.22).

Plan Review

We recommend that final plans for foundations be reviewed by this office prior to construction so that the intent of our recommendations is included in the project plans and specifications and to further see that no misunderstandings or misinterpretations have occurred.

Construction Observation

To a degree, the performance of any structure is dependent upon construction procedures and quality. Hence, observation of foundation excavations, and pile installations should be carried out by the regulating agencies. If the subsurface conditions different from those forming the basis of our recommendations is encountered this office should be informed in order to assess the need for design changes. Therefore, the recommendations presented in this report are contingent upon good quality control and these geotechnical observations during construction.

INVESTIGATION LIMITATIONS

Our services consist of professional opinions and recommendations made in accordance with generally accepted geotechnical engineering principles and practices and are based on our site reconnaissance and the assumption that the subsurface conditions do not deviate from observed conditions. All work done is in accordance with generally accepted geotechnical engineering principles and practices. No warranty, expressed or implied, of merchantability or fitness, is made or intended in connection with our work or by the furnishing of oral or written reports or findings. The scope of our services did not include any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in structures, soil, surface water, groundwater or air, below or around this site. Unanticipated soil conditions are commonly encountered and cannot be fully determined by taking soil samples and excavating test borings; different soil

conditions may require that additional expenditures be made during construction to attain a properly constructed project. Some contingency fund is thus recommended to accommodate these possible extra costs.

This report has been prepared for the proposed project as described earlier, to assist the engineer in the design of this project. In the event any changes in the design or location of the facilities are planned, or if any variations or undesirable conditions are encountered during construction, our conclusions and recommendations shall not be considered valid unless the changes or variations are reviewed and our recommendations modified or approved by us in writing.

This report is issued with the understanding that it is the designer's responsibility to ensure that the information and recommendations contained herein are incorporated into the project and that necessary steps are also taken to see that the recommendations are carried out in the field.

The findings in this report are valid as of the present date. However, changes in the subsurface conditions can occur with the passage of time, whether they are due to natural processes or to the works of man, on this or adjacent properties. In addition, changes in applicable or appropriate standards occur, whether they result from legislation or from the broadening of knowledge. Accordingly, the findings in this report might be invalidated, wholly or partially, by changes outside of our control.

Respectfully submitted,
PARIKH CONSULTANTS, INC.

Partha Sircar, Ph.D., P.E. C54619
Senior Engineer

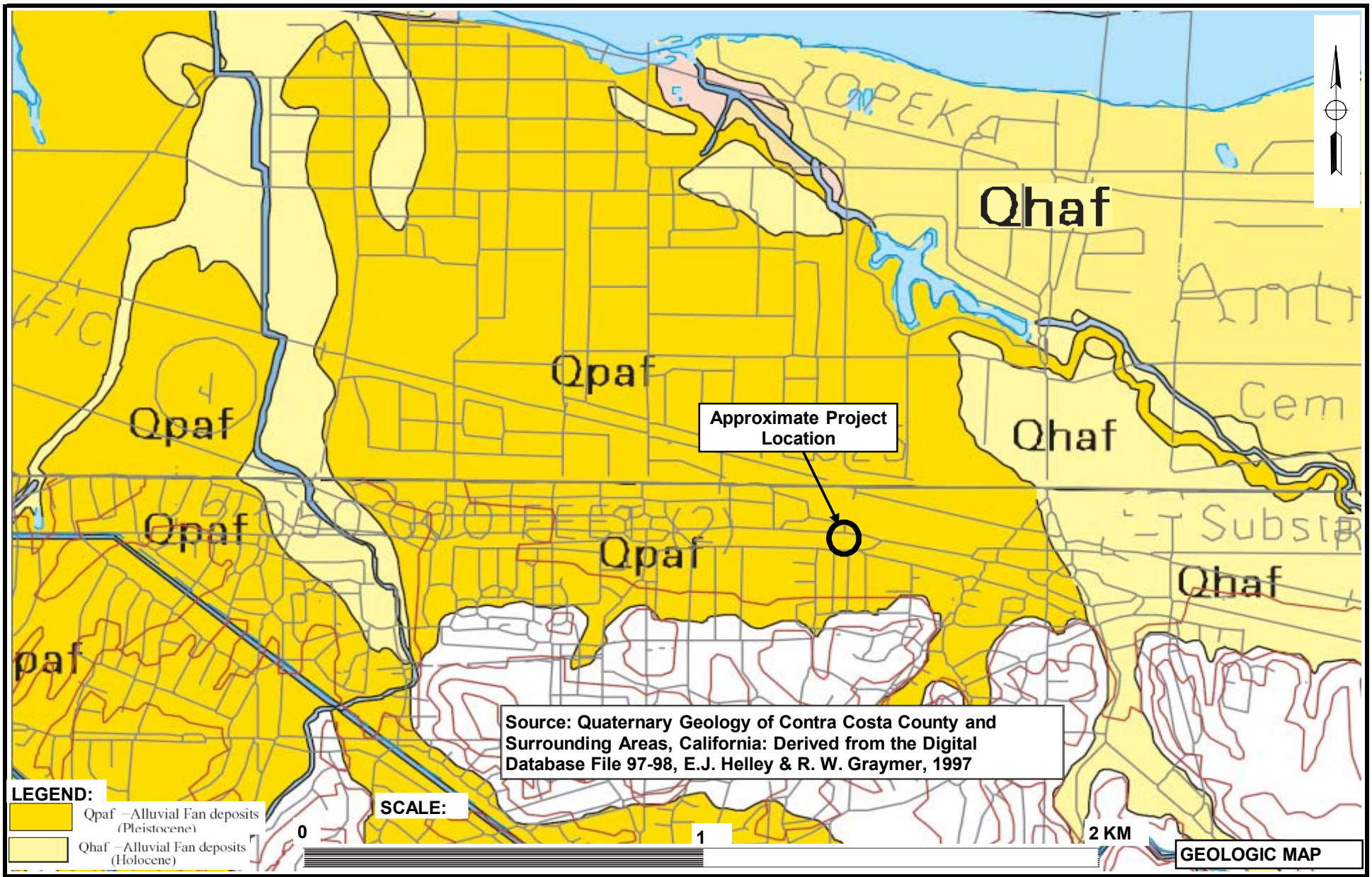
Gary Parikh, G.E. 666
Project Manager

REGISTERED PROFESSIONAL ENGINEER
GAURANG R. PARIKH
No. 666
EXP. 12-31-11
GEOTECHNICAL
STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

eBART CAVALLO ROAD UNDERPASS
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO.: 206117.EBS	PLATE NO.: 1

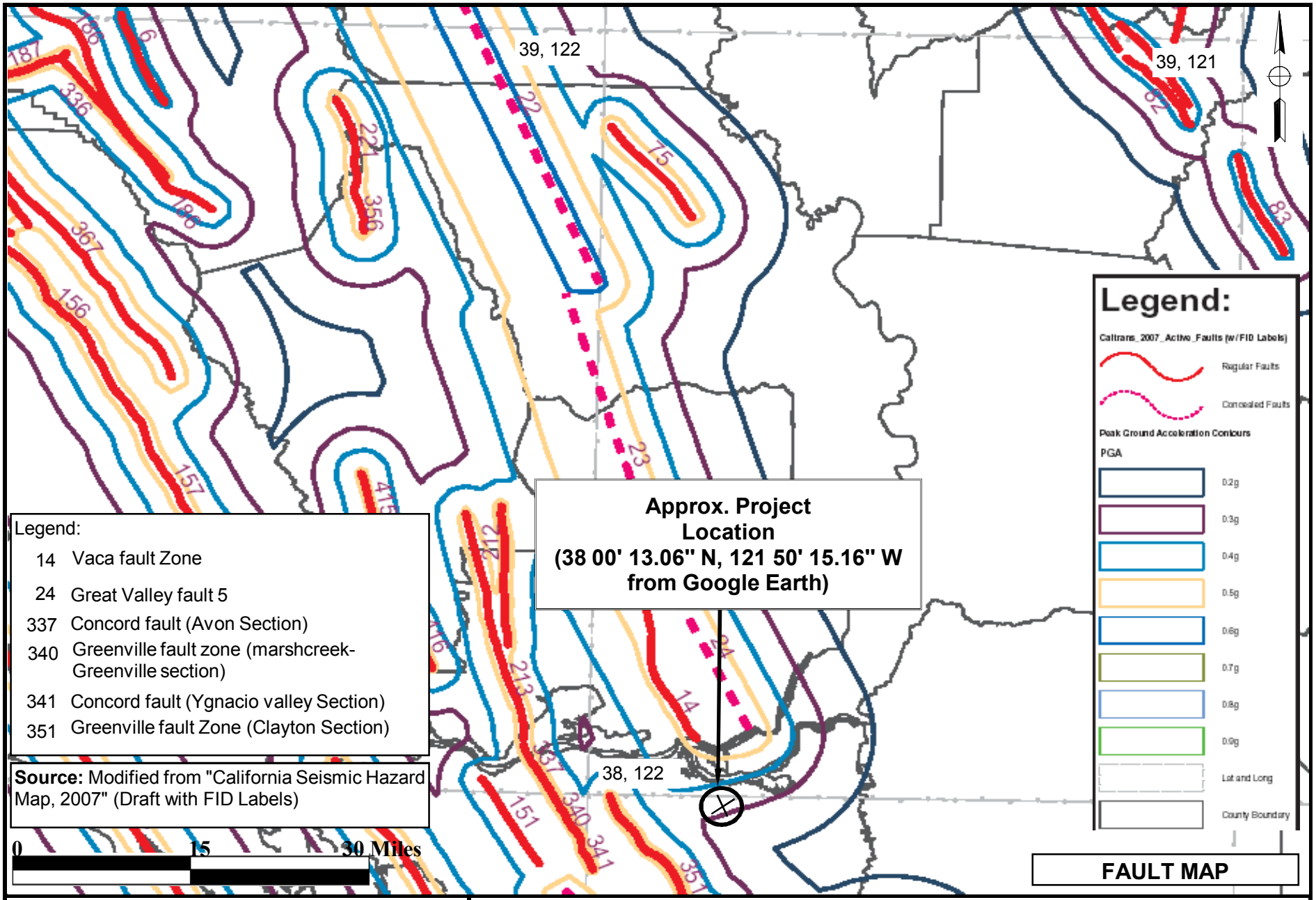


PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

eBART CAVALLO ROAD UNDERPASS
ANTIOCH, CALIFORNIA

JOB NO.: 206117.EBS

PLATE NO.: 2



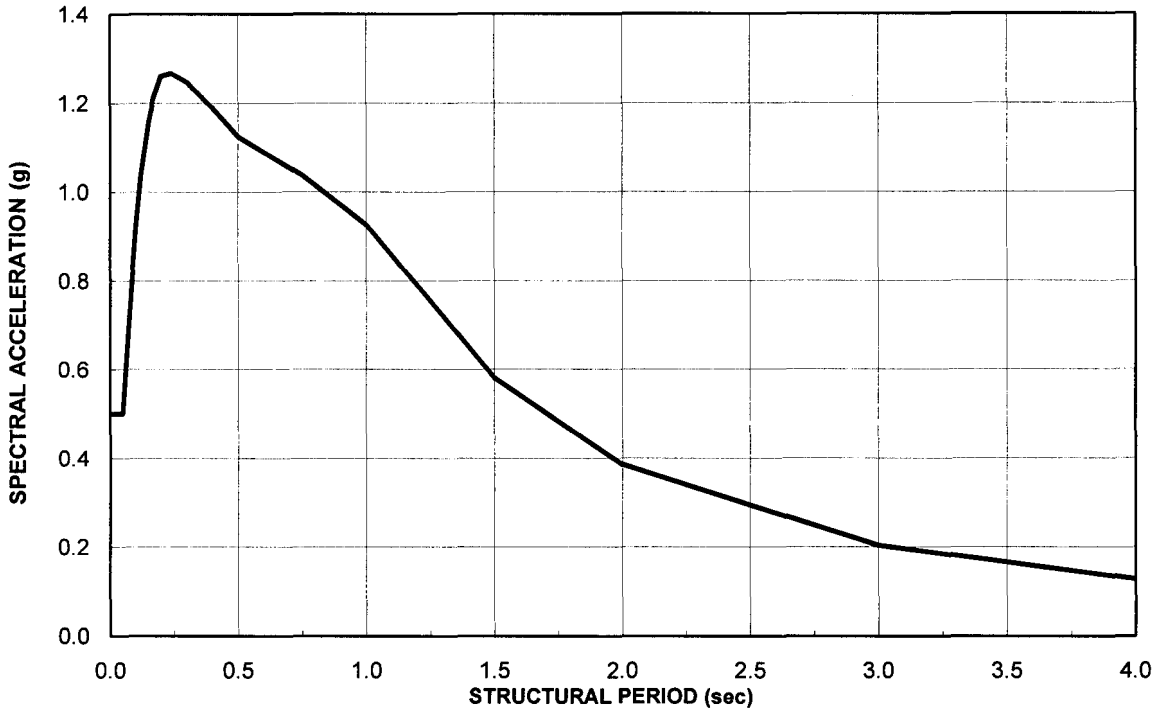
FAULT MAP

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

eBART CAVALLO ROAD UNDERPASS
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO.: 206117.EBS	PLATE NO.: 3

eBART Cavallo Road Underpass



Spectral Data

Period (sec)	Spectral Accel. (g)
0.010	0.500
0.020	0.500
0.030	0.500
0.050	0.500
0.075	0.719
0.100	0.919
0.120	1.037
0.150	1.156
0.170	1.209
0.200	1.259
0.240	1.266
0.300	1.247
0.400	1.190
0.500	1.125
0.750	1.038
1.000	0.927
1.500	0.581
2.000	0.386
3.000	0.204
4.000	0.128

Caltrans SDC (v 1.4, June 2006), Figure B.8,
Governing Fault: Vaca Fault Zone
Fault Distance = 5.45 km (3.4 miles)
(Mw = 6.9, Soil Profile Type D, PBA = 0.5g)

Notes:
(a) The new (in-progress) Caltrans Hazard Map and Data Base was used
(b) PBA was obtained by using Sadigh Attenuation Relationship: 0.49g (rounded off to 0.5 g)
(c) The following modifications were then applied for near-fault effects:
(1) No change of Sa for structural periods $\leq$ 0.5 sec
(2) 20% increase of Sa for structural periods > 1 sec
(3) Linear interpolation for structural periods between 0.5 and 1 sec

APPENDIX A

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

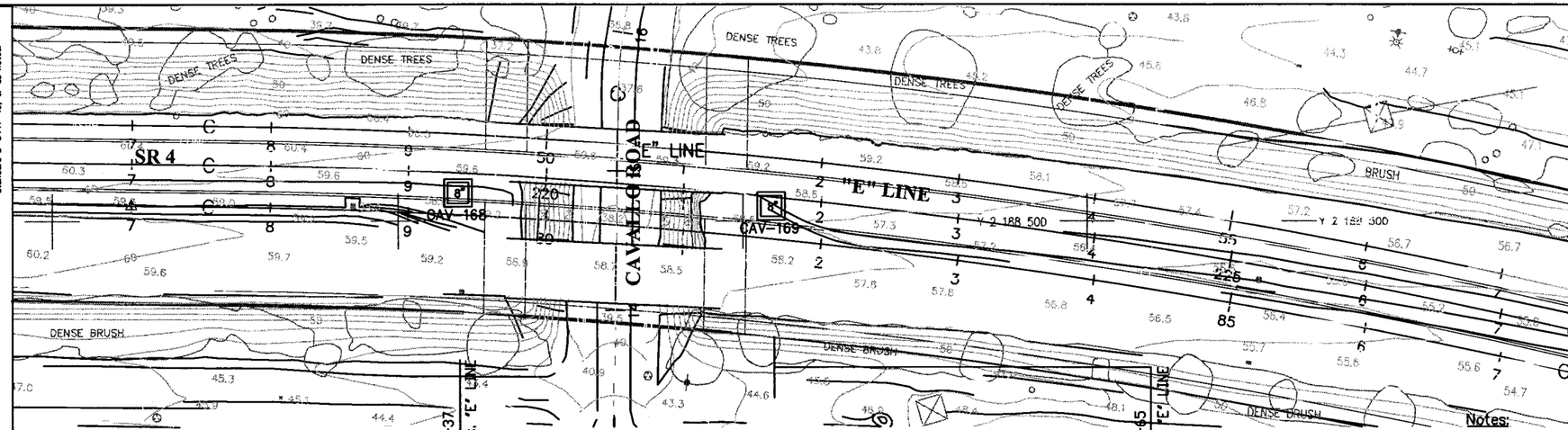
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE. 666 Exp. 12/31/09 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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.



PLAN
1"=50'

Notes:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)

PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ELEVATION (feet)

CAV-168

Sta 219+37, 12.8'± Rt. "E" LINE; Elev. 58.7 ft±; 8"

Blows	Hammer	Penetration (in)	Moisture (%)	Dry Density (pcf)	Soil Symbol	Description
23	2.5	1	111.9	16		LEAN CLAY (CL), stiff, grayish brown, moist
35	2.5	2	106.9	20	CA	--very stiff, brown
–	2.5	3	108.0	21	AL	--very stiff, bluish gray (LL=31, PI=11)
1.6 / 33	2.5	4	105.1	20	UC	--very stiff, bluish black
30	2.5	5	109.3	15	AL	--very stiff, brown (LL=39, PI=22)
90	2.5	6	108.1	10		SANDY LEAN CLAY (CL), hard, brown, dry
60	2.5	7	104.0	18		LEAN CLAY (CL), hard, brown, moist
41	2.5	8	101.9	4	SA	POORLY-GRADED SAND WITH SILT (SP-SM), medium dense, bluish brown, moist, fine-grained (+#4=0%, -#200=8%)
63	2.5	9	118.0	13		SANDY LEAN CLAY (CL), hard, brown, moist
43	2.5	10	111.9	18	SA	CLAYEY SAND (SC), medium dense, bluish brown, moist (+#4=1%, -#200=37%)
48	2.5	11	106.4	17	SA	POORLY-GRADED SAND (SP), dense, bluish brown, moist (+#4=0%, -#200=4%)
41	1.4	12	–	41		LEAN CLAY (CL), hard, brown, wet
50/6"	2.5	13	–	–		--(No Recovery)
50/5"	1.4	14	–	32	SA	POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM), very dense, bluish brown, wet (+#4=27%, -#200=6%)
60	1.4	15	–	38		--very dense
50/6"	1.4	16	–	31		--very dense
50/6"	1.4	17	–	24		--very dense, fine-grained
50/6"	1.4	18	–	47		LEAN CLAY (CL), hard, grayish brown, wet
72	2.5	19	90.8	32		--hard, bluish brown

GWS ▽ ELEV. = 5.2'± 9-7-06

9-7-06

CAV-169

Sta 221+65, 6.0'± Rt. "E" LINE; Elev. 58.5 ft±; 8"

Blows	Hammer	Penetration (in)	Moisture (%)	Dry Density (pcf)	Soil Symbol	Description
17	2.5	1	105.3	18		LEAN CLAY (CL), stiff, gray and brown, moist, medium plasticity
34	2.5	2	102.0	22	UC	LEAN CLAY WITH SAND (CL), very stiff, brown, moist, medium plasticity
2.6 / 25	2.5	3	108.6	19	AL	LEAN CLAY (CL), very stiff, brown and mottled gray, moist, medium plasticity (LL=35, PI=17)
18	2.5	4	108.2	15		--stiff, dark brown
62	2.5	5	104.5	10	SA	SILTY SAND (SM), very dense, yellowish brown, moist, fine-grained (+#4=1%, -#200=28%)
50/6"	2.5	6	99.7	16		LEAN CLAY (CL), hard, yellowish brown and mottled white, moist, medium plasticity
61	2.5	7	107.8	17		--hard
3.8 / 45	2.5	8	95.7	22	UC AL	--very stiff, gray and mottled brown (LL=44, PI=20)
76	2.5	9	111.2	12	SA	SANDY LEAN CLAY (CL), hard, gray and mottled red, moist, medium plasticity (+#4=0%, -#200=62%)
82	2.5	10	109.7	19		--hard, gray
80	2.5	11	102.3	24	SA	SANDY SILT (ML), hard, yellowish brown and gray, low plasticity, fine-grained sand (+#4=0%, -#200=57%)
19	1.4	12	–	56	SA	SILTY CLAY WITH SAND AND GRAVEL (CL-ML), very stiff, gray and brown, wet, low plasticity, gravel up to 3", medium to coarse grained sand, decomposed bedrock (+#4=0%, -#200=71%)
22	1.4	13	–	42	SA	SANDY SILTY CLAY WITH GRAVEL (CL-ML), very stiff, gray and brown, low plasticity, gravel up to 3", medium to coarse grained sand, decomposed bedrock (+#4=0%, -#200=58%)
50/5.5"	2.5	14	106.5	21		LEAN CLAY WITH SAND (CL), hard, gray, moist, medium to high plasticity, fine-grained sand
50/4"	2.5	15	83.2	26		POORLY-GRADED SAND WITH GRAVEL (SP), very dense, dark gray, wet, gravel up to 1", fine to medium grained
50/3"	2.5	16	82.8	37		LEAN CLAY (CL), hard, gray, moist, medium plasticity, trace decomposed bedrock
50/5.5"	2.5	17	96.8	27		LEAN CLAY WITH SAND (CL), hard, bluish gray, moist, medium plasticity, fine-grained sand

GWS ▽ ELEV. = 4.5'± 9-6-06

9-6-06

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

218+00 220+00 222+00 224+00

LEGEND OF BORING OPERATIONS

IN-SITU, LAB & FIELD TEST DESIGNATIONS

TYPES OF BORINGS

LEGEND OF EARTH MATERIALS (USCS) BASED ON ASTM D2487, D2488

CONSISTENCY CLASSIFICATION FOR SOILS According to the Standard Penetration Test (ASTM D-1586)

NOTE: Visual classifications of earth materials are based on field inspection and or a confirmed or revised with laboratory test results as necessary.

DESIGN OVERSIGHT

SIGN OFF DATE

DESIGN By: D. GOUTHIER
CHECKED By: P. SIRCAR

Field Investigation by: L. BHANGOO

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

P. SIRCAR
PROJECT ENGINEER

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04275
EA 228511

STRUCTURE NO. 28-0402 L/R
POST MILES (PM) 28.2

CAVALLO ROAD UNDERCROSSING (L/R)

LOG OF TEST BORINGS

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) 08/31/09

SHEET 1 OF 2

PLATE A-1

S:\ACAD\206117.CAV\LOTB.dwg, 1, 8/31/2009 1:36:22 PM, O.G

DIST.	COUNTY	ROUTE	KILOMETER POST–TOTAL PROJECT	Sheet No.	Total Sheets
04	CC	4			

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 CIVIL ENGINEER — DATE: 06-23-08

LOG OF TEST BORINGS

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

CU: 04275
EA: 228511

BRIDGE No. 28-6402L/R

Sheet 2 of 2

REGISTERED PROFESSIONAL ENGINEER — GARY PARIKH — No. G.E. 666 — Exp. 12/31/09 — GEOTECHNICAL — STATE OF CALIFORNIA

Revisions made to this Log of Test Borings from the original 1969 Log of Test Borings are the addition of the following table and notes:

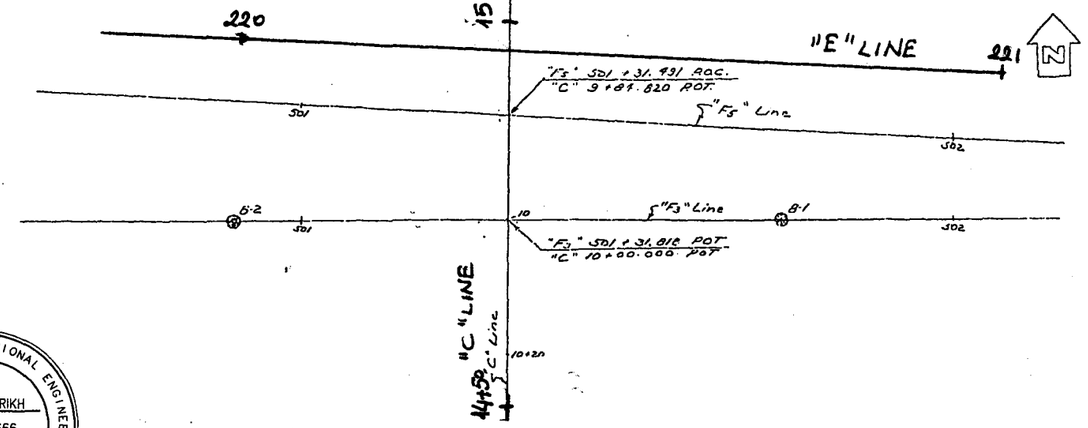
Boring	Station	Offset from "E" LINE
B-2	219+99	12 ft Rt
B-1	220+72	10 ft Rt

'F5' Line parallels 'E' Lines

'C' Line intersects 'E' Line at Station 220+36 ft

Notes:

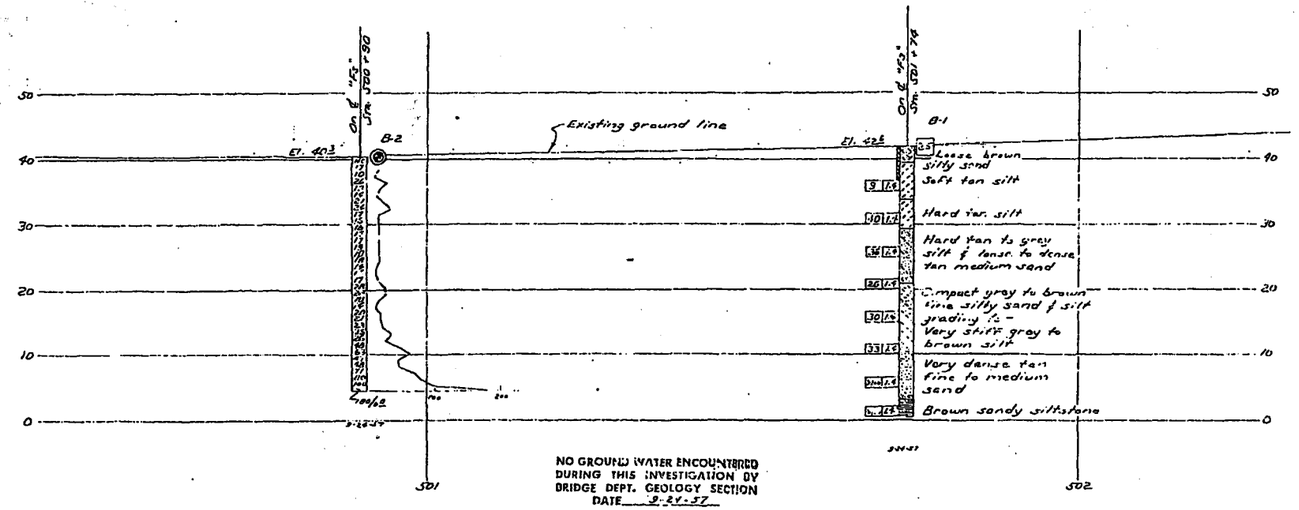
1. See the "Log of Test Borings" for stationing.
2. The Division of Structure Design produced the data presented in the table above. The data are the English locations for the As-Built Test Borings referenced to the proposed new structure location. This table is presented on the As-Built Log of Test Boring sheet for the convenience of any bidder, contractor or other interested party.



Dist.	County	Route	PM	Sheet No.	Total Sheets
04	CC	4	23.7/25.4 R.S.M/L.M.	204	315

Section Supervisor — April 4, 1962

BM #54 - "X" Cut into PCC base lattice tower N. side Tragallis Rd. 121' Rt. "F3" Sta. 498 + 99 ± Elev. 45 ±



NO GROUND WATER ENCOUNTERED DURING THIS INVESTIGATION BY BRIDGE DEPT. GEOLOGY SECTION
DATE 9-27-57

AS BUILT
CONTRACT No. ____
CONTRACT No. ____
DATE ____

CLASSIFICATION OF MATERIAL BASED ON STANDARD GRADE SIZE LIMITS

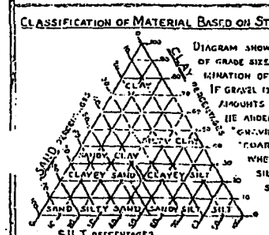


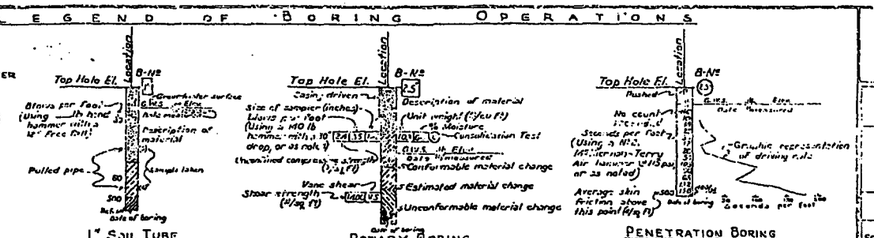
DIAGRAM SHOWING THE BASIS FOR ESTIMATES OF GRADE SIZE DISTRIBUTION USED IN DETERMINATION OF CLASS NAMES. IF GRAVEL IS PRESENT IN APPRECIABLE AMOUNTS THE TERM "GRAVELLY" MAY BE ADDED TO THE CLASS NAME, VIZ. "GRAVELLY SAND." THE TERMS "COARSE", "MEDIUM" AND "FINE" WHEN USED TO DESCRIBE SAND, SILT AND GRAVEL 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 — 70 11

CAVALLO ROAD UNDERCROSSING

LOG OF TEST BORINGS

SCALE 1" = 10' | BRIDGE 28-80 | FILE | DRAWING 2385-10

APPENDIX B

APPENDIX B

LABORATORY TESTS

Classification Tests

The field classification of the samples was visually verified in the laboratory according to the Unified Soil Classification System. The results are presented on "Log of Test Borings", Appendix A.

Moisture-Density

The natural moisture contents and dry unit weights were determined for selected undisturbed samples of the soils in general accordance with ASTM Test Method D 2216-92. This information was used to classify and correlate the soils. The results are presented at the appropriate depths on the "Log of Test Borings", Appendix A.

Atterberg Limits

The Atterberg Limits were determined for selected samples of the fine-grained materials. These results were used to classify the soils, as well as to obtain an indication of the effective strength characteristics and expansion potential with variations in moisture content. The Atterberg Limits were determined in general accordance with ASTM Test Method D 4318-93. The results of these tests are presented on Plate B-2, "Plasticity Chart".

Grain Size Classification

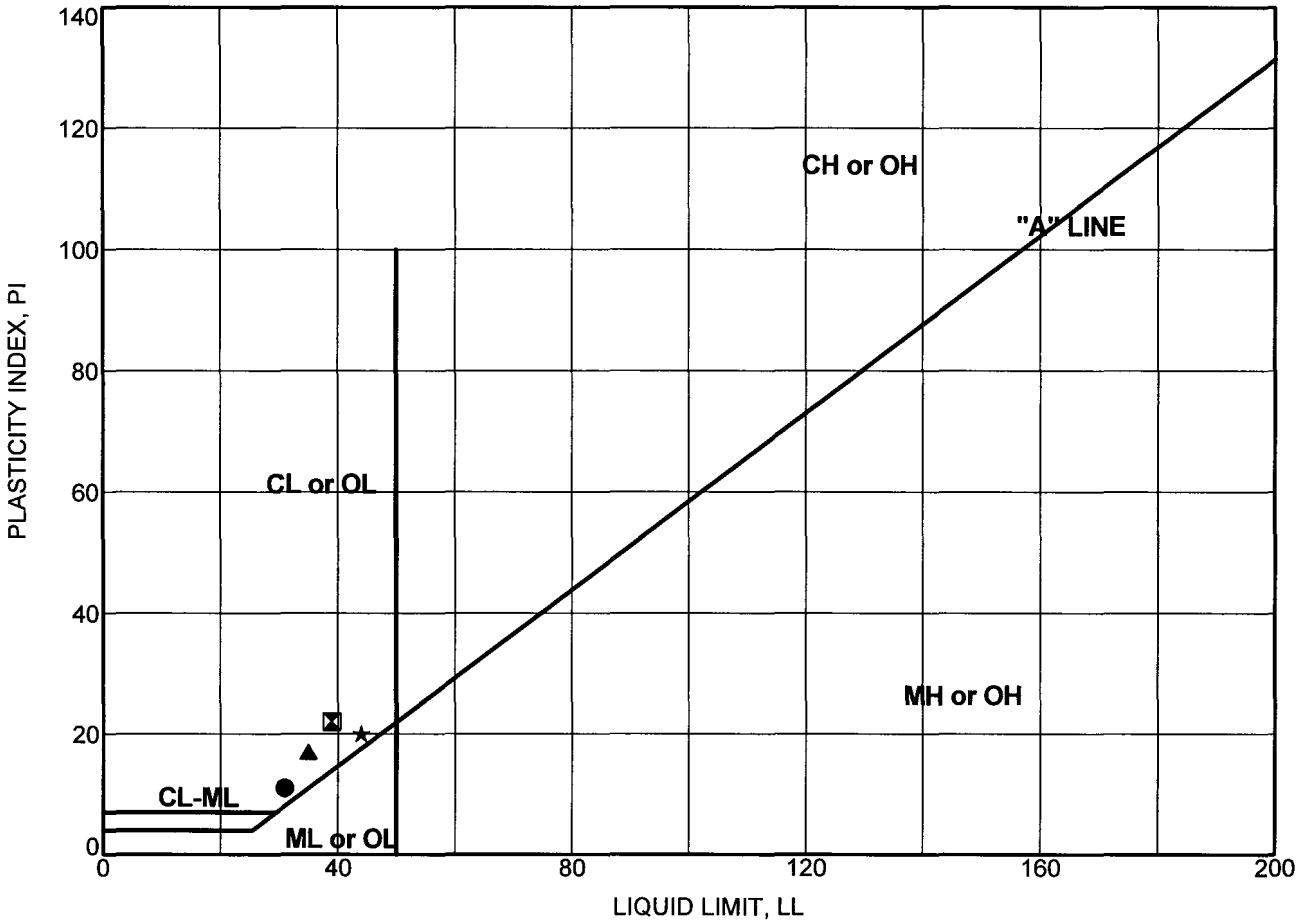
Grain size classification tests (ASTM Test Method D422-63) were performed on selected samples of granular soil to aid in the classification. The results are presented on Plates B-3A to B-3C, "Grain Size Distribution Curves".

Unconfined Compression Tests

Strength tests were performed on selected undisturbed samples using unconfined compression machine. Unconfined compression tests were performed in general accordance with ASTM Test Method D 2166-91. The results are presented on "Log of Test Borings"

Corrosion Test

Corrosion test was performed on selected sample to determine the corrosion potential of the soils. The pH and minimum resistively test was performed according to California Test Method 643. The test was performed by Sunland Analytical. The test result is presented on Plate B-4.



PLASTICITY CHART

Boring Number	Sample Number	Depth (feet)	Test Symbol	Moisture Content (%)	LL	PL	PI	Description
CAV-168	MC-3	14.5	●	21	31	20	11	LEAN CLAY (CL)
CAV-168	MC-5	25.0	⊠	15	39	17	22	LEAN CLAY (CL)
CAV-169	MC-3	10.0	▲	19	35	18	17	LEAN CLAY (CL)
CAV-169	MC-8	35.0	★	22	44	24	20	LEAN CLAY (CL)

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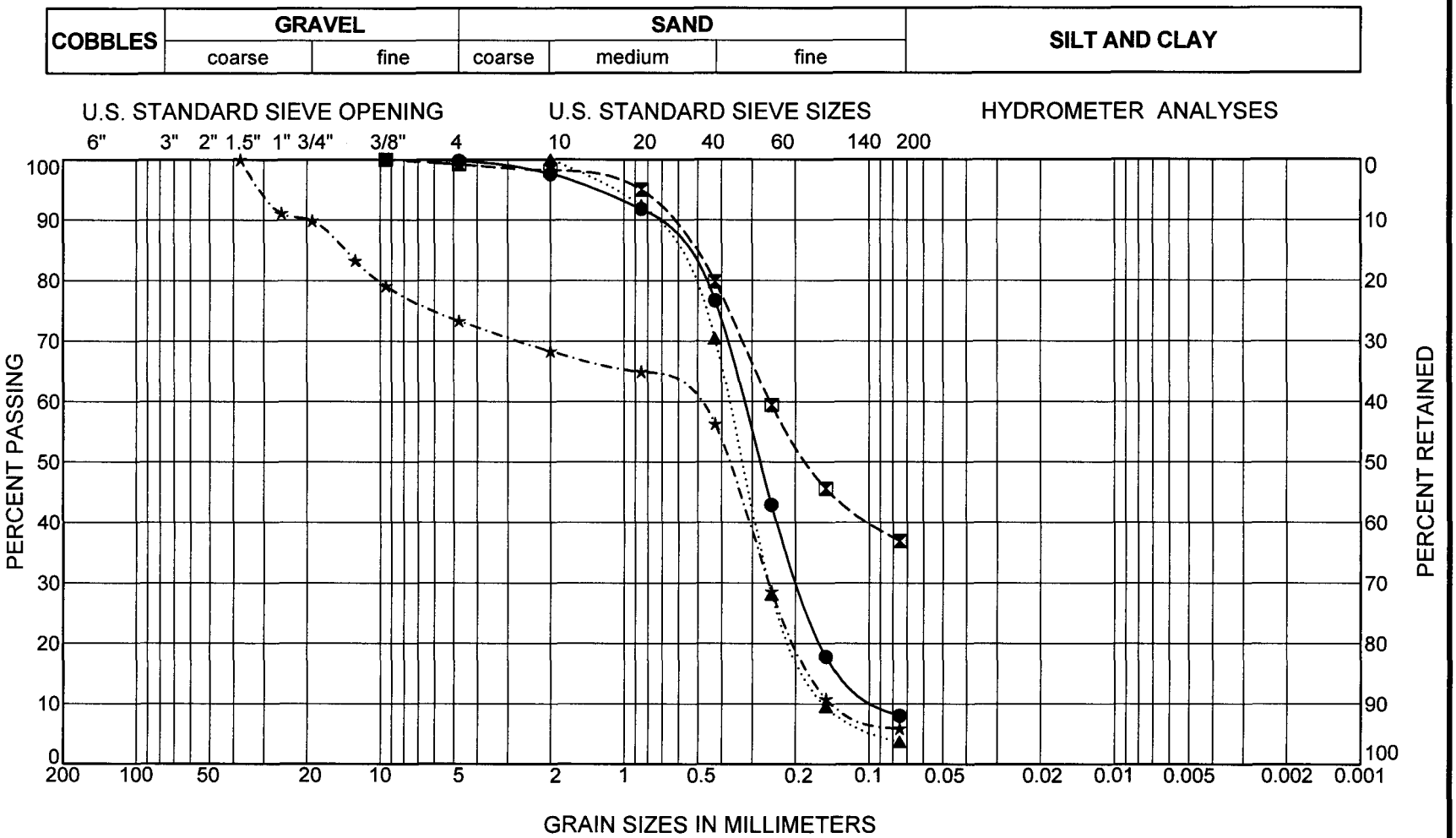
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

CAVALLO ROAD UNDERCROSSING
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.CAV

PLATE NO: B-2

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
CAV-168	MC-8	40.0	●			POORLY GRADED SAND WITH SILT (SP-SM)
CAV-168	MC-10	50.0	⊠			CLAYEY SAND (SC)
CAV-168	MC-11	55.0	▲			POORLY GRADED SAND (SP)
CAV-168	SPT-14	70.0	★			POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)

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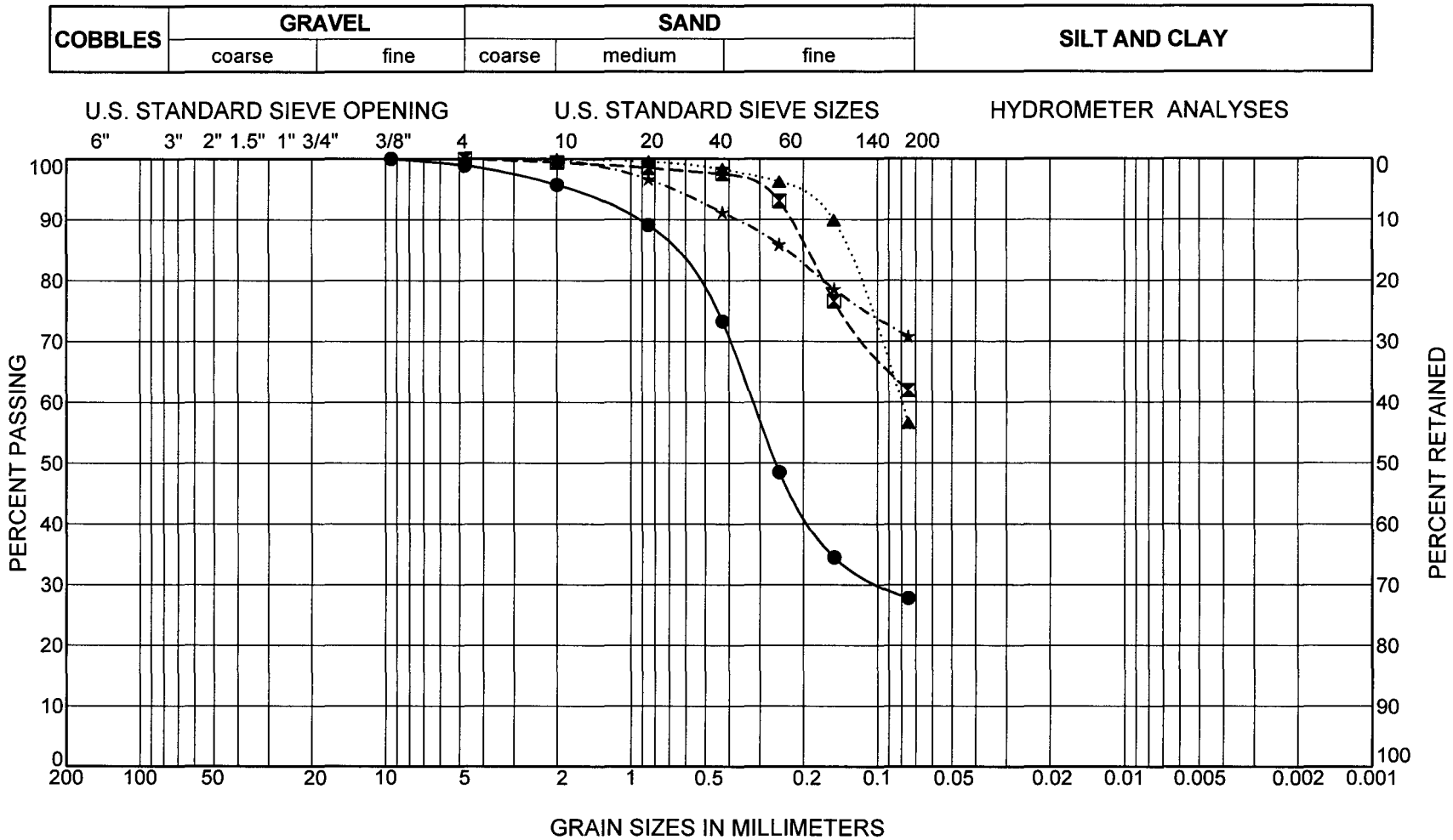
MATERIALS ENGINEERING

CAVALLO ROAD UNDERCROSSING
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.CAV

PLATE NO: B-3A

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
CAV-169	MC-5	20.0	●			SILTY SAND (SM)
CAV-169	MC-9	40.0	⊠			SANDY LEAN CLAY (CL)
CAV-169	MC-11	50.0	▲			SANDY SILT (ML)
CAV-169	SPT-12	55.0	★			SILTY CLAY WITH SAND (CL-ML)

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MATERIALS ENGINEERING

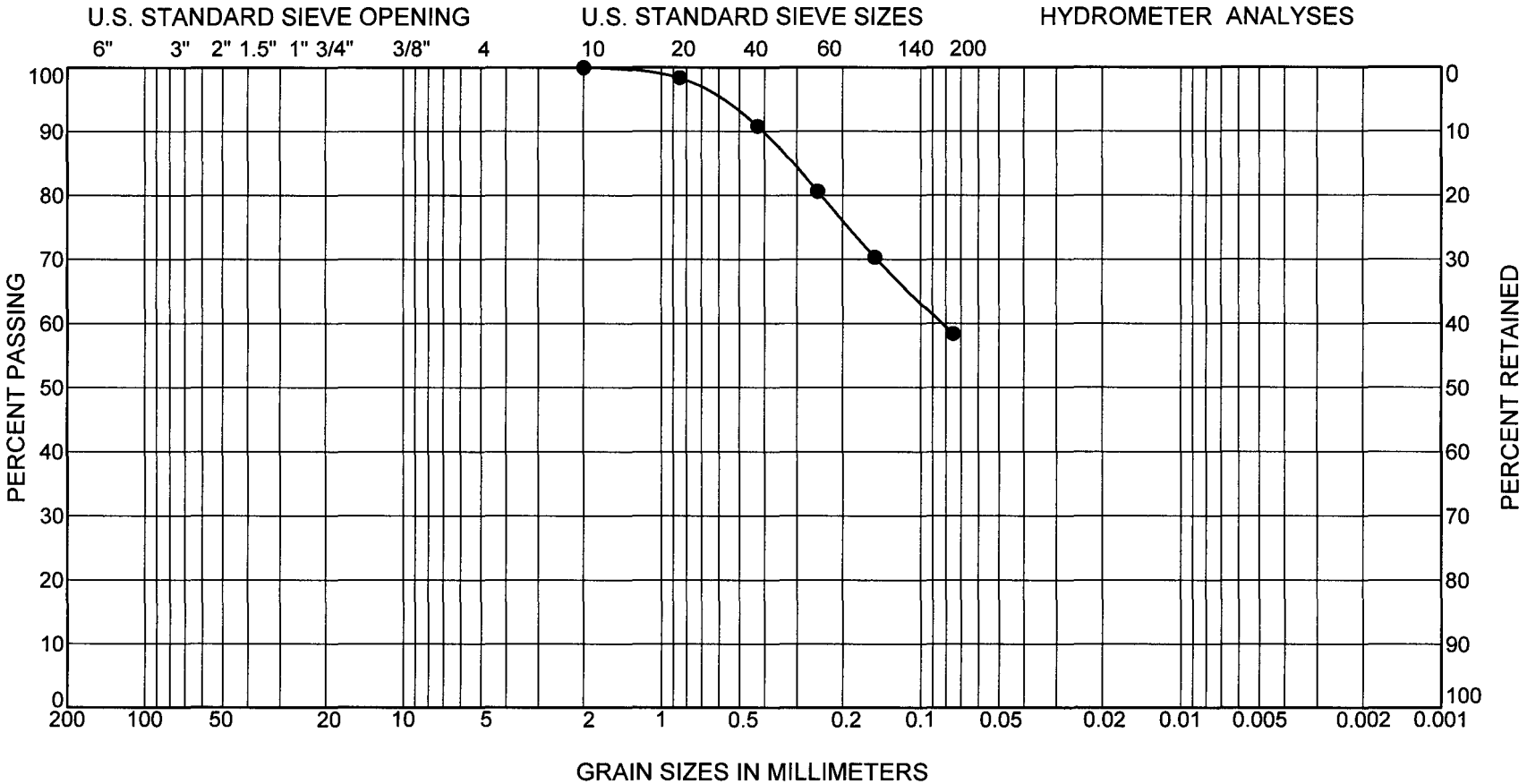
JOB NO: 206117.CAV

CAVALLO ROAD UNDERCROSSING
CONTRA COSTA COUNTY, CALIFORNIA

PLATE NO: B-3B

GRAIN SIZE DISTRIBUTION CURVES

COBBLES	GRAVEL		SAND			SILT AND CLAY
	coarse	fine	coarse	medium	fine	



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
CAV-169	SPT-13	60.0	●			SANDY SILTY CLAY (CL-ML)

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

JOB NO: 206117.CAV

CAVALLO ROAD UNDERCROSSING
CONTRA COSTA COUNTY, CALIFORNIA

PLATE NO: B-3C

Sunland Analytical

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 12/08/2006
Date Submitted 12/04/2006

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.CAV/CAVALO RD Site ID : CAV108 #2 @ 8.5. CAV162
Thank you for your business.

* For future reference to this analysis please use SUN # 49464-98601.

EVALUATION FOR SOIL CORROSION

Soil pH	7.61		
Minimum Resistivity	1.45	ohm-cm (x1000)	
Chloride	6.2 ppm	00.00062	%
Sulfate	43.6 ppm	00.00436	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

APPENDIX C

Attenuation Relationships for Shallow Crustal Earthquakes (Sadigh, et al, 1997)

Fault = Vaca fault zone (RLSS Fault, Map NO: 14)

Mmax = 6.9 **Rrup = 5.45** **km**

M>=6.5 *ROCK SITE:*

C1 = -1.274 C2 = 1.1 C3 = 0 C4 = -2.1

C5 = -0.48451 C6 = 0.524 C7 = 0

A=C1+C2M+C3(8.5M)^2.5= 6.316

B=C4*Ln(Rrup+exp(C5+C6M))= -7.024

C=C7*Ln(Rrup+2)= 0

Ln(y) = A+B+C = -0.708

y = Exp(Ln(y)) = 0.49 **Peak Bed Rock Acceleration PBA = 0.490 - Use 0.5g**

Fault = Great valley fault 5 (Reverse Fault, Map No: 24)

Mmax = 6.5 **Rrup = 7.045** **km**

A= 5.876

B= -6.811

C= 0

Ln(y) = -0.935

y = 0.39 **Peak Bed Rock Acceleration PBA = 0.39g x 1.2 = 0.468g**

Fault = Greenville fault zone (Clayton section, RLSS Fault, Map No: 351)

Mmax = 6.6 **Rrup = 6.59** **km**

A= 5.986

B= -6.855

C= 0

Ln(y) = -0.869

y = 0.42 **Peak Bed Rock Acceleration PBA = 0.42g**

Fault = Concord fault zone (Ygnacio valley section, RLSS Fault, Map No: 341)

Mmax = 6.6 **Rrup = 11.136** **km**

A= 5.986

B= -7.191

C= 0

Ln(y) = -1.205

y = 0.30 **Peak Bed Rock Acceleration PBA = 0.3g**

AXIAL PILE CAPACITIES

(SHAFT Program)

SHAFT Runs – 24-in. CIDH Pile
eBART Cavallo Road Underpass
Job No. 206117.EBS
Pile capacities computed using SHAFT program – Output follows
Note: Neglected End Bearing for Pile Capacity
Revised August 31, 2009

Abutment 1 (based on boring CAV-168)

Ground Surface Elevation = 52.5 (approx.)
Nominal Compression Load = 410 kips = 205 tons
Reqd. Shaft Length per SHAFT output = 45.5 ft
Recommended Penetration = 45.5 feet
Reqd. Tip Elevation = 52.5-45.5 = 7.0

Abutment 2 (based on boring CAV-169)

Ground Surface Elevation = 52.0 (approx.)
Nominal Compression Load = 410 kips = 205 tons
Reqd. Shaft Length per SHAFT output = 42.0 ft
Recommended Penetration = 42.0 feet
Reqd. Tip Elevation = 52.0 – 42.0 = 10.0

El. 52.5 (approx.)

depth= 0 - 23; Clay

8.0'

Bottom of Footing @ 44.5' (El.)

$\gamma = 125$ pcf

$S_u = 2.5$ ksf

depth= 23 - 43; Clay

$\gamma = 125$ pcf

$S_u = 4.0$ ksf

depth= 43 - 51; Sand

(at depth 48 feet)

$\gamma = 130$ pcf

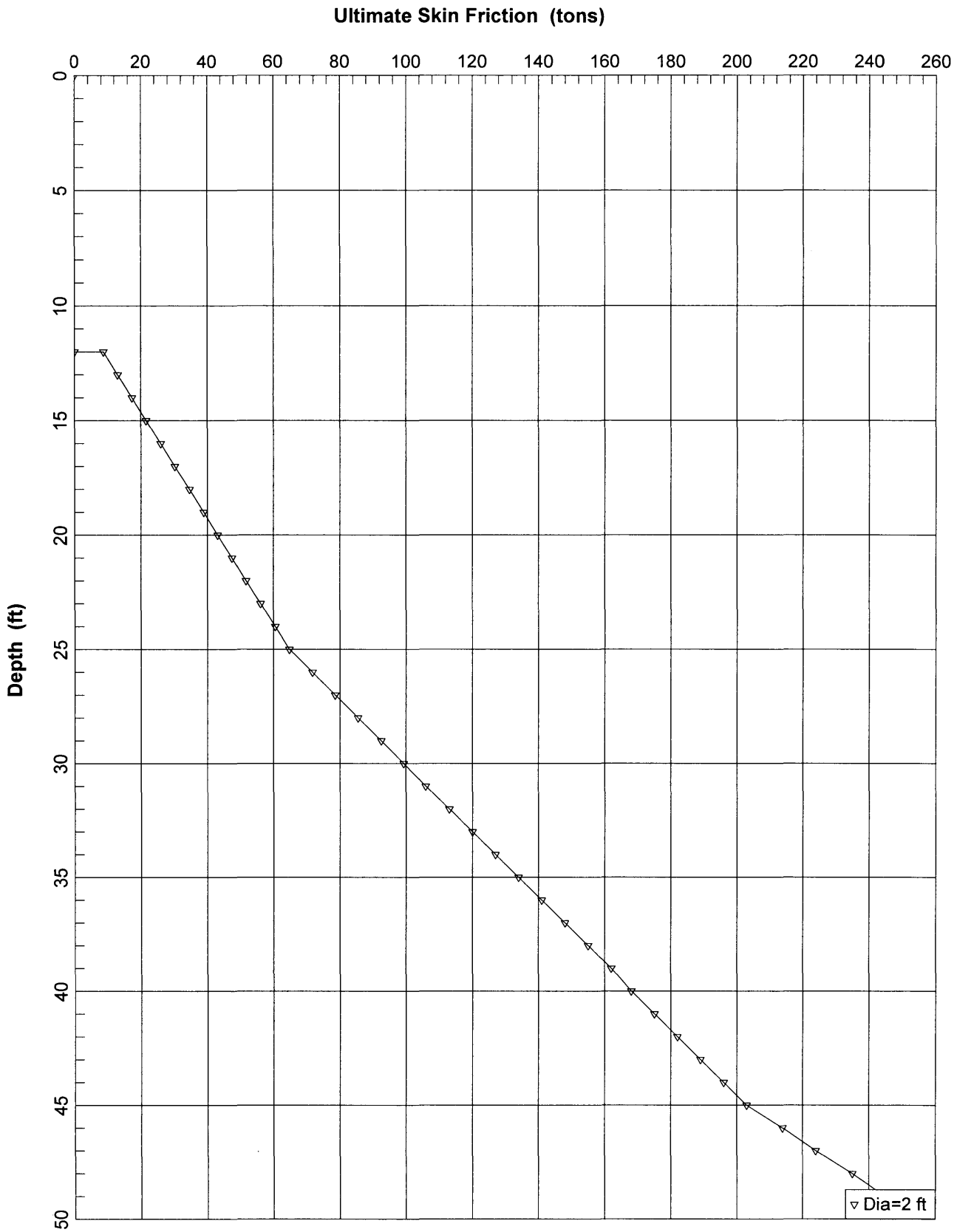
$\phi' = 35°$

depth= 51 - 61; Clay

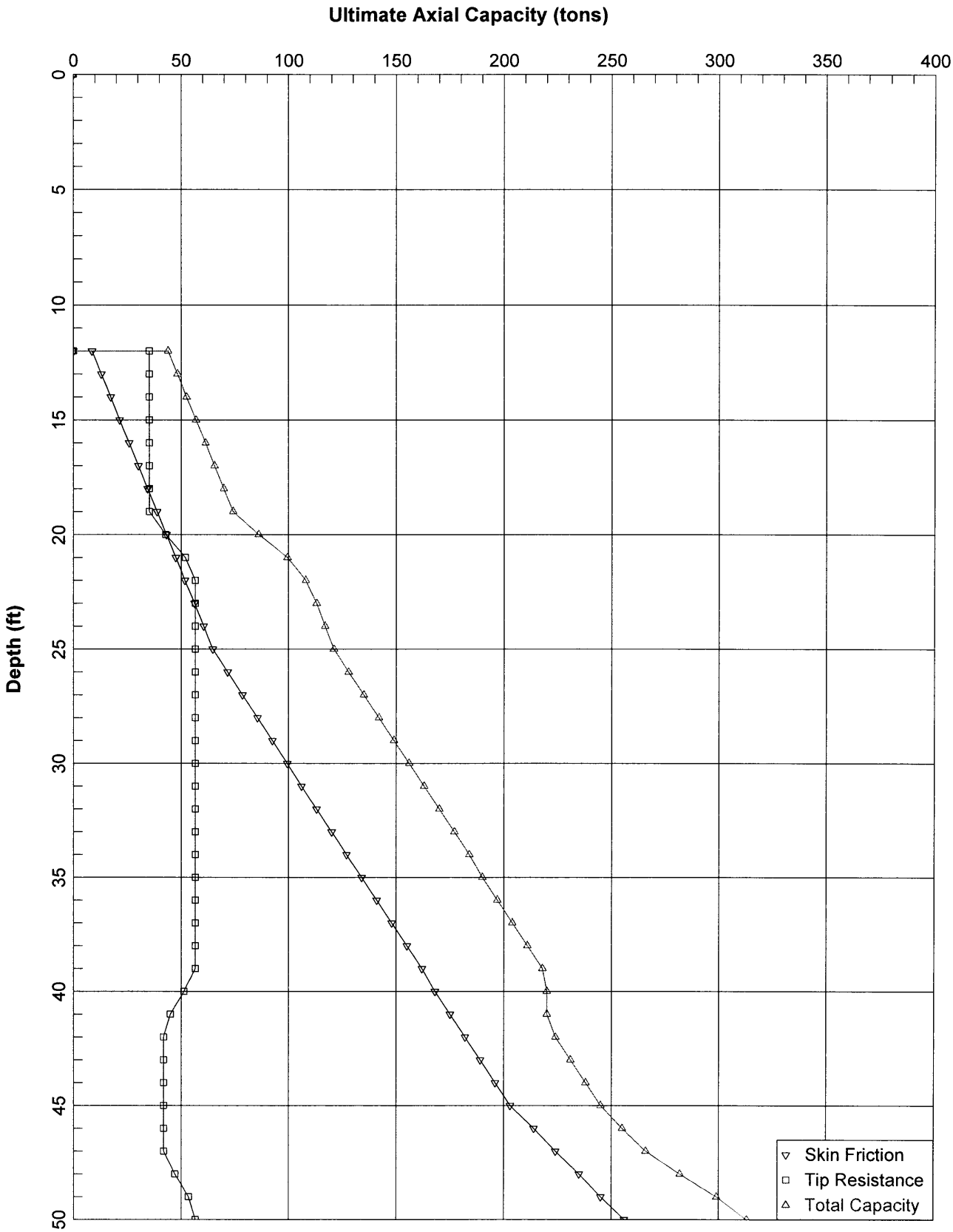
$\gamma = 125$ pcf

$S_u = 4.0$ ksf

Abutment 1



eBART Cavallo Road Underpass - Abutment 1 - 24-in CIDH Pile



eBART Cavallo Road Underpass - Abutment 1 - 24-in CIDH Pile

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 5.0 (C) COPYRIGHT ENSOFT,INC. 1989,1995,1998,2001,2003

eBARTCavallo Road Underpass - SR4 - Abutment 1

PROPOSED DEPTH = 50.0 FT

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 48.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 2.50

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 3.00

SOIL INFORMATION

LAYER NO 1----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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.000E+00

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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.230E+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	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00

BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.230E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
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.	= 0.350E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.400E+04
DEPTH, FT	= 0.430E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.536E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.350E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.400E+04
DEPTH, FT	= 0.510E+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	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.510E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00

SOIL UNIT WEIGHT, LB/CU FT = 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT = 0.640E+04
DEPTH, FT = 0.610E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	=	2.000	FT.
DIAMETER OF BASE	=	2.000	FT.
END OF STEM TO BASE	=	0.000	FT.
ANGLE OF BELL	=	0.000	DEG.
IGNORED TOP PORTION	=	8.000	FT.
IGNORED BOTTOM PORTION	=	2.000	FT.
AREA OF ONE PERCENT STEEL	=	4.524	SQ.IN.
ELASTIC MODULUS, Ec	=	0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	=	0.000	CU.YDS.

PREDICTED RESULTS

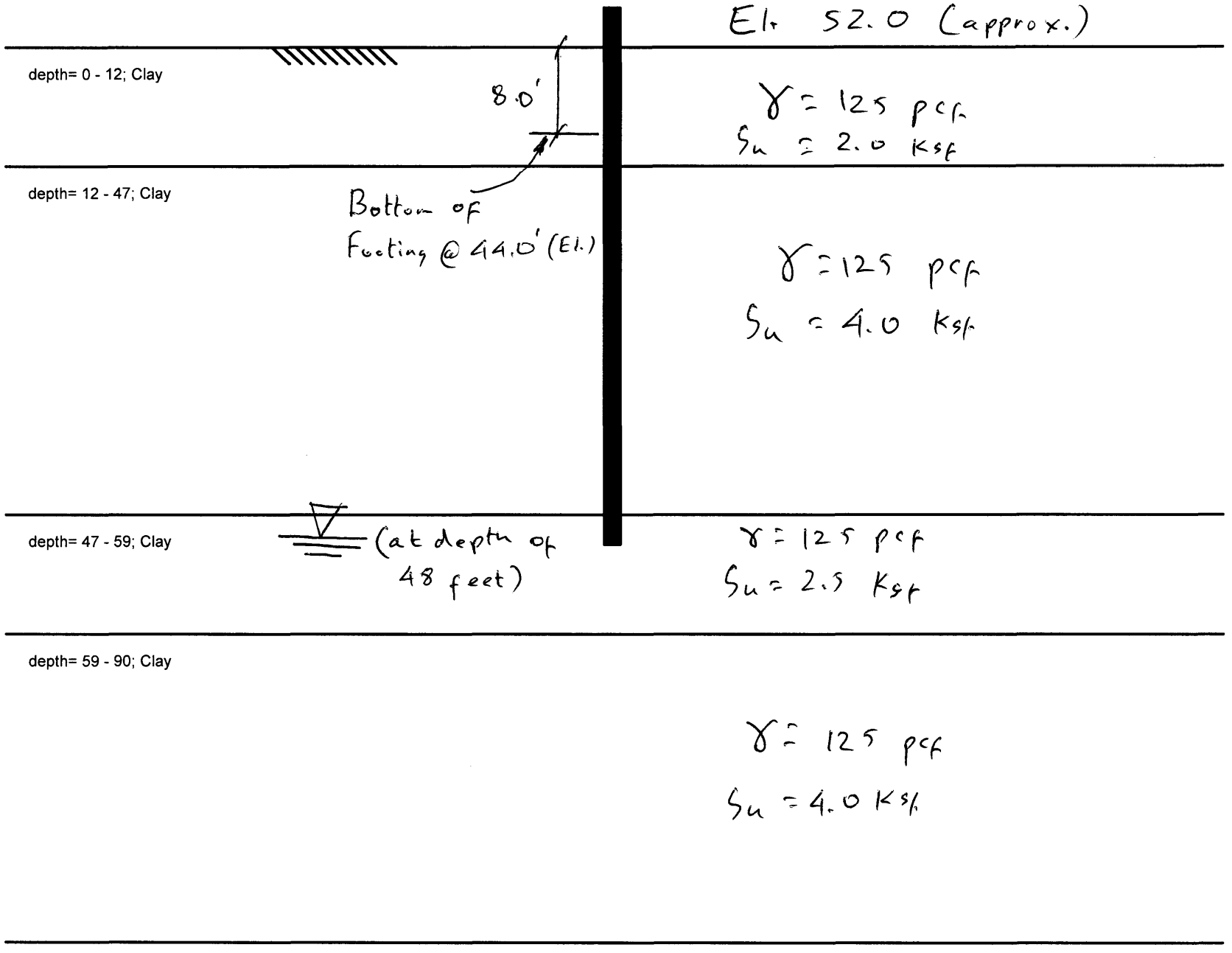
QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED 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	1.28	4.32	35.35	39.67	16.10	13.51	30.99
12.0	1.40	8.64	35.35	43.99	20.42	15.24	31.50
13.0	1.51	12.96	35.35	48.31	24.74	16.97	31.93
14.0	1.63	17.28	35.35	52.63	29.06	18.69	32.30
15.0	1.75	21.60	35.35	56.95	33.38	20.42	32.63
16.0	1.86	25.92	35.35	61.27	37.70	22.15	32.91
17.0	1.98	30.24	35.35	65.59	42.02	23.88	33.15
18.0	2.09	34.56	35.35	69.91	46.34	25.61	33.38
19.0	2.21	38.88	35.35	74.23	50.66	27.34	33.57
20.0	2.33	43.20	42.92	86.12	57.51	31.59	37.00
21.0	2.44	47.52	52.01	99.53	64.86	36.35	40.73
22.0	2.56	51.84	56.56	108.40	70.70	39.59	42.34
23.0	2.68	56.16	56.56	112.72	75.02	41.32	42.11
24.0	2.79	60.48	56.56	117.04	79.34	43.05	41.91
25.0	2.91	64.80	56.56	121.36	83.66	44.77	41.72
26.0	3.03	71.72	56.56	128.27	90.57	47.54	42.40
27.0	3.14	78.63	56.56	135.18	97.48	50.30	43.03
28.0	3.26	85.54	56.56	142.10	104.39	53.07	43.61
29.0	3.37	92.45	56.56	149.01	111.31	55.83	44.15
30.0	3.49	99.37	56.56	155.92	118.22	58.60	44.66
31.0	3.61	106.28	56.56	162.83	125.13	61.36	45.14
32.0	3.72	113.19	56.56	169.75	132.04	64.13	45.58
33.0	3.84	120.10	56.56	176.66	138.95	66.89	46.00
34.0	3.96	127.02	56.56	183.57	145.87	69.66	46.40
35.0	4.07	133.93	56.56	190.48	152.78	72.42	46.77

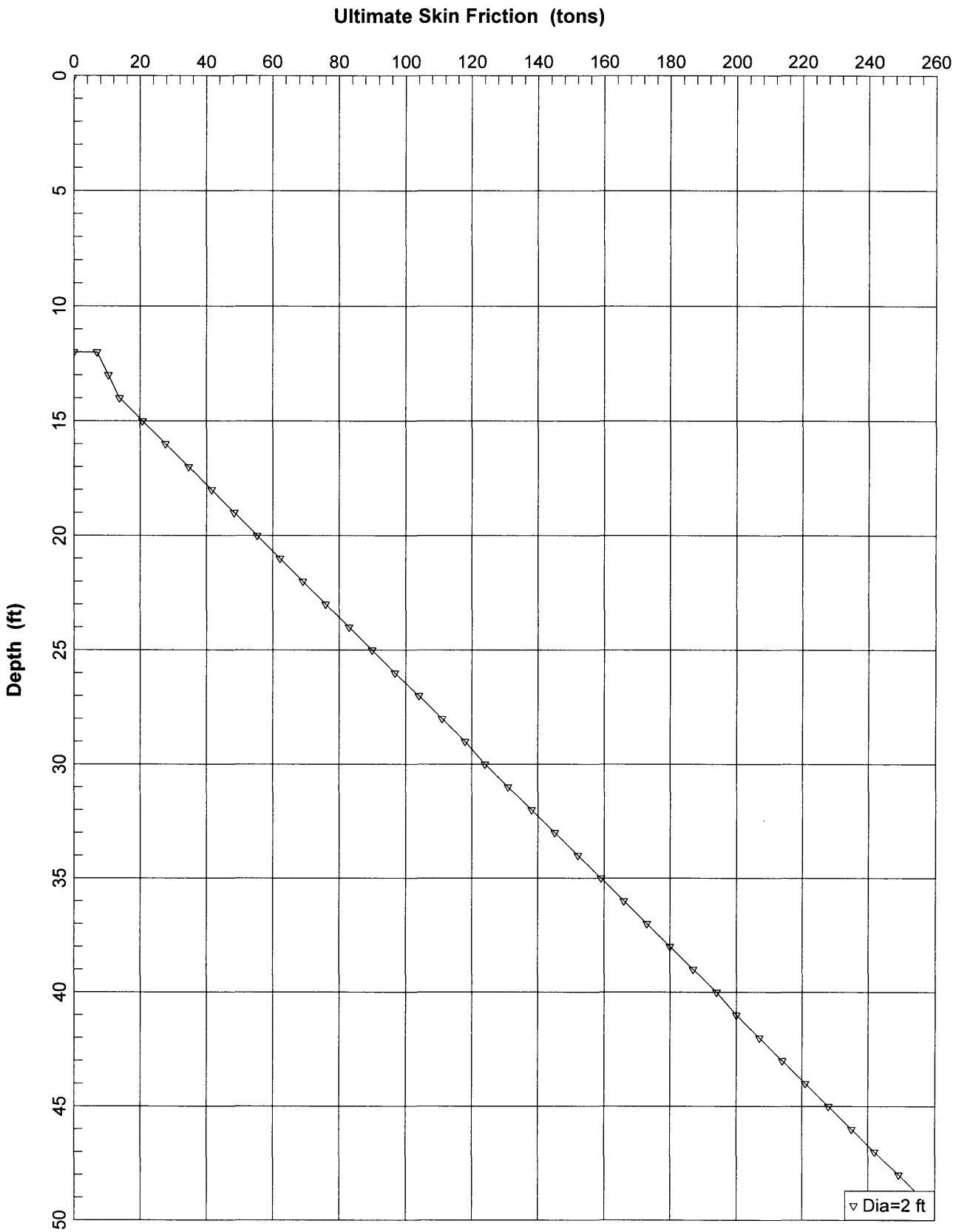
36.0	4.19	140.84	56.56	197.40	159.69	75.19	47.12
37.0	4.31	147.75	56.56	204.31	166.60	77.95	47.45
38.0	4.42	154.66	56.56	211.22	173.52	80.72	47.77
39.0	4.54	161.58	56.56	218.13	180.43	83.48	48.06
40.0	4.65	168.49	51.32	219.81	185.60	84.50	47.22
41.0	4.77	175.40	45.04	220.44	190.42	85.17	46.20
42.0	4.89	182.31	41.90	224.21	196.28	86.89	45.87
43.0	5.00	189.23	41.90	231.13	203.19	89.66	46.19
44.0	5.12	196.14	41.90	238.04	210.11	92.42	46.49
45.0	5.24	203.05	41.90	244.95	217.02	95.19	46.78
46.0	5.35	213.51	41.90	255.41	227.47	99.37	47.71
47.0	5.47	224.03	41.90	265.93	238.00	103.58	48.62
48.0	5.59	234.62	47.13	281.75	250.33	109.56	50.44
49.0	5.70	245.26	53.42	298.67	263.06	115.91	52.38
50.0	5.82	255.95	56.56	312.50	274.80	121.23	53.71

RESULT FROM TREND (AVERAGED) LINE

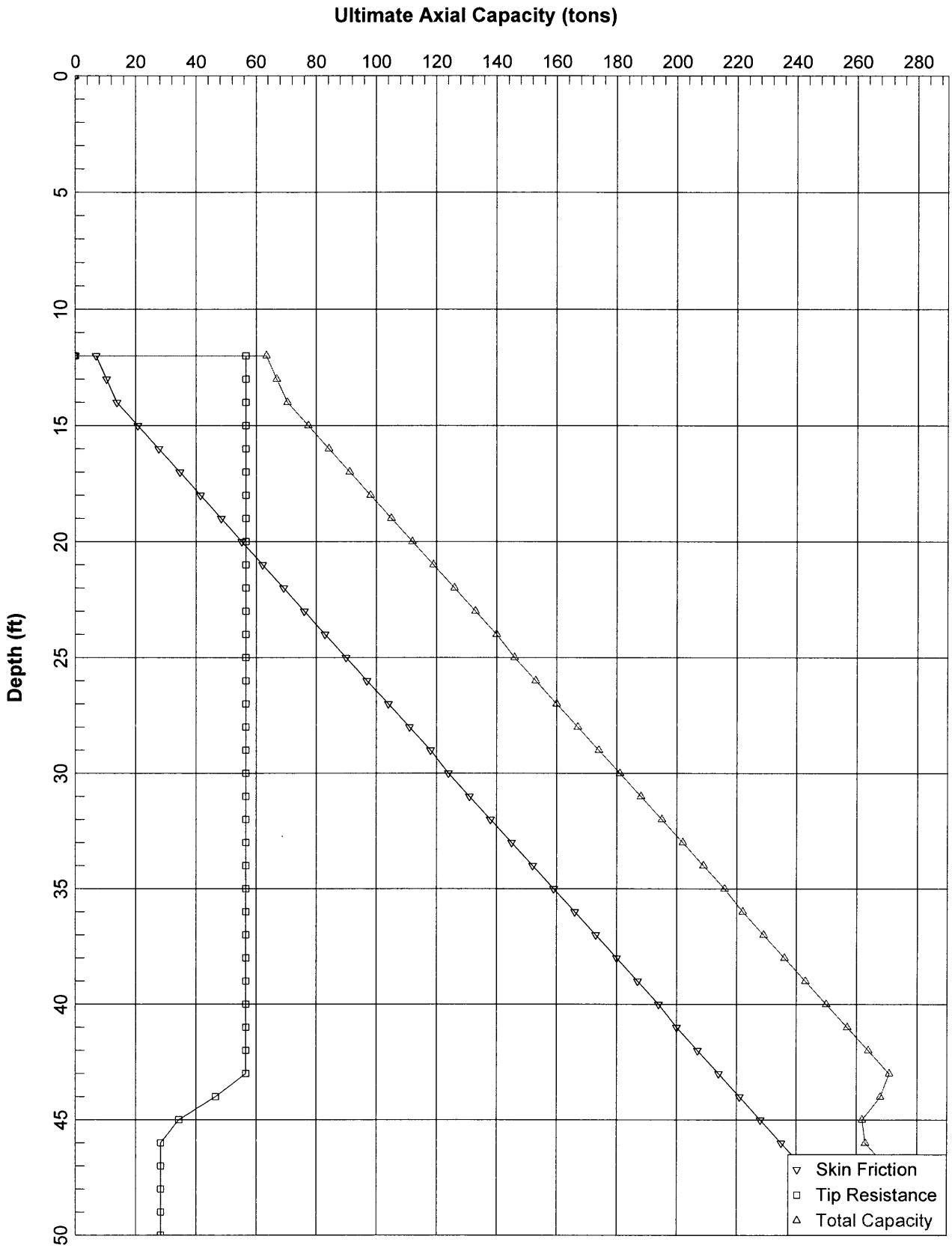
TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.8110E+00	0.3929E-03	0.1862E-01	0.1000E-03
0.8110E+01	0.3929E-02	0.1862E+00	0.1000E-02
0.2050E+02	0.9864E-02	0.4654E+00	0.2500E-02
0.4130E+02	0.1983E-01	0.9308E+00	0.5000E-02
0.6190E+02	0.2980E-01	0.1396E+01	0.7500E-02
0.8042E+02	0.3952E-01	0.1862E+01	0.1000E-01
0.1528E+03	0.8609E-01	0.4654E+01	0.2500E-01
0.2069E+03	0.1380E+00	0.9308E+01	0.5000E-01
0.2302E+03	0.1766E+00	0.1396E+02	0.7500E-01
0.2403E+03	0.2079E+00	0.1862E+02	0.1000E+00
0.2577E+03	0.3715E+00	0.3233E+02	0.2500E+00
0.2514E+03	0.6232E+00	0.4503E+02	0.5000E+00
0.2576E+03	0.8777E+00	0.5125E+02	0.7500E+00
0.2602E+03	0.1130E+01	0.5392E+02	0.1000E+01
0.2621E+03	0.2531E+01	0.5605E+02	0.2400E+01


El. 52.0 (approx.)
depth= 0 - 12; Clay
8.0'
γ = 125 pcf
Su = 2.0 ksf
depth= 12 - 47; Clay
Bottom of
Footing @ 44.0' (El.)
γ = 125 pcf
Su = 4.0 ksf
depth= 47 - 59; Clay
(at depth of
48 feet)
γ = 125 pcf
Su = 2.5 ksf
depth= 59 - 90; Clay
γ = 125 pcf
Su = 4.0 ksf

Abutment 2



eBART Cavallo Road Underpass - Abutment 2 - 24-in CIDH Pile



eBART Cavallo Road Underpass - Abutment 2 - 24-in CIDH Pile

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 5.0 (C) COPYRIGHT ENSOFT,INC. 1989,1995,1998,2001,2003

eBART Cavallo Road Underpass - SR4 - Abutment 2

PROPOSED DEPTH = 50.0 FT

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 48.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 2.50

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 3.00

SOIL INFORMATION

LAYER NO 1----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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.000E+00

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	= 0.250E+04
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.120E+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	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00

BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.120E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.470E+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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.470E+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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.590E+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	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.590E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.400E+04

INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.900E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	=	2.000	FT.
DIAMETER OF BASE	=	2.000	FT.
END OF STEM TO BASE	=	0.000	FT.
ANGLE OF BELL	=	0.000	DEG.
IGNORED TOP PORTION	=	8.000	FT.
IGNORED BOTTOM PORTION	=	2.000	FT.
AREA OF ONE PERCENT STEEL	=	4.524	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	1.28	3.46	56.56	60.01	22.31	20.23	46.88
12.0	1.40	6.91	56.56	63.47	25.76	21.62	45.45
13.0	1.51	10.37	56.56	66.92	29.22	23.00	44.24
14.0	1.63	13.82	56.56	70.38	32.68	24.38	43.20
15.0	1.75	20.74	56.56	77.29	39.59	27.15	44.28
16.0	1.86	27.65	56.56	84.21	46.50	29.91	45.22
17.0	1.98	34.56	56.56	91.12	53.41	32.68	46.06
18.0	2.09	41.47	56.56	98.03	60.33	35.44	46.80
19.0	2.21	48.39	56.56	104.94	67.24	38.21	47.46
20.0	2.33	55.30	56.56	111.86	74.15	40.97	48.06
21.0	2.44	62.21	56.56	118.77	81.06	43.74	48.60
22.0	2.56	69.12	56.56	125.68	87.98	46.50	49.09
23.0	2.68	76.04	56.56	132.59	94.89	49.27	49.54
24.0	2.79	82.95	56.56	139.50	101.80	52.03	49.95
25.0	2.91	89.86	56.56	146.42	108.71	54.80	50.33
26.0	3.03	96.77	56.56	153.33	115.63	57.56	50.68
27.0	3.14	103.69	56.56	160.24	122.54	60.33	51.00
28.0	3.26	110.60	56.56	167.15	129.45	63.09	51.30
29.0	3.37	117.51	56.56	174.07	136.36	65.86	51.58
30.0	3.49	124.42	56.56	180.98	143.28	68.62	51.84
31.0	3.61	131.34	56.56	187.89	150.19	71.39	52.08
32.0	3.72	138.25	56.56	194.80	157.10	74.15	52.31
33.0	3.84	145.16	56.56	201.72	164.01	76.92	52.53

34.0	3.96	152.07	56.56	208.63	170.92	79.68	52.73
35.0	4.07	158.99	56.56	215.54	177.84	82.45	52.92
36.0	4.19	165.90	56.56	222.45	184.75	85.21	53.10
37.0	4.31	172.81	56.56	229.37	191.66	87.98	53.27
38.0	4.42	179.72	56.56	236.28	198.57	90.74	53.43
39.0	4.54	186.63	56.56	243.19	205.49	93.51	53.58
40.0	4.65	193.55	56.56	250.10	212.40	96.27	53.73
41.0	4.77	200.46	56.56	257.02	219.31	99.04	53.87
42.0	4.89	207.37	56.56	263.93	226.22	101.80	54.00
43.0	5.00	214.28	56.56	270.84	233.14	104.57	54.13
44.0	5.12	221.20	46.46	267.65	236.68	103.96	52.27
45.0	5.24	228.11	34.34	262.45	239.56	102.69	50.12
46.0	5.35	235.02	28.28	263.30	244.45	103.43	49.19
47.0	5.47	241.93	28.28	270.21	251.36	106.20	49.40
48.0	5.59	248.85	28.28	277.12	258.27	108.96	49.61
49.0	5.70	255.76	28.28	284.04	265.18	111.73	49.81
50.0	5.82	260.08	28.28	288.36	269.51	113.46	49.56

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.8642E+00	0.4156E-03	0.9308E-02	0.1000E-03
0.8642E+01	0.4156E-02	0.9308E-01	0.1000E-02
0.2189E+02	0.1045E-01	0.2327E+00	0.2500E-02
0.4407E+02	0.2101E-01	0.4654E+00	0.5000E-02
0.6596E+02	0.3156E-01	0.6981E+00	0.7500E-02
0.8585E+02	0.4184E-01	0.9308E+00	0.1000E-01
0.1624E+03	0.9007E-01	0.2327E+01	0.2500E-01
0.2145E+03	0.1397E+00	0.4654E+01	0.5000E-01
0.2366E+03	0.1770E+00	0.6981E+01	0.7500E-01
0.2424E+03	0.2053E+00	0.9308E+01	0.1000E+00
0.2492E+03	0.3611E+00	0.1617E+02	0.2500E+00
0.2321E+03	0.6055E+00	0.2252E+02	0.5000E+00
0.2352E+03	0.8578E+00	0.2563E+02	0.7500E+00
0.2365E+03	0.1109E+01	0.2696E+02	0.1000E+01
0.2376E+03	0.2510E+01	0.2802E+02	0.2400E+01

PILE LATERAL LOAD BEHAVIOR

(LPILE Analysis)

Abutment 1

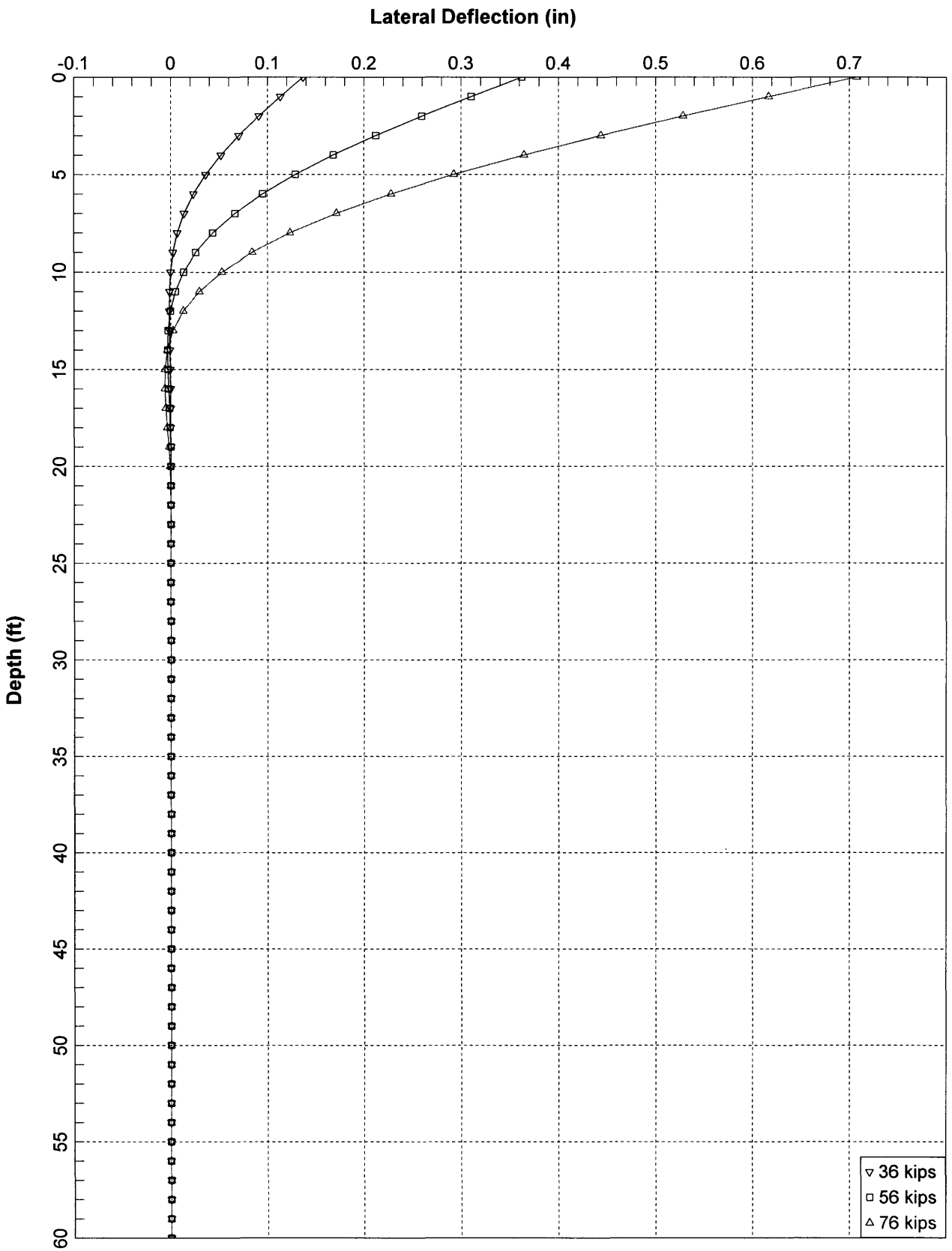
Profile based on boring CAV-168

24-in. Diameter CIDH Pile

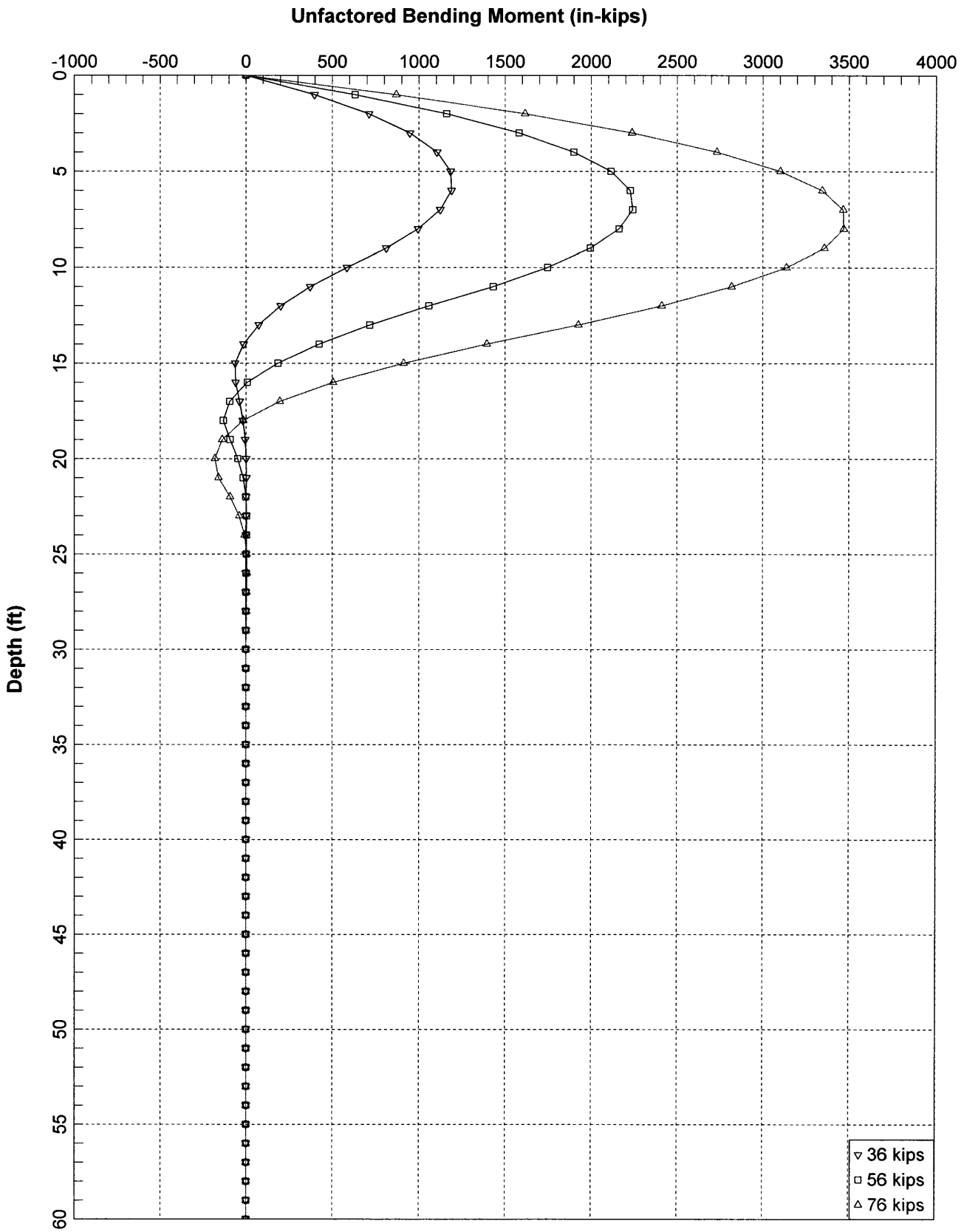
Area = 452.4 in², I = 16286 in⁴

El. = 52.5 (approx.)

Depths -96 - 180 = Stiff Clay w/o free water	$S_u = 2.5$ ksf $\gamma' = 125$ pcf $\epsilon_{50} = 0.005$
Depths 180 - 420 = Stiff Clay w/o free water	$S_u = 4.0$ ksf $\gamma' = 125$ pcf $\epsilon_{50} = 0.004$
Depths 420 - 516 = API RP-2A Sand	$\phi' = 35°$ $\gamma' = 130$ pcf $K = 125$ lb/in³
Depths 516 - 636 = Stiff Clay w/o free water	$S_u = 4.0$ ksf $\gamma' = 65$ pcf $\epsilon_{50} = 0.004$
Depths 636 - 924 = API RP-2A Sand	$\phi' = 40°$ $\gamma' = 70$ pcf $K = 125$ lb/in³



eBART Cavallo Road Underpass - Abutment 1 - 24-in. CIDH Pile -



eBART Cavallo Road Underpass - Abutment 1 - 24-in. CIDH Pile

LPILE Plus for Windows, Version 5.0 (5.0.21)

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:

Gary Parikh
Parikh Consultants

Path to file locations: S:\Ongoing Projects\2006\206117 TYLIn Rte 4 Project\EBART PROJECT\Cavallo Road Underpass\LPILE\
Name of input data file: Cavallo Road - Abutment 1.lpd
Name of output file: Cavallo Road - Abutment 1.lpo
Name of plot output file: Cavallo Road - Abutment 1.lpp
Name of runtime file: Cavallo Road - Abutment 1.lpr

Time and Date of Analysis

Date: August 20, 2009 Time: 11: 0:50

Problem Title

eBARTCavallo Road Underpass - Abutment 1 - 24-in CIDH Pile

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant 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 pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 60
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 720.00 in
Depth of ground surface below top of pile = -96.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	24.00000000	16286.0000	452.4000	3600000.
2	720.0000	24.00000000	16286.0000	452.4000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 5 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -96.000 in
Distance from top of pile to bottom of layer = 180.000 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 180.000 in
Distance from top of pile to bottom of layer = 420.000 in

Layer 3 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 420.000 in
Distance from top of pile to bottom of layer = 516.000 in
p-y subgrade modulus k for top of soil layer = 125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 125.000 lbs/in**3

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 516.000 in
Distance from top of pile to bottom of layer = 636.000 in

Layer 5 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 636.000 in
Distance from top of pile to bottom of layer = 924.000 in
p-y subgrade modulus k for top of soil layer = 125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 125.000 lbs/in**3

(Depth of lowest layer extends 204.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth is defined using 10 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-96.00	.07230
2	180.00	.07230
3	180.00	.07230
4	420.00	.07230
5	420.00	.07520
6	516.00	.07520
7	516.00	.03760
8	636.00	.03760
9	636.00	.04050
10	924.00	.04050

Shear Strength of Soils

Distribution of shear strength parameters with depth defined using 10 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-96.000	17.36000	.00	.00500	.0
2	180.000	17.36000	.00	.00500	.0
3	180.000	27.78000	.00	.00400	.0
4	420.000	27.78000	.00	.00400	.0
5	420.000	.00000	35.00	------	------
6	516.000	.00000	35.00	------	------
7	516.000	27.78000	.00	.00400	.0
8	636.000	27.78000	.00	.00400	.0
9	636.000	.00000	40.00	------	------
10	924.000	.00000	40.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.6000	1.0000
2	720.000	.6000	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 3

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 36000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 56000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 76000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 36000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 200000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.136913	3.3902E-08	36000.0000	-.0019483	442.0866	-554.7684
12.000	.113533	396733.	29318.5420	-.0019077	734.4109	-558.8079
24.000	.091128	712802.	22625.1078	-.0017942	967.3001	-556.7645
36.000	.070473	948347.	15995.2000	-.0016242	1140.8567	-548.2202

48.000	.052147	1104483.	9509.8262	-.0014141	1255.9021	-532.6755
60.000	.036534	1183371.	3256.8165	-.0011800	1314.0290	-509.4928
72.000	.023827	1188311.	-2666.7759	-.0009373	1317.6686	-477.7726
84.000	.014039	1123867.	-8149.6453	-.0007007	1270.1849	-436.0390
96.000	.007011	996082.	-13053.2749	-.0004837	1176.0292	-381.2326
108.000	.002430	812911.	-17163.4319	-.0002986	1041.0628	-303.7935
120.000	-.000154	585593.	-18310.9879	-.0001555	873.5687	112.5342
132.000	-.001301	374193.	-15961.6384	-5.7233E-05	717.8030	279.0240
144.000	-.001528	202789.	-12484.3464	1.8137E-06	591.5071	300.5246
156.000	-.001257	74559.9590	-8963.7262	3.0197E-05	497.0246	286.2454
168.000	-.000803	-12485.8724	-5710.6966	3.6549E-05	451.2866	255.9262
180.000	-.000380	-62672.1956	-1961.5381	2.8858E-05	488.2654	368.9335
192.000	-.000111	-59701.3044	1083.3706	1.6334E-05	486.0763	138.5512
204.000	1.21E-05	-36749.7075	1821.0045	6.4639E-06	469.1649	-15.6123
216.000	4.45E-05	-16028.2229	1374.3664	1.0628E-06	453.8967	-58.8274
228.000	3.76E-05	-3770.0152	723.3984	-9.6331E-07	444.8645	-49.6672
240.000	2.14E-05	1337.9622	255.7892	-1.2122E-06	443.0725	-28.2676
252.000	8.48E-06	2374.7449	18.9132	-8.3225E-07	443.8364	-11.2117
264.000	1.41E-06	1795.8731	-59.5500	-4.0544E-07	443.4099	-1.8655
276.000	-1.25E-06	947.4904	-60.8403	-1.2469E-07	442.7848	1.6504
288.000	-1.58E-06	336.3049	-38.3959	6.6854E-09	442.3344	2.0903
300.000	-1.09E-06	25.9577	-17.2240	4.3758E-08	442.1058	1.4383
312.000	-5.31E-07	-77.2800	-4.3811	3.8506E-08	442.1436	.7021237
324.000	-1.64E-07	-79.3740	1.1324	2.2475E-08	442.1451	.2167895
336.000	8.21E-09	-50.2113	2.3680	9.2133E-09	442.1236	-.0108556
348.000	5.71E-08	-22.5871	1.8499	1.7633E-09	442.1033	-.0754889
360.000	5.05E-08	-5.8222	.9962055	-1.1441E-09	442.0909	-.0667929
372.000	2.97E-08	1.3273	.3602793	-1.6041E-09	442.0876	-.0391948
384.000	1.20E-08	2.8322	.0296740	-1.1784E-09	442.0887	-.0159060
396.000	1.37E-09	2.0452	-.0766341	-6.7925E-10	442.0882	-.0018120
408.000	-4.27E-09	.9962247	-.0536515	-3.6801E-10	442.0874	.0056424
420.000	-7.46E-09	.7592995	-.0187632	-1.8835E-10	442.0872	.0001723
432.000	-8.79E-09	.3468113	-.0164643	-5.4687E-11	442.0871	.0002109
444.000	-8.77E-09	.3644185	-.0138888	3.8566E-11	442.0869	.0002184
456.000	-7.86E-09	.2132949	-.0113616	9.7688E-11	442.0868	.0002028
468.000	-6.43E-09	.0912711	-.0091151	1.2886E-10	442.0867	.0001716
480.000	-4.77E-09	-.0060863	-.0072957	1.3757E-10	442.0867	.0001316
492.000	-3.13E-09	-.0844850	-.0059712	1.2830E-10	442.0867	8.9108E-05
504.000	-1.69E-09	-.1500108	-.0051382	1.0431E-10	442.0868	4.9719E-05
516.000	-6.24E-10	-.2083033	.0001103	6.7638E-11	442.0868	.0008250
528.000	-6.83E-11	-.1476874	.0056024	3.1207E-11	442.0868	9.0304E-05
540.000	1.25E-10	-.0739952	.0051544	8.5207E-12	442.0867	-.0001650
552.000	1.36E-10	-.0240215	.0030846	-1.5100E-12	442.0867	-.0001800
564.000	8.86E-11	4.3210E-05	.0013022	-3.9639E-12	442.0866	-.0001171
576.000	4.10E-11	.0072513	.0002744	-3.2174E-12	442.0867	-5.4255E-05
588.000	1.13E-11	.0066431	-.0001411	-1.7955E-12	442.0867	-1.4992E-05
600.000	-2.05E-12	.0038729	-.0002148	-7.1932E-13	442.0867	2.7049E-06
612.000	-5.92E-12	.0014902	-.0001516	-1.7048E-13	442.0867	7.8280E-06
624.000	-6.14E-12	.0002341	-5.6003E-05	5.9864E-15	442.0866	8.1131E-06
636.000	-5.78E-12	.0001461	-6.3584E-06	4.4897E-14	442.0866	1.6111E-07
648.000	-5.06E-12	8.1279E-05	-4.5179E-06	6.8169E-14	442.0866	1.4564E-07
660.000	-4.14E-12	3.7367E-05	-2.9063E-06	8.0311E-14	442.0866	1.2295E-07
672.000	-3.13E-12	1.1141E-05	-1.5938E-06	8.5275E-14	442.0866	9.5805E-08
684.000	-2.10E-12	-1.2940E-06	-6.2310E-07	8.6283E-14	442.0866	6.5979E-08
696.000	-1.06E-12	-4.2274E-06	-2.0889E-08	8.5718E-14	442.0866	3.4389E-08
708.000	-3.86E-14	-2.2068E-06	1.9316E-07	8.5059E-14	442.0866	1.2846E-09
720.000	9.79E-13	0.0000	0.0000	8.4833E-14	442.0866	-3.3477E-08

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:


```
Pile-head deflection              =      .13691342 in
Computed slope at pile head       =     -.00194835
Maximum bending moment            =       1188311. lbs-in
Maximum shear force               =    36000.00000 lbs
Depth of maximum bending moment   =    72.00000000 in
Depth of maximum shear force      =       0.00000 in
Number of iterations              =             23
Number of zero deflection points  =              8
```

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

```
Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head  =       56000.000 lbs
Specified moment at pile head       =            .000 in-lbs
Specified axial load at pile head   =      200000.000 lbs
```

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.362551	-4.5203E-08	56000.0000	-.0043434	442.0866	-707.6704
12.000	.310430	631472.	47442.6461	-.0042788	907.3736	-718.5553
24.000	.259860	1159162.	38790.3992	-.0040956	1296.1909	-723.4859
36.000	.212137	1582100.	30116.9730	-.0038150	1607.8243	-722.0851
48.000	.168299	1900281.	21500.8539	-.0034587	1842.2694	-713.9347
60.000	.129129	2114722.	13025.9256	-.0030478	2000.2757	-698.5533
72.000	.095153	2227533.	4782.4659	-.0026034	2083.3978	-675.3566
84.000	.066648	2241998.	-3131.1664	-.0021460	2094.0560	-643.5821
96.000	.043649	2162686.	-10605.4080	-.0016952	2035.6165	-602.1249
108.000	.025962	1995605.	-17512.9085	-.0012697	1912.5067	-549.1252
120.000	.013177	1748470.	-23691.6130	-.0008865	1730.4105	-480.6589
132.000	.004686	1431262.	-28882.2115	-.0005611	1496.6820	-384.4409
144.000	-.000290	1057991.	-29828.7833	-.0003064	1221.6449	226.6789
156.000	-.002667	716841.	-26396.0860	-.0001247	970.2763	345.4373
168.000	-.003284	425083.	-22140.1822	-7.8784E-06	755.3003	363.8800
180.000	-.002856	185515.	-17336.1722	5.4609E-05	578.7794	436.7883
192.000	-.001973	8752.9345	-11633.6798	7.4489E-05	448.5361	513.6271
204.000	-.001069	-94050.9960	-5820.9719	6.5760E-05	511.3862	455.1575
216.000	-.000395	-131266.	43.3914	4.2702E-05	538.8073	522.2364
228.000	-4.39E-05	-93214.5708	3524.7144	1.9729E-05	510.7699	57.9841
240.000	7.84E-05	-46767.5960	3250.7474	5.4038E-06	476.5464	-103.6453
252.000	8.58E-05	-15222.5703	1948.2184	-9.4016E-07	453.3031	-113.4429
264.000	5.58E-05	-5.8419	824.6404	-2.4986E-06	442.0910	-73.8201
276.000	2.59E-05	4580.7921	176.6493	-2.0304E-06	445.4619	-34.1784
288.000	7.12E-06	4243.4877	-84.8708	-1.1273E-06	445.2134	-9.4083
300.000	-1.20E-06	2549.3053	-131.8089	-4.3219E-07	443.9651	1.5853
312.000	-3.25E-06	1082.1475	-96.4828	-6.0559E-08	442.8840	4.3024
324.000	-2.65E-06	234.0087	-49.6298	7.4133E-08	442.2591	3.5064
336.000	-1.48E-06	-109.3231	-16.8874	8.6893E-08	442.1672	1.9507
348.000	-5.67E-07	-171.7066	-.6845096	5.8133E-08	442.2132	.7498297
360.000	-8.05E-08	-126.0303	4.4532	2.7664E-08	442.1795	.1064516
372.000	9.67E-08	-64.9631	4.3253	8.1180E-09	442.1345	-.1277667
384.000	1.14E-07	-22.2624	2.6522	-8.0843E-10	442.1031	-.1510811
396.000	7.73E-08	-1.3064	1.1330	-3.2204E-09	442.0876	-.1021202
408.000	3.70E-08	4.9449	.2267631	-2.8481E-09	442.0903	-.0489180

420.000	8.90E-09	4.1496	-.0679785	-1.9174E-09	442.0897	-.0002056
432.000	-9.01E-09	3.3226	-.0679154	-1.1527E-09	442.0891	.0002161
444.000	-1.88E-08	2.5251	-.0638168	-5.5424E-10	442.0885	.0004670
456.000	-2.23E-08	1.7936	-.0575625	-1.1227E-10	442.0880	.0005754
468.000	-2.15E-08	1.1442	-.0506742	1.8838E-10	442.0875	.0005727
480.000	-1.78E-08	.5765651	-.0442933	3.6448E-10	442.0871	.0004908
492.000	-1.27E-08	.0793679	-.0391761	4.3160E-10	442.0867	.0003620
504.000	-7.43E-09	-.3657335	-.0356935	4.0230E-10	442.0869	.0002184
516.000	-3.05E-09	-.7792064	-.0101762	2.8513E-10	442.0872	.0040345
528.000	-5.88E-10	-.6113302	.0186911	1.4282E-10	442.0871	.0007767
540.000	3.76E-10	-.3313057	.0203733	4.6355E-11	442.0869	-.0004963
552.000	5.25E-10	-.1225929	.0132322	-9.5717E-14	442.0867	-.0006938
564.000	3.73E-10	-.0137315	.0061094	-1.4047E-11	442.0867	-.0004933
576.000	1.88E-10	.0240995	.0016602	-1.2986E-11	442.0867	-.0002482
588.000	6.15E-11	.0261757	-.0003172	-7.8407E-12	442.0867	-8.1357E-05
600.000	-3.94E-13	.0165235	-.0008022	-3.4710E-12	442.0867	5.2121E-07
612.000	-2.18E-11	.0069383	-.0006266	-1.0700E-12	442.0867	2.8756E-05
624.000	-2.61E-11	.0014906	-.0002473	-2.0738E-13	442.0867	3.4465E-05
636.000	-2.67E-11	.0010049	-3.6009E-05	4.8004E-14	442.0866	7.4531E-07
648.000	-2.49E-11	.0006261	-2.7233E-05	2.1492E-13	442.0866	7.1727E-07
660.000	-2.16E-11	.0003503	-1.9087E-05	3.1484E-13	442.0866	6.4033E-07
672.000	-1.74E-11	.0001665	-1.2059E-05	3.6773E-13	442.0866	5.3105E-07
684.000	-1.27E-11	5.9113E-05	-6.4649E-06	3.9082E-13	442.0866	4.0132E-07
696.000	-7.99E-12	9.4761E-06	-2.5055E-06	3.9784E-13	442.0866	2.5858E-07
708.000	-3.20E-12	-2.9299E-06	-3.1514E-07	3.9851E-13	442.0866	1.0649E-07
720.000	1.58E-12	0.0000	0.0000	3.9821E-13	442.0866	-5.3967E-08

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

```
Pile-head deflection              =      .36255131 in
Computed slope at pile head       =     -.00434344
Maximum bending moment            =       2241998. lbs-in
Maximum shear force               =    56000.00000 lbs
Depth of maximum bending moment   =    84.00000000 in
Depth of maximum shear force      =       0.00000 in
Number of iterations              =             29
Number of zero deflection points  =              8
```

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 3

```
Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head  =       76000.000 lbs
Specified moment at pile head       =            .000 in-lbs
Specified axial load at pile head   =      200000.000 lbs
```

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.707719	1.3561E-07	76000.0000	-.0075515	442.0866	-836.4699
12.000	.617102	869898.	65861.9350	-.0074624	1083.0526	-853.2076

24.000	.528621	1616506.	55558.5242	-.0072080	1633.1755	-864.0275
36.000	.444110	2237901.	45162.9575	-.0068135	2091.0370	-868.5669
48.000	.365096	2733122.	34752.9478	-.0063048	2455.9307	-866.4347
60.000	.292795	3102234.	24411.1607	-.0057076	2727.9034	-857.1965
72.000	.228113	3346386.	14225.8703	-.0050477	2907.8019	-840.3519
84.000	.171650	3467884.	4291.9878	-.0043503	2997.3249	-815.2952
96.000	.123705	3470276.	-5287.2407	-.0036403	2999.0871	-781.2429
108.000	.084283	3358464.	-14397.2173	-.0029415	2916.7008	-737.0865
120.000	.053109	3138862.	-22906.0273	-.0022766	2754.8915	-681.0485
132.000	.029646	2819647.	-30650.6261	-.0016668	2519.6846	-609.7180
144.000	.013107	2411247.	-37395.1540	-.0011315	2218.7639	-514.3700
156.000	.002491	1927594.	-42520.3911	-.0006874	1862.3941	-339.8362
168.000	-.003391	1394057.	-42359.6364	-.0003475	1469.2689	366.6286
180.000	-.005850	912631.	-37025.6869	-.0001114	1114.5396	522.3629
192.000	-.006066	505976.	-29811.8523	3.3734E-05	814.9044	679.9428
204.000	-.005040	196984.	-21708.7060	.0001057	587.2304	670.5816
216.000	-.003530	-15540.2849	-13924.4018	.0001242	453.5372	626.8025
228.000	-.002058	-137798.	-6877.3024	.0001085	543.6200	547.7141
240.000	-.000925	-181117.	-900.4922	7.5912E-05	575.5386	448.4210
252.000	-.000236	-159774.	3663.8344	4.1026E-05	559.8127	312.3001
264.000	5.98E-05	-93381.4803	5063.0435	1.5119E-05	510.8928	-79.0986
276.000	.000127	-38333.4095	3584.4554	1.6397E-06	470.3318	-167.3327
288.000	9.92E-05	-7362.4213	1793.7587	-3.0367E-06	447.5115	-131.1167
300.000	5.37E-05	4731.3752	581.0674	-3.3059E-06	445.5729	-70.9985
312.000	1.99E-05	6599.0647	-2.3681	-2.1464E-06	446.9490	-26.2408
324.000	2.20E-06	4684.8445	-177.2545	-9.9163E-07	445.5386	-2.9070
336.000	-3.95E-06	2349.7157	-163.3925	-2.7173E-07	443.8180	5.2173
348.000	-4.32E-06	764.7282	-97.8090	4.6995E-08	442.6501	5.7133
360.000	-2.82E-06	2.0745	-41.1705	1.2547E-07	442.0882	3.7265
372.000	-1.31E-06	-223.9663	-8.4137	1.0276E-07	442.2517	1.7330
384.000	-3.53E-07	-200.3484	4.7836	5.9336E-08	442.2343	.4665788
396.000	1.13E-07	-109.4447	6.6868	2.7633E-08	442.1673	-.1493850
408.000	3.10E-07	-39.9987	3.3302	1.2339E-08	442.1161	-.4100347
420.000	4.09E-07	-29.5780	.8133506	5.2189E-09	442.1084	-.0094479
432.000	4.35E-07	-20.5033	.6939806	9.3663E-11	442.1018	-.0104471
444.000	4.11E-07	-12.9229	.5698561	-3.3271E-09	442.0962	-.0102403
456.000	3.56E-07	-6.8108	.4533852	-5.3466E-09	442.0917	-.0091715
468.000	2.83E-07	-2.0160	.3530209	-6.2499E-09	442.0881	-.0075559
480.000	2.06E-07	1.6917	.2736477	-6.2831E-09	442.0879	-.0056730
492.000	1.32E-07	4.5817	.2169949	-5.6411E-09	442.0900	-.0037691
504.000	7.02E-08	6.9267	.1819965	-4.4633E-09	442.0918	-.0020640
516.000	2.52E-08	8.9710	-.0300098	-2.8364E-09	442.0933	-.0032704
528.000	2.15E-09	6.2201	-.2466853	-1.2818E-09	442.0912	-.0028422
540.000	-5.59E-09	3.0567	-.2193832	-3.3242E-10	442.0889	.0073925
552.000	-5.83E-09	.9564578	-.1288071	7.8279E-11	442.0874	.0077035
564.000	-3.71E-09	-.0350006	-.0531308	1.7258E-10	442.0867	.0049092
576.000	-1.69E-09	-.3195106	-.0103035	1.3630E-10	442.0869	.0022286
588.000	-4.43E-10	-.2829384	.0065805	7.4646E-11	442.0869	.0005853
600.000	1.05E-10	-.1619369	.0092563	2.9118E-11	442.0868	-.0001394
612.000	2.56E-10	-.0609271	.0063897	6.3109E-12	442.0867	-.0003384
624.000	2.57E-10	-.0086152	.0023218	-8.0589E-13	442.0867	-.0003396
636.000	2.37E-10	-.0051999	.0002447	-2.2197E-12	442.0867	-6.5984E-06
648.000	2.04E-10	-.0027322	.0001699	-3.0314E-12	442.0867	-5.8609E-06
660.000	1.64E-10	-.0011071	.0001056	-3.4244E-12	442.0866	-4.8649E-06
672.000	1.21E-10	-.0001820	5.4097E-05	-3.5563E-12	442.0866	-3.7142E-06
684.000	7.86E-11	.0002083	1.6974E-05	-3.5536E-12	442.0866	-2.4730E-06
696.000	3.62E-11	.0002424	-4.8905E-06	-3.5075E-12	442.0866	-1.1711E-06
708.000	-5.63E-12	.0001077	-1.0794E-05	-3.4716E-12	442.0866	1.8723E-07
720.000	-4.72E-11	0.0000	0.0000	-3.4606E-12	442.0866	1.6117E-06

Output Verification:

Computed forces and moments are within specified convergence limits.

Cavallo Road - Abutment 1.lpo

Output Summary for Load Case No. 3:

```
Pile-head deflection              =      .70771897 in
Computed slope at pile head       =     -.00755145
Maximum bending moment            =       3470276. lbs-in
Maximum shear force               =    76000.00000 lbs
Depth of maximum bending moment   =    96.00000000 in
Depth of maximum shear force      =        0.00000 in
Number of iterations              =             32
Number of zero deflection points  =              7
```

Summary of Pile Response(s)

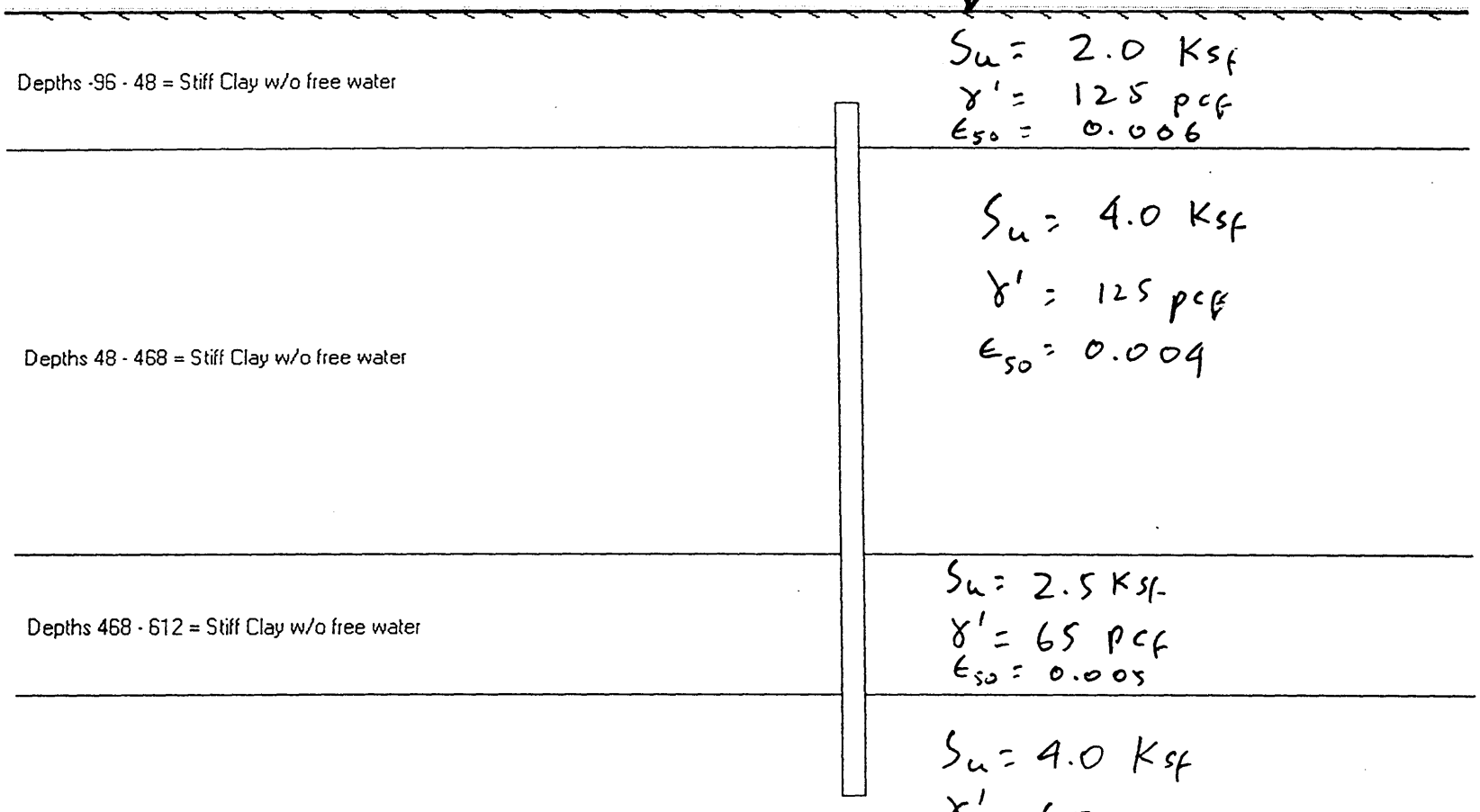
Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 36000.	M= 0.000	200000.	.1369134	1188311.	36000.0000
1	V= 56000.	M= 0.000	200000.	.3625513	2241998.	56000.0000
1	V= 76000.	M= 0.000	200000.	.7077190	3470276.	76000.0000

The analysis ended normally.

El. = 52.5 (approx.)

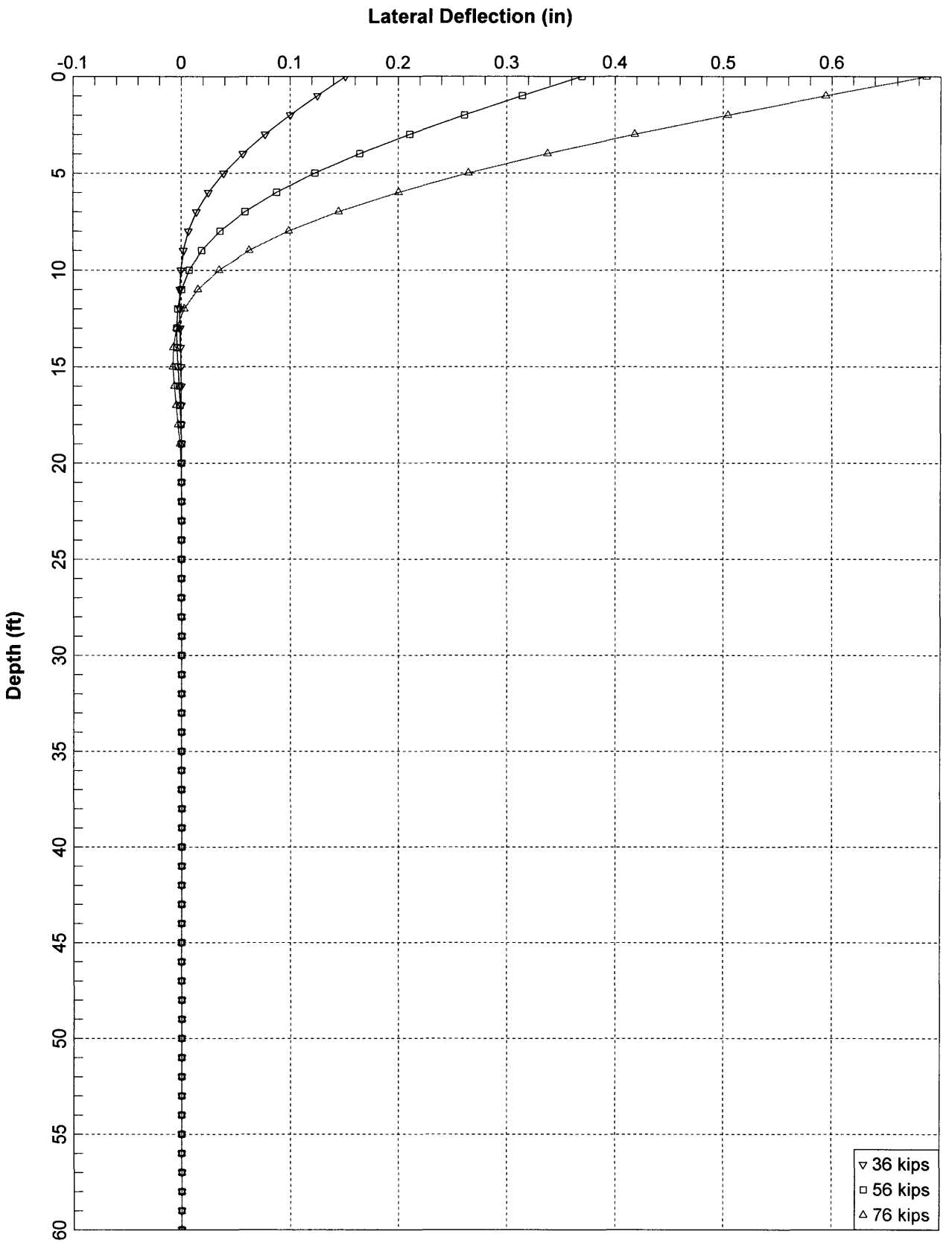


Abutment 2

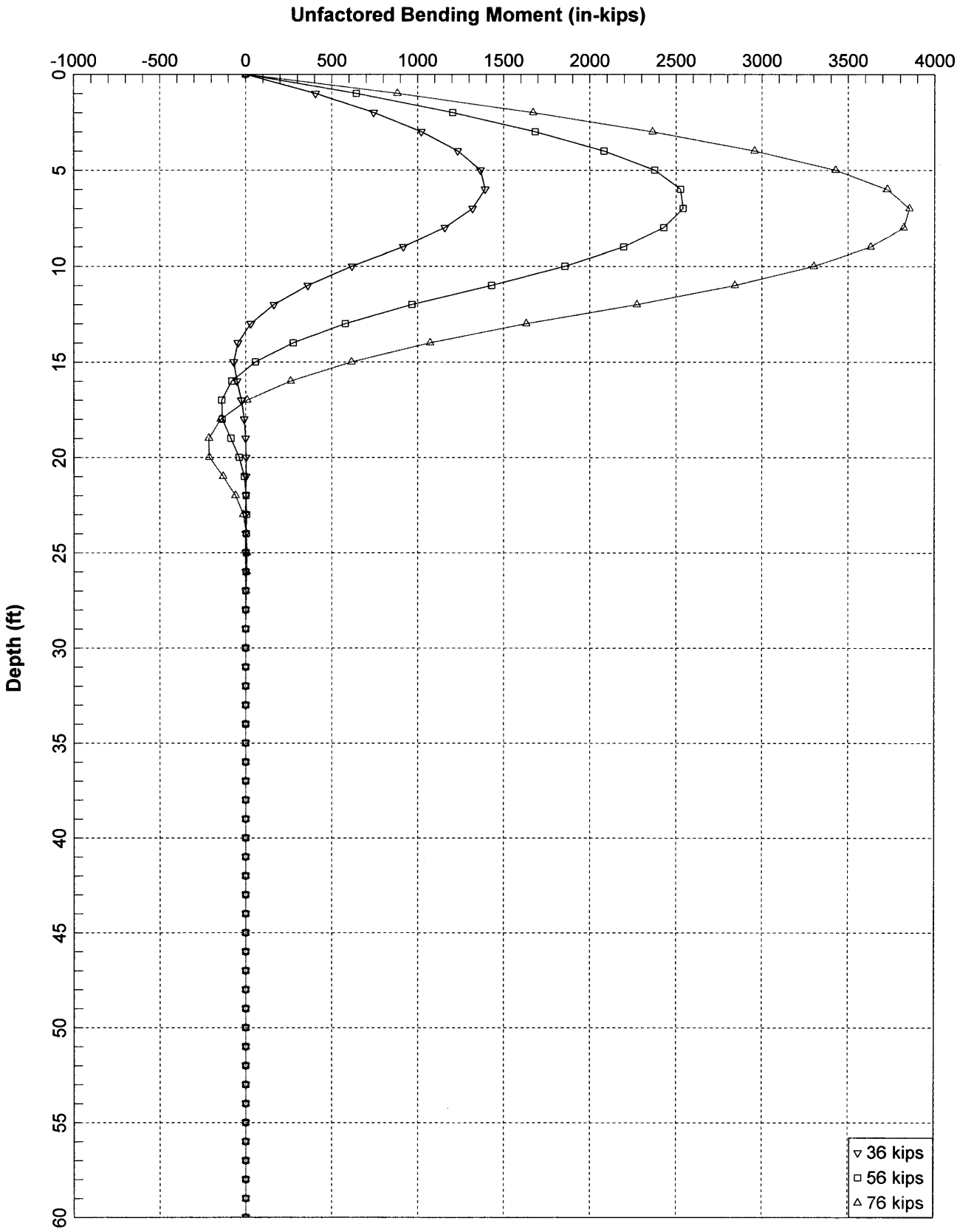
Profile based on boring CAV-169

24-in. Diameter CIDH Pile

Area = 452.4 in²; I = 16286 in⁴



eBART Cavallo Road Underpass - Abutment 2 - 24-in. CIDH PIle -



eBART CAvallo Road Underpass - Abutment 2 - 24-in. CIDH PIle

LPILE Plus for Windows, Version 5.0 (5.0.21)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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Gary Parikh
Parikh Consultants

Path to file locations: S:\Ongoing Projects\2006\206117 TYLIn Rte 4 Project\EBART PROJECT\Cavallo Road Underpass\LPILE\
Name of input data file: Cavallo Road -Abutment 2.lpd
Name of output file: Cavallo Road -Abutment 2.lpo
Name of plot output file: Cavallo Road -Abutment 2.lpp
Name of runtime file: Cavallo Road -Abutment 2.lpr

Time and Date of Analysis

Date: August 20, 2009 Time: 11: 7:40

Problem Title

Ebart Cavallo Road Underpass - Abutment 2 - 24-in CIDH Pile

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant 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 pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 60
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 720.00 in
Depth of ground surface below top of pile = -96.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	24.00000000	16286.0000	452.4000	3600000.
2	720.0000	24.00000000	16286.0000	452.4000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -96.000 in
Distance from top of pile to bottom of layer = 48.000 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 48.000 in
Distance from top of pile to bottom of layer = 468.000 in

Layer 3 is stiff clay without free water
Distance from top of pile to top of layer = 468.000 in
Distance from top of pile to bottom of layer = 612.000 in

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 612.000 in
Distance from top of pile to bottom of layer = 972.000 in

(Depth of lowest layer extends 252.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 8 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-96.00	.07230

2	48.00	.07230
3	48.00	.07230
4	468.00	.07230
5	468.00	.03760
6	612.00	.03760
7	612.00	.03760
8	972.00	.03760

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 8 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-96.000	13.89000	.00	.00600	.0
2	48.000	13.89000	.00	.00600	.0
3	48.000	27.78000	.00	.00400	.0
4	468.000	27.78000	.00	.00400	.0
5	468.000	17.36000	.00	.00500	.0
6	612.000	17.36000	.00	.00500	.0
7	612.000	27.78000	.00	.00400	.0
8	972.000	27.78000	.00	.00400	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.6000	1.0000
2	720.000	.6000	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 3

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 36000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 56000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 76000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 200000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 36000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 200000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.151190	-4.5203E-08	36000.0000	-.0021610	442.0866	-442.7887
12.000	.125258	405306.	30664.5996	-.0021195	740.7277	-446.4447
24.000	.100321	746124.	25315.6305	-.0020017	991.8527	-445.0502
36.000	.077217	1022489.	20016.5506	-.0018207	1195.4864	-438.1298
48.000	.056624	1235261.	14083.4224	-.0015897	1352.2629	-550.7249
60.000	.039065	1368122.	6388.8107	-.0013232	1450.1585	-731.7104
72.000	.024866	1394944.	-2114.5414	-.0010405	1469.9220	-685.5150
84.000	.014093	1322367.	-9962.8344	-.0007624	1416.4452	-622.5339
96.000	.006568	1159495.	-16922.0871	-.0005084	1296.4367	-537.3416
108.000	.001891	918677.	-22610.1451	-.0002957	1118.9948	-410.6681
120.000	-.000529	618271.	-23216.2540	-.0001384	897.6471	309.6499
132.000	-.001431	362152.	-18877.0120	-3.8113E-05	708.9305	413.5571
144.000	-.001444	165406.	-13814.2944	1.5876E-05	563.9627	430.2292
156.000	-.001050	30532.3391	-8762.0122	3.5928E-05	464.5838	411.8178
168.000	-.000582	-45054.6478	-4084.5615	3.4441E-05	475.2842	367.7573
180.000	-.000224	-67662.4549	-187.2869	2.2906E-05	491.9423	281.7885

192.000	-3.21E-05	-49659.4842	1753.5820	1.0900E-05	478.6772	41.6897
204.000	3.77E-05	-25628.8062	1704.3439	3.1950E-06	460.9707	-49.8960
216.000	4.46E-05	-8770.5654	1051.1342	-3.2535E-07	448.5491	-58.9723
228.000	2.99E-05	-400.0246	459.8520	-1.2638E-06	442.3814	-39.5747
240.000	1.43E-05	2271.9497	109.1325	-1.0723E-06	443.7607	-18.8785
252.000	4.20E-06	2224.3013	-37.4880	-6.1214E-07	443.7256	-5.5582
264.000	-4.09E-07	1375.1769	-67.5922	-2.4378E-07	443.0999	.5408456
276.000	-1.65E-06	603.2586	-51.2949	-4.1312E-08	442.5311	2.1754
288.000	-1.40E-06	144.2979	-27.1342	3.5191E-08	442.1930	1.8514
300.000	-8.01E-07	-48.1305	-9.6718	4.5033E-08	442.1221	1.0590
312.000	-3.20E-07	-88.0415	-.7810195	3.1097E-08	442.1515	.4228128
324.000	-5.48E-08	-67.0242	2.1907	1.5228E-08	442.1360	.0724698
336.000	4.56E-08	-35.5383	2.2638	4.7321E-09	442.1128	-.0602778
348.000	5.87E-08	-12.7150	1.4363	-2.0603E-10	442.0960	-.0776496
360.000	4.07E-08	-1.0670	.6479143	-1.6165E-09	442.0874	-.0537418
372.000	1.99E-08	2.8427	.1672441	-1.4347E-09	442.0887	-.0263699
384.000	6.22E-09	2.9537	-.0403349	-8.4155E-10	442.0888	-.0082266
396.000	-2.48E-10	1.8787	-.0877306	-3.4702E-10	442.0880	.0003273
408.000	-2.10E-09	.8498361	-.0690733	-6.7795E-11	442.0873	.0027822
420.000	-1.87E-09	.2212295	-.0375117	4.1815E-11	442.0868	.0024781
432.000	-1.10E-09	-.0506454	-.0139092	5.9272E-11	442.0867	.0014557
444.000	-4.52E-10	-.1128764	-.0015887	4.2538E-11	442.0867	.0005977
456.000	-8.04E-11	-.0889781	.0026352	2.1880E-11	442.0867	.0001062
468.000	7.29E-11	-.0497374	.0028164	7.6845E-12	442.0867	-7.6037E-05
480.000	1.04E-10	-.0214217	.0018724	4.0223E-13	442.0867	-8.1286E-05
492.000	8.26E-11	-.0048007	.0009977	-2.2813E-12	442.0867	-6.4506E-05
504.000	4.93E-11	.0025339	.0003796	-2.5133E-12	442.0867	-3.8515E-05
516.000	2.23E-11	.0043211	4.4172E-05	-1.8118E-12	442.0867	-1.7385E-05
528.000	5.82E-12	.0036027	-8.7416E-05	-1.0009E-12	442.0867	-4.5464E-06
540.000	-1.77E-12	.0022279	-.0001064	-4.0416E-13	442.0867	1.3798E-06
552.000	-3.88E-12	.0010507	-7.9949E-05	-6.8644E-14	442.0866	3.0312E-06
564.000	-3.41E-12	.0003094	-4.5761E-05	7.0547E-14	442.0866	2.6668E-06
576.000	-2.19E-12	-4.7934E-05	-1.9509E-05	9.7309E-14	442.0866	1.7086E-06
588.000	-1.08E-12	-.0001593	-4.2041E-06	7.6107E-14	442.0866	8.4233E-07
600.000	-3.61E-13	-.0001492	2.5399E-06	4.4541E-14	442.0866	2.8166E-07
612.000	-9.28E-15	-9.8510E-05	4.2879E-06	1.9191E-14	442.0866	9.6769E-09
624.000	1.00E-13	-4.6381E-05	3.5526E-06	4.3630E-15	442.0866	-1.3223E-07
636.000	9.54E-14	-1.3270E-05	2.0023E-06	-1.7414E-15	442.0866	-1.2615E-07
648.000	5.82E-14	1.6831E-06	7.8355E-07	-2.9272E-15	442.0866	-7.6983E-08
660.000	2.52E-14	5.5495E-06	1.2194E-07	-2.1870E-15	442.0866	-3.3285E-08
672.000	5.75E-15	4.6202E-06	-1.2339E-07	-1.1463E-15	442.0866	-7.6033E-09
684.000	-2.33E-15	2.5937E-06	-1.5054E-07	-4.0800E-16	442.0866	3.0786E-09
696.000	-4.04E-15	1.0093E-06	-1.0002E-07	-3.9277E-17	442.0866	5.3400E-09
708.000	-3.27E-15	1.9332E-07	-4.2037E-08	8.3797E-17	442.0866	4.3246E-09
720.000	-2.03E-15	0.0000	0.0000	1.0358E-16	442.0866	2.6816E-09

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection              =      .15119007 in
Computed slope at pile head       =     -.00216103
Maximum bending moment            =      1394944. lbs-in
Maximum shear force               =    36000.00000 lbs
Depth of maximum bending moment   =    72.00000000 in
Depth of maximum shear force      =       0.00000 in
Number of iterations              =            26
Number of zero deflection points  =             9
```

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

```
Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head  =       56000.000 lbs
Specified moment at pile head       =            .000 in-lbs
Specified axial load at pile head   =      200000.000 lbs
```

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.369538	2.2601E-07	56000.0000	-.0045831	442.0866	-553.6317
12.000	.314540	.643138.	49306.3012	-.0045173	915.9695	-561.9848
24.000	.261123	1205034.	42542.7490	-.0043282	1329.9910	-565.2739
36.000	.210665	1684939.	35772.7318	-.0040324	1683.5989	-563.0623
48.000	.164345	2082935.	28081.6121	-.0036468	1976.8542	-718.7910
60.000	.123141	2376402.	17919.4093	-.0031904	2193.0893	-974.9095
72.000	.087774	2528315.	6432.7339	-.0026885	2305.0231	-939.5364
84.000	.058617	2543693.	-4537.7777	-.0021695	2316.3538	-888.8822
96.000	.035707	2429822.	-14792.4352	-.0016605	2232.4504	-820.2274
108.000	.018766	2196645.	-24082.5321	-.0011870	2060.6386	-728.1221
120.000	.007219	1857539.	-32032.4665	-.0007721	1810.7755	-596.8670
132.000	.000235	1431572.	-37152.4037	-.0004355	1496.9105	-256.4559
144.000	-.003234	967972.	-35531.3496	-.0001900	1155.3165	526.6315
156.000	-.004325	579731.	-28849.8543	-3.1576E-05	869.2495	586.9510
168.000	-.003992	275727.	-21754.9858	5.5969E-05	645.2502	595.5271
180.000	-.002981	57342.9233	-14747.2479	9.0055E-05	484.3386	572.4292
192.000	-.001830	-78639.3607	-8172.5926	8.7875E-05	500.0304	523.3466
204.000	-.000872	-139221.	-2379.7653	6.5580E-05	544.6688	442.1246
216.000	-.000256	-136069.	2306.1574	3.7408E-05	542.3459	338.8625
228.000	2.54E-05	-84052.8803	4137.6156	1.4881E-05	504.0193	-33.6195
240.000	.000101	-36837.1685	3136.5644	2.5096E-06	469.2293	-133.2224
252.000	8.57E-05	-8787.3800	1657.8343	-2.1595E-06	448.5614	-113.2327
264.000	4.90E-05	2961.2212	590.1508	-2.7557E-06	444.2686	-64.7146
276.000	1.95E-05	5389.4670	47.0022	-1.9012E-06	446.0578	-25.8102
288.000	3.33E-06	4098.4003	-134.2754	-9.3020E-07	445.1065	-4.4028
300.000	-2.80E-06	2171.3232	-138.4972	-2.8857E-07	443.6865	3.6991
312.000	-3.59E-06	775.8534	-87.7918	1.3036E-08	442.6583	4.7518
324.000	-2.49E-06	64.2573	-39.5676	9.9010E-08	442.1340	3.2856
336.000	-1.22E-06	-174.2453	-10.1893	8.7754E-08	442.3350	1.6108
348.000	-3.80E-07	-180.7070	2.4857	5.1429E-08	442.2198	.5017000
360.000	1.57E-08	-114.8352	5.3715	2.1184E-08	442.1713	-.0207317
372.000	1.29E-07	-51.8923	4.2250	4.1220E-09	442.1249	-.1703490
384.000	1.15E-07	-13.4542	2.2940	-2.5654E-09	442.0966	-.1514969
396.000	6.73E-08	3.1750	.8511812	-3.6173E-09	442.0890	-.0889657
408.000	2.78E-08	6.9915	.0969354	-2.5769E-09	442.0918	-.0367420
420.000	5.46E-09	5.5138	-.1668150	-1.2972E-09	442.0907	-.0072164
432.000	-3.34E-09	2.9942	-.1836623	-4.2647E-10	442.0889	.0044085
444.000	-4.78E-09	1.1079	-.1193345	-6.6677E-12	442.0875	.0063128
456.000	-3.50E-09	.1301936	-.0537376	1.2004E-10	442.0867	.0046200
468.000	-1.89E-09	-.1823347	-.0141621	1.1470E-10	442.0868	.0019759
480.000	-7.42E-10	-.2102478	.0011725	7.4528E-11	442.0868	.0005799
492.000	-1.06E-10	-.1545521	.0051496	3.7196E-11	442.0868	8.2943E-05
504.000	1.50E-10	-.0868367	.0049424	1.2493E-11	442.0867	-.0001175
516.000	1.94E-10	-.0359950	.0033299	-7.7746E-14	442.0867	-.0001513
528.000	1.49E-10	-.0069195	.0017261	-4.4695E-12	442.0867	-.0001160
540.000	8.64E-11	.0054531	.0006251	-4.6196E-12	442.0867	-6.7479E-05
552.000	3.76E-11	.0081059	4.3825E-05	-3.2320E-12	442.0867	-2.9405E-05

564.000	8.81E-12	.0065204	-.0001739	-1.7351E-12	442.0867	-6.8839E-06
576.000	-4.00E-12	.0039404	-.0001965	-6.6462E-13	442.0867	3.1267E-06
588.000	-7.14E-12	.0018087	-.0001442	-7.6269E-14	442.0867	5.5768E-06
600.000	-5.83E-12	.0004792	-8.3432E-05	1.5787E-13	442.0866	4.5566E-06
612.000	-3.35E-12	-.0001944	-3.5133E-05	1.8700E-13	442.0866	3.4933E-06
624.000	-1.34E-12	-.0003649	-3.5083E-06	1.2976E-13	442.0866	1.7775E-06
636.000	-2.36E-13	-.0002793	9.0264E-06	6.3839E-14	442.0866	3.1160E-07
648.000	1.87E-13	-.0001486	9.4098E-06	2.0054E-14	442.0866	-2.4770E-07
660.000	2.46E-13	-5.3519E-05	5.9760E-06	-6.2904E-16	442.0866	-3.2460E-07
672.000	1.72E-13	-5.1634E-06	2.6620E-06	-6.6344E-15	442.0866	-2.2774E-07
684.000	8.63E-14	1.0400E-05	6.1073E-07	-6.0986E-15	442.0866	-1.1413E-07
696.000	2.59E-14	9.5234E-06	-2.7968E-07	-4.0597E-15	442.0866	-3.4274E-08
708.000	-1.11E-14	3.7069E-06	-3.9735E-07	-2.7058E-15	442.0866	1.4662E-08
720.000	-3.90E-14	0.0000	0.0000	-2.3264E-15	442.0866	5.1563E-08

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

```
Pile-head deflection              =      .36953770 in
Computed slope at pile head       =     -.00458311
Maximum bending moment            =      2543693. lbs-in
Maximum shear force               =    56000.00000 lbs
Depth of maximum bending moment   =    84.00000000 in
Depth of maximum shear force      =       0.00000 in
Number of iterations              =            23
Number of zero deflection points  =             9
```

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 3

```
Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head  =       76000.000 lbs
Specified moment at pile head       =            .000 in-lbs
Specified axial load at pile head   =      200000.000 lbs
```

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.686895	-9.0405E-08	76000.0000	-.0076966	442.0866	-646.4342
12.000	.594535	883929.	68167.7614	-.0076062	1093.3911	-658.9389
24.000	.504347	1672536.	60215.8177	-.0073446	1674.4600	-666.3850
36.000	.418266	2364362.	52207.2919	-.0069314	2184.2177	-668.3693
48.000	.337992	2958782.	43032.4838	-.0063867	2622.2035	-860.7654
60.000	.264985	3427798.	30783.3046	-.0057331	2967.7882	-1180.7645
72.000	.200398	3725100.	16769.3983	-.0050011	3186.8491	-1154.8866
84.000	.144959	3854269.	3152.0920	-.0042254	3282.0243	-1114.6645
96.000	.098987	3821032.	-9886.0754	-.0034400	3257.5348	-1058.3634
108.000	.062400	3633515.	-22135.6677	-.0026771	3119.3663	-983.2353
120.000	.034737	3302626.	-33339.1900	-.0019673	2875.5581	-884.0184
132.000	.015186	2842817.	-43125.8525	-.0013384	2536.7572	-747.0920
144.000	.002617	2274030.	-50607.2666	-.0008147	2117.6581	-499.8104
156.000	-.004367	1632153.	-50077.3914	-.0004150	1644.7048	588.1229

168.000	-.007342	1074164.	-42388.6104	-.0001380	1233.5623	693.3406
180.000	-.007679	615489.	-33878.6943	3.4914E-05	895.5969	724.9787
192.000	-.006504	260908.	-25218.8272	.0001246	634.3314	718.3325
204.000	-.004689	9639.0058	-16871.2558	.0001523	449.1889	672.9295
216.000	-.002849	-144733.	-9268.8045	.0001385	548.7302	594.1458
228.000	-.001366	-213477.	-2737.8775	.0001018	599.3827	494.3421
240.000	-.000406	-210931.	3448.1145	5.8373E-05	597.5066	536.6566
252.000	3.55E-05	-131002.	6386.9024	2.3381E-05	538.6130	-46.8586
264.000	.000155	-57757.3066	4875.3176	4.0637E-06	484.6439	-205.0722
276.000	.000133	-14014.2613	2590.2304	-3.2812E-06	452.4128	-175.7757
288.000	7.64E-05	4423.9715	929.6868	-4.2626E-06	445.3464	-100.9816
300.000	3.07E-05	8318.6830	80.4973	-2.9586E-06	448.2161	-40.5500
312.000	5.39E-06	6370.1078	-205.5538	-1.4553E-06	446.7803	-7.1252
324.000	-4.25E-06	3392.3784	-214.5909	-4.5628E-07	444.5863	5.6190
336.000	-5.56E-06	1222.1161	-136.7787	1.5955E-08	442.9871	7.3497
348.000	-3.87E-06	109.6137	-62.0033	1.5224E-07	442.1674	5.1128
360.000	-1.91E-06	-266.6934	-16.2057	1.3617E-07	442.2832	2.5201
372.000	-6.00E-07	-279.9756	3.6740	8.0221E-08	442.2929	.7931766
384.000	1.88E-08	-178.9028	8.2843	3.3260E-08	442.2185	-.0247977
396.000	1.98E-07	-81.3130	6.5637	6.6304E-09	442.1466	-.2619606
408.000	1.78E-07	-21.4057	3.5811	-3.8815E-09	442.1024	-.2351394
420.000	1.05E-07	4.6522	1.3373	-5.5960E-09	442.0901	-.1388242
432.000	4.36E-08	10.7170	.1587069	-4.0232E-09	442.0945	-.0576124
444.000	8.47E-09	8.4804	-.2541293	-2.0586E-09	442.0929	-.0111936
456.000	-5.82E-09	4.6278	-.2751322	-7.1711E-10	442.0901	.0076932
468.000	-8.74E-09	1.8807	-.1742766	-5.1044E-11	442.0880	.0091161
480.000	-7.05E-09	.4454189	-.0865578	1.8701E-10	442.0870	.0055037
492.000	-4.25E-09	-.1975655	-.0335956	2.1237E-10	442.0868	.0033233
504.000	-1.95E-09	-.3618943	-.0045236	1.5512E-10	442.0869	.0015220
516.000	-5.31E-10	-.3068769	.0070987	8.6677E-11	442.0869	.0004151
528.000	1.32E-10	-.1919412	.0089705	3.5630E-11	442.0868	-.0001031
540.000	3.24E-10	-.0917567	.0068341	6.5968E-12	442.0867	-.0002530
552.000	2.90E-10	-.0279535	.0039557	-5.6541E-12	442.0867	-.0002268
564.000	1.88E-10	.0032078	.0017133	-8.1865E-12	442.0867	-.0001470
576.000	9.38E-11	.0132061	.0003919	-6.5067E-12	442.0867	-7.3289E-05
588.000	3.20E-11	.0126444	-.0001976	-3.8612E-12	442.0867	-2.4962E-05
600.000	1.15E-12	.0084819	-.0003528	-1.6992E-12	442.0867	-8.9548E-07
612.000	-8.83E-12	.0041864	-.0003029	-4.0276E-13	442.0867	9.2054E-06
624.000	-8.52E-12	.0012143	-.0001801	1.4993E-13	442.0866	1.1262E-05
636.000	-5.23E-12	-.0001136	-7.1047E-05	2.6023E-13	442.0866	6.9125E-06
648.000	-2.27E-12	-.0004920	-1.1533E-05	1.9590E-13	442.0866	3.0065E-06
660.000	-5.28E-13	-.0004143	1.0693E-05	1.0315E-13	442.0866	6.9786E-07
672.000	2.01E-13	-.0002359	1.3286E-05	3.6610E-14	442.0866	-2.6575E-07
684.000	3.51E-13	-9.5609E-05	8.9103E-06	2.6867E-15	442.0866	-4.6356E-07
696.000	2.66E-13	-2.2045E-05	4.0231E-06	-9.3538E-15	442.0866	-3.5098E-07
708.000	1.26E-13	9.8903E-07	9.1625E-07	-1.1509E-14	442.0866	-1.6683E-07
720.000	-1.07E-14	0.0000	0.0000	-1.1407E-14	442.0866	1.4117E-08

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

```
Pile-head deflection              =      .68689505 in
Computed slope at pile head       =     -.00769665
Maximum bending moment            =       3854269. lbs-in
Maximum shear force               =    76000.00000 lbs
Depth of maximum bending moment   =    84.00000000 in
Depth of maximum shear force      =       0.00000 in
Number of iterations              =            32
Number of zero deflection points  =             9
```

Cavallo Road -Abutment 2.lpo

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 36000.	M= 0.000	200000.	.1511901	1394944.	36000.0000
1	V= 56000.	M= 0.000	200000.	.3695377	2543693.	56000.0000
1	V= 76000.	M= 0.000	200000.	.6868951	3854269.	76000.0000

The analysis ended normally.

APPENDIX D

Office of Special Funded Projects
Comment & Response Form

General Project Information	Review Phase		Reviewer Information
Dist: _ EA: 228511 Project Name: Route 4 Widenining SEG 3A OSFP Liaison: O. Hor Phone: 916-227-8419 e-mail: overcomer_hor@dot.ca.gov	☐ PSR/PDS (Review No. _) ☐ APS/PSR (Review No. _) ☐ APS/PR (Review No. _) ☐ Type Selection	☒ 65% PS&E Unchecked Details ☐ PS&E (Review No. 1) ☐ Construction Support ☒ Other: Foundation Report	Reviewer Name: Ali Kaddoura Functional Unit: 327 Cost Center: 59 Phone Number: 510-286-4676 e-mail: ali_kaddoura@dot.ca.gov Date of Review: 03/09/09
	Structure Information (Use when necessary to document comments by individual structure) Structure Name: Cavallo Road UP Br No: 28-C0488		

Consultant Information (to be filled in by Consultant)

Consultant Structure Lead (First and Last Name)	Structure Consultant Firm	Phone Number	e-mail	Response Date

#	Doc. (See Note 1)	Page, Section, or SSP	Review Comments	Consultant Responses
1	FR Cavallo Road UP Bridge No. 28-C0488 65% PS&E		Draft FR Prepared by Parikh Consultants Dated February 2009.	
2			The report lacks the County, Route, and Postmile designation.	
3		6	In Table, "RLSS" stands for "right lateral strike slip" and not "right left strike slip.	
4		Appendic C Lpile input for East Abutments Page 6	Axial load input should be 450,000 lbs in lieu of 400,000 lbs	
5	A Street UP Bridge No. 28-C0487 65% PS&E		(C3) Not approved (resubmittal to GS required)	

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved (for Reviewer's use)

Responses to Caltrans Comments on 65% Foundation Report

Cavallo Road Underpass (Bridge No. 28C0488)

Response ot Comment No. 1

No response required.

Response ot Comment No. 2

County, route and Post Mile Designations have been added in the cover sheet an also in the heading for the report.

Response ot Comment No. 3

Agreed. Text is revised to state "right lateral strike slip" for RLSS.

Response ot Comment No. 4

This should have no impact on the results. Also, the ultimate load has changed to 404,000 kips. Therefore, use of 400,000 kips should suffice.

Response ot Comment No. 5

No response required.

Office of Special Funded Projects
Comment & Response Form

General Project Information	Review Phase	Reviewer Information
Dist: _ EA: 228511 Project Name: Route 4 Widenining SEG 3A OSFP Liaison: O. Hor Phone: 916-227-8419 e-mail: overcomer_hor@dot.ca.gov	☐ PSR/PDS (Review No. _) ☐ APS/PSR (Review No. _) ☐ APS/PR (Review No. _) ☐ Type Selection ☐ 65% PS&E Unchecked Details ☐ PS&E (Review No. 1) ☐ Construction Support ☒ Other: Final Foundation Report **Structure Information** (Use when necessary to document comments by individual structure) Structure Name: Cavallo Road UP Br No: 28-C0488	Reviewer Name: Ali Kaddoura/R. Nashed Functional Unit: 327 Cost Center: 59 Phone Number: 510-286-4676 e-mail: ali_kaddoura@dot.ca.gov Date of Review: 11/2/09

Consultant Information (to be filled in by Consultant)

Consultant Structure Lead (First and Last Name)	Structure Consultant Firm	Phone Number	e-mail	Response Date

#	Doc. (See Note 1)	Page, Section, or SSP	Review Comments	Consultant Responses
1	Final FR Cavallo Road UP Bridge No. 28-C0488		Final FR Prepared by Parikh Consultants Dated August 2009.	No response required.
2		Page 6, Seismic Sources	In the table: – The distance between the site and Vaca Fault Zone is 5.5 miles not 3.4 miles. _ The distance between the site and Great Valley Fault is 6.6 miles not 4.4 miles. Please correct and check all calculations based on these values.	Per e-mail from Hossein Salimi of Caltrans dated March 2, 2010, no further action on this comment is required. (See attached e-mail)
3			Our previous comments have been addressed to our satisfaction.	
4	Final FR Cavallo Road UP		(C2) Approved subject to OSFP verification	

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved (for Reviewer's use)

	Bridge No. 28-C0488			

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved
(for Reviewer's use)

Partha Sircar

From: "Hossain Salimi" <hossain_salimi@dot.ca.gov>
To: "Partha Sircar" <psircar@parikhnet.com>
Sent: Tuesday, March 02, 2010 10:53 AM
Attach: 228511GeoSeg 3A-1stPSE.pdf
Subject: Fw: SR4 Segment 3A bridges - Seismic

FYI

Hossain Salimi
Senior Materials and Research Engineer
Office of Geotechnical Design-West
(916) 227-7147
----- Forwarded by Hossain Salimi/HQ/Caltrans/CAGov on 03/02/2010 09:53 AM

Hossain Salimi/HQ/Caltrans/CAGov
02/25/2010 10:43 AM

To
Ali Kaddoura/D04/Caltrans/CAGov, Rifaat Nashed/HQ/Caltrans/CAGov
cc
Tim Pokrywka/D04/Caltrans/CAGov@DOT
Subject
Fw: SR4 Segment 3A bridges - Seismic

Gentlemen,

I am writing you in regards to the reports submitted by Parikh and our subsequent attached comments (Bridges under EA # 04-228511). Parikh had used the old 1996 Caltrans Seismic Hazard Map as well as the old Seismic Design Criteria (SDC) to produce the seismic recommendations. These bridges were type selected before the Department mandated changes to the SDC became official. In fact, their findings are more conservative compared to the new criteria. In light of this, I find it unreasonable for us to request changes to the seismic recommendations of these reports. I am satisfied with the findings in the reports and have no further comments. In the future, I will check the type selection date of each bridge to see if the changes to the new SDC are warranted.

Sincerely,

Hossain Salimi

Senior Materials and Research Engineer
Office of Geotechnical Design-West
(916) 227-7147
----- Forwarded by Hossain Salimi/HQ/Caltrans/CAGov on 02/25/2010 10:30 AM

"Partha Sircar"
<psircar@parikhne
t.com>
02/24/2010 10:13
AM

To
"Hossain Salimi"
<hossain_salimi@dot.ca.gov>
cc

Subject
SR4 Segment 3A bridges - Seismic

Hossein:

As I had discussed with you earlier, I have the same issues with the above bridges. Please call me to advise.

Partha Sircar
Parikh Consultanta
(408) - 452 -9000

----- Original Message -----
From: "Hossain Salimi" <hossain_salimi@dot.ca.gov>
To: "Rifaat Nashed" <rifaat_nashed@dot.ca.gov>; "Ali Kaddoura" <ali_kaddoura@dot.ca.gov>
Cc: "Partha Sircar" <psircar@parikhnet.com>; "Tim Pokrywka" <tim_pokrywka@dot.ca.gov>
Sent: Thursday, December 17, 2009 10:38 AM
Subject: Updated status of Somersville Rd UC replacement (04-228511)

>
> Hi Rifaat/Ali,
>
> I had a conversation with Mr. Sircar of Parikh subsequent to the e-mail I
> sent you. As it turns out, this project has been in the works for a long
> time, and the seismic analysis and design have already been completed
> using

> the old SDC. Therefore, Parikh is not required to take any further
> actions
> regarding my comments. Thank you all.
>
> Sincerely,
>
> Hossain Salimi
> Senior Materials and Research Engineer
> Office of Geotechnical Design-West
> (916) 227-7147
> ----- Forwarded by Hossain Salimi/HQ/Caltrans/CAGov on 12/17/2009 10:31
AM
> -----
>
> Hossain
> Salimi/HQ/Caltran
> s/CAGov To
> Rifaat Nashed/HQ/Caltrans/CAGov
> 11/30/2009 09:25 cc
> AM Tim Pokrywka/D04/Caltrans/CAGov@DOT
> Subject
> Somersville Rd UC replacement
> (04-228511)(Document link: Hossain
> Salimi)
>
>
>
>
>
>
>
>
>
> Hi Rifaat,
>
> I reviewed the attached documents you sent me on November 19, 2009
(Report
> containing Final Foundation Report from Parikh Consultants to Mark Thomas
> and Company Inc. for the proposed Somersville Road Undercrossing
> replacement) and have the following comments. I should note that the
> proposed bridge (28-0398L/R) is located on Route 4 and will replace the
> existing 2-span structure (28-0211R).
>
> 1. According to the report, Parikh is using the in-progress Seismic
Hazard
> Map (CSHM) . However, the distances as outlined in the table does not
> match our latest CSHM.
>
> 2. The Department has finalized the new ARS curves based on the new
> Seismic
> Design Criteria (SDC) and is now mandatory for use by both the Department
> personnel as well as our consultants effective September 30, 2009.
> However, Parikh is still using the ARS curve based on the 2001SDC which
> was

> based on Sadigh 1996 Attenuation Relationship models.
>
> To re-iterate, the Department has implemented the new SDC and the
> consultant shall re-submit the report using the now mandated seismic
> design
> criteria.
>
> Sincerely,
>
> Hossain Salimi
> Senior Materials and Research Engineer
> Office of Geotechnical Design-West
> (916) 227-7147
>
>
>
>
>
> Rifaat
> Nashed/HQ/Caltran
> s/CAGov To
> Hossain
> 11/19/2009 03:20 Salimi/HQ/Caltrans/CAGov@DOT
> PM cc
> Tim Pokrywka/D04/Caltrans/CAGov
> Subject
> Somerville Rd UC (Replacement)
>
>
>
>
>
>
>
>
>
> Hi Hossain
>
> Please find attached the Final Foundation Report for Somerville Road
> Undercrossing (Replacement) by PARIKH Consultant
>
> (See attached file: FR- Somerville Rd UC (Replacement).pdf)(See attached
> file: Appendix B- Lab Tests.pdf)(See attached file: Appendix C.pdf)
>
>
> Regards
>
> Rifaat Nashed
(See attached file: 228511GeoSeg 3A-1stPSE.pdf)

7. Foundation Report – Roosevelt Lane PUC (Replacement) – At State Route 4 (Br. No. 28-0396) Contra Costa County, CA

FINAL FOUNDATION REPORT
ROOSEVELT LANE PUC (REPLACEMENT)
At State Route 4
(Bridge No. 28-0403)
Antioch, California
04-CC-4-R28.1 EA 2285F1

For

T. Y. Lin International
2010 Crow Canyon Place, Suite 350
San Ramon, CA 94583

PARIKH CONSULTANTS, INC.
1243 Alpine Road, Suite 110
Walnut Creek, California
(925) 933-6336

March 2011 Job No. 206117.EBS

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Construction Observation 8
INVESTIGATION LIMITATIONS 9

PROJECT LOCATION MAP ..... Plate 1
GEOLOGIC MAP ..... Plate 2
FAULT MAP ..... Plate 3

Appendix A Log of Test Borings and Laboratory Test Data
Appendix B Caltrans Comments and Responses

FINAL FOUNDATION REPORT
ROOSEVELT LANE PEDESTRIAN UNDERCROSSING PUC (REPLACEMENT)
AT STATE ROUTE 4 (BRIDGE NO. 28-0403)
ANTIOCH, CONTRA COSTA COUNTY, CALIFORNIA
04-CC-4-R28.1 EA 2285F1

INTRODUCTION

This report presents the results of our geotechnical engineering investigation performed for the proposed "Roosevelt Lane Pedestrian Undercrossing (PUC) Replacement" project in Antioch, Contra Costa County, CA. Our work was performed generally in accordance with the scope of work as per our agreement. The general location of the site and its vicinity are shown on the Project Location Map, Plate 1.

The geotechnical recommendations presented in this report are intended for design input and are not intended to be used as specifications. These recommendations should not be used for direct bidding purposes.

PROPOSED CONSTRUCTION

Based on the preliminary plans provided by T. Y. Lin International, the proposed project consists of demolition of the existing Roosevelt Lane Pedestrian Undercrossing tunnel across State Route 4 and replacement by a new tunnel. The proposed project is part of the overall improvement projects along State Route 4 between Loveridge Road in Pittsburg, California and Hillcrest Avenue in Antioch, California. The improvement primarily involves (a) widening the existing 4-lane highway to an 8-lane highway; and (b) construction of railroad tracks in the median for eBART.

PURPOSE AND SCOPE

The purpose of this investigation is to evaluate the pertinent subsurface conditions at the project site and provide recommendations for design and construction of the PUC.

No new soil borings were drilled as part of this project. Borings drilled in the vicinity for the overall improvement project along State Route 4 were utilized for the present project, as appropriate. The scope of work performed for this investigation included a review of all pertinent

available soils and geologic information, engineering analysis of the information, and preparation of this report. The basis for this investigation is the preliminary plans provided to us by T. Y. Lin International.

Due to limitations inherent in geotechnical investigations, it is neither uncommon to encounter unforeseen variations in the soil conditions during construction nor is it practical to determine all such variations during an acceptable program of drilling and sampling for a project of this scope. Such variations, when encountered, generally require additional engineering services to attain a properly constructed project. We, therefore, recommend that a contingency fund be provided to accommodate any additional charges resulting from technical services that may be required during construction.

Our recommendations in this report are based on the above information. Any major deviation should be reported to this office for consideration.

SITE CONDITIONS

At the Roosevelt Lane PUC location, the State Route 4 consists of 2 lanes each in the east and westbound directions with a median. The road surfaces are at an approximate elevation of 63 feet. The highway is built on an embankment with approximate side slopes of 3 (horizontal) to 1 (vertical). The native ground is at an approximate elevation of 45 feet at the northern end and 50 feet at the southern end.

The existing Roosevelt Lane PUC is a reinforced concrete box culvert (RCB) crossing State Route 4 as a northern continuation of Roosevelt Lane. A Project Location Map is presented as Plate 1. Per the as-built plans from 1971, the RCB is 159 feet long and 8’ x 8’ on the inside. The depth of the top of the box varies between 3 and 7 feet below existing ground surface. Two 17.5-foot long open tunnels are present at the two ends of the RCB – the open tunnel floors are matched to the adjacent existing grades.

PROJECT DESCRIPTION

Per the plans supplied to us by T. Y. Lin, the existing Roosevelt Lane PUC will be demolished and replaced by a new PUC. The new PUC will also be a reinforced concrete box (RCB) structure along the same alignment as the existing one. The RCB will be 214.5 feet long, the additional length of 55.5 feet being necessitated by the widening of State Route 4. The primary extension will be on the northern end, which will be 48 feet and on the southern end only 7.5 feet. The concrete box will 8 feet by 8 feet on the inside, as before, with 8.5-in. thick side walls. The top and bottom slabs will be 8-in. thick.

A 16.5-ft long open tunnel will be constructed at the southern end of the RCB. The base slab of the tunnel will be 1.75-ft thick, the tunnel floor being matched to the adjacent existing grade. The side walls of the tunnel will be 1-ft thick. At the northern end, the RCB ends immediately behind a retaining wall (Retaining Wall #4) – the footings for the retaining wall are lowered to accommodate the RCB. The floor of the RCB is matched to the adjacent existing grade.

The RCB will be designed to satisfy the Caltrans Bridge Design Specifications (Section 6 – Culverts). Additionally, it shall be designed to accommodate loads from the future eBART trains.

GEOLOGY

General geologic features pertaining to the site were evaluated with reference to the "Geologic Map of Quaternary Geology of Contra Costa County and Surrounding Areas, CA: Derived from Digital Database open-file 97-98" by E.J. Helley and R.W. Graymer 1997; Scale 1:100000. Based on the map, the site is located in an area covered by Pleistocene alluvial deposits (Qpaf). A geologic map of the general project area is shown on Plate 2. Description of the main geologic unit is as follows:

> *Qpaf (Alluvial Fans and Fluvial Deposits (Pleistocene)) – Brown dense gravely and clayey sand or clayey gravel that fines upward to sandy clay. These deposits display various sorting and are located in most stream channels in the county. All Qpaf deposits can be related to modern stream courses. They are distinguished from younger alluvial fans and fluvial deposits by higher topographic position, greater degree of dissection, and stronger soil profile development. They are less permeable than Holocene deposits, and locally contain*

fresh water mollusks and extinct late Pleistocene vertebrate fossils. They are overlain by Holocene deposits on lower parts of the alluvial plain, and incised by channels that are partly filled with Holocene alluvium on higher parts of the alluvial plain. Maximum thickness is unknown but at least 50m (150 feet).

FIELD AND LABORATORY INVESTIGATIONS

As noted earlier, site specific soil borings were not drilled for this project. However, several soil borings drilled in the project site vicinity as part of the overall improvement projects along State Route 4 were utilized for this project. A log of test boring (LOTB) sheet showing borings in the vicinity is presented in the Appendix A. The LOTB sheet indicates that Boring SW-199 is on the PUC footprint near the southern end and Boring SW-200 is located about 167 feet east of the PUC footprint. Borings RW-SW-196 and RW/SW-197 are also in the vicinity.

Associated laboratory testing performed on selected samples from the above borings included tests for moisture content, dry density, unconfined compression tests and Atterberg Limits. The test results are noted on the LOTB sheet. In addition, a Plasticity Chart for Atterberg Limits is also presented in the Appendix A.

SUBSURFACE CONDITIONS

The borings indicate predominantly hard lean clays and hard sandy silts within the depths of interest.

Groundwater was not encountered in any of the borings to the depths drilled.

EARTHQUAKE CONSIDERATIONS

Seismic Sources

The project is located in a seismically active part of Northern California. Many faults exist in the area, which are capable of producing earthquakes which may cause strong ground shaking at the site.

Applicable major faults in the vicinity of the project site were identified and their associated maximum earthquake magnitudes were established using the In-Progress Seismic Hazard Map currently under development by Caltrans and the associated Data Base. The documents were supplied to us by Caltrans, with the understanding that the fault locations in the map and the associated magnitudes in the Data Base have essentially been finalized. Pertinent information is summarized below. The moment magnitudes noted in the table represent the largest earthquakes that could occur on the given fault based on the current understanding of the regional tectonic structure. A fault map of the project vicinity is shown on Plate 3.

Fault	**Fault No.(1)**	**Fault Type**	**Distance from Site (miles)**	**Maximum Moment Magnitude**
Vaca Fault Zone	14	RLSS(2)	3.4	6.9
Great Valley Fault 5	24	Reverse Fault	4.4	6.5
Greenville Fault Zone (Clayton Section)	351	RLSS	4.1	6.6
Concord Fault Zone (Ygnacio Valley Section)	341	RLSS	6.9	6.6

(1) Number of the Fault in the Data Base associated with the Caltrans In-Progress Seismic Hazard Map
(2) RLSS – Right-Lateral Strike Slip Fault

Based on the Caltrans In-Progress Seismic Hazard Map and the attenuation relationship by Sadigh et al. (1997), the controlling fault is the Vaca Fault Zone (Fault No. 14 in the map), which is associated with a Maximum Moment Magnitude (Mmax) of 6.9. A peak bedrock acceleration (PBA) of 0.50g is anticipated at the site. The corresponding peak ground acceleration (PGA) is also 0.5g.

Additionally, there is no evidence of groundwater or presence of loose to medium granular soils within the depth of interest. Potential hazard from soils at the site liquefying during an earthquake is, therefore, also considered minimal.

Seismic Hazards/Liquefaction Impact

Potential seismic hazards may arise from three sources: ground shaking, surface fault rupture and liquefaction.

Based on available geological and seismic information, the possibility of the site to experience strong ground shaking may be considered significant.

Per Plate No. 3, there is no evidence of the presence of a fault along the project site or in the immediate vicinity. Potential hazard from fault rupture during an earthquake is therefore considered minimal.

Liquefaction is a phenomenon in which saturated soils are subject to a temporary but essentially total loss of shear strength under the reversing, cyclic shear stresses associated with earthquake shaking. Submerged, cohesionless sands and silts of low relative density are the type of soils which usually are susceptible to liquefaction - the susceptibility increases with decreasing relative density (reflected by the number of blows to drive a sampler), and decreasing fines content. Accepted procedures for the assessment of liquefaction potential for cohesionless soils have evolved over the years through research and field observations (Youd et al, 2001). Recent research and field observations have shown that clays of low plasticity are also potentially liquefiable, based on the moisture content and plasticity characteristics of the clay. Procedures for the assessment of liquefaction potential for clay soils have also been established and have received general acceptance (Bray et. al., 2004).

There was no evidence of the presence of groundwater or loose or medium dense sands within the depth of interest. Potential for liquefaction at the site due to an earthquake is therefore considered low.

FINDINGS AND RECOMMENDATIONS

Design Recommendations

Recommendations for design of the RCB are presented below:

1. Vertical Earth Pressure: 140 pcf

2. Lateral Earth Pressure: (a) 100 pcf (b) 35 pcf
   These two loadings should be applied separately and the resulting maximum moments should be utilized in design.

3. Bearing Capacity
   An allowable bearing capacity of 7.5 ksf (ultimate bearing capacity of 22.5 ksf) is recommended for design of the bottom slab of the RCB.

4. Modulus of Subgrade Reaction
   A modulus of subgrade reaction of 200 lb/in^3 is recommended for design of the bottom slab of the RCB.

Design of the reconstructed RCB shall be based on appropriate loadings from the eBART trains and shall conform to all applicable requirements of Caltrans, BART and other pertinent agencies.

Design of the eBART Type A retaining walls parallel to the eBART railroad tracks shall follow the applicable recommendations for the eBART retaining walls, which are presented in a separate document.

Construction Recommendations

All construction shall follow Caltrans Standard Specifications and any additional BART requirements for the eBART structure. It is expected that cut-and-cover methods will be adopted for construction of the new RCB.

The soils at the foundation levels are expected to be hard clays and silts. Special foundation treatment is, therefore, not required.

Replacement of the RCB will require significant excavation and subsequent backfilling. The excavation and backfilling shall conform to applicable subsections of Section 19 (Earthwork) of the Caltrans Standard Specifications.

The excavated material may be reused as backfill provided it meets the criteria for backfill material. Additional backfill material imported to the site should be non-expansive, relatively

granular material having a Plasticity Index (P.I.) of less than 15. It should also be non-corrosive, free of deleterious material and should be reviewed by the Geotechnical Engineer. A representative from our office or regulatory agency should observe all excavated areas during grading and perform moisture and density tests on prepared subgrade and compacted fill material.

Grading

All grading operations should be performed in accordance with the project specifications and Caltrans Standard Specifications for Earthwork (Section 19). A representative from our office or regulatory agency should observe all excavated areas during grading and perform moisture and density tests on prepared subgrade and compacted fill material. Any fill material imported to the site should be non-expansive, relatively granular material having a Plasticity Index (P.I.) of less than 15. It should also be non-corrosive, free of deleterious material and should be reviewed by the Geotechnical Engineer.

Should there be any alterations of the proposed construction that will affect the stated bases of our recommendations, we should be informed so that we can review such changes and amend or submit additional recommendations. Our office should review the final grading plans prior to grading to see that the intent of our recommendations is included in the plans.

Plan Review

We recommend that final plans for foundations be reviewed by this office prior to construction so that the intent of our recommendations is included in the project plans and specifications and to further see that no misunderstandings or misinterpretations have occurred.

Construction Observation

To a degree, the performance of any structure is dependent upon construction procedures and quality. Hence, observation of foundation excavations, and pile installations should be carried out by the regulating agencies. If the subsurface conditions different from those forming the basis of our recommendations is encountered, this office should be informed in order to assess the need for design changes. Therefore, the recommendations presented in this report are contingent upon good quality control and these geotechnical observations during construction.

INVESTIGATION LIMITATIONS

Our services consist of professional opinions and recommendations made in accordance with generally accepted geotechnical engineering principles and practices and are based on our site reconnaissance and the assumption that the subsurface conditions do not deviate from observed conditions. All work done is in accordance with generally accepted geotechnical engineering principles and practices. No warranty, expressed or implied, of merchantability or fitness, is made or intended in connection with our work or by the furnishing of oral or written reports or findings. The scope of our services did not include any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in structures, soil, surface water, groundwater or air, below or around this site. Unanticipated soil conditions are commonly encountered and cannot be fully determined by taking soil samples and excavating test borings; different soil conditions may require that additional expenditures be made during construction to attain a properly constructed project. Some contingency fund is thus recommended to accommodate these possible extra costs.

This report has been prepared for the proposed project as described earlier, to assist the engineer in the design of this project. In the event any changes in the design or location of the facilities are planned, or if any variations or undesirable conditions are encountered during construction, our conclusions and recommendations shall not be considered valid unless the changes or variations are reviewed and our recommendations modified or approved by us in writing.

This report is issued with the understanding that it is the designer's responsibility to ensure that the information and recommendations contained herein are incorporated into the project and that necessary steps are also taken to see that the recommendations are carried out in the field.

The findings in this report are valid as of the present date. However, changes in the subsurface conditions can occur with the passage of time, whether they are due to natural processes or to the works of man, on this or adjacent properties. In addition, changes in applicable or appropriate standards occur, whether they result from legislation or from the broadening of knowledge.

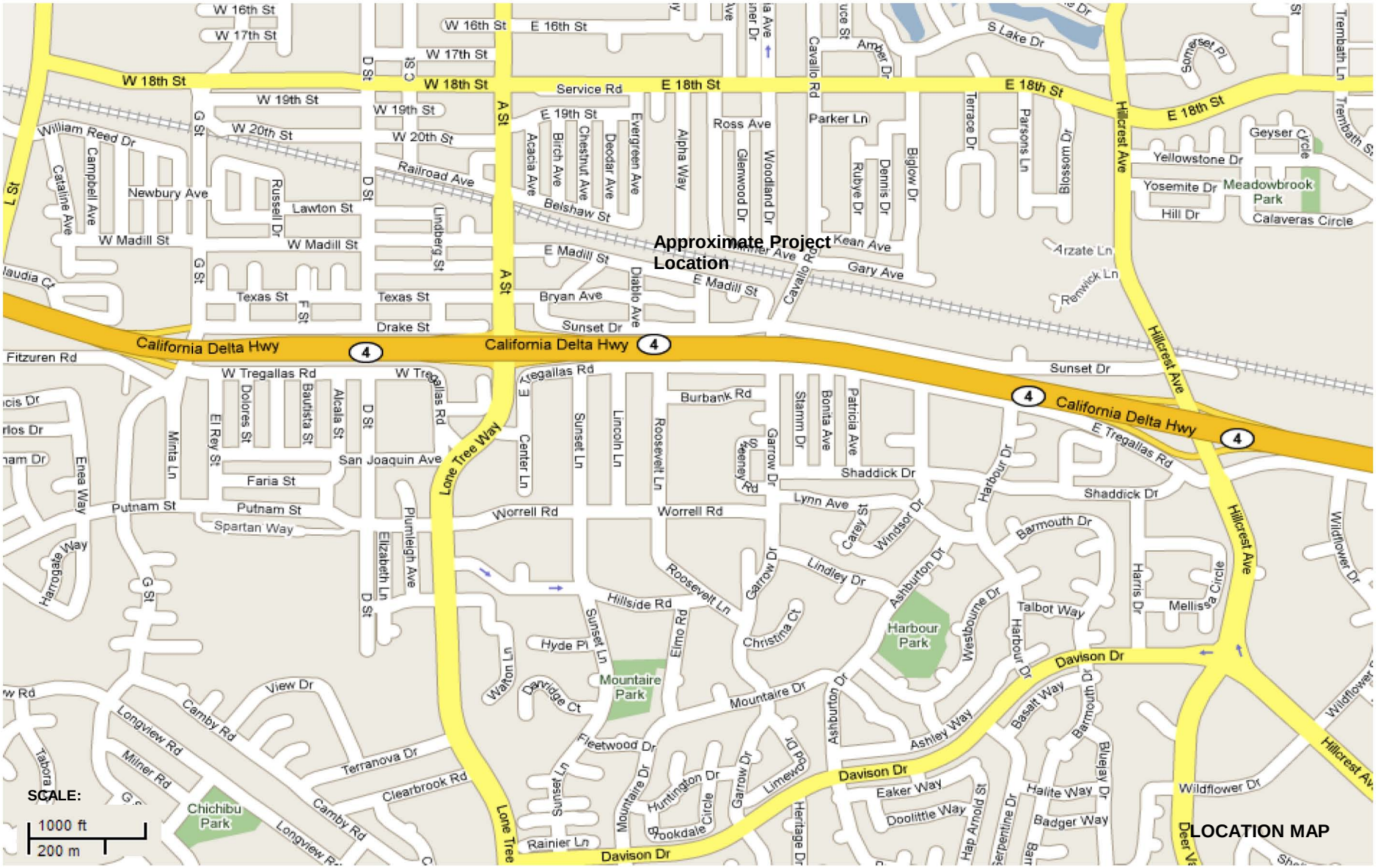
Accordingly, the findings in this report might be invalidated, wholly or partially, by changes outside of our control.

Respectfully submitted,
PARIKH CONSULTANTS, INC.

Partha Sircar, Ph.D., P.E. C54619
Senior Engineer

Gary Parikh, G.E. 666
Project Manager

REGISTERED PROFESSIONAL ENGINEER
GAURANG R. PARIKH
No. 666
EXP. 12-31-11
GEOTECHNICAL
STATE OF CALIFORNIA



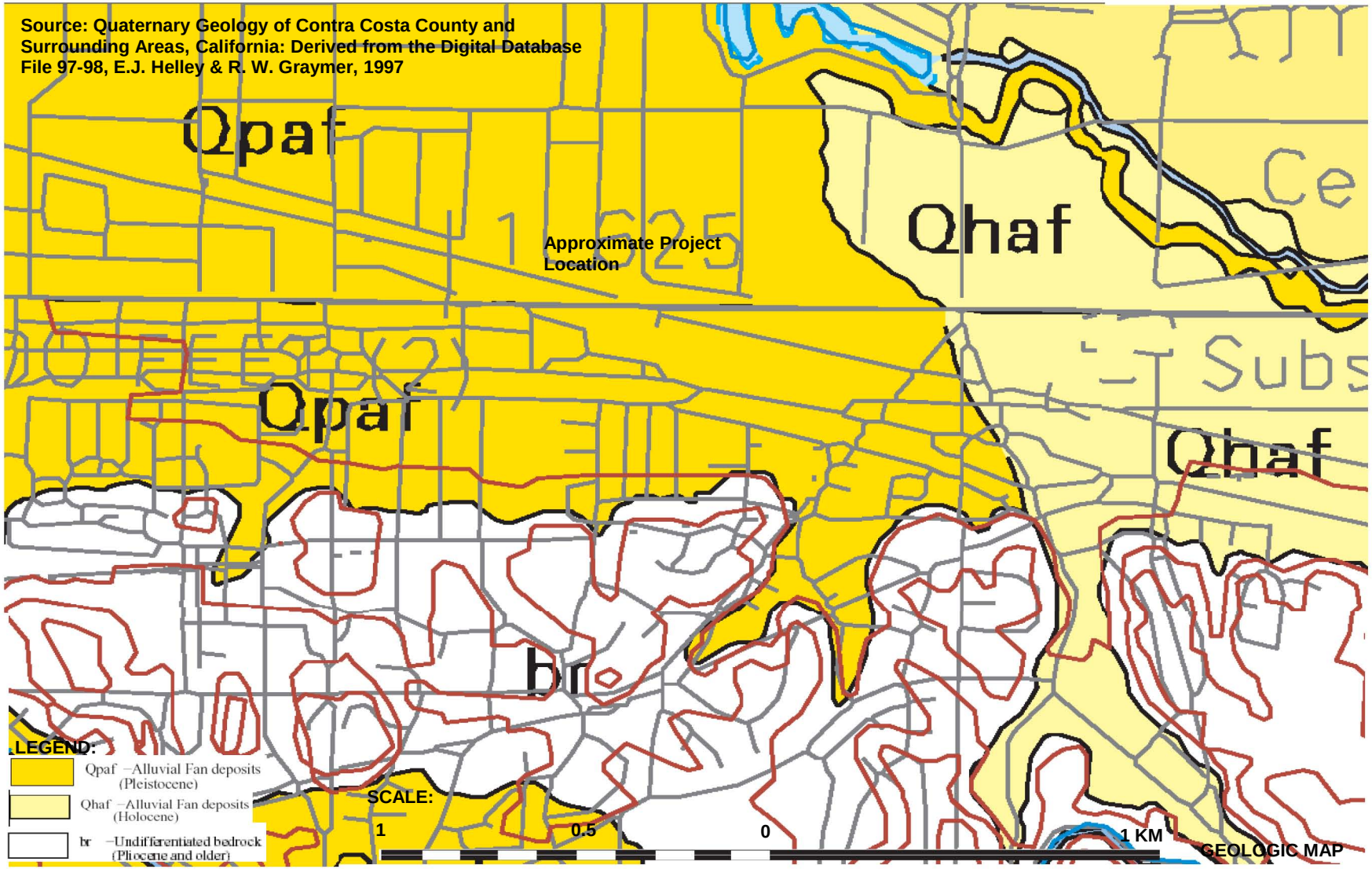
LOCATION MAP

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

ROOSEVELT LANE PUC (REPLACEMENT)
ANTIOCH, CALIFORNIA

JOB NO.: 206117.EBS

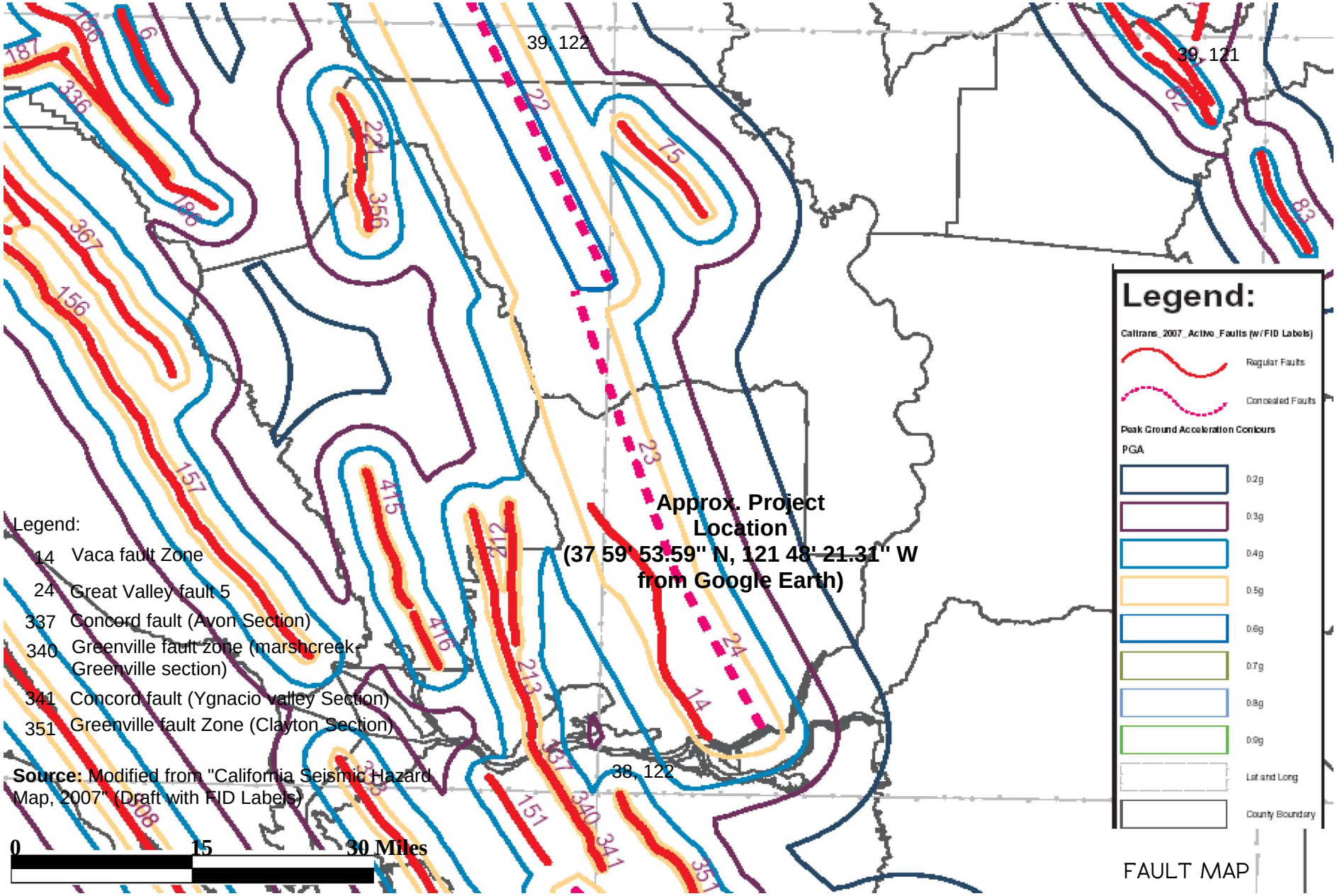
PLATE NO.: 1



PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

ROOSEVELT LANE PUC (REPLACEMENT)
ANTIOCH, CALIFORNIA

JOB NO.: 206117.EBS **PLATE NO.: 2**



FAULT MAP

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

ROOSEVELT LANE PUC (REPLACEMENT)
ANTIOCH, CALIFORNIA

JOB NO.: 206117.EBS

PLATE NO.: 3

APPENDIX A

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

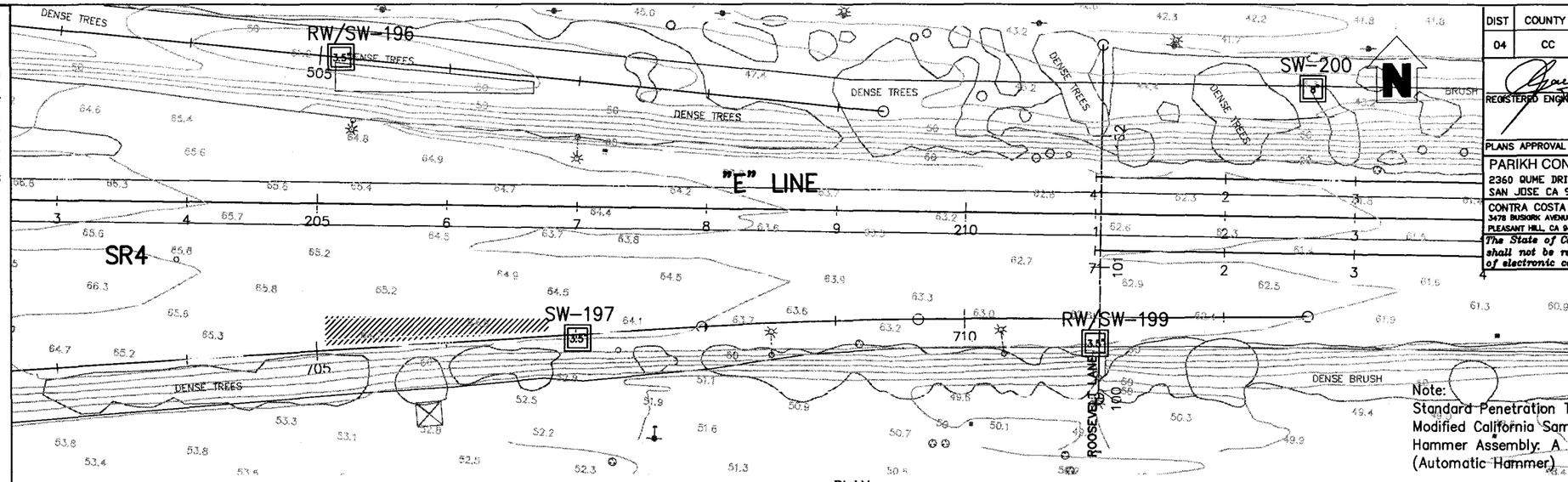
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

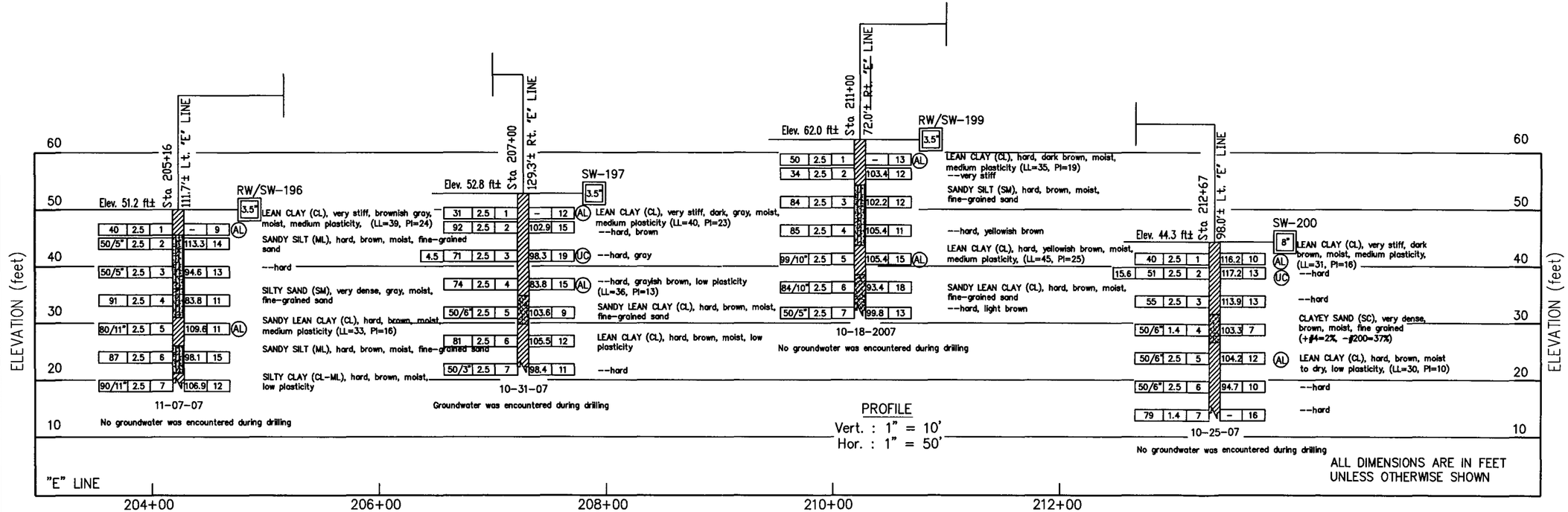
CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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.



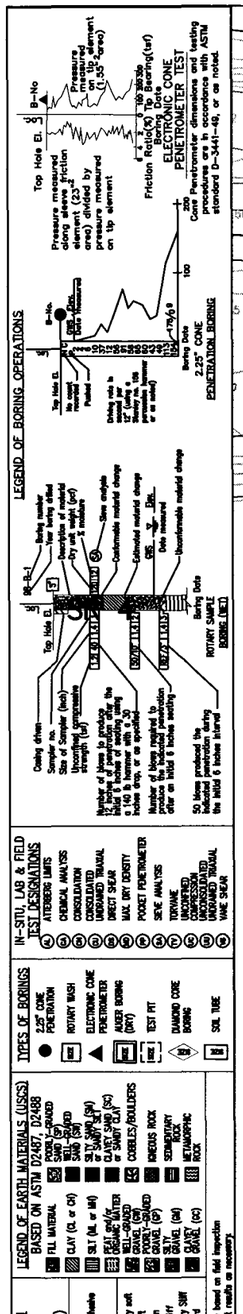
PLAN
1"=50'

Note:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)



PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

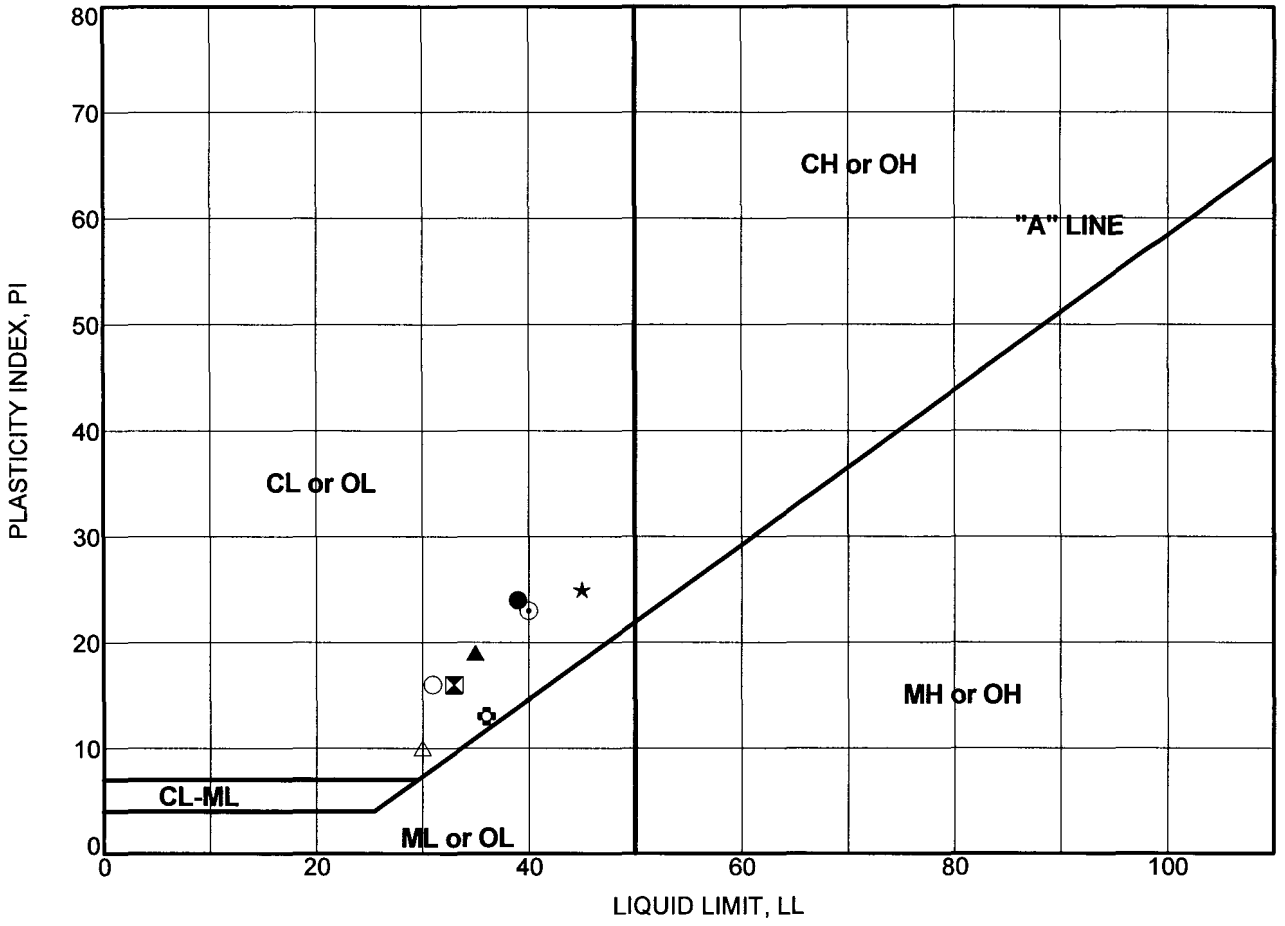
ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN



DESIGN OVERSIGHT	DESIGN By: D. GOUTHIER	Field investigation by: G. TRIPATHI	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	P. SIRCAR PROJECT ENGINEER
SIGN OFF DATE	CHECKED By: P. SIRCAR	ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5		CU 04725 EA 2285F1

STRUCTURE NO.	ROOSEVELT LANE PUC (REPLACEMENT)
28-0403	
POST MILE (PM) 28.1	LOG OF TEST BORINGS

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) 08/31/09 | SHEET | OF



PLASTICITY CHART

Boring Number	Sample Number	Depth (feet)	Test Symbol	Moisture Content (%)	LL	PL	PI	Description
RW/SW-196	MC-1	2.5	●	9	39	15	24	LEAN CLAY (CL)
RW/SW-196	MC-5	19.5	⊠	11	33	17	16	LEAN CLAY (CL)
RW/SW-199	MC-1	2.5	▲	13	35	16	19	LEAN CLAY (CL)
RW/SW-199	MC-5	19.5	★	15	45	20	25	LEAN CLAY (CL)
SW-197	MC-1	2.5	⊙	12	40	17	23	LEAN CLAY (CL)
SW-197	MC-4	14.5	✿	15	36	23	13	LEAN CLAY (CL)
SW-200	MC-1	2.5	○	10	31	15	16	LEAN CLAY (CL)
SW-200	MC-5	19.5	△	12	30	20	10	LEAN CLAY (CL)

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

ROOSEVELT LANE PUC (REPLACEMENT)
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.EBS

PLATE NO:

APPENDIX B

Office of Special Funded Projects
Comment & Response Form

General Project Information	Review Phase		Reviewer Information
Dist: _ EA: 228511 Project Name: Route 4 Widenining SEG 3A OSFP Liaison: O. Hor Phone: 916-227-8419 e-mail: overcomer_hor@dot.ca.gov	☐ PSR/PDS (Review No. _) ☐ APS/PSR (Review No. _) ☐ APS/PR (Review No. _) ☐ Type Selection	☒ 65% PS&E Unchecked Details ☐ PS&E (Review No. 1) ☐ Construction Support ☒ Other: Foundation Report	Reviewer Name: Ali Kaddoura Functional Unit: 327 Cost Center: 59 Phone Number: 510-286-4676 e-mail: ali_kaddoura@dot.ca.gov Date of Review: 03/09/09
	Structure Information (Use when necessary to document comments by individual structure) Structure Name: Roosevelt Lane PUC Br No: 28-0403		

Consultant Information (to be filled in by Consultant)

Consultant Structure Lead (First and Last Name)	Structure Consultant Firm	Phone Number	e-mail	Response Date

#	Doc. (See Note 1)	Page, Section, or SSP	Review Comments	Consultant Responses	✓
1	FR Roosevelt Lane PUC Bridge No. 28-0403 65% PS&E		Draft FR Prepared by Parikh Consultants Dated February 2009.		
2			The report lacks the County, Route, and Postmile designation.		
3		Subsurface Conditions, page 2	"...Several soil borings drilled in the project site vicinity as part of the overall improvement projects along State Route 4 may be utilized for this project." How close do the borings lie to the undercrossing? If they are not immediately in the footprint of the proposed project, on what basis are the borings considered relevant to the project?		

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓ = Comment Resolved (for Reviewer's use)

			How laterally continuous are the Quaternary units, given that they are alluvial fan deposits? Caltrans Foundation Report guidelines call for a soil profile (fence diagram). This would be very helpful if interpolating between borings.	
4		Soil profile?	"Potential damages at the site due to fault rupture and due to liquefaction are small." Provide information to justify this.	
5		Design Recommendation Section	The recommendation should specify whether or not foundation treatment is needed?	
6		Seismic Design Consideration Section	In Table, "RLSS" stands for "right lateral strike slip" and not "right left strike slip.	
7		General	Report does not have page numbering	
8	FR Roosevelt Lane PUC Bridge No. 28-0403 65% PS&E		(C3) Not approved (resubmittal to GS required)	

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved
(for Reviewer's use)

Responses to Caltrans Comments on 65% Foundation Report

Roosevelt Lane PUC (Bridge No. 28-0403)

Response ot Comment No. 1

No response required.

Response ot Comment No. 2

County, route and Post Mile Designations have been added in the cover sheet an also in the first page of the letter report.

Response ot Comment No. 3

Agreed. Text is revised to state "right lateral strike slip" for RLSS.

Response ot Comment No. 4

Boring RW-199 is on the undercrossing footprint near the southern end. Boring SW-200 is located about 167 feet east of the PUC alignment on the north side. Additional borings in the vicinity are: Boring RW/SW-196on the north side, 600 feet west of the PUC alignment; and Boring RW/SW-197 on the south side , 400 feet west of the alignment. The borings are presented in the LOTB sheet attached to the report. All borings indicate hard lean clays and sandy silts. In the present situation, a fence diagram will not be particularly useful, an thus, has not been prepared.

Response ot Comment No. 5

A fault map has been added to show that there are no faults crossing the PUC alignment or exist in the vicinity. Thus, potential damages due to fault rupture are small. There is no indication of groundwater or the presence of potentially liquefiable loose to medium dense granular soils within the depths drilled for the soil borings. Therefore potential for occurrence of liquefaction and consequent damages are small. Text has been revised to address the issues of potential hazards due to fault rupture or liquefaction.

Response ot Comment No. 6

Agreed. Text has been revised to state that "RLSS" indicates "right lateral strike slip" fault.

Response ot Comment No. 7

Page numbers have been added in the revised report.

Response ot Comment No. 8

No response required.

Office of Special Funded Projects
Comment & Response Form

General Project Information	Review Phase		Reviewer Information
Dist: _ EA: 228511 Project Name: Route 4 Widenining SEG 3A OSFP Liaison: O. Hor Phone: 916-227-8419 e-mail: overcomer_hor@dot.ca.gov	☐ PSR/PDS (Review No. _) ☐ APS/PSR (Review No. _) ☐ APS/PR (Review No. _) ☐ Type Selection	☐ 65% PS&E Unchecked Details ☐ PS&E (Review No. 1) ☐ Construction Support ☒ Other: Final Foundation Report	Reviewer Name: Ali Kaddoura/R. Nashed Functional Unit: 327 Cost Center: 59 Phone Number: 510-286-4676 e-mail: ali_kaddoura@dot.ca.gov Date of Review: 11/03/09
	Structure Information (Use when necessary to document comments by individual structure) Structure Name: Roosevelt Lane PUC Br No: 28-0403		

Consultant Information (to be filled in by Consultant)

Consultant Structure Lead (First and Last Name)	Structure Consultant Firm	Phone Number	e-mail	Response Date

#	Doc. (See Note 1)	Page, Section, or SSP	Review Comments	Consultant Responses	✓
1	Final FR Roosevelt Lane PUC Bridge No. 28-0403		Final FR Prepared by Parikh Consultants Dated August 2009.	No response required.	
2		Page3, **Seismic Sources**	In the table: – The distance between the site and Vaca Fault Zone is 5.45 miles not 3.4 miles. _ The distance between the site and Great Valley Fault is 6.6 miles not 4.4 miles. Please correct and check all calculations based on these values.	Per e-mail from Hossein Salimi of Caltrans dated March 2, 2010, no further action on this comment is required. (See attached e-mail)	
			Our previous comments have been addressed to our satisfaction.		
8	Final FR Roosevelt Lane PUC		(C2) Approved subject to OSFP verification		

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved (for Reviewer's use)

	Bridge No. 28-0403 65% PS&E				

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved (for Reviewer's use)

Partha Sircar

From: "Hossain Salimi" <hossain_salimi@dot.ca.gov>
To: "Partha Sircar" <psircar@parikhnet.com>
Sent: Tuesday, March 02, 2010 10:53 AM
Attach: 228511GeoSeg 3A-1stPSE.pdf
Subject: Fw: SR4 Segment 3A bridges - Seismic

FYI

Hossain Salimi
Senior Materials and Research Engineer
Office of Geotechnical Design-West
(916) 227-7147
----- Forwarded by Hossain Salimi/HQ/Caltrans/CAGov on 03/02/2010 09:53 AM

Hossain Salimi/HQ/Caltrans/CAGov
02/25/2010 10:43 AM

To
Ali Kaddoura/D04/Caltrans/CAGov, Rifaat Nashed/HQ/Caltrans/CAGov
cc
Tim Pokrywka/D04/Caltrans/CAGov@DOT
Subject
Fw: SR4 Segment 3A bridges - Seismic

Gentlemen,

I am writing you in regards to the reports submitted by Parikh and our subsequent attached comments (Bridges under EA # 04-228511). Parikh had used the old 1996 Caltrans Seismic Hazard Map as well as the old Seismic Design Criteria (SDC) to produce the seismic recommendations. These bridges were type selected before the Department mandated changes to the SDC became official. In fact, their findings are more conservative compared to the new criteria. In light of this, I find it unreasonable for us to request changes to the seismic recommendations of these reports. I am satisfied with the findings in the reports and have no further comments. In the future, I will check the type selection date of each bridge to see if the changes to the new SDC are warranted.

Sincerely,

Hossain Salimi

Senior Materials and Research Engineer
Office of Geotechnical Design-West
(916) 227-7147
----- Forwarded by Hossain Salimi/HQ/Caltrans/CAGov on 02/25/2010 10:30 AM

"Partha Sircar"
<psircar@parikhnet.com>
02/24/2010 10:13 AM

To
"Hossain Salimi"
<hossain_salimi@dot.ca.gov>

cc

Subject
SR4 Segment 3A bridges - Seismic

Hossein:

As I had discussed with you earlier, I have the same issues with the above bridges. Please call me to advise.

Partha Sircar
Parikh Consultanta
(408) - 452 -9000

----- Original Message -----
From: "Hossain Salimi" <hossain_salimi@dot.ca.gov>
To: "Rifaat Nashed" <rifaat_nashed@dot.ca.gov>; "Ali Kaddoura" <ali_kaddoura@dot.ca.gov>
Cc: "Partha Sircar" <psircar@parikhnet.com>; "Tim Pokrywka" <tim_pokrywka@dot.ca.gov>
Sent: Thursday, December 17, 2009 10:38 AM
Subject: Updated status of Somersville Rd UC replacement (04-228511)

>
> Hi Rifaat/Ali,
>
> I had a conversation with Mr. Sircar of Parikh subsequent to the e-mail I
> sent you. As it turns out, this project has been in the works for a long
> time, and the seismic analysis and design have already been completed
> using

> the old SDC. Therefore, Parikh is not required to take any further
> actions
> regarding my comments. Thank you all.
>
> Sincerely,
>
> Hossain Salimi
> Senior Materials and Research Engineer
> Office of Geotechnical Design-West
> (916) 227-7147
> ----- Forwarded by Hossain Salimi/HQ/Caltrans/CAGov on 12/17/2009 10:31
AM
> -----
>
> Hossain
> Salimi/HQ/Caltran
> s/CAGov To
> Rifaat Nashed/HQ/Caltrans/CAGov
> 11/30/2009 09:25 cc
> AM Tim Pokrywka/D04/Caltrans/CAGov@DOT
> Subject
> Somersville Rd UC replacement
> (04-228511)(Document link: Hossain
> Salimi)
>
>
>
>
>
>
>
>
>
> Hi Rifaat,
>
> I reviewed the attached documents you sent me on November 19, 2009
(Report
> containing Final Foundation Report from Parikh Consultants to Mark Thomas
> and Company Inc. for the proposed Somersville Road Undercrossing
> replacement) and have the following comments. I should note that the
> proposed bridge (28-0398L/R) is located on Route 4 and will replace the
> existing 2-span structure (28-0211R).
>
> 1. According to the report, Parikh is using the in-progress Seismic
Hazard
> Map (CSHM) . However, the distances as outlined in the table does not
> match our latest CSHM.
>
> 2. The Department has finalized the new ARS curves based on the new
> Seismic
> Design Criteria (SDC) and is now mandatory for use by both the Department
> personnel as well as our consultants effective September 30, 2009.
> However, Parikh is still using the ARS curve based on the 2001SDC which
> was

> based on Sadigh 1996 Attenuation Relationship models.
>
> To re-iterate, the Department has implemented the new SDC and the
> consultant shall re-submit the report using the now mandated seismic
> design
> criteria.
>
> Sincerely,
>
> Hossain Salimi
> Senior Materials and Research Engineer
> Office of Geotechnical Design-West
> (916) 227-7147
>
>
>
>
>
> Rifaat
> Nashed/HQ/Caltran
> s/CAGov To
> Hossain
> 11/19/2009 03:20 Salimi/HQ/Caltrans/CAGov@DOT
> PM cc
> Tim Pokrywka/D04/Caltrans/CAGov
> Subject
> Somerville Rd UC (Replacement)
>
>
>
>
>
>
>
>
>
> Hi Hossain
>
> Please find attached the Final Foundation Report for Somerville Road
> Undercrossing (Replacement) by PARIKH Consultant
>
> (See attached file: FR- Somerville Rd UC (Replacement).pdf)(See attached
> file: Appendix B- Lab Tests.pdf)(See attached file: Appendix C.pdf)
>
>
> Regards
>
> Rifaat Nashed
(See attached file: 228511GeoSeg 3A-1stPSE.pdf)

OSFP Review Comment & Response Form

General Project Information	Review Phase	Reviewer Information
Dist: 04 EA: 2285F1 Project Name: ROOSEVELT LANE PUC(Replacement) OSFP Liaison: Overcomer Hor Phone: 916-227-8419 e-mail:	☐ PSR/PDS (Review No.) ☐ APS/PSR (Review No.) ☐ APS/PR (Review No.) ☐ Type Selection ☐ 65% PS&E Unchecked Details ☐ PS&E (Review No. 1) ☐ Construction Support ☒ Other: FINAL FR **Structure Information** (Use when necessary to document comments by individual structure) Structure Name: ROOSEVELT LANE PUC(Replacement) Br No: 28-0403	Reviewer Name: Ali Kaddoura/ Rifaat Nashed Functional Unit: GS Phone Number: 510-286-4676 / 510-622-1773 e-mail: ali_kaddoura@dot.ca.gov Date of Review: 06/07/10

Consultant Information (to be filled in by Consultant)

Consultant Structure Lead (First and Last Name)	Structure Consultant Firm	Phone Number	e-mail	Response Date

#	Doc. (See Note 1)	Page, Section, or SSP	Review Comments	Consultant Responses	
1	Fr Final Roosevelt Lane PUC (Replacement) Br No. 28-0403	GENERAL	The Report doesn't comply with Caltrans Foundation Report guidelines.	The report has been revised to comply with Caltrans Foundation Report Guidelines.	
2		Page 2, **SUBSURFACE CONDITIONS**	Borings RW-SW-196 and RW/SW-197 are located at far distance (600 ft and 400 ft) from the project site and are not appropriate to consider for subsurface soil conditions (materials)	Borings RW-SW-196 and RW-SW-197 are presented for additional supporting information. They were not specifically used for design or construction recommendations.	
3		Page 2, **SUBSURFACE CONDITIONS**	- Geology description is insufficient. A Geology section should be added	A Geology section has been added in the revised report.	
4	Fr Final Roosevelt Lane PUC		(C3) Not approved (resubmittal to GS required)		

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved (for Reviewer's use)

8. Geotechnical Letter/Report - Roosevelt Lane PUC (Replacement) – At State Route 4 (Br. No. 28-0403) – Antioch, CA

FINAL GEOTECHNICAL LETTER/REPORT
ROOSEVELT LANE PUC (REPLACEMENT)
At State Route 4
(Bridge No. 28-0403)
Antioch, California
04-CC-4-R28.1 EA 228511

For

T. Y. Lin International
2010 Crow Canyon Place, Suite 350
San Ramon, CA 94583

PARIKH CONSULTANTS, INC.
1243 Alpine Road, Suite 110
Walnut Creek, California
(925) 933-6336

August 2009 Job No. 206117.EBS

T. Y. LIN INTERNATIONAL
2010 Crow Canyon Place, Suite 350
San Ramon, CA 94583

August 31, 2009
Job No.: 206117.EBS

Attn.: Mr. Odeon Li

Sub: Final Geotechnical Foundation Report
Roosevelt Lane PUC (Replacement) - Bridge No. 28-0403, Antioch, California
04-CC-4-R28.1 EA 228511

Dear Mr. Li:

The Final Geotechnical Foundation Report for the proposed Roosevelt Lane Pedestrian Undercrossing (PUC) Replacement in Antioch, California is presented herein. The purpose of this letter/report is to evaluate the pertinent subsurface conditions at the project site and provide recommendations for design and construction of the PUC.

INTRODUCTION

The Roosevelt Lane PUC (Replacement) project is part of the overall improvement projects along State Route 4 between Loveridge Road in Pittsburg, California and Hillcrest Avenue in Antioch, California. The improvement primarily involves (a) widening the existing 4-lane highway to an 8-lane highway; and (b) construction of railroad tracks in the median for eBART.

SITE TOPOGRAPHY AND EXISTING SITE CONDITIONS

At the Roosevelt Lane PUC location, the State Route 4 consists of 2 lanes each in the east and westbound directions with a median. The road surfaces are at an approximate elevation of 63 feet. The highway is built on an embankment with approximate side slopes of 3 (horizontal) to 1 (vertical). The native ground is at an approximate elevation of 45 feet at the northern end and 50 feet at the southern end.

The existing Roosevelt Lane PUC is a reinforced concrete box culvert (RCB) crossing State Route 4 as a northern continuation of Roosevelt Lane. A Project Location Map is presented as Plate 1. Per the as-built plans from 1971, the RCB is 159 feet long and 8' x 8' on the inside. The depth of the top of the box varies between 3 and 7 feet below existing ground surface. Two 17.5-foot long open

tunnels are present at the two ends of the RCB – the open tunnel floors are matched to the adjacent existing grades.

PROJECT DESCRIPTION

Per the plans supplied to us by T. Y. Lin, the existing Roosevelt Lane PUC will be demolished and replaced by a new PUC. The new PUC will also be a reinforced concrete box (RCB) structure along the same alignment as the existing one. The RCB will be 214.5 feet long, the additional length of 55.5 feet being necessitated by the widening of State Route 4. The primary extension will be on the northern end, which will be 48 feet and on the southern end only 7.5 feet. The concrete box will 8 feet by 8 feet on the inside, as before, with 8.5-in. thick side walls. The top and bottom slabs will be 8-in. thick.

A 16.5-ft long open tunnel will be constructed at the southern end of the RCB. The base slab of the tunnel will be 1.75-ft thick, the tunnel floor being matched to the adjacent existing grade. The side walls of the tunnel will be 1-ft thick. At the northern end, the RCB ends immediately behind a retaining wall (Retaining Wall #4) – the footings for the retaining wall are lowered to accommodate the RCB. The floor of the RCB is matched to the adjacent existing grade.

The RCB will be designed to satisfy the Caltrans Bridge Design Specifications (Section 6 – Culverts). Additionally, it shall be designed to accommodate loads from the future eBART trains.

SUBSURFACE CONDITIONS

Site specific soil borings were not drilled for this project. However, several soil borings drilled in the project site vicinity as part of the overall improvement projects along State Route 4 may be utilized for this project. A log of test boring (LOTB) sheet showing borings in the vicinity is shown on Plate 2. The LOTB sheet indicates that Boring SW-199 is on the PUC footprint near the southern end and Boring SW-200 is located about 167 feet east of the PUC footprint. Borings RW-SW-196 and RW/SW-197 are also in the vicinity.

The borings indicate predominantly hard lean clays and hard sandy silts within the depths of interest.

Groundwater was not encountered in any of the borings to the depths drilled.

A geologic map of the site is presented as Plate 3. The map indicates the site to be underlain by Pleistocene alluvial fan deposits.

SEISMIC DESIGN CONSIDERATIONS

A Fault Map of the project site, based on the In-Progress Seismic Hazard Map currently under development by Caltrans is presented as Plate 4. The faults in the vicinity of the site are listed below.

Fault	Fault No.(1)	Fault Type	Distance from Site (miles)	Maximum Moment Magnitude
Vaca Fault Zone	14	RLSS(2)	3.4	6.9
Great Valley Fault 5	24	Reverse Fault	4.4	6.5
Greenville Fault Zone (Clayton Section)	351	RLSS	4.1	6.6
Concord Fault Zone (Ygnacio Valley Section)	341	RLSS	6.9	6.6

(1) Number of the Fault in the Data Base associated with the Caltrans In-Progress Seismic Hazard Map
(2) RLSS – Right-Lateral Strike Slip Fault

Based on the Caltrans In-Progress Seismic Hazard Map and the attenuation relationship by Sadigh et al. (1997), the controlling fault is the Vaca Fault Zone (Fault No. 14 in the map), which is associated with a Maximum Moment Magnitude (Mmax) of 6.9. A peak bedrock acceleration (PBA) of 0.50g is anticipated at the site. The corresponding peak ground acceleration (PGA) is also 0.5g.

Per Plate No. 4, there is no evidence of the presence of a fault along the project site or in the immediate vicinity. Potential hazard from fault rupture during an earthquake is therefore considered minimal. Additionally, there is no evidence of groundwater or presence of loose to medium granular soils within the depth of interest. Potential hazard from soils at the site liquefying during an earthquake is, therefore, also considered minimal.

FINDINGS AND RECOMMENDATIONS

Design Recommendations

Recommendations for design of the RCB are presented below:

1. Vertical Earth Pressure: 140 pcf

2. Lateral Earth Pressure: (a) 100 pcf (b) 35 pcf
   These two loadings should be applied separately and the resulting maximum moments should be utilized in design.

3. Bearing Capacity
   An allowable bearing capacity of 7.5 ksf (ultimate bearing capacity of 22.5 ksf) is recommended for design of the bottom slab of the RCB.

4. Modulus of Subgrade Reaction
   A modulus of subgrade reaction of 200 lb/in^3 is recommended for design of the bottom slab of the RCB.

All construction shall follow Caltrans Standard Specifications and any additional BART requirements for the eBART structure. It is expected that cut-and-cover methods will be adopted for construction of the new RCB.

The soils at the foundation levels are expected to be hard clays and silts. Special foundation treatment is, therefore not required.

Replacement of the RCB will require significant excavation and subsequent backfilling. The excavation and backfilling shall conform to applicable subsections of Section 19 (Earthwork) of the Caltrans Standard Specifications.

The excavated material may be reused as backfill provided it meets the criteria for backfill material. Additional backfill material imported to the site should be non-expansive, relatively granular material having a Plasticity Index (P.I.) of less than 15. It should also be non-corrosive, free of deleterious material and should be reviewed by the Geotechnical Engineer. A representative from our office or regulatory agency should observe all excavated areas during grading and perform moisture and density tests on prepared subgrade and compacted fill material.

Design of the reconstructed RCB shall be based on appropriate loadings from the eBART trains and shall conform to all applicable requirements of Caltrans, BART and other pertinent agencies.

Design of the Type A eBART retaining walls parallel to the eBART railroad tracks shall follow the applicable recommendations for the eBART retaining walls, which are presented in a separate document.

Please be advised that we are performing a professional service and that our conclusions are professional opinions only. All work done and all recommendations made are in accordance with generally accepted geotechnical engineering principles and practices. No warranty, expressed or implied, of merchantability or fitness, is made or intended in connection with our work.

Very truly yours,
PARIKH CONSULTANTS, INC.

Partha Sircar, Ph.D., P.E., C54619
Senior Engineer

Gary Parikh, P.E., G.E., 666
Project Manager

REGISTERED PROFESSIONAL ENGINEER
GAURANG R. PARIKH
No. 666
EXP. 12-31-09
GEOTECHNICAL
STATE OF CALIFORNIA

Attachments: Project Location Map
Log of Test Borings (LOTB) Sheet
Geologic Map
Fault Map
Caltrans Comments and Responses

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

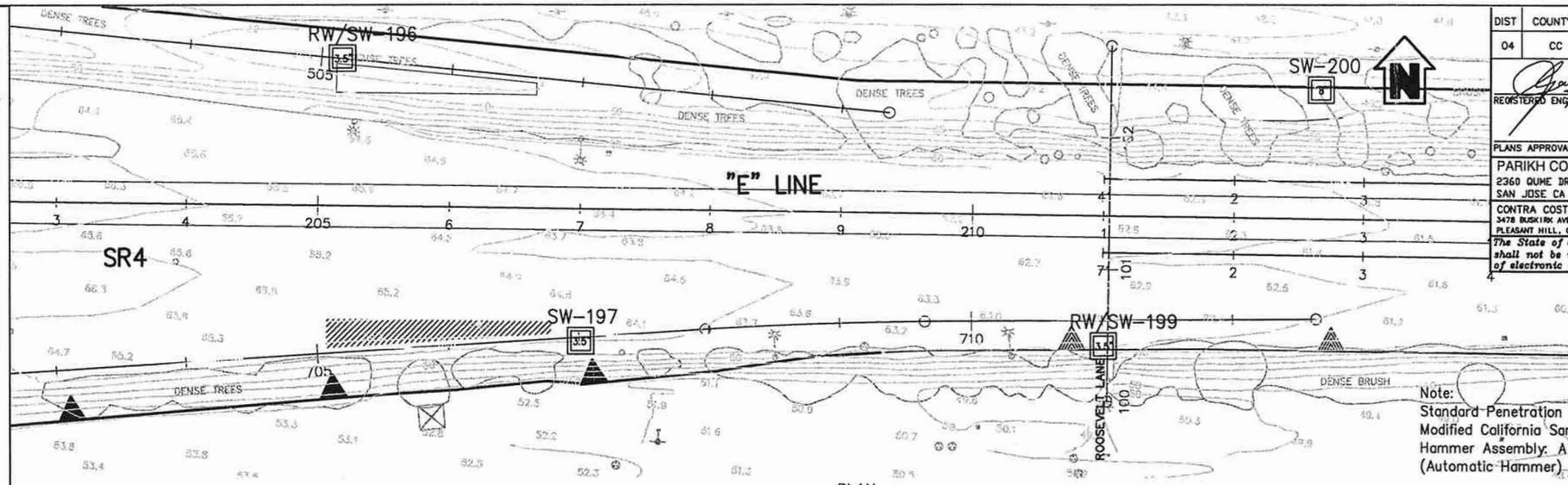
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/09 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

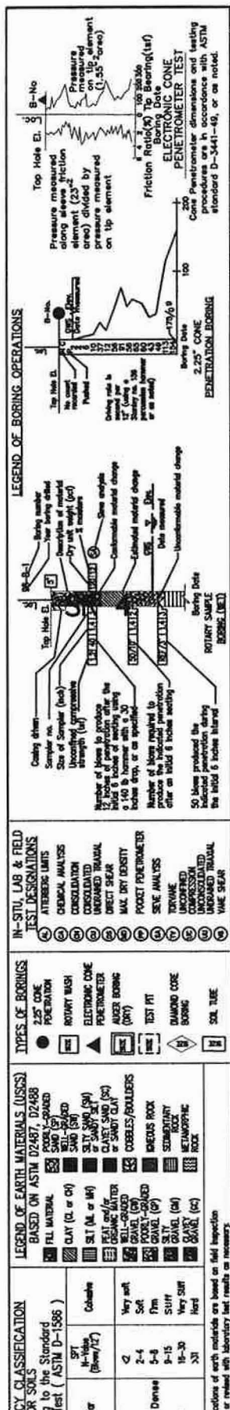
The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

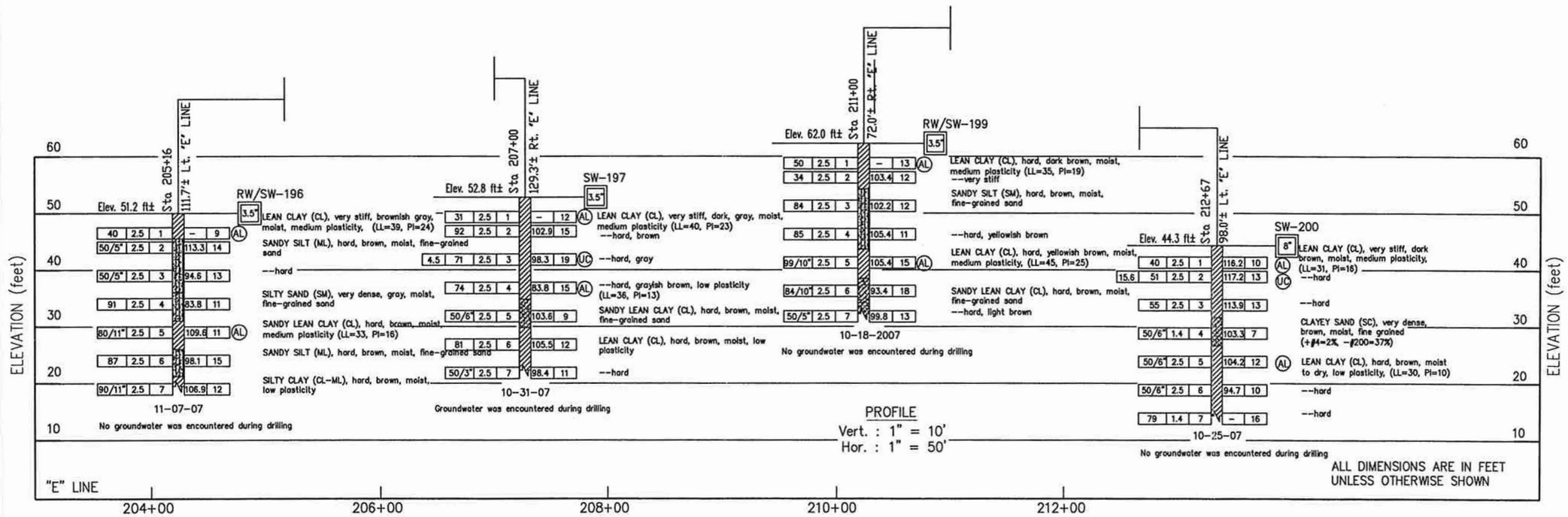


PLAN
1"=50'

DRAFT

Note:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)





PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

DESIGN OVERSIGHT	DESIGN By: D. GOUTHIER	Field investigation by: G. TRIPATHI	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION
SIGN OFF DATE	CHECKED By: P. SIRCAR		P. SIRCAR PROJECT ENGINEER

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

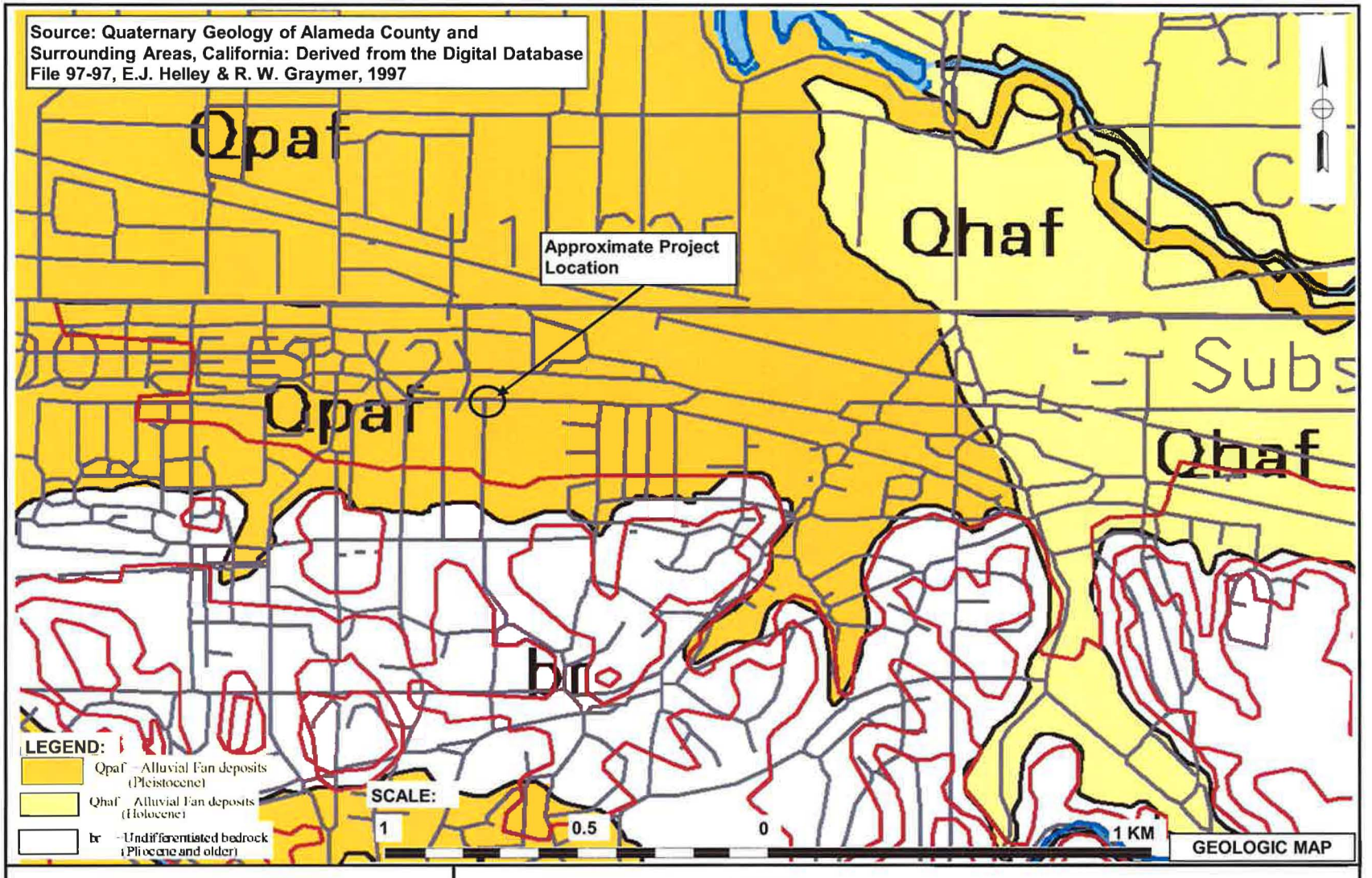
CU 04725
EA 228511

STRUCTURE NO. 28-0403
POST MILE (PM) 28.1

ROOSEVELT LANE PUC (REPLACEMENT)

LOG OF TEST BORINGS

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) 08/31/09 SHEET OF



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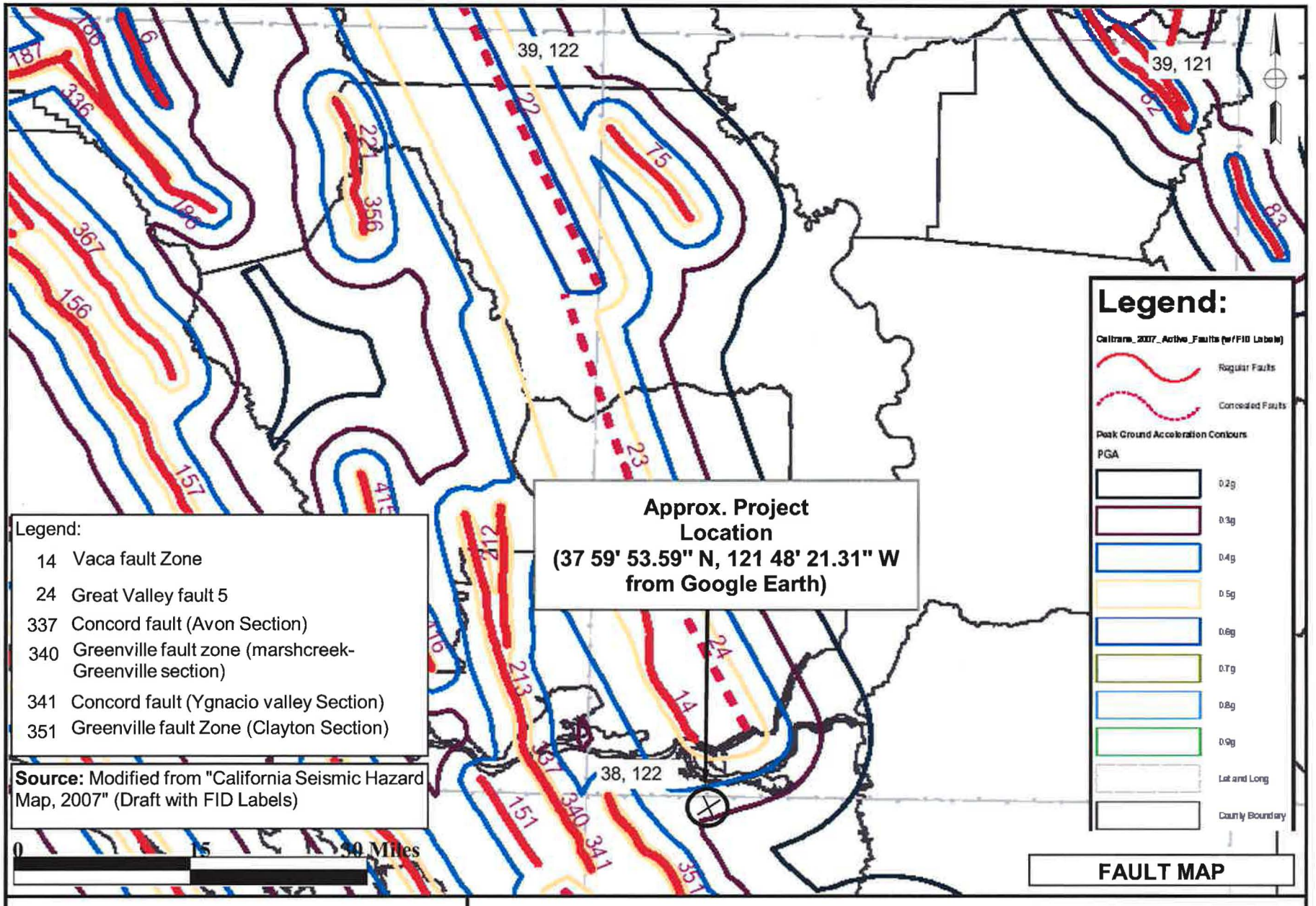
MATERIALS TESTING

ROOSEVELT LANE PUC (REPLACEMENT)
ANTIOCH, CALIFORNIA

JOB NO.: 206117.EBS

PLATE NO.: 3



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MATERIALS TESTING

ROOSEVELT LANE PUC (REPLACEMENT)
ANTIOCH, CALIFORNIA

JOB NO.: 206117.EBS	PLATE NO.: 4

Office of Special Funded Projects
Comment & Response Form

General Project Information	Review Phase		Reviewer Information
Dist: _ EA: 228511 Project Name: Route 4 Widenining SEG 3A OSFP Liaison: O. Hor Phone: 916-227-8419 e-mail: overcomer_hor@dot.ca.gov	☐ PSR/PDS (Review No. _) ☐ APS/PSR (Review No. _) ☐ APS/PR (Review No. _) ☐ Type Selection	☒ 65% PS&E Unchecked Details ☐ PS&E (Review No. 1) ☐ Construction Support ☒ Other: Foundation Report	Reviewer Name: Ali Kaddoura Functional Unit: 327 Cost Center: 59 Phone Number: 510-286-4676 e-mail: ali_kaddoura@dot.ca.gov Date of Review: 03/09/09
	Structure Information (Use when necessary to document comments by individual structure) Structure Name: Roosevelt Lane PUC Br No: 28-0403		

Consultant Information (to be filled in by Consultant)				
Consultant Structure Lead (First and Last Name)	Structure Consultant Firm	Phone Number	e-mail	Response Date

#	Doc. (See Note 1)	Page, Section, or SSP	Review Comments	Consultant Responses	✓
1	FR Roosevelt Lane PUC Bridge No. 28-0403 65% PS&E		Draft FR Prepared by Parikh Consultants Dated February 2009.		
2			The report lacks the County, Route, and Postmile designation.		
3		Subsurface Conditions, page 2	"…Several soil borings drilled in the project site vicinity as part of the overall improvement projects along State Route 4 may be utilized for this project." How close do the borings lie to the undercrossing? If they are not immediately in the footprint of the proposed project, on what basis are the borings considered relevant to the project?		

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved (for Reviewer's use)

			How laterally continuous are the Quaternary units, given that they are alluvial fan deposits? Caltrans Foundation Report guidelines call for a soil profile (fence diagram). This would be very helpful if interpolating between borings.		
4		Soil profile?	"Potential damages at the site due to fault rupture and due to liquefaction are small." Provide information to justify this.		
5		Design Recommendation Section	The recommendation should specify whether or not foundation treatment is needed?		
6		Seismic Design Consideration Section	In Table, "RLSS" stands for "right lateral strike slip" and not "right left strike slip.		
7		General	Report does not have page numbering		
8	FR Roosevelt Lane PUC Bridge No. 28-0403 65% PS&E		(C3) Not approved (resubmittal to GS required)		

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved (for Reviewer's use)

Responses to Caltrans Comments on 65% Foundation Report

Roosevelt Lane PUC (Bridge No. 28-0403)

Response ot Comment No. 1

No response required.

Response ot Comment No. 2

County, route and Post Mile Designations have been added in the cover sheet an also in the first page of the letter report.

Response ot Comment No. 3

Agreed. Text is revised to state "right lateral strike slip" for RLSS.

Response ot Comment No. 4

Boring RW-199 is on the undercrossing footprint near the southern end. Boring SW-200 is located about 167 feet east of the PUC alignment on the north side. Additional borings in the vicinity are: Boring RW/SW-196on the north side, 600 feet west of the PUC alignment; and Boring RW/SW-197 on the south side , 400 feet west of the alignment. The borings are presented in the LOTB sheet attached to the report. All borings indicate hard lean clays and sandy silts. In the present situation, a fence diagram will not be particularly useful, an thus, has not been prepared.

Response ot Comment No. 5

A fault map has been added to show that there are no faults crossing the PUC alignment or exist in the vicinity. Thus, potential damages due to fault rupture are small. There is no indication of groundwater or the presence of potentially liquefiable loose to medium dense granular soils within the depths drilled for the soil borings. Therefore potential for occurrence of liquefaction and consequent damages are small. Text has been revised to address the issues of potential hazards due to fault rupture or liquefaction.

Response ot Comment No. 6

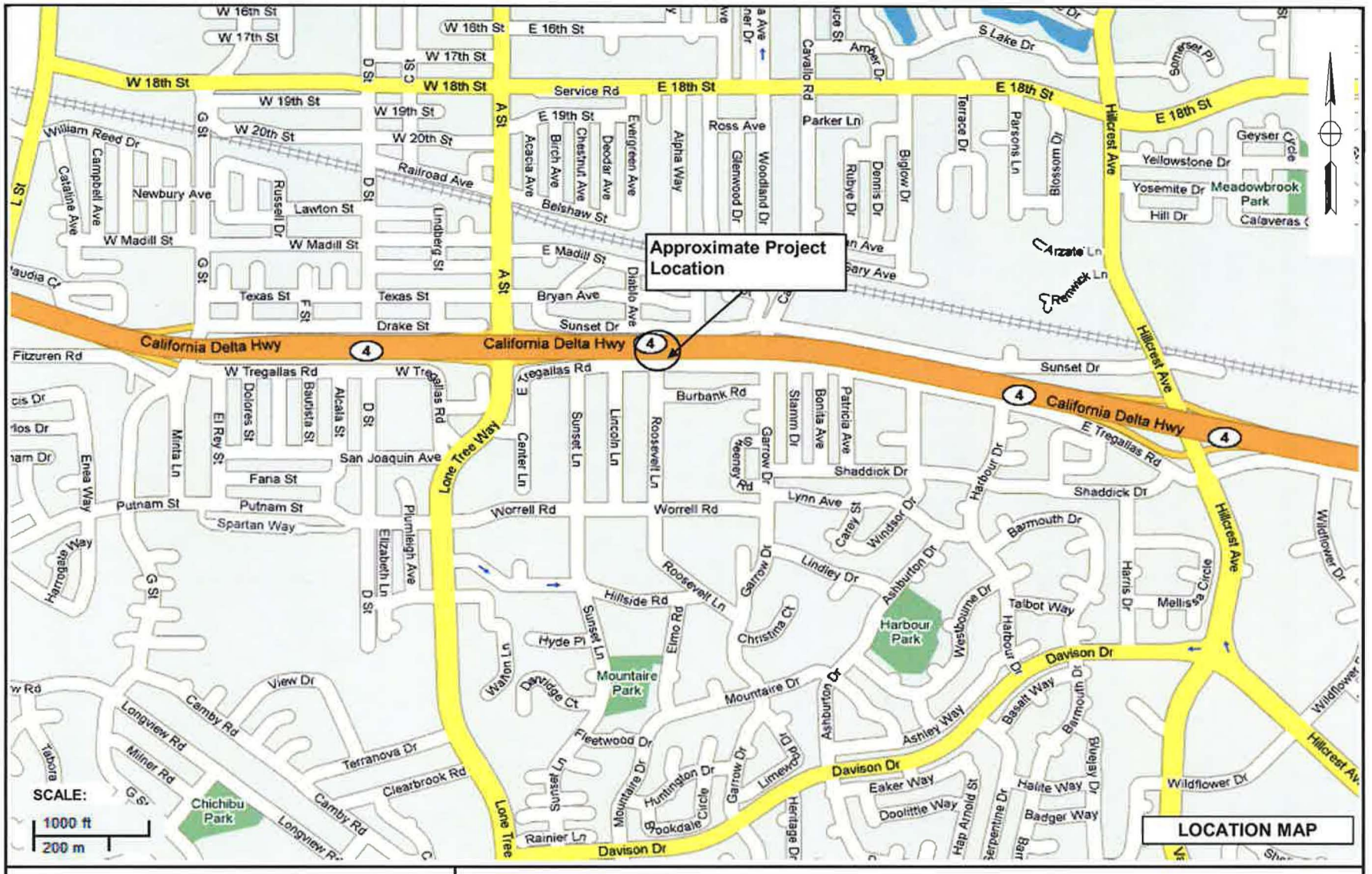
Agreed. Text has been revised to state that "RLSS" indicates "right lateral strike slip" fault.

Response ot Comment No. 7

Page numbers have been added in the revised report.

Response ot Comment No. 8

No response required.



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GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

ROOSEVELT LANE PUC (REPLACEMENT)
ANTIOCH, CALIFORNIA

JOB NO.: 206117.EBS | **PLATE NO.: 1**

9. Foundation Report - Retaining Walls in the Median for Segment 3A Project – North Retaining Wall and South Retaining Wall – East Contra Costa Transit Development (eBART) – Contra Costa County, CA

FINAL FOUNDATION REPORT
RETAINING WALLS IN THE MEDIAN FOR SEGMENT 3A PROJECT
NORTH RETAINING WALL AND SOUTH RETAINING WALL
EAST CONTRA COSTA COUNTY TRANSIT DEVELOPMENT (eBART)
CONTRA COSTA COUNTY, CALIFORNIA
04-CC-4-R27.4/R28.7 EA 2285F1

For

T. Y. Lin International
2010 Crow Canyon Place, Suite 350
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PARIKH CONSULTANTS, INC.

1243 Alpine Road, Suite 110
Walnut Creek, California 94596
(925) 933-6336

April 2010 Job No. 206117.EBS

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PROJECT DESCRIPTION 1
SUBSURFACE INVESTIGATIONS 2
SITE SUBSURFACE CONDITIONS 3
SITE GEOLOGY 3
EARTHQUAKE SOURCES AND SITE SEISMICITY 4
CONCLUSIONS AND RECOMMENDATIONS 4
INVESTIGATION LIMITATIONS 5

PROJECT LOCATION MAP ..... Plate 1
TYPICAL RETAINING WALL SECTIONS ..... Plate 2
SOIL PROFILES ..... Plates 3A & 3B
GEOLOGIC MAP ..... Plate 4
FAULT MAP ..... Plate 5

Appendix A Log of Test Borings & As-Built Log of Test Borings
Appendix B Laboratory Test Data
Appendix C Caltrans Comments and Responses

FINAL FOUNDATION REPORT

RETAINING WALLS IN THE MEDIAN FOR SEGMENT 3A PROJECT
NORTH RETAINING WALL AND SOUTH RETAINING WALL
EAST CONTRA COSTA COUNTY TRANSIT DEVELOPMENT (eBART)
CONTRA COSTA COUNTY, CALIFORNIA
04-CC-4-R27.4/R28.7 EA 2285F1

INTRODUCTION

This report presents the results of our geotechnical engineering investigation for the proposed new retaining walls for Segment 3A for the eBART structure in the median of Highway SR4 in Contra Costa County, California. Our work was performed generally in accordance with the scope of work as per our agreement. The general location of the site and its vicinity are shown on the Project Location Map, Plate 1.

The geotechnical recommendations presented in this report are intended for design input and are not intended to be used as specifications. These recommendations should not be used for direct bidding purposes.

PROJECT DESCRIPTION

The proposed eBART project (within Segment 3A) will construct two parallel railroad tracks and will include two underpasses, one at A Street and the other at Cavallo Road. The following plans were supplied to us by the Designers for our information:

- General Plans for North Retaining Wall (13 Sheets)
- General Plans for South Retaining Wall (15 Sheets)
- Combined Layout for the Retaining Walls (2 Drawings)

In Segment 3A, the eBART tracks are separated from the adjacent travel ways for SR4 by short retaining walls on either side. North Retaining Wall is approximately 5840 feet long from Sta. 181+63 to Sta. 240+00 ("E" Line)) and South Retaining Wall is approximately 7015 feet long from Sta. 179+00 to Sta. 249+20 ("E" Line)).

Three wall types are used in the project. Typical sections for the three wall types are presented in Plate 2. Major portions of the walls are barrier rail/walls, which are designated as Type A walls per

the General Plans. Type C and Type B walls are located along the two underpasses as shown on the Log of Test Boring (LOTB) sheets, Nos. 3 and 4. Both wall types have L-shaped configurations. The bottom of the footing is 4 feet below finish grade of the adjacent travel way for both wall types. For Type B wall, the footing is 4 feet wide, and the top of wall is 3 feet above finish grade. For Type C wall, the footing is 6 feet wide, and the top of wall location varies between 3 feet and 4'-2" above finish grade. Plans require an allowable bearing capacity of 3000 psf for the wall footings.

The report addresses the standard cantilever walls with footings, e.g. Type C and Type B walls in the General Plans. Barrier rail/walls (Type A walls in the General Plans) are a standard design and do not require any special geotechnical design recommendations.

SUBSURFACE INVESTIGATIONS

Eight 30-ft deep soil borings were drilled for the project: two on each side of the two underpasses. The boring locations are presented on the LOTB sheets. In addition, the borings for each of the two bridge underpasses were used in our study.

The borings were drilled by a truck mounted drill rig using hollow stem drilling techniques. Samples were obtained using a 3.0-inch O.D. & 2.5 inches I.D. (Modified California) samplers at selected depths. The samplers were driven in subsurface soils under the impact of a 140-lb hammer having a free fall of 30 inches. The samples were sealed and transported to our laboratory for further evaluation and testing. The field investigation was conducted under the supervision of our field engineer who logged the test borings and prepared the samples for subsequent laboratory testing and evaluation. Log of Test Borings (LOTB) sheets for the eight borings are presented in Appendix A. Appendix A also includes LOTB sheets for A Street Undercrossing and Cavallo Road Undercrossing. The LOTB sheets include descriptions of the soils encountered, number of blows required to drive the sampler (an indicator of the density/strength of the material encountered), and the results of the laboratory tests performed on the samples (moisture, density, unconfined

compressive strength of the clay soils and grain size distribution of the granular soils).

Laboratory tests performed on selected samples obtained during field exploration to determine the physical and engineering properties of the subsoils. Laboratory tests performed included tests for moisture content, density, grain size distribution, Atterberg Limits and unconfined compressive strengths. A detailed description of the applicable laboratory test procedures are presented in Appendix B. Appendix B also includes Plasticity Charts for Atterberg Limits and grain size distribution curves. Atterberg Limits and grain size distribution curves for tests on samples from the borings drilled for A Street Undercrossing and Cavallo Road Undercrossing are also included.

SITE SUBSURFACE CONDITIONS

Subsurface conditions adjacent to both the bridge locations indicate predominantly very stiff to hard lean clays with occasional layers of medium dense to very dense silty and clayey sands. Groundwater was not encountered in any of the 30-ft borings drilled. However, groundwater was encountered at depths ranging from 40 to 80 feet in the deeper borings drilled adjacent to A Street Undercrossing and at depths ranging from 53 to 55 feet in the borings drilled adjacent to Cavallo Road Undercrossing.

Soil profiles adjacent to the two underpasses are presented on Plate 3. The 'edge of pavement' and the 'original ground surface' are also shown on the profiles. It appears that the bottom of the footings for the Type B and Type C walls will be founded on native soils for both underpass locations.

SITE GEOLOGY

A geologic map of the site is presented in Plate 4. The map indicates the site to be in an area of Pleistocene alluvial fan deposits (Qpaf). The source of the map is noted on the plate. In a companion

text to the map the geologic unit Qpaf is described as follows:

Qpaf (Alluvial Fans and Fluvial Deposits (Pleistocene)) – Brown dense gravely and clayey sand or clayey gravel that fines upward to sandy clay. These deposits display various sorting and are located in most stream channels in the county. All Qpaf deposits can be related to modern stream courses. They are distinguished from younger alluvial fans and fluvial deposits by higher topographic position, greater degree of dissection, and stronger soil profile development. They are less permeable than Holocene deposits, and locally contain fresh water mollusks and extinct late Pleistocene vertebrate fossils. They are overlain by Holocene deposits on lower parts of the alluvial plain, and incised by channels that are partly filled with Holocene alluvium on higher parts of the alluvial plain. Maximum thickness is unknown but at least 50m (150 feet).

EARTHQUAKE SOURCES AND SITE SEISMICITY

A Fault Map of the site vicinity is presented in Plate 5. The map is based on the 2007 Caltrans Deterministic PGA Map. Per the map, the controlling fault is the Vaca Fault Zone, approximately 5.4 miles from the project site. The Vaca Fault Zone is a strike slip fault, capable of a maximum seismic event of 6.9 (Moment Magnitude). Design peak ground acceleration (PGA) of 0.5g was computed for the project using the attenuation relationships per Sadigh (1999). Potential hazards from fault rupture and liquefaction are low.

CONCLUSIONS AND RECOMMENDATIONS

1. The soils at the proposed foundation levels are competent soils (compacted fill, stiff to very stiff clays and medium dense to dense sands). In addition, there is no evidence of existence of soft clays or loose sands within the depth of interest.
2. Compacted fill placed above the base of the footing should be structure backfill as per Caltrans standards.
3. The walls are buried and if there is provision for drainage it should be designed as drained

condition. If there is no means of providing longitudinal drain and cleanouts within eBART, hydrostatic pressures should be incorporated in the design.

4. The controlling fault is the Vaca Fault Zone, approximately 5.4 miles from the project site. Design peak ground acceleration (PGA) of 0.5g was computed for the project

5. Design recommendations are given below:

a.	Active Earth Pressure:	36 pcf (equivalent fluid pressure)
b.	Passive Earth Pressure:	310 pcf (equivalent fluid pressure)
c.	Allowable Bearing Capacity:	3000 psf (The bearing capacity may be increased by 30 percent for seismic loads)
d.	Coefficient of Friction:	0.4
e.	Surcharge Load:	As appropriate for eBART train loading condition
f.	Seismic Lateral Load :	$12H^2$ (lbs) per foot of wall, acting at 0.6H above the base (The earth pressures are based on Mononobe-Okabe formulation. The acceleration used is half of the corresponding peak acceleration per BART Facilities Standards)

INVESTIGATION LIMITATIONS

Our services consist of professional opinions and recommendations made in accordance with generally accepted geotechnical engineering principles and practices and are based on our site reconnaissance and the assumption that the subsurface conditions do not deviate from observed conditions. All work done is in accordance with generally accepted geotechnical engineering principles and practices. No warranty, expressed or implied, of merchantability or fitness, is made or intended in connection with our work or by the furnishing of oral or written reports or findings. The

scope of our services did not include any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in structures, soil, surface water, groundwater or air, below or around this site. Unanticipated soil conditions are commonly encountered and cannot be fully determined by taking soil samples and excavating test borings; different soil conditions may require that additional expenditures be made during construction to attain a properly constructed project. Some contingency fund is thus recommended to accommodate these possible extra costs.

This report has been prepared for the proposed project as described earlier, to assist the engineer in the design of this project. In the event any changes in the design or location of the facilities are planned, or if any variations or undesirable conditions are encountered during construction, our conclusions and recommendations shall not be considered valid unless the changes or variations are reviewed and our recommendations modified or approved by us in writing.

This report is issued with the understanding that it is the designer's responsibility to ensure that the information and recommendations contained herein are incorporated into the project and that necessary steps are also taken to see that the recommendations are carried out in the field.

The findings in this report are valid as of the present date. However, changes in the subsurface conditions can occur with the passage of time, whether they are due to natural processes or to the

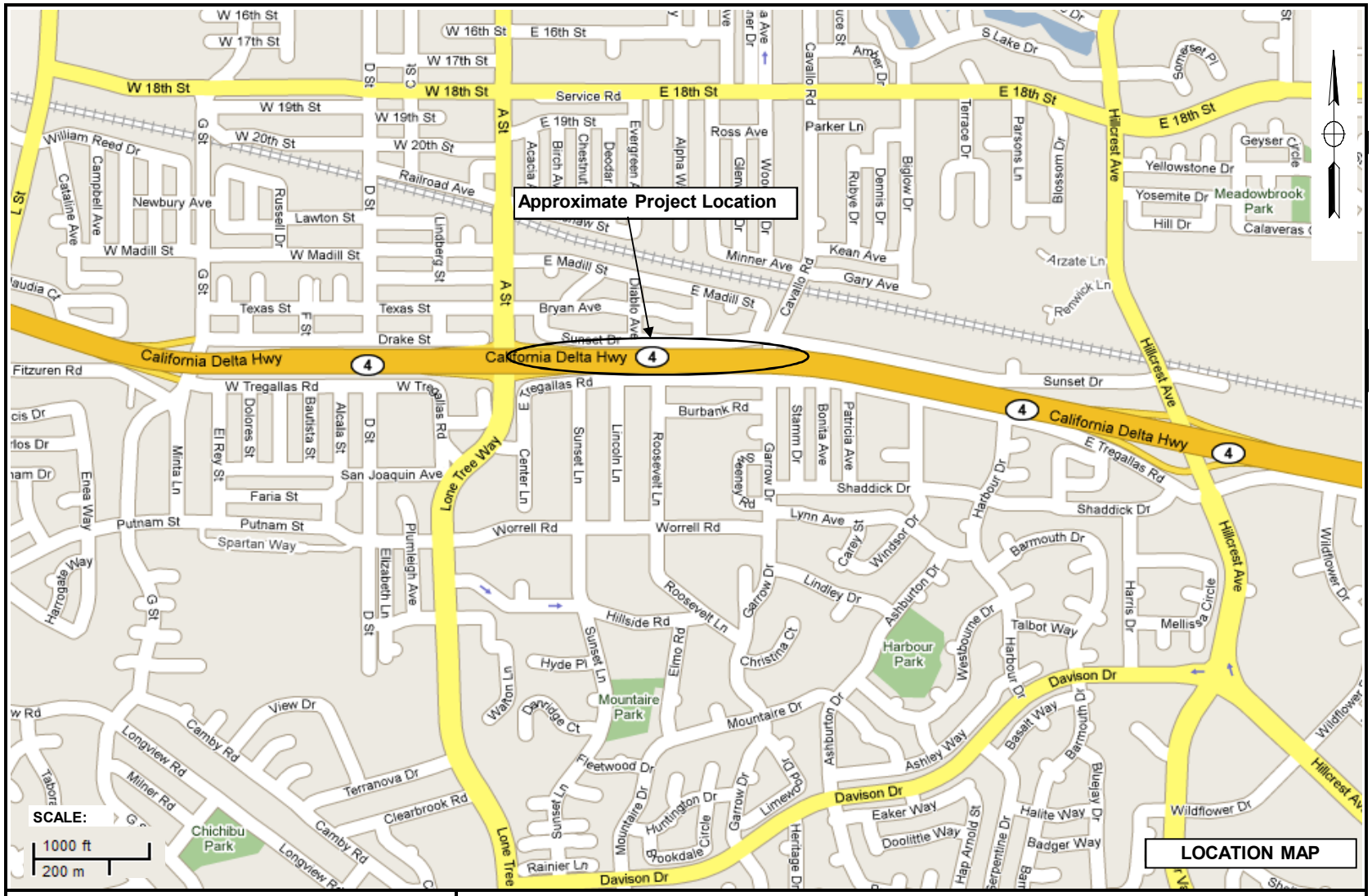
works of man, on this or adjacent properties. In addition, changes in applicable or appropriate standards occur, whether they result from legislation or from the broadening of knowledge. Accordingly, the findings in this report might be invalidated, wholly or partially, by changes outside of our control.

Respectfully submitted,
PARIKH CONSULTANTS, INC.

Partha Sircar, Ph.D., P.E. C54619
Senior Engineer

REGISTERED PROFESSIONAL ENGINEER
GAURANG R. PARIKH
No. 666
EXP. 12-31-11
GEOTECHNICAL
STATE OF CALIFORNIA

Gary Parikh, G.E. 666
Project Manager



PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

eBART MEDIAN RETAINING WALLS
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO.: 206117.EBS | **PLATE NO.: 1**

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
X	X	X			

REGISTERED CIVIL ENGINEER X DATE

PLANS APPROVAL DATE

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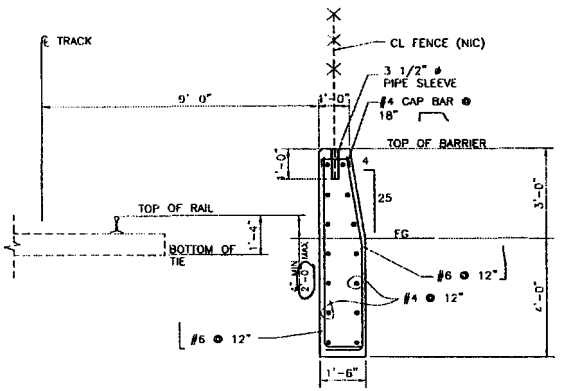
REGISTERED PROFESSIONAL ENGINEER X X X X CIVIL STATE OF CALIFORNIA



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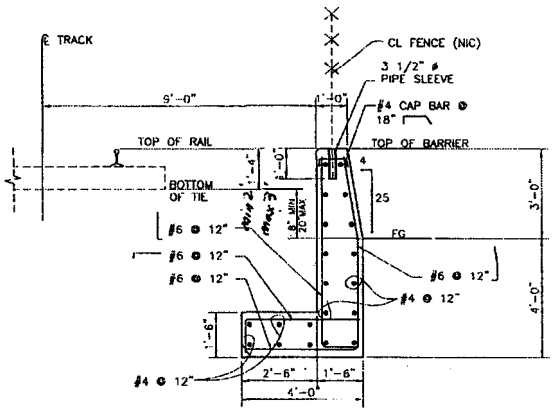

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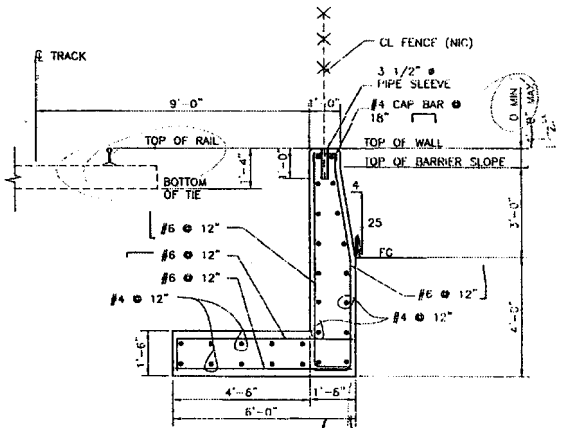


TYPE C

TENTATIVE & PRELIMINARY FOR TYPE SELECTION ONLY

TYPE SELECTION

C-100

X
DESIGN OVERNIGHT
X
SIGN OFF DATE

DESIGN DETAIL SHEET (ENGLISH) (REV. 2/15/06)

DESIGN	BY	CHECKED	
DETAILS	BY	CHECKED	
QUANTITIES	BY	CHECKED	

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

PROJECT ENGINEER

CU X
EA X

BRIDGE NO.

POST MILE

eBART RET WALL TYPE A, B & C

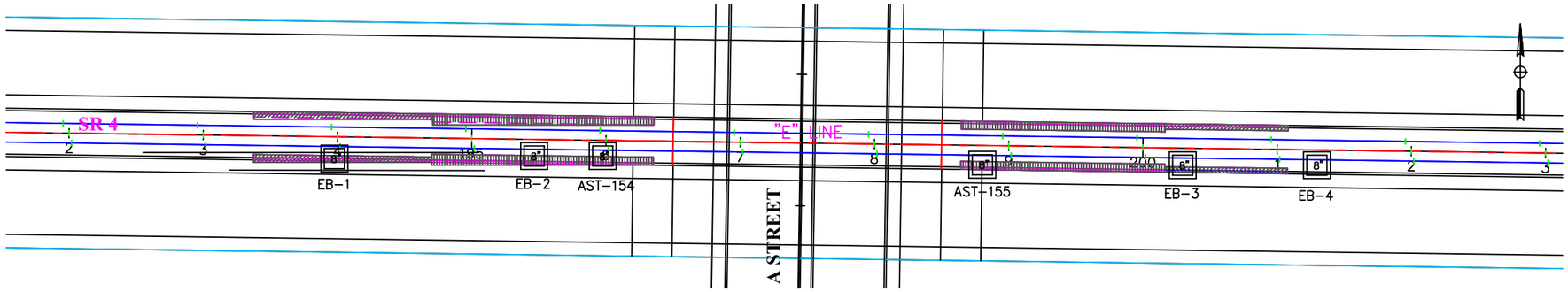
STRUCTURE DETAILS

STANDARD PRINTS BLANKING
EARLIER REVISION DATES

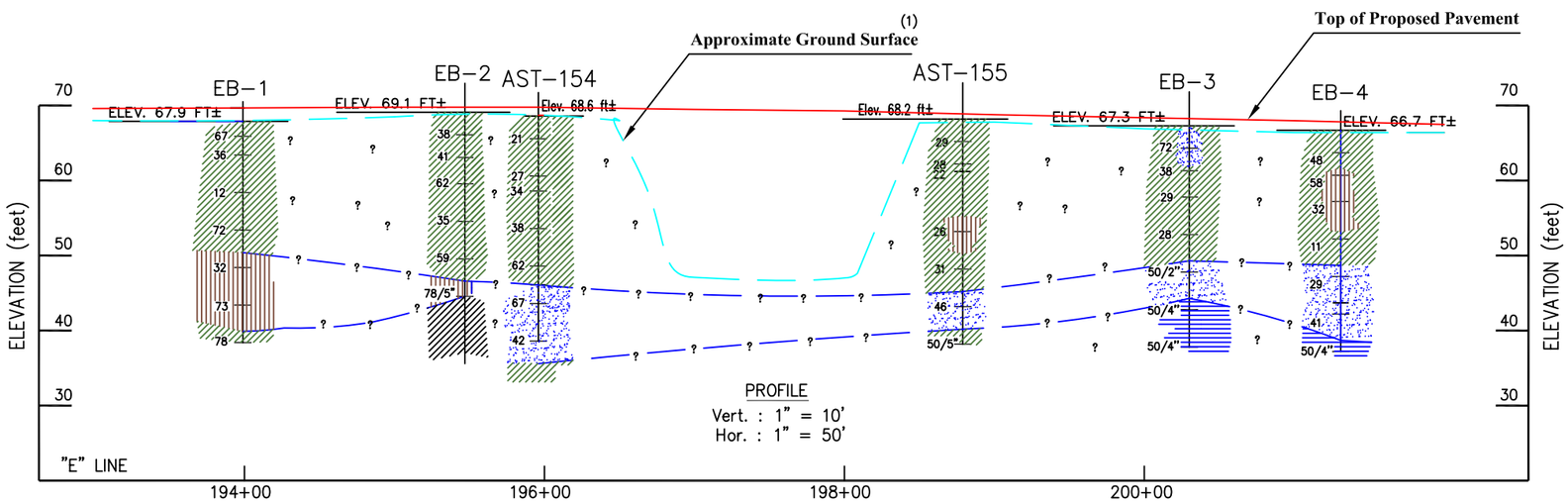
REVISION DATE (PRELIMINARY STAGE ONLY)

SHEET X OF X

PLATE NO: 2



PLAN
1"=50'



PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ALL DIMENSIONS ARE IN FEET
UNLESS OTHERWISE SHOWN

LEGEND

- Gravels, Sands and Non-plastic Silts
- Clays
- Silts
- Siltstone
- EB-1 Boring Number

Notes:

1. Ground surface elevations are based on topographic map provided by T.Y LIN INTERNATIONAL

2. Blow counts are shown at appropriate depths

3. (*) indicates SPT sample blow counts; otherwise they indicate Modified California sample blow counts

NOTE:
The generalized soil profile was constructed by direct interpolation between results of borings. The dashed lines connecting the various layers at each exploration are for schematic and for illustration purpose only. They should not be construed to represent the actual conditions in the field.

GENERALIZED SOIL PROFILE

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

eBART MEDIAN RETAINING WALLS
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO.:206117.EBS | PLATE NO: 3A

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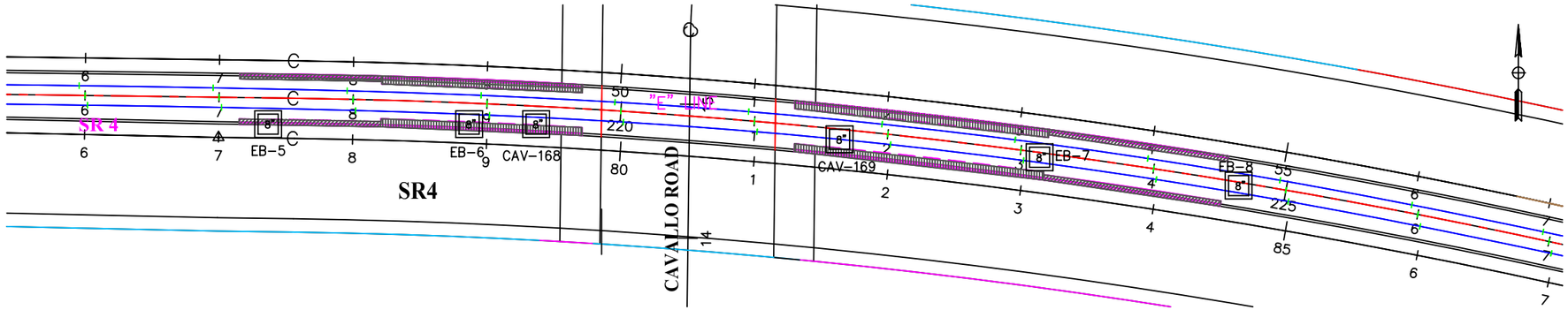
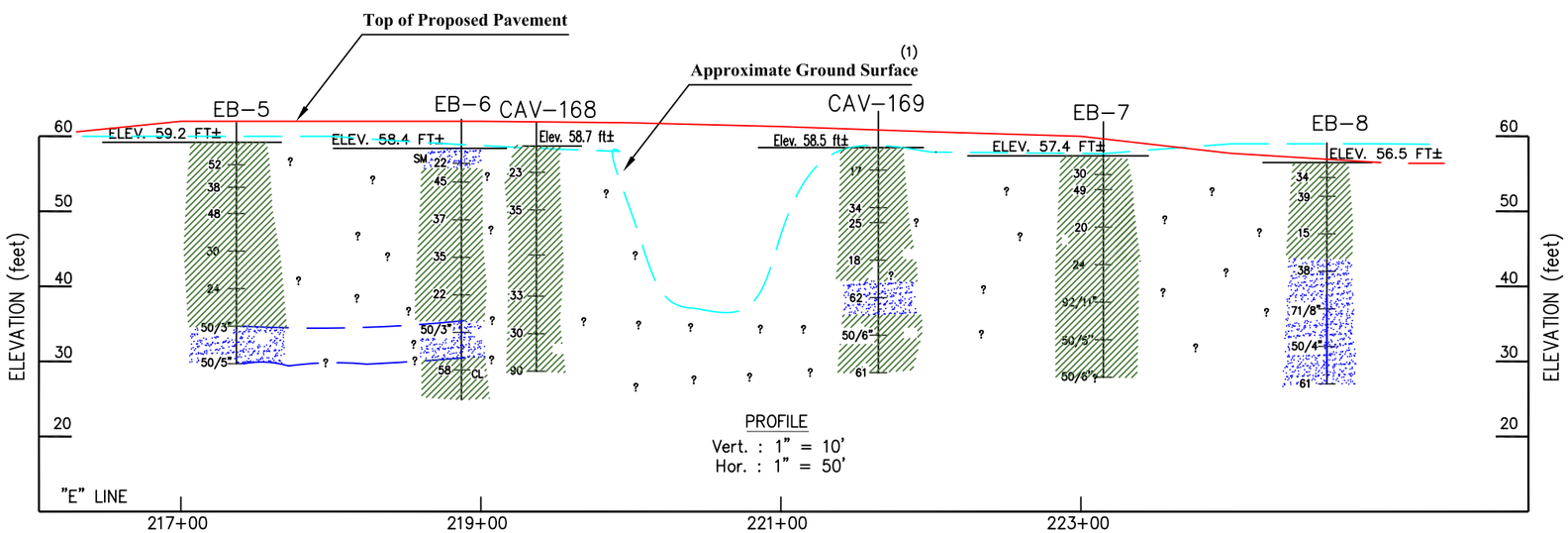


PLAN
1"=50'



PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ALL DIMENSIONS ARE IN FEET
UNLESS OTHERWISE SHOWN

LEGEND

- Gravels, Sands and Non-plastic Silts
- Clays
- Silts
- EB-6 Boring Number

Notes:

1. Ground surface elevations are based on topographic map provided by T.Y LIN INTERNATIONAL

2. Blow counts are shown at appropriate depths

3. (*) indicates SPT sample blow counts; otherwise they indicate Modified California sample blow counts

NOTE:
The generalized soil profile was constructed by direct interpolation between results of borings. The dashed lines connecting the various layers at each exploration are for schematic and for illustration purpose only. They should not be construed to represent the actual conditions in the field.

GENERALIZED SOIL PROFILE

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

eBART MEDIAN RETAINING WALLS
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO.:206117.EBS | PLATE NO: 3B

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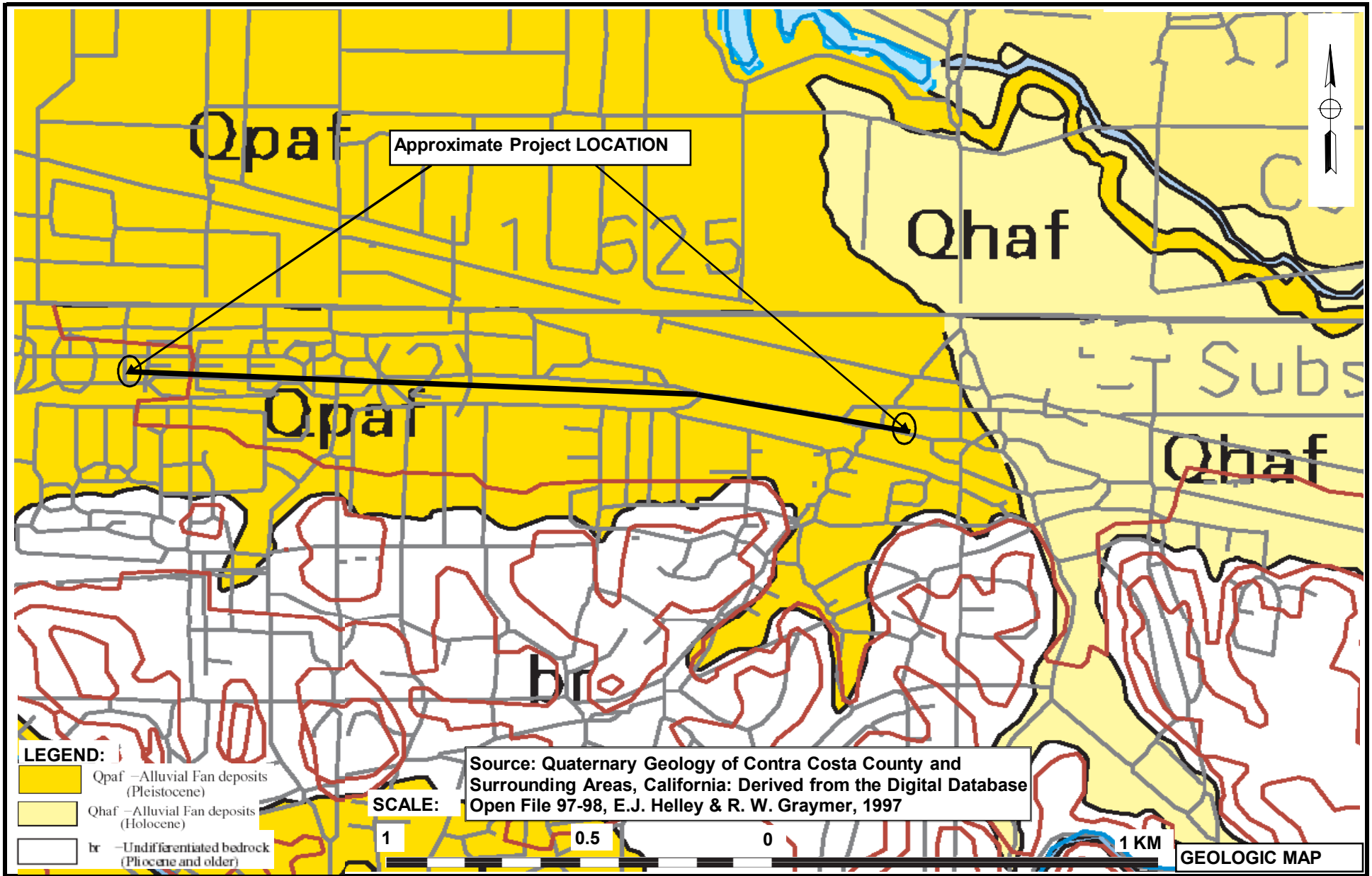
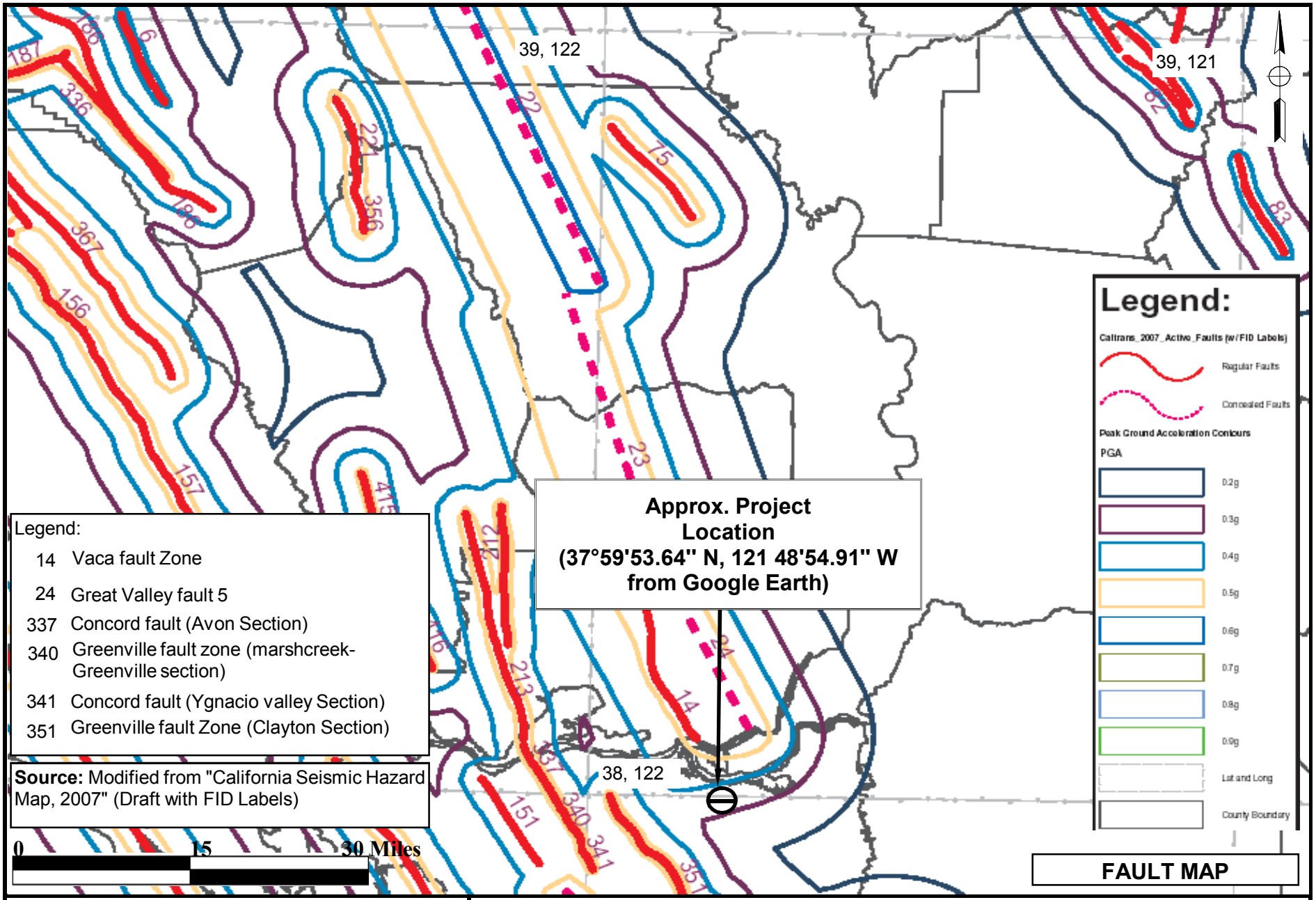


PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

eBART MEDIAN RETAINING WALLS
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO.: 206117.EBS | PLATE NO.: 4



FAULT MAP

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

eBART MEDIAN RETAINING WALLS
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO.: 206117.EBS	PLATE NO.: 5

APPENDIX A

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (JUNE 2007)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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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
- (PP) Pocket Penetrometer
- (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)
- (TV) Pocket Torvane
- (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)
- (VS) Vane Shear (AASHTO T 223)

APPARENT DENSITY OF COHESIONLESS SOILS

Description	SPT N_{60} (Blows / 12 inches)
Very loose	0 – 4
Loose	5 – 10
Medium Dense	11 – 30
Dense	31 – 50
Very Dense	> 50

MOISTURE

Description	Criteria
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

PERCENT OR PROPORTION OF SOILS

Description	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

PARTICLE SIZE

Description		Size
Boulder		> 12"
Cobble		3" to 12"
Gravel	Coarse	3/4" to 3"
	Fine	No. 4 to 3/4"
Sand	Coarse	No. 10 to No. 4
	Medium	No. 40 to No. 10
	Fine	No. 200 to No. 40

ENGINEERING SERVICES	GEOTECHNICAL SERVICES
PREPARED BY	O. GOUTHIER
CHECKED BY	P. SIRCAR

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

DIVISION OF ENGINEERING SERVICES
STRUCTURE DESIGN
DESIGN BRANCH ___

BRIDGE NO. 28C0487
POST MILE 27.8

SOIL LEGEND
LOG OF TEST BORINGS

GS LOTB SOIL LEGEND

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 04275
EA 228511

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

SHEET 1 OF ___

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (JUNE 2007)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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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
Size	R P	Rotary drilled boring 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 5778-95)
□	O	Other

Note: Size in inches.

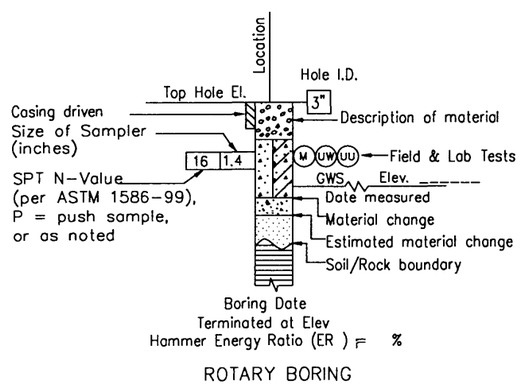
Notes:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly : A 140 lb hammer with a 30" drop (Automatic Hammer)

CONSISTENCY OF COHESIVE SOILS

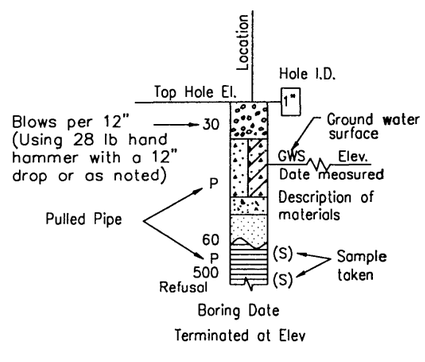
Description	Unconfined Compressive Strength (tsf)	Pocket Penetrometer Measurement (tsf)	Torvane Measurement (tsf)	Field Approximation
Very Soft	< 0.25	< 0.25	< 0.12	Easily penetrated several inches by fist
Soft	0.25 to 0.50	0.25 to 0.50	0.12 to 0.25	Easily penetrated several inches by thumb
Medium Stiff	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

PLASTICITY OF FINE-GRAINED SOILS

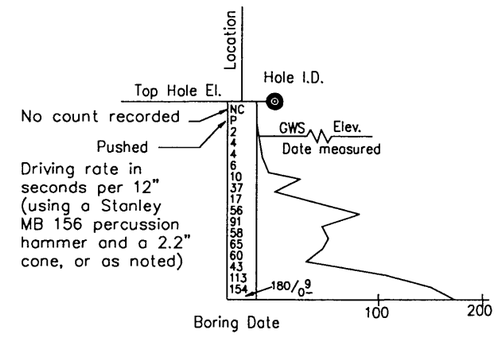
Description	Criteria
Nonplastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.



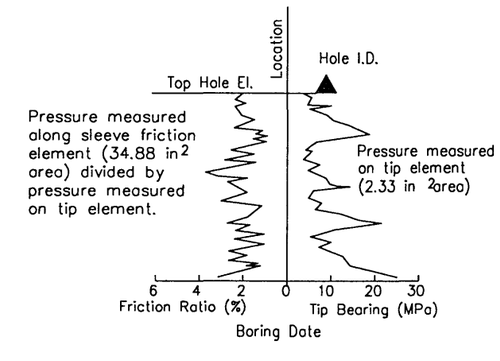
ROTARY BORING



HAND BORING



DYNAMIC CONE PENETRATION BORING



CONE PENETRATION TEST (CPT) SOUNDING

ENGINEERING SERVICES	GEOTECHNICAL SERVICES	STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN DESIGN BRANCH ___	BRIDGE NO. 28C0487	SOIL LEGEND
PREPARED BY	O. GOUTHIER			POST MILE 27.8	LOG OF TEST BORINGS
CHECKED BY	P. SIRCAR				

GS LOTB SOIL LEGEND

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 04275
EA 228511

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

SHEET 2 OF ___

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
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CONTRA COSTA TRANSPORTATION AUTHORITY
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PLEASANT HILL, CA 94523

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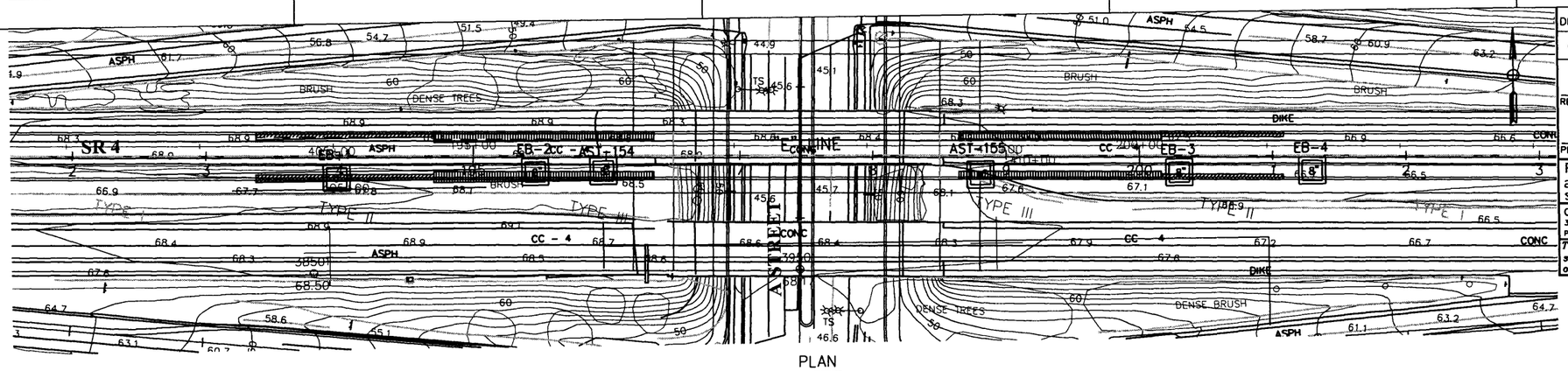
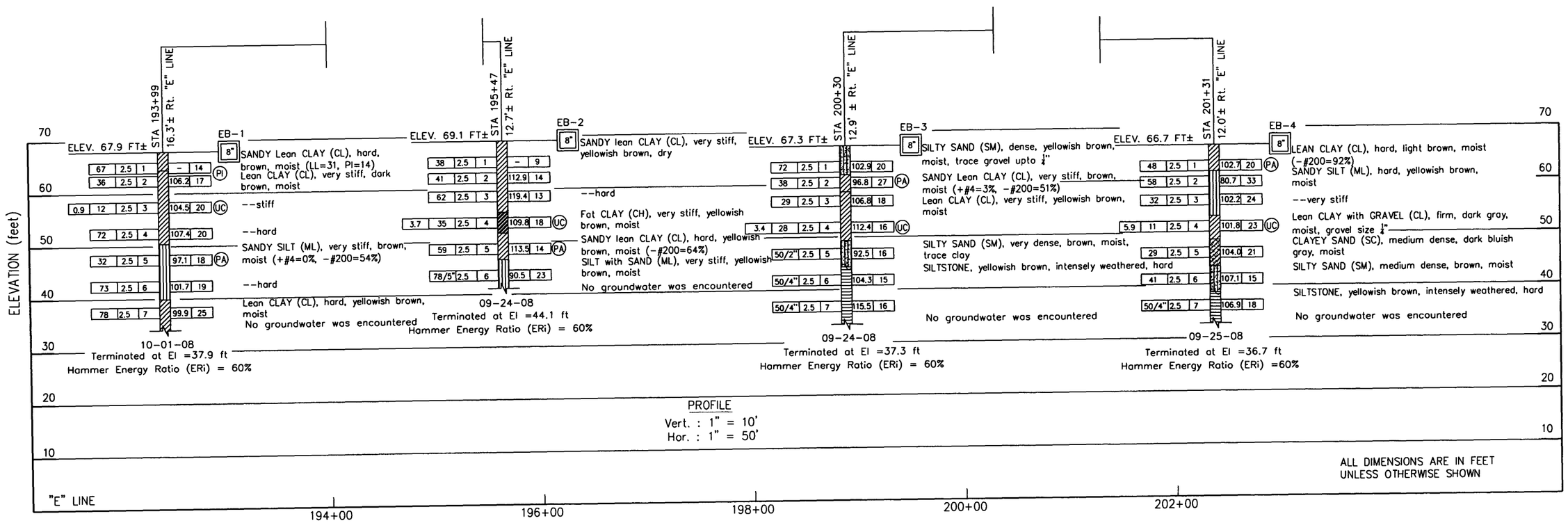


PLAN
1"=50'

TYPE A
TYPE B
TYPE C

Note:
See sheet 1 & sheet 2 for the soil legend and sampler, hammer details



PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

ENGINEERING SERVICES	GEOTECHNICAL SERVICES	STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN	BRIDGE NO.	eBART MEDIAN RETAINING WALLS
FUNCTIONAL SUPERVISOR	DRAWN BY: O. GOUTHIER	FIELD INVESTIGATION BY:	DESIGN BRANCH	POST MILES	LOG OF TEST BORINGS 3 OF 4
NAME: G. PARIKH	CHECKED BY: P. SIRCAR	L.S. BHANGOO	CU 04275 EA 2285F1	DISREGARD PRINTS BEARING EARLIER REVISION DATES	REVISION DATES — SHEET 3 OF 6
OGS CIVIL LOG OF TEST BORINGS SHEET		ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3	FILE => $REQUEST		

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

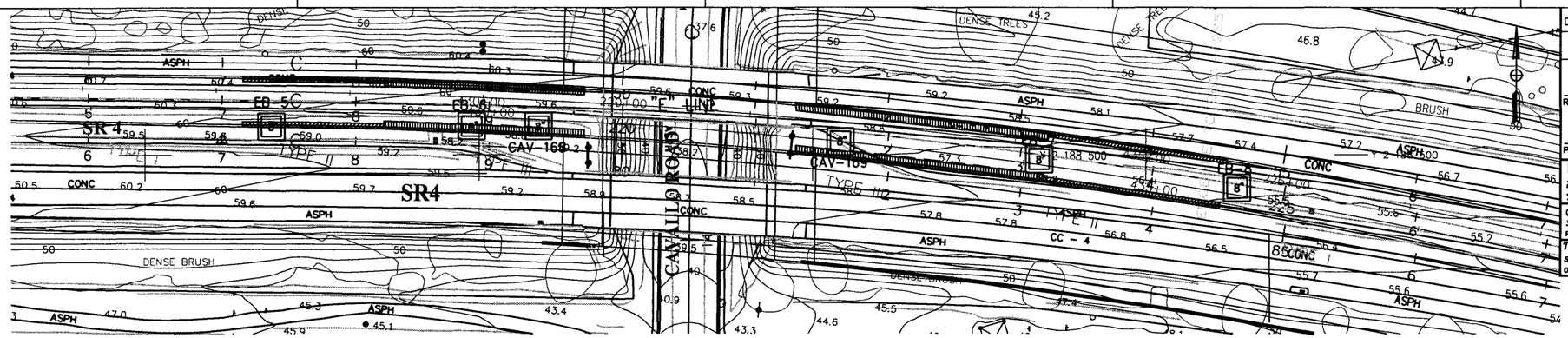
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

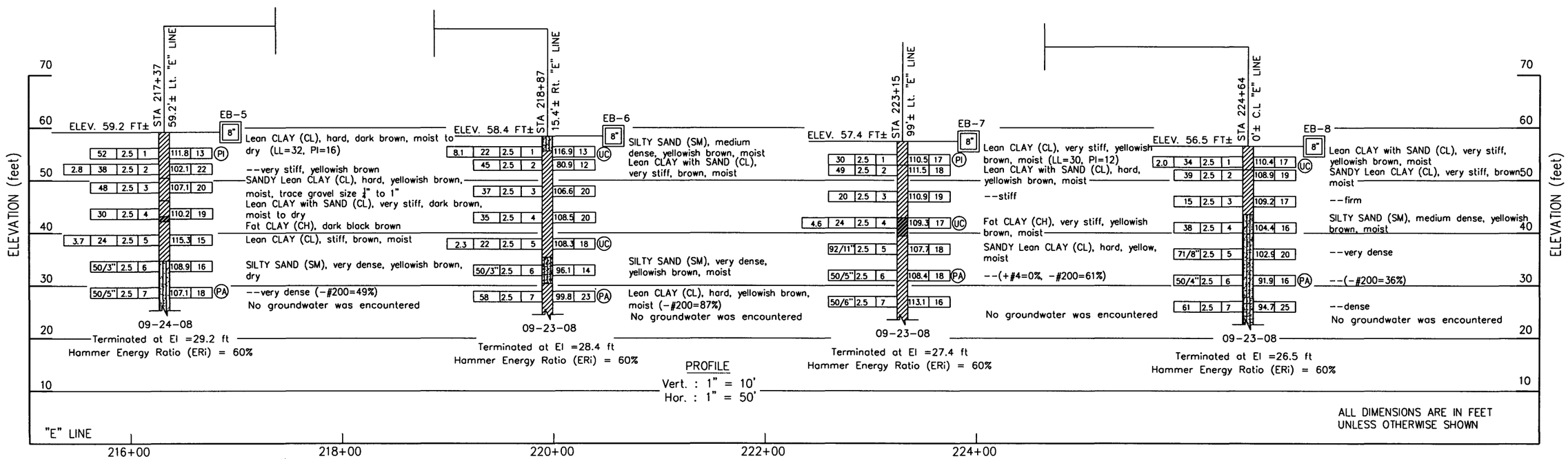
The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.



PLAN
1"=50'

TYPE A
TYPE B
TYPE C

Note:
See sheet 1 & sheet 2 for the soil legend and sampler, hammer details



ENGINEERING SERVICES	GEOTECHNICAL SERVICES	STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN	BRIDGE NO.	eBART MEDIAN RETAINING WALLS
FUNCTIONAL SUPERVISOR	DRAWN BY: O. GOUTHIER	FIELD INVESTIGATION BY:	DESIGN BRANCH	POST MILES	LOG OF TEST BORINGS 4 OF 4
NAME: G. PARIKH	CHECKED BY: P. SIRCAR	L.S. BHANGOO			

OGS CIVIL LOG OF TEST BORINGS SHEET

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 04275
EA 2285F1

FILE => $REQUEST

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

SHEET 4 OF 6

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/09 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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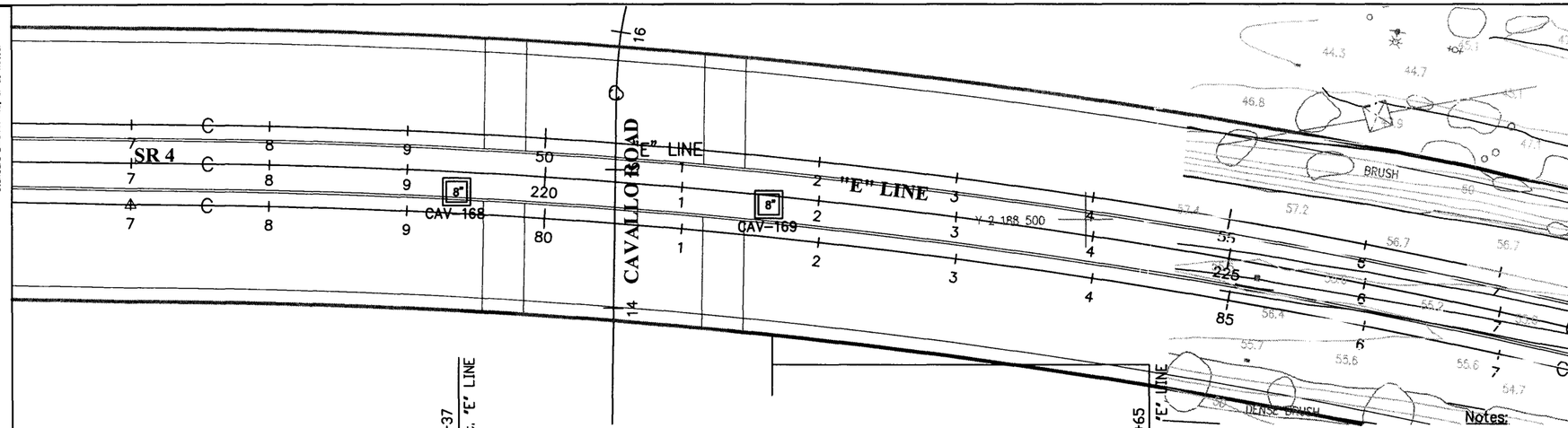
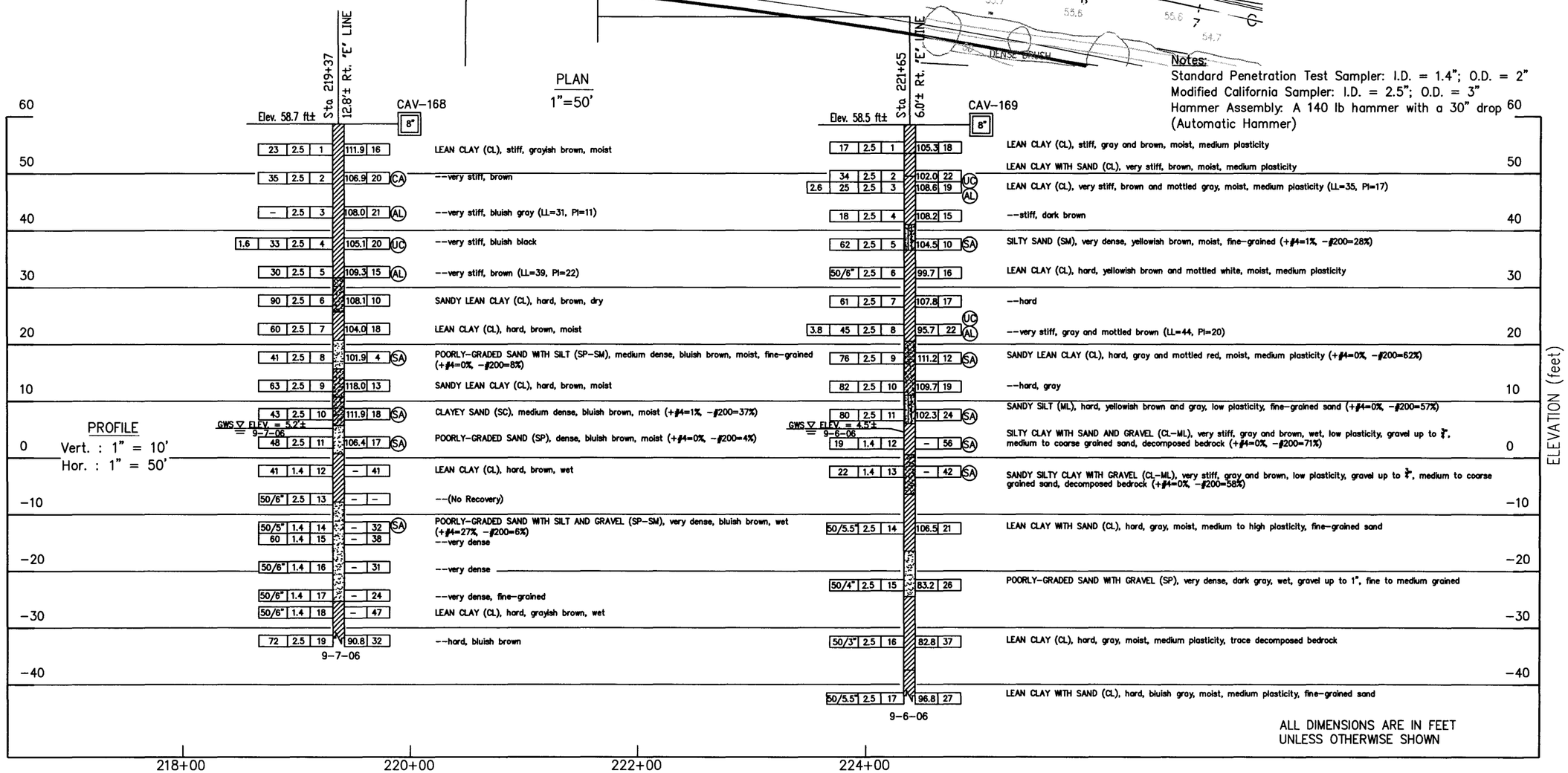
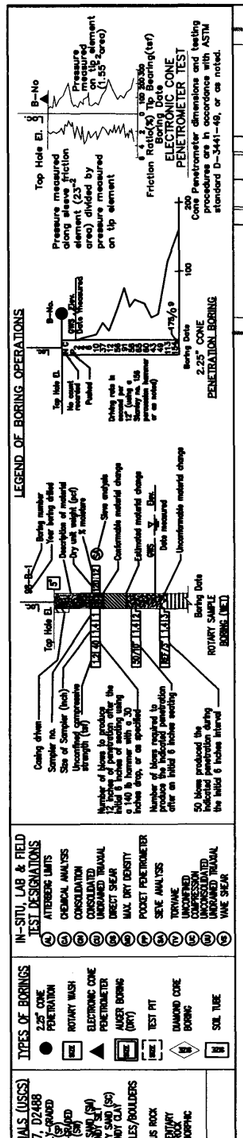


PLAN
1"=50'

Notes:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)



ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN



DESIGN OVERSIGHT	DESIGN By: D. GOUTHIER	Field Investigation by: L. BHANGOO	P. SIRCAR PROJECT ENGINEER	STRUCTURE NO. 28C0488
SIGN OFF DATE	CHECKED By: P. SIRCAR			POST MILES (PM) 28.2

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

eBART CAVALLO ROAD UNDERPASS

LOG OF TEST BORINGS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04275
EA 2285F1

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) 08/31/09

SHEET 1 OF 2

PLATE A-1

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	–		

REGISTERED ENGINEER-GEOTECHNICAL

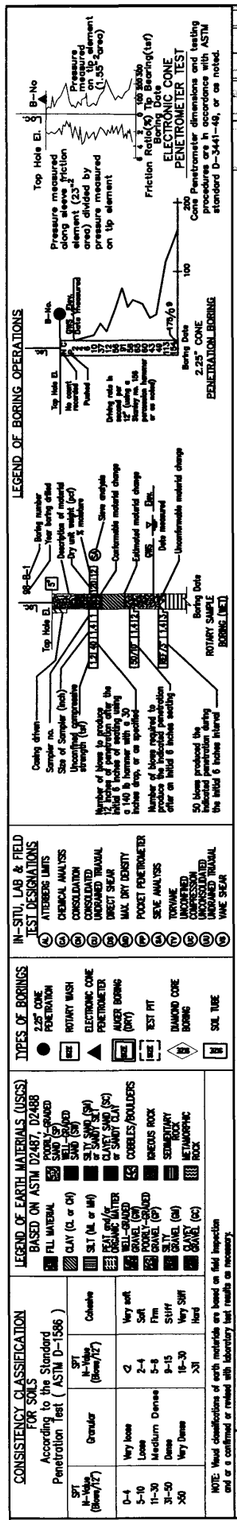
PLANS APPROVAL DATE

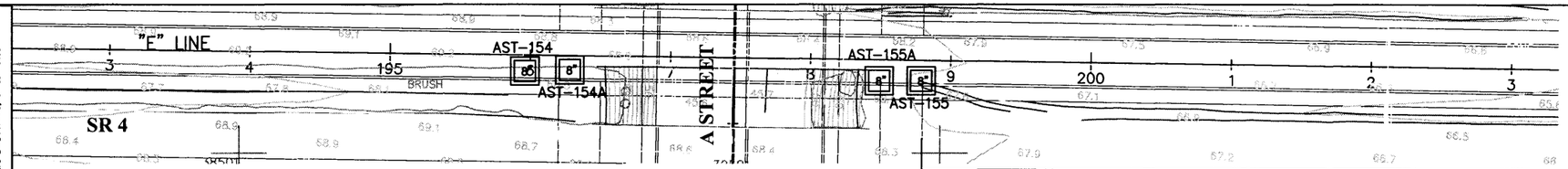
REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE. 666 Exp. 12/31/09 GEOTECHNICAL STATE OF CALIFORNIA

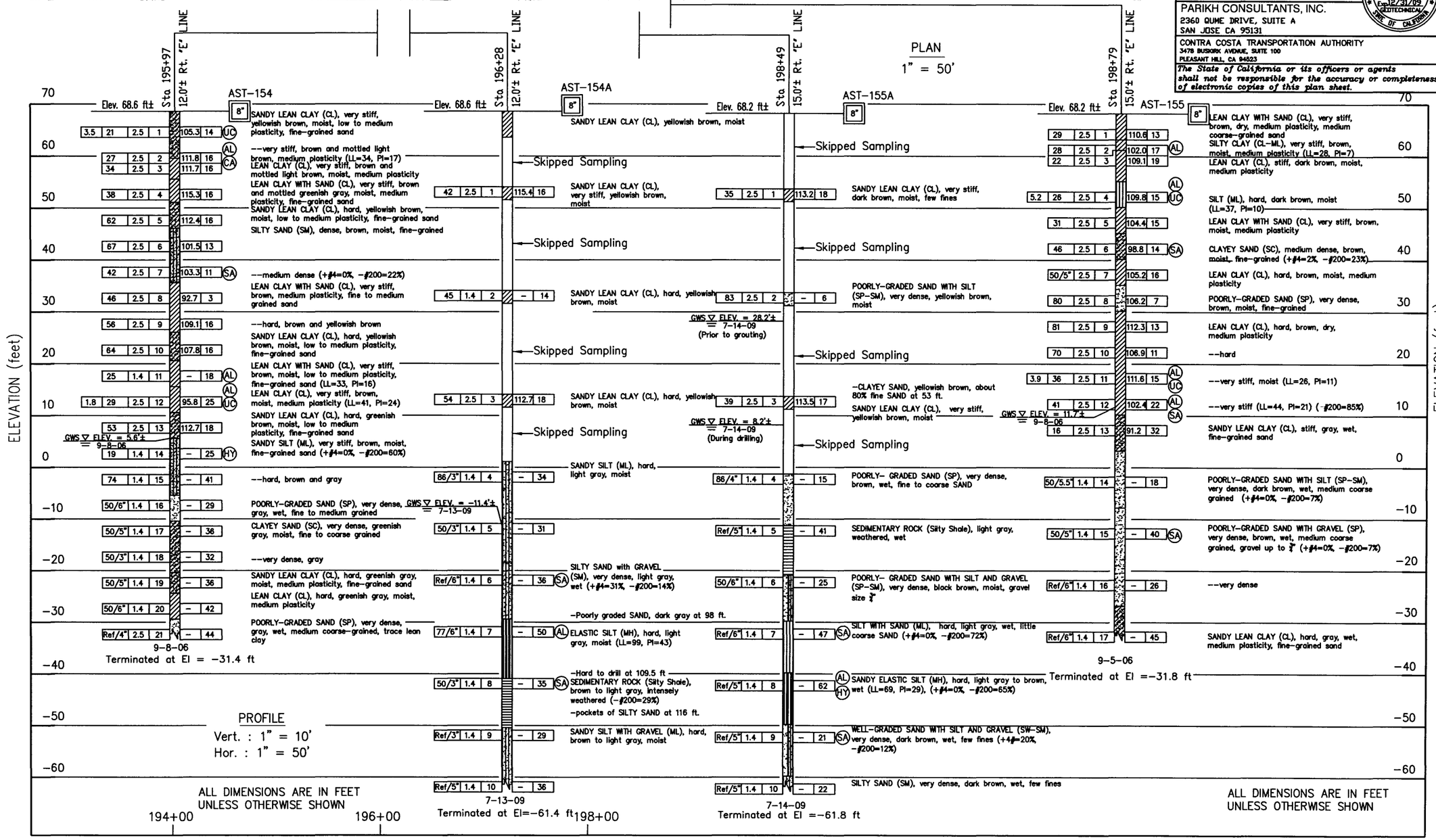
PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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.







DESIGN OVERSIGHT	DESIGN By: D. GOUTHIER	Field investigation by: L. BHANGOO	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION
SIGN OFF DATE	CHECKED By: P. SIRCAR		P. SIRCAR, PROJECT ENGINEER

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04275
EA 2285F1

STRUCTURE NO.	eBART A STREET UNDERPASS
28C0487	
POST MILES (PM) 27.8	LOG OF TEST BORINGS

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) 08/31/09 SHEET OF

APPENDIX B

APPENDIX B

LABORATORY TESTS

Classification Tests

The field classification of the samples was visually verified in the laboratory according to the Unified Soil Classification System. The results are presented on "Log of Test Borings", Appendix A.

Moisture-Density

The natural moisture contents and dry unit weights were determined for selected undisturbed samples of the soils in general accordance with ASTM Test Method D 2216-92. This information was used to classify and correlate the soils. The results are presented at the appropriate depths on the "Log of Test Borings", Appendix A.

Atterberg Limits

The Atterberg Limits were determined for selected samples of the fine-grained materials. These results were used to classify the soils, as well as to obtain an indication of the effective strength characteristics and expansion potential with variations in moisture content. The Atterberg Limits were determined in general accordance with ASTM Test Method D 4318-93. The results of these tests are presented on Plates B-2A, "Plasticity Chart".

Grain Size Classification

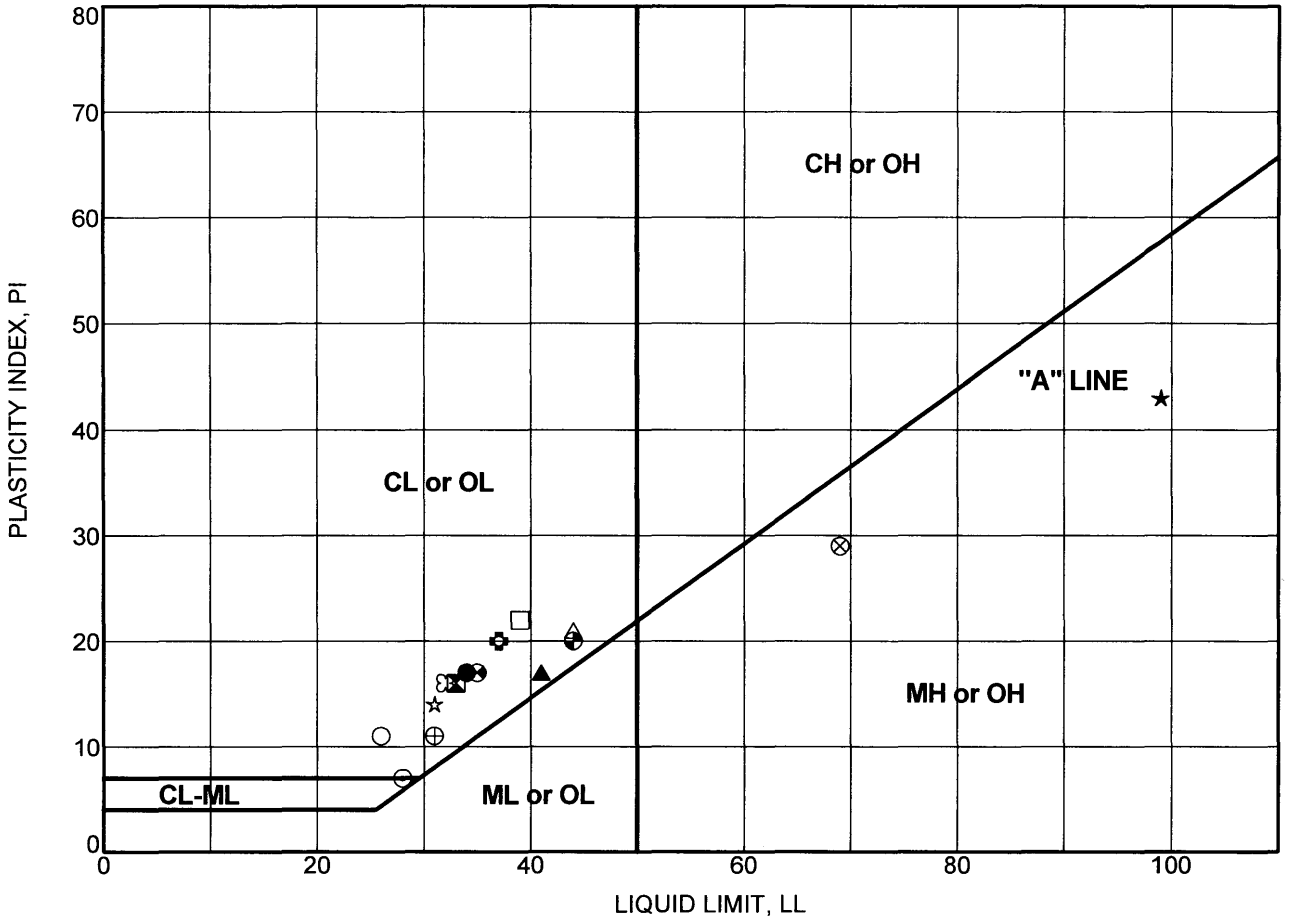
Grain size classification tests (ASTM Test Method D422-63) were performed on selected samples of granular soil to aid in the classification. The results are presented on Plates B-3A thru B-3E, "Grain Size Distribution Curves".

Unconfined Compression Tests

Strength tests were performed on selected undisturbed samples using unconfined compression machine. Unconfined compression tests were performed in general accordance with ASTM Test Method D 2166-91. The results are presented on "Log of Test Borings"

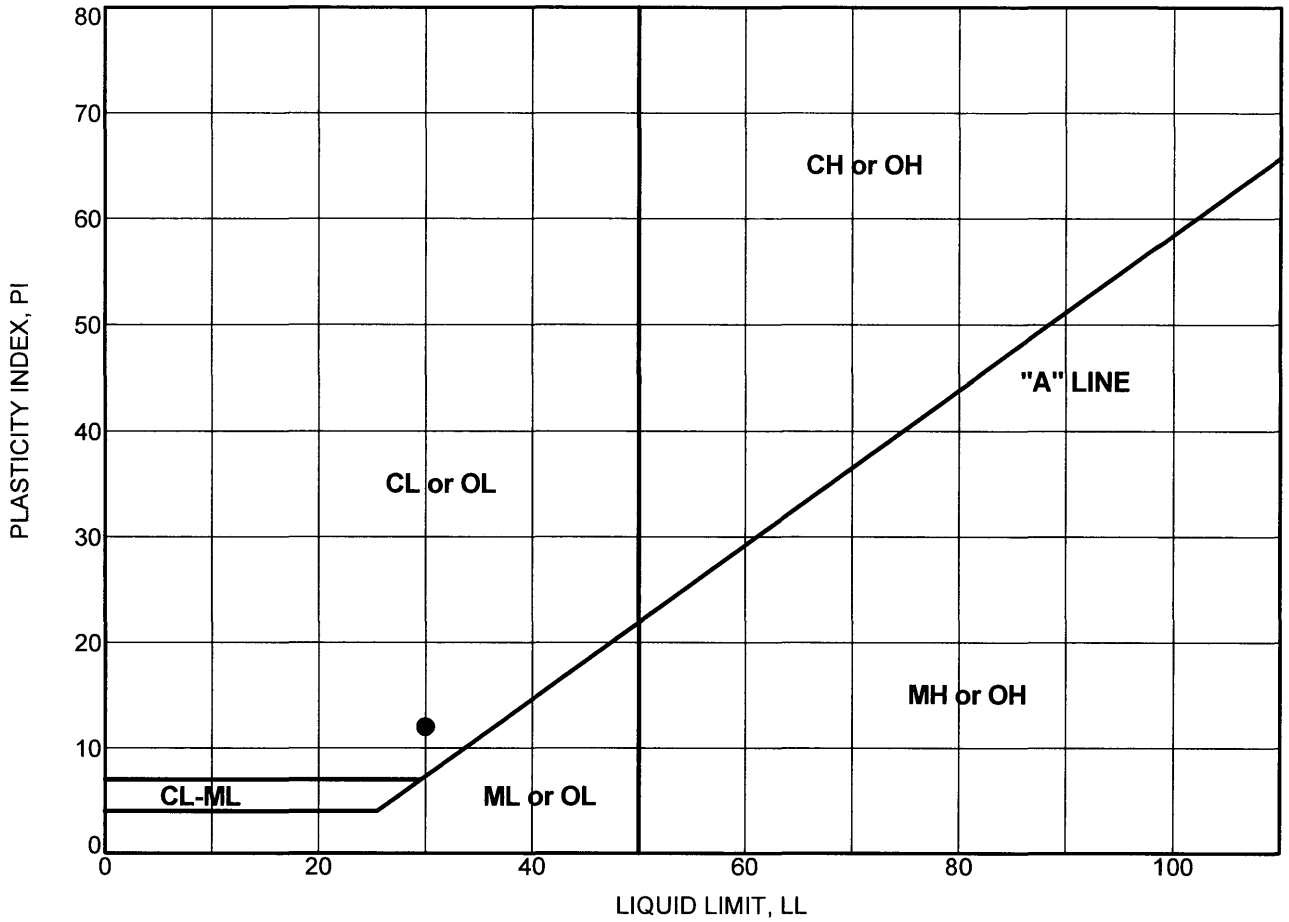
Corrosion Tests

Corrosion tests were performed on selected samples to determine the corrosion potential of the soils. The pH and minimum resistively tests were performed according to California Test Method 643, 417 and 422. The tests were performed by Sunland Analytical. The test results are presented on Plates B-4-A thru B-4-B.



PLASTICITY CHART

Boring Number	Sample Number	Depth (feet)	Test Symbol	Moisture Content (%)	LL	PL	PI	Description
AST-154	MC-2	8.0	●	16	34	17	17	LEAN CLAY (CL)
AST-154	MC-7	30.0	⊠	11	33	17	16	SILTY SAND (SM)
AST-154	MC-12	55.0	▲	25	41	24	17	LEAN CLAY (CL)
AST-154A	SPT-7	99.5	★	50	99	56	43	ELASTIC SILT (MH)
AST-155	MC-2	10.0	⊙	19	28	21	7	SILTY CLAY (CL-ML)
AST-155	MC-4	15.0	✿	15	37	17	20	SILT (ML)
AST-155	MC-11	50.0	○	24	26	15	11	LEAN CLAY (CL)
AST-155	MC-12	55.0	△	56	44	23	21	LEAN CLAY (CL)
AST-155A	SPT-8	109.5	⊗	62	69	40	29	SANDY ELASTIC SILT (MH)
CAV-168	MC-3	14.5	⊕	21	31	20	11	LEAN CLAY (CL)
CAV-168	MC-5	25.0	□	15	39	17	22	LEAN CLAY (CL)
CAV-169	MC-3	10.0	⊗	19	35	18	17	LEAN CLAY (CL)
CAV-169	MC-8	35.0	◕	22	44	24	20	LEAN CLAY (CL)
EB-1	MC-1	2.0	☆	14	31	17	14	LEAN CLAY (CL)
EB-5	MC-1	3.0	⊠	13	32	16	16	LEAN CLAY (CL)



PLASTICITY CHART

Boring Number	Sample Number	Depth (feet)	Test Symbol	Moisture Content (%)	LL	PL	PI	Description
EB-7	MC-1	2.5	●	17	30	18	12	LEAN CLAY (CL)

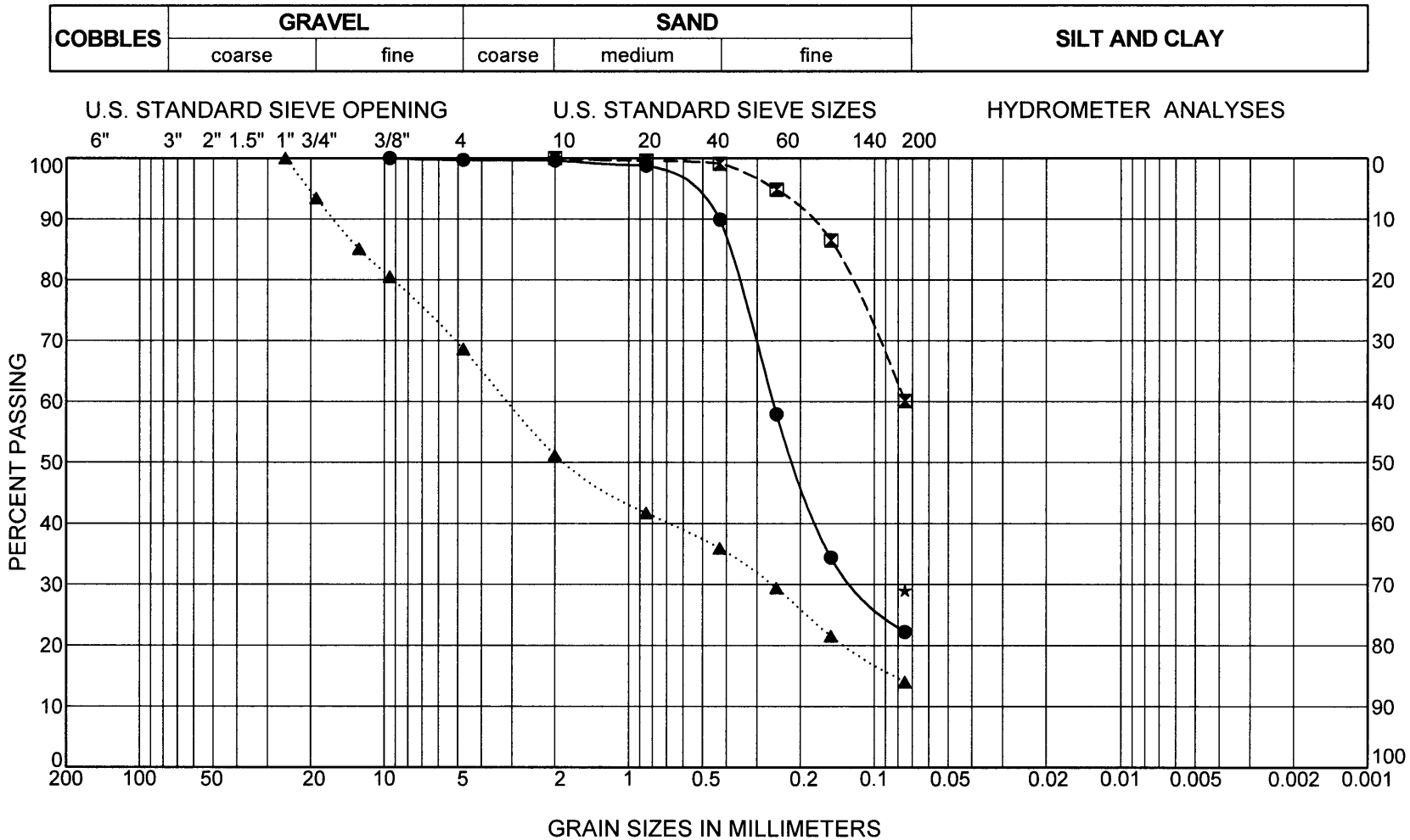
PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

eBART MEDIAN RETAINING WALLS
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.EBS

PLATE NO: B-2B

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
AST-154	MC-7	30.0	●	33	16	SILTY SAND (SM)
AST-154	SPT-14	65.0	⊠			SANDY SILT (ML)
AST-154A	SPT-8	89.5	▲			SILTY SAND WITH GRAVEL (SM)
AST-154A	SPT-9	109.5	★			SANDY SILT (ML)

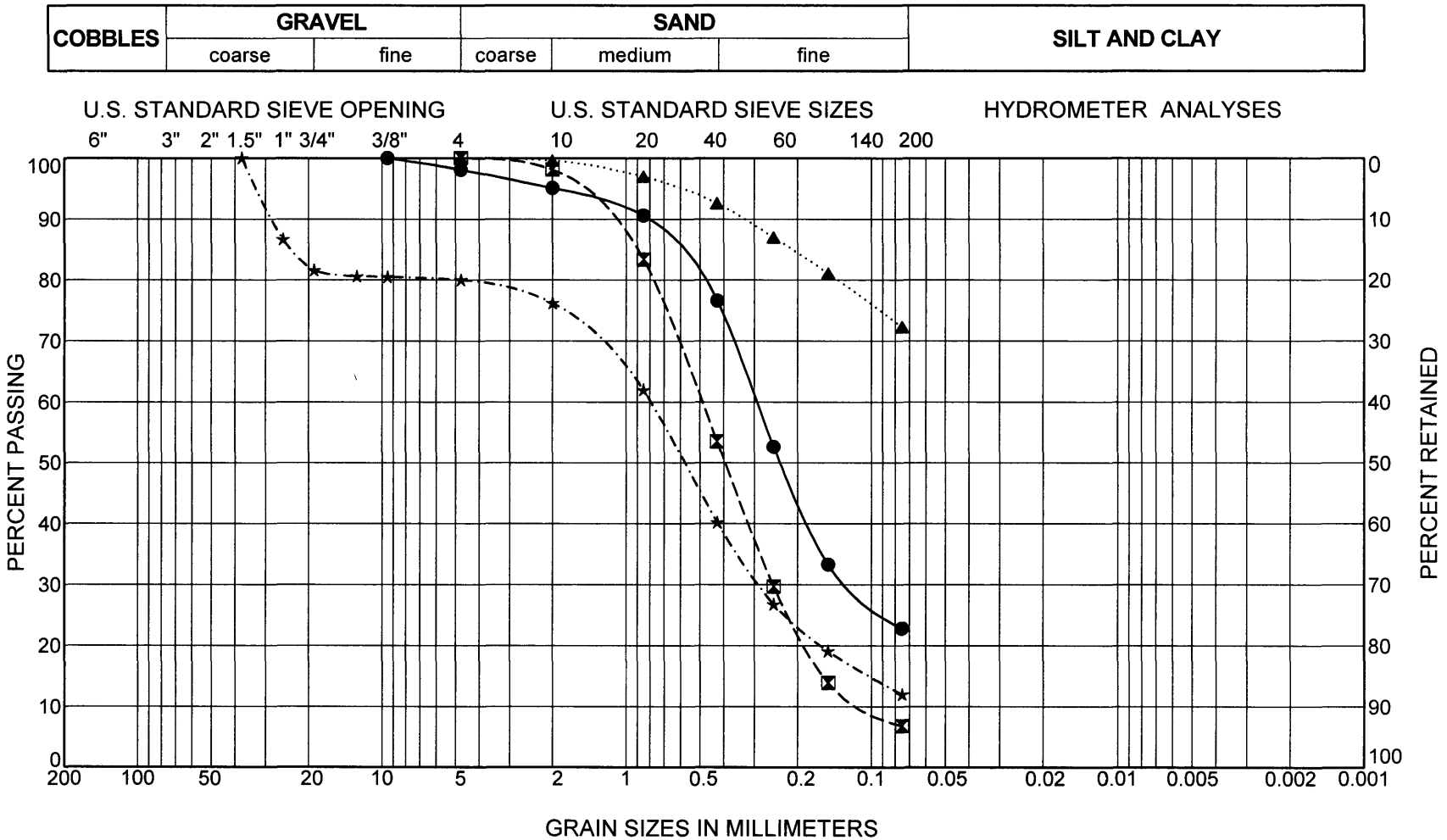
PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

JOB NO: 206117.EBS

eBART MEDIAN RETAINING WALLS
CONTRA COSTA COUNTY, CALIFORNIA

PLATE NO: B-3A

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
AST-155	MC-6	25.0	●			CLAYEY SAND (SC)
AST-155	SPT-14	70.0	⊠			POORLY GRADED SAND WITH SILT (SP-SM)
AST-155A	SPT-7	99.5	▲			SILT WITH SAND (ML)
AST-155A	SPT-9	119.5	★			WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM)

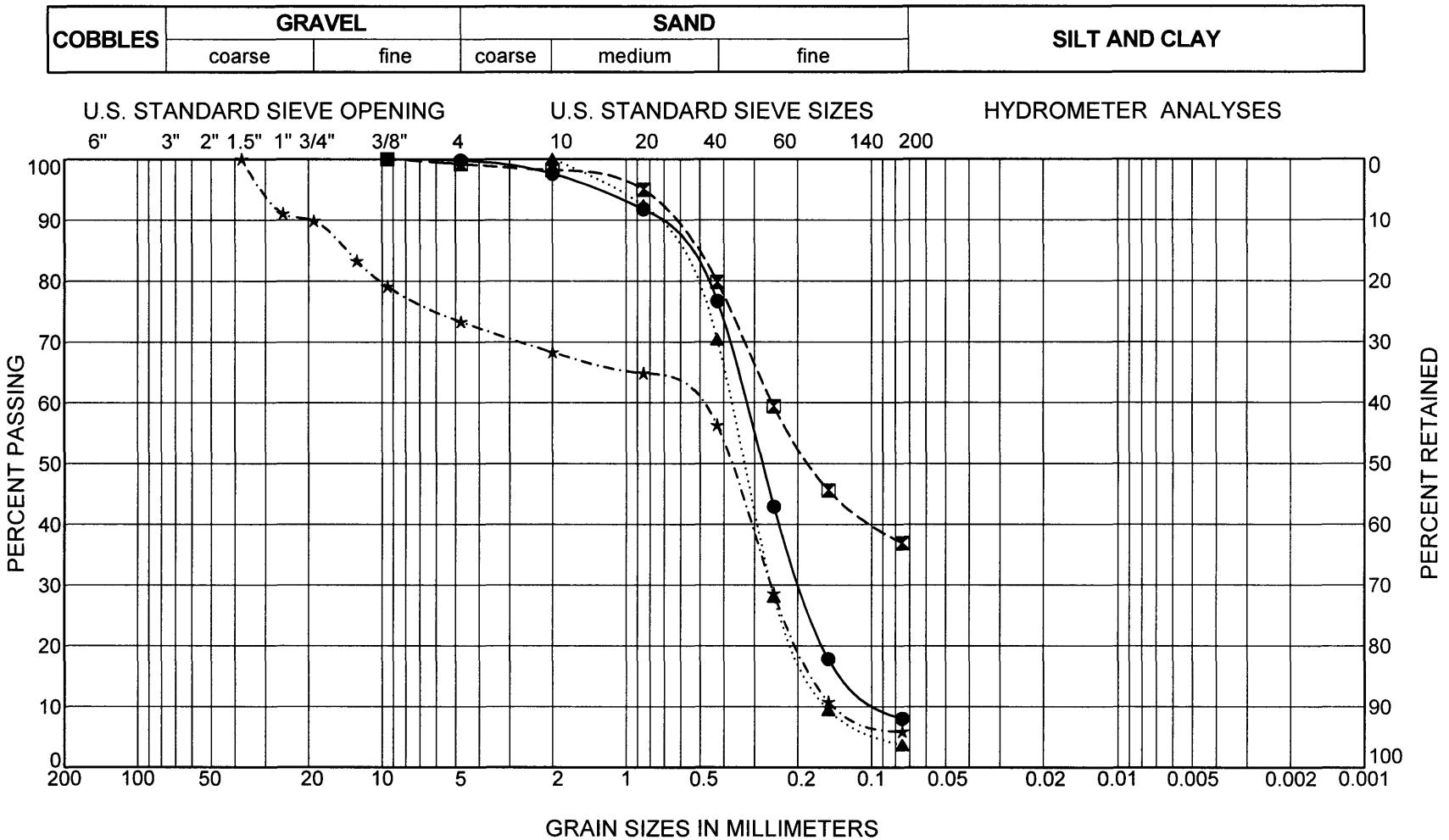
PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

JOB NO: 206117.EBS

eBART MEDIAN RETAINING WALLS
CONTRA COSTA COUNTY, CALIFORNIA

PLATE NO: B-3B

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
CAV-168	MC-8	40.0	●			POORLY GRADED SAND WITH SILT (SP-SM)
CAV-168	MC-10	50.0	⊠			CLAYEY SAND (SC)
CAV-168	MC-11	55.0	▲			POORLY GRADED SAND (SP)
CAV-168	SPT-14	70.0	★			POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)

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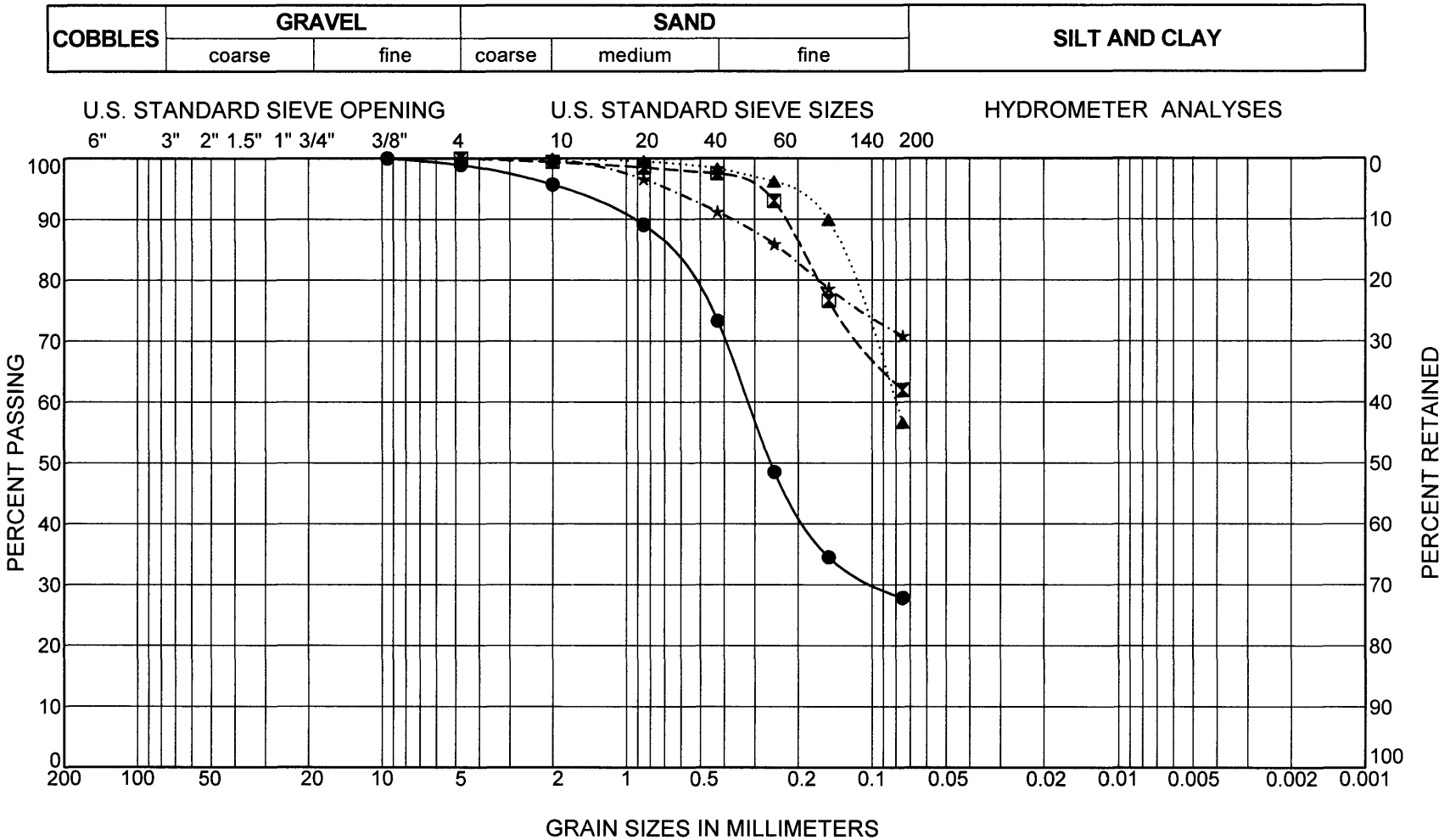
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

eBART MEDIAN RETAINING WALLS
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.EBS

PLATE NO: B-3C

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
CAV-169	MC-5	20.0	●			SILTY SAND (SM)
CAV-169	MC-9	40.0	⊠			SANDY LEAN CLAY (CL)
CAV-169	MC-11	50.0	▲			SANDY SILT (ML)
CAV-169	SPT-12	55.0	★			SILTY CLAY WITH SAND (CL-ML)

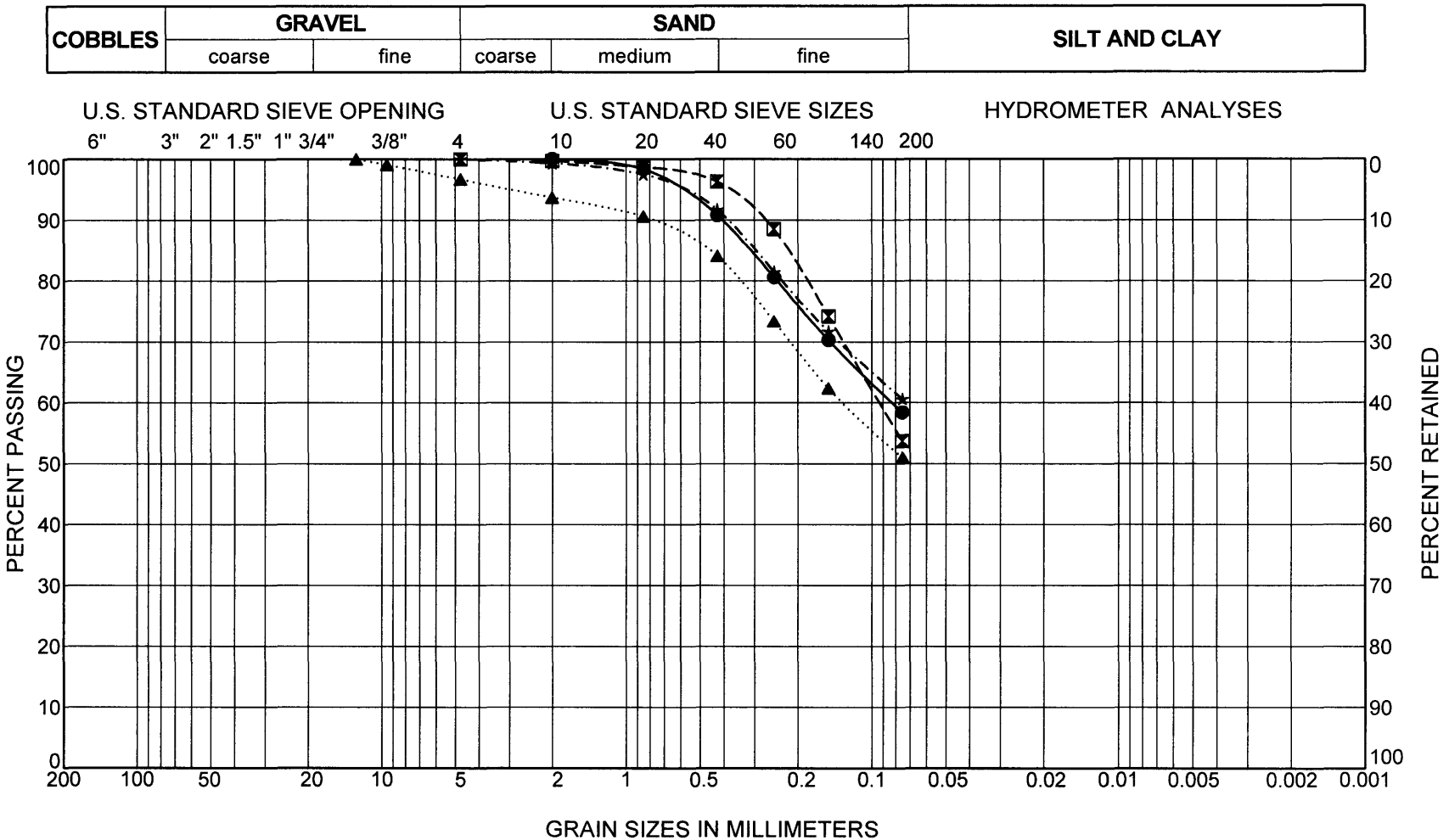
PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

eBART MEDIAN RETAINING WALLS
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.EBS

PLATE NO: B-3D

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
CAV-169	SPT-13	60.0	●			SANDY SILTY CLAY (CL-ML)
EB-1	MC-5	19.5	⊠			SANDY SILT (ML)
EB-3	MC-2	6.0	▲			SANDY LEAN CLAY (CL)
EB-7	MC-6	24.5	★			SANDY LEAN CLAY (CL)

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

JOB NO: 206117.EBS

eBART MEDIAN RETAINING WALLS
CONTRA COSTA COUNTY, CALIFORNIA

PLATE NO: B-3E

Sunland Analytical

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 12/08/2006
Date Submitted 12/04/2006

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.CAV/CAVALO RD Site ID : CAV108 #2 @ 8.5.
Thank you for your business.

* For future reference to this analysis please use SUN # 49464-98601.

EVALUATION FOR SOIL CORROSION

Soil pH	7.61		
Minimum Resistivity	1.45	ohm-cm (x1000)	
Chloride	6.2 ppm	00.00062	%
Sulfate	43.6 ppm	00.00436	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 12/08/2006
Date Submitted 12/04/2006

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.AST/A ST.BDGE Site ID : AST 154 #2 @ 8'.
Thank you for your business.

* For future reference to this analysis please use SUN # 49465-98602.

EVALUATION FOR SOIL CORROSION

Soil pH	7.50		
Minimum Resistivity	0.86	ohm-cm (x1000)	
Chloride	10.9 ppm	00.00109	%
Sulfate	89.1 ppm	00.00891	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

APPENDIX C

Office of Special Funded Projects
Comment & Response Form

General Project Information	Review Phase	Reviewer Information
Dist: _ EA: 228511 Project Name: Route 4 Widenining SEG 3A OSFP Liaison: O. Hor Phone: 916-227-8419 e-mail: overcomer_hor@dot.ca.gov	☐ PSR/PDS (Review No. _) ☐ APS/PSR (Review No. _) ☐ APS/PR (Review No. _) ☐ Type Selection ☒ 65% PS&E Unchecked Details ☐ PS&E (Review No. 1) ☐ Construction Support ☒ Other: Foundation Report **Structure Information** (Use when necessary to document comments by individual structure) Structure Name: e BART North & South Ret. Walls Br No: N/A	Reviewer Name: Ali Kaddoura Functional Unit: 327 Cost Center: 59 Phone Number: 510-286-4676 e-mail: ali_kaddoura@dot.ca.gov Date of Review: 03/09/09

Consultant Information (to be filled in by Consultant)

Consultant Structure Lead (First and Last Name)	Structure Consultant Firm	Phone Number	e-mail	Response Date

#	Doc. (See Note 1)	Page, Section, or SSP	Review Comments	Consultant Responses	✓
1	FR e BART North & South Ret. Walls 65% PS&E		FR Prepared by Parikh Consultants Dated January 2009.		
2		General	There is no geologic map or fault map.		
3		2	"Type C and Type B walls are located adjacent to the two underpasses." From this text, we understand that the two walls will lie in the Highway 4 median, between the A Street Undepass and the Cavallo Road Underpass, which must lie at least a mile apart. A schematic, one-page layout plan/location map should be included and the project description should be		

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved (for Reviewer's use)

			improved so that the reader can understand the scope of the proposed project. The borings used to develop recommendations were drilled on either side of the undercrossings, meaning that half of the borings do not lie within the proposed footprint of the walls and the other half only cover the extreme ends of the planned walls. Are four borings, placed at the ends of the proposed walls, adequate coverage for over 12,000 lineal feet of retaining wall? Justify this. The walls are 4' to 6' high: what is the likelihood that they will be placed entirely in engineered fill? Justify comment.		
44		Page 2	The north wall stations are given for the south wall, and the south wall stations are given for the north wall.		
5		General	A soil profile should be developed for this section, keeping in mind that the Quaternary units are not likely to be highly laterally continuous.		
6		Page 3	The recommendation should specify clearly the footing type recommended and whether or not any kind of foundation treatment is necessary.		
7	FR e BART North & South Ret. Walls 65% PS&E		(C3) Not approved (resubmittal to GS required)		

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved (for Reviewer's use)

Responses to Caltrans Comments on 65% Foundation Report

eBART North and South Retaining Walls

Response ot Comment No. 1

No response required.

Response ot Comment No. 2

A Geologic Map and a Fault Map has been added to the revised report.

Response ot Comment No. 3

A better description of the project will be given in the revised report. The wall locations for Type B and Type C walls will be shown on the LOTB sheets.

As the LOTB sheets indicate, two borings are drilled on either side of the two underpasses (total of eight borings), covering the lengths of the Type B and Type C walls. Type A walls are standard barrier walls, where specific subsurface information is not required.

Available wall elevations indicate that the Type B and Type C walls adjacent to the A Street Underpass will be founded on fill; adjacent to the Cavallo Road Underpass, they will be founded on native soil.

Response ot Comment No. 4

Agreed. The station numbers have been corrected in the revised report.

Response ot Comment No. 5

Soil Profiles have been developed for two segments: one at each underpass location.

Response ot Comment No. 6

Agreed. Revised text indicates that the in-place soils are competent and thus, foundation treatment of any kind is not required.

Response ot Comment No. 7

No response required.

OSFP Review Comment & Response Form

General Project Information	Review Phase		Reviewer Information
Dist: 04 EA: 228511 Project Name: NORTH AND SOUTH RETAINING WALL FOR SEGMENT 3A (eBART) OSFP Liaison: Overcomer Hor Phone: 916-227-8419 e-mail:	☐ PSR/PDS (Review No.) ☐ APS/PSR (Review No.) ☐ APS/PR (Review No.) ☐ Type Selection	☐ 65% PS&E Unchecked Details ☐ PS&E (Review No. 1) ☐ Construction Support ☒ Other: FINAL FR	Reviewer Name: Rifaat Nashed/Ali Kaddoura Functional Unit: GS Phone Number: 510-622-1773 e-mail: Rifaat_Nashed@dot.ca.gov Date of Review: 11/04/09
	Structure Information (Use when necessary to document comments by individual structure) Structure Name: North & South Ret Walls Br No:		

Consultant Information (to be filled in by Consultant)

Consultant Structure Lead (First and Last Name)	Structure Consultant Firm	Phone Number	e-mail	Response Date

#	Doc. (See Note 1)	Page, Section, or SSP	Review Comments	Consultant Responses	
1	North And South Retaining Wall For Segment 3a (eBART)	N/A	The Report doesn't comply with Caltrans Foundation Report guidelines and why is it called **Letter**/Report?	The report format has been revised as a regular report, e.g. changed from the earlier letter report.	
2		Page 2, **Subsurface Investigations**	The report states that" The samples were sealed and transported to our laboratory for further evaluation and testing". Where are the results of the tested samples and why it is not attached to the report?	The laboratory test results have now been attached as Appendix B.	
4		Page 2, **Subsurface Investigations**	Geology section should be added	A separate geology section has now been added.	
5		Page 3, **Site Subsurface Conditions**	The statement: " Groundwater was not encountered in any of the borings drilled", should be corrected to be: Ground water was not encountered in any	Agreed. Text will be revised to indicate that groundwater was encountered in the deeper borings.	

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved (for Reviewer's use)

			of 30 footers borings drilled. This because groundwater was encountered in borings No. AST's and CAV's		
6		Page4, **Conclusions and Recommendations**	4- The Vaca Fault Zone, approximately **5.4 miles** from project site and not 3.4 miles. Should be corrected.	Agreed. Text has been revised.	
7	North And South Retaining Wall For Segment 3a (eBART)		(C3) Not approved (resubmittal to GS required)		
8					

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
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✓= Comment Resolved (for Reviewer's use)

10. Final Geotechnical Design & Materials Report – State Route 4 (East) Widening Project – Segment 3A – Antioch, Contra Costa County, CA

FINAL
GEOTECHNICAL DESIGN & MATERIALS REPORT
STATE ROUTE 4 (EAST) WIDENING PROJECT
SEGMENT 3A
ANTIOCH, CONTRA COSTA COUNTY, CALIFORNIA
04-CC-4-R27.4/R28.7 EA 2285F1

For

T. Y. Lin International
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PARIKH CONSULTANTS, INC.
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(925) 933-6336

May 2011

Job No. 206117.GDR

PARIKH
Practicing in the Geosciences

Geotechnical ■
Environmental ■
Materials Testing ■
Construction Inspection ■

T. Y. Lin International
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Job No.: 206117.GDR
May 6, 2011

Attn: Mr. Keith Rhodes

Sub: GEOTECHNICAL DESIGN & MATERIALS REPORT (FINAL)
State Route 4 (East) Widening Project – Segment 3A
Antioch, Contra Costa County, California
04-CC-4-27.4/R28.7 EA 2285F1

Dear Mr. Rhodes:

Transmitted herewith is the Geotechnical Design & Materials Report for the subject project. The report was prepared in accordance with the scope of work outlined in our proposal. The report is for submittal to Caltrans for their review and approval.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning our findings or conclusions, please feel free to contact this office.

Very truly yours,
PARIKH CONSULTANTS, INC.

Gary Parikh, P.E., G.E., 666
Project Manager

Attachment: Geotechnical Design & Materials Report (Final)

1243 Alpine Road, Suite 110, Walnut Creek, CA 94596 • (925) 933-6336 • (925) 933-6818 • www.PARIKHNET.com
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"Approved as to impact on State facilities and conformance with applicable State standards and practices, and the technical oversight were performed as described in the California Department of Transportation A&E Consultant Services Manual."

Caltrans_____

Title_____

Date_____

Caltrans_____

Title_____

Date_____

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Caltrans Comments dated 11-09-09
Caltrans Comments dared 12-14-09
Caltrans Comments dated 06-01-10

GEOTECHNICAL DESIGN & MATERIALS REPORT
STATE ROUTE 4 (EAST) WIDENING PROJECT – SEGMENT 3A
ANTIOCH, CONTRA COSTA COUNTY, CALIFORNIA
04-CC-4-R27.4/R28.7 EA 2285F1

1. INTRODUCTION

This report presents the results of our geotechnical engineering investigation for the proposed "State Route 4 (East) Widening Project – Segment 3A" in Antioch, California, hereinafter referred to as "PROJECT." The work was performed in general accordance with the scope of work outlined in our proposal to T. Y. Lin International (Designer). The general location of the project site and its vicinity are shown in the Project Location Map, Plate 1.

This report addresses geotechnical design recommendations for embankments, retaining walls, soundwalls, corrosion recommendations for the culvert design, overhead sign structures, and structural pavement sections. Separate foundation investigation reports have been prepared for the three proposed bridge structures within the corridor. The investigation included review of readily available soils and geologic literature pertaining to the site including as-built information and "Log of Test Borings" (LOTB), site reconnaissance, drilling exploratory soil borings, obtaining representative soil samples and logging soil materials encountered in exploratory borings, laboratory testing of the representative soil samples, performing engineering analyses, and preparation of this report.

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 to 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, if any.

The report is intended for use by the project roadway design engineer, construction personnel, bidders and contractors for information and reference purposes only and should not be construed as project specifications.

Due to limitations inherent in geotechnical investigations, it is neither uncommon to encounter unforeseen variations in the subsurface soil conditions during construction nor is it practical to determine all such variations during an acceptable program of drilling and sampling for a project of this scope. Such variations, when encountered, generally require additional engineering services to attain a properly constructed project. We, therefore, recommend that a contingency fund be provided to accommodate any additional charges resulting from technical services that may be required during construction.

2. EXISTING FACILITIES AND PROPOSED IMPROVEMENTS

The proposed "State Route 4 (East) Widening Project, Segment 3A" project is a segment of the State Route 4 (East) widening project between Loveridge Road and State Route 160. The project site is located in Antioch, California along State Route 4 from Sta. 171 + 00 to Sta. 261+39. Currently, State Route 4 is a 4-lane median divided freeway. Within the project limits, State Route 4 is built in cut to approximately Sta. 185+00; on embankment to approximately Sta. 234+00 and in cut beyond Sta.234+00 to the end of this project segment.

Generally, the terrain is relatively flat, sloping gently towards the north. Along the project alignment, the adjacent terrain slopes gently downwards from an elevation of approximately 70 feet at Sta. 171+00 to an elevation of approximately 40 feet at Sta. 220+00. Beyond Sta. 220+00, the terrain rises gently to an approximate elevation of around 60 feet near the end of the project limit.

The following bridge structures exist within the project limits:

A Street Undercrossing (Bridge No. 28-86R/L)
Cavallo Road Undercrossing (Bridge No. 28-88R/L)
Roosevelt Lane Pedestrian Undercrossing (Bridge No. 28C0229)

A Street and Cavallo Road undercrossings consist of two parallel bridges: the left and the right bridges, carrying the westbound and eastbound traffic, respectively along State Route 4. The A Street Undercrossing (Bridge No. 28-86R/L) structures were built in 1975. They are both single span cast- in-place prestressed box girder structures, approximately 157 feet long and 41 feet wide. The abutments at the two ends are founded on 70-ton piles. The Cavallo Road Undercrossing (Bridge No. 28-88R/L) structures are also both single span cast-in-place prestressed box girder structures, built in 1975. They are approximately 117 feet long and 41 feet wide. The abutments at the two ends are founded on spread footings. The Roosevelt Lane PUC (Pedestrian Undercrossing) is a 159-foot reinforced concrete box, 8-ft by 8-ft on the inside, with two 17.5-ft long open tunnels at the two ends. The structure, built in 1971, is a northern continuation of Roosevelt Lane crossing State Route 4. The top of the box is located at depths varying from 3 to 7 feet from the ground surface.

The proposed project consists of improvement of State Route 4 (East) – Segment 3A, which includes: widening of Segment 3A of State Route 4 (East); demolition of the existing undercrossings; construction of a new A Street Undercrossing (Bridge No. 28-0401R/L) and a new Cavallo Road Undercrossing (Bridge Nos. 28-0402R/L) to replace the existing

undercrossings; reconstruction of Roosevelt Avenue PUC; widening of segments of Lone Tree Way and A Street; construction of new pavement for Sunset Drive; construction of retaining walls and soundwalls and the construction of associated on and off ramps.

In summary:

- State Route 4 will be widened from 4 lanes to 8 lanes: from Sta.179+00 to Sta. 240+00. It will also consist of standard median and shoulders. The median widening for future eBART is planned; however, it is not part of this study.

- Lone Tree Way/A Street will be widened from Sta. 15+84 to Sta. 35+18 ("AST" Line)

- Portion of Sunset Drive pavement will be rebuilt and part of East Tregallas Road will be rebuilt.

- New on and off ramps will be constructed for the A Street Interchange for both directions of State Route 4.

- The existing A Street Undercrossing bridges (Bridge No. 28-86R/L) will be demolished and replaced by new bridges.

- The existing Cavallo Road Undercrossing bridges (Bridge No. 28-88R/L) will be demolished and replaced by new bridges

- The existing Roosevelt Lane PUC will be reconstructed (modified). Reconstruction will include extension of the concrete box by 48 feet at the northern end and by 7.5 feet at the southern end to accommodate the widened roadway on top.

The proposed project will generally include the following structures:

Bridge Structures

- A Street Undercrossing (Bridge No. 28-0401R/L)
- Cavallo Road Undercrossing (Bridge No. 28-0402R/L)
- Roosevelt Lane PUC (Bridge No. 28-0403)

Retaining Walls

Retaining Wall No. 1	South side of exit ramp from eastbound SR4 to A Street
Retaining Wall No. 2	North side of entrance ramp to westbound SR4 from A Street
Retaining Wall No. 3	South side of exit ramp from eastbound SR4 to A Street, east of Wall # 1
Retaining Wall No. 4	North side of westbound SR4 travel way and exit ramp to A Street
Retaining Wall No. 5	South side of entrance ramp from A Street to eastbound SR4
Retaining Wall No. 6	South side of entrance ramp from A Street to eastbound SR4, east of Wall # 5
Retaining Wall No. 7	Not Used -deleted
Retaining Wall No. 8	Not Used - deleted
Retaining Wall No. 9	South side of eastbound SR4 travel way, starting from east of Cavallo Road
Retaining Wall No. 10	South side of eastbound SR4 travel way, east of Wall # 9
Retaining Wall No. 11	North side of westbound SR4 travel way, east of Cavallo Road
Retaining Wall No. 12	North side of westbound SR4 travel way, east of Wall # 11
Retaining Wall No. 13	North side of westbound off-ramp
Retaining Wall No. 14	West side of A Street between SR4 westbound on-ramp and Texas Street
Retaining Wall No. 15	East side of Sunset Drive, north of Bryan Avenue
Retaining Wall No. 16	West side of Sunset Drive, north of Bryan Avenue

Overhead Sign Structures

- Seven single post overhead sign structures

Soundwalls

- Seven soundwalls

Project plans indicate the finish grade for the new travel way for State Route 4 will generally be within 1 to 2 feet of the existing travel way. Cuts and fills will be required for widening on either side of the existing travel way. Embankment is required for the westbound off ramp to A Street. Cuts and fills will also be required for the other on and off ramps. Generally, cuts and fills will be retained by retaining walls. When not supported by retaining walls, the proposed side slopes will have a gradient of 2(H): 1(V) or flatter.

Our recommendations presented in this report are based on the above information. Any major deviation should be reported to our office for consideration.

3. PERTINENT REPORTS AND INVESTIGATIONS

We referred to the following available as-built information:

- As-built LOTB (Caltrans, 1969) (Br. Nos. 28-86R/L and 28-88R/L)

- As-Built Plans (Caltrans, 1975) (Br. Nos. 28-86R/L and 28-88R/L)
- As-Built Plans (Caltrans, 1971) (Br. No. C0229)
- As-Built Pavement Sections for State Route 4 and A Street

4. PHYSICAL SETTING

4.1 Climate

The project area is characterized with moderate climatic conditions. This consists of mild winters, warm summers, small daily and seasonal temperature ranges and low to mild humidity. Extremes of temperature range from 92°F to 48°F in July/August and 50°F to 37°F in January. Based on statistics of National Weather Services, average rainfall precipitation is about 13 inches in the Antioch area and is principally during the months of November through March. January usually has the most precipitation accumulation with 2.73 inches average precipitation.

4.2 Topography

The project is located along the base of the north flank of Mount Diablo to the south and Suisun Bay to the north. The topography in the immediate project area is relatively flat, sloping gently towards the north in the direction of Suisun Bay.

4.3 Surface Drainage

There are no significant drainage channels/features crossing the project area.

4.4 Man-Made and Natural Features of Engineering and Construction Significance

Major man-made structures within the project site include the A Street Interchange, the Cavallo Road Undercrossing and the Roosevelt Lane PUC. Other man-made or natural features of engineering and construction significance within the project site include a PG&E tower, and several gas lines, sewer lines and water lines beyond A Street.

4.5 Regional Geology and Seismicity

The project area is located in Contra Costa County at the northeastern flanks of Mount Diablo and south San Joaquin plain. Contra Costa County lies in parts of two geomorphic provinces. The major portion of the county is in the Coast Ranges

province, with a small portion in the eastern end within the Great Valley province, where the project area is located. The Great Valley sequence is depositionally linked to the Coast Range Ophiolite. The Franciscan Complex presumably underlies all of Contra Costa County. It was emplaced below the Coast Range Ophiolite (USGS OFR 94-622). Quaternary deposits in this area form a combination of eolian dune sand and river delta deposits (USGS OFR 97-98).

In the general project area, the geologic unit comprises primarily of alluvial soils deposited during the Pleistocene period. A geologic map of the project site is presented on Plate 3.

Faults in the vicinity of the site with a moderate to high potential for surface rupture include the Vaca Fault Zone, Great Valley Fault, and Greenville Fault. Significant earthquakes, which have occurred in this area, are generally associated with crustal movements along well-defined active fault zones. A Fault Map, showing the site location relative to the major active faults in the vicinity, is presented on Plate 4.

5. EXPLORATION

5.1 Drilling and Sampling

Based on the Geometric Approval Drawings, discussions with the designer, and readily available geotechnical data in the area, a total of seventy-eight borings were drilled for the PROJECT. Majority of the borings were drilled between June 2006 and December 2007.

Twenty borings were drilled to depths of approximately 5 feet to collect bulk samples for the pavement design.

Forty-seven borings were drilled to depths of approximately 30 feet below ground surface and five borings were drilled to depths of approximately 50 feet below ground surface for the design of new retaining walls, soundwalls, ramps, and embankments.

For the bridge structures, four "deep" borings were drilled near the abutments of the two proposed new undercrossings at A Street and Cavallo Road in September 2006. These borings were drilled to the depths of approximately 100 feet below the existing ground surface. Later, in July 2009, two additional borings were drilled adjacent to

the A Street borings to depths of 130 feet, to obtain additional information beyond 100-ft depth.

The approximate locations of these borings are shown on the attached Site Plans (Plates 2A through 2F). The approximate locations of the borings deeper than 5 feet are also on the log of test borings (LOTB) in Appendix A. The as-built LOTB of the existing A Street Undercrossing (Bridge No. 28-86R/L) and Cavallo Road Undercrossing (Bridge No. 28-88R/L) are also included in the report.

Shallow (5-ft deep) borings drilled generally for pavement design were drilled with a jeep-mounted rig, using a 6-in solid stem auger. Most of the other borings were drilled with truck-mounted drill rig using 8-inch-diameter hollow stem auger. A few borings, where the boring locations presented access difficulties, were drilled using a portable drill rig using a 3.5-inch-diameter solid stem auger. The borings were drilled under the technical supervision of our engineer, who classified and continuously logged the soils encountered during drilling and supervised the collection of soil samples at various depths for visual examination and laboratory testing. The soil samples were obtained during drilling by driving generally a 2.5-inch Inside Diameter (I.D.) Modified California sampler. On a few occasions, a 1.4-inch I.D. Standard Penetration Test sampler was used. The sampler was driven into the subsurface soils under the impact of a 140-lb hammer falling through 30 inches. The blow counts required to drive the sampler for the last 12 inches are presented on the LOTB in Appendix A. After visual examination, the collected samples were sealed and transported to our laboratory for further evaluation and testing. The boring locations, stations, and relevant information are summarized in Tables 1A through 1C below. Please note that the locations and the elevations in the tables are approximate based on readily available information and are for reference purposes only.

The descriptions of the soil materials encountered in the exploratory borings and relevant boring information are presented in the LOTB in Appendix A. The laboratory test methods and results are presented in Appendix B. The LOTB in Appendix A were prepared from the field logs which were edited after visual re-examination of the soil samples in the laboratory and results of classification tests on selected soil samples as indicated on the LOTB.

TABLE 1A: SUMMARY OF BORINGS (PAVEMENT DESIGN AND ROADWAY)

Boring No.	Station (ft) (approx.)	Offset (ft) (approx.)	Boring Depth (ft)	Approx. Ground Elev. (ft)	Approx. Groundwater Elev. (ft)	Soil Description
R-40	174+40	45 Rt.	5.0	54.4		Silty Sand
R-41	180+80	0 CL.	5.0	58.7	-	Lean Clay
R-42	185+00	55 Rt.	5.0	63.1	-	Lean Clay
R-43	186+40	75 Lt.	5.0	62.0	-	Lean Clay
R-44	189+60	80 Lt.	5.0	63.0	-	Lean Clay
R-45	192+70	0 C.L.	5.0	68.9	-	Lean Clay
R-45A	192+00	0 C.L.	5.0	68.2	-	Sandy Lean Clay
R-46	195+00	50 Rt.	5.0	69.0	-	Silty Sand
R-47	196+10	200 Rt.	5.0	52.7	-	Lean Clay
R-50	200+70	0 C.L.	5.0	66.8	-	Lean Clay
R-53	205+20	110 Lt.	5.0	51.3	-	Lean Clay
R-54	207+10	80 Rt.	5.0	64.3	-	Silty Sand
R-55	210+50	0 C.L.	5.0	62.6	-	Silty Sand
R-57	223+00	0 C.L.	5.0	58.0	-	Sandy Lean Clay
R-58	228+20	70 Rt.	5.0	54.0	-	Sandy Lean Clay
R-59	233+40	0 C.L.	5.0	53.1	-	Lean Clay
R-60	239+40	65 Rt.	5.0	50.0	-	Sandy Lean Clay
R--61	244+20	20 Lt.	5.0	48.3	-	Sandy Lean Clay
R-62	249+20	90 Lt.	5.0	47.3	-	Sandy Lean Clay
R-63	252+80	45 Lt.	5.0	44.5	-	Sandy Lean Clay

TABLE 1B: SUMMARY OF BORINGS (WALL STRUCTURES AND OTHER CUTS AND FILLS)

Boring No.	Station (ft) (approx.)	Offset (ft) (approx.)	Boring Depth (ft)	Approx. Ground Elev. (ft)	Approx. Groundwater Elev. (ft)
RW/SW-139	"E" Line 172+30	125 Rt.	30.0	68.0	-
SW-140	"E" Line 174+50	145Lt.	30.0	65.5	-
RW/SW-141	"E" Line 175+70	115 Rt.	30.0	70.0	-
SW-142	"E" Line 177+40	150 Rt.	30.0	65.3	-
RW/SW-143	"E" Line 178+60	100 Rt.	30.0	60.0	-
SW-144	"E" Line 181+15	105 Lt.	30.0	63.9	-
SW-145	"E" Line 181+90	110 Rt.	30.0	66.7	-
SW-146	"E" Line 185+00	130 Lt.	30.0	61.7	-
SW-147	"E" Line185+50	110 Rt.	30.0	64.0	-
SW-148	"E" Line 187+60	160 Lt.	30.0	59.6	-
SW-149	"E" Line 188+60	110 Rt.	50.0	64.8	-
RW/SW-185	"E" Line 191+00	95 Rt.	30.0	66.3	-
RW-186	"E" Line 192+20	155 Lt.	30.0	52.0	-
RW-187	"E" Line 192+30	160 Rt.	30.0	63.4	-
SW-188	"E" Line 194+25	140 Lt.	30.0	63.0	-
RW-189	"E" Line 196+40	210 Rt.	30.0	54.0	-
E-191	"E" Line 199+50	130 Rt.	30.0	49.2	-
RW-190	"E" Line 198+10	225 Rt.	30.0	50.0	-
RW-192A	"E" Line 196+70	310 Lt.	30.0	47.8	-
RW-192	"E" Line 198+70	320 Lt.	50.0	45.8	8.8
RW-192B	"E" Line 199+80	610 Lt.	30.0	48.7	-
SW-193	"E" Line 201+10	175 Rt.	30.0	55.9	-
RW-194	"E" Line 203+00	135 Lt.	30.0	48.3	-
SW-195	"E" Line 204+10	150 Rt.	30.0	56.0	-
SW/RW-196	"E" Line 205+20	110 Lt.	30.0	51.2	-
SW-197	"E" Line 207+00	130Rt.	30.0	52.8	-
RW/SW-199	"E" Line 211+00	70 Rt.	30.0	62.0	-
SW-200	"E" Line 212+70	100 Lt.	30.0	44.3	-
SW-201	"E" Line 214+98	120 Rt.	30.0	50.0	-
SW/RW-202	"E" Line 215+50	100 Lt.	30.0	42.4	-
SW-203	"E" Line 217+00	115Rt.	30.0	49.0	-

TABLE 1B (CONTD.): SUMMARY OF BORINGS (WALL STRUCTURES AND OTHER CUTS AND FILLS)

Boring No.	Station (ft) (approx.)	Offset (ft) (approx.)	Boring Depth (ft)	Approx. Ground Elev. (ft)	Approx. Groundwater Elev. (ft)
RW/SW-204	"E" Line 218+50	110Lt.	30.0	39.7	-
RW/SW-170	"E" Line 223+50	110 Rt.	30.0	47.9	-
RW/SW-171A	"E" Line 226+40	90 Rt.	30.0	52.0	-
RW/SW-172	"E" Line 230+60	80 Rt.	30.0	53.8	-
RW/SW-173	"E" Line 233+70	80 Rt.	50.0	52.8	14.8
RW/SW-174	"E" Line 237+10	80 Rt.	30.0	53.0	-
RW/SW-175	"E" Line 241+30	120 Rt.	30.0	56.5	-
SW-176	"E" Line 244+46	120 Rt.	30.0	58.3	-
RW/SW-177	"E" Line 247+30	160 Rt.	30.0	59.0	-
RW/SW-178	"E" Line 250+30	205 Rt.	30.0	60.8	-
RW/SW-179	"E" Line 253+60	300 Rt.	30.0	62.7	-
SW-205	"E" Line 223+10	110 Lt.	50.0	45.2	6.7
SW-206	"E" Line 225+40	110 Lt.	30.0	47.0	-
SW-207	"E" Line 230+20	110 Lt.	30.0	49.2	-
SW-208	"E" Line 232+60	110 Lt.	30.0	51.8	-
RW/SW-209	"E" Line 236+40	110 Lt.	30.0	52.5	-
RW/SW-210	"E" Line 239+00	110 Lt.	30.0	53.3	-
RW/SW-211	"E" Line 242+90	85 Lt.	50.0	55.4	18.4
RW/SW-212	"E" Line 245+60	110 Lt.	30.0	56.3	-
RW/SW-213	"E" Line 248+80	140 Lt.	30.0	56.3	-
RW/SW-214	"E" Line 251+50	160 Lt.	30.0	53.9	-

TABLE 1C: SUMMARY OF BORINGS FOR A STREET AND CAVALLO ROAD UNDERCROSSINGS

Boring No.	Station (ft) (approx.)	Offset (ft) (approx.)	Boring Depth (ft)	Approx. Ground Elev. (ft)	Approx. Groundwater Elev. (ft)
AST-154	"E" Line 196+00	10 Lt.	100	68.6	5.6
AST-154A	"E" Line 196+30	10 Lt.	130	68.6	-11.4
AST-155A	"E" Line 198+50	15 Rt.	130	68.2	8.2*; 28.2**
AST-155	"E" Line 198+80	15 Rt.	100	68.2	11.7
CAV-168	"E" Line 219+40	15 Rt.	90	58.7	5.2
CAV-169	"E" Line 221+70	5 Rt.	100	58.5	4.5

* During drilling ** Prior to grouting

5.2 Geologic Mapping

The project site consists of older alluvial deposits and embankment. The subject was considered and was determined to be not significant for the project.

5.3 Geophysical Studies

The subject was considered and was determined to be not applicable to the project.

5.4 Instrumentation

The subject was considered and was determined to be not applicable to the project.

5.5 Exploration Notes

Roadway fill material consisting of lean clay and sandy lean clay to silty sand and sandy silt was typically encountered in the shallow borings up to 5-ft depth. The other exploratory borings encountered alluvial deposits, predominantly consisting of very stiff to hard lean clay interbedded occasionally with layers of dense to very dense silty sands. Weathered siltstone and sandstone were encountered at around 70-ft depth in the deep borings drilled for the undercrossings.

6. GEOTECHNICAL TESTING

6.1 In-Situ Testing

In-situ testing consisted of recording blow counts during sampling in the field. The soil samples were obtained during drilling by driving a 2.5-inch I.D. Modified California sampler or a 1.4-inch I.D. Standard Penetration Test Sampler into the subsurface soils under the impact of a 140-lb hammer falling through 30 inches. Based on our previous experience, when correlating standard penetration test data in similar soils, the blow counts for the Modified California Sampler can be taken as roughly 1.6 times that for the Standard Penetration Test Sampler in similar soils. The field blow counts (SPT-N values) typically ranged from 10 to more than 50 (practical refusal). From the average SPT-N values for various soil materials encountered in the field exploration, the subsoils are generally stiff to hard for the clay and medium dense to very dense for the sandy soils. Loose sand was not encountered in any of the borings drilled.

6.2 Laboratory Testing

Laboratory tests performed for the study include the following: Laboratory determination of Moisture-Density (California Test Method T226), Atterberg Limits (California Test Method T204), Grain Size Analysis (California Test Method T203), Unconfined Compression Test (California Test Method T221), R-value Test (California Test Method T301), Corrosion Test (California Test Method T 643) and Direct Shear Tests (ASTM Test Method D3080. The laboratory test results are contained in Appendix B.

In general, the average natural moisture content of the soils is on the order of 10% to 30%. Laboratory data of moisture contents, total density, grain size distribution, Atterberg Limits and unconfined compression strengths are presented on the Log of Test Borings.

7. GEOTECHNICAL CONDITIONS

7.1 Site Geology

General geologic features pertaining to the site were evaluated with reference to the "Geologic Map of Quaternary Geology of Contra Costa County and Surrounding Areas, CA: Derived from Digital Database open-file 97-98" by E.J. Helley and R.W. Graymer 1997; Scale 1:100000. Based on the map, the site consists primarily of Pleistocene alluvial deposits (Qpaf). A geologic map of the general project area is shown on Plate 3. Description of the main geologic unit(s) along the project site is as follows:

Qpaf (Alluvial Fans and Fluvial Deposits (Pleistocene)) – *Brown dense gravely and clayey sand or clayey gravel that fines upward to sandy clay. These deposits display various sorting and are located in most stream channels in the county. All Qpaf deposits can be related to modern stream courses. They are distinguished from younger alluvial fans and fluvial deposits by higher topographic position, greater degree of dissection, and stronger soil profile development. They are less permeable than Holocene deposits, and locally contain fresh water mollusks and extinct late Pleistocene vertebrate fossils. They are overlain by Holocene deposits on lower parts of the alluvial plain, and incised by channels that are partly filled with Holocene alluvium on higher parts of the alluvial plain. Maximum thickness is unknown but is estimated to be at least 150 feet (50m).*

The map also indicates the presence of undifferentiated bedrock at the surface, at less than a quarter of a mile south of the project site.

Another map ('Preliminary geologic map emphasizing bedrock formations in Contra Costa County: A digital database', compiled by Graymer, Jones and Brabb (USGS Open File Report 94-622) was also considered for additional information for the bedrock. Bedrock (Tulare Formation) exposed at the surface is noted to the south of the site. The rock has a shallow dip towards the north and is therefore expected to underlie the hard Pleistocene clays at the site. Description of the rock is as follows:

Ttu (Tulare Formation (Pliocene)) – *Poorly consolidated, non-marine, gray to maroon siltstone, sandstone, and conglomerate. This formation contains tuff correlated with the Putah Tuff.*

7.1.1 Lithology

The project site consists of mainly Pleistocene Alluvial Fans and Fluvial Deposits. The Pleistocene deposits predominantly consist of lean hard clays and sandy clays. In the deeper borings drilled for the undercrossings, below elevations ranging from 0 to -10 feet, the soils encountered were very hard/very dense layers, possibly interbedded layers of weathered sandstone or siltstone of the Pliocene Tulare Formation.

7.1.2 Structure

The fault that is closest to the project site is the Vaca Fault Zone, which is a right-lateral strike-slip fault.

7.1.3 Existing Slope Stability

The existing slopes along the corridor appear to be stable. Some shallow slumps related to local and surficial deposits are noted. Most of these slopes will be replaced by new retaining walls.

7.2 Subsurface Soil Conditions

Based on the boring data and as-built LOTBs, the subsurface soil conditions at the project site indicate predominantly hard lean clays and sandy clays with occasional layers of clayey or silty sand, generally dense to very dense, interbedded with the clay

soils. Hard clays were generally encountered within 10 feet of the ground surface – hard clays were encountered at the ground surface in fourteen borings. Other pertinent information includes:

a) The only evidences of potential liquefaction are in a 5-ft thick medium dense sand layer in boring RW/SW-173 at a depth of 43 feet; and a 5-ft layer of very stiff sandy silt in boring AST-154 at a depth of 65 feet.

b) A surficial layer of potentially expansive fat clay was encountered in two borings (SW-144 and SW- 148). A 5-foot thick fat clay layer was encountered in boring RW/SW-149 at a depth of 25 feet. A low (less than 5) R-value was noted in only one sample, out of the fifteen samples tested.
c) Very hard/very dense interbedded layers of sandstone and siltstone were encountered in all the deep borings for the undercrossings at depths of approximately 70 feet below the bridge embankments.

Groundwater was encountered at depths ranging from 53 to 63 feet below ground surface in the six deep borings. Groundwater was also encountered in four of the five 50-ft deep borings. The groundwater elevations at the project site ranged from -11.4 feet to 18.4 feet. Groundwater conditions at the project site are described in Section 7.3.2.

Detailed descriptions of the materials encountered in the exploratory borings are presented in the LOTB in Appendix A. It should be noted that these descriptions and related information depict subsurface conditions only at the locations indicated and on the particular date noted on the LOTB. Because of the variability from place to place within soil/rock in general, subsurface conditions at other locations may differ from conditions occurring at the locations explored. The abrupt stratum changes shown on the logs may be gradational, and relatively minor changes in soil types within a stratum may not be noted due to inherent limitations in the field investigations. Also, the passage of time may result in a change in the soil conditions at the locations due to environmental changes.

7.3 Water

7.3.1 Surface Water

The terrain at the project site gently slopes toward the north, and the surface water/drainage sheet flows toward the north.

7.3.1.1 Scour

The subject was considered and was determined to be not applicable for the roadway project.

7.3.1.2 Erosion

The existing slopes have established landscaping to help control erosion. The subject was considered and was determined to be not applicable for the project. It is recommended that construction of the proposed project be undertaken during the dry season. Erosion control measures should be implemented as appropriate. In particular, winterization would be necessary during interim periods of construction that extend through winter season.

7.3.2 Groundwater

Groundwater was encountered during drilling in all the six deep borings drilled for the undercrossing foundations and in four borings drilled for retaining walls and soundwalls. The boring numbers, station and offset, approximate ground elevations and approximate groundwater elevations are summarized in Table 2. In general, groundwater was encountered between Elev. -11.4 and 18.4 feet during field exploration.

TABLE 2: SUMMARY OF GROUNDWATER ELEVATIONS

Boring No.	Station (ft) (approx.)	Offset (ft) (approx.)	Boring Depth (ft)	Approx. Ground Elev.(ft)	Approx. Groundwater Elev. (ft)
AST-154	"E" Line 196+00	10 Lt.	100	68.6	5.6
AST-154A	"E" Line 196+30	10 Lt.	130	68.6	-11.4
AST-155	"E" Line 198+80	15 Rt.	100	68.2	11.7
AST-155A	"E" Line 198+50	15 Rt.	100	68.2	8.2*; 28.2**
CAV-168	"E" Line 219+40	15 Rt.	90	58.7	5.2
CAV-169	"E" Line 221+70	5 Rt.	100	58.5	4.5
RW-192	"E" Line 198+70	320 Lt.	50.0	45.8	8.8
SW-205	"E" Line 223+10	110 Lt.	50.0	45.2	6.7
RW/SW-173	"E" Line 233+70	80 Rt.	50.0	52.8	14.8
RW/SW-211	"E" Line 242+90	85 Lt.	50.0	55.4	18.4

* During drilling ** Prior to grouting

It is anticipated that groundwater level will vary with the passage of time due to seasonal groundwater fluctuations, surface and subsurface flow, ground surface run-off and other environmental factors.

7.4 Project Site Seismicity

7.4.1 Ground Motions

The project is located in a seismically active part of Northern California. Many faults exist in the area, which are capable of producing earthquakes which may cause strong ground shaking at the site.

Applicable major faults in the vicinity of the project site were identified and their associated maximum earthquake magnitudes were established using the 2007 Caltrans Deterministic PGA Map and the associated 2007 Fault Database. The documents have been finalized by Caltrans and released for use in design in September, 2009. Pertinent information is summarized in the table below. The moment magnitudes noted in the table represent the largest earthquakes that could occur on the given fault based on the current understanding of the regional tectonic structure. A fault map of the project vicinity is shown on Plate 4.

TABLE 3: SEISMIC SOURCES

Fault	Fault No.(1)	Fault Type	Distance from Site (miles)	Maximum Moment Magnitude
Vaca Fault Zone	14	RLSS(2)	3.4	6.9
Great Valley Fault 5	24	Reverse Fault	4.4	6.5
Greenville Fault Zone (Clayton Section)	351	RLSS	4.1	6.6
Concord Fault Zone (Ygnacio Valley Section)	341	RLSS	7.0	6.6

(1) Number of the Fault in the 2007 Fault Database associated with the 2007 Caltrans Deterministic PGA Map
(2) RLSS – Right-lateral Strike Slip Fault

Based on the 2007 Caltrans Deterministic PGA Map and the attenuation relationship by Sadigh et al. (1997), the controlling fault is the Vaca Fault Zone (Fault No. 14 in the map), which is associated with a Maximum Moment Magnitude (Mmax) of 6.9. Peak bedrock acceleration (PBA) of 0.5g is anticipated at the site.

7.4.2 Ground Rupture

Since no active faults pass through the site, the potential for fault rupture is low.

8. GEOTECHNICAL ANALYSES AND DESIGN

8.1 Seismic Analysis

8.1.1 Parameter Selection

The value of PBA for the project site was calculated from the distances to the applicable faults in the project vicinity using the 2007 Caltrans Deterministic PGA Map and the attenuation relation by Sadigh et al. (1997). The computed PBA value was increased by 20%, also per Sadigh (1997), to account for the reverse fault effect, wherever applicable. The PBA computations based on Sadigh attenuation relation are presented in Appendix C. Based on the computations; the maximum PBA computed within the project limit is 0.5g.

Based on the available boring information in the vicinity of the project site, the subsurface soil conditions at the project site generally matches the criteria for Soil Type D, as per Caltrans Seismic Design Criteria (Version 1.4, June 2006). Based on the above information, the seismic design criteria are as follows:

1. Closest Distance to Fault:	3.4 miles (5.5 km)
2. PBA:	0.5g
3. Design ARS Curve:	Caltrans Seismic Design Criteria June 2006 Version 1.4 Figure B.8 (Soil Profile Type D).
4. Design ARS Curve:	Curve based on Caltrans SDC (v. 1.4, 6/2006) for different structural periods. The curve is based on (Governing Fault – Vaca Fault Zone; Mmax =6.9) Figure B.8. The curve was adjusted for near fault effect as required by SDC.

A copy of the ARS Design Curve is included on Plate No. 5.

8.1.2 Analysis

Majority of the proposed cuts and fills are supported by retaining walls. For the minor slopes, the maximum slope heights, relatively flat slopes, the competent subsurface soils and the low groundwater table suggest that the slopes should be stable under seismic loads. Therefore, analyses to assess the stability of the slopes in the project site were not deemed necessary and were not performed.

8.1.3 Liquefaction Potential

Liquefaction is a phenomenon in which saturated soils are subject to a temporary but essentially total loss of shear strength under the reversing, cyclic shear stresses associated with earthquake shaking. Submerged, cohesionless sands and silts of low relative density are the type of soils which usually are susceptible to liquefaction - the susceptibility increases with decreasing relative density (reflected by the number of blows to drive a sampler), and decreasing fines content. Accepted procedures for the assessment for liquefaction potential for cohesionless soils have evolved over

the years through research and field observations (Youd et al, 2001). Recent research and field observations have shown that clays of low plasticity are also potentially liquefiable, based on the moisture content and plasticity characteristics of the clay. Procedures for the assessment of liquefaction potential for clay soils have also been established and have received general acceptance. (Bray et. al., 2004). Based on the analyses, a potential for liquefaction is indicated in a sample of very stiff sandy silt encountered at a depth of 65 feet in a deep boring (boring AST-154) drilled for the A Street Undercrossing foundation. Groundwater in this boring was encountered at a depth of 63 feet. Thus, based on standard practice, it was inferred that since the water table is greater than 50 feet in depth, the potential for liquefaction at this location and its consequent effects may be ignored (per FEMA 356). The analyses also indicate a potentially liquefiable medium dense sand layer at a depth of 43 feet in boring RW/SW-173, based on the blow counts by the drive sampler. Liquefaction potential is not indicated at any other location.

8.2 Cuts and Excavations

Based on the plans, the finish grades for State Route 4 will require significant cuts and excavations for the project:

- Widening of the road on the north side of the westbound travel way from Sta. 179+00 to Sta. 188+30: the maximum cut depths will be about 10 feet and the final cut slope gradients will be 4(H): 1(V) or flatter.

- Widening of the road on the south side of the eastbound travel way from Sta. 179+00 to Sta. 185+60: the maximum cut depths will be about 12 feet and the final cut slope gradients will be 2(H): 1(V) or flatter.

- Widening of the road on both the north side of the westbound travel way and the south side of the eastbound travel way from Sta. 234+00 to Sta. 245+01: the cut depths will be about 12 feet and will be contained by retaining walls.

- Construction of the entrance and exit ramps connecting the eastbound travel way to A Street: the maximum cut depths will be approximately 22 feet at Sta. 896+00 ("AST" Line).

8.2.1 Stability

Cut slopes up to a maximum 22-ft in height and slope gradients of 2(H): 1(V) are indicated on the entrance and exit ramps connecting the eastbound travel way to A Street. The soils in the vicinity, based on the soil borings (RW/SW-189, AST-154) are predominantly very stiff to hard clays. A slope stability analysis performed for the maximum slope height indicated a Factor of Safety of 6.16 (i.e.> 1.5); therefore the stability of the cut slope is judged acceptable. Slope stability calculations are presented in Appendix C.

Where not contained by retaining walls, the maximum heights of the cut slopes are generally estimated to be less than 12 feet and the slope gradients are 2(H): 1(V) or less. The subsurface soil conditions generally consist of very stiff to hard lean clays with occasional pockets/lenses of medium dense to dense sands. Groundwater was not encountered within the depths of interest. Based on the subsurface soil conditions, it appears that the stability of the cut slopes should be acceptable.

8.2.2 Rippability

The proposed cuts are anticipated to be in native soils. Based on the investigation, rippability does not appear to be a concern for construction.

8.2.3 Grading Factor

Material generated from the cuts planned for the project will be used as fill as applicable. Based on previous experience, for preliminary estimate, a grading factor of 0.9 may be assumed. Import material for fill is not presently anticipated.

8.3 Embankments

8.3.1 Evaluation of Embankment Settlements

The finish grades for the State Route 4 travel way are generally about 1 to 2 feet higher than the existing grades for the travel way. Embankment fill will also be required in some locations for widening of State Route 4 and for the construction of new on and off ramps. The approximate maximum fill

thicknesses at the approach embankments and ramps and for the widening are summarized in Table 4 below.

TABLE 4 SUMMARY OF PROPOSED CONSTRUCTION AND MAXIMUM FILL THICKNESS

Proposed Construction	Approx. Max Fill Thickness (ft)	Relevant Boring(s)
Exit Ramp from westbound SR4 to A Street	15	E-191, RW-194, RW/SW-196
Widening north of westbound SR4 from Sta. 188+30 to Sta. 196+20 (west of A Street)	20	RW-186, SW-188
Widening north of westbound SR4 from Sta. 198+80 to Sta. 219+55 (east of A Street, west of Cavallo Road)	23	E-191, RW-194, RW/SW-196
Widening north of westbound SR4 from Sta. 221+46 to Sta. 234+06(east of Cavallo Road)	19	SW-205, SW-206, SW-207, SW-208
Widening south of eastbound SR4 from Sta. 206+80 to Sta. 219+55(east of Cavallo Road)	8	SW-197, RW/SW-199, SW-201, SW-203

Subsurface Soil Conditions

The boring data indicates that the subsurface soil conditions underneath the proposed fill embankments within the project limits generally consists of very stiff to hard clays with pockets/lenses/layers of medium dense to dense sands. Groundwater was encountered at least 35 feet below ground surface.

Evaluations

Based on the subsurface conditions and the relatively deep groundwater table (at least 35 feet below ground surface), a potential total settlement of less than 1 inch is estimated for a maximum height of embankment of 23 feet. A major portion of the settlement should occur from compression of soils above the water table. The settlement is therefore expected to be relatively rapid. Based on this, greater than half of the total settlement is expected to occur by the end of construction period.

Waiting Periods

Based on our previous Caltrans project experience, the standard "30-day waiting period" is considered adequate. The waiting period allows for the settlement and adjustment of the fill and serves as a contingency for the estimated consolidation settlement within the over-consolidated range.

Differential Settlement

Differential settlements are not expected to be significant for the proposed roadway improvements.

8.3.2 Evaluation of Embankment Stability

New embankment fill will be required at the locations as described in Section 8.3.1 above. The maximum height of embankment at locations where retaining walls are not present will be on the order of 20 feet. The gradient of the slope is between 2(H): 1(V) to 4(H): 1(V) or flatter. The underlying soils are stiff to hard clays and medium dense to dense sands. Groundwater was encountered at more than 35 feet below ground surface. A minimum factor of safety of 1.5 for static and 1.1 for pseudo-static condition is required. It was judged that under the above conditions, potential for slope instability was minimal.

A slope stability analysis was performed for an embankment height of 20 feet on the north side of westbound SR4 at Sta. 196+00. The soils at the location, based on the soil borings (SW-188, AST-154) are predominantly very stiff clays and dense sands. The slope stability analysis performed for the maximum slope height indicated a Factor of Safety of 2.62 (i.e.> 1.5); therefore the stability of the cut slope is judged acceptable. Slope stability calculations are presented in Appendix C.

8.4 Earth Retaining Systems

It is our understanding that due to right-of-way and other geometric constraints, the project will require construction of fourteen retaining walls. Information of approximate wall locations, type of walls, design loading cases, and maximum wall heights was provided by the designer and is summarized in Table 5. Relevant recommendations for most of these walls were also included in the previously submitted "Type Selection" report. Some changes have been made since that submittal.

TABLE 5: SUMMARY OF PROPOSED RETAINING WALLS

Wall No.	Wall Type	Location (Along approx. Sta.)	Wall Height (ft)	Total Length (ft)	Relevant Borings
1	1SWB	"AST-3" Line 886+48 to 888+99	8	251	SW-147, RW/SW-149
2	1SWB	"AST-4" Line 986+78 to 992+84	6 - 12	606	RW/SW-148, RW-186
3	1SW	"AST-3" Line 890+15 to 895+08	6 - 20	704	RW/SW-185, RW-187, RW-189
	7SW	"AST-3" Line 895+08 to 896+59	16 - 22		RW-187, RW-189
	1SWP (24-in. CIDH)	"AST-3" Line 896+59 to "AST" Line 23+77	16 - 22		RW-189
4	1SWB, 5SWB, 1SWBP (24-in. CIDH)	"AST-1" Line 500+33 to "ECL" Line 49+78	6 - 22	1947	E-191, RW-194, RW/SW-196, SW-200, RW/SW-202, RW/SW-204
5	1SW, 7SW	"AST" Line 22+50 to "AST-2" 701+36	6 - 18	493	RW-190, SW-193
6	1SWB	"AST-2" Line 701+36 to 709+34	8 - 16	797	SW-193, SW-195, SW-197
7	Not Used				
8	Not Used				
9	1SWB	"ECR" Line 81+25 to 82+85 "ECR" Line 84+35 to 86+02	10 - 14	669	CAV-169, RW/SW-170, RW/SW-171A
	1SWBP (36-in. CIDH)	"ECR" Line 82+855 to 84+35	14		RW?SW-170
	5SWB	"ECR" Line 86+02 to 88+04	6 - 8		RW-SW-171A
10	7SWB. 7SWBP (24-in. CIDH)	"ECR" Line 92+60 to "HCT-6" Line 349+65	8 - 18	1695	RW/SW-173, 174, 175, 176, 177
11	1 SWB	"ECL" Line 54+98 to 55+14	6 - 10	865	RW-206
	5SWBP (36-in. CIDH)	"ECL" Line 55+14 to56+41	14		RW-206
	5	"ECL" Line 56+41 to 63+59	6 - 12		RW-206, RW-207, RW-208
12	7 (incl. 7 on piles 24-in. CIDH piles and & 7(mod.) for 14-ft high walls)	"ECL" Line 63+59 to "E" Line 244+73	10 - 14	1120	RW-208, RW-209, RW-210, RW/SW-211, RW/SW-212
13	1SW	"AST-1" Line 498+99 to "AST-1" Line 500+33	8 - 10	31	E-191
			6 - 10	107	
14	7SW	"AST-4" Line 996+54 to "AST" Line 30+75	8	29	RW-192A
	7 (incl. 7 on piles 24-in. CIDH piles)		6 - 8	193	
15	7	"S" Line 402+52 to 403+93	8 - 12	154	RW-192B
16	7	"S" Line 401+62 to 403+85	4 - 12	183	RW-192B

Retaining Wall No. 1 (AST-3 Line: Sta. 886+48 to Sta. 888+99)

Retaining Wall No. 1 is a fill wall, approximately 251 feet long, located on the south side of the eastbound off-ramp from Route 4 to Lone Tree Way/A Street. The wall, as planned, will have a constant height of 8 feet, with a concrete barrier (Type 736A) and a soundwall (Soundwall # 5) on top of the wall for the entire alignment. The wall will be on a 2:1 slope on the downhill side. A minimum horizontal distance of 8 feet is recommended between the bottom of the footing at the toe of the wall and the face of the slope. Based on the relevant borings, soil conditions in this section indicate the surficial soils to be very stiff clays underlain by a layer of medium dense sandy soil. Type 1SWB wall on spread footing is reasonable, since the required ultimate bearing capacity (5.5 ksf) per Caltrans Bridge Standard Detail Sheets for an 8-ft high wall with a soundwall on top is less than the recommended ultimate bearing pressure of 12.5 ksf.

Retaining Wall No. 2 (AST-4 Line: Sta. 986+78 to Sta. 992+84)

Retaining Wall No. 2 is a fill wall, approximately 606 feet long, located on the north side of the westbound on-ramp from A Street to Route 4. The wall heights, as planned, range from 6 to 12 feet along the alignment, with a concrete barrier (Type 736A) and a soundwall (Soundwall # 3) on top of the wall for the entire alignment. Based on the relevant borings, the soil conditions in this section indicate the surficial soils to be very stiff clays underlain by hard clays within a depth of 10 feet below ground surface. Type 1SWB wall on spread footing is reasonable, since the required ultimate bearing capacity (6.6 ksf) per Caltrans Bridge Standard Detail Sheets for a 12-ft high wall with a soundwall on top is less than the recommended ultimate bearing pressure of 12.5 ksf.

Retaining Wall No. 3 (AST-3 Line: Sta. 890+15 to AST Line: Sta. 23+77)

Retaining Wall No. 3 is a cut wall, approximately 704 feet long, located on the south side of the eastbound off-ramp from Lone Tree Way/A Street to Route 4. The wall heights range from 6 to 22 feet along the alignment, with a soundwall (Soundwall # 5A) on top of the retaining wall. Based on the relevant soil borings, soil conditions in this section indicate the soils to be predominantly silty sands or hard clays at the foundation levels.

Three wall types will be used along the wall alignment:

(a) Between Sta. 890+15 and 895+08, wall heights range from 6 to 20 feet. A Type 1SW wall on spread footing is reasonable, since the required ultimate bearing capacity (10.6 ksf) per Caltrans Bridge Standard Detail

Sheets for a 20-ft high wall with a soundwall on top is less than the recommended ultimate bearing pressure of 12.5 ksf.

(b) Wall heights range from 16 to 22 feet between Sta. 895+08 and 896+59. A Type 7SW is recommended. The change in the wall type is necessitated by the plans for installation of a new PG&E transmission pole and relocation of an existing PG&E transmission tower behind the wall at close proximity to the wall alignment. A Type 7SW wall, instead of a Type 1SW wall will involve less excavation behind the wall, thereby minimizing disturbance to the foundations for the two PG&E structures. A Type 7SW wall on spread footing is reasonable, since the required ultimate bearing capacity (6.0 ksf) per Caltrans Bridge Standard Detail Sheets for a 22-ft high wall with a soundwall on top is less than the recommended ultimate bearing pressure of 12.5 ksf. Excavation for the retaining wall in the vicinity of the PG&E towers should be carefully planned to avoid adversely affecting the foundations for the structures. This may involve designing appropriate shoring for the excavation incorporating loads from the PG&E structures.

(c) Three gas lines (24-in., 34-in. and 8-in.) cross the retaining wall alignment approximately near the eastern end. To avoid loading on the gas lines, it is proposed that a portion of the retaining wall over the gas lines (from Sta. 23+16 to Sta. 23+77 – "AST" Line) be a Type 1SWP wall, founded on 24-in diameter CIDH piles, instead of the spread footings to span over the line. The required pile penetrations were computed based on the design load and other pertinent information provided by the designer. The SHAFT computer program was used in the computations; the results are presented in Appendix C. A Pile Data Table is presented below.

PILE DATA TABLE – Retaining Wall No. 3

Location	Pile Type	Design Load (tons)	Nominal Resistance (kips)		Finish Grade (ft)	Cut-off Elev. (ft)	Design Tip Elev. (ft)(1)	Specified Tip Elev. (ft)
			Comp.	Tens.				
Sta. 23+16 to Sta. 23+77 ("AST" Line)	24-in. CIDH	70	280	80	47.5	44.00	25.5 (a) 31.0 (b) 26.0 (c)	25.5

Notes:
1. Design Tip Elevation is controlled by the following demands: (a) Compression; (b) Tension; (c) Lateral.

Computations were also performed for lateral load analyses for the loads provided by the designer, using the LPILE program. A free head condition and a group factor of 0.6 (reflective of a 3D center-to-center spacing) were used in the analyses. Plots of deflection and moment are presented in Appendix C. Results of the analyses are summarized in the table below.

Ground Surface Elevation (ft)	Cut-off Elevation (ft)	Shear Load on top of Pile (kips)	Deflection on Top of Pile (inches)	Maximum Bending Moment	
				Magnitude (kip-ft)	At depth (ft)(1)
47.5	44.00	42	0.122	114.65	5.0
		52	0.162	140.76	5.0
		62	0.206	167.08	5.5

(1) Depth measured from top of pile (bottom of footing)

Caltrans standard specifications and standard special provisions (SSP) for "Cast-in-Place Concrete Piling" should be used for the construction of CIDH piles. Hard drilling through dense sand and hard clay is anticipated.

Retaining Wall No. 4 ("AST-1" Line: Sta. 500+33 to "ECL" Line: Sta. 49+78)

Retaining Wall No. 4 is a fill wall, approximately 1947 feet long, located on the north side of the westbound off-ramp from State Route 4 to Lone Tree Way/A Street and continuing on to north side of westbound State Route 4. The wall heights range from 6 to 22 with a concrete barrier (Type 736A) and a soundwall (Soundwall # 7) on top of the wall for the entire alignment. The relevant soil borings all indicate the soils to be hard clays at the surface or within a maximum of 8 feet depth. Type 1SWB wall on spread footing is reasonable for most of the alignment since the required ultimate bearing capacity (11.3 ksf) per Caltrans Bridge Standard Detail Sheets for a 22-ft high wall with a soundwall on top is less than the recommended ultimate bearing pressure of 15 ksf.

A Type 5SWB wall is proposed in a 15.6-ft length of the wall, where the alignment crosses over the Roosevelt Lane PUC.

It should also be noted that a 30-in. sewer line crosses the retaining wall alignment approximately near Sta. 44+18 ("ECL" Line). To avoid loading on this sewer line, it is proposed that a portion of the retaining wall over the sewer line (from Sta.43+96 to Sta. 44+33 – "ECL" Line) be founded on 24-in diameter CIDH piles, instead of the spread footings to span over the line. The required pile penetrations were computed based on the design load and other pertinent information provided by the designer. The SHAFT computer program was used in the computations; the results are presented in Appendix C. A Pile Data Table is presented below.

PILE DATA TABLE – Retaining Wall No. 4

Location	Pile Type	Design Load (tons)	Nominal Resistance (kips)		Finish Grade (ft)	Cut-off Elev. (ft)	Design Tip Elev. (ft)(1)	Specified Tip Elev. (ft)
			Comp.	Tension				
Sta. 43+96 to Sta. 44+33 ("ECL" Line)	24-in. CIDH	80	320	60	48.5	43.75	20.0 (a) 32.0 (b) 21.0 (c)	20.0

Notes:
1. Design Tip Elevation is controlled by the following demands: (a) Compression; (b) Tension, (c) Lateral

Computations were also performed for lateral load analyses for the loads provided by the designer, using the LPILE program. A free head condition and a group factor of 0.6 (reflective of a 3D center-to-center spacing) were used in the analyses. Plots of deflection and moment are presented in Appendix C. Results of the analyses are summarized in the table below.

Ground Surface Elevation (ft)	Cut-off Elevation (ft)	Shear Load on top of Pile (kips)	Deflection on Top of Pile (inches)	Maximum Bending Moment	
				Magnitude (kip-ft)	At depth (ft)(1)
48.5	43.75	66.4	0.487	246.12	7.0
		76.4	0.625	306.10	7.5
		86.4	0.772	368.20	7.5

(1) Depth measured from top of pile (bottom of footing)

Caltrans standard specifications and standard special provisions (SSP) for "Cast-in-Place Concrete Piling" should be used for the construction of CIDH piles. Hard drilling through dense sand and hard clay is anticipated.

Retaining Wall No. 5 ("AST Line": Sta. 22+50 to "AST2 Line":Sta. 701+36)
Retaining Wall No. 5 is a cut wall, approximately 493 feet long, located on the east side of Lone Tree way and continuing into the south side of the eastbound on-ramp from Lone Tree Way/A Street to Route 4. The wall heights range from 6 to 18 feet along the alignment with a soundwall (Soundwall # 6) on top of the wall for the entire alignment. Based on the relevant soil borings, at the foundation levels the soil conditions in this section indicate hard sandy silts and hard clays at the western end and stiff to very stiff clays at the eastern end. Type 1SW wall on spread footing is reasonable, since the required ultimate bearing capacity (9.0 ksf) per Caltrans Bridge Standard Detail Sheets for an 18-ft high wall with a soundwall on top is less than the recommended ultimate bearing pressure of 10 ksf. A small portion of the wall at the eastern end (Sta. 700+79 to 701+36) is planned as a wall type 7SW, to minimize the disturbances of the existing PG&E transmission tower foundation due to excavation for the retaining wall. A Type 7SW wall on spread footing is reasonable, since the required ultimate bearing capacity for an 18-ft high wall is 5.5 ksf and therefore less than the recommended ultimate bearing pressure of 10 ksf. Excavation for the retaining wall in the vicinity of the PG&E tower should be carefully planned to avoid adversely affecting the tower foundation. This may involve designing appropriate shoring for the excavation incorporating loads from the PG&E tower.

Retaining Wall No. 6 (AST-2 Line: Sta. 701+36 to Sta. 709+34).
Retaining Wall No. 6 is a fill wall, approximately 797 feet long, located on the located on the south side of the eastbound on-ramp from Route 4 from Lone Tree Way/A Street, immediately east of Wall No. 5. The wall heights range from 8 to 16 feet along the alignment, with a concrete barrier (Type 736A) and a soundwall (Soundwall # 6A) on top of the wall for the entire alignment. Based on the relevant soil borings, the soil conditions for the major portion of the alignment indicate the soils to be hard clays within a depth of 4 to 5 feet below ground surface. A Type 1SWB wall on spread footing is reasonable, since the required ultimate bearing capacity (9.0 ksf) per Caltrans Bridge Standard Detail Sheets for a 16-ft high wall with a soundwall on top is less than the recommended ultimate bearing pressure of 15 ksf.

Retaining Wall No. 9 (ECR Line: Sta. 81+25 to Sta. 88+04)
Retaining Wall No. 9 is a fill wall, approximately 669 feet long, located on the south side of the eastbound State Route 4 travel way starting east of the Cavallo Road Undercrossing. The retaining wall heights range from 6 to 14 feet, with a concrete barrier (Type 736A) and a soundwall (Soundwall # 6A) on top of the wall for the entire alignment. The wall will be on a 2:1 slope or flatter on the downhill side. A

minimum horizontal distance of 3 feet is recommended between the bottom of the footing at the toe of the wall and the face of the slope. Based on the relevant soil borings, soil conditions in this section indicate the surficial soils to be hard clays.

Three wall types will be used along the wall alignment:

(a) A Type 1SWB is proposed between Sta. 81+25 and 82+85; and between Sta. 84+35 and 86+02 (wall heights in these sections range from 10 to 14 feet). A Type 1SWB wall on spread footing is reasonable, since the required ultimate bearing capacity (7.6 ksf) per Caltrans Bridge Standard Detail Sheets for a 14-ft high wall with a soundwall on top is less than the recommended ultimate bearing pressure of 15 ksf.

(b) Two gas lines and a water line cross the retaining wall alignment between Sta. 82+85 and 84+35. To avoid loading on these lines, it is proposed that the retaining wall between these stations be founded on 36-in diameter CIDH piles, instead of the spread footings to span over these lines. The required pile penetrations were computed based on the design load and other pertinent information provided by the designer. The SHAFT computer program was used in the computations; the results are presented in Appendix C. A Pile Data Table is presented below.

PILE DATA TABLE – Retaining Wall No. 9

Location	Pile Type	Design Load (tons)	Nominal Resistance (kips)		Finish Grade (ft)	Cut-off Elev. (ft)	Design Tip Elev. (ft)(1)	Specified Tip Elev. (ft)
			Comp.	Tens.				
Sta. 82+85 to Sta. 84+35	36-in. CIDH	150	600	0 kips	47.0	43.25	18.0 (a) 19.0 (c)	18.0

Notes:
1. Design Tip Elevation is controlled by the following demands: (a) Compression; (c) Lateral

Computations were also performed for lateral load analyses for the loads provided by the designer, using the LPILE program. A free head condition and a group factor of 0.6 (reflective of a 3D center-to-center spacing) were used in the analyses. Plots of deflection and moment are presented in Appendix C. Results of the analyses are summarized in the table below.

Ground Surface Elevation (ft)	Cut-off Elevation (ft)	Shear Load on top of Pile (kips)	Deflection on Top of Pile (inches)	Maximum Bending Moment	
				Magnitude (kip-ft)	At depth (ft)(1)
47.0	43.25	76.9	0.064	217.4	6.0
		86.9	0.084	260.2	6.0
		96.9	0.108	303.7	6.5
(1) Depth measured from top of pile (bottom of footing)					

Caltrans standard specifications and standard special provisions (SSP) for "Cast-in-Place Concrete Piling" should be used for the construction of CIDH piles. Hard drilling through hard clay is anticipated.

(c) Between Sta. 86+02 and Sta. 87+04, the wall alignment is very close to the right-of-way (ROW) line. Wall heights range from 6 to 8 feet. A Type 5SWB wall is proposed to avoid interference with the ROW line. A Type 5SWB wall on spread footing is reasonable, since the required ultimate bearing capacity (7.8 ksf) per Caltrans Bridge Standard Detail Sheets for an 8-ft high wall with a soundwall on top is less than the recommended ultimate bearing pressure of 15 ksf.

Retaining Wall No. 10 (ECR Line: Sta. 92+44 to HCT-6" Line 349+65)

Retaining Wall No. 10 is a cut wall, approximately 1695 feet long, located on the south side of the eastbound Route 4 travel way, east of Wall No. 9, continuing on to the south side of the eastbound off-ramp to Hillcrest Avenue. East Tregellas Road runs adjacent to the wall on the south side. The wall heights range from 8 to 18 feet along the alignment with a concrete barrier (Type 26) and a soundwall (Soundwall # 6B) on top of the wall for the entire alignment. Based on the relevant soil borings, the soil conditions in this section indicate the soils to be hard clays at the foundation levels. There are some limitations to the use of a Type 1SWB wall, due to the proximity of the right-of-way (ROW) line. A Type 7SWB wall on spread footing is therefore considered reasonable, since the required ultimate bearing capacity (5.25 ksf) per Caltrans Bridge Standard Detail Sheets for an 18-ft high wall with a soundwall on top is less than the recommended ultimate bearing pressure of 15 ksf.

A 5-ft thick potentially liquefiable medium dense sand layer was encountered in boring RW/SW-173 near the western end of the wall at a depth of over 40 feet below ground surface (over 30 feet below bottom of footing). Post liquefaction settlements are expected to be less than 1 inch. The potentially liquefiable layer is too deep to have any adverse effect on the retaining wall.

A 34-in. sewer line crosses the retaining wall alignment approximately 515 feet from the eastern end. To avoid loading on this sewer line, it is proposed that a portion of the retaining wall over the sewer line (between Sta. 238+40 and 238+78 ("E" Line)) be founded on 24-in diameter CIDH piles, instead of the spread footings to span over the line. The required pile penetrations were computed based on the design load and other pertinent information provided by the designer. The SHAFT computer program was used in the computations; the results are presented in Appendix C. A Pile Data Table is presented below.

PILE DATA TABLE – Retaining Wall No. 10

Location	Pile Type	Design Load (tons)	Nominal Resistance (kips)		Finish Grade (ft)	Cut-off Elev. (ft)	Design Tip Elev. (ft)(1)	Specified Tip Elev. (ft)
			Comp.	Tension				
Sta. 238+40 to Sta. 238+78 ("E" Line)	24-in. CIDH	70	280	80	45.5	41.25	16.0 (a) 24.5 (b) 16.0 (c)	16.0

Notes:
1. Design Tip Elevation is controlled by the following demands: (a) Compression; (b) Tension; (c) Lateral.

Computations were also performed for lateral load analyses for the loads provided by the designer, using the LPILE program. A free head condition and a group factor of 0.6 (reflective of a 3D center-to-center spacing) were used in the analyses. Plots of deflection and moment are presented in Appendix C. Results of the analyses are summarized in the table below.

Ground Surface Elevation (ft)	Cut-off Elevation (ft)	Shear Load on top of Pile (kips)	Deflection on Top of Pile (inches)	Maximum Bending Moment	
				Magnitude (kip-ft)	At depth(ft)(1)
45.5	41.25	65.1	0.493	219.4	7.0
		75.1	0.695	277.0	7.5
		85.1	0.922	334.3	8.0

(1) Depth measured from top of pile (bottom of footing)

Caltrans standard specifications and standard special provisions (SSP) for "Cast-in-Place Concrete Piling" should be used for the construction of CIDH piles. Hard drilling through hard clay is anticipated.

Retaining Wall No. 11 (ECL Line: Sta. 54+98 to Sta. 63+59)

Retaining Wall No. 11 is a fill wall, approximately 865 feet long, located on the north side of the westbound Route 4 travel way. The wall heights range from 6 to 14 feet. A 24-in gas line in a 30-in casing and a 34-in gas line in 42-in casing cross the

retaining wall alignment between approximately Sta. 55+50 and Sta. 56+30. After crossing the wall alignment, the 34-in. gas line runs parallel to the wall alignment on the north side, going eastward. Based on the relevant soil borings, the soil conditions in this section indicate the surficial soils to be hard clays at the foundation levels for the entire length of the alignment. Three wall types will be used along the wall alignment:

(a) Between Sta. 54+98 and 55+14, a concrete barrier (Type 736A) and a soundwall (Soundwall # 7) is proposed on top of the wall. A Type 1SWB wall on spread footing is reasonable, since the required ultimate bearing capacity (6.5 ksf) per Caltrans Bridge Standard Detail Sheets for a 10-ft high wall with a soundwall on top is less than the recommended ultimate bearing pressure of 15 ksf.

(b) Between Sta. 55+14 and Sta. 56+41, as in the previous section, a concrete barrier (Type 736A) and a soundwall (Soundwall # 7) are proposed on top of the wall. However, the two gas lines cross the alignment in this section. To avoid loading on these gas lines, it is proposed that a portion of the retaining wall on over these lines be founded on 36-in diameter CIDH piles, instead of the spread footings to span over the line.

The required pile penetrations were computed based on the design load and other pertinent information provided by the designer. The SHAFT computer program was used in the computations; the results are presented in Appendix C. A Pile Data Table is presented below.

PILE DATA TABLE – Retaining Wall No. 11

Location	Pile Type	Design Load (tons)	Nominal Resistance (kips)		Finish Grade (ft)	Cut-off Elev. (ft)	Design Tip Elev. (ft)(1)	Specified Tip Elev. (ft)
			Comp.	Tension				
Sta. 55+14 toSta. 56+41	36-in. CIDH	210	840	0	47.0	43.25	18.0 (a) 20.5 (c)	18.0
Notes: Design Tip Elevation is controlled by the following demands: (a) Compression; (c) Lateral								

Computations were also performed for lateral load analyses for the loads provided by the designer, using the LPILE program. A free head

condition and a group factor of 0.6 (reflective of a 3D center-to-center spacing) were used in the analyses. Plots of deflection and moment are presented in Appendix C. Results of the analyses are summarized in the table below.

Ground Surface Elevation (ft)	Cut-off Elevation (ft)	Shear Load on top of Pile (kips)	Deflection on Top of Pile (inches)	Maximum Bending Moment	
				Magnitude (kip-ft)	At depth (ft)(1)
47.0	43.25	73.1	0.063	215.5	6.0
		83.1	0.085	260.0	6.0
		93.1	0.108	305.3	6.6
(1) Depth measured from top of pile (bottom of footing)					

Caltrans standard specifications and standard special provisions (SSP) for "Cast-in-Place Concrete Piling" should be used for the construction of CIDH piles. Hard drilling through very hard clay is anticipated.

(c) Between Sta. 56+41 and Sta. 63+59, a concrete barrier (Type 736A) on top of the wall (e.g. there is no sound wall) is proposed. The maximum wall height in this section is 12 feet. A Type 5 wall is proposed, since, the 34-in. gas line near the toe of the wall, will interfere with the spread footing if a Type 1 wall is used. The Type 5 wall on a spread footing is reasonable, since the required toe pressure for Loading Case I (3.6 ksf) per Caltrans Standard Plans for a 12-ft high wall is less than the recommended allowable bearing pressure of 5 ksf (ultimate bearing pressure of 15 ksf).

Retaining Wall No. 12 (ECL Line: Sta. 63+59 to E Line Sta. 244+73)

Retaining Wall No. 12 is a cut wall, approximately 1120 feet long, located on the north side of the westbound Route 4 travel way, immediately east of Wall No. 11. The wall heights range from 10 to 14 feet along the alignment. Soil conditions in this section indicate the soils to be predominantly very stiff clays to hard clays at the foundation levels. An allowable toe pressure of 4.2 ksf (ultimate bearing pressure of 12.5 ksf) is recommended. There are some limitations to the use of a Type 1 wall, due to the continuation of the 34-in. gas line on the north side of Wall No. 12; therefore a Type 7 wall was selected. Type 7 walls are limited to a height of 12 feet in the Caltrans Bridge Standard Detail Sheets. A Type 7 wall on spread footing is therefore reasonable, since up to a 12-foot height, the required allowable bearing pressure (2 ksf) per Caltrans Bridge Standard Detail Sheets is less than the recommended allowable bearing pressure of 4.2 ksf. Special design was required for

14-foot high walls (e.g. Type 7 (Modified)). Per computations provided by the Designer, the toe pressure for a 14-ft high wall, as designed, was 1.44 ksf. A wall on spread footing is therefore also reasonable for a 14-ft high wall, since the toe pressure is less than the allowable bearing pressure of 4.2 ksf.

It should be noted that a 34-in. sewer line crosses the retaining wall alignment approximately near Sta. 237+98 ("E" Line). To avoid loading on this sewer line, it is proposed that a portion of the retaining wall over the sewer line (from Sta.237+86 to Sta. 238+13 – "E" Line) be founded on 24-in diameter CIDH piles. The required pile penetrations were computed based on the design load and other pertinent information provided by the designer. The SHAFT computer program was used in the computations; the results are presented in Appendix C. A Pile Data Table is presented below.

PILE DATA TABLE – Retaining Wall No. 12

Location	Pile Type	Design Load (tons)	Nominal Resistance (kips)		Finish Grade (ft)	Cut-off Elev. (ft)	Design Tip Elev. (ft)(1)	Specified Tip Elev. (ft)
			Comp.	Tension				
Sta. 237+86 to Sta. 238+13	24-in. CIDH	45	180	60	45.0	42.00	20.0 (a) 26.0 (b) 18.0 (c)	18.0

Notes:
1. Design Tip Elevation is controlled by the following demands: (a) Compression; (b) Tension; (c) Lateral

Computations were also performed for lateral load analyses for the loads provided by the designer, using the LPILE program. A free head condition and a group factor of 0.7 (reflective of a 3.5D center-to-center spacing) were used in the analyses. Plots of deflection and moment are presented in Appendix C. Results of the analyses are summarized in the table below.

Ground Surface Elevation (ft)	Cut-off Elevation (ft)	Shear Load on top of Pile (kips)	Deflection on Top of Pile (inches)	Maximum Bending Moment	
				Magnitude (kip-ft)	At depth (ft)(1)
45.0	42.00	44.7	0.250	146.21	6.0
		54.7	0.387	197.08	7.0
		64.7	0.549	250.65	7.5

(1) Depth measured from top of pile (bottom of footing)

Caltrans standard specifications and standard special provisions (SSP) for "Cast-in-Place Concrete Piling" should be used for the construction of CIDH piles.

Retaining Wall No. 13 (AST-1 Line: Sta. 498+99 Sta. 500+33)

Retaining Wall No. 13 is a cut wall, approximately 138 feet long, located on the north side of westbound off-ramp. The wall heights range from 6 to 10 feet along the alignment. Based on the relevant soil boring (Boring E-191), soil conditions in this section indicate the soils to be predominantly hard clays at the proposed foundation levels. Two types of wall will be used along the alignment:

(a) For the initial 31 feet of the wall from the western end, the wall heights range from 8 to 10 feet along the alignment. There is no soundwall on top of the retaining wall. Nevertheless, the wall was designed as a Type 1SW wall, similar to the longer segment of the wall to the east. A Type 1SW wall on spread footing is reasonable, since the required ultimate bearing capacity (6.5 ksf) per Caltrans Bridge Standard Detail Sheets for a 10-ft high wall is less than the recommended ultimate bearing pressure of 15 ksf.

(b) For the rest of the wall the wall heights range from 6 to 10 feet along the alignment. A soundwall (Soundwall # 7) is proposed on top of the wall in this segment. A Type 1SW wall on spread footing is reasonable, since the required ultimate bearing capacity (6.5 ksf) per Caltrans Standard Plans for a 10-ft high wall with a soundwall on top is less than the recommended ultimate bearing pressure of 15 ksf.

Retaining Wall No. 14 (AST- 4 Line: Sta. 996+54 to AST Line Sta. 30+75)

Retaining Wall No. 14 is a cut wall, approximately 222 feet long, located on the west side of A Street between SR4 westbound on-ramp and Texas Street. The wall heights range from 6 to 8 feet along the alignment. Based on the relevant soil boring (Boring RW-192A), soil conditions in this section indicate the soils to be predominantly very stiff clays at the foundation levels. There are some limitations to the use of a Type 1 wall, due to the proximity of the right-of-way (ROW) line. Two types of wall will be used along the alignment:

(a) A soundwall (Soundwall No. 4) is proposed on top of the wall for the initial 29 feet at the western end of the wall. A Type 7SW wall is proposed. A Type 7SW wall on spread footing is reasonable, since the required ultimate bearing capacity (3.75 ksf) per Caltrans Bridge Standard Detail Sheets for an 8-ft high wall with a soundwall on top is less than the recommended ultimate bearing pressure of 12.5 ksf.

(b) A Type 7 wall is proposed for the rest of the wall. A Type 7 wall on spread footing is reasonable, since up to a 12-foot high wall, the required allowable bearing pressure (2 ksf) per Caltrans Bridge Standard Detail Sheets is less than the recommended allowable bearing pressure of 4.2 ksf (ultimate bearing pressure of 12.5 ksf).

It should be noted that a 6-in. sewer line, a 10-in. water line and an 18-in. water line cross the retaining wall alignment between Sta. 28+24 and Sta. 30+74 ("AST" Line). To avoid loading on these lines, it is proposed that a portion of the retaining wall over the utility lines (from Sta. 28+24 to Sta. 30+74 – "AST" Line) be founded on 24-in diameter CIDH piles. The required pile depths were computed based on the design load and other pertinent information provided by the designer. The SHAFT computer program was used in the computations; the results are presented in Appendix C. A Pile Data Table is presented below.

PILE DATA TABLE – Retaining Wall No. 14

Location	Pile Type	Design Load (tons)	Nominal Resistance (kips)		Finish Grade (ft)	Cut-off Elev. (ft)	Design Tip Elev. (ft)(1)	Specified Tip Elev. (ft)
			Comp.	Tension				
Sta. 28+24 to Sta. 30+74 ("AST" Line)	24-in. CIDH	45	180	60	45.0	38.00	23.0 (a) 27.0 (b) 19.0 (c)	19.0

Notes:
1. Design Tip Elevation is controlled by the following demands: (a) Compression; (b) Tension; (c) Lateral

Computations were also performed for lateral load analyses for the loads provided by the designer, using the LPILE program. A free head condition and a group factor of 0.7 (reflective of a 3.5D center-to-center spacing) were used in the analyses. Plots of deflection and moment are presented in Appendix C. Results of the analyses are summarized in the table below.

Ground Surface Elevation (ft)	Cut-off Elevation (ft)	Shear Load on top of Pile (kips)	Deflection on Top of Pile (inches)	Maximum Bending Moment	
				Magnitude (kip-ft)	At depth (ft)(1)
45.0	38.00	45.0	0.107	106.70	4.5
		55.0	0.166	142.65	5.0
		65.0	0.239	189.89	5.5

(1) Depth measured from top of pile (bottom of footing)

Caltrans standard specifications and standard special provisions (SSP) for "Cast-in-Place Concrete Piling" should be used for the construction of CIDH piles.

Retaining Wall No. 15 (S Line: Sta. 402+52 to Sta. 403+93)
Retaining Wall No. 15 is a cut wall, approximately 154 feet long, located on the east side Sunset Drive, north of Bryan Avenue. The wall heights range from 8 to 12 feet along the alignment. Based on the relevant soil boring (Boring RW-192B), soil conditions in this section indicate the soils to be predominantly very stiff to hard sandy silt the foundation levels. There are some limitations to the use of a Type 1 wall, due to the proximity of the right-of-way (ROW) line. A Type 7 wall on spread footing is therefore reasonable, since up to a 12-foot high wall, the required allowable bearing pressure (2 ksf) per Caltrans Bridge Standard Detail Sheets is less than the recommended allowable bearing pressure of 4.2 ksf (ultimate bearing pressure of 12.5 ksf).

Retaining Wall No. 16 (S Line: Sta. 401+62 to Sta. 403+85)
Retaining Wall No. 16 is a cut wall, approximately 183 feet long, located on the west side of Sunset Drive, north of Bryan Avenue. The wall heights range from 4 to 12 feet along the alignment. Based on the relevant boring, soil conditions in this section indicate the soils to be predominantly very stiff to hard sandy silt at the foundation levels. There are some limitations to the use of a Type 1 wall, due to the proximity of the right-of-way (ROW) line. A Type 7 wall on spread footing is therefore reasonable, since up to a 12-foot high wall, the required allowable bearing pressure (2 ksf) per Caltrans Bridge Standard Detail Sheets is less than the recommended allowable bearing pressure of 4.2 ksf (ultimate bearing pressure of 12.5 ksf).

8.5 Culverts

The drainage plans provided by the designer indicates several new Alternative Pipe Culverts (APC) with diameters ranging from 18 to 24 inches. It is our understanding that small diameter culverts (24 inches and under) can be designed and constructed using Standard Plans and Specifications, and no specific geotechnical investigation is required per Caltrans guidelines.

8.5.1 Corrosion Investigation

The corrosion investigation for this project was performed in general accordance with the provisions of California Test Method 643.

Representative native soil samples at the anticipated pipe subgrade were obtained for corrosion tests. A summary of the corrosion test results is presented in Table 6. Based on the results obtained, corrosion analyses were carried out using Caltrans CULVERT 4 program. The analysis results and design for culverts are presented in Table 7.

TABLE 6: SUMMARY OF CORROSION TEST RESULTS

Boring No.	Station (approx.)	Offset From "E" Line (ft) (approx.)	Corrosion Tests					
			Sample No.	Depth (ft)	pH	Resistivity (ohm-cm)	Chloride (ppm)	Sulfate (ppm)
RW/SW-139	172+30	125 Rt.	2	6.0	7.71	1470	42.1	27.7
SW-140	174+50	145 Lt.	5	19.5	8.87	430	248.9	244.5
RW/SW-143	178+60	100Rt.	4	16	7.67	1.23	27.8	24.9
SW-148	187+60	160 Lt.	4	14	7.48	0.88	205.2	90.6
RW/SW-149	188+60	110 Rt.	7	28.5	7.95	1.47	18.4	12.7
RW-186	192+20	155 Lt.	2	4.5	7.86	0.80	78.8	221
RW-187	192+30	105 Rt.	2	4.5	7.38	0.56	80.9	276.2
AST-154	196+00	10 Rt.	2	8	7.50	0.86	10.9	89.1
RW-189	196+40	210 Rt.	3	8.5	7.66	0.62	157.5	218.1
RW-193	201+10	175 Rt.	3	8.5	7.40	0.83	53.1	214.1
RW-194	203+00	115 Rt.	5	18.5	7.79	1.45	35.4	22.8
RW-197	207+00	130 Rt.	2	4.5	7.12	0.24	607.7	240.2
SW-200	212+70	100 Lt	4	13.5	7.39	2.12	28.2	51.9
RW-201	214+00	120 Rt.	2	4.5	7.55	0.54	81.2	522.6
RW-204	218+50	110 Lt.	3	8.5	7.84	0.59	195.8	216.4
CAV-168	219+40	15 Rt.	2	8.5	7.61	1.45	6.2	43.6
RW-205	223+10	110 Lt.	1	1.5	6.99	0.75	238.9	136.2
SW-170	223+50	110 Rt.	1	2.0	6.93	3.75	9.7	18.0
SW-206	225+40	110 Lt.	2	4.5	7.37	0.32	462.1	298.0
SW-207	230+20	110.3Lt.	3	8.5	7.70	1.13	10.9	44.4
RW/SW-172	230+50	80 Rt.	3	9.5	7.73	2.06	12.1	30.1
RW/SW-173	233+70	80 Rt.	5	18.5	7.94	2.06	16.2	5.1
RW/SW-209	236+40	110 Lt.	3	8.5	7.66	0.56	160.2	200.8
RW/SW-175	241+30	115 Rt.	1	2.0	7.81	2.57	9.4	12.2
RW-211	242+90	120 Lt.	2	4.5	7.83	0.99	20.8	113.8
RW-212	245+60	130 Lt.	3	8.5	7.8	9.6	35.7	90.4
SW-177	247+30	165 Rt.	4	15.0	7.96	1.66	9.7	14.4
RW-214	251+50	155 Lt.	3	8.5	7.60	0.91	33.3	136.4

TABLE 7: RECOMMENDED MINIMUM THICKNESS AND PROTECTIVE MEASURES FOR CULVERTS

										Alternative Design (also see note below)		
						Corrugated Steel (Gal.) (gage)			Reinforced Concrete	Corrugated Aluminum (gage)	Corrugated Aluminized Steel (Type 2, gage)	Steel Pipe (Gal., mm)
				Est. Service Life (yr.)		25	50	50		50	50	50
Boring No.	**Station**	**Offset**	**Depth(ft)**	**Resistivity (ohm-cm)**	**pH**	**Gal. (2oz./sq. ft.)**		Bit. Coat (Soil Sides)				**Galv.+polymer (90° Invert)**
SW-134	167+00	85 Rt	4.5	1050	7.6	18	12	18	See note (2)	No	No	18
RW/SW-136	169+50	165 Lt	9.5	800	7.6	16	12	16	See note (2**)	No	No	18
GST-138	170+25	125 Lt	4.0	430	7.6	14	8	14	See note (2**)	No	No	18
RW/SW-139	172+50	120 Rt	11.0	1470	7.7	18	12	18	See note (2)	No	No	18
SW-140	174+50	130 Lt	9.5	430	7.7	14	10	14	See note (2**)	No	No	18
RW/SW-143	178+60	100 Rt.	16	1230	7.67	16	12	18	See note (2)	No	No	18
SW-148	187+60	160 Lt.	14	880	7.48	16	10	16	See note (2**)	No	No	18
RW/SW-149	188+60	110 Rt.	28.5	1470	7.95	18	12	18	See note (2)	No	No	18
RW-186	192+20	155 Lt.	4.5	800	7.86	16	12	16	See note (2**)	No	No	18
RW-187	192+30	105 Rt.	4.5	560	7.38	16	10	16	See note (2**)	No	No	18
AST-154	196+00	10 Rt.	8	860	7.50	16	12	16	See note (2**)	No	No	18
RW-189	196+40	210 Rt.	8.5	620	7.66	16	10	16	See note (2**)	No	No	18
RW-193	201+10	175 Rt.	8.5	830	7.40	16	12	16	See note (2**)	No	No	18
RW-194	203+00	115 Rt.	18.5	1450	7.79	18	12	18	See note (2)	No	No	18
RW-197	207+00	130 Rt.	4.5	240	7.12	10	N/A	10	See note (2***)	No	No	18
SW-200	212+70	100 Lt	13.5	2120	7.39	18	14	18	See note (2)	16	16	18
RW-201	214+00	120 Rt.	4.5	540	7.55	16	10	16	See note (2**)	No	No	18

TABLE 7: RECOMMENDED MINIMUM THICKNESS AND PROTECTIVE MEASURES FOR CULVERTS (contd.)

Approximate Location				Culvert Type		Corrugated Steel (Gal.) (gage)			Reinforced Concrete	Alternative Design (also see note below) Corrugated Aluminum (gage)	Corrugated Aluminized Steel (Type 2, gage)	Steel Pipe (Gal., mm)
				Est. Service Life		25	50	50		50	50	50
Boring No.	Station	Offset	Depth (ft)	Resistivity (ohm-cm)	pH	Gal. (2oz./sq. ft.)		Bit. Coat (Soil Sides)				Galv.+polymer (90° Invert)
RW-204	218+50	110 Lt.	8.5	590	7.84	16	10	16	See note (2**)	No	No	18
CAV-168	219+40	15 Rt.	8.5	1450	7.61	18	12	18	See note (2)	No	No	18
RW-205	223+10	110 Lt.	1.5	750	6.99	12	8	12	See note (2*)	No	No	18
SW-170	223+50	110 Rt.	2.0	3750	6.93	16	12	16	See note (2*)	No	No	18
SW-206	225+40	110 Lt.	4.5	320	7.37	14	10	14	See note (2**)	No	No	18
SW-207	230+20	110 Lt.	8.5	1130	7.70	18	12	18	See note (2)	No	No	18
RW/SW-172	230+55	80 Rt.	9.5	2060	7.73	18	14	18	See note (2)	16	16	18
RW/SW-173	233+70	80 Rt.	18.5	2060	7.94	18	14	18	See note (2)	16	16	18
RW/SW-209	236+40	110 Lt.	8.5	560	7.66	16	10	16	See note (2)	No	No	18
RW/SW-175	241+30	115 Rt.	2.0	2570	7.81	18	14	18	See note (2)	16	16	18
RW-211	242+90	120 Lt.	4.5	990	7.83	16	12	16	See note (2**)	No	No	18
RW-212	245+60	130 Lt.	8.5	960	7.8	16	12	16	See note (2**)	No	No	18
SW-177	247+30	165 Rt.	15.0	1660	7.96	18	12	18	See note (2)	No	No	18
RW-214	251+50	155 Lt.	8.5	910	7.60	16	12	16	See note (2**)	No	No	18

Note (1): Thermoplastic pipe can be used as an alternative and should not have any corrosion concerns. However, the types of thermoplastic pipe that can be used will depend on the height of fill, available sizes and manufacturer's specifications.

Note (2): Standard reinforced concrete pipe design is suitable with Type IP (MS) modified cement or Type II Modified cement, minimum required by Caltrans Std. Specs 90-1.01 (* - Maximum water/cement ratio = 0.45; ** - Sulfate Resistant Concrete and RCP; *** - Sulfate and Chloride Resistant Cement and RCP).

Note (3): The result of analysis from Program "Culvert 4" is presented in Appendix C.

Corrosion test results indicate that the soils at the site are generally corrosive. In addition, a significant number of samples indicate high sulfate contents. Based on CULVERT 4 analysis (see Table 7) using corrosion information from the borings, the following recommendations may be made:

- Reinforced Concrete Pipe: For all locations, sulfate resistant Type IP (MS) modified cement or Type II Modified cement, minimum required as per Caltrans Bridge Design Specifications (Section 8.22) is recommended. Additionally, between Sta. 221+00 and Sta. 227+00, the maximum water/cement ratio should be 0.45.

- Corrugated Aluminum or Corrugated Aluminized Steel Pipe: Not recommended at any location.

- Corrugated Steel Pipe (galvanized 57g):
  - Sta. 164+00 to Sta. 177+00:
    14 gage ---- 25-yr design life
    8 gage ---- 50-yr design life
  - Sta. 204+00 to Sta. 212+00:
    10 gage ---- 25-yr design life
    N/A ---- 50-yr design life
  - Sta. 221+00 to Sta. 227+00:
    12 gage ---- 25-yr design life
    8 gage ---- 50-yr design life
  - For all other locations:
    16 gage ---- 25-yr design life
    10 gage ---- 50-yr design life

- Corrugated Steel Pipe (bitumen coated – soil sides):
  - Sta. 164+00 to Sta. 177+00:
    14 gage ---- 50-yr design life
  - Sta. 204+00 to Sta. 212+00:
    10 gage ---- 50-yr design life
  - Sta. 221+00 to Sta. 227+00:
    12 gage ---- 50-yr design life
  - For all other locations:
    16 gage ---- 50-yr design life

- Steel Pipe (galvanized + polymer 90 deg. Invert)
  - For all locations:
    18 gage ---- 50-yr design life

- Thermoplastic Pipe may be used at all locations (for 50-yr design life). Considerations should be given to damage due to abrasion, height of fill, available pipe sizes and manufacturer's recommendations.

8.5.2 Bore-and-Jack Culvert

Based on the Drainage Plans provided by the designer, there are four bore-and-jack culverts crossing State Route 4 within the limits of the project alignment. The approximate locations, sizes and culvert types are tabulated below.

No.	Type	Size	Length	From Sta.	To Sta.
1	RCP	18-in.	96 ft	100.0 Rt. "E" 179+06	0.5 Rt. "E" 179+06
2	RCP	18-in.	17.5 ft.	0.5' Rt. "E" 179+06	19 Lt. "E" 179+06
3	RCP	18-in.	95 ft.	28' Rt ECL 49+30 "ECR" 219+25	70' Rt."ECR" 79+23
4	RCP	18-in.	69.5 ft.	0.0 Lt. "E" 241+72	73' Lt. "E" 241+72

Minimum Soil Cover

The required overburden depends on the construction equipment and procedures, the contractor's experience and geotechnical conditions at the pipe/jacking locations. In general, as a standard practice, a minimum overburden of 2 times the diameter of the RCP is recommended below the subgrade throughout the length of the RCP during the construction of the bore-and-jack culvert. Additional overburden may be required by the Contractor, depending upon the type and method of operation/equipment. Also, in the event an overburden of less than two times the diameter is available for some segments of the pipe(s), we strongly recommend that a specialty contractor be consulted to assess if the lower overburden is tenable.

Lateral Design

It is anticipated that the shoring system such as sheet piles will be used for the proposed jacking and receiving pits. Lateral earth pressures for internally braced sheet pile system are presented on "Lateral Pressure Diagram for Shoring Design", Plate 6. Additional lateral load resulting from adjacent street traffic and construction operation should be included for design. The lateral load may be assumed at 40% of the total surcharge load.

Shoring design may require the sheet piles to be relatively deep. An equivalent fluid density 375 pcf may be used in calculating passive resistance below the base of excavation. A minimum factor of safety of 1.5 is recommended. The contractor shall provide their own design-build system for the shoring work. It is the contractor's responsibility to select the type of shoring system and design the performance of the system. The pressure exerted by the reaction block on the surrounding soil should not exceed a horizontal bearing capacity of 2500 psf. The reaction block should be properly designed to distribute the jacking thrust to the jacking pit shoring system.

Construction Dewatering

Groundwater was not encountered in the nearest borings for the Culvert Nos. 1 and 2 (Boring RW/SW-143) or for Culvert No. 3 (Boring SW-203) within the drilled depth of 30 feet. For Culvert No. 4, groundwater was encountered at a depth of 35 feet in the nearest boring (Boring RW/SW-211). However, groundwater levels may change with the passage of time. Therefore, the contractor should satisfy themselves with the prevailing conditions and obtain additional information if needed to design dewatering method, if required. Developing and implementing an effective dewatering program should be the contractor's responsibility. The dewatering system should prevent pumping soil fines with the discharge water. If soil fines are pumped, failure of shoring, partial instability of excavation bottom resulting in intolerable settlement of existing structure/utilities, and unsafe working conditions may occur.

Working Platform

If groundwater is present in close proximity of the subgrade, equipment and personnel may lose mobility in the soil. If mobility and support become difficult, it may be necessary to stabilize the subgrade soil. Stabilization can be accomplished by constructing a working platform, which may consist of minimum 12 inches of ¾-inch crushed rock wrapped around by a layer of high strength geofabric (such as subgrade enhancement geotextile). The contractor may choose to use other measures such as placing timber material or other construction techniques.

Grading

It is anticipated that earthwork will consist of excavating and backfilling the pits. The areas between the bottom of the excavation and 12 inches (minimum) above the pipeline should be backfilled with suitable bedding material (minimum 90% relative compaction per the project specification). Above the bedding material and up to 2 feet (minimum) below the pavement subgrade, native material at a minimum 90% relative compaction may be used for the backfill. This backfill should be placed and compacted at or above the optimum moisture content to reduce settlement resulting from potential hydro-compaction in the future. Select backfill should be used within 2 feet (minimum) below the pavement subgrade. The select backfill should be relatively non-expansive granular material having a plasticity index less than 15 and a minimum R-Value of 15 and should be compacted to a minimum 95% relative compaction per the project specifications. Pavement restoration should be in accordance with the Caltrans standards or restored to match the adjacent existing pavement section.

8.6 Minor Structure Foundations

8.6.1 Soundwall

Based on the "Retaining Wall Plan" and "Soundwall Plan" provided by T. Y. Lin International, seven soundwalls are planned. The locations and other details are presented below.

TABLE 8: SUMMARY OF PROPOSED SOUNDWALLS

Wall No.	Location	Total Length (ft)	Length (ft)	Height (ft)	Relevant Soil Borings	Remarks
1[1]	Begin: "E" Line 179+00, 146.5 Lt (offset) End: "AST-4" Line 987+58 53.2 Lt. (offset)	853.5	300	8	SW-144 SW-146 SW-148	On 16-in CIDH pile
			553.5	10		
2[2]	Begin: "E" Line 179+00, 128.8 Rt. (offset) End: "E" Line 186+80 133.6 Rt.(offset)	778.6	70.8	8	RW/SW-143 SW-145 SW-147	On 16-in CIDH pile
			645.6	12		
			62.3	10		
3[3]	Begin: "AST-4" Line 896+78, 32.4 Lt (offset) End: "AST-4" Line 992+84, 51.3 Lt (offset)	583.7	583.7	10'-4"	SW-148 RW-186	On concrete barrier on Retaining wall No. 2
4[3]	Begin: "AST-4" Line 992+27, 60.2 Lt (offset) End: "AST-4" Line 996+83, 79.9 Lt (offset)	449.6	140	14	SW-188	On 16-in CIDH pile (on Retaining Wall No. 14 from Sta. 996+54 to Sta. 996+83)
			309.6	16		
5[4]	Begin: "AST-3" Line 886+48, 34.0 Rt. (offset) End: "AST-3" Line 890+15, 46.0 Rt. (offset)	370.0	251	10'- 4"	SW-147	On concrete barrier on Retaining Wall No. 1
			119		RW/SW-149	On concrete barrier on 16-in. CIDH pile
5A[4]	Begin: "AST-3" Line 890+15, 47.0 Rt. (offset) End: "AST-3" Line 896+28, 51.5 Rt. (offset)	614.8	614.8	10	RW-187 RW-189	On Retaining Wall No. 3
6[5]	Begin: "AST-2" Line 698+40, 58.7 Rt. (offset) End: "AST-2" Line 701+36, 42.9 Rt. (offset)	297.6	297.6	14	RW-190 SW-193	On Retaining Wall No. 5
6A[5]	Begin: "AST-2" Line 701+936, 42 Rt. (offset) End: "ECR" Line 92+60, 70.0 Rt. (offset)	3108	265 531.8			
			982.9	12	RW/SW-199	On concrete barrier on 16-in. CIDH Pile
			871.8	12'- 4"	CAV-169 RW/SW-170 RW/SW-171A	On concrete barrier on Retaining Wall No. 9
			456.5	12'- 4"	RW/SW-172	On concrete barrier on 16-in. CIDH Pile

TABLE 8: SUMMARY OF PROPOSED SOUNDWALLS (contd.)

Wall No.	Location	Total Length (ft)	Length (ft)	Height (ft)	Asso-ciated Borings	Remarks
6B(6)	Begin: "ECR" Line 92+60, 71 Rt. (offset) End: "HCT-6" Line 349+65, 69.6 Rt. (offset)	1695	433 1262	12'-4" 10'-4"	RW/SW-173 RW/SW-174 RW/SW-175 RW/SW-176 RW/SW-177	On concrete barrier on Retaining Wall No. 10
7(7)	Begin: "AST-1" Line 499+27, 37 Lt (offset) End: "AST-1" Line 500+33, 35 Lt (offset)	106.33	106.33	12	E-191	On Retaining Wall No. 13
7A(8)	Begin: "AST-1" Line 500+33, 35.5 Lt (offset) End: "ECL" Line 55+99, 71.5 Lt (offset)	2578.3	92.2'	12'-4"	RW-194, SW-200, RW/SW-196, 202, 2004	On Retaining Wall No. 4
			2008.6'	10'-6"		
			373.5'	12'-4"	SW-205/206	On Concrete Barrier on 16 in. CIDH Pile
			104.0	10'-4"	SW-207	On Concrete barrier on Retaining Wall No. 11
7B(7)	Begin: "AST-1" Line 499+23, 93 Lt (offset) End: "AST-1" Line 499+27, 38 Lt (offset)		55.6'	12		On 1.25' wide, 9.75' deep trench footing. The trench dimensions correspond to Caltrans Standard Plans RSP B15-1 for a 12-ft high soundwall for Case-2 (sloping ground for a phi = 30-degree soil.

(1) On north side of Westbound State Route 4 and north side of Westbound On-ramp
(2) On south side of Eastbound State Route 4
(3) On north side of Westbound On-ramp
(4) On south side of Eastbound Off-ramp
(5) On south side of Eastbound On-ramp
(6) On south side of Eastbound travel way and off-ramp for Hillcrest Avenue
(7) On north side of Westbound Off-ramp
(8) On north side of Westbound Off-ramp and Westbound travel way

8.6.1.1 Subsurface Soil Conditions

Existing borings along the soundwall alignments indicate predominantly stiff to hard lean clays with occasional layers of medium dense to dense sands. Groundwater was encountered at least 35 feet below ground surface.

8.6.1.2 Foundation Recommendations

Foundations for soundwalls are discussed below:

1. Foundations for soundwalls located on top of retaining walls should be as recommended in the earlier section on Retaining Walls (Section 8.4).
2. For foundations for soundwalls at grade or on concrete traffic barriers, it is recommended to use Caltrans standard soundwall supported on Cast-in-drilled-hole (CIDH) piles. Details for design and construction for the CIDH piles are presented in the following section.
3. Soundwalls at grade may also be founded on spread footings or trench footings. The footing design should conform to Caltrans Standard Plans (as used in Soundwall No. 7B).

8.6.1.3 Design and Construction Considerations for the CIDH Piles

According to Caltrans Bridge Design Aids, pile foundations for sound walls may be designed by Sheet Piling Procedure or by using a variation of the simplified and approximate method outlined in the Uniform Building Code (1997) Section 1806.8. For lateral design, Caltrans standard design can be used for this project. Based on the Caltrans "Standard Drawing – Soundwall – Masonry Block on Pile Cap Detail No. 2", and an assumed angle of shearing resistance of 30°, an allowable ultimate lateral soil pressure of 395 psf/ft can be used for level ground conditions and an allowable ultimate lateral soil pressure of 67 psf/ft can be used for the condition of level ground on one side of wall and sloping ground on the opposite side. As discussed with the designer, the maximum slope gradient of the sloping ground is 1V: 2H. It is anticipated that the soundwall foundation will be in relatively competent native soils. The criteria for level ground condition are described in Caltrans Memo to Designer (22-1, Section IV).

Caltrans standard specification for "Cast-in-Place Concrete Piling" should be used for the construction of CIDH piles. Groundwater is not anticipated during pile construction. Due to presence of sand and gravel layers, raveling or caving is expected, which may require

additional drilling and cleaning effort and may increase the concrete volume for the piles. Relatively difficult drilling conditions may be encountered for drilling into the hard clays and the dense sand layers. It is prudent to make the contractor aware of these conditions so that appropriate steps can be taken to comply with the standards and to maintain the integrity of the CIDH piles. The use of temporary steel casing should be anticipated at all times to maintain the integrity of the piles. All pile excavations should be observed by the Geotechnical Engineer prior to the placement of reinforcement and concrete so that if conditions differ from those anticipated, appropriate recommendations can be made.

8.6.2 Overhead Sign Structures

It is proposed to construct seven overhead sign structures along State Route 4 to be located at grade. The overhead sign structures will be Caltrans Standard "Overhead Signs-Truss Single Post Type VII or Type VIII. The overhead sign structures will be along both eastbound and westbound directions of State Route 4. The proposed sign structures will be 15 to 20 feet above grade. The recommended foundation system will consist of a 5-ft diameter "Cast-in-drilled-hole" (CIDH) pile, which is used in the Caltrans standard design.

8.6.2.1 Subsurface Soil Conditions

Subsurface soil conditions for all the sign structure locations were established from adjacent borings. Based on the boring data, the subsurface soil conditions at the overhead sign structure locations are summarized in the table below.

TABLE 9: SUMMARY OF SIGN OVERHEAD STRUCTURES

Sign	Location		Post Type	Post Height	Relevant Boring	Subsurface Soil Conditions
	Station	Direction				
A	184+00 ("E" line)	Eastbound	VIII	18'-0"	SW-147	Stiff to very stiff lean clay to 8-ft depth, underlain by hard sandy lean clay
D	198+80 ("E" Line)	Westbound	VII	19'-6"	AST-155	Stiff to very stiff lean clay to 18-ft depth, underlain by hard silt to 28-ft depth
F(1)	209+36 ("E" line)	Westbound	VIII	19' 9"	RW/SW-199	Hard lean clay and hard sandy silt to 30-ft depth
G	75+00 ("ECR" line)	Eastbound	VIII	19' 9"	SW-201	Very stiff lean clay to 8-ft depth, underlain by very dense clayey sand and hard sandy clay
H	79+00 ("ECR" line)	Eastbound	VII	19' 5"	CAV-168	Very stiff lean clay to 6-ft depth, underlain by medium dense silty sand and very stiff silt
I(2)	238+75 ("E" line)	Westbound	VII	14' 6"	RW-210	Hard gravelly clay fill to 6-ft depth, underlain by very stiff lean clay 18-ft depth, underlain successively by layers of hard sandy clay, stiff lean clay and medium dense sand to hard lean clays and medium dense sand
J(3)	245+04.44 ("E" line)	Eastbound	VIII	18' 6"	RW-212	Very stiff lean clay to 3-ft depth, underlain by layers of hard sandy silt and leas clay to 13-ft depth, underlain by very dense silty sand to 23-ft depth, underlain by hard lean clay

(1) To be installed on top of Retaining Wall No. 4
(2) To be installed on top of Retaining Wall No. 12
(3) To be installed on top of Retaining Wall No. 10

8.6.2.2 Pile Capacity

The piles for the overhead sign structures are subject to vertical loads, lateral loads, bending moments and torsional moments. According to Caltrans Standard Plan (2006 Standard Plan S8), the recommended pile diameter is 5 feet and the recommended pile length is 23 feet for Post Type VII and 25 feet for Post Type VIII. Based on the laboratory test results, the existing subsurface soil conditions generally meet the requirements as specified in the Caltrans Standard Plans. Three of the structures are mounted on retaining walls.

Vertical loads are generally small and vertical capacities developed from the frictional resistance should be acceptable. Specific loads

were not provided by the designer. Therefore, definitive analyses for lateral loads were not performed. However, as noted in Table 9, the soils are generally stiff to very stiff clays. Standard design for the piles is therefore judged to be adequate.

8.6.3 Other Minor Structures

According to the designer, the other minor structures for this project include the traffic signal systems and minor drainage structures. The foundation design of these minor structures should be according to the Caltrans Standard Plans. Based on the borings, the subsurface soil conditions at the proposed traffic signal systems generally consist of stiff to hard lean clays with pockets/lenses/layers of medium dense to dense sands. The native soil on site should provide adequate design capacity for these structures.

9. STRUCTURAL PAVEMENT

R-value tests were conducted on representative samples collected at subgrade level. The test results are summarized in Table 10.

TABLE 10: SUMMARY OF R-VALUE TESTS

Boring No.	Station (approx.)	Offset From Center Line (approx.)	Boring Depth	Profile		R Value	Soil Type	Remarks *
				a	b			
R-40	174+45	45 (R)	0-5'			35	Silty Sand	
R-41	181+25	0' (C)	0-5'	C/F (0.0 ft.)	C (3.0 ft)	58	Silty Sand	
R-42	184+00	25' (L)	0-5'	F (1.0 ft)	C (2.0 ft)	23	Clay	
R-45A	192+00	0' (C)	0-5'	F (1.0 ft)	C (2.0 ft)	15	Sandy Clay	
R-45	192+70	0' (C)	0-5'	F (1.0 ft)	C (2.0 ft)	14	Clay	EI = 61
R-46	195+00	25' (R)	0-5'	F (1.0 ft)	C (2.0 ft)	33	Silty Sand	
R-47	196+00	Ramp (L)	0-5'	F	F	8	Clay	
R-50	200+75	0 (C)	0-5'	F (1.0 ft)	C (2.0 ft)	<5	Clay	EI = 68
R-53	205+50	25' (L)	0-5'	F (1.0 ft)	C (2.0 ft)	36	Sandy Clay	
R-55	210+50	0' (C)	0-5'	F (1.0 ft)	C (2.0 ft)	51	Clayey Sand	
R-57	223+00	0' (C)	0-5'	F (1.0 ft)	C (2.0 ft)	26	Sandy Clay	
R-58	228+00	25' (R)	0-5'	F (1.0 ft)	C (2.0 ft)	28	Sandy Clay	
R-60	239+00	25' (R)	0-5'	F (1.0 ft)	C (2.0 ft)	44	Sandy Silt	
R-61	243.00	0' (C)	0-5'	F (1.0 ft)	C (2.0 ft)	33	Sandy Clay	
R-63	253+00	0' (C)	0-5'	F (1.0 ft)	C (2.0 ft)	26	Sandy Clay	

Stationing is referenced to the plan, 08/02/2007 (English)
Potential Expansion: Medium (Expansion Index, EI = 51 to 90), ASTM D-4829
a: New roadway formation level (reference made with existing roadway level)
b: New subgrade level (reference made with existing roadway level)
F: Fill
C: Cut

As-built Pavement Sections

The following are the as-built pavement sections based on the "Typical Cross Sections" of the plan provided by the designer:

TABLE 11: AS-BUILT PAVEMENT SECTIONS

Location	Station	Pavement Section
State Route 4	"E" Line 179+00 to 196+29 (Eastbound and Westbound traffic lanes)	0.15-ft RAC 0.75-ft PCC 0.45-ft CTB (Class A) 0.50-ft AS (Class 4)
	"E" Line 179+00 to 196+29 (Eastbound and Westbound shoulders)	0.15-ft RAC 0.35-ft AC (Type B) 0.85-ft AB (Class 2) 0.50-ft AS (Class 4)
	"E" Line 198+80 to 240+00 (Eastbound and Westbound traffic lanes)	0.75-ft PCC 0.45-ft CTB (Class A) 0.50-ft AS (Class 4)
	"E" Line 198+80 to 240+00 (Eastbound and Westbound shoulders)	0.35-ft AC (Type B) 0.85-ft AB (Class 2) 0.50-ft AS (Class 4)
Lone Tree Way/A Street	"AST" Line 15+84 to 34+20	0.35-ft AC (Type B) 0.75-ft CTB (Class A) 0.50-ft AS (Class 4)
East Tregallas Road	"T" Line 17+08 to 22+30 "T" Line 17+08 to 22+30	0.25-ft AC (Type B) 0.60-ft CTB (Class A) 0.50-ft AS (Class 4)

The existing and proposed new pavement sections of State Route 4, the On and Off-Ramps at A Street Interchange, widening of Lone Tree Way and A Street and the new pavement for Sunset Drive, Drake Street and East Tregallas Road are presented as Appendix D. It should be noted that the above table and the sections do not account for any overlays that may have been placed during routine maintenance program.

Findings, Design Approach and Recommendations:

- According to the designer, the structural pavement design will be required for:
  - New pavement for the travel lanes and shoulders along State Route 4 from Sta. 179+00 to Sta. 249+19;
  - New pavement along the new on-ramps and off-ramps with Lone Tree Way/A Street;
  - Widening of Lone Tree Way/A Street from Sta. "AST" 15+84 to Sta. "AST" 35+18;
  - New pavement for Sunset Drive from Sta. "S" 400+65 to Sta. "S" 404+88; Drake Street from Sta. "D" 350+99 to Sta. "D" 353+69; and East Tregallas Road from Sta. "T" 16+11 to Sta. "T" 39+37;
- Based on the R-value tests results, the R-values of the subsurface soils at the project site are typically between 14 and 51, with some low values at two locations as indicated in the Table 10.

- Fill material to be placed within 2.5 feet of the grading plane on the Mainline should have a minimum R-value of 20.
- The R-value for the subgrade along the on and off ramps, A Street, Lone Tree Way, Sunset Drive, Drake Street and East Tregallas Road are all assumed as 10.
- The recommended minimum R-value for Class 3 Aggregate Base (AB) is 78 and for Class 4 Aggregate Subbase (AS), it is 50.

Recommended Structural Pavement Sections

The Traffic Indices and the recommended typical structural pavement sections for 40-year design of Segment 3A of State Route 4, the entrance and exit ramps to and from A Street, the portions of Lone Tree Way and A Street to be widened and the new pavement for Sunset Drive, Drake Street and East Tregallas Road are presented in Table 12. The calculations for the proposed pavement sections are contained in Appendix C.

Based on the field investigations and the laboratory test data, the in-place soil at the anticipated subgrade generally has R-values of 20 or greater. Low R-values are indicated at two locations with one location having an R-value of less than 5 (Sta. 200+75) and the other having an R-values of 15 and 14 at Sta. 192+00 and at Sta. 192+70, respectively. It is recommended that segments between Sta. 191+50 and 193+00 and between Sta. 198+80.29 and 201+50 be overexcavated by 30 inches and replaced by import borrow material having an R-value of 20. The road profile for the SR4 Mainline, as planned, indicates that the road will primarily be on fill starting from the western end to A Street. The import borrow is assumed to have an R-value of 20 in the design for this section. Beyond A Street, parts or whole of the road section will be on cut, e.g. on native soil. Based on the R-value tests, a design R-value of 20 is also chosen for this section. The above R-values are used for both the travel ways and the shoulders as applicable.

The pavement section for the ramps has assumed an R-value of 10 for design, since parts of the pavements are on native soil. An R-value of 10 is also assumed for Lone Tree Way and A Street widening and for the new pavement for Sunset Drive, Drake Street and East Tregallas Road.

Traffic Indices (TI-values) have been approved by Caltrans for the corridor and were provided by the client. The TI-values were 14.5 for the outside lane; 12.5 for the median lane up to A Street; and 12.0 for the median beyond A Street. The respective shoulders are assumed to have the same design requirement as the adjoining travel lane. The TI values correspond to a 40-year design life. However, for ease of construction, and to allow for

offsetting of the joints from that of lane line joints, outside lane TI has been used in design of both inside and outside lane structural sections.

The ramps are to be designed for a TI value of 10.0, reflecting a 20-year design life. Rubberized HMA is not recommended for ramps if a concrete pavement is used for the Mainline.

The temporary structural sections for Mainline are to be designed for a TI value of 9.5. A 2-yr use is assumed for determining the TI for the temporary structural sections.

The TI values provided for Lone Tree Way and A Street are 13.0 and 12.0 respectively. The TI-value provided for Sunset Drive, Drake Street and E. Tregallas Road is 8.0.

The LCCA analyses required that the pavement section be considered with two primary options: Hot Mix Asphalt and PCC section. The concrete section is based on HDM tables for Inland Valley Type II Subgrade Soil conditions. The summary of pavement sections have been reviewed and concurred with the Materials Department (District 4). The following Tables provide the details of the mainline pavement design, the on and off ramps, widening of A Street and Lone Tree Way and the new pavement for Sunset Drive, Drake Street and E. Tregallas Road.

It should be noted that the PCC section is based on the assumption that there is lateral confinement from the adjacent lane of a minimum 2' wide PCC shoulder. The shoulders have been designed using the Traffic Index of the adjacent lane. The three options for shoulder section include PCC, HMA and 2 feet of PCC plus HMA (hybrid section). The PCC design can further reduce the LCB section to 0.35-ft and the HMA section to 0.25-ft as per the "Rigid Pavement Base Design – Pavement Policy Manual PPB09-01" dated August 27, 2009.

TABLE 12A: RECOMMENDED PAVEMENT SECTIONS FOR MAINLINE

West of A Street to Hillcrest Avenue [R-Value: 20*]**

Lane	TI[4]	Flexible Pavement Section (ft.)										Rigid Pavement Section (ft.)			
		Option -1 – Full Depth [1]				Option -2 (HMA/LCB/AS)						Options - 3 (JPCP/LCB/AS)			
		RHMA-O	RHMA-G	HMA-A	**Total**	RHMA-O	RHMA-G	HMA-A	LCB	AS	**Total**	JPCP	LCB/HMA-A	AS	**Total**
Outside	14.5	0.10	0.20	1.60	**1.90**	0.10	0.20	0.55	0.70	1.20	**2.75**	1.00	0.35/0.25[3]	0.70	**2.05/1.95**
Median	14.5	0.10	0.20	1.60	**1.90**	0.10	0.20	0.55	0.70	1.20	**2.75**	1.00	0.35/0.25	0.70	**2.05/1.95**
Outside Shoulder	14.5					0.10	0.20	0.55	0.70	1.20	**2.75**	1.00	0.35/0.25	0.70	**2.05/1.95**
Median Shoulder	14.5					0.10	0.20	0.55	0.70	1.20	**2.75**	1.00	0.35/0.25	0.70	**2.05/1.95**
Outside Shoulder		Hybrid Shoulder using 14' JPCP outside lane and 8' HMA shoulder										HMA 0.70 – 1.00	0.35/0.25	0.70	**1.65-2.05**

(1) Full depth HMA should only be used for narrow widening, i.e. areas inaccessible to conventional equipment
(2) Majority of subgrade material is tested at R-value of 20 or higher.
(3) Per the "Rigid Pavement Base Design – Pavement Policy Manual PPB09-01" dated August 27, 2009, the LCB section and the HMA-A section may be reduced to 0.35-ft and 0.25-ft, respectively. If HMA-A is used, the AS should be prime coated, prior to placement of HMA-A.
(4) TI values correspond to a 40-year design life.

Notes:

TI: Traffic Index (Outside lane TI has been used for both inside and outside structural section for ease of construction and to allow for offsetting of LCB joints from that of lane line joints)
FDHMA-A: Full Depth Asphalt Concrete (Type A); **HMA-A:** Asphalt Concrete (Type A)
RHMA-G: Rubberized Hot Mix Asphalt Concrete – gap graded; **RHMA-O**: Open Graded HMA
LCB: Lean Concrete Base; **AS:** Aggregate Subbase (Class 4, R-Value=50); **JPCP:** Jointed Plain Concrete Pavement
Subgrade Type: Inland Valley, Type II Subgrade Soil
Flexible Pavement: Gravel Equivalent Calculation (Table 633.1, Highway Design Manual, June 2006)
Rigid Pavement Thickness: Table 623.1G; Inland Valley Type II Subgrade Soil Condition; Lateral Support (Highway Design Manual, June 2006)

The pavement subgrade between Sta. 191+50 and Sta. 193+00 and between Sta. 198+80.29 and Sta. 201+50 should be excavated to 30 inches and replaced with R=20 material.

TABLE 12B: RECOMMENDED PAVEMENT SECTIONS FOR LONE TREE WAY AND A STREET WIDENING

Lane	R-Value	TI	Flexible Pavement Section (ft.)								Rigid Pavement Section (ft.)			
			Option -1 (Full Depth)*			Option -2 (HMA-A/LCB/AS)					Option - 3 (JPCP/LCB/AS*)			
			RHMA-G	HMA-A	**Total**	RHMA-G	HMA-A	LCB	AS	**Total**	JPCP	LCB / HMA-A	AS*	**Total**
Lone Tree Way	10	13.0	---	1.70	**1.70**	---	0.65	0.65	1.45	**2.75**	--	--	--	--
A Street		12.0	---	1.55	**1.55**	---	0.60	0.60	1.30	**2.50**	--	--	--	--

Notes:
TI: Traffic Index
FDHMA-A: Full Depth Asphalt Concrete (Type A)
HMA-A: Asphalt Concrete (Type A)
RHMA-G: Rubberized HMA – gap graded
LCB: Lean Concrete Base
AS: Aggregate Subbase (Class 4, R-Value=50)
Subgrade Type: Inland Valley, Type II Subgrade Soil
Flexible Pavement: Gravel Equivalent Calculation (Table 633.1, Highway Design Manual, June 2006)

*Full depth HMA should only be used for narrow widening, i.e. areas inaccessible to conventional equipment.

TABLE 12C RECOMMENDED PAVEMENT SECTIONS FOR ON AND OFF RAMPS, SUNSET DR., DRAKE ST., E. TREGALLAS RD. AND MAINLINE TEMPORARY PAVEMENT

Lane	R-Value	TI	Flexible Pavement Section (ft)											
			Option 1 – Full Depth (FDHMA-A)[2]			Option 2 – (HMA-A/AB)				Option 3 – (HMA-A/AB/AS)				
			RHMA-G	HMA-A	**Total**	RHMA-G	HMA-A	AB	**Total**	RHMA-G	HMA-A	AB	AS	**Total**
On and Off Ramps [3]	10	10.0[4]	0.20	1.05	**1.25**	0.20	0.30	1.80	**2.30**	0.20	0.30	0.90	1.00	**2.40**
Sunset Drive, Drake St. and E. Tregallas Rd.		8.0	--	1.00	**1.00**	--	0.40	1.40	**1.80**	--	0.40	0.65	0.80	**1.85**
Mainline Temporary Pavement [1]	20	9.5[4]	--	1.10	**1.10**	--	0.50	1.40	**1.90**	--	0.50	0.75	0.70	**1.95**

Notes: **TI: Traffic Index**
FDHMA-A: Full Depth Asphalt Concrete (Type A)
RHMA-G: Rubberized HMA – gap graded
HMA-A: Asphalt Concrete (Type A)
AB: Aggregate Base (Class 3, R-Value = 78)
AS: Aggregate Subbase (Class 4, R-Value=50)
Flexible Pavement: Gravel Equivalent Calculation (Table 633.1, Highway Design Manual, June 2006)

(1) Applicable to Mainline Travel Way
(2) Full Depth Hot Mix Asphalt will be used only for narrow widening, areas inaccessible to conventional equipment
(3) If JPCP option is chosen for Mainline, Then RHMA-A should be replaced by HMA-A, since RHMA quantities would be insufficient for justifiable use
(4) TI for On and Off Ramps based on 20-yr design life. A 2-yr use is assumed for temporary pavement.

10. MATERIAL SOURCES

There are several commercial sources of asphalt, concrete, and aggregate products in the area. Table 13 lists available commercial suppliers in the area.

TABLE 13: SOURCES OF IMPORTED BORROW

Source	Location	Approx. Haul Distance (one way, miles)
Antioch Rock & Ready Mix	3600 Wilbur Ave., Antioch	4
NAV-Land	2665 Pittsburg-Antioch Hwy, Antioch	1
Mega-Sand Incorporated	110 L Street #2, Antioch	2
Mex-Cal Incorporated	4826 Belle Drive, Antioch	3
RMC Pacific Materials	1544 Stanley Blvd., Pleasanton	37

11. MATERIAL DISPOSAL

Disposal of ADL contaminated material (if any) is beyond the scope of this report.

12. CONSTRUCTION CONSIDERATIONS

12.1 Construction Advisories

A significant portion of the project will need fill material for the proposed new interchange. The site is the existing State Route 4. Therefore traffic control and construction staging is required to maintain traffic flow during construction. There are numerous utility lines at the site. The contractor should verify the utility lines, be aware of the existing conditions and plan the construction activities accordingly.

The borings encountered clayey/sandy materials near the existing ground surface. Localized subgrade pumping may be encountered during earthwork construction depending on the weather, subsurface moisture, and surface drainage conditions. Equipment mobility may also be difficult if the subgrade is wet. In such a case, the subgrade soils may require reworking, aeration, or over-excavation and replacing with dry granular fill to facilitate earthwork construction.

12.2 Construction Consideration that Influence Specifications

The contractor should verify the existing utility line conditions, and these locations should not be used for stockpiling of borrow materials. Any utility conflicts with proposed construction should also be reviewed prior to construction. There may be excavations that are proposed near existing utility lines. Contractor should take precautions to protect the utilities from damage caused by such excavations.

12.3 Construction Monitoring and Instrumentation

In general, the construction subject of monitoring and instrumentation was considered and was determined to be not significant for the project. However, Contractor may need to monitor his excavations that are in near proximity to existing utilities or other improvements.

12.4 Hazardous Waste Considerations

The project environmental study report should be referred to for further details at the sites within the project.

12.5 Differing Site Conditions

The soil conditions described in this report are based on available boring data. It should be noted that these borings depict subsurface conditions only at the locations drilled. Because of the variability from place to place within soils in general, and the nature of geologic depositions, subsurface soil conditions could change between the explored locations.

Early communication should be made between the Resident Engineer, the Contractor and the Geotechnical Engineer as soon as conditions that differ from those established in this report are recognized by any of the parties. Additional recommendations could be provided if such conditions arise.

13. RECOMMENDATIONS AND SPECIFICATIONS

13.1 Summary of Recommendations

If the designer has questions or concerns regarding any of these recommendations, or, if conditions are found to be different during construction, the Geotechnical Engineer who prepared this report should be contacted. Additional fieldwork, analysis or changes in recommendations may be required. These services may be provided under a separate authorization, as necessary. A concise summary of the geotechnical recommendations is presented below:

- Design peak bedrock acceleration (PBA) = 0.5 g.

- The boring data indicates that the subsoils consist predominantly of stiff to hard clay with occasional layers of medium dense to very dense sand. Groundwater was encountered between Elev. -11.4 feet and 18.4 feet during drilling. The impact of liquefaction potential to this project is considered relatively low. (Ref.: Section 8.1.3).

- The settlement due to the placing of the embankment fill is expected to be insignificant.

Pavement Sections for the project (Ref: Section 9):

The structural pavement sections for the project include HMA and PCC sections for the mainline, HMA for the on-off-ramps from the State Route 4, widening of A Street and Lone Tree Way and the new pavement for Sunset Drive, Drake Street and East Tregallas Road. These are detailed in Tables 12A through 12C above.

13.2 Recommended Materials Specifications

13.2.1 Standard Specifications

Unless otherwise stated in the special provisions, all materials specifications should conform to Caltrans Standard Specifications, May 2006 edition, including but not limited to the following: Earthwork, Structure Backfill, Pervious Backfill Material, Reinforcing Geofabric, Thermoplastic Pipes, Asphalt Concrete, Aggregate Base, Aggregate Subbase and Cement Treated Base, etc.

13.2.2 Special Provisions

Installation of CIDH Piles

Installation of CIDH piles for retaining walls, soundwalls and sign structures will involve drilling through hard clays and sometimes through dense to very dense sands, where hard drilling is anticipated.

Borrow Material:

Borrow material should be in accordance with the specifications set forth in Caltrans Section 19. In particular, for new embankment/roadway construction, the material placed within 2.5 feet of the finish pavement subgrade (grading plane) should meet the following requirements:

1. Free of organic or other deleterious materials.
2. An R-value of no less than 20.

Aggregate Base:

Aggregate Base (Class 3) shall conform to the provisions in Section 26 of the Standard Specifications and to the Special Provisions. It shall also be clean and free from organic matter and other deleterious substances. The percentage composition by weight of Class 3 aggregate base shall conform to the following grading as determined by California Test Method No. 202.

Gradation Requirement (Percent Passing ¾ in. Maximum)

Sieve Sizes	Operating Range	Contract Compliance
1 in.	100	100
3/4 in.	90 – 100	87 – 100
No. 4	35 – 60	30 – 65
No. 30	10 – 30	5 – 35
No. 200	2 – 11	0 – 14

Gradation Requirement (Percent Passing 1-1/2 in. Maximum)

Sieve Sizes	Operating Range	Contract Compliance
2 in.	100	100
1-1/2 in.	90 – 100	87 – 100
1 in.	------	------
3/4 in.	50 – 85	45 – 90
No. 4	25 – 45	20 – 50
No. 30	10 – 25	6 – 29
No. 200	2 – 11	0 – 14

Aggregate Base (Class 3) shall also conform to the quality requirements given on the following table:

Quality Requirements

California Test Method	Operating Range	Contract Compliance
Sand Equivalent (217)	25 min	22 Min.
Resistance (R-value) (301)	-	78 Min.
Durability Index	-	35 Min.

Aggregate Subbase: Aggregate Subbase (Class 4) shall conform to the provisions in Section 25 of the Standard Specifications and to these Special Provisions.

Aggregate Subbase (Class 4) shall be clean and free from organic matter and other deleterious substances. The percentage composition by weight of Class 4 aggregate subbase shall conform to the following grading as determined by California Test Method No. 202.

Gradation Requirement (Percent Passing)

Sieve Sizes	Operating Range	Contract Compliance
2-1/2 in.	100	100
No. 4	30 - 65	25 - 70
No. 200	0 - 15	0 – 18

Aggregate Subbase (Class 4) shall also conform to the quality requirements given on the following table:

Quality Requirements

California Test Method	Operating Range	Contract Compliance
Sand Equivalent (217)	21 Min.	18 Min.
Resistance (R-value) (301)	-	50 Min.

14. INVESTIGATION LIMITATIONS

Our services consist of professional opinions and recommendations made in accordance with generally accepted geotechnical engineering principles and practices and are based on our field exploration and the assumption that the soil conditions do not deviate from observed conditions. No warranty, expressed or implied, of merchantability or fitness, is made or

intended in connection with our work or by the furnishing of oral or written reports or findings. The scope of our services did not include any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in structures, soil, surface water, groundwater or air, below or around this site. Unanticipated soil conditions are commonly encountered and cannot be fully determined by taking soil samples and excavating test borings; differing soil conditions may require that additional expenditures be made during construction to attain a properly constructed project. Some contingency fund is thus recommended to accommodate these possible extra costs.

This report has been prepared for the proposed "State Route 4 (East) Widening Project – Segment 3A" project as described earlier, to assist the engineer in the design of this project. In the event any changes in the design or location of the facilities are planned, or if any variations or undesirable conditions are encountered during construction, our findings and recommendations shall not be considered valid unless the changes or variations are reviewed and our recommendations modified or approved by us in writing.

This report is issued with the understanding that it is the designer's responsibility to ensure that the information and recommendations contained herein are incorporated into the project and that necessary steps are also taken to see that the recommendations are carried out in the field.

The findings in this report are valid as of the present date. However, changes in the soil conditions can occur with the passage of time, whether they are due to natural processes or to the works of man, on this or adjacent properties. In addition, changes in applicable or appropriate standards occur, whether they result from legislation or from the broadening of knowledge. Accordingly, the findings in this report might be invalidated, wholly or partially, by changes outside of our control.

Respectfully submitted,
PARIKH CONSULTANTS, INC.

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Senior Engineer

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Project Manager

REGISTERED PROFESSIONAL ENGINEER
GAURANG R. PARIKH
No. 666
EXP. 12-31-11
GEOTECHNICAL
STATE OF CALIFORNIA

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REFERENCES

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2. California Department of Transportation, May 2006, Standard Specifications, Sections 1 through 95.

3. California Department of Transportation, Highway Design Manual, June 2006

4. 2007 Caltrans Deterministic PGA Map and 2007 Fault Database;

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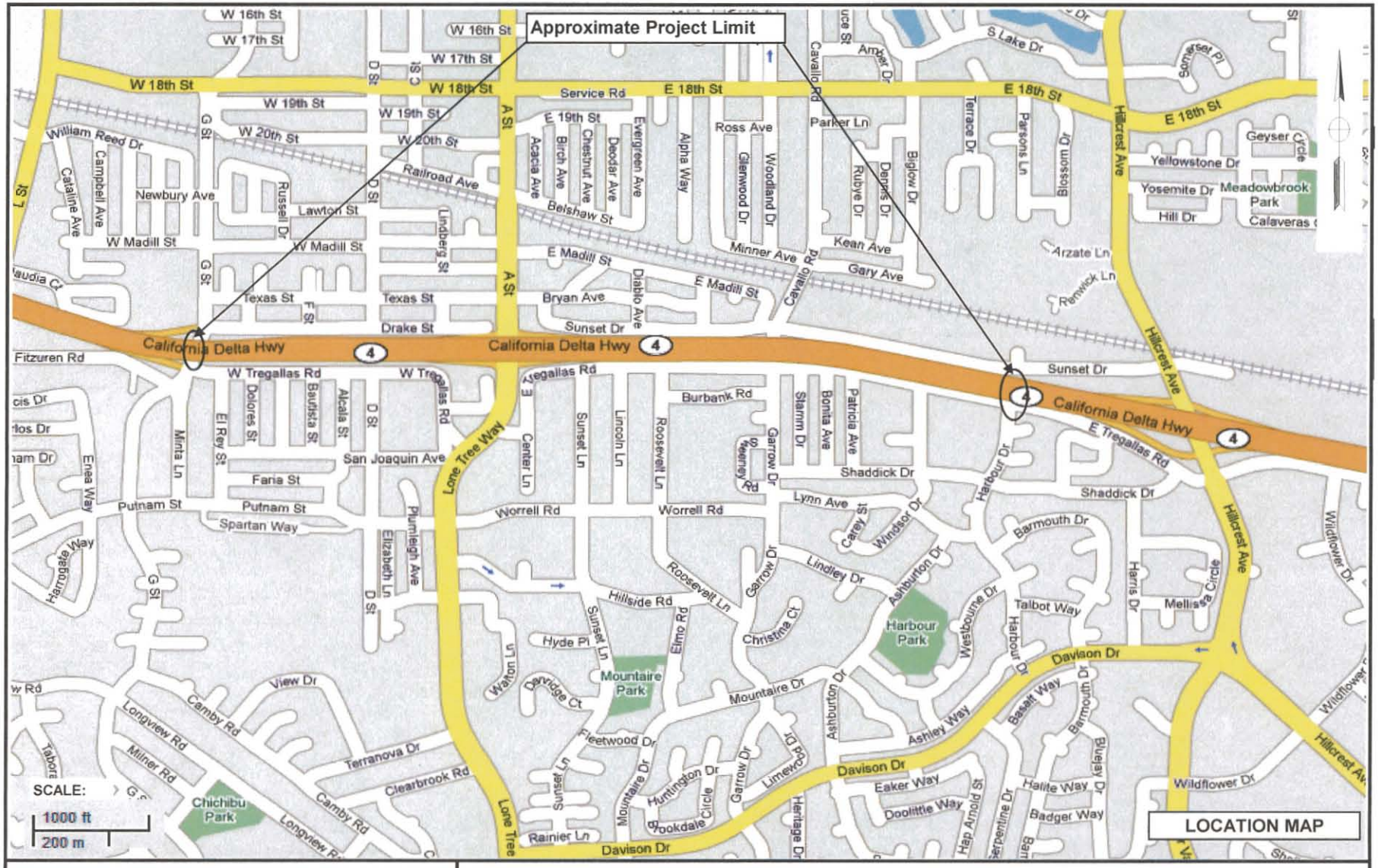
6. Youd, T.L. and Idriss, I.M., Co-Chairs, 2001, Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils, ASCE, Journal of Geotechnical and Geoenvironmental Engineering, V. 127, No. 4, p 297-313.



PARIKH CONSULTANTS, INC.
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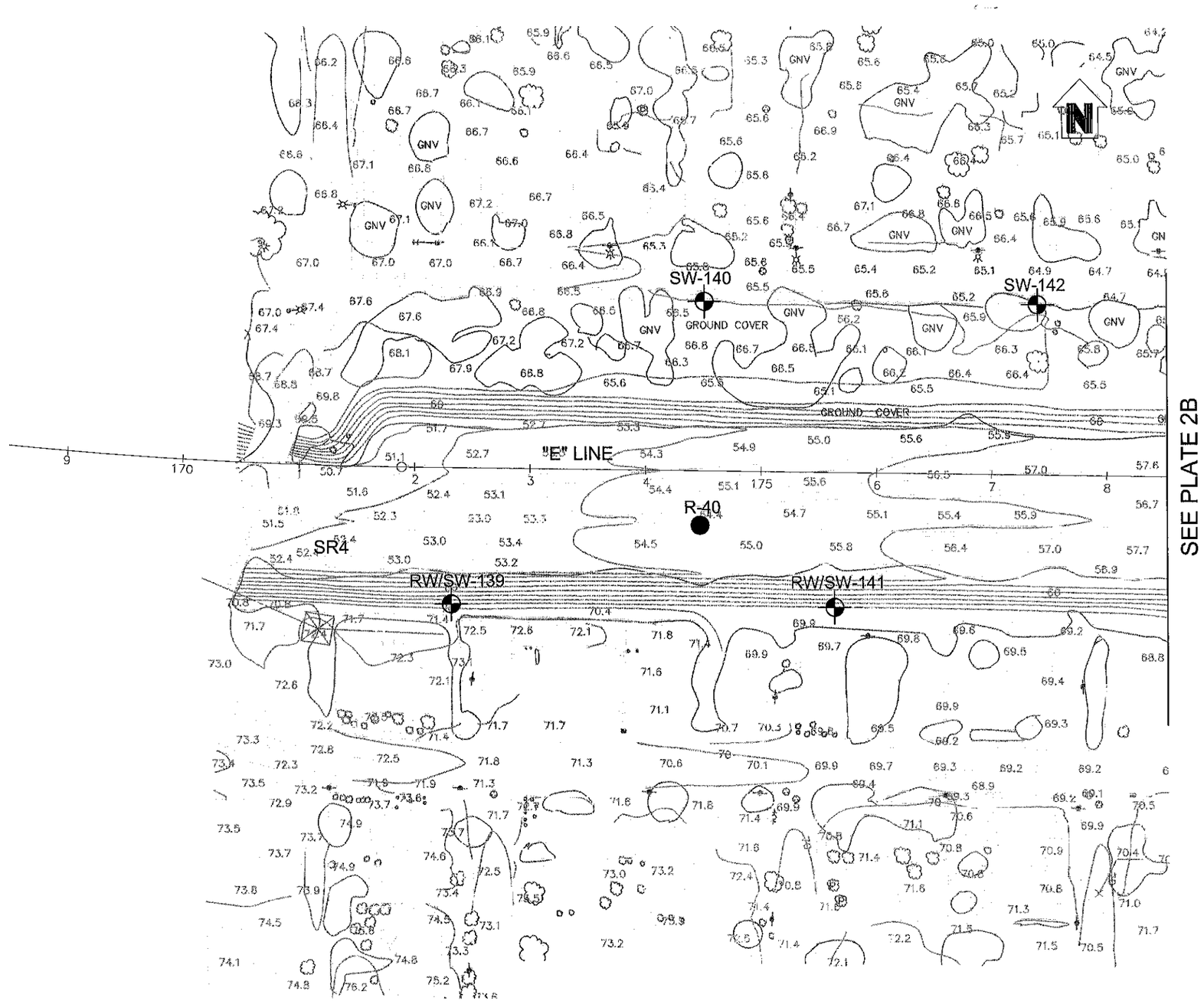
MATERIALS TESTING

STATE ROUTE 4 (EAST) WIDENING PROJECT-SEGMENT 3A
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO.: 206117.GDR	PLATE NO.: 1



SITE PLAN

LEGEND

SW-140 — Approx. Boring Location

R-40 — R-value Boring

SCALE 1 inch = 100 feet

Note: All units are in feet unless otherwise specified
Reference Map was provided by T.Y. Lin International

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MATERIALS ENGINEERING

STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A
ANTIOCH, CALIFORNIA

JOB NO.:206117.GDR | PLATE NO: 2A

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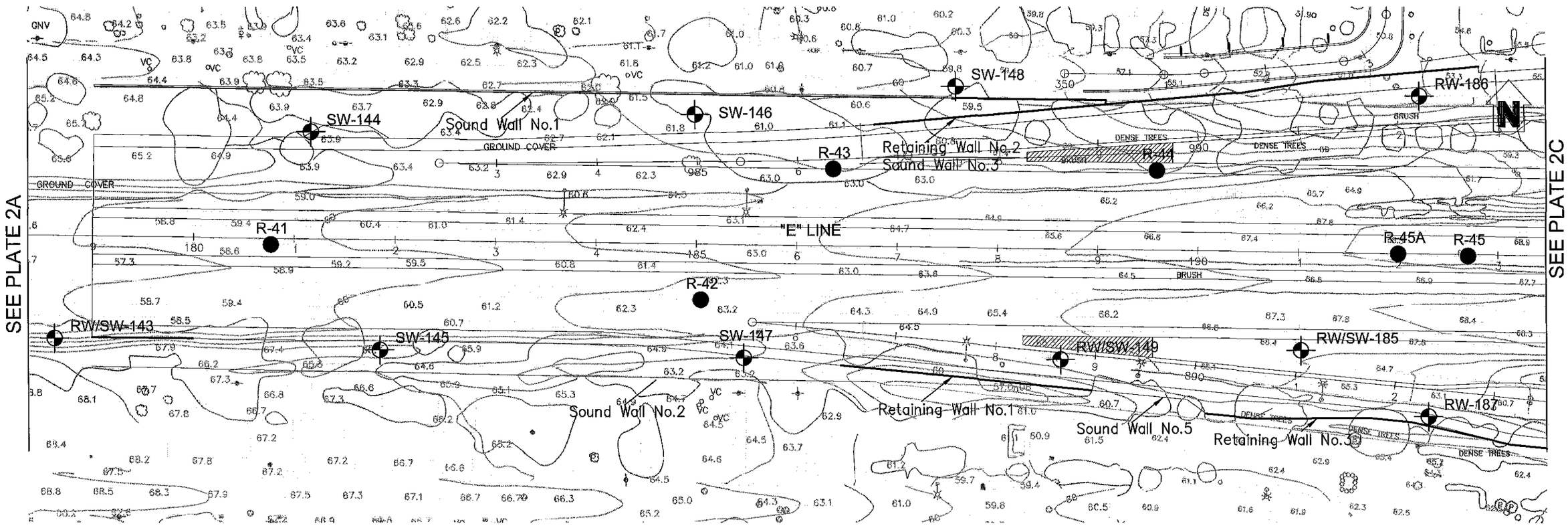

SITE PLAN

LEGEND

SW-144 — Approx. Boring Location

R-41 — R-value Borings

SCALE 1 inch = 100 feet

Note: All units are in feet unless otherwise specified
Reference Map was provided by T.Y. Lin International

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STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A
ANTIOCH, CALIFORNIA

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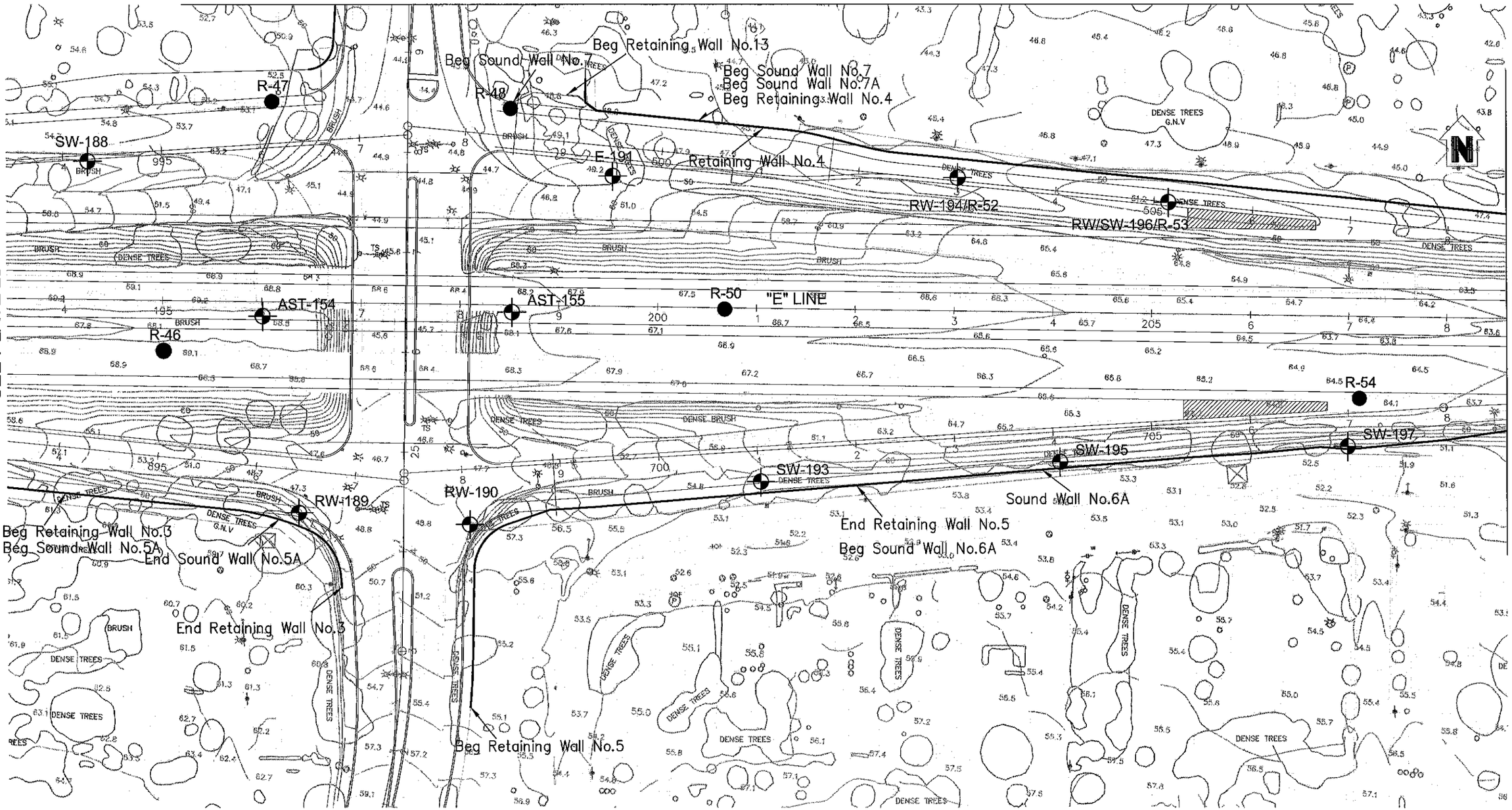
SEE PLATE 2E

SEE PLATE 2B

SEE PLATE 2D



SITE PLAN

LEGEND

SW-144 — Approx. Boring Location

R-41 — R-value Borings

SCALE 1 inch = 100 feet

Note: All units are in feet unless otherwise specified
Reference Map was provided by T.Y. Lin International

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STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A
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JOB NO.:206117.GDR | PLATE NO: 2C

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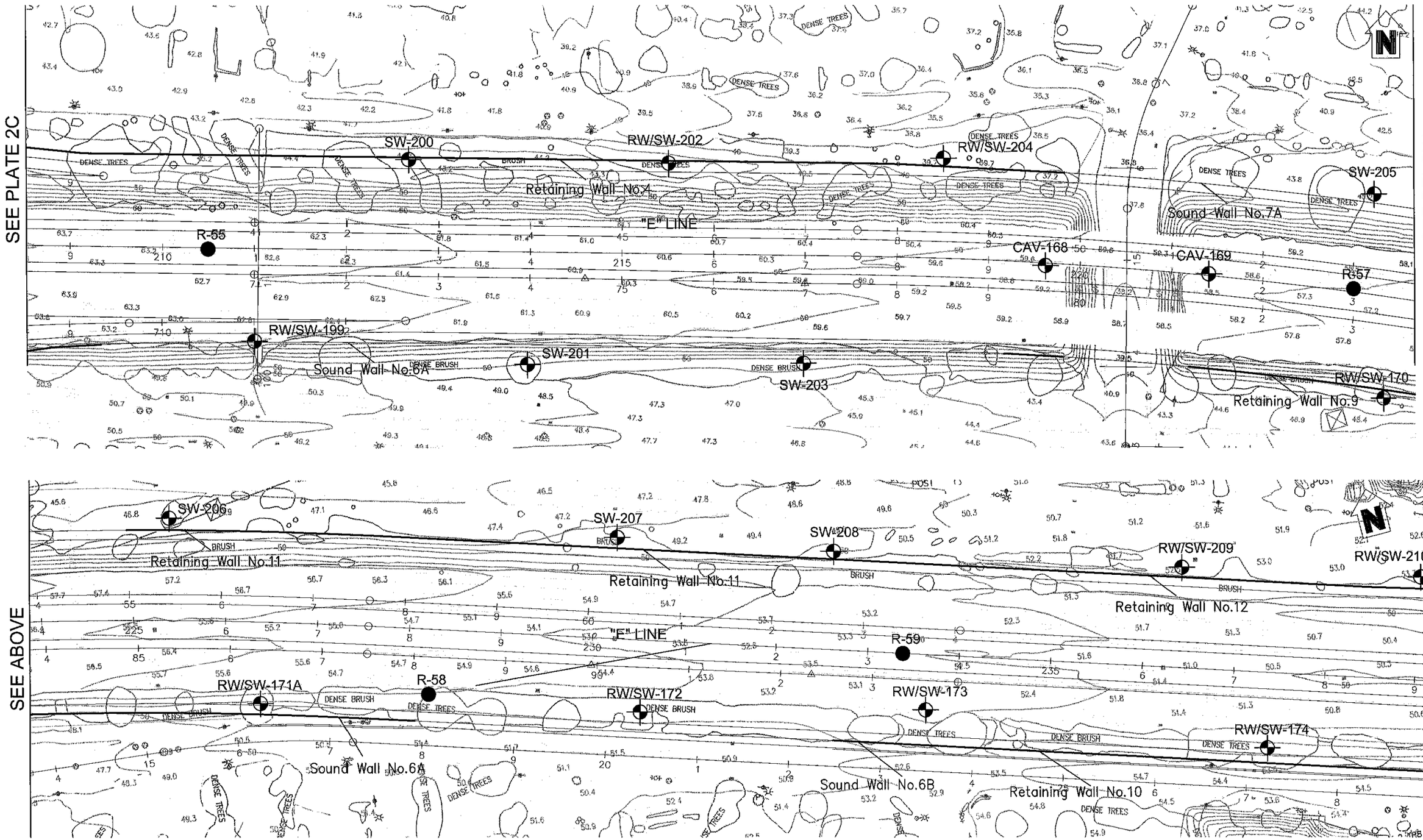

SITE PLAN

LEGEND

SW-200 — Approx. Boring Location

R-55 — R-value Borings

SCALE 1 inch = 100 feet

Note: All units are in feet unless otherwise specified
Reference Map was provided by T.Y. Lin International

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A
ANTIOCH, CALIFORNIA

JOB NO.:206117.GDR | PLATE NO: 2D

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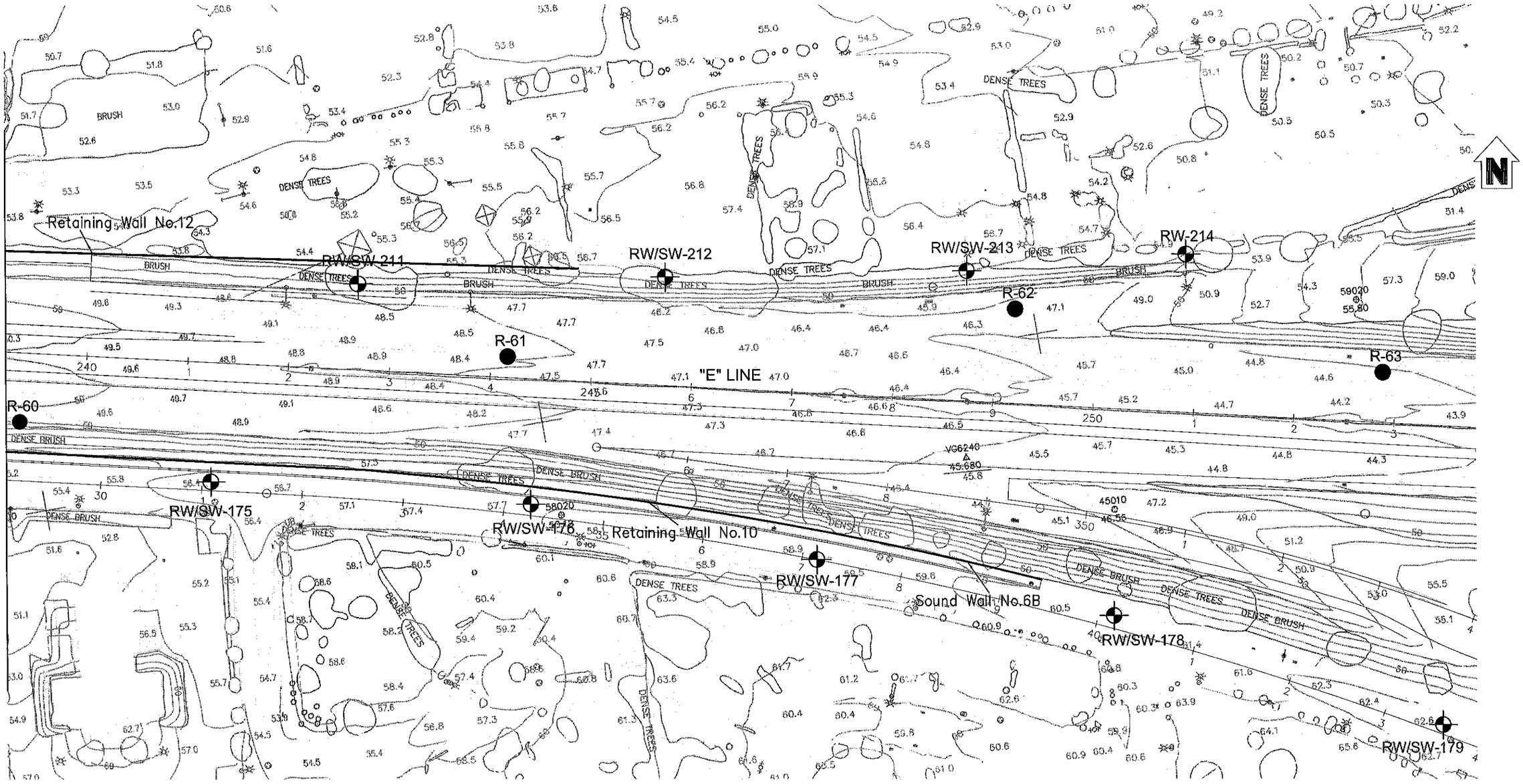
SEE PLATE 2D



LEGEND

RW/SW-211 — Approx. Boring Location

R-61 — R-value Borings

SCALE 1 inch = 100 feet

Note: All units are in feet unless otherwise specified
Reference Map was provided by T.Y. Lin International

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

SITE PLAN

STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A
ANTIOCH, CALIFORNIA

JOB NO.:206117.GDR | PLATE NO: 2E

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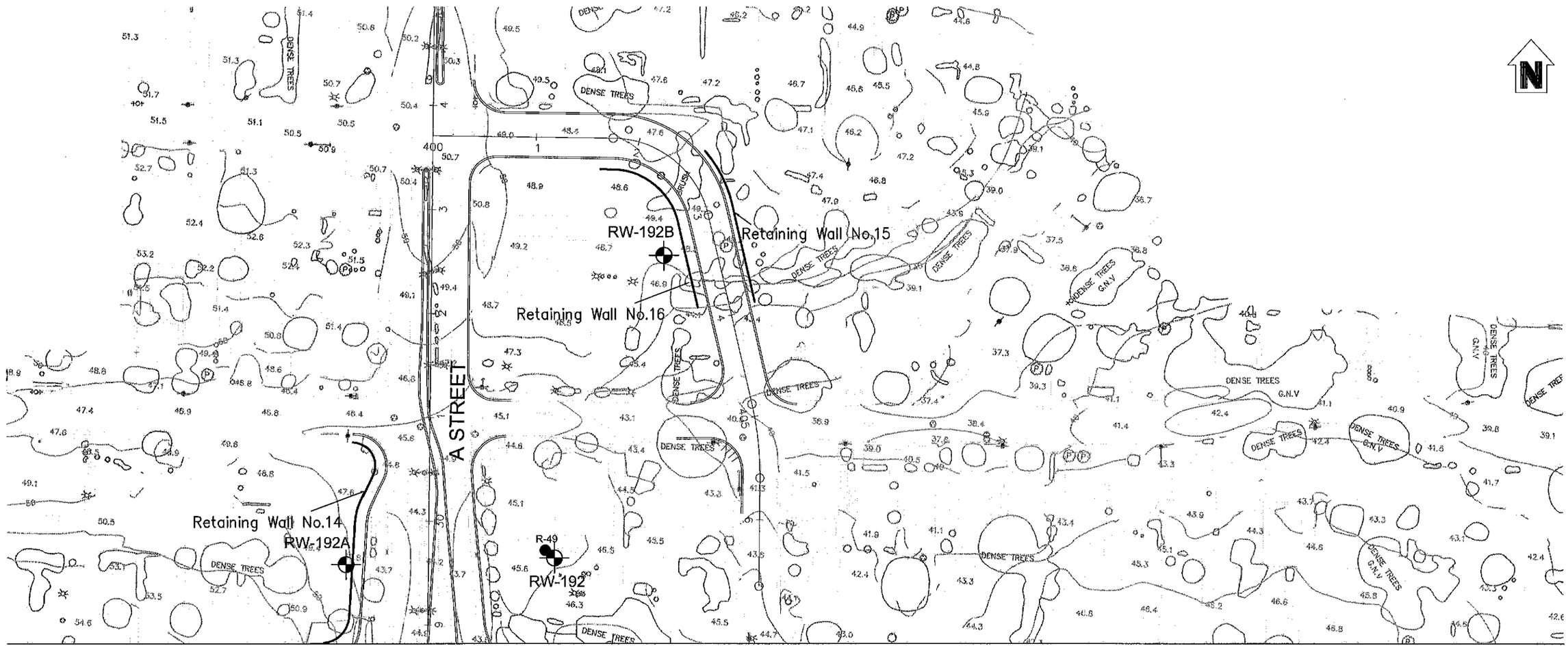

SEE PLATE 2B

SITE PLAN

LEGEND

RW-192 — Approx. Boring Location

R-49 — R-value Borings

SCALE 1 inch = 100 feet

Note: All units are in feet unless otherwise specified
Reference Map was provided by T.Y. Lin International

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A
ANTIOCH, CALIFORNIA

JOB NO.:206117.GDR | PLATE NO: 2F

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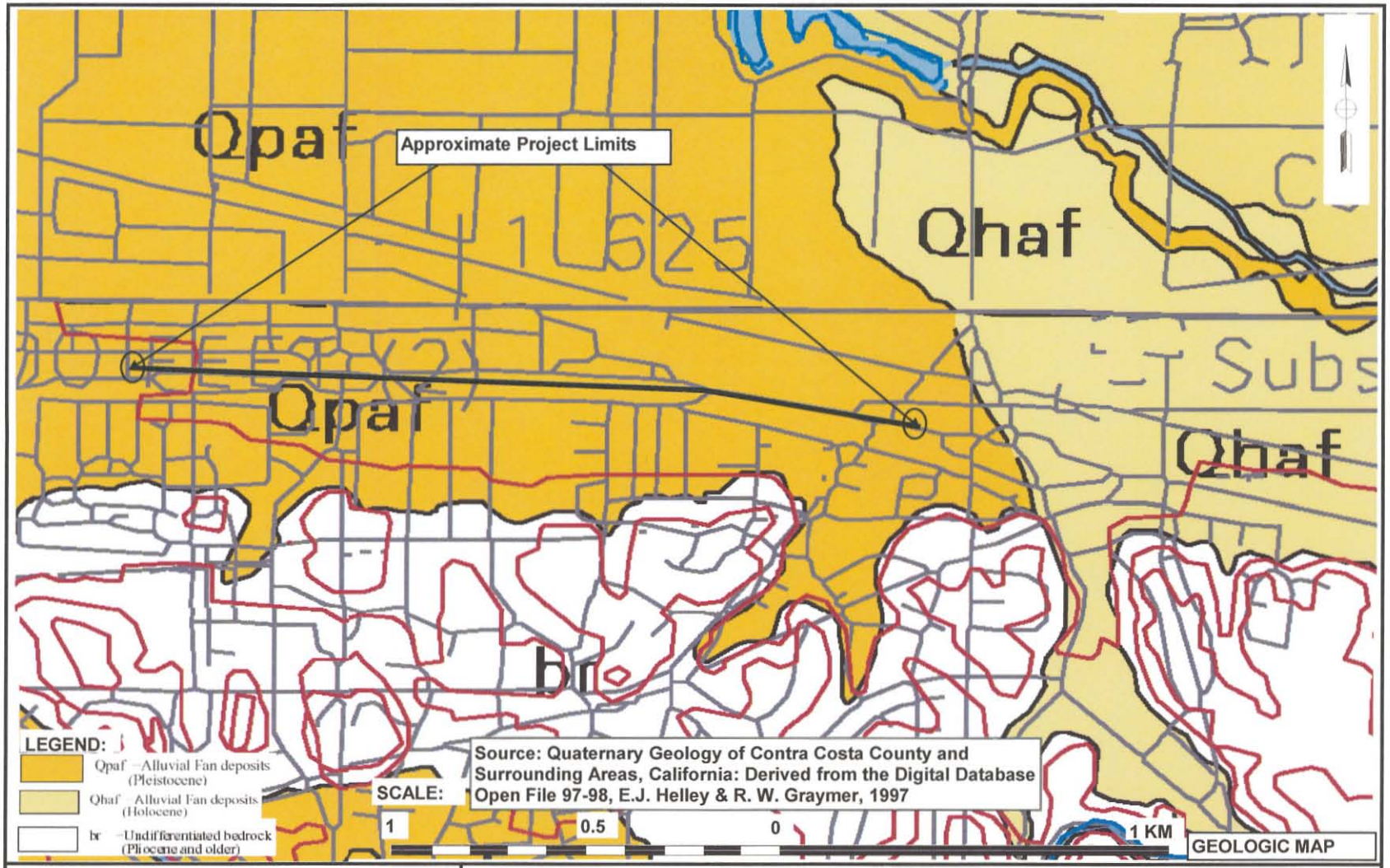
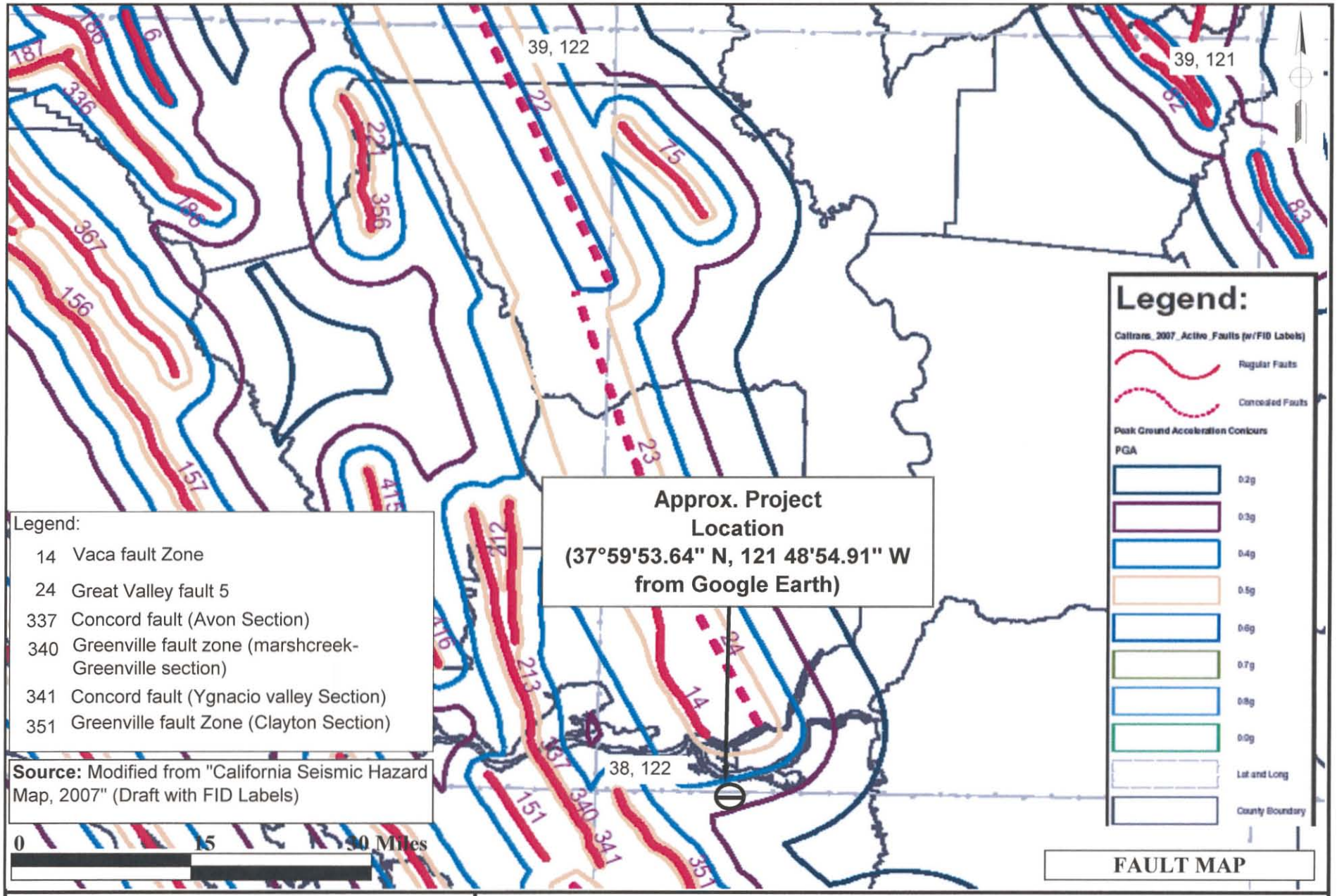


PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

STATE ROUTE 4 (EAST) WIDENING PROJECT - SEGMENT 3A
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO.: 206117.GDR | PLATE NO.: 3



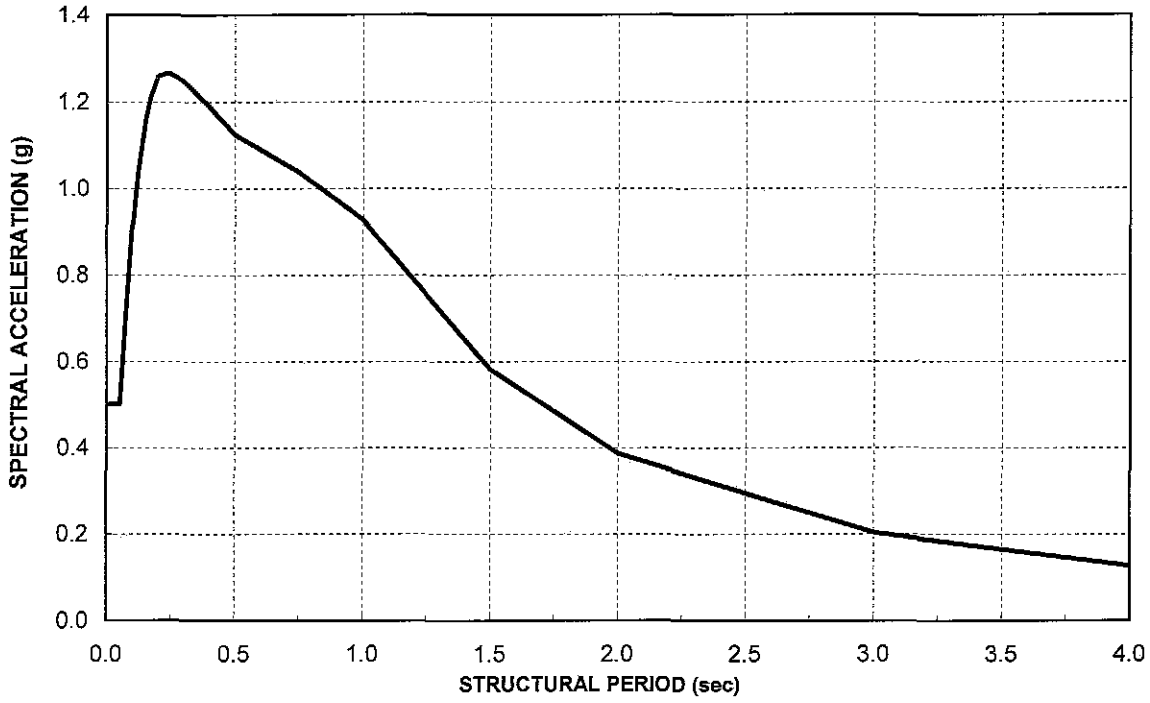
FAULT MAP

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

STATE ROUTE 4 (EAST) WIDENING PROJECT-SEGMENT 3A
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO.: 206117.GDR	PLATE NO.: 4

STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A
CONTRA COSTA COUNTY, CALIFORNIA



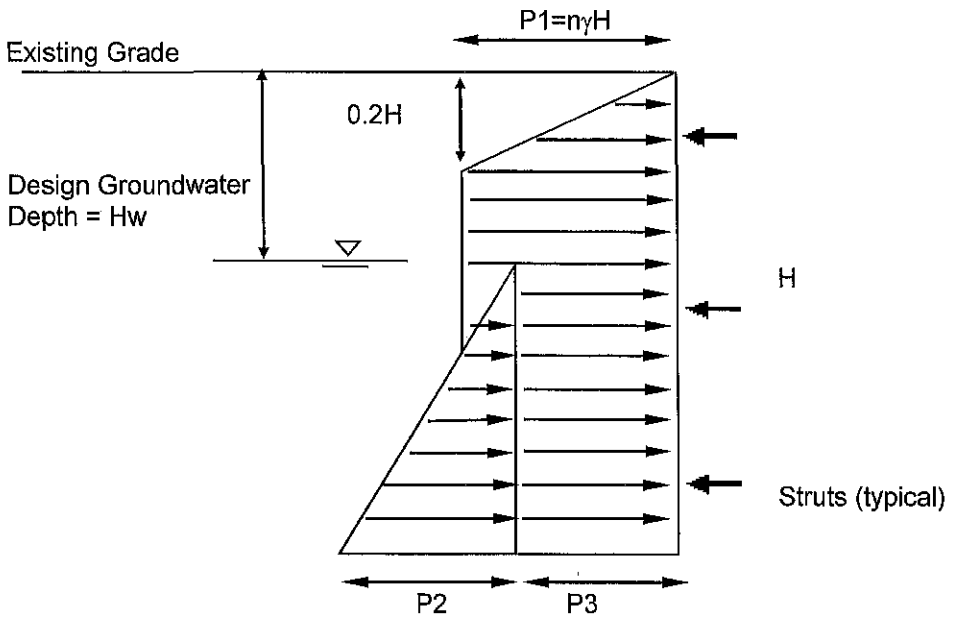
Spectral Data

Period (sec)	Spectral Accel. (g)
0.010	0.500
0.020	0.500
0.030	0.500
0.050	0.500
0.075	0.719
0.100	0.919
0.120	1.037
0.150	1.156
0.170	1.209
0.200	1.259
0.240	1.266
0.300	1.247
0.400	1.190
0.500	1.125
0.750	1.038
1.000	0.927
1.500	0.581
2.000	0.386
3.000	0.204
4.000	0.128

Caltrans SDC (v 1.4, June 2006), Figure B.8,
Governing Fault: Vaca Fault Zone
Fault Distance = 5.45 km (3.3 miles)
(Mw = 6.9, Soil Profile Type D, PBA = 0.5g)

Notes:
(a) The new (in-progress) Caltrans Hazard Map and Data Base was used
(b) PBA was obtained by using Sadigh Attenuation Relationship: 0.49g (rounded off to 0.5 g)
(c) The following modifications were then applied for near-fault effects:
- (1) No change of Sa for structural periods ≤ 0.5 sec
- (2) 20% increase of Sa for structural periods > 1 sec
- (3) Linear interpolation for structural periods between 0.5 and 1 sec

LATERAL EARTH PRESSURE DIAGRAM FOR SHORING DESIGN



H = Excavation Depth in feet

P1 = nγH = 0.3(125)H = 37.5H psf

P2 = 62.4 (H-Hw) psf

P3 = n(γHw + γ'(H - Hw)) psf

γ = 125 pcf (Total Unit Weight)

γ' = 65 pcf (Buoyant Unit Weight)

1. The pressure diagram is based on average soil and groundwater conditions.
2. Lateral earth pressure should be checked where conditions are different.
3. All relevant surcharge loads including construction operation should be added for designing the shoring system.

LATERAL EARTH PRESSURE DIAGRAM FOR SHORING DESIGN

PARIKH

Practicing in the Geosciences

STATE ROUTE 4 (EAST) WIDENING PROJECT-SEGMENT 3A
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO.: 206117.GDR	PLATE NO. 6

APPENDIX A

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 GUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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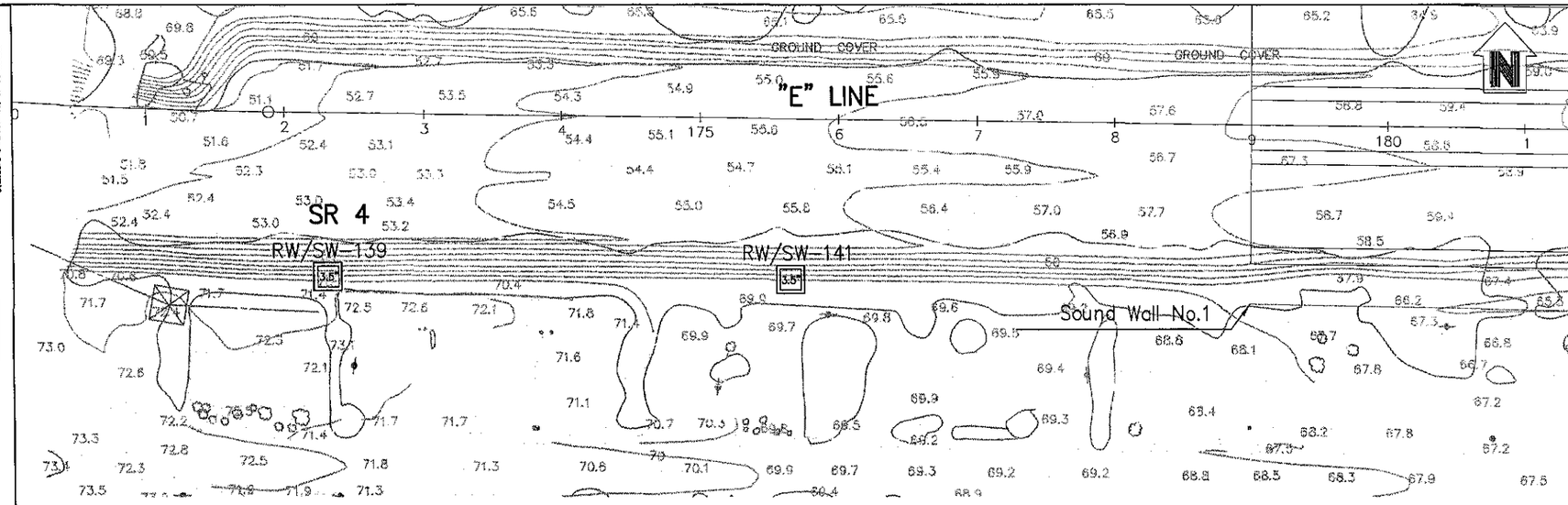
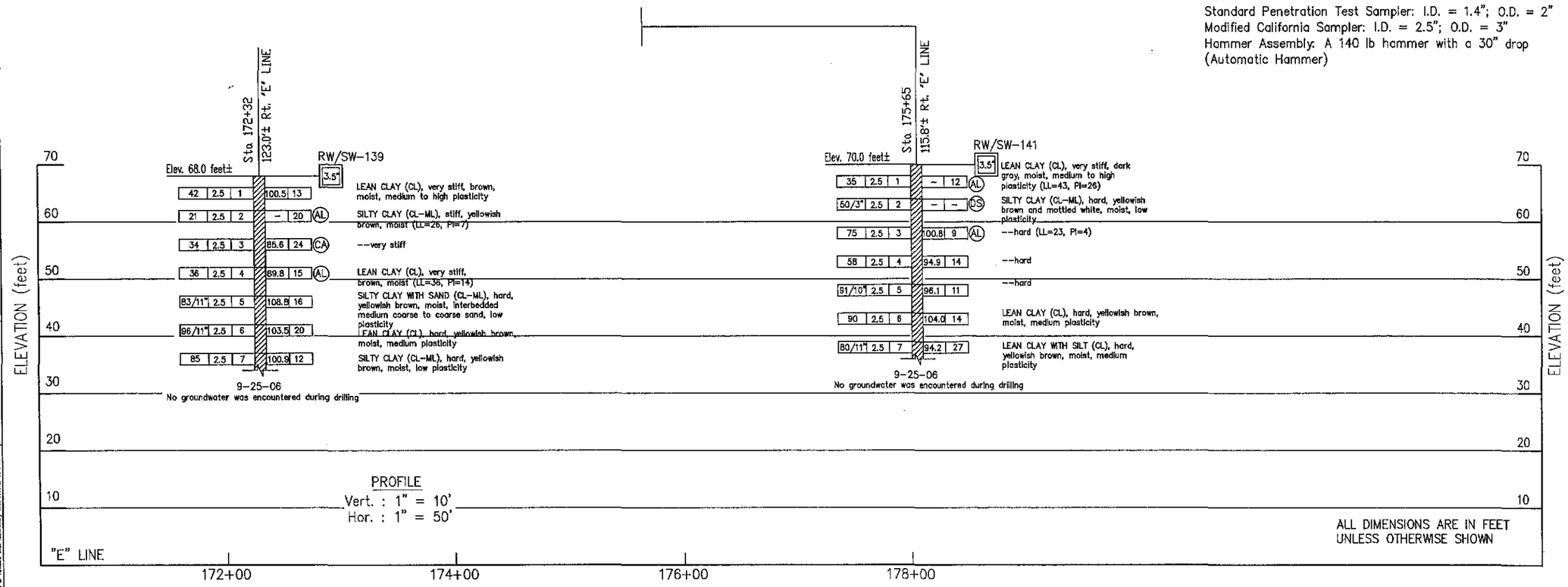


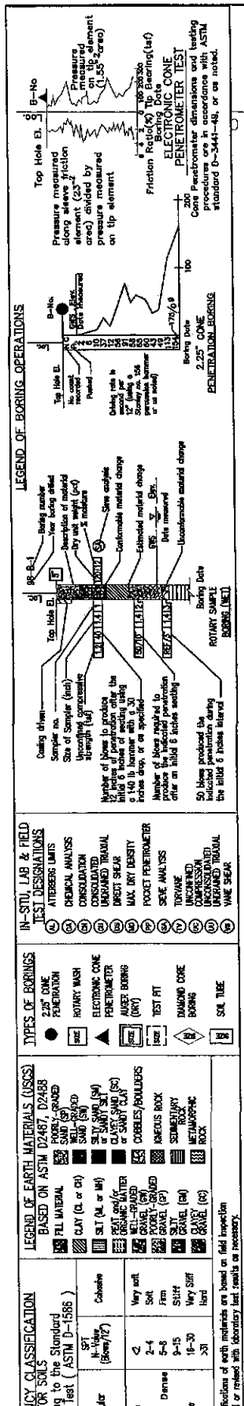
PLAN
1"=50'

Note:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)



PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN



DESIGN OVERSIGHT		DESIGN By: D. GOUTHIER	Field Investigation by: G. TRIPATHI	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	P. SIRCAR PROJECT ENGINEER	STRUCTURE NO.	STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A
SIGN OFF DATE		CHECKED By: P. SIRCAR				POST MILES (PM)	LOG OF TEST BORINGS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04725
EA 2285F1

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) 08/14/09 03/01/10

SHEET 1 OF 24

PLATE A-1

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE, 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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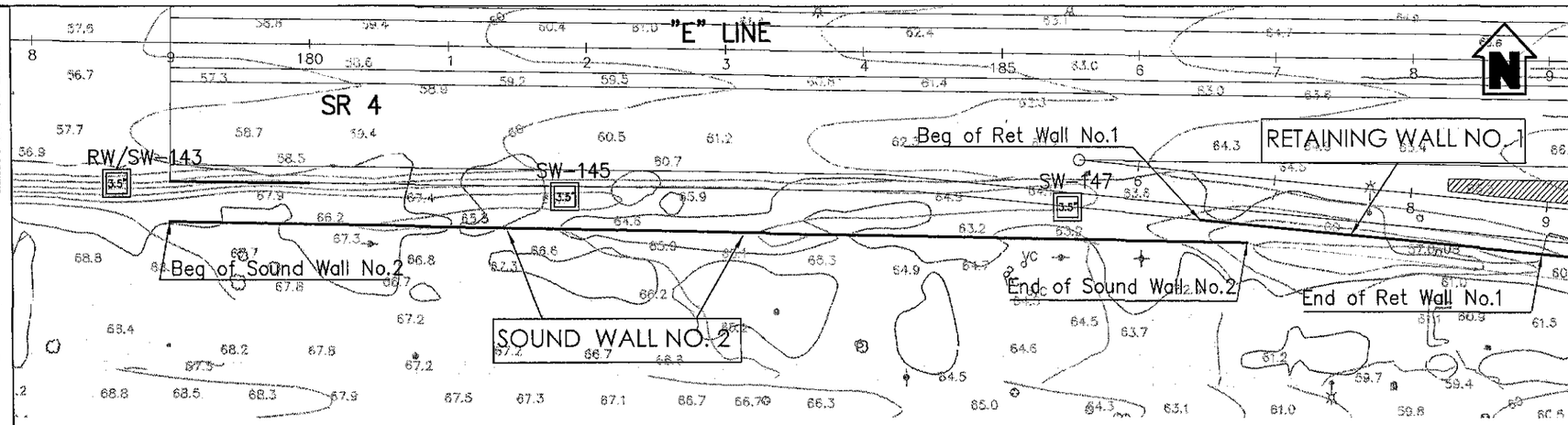

PLAN
1"=50'

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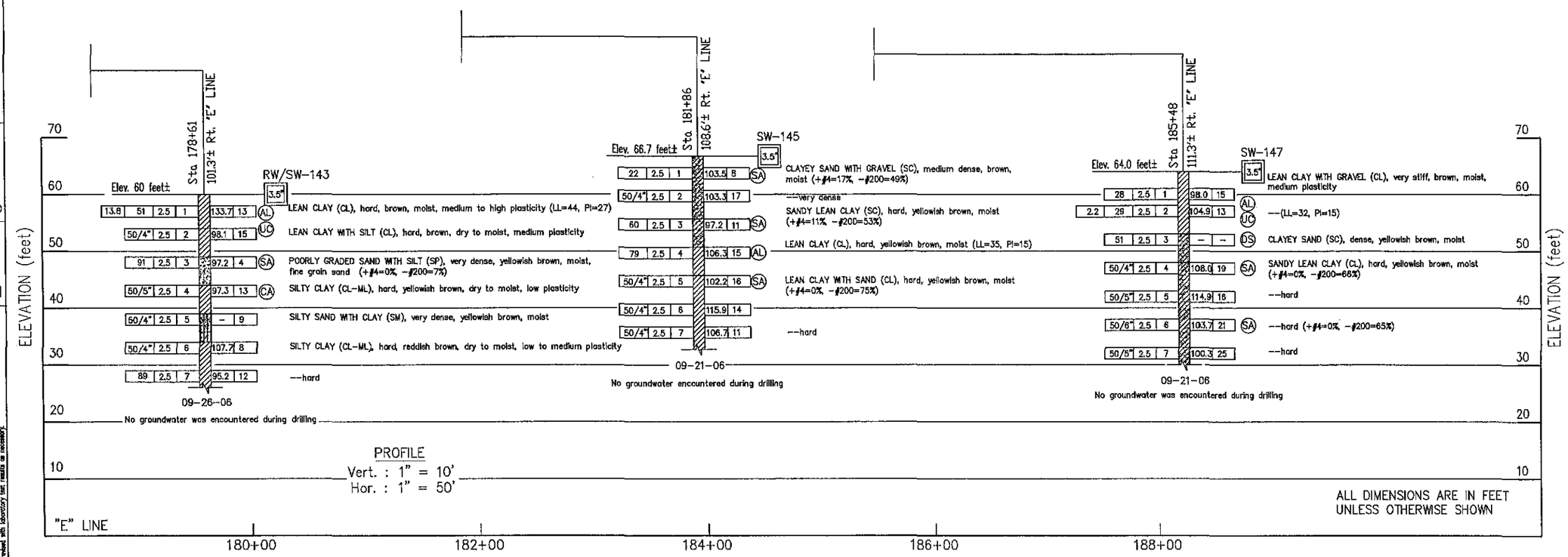
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)



PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

LEGEND OF BORING OPERATIONS

IN-SITU, LAB & FIELD TEST DESIGNATIONS: ATTERBERG LIMITS; CHEMICAL ANALYSIS; CONSOLIDATION; CONSOLIDATED UNDRAINED DIRECT SHEAR; MAX. DRY DENSITY; POCKET PENETROMETER; SIEVE ANALYSIS; TORVANE; UNCONFINED COMPRESSION; UNCONSOLIDATED UNDRAINED VANE SHEAR

TYPES OF BORINGS: 2.25" CONE PENETRATION; ROTARY WASH; ELECTRONIC CONE PENETROMETER; AUGER BORING (DRY); TEST PIT; DIAMOND CORE BORING; SOIL TUBE

LEGEND OF EARTH MATERIALS (USCS) BASED ON ASTM D2487, D2488: FILL MATERIAL; CLAY (CL or CH); SILT (ML or MH); PEAT and/or ORGANIC WATER SENSITIVE SOILS; POORLY-GRADED GRAVEL (GP); WELL-GRADED GRAVEL (GW); POORLY-GRADED SAND (SP); WELL-GRADED SAND (SW); SILTY GRAVEL (GM); CLAYEY GRAVEL (GC); SILTY SAND (SM); CLAYEY SAND (SC); SILTY CLAY or SANDY CLAY; COBBLES/BOULDERS; INFERIOUS ROCK; SEDIMENTARY ROCK; METAMORPHIC ROCK

CONSISTENCY CLASSIFICATION FOR SOILS According to the Standard Penetration Test (ASTM D-1586)

SPT N-Value (Blows/ft)	Granular	SPT N-Value (Blows/ft)	Cohesive
0-4	Very loose	<2	Very soft
5-10	Loose	2-4	Soft
11-30	Medium Dense	5-8	Firm
31-50	Dense	9-15	Stiff
>50	Very Dense	16-30	Very Stiff
		>30	Hard

NOTE: Visual classifications of earth materials are based on field inspection and or a confirmed or revised with laboratory test results as necessary.

DESIGN OVERSIGHT	DESIGN By: D. GOUTHIER	Field Investigation by: G. TRIPATHI	P. SIRCAR PROJECT ENGINEER
SIGN OFF DATE	CHECKED By: P. SIRCAR	ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5	CU 04725 EA 2285F1

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

STRUCTURE NO.
POST MILES (PM)

STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A

LOG OF TEST BORINGS

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) 08/14/09 03/01/10

SHEET 2 OF 24

PLATE A-2

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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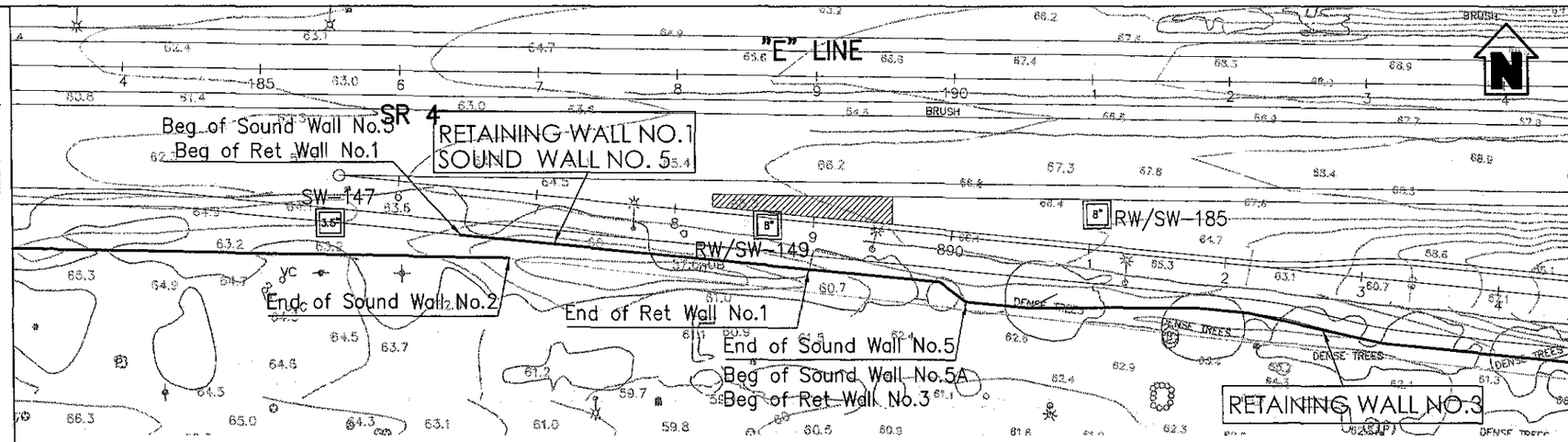

PLAN
1"=50'

Note:
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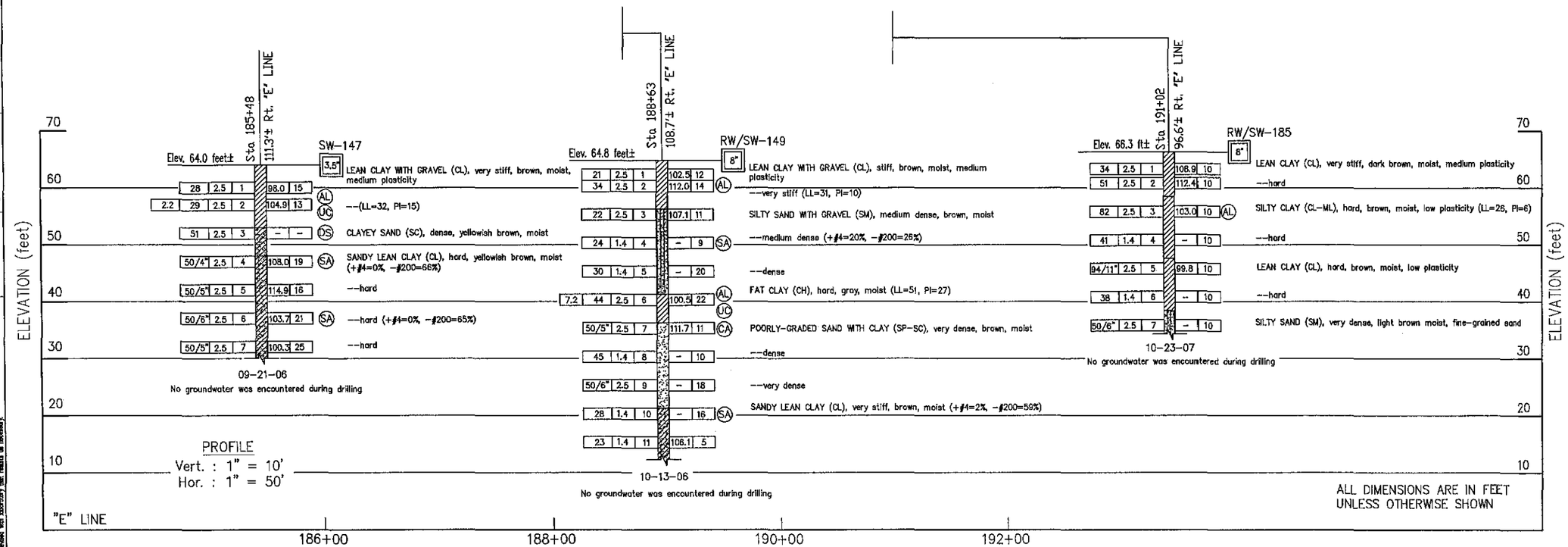
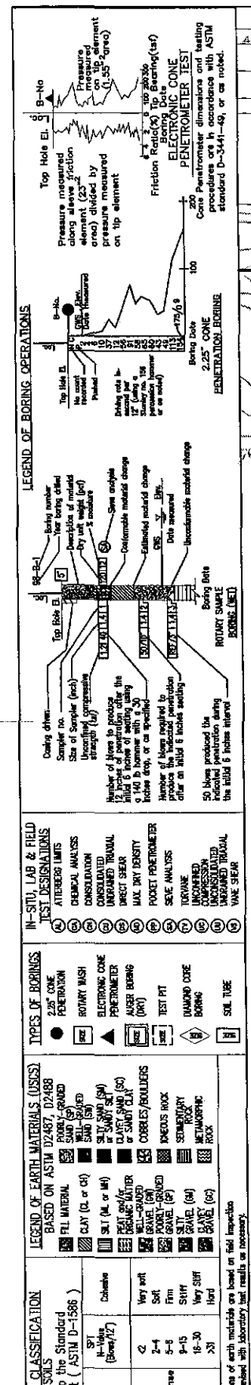


PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN



DESIGN OVERSIGHT		DESIGN	By: O. GOUTHIER	Field investigation by: G. TRIPATHI	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	P. SIRCAR PROJECT ENGINEER	STRUCTURE NO.	STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A
SIGN OFF DATE		CHECKED	By: P. SIRCAR			CU 04725 EA 2285F1	POST MILES (PM)	LOG OF TEST BORINGS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) ~~08/14/09~~ 03/01/10 | SHEET 3 | OF 24

PLATE A-3

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER–GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE. 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
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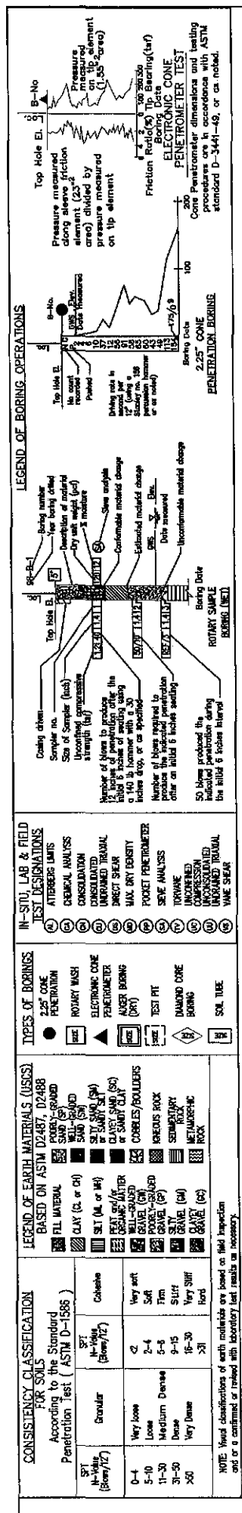

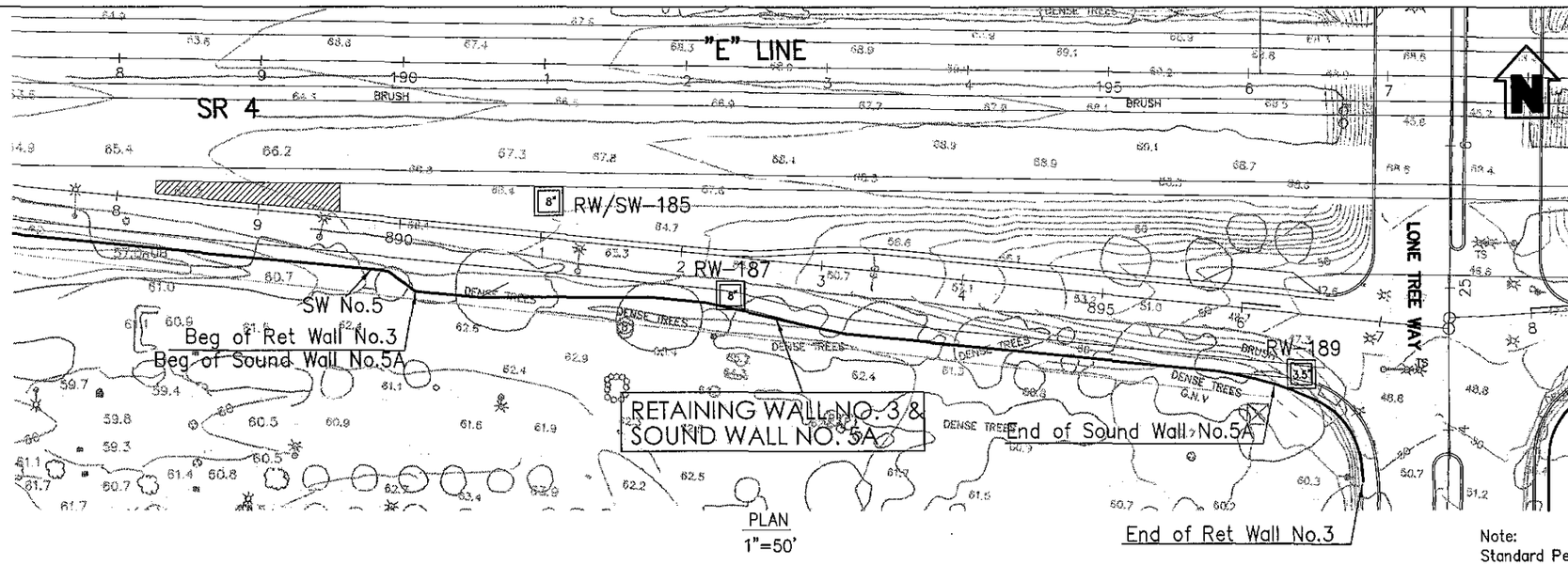

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1"=50'

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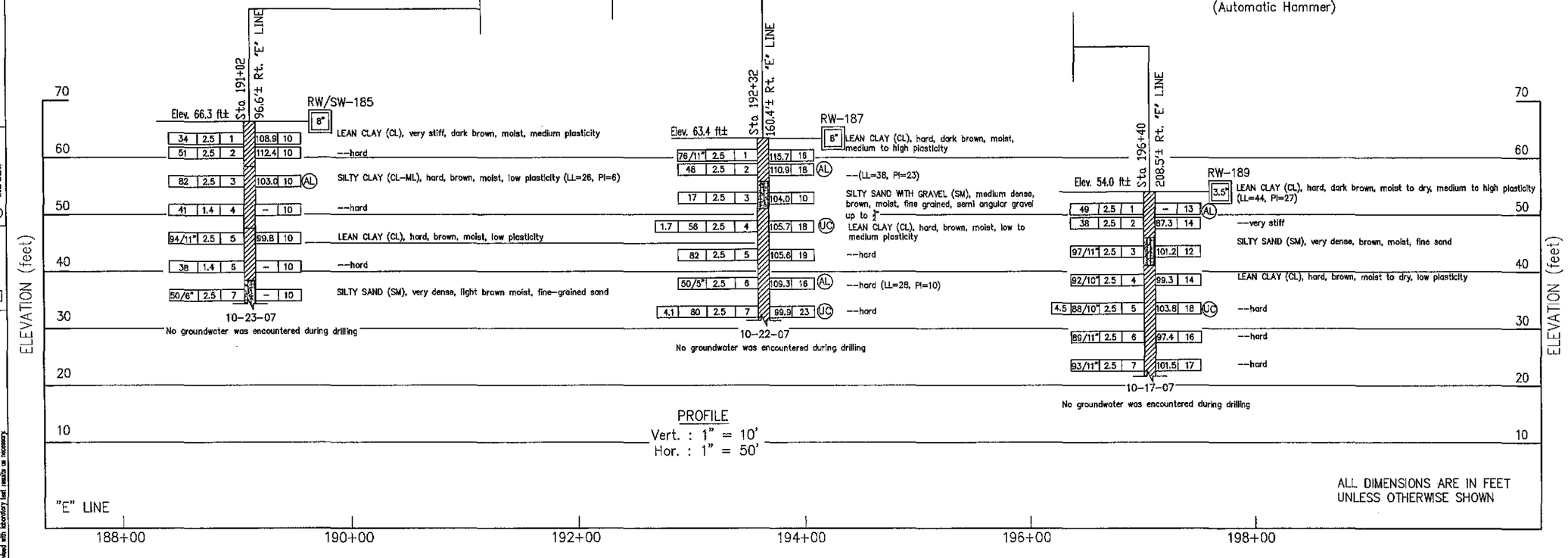

PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

DESIGN OVERSIGHT	DESIGN By: D. GOUTHIER	Field Investigation by: G. TRIPATHI	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION
SIGN OFF DATE	CHECKED By: P. SIRCAR	ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5	P. SIRCAR PROJECT ENGINEER

CU 04725
EA 2285F1

STRUCTURE NO.
POST MILES (PM)

STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A

LOG OF TEST BORINGS

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) ~~08/14/09~~ 03/01/10

SHEET 4 OF 24

PLATE A-4

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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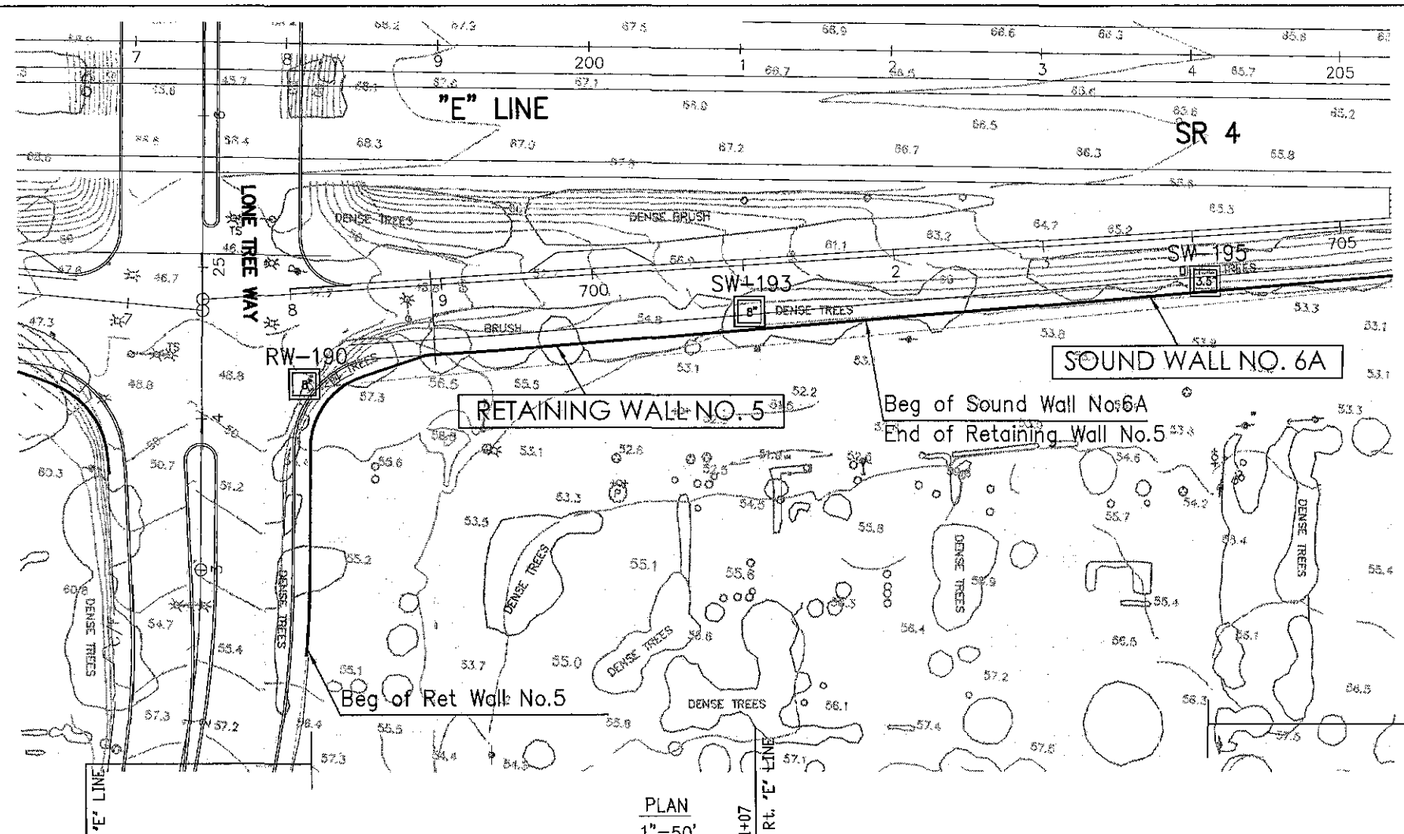

PLAN
1"=50'

Note:
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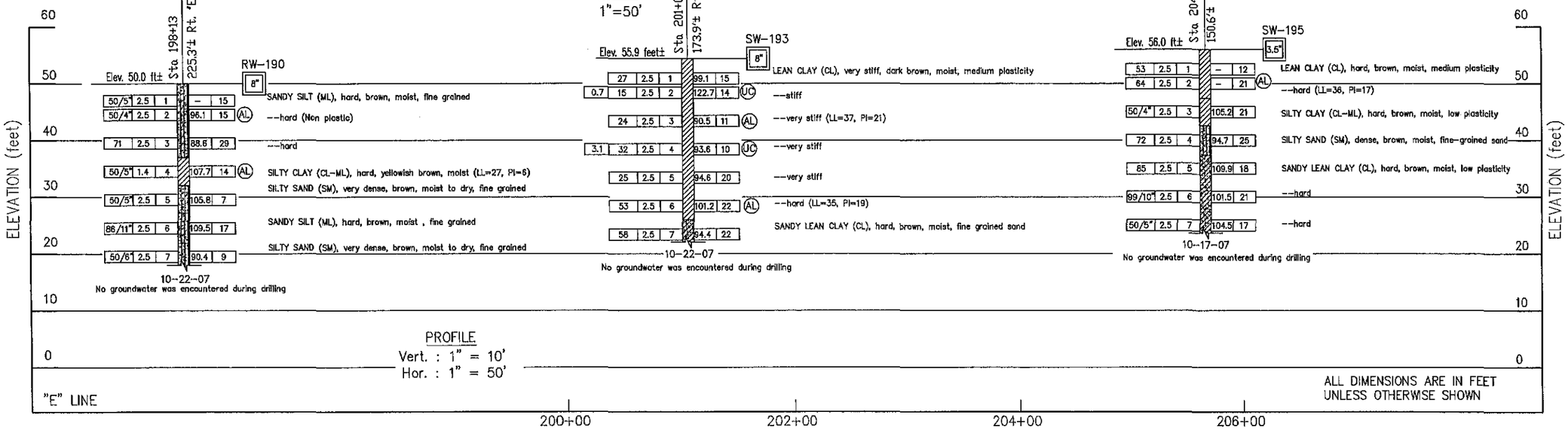

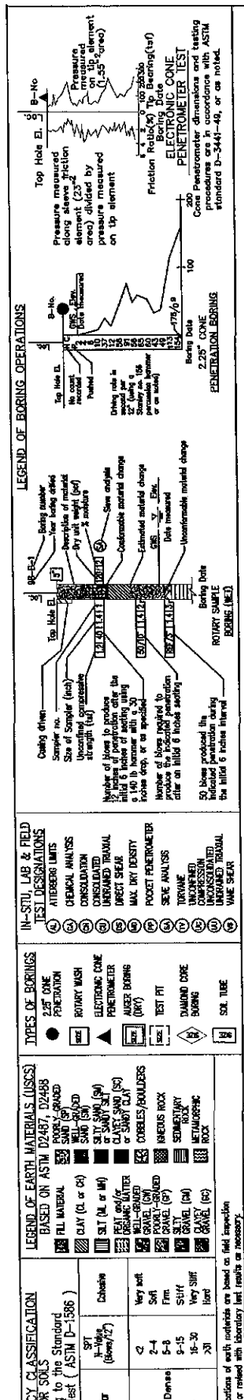

DESIGN OVERSIGHT

SIGN OFF DATE

DESIGN By: D. GOUTHIER
CHECKED By: P. SIRCAR

Field investigation by: G. TRIPATHI

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

P. SIRCAR
PROJECT ENGINEER

STRUCTURE NO.
POST MILES (PM)

STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A

LOG OF TEST BORINGS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04725
EA 2285F1

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) 08/14/09 03/01/10

SHEET 5 OF 24

PLATE A-5

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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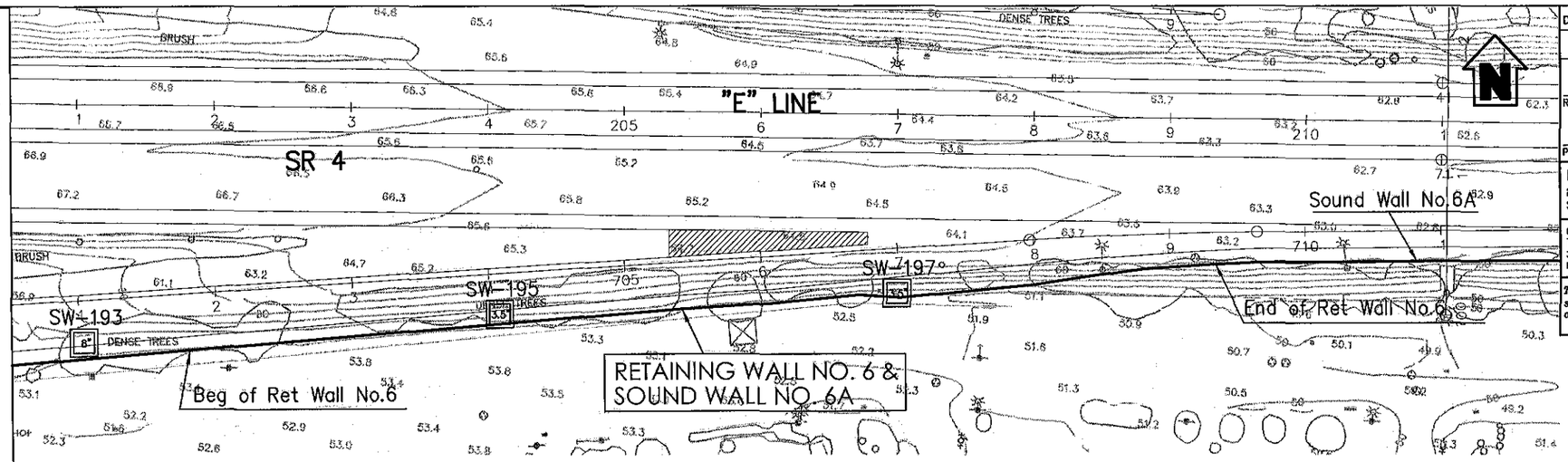
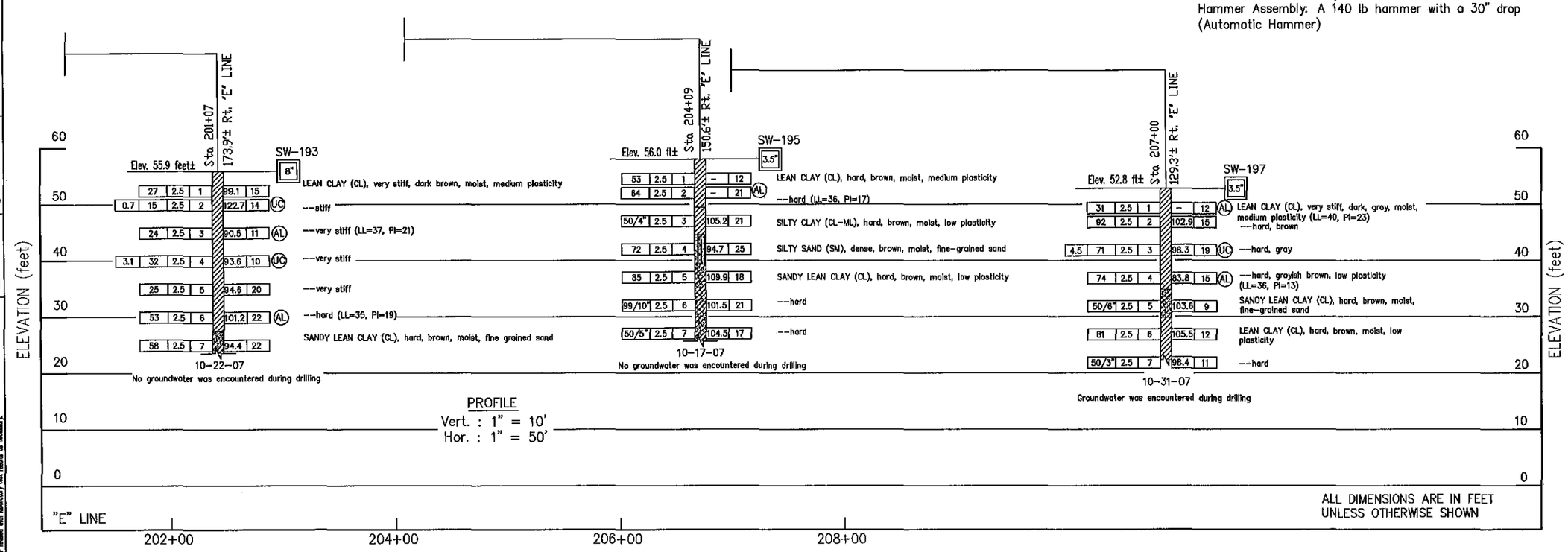


PLAN
1"=50'

Note:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)



PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

LEGEND OF BORING OPERATIONS

IN-SITU, LAB & FIELD TEST DESIGNATIONS

TYPES OF BORINGS

LEGEND OF EARTH MATERIALS (USCS) BASED ON ASTM D2487, D2488

CONSISTENCY CLASSIFICATION FOR SOILS According to the Standard Penetration Test (ASTM D-1586)

NOTE: Field classifications of earth materials are based on field inspection and or a combined or mixed with laboratory test results as necessary.

DESIGN OVERSIGHT		DESIGN By: D. GOUTHIER	Field Investigation by: G. TRIPATHI	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	P. SIRCAR PROJECT ENGINEER
SIGN OFF DATE		CHECKED By: P. SIRCAR			

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04725
EA 2285F1

STRUCTURE NO.

POST MILES (PM)

STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A

LOG OF TEST BORINGS

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) ~~08/14/09~~ 03/01/10

SHEET 6 OF 24

PLATE A-6

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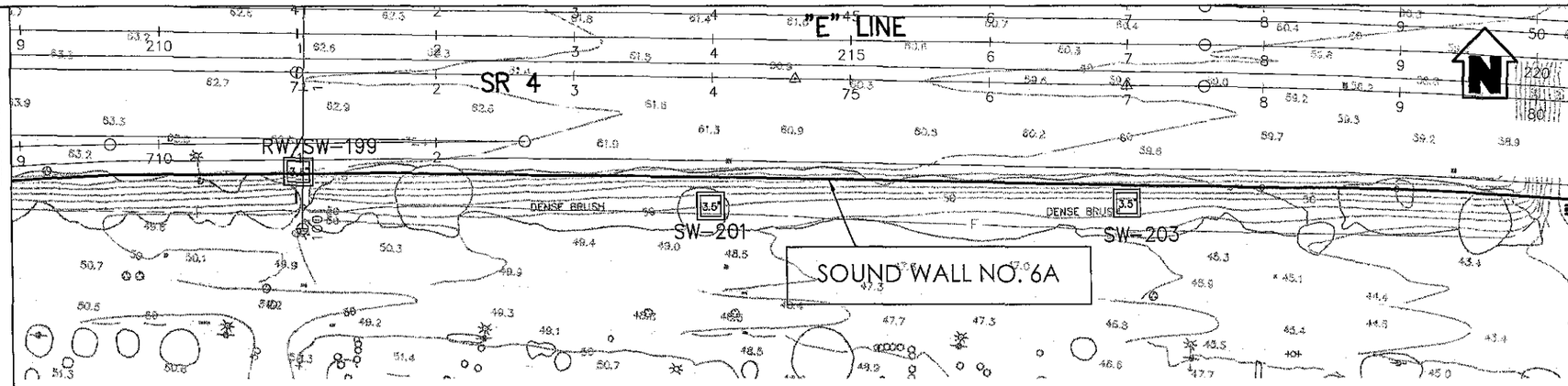

PLAN
1"=50'

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA
TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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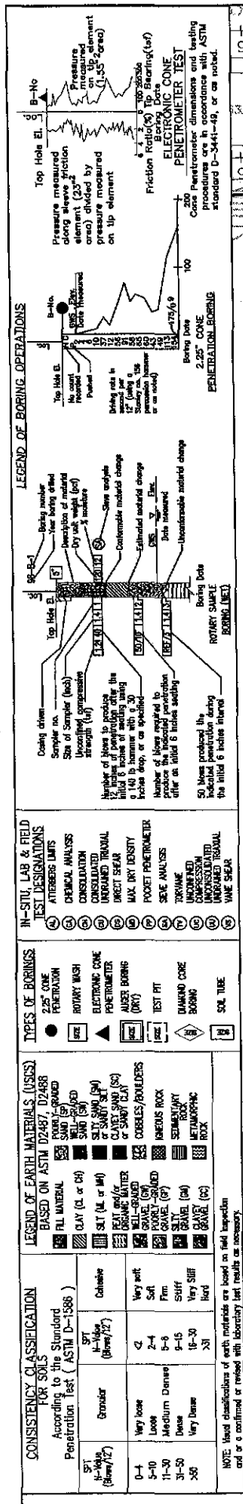
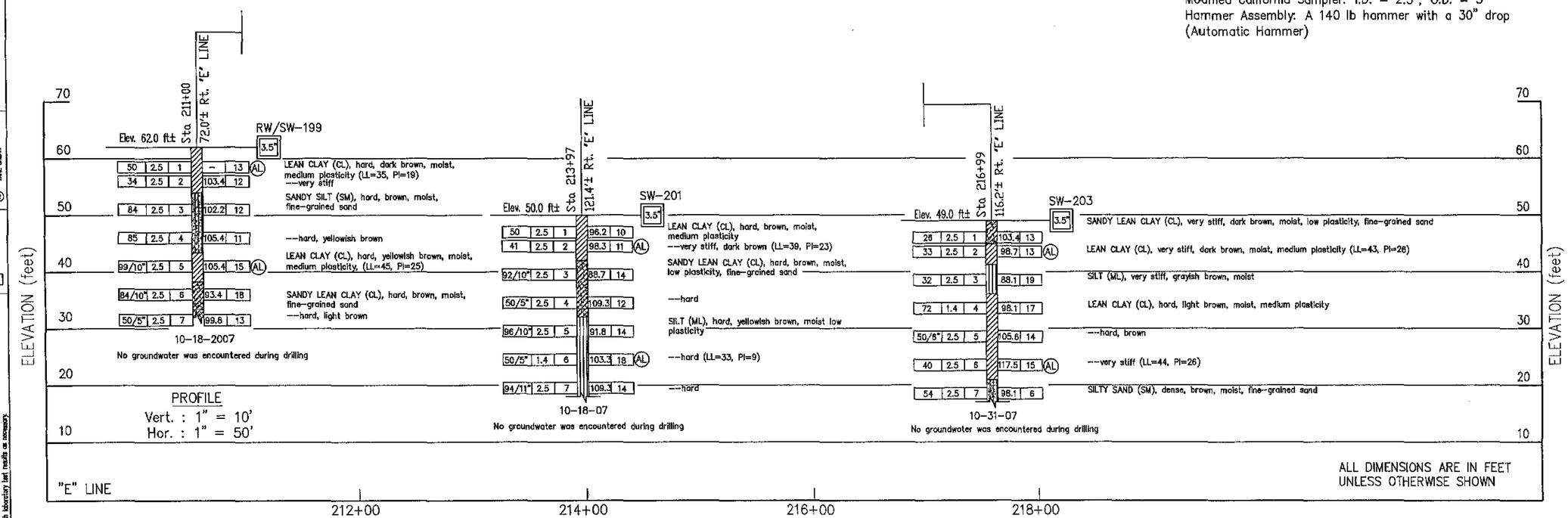


Note:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop
(Automatic Hammer)



PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

DESIGN OVERSIGHT	DESIGN By: D. GOUTHIER	Field investigation by: G. TRIPATHI	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	P. SIRCAR PROJECT ENGINEER	STRUCTURE NO. / POST MILES (PM)
SIGN OFF DATE	CHECKED By: P. SIRCAR				

STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A

LOG OF TEST BORINGS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04725
EA 2285F1

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) ~~08/11/09~~ 03/01/10

SHEET 7 OF 24

PLATE A-7

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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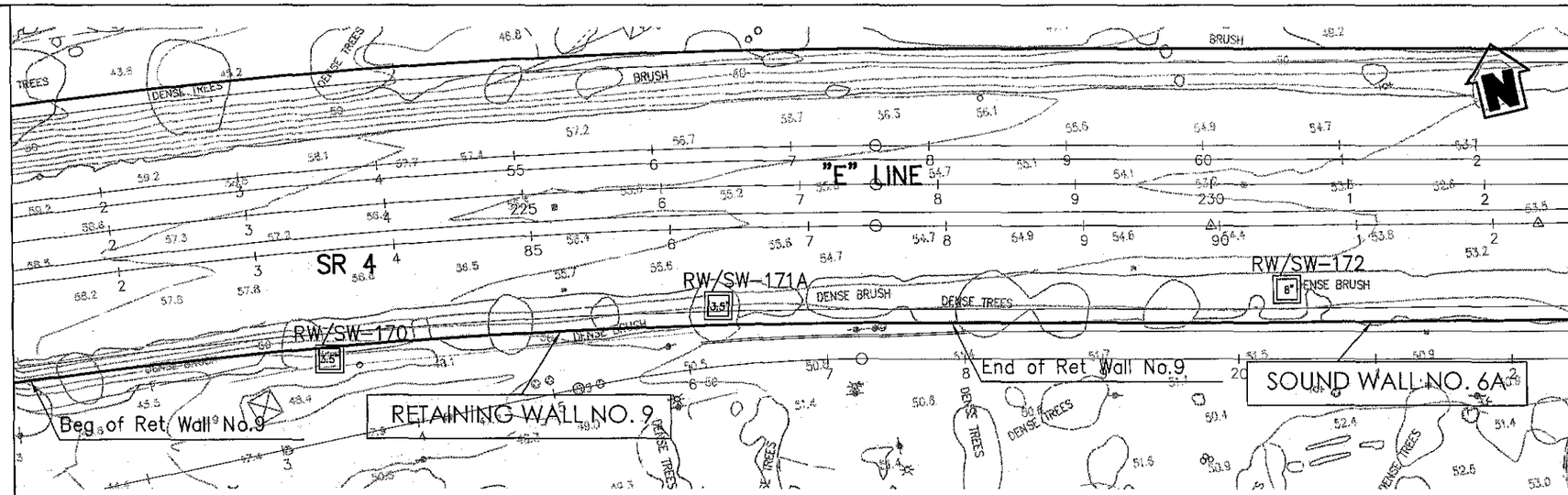
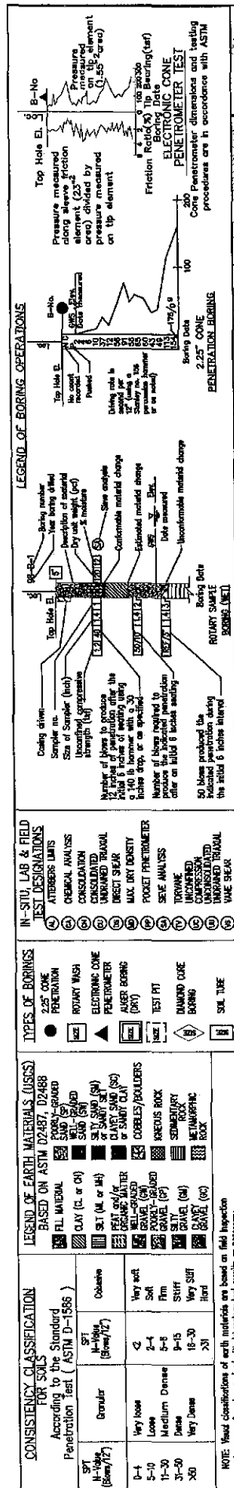
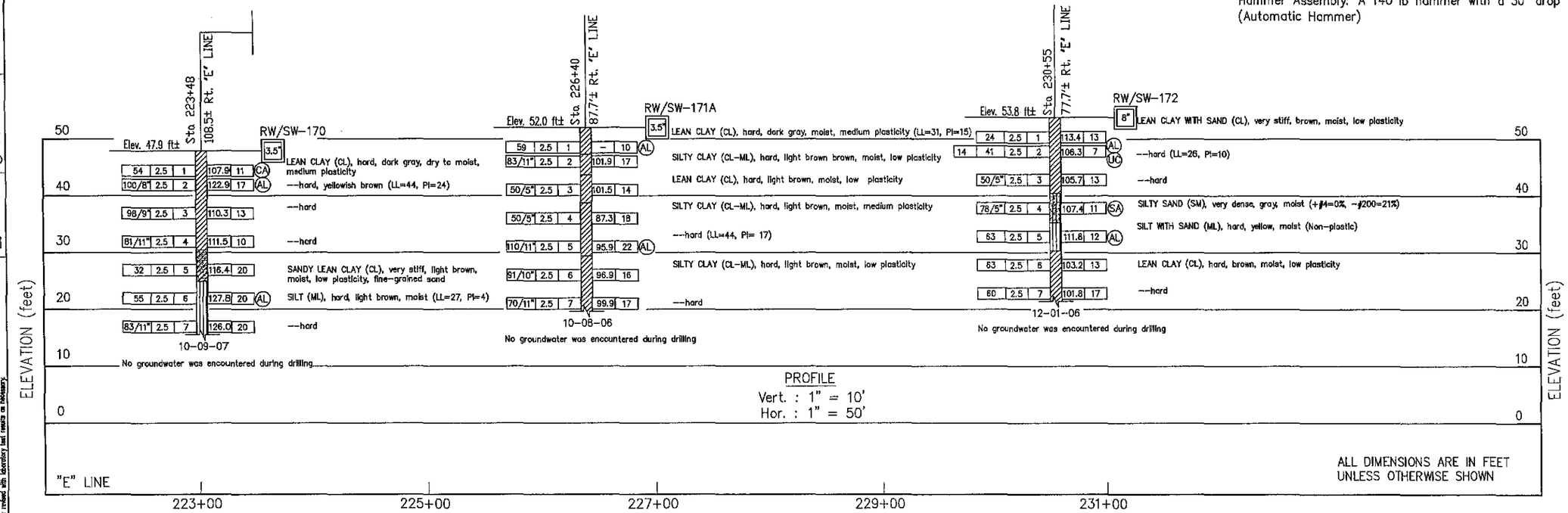


PLAN
1"=50'





PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

Note:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

DESIGN OVERSIGHT
SIGN OFF DATE

DESIGN By: D. GOUTHIER
CHECKED By: P. SIRCAR

Field Investigation by: G. TRIPATHI

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

P. SIRCAR
PROJECT ENGINEER

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04725
EA 2285F1

STRUCTURE NO.
POST MILES (PM)

STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A

LOG OF TEST BORINGS

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) ~~08/14/09~~ 03/01/10

SHEET 8 OF 24

PLATE A-8

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE 665 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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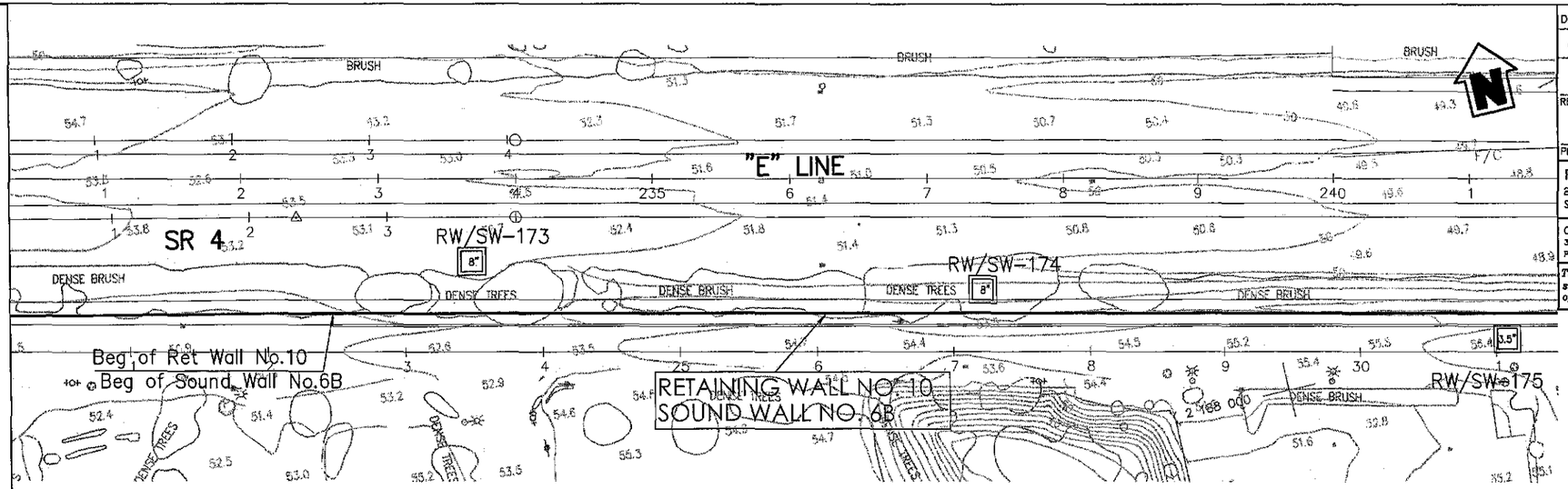
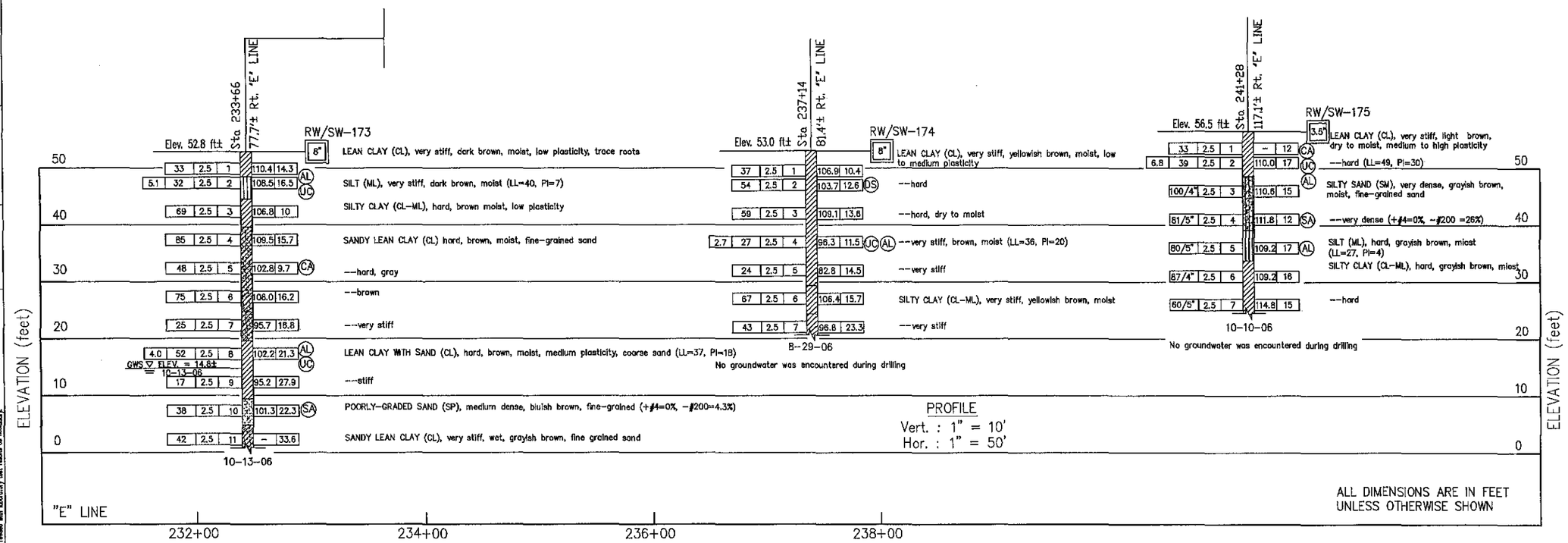


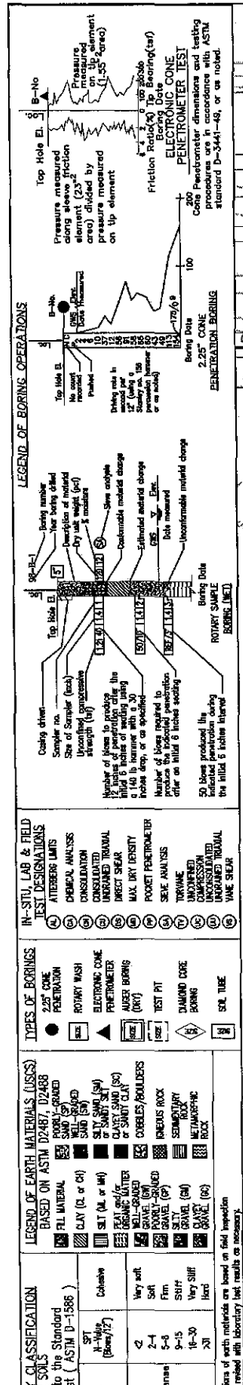
PLAN
1"=50'

Note:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)



PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN



DESIGN OVERSIGHT		DESIGN	By: D. GOUTHIER	Field investigation by: G. TRIPATHI	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	P. SIRCAR PROJECT ENGINEER	STRUCTURE NO.	STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A
SIGN OFF DATE		CHECKED	By: P. SIRCAR				POST MILES (PM)	LOG OF TEST BORINGS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04725
EA 2285F1

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) ~~08/14/09~~ 03/01/10

SHEET 9 OF 24

PLATE A-9

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER–GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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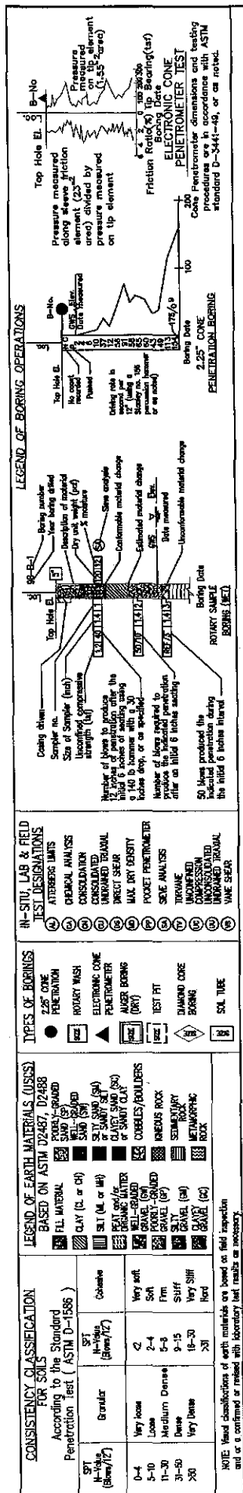
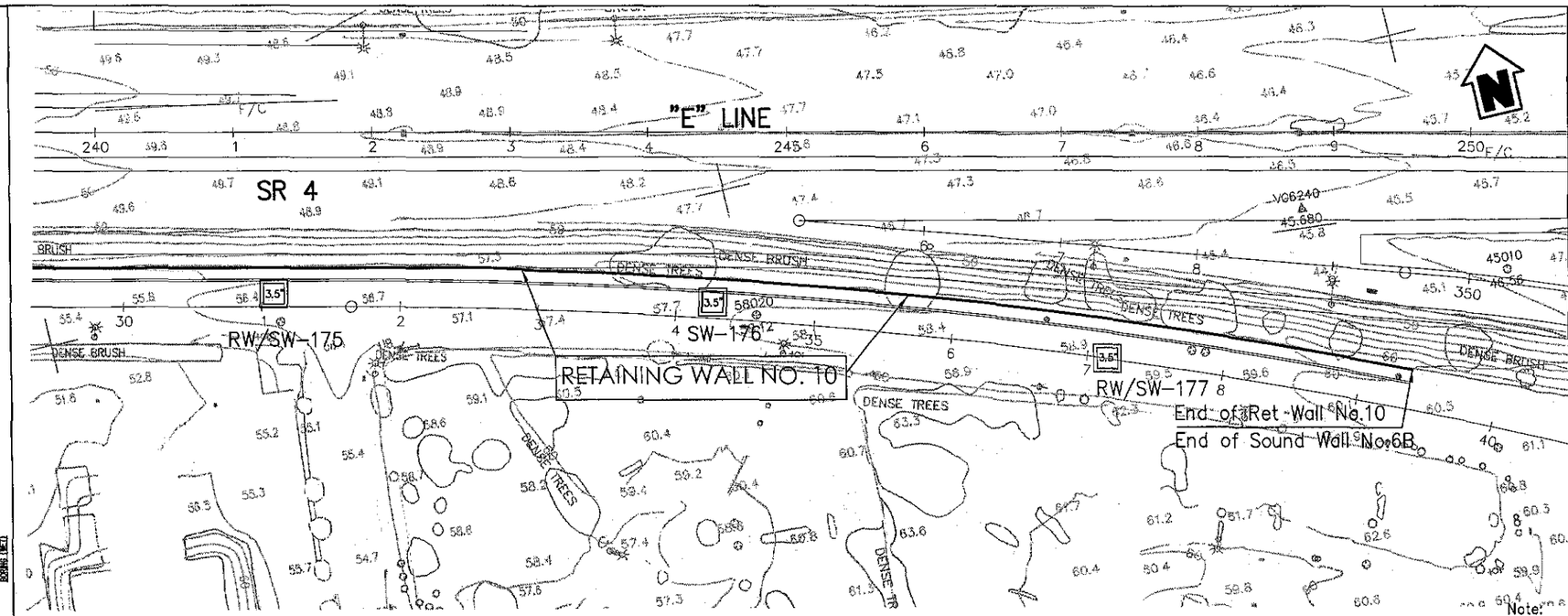
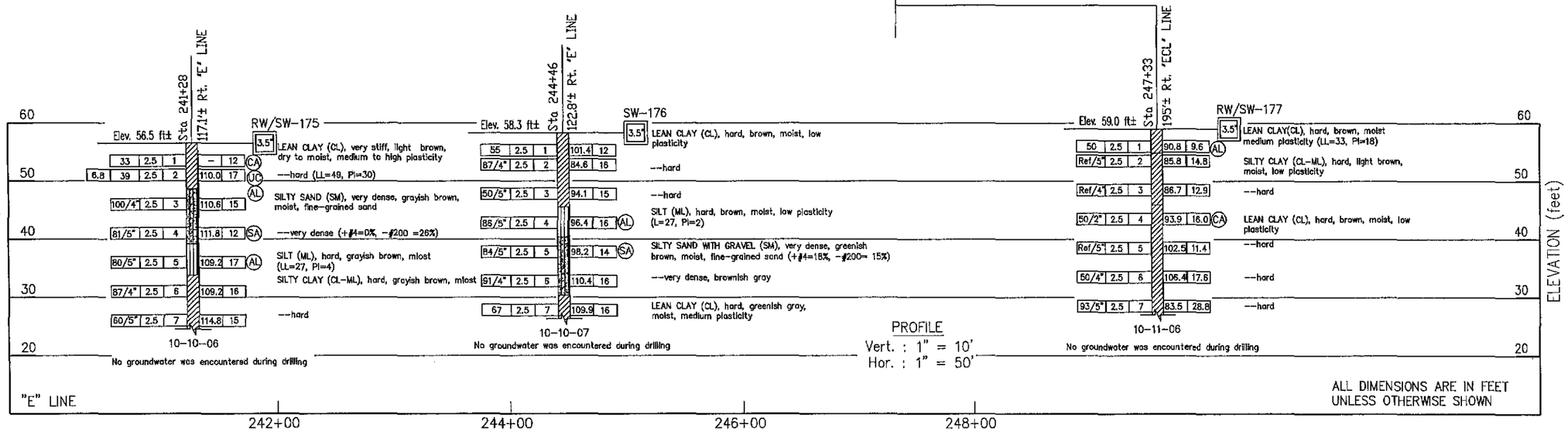




PLAN
1"=50'

Note:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)



PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

DESIGN OVERSIGHT

SIGN OFF DATE

DESIGN By: D. GOUTHIER
CHECKED By: P. SIRCAR

Field Investigation by: G. TRIPATHI

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

P. SIRCAR
PROJECT ENGINEER

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04725
EA 2285F1

STRUCTURE NO.
POST MILES (PM)

STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A

LOG OF TEST BORINGS

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) 08/14/09 03/01/10

SHEET 10 OF 24

PLATE A-10

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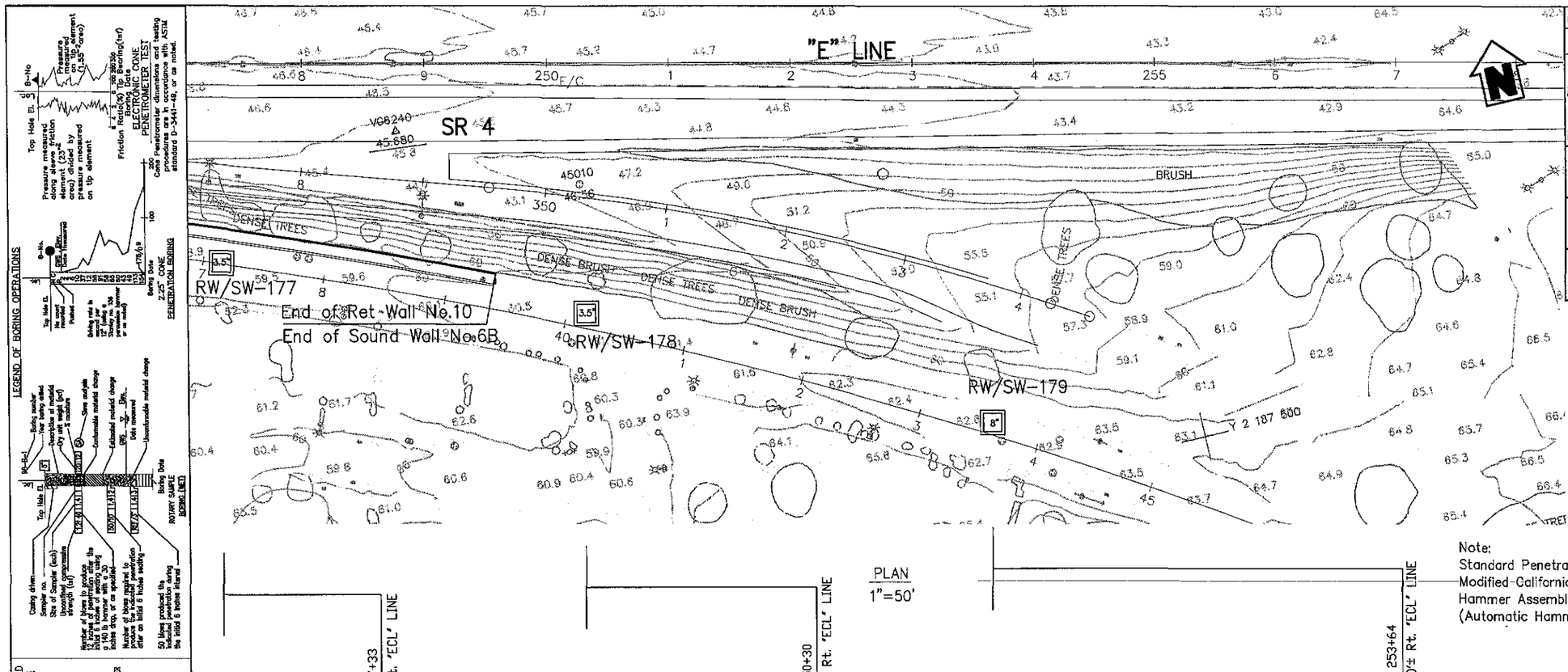

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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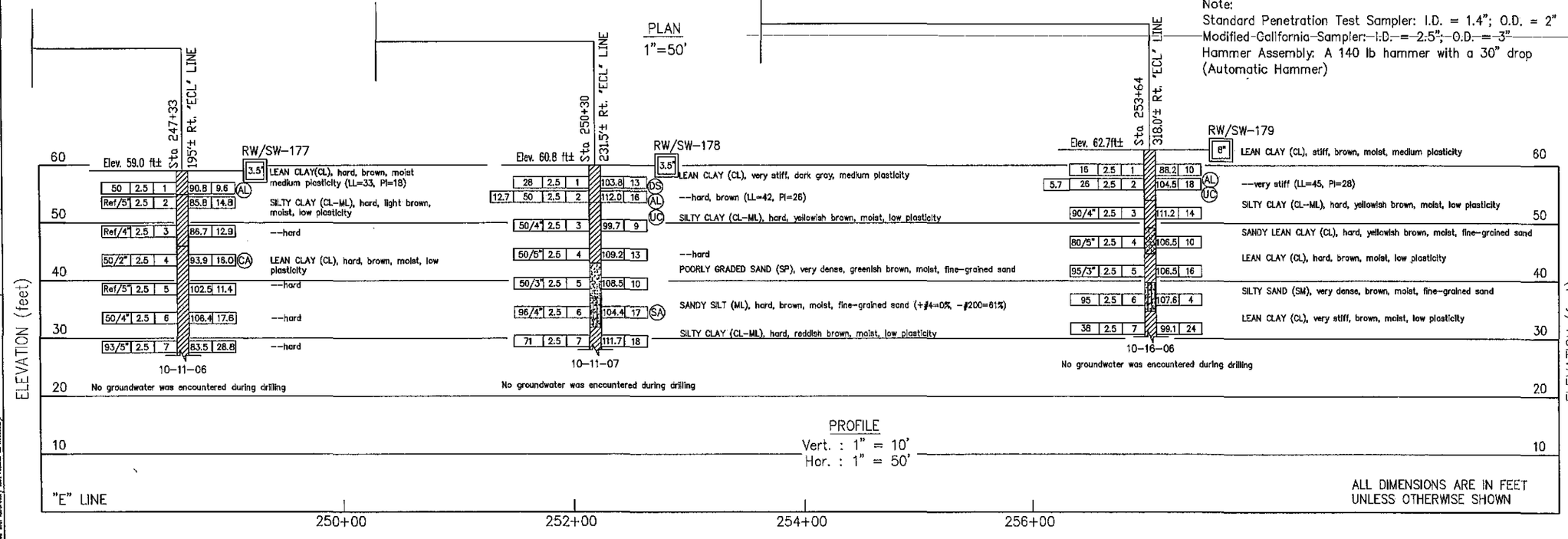
PLAN
1"=50'

Note:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)



DESIGN OVERSIGHT	DESIGN By: D. GOUTHIER	Field Investigation by: G. TRIPATHI	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	STRUCTURE NO.	STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A
SIGN OFF DATE	CHECKED By: P. SIRCAR		P. SIRCAR PROJECT ENGINEER	POST MILES (PM)	LOG OF TEST BORINGS
		ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5	CU 04725 EA 2285F1	DISREGARD PRINTS BEARING EARLIER REVISION DATES →	REVISION DATES (PRELIMINARY STAGE ONLY) ~~08/14/09~~ 03/01/10 — SHEET 11 OF 24

PLATE A-11

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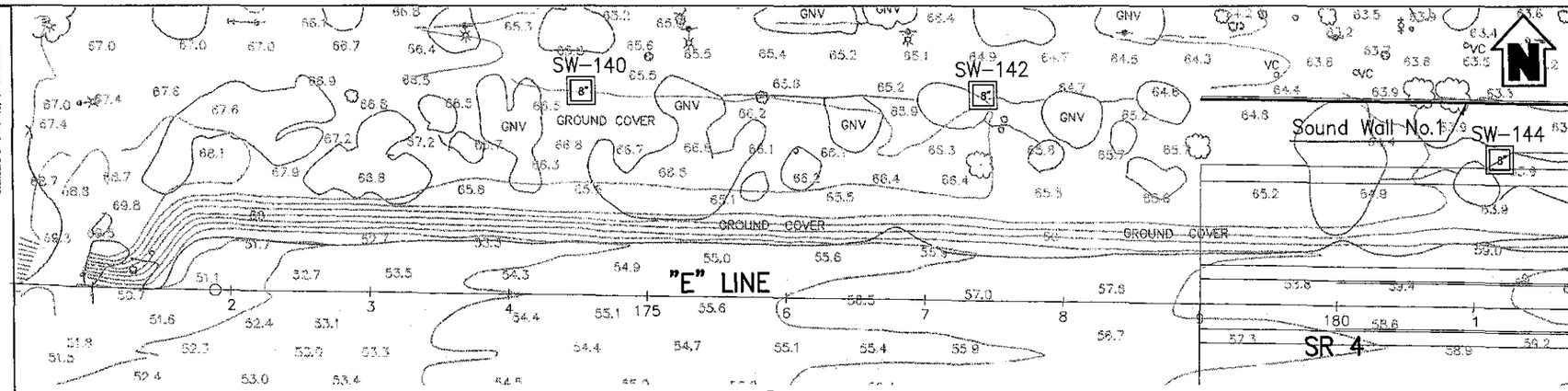

PLAN
1"=50'

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA
TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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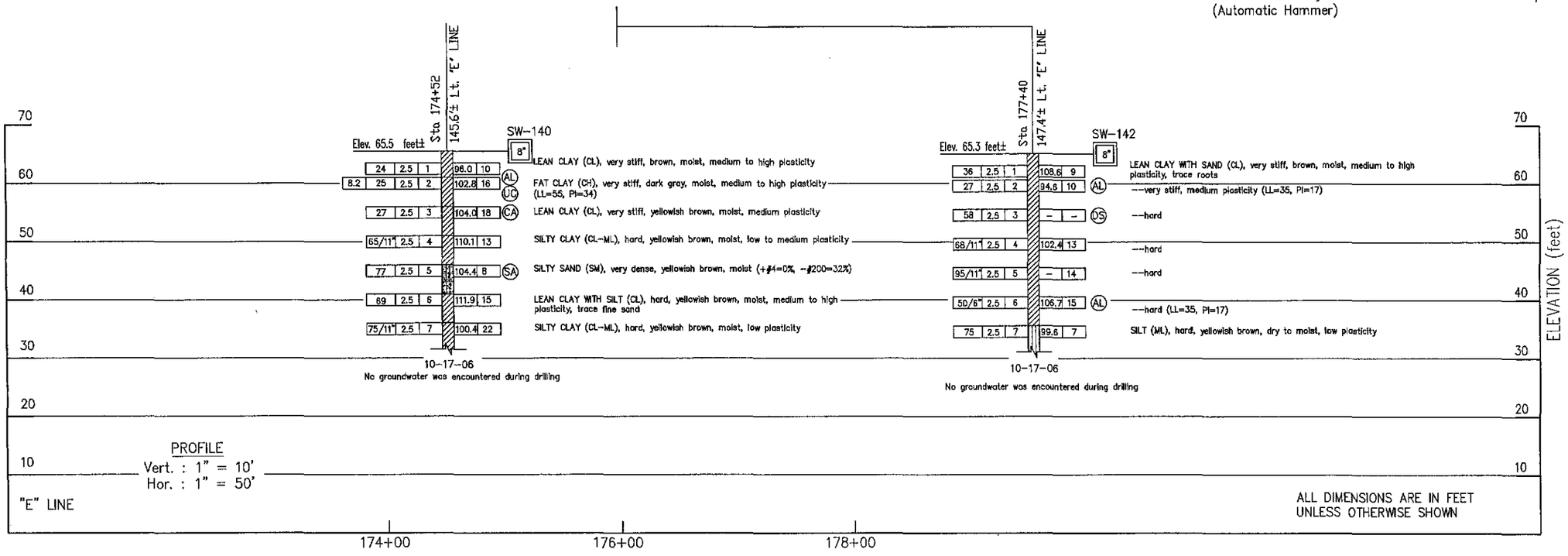
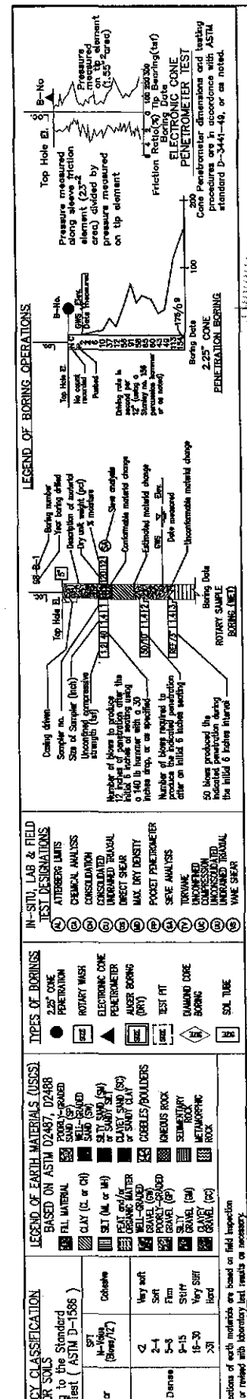
Note:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)



PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN



DESIGN OVERSIGHT	DESIGN By: D. GOUTHIER	Field Investigation by: G. TRIPATHI	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	P. SIRCAR PROJECT ENGINEER	STRUCTURE NO. / KILO POST (PM)	STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A
SIGN OFF DATE	CHECKED By: P. SIRCAR					LOG OF TEST BORINGS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04725
EA 2285F1

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) 08/14/09 03/01/10

SHEET 12 OF 24

PLATE A-12

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DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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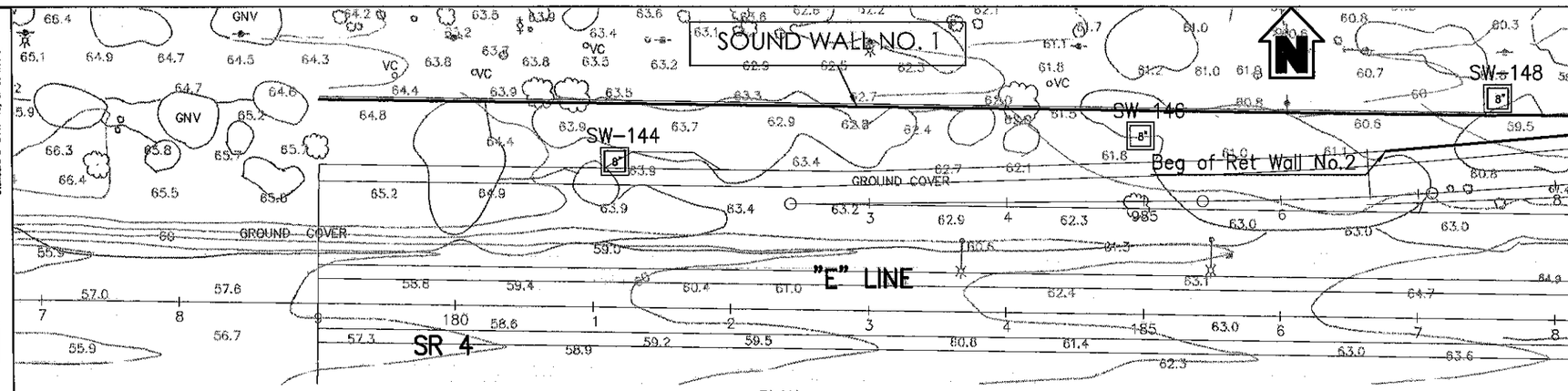
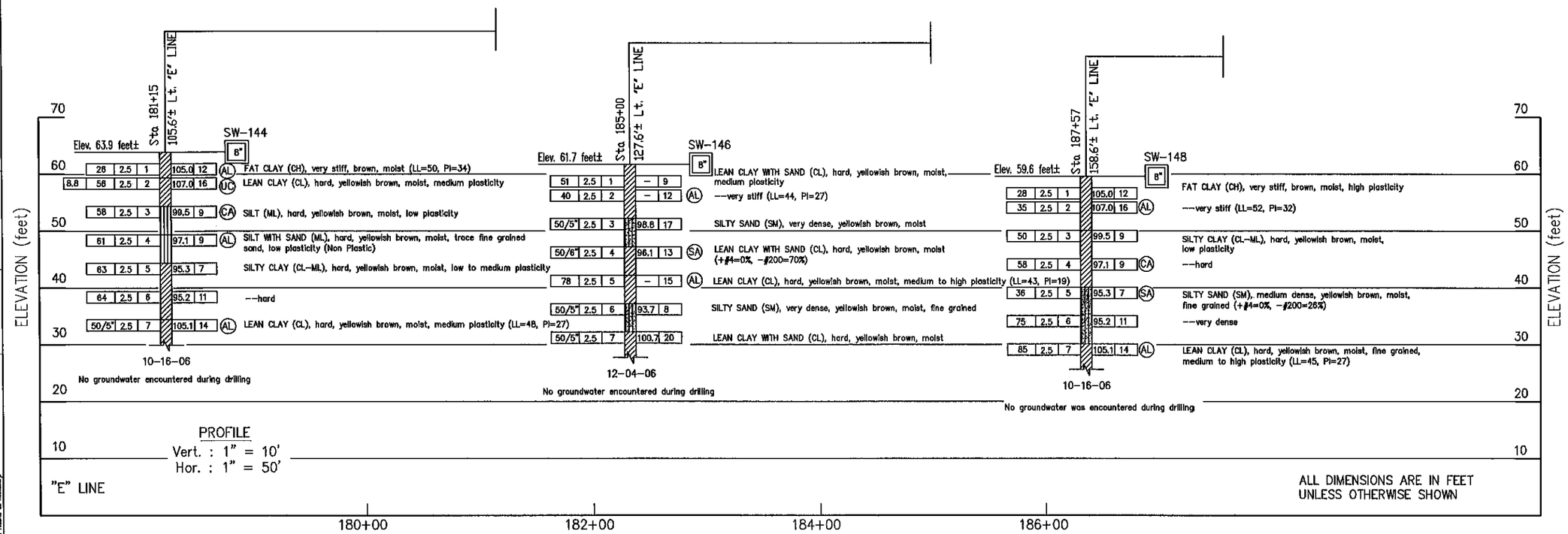


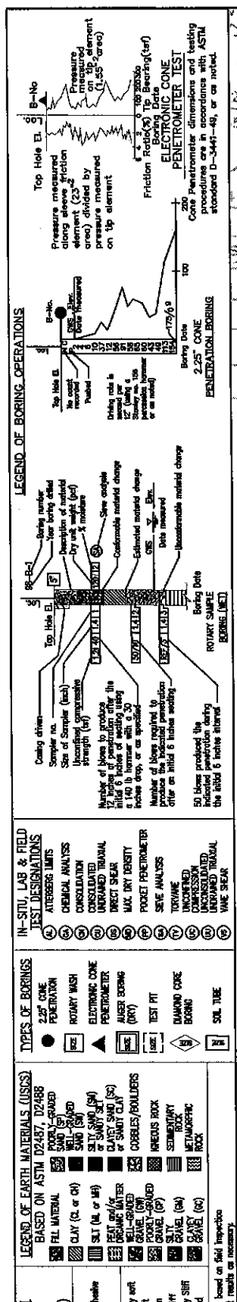
PLAN
1"=50'

Note:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)



PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'
"E" LINE

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN



DESIGN OVERSIGHT	DESIGN By: D. GOUTHIER	Field Investigation by: G. TRIPATHI	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	P. SIRCAR PROJECT ENGINEER
SIGN OFF DATE	CHECKED By: P. SIRCAR			

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04725
EA 2285F1

STRUCTURE NO.
KILO POST (PM)

STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A

LOG OF TEST BORINGS 1 OF 2

DISREGARD PRINTS BEARING EARLIER REVISION DATES → ~~08/14/09~~ 03/01/10

REVISION DATES (PRELIMINARY STAGE ONLY) SHEET OF

PLATE A-13

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DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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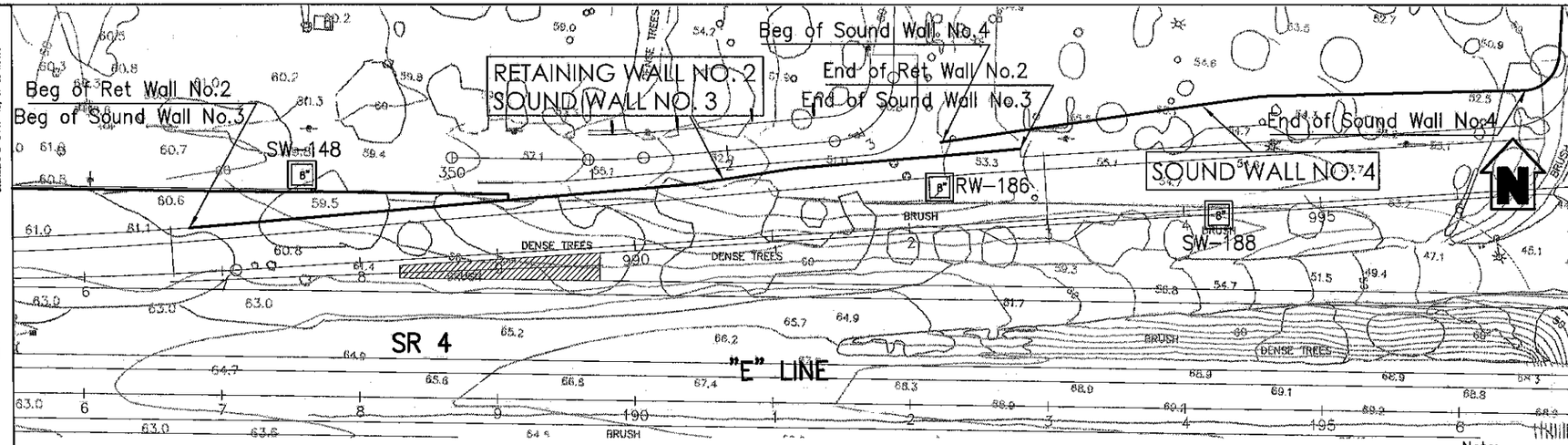
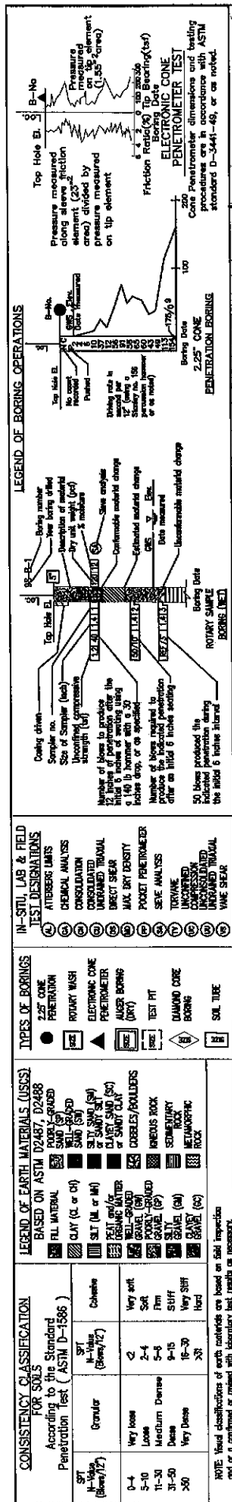
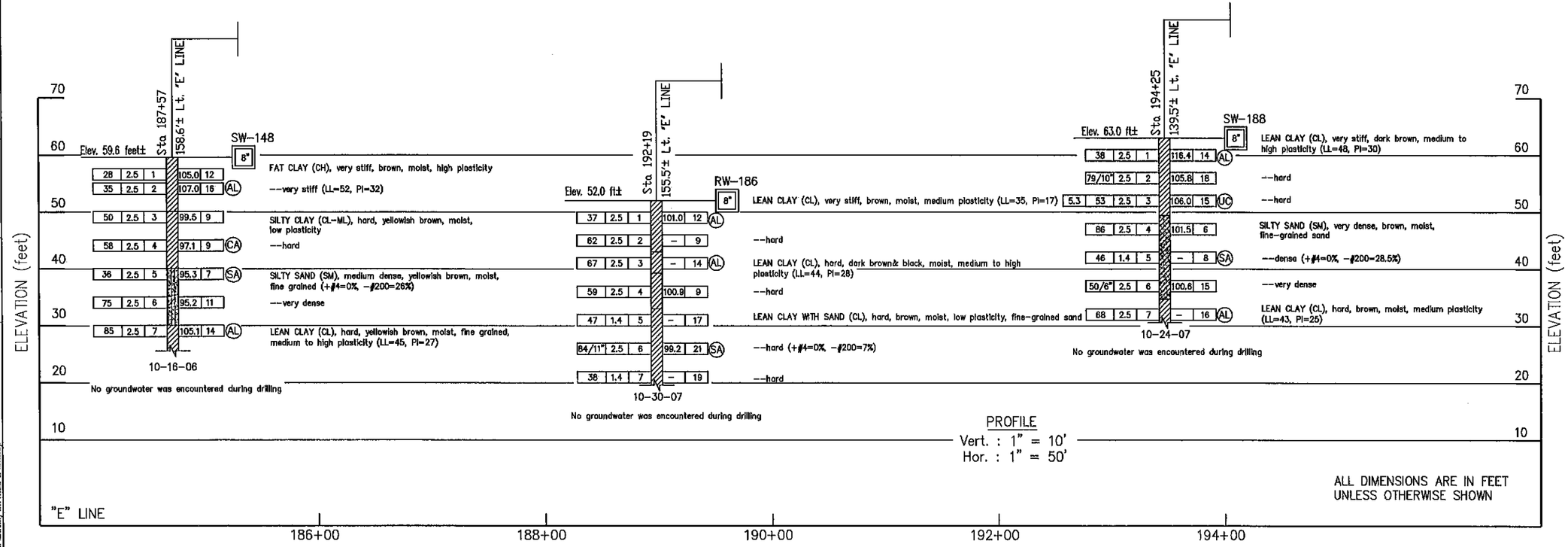


PLAN
1"=50'

Note:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)





PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

DESIGN OVERSIGHT		DESIGN By: D. GOUTHIER	Field Investigation by: G. TRIPATHI	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	P. SIRCAR PROJECT ENGINEER
SIGN OFF DATE		CHECKED By: P. SIRCAR			

STRUCTURE NO.
KILO POST (PM)

STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A

LOG OF TEST BORINGS 2 OF 2

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04725
EA 2285F1

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) 08/14/09 03/01/10 SHEET OF

PLATE A-14

S:\ACAD\206117.GDR\LOTB\02-LOTB-GDMR(Westbound).dwg, A-14, 4/27/2011 2:43:20 PM, \\PA2IKH-FILE\HP5200

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA
TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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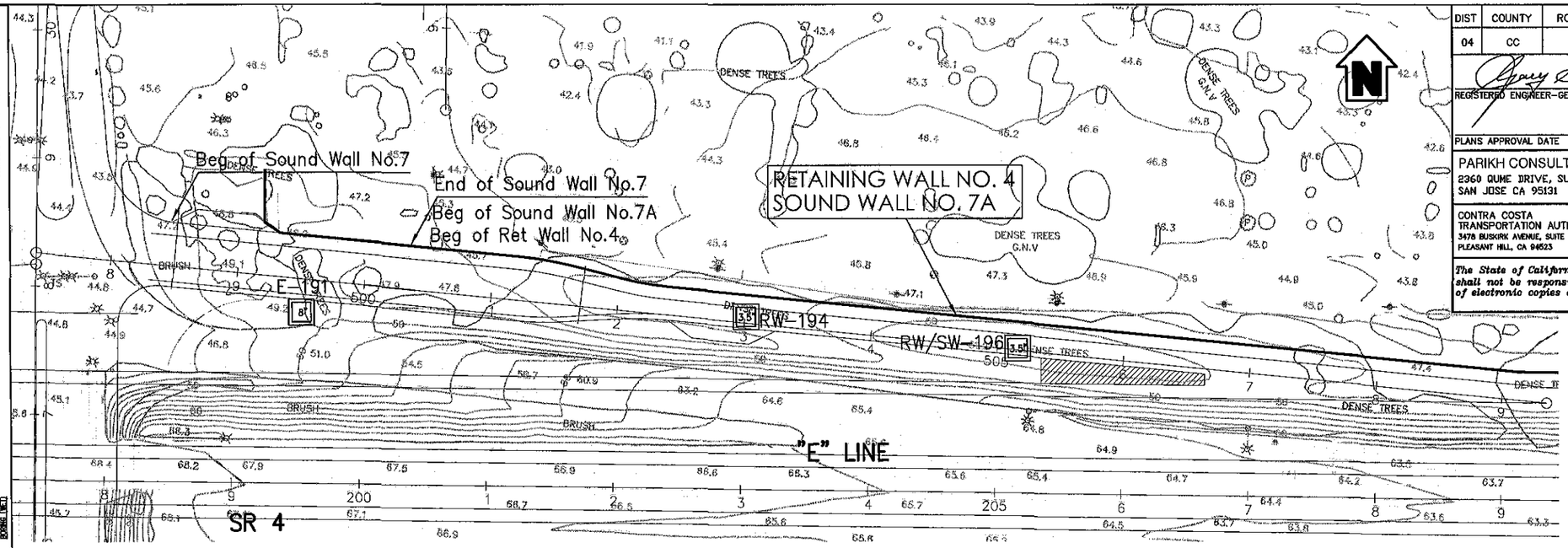
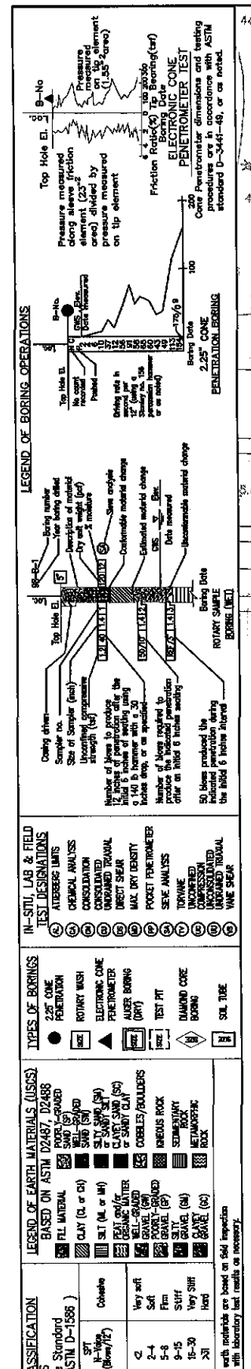
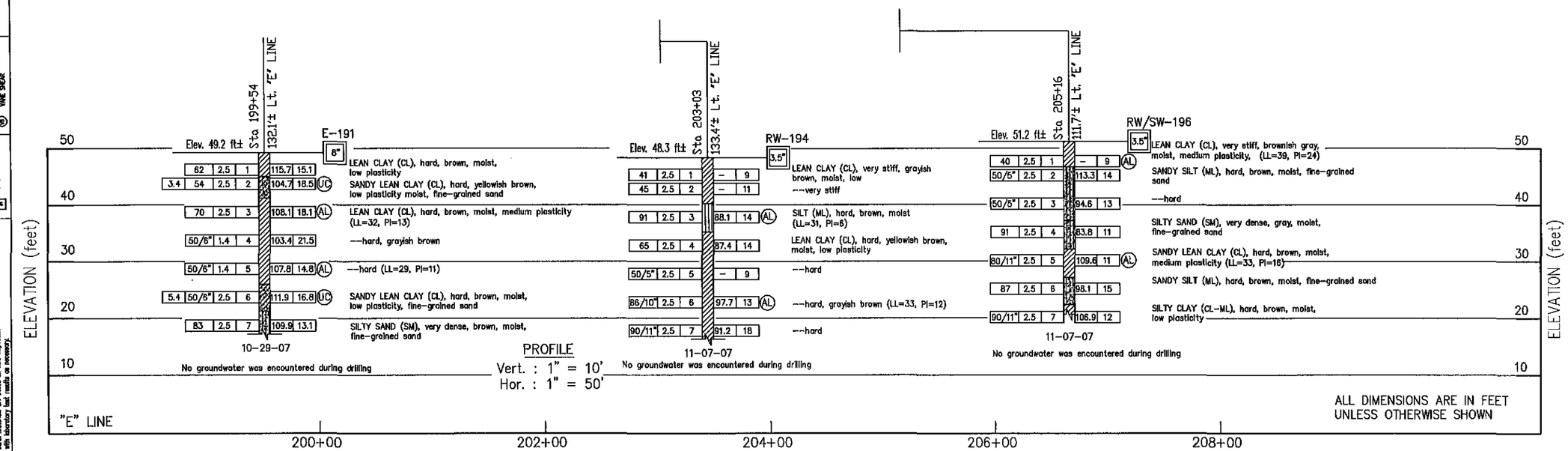


PLAN
1"=50'

Note:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)





PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

DESIGN OVERSIGHT	DESIGN By: D. GOUTHIER	Field Investigation by: G. TRIPATHI	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	STRUCTURE NO.
SIGN OFF DATE	CHECKED By: P. SIRCAR		P. SIRCAR PROJECT ENGINEER	KILO POST (PM)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04725
EA 2285F1

STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A

LOG OF TEST BORINGS

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) ~~08/14/09~~ 03/01/11

SHEET 15 OF 24

PLATE A-15

S:\ACAD\206117.GDR\LOTB\D2-LOTB-GDMR(Westbound).dwg, A-15, 4/27/2011 2:21:32 PM, \\PARIKH-FILE\HP5200

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER–GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2350 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA
TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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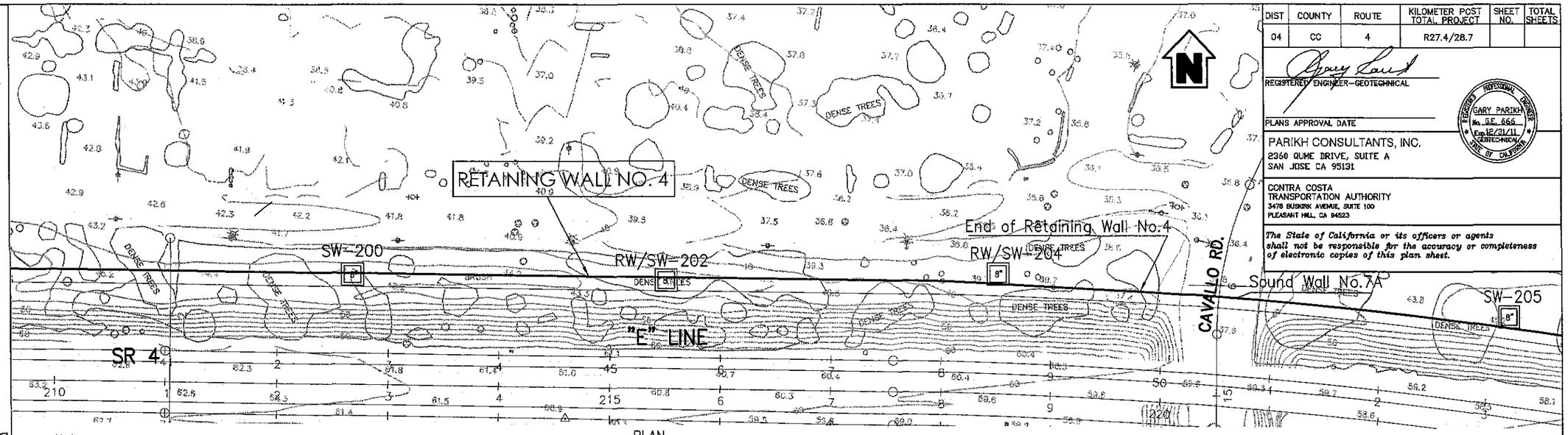
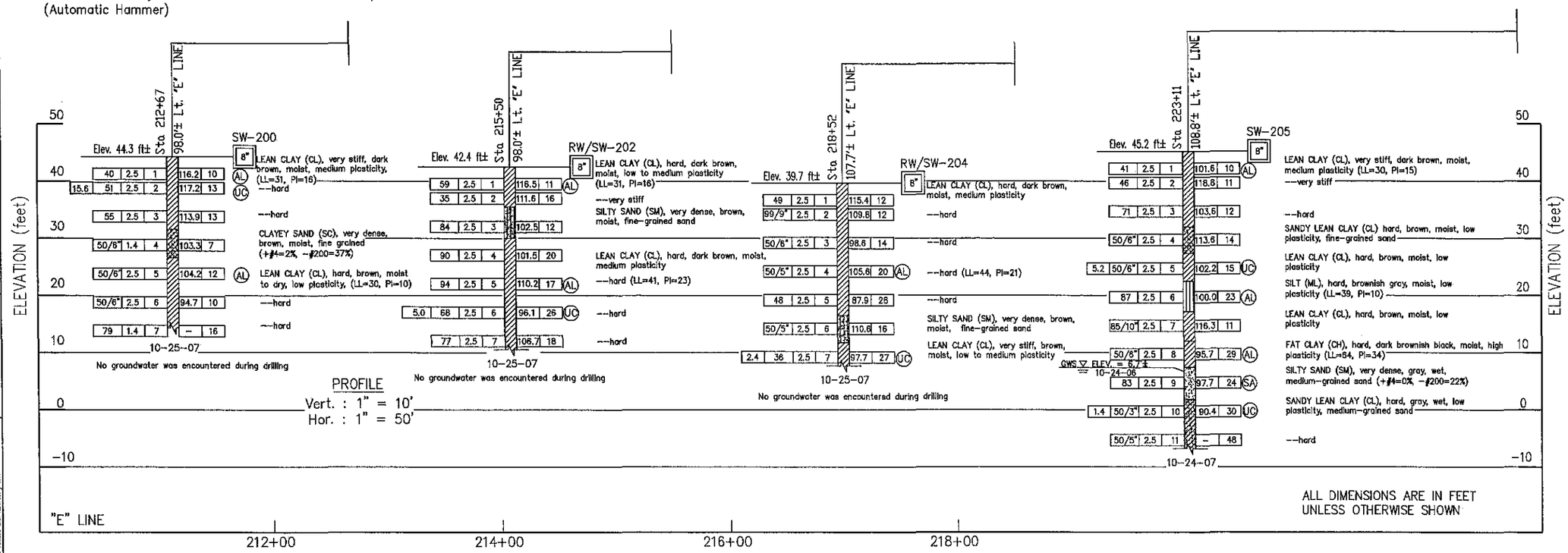


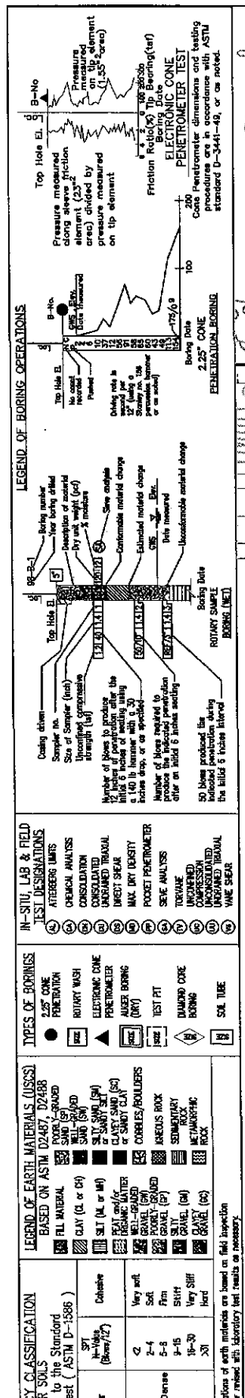
PLAN
1"=50'

Note:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop
(Automatic Hammer)



PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN



DESIGN OVERSIGHT	DESIGN By: D. GOUTHIER	Field Investigation by: G. TRIPATHI	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	STRUCTURE NO.
SIGN OFF DATE	CHECKED By: P. SIRCAR		P. SIRCAR PROJECT ENGINEER	KILO POST (PM)
		ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5	CU 04725 EA 2285F1	DISREGARD PRINTS BEARING EARLIER REVISION DATES

SOUND WALL NO. 7A

LOG OF TEST BORINGS 1 OF 2

REVISION DATES (PRELIMINARY STAGE ONLY) ~~08/14/09~~ 03/01/10 SHEET OF

PLATE A-16

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DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

GARY PARIKH No. GE 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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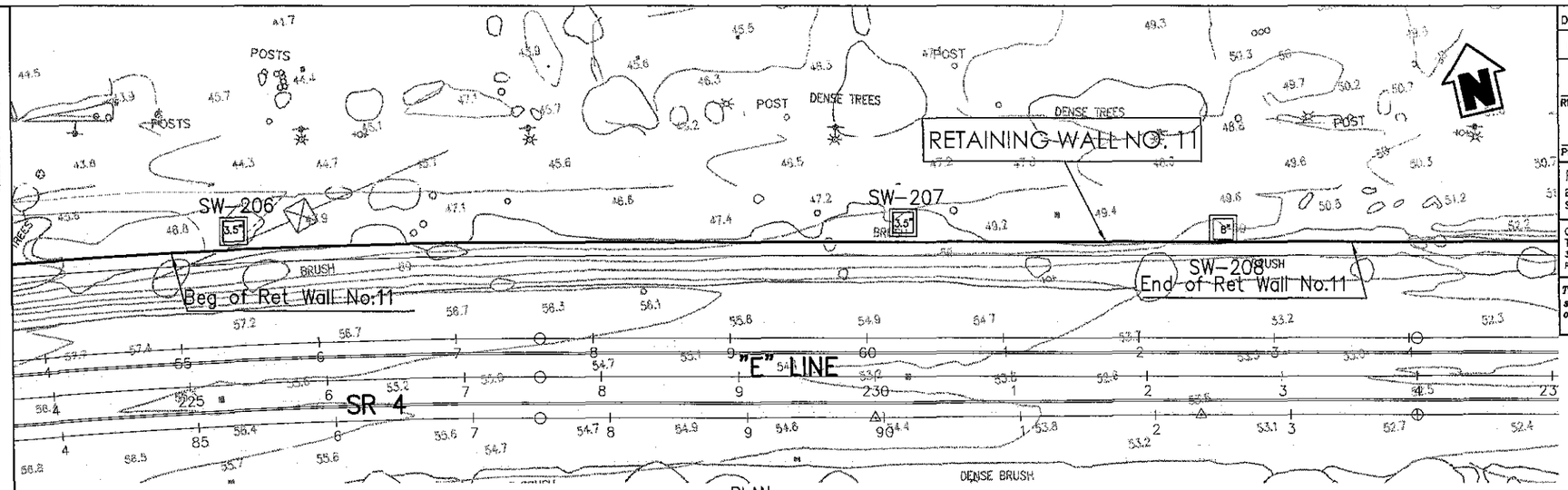
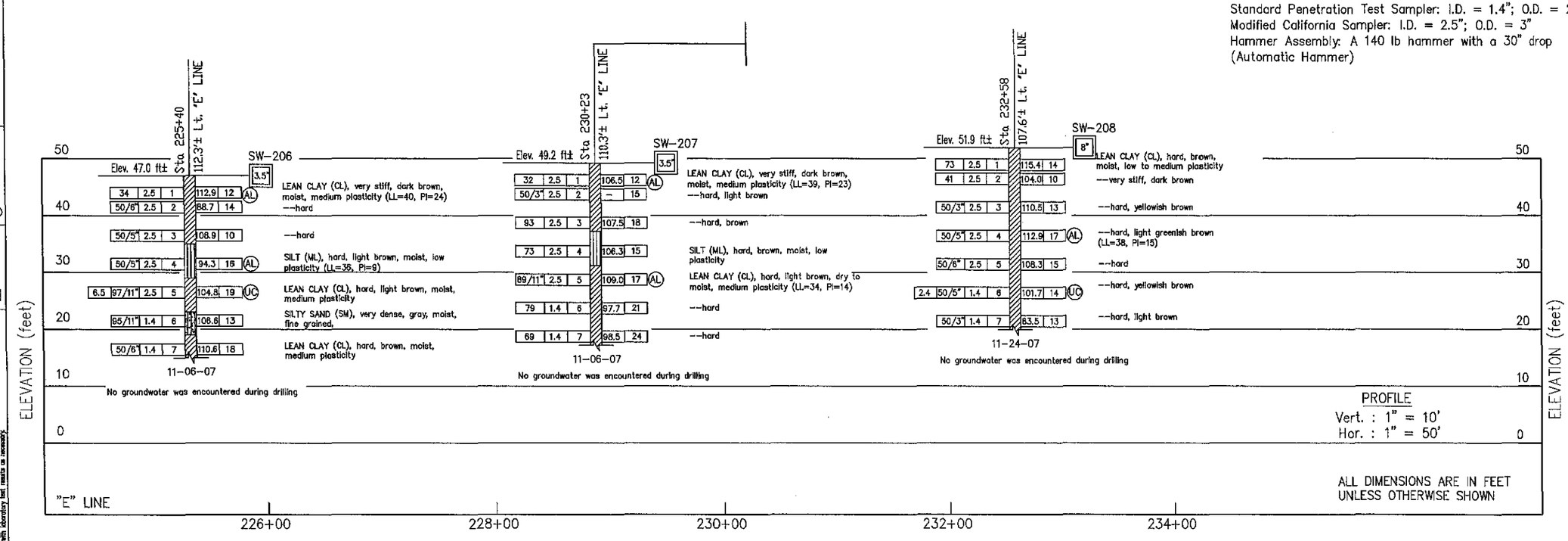


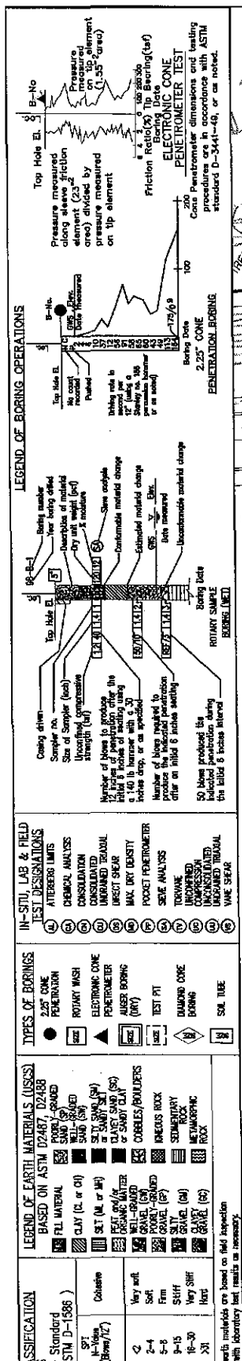
PLAN
1"=50'

Note:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)



PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN



DESIGN OVERSIGHT	DESIGN By: D. GOUTHIER	Field investigation by: G. TRIPATHI	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION
SIGN OFF DATE	CHECKED By: P. SIRCAR		P. SIRCAR PROJECT ENGINEER

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04725
EA 2285F1

STRUCTURE NO.
KILO POST (PM)

SOUND WALL NO. 7A

LOG OF TEST BORINGS 2 OF 2

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) 08/14/09 03/01/10 SHEET OF

PLATE A-17

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DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

GARY PARIKH No. GE 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA REGISTERED PROFESSIONAL ENGINEER

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA
TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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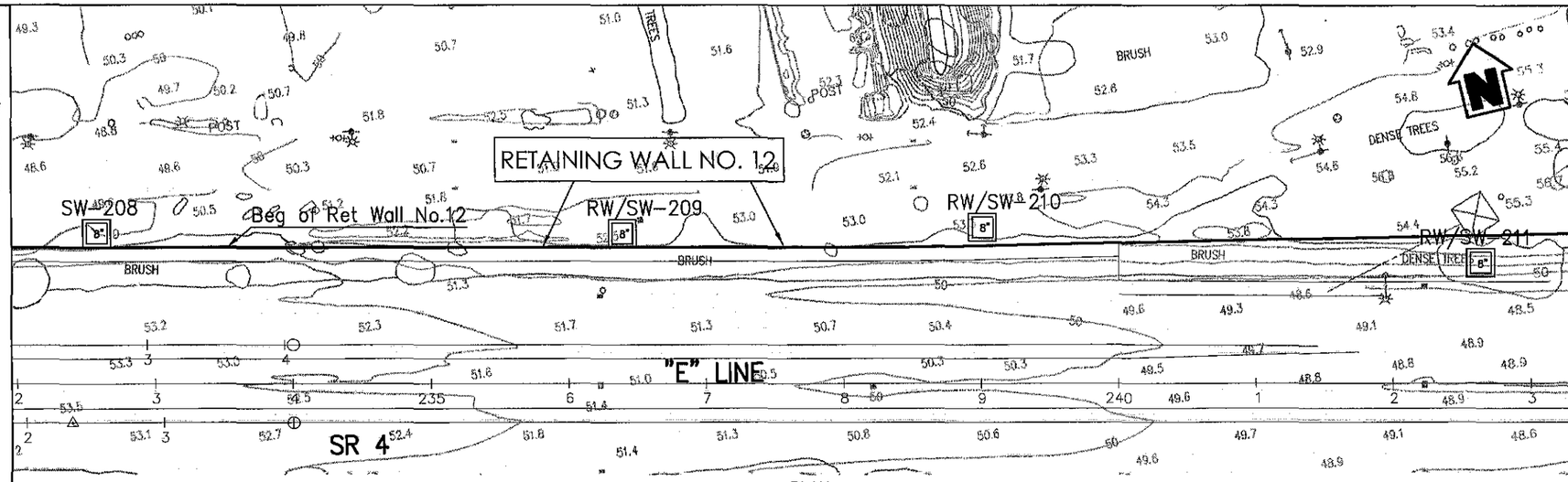
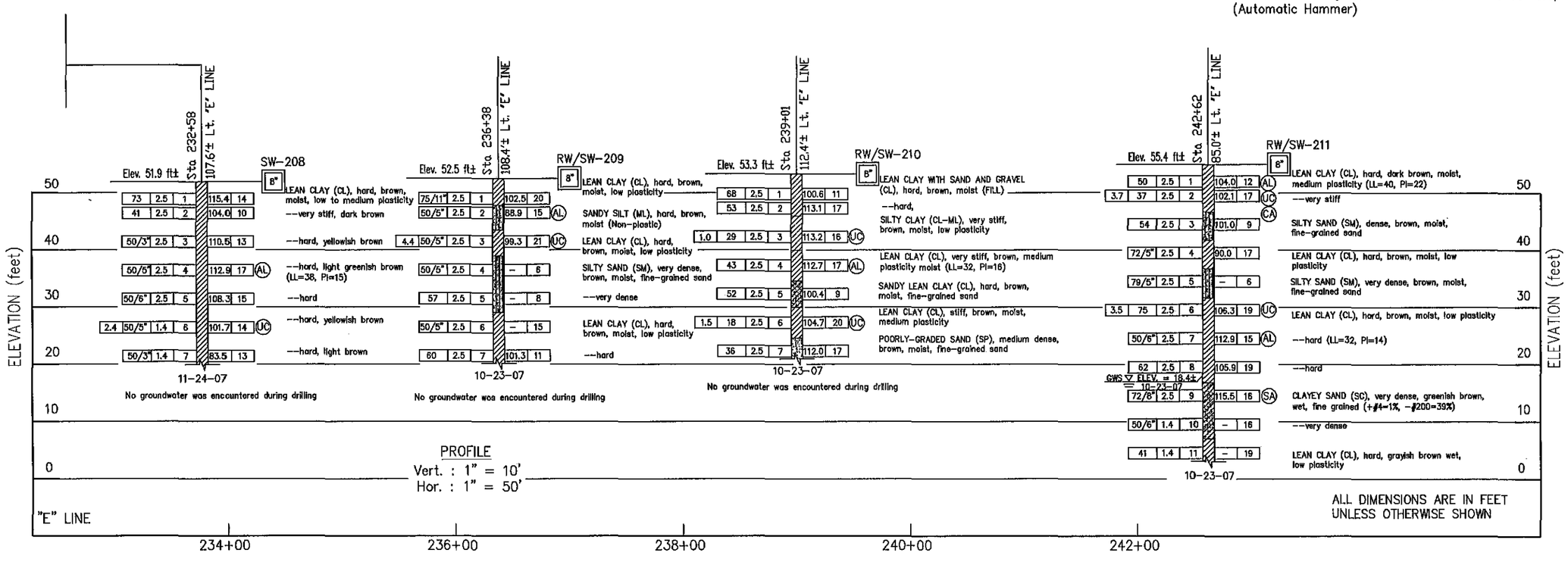


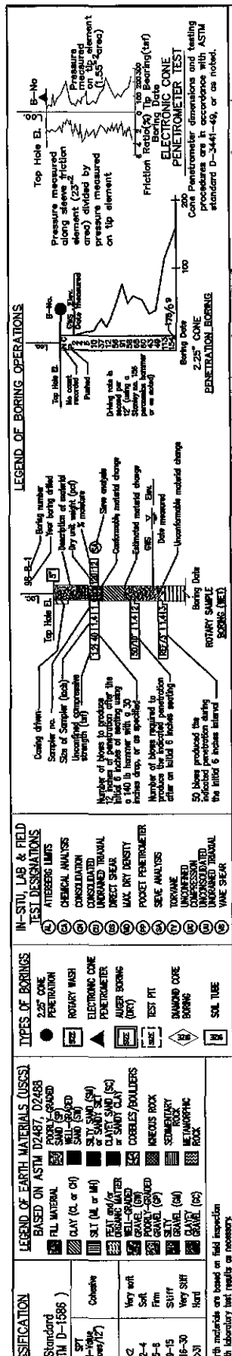
PLAN
1"=50'

Note:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)



PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN



DESIGN OVERSIGHT	DESIGN By: D. GOUTHIER	Field Investigation by: G. TRIPATHI	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION
SIGN OFF DATE	CHECKED By: P. SIRCAR		P. SIRCAR PROJECT ENGINEER

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04725
EA 2285F1

STRUCTURE NO.
KILO POST (PM)

STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A

LOG OF TEST BORINGS

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) ~~08/14/09~~ 03/01/11

SHEET 18 OF 24

PLATE A-18

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DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE. 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA
TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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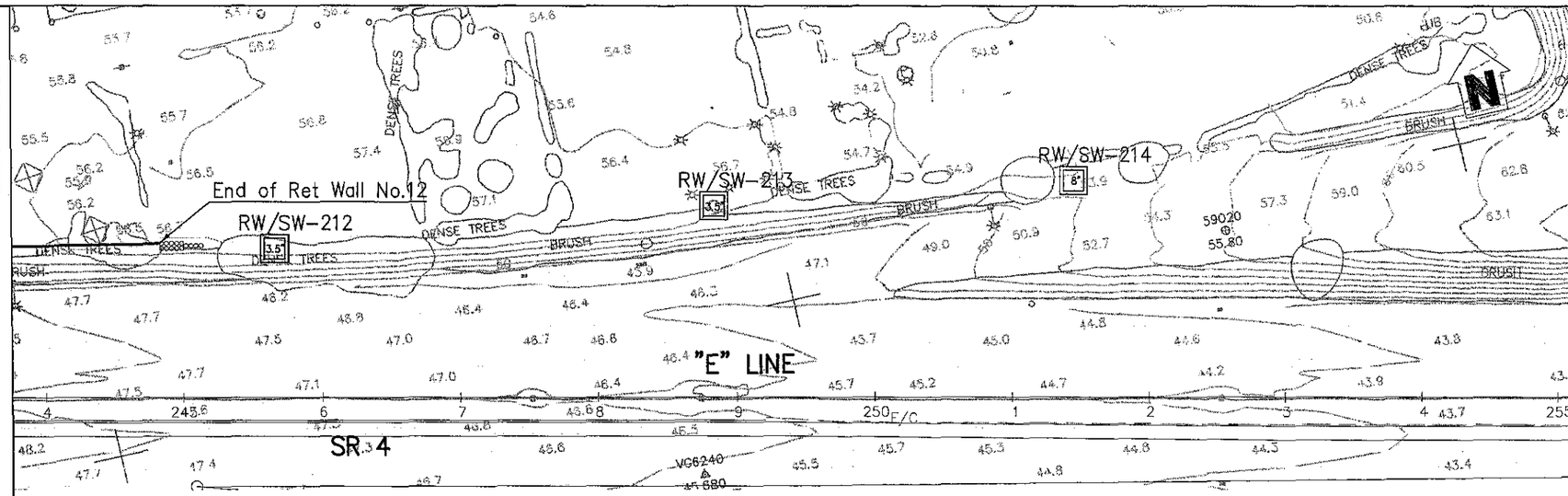
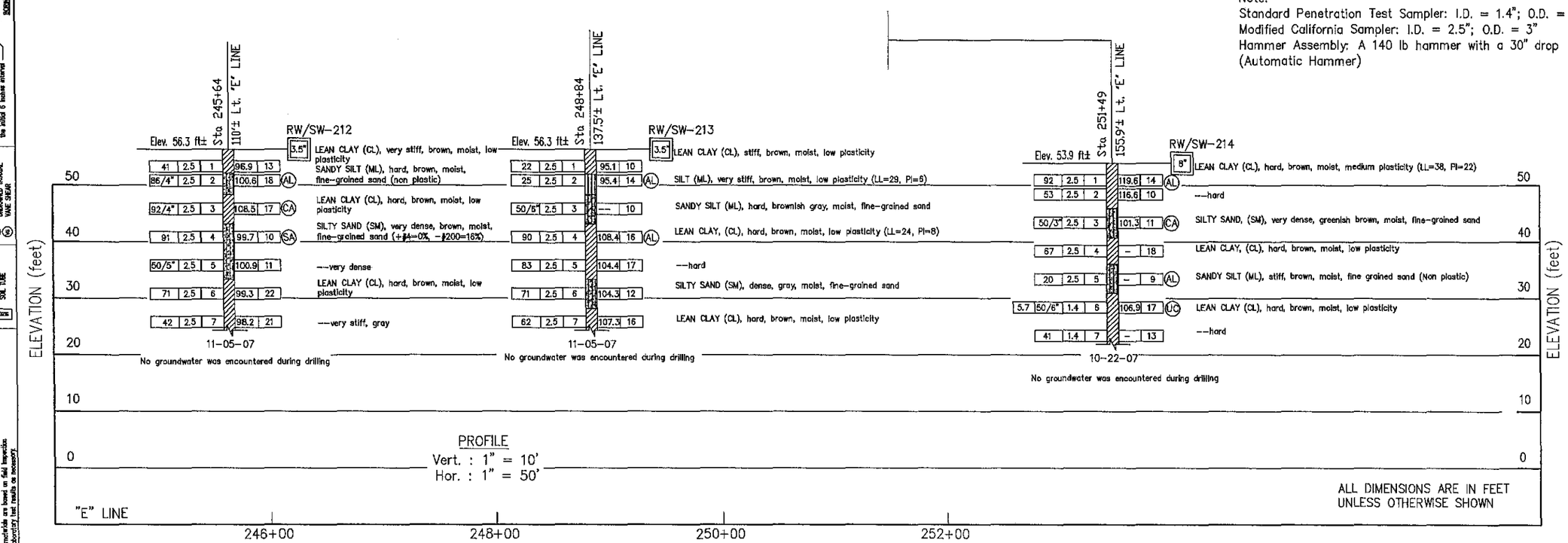
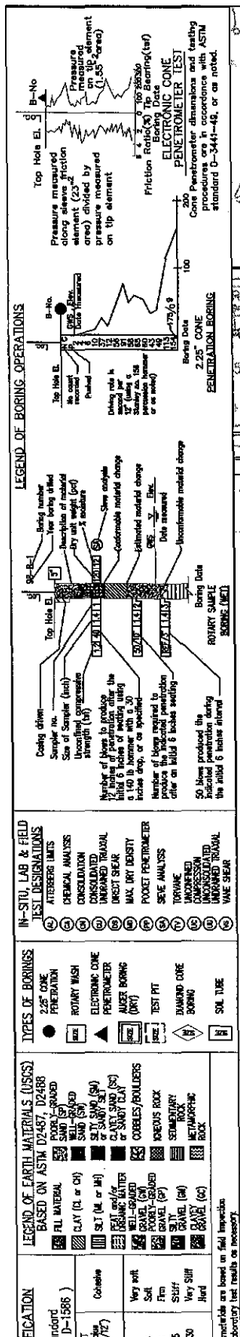


PLAN
1"=50'

Note:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)





DESIGN OVERSIGHT		DESIGN By: D. GOUTHIER	Field Investigation by: G. TRIPATHI	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	P. SIRCAR PROJECT ENGINEER	STRUCTURE NO.	STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A
SIGN OFF DATE		CHECKED By: P. SIRCAR				KILO POST (PM)	LOG OF TEST BORINGS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04725
EA 22B5F1

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) ~~08/14/09~~ 03/01/11

SHEET 19 OF 24

PLATE A-19

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DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. GE 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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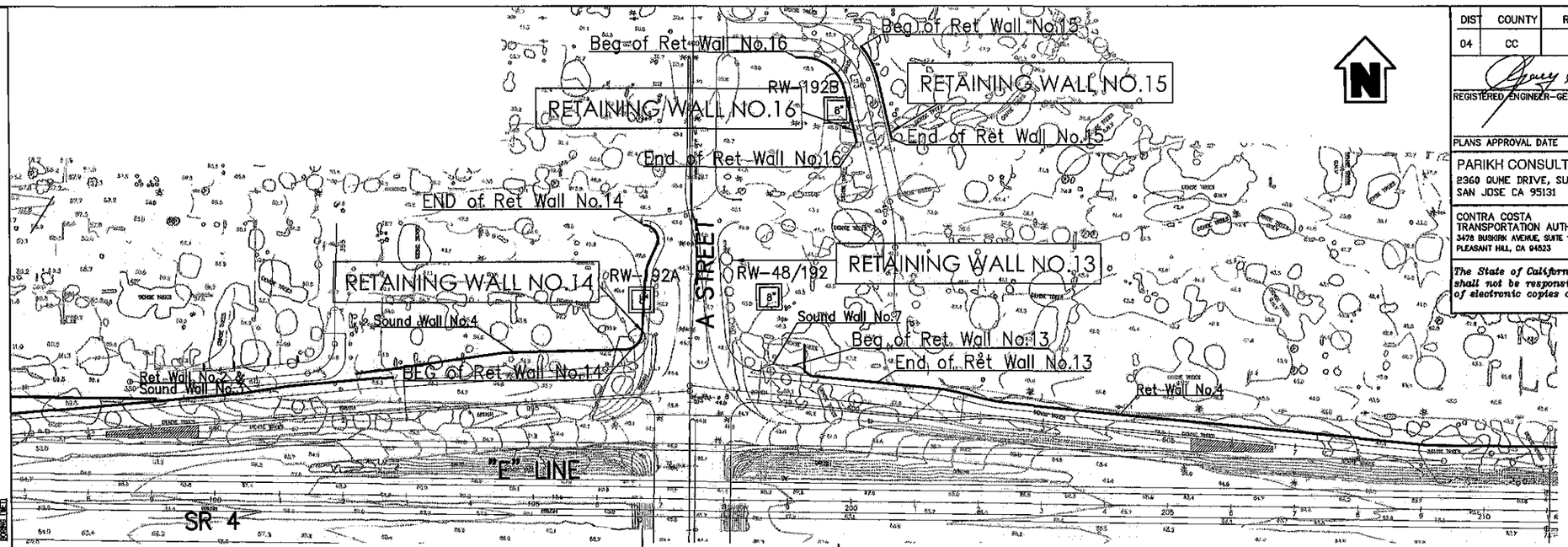
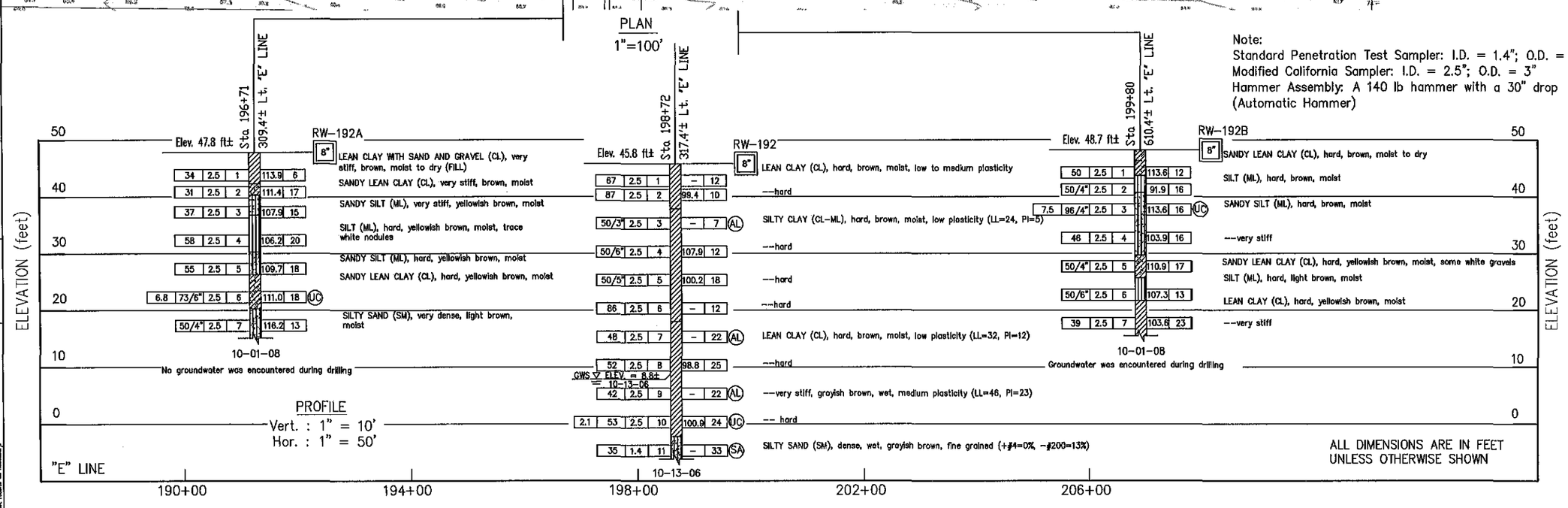


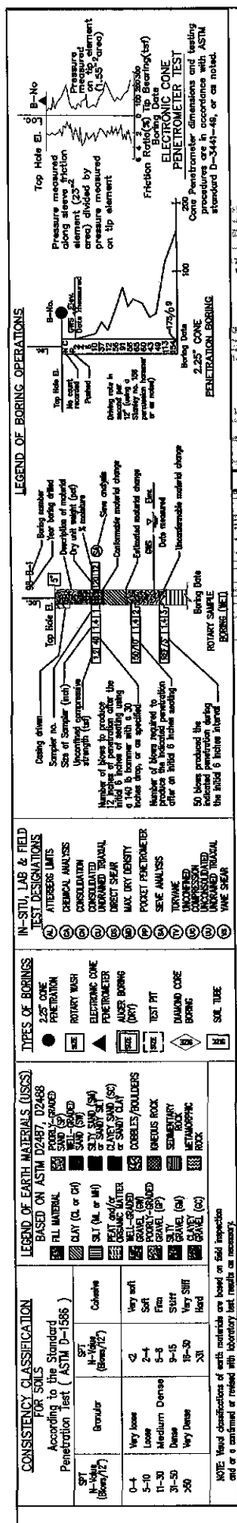
PLAN
1"=100'

Note:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)



PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN



DESIGN OVERSIGHT		DESIGN By: D. GOUTHIER	Field Investigation by: G. TRIPATHI	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	P. SIRCAR PROJECT ENGINEER	STRUCTURE NO.	STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A
SIGN OFF DATE		CHECKED By: P. SIRCAR				KILO POST (PM)	LOG OF TEST BORINGS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04725
EA 2285F1

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) ~~08/11/09~~ 03/01/11 SHEET 20 OF 24

PLATE A-20

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DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER-GEOTECHNICAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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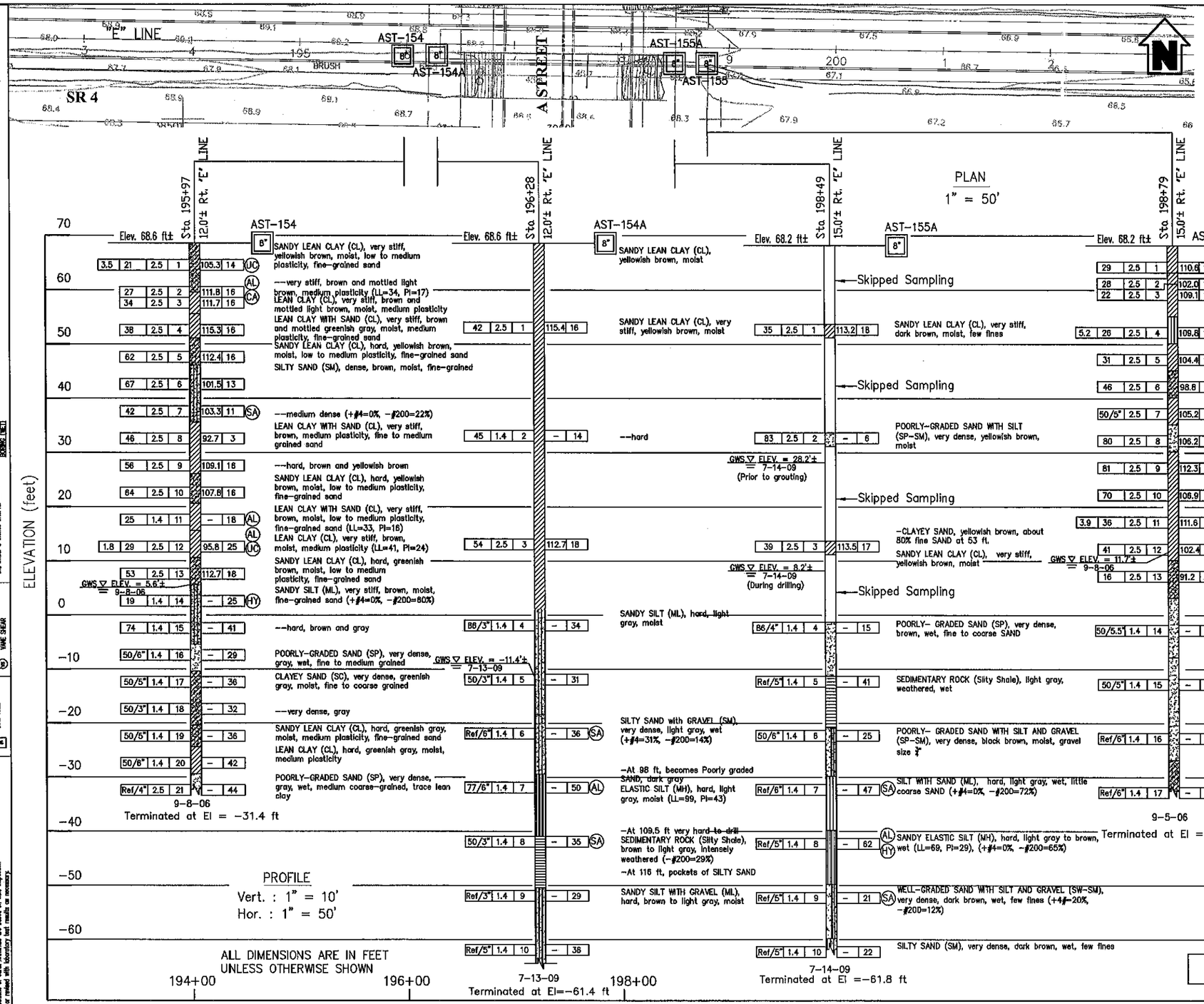
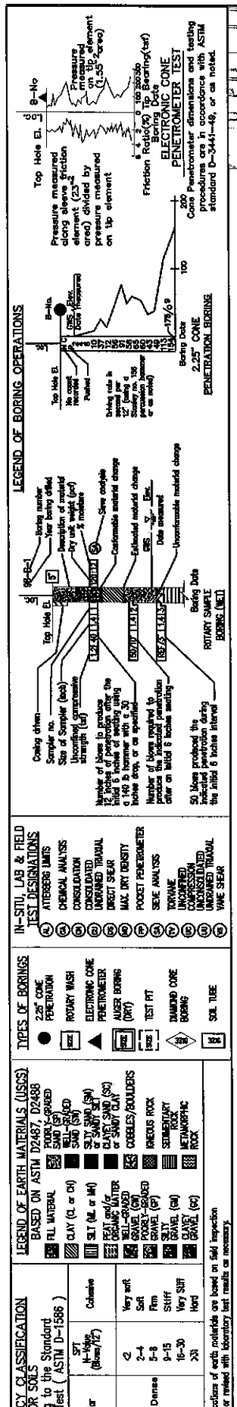


A STREET UNDERCROSSING



DESIGN OVERSIGHT	DESIGN By: D. GOUTHIER	Field Investigation by: L. BHANGOO	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	P. SIRCAR PROJECT ENGINEER	STRUCTURE NO. 28-0401 L/R	STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A
SIGN OFF DATE	CHECKED By: P. SIRCAR	ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5		CU 04275 EA 2285F1	POST MILES (PM) 27.8	LOG OF TEST BORINGS

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) ~~08/14/09~~ 03/01/10 | SHEET 21 OF 24

PLATE A-21

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DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/28.7		

REGISTERED ENGINEER–GEOTECHNICAL

PLANS APPROVAL DATE

GARY PARIKH No. G.E. 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE CA 95131

CONTRA COSTA
TRANSPORTATION AUTHORITY
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

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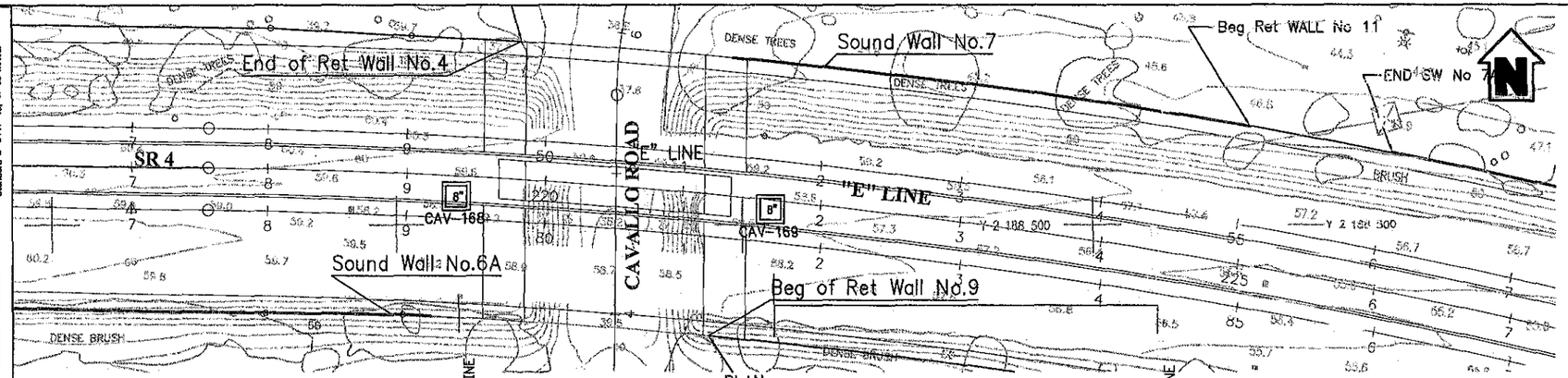
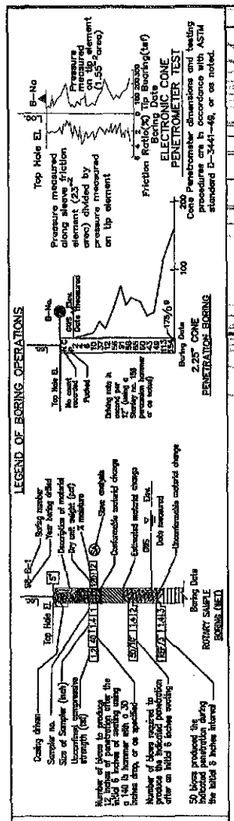


PLAN
1" = 50'

Notes:
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)



PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ELEVATION (feet)

Sta. 219+37, 12.8'± Rt. "E" LINE — CAV-168 — Elev. 58.7 ft±

Elev.	Blows	Rec.	Moisture	Dry Density	Other	Description
55	23	2.5	1	111.9	16	LEAN CLAY (CL), stiff, grayish brown, moist
50	35	2.5	2	106.9	20 CA	--very stiff, brown
45	–	2.5	3	108.0	21 AL	--very stiff, bluish gray (LL=31, PI=11)
40	1.8	33	2.5	4	105.1	20 UC --very stiff, bluish black
35	30	2.5	5	109.3	15 AL	--very stiff, brown (LL=39, PI=22)
30	90	2.5	6	108.1	10	SANDY LEAN CLAY (CL), hard, brown, dry
25	60	2.5	7	104.0	18	LEAN CLAY (CL), hard, brown, moist
20	41	2.5	8	101.9	4 SA	POORLY-GRADED SAND WITH SILT (SP-SM), medium dense, bluish brown, moist, fine-grained (+#4=0%, -#200=8%)
15	63	2.5	9	118.0	13	SANDY LEAN CLAY (CL), hard, brown, moist
10	43	2.5	10	111.9	18 SA	CLAYEY SAND (SC), medium dense, bluish brown, moist (+#4=1%, -#200=37%)
	GWS ▽ ELEV. = 5.2'± 9-7-06					
5	48	2.5	11	106.4	17 SA	POORLY-GRADED SAND (SP), dense, bluish brown, moist (+#4=0%, -#200=4%)
0	41	1.4	12	–	41	LEAN CLAY (CL), hard, brown, wet
-5	50/6"	2.5	13	–	--	--(No Recovery)
-10	50/5"	1.4	14	–	32 SA	POORLY-GRADED SAND WITH SILT AND GRAVEL (SP-SM), very dense, bluish brown, wet (+#4=27%, -#200=6%)
	60	1.4	15	–	38	--very dense
-15	50/6"	1.4	16	–	31	--very dense
-20	50/6"	1.4	17	–	24	--very dense, fine-grained
-25	50/6"	1.4	18	–	47	LEAN CLAY (CL), hard, grayish brown, wet
-30	72	2.5	19	90.8	32	--hard, bluish brown
	9-7-06					

Sta. 221+65, 6.0'± Rt. "E" LINE — CAV-169 — Elev. 58.5 ft±

Elev.	Blows	Rec.	Moisture	Dry Density	Other	Description
55	17	2.5	1	105.3	18	LEAN CLAY (CL), stiff, gray and brown, moist, medium plasticity
50	34	2.5	2	102.0	22 UC	LEAN CLAY WITH SAND (CL), very stiff, brown, moist, medium plasticity
45	2.6 25	2.5	3	108.6	19 AL	LEAN CLAY (CL), very stiff, brown and mottled gray, moist, medium plasticity (LL=35, PI=17)
40	18	2.5	4	108.2	15	--stiff, dark brown
35	52	2.5	5	104.5	10 SA	SILTY SAND (SM), very dense, yellowish brown, moist, fine-grained (+#4=1%, -#200=28%)
30	50/6"	2.5	6	99.7	16	LEAN CLAY (CL), hard, yellowish brown and mottled white, moist, medium plasticity
25	61	2.5	7	107.8	17	--hard
20	3.8 45	2.5	8	95.7	22 UC AL	--very stiff, gray and mottled brown (LL=44, PI=20)
15	76	2.5	9	111.2	12 SA	SANDY LEAN CLAY (CL), hard, gray and mottled red, moist, medium plasticity (+#4=0%, -#200=62%)
10	82	2.5	10	109.7	19	--hard, gray
	80	2.5	11	102.3	24 SA	SANDY SILT (ML), hard, yellowish brown and gray, low plasticity, fine-grained sand (+#4=0%, -#200=57%)
	GWS ▽ ELEV. = 4.5'± 9-6-06					
5	19	1.4	12	–	56 SA	SILTY CLAY WITH SAND AND GRAVEL (CL-ML), very stiff, gray and brown, wet, low plasticity, gravel up to ¾", medium to coarse grained sand, decomposed bedrock (+#4=0%, -#200=71%)
0	22	1.4	13	–	42 SA	SANDY SILTY CLAY WITH GRAVEL (CL-ML), very stiff, gray and brown, low plasticity, gravel up to ¾", medium to coarse grained sand, decomposed bedrock (+#4=0%, -#200=58%)
-5						
-10						
-15	50/5.5"	2.5	14	106.5	21	LEAN CLAY WITH SAND (CL), hard, gray, moist, medium to high plasticity, fine-grained sand
-20						
-25	50/4"	2.5	15	83.2	26	POORLY-GRADED SAND WITH GRAVEL (SP), very dense, dark gray, wet, gravel up to 1", fine to medium grained
-30						
-35	50/3"	2.5	16	82.6	37	LEAN CLAY (CL), hard, gray, moist, medium plasticity, trace decomposed bedrock
-40						
	50/5.5"	2.5	17	96.8	27	LEAN CLAY WITH SAND (CL), hard, bluish gray, moist, medium plasticity, fine-grained sand
	9-6-06					

ALL DIMENSIONS ARE IN FEET
UNLESS OTHERWISE SHOWN

"E" LINE
218+00 220+00 222+00 224+00

CAVALLO ROAD UNDERCROSSING

DESIGN OVERSIGHT	DESIGN By: D. GOUTHIER	Field Investigation by: L. BHANGOO	P. SIRCAR, PROJECT ENGINEER
SIGN OFF DATE	CHECKED By: P. SIRCAR		

PREPARED FOR THE
COUNTY OF CONTRA COSTA
DEPARTMENT OF PUBLIC WORKS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3 4 5

CU 04275
EA 2285F1

STRUCTURE NO. 28-6402 L/R
KILO POST (PM)

STATE ROUTE 4 (EAST) WIDENING PROJECT- SEGMENT 3A

LOG OF TEST BORINGS

DISREGARD PRINTS BEARING EARLIER REVISION DATES → REVISION DATES (PRELIMINARY STAGE ONLY) ~~08/11/09~~ 03/01/10

SHEET 22 OF 24

PLATE A-22

DIST.	COUNTY	ROUTE	KILOMETER POST-TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	CC	4	R27.4/R28.7		

John H. Cornfield
April 1, 1969

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.

Gary Parikh
REGISTERED CIVIL ENGINEER — DATE 11-03-2008

STATE ROUTE 4 (EAST) WIDENING PROJECT

LOG OF TEST BORINGS

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

OU: 04278
EA: 2206F1

BRIDGE No. 28-0401L/R

Sheet 23 of 24

REGISTERED PROFESSIONAL ENGINEER
GARY PARIKH
No. G.E. 666
Exp. 12/31/11
GEOTECHNICAL
STATE OF CALIFORNIA

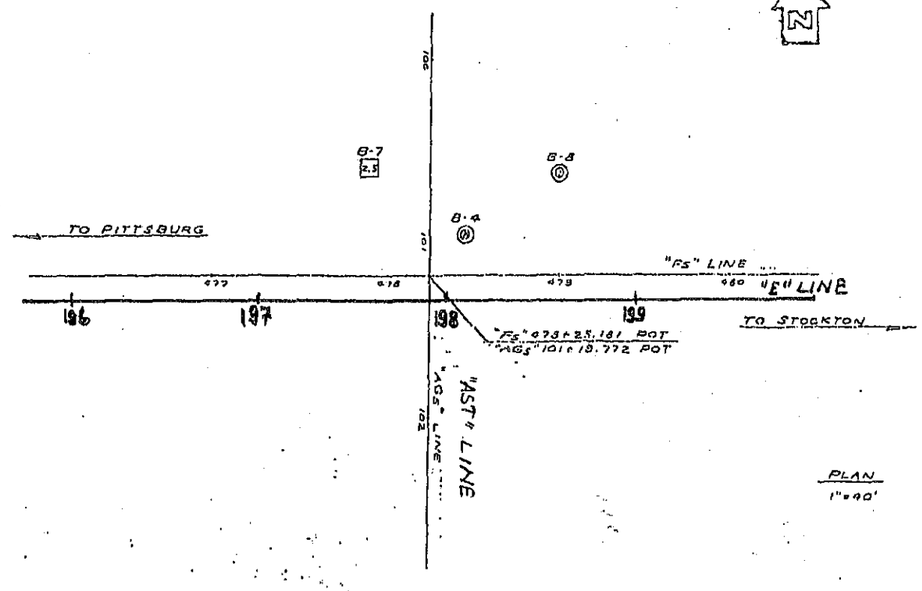
Revisions made to this Log of Test Borings from the original 1969 Log of Test Borings are the addition of the following table and notes:

Boring	Station	Offset from "E" LINE
B-7	197+58	36 ft Lt
B-4	198+10	17 ft Lt
B-8	199+58	33 ft Lt

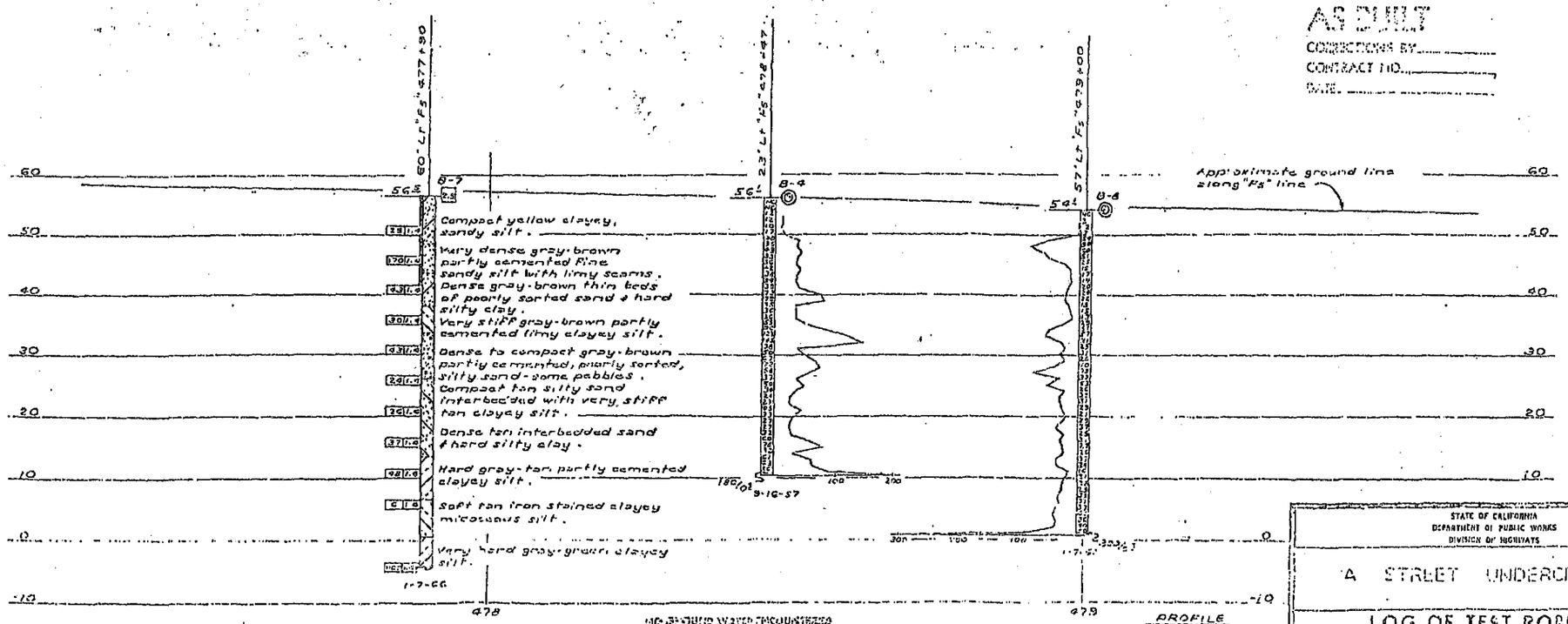
"AGS" Line corresponds to the "AST" Line
"FS" Line parallels to "E" Lines
"AGS" Line intersects "E" Line at Station 197+45 ft

Notes:

1. See the "Log of Test Borings" for stationing.
2. The Division of Structure Design produced the data presented in the table above. The data are the English locations for the As-Built Test Borings referenced to the proposed new structure location. This table is presented on the As-Built Log of Test Boring sheet for the convenience of any bidder, contractor or other interested party.



PLAN
1" = 40'



AS BUILT
CORRECTIONS BY
CONTRACT NO.
DATE

SHEET 11 OF 12

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

A STREET UNDERCROSSING

LOG OF TEST BORINGS 2 of 2

SCALE AS NOTED | BRIDGE 28-0401L/R | FILE | DRAWING 2896-15

PREL. DRAWING NO. PR-

Disregard pilot drawing center numbers

LEGEND OF EXPLORATIONS

LEGEND OF EARTH MATERIALS

CLASSIFICATION OF MATERIAL BASED ON STANDARD GRAIN SIZE LIMITS

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.

AS BUILT PLANS
Contract No

04205
108801

210

DIST.	COUNTY	ROUTE	KILOMETER POST-TOTAL PROJECT	Sheet No.	Total Sheets
04	CC	4	R27.4/R28.7		

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 CIVIL ENGINEER — DATE: 11-03-2006

STATE ROUTE 4 (EAST) WIDENING PROJECT

LOG OF TEST BORINGS

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

CU: 04275
EA: 2265F1

BRIDGE No. 28-6402L/R

Sheet 24 of 24

REGISTERED PROFESSIONAL ENGINEER — GARY PARIKH — No. G.E. 666 — Exp. 12/31/11 — GEOTECHNICAL — STATE OF CALIFORNIA

Revisions made to this Log of Test Borings from the original 1969 Log of Test Borings are the addition of the following table and notes:

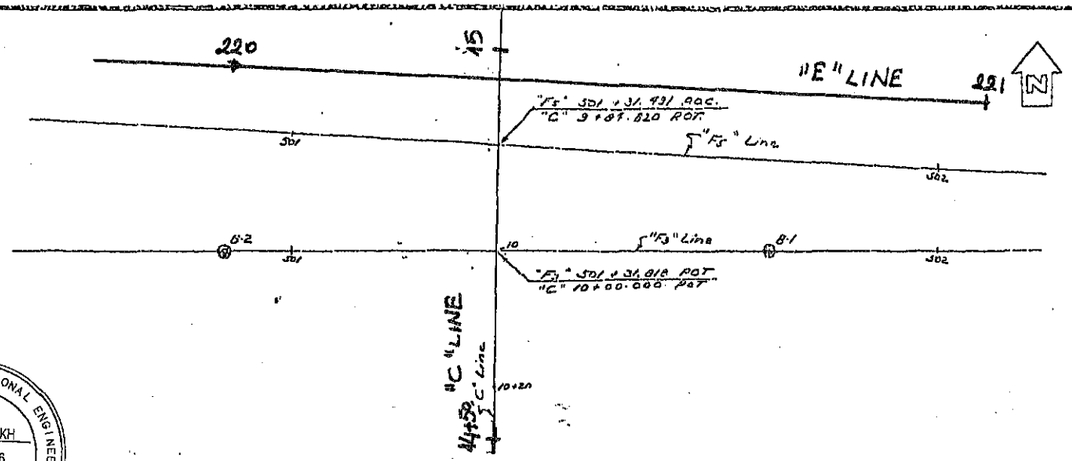
Boring	Station	Offset from "E" LINE
B-2	218+99	12 ft Rt
B-1	220+72	10 ft Rt

"F5" Line parallels to "E" Lines

"C" Line intersects "E" Line at Station 220+36 ft

Notes:

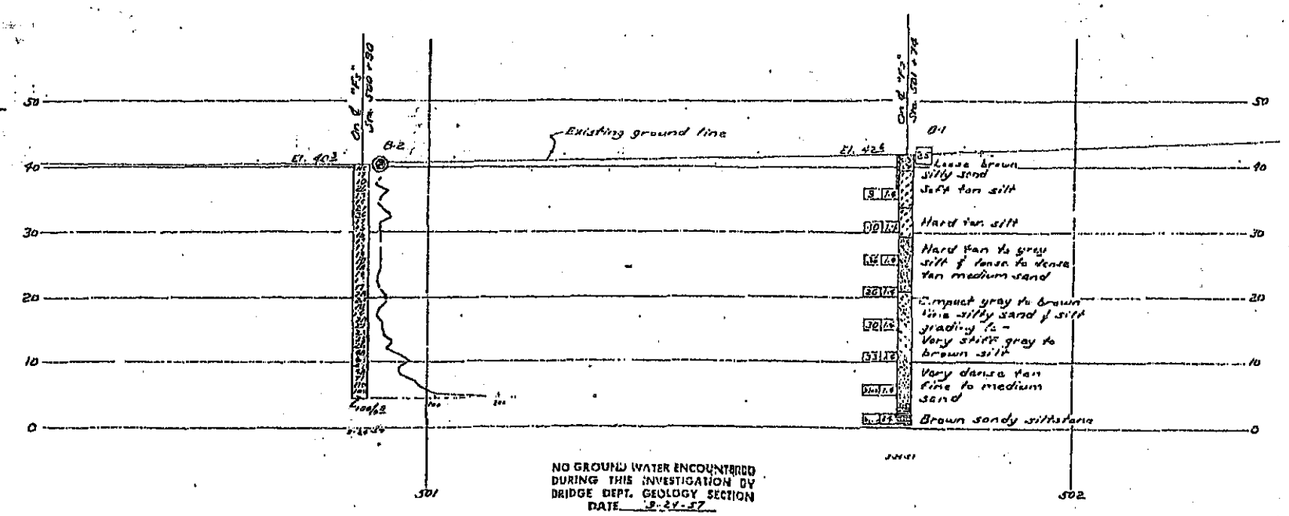
1. See the "Log of Test Borings" for stationing.
2. The Division of Structure Design produced the data presented in the table above. The data are the English locations for the As-Built Test Borings referenced to the proposed new structure location. This table is presented on the As-Built Log of Test Boring sheet for the convenience of any bidder, contractor or other interested party.



DIST.	COUNTY	ROUTE	BM	PREF. No.	SHEET No.
04	CC	4	04/11/06 04/11/06	204	115

Section Supervisor
April 4, 1969

BM #54 - "X" Cut into PCC base footing tower No. side Tregallis Rd 121' Rt "F5" Sta. 498+39 ± Elev. 45' ±



NO GROUND WATER ENCOUNTERED DURING THIS INVESTIGATION BY BRIDGE DEPT. GEOLOGY SECTION
DATE 9-27-57

AS BUILT
CONTRACT No.
DATE

CLASSIFICATION OF MATERIAL BASED ON STANDARD GRADE SIZE LIMITS

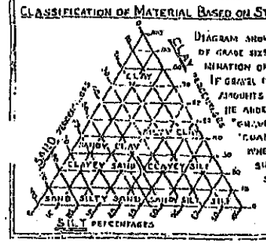


DIAGRAM SHOWING THE BASIS FOR ESTIMATES OF GRADE SIZE DISTRIBUTION USED IN DETERMINATION OF CLASS NAMES.

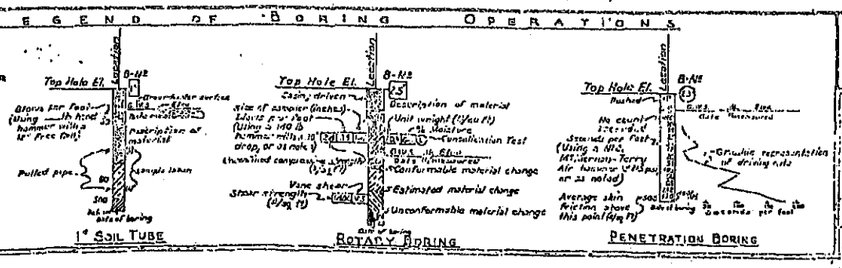
IF GRAVEL IS PRESENT IN APPRECIABLE AMOUNTS THE TERM "GRAVELLY" MAY BE ADDED TO THE CLASS NAME, VIZ. "GRAVELLY SAND." THE TERMS "COARSE", "MEDIUM" AND "FINE" WHEN USED TO DESCRIBE SAND, SILT AND GRAVEL REFER TO STANDARD GRADE SIZE LIMITS.

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
- 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 7, Article (c) of the Standard Specifications and to the Special Provisions accompanying this set of plans.

Classification of each 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

70 | 11

CAVALLO ROAD UNDERCROSSING

LOG OF TEST BORINGS

SCALE 1" = 10' | BRIDGE 28-88 | FILE | DRAWING 2935-10

(STATE ROUTE 4 (EAST) WIDENING PROJECT-SEGMENT 3A)

SUMMARY OF R-VALUE BORINGS

Boring No.	Station (ft.)	Offset (ft.) From "E" line	Approx. Ground Elev. (ft)	Boring Depth (ft)	Description	Lab Tests
R-40	171+83	0 C.L.	54.4	0-5'	SILTY SAND (SM), yellowish gray, moist	R=35
R-41	180+77	2 Rt.	58.7	0-5'	SILTY SAND (SM), yellowish brown, dry Top 3": Lean clay, grayish brown, humic	R=58
R-42	185+04	54.8 Rt.	63.1	0-5'	LEAN CLAY (CL), brown, moist	--
R-43	186+36	76 Lt.	62.0	0-5'	LEAN CLAY (CL), brown, moist	--
R-44	189+58	78.6 Lt.	63.0	0-5'	LEAN CLAY (CL), yellowish brown, moist	R=23
R-45A	192+00	0 C.L.	68.9	0-5'	SANDY LEAN CLAY (CL), brown, moist	R=15
R-45	192+70	0 C.L.	68.2	0-5'	LEAN CLAY (CL), yellowish brown, moist	R=14 EI=55
R-46	195+00	50.3 Rt.	69.0	0-5'	SILTY SAND (SM), yellowish brown, dry	R=33
R-47	196+08	198 Rt.	52.7	0-5'	LEAN CLAY (CL), brown, dry	R=8
R-50	200+68	0 C.L.	66.8	0-5'	LEAN CLAY (CL), grayish brown, dry	R<5 EI=67
R-53	205+15	111.7 Lt.	51.3	0-5'	SANDY LEAN CLAY (CL), grayish brown, moist	R=36
R-54	207+09	82.2 Rt.	64.3	0-5'	SILTY SAND with GRAVEL(SM), yellowish brown	R=39
R-55	210+50	0 C.L.	62.6	0-5'	CLAYEY SAND (SC), grayish brown, moist	R=51
R-57	223+00	0 C.L.	58.0	0-5'	SANDY LEAN CLAY (CL), grayish brown, moist	R=26
R-58	228+20	68.6 Rt.	54.0	0-5'	SANDY LEAN CLAY (CL), brown, moist	R=28
R-59	233+38	0 C.L.	53.1	0-5'	LEAN CLAY (CL), yellowish brown, moist	--
R-60	239+35	66.4 Rt.	50.0	0-5'	SANDY SILT (ML), yellowish brown, moist	R=44
R-61	244+16	20 Lt.	48.3	0-5'	SANDY LEAN CLAY (CL), brown, moist	R=33
R-62	249+18	92 Lt.	47.3	0-5'	SANDY LEAN CLAY (CL), brown, moist	--
R-63	252+84	44.2 Lt.	44.5	0-5'	SANDY LEAN CLAY (CL), brown, moist	R=26

Note : All Borings drilled with 6" Solid Stem Auger ; EI=Expensive Index

APPENDIX B

APPENDIX B

LABORATORY TESTS

Classification Tests
The field classification of the samples was visually verified in the laboratory according to the Unified Soil Classification System. The results are presented on "Log of Test Borings", Appendix A.

Moisture-Density
The natural moisture contents and dry unit weights were determined for selected undisturbed samples of the soils in general accordance with ASTM Test Method D 2216-92. This information was used to classify and correlate the soils. The results are presented at the appropriate depths on the "Log of Test Borings", Appendix A.

Atterberg Limits
The Atterberg Limits were determined for selected samples of the fine-grained materials. These results were used to classify the soils, as well as to obtain an indication of the effective strength characteristics and expansion potential with variations in moisture content. The Atterberg Limits were determined in general accordance with ASTM Test Method D 4318-93. The results of these tests are presented on Plates B-2A thru B-2G, "Plasticity Chart".

Grain Size Classification
Grain size classification tests (ASTM Test Method D422-63) were performed on selected samples of granular soil to aid in the classification. The results are presented on Plates B-3A thru B-3J, "Grain Size Distribution Curves".

Unconfined Compression Tests
Strength tests were performed on selected undisturbed samples using unconfined compression machine. Unconfined compression tests were performed in general accordance with ASTM Test Method D 2166-91. The results are presented on "Log of Test Borings"

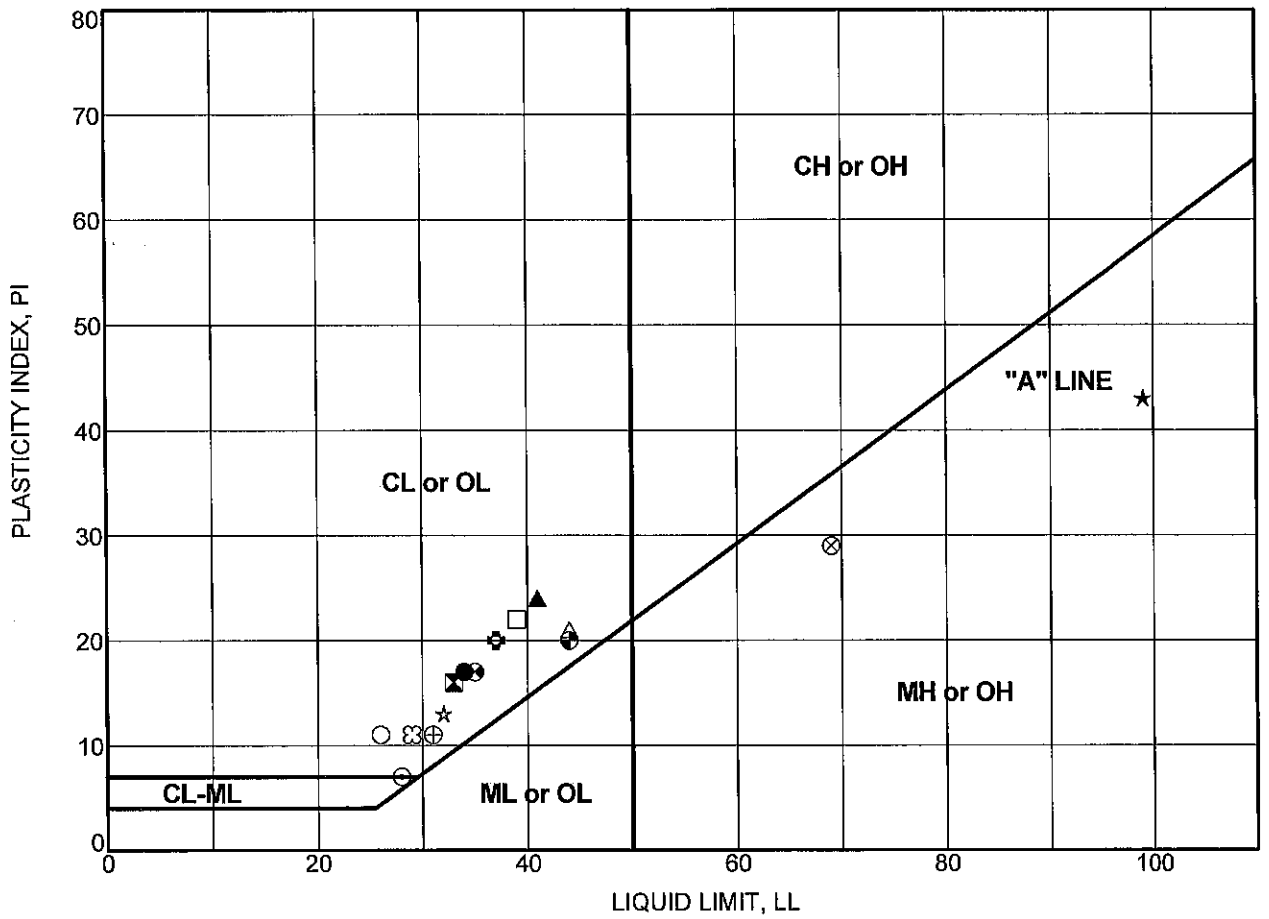
Corrosion Tests
Corrosion tests were performed on selected samples to determine the corrosion potential of the soils. The pH and minimum resistively tests were performed according to California Test Method 643, 417 and 422. The tests were performed by Sunland Analytical. The test results are presented on Plates B-4-1 thru B-4-28.

R-value Tests
R-value tests were performed on representative bulk samples for pavement design. The tests were performed according to California Test Method 301. The test results are presented on Plates B-5A thru B-5N.

Expansion Index
Expansion Index tests were performed on representative bulk samples to determine an indication of swelling potential of a compacted soil. The tests were performed according to ASTM Test Method D-4829. The test results are presented on Plates B-6A and B-6B.

Direct Shear Tests
Direct Shear test was performed on selected undisturbed sample to determine the shear strength of a soil material in direct shear. The test was performed according to ASTM Test Method D 3080 by Cooper. The test result is presented on Plate B-7A and B-7B.

Hydrometer
Hydrometer test (ASTM Test Method D 422) was performed on selected samples to aid in the classification. The result is presented on Plate B-8, " Grain Size Distribution Curves"



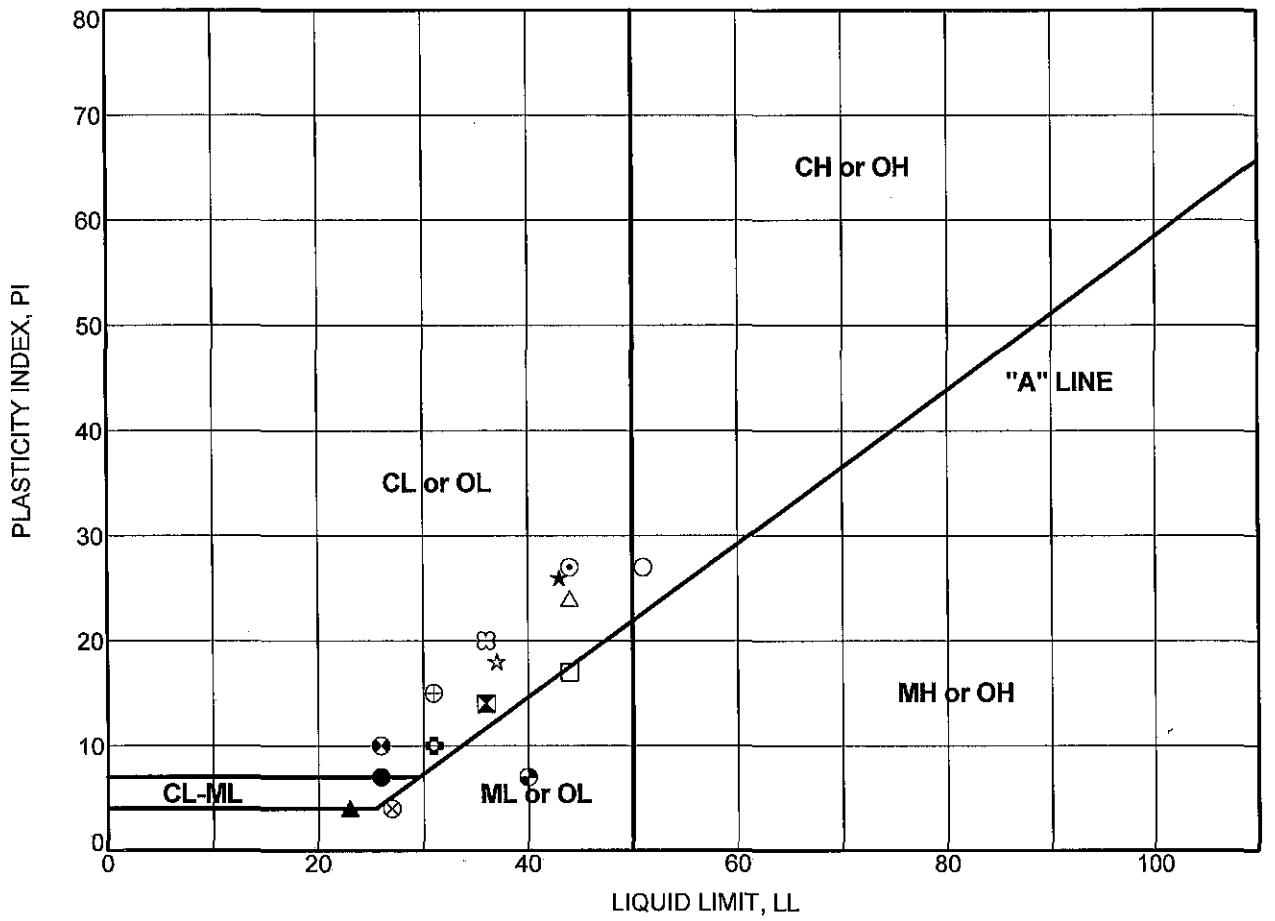
PLASTICITY CHART

Boring Number	Sample Number	Depth (feet)	Test Symbol	Moisture Content (%)	LL	PL	PI	Description
AST-154	MC-2	8.0	●	16	34	17	17	LEAN CLAY (CL)
AST-154	SPT-11	50.0	⊠	18	33	17	16	LEAN CLAY (CL)
AST-154	MC-12	55.0	▲	25	41	17	24	LEAN CLAY (CL)
AST-154A	SPT-7	99.5	★	50	99	56	43	ELASTIC SILT (MH)
AST-155	MC-2	10.0	⊙	19	28	21	7	SILTY CLAY (CL-ML)
AST-155	MC-4	15.0	✿	15	37	17	20	LEAN CLAY (CL)
AST-155	MC-11	50.0	○	24	26	15	11	LEAN CLAY (CL)
AST-155	MC-12	55.0	△	56	44	23	21	LEAN CLAY (CL)
AST-155A	SPT-8	109.5	⊗	62	69	40	29	SANDY ELASTIC SILT (MH)
CAV-168	MC-3	14.5	⊕	21	31	20	11	LEAN CLAY (CL)
CAV-168	MC-5	25.0	□	15	39	17	22	LEAN CLAY (CL)
CAV-169	MC-3	10.0	⊗	19	35	18	17	LEAN CLAY (CL)
CAV-169	MC-8	35.0	◕	22	44	24	20	LEAN CLAY (CL)
E-191	MC-3	9.5	☆	18	32	19	13	LEAN CLAY (CL)
E-191	MC-5	19.5	⊠	15	29	18	11	LEAN CLAY (CL)

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

STATE ROUTE 4 (EAST) WIDENING PROJECT - SEGMENT 3A
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.GDR | PLATE NO: B-2A



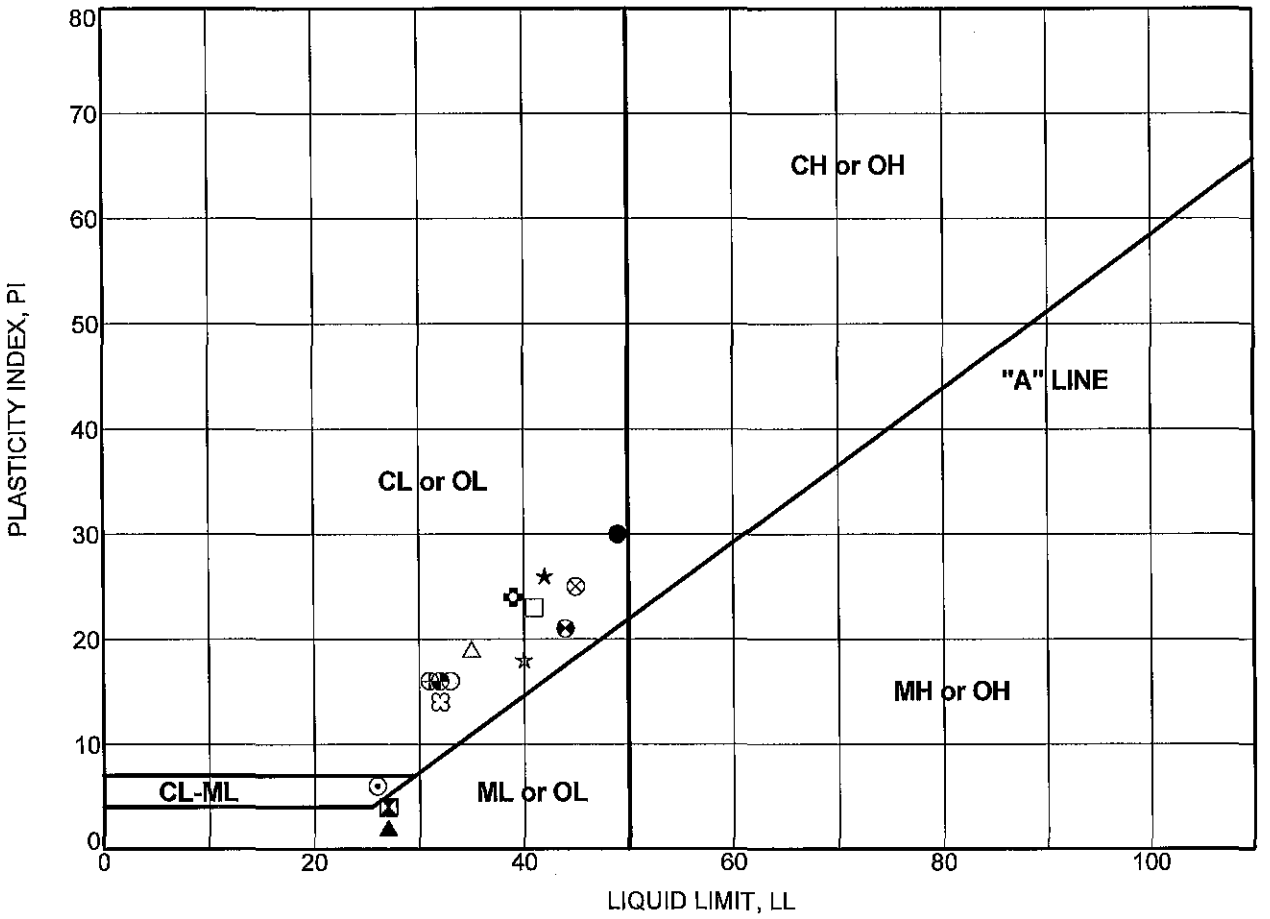
PLASTICITY CHART

Boring Number	Sample Number	Depth (feet)	Test Symbol	Moisture Content (%)	LL	PL	PI	Description
RW/SW-139	MC-2	6.0	●	20	26	19	7	LEAN CLAY (CL)
RW/SW-139	MC-4	16.0	⊠	15	36	22	14	LEAN CLAY (CL)
RW/SW-141	MC-1	2.0	▲	12	23	19	4	SILTY CLAY (CL-ML)
RW/SW-141	MC-3	11.0	★	9	43	17	26	LEAN CLAY (CL)
RW/SW-143	MC-1	2.0	⊙	13	44	17	27	LEAN CLAY (CL)
RW/SW-149	MC-2	3.5	✿	14	31	21	10	LEAN CLAY (CL)
RW/SW-149	MC-6	23.5	○	22	51	24	27	FAT CLAY (CH)
RW/SW-170	MC-2	6.0	△	11	44	20	24	LEAN CLAY (CL)
RW/SW-170	MC-6	25.0	⊗	20	27	23	4	SILT (ML)
RW/SW-171A	MC-1	2.0	⊕	10	31	16	15	LEAN CLAY (CL)
RW/SW-171A	MC-5	20.0	□	22	44	27	17	SILT (ML)
RW/SW-172	MC-2	4.5	⊗	13	26	16	10	LEAN CLAY (CL)
RW/SW-173	MC-2	3.0	◕	17	40	33	7	SILT (ML)
RW/SW-173	MC-8	33.0	☆	21	37	19	18	LEAN CLAY (CL)
RW/SW-174	MC-4	14.5	✿	12	36	16	20	LEAN CLAY (CL)

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

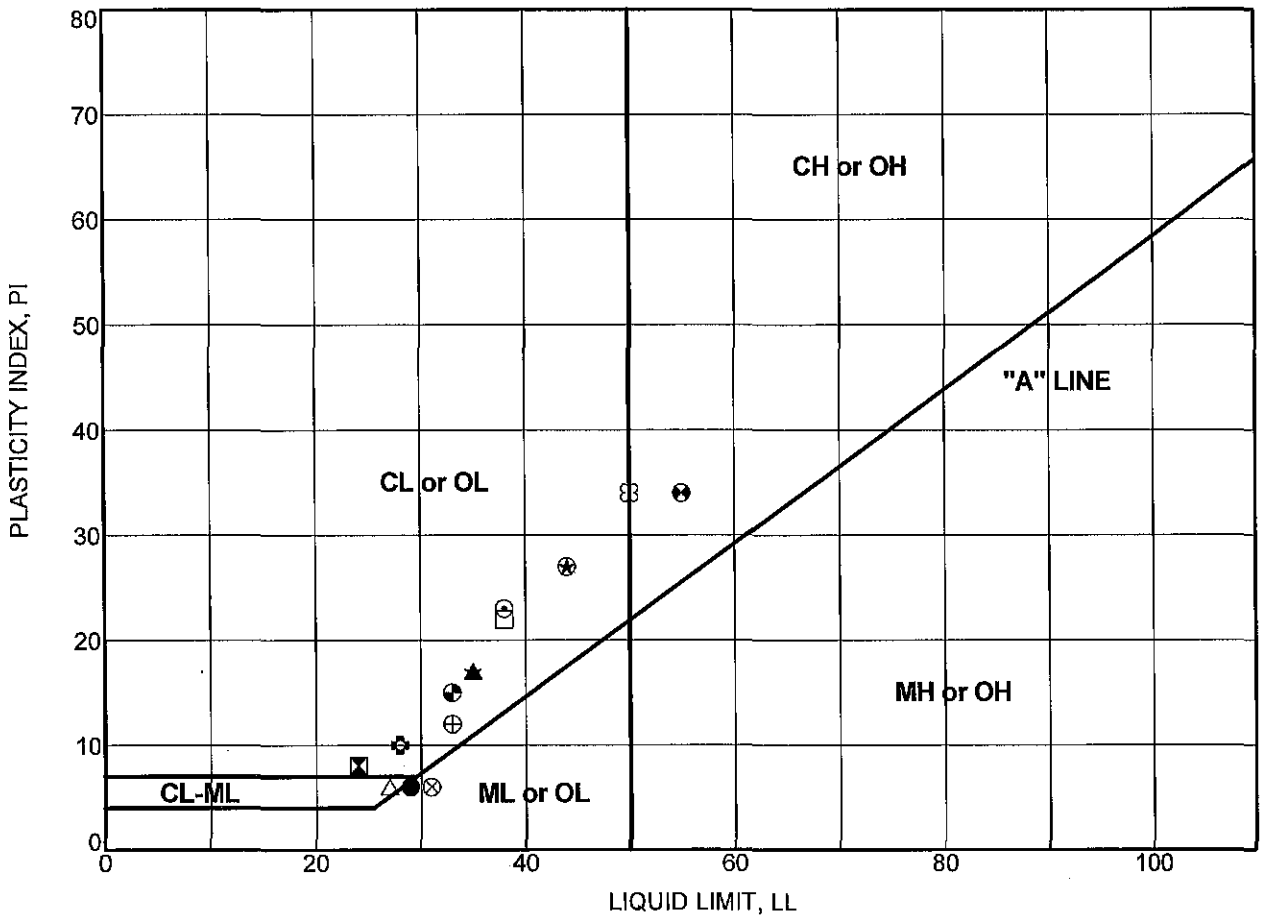
STATE ROUTE 4 (EAST) WIDENING PROJECT - SEGMENT 3A
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.GDR | PLATE NO: B-2B



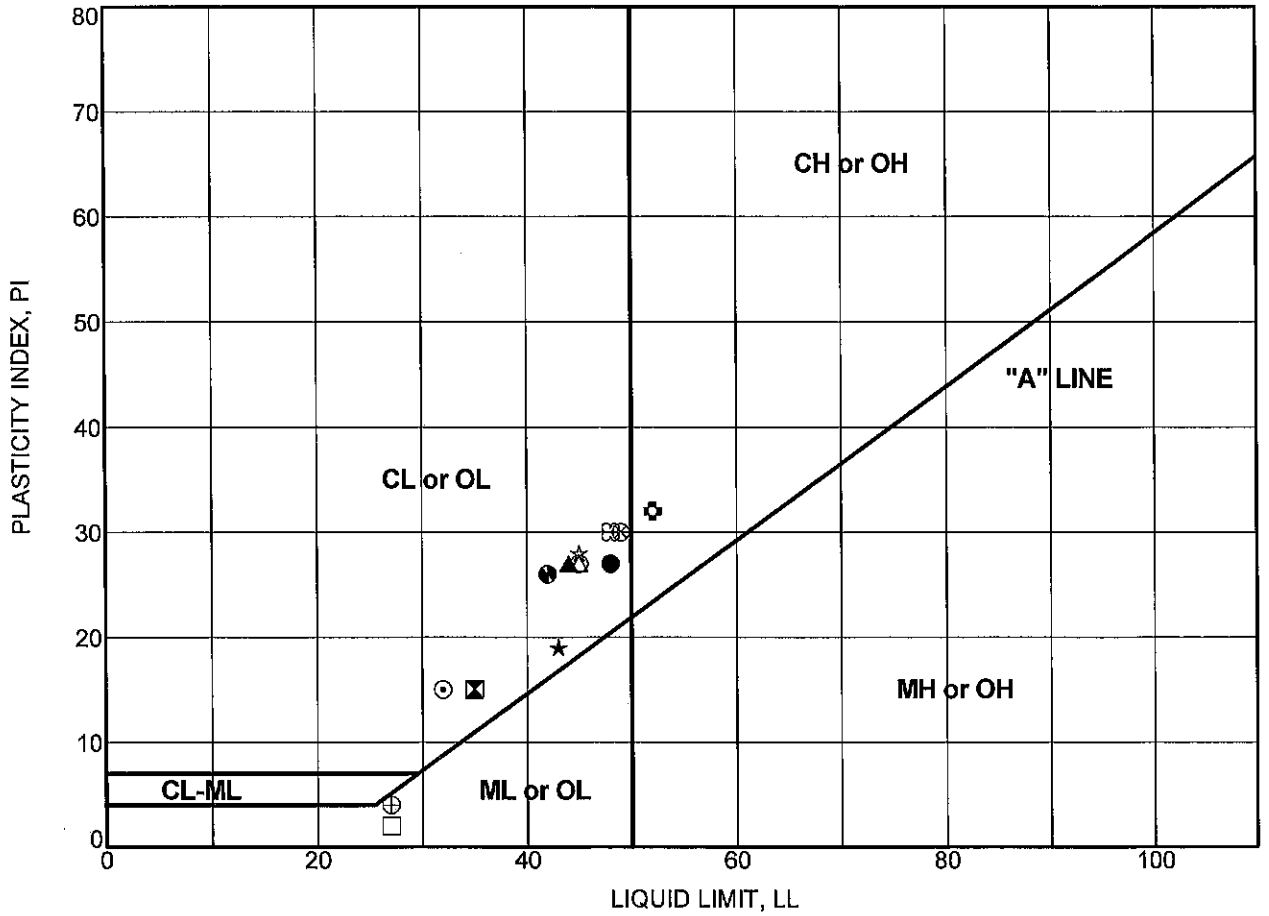
PLASTICITY CHART

Boring Number	Sample Number	Depth (feet)	Test Symbol	Moisture Content (%)	LL	PL	PI	Description
RW/SW-175	MC-2	6.0	●	17	49	19	30	LEAN CLAY (CL)
RW/SW-175	MC-5	20.0	⊠	17	27	23	4	SILT (ML)
RW/SW-176	MC-4	15.0	▲	16	27	25	2	SILT (ML)
RW/SW-177	MC-1	2.0	★	10	42	16	26	LEAN CLAY (CL)
RW/SW-185	MC-3	9.5	⊙	10	26	20	6	SILTY CLAY (CL-ML)
RW/SW-196	MC-1	2.5	✿	9	39	15	24	LEAN CLAY (CL)
RW/SW-196	MC-5	19.5	○	11	33	17	16	LEAN CLAY (CL)
RW/SW-199	MC-1	2.5	△	13	35	16	19	LEAN CLAY (CL)
RW/SW-199	MC-5	19.5	⊗	15	45	20	25	LEAN CLAY (CL)
RW/SW-202	MC-1	2.5	⊕	11	31	15	16	LEAN CLAY (CL)
RW/SW-202	MC-5	19.5	□	17	41	18	23	LEAN CLAY (CL)
RW/SW-204	MC-4	14.5	⊞	20	44	23	21	LEAN CLAY (CL)
RW/SW-210	MC-4	14.5	◕	17	32	16	16	LEAN CLAY (CL)
RW/SW-211	MC-1	1.5	☆	12	40	22	18	LEAN CLAY (CL)
RW/SW-211	MC-7	28.5	⊠	15	32	18	14	LEAN CLAY (CL)



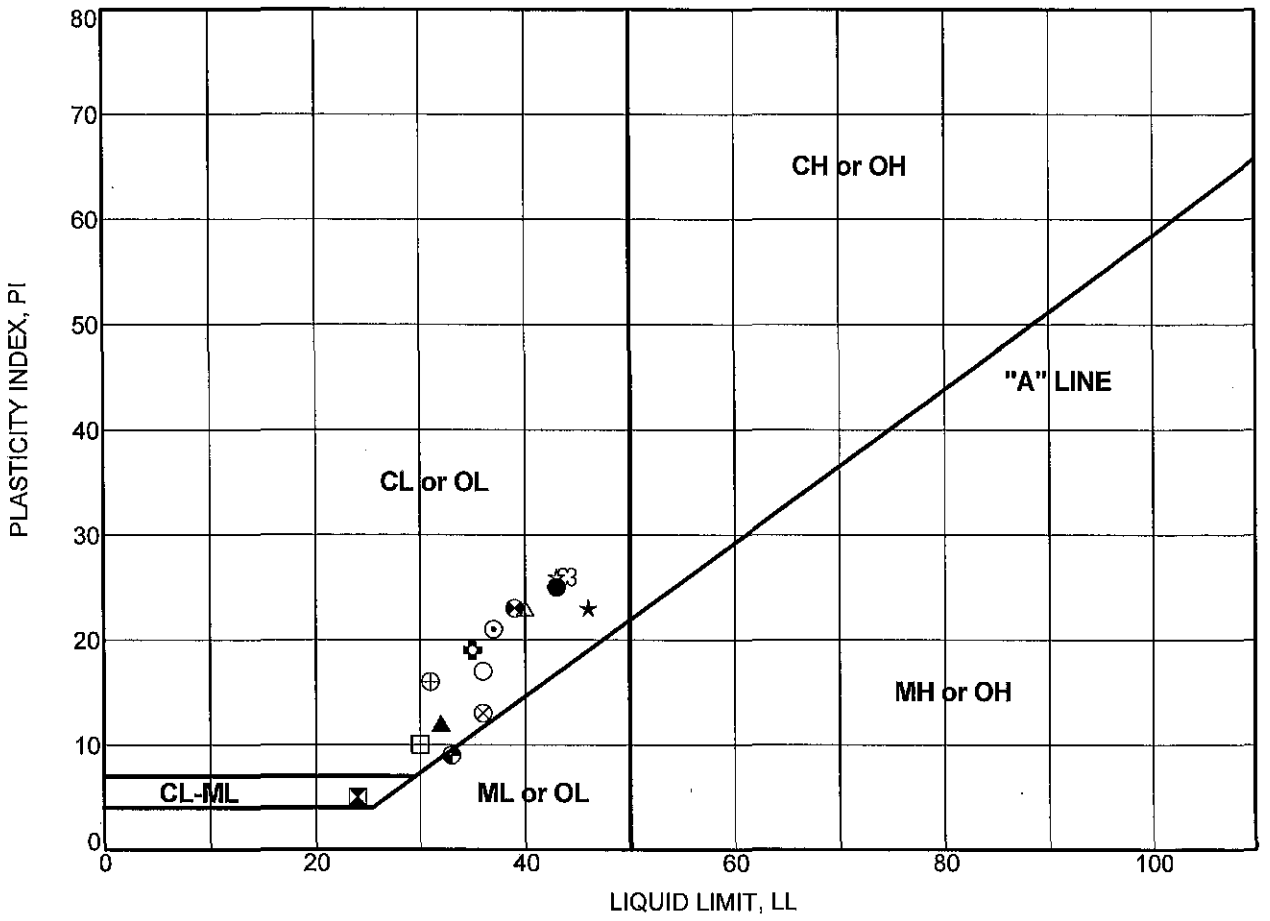
PLASTICITY CHART

Boring Number	Sample Number	Depth (feet)	Test Symbol	Moisture Content (%)	LL	PL	PI	Description
RW/SW-213	MC-2	4.5	●	14	29	23	6	SILT (ML)
RW/SW-213	MC-4	13.5	⊠	16	24	16	8	LEAN CLAY (CL)
RW-186	MC-1	1.5	▲	12	35	18	17	LEAN CLAY (CL)
RW-186	MC-3	8.5	★	14	44	17	27	LEAN CLAY (CL)
RW-187	MC-2	5.5	⊙	18	38	15	23	LEAN CLAY (CL)
RW-187	MC-6	24.5	✿	16	28	18	10	LEAN CLAY (CL)
RW-189	MC-1	2.5	○	13	44	17	27	LEAN CLAY (CL)
RW-190	MC-4	14.5	△	14	27	21	6	SILTY CLAY (CL-ML)
RW-194	MC-3	9.5	⊗	14	31	25	6	SILT (ML)
RW-194	MC-6	24.5	⊕	13	33	21	12	LEAN CLAY (CL)
RW-214	MC-1	1.5	□	14	38	16	22	LEAN CLAY (CL)
SW-140	MC-2	4.5	⊞	16	55	21	34	FAT CLAY (CH)
SW-142	MC-2	4.5	◕	10	33	18	15	LEAN CLAY (CL)
SW-142	MC-6	24.5	☆	15	35	18	17	LEAN CLAY (CL)
SW-144	MC-1	2.0	⊠	15	50	16	34	FAT CLAY (CH)



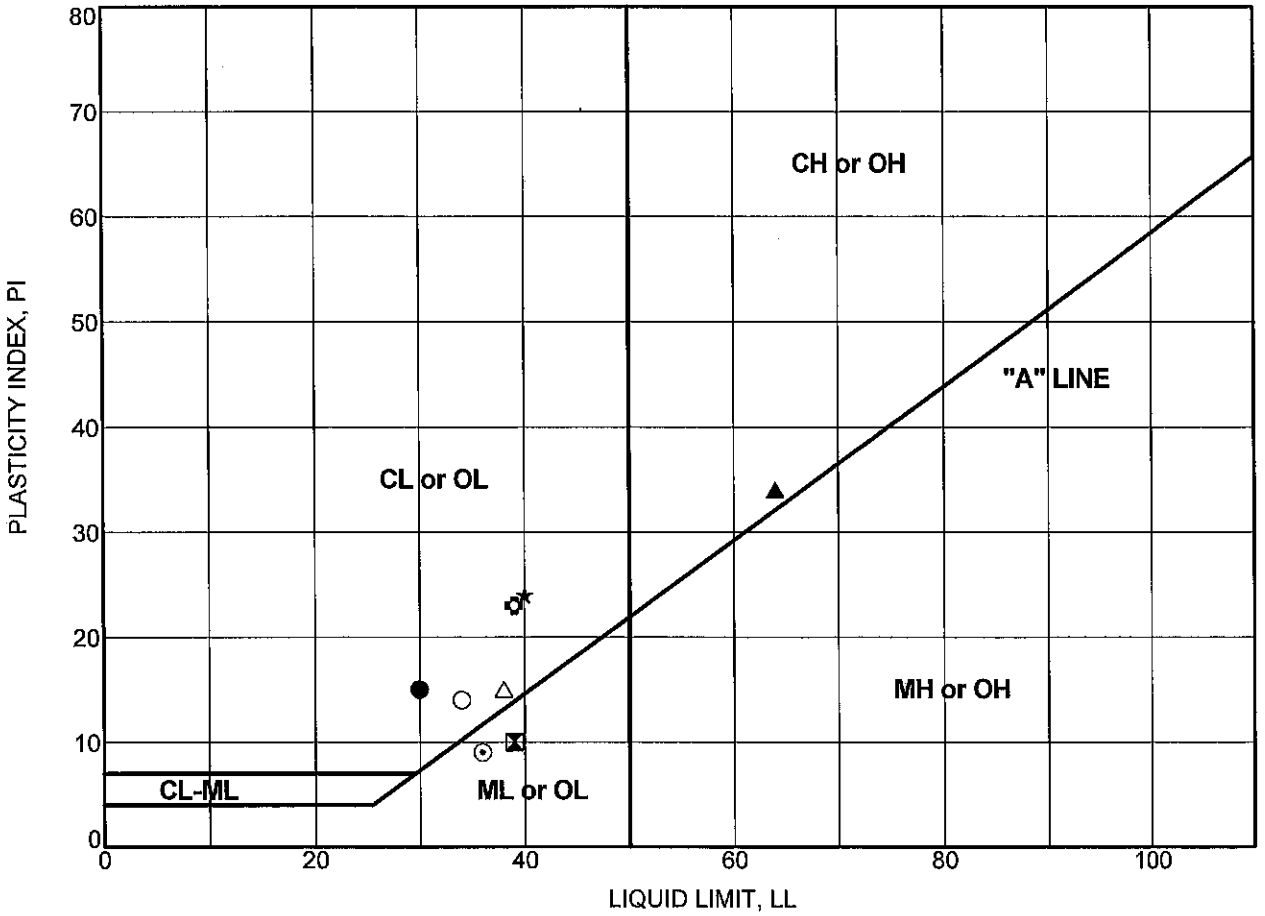
PLASTICITY CHART

Boring Number	Sample Number	Depth (feet)	Test Symbol	Moisture Content (%)	LL	PL	PI	Description
SW-144	SPT-7	29.5	●	18	48	21	27	LEAN CLAY (CL)
SW-145	MC-4	16.0	⊠	15	35	20	15	LEAN CLAY (CL)
SW-146	MC-2	4.5	▲	12	44	17	27	LEAN CLAY (CL)
SW-146	MC-5	19.5	★	15	43	24	19	LEAN CLAY (CL)
SW-147	MC-2	6.0	⊙	13	32	17	15	LEAN CLAY (CL)
SW-148	MC-2	4.5	✿	16	52	20	32	FAT CLAY (CH)
SW-148	MC-5	19.5	○	7	45	18	27	SILTY SAND (SM)
SW-148	MC-7	29.5	△	14	45	18	27	LEAN CLAY (CL)
SW-175	MC-2	6.0	⊗	17	49	19	30	LEAN CLAY (CL)
SW-175	MC-5	20.0	⊕	17	27	23	4	SILT (ML)
SW-176	MC-4	15.0	□	16	27	25	2	SILT (ML)
SW-178	MC-1	2.0	◕	13	42	16	26	LEAN CLAY (CL)
SW-178	MC-2	6.0	◕	16	42	16	26	LEAN CLAY (CL)
SW-179	MC-2	4.5	☆	18	45	17	28	LEAN CLAY (CL)
SW-188	MC-1	2.5	⊠	14	48	18	30	LEAN CLAY (CL)



PLASTICITY CHART

Boring Number	Sample Number	Depth (feet)	Test Symbol	Moisture Content (%)	LL	PL	PI	Description
SW-188	SPT-7	28.5	●	17	43	18	25	LEAN CLAY (CL)
SW-192	MC-3	8.5	⊠	7	24	19	5	SILTY CLAY (CL-ML)
SW-192	SPT-7	28.5	▲	22	32	20	12	LEAN CLAY (CL)
SW-192	SPT-9	38.5	★	22	46	23	23	LEAN CLAY (CL)
SW-193	MC-3	9.5	⊙	21	37	16	21	LEAN CLAY (CL)
SW-193	MC-6	24.5	✿	17	35	16	19	LEAN CLAY (CL)
SW-195	MC-2	5.5	○	14	36	19	17	LEAN CLAY (CL)
SW-197	MC-1	2.5	△	12	40	17	23	LEAN CLAY (CL)
SW-197	MC-4	14.5	⊗	15	36	23	13	LEAN CLAY (CL)
SW-200	MC-1	2.5	⊕	10	31	15	16	LEAN CLAY (CL)
SW-200	MC-5	19.5	□	12	30	20	10	LEAN CLAY (CL)
SW-201	MC-2	5.5	⊞	11	39	16	23	LEAN CLAY (CL)
SW-201	MC-6	24.5	◕	18	33	24	9	SILT (ML)
SW-203	MC-2	5.5	☆	13	43	17	26	LEAN CLAY (CL)
SW-203	SPT-6	24.5	⊠	15	44	18	26	LEAN CLAY (CL)



PLASTICITY CHART

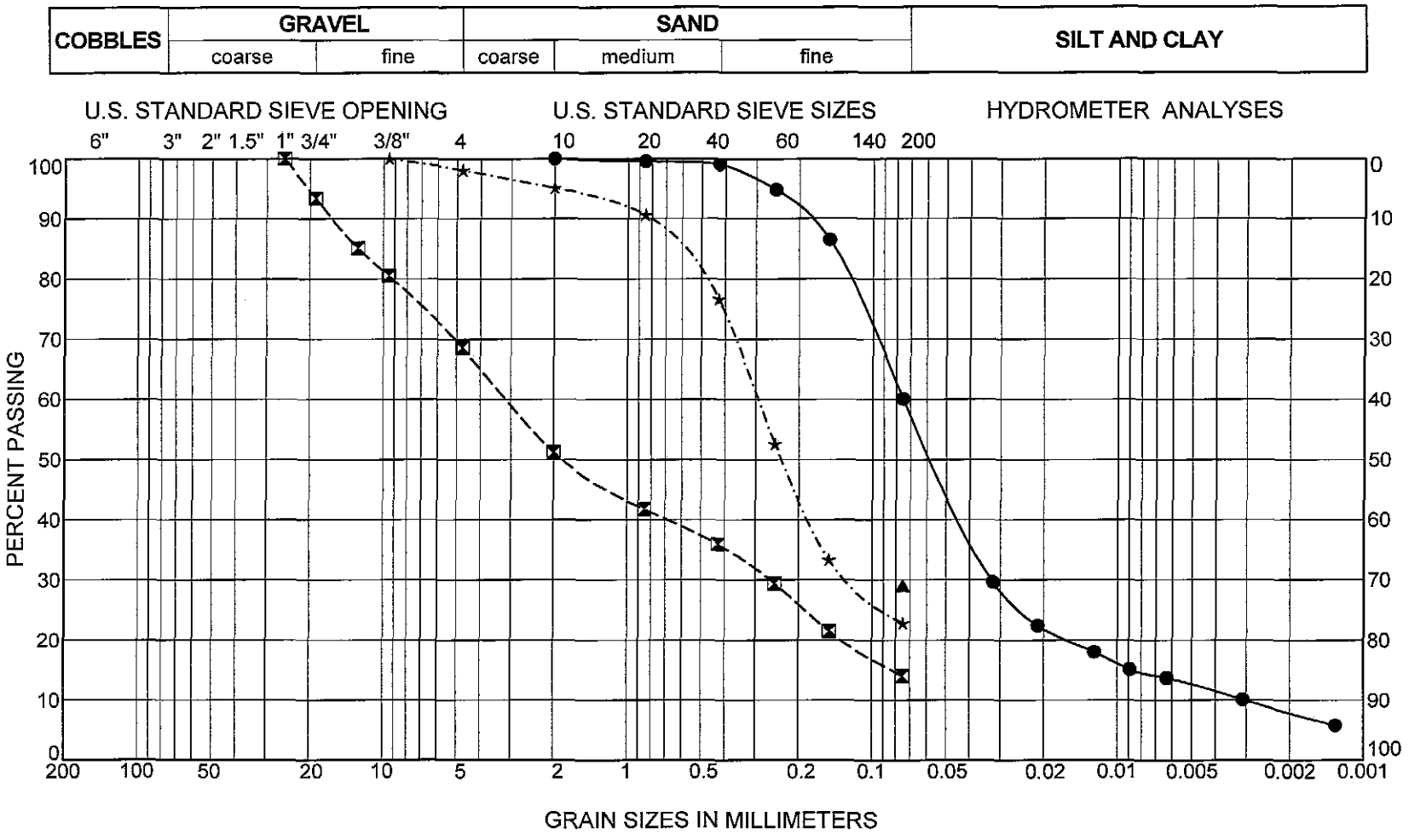
Boring Number	Sample Number	Depth (feet)	Test Symbol	Moisture Content (%)	LL	PL	PI	Description
SW-205	MC-1	2.5	●	10	30	15	15	LEAN CLAY (CL)
SW-205	MC-6	24.5	⊠	23	39	29	10	SILT (ML)
SW-205	MC-8	34.5	▲	29	64	30	34	FAT CLAY (CH)
SW-206	MC-1	2.5	★	12	40	16	24	LEAN CLAY (CL)
SW-206	MC-4	14.5	⊙	16	36	27	9	SILT (ML)
SW-207	MC-1	2.5	✿	12	39	16	23	LEAN CLAY (CL)
SW-207	MC-5	19.5	○	17	34	20	14	LEAN CLAY (CL)
SW-208	MC-4	14.5	△	17	38	23	15	LEAN CLAY (CL)

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

STATE ROUTE 4 (EAST) WIDENING PROJECT - SEGMENT 3A
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.GDR | PLATE NO: B-2G

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
AST-154	SPT-14	65.0	●			SANDY SILT (ML)
AST-154A	SPT-8	89.5	⊠			SILTY SAND WITH GRAVEL (SM)
AST-154A	SPT-9	109.5	▲			SANDY SILT (ML)
AST-155	MC-6	25.0	★			CLAYEY SAND (SC)

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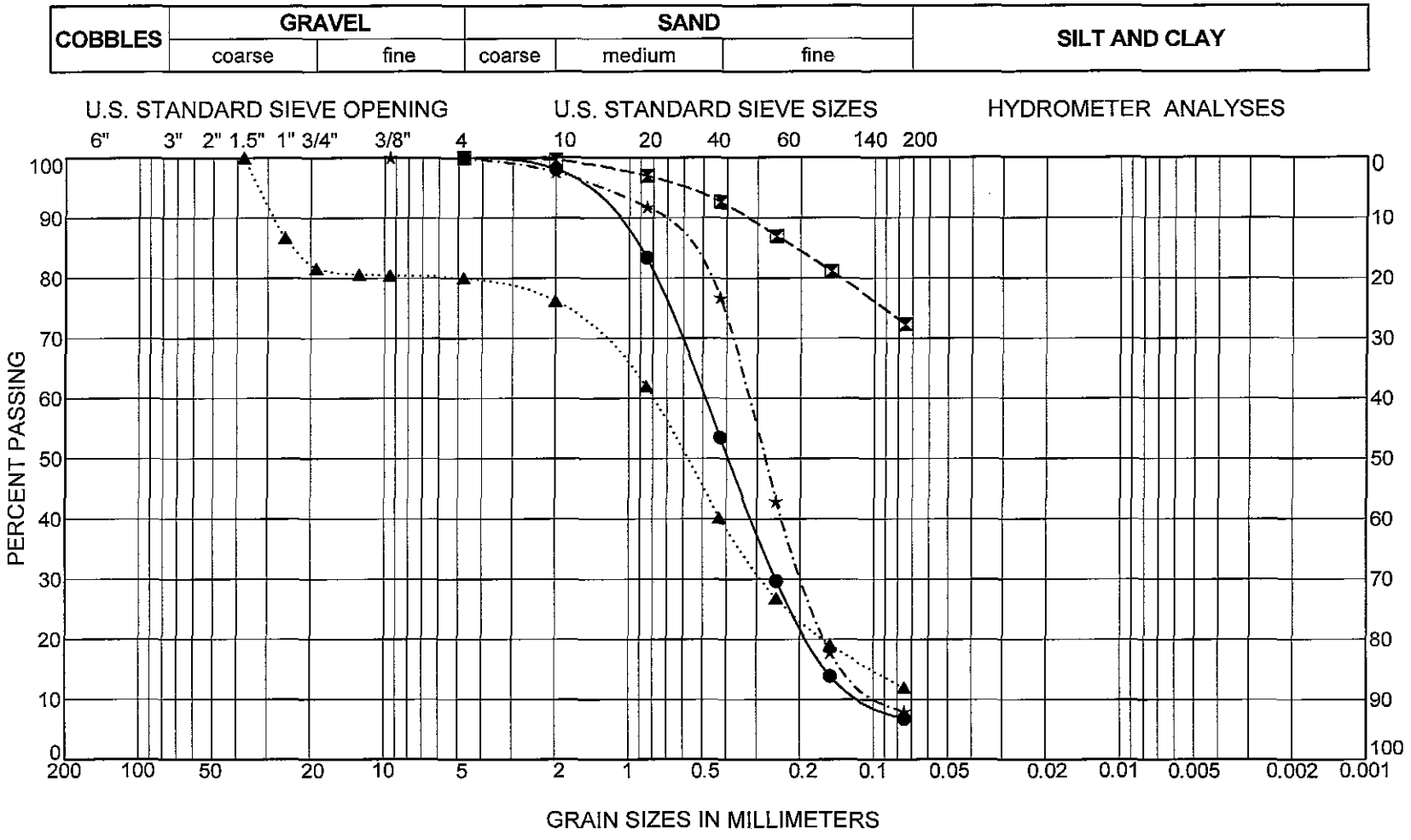
MATERIALS ENGINEERING

STATE ROUTE 4 (EAST) WIDENING PROJECT - SEGMENT 3A
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.GDR

PLATE NO: B-3A

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
AST-155	SPT-14	70.0	●			POORLY GRADED SAND WITH SILT (SP-SM)
AST-155A	SPT-7	99.5	⊠			SILT WITH SAND (ML)
AST-155A	SPT-9	119.5	▲			WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM)
CAV-168	MC-8	40.0	★			POORLY GRADED SAND WITH SILT (SP-SM)

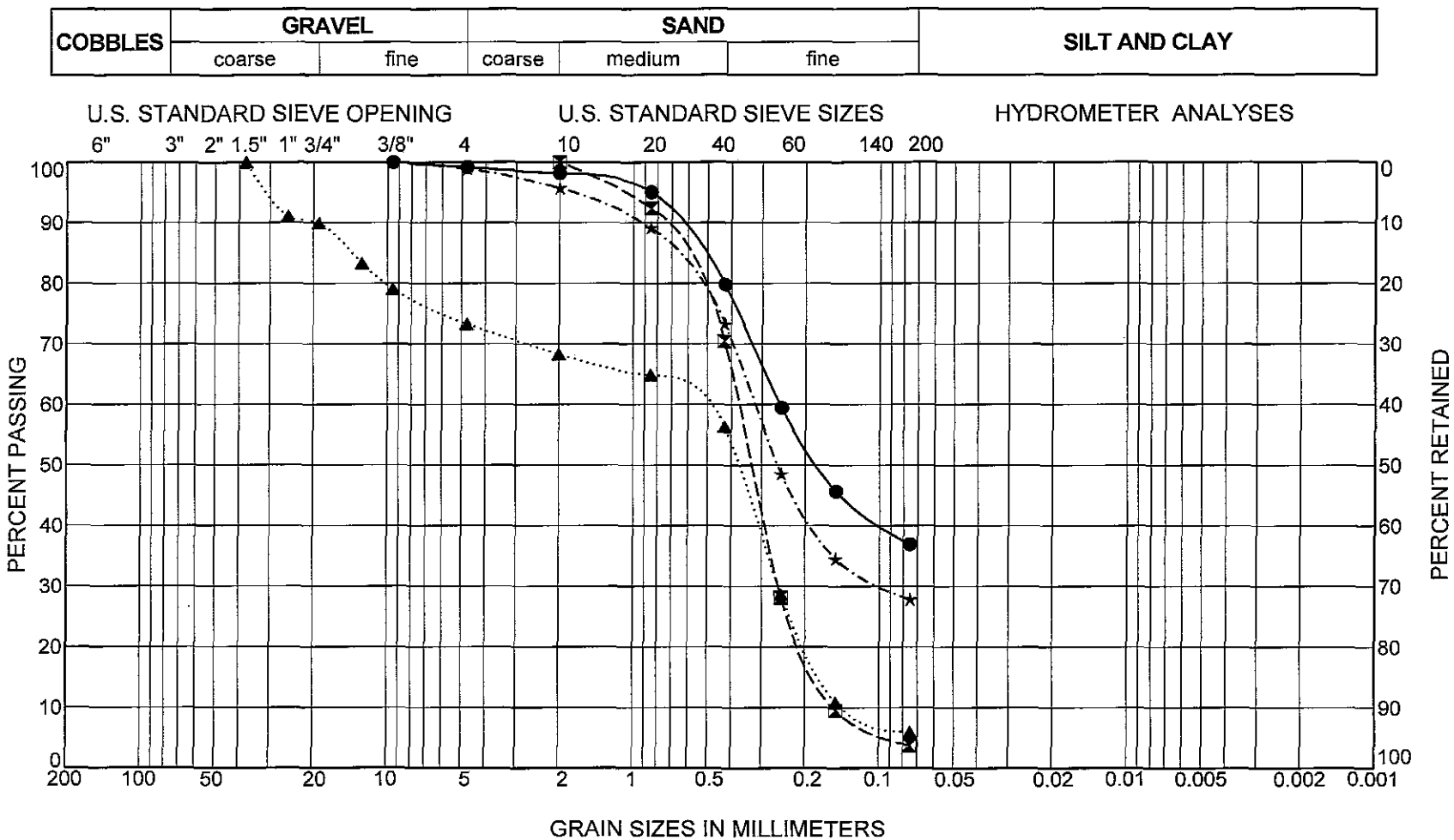
PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

STATE ROUTE 4 (EAST) WIDENING PROJECT - SEGMENT 3A
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.GDR

PLATE NO: B-3B

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
CAV-168	MC-10	50.0	●			CLAYEY SAND (SC)
CAV-168	MC-11	55.0	⧗			POORLY GRADED SAND (SP)
CAV-168	SPT-14	70.0	▲			POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)
CAV-169	MC-5	20.0	★			SILTY SAND (SM)

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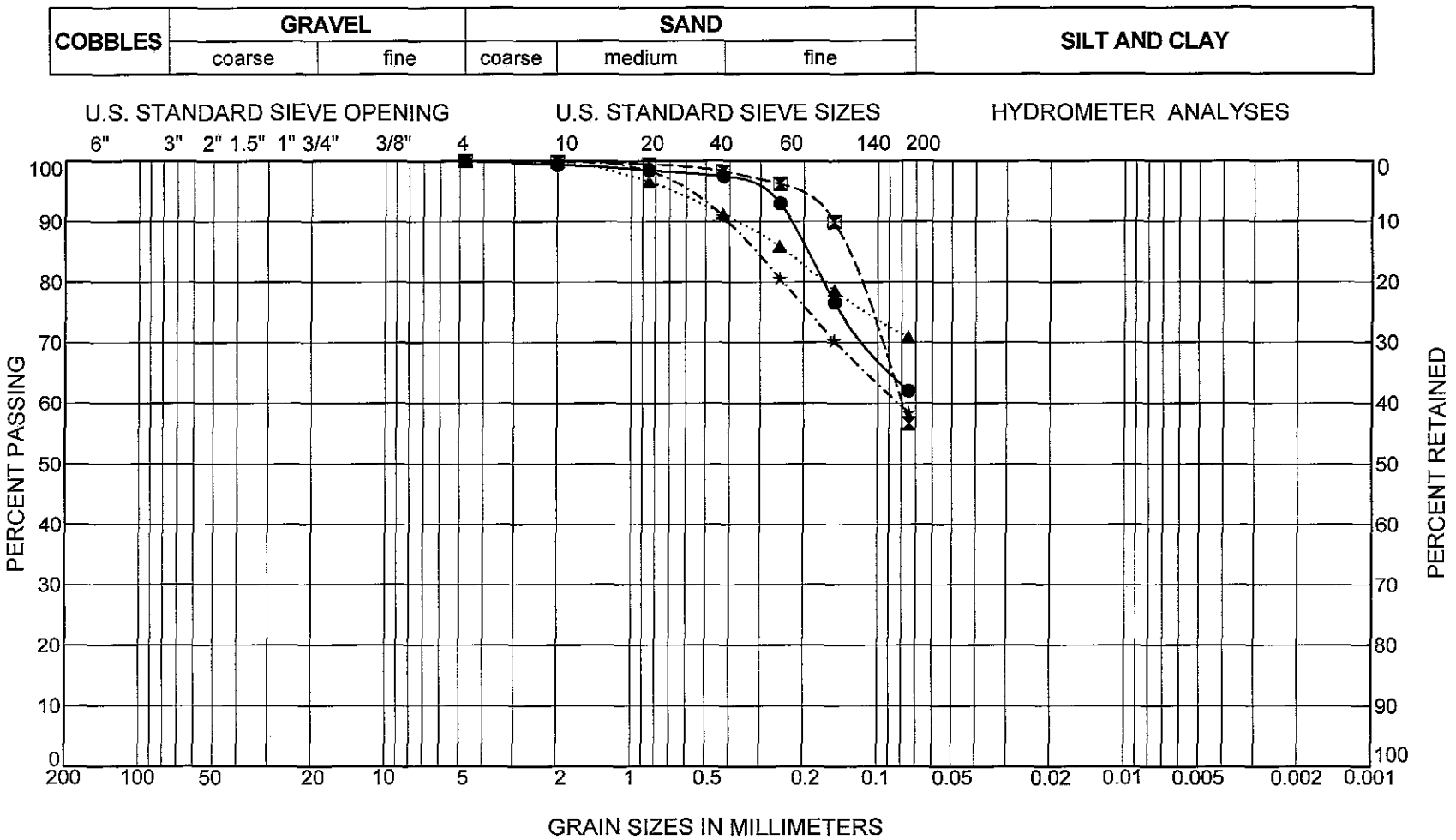
STATE ROUTE 4 (EAST) WIDENING PROJECT - SEGMENT 3A
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.GDR

PLATE NO: B-3C

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
CAV-169	MC-9	40.0	●			SANDY LEAN CLAY (CL)
CAV-169	MC-11	50.0	⧓			SANDY SILT (ML)
CAV-169	SPT-12	55.0	▲			SILTY CLAY WITH SAND (CL-ML)
CAV-169	SPT-13	60.0	★			SANDY SILTY CLAY (CL-ML)

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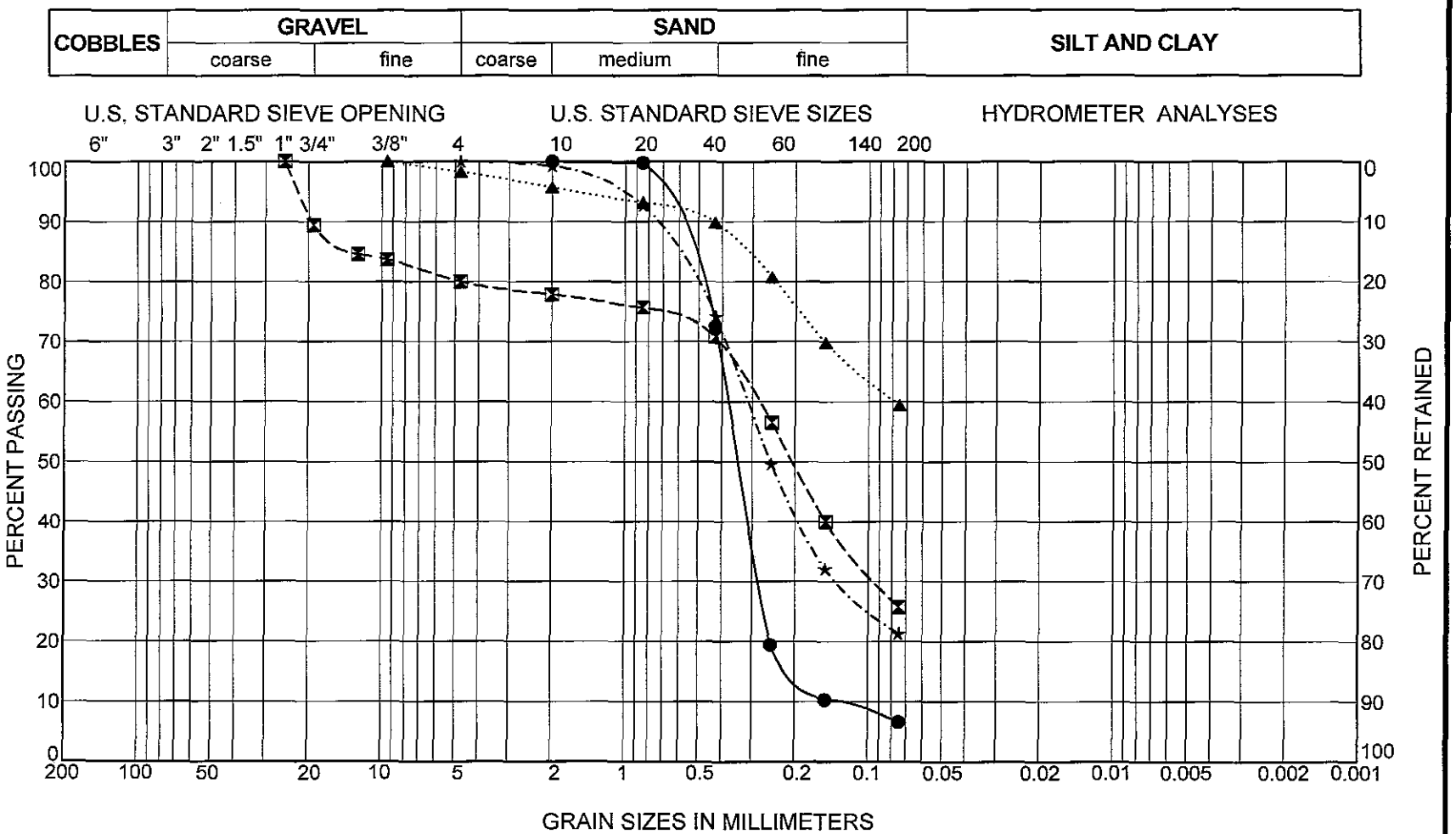
STATE ROUTE 4 (EAST) WIDENING PROJECT - SEGMENT 3A
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.GDR

PLATE NO: B-3D

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
RW/SW-143	MC-3	11.0	●			POORLY-GRADED SAND WITH SILT (SP-SM)
RW/SW-149	MC-4	13.5	⊠			SILTY SAND WITH GRAVEL (SM)
RW/SW-149	SPT-10	43.5	▲			SANDY CLAY (CL)
RW/SW-172	MC-4	19.5	★			SILTY SAND (SM)

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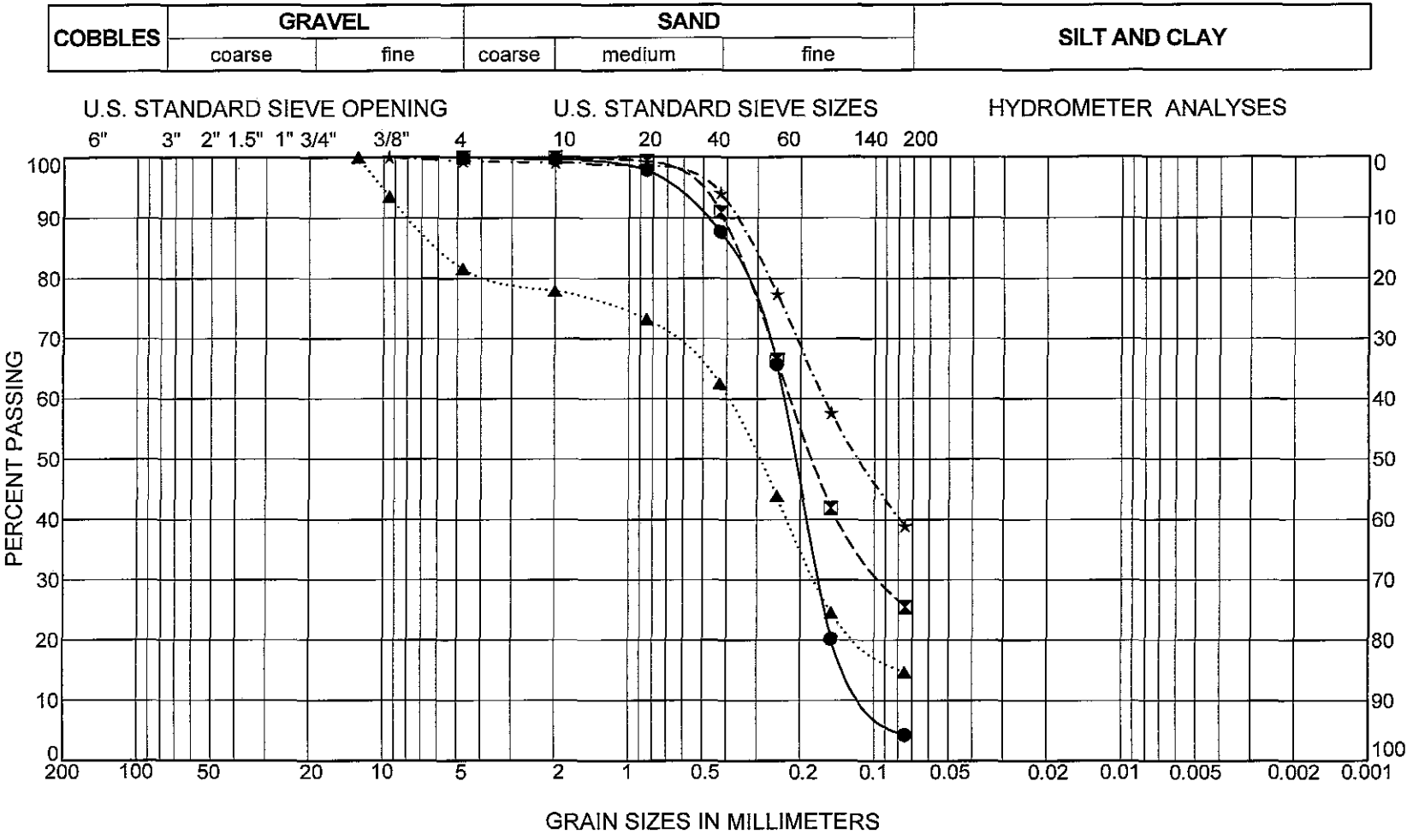
STATE ROUTE 4 (EAST) WIDENING PROJECT - SEGMENT 3A
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.GDR

PLATE NO: B-3E

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
RW/SW-173	MC-10	43.0	●			POORLY-GRADED SAND (SP)
RW/SW-175	MC-4	15.0	⊠			SILTY SAND (SM)
RW/SW-176	MC-5	20.0	▲			SILTY SAND WITH GRAVEL (SM)
RW/SW-211	MC-9	38.5	★			CLAYEY SAND (SC)

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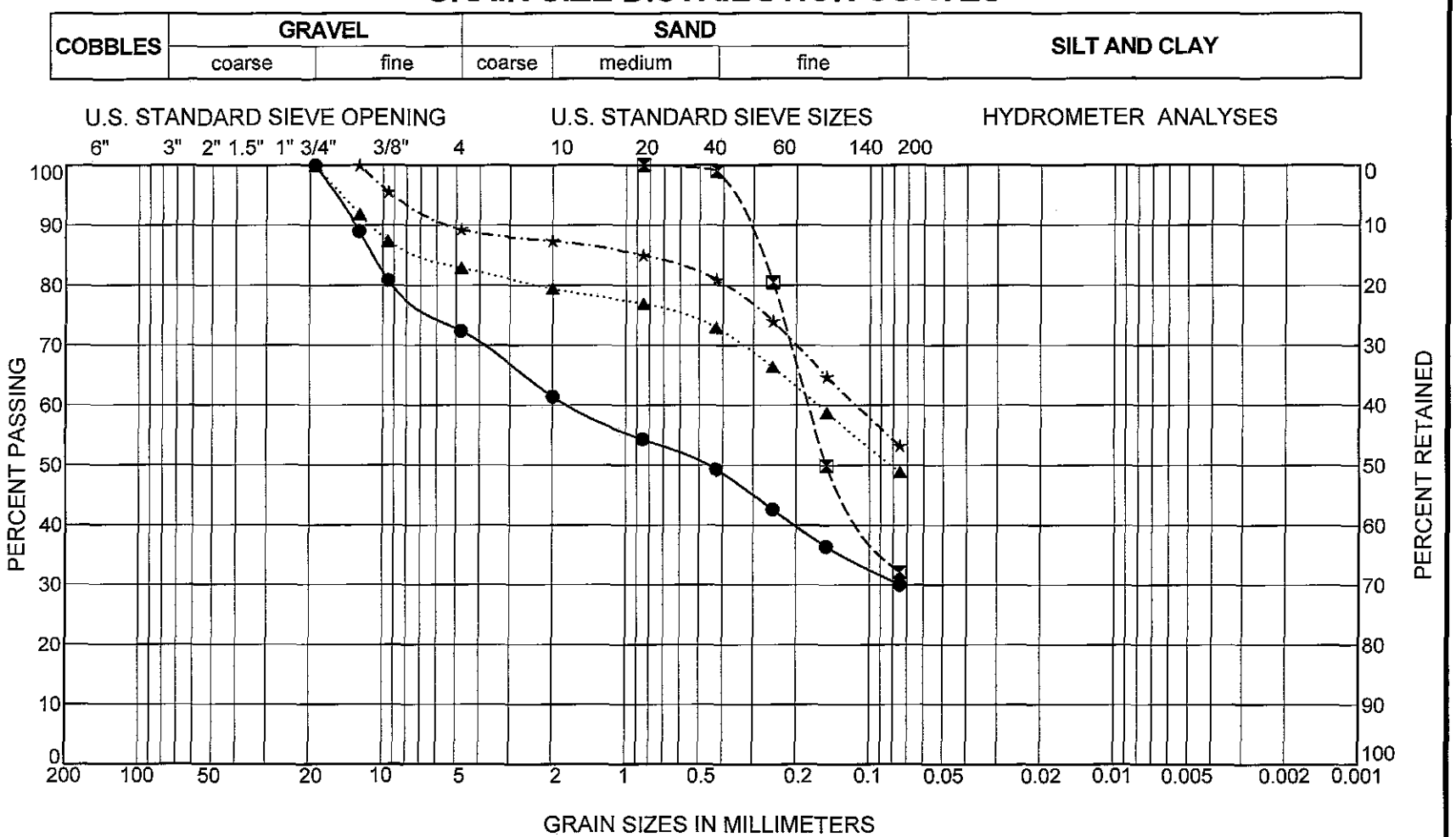
STATE ROUTE 4 (EAST) WIDENING PROJECT - SEGMENT 3A
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.GDR

PLATE NO: B-3F

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
RW-194	MC-3	9.5	●	31	6	SILT (ML)
SW-140	MC-5	19.5	⊠			SILTY SAND (SM)
SW-145	MC-1	2.0	▲			CLAYEY SAND WITH GRAVEL (SC)
SW-145	MC-3	11.0	★			SANDY LEAN CLAY (CL)

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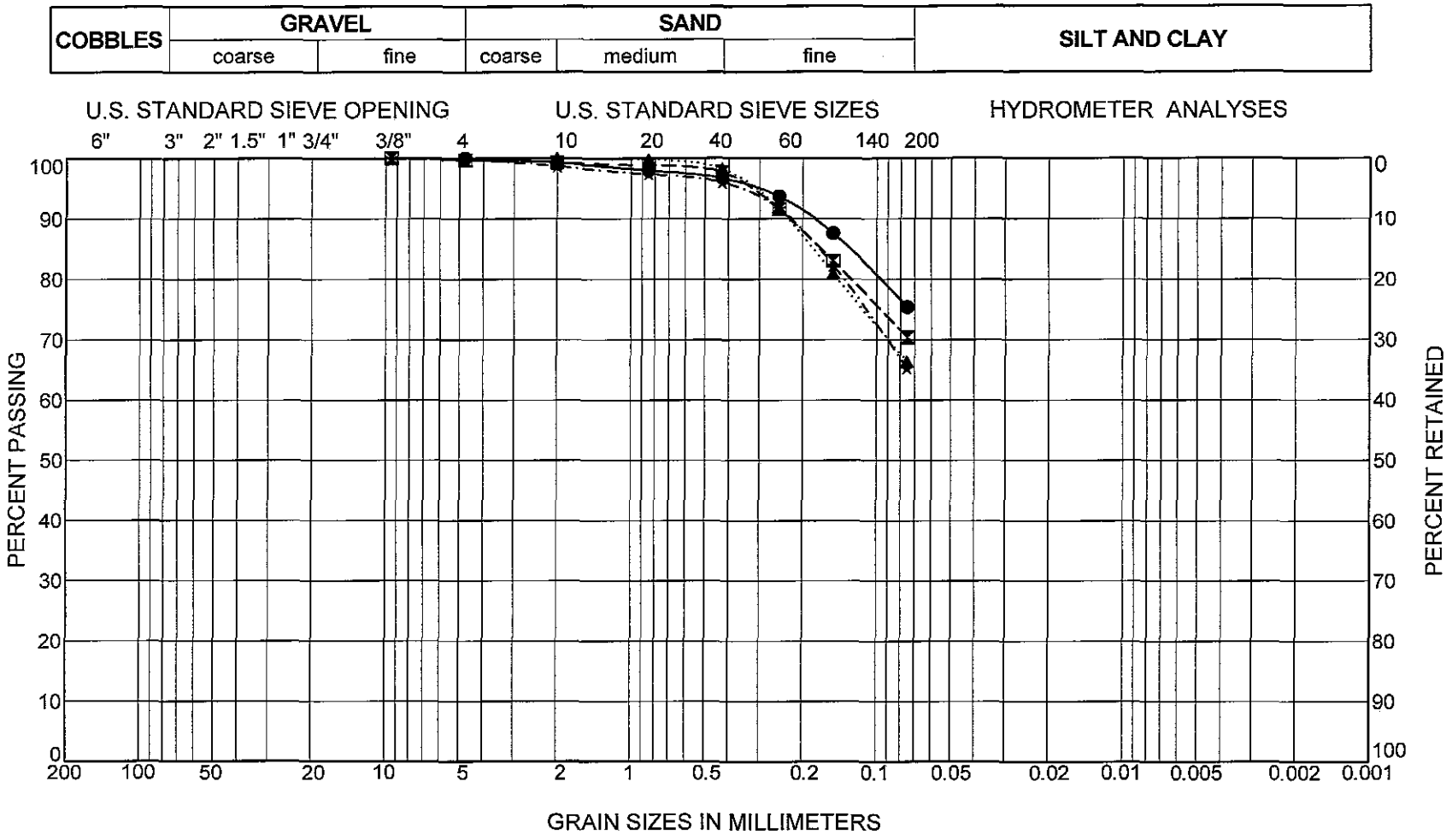
MATERIALS ENGINEERING

STATE ROUTE 4 (EAST) WIDENING PROJECT - SEGMENT 3A
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.GDR

PLATE NO: B-3G

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
SW-145	MC-5	21.0	●			LEAN CLAY WITH SAND (CL)
SW-146	MC-4	14.5	⧓			LEAN CLAY WITH SAND (CL)
SW-147	MC-4	16.0	▲			SANDY LEAN CLAY (CL)
SW-147	MC-6	26.0	★			SANDY LEAN CLAY (CL)

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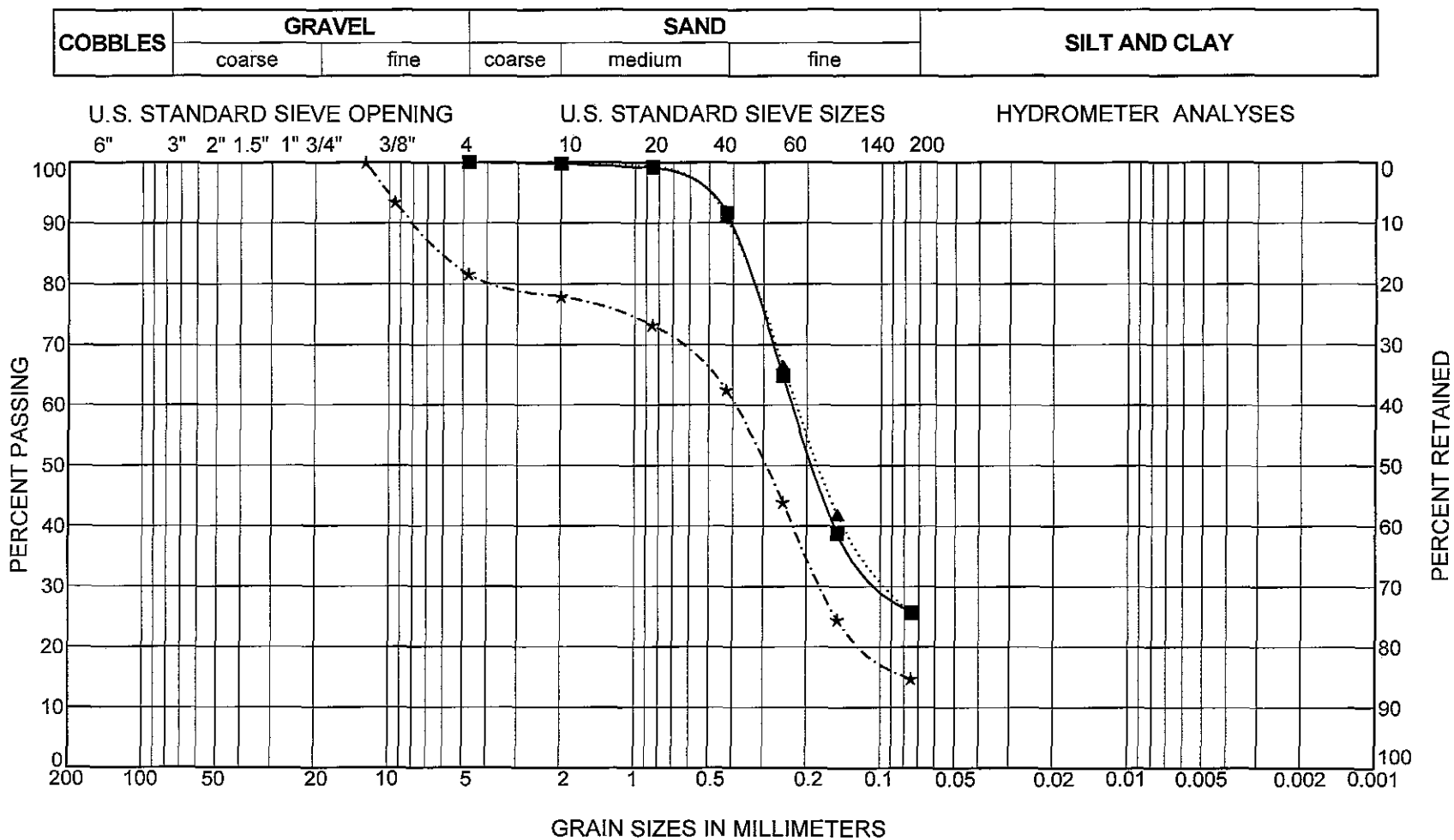
STATE ROUTE 4 (EAST) WIDENING PROJECT - SEGMENT 3A
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.GDR

PLATE NO: B-3H

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
SW-148	MC-5	19.5	●	45	27	SILTY SAND (SM)
SW-148	MC-7	29.5	⊠	45	27	LEAN CLAY (CL)
SW-175	MC-4	15.0	▲			SILTY SAND (SM)
SW-176	MC-5	20.0	★			SILTY SAND WITH GRAVEL (SM)

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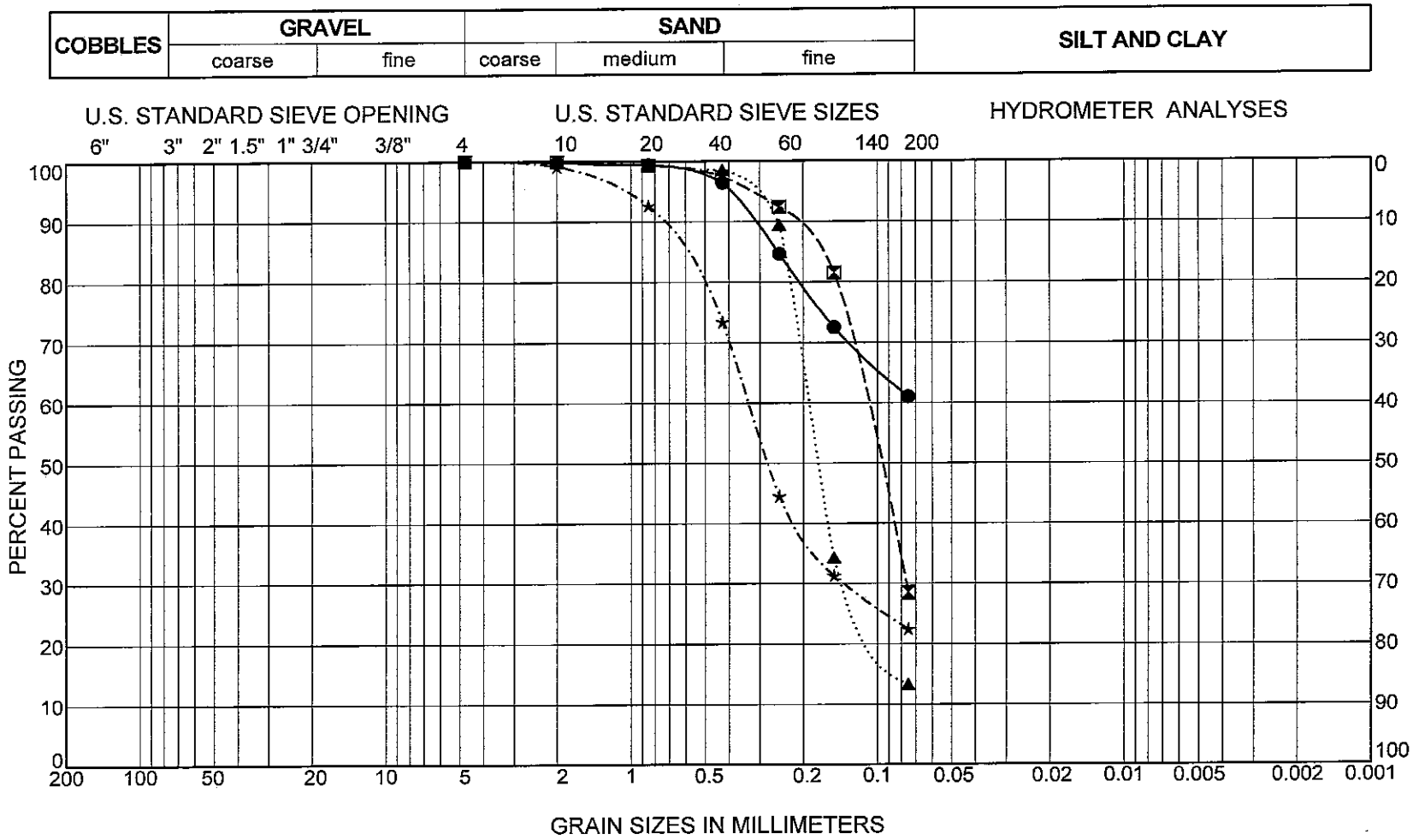
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

STATE ROUTE 4 (EAST) WIDENING PROJECT - SEGMENT 3A
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.GDR

PLATE NO: B-3I

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
SW-178	MC-6	25.0	●			SANDY SILT (ML)
SW-188	SPT-5	19.5	⊠			SILTY SAND (SM)
SW-192	SPT-11	48.5	▲			SILTY SAND (SM)
SW-205	MC-9	39.5	★			SILTY SAND (SM)

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GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

STATE ROUTE 4 (EAST) WIDENING PROJECT - SEGMENT 3A
CONTRA COSTA COUNTY, CALIFORNIA

JOB NO: 206117.GDR

PLATE NO: B-3J

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 02/09/2007
Date Submitted 02/06/2007

To: P av Dayah
P rikh Consultants, Inc.
3 6 S. Milpitas Blvd.
M lpitas, Ca 95035

From: ene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

T e reported analysis was requested for the following location:
Locati n : 206118GDR RTE4 EAST Site ID : RW/SW139#3@11'.
T ank you for your business.

* For uture reference to this analysis please use SUN # 49834-99330.

EVALUATION FOR SOIL CORROSION

Soil pH	7.71	
Minimum Resistivity	1.47 ohm-cm (x1000)	
Chloride	27.7 ppm	00.00277 %
Sulfate	42.1 ppm	00.00421 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 02/16/2007
Date Submitted 02/12/2007

To: 'rav Dayah
'arikh Consultants, Inc.
:56 S. Milpitas Blvd.
filpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

'he reported analysis was requested for the following location:
Locat.on : 206118.GDR\RTE. 4 Site ID : SW140#3 @ 9.5'.
'hank you for your business.

* For future reference to this analysis please use SUN # 49869-99408.

EVALUATION FOR SOIL CORROSION

Soil pH	7.87		
Minimum Resistivity	0.43	ohm-cm (x1000)	
Chloride	244.5 ppm	00.02445	%
Sulfate	248.9 ppm	00.02489	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 02/09/2007
Date Submitted 02/06/2007

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206118GDR RTE4 EAST Site ID : RW/SW143 #4@16'.
Thank you for your business.

* For future reference to this analysis please use SUN # 49834-99334.

EVALUATION FOR SOIL CORROSION

Soil pH	7.67		
Minimum Resistivity	1.23 ohm-cm (x1000)		
Chloride	27.8 ppm	00.00278	%
Sulfate	24.9 ppm	00.00249	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 02/09/2007
Date Submitted 02/06/2007

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206118GDR RTE4 EAST Site ID : SW148#4@14 1/2'.
Thank you for your business.

* For future reference to this analysis please use SUN # 49834-99331.

EVALUATION FOR SOIL CORROSION

Soil pH	7.48		
Minimum Resistivity	0.88	ohm-cm (x1000)	
Chloride	205.2 ppm	00.02052	%
Sulfate	90.6 ppm	00.00906	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 02/16/2007
Date Submitted 02/12/2007

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206118.GDR\RTE. 4 Site ID : RW/SW149#7@28.5.
Thank you for your business.

* For future reference to this analysis please use SUN # 49869-99409.

EVALUATION FOR SOIL CORROSION

Soil pH	7.95		
Minimum Resistivity	1.47 ohm-cm (x1000)		
Chloride	18.4 ppm	00.00184	%
Sulfate	12.7 ppm	00.00127	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 12/08/2006
Date Submitted 12/04/2006

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.AST/A ST.BDGE Site ID : AST 154 #2 @ 8'.
Thank you for your business.

* For future reference to this analysis please use SUN # 49465-98602.

EVALUATION FOR SOIL CORROSION

Soil pH	7.50		
Minimum Resistivity	0.86	ohm-cm (x1000)	
Chloride	10.9 ppm	00.00109	%
Sulfate	89.1 ppm	00.00891	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 12/08/2006
Date Submitted 12/04/2006

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.CAV/CAVALO RD Site ID : ~~CAV108~~ #2 @ 8.5. CAV168
Thank you for your business.

* For future reference to this analysis please use SUN # 49464-98601.

EVALUATION FOR SOIL CORROSION

Soil pH	7.61		
Minimum Resistivity	1.45 ohm-cm (x1000)		
Chloride	6.2 ppm	00.00062	%
Sulfate	43.6 ppm	00.00436	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 12/19/2006
Date Submitted 12/13/2006

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR Site ID : SW 170 #1 @ 2'.
Thank you for your business.

* For future reference to this analysis please use SUN # 49525-98730.

EVALUATION FOR SOIL CORROSION

Soil pH	6.93		
Minimum Resistivity	3.75 ohm-cm (x1000)		
Chloride	9.7 ppm	00.00097	%
Sulfate	18.0 ppm	00.00180	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 02/09/2007
Date Submitted 02/06/2007

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206118GDR RTE4 EAST Site ID : SW172 #3@9 1/2'.
Thank you for your business.

* For future reference to this analysis please use SUN # 49834-99332.

EVALUATION FOR SOIL CORROSION

Soil pH	7.73		
Minimum Resistivity	2.06	ohm-cm (x1000)	
Chloride	12.1 ppm	00.00121	%
Sulfate	30.1 ppm	00.00301	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 12/19/2006
Date Submitted 12/13/2006

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR Site ID : RW173 #5 @ 18.5.
Thank you for your business.

* For future reference to this analysis please use SUN # 49525-98728.

EVALUATION FOR SOIL CORROSION

Soil pH	7.94		
Minimum Resistivity	2.06	ohm-cm (x1000)	
Chloride	16.2 ppm	00.00162	%
Sulfate	5.1 ppm	00.00051	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical
11353 Pyrites Way, Suite 4
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(916) 852-8557

Date Reported 12/19/2006
Date Submitted 12/13/2006

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR Site ID : SW175 #1 @ 2'.
Thank you for your business.

* For future reference to this analysis please use SUN # 49525-98727.

EVALUATION FOR SOIL CORROSION

Soil pH	7.81	
Minimum Resistivity	2.57 ohm-cm (x1000)	
Chloride	9.4 ppm	00.00094 %
Sulfate	12.2 ppm	00.00122 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 12/19/2006
Date Submitted 12/13/2006

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR Site ID : SW177 #4 @ 15'.
Thank you for your business.

* For future reference to this analysis please use SUN # 49525-98729.

EVALUATION FOR SOIL CORROSION

Soil pH	7.96	
Minimum Resistivity	1.66 ohm-cm (x1000)	
Chloride	9.7 ppm	00.00097 %
Sulfate	14.4 ppm	00.00144 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 09/17/2008
Date Submitted 09/10/2008

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, CA 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR- SR4 Site ID : SW-186#2@4.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 54379-109148.

EVALUATION FOR SOIL CORROSION

Soil pH	7.86		
Minimum Resistivity	0.80 ohm-cm (x1000)		
Chloride	78.8 ppm	00.00788	%
Sulfate	221.0 ppm	00.02210	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 09/17/2008
Date Submitted 09/10/2008

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, CA 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR- SR4 Site ID : RW-187#2@4.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 54379-109149.

EVALUATION FOR SOIL CORROSION

Soil pH	7.38		
Minimum Resistivity	0.56 ohm-cm (x1000)		
Chloride	80.9 ppm	00.00809	%
Sulfate	276.2 ppm	00.02762	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

11353 Pyrites Way, Suite 4
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(916) 852-8557

Date Reported 09/17/2008
Date Submitted 09/10/2008

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, CA 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR- SR4 Site ID : RW-189#3@8.5.
Thank you for your business.

* For future reference to this analysis please use SUN # 54379-109150.

EVALUATION FOR SOIL CORROSION

Soil pH	7.66	
Minimum Resistivity	0.62 ohm-cm (x1000)	
Chloride	157.5 ppm	00.01575 %
Sulfate	218.1 ppm	00.02181 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

11353 Pyrites Way, Suite 4
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(916) 852-8557

Date Reported 09/17/2008
Date Submitted 09/10/2008

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, CA 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR- SR4 Site ID : RW-193#3@8.5.
Thank you for your business.

* For future reference to this analysis please use SUN # 54379-109151.

EVALUATION FOR SOIL CORROSION

Soil pH	7.40	
Minimum Resistivity	0.83 ohm-cm (x1000)	
Chloride	53.1 ppm	00.00531 %
Sulfate	214.1 ppm	00.02141 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

11353 Pyrites Way, Suite 4
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(916) 852-8557

Date Reported 09/17/2008
Date Submitted 09/10/2008

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, CA 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR- SR4 Site ID : RW-194#5@18.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 54379-109152.

EVALUATION FOR SOIL CORROSION

Soil pH	7.79		
Minimum Resistivity	1.45 ohm-cm (x1000)		
Chloride	35.4 ppm	00.00354	%
Sulfate	22.8 ppm	00.00228	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical
11353 Pyrites Way, Suite 4
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(916) 852-8557

Date Reported 09/17/2008
Date Submitted 09/10/2008

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, CA 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR- SR4 Site ID : RW-197#2@4.5.
Thank you for your business.

* For future reference to this analysis please use SUN # 54379-109153.

EVALUATION FOR SOIL CORROSION

Soil pH	7.12	
Minimum Resistivity	0.24 ohm-cm (x1000)	
Chloride	607.7 ppm	00.06077 %
Sulfate	240.2 ppm	00.02402 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

11353 Pyrites Way, Suite 4
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(916) 852-8557

Date Reported 09/17/2008
Date Submitted 09/10/2008

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, CA 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR- SR4 Site ID : SW-200#4@13.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 54379-109154.

EVALUATION FOR SOIL CORROSION

Soil pH	7.39		
Minimum Resistivity	2.12 ohm-cm (x1000)		
Chloride	28.2 ppm	00.00282	%
Sulfate	51.9 ppm	00.00519	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

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(916) 852-8557

Date Reported 09/17/2008
Date Submitted 09/10/2008

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, CA 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR - SR4 Site ID : RW201#2@4.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 54377-109142.

EVALUATION FOR SOIL CORROSION

Soil pH	7.55		
Minimum Resistivity	0.54 ohm-cm (x1000)		
Chloride	81.2 ppm	00.00812	%
Sulfate	522.6 ppm	00.05226	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

11353 Pyrites Way, Suite 4
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(916) 852-8557

Date Reported 09/17/2008
Date Submitted 09/10/2008

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, CA 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR - SR4 Site ID : RW204#3@8.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 54377-109143.

EVALUATION FOR SOIL CORROSION

Soil pH	7.84		
Minimum Resistivity	0.59 ohm-cm (x1000)		
Chloride	195.8 ppm	00.01958	%
Sulfate	216.4 ppm	00.02164	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

11353 Pyrites Way, Suite 4
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(916) 852-8557

Date Reported 09/17/2008
Date Submitted 09/10/2008

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, CA 95035

From: Gene Oliphant, Ph.D. \ Randy Horney RA
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR - SR4 Site ID : RW205#1@1.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 54377-109144.

EVALUATION FOR SOIL CORROSION

Soil pH	6.99		
Minimum Resistivity	0.75 ohm-cm (x1000)		
Chloride	238.9 ppm	00.02389	%
Sulfate	136.2 ppm	00.01362	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 09/17/2008
Date Submitted 09/10/2008

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, CA 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR - SR4 Site ID : RW206#2@4.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 54377-109145.

EVALUATION FOR SOIL CORROSION

Soil pH	7.37	
Minimum Resistivity	0.32 ohm-cm (x1000)	
Chloride	462.1 ppm	00.04621 %
Sulfate	298.0 ppm	00.02980 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

11353 Pyrites Way, Suite 4
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(916) 852-8557

Date Reported 09/17/2008
Date Submitted 09/10/2008

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, CA 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR - SR4 Site ID : RW207#3@8.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 54377-109146.

EVALUATION FOR SOIL CORROSION

Soil pH	7.67	
Minimum Resistivity	1.13 ohm-cm (x1000)	
Chloride	10.9 ppm	00.00109 %
Sulfate	44.4 ppm	00.00444 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 09/17/2008
Date Submitted 09/10/2008

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, CA 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR - SR4 Site ID : SW-209#3@8.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 54376-109138.

EVALUATION FOR SOIL CORROSION

Soil pH	7.66	
Minimum Resistivity	0.56 ohm-cm (x1000)	
Chloride	160.2 ppm	00.01602 %
Sulfate	200.8 ppm	00.02008 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 09/17/2008
Date Submitted 09/10/2008

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, CA 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR - SR4 Site ID : RW-211#2@4.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 54376-109139.

EVALUATION FOR SOIL CORROSION

Soil pH	7.83	
Minimum Resistivity	0.99 ohm-cm (x1000)	
Chloride	20.8 ppm	00.00208 %
Sulfate	113.8 ppm	00.01138 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 09/17/2008
Date Submitted 09/10/2008

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, CA 95035

From: Gene Oliphant, Ph.D. \ Randy Horney RA
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR - SR4 Site ID : RW-212#3@8.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 54376-109140.

EVALUATION FOR SOIL CORROSION

Soil pH	7.84	
Minimum Resistivity	0.96 ohm-cm (x1000)	
Chloride	35.7 ppm	00.00357 %
Sulfate	90.4 ppm	00.00904 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 09/17/2008
Date Submitted 09/10/2008

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, CA 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 206117.GDR - SR4 Site ID : RW-214#3@8.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 54376-109141.

EVALUATION FOR SOIL CORROSION

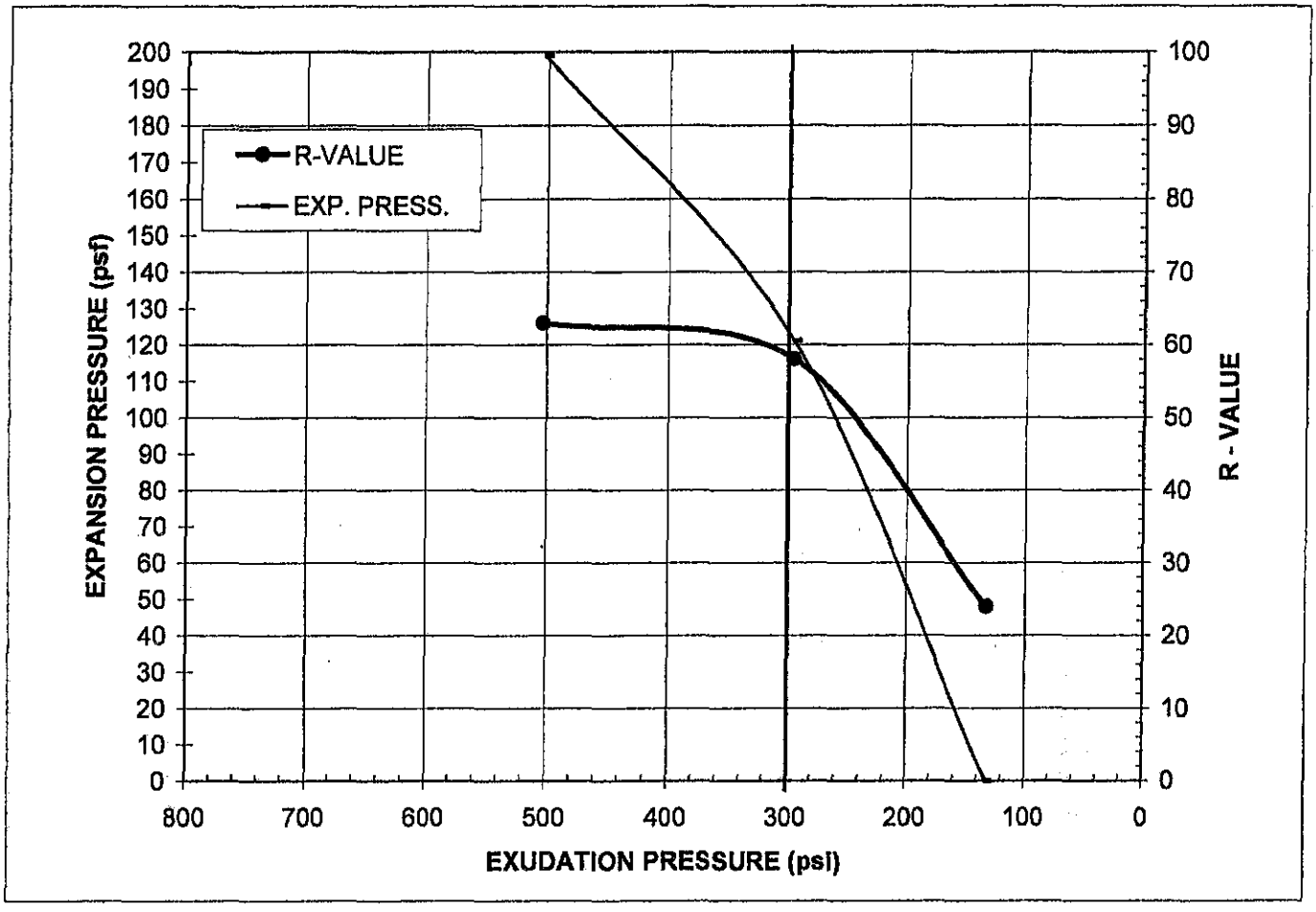
Soil pH	7.60	
Minimum Resistivity	0.91 ohm-cm (x1000)	
Chloride	33.3 ppm	00.00333 %
Sulfate	136.4 ppm	00.01364 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

R-VALUE REPORT

Parikh Consultants, Inc. | ASTM D2844 or CTM 301 | (408) 945-1011

Project Name:	Route 4 East	Date:	7/26/06
Client:	Ty Lin	Project #:	206117.GDR
Sample #:	R41	Depth:	0' - 5'
Lab #:	M589		
Location / Source:	Antioch	Sample Date:	
Material :	Silty sands, yellowish gray	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	133	295	503
Expansion Pressure, psf	0	121	199
R-Value	24	58	63
Moisture Content at Test, %	20.7	18.4	17.7
Dry Density at Test, pcf	103.6	106.3	107.9

R-Value @ 300 psi Exudation Pressure = 58

Expansion Pressure @300 psi Exudation, psf = **124**

Minimum R-Value Requirement:

Comments:

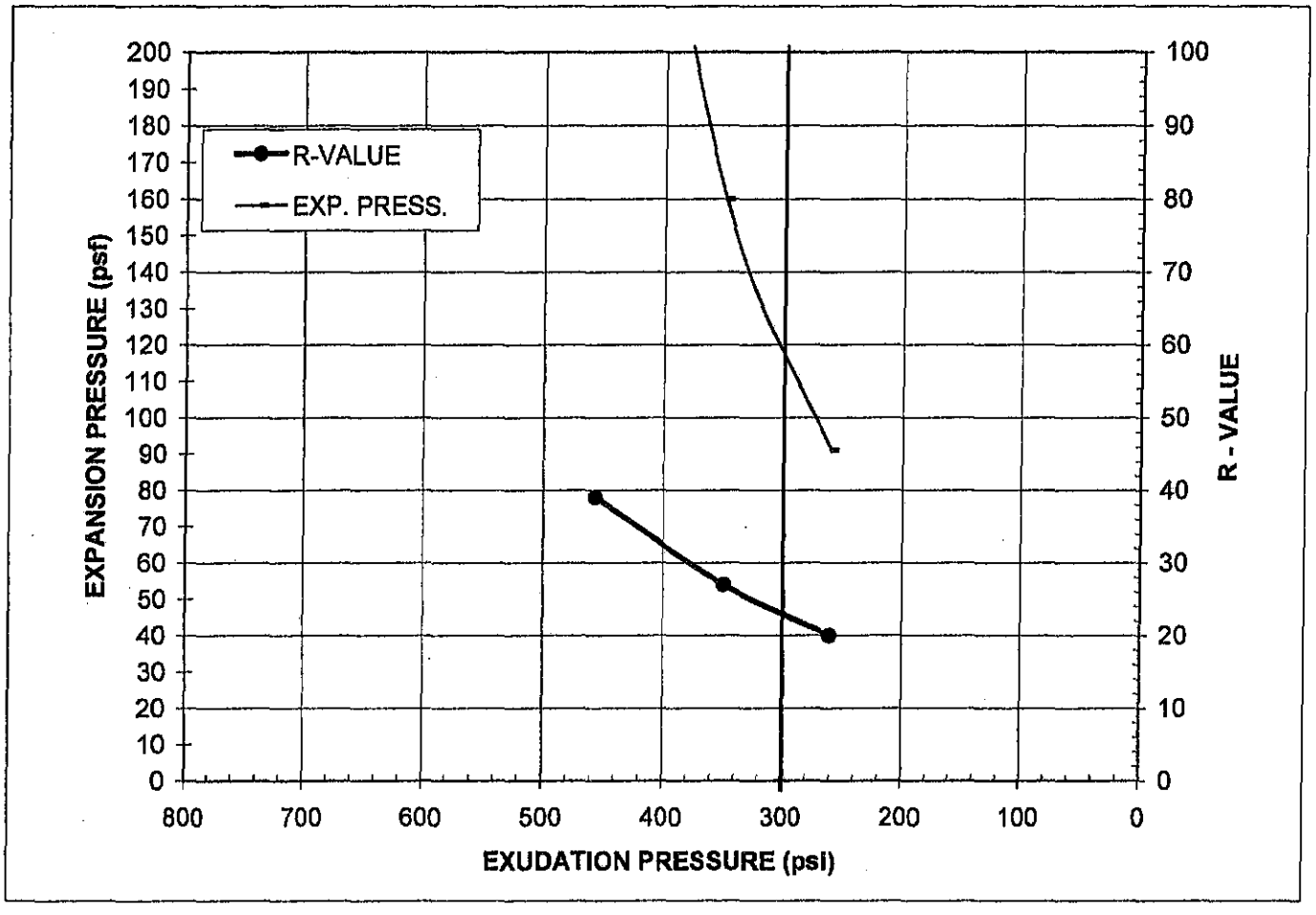
Report By: Prav Dayah

RVALUE with calcs pdp

R-VALUE REPORT

Parikh Consultants, Inc. ASTM D2844 or CTM 301 (408) 945-1011

Project Name:	Route 4 East	Date:	7/26/06
Client:	Ty Lin	Project #:	206117.GDR
Sample #: R44	Depth: 0' - 5'	Lab #:	M589
Location / Source:	Antioch	Sample Date:	
Material :	Clay, yellowish brown	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	260	349	457
Expansion Pressure, psf	91	160	333
R-Value	20	27	39
Moisture Content at Test, %	19.6	18.7	17.7
Dry Density at Test, pcf	105.2	107.3	110.1

R-Value @ 300 psi Exudation Pressure = 23

Expansion Pressure @300 psi Exudation, psf = **118**

Minimum R-Value Requirement:

Comments:

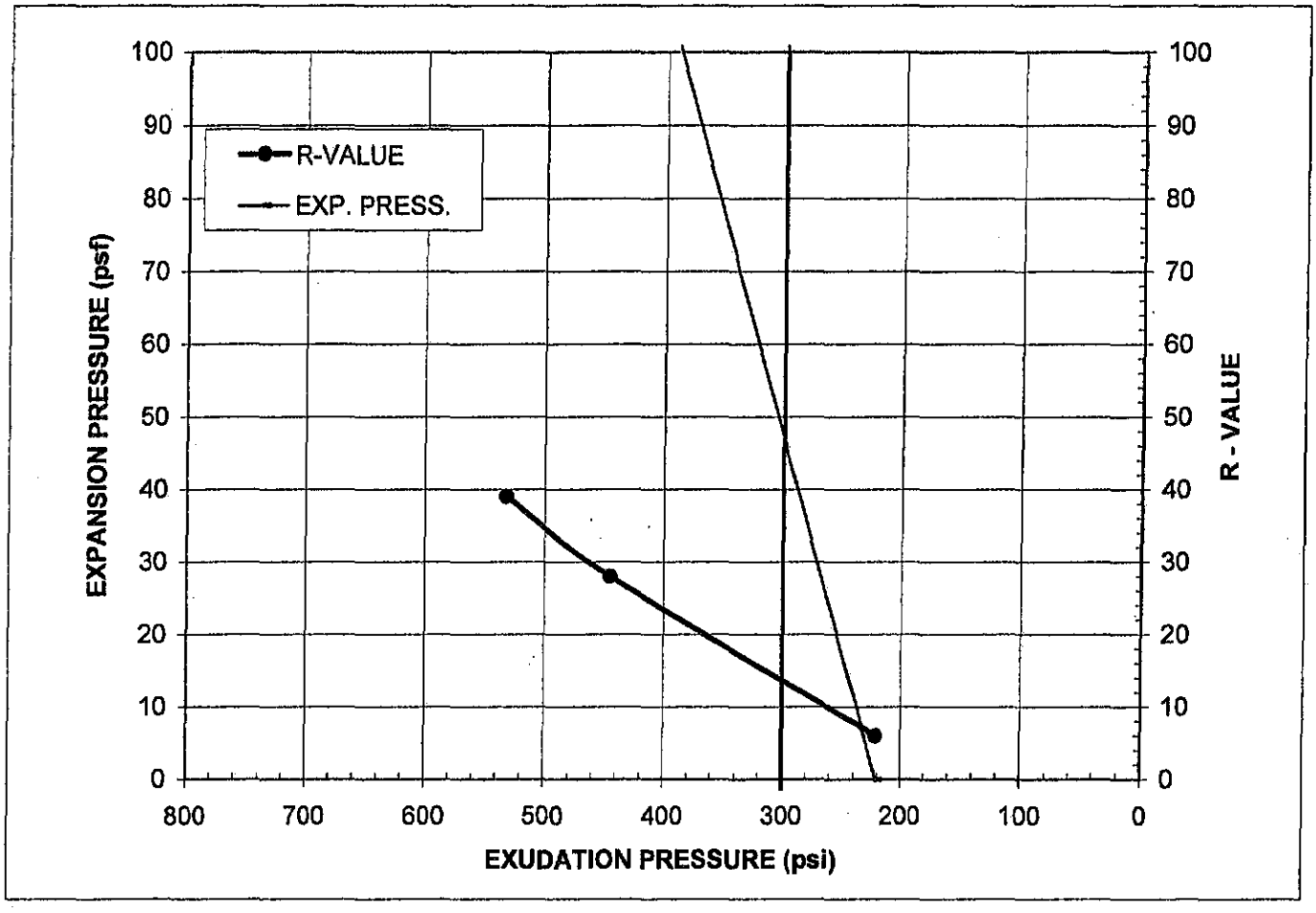
Report By: Prav Dayah

RVALUE with calcs pdp

R-VALUE REPORT

Parikh Consultants, Inc. ASTM D2844 or CTM 301 (408) 945-1011

Project Name:	Route 4 East	Date:	7/26/06
Client:	Ty Lin	Project #:	206117.GDR
Sample #: R45	Depth: 0' - 5'	Lab #:	M589
Location / Source:	Antioch	Sample Date:	
Material :	Clay, brown	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	221	445	532
Expansion Pressure, psf	0	134	190
R-Value	6	28	39
Moisture Content at Test, %	21.3	17.6	16.6
Dry Density at Test, pcf	101.8	110.5	113.3

R-Value @ 300 psi Exudation Pressure = 14

Expansion Pressure @300 psi Exudation, psf = 48

Minimum R-Value Requirement:

Comments:

Report By: Prav Dayah

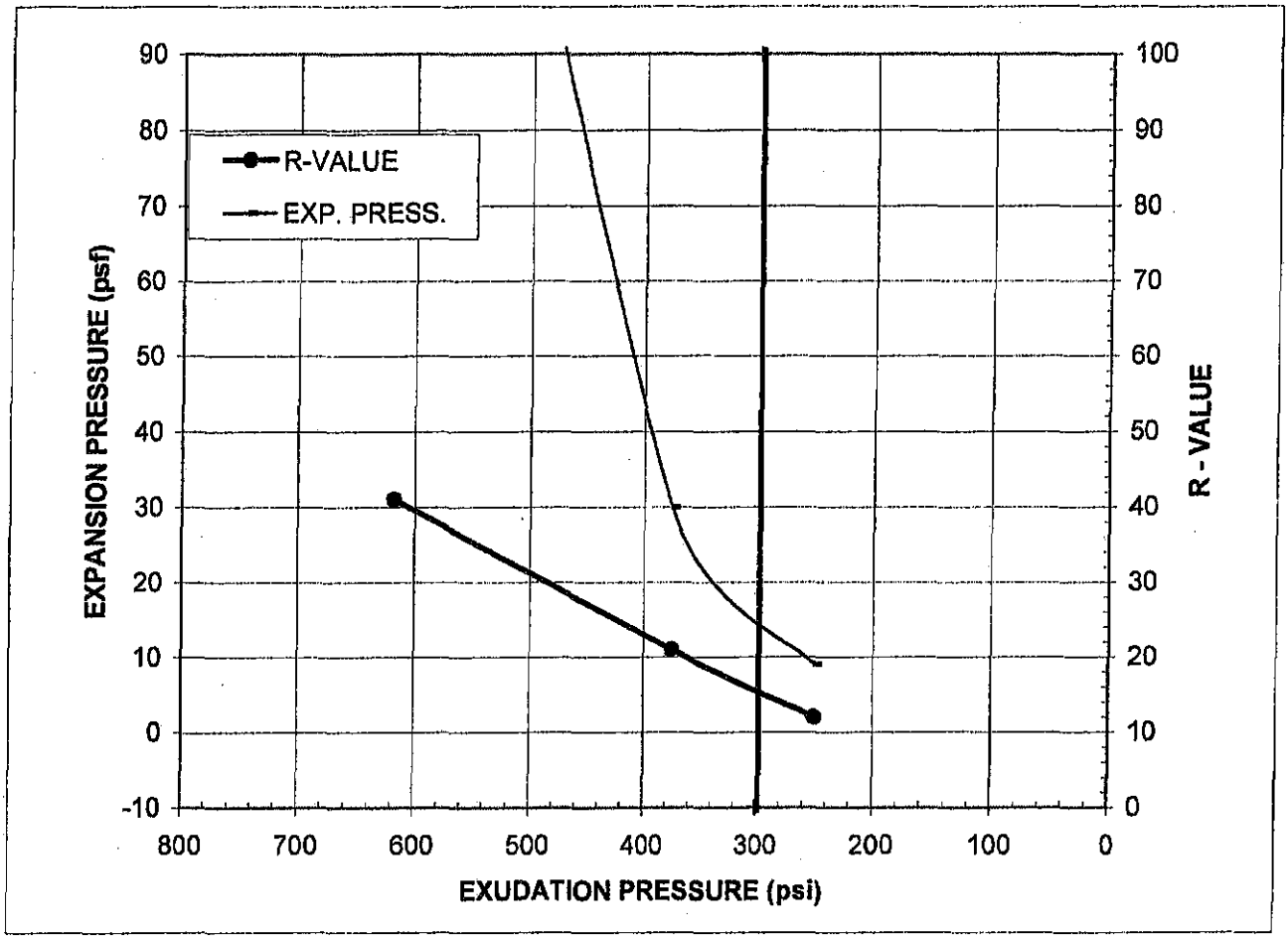
RVALUE with calcs pdp

Plate B-5C

R-VALUE REPORT

Parikh Consultants, Inc. ASTM D2844 or CTM 301 (408) 945-1011

Project Name: Highway 4 East		Date:	5/20/08
Client: T Y Lin		Project #:	206117.GDR
Sample #: R-45A	Depth: 0'-5'	Lab #:	M707
Location / Source:	Native / Onsite	Sample Date:	
Material : Sandy clay, brown		Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	250	375	618
Expansion Pressure, psf	9	30	191
R-Value	12	21	41
Moisture Content at Test, %	18.8	17.4	15.6
Dry Density at Test, pcf	105.7	109.8	114.2

R-Value @ 300 psi Exudation Pressure = 15 | Expansion Pressure @300 psi Exudation, psf = **15**

Minimum R-Value Requirement:

Comments:

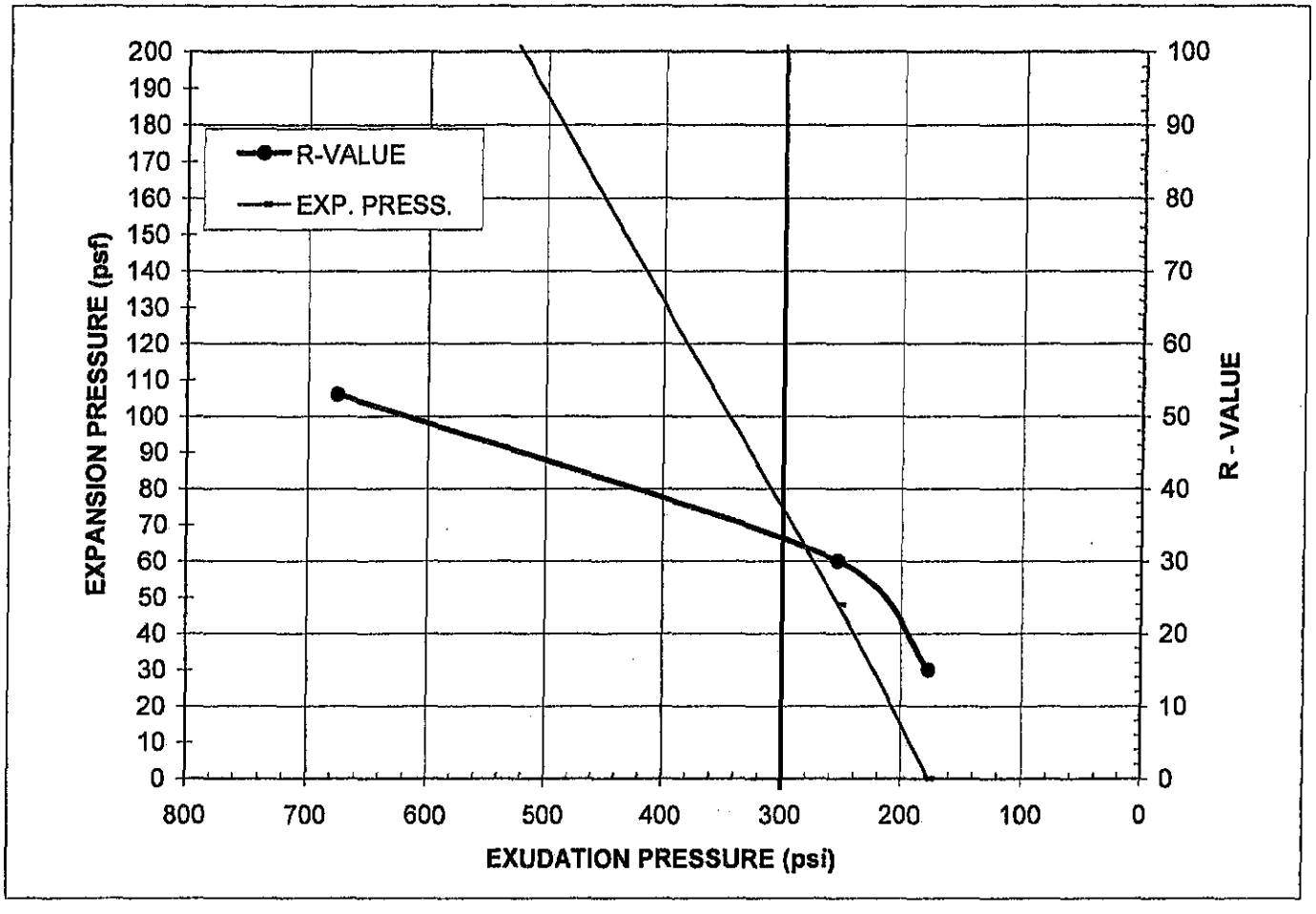
Report By: Prav Dayah

RVALUE with calcs pdp

R-VALUE REPORT

Parikh Consultants, Inc. ASTM D2844 or CTM 301 (408) 945-1011

Project Name:	Route 4 East	Date:	7/27/06
Client:	Ty Lin	Project #:	206117.GDR
Sample #: R46	Depth: 0' - 5'	Lab #:	M589
Location / Source:	Antioch	Sample Date:	
Material :	Silty sands, yellowish brown	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	177	253	675
Expansion Pressure, psf	0	48	286
R-Value	15	30	53
Moisture Content at Test, %	17.8	16.0	14.2
Dry Density at Test, pcf	108.0	112.1	115.9

R-Value @ 300 psi Exudation Pressure = 33

Expansion Pressure @300 psi Exudation, psf = **75**

Minimum R-Value Requirement:

Comments:

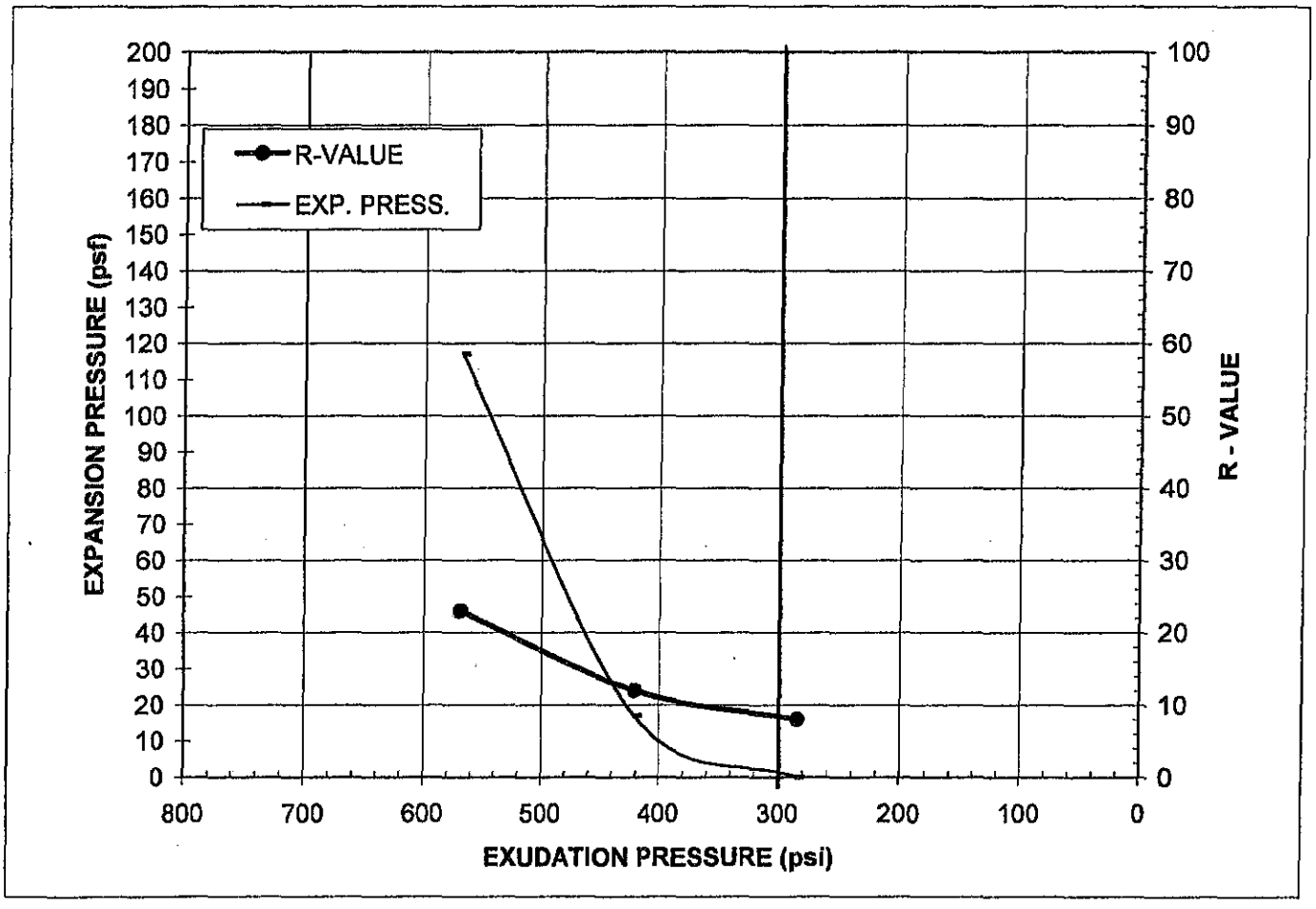
Report By: Prav Dayah

RVALUE with calcs pdp

R-VALUE REPORT

Parikh Consultants, Inc. ASTM D2844 or CTM 301 (408) 945-1011

Project Name:	Route 4 East	Date:	9/21/06
Client:	Ty Lin	Project #:	206117.GDR
Sample #:	R47 Depth: 0' - 5'	Lab #:	M589
Location / Source:	Rte 4 / Native	Sample Date:	
Material :	Lean clay, brown	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	284	421	569
Expansion Pressure, psf	0	17	117
R-Value	8	12	23
Moisture Content at Test, %	22.5	20.7	18.8
Dry Density at Test, pcf	100.4	103.7	108.0

R-Value @ 300 psi Exudation Pressure = 8

Expansion Pressure @300 psi Exudation, psf = 1

Minimum R-Value Requirement:

Comments:

Report By: Prav Dayah

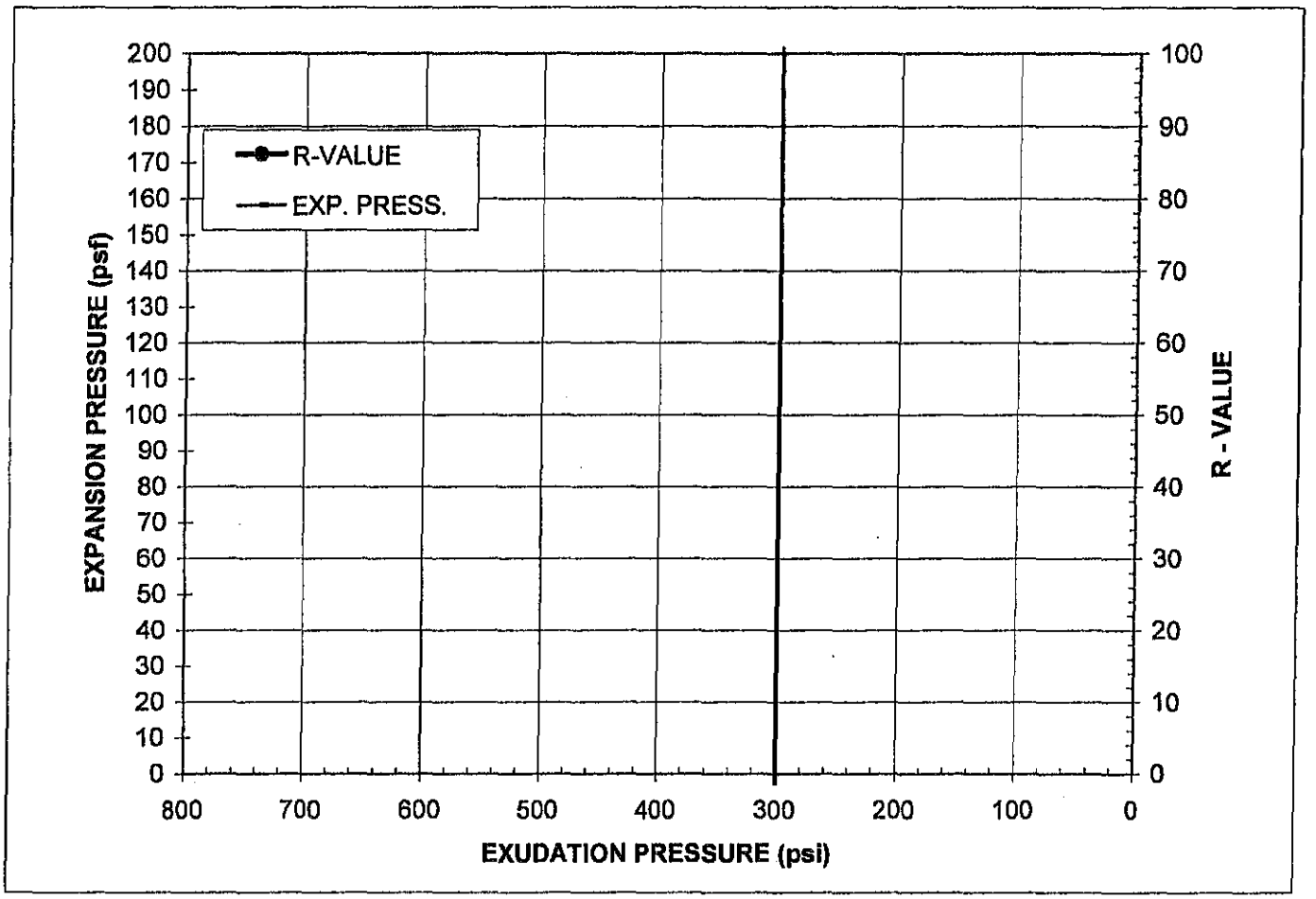
RVALUE with calcs pdp

Plate B-5F

R-VALUE REPORT

Parikh Consultants, Inc. ASTM D2844 or CTM 301 (408) 945-1011

Project Name:	Route 4 East	Date:	7/27/06
Client:	Ty Lin	Project #:	206117.GDR
Sample #:	R50 Depth: 0' - 5'	Lab #:	M589
Location / Source:	Antioch	Sample Date:	
Material :	Clay, grayish brown	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi			
Expansion Pressure, psf			
R-Value			
Moisture Content at Test, %			
Dry Density at Test, pcf			

R-Value @ 300 psi Exudation Pressure = <5

Expansion Pressure @300 psi Exudation, psf =

Minimum R-Value Requirement:

Comments:

Test sample extruded from under the mold and around the follower ram during Exudation Test.
Test terminated - R-Valve = < 5

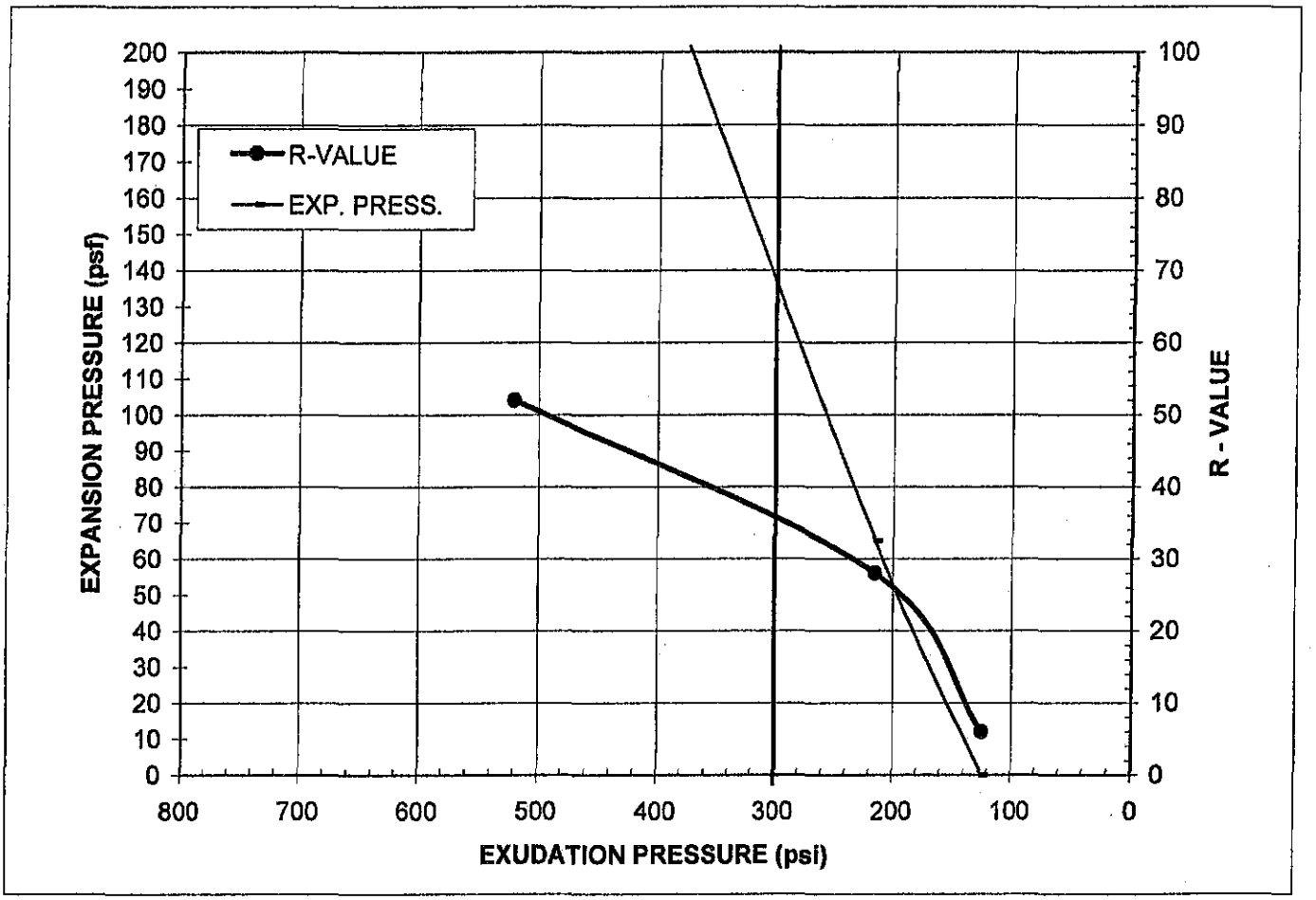
Report By: Prav Dayah

RVALUE with calcs pdp

R-VALUE REPORT

Parikh Consultants, Inc. ASTM D2844 or CTM 301 (408) 945-1011

Project Name:	Route 4 East	Date:	7/27/06
Client:	Ty Lin	Project #:	206117.GDR
Sample #: R53	Depth: 0' - 5'	Lab #:	M589
Location / Source:	Antioch	Sample Date:	
Material :	Sandy clay, grayish brown	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	125	215	520
Expansion Pressure, psf	0	65	325
R-Value	6	28	52
Moisture Content at Test, %	22.4	18.5	16.5
Dry Density at Test, pcf	101.5	109.1	113.3

R-Value @ 300 psi Exudation Pressure = 36

Expansion Pressure @300 psi Exudation, psf = **138**

Minimum R-Value Requirement:

Comments:

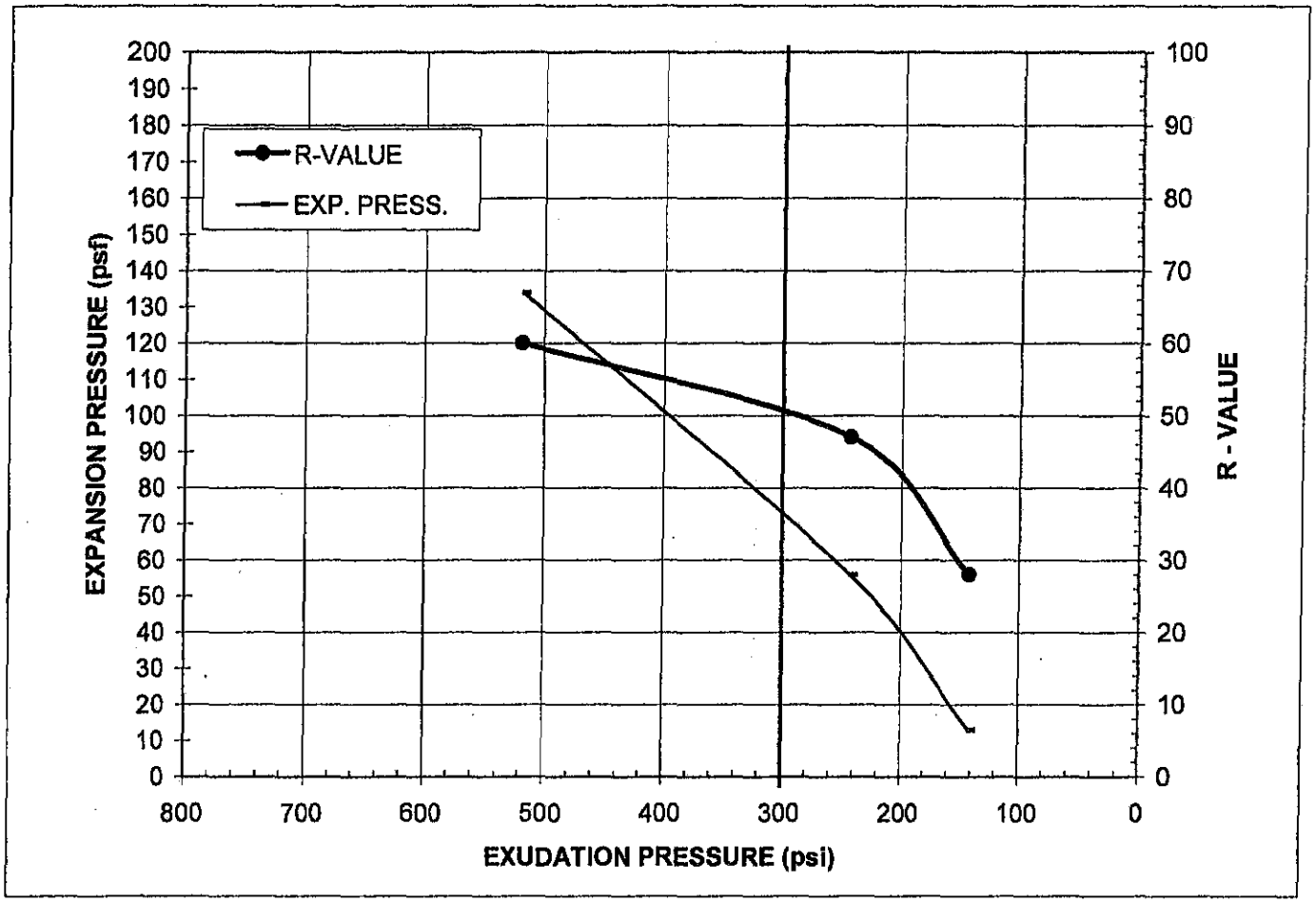
Report By: Prav Dayah

RVALUE with calcs pdp

R-VALUE REPORT

Parikh Consultants, Inc. ASTM D2844 or CTM 301 (408) 945-1011

Project Name:	Route 4 East			Date:	7/27/06
Client:	Ty Lin			Project #:	206117.GDR
Sample #:	R55	Depth:	0' - 5'	Lab #:	M589
Location / Source:		Antioch		Sample Date:	
Material :	Clayey sand, grayish brown			Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	142	243	518
Expansion Pressure, psf	13	56	134
R-Value	28	47	60
Moisture Content at Test, %	22.0	20.7	19.9
Dry Density at Test, pcf	100.6	102.7	104.2

R-Value @ 300 psi Exudation Pressure = **51**

Expansion Pressure @300 psi Exudation, psf = **72**

Minimum R-Value Requirement:

Comments:

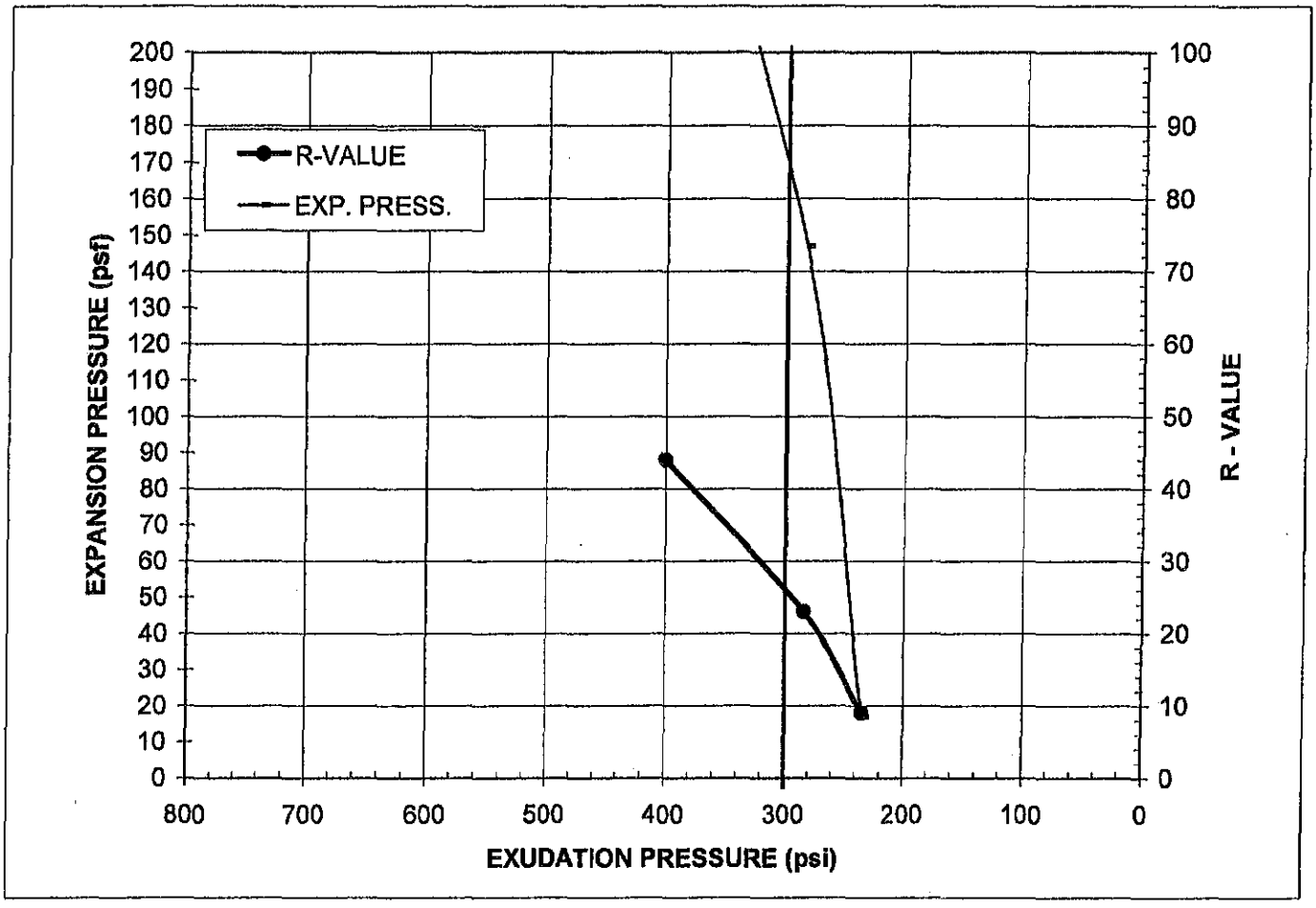
Report By: Prav Dayah

RVALUE with calcs pdp

R-VALUE REPORT

Parikh Consultants, Inc. ASTM D2844 or CTM 301 (408) 945-1011

Project Name:	Route 4 East	Date:	7/31/06
Client:	Ty Lin	Project #:	206117.GDR
Sample #:	R57 Depth: 0' - 5'	Lab #:	M589
Location / Source:	Antioch	Sample Date:	
Material :	Sandy clay, grayish brown	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	234	284	400
Expansion Pressure, psf	17	147	281
R-Value	9	23	44
Moisture Content at Test, %	20.9	19.0	17.0
Dry Density at Test, pcf	104.0	108.2	112.1

R-Value @ 300 psi Exudation Pressure = 26

Expansion Pressure @300 psi Exudation, psf = **170**

Minimum R-Value Requirement:

Comments:

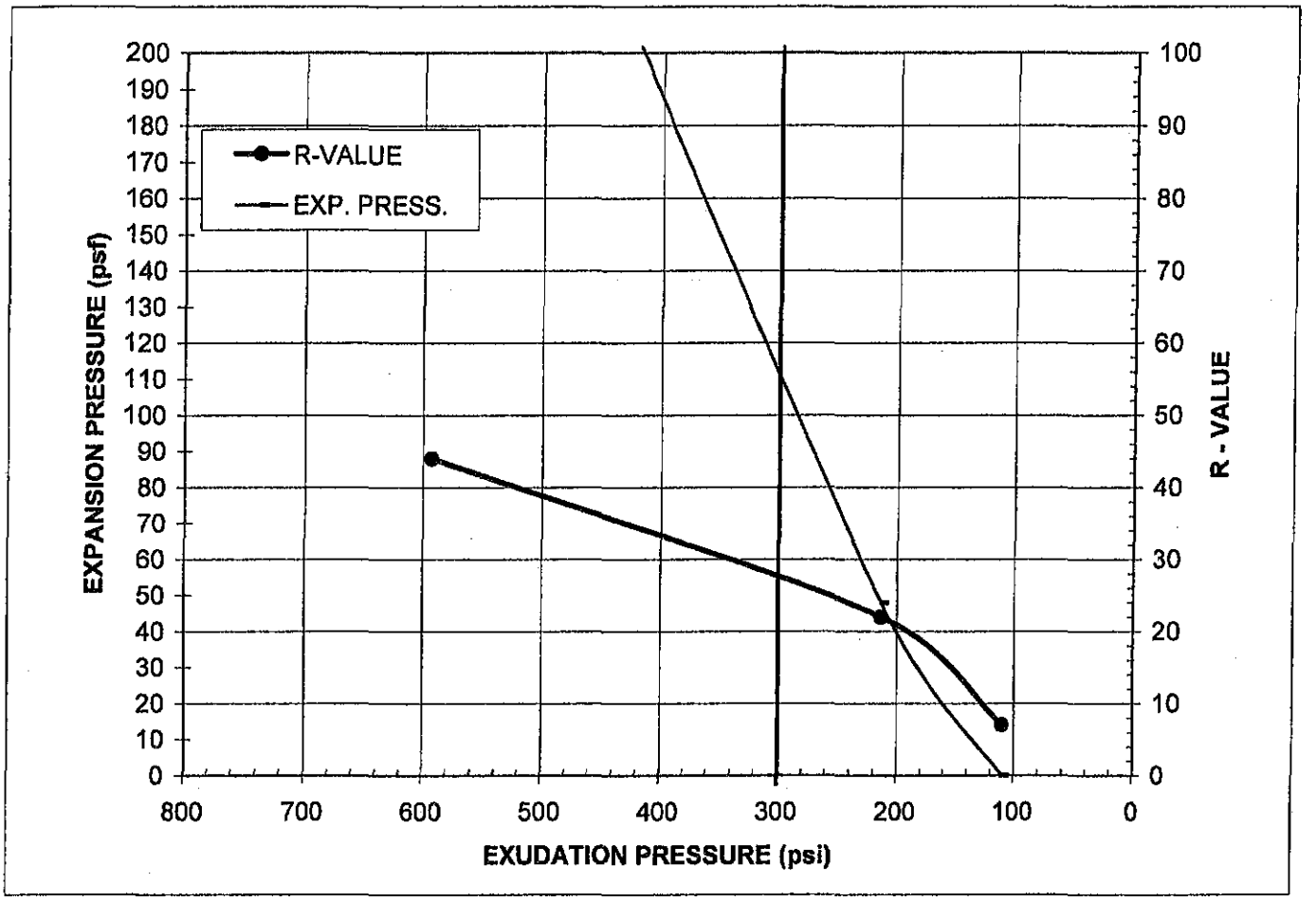
Report By: Prav Dayah

RVALUE with calcs pdp

R-VALUE REPORT

Parikh Consultants, Inc. ASTM D2844 or CTM 301 (408) 945-1011

Project Name:	Route 4 East	Date:	7/31/06
Client:	Ty Lin	Project #:	206117.GDR
Sample #:	R58 Depth: 0' - 5'	Lab #:	M589
Location / Source:	Antioch	Sample Date:	
Material :	Sandy clay, brown	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	110	213	593
Expansion Pressure, psf	0	48	334
R-Value	7	22	44
Moisture Content at Test, %	19.8	17.6	15.5
Dry Density at Test, pcf	105.0	109.8	114.5

R-Value @ 300 psi Exudation Pressure = 28

Expansion Pressure @300 psi Exudation, psf = **110**

Minimum R-Value Requirement:

Comments:

Report By: Prav Dayah

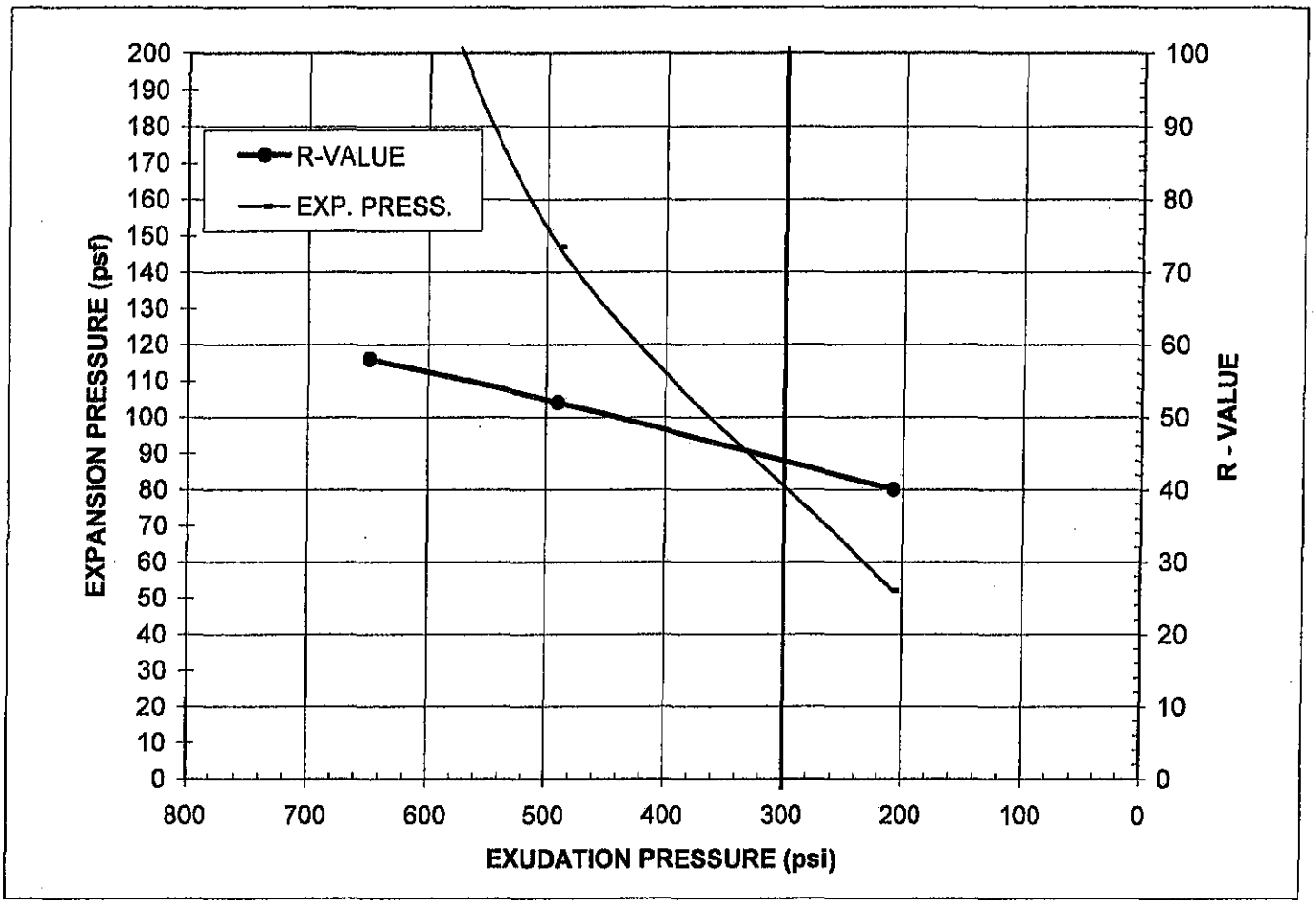
RVALUE with calcs pdp

Plate B-5K

R-VALUE REPORT

Parikh Consultants, Inc. ASTM D2844 or CTM 301 (408) 945-1011

Project Name:	Route 4 East	Date:	7/31/06
Client:	Ty Lin	Project #:	206117.GDR
Sample #: R60	Depth: 0' - 5'	Lab #:	M589
Location / Source:	Antioch	Sample Date:	
Material :	Sandy silt, yellowish brown	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	208	490	649
Expansion Pressure, psf	52	147	264
R-Value	40	52	58
Moisture Content at Test, %	17.1	16.2	15.2
Dry Density at Test, pcf	108.8	110.5	112.6

R-Value @ 300 psi Exudation Pressure = 44

Expansion Pressure @300 psi Exudation, psf = **82**

Minimum R-Value Requirement:

Comments:

Report By: Prav Dayah

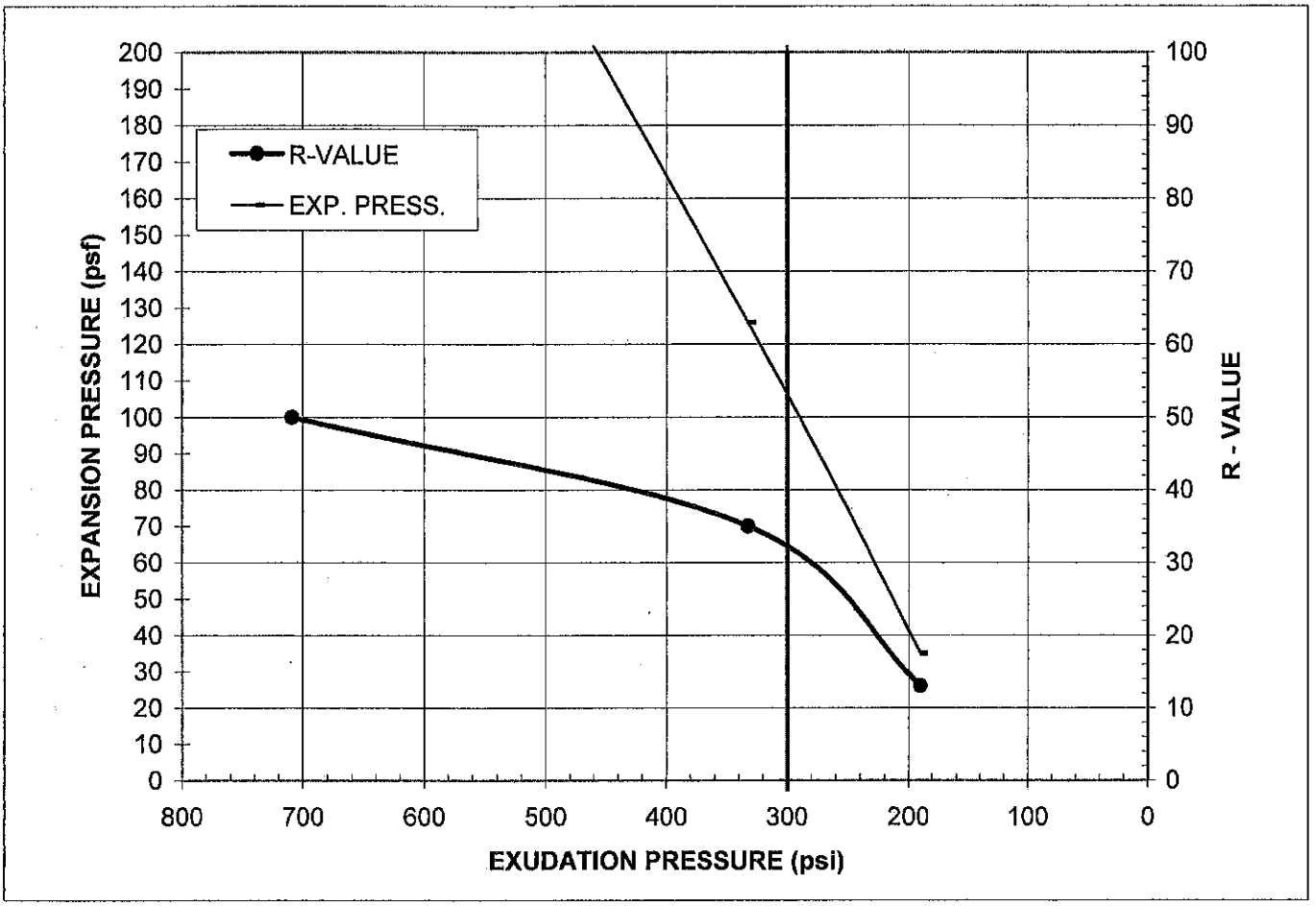
RVALUE with calcs pdp

Plate B-5L

R-VALUE REPORT

Parikh Consultants, Inc. | ASTM D2844 or CTM 301 | (408) 945-1011

Project Name:	Route 4 East			Date:	7/31/06
Client:	Ty Lin			Project #:	206117.GDR
Sample #:	R61	Depth:	0' - 5'	Lab #:	M589
Location / Source:		Antioch		Sample Date:	
Material :	Sandy clay, brown			Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	190	332	709
Expansion Pressure, psf	35	126	347
R-Value	13	35	50
Moisture Content at Test, %	19.7	18.0	16.6
Dry Density at Test, pcf	104.0	107.8	111.7

R-Value @ 300 psi Exudation Pressure = **33**

Expansion Pressure @300 psi Exudation, psf = **105**

Minimum R-Value Requirement:

Comments:

Plate B-5M

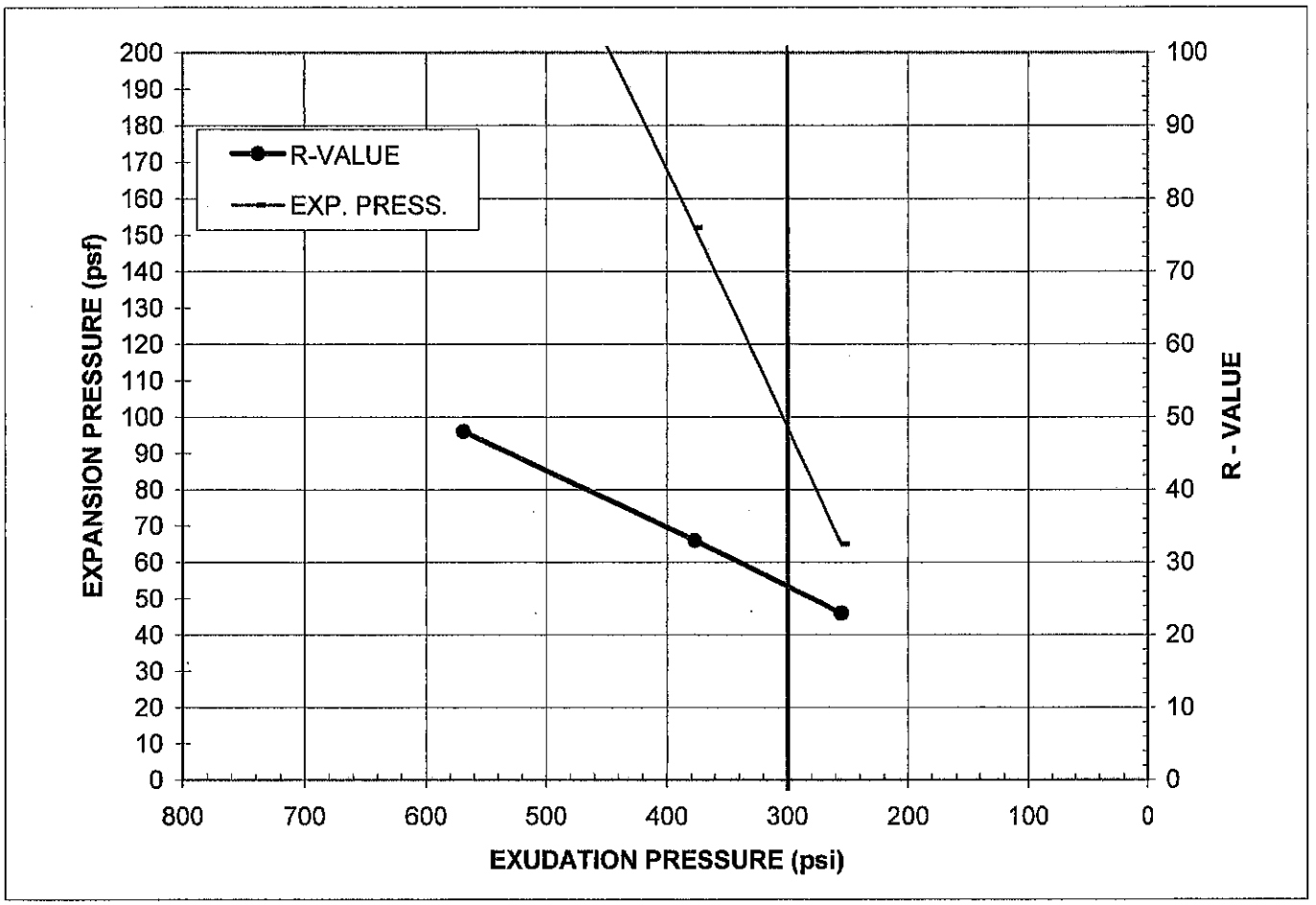
Report By: Prav Dayah

RVALUE with calcs pdp

R-VALUE REPORT

Parikh Consultants, Inc. ASTM D2844 or CTM 301 (408) 945-1011

Project Name:	Route 4 East			Date:	7/31/06
Client:	Ty Lin			Project #:	206117.GDR
Sample #:	R63	Depth:	0' - 5'	Lab #:	M589
Location / Source:		Antioch		Sample Date:	
Material :	Sandy clay, brown			Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	255	377	569
Expansion Pressure, psf	65	152	283
R-Value	23	33	48
Moisture Content at Test, %	18.5	17.5	16.6
Dry Density at Test, pcf	107.7	109.1	111.7

R-Value @ 300 psi Exudation Pressure = **26**

Expansion Pressure @300 psi Exudation, psf = **98**

Minimum R-Value Requirement:

Comments:

Plate B-5N

Report By: Prav Dayah

RVALUE with calcs pdp

LABORATORY TEST REPORT

(408)-945-1011

Parikh Consultants, Inc.

PROJECT NAME:	Route 4 East	PROJECT #:	206117.GDR
SAMPLE #:	R50 DEPTH: 0'-5'	LAB #:	M589
SOURCE:	Native / Antioch	DATE:	8/17/2006
MATERIAL DESCRIPTION	Clay, grayish brown		

EXPANSION INDEX - ASTM D-4829

					Specification
Expansion Index			67		
Corrected Expansion Index			68		
Expansion Potential			Medium		
Saturation %	Initial:	51	Final:	91	
Moisture Contenet%	Initial:	11.9	Final:	24.9	
Dry Density, pcf	Initial:	103.1	Final:	96.8	

SAND EQUIVALENT CTM 217

		Specifications
SE		

Sieve Analysis CTM 202

Sieve Size	Percent Passing	Project Specification
6"		
3"		
1-1/2"		
1"		
3/4"		
3/8"		
No. 4		
No. 30		
No. 50		
No. 100		
No. 200		

Comments:

Reported by : Prav Dayah

LABORATORY TEST REPORT

(408)-945-1011
Parikh Consultants, Inc.

PROJECT NAME:	Route 4 East	PROJECT #:	206117.GDR
SAMPLE #:	R45 DEPTH: 0'-5'	LAB #:	M589
SOURCE:	Native / Antioch	DATE:	8/16/2006
MATERIAL DESCRIPTION	Clay, brown		

EXPANSION INDEX - ASTM D-4829

					Specification
Expansion Index			55		
Corrected Expansion Index			61		
Expansion Potential			Medium		
Saturation %	Initial:	58	Final:	97	
Moisture Contenet%	Initial:	12.1	Final:	23.0	
Dry Density, pcf	Initial:	108	Final:	102.5	

SAND EQUIVALENT CTM 217

		Specifications
SE		

Sieve Analysis CTM 202

Sieve Size	Percent Passing	Project Specification
6"		
3"		
1-1/2"		
1"		
3/4"		
3/8"		
No. 4		
No. 30		
No. 50		
No. 100		
No. 200		

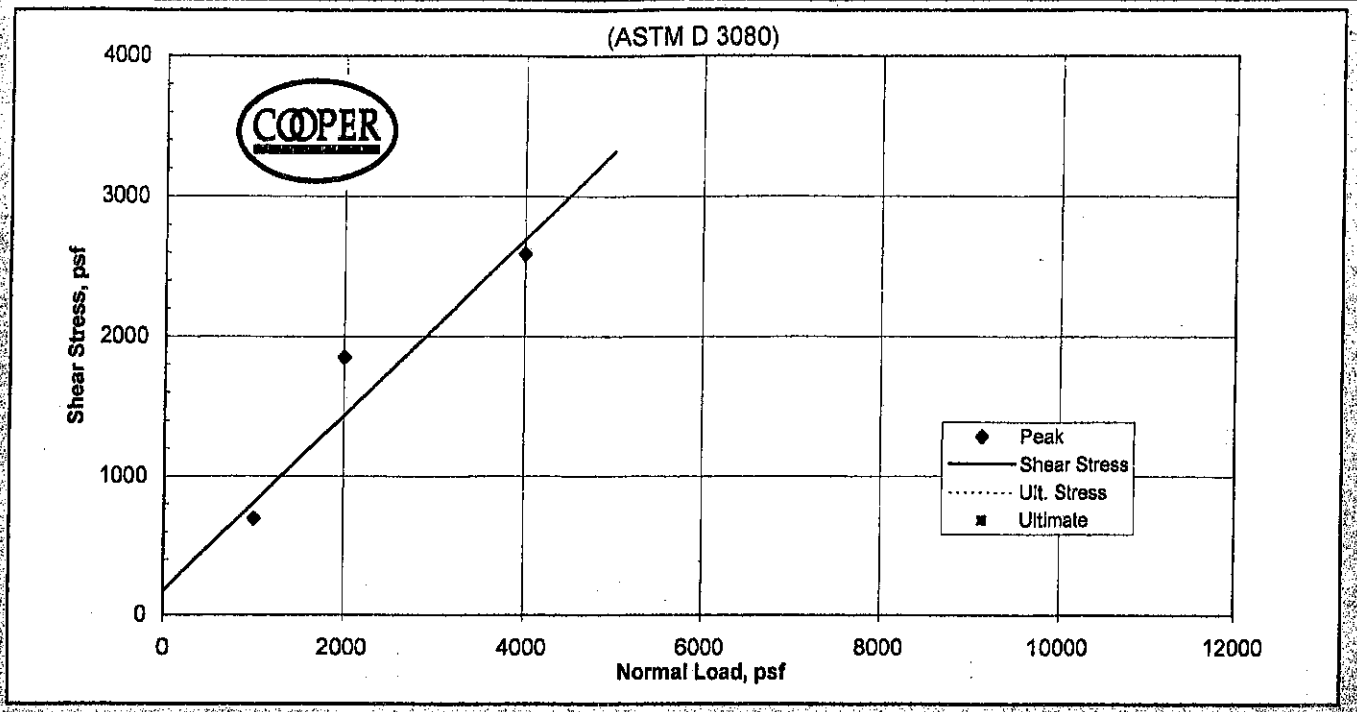
Comments:

Reported by : Prav Dayah

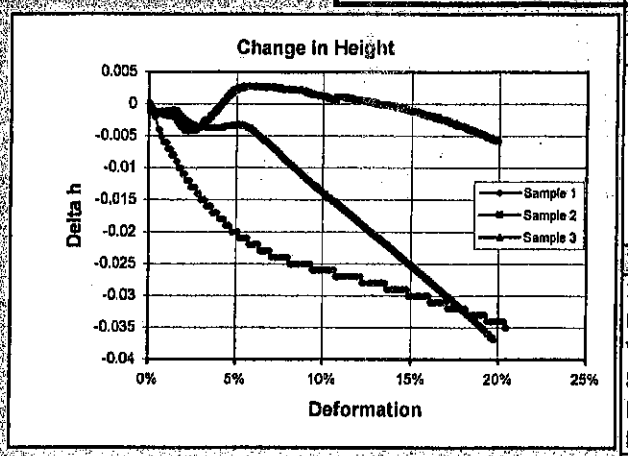
PARIKH CONSULTANTS INC.

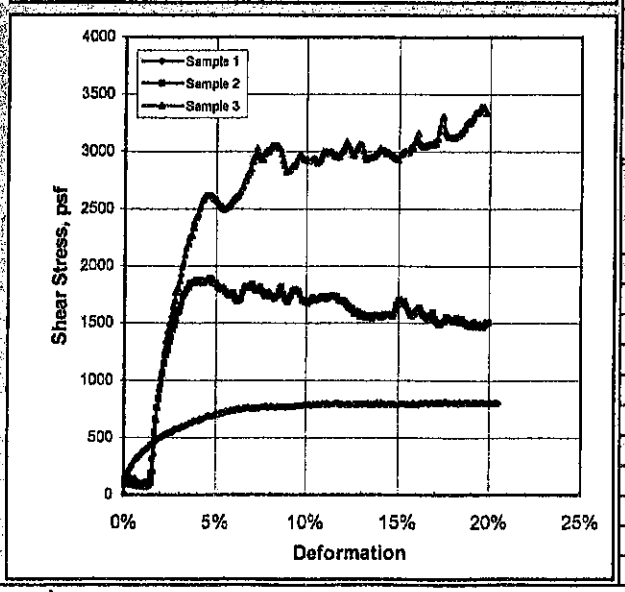
6/14/2005

Direct Shear



P. Phi (degrees)	32.1	Ult. phi (degrees)	
P. Cohesion (psf)	180	Ult.Cohesion (psf)	



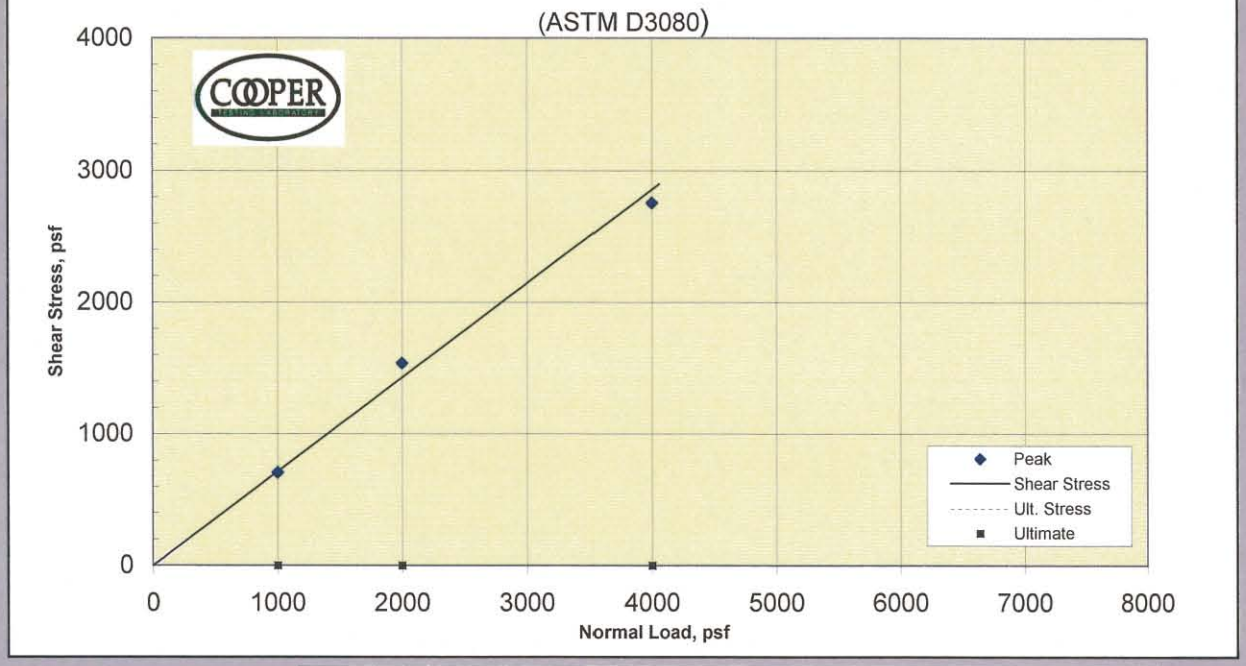


Sample Data: Initial				
Initial	1	2	3	4
Moisture	18.2%	18.3%	16.8%	
Dry Density, pcf	105.9	106.0	107.5	
Void Ratio	0.6214	0.6201	0.6201	
Saturation	80.3%	81.1%	75.6%	
Diameter, in.	2.43	2.43	2.43	
Height, in.	1.00	1.00	1.00	
Sample Data: At Test				
Moisture	22.2%	22.1%	20.6%	
Dry Density, pcf	106.5	106.5	110.5	
Void Ratio	0.6116	0.6102	0.5762	
Saturation	99.8%	99.2%	99.9%	
Diameter, in.	2.43	2.43	2.43	
Height, in.	0.99	0.99	0.97	
Normal Stress, psf	1000	2000	4000	
Shear Stress, psf	696	1851	2586	
Deformation	5%	5%	5%	
Ultimate Stress, psf	0	0	0	
Rate in/min.	0.0002	0.0002	0.0002	

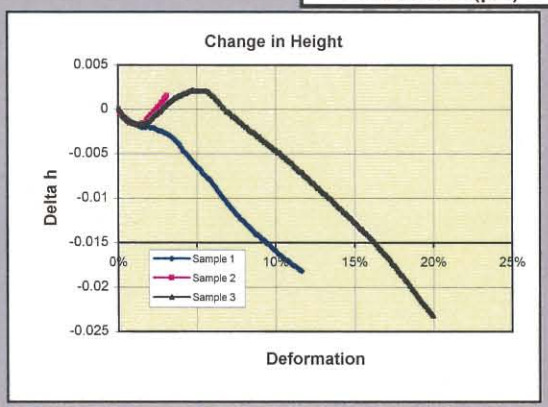
CTL #	157-241	Date:	4/16/2007	
Client:	Parikh Consultants Inc			
Project Name:	RTE-4 East			
Project Number:	206118GDR		Reduced by:	MD
Sample #	Boring	Sample	Depth, ft.	
1	SW 147	3	11	
2	SW 147	3	11	
3	SW 147	3	11	
4				
Visual Soil Classification				
1	Brown Sandy CLAY			
2	Brown Sandy CLAY			
3	Brown Sandy CLAY			
4				

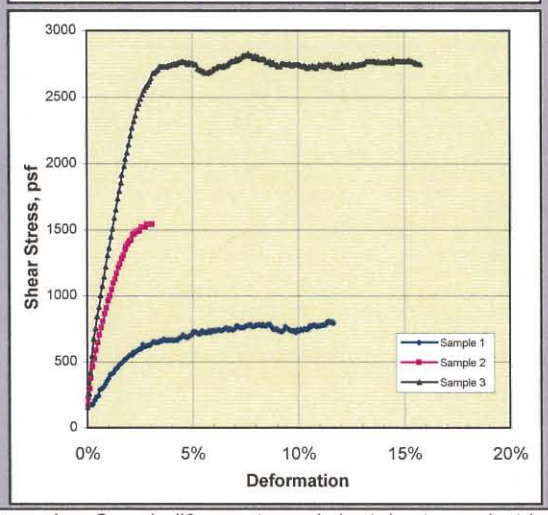
Remarks:

Direct Shear



P. Phi (degrees)	35.5	Ult. phi (degrees)	
P. Cohesion (psf)	0	Ult.Cohesion (psf)	





	Sample Data: Initial			
	1	2	3	4
Moisture	12.7%	12.6%	14.1%	
Dry Density, pcf	103.7	114.0	112.2	
Void Ratio	0.66	0.51	0.53	
Saturation	53.3%	68.8%	72.9%	
Diameter, in.	2.43	2.42	2.43	
Height, in.	1.01	1.00	1.00	
	Sample Data: At Test			
Moisture	23.3%	17.6%	18.6%	
Dry Density, pcf	104.5	114.5	113.3	
Void Ratio	0.64	0.50	0.51	
Saturation	99.8%	97.2%	99.4%	
Diameter, in.	2.43	2.42	2.43	
Height, in.	1.00	1.00	0.99	
Normal Stress, psf	1000	2000	4000	
Shear Stress, psf	705	1537	2754	
Strengths picked at Ult. Stress, psf	5%	3%	5%	
Rate in/min.	0.004	0.004	0.004	

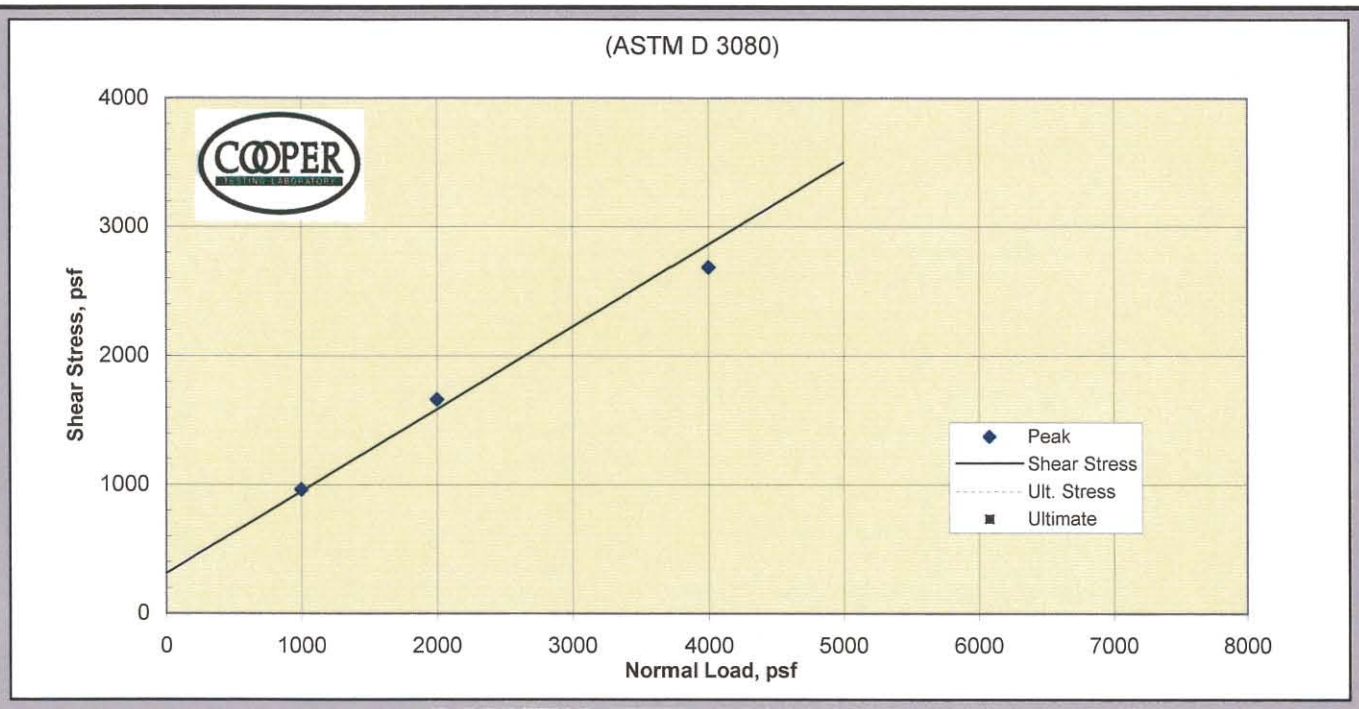
CTL #	157-237	Date:	12/19/2006	
Client:	Parikh			
Project Name:	T.Y. Lin, Route 4 East			
Project Number:	206117.GDR		Reduced by:	DC
Sample #	Boring	Sample	Depth, ft.	
1	SW-174	2	4	
2	SW-174	2	4	
3	SW-174	2	4	
4				

Visual Soil Classification	
1	Brown Clayey SAND, Hard
2	Brown Clayey SAND, Hard
3	Brown Clayey SAND, Hard
4	

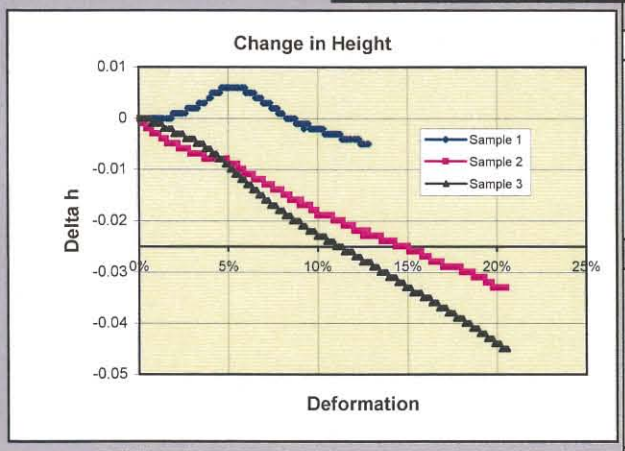
Remarks: Sample #2 was stopped short due to an electrical surge.

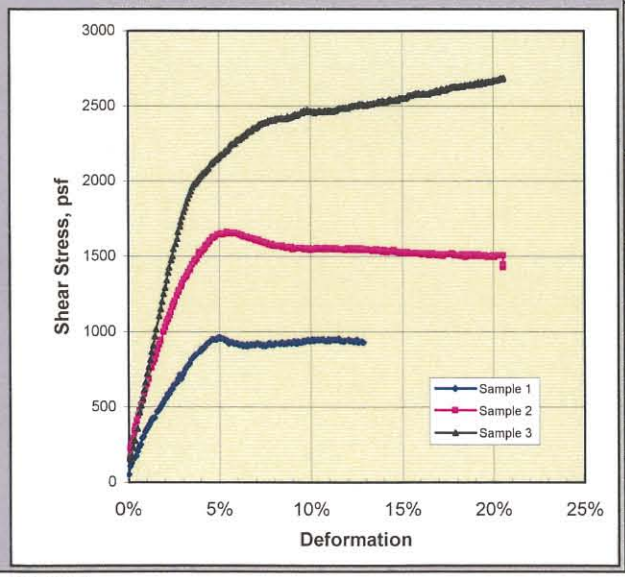
PLATE-7B

Direct Shear



P. Phi (degrees)	32.5	Ult. phi (degrees)	
P. Cohesion (psf)	310	Ult.Cohesion (psf)	





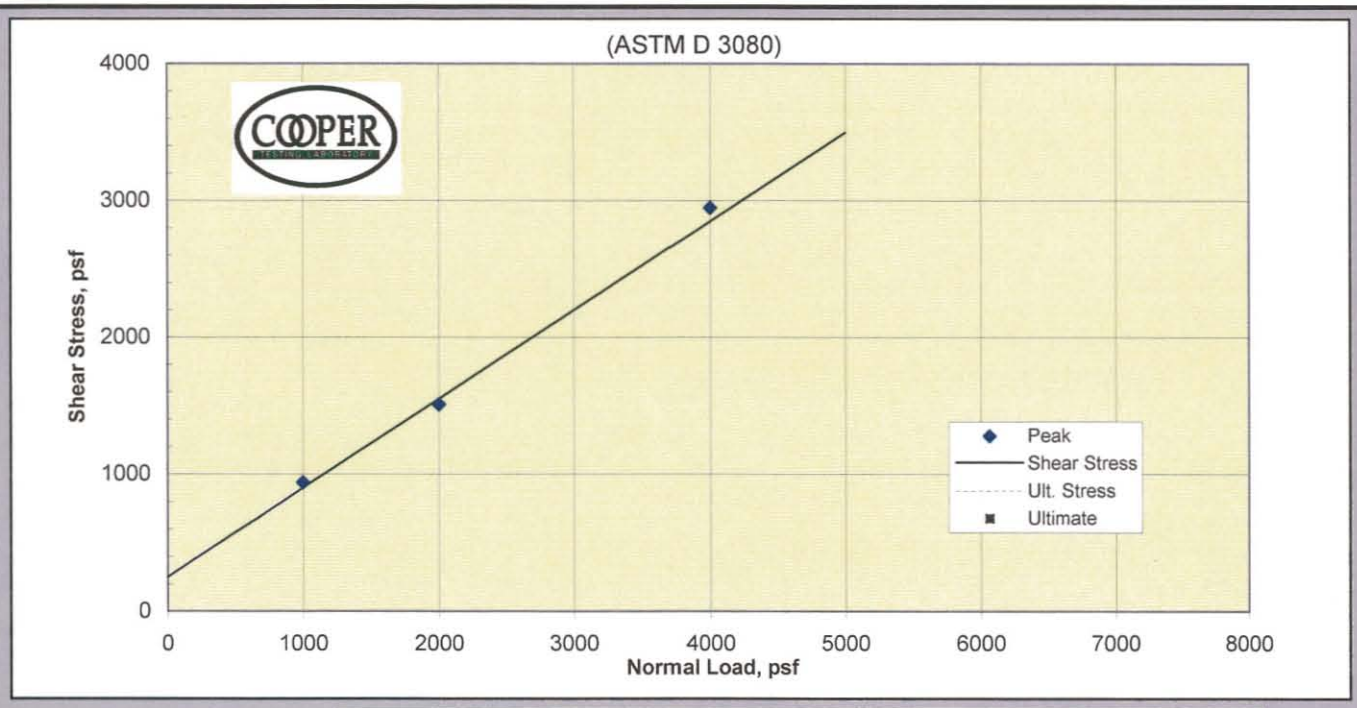
	Sample Data: Initial			
Initial	1	2	3	4
Moisture	15.6%	17.6%	17.6%	
Dry Density, pcf	92.1	90.5	93.1	
Void Ratio	0.8640	0.8974	0.8802	
Saturation	49.5%	54.0%	56.2%	
Diameter, in.	2.42	2.43	2.425	
Height, in.	1.00	1.01	1.00	
	Sample Data: At Test			
Moisture	31.1%	31.9%	30.9%	
Dry Density, pcf	92.6	91.8	94.9	
Void Ratio	0.8493	0.8634	0.8225	
Saturation	99.6%	99.8%	100.0%	
Diameter, in.	2.42	2.43	2.425	
Height, in.	0.99	0.99	0.97	
Normal Stress, psf	1000	2000	4000	
Shear Stress, psf	961	1661	2688	
Deformation	5%	5%	20%	
Ultimate Stress, psf	0	0	0	
Rate in/min.	0.0002	0.0002	0.0002	

CTL #	157-237	Date:	12/19/2006	
Client:	Parikh			
Project Name:	T.Y. Lin, Route 4 East			
Project Number:	206117		Reduced by:	DC
Sample #	Boring	Sample	Depth, ft.	
1	RW-173	3	8.5'	
2	RW-173	3	8.5'	
3	RW-173	3	8.5'	
4				
Visual Soil Classification				
1	Light Brown Sandy SILT			
2	Light Brown Sandy SILT			
3	Light Brown Sandy SILT			
4				

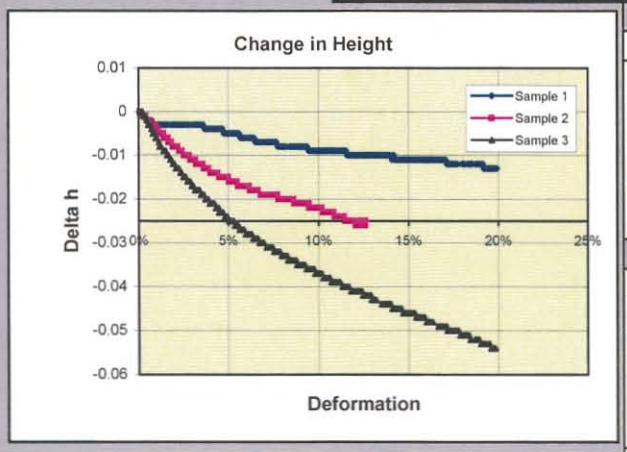
Remarks:

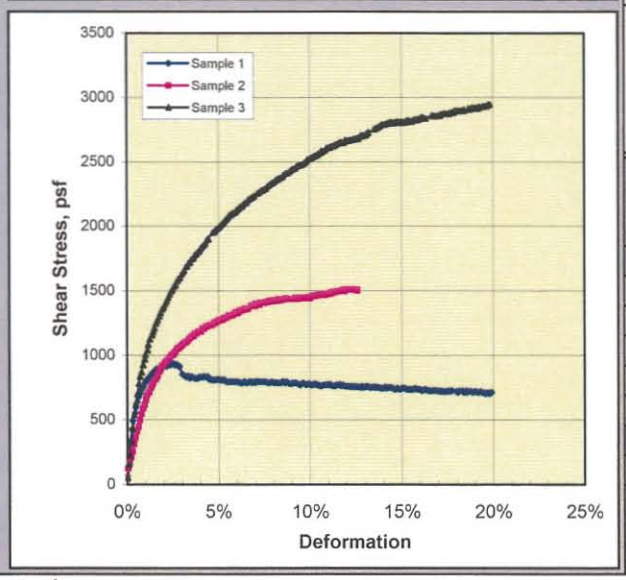
PLATE-7C

Direct Shear



P. Phi (degrees)	33.0	Ult. phi (degrees)	
P. Cohesion (psf)	250	Ult.Cohesion (psf)	





	Sample Data: Initial			
Initial	1	2	3	4
Moisture	12.6%	13.1%	13.2%	
Dry Density, pcf	108.0	105.5	100.2	
Void Ratio	0.5896	0.6270	0.6677	
Saturation	58.7%	57.5%	53.0%	
Diameter, in.	2.42	2.42	2.42	
Height, in.	1.00	1.00	1.03	
	Sample Data: At Test			
Moisture	24.4%	25.0%	22.9%	
Dry Density, pcf	104.8	103.8	103.5	
Void Ratio	0.6004	0.6102	0.6089	
Saturation	98.7%	97.6%	98.9%	
Diameter, in.	2.42	2.42	2.42	
Height, in.	1.01	0.99	0.99	
Normal Stress, psf	1000	2000	4000	
Shear Stress, psf	939	1509	2946	
Deformation	2%	12%	20%	
Ultimate Stress, psf	0	0	0	
Rate in/min.	0.0002	0.0002	0.0002	

CTL #	157-237	Date:	12/19/2006	
Client:	Parikh Consultants			
Project Name:	T.Y. Lin, Route 4-East			
Project Number:	206117		Reduced by:	DC
Sample #	Boring	Sample	Depth, ft.	
1	SW178	1	2	
2	SW178	1	2	
3	SW178	1	2	
4				
	Visual Soil Classification			
1	Brown Sandy CLAY			
2	Brown Sandy CLAY			
3	Brown Sandy CLAY			
4				

Remarks:

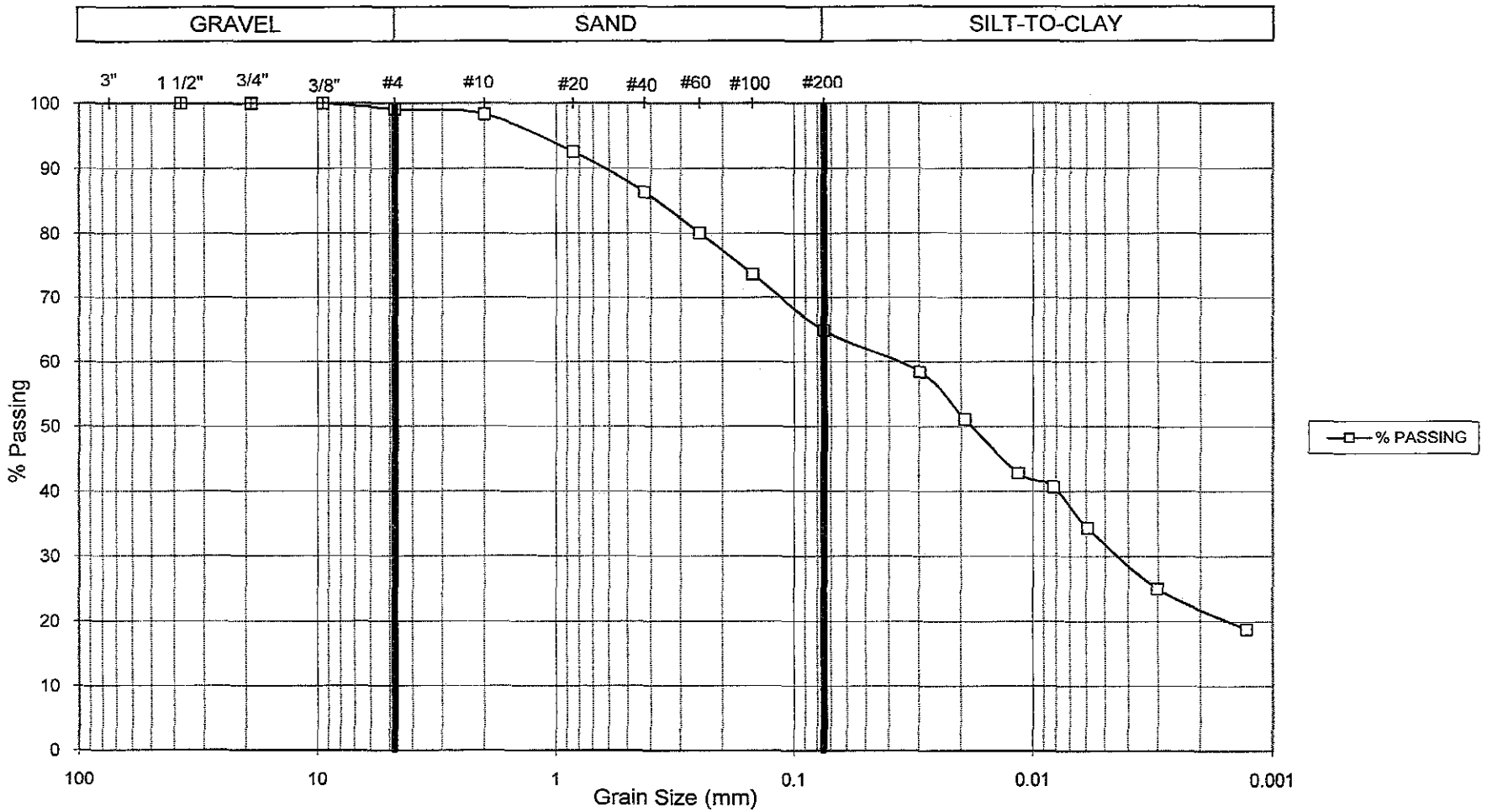
PLATE-7D

PARIKH CONSULTANTS, INC.

GRAIN SIZE DISTRIBUTION

(408) 452-9000

Project:	e BART A Street Underpass	Date:	7/29/2009
Client:	T Y Lin	Project #:	206117.ESB
Source/Location:	0 [illegible]	Sample: A155A #8 @ 109.5' feet	Lab # : G665
Material Description:	SANDY SILT (ML), light gray	Date Tested:	7/27/2009



Reported By: Prav Dayah

APPENDIX C

Attenuation Relationships for Shallow Crustal Earthquakes (Sadigh, et al, 1997)

Fault = Vaca fault zone (RLSS Fault, Map NO: 14)

Mmax = 6.9 **Rrup = 5.45** **km**

M>=6.5 *ROCK SITE:*

C1 = -1.274 C2 = 1.1 C3 = 0 C4 = -2.1

C5 = -0.48451 C6 = 0.524 C7 = 0

A=C1+C2M+C3(8.5M)^2.5= 6.316

B=C4*Ln(Rrup+exp(C5+C6M))= -7.024

C=C7*Ln(Rrup+2)= 0

Ln(y) = A+B+C = -0.708

y = Exp(Ln(y)) = 0.49 **Peak Bed Rock Acceleration PBA = 0.490 - Use 0.5g**

Fault = Great valley fault 5 (Reverse Fault, Map No: 24)

Mmax = 6.5 **Rrup = 7.045** **km**

A= 5.876

B= -6.811

C= 0

Ln(y) = -0.935

y = 0.39 **Peak Bed Rock Acceleration PBA = 0.39g x 1.2 = 0.468g**

Fault = Greenville fault zone (Clayton section, RLSS Fault, Map No: 351)

Mmax = 6.6 **Rrup = 6.59** **km**

A= 5.986

B= -6.855

C= 0

Ln(y) = -0.869

y = 0.42 **Peak Bed Rock Acceleration PBA = 0.42g**

Fault = Concord fault zone (Ygnacio valley section, RLSS Fault, Map No: 341)

Mmax = 6.6 **Rrup = 11.136** **km**

A= 5.986

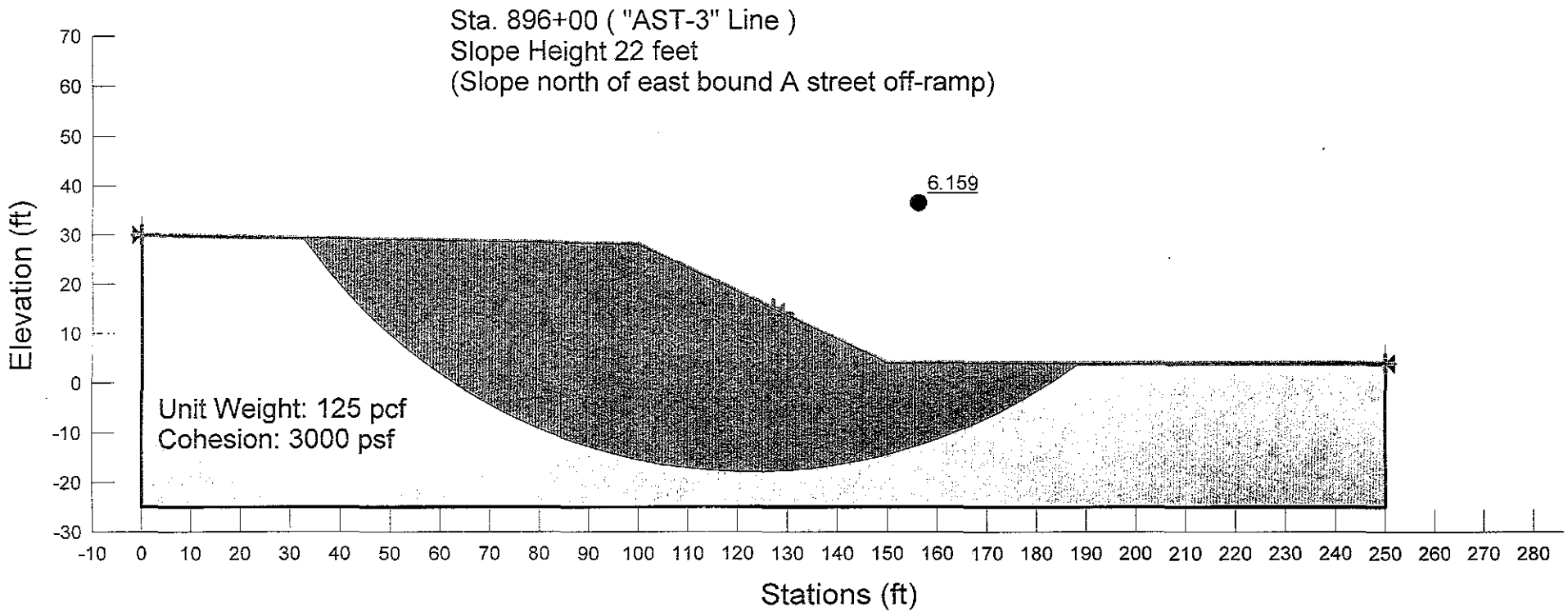
B= -7.191

C= 0

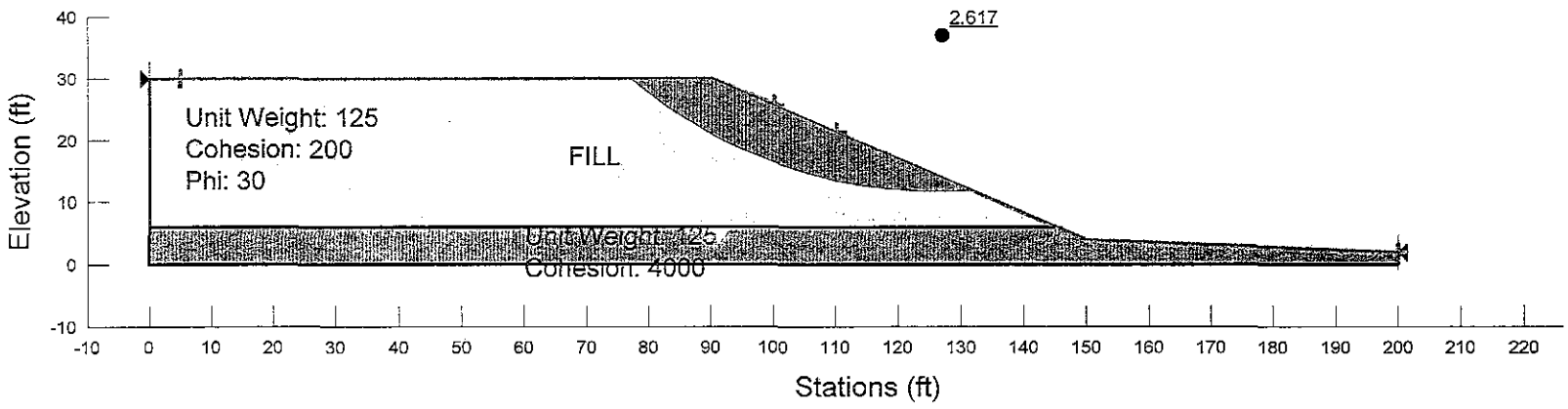
Ln(y) = -1.205

y = 0.30 **Peak Bed Rock Acceleration PBA = 0.3g**

SLOPE STABILITY


Sta. 896+00 ("AST-3" Line)
Slope Height 22 feet
(Slope north of east bound A street off-ramp)
6.159
Unit Weight: 125 pcf
Cohesion: 3000 psf
Elevation (ft)
70
60
50
40
30
20
10
0
-10
-20
-30
-10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280
Stations (ft)

Sta. 196+00 ("E" Line)
Fill Height 20 feet
(Slope north of westbound SR4)



CIDH Pile

AXIAL PILE CAPACITY

SHAFT Program

SHAFT Runs SR Bypass – Segment 3A
Job No. 206117.GDR
Pile capacities computed using SHAFT program – Output follows
Note: Neglected End Bearing for Pile Capacity
Revised 03/14/10

Retaining Wall No. 3 (based on boring RW-189)

24-in. Diameter CIDH PIle

Ground Surface Elevation = 47.5 (approx.)

Nominal Compression Load = 280 kips = 140 tons
Reqd. Shaft Length per SHAFT output = 22.0 ft --- Compression
Recommended Penetration = 22.0 feet
Reqd. Tip Elevation = 47.5 – 22.0 = 25.5

Nominal Tension Load = 80 kips = 40 tons
Equivalent Compression Skin Friction = 40/0.5 = 80 tons
Reqd. Shaft Length per SHAFT output = 16.5 ft --- Tension
Recommended Penetration = 16.5 feet
Reqd. Tip Elevation = 47.5 – 16.5 = 31.0

Specified Tip Elevation = 25.5

Retaining Wall No. 4 (based on boring RW-202)

24-in. Diameter CIDH PIle

Ground Surface Elevation = 48.5 (approx.)

Nominal Compression Load = 320 kips = 160 tons
Reqd. Shaft Length per SHAFT output = 28.5 ft -- Compression
Recommended Penetration = 28.5 feet
Reqd. Tip Elevation = 48.5 – 28.5 = 20.0 -- Compression

Nominal Tension Load = 60 kips = 30 tons
Equivalent Compression Skin Friction = 30/0.5 = 60 tons
Reqd. Shaft Length per SHAFT output = 16.5 ft --- Tension
Recommended Penetration = 16.5 feet
Reqd. Tip Elevation = 48.5 – 16.5 = 32.0 -- Tension

Specified Tip Elevation = 18.0

Retaining Wall No. 9 (based on boring RW-170)

36-in. Diameter CIDH PIle

Ground Surface Elevation = 47.0 (approx.)
Nominal Compression Load = 600 kips = 300 tons
Reqd. Shaft Length per SHAFT output = 29.0 ft
Recommended Penetration = 29.0 feet
Reqd. Tip Elevation = 47.0 – 29.0 = 18.0

No Tension

Specified Tip Elevation = 18.0

Retaining Wall No. 10 (based on boring RW-174)

24-in. Diameter CIDH PIle

Ground Surface Elevation = 45.5 (approx.)
Nominal Compression Load =280 kips = 140 tons
Reqd. Shaft Length per SHAFT output = 29.5 ft
Recommended Penetration = 29.5 feet
Reqd. Tip Elevation = 45.5-29.5 = 16.0

Nominal Tension Load = 80 kips =430 tons
Equivalent Compression Skin Friction = 40/0.5 = 80 tons
Reqd. Shaft Length per SHAFT output = 21.0 ft --- Tension
Recommended Penetration = 21.0 feet
Reqd. Tip Elevation = 45.5 – 21.0 = 24.5 -- Tension

Specified Tip Elevation = 16.0

Retaining Wall No. 11 (based on boring RW-206)

36-in. Diameter CIDH PIle

Ground Surface Elevation = 47.0 (approx.)

Nominal Compression Load = 840 kips = 420 tons
Reqd. Shaft Length per SHAFT output = 29.0 ft
Recommended Penetration = 27.5 feet
Reqd. Tip Elevation = 47.0 – 29.0 =8.0

No Tension

Specified Tip Elevation = 18.0

Retaining Wall No. 12 (based on boring RW-210)

24-in. Diameter CIDH PIle

Ground Surface Elevation = 45.0 (approx.)

Nominal Compression Load = 180 kips = 90 tons
Reqd. Shaft Length per SHAFT output = 25.0 ft -- Compression
Recommended Penetration = 25.0 feet
Reqd. Tip Elevation = 45.0 – 25.0 = 20.0 -- Compression

Nominal Tension Load = 60 kips = 30 tons
Equivalent Compression Skin Friction = 30/0.5 = 60 tons
Reqd. Shaft Length per SHAFT output = 19.0 ft --- Tension
Recommended Penetration = 19.0 feet
Reqd. Tip Elevation = 45.0 – 19.0 = 26.0 -- Tension

Specified Tip Elevation = 20.0

Retaining Wall No. 14 (based on boring RW-192A)

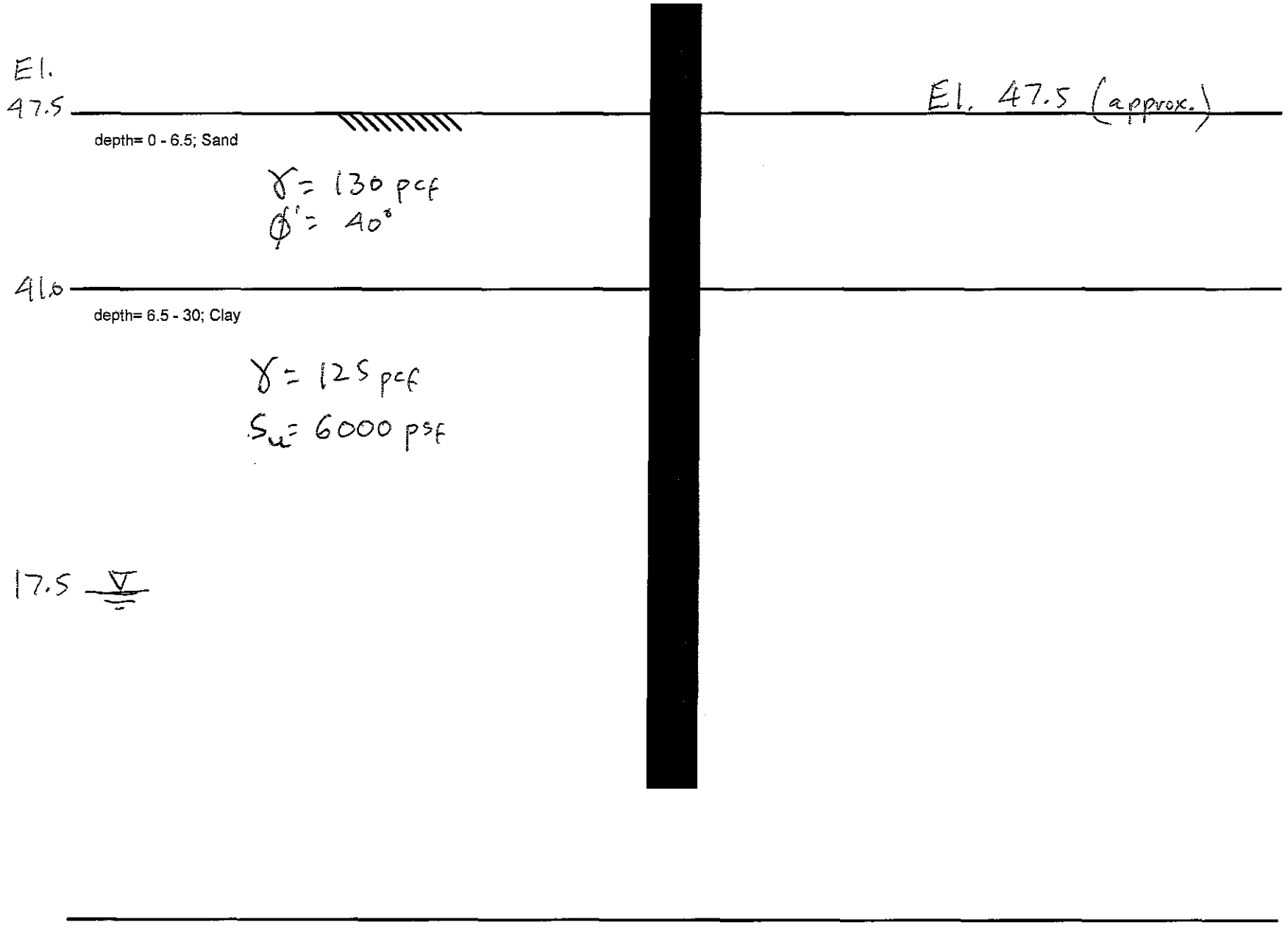
24-in. Diameter CIDH PIle

Ground Surface Elevation = 45.0 (approx.)

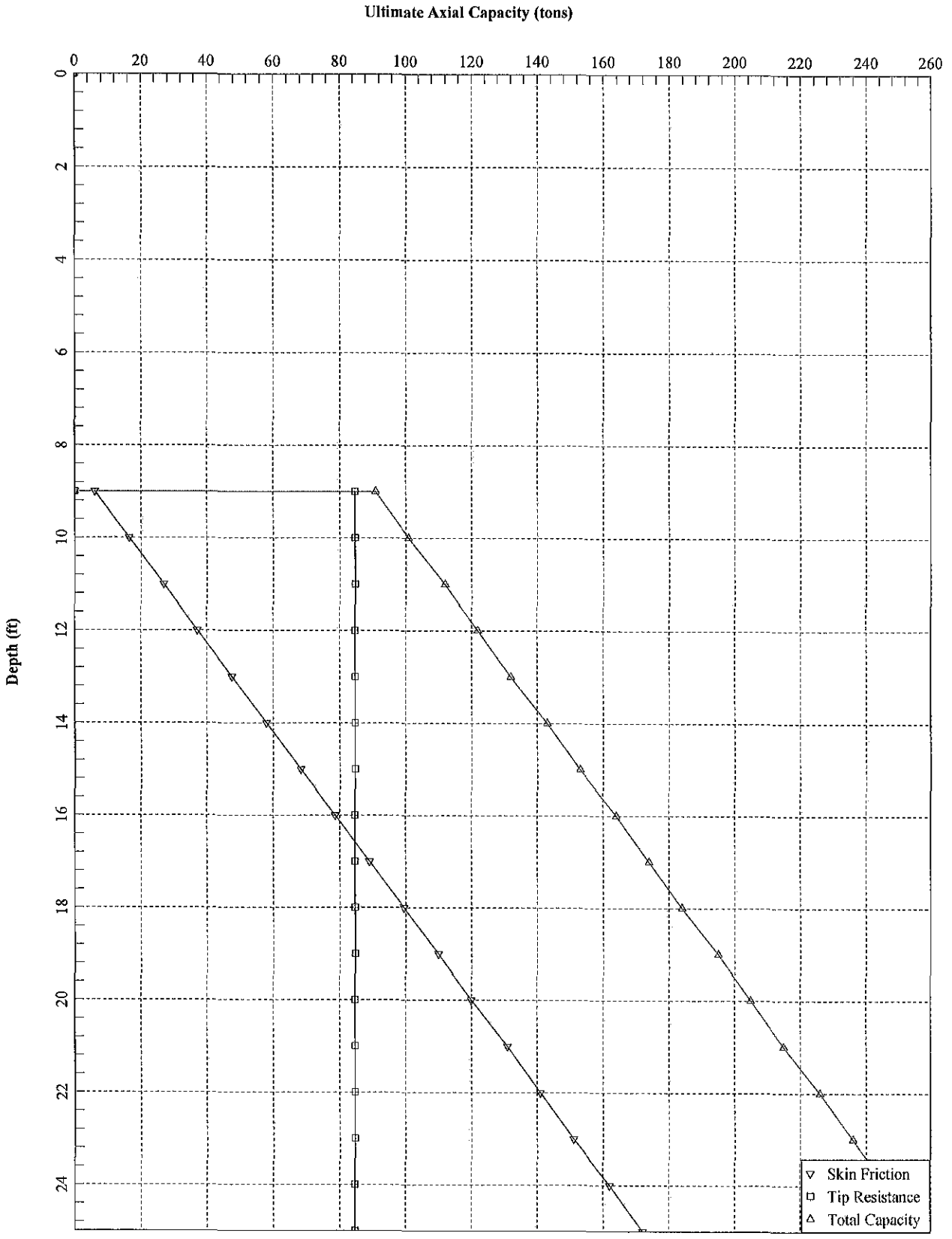
Nominal Compression Load = 180 kips = 90 tons
Reqd. Shaft Length per SHAFT output = 22.0 ft -- Compression
Recommended Penetration = 25.0 feet
Reqd. Tip Elevation = 45.0 – 22.0 = 23.0 -- Compression

Nominal Tension Load = 60 kips = 30 tons
Equivalent Compression Skin Friction = 30/0.5 = 60 tons
Reqd. Shaft Length per SHAFT output = 18.0 ft --- Tension
Recommended Penetration = 18.0 feet
Reqd. Tip Elevation = 45.0 – 18.0 = 27.0 -- Tension

Specified Tip Elevation = 23.0



Retaining Wall No. 3
Profile based on Boring RW-189



SR4 Segment 3A - Retaining Wall No. 3 - 24-in. CIDH PIle

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 5.0 (C) COPYRIGHT ENSOFT,INC. 1989,1995,1998,2001,2003

SR4 Seg. 3A - Ret. Wall No. 3 - 24-in Cidh Pile

PROPOSED DEPTH = 25.0 FT

NUMBER OF LAYERS = 2

WATER TABLE DEPTH = 30.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 2.50

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 3.00

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.	= 0.400E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.116E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.400E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03

MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.650E+01

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	= 0.600E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.650E+01

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.600E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.300E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	=	2.000	FT.
DIAMETER OF BASE	=	2.000	FT.
END OF STEM TO BASE	=	0.000	FT.
ANGLE OF BELL	=	0.000	DEG.
IGNORED TOP PORTION	=	5.000	FT.
IGNORED BOTTOM PORTION	=	2.000	FT.
AREA OF ONE PERCENT STEEL	=	4.524	SQ.IN.
ELASTIC MODULUS, Ec	=	0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	=	0.000	CU.YDS.

PREDICTED RESULTS

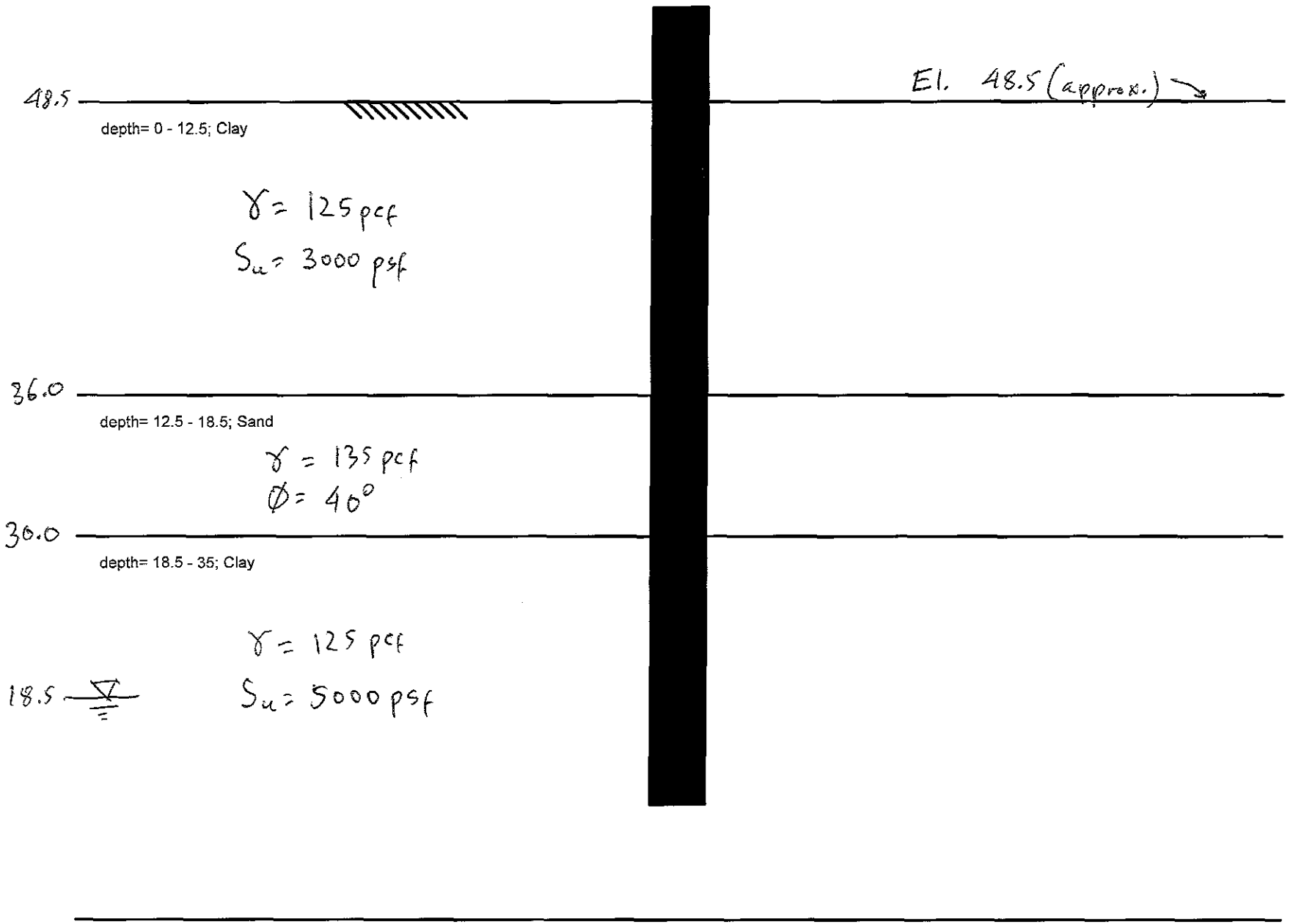
QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED 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)
8.0	0.93	2.87	84.83	87.70	31.14	29.42	94.20
9.0	1.05	6.13	84.83	90.97	34.41	30.73	86.86
10.0	1.16	16.50	84.83	101.34	44.78	34.88	87.08
11.0	1.28	26.87	84.83	111.70	55.15	39.03	87.26
12.0	1.40	37.24	84.83	122.07	65.52	43.17	87.42
13.0	1.51	47.61	84.83	132.44	75.89	47.32	87.55
14.0	1.63	57.98	84.83	142.81	86.25	51.47	87.66
15.0	1.75	68.34	84.83	153.18	96.62	55.62	87.75
16.0	1.86	78.71	84.83	163.55	106.99	59.76	87.84
17.0	1.98	89.08	84.83	173.92	117.36	63.91	87.91
18.0	2.09	99.45	84.83	184.28	127.73	68.06	87.98
19.0	2.21	109.82	84.83	194.65	138.10	72.21	88.04
20.0	2.33	120.19	84.83	205.02	148.47	76.35	88.09
21.0	2.44	130.56	84.83	215.39	158.83	80.50	88.14
22.0	2.56	140.93	84.83	225.76	169.20	84.65	88.18
23.0	2.68	151.29	84.83	236.13	179.57	88.80	88.22
24.0	2.79	161.66	84.83	246.50	189.94	92.94	88.26
25.0	2.91	172.03	84.83	256.86	200.31	97.09	88.29

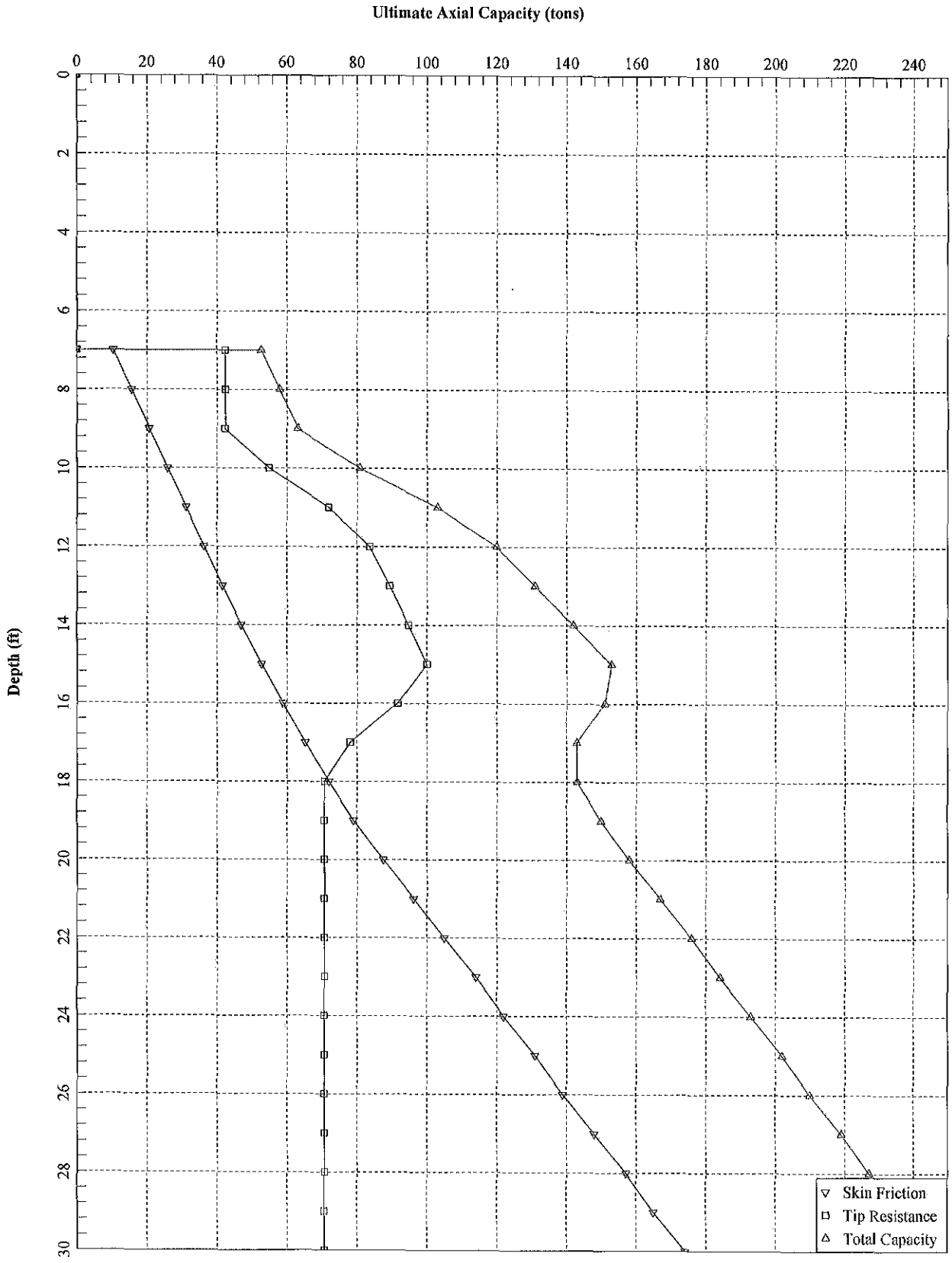
RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.4006E+00	0.1947E-03	0.2792E-01	0.1000E-03
0.4006E+01	0.1947E-02	0.2792E+00	0.1000E-02
0.1002E+02	0.4868E-02	0.6981E+00	0.2500E-02
0.2025E+02	0.9771E-02	0.1396E+01	0.5000E-02
0.3047E+02	0.1468E-01	0.2094E+01	0.7500E-02
0.4067E+02	0.1958E-01	0.2792E+01	0.1000E-01
0.9213E+02	0.4715E-01	0.6981E+01	0.2500E-01
0.1343E+03	0.8284E-01	0.1396E+02	0.5000E-01
0.1608E+03	0.1153E+00	0.2094E+02	0.7500E-01
0.1704E+03	0.1434E+00	0.2792E+02	0.1000E+00

0.1939E+03	0.3016E+00	0.4850E+02	0.2500E+00
0.1986E+03	0.5551E+00	0.6755E+02	0.5000E+00
0.2079E+03	0.8085E+00	0.7688E+02	0.7500E+00
0.2119E+03	0.1060E+01	0.8088E+02	0.1000E+01
0.2150E+03	0.2461E+01	0.8407E+02	0.2400E+01



Retaining Wall No 4
Profile based on Boring RW-202



SR4 - Segment 3A - Retaining Wall No. 4 - 24-in. CIDH Pile

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 5.0 (C) COPYRIGHT ENSOFT,INC. 1989,1995,1998,2001,2003

SR4 Seg. 3A - Ret. WAll No. 4 - 24-in Cidh Pile

PROPOSED DEPTH = 30.0 FT

NUMBER OF LAYERS = 3

WATER TABLE DEPTH = 30.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 2.50

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 3.00

SOIL INFORMATION

LAYER NO 1----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.300E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.300E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00

BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.125E+02

LAYER NO 2----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.102E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.400E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.135E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.400E+04
DEPTH, FT	= 0.125E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.919E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.400E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.135E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.400E+04
DEPTH, FT	= 0.185E+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	= 0.500E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.185E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.500E+04

INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.350E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	=	2.000	FT.
DIAMETER OF BASE	=	2.000	FT.
END OF STEM TO BASE	=	0.000	FT.
ANGLE OF BELL	=	0.000	DEG.
IGNORED TOP PORTION	=	5.000	FT.
IGNORED BOTTOM PORTION	=	0.000	FT.
AREA OF ONE PERCENT STEEL	=	4.524	SQ.IN.
ELASTIC MODULUS, Ec	=	0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	=	0.000	CU.YDS.

PREDICTED RESULTS

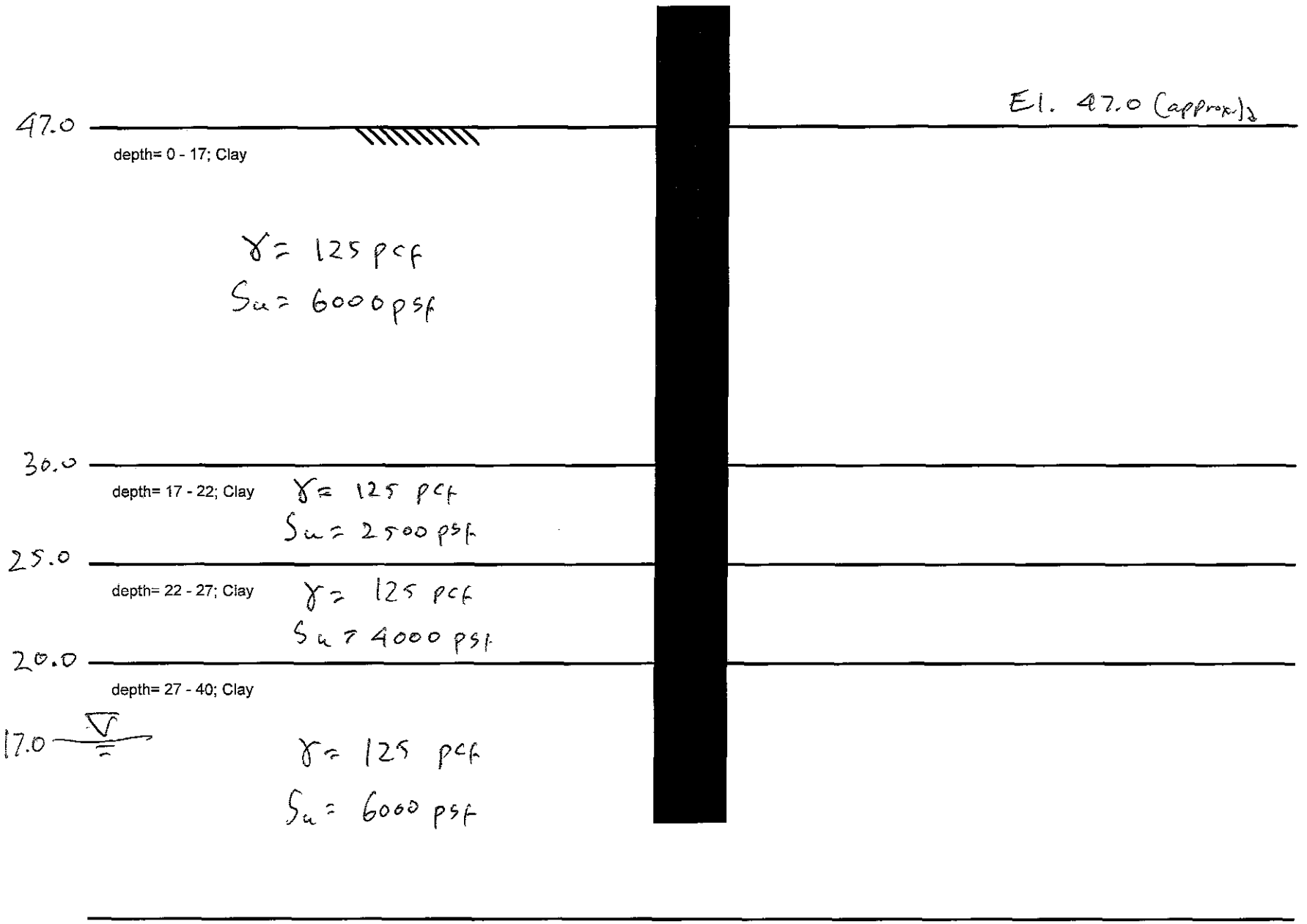
QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED 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)
6.0	0.70	5.18	42.42	47.60	19.32	16.21	68.17
7.0	0.81	10.37	42.42	52.79	24.31	18.29	64.80
8.0	0.93	15.55	42.42	57.97	29.69	20.36	62.27
9.0	1.05	20.74	42.42	63.15	34.88	22.43	60.30
10.0	1.16	25.92	54.92	80.84	44.23	28.67	69.47
11.0	1.28	31.11	71.89	103.00	55.07	36.41	80.46
12.0	1.40	36.29	83.74	120.03	64.20	42.43	85.95
13.0	1.51	41.47	89.27	130.74	71.23	46.35	86.42
14.0	1.63	46.98	94.80	141.77	78.58	50.39	87.02

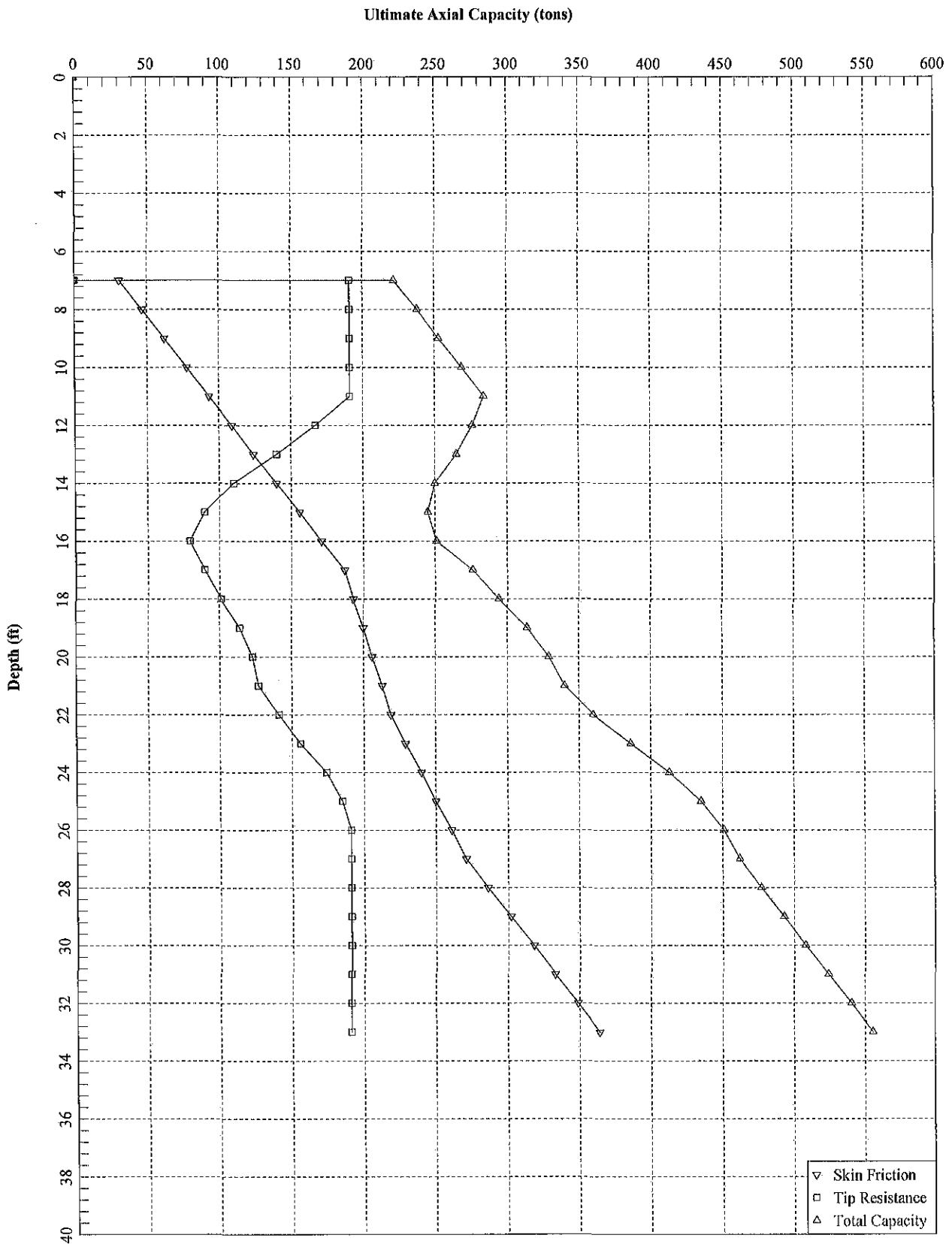
15.0	1.75	52.79	100.33	153.12	86.24	54.56	87.72
16.0	1.86	58.92	91.61	150.52	89.45	54.10	80.84
17.0	1.98	65.33	78.06	143.40	91.35	52.15	72.48
18.0	2.09	72.04	70.69	142.73	95.60	52.38	68.14
19.0	2.21	79.01	70.69	149.70	102.57	55.17	67.71
20.0	2.33	87.65	70.69	158.34	111.21	58.62	68.03
21.0	2.44	96.29	70.69	166.99	119.86	62.08	68.33
22.0	2.56	104.93	70.69	175.63	128.50	65.54	68.60
23.0	2.68	113.57	70.69	184.27	137.14	68.99	68.85
24.0	2.79	122.21	70.69	192.91	145.78	72.45	69.07
25.0	2.91	130.85	70.69	201.55	154.42	75.91	69.28
26.0	3.03	139.49	70.69	210.19	163.06	79.36	69.47
27.0	3.14	148.13	70.69	218.83	171.70	82.82	69.65
28.0	3.26	156.77	70.69	227.47	180.34	86.27	69.81
29.0	3.37	165.41	70.69	236.11	188.98	89.73	69.96
30.0	3.49	174.05	70.69	244.75	197.62	93.19	70.11

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.4874E+00	0.2227E-03	0.2327E-01	0.1000E-03
0.4874E+01	0.2227E-02	0.2327E+00	0.1000E-02
0.1220E+02	0.5567E-02	0.5818E+00	0.2500E-02
0.2464E+02	0.1117E-01	0.1164E+01	0.5000E-02
0.3705E+02	0.1678E-01	0.1745E+01	0.7500E-02
0.4948E+02	0.2240E-01	0.2327E+01	0.1000E-01
0.1061E+03	0.5324E-01	0.5818E+01	0.2500E-01
0.1533E+03	0.9184E-01	0.1164E+02	0.5000E-01
0.1783E+03	0.1256E+00	0.1745E+02	0.7500E-01
0.1892E+03	0.1545E+00	0.2327E+02	0.1000E+00
0.2118E+03	0.3137E+00	0.4041E+02	0.2500E+00
0.2136E+03	0.5668E+00	0.5629E+02	0.5000E+00
0.2213E+03	0.8202E+00	0.6407E+02	0.7500E+00
0.2246E+03	0.1072E+01	0.6740E+02	0.1000E+01
0.2270E+03	0.2473E+01	0.7006E+02	0.2400E+01



Retaining Wall No. 9
Profile based on Boring RW-170



SR4 Segment 3A - Retaining Wall No. 9 - 36-in. CIDH PIle

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 5.0 (C) COPYRIGHT ENSOFT,INC. 1989,1995,1998,2001,2003

SR4 Seg. 3A - Ret. Wall No. 9 - 36-in CIDH Pile

PROPOSED DEPTH = 35.0 FT

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 30.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 2.50

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 3.00

SOIL INFORMATION

LAYER NO 1----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.600E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.600E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.170E+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	= 0.250E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00

SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.170E+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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.220E+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	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.220E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.270E+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	= 0.600E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.270E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.600E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00

SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.400E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	=	3.000	FT.
DIAMETER OF BASE	=	3.000	FT.
END OF STEM TO BASE	=	0.000	FT.
ANGLE OF BELL	=	0.000	DEG.
IGNORED TOP PORTION	=	5.000	FT.
IGNORED BOTTOM PORTION	=	0.000	FT.
AREA OF ONE PERCENT STEEL	=	10.180	SQ.IN.
ELASTIC MODULUS, Ec	=	0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	=	0.000	CU.YDS.

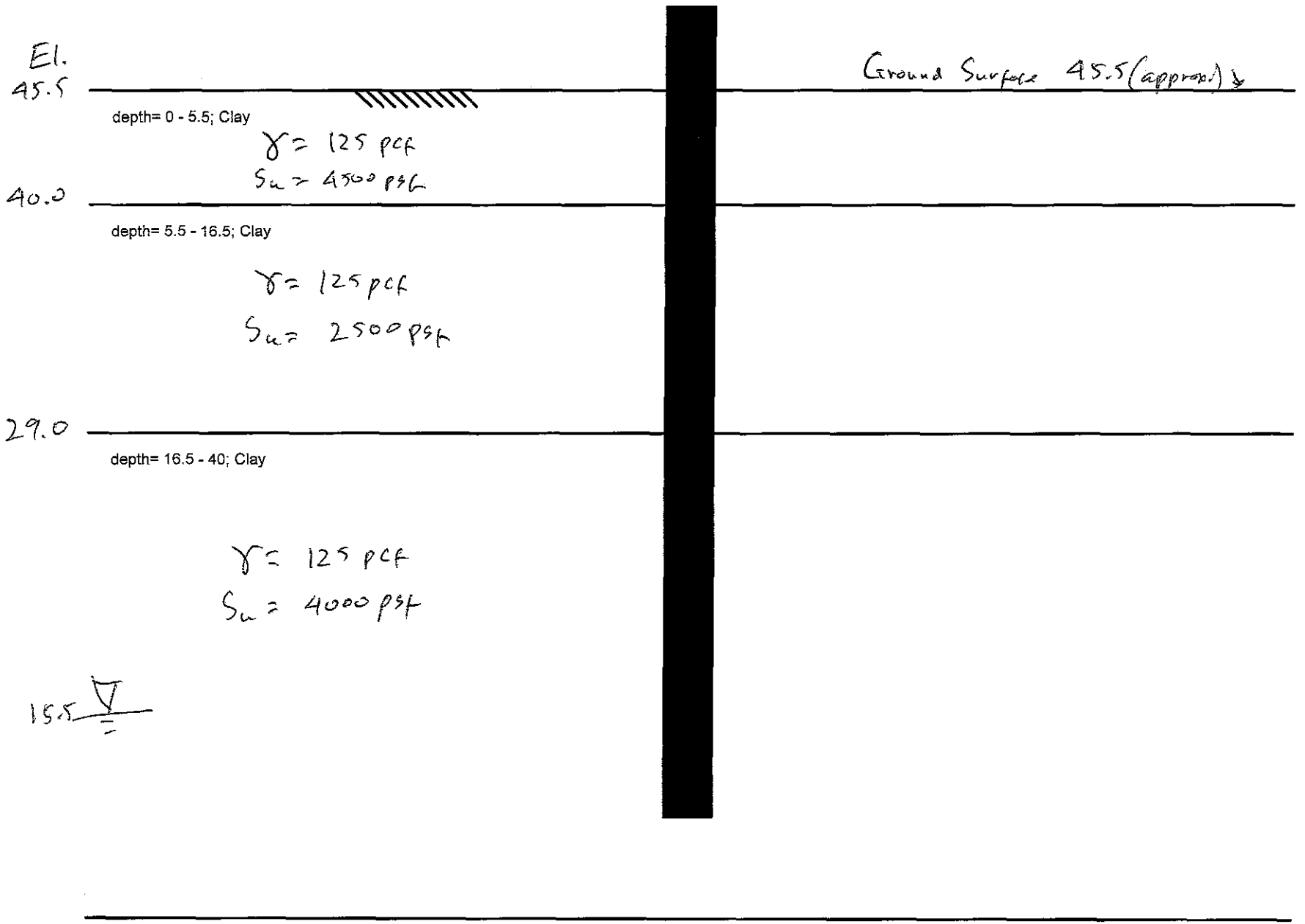
PREDICTED RESULTS

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.

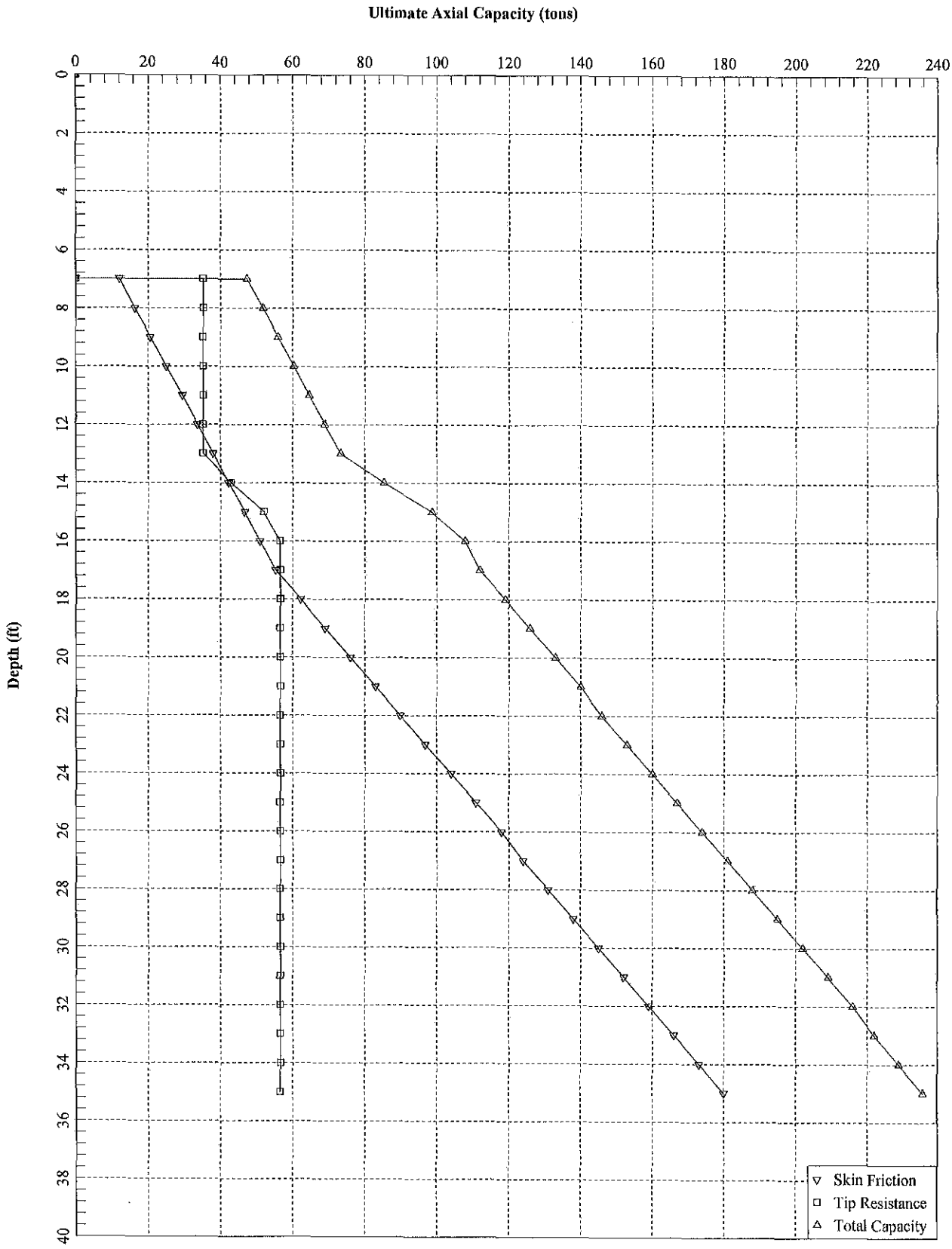
LENGTH (FEET)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU.YDS)
6.0	1.57	15.55	190.88	206.43	79.18	69.85	131.40
7.0	1.83	31.11	190.88	221.98	94.73	76.07	121.11
8.0	2.09	46.66	190.88	237.54	110.28	82.29	113.40
9.0	2.36	62.21	190.88	253.09	125.84	88.51	107.40
10.0	2.62	77.76	190.88	268.64	141.39	94.73	102.60
11.0	2.88	93.32	190.88	284.19	156.94	100.95	98.67
12.0	3.14	108.87	167.26	276.13	164.62	99.30	87.88
13.0	3.40	124.42	140.27	264.69	171.18	96.52	77.76
14.0	3.67	139.98	109.90	249.87	176.61	92.62	68.17
15.0	3.93	155.53	89.65	245.18	185.41	92.10	62.43
16.0	4.19	171.08	79.53	250.61	197.59	94.94	59.82
17.0	4.45	186.63	89.65	276.29	216.52	104.54	62.07
18.0	4.71	193.12	101.22	294.34	226.86	110.99	62.45
19.0	4.97	199.60	114.24	313.83	237.67	117.92	63.08
20.0	5.24	206.08	122.91	328.99	247.05	123.40	62.82
21.0	5.50	212.56	127.25	339.81	254.97	127.44	61.80
22.0	5.76	219.04	140.75	359.78	265.95	134.53	62.46
23.0	6.02	229.41	156.17	385.58	281.46	143.82	64.03
24.0	6.28	239.77	173.52	413.30	297.62	153.75	65.77
25.0	6.55	250.14	185.09	435.23	311.84	161.75	66.49
26.0	6.81	260.51	190.88	451.39	324.14	167.83	66.31
27.0	7.07	270.88	190.88	461.76	334.51	171.98	65.32
28.0	7.33	286.43	190.88	477.31	350.06	178.20	65.11
29.0	7.59	301.99	190.88	492.86	365.61	184.42	64.91
30.0	7.86	317.54	190.88	508.41	381.16	190.64	64.72
31.0	8.12	333.09	190.88	523.97	396.72	196.86	64.55
32.0	8.38	348.64	190.88	539.52	412.27	203.08	64.39
33.0	8.64	364.20	190.88	555.07	427.82	209.30	64.24

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.7378E+00	0.1811E-03	0.4189E-01	0.1000E-03
0.7378E+01	0.1811E-02	0.4189E+00	0.1000E-02
0.1845E+02	0.4529E-02	0.1047E+01	0.2500E-02
0.3706E+02	0.9064E-02	0.2094E+01	0.5000E-02
0.5576E+02	0.1361E-01	0.3142E+01	0.7500E-02
0.7446E+02	0.1816E-01	0.4189E+01	0.1000E-01
0.1842E+03	0.4537E-01	0.1047E+02	0.2500E-01
0.2799E+03	0.8265E-01	0.2094E+02	0.5000E-01
0.3497E+03	0.1165E+00	0.3142E+02	0.7500E-01
0.3964E+03	0.1487E+00	0.4189E+02	0.1000E+00
0.4651E+03	0.3116E+00	0.8764E+02	0.2500E+00
0.4879E+03	0.5684E+00	0.1277E+03	0.5000E+00
0.4830E+03	0.8203E+00	0.1520E+03	0.7500E+00
0.4998E+03	0.1074E+01	0.1688E+03	0.1000E+01
0.5202E+03	0.3678E+01	0.1892E+03	0.3600E+01



Retaining Wall No. 10
Profile based on Boring RW-174



SR4 Segment 3A - Retaining Wll No. 10 - 24-in. CIDH Plle

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 5.0 (C) COPYRIGHT ENSOFT,INC. 1989,1995,1998,2001,2003

SR4 Seg. 3A - Ret. Wall No. 10 - 30-in CIDH Pile

PROPOSED DEPTH = 35.0 FT

NUMBER OF LAYERS = 3

WATER TABLE DEPTH = 30.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 2.50

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 3.00

SOIL INFORMATION

LAYER NO 1----CLAY

AT THE TOP

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.450E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.450E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00

BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.550E+01

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	= 0.250E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.550E+01

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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.165E+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	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.165E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00

END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.400E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	=	2.000	FT.
DIAMETER OF BASE	=	2.000	FT.
END OF STEM TO BASE	=	0.000	FT.
ANGLE OF BELL	=	0.000	DEG.
IGNORED TOP PORTION	=	5.000	FT.
IGNORED BOTTOM PORTION	=	0.000	FT.
AREA OF ONE PERCENT STEEL	=	4.524	SQ.IN.
ELASTIC MODULUS, Ec	=	0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	=	0.000	CU.YDS.

PREDICTED RESULTS

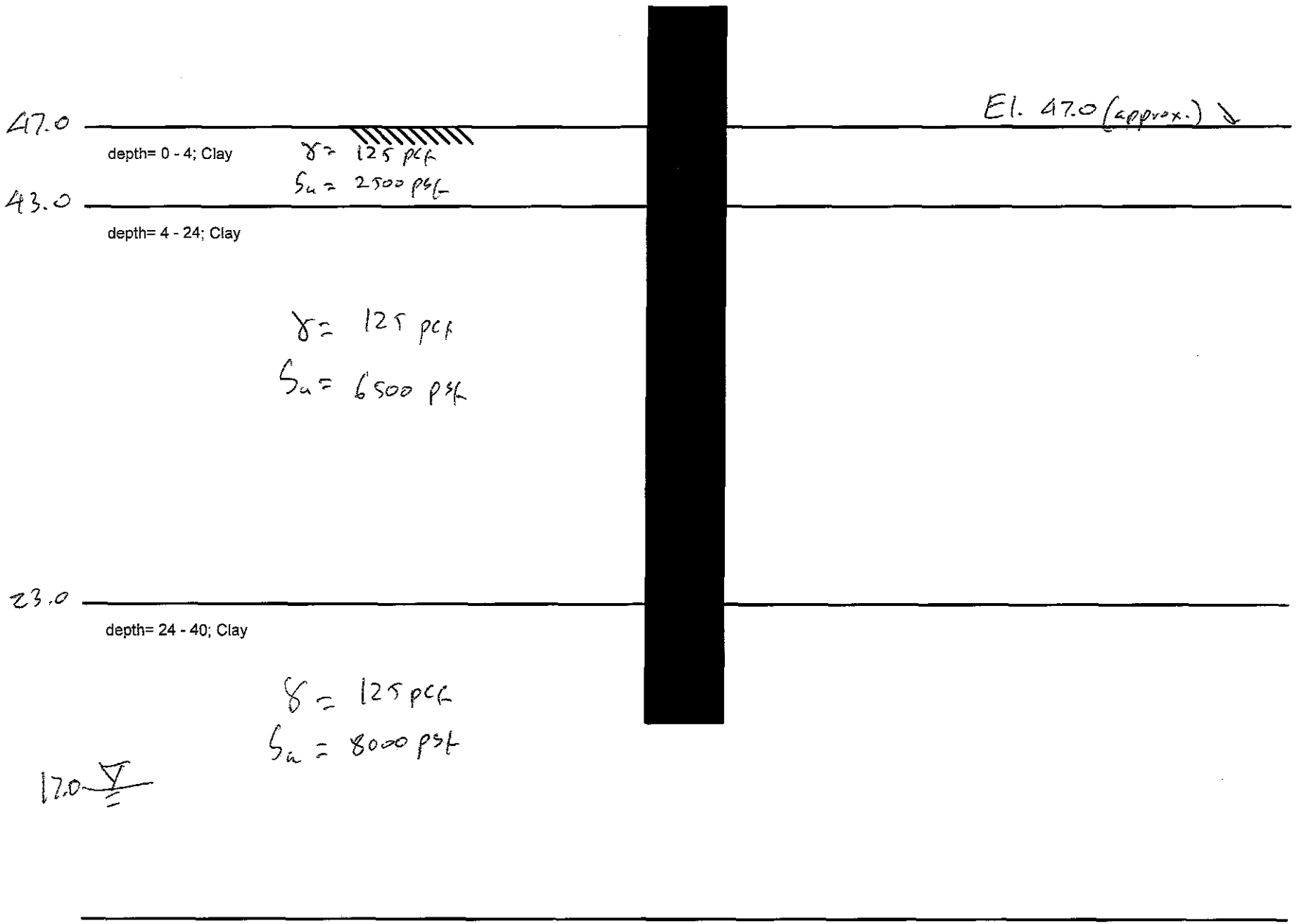
QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED 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)
6.0	0.70	7.78	35.35	43.12	19.56	14.89	61.76
7.0	0.81	12.10	35.35	47.44	23.88	16.62	58.24
8.0	0.93	16.42	35.35	51.76	28.20	18.35	55.60
9.0	1.05	20.74	35.35	56.08	32.52	20.08	53.55
10.0	1.16	25.06	35.35	60.40	36.84	21.81	51.91
11.0	1.28	29.38	35.35	64.73	41.16	23.53	50.56
12.0	1.40	33.70	35.35	69.05	45.48	25.26	49.44

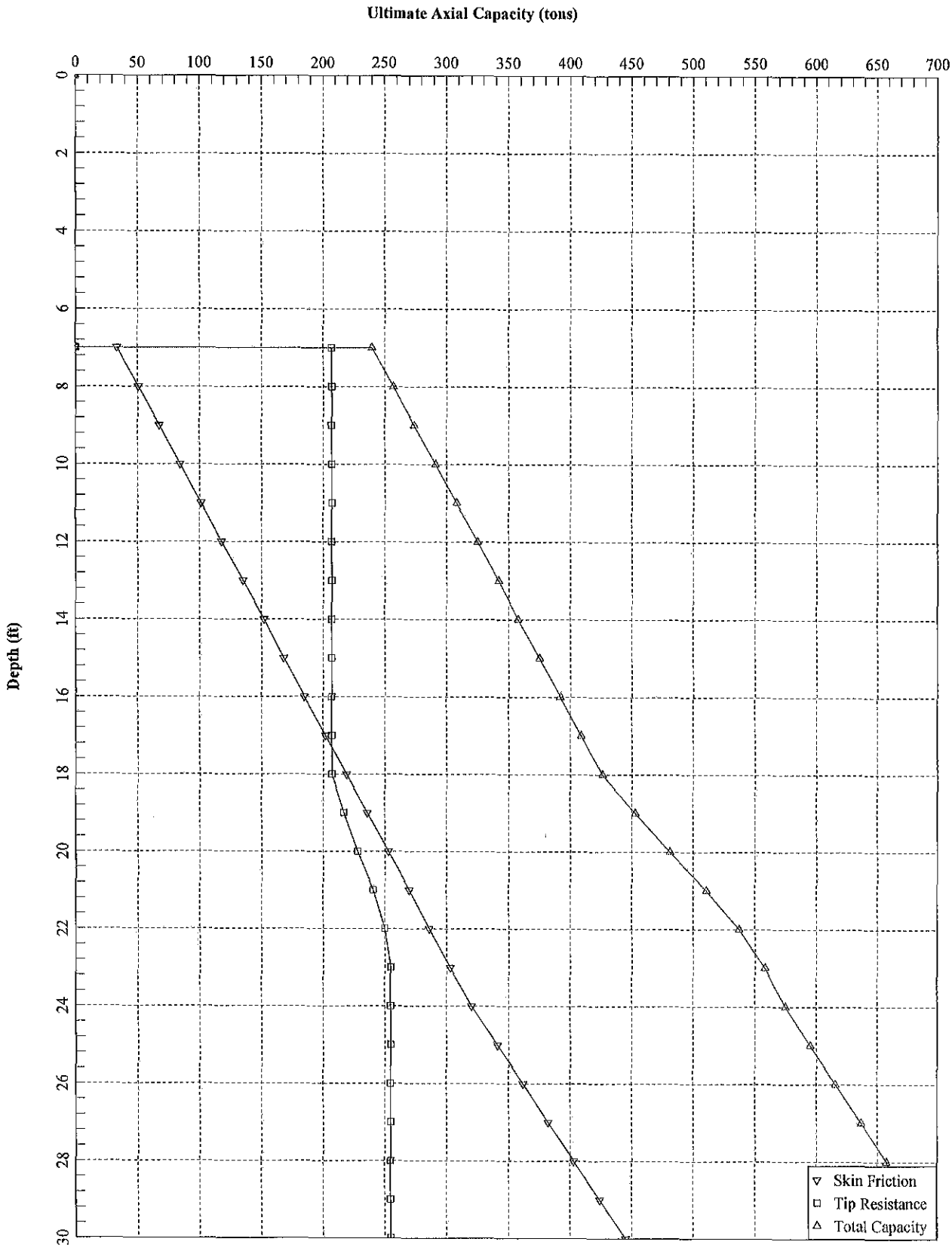
13.0	1.51	38.02	35.35	73.37	49.80	26.99	48.50
14.0	1.63	42.34	42.92	85.26	56.65	31.24	52.33
15.0	1.75	46.66	52.01	98.67	64.00	36.00	56.53
16.0	1.86	50.98	56.56	107.53	69.83	39.24	57.75
17.0	1.98	55.30	56.56	111.86	74.15	40.97	56.54
18.0	2.09	62.21	56.56	118.77	81.06	43.74	56.70
19.0	2.21	69.12	56.56	125.68	87.98	46.50	56.84
20.0	2.33	76.04	56.56	132.59	94.89	49.27	56.97
21.0	2.44	82.95	56.56	139.50	101.80	52.03	57.09
22.0	2.56	89.86	56.56	146.42	108.71	54.80	57.19
23.0	2.68	96.77	56.56	153.33	115.63	57.56	57.29
24.0	2.79	103.69	56.56	160.24	122.54	60.33	57.38
25.0	2.91	110.60	56.56	167.15	129.45	63.09	57.46
26.0	3.03	117.51	56.56	174.07	136.36	65.86	57.53
27.0	3.14	124.42	56.56	180.98	143.28	68.62	57.60
28.0	3.26	131.34	56.56	187.89	150.19	71.39	57.66
29.0	3.37	138.25	56.56	194.80	157.10	74.15	57.72
30.0	3.49	145.16	56.56	201.72	164.01	76.92	57.78
31.0	3.61	152.07	56.56	208.63	170.92	79.68	57.83
32.0	3.72	158.99	56.56	215.54	177.84	82.45	57.88
33.0	3.84	165.90	56.56	222.45	184.75	85.21	57.93
34.0	3.96	172.81	56.56	229.37	191.66	87.98	57.97
35.0	4.07	179.72	56.56	236.28	198.57	90.74	58.01

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.6001E+00	0.2560E-03	0.1862E-01	0.1000E-03
0.6001E+01	0.2560E-02	0.1862E+00	0.1000E-02
0.1507E+02	0.6406E-02	0.4654E+00	0.2500E-02
0.3039E+02	0.1286E-01	0.9308E+00	0.5000E-02
0.4571E+02	0.1932E-01	0.1396E+01	0.7500E-02
0.6099E+02	0.2578E-01	0.1862E+01	0.1000E-01
0.1227E+03	0.5958E-01	0.4654E+01	0.2500E-01
0.1699E+03	0.9970E-01	0.9308E+01	0.5000E-01
0.1923E+03	0.1338E+00	0.1396E+02	0.7500E-01
0.1999E+03	0.1620E+00	0.1862E+02	0.1000E+00
0.2144E+03	0.3198E+00	0.3233E+02	0.2500E+00
0.2085E+03	0.5708E+00	0.4503E+02	0.5000E+00
0.2147E+03	0.8240E+00	0.5125E+02	0.7500E+00
0.2174E+03	0.1075E+01	0.5392E+02	0.1000E+01
0.2195E+03	0.2476E+01	0.5605E+02	0.2400E+01



Retaining Wall No. 11
Profile based on Boring RW-206



SR4 Segment 3A - REtaining WAll No. 11 - 36-in CIDH Pile

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 5.0 (C) COPYRIGHT ENSOFT,INC. 1989,1995,1998,2001,2003

SR4 Seg. 3A - Ret. Wall No. 11 - 36-in CIDH Pile

PROPOSED DEPTH = 30.0 FT

NUMBER OF LAYERS = 3

WATER TABLE DEPTH = 30.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 2.50

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 3.00

SOIL INFORMATION

LAYER NO 1----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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.000E+00

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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.400E+01

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	= 0.640E+04
DEPTH, FT	= 0.400E+01

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	= 0.650E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.400E+01

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.650E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.240E+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	= 0.800E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.240E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00

END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.800E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.400E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	=	3.000	FT.
DIAMETER OF BASE	=	3.000	FT.
END OF STEM TO BASE	=	0.000	FT.
ANGLE OF BELL	=	0.000	DEG.
IGNORED TOP PORTION	=	5.000	FT.
IGNORED BOTTOM PORTION	=	0.000	FT.
AREA OF ONE PERCENT STEEL	=	10.180	SQ.IN.
ELASTIC MODULUS, Ec	=	0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	=	0.000	CU.YDS.

PREDICTED RESULTS

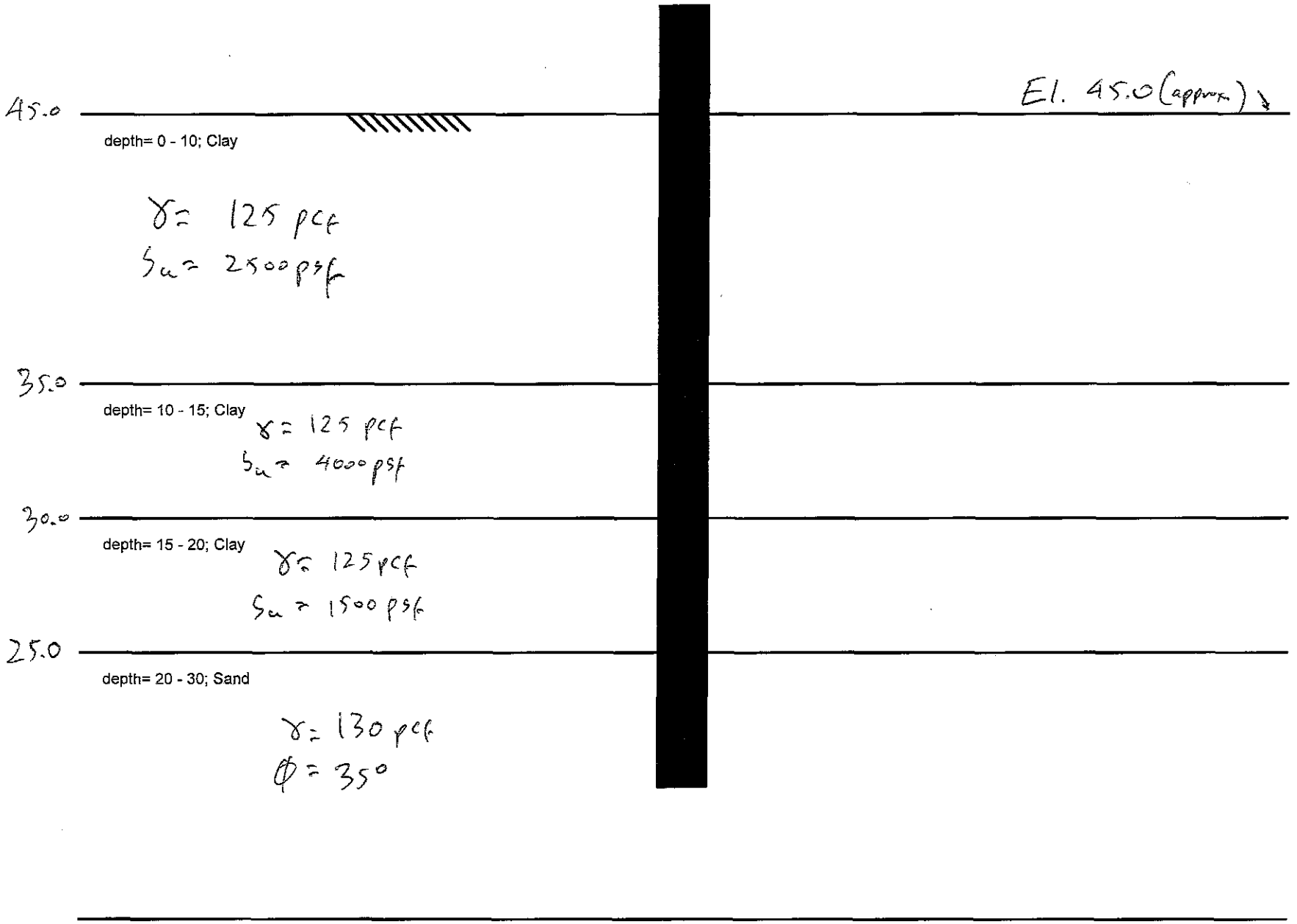
QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED 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)
6.0	1.57	16.85	206.78	223.63	85.78	75.67	142.35
7.0	1.83	33.70	206.78	240.48	102.63	82.41	131.21
8.0	2.09	50.55	206.78	257.33	119.47	89.15	122.85
9.0	2.36	67.40	206.78	274.18	136.32	95.89	116.35
10.0	2.62	84.24	206.78	291.03	153.17	102.63	111.15
11.0	2.88	101.09	206.78	307.88	170.02	109.37	106.90
12.0	3.14	117.94	206.78	324.73	186.87	116.10	103.35

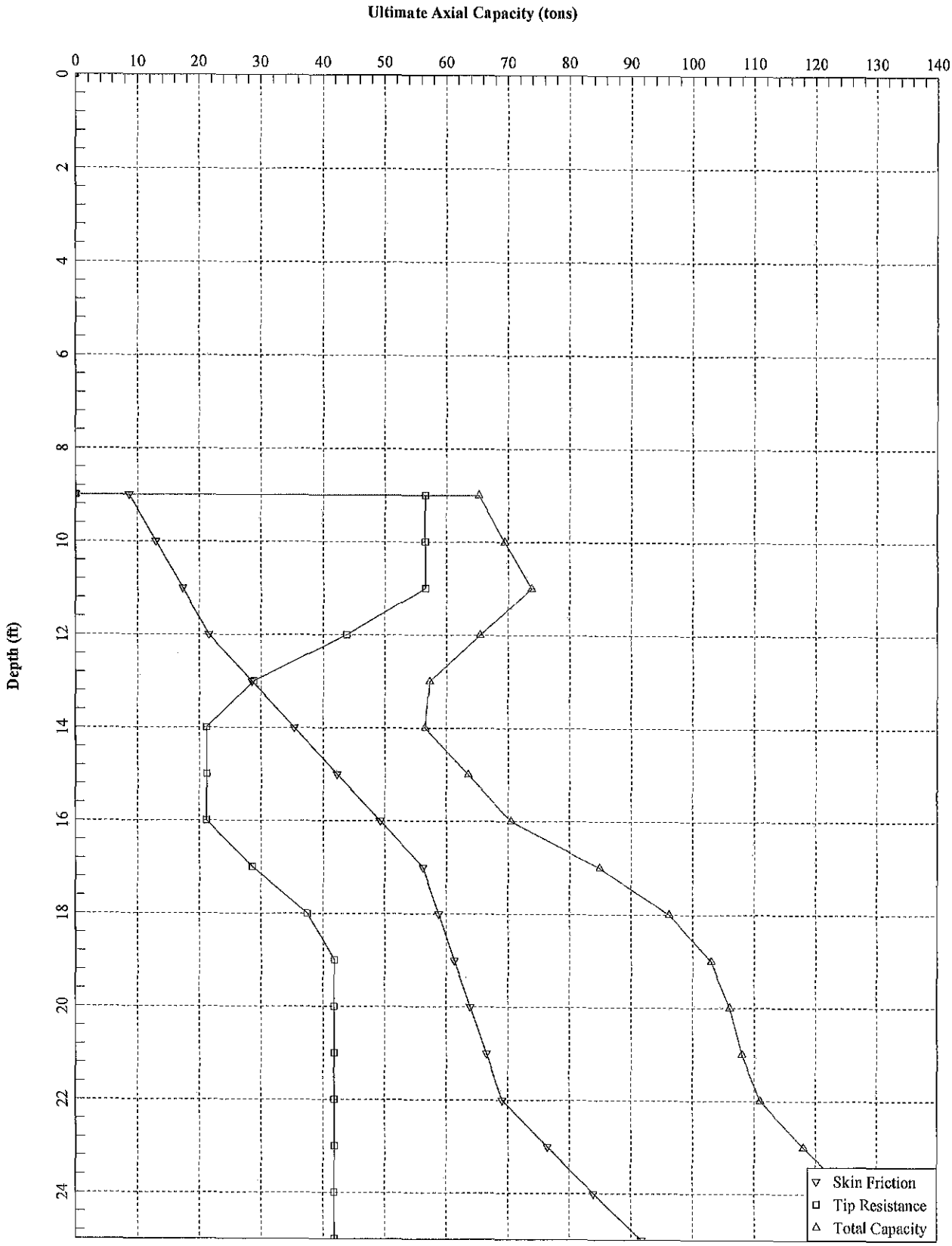
13.0	3.40	134.79	206.78	341.57	203.72	122.84	100.35
14.0	3.67	151.64	206.78	358.42	220.57	129.58	97.78
15.0	3.93	168.49	206.78	375.27	237.42	136.32	95.55
16.0	4.19	185.34	206.78	392.12	254.27	143.06	93.60
17.0	4.45	202.19	206.78	408.97	271.12	149.80	91.88
18.0	4.71	219.04	206.78	425.82	287.96	156.54	90.35
19.0	4.97	235.89	216.91	452.79	308.19	166.66	91.02
20.0	5.24	252.73	228.47	481.21	328.89	177.25	91.89
21.0	5.50	269.58	241.49	511.07	350.08	188.33	92.95
22.0	5.76	286.43	250.16	536.60	369.82	197.96	93.15
23.0	6.02	303.28	254.50	557.78	388.12	206.15	92.62
24.0	6.28	320.13	254.50	574.63	404.96	212.89	91.44
25.0	6.55	340.87	254.50	595.37	425.70	221.18	90.95
26.0	6.81	361.60	254.50	616.11	446.44	229.48	90.50
27.0	7.07	382.34	254.50	636.84	467.18	237.77	90.08
28.0	7.33	403.08	254.50	657.58	487.91	246.07	89.69
29.0	7.59	423.82	254.50	678.32	508.65	254.36	89.33
30.0	7.86	444.55	254.50	699.06	529.39	262.66	89.00

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.8916E+00	0.1963E-03	0.5585E-01	0.1000E-03
0.8916E+01	0.1963E-02	0.5585E+00	0.1000E-02
0.2229E+02	0.4907E-02	0.1396E+01	0.2500E-02
0.4491E+02	0.9830E-02	0.2792E+01	0.5000E-02
0.6757E+02	0.1477E-01	0.4189E+01	0.7500E-02
0.9023E+02	0.1970E-01	0.5585E+01	0.1000E-01
0.2215E+03	0.4917E-01	0.1396E+02	0.2500E-01
0.3377E+03	0.8866E-01	0.2792E+02	0.5000E-01
0.4218E+03	0.1242E+00	0.4189E+02	0.7500E-01
0.4784E+03	0.1577E+00	0.5585E+02	0.1000E+00
0.5664E+03	0.3230E+00	0.1169E+03	0.2500E+00
0.5993E+03	0.5813E+00	0.1702E+03	0.5000E+00
0.5970E+03	0.8338E+00	0.2026E+03	0.7500E+00
0.6195E+03	0.1088E+01	0.2251E+03	0.1000E+01
0.6466E+03	0.3693E+01	0.2522E+03	0.3600E+01



Retaining Wall No. 12
Profile based on Boring RW-206



SR4 SEgment 3A - Retaining Wall No. 12 - 24-in. CIDH PIle

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 5.0 (C) COPYRIGHT ENSOFT,INC. 1989,1995,1998,2001,2003

SR4 Seg. 3A - Ret. WAll No. 12 - 24-in Cidh Pile

PROPOSED DEPTH = 25.0 FT

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 30.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 2.50
FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 3.00

SOIL INFORMATION

LAYER NO 1----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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.000E+00

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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.100E+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	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00

SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.100E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.150E+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	= 0.150E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.150E+02

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.150E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.200E+02

LAYER NO 4----SAND

AT THE TOP

SKIN FRICTION COEFFICIENT- BETA	= 0.896E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.350E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.200E+02

AT THE BOTTOM

SKIN FRICTION COEFFICIENT- BETA	= 0.761E+00
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.000E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.350E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04

DEPTH, FT	= 0.300E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	=	2.000	FT.
DIAMETER OF BASE	=	2.000	FT.
END OF STEM TO BASE	=	0.000	FT.
ANGLE OF BELL	=	0.000	DEG.
IGNORED TOP PORTION	=	5.000	FT.
IGNORED BOTTOM PORTION	=	2.000	FT.
AREA OF ONE PERCENT STEEL	=	4.524	SQ.IN.
ELASTIC MODULUS, Ec	=	0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	=	0.000	CU.YDS.

PREDICTED RESULTS

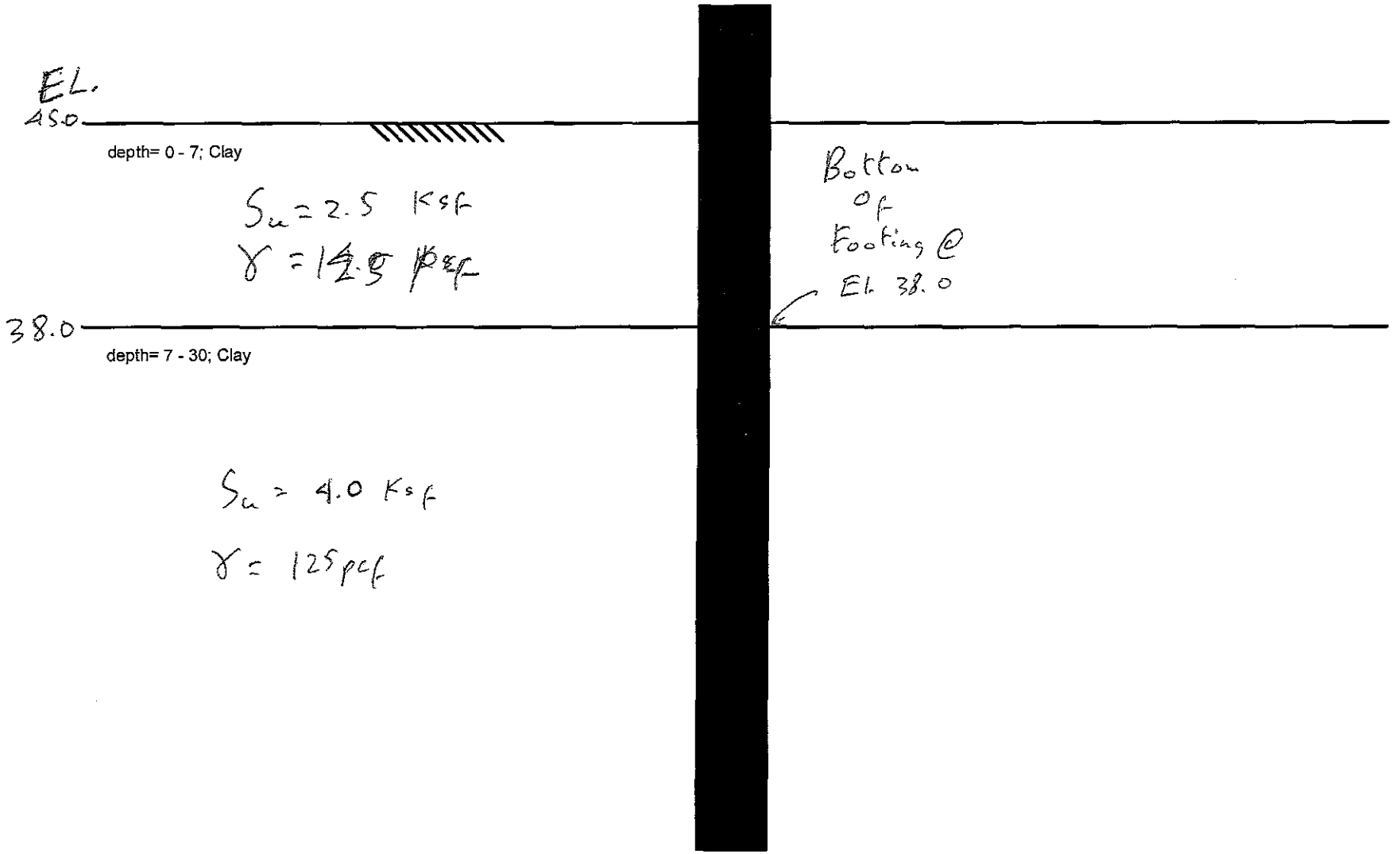
QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY APPLIED 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)
8.0	0.93	4.32	52.01	56.33	21.66	19.07	60.51
9.0	1.05	8.64	56.56	65.20	27.49	22.31	62.25
10.0	1.16	12.96	56.56	69.52	31.81	24.04	59.74
11.0	1.28	17.28	56.56	73.84	36.13	25.76	57.68
12.0	1.40	21.60	43.93	65.53	36.25	23.28	46.93
13.0	1.51	28.51	28.78	57.30	38.11	21.00	37.87
14.0	1.63	35.43	21.21	56.63	42.50	21.24	34.76
15.0	1.75	42.34	21.21	63.55	49.41	24.00	36.40
16.0	1.86	49.25	21.21	70.46	56.32	26.77	37.84
17.0	1.98	56.16	28.60	84.76	65.70	32.00	42.85
18.0	2.09	58.76	37.46	96.22	71.24	35.99	45.94
19.0	2.21	61.35	41.90	103.25	75.31	38.51	46.70
20.0	2.33	63.94	41.90	105.84	77.91	39.54	45.47
21.0	2.44	66.53	41.90	108.43	80.50	40.58	44.37
22.0	2.56	69.12	41.90	111.02	83.09	41.62	43.37
23.0	2.68	76.41	41.90	118.31	90.37	44.53	44.20
24.0	2.79	83.92	41.90	125.82	97.89	47.54	45.05
25.0	2.91	91.67	41.90	133.56	105.63	50.63	45.91

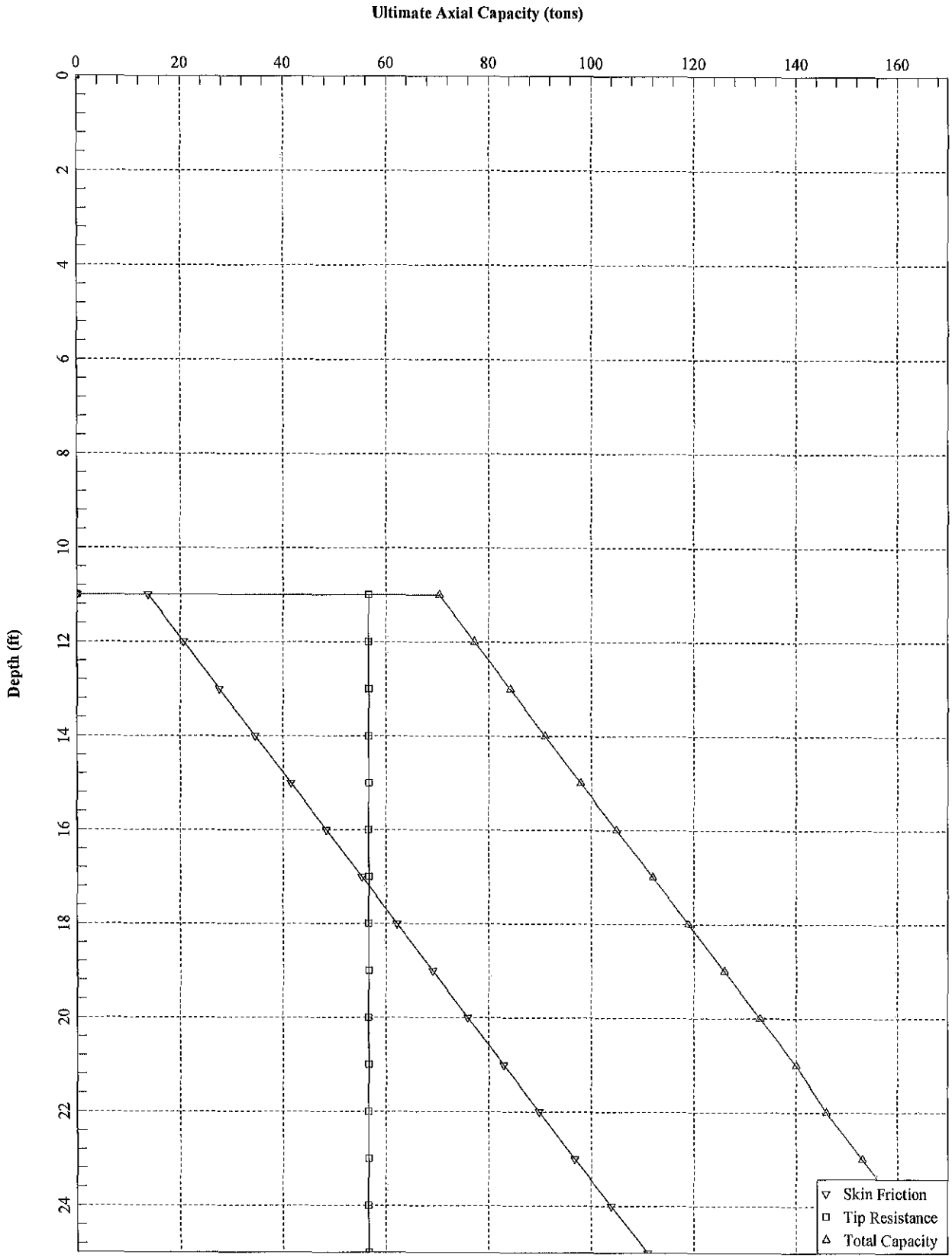
RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.1939E+00	0.1358E-03	0.6110E-02	0.1000E-03
0.1939E+01	0.1358E-02	0.6110E-01	0.1000E-02
0.4848E+01	0.3396E-02	0.1528E+00	0.2500E-02

0.9696E+01	0.6792E-02	0.3055E+00	0.5000E-02
0.1461E+02	0.1019E-01	0.4583E+00	0.7500E-02
0.1951E+02	0.1360E-01	0.6110E+00	0.1000E-01
0.4565E+02	0.3357E-01	0.1528E+01	0.2500E-01
0.6588E+02	0.6260E-01	0.3055E+01	0.5000E-01
0.7946E+02	0.9050E-01	0.4583E+01	0.7500E-01
0.8237E+02	0.1164E+00	0.6110E+01	0.1000E+00
0.9334E+02	0.2701E+00	0.1494E+02	0.2500E+00
0.9460E+02	0.5221E+00	0.2431E+02	0.5000E+00
0.1019E+03	0.7747E+00	0.3137E+02	0.7500E+00
0.1083E+03	0.1027E+01	0.3781E+02	0.1000E+01
0.1316E+03	0.2436E+01	0.6117E+02	0.2400E+01



Retaining Wall No. 14
Profile based on Boring 192A



SR4 Segment 3A - Retaining WAll No. 14 - 24-in. CIDH PIle

VERTICALLY LOADED DRILLED SHAFT ANALYSIS PROGRAM SHAFT
VERSION 5.0 (C) COPYRIGHT ENSOFT,INC. 1989,1995,1998,2001,2003

SR4 Seg. 3A - Ret. Wall No. 14 - 24-in Cidh Pile

PROPOSED DEPTH = 25.0 FT

NUMBER OF LAYERS = 2

WATER TABLE DEPTH = 30.0 FT.

FACTOR OF SAFETY APPLIED TO THE TOTAL ULTIMATE CAPACITY = 2.50

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 3.00

SOIL INFORMATION

LAYER NO 1----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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.000E+00

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	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.700E+01

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	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00

SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.700E+01

AT THE BOTTOM

STRENGTH REDUCTION FACTOR-ALPHA	= 0.550E+00
END BEARING COEFFICIENT-Nc	= 0.900E+01
UNDRAINED SHEAR STRENGTH, LB/SQ FT	= 0.400E+04
INTERNAL FRICTION ANGLE, DEG.	= 0.000E+00
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.640E+04
DEPTH, FT	= 0.300E+02

DRILLED SHAFT INFORMATION

DIAMETER OF STEM	=	2.000	FT.
DIAMETER OF BASE	=	2.000	FT.
END OF STEM TO BASE	=	0.000	FT.
ANGLE OF BELL	=	0.000	DEG.
IGNORED TOP PORTION	=	7.000	FT.
IGNORED BOTTOM PORTION	=	2.000	FT.
AREA OF ONE PERCENT STEEL	=	4.524	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)
10.0	1.16	6.91	56.56	63.47	25.76	21.62	54.54
11.0	1.28	13.82	56.56	70.38	32.68	24.38	54.98
12.0	1.40	20.74	56.56	77.29	39.59	27.15	55.35
13.0	1.51	27.65	56.56	84.21	46.50	29.91	55.66
14.0	1.63	34.56	56.56	91.12	53.41	32.68	55.93
15.0	1.75	41.47	56.56	98.03	60.33	35.44	56.16
16.0	1.86	48.39	56.56	104.94	67.24	38.21	56.36
17.0	1.98	55.30	56.56	111.86	74.15	40.97	56.54
18.0	2.09	62.21	56.56	118.77	81.06	43.74	56.70
19.0	2.21	69.12	56.56	125.68	87.98	46.50	56.84
20.0	2.33	76.04	56.56	132.59	94.89	49.27	56.97
21.0	2.44	82.95	56.56	139.50	101.80	52.03	57.09
22.0	2.56	89.86	56.56	146.42	108.71	54.80	57.19
23.0	2.68	96.77	56.56	153.33	115.63	57.56	57.29

24.0	2.79	103.69	56.56	160.24	122.54	60.33	57.38
25.0	2.91	110.60	56.56	167.15	129.45	63.09	57.46

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD ton	TOP MOVEMENT IN.	TIP LOAD ton	TIP MOVEMENT IN.
0.3248E+00	0.1672E-03	0.1862E-01	0.1000E-03
0.3248E+01	0.1672E-02	0.1862E+00	0.1000E-02
0.8121E+01	0.4179E-02	0.4654E+00	0.2500E-02
0.1640E+02	0.8375E-02	0.9308E+00	0.5000E-02
0.2469E+02	0.1258E-01	0.1396E+01	0.7500E-02
0.3295E+02	0.1678E-01	0.1862E+01	0.1000E-01
0.7415E+02	0.4077E-01	0.4654E+01	0.2500E-01
0.1073E+03	0.7330E-01	0.9308E+01	0.5000E-01
0.1277E+03	0.1036E+00	0.1396E+02	0.7500E-01
0.1340E+03	0.1307E+00	0.1862E+02	0.1000E+00
0.1495E+03	0.2862E+00	0.3233E+02	0.2500E+00
0.1499E+03	0.5383E+00	0.4503E+02	0.5000E+00
0.1561E+03	0.7906E+00	0.5125E+02	0.7500E+00
0.1587E+03	0.1042E+01	0.5392E+02	0.1000E+01
0.1609E+03	0.2442E+01	0.5605E+02	0.2400E+01

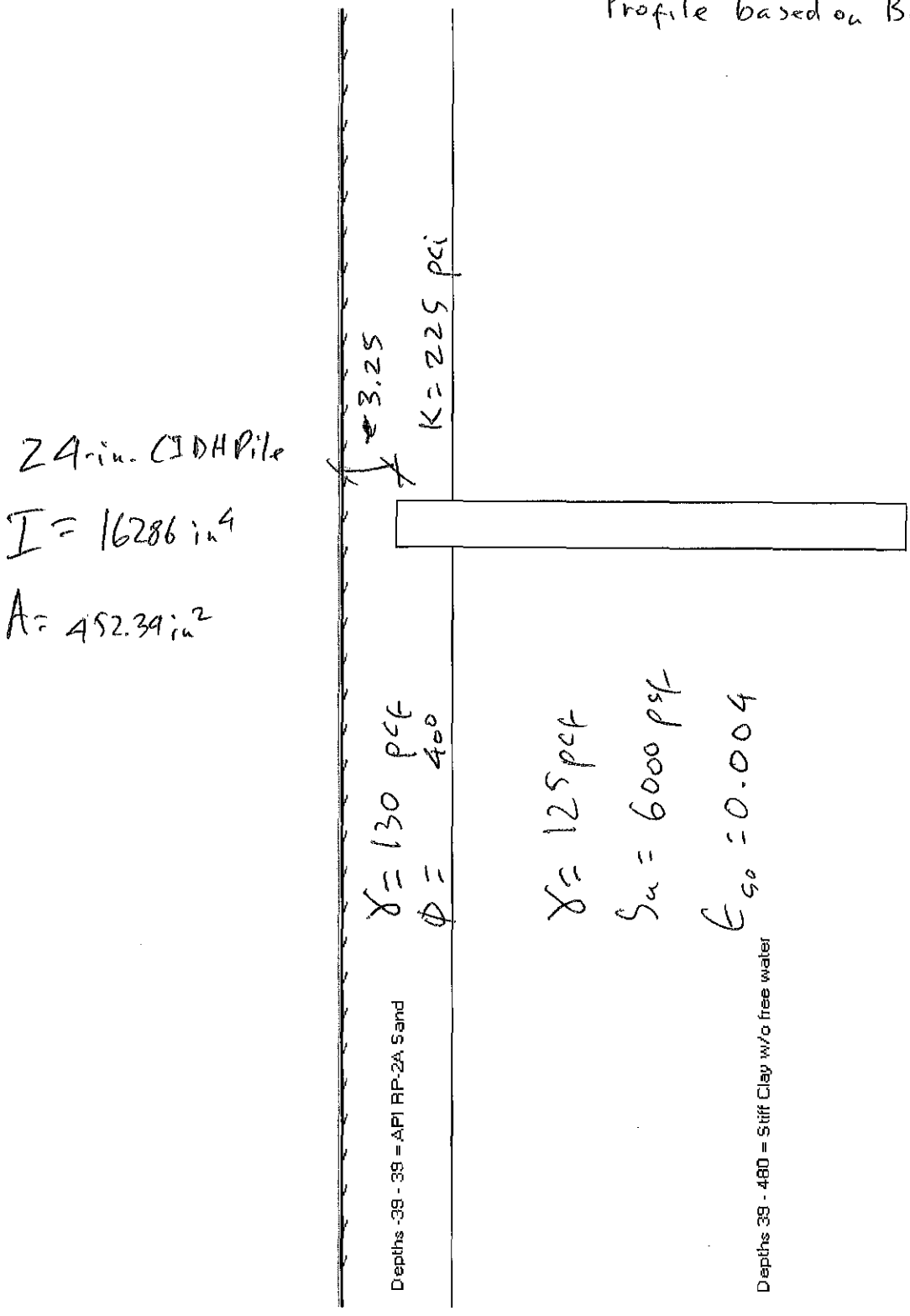
CIDH Pile

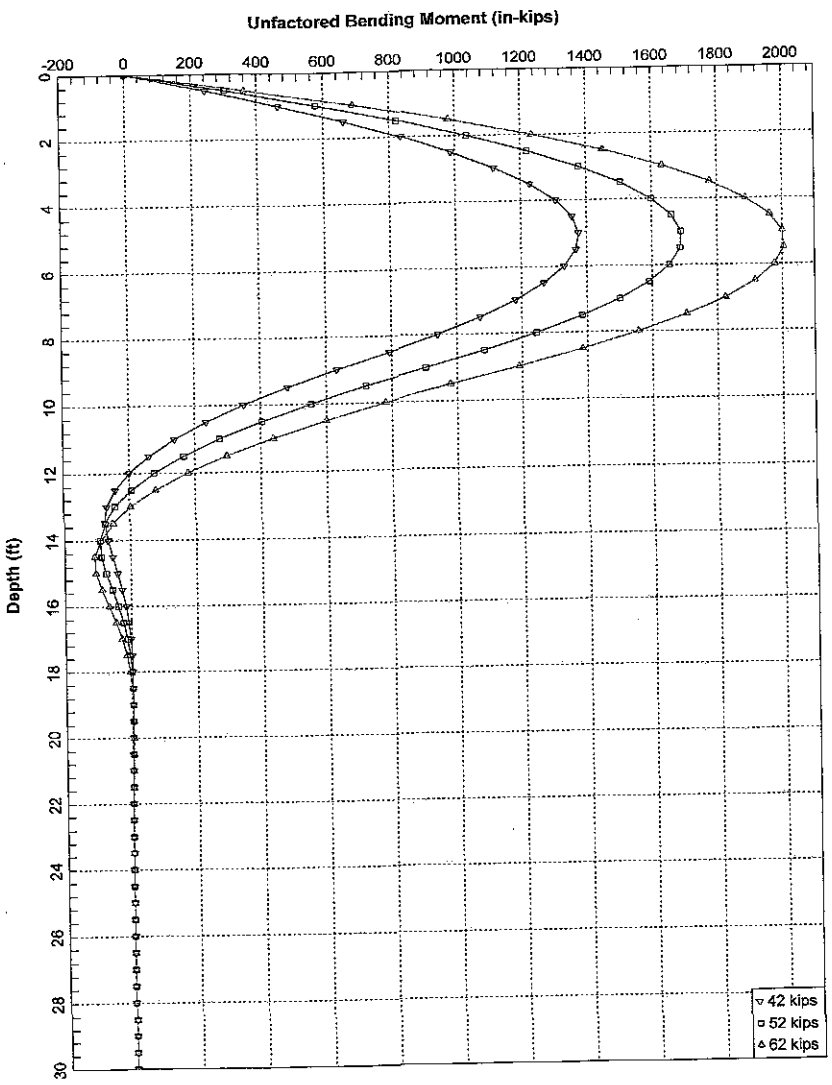
LATERAL PILE BEHAVIOR

LPILE Program

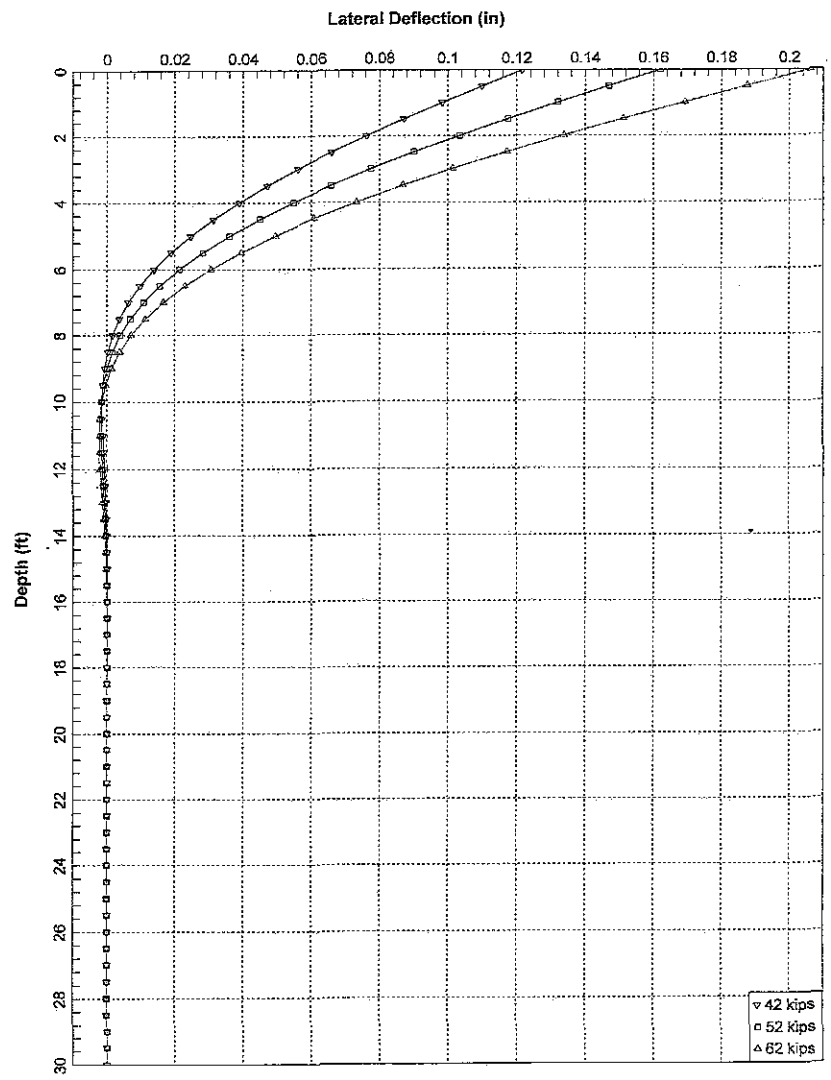
Retaining Wall No. 3

Profile based on Boring RW-189





SR4 - Segment 3A = Retaining Wall No. 3 - 24-in. CIDH Pile



SR4 - Segment 3A - Retaining WAll No. 3 - 24-in. CIDH Pile

LPILE Plus for Windows, Version 5.0 (5.0.21)

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:

Gary Parikh
Parikh Consultants

Path to file locations: S:\Ongoing Projects\2006\206117 TYLIn Rte 4 Project\Retaining and Sound Walls\LPILE\
Name of input data file: Retaining Wall No. 3.lpd
Name of output file: Retaining Wall No. 3.lpo
Name of plot output file: Retaining Wall No. 3.lpp
Name of runtime file: Retaining Wall No. 3.lpr

Time and Date of Analysis

Date: July 16, 2009 Time: 15:40: 3

Problem Title

SR4- Segment 3A - Retaining WAll No. 3 - 24-in. CIDH PIle

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant 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 pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 60
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 360.00 in
Depth of ground surface below top of pile = -39.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	24.00000000	16286.0000	452.3900	3600000.
2	360.0000	24.00000000	16286.0000	452.3900	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = -39.000 in
Distance from top of pile to bottom of layer = 39.000 in
p-y subgrade modulus k for top of soil layer = 225.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 225.000 lbs/in**3

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 39.000 in
Distance from top of pile to bottom of layer = 480.000 in

(Depth of lowest layer extends 120.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth is defined using 4 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-39.00	.07520
2	39.00	.07520
3	39.00	.07230
4	480.00	.07230

Shear Strength of Soils

Distribution of shear strength parameters with depth defined using 4 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-39.000	.00000	40.00	------	------
2	39.000	.00000	49.00	------	------
3	39.000	41.67000	.00	.00400	.0
4	480.000	41.67000	.00	.00400	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.6000	1.0000
2	360.000	.6000	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 3

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 42000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 140000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 52000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 280000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 62000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 280000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

**** WARNING ****

An unreasonable value was input for friction angle has been specified for a soil layer defined uisng the API sand criteria. The input value is either smaller than 20 degrees or higher than 48 degrees. The input data should be checked for correctness.

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 42000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 140000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.121632	-1.8081E-07	42000.0000	-.0019487	309.4675	-586.4041
6.000	.109940	243082.	38370.3941	-.0019363	488.5772	-623.4646
12.000	.098396	463698.	34576.7294	-.0019001	651.1335	-641.0903
18.000	.087138	661195.	30731.9691	-.0018426	796.6550	-640.4964
24.000	.076286	835577.	26940.4698	-.0017660	925.1449	-623.3367
30.000	.065946	987447.	23269.8902	-.0016727	1037.0473	-600.1899
36.000	.056213	1117626.	19784.0957	-.0015650	1132.9667	-561.7416
42.000	.047166	1227485.	15559.9465	-.0014450	1213.0146	-846.3081
48.000	.038873	1306773.	10524.4734	-.0013153	1272.3357	-832.1829
54.000	.031383	1355989.	5588.0454	-.0011791	1308.5996	-813.2930
60.000	.024725	1375810.	780.3051	-.0010393	1323.2044	-789.2871
66.000	.018911	1367099.	-3866.6712	-.0008989	1316.7856	-759.7050
72.000	.013937	1330920.	-8317.4930	-.0007609	1290.1283	-723.9023
78.000	.009781	1268567.	-12531.8821	-.0006279	1244.1846	-680.8941
84.000	.006403	1181592.	-16461.5509	-.0005025	1180.0992	-628.9955
90.000	.003751	1071872.	-20043.0012	-.0003872	1099.2544	-564.8213
96.000	.001757	941727.	-23176.0284	-.0002842	1003.3593	-479.5211
102.000	.000341	794237.	-25874.5404	-.0001953	894.6848	-419.9829
108.000	-.000587	631560.	-25992.6096	-.0001224	774.8197	380.8265
114.000	-.001127	482532.	-23471.9573	-6.5363E-05	665.0110	459.5909
120.000	-.001371	350007.	-20611.0363	-2.2763E-05	567.3627	494.0495
126.000	-.001401	235238.	-17605.0107	7.1834E-06	482.7974	507.9591
132.000	-.001285	138735.	-14556.5929	2.6319E-05	411.6912	508.1802

138.000	-.001085	60514.2108	-11539.2004	3.6514E-05	354.0561	497.6173
144.000	-.000847	202.8470	-8613.3272	3.9621E-05	309.6170	477.6738
150.000	-.000609	-42912.2789	-5833.2899	3.7436E-05	341.0865	449.0053
156.000	-.000398	-69859.5235	-2695.4696	3.1655E-05	360.9420	596.9347
162.000	-.000228	-75311.1123	148.0889	2.4237E-05	364.9589	350.9181
168.000	-.000107	-68123.1748	1701.7816	1.6898E-05	359.6626	166.9795
174.000	-2.66E-05	-54918.3210	2329.4442	1.0602E-05	349.9328	42.2414
180.000	2.02E-05	-40187.6554	2358.1165	5.7355E-06	339.0789	-32.6840
186.000	4.23E-05	-26630.3586	2050.9725	2.3165E-06	329.0895	-69.6973
192.000	4.80E-05	-15579.8771	1600.1732	1.5669E-07	320.9472	-80.5691
198.000	4.41E-05	-7428.5431	1132.1690	-1.0206E-06	314.9411	-75.4323
204.000	3.57E-05	-1992.1341	719.4688	-1.5027E-06	310.9354	-62.1344
210.000	2.61E-05	1207.6071	394.5512	-1.5428E-06	310.3573	-46.1714
216.000	1.72E-05	2745.0728	163.1340	-1.3406E-06	311.4901	-30.9677
222.000	1.00E-05	3167.4670	15.2844	-1.0380E-06	311.8014	-18.3156
228.000	4.76E-06	2930.2290	-66.2062	-7.2601E-07	311.6266	-8.8480
234.000	1.30E-06	2374.2122	-100.1419	-4.5458E-07	311.2169	-2.4639
240.000	-6.94E-07	1729.2898	-103.5427	-2.4461E-07	310.7417	1.3303
246.000	-1.63E-06	1132.1102	-90.0249	-9.8199E-08	310.3017	3.1756
252.000	-1.87E-06	649.1560	-69.3917	-7.0543E-09	309.9458	3.7021
258.000	-1.72E-06	299.4218	-48.0840	4.1483E-08	309.6881	3.4005
264.000	-1.37E-06	72.0785	-29.7085	6.0492E-08	309.5206	2.7247
270.000	-9.89E-07	-57.1820	-15.6509	6.1255E-08	309.5096	1.9612
276.000	-6.39E-07	-115.8352	-5.9655	5.2402E-08	309.5528	1.2673
282.000	-3.60E-07	-128.8562	-.0204579	3.9881E-08	309.5624	.7144039
288.000	-1.61E-07	-116.1477	3.0780	2.7344E-08	309.5531	.3184024
294.000	-3.22E-08	-91.9666	4.2246	1.6696E-08	309.5353	.0638043
300.000	3.98E-08	-65.4807	4.1795	8.6391E-09	309.5157	-.0788297
306.000	7.15E-08	-41.8271	3.5178	3.1483E-09	309.4983	-.1417444
312.000	7.75E-08	-23.2725	2.6313	-1.8274E-10	309.4846	-.1537371
318.000	6.93E-08	-10.2507	1.7579	-1.8981E-09	309.4750	-.1373966
324.000	5.48E-08	-2.1742	1.0200	-2.5339E-09	309.4691	-.1085764
330.000	3.89E-08	1.9938	.4629614	-2.5431E-09	309.4690	-.0771092
336.000	2.42E-08	3.3856	.0874258	-2.2678E-09	309.4700	-.0480693
342.000	1.17E-08	3.0467	-.1262358	-1.9387E-09	309.4697	-.0231512
348.000	9.80E-10	1.8740	-.2015162	-1.6869E-09	309.4689	-.0019423
354.000	-8.87E-09	.6313098	-.1563875	-1.5587E-09	309.4680	.0169852
360.000	-1.77E-08	0.0000	0.0000	-1.5264E-09	309.4675	.0351440

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	.12163190 in
Computed slope at pile head	=	-.00194873
Maximum bending moment	=	1375810. lbs-in
Maximum shear force	=	42000.00000 lbs
Depth of maximum bending moment	=	60.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	14
Number of zero deflection points	=	5

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)

Specified shear force at pile head = 52000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 280000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope s Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.162093	4.0682E-07	52000.0000	-.0025122	618.9350	-734.9102
6.000	.147020	302992.	47415.7057	-.0024967	842.1885	-793.1880
12.000	.132133	577377.	42558.1888	-.0024517	1044.3636	-825.9843
18.000	.117600	821928.	37577.5612	-.0023801	1224.5556	-834.2249
24.000	.103572	1036305.	32616.2106	-.0022850	1382.5149	-819.5586
30.000	.090180	1221000.	27743.0968	-.0021695	1518.6035	-804.8126
36.000	.077538	1376512.	23031.0324	-.0020366	1633.1891	-765.8755
42.000	.065741	1504215.	17974.8470	-.0018892	1727.2848	-919.5196
48.000	.054868	1598558.	12495.2510	-.0017304	1796.7990	-907.0124
54.000	.044976	1659973.	7104.8081	-.0015637	1842.0513	-889.8019
60.000	.036104	1689069.	1832.6751	-.0013923	1863.4906	-867.5758
66.000	.028268	1686643.	-3289.8691	-.0012196	1861.7027	-839.9390
72.000	.021469	1653689.	-8228.7736	-.0010487	1837.4211	-806.3625
78.000	.015684	1591421.	-12946.1175	-.0008826	1791.5405	-766.0854
84.000	.010877	1501301.	-17398.0953	-.0007244	1725.1373	-717.9072
90.000	.006992	1385078.	-21530.8864	-.0005767	1639.5008	-659.6898
96.000	.003957	1244868.	-25270.6221	-.0004421	1536.1900	-586.8888
102.000	.001687	1083316.	-28490.2434	-.0003230	1417.1537	-486.3183
108.000	8.17E-05	904070.	-30258.3384	-.0002213	1285.0802	-103.0466
114.000	-.000968	720959.	-29240.1170	-.0001381	1150.1588	442.4538
120.000	-.001576	553653.	-26377.7344	-7.2905E-05	1026.8825	511.6737
126.000	-.001843	404671.	-23209.9247	-2.3869E-05	917.1087	544.2628
132.000	-.001862	275214.	-19903.8743	1.0920E-05	821.7206	557.7540
138.000	-.001712	165788.	-16556.6765	3.3485E-05	741.0926	557.9787
144.000	-.001460	76421.2829	-13240.0632	4.5879E-05	675.2444	547.5591
150.000	-.001162	6753.3210	-10013.9774	5.0135E-05	623.9110	527.8028
156.000	-.000859	-43914.8997	-6932.6251	4.8233E-05	651.2928	499.3146
162.000	-.000583	-76600.2439	-4048.1161	4.2067E-05	675.3763	462.1884
168.000	-.000354	-92633.6368	-1004.8914	3.3407E-05	687.1902	552.2198
174.000	-.000182	-88771.1897	1519.7766	2.4125E-05	684.3442	289.3362
180.000	-6.45E-05	-74477.3775	2701.1931	1.5772E-05	673.8121	104.4693
186.000	7.26E-06	-56409.8664	2978.6648	9.0745E-06	660.4994	-11.9787
192.000	4.44E-05	-38763.8899	2719.0964	4.2046E-06	647.4974	-74.5441
198.000	5.77E-05	-23794.8372	2199.5290	1.0035E-06	636.4677	-98.6450
204.000	5.64E-05	-12372.9136	1609.1916	-8.4711E-07	628.0517	-98.1342
210.000	4.76E-05	-4481.6922	1062.4626	-1.7095E-06	622.2372	-84.1088
216.000	3.59E-05	382.3813	616.3238	-1.9193E-06	619.2167	-64.6041
222.000	2.45E-05	2920.6426	288.0082	-1.7503E-06	621.0870	-44.8345
228.000	1.49E-05	3844.3611	70.3531	-1.4041E-06	621.7676	-27.7173
234.000	7.67E-06	3769.5977	-56.2503	-1.0145E-06	621.7125	-14.4839
240.000	2.74E-06	3172.7669	-115.4744	-6.5930E-07	621.2728	-5.2575
246.000	-2.40E-07	2386.1196	-129.8419	-3.7486E-07	620.6932	.4683905
252.000	-1.76E-06	1615.9242	-118.0124	-1.7008E-07	620.1256	3.4748
258.000	-2.28E-06	970.5421	-94.0179	-3.7732E-08	619.6501	4.5234
264.000	-2.21E-06	487.8363	-67.3031	3.6892E-08	619.2944	4.3815
270.000	-1.84E-06	162.7804	-43.2217	7.0183E-08	619.0549	3.6457
276.000	-1.37E-06	-31.0595	-24.1497	7.6923E-08	618.9579	2.7117
282.000	-9.16E-07	-127.2745	-10.5684	6.8821E-08	619.0288	1.8155
288.000	-5.42E-07	-158.1110	-1.8993	5.4218E-08	619.0515	1.0742
294.000	-2.65E-07	-150.2487	2.8997	3.8440E-08	619.0457	.5254588
300.000	-8.05E-08	-123.4440	4.9549	2.4435E-08	619.0259	.1596234
306.000	2.82E-08	-90.8717	5.2660	1.3469E-08	619.0019	-.0559258
312.000	8.11E-08	-60.2970	4.6157	5.7340E-09	618.9794	-.1608438
318.000	9.70E-08	-35.5024	3.5561	8.3206E-10	618.9611	-.1923534

324.000	9.11E-08	-17.6264	2.4371	-1.8865E-09	618.9480	-.1806409
330.000	7.44E-08	-6.2505	1.4528	-3.1082E-09	618.9396	-.1474691
336.000	5.38E-08	-.1823014	.6903352	-3.4374E-09	618.9351	-.1066878
342.000	3.31E-08	2.0451	.1732180	-3.3421E-09	618.9365	-.0656846
348.000	1.37E-08	1.9075	-.1053491	-3.1398E-09	618.9364	-.0271711
354.000	-4.55E-09	.7914804	-.1598025	-3.0017E-09	618.9356	.0090200
360.000	-2.23E-08	0.0000	0.0000	-2.9612E-09	618.9350	.0442475

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

Pile-head deflection	=	.16209340 in
Computed slope at pile head	=	-.00251223
Maximum bending moment	=	1689069. lbs-in
Maximum shear force	=	52000.00000 lbs
Depth of maximum bending moment	=	60.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	15
Number of zero deflection points	=	5

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 62000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 280000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope s Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.206215	-3.6162E-07	62000.0000	-.0031021	618.9350	-864.3747
6.000	.187603	361653.	56562.6197	-.0030836	885.4113	-948.0854
12.000	.169212	689112.	50716.2563	-.0030298	1126.6931	-1000.7024
18.000	.151245	980428.	44647.9186	-.0029444	1341.3431	-1022.0769
24.000	.133879	1234781.	38542.0628	-.0028311	1528.7574	-1013.2084
30.000	.117272	1452445.	32449.8150	-.0026936	1689.1391	-1017.5409
36.000	.101556	1633229.	26439.1596	-.0025357	1822.3456	-986.0109
42.000	.086844	1778235.	20523.8147	-.0023611	1929.1905	-985.7707
48.000	.073223	1887448.	14641.9830	-.0021735	2009.6617	-974.8399
54.000	.060761	1961242.	8839.6616	-.0019766	2064.0353	-959.2673
60.000	.049503	2000165.	3145.5390	-.0017739	2092.7152	-938.7736
66.000	.039474	2004949.	-2409.8317	-.0015690	2096.2398	-913.0166
72.000	.030676	1976519.	-7793.5498	-.0013653	2075.2919	-881.5561
78.000	.023091	1916014.	-12969.5879	-.0011661	2030.7097	-843.7899
84.000	.016683	1824802.	-17897.4471	-.0009747	1963.5024	-798.8298
90.000	.011395	1704519.	-22529.6285	-.0007941	1874.8743	-745.2306
96.000	.007154	1557115.	-26806.2514	-.0006272	1766.2625	-680.3104
102.000	.003869	1384951.	-30641.1976	-.0004766	1639.4076	-598.0050
108.000	.001434	1191022.	-33869.9934	-.0003448	1496.5146	-478.2603
114.000	-.000269	979670.	-34261.8916	-.0002338	1340.7845	347.6276
120.000	-.001371	780664.	-31736.5310	-.0001437	1194.1514	494.1593

126.000	-.001993	599314.	-28588.7485	-7.3073E-05	1060.5274	555.1015
132.000	-.002248	437845.	-25169.2604	-2.0003E-05	941.5520	584.7278
138.000	-.002233	297351.	-21625.7938	1.7616E-05	838.0316	586.4278
144.000	-.002036	178276.	-18051.0656	4.1953E-05	750.2942	595.1483
150.000	-.001730	80596.7985	-14516.0321	5.5199E-05	678.3211	583.1962
156.000	-.001374	3898.4752	-11081.3005	5.9523E-05	621.8075	561.7143
162.000	-.001016	-52578.8036	-7802.6176	5.7032E-05	657.6766	531.1800
168.000	-.000690	-89924.5629	-4734.4127	4.9740E-05	685.1940	491.5550
174.000	-.000419	-109559.	-1262.1262	3.9533E-05	699.6612	665.8738
180.000	-.000215	-105203.	1781.5445	2.8544E-05	696.4516	348.6830
186.000	-7.63E-05	-88276.2558	3205.2761	1.8644E-05	683.9795	125.8941
192.000	8.43E-06	-66802.2377	3540.4659	1.0709E-05	668.1568	-14.1642
198.000	5.22E-05	-45826.6459	3230.4455	4.9455E-06	652.7014	-89.1759
204.000	6.78E-05	-28053.5086	2609.3186	1.1651E-06	639.6056	-117.8664
210.000	6.62E-05	-14518.7371	1904.6601	-1.0132E-06	629.6328	-117.0198
216.000	5.56E-05	-5194.1828	1253.4742	-2.0219E-06	622.7622	-100.0422
222.000	4.19E-05	529.7465	723.5348	-2.2606E-06	619.3253	-76.6043
228.000	2.85E-05	3495.8309	334.8666	-2.0546E-06	621.5108	-52.9518
234.000	1.72E-05	4555.0496	78.3534	-1.6426E-06	622.2913	-32.5526
240.000	8.78E-06	4441.5914	-69.8429	-1.1823E-06	622.2077	-16.8462
246.000	3.05E-06	3720.9068	-138.2231	-7.6463E-07	621.6767	-5.9472
252.000	-3.92E-07	2785.4831	-153.7386	-4.3171E-07	620.9874	.7753852
258.000	-2.13E-06	1877.4944	-138.7598	-1.9311E-07	620.3184	4.2176
264.000	-2.71E-06	1121.0147	-109.9912	-3.9678E-08	619.7610	5.3720
270.000	-2.60E-06	557.7328	-78.3905	4.6221E-08	619.3459	5.1616
276.000	-2.15E-06	180.1728	-50.0890	8.3979E-08	619.0677	4.2722
282.000	-1.60E-06	-43.6178	-27.7818	9.0966E-08	618.9671	3.1635
288.000	-1.06E-06	-153.5144	-11.9676	8.0879E-08	619.0481	2.1079
294.000	-6.25E-07	-187.5004	-1.9264	6.3430E-08	619.0731	1.2392
300.000	-3.02E-07	-176.8439	3.5873	4.4787E-08	619.0653	.5987231
306.000	-8.75E-08	-144.6030	5.9042	2.8339E-08	619.0415	.1735700
312.000	3.81E-08	-106.0887	6.1983	1.5511E-08	619.0132	-.0755370
318.000	9.86E-08	-70.2755	5.3852	6.4870E-09	618.9868	-.1954870
324.000	1.16E-07	-41.4877	4.1091	7.6822E-10	618.9656	-.2298805
330.000	1.08E-07	-20.9685	2.7782	-2.4276E-09	618.9504	-.2137651
336.000	8.68E-08	-8.1412	1.6205	-3.9171E-09	618.9410	-.1721217
342.000	6.08E-08	-1.5089	.7424675	-4.4109E-09	618.9361	-.1205669
348.000	3.39E-08	.7832355	.1792414	-4.4480E-09	618.9356	-.0671751
354.000	7.43E-09	.6569373	-.0664944	-4.3743E-09	618.9355	-.0147368
360.000	-1.86E-08	0.0000	0.0000	-4.3407E-09	618.9350	.0369016

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

Pile-head deflection	=	.20621543 in
Computed slope at pile head	=	-.00310212
Maximum bending moment	=	2004949. lbs-in
Maximum shear force	=	62000.00000 lbs
Depth of maximum bending moment	=	66.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	19
Number of zero deflection points	=	5

Summary of Pile Response(s)

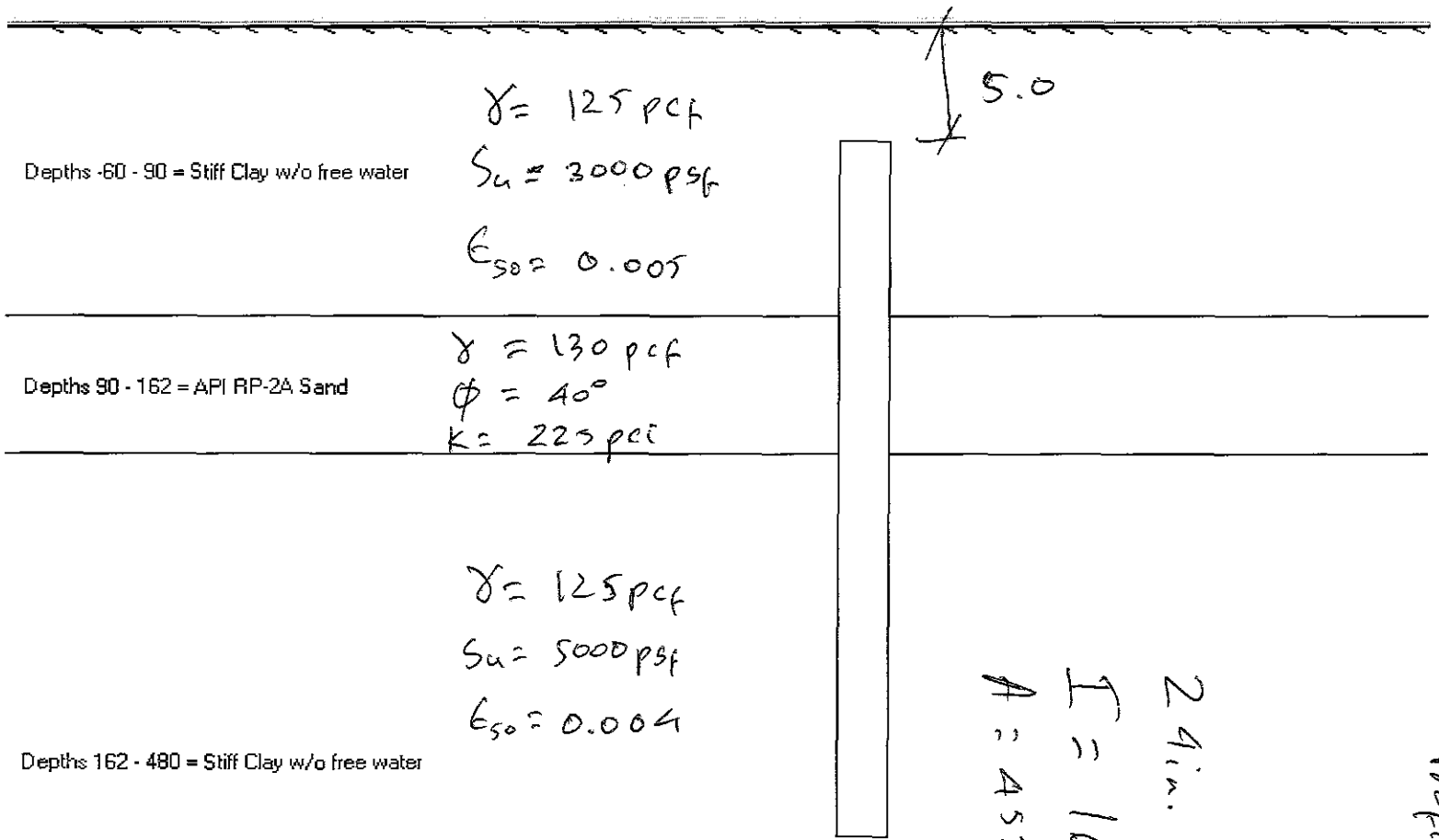
Retaining Wall No. 3.lpo

Definition of Symbols for Pile-Head Loading Conditions:

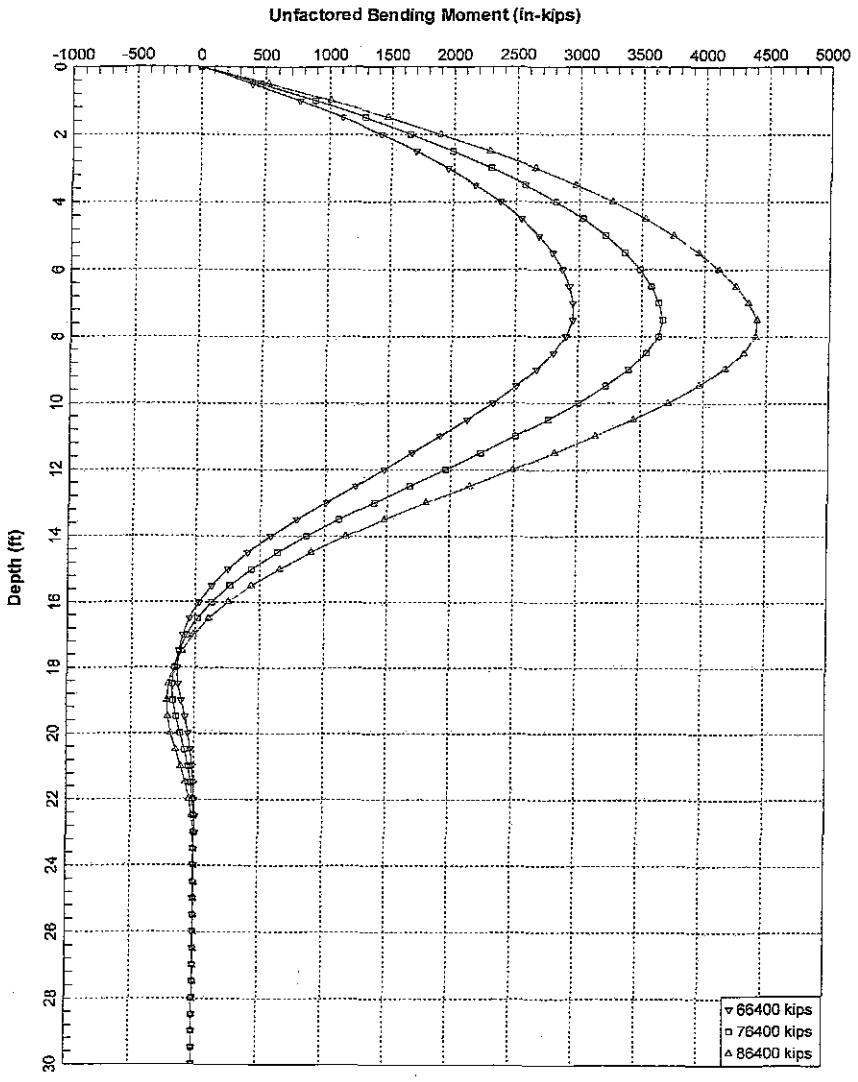
Type 1 = Shear and Moment, Y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 42000. M=	0.000	140000.	.1216319	1375810.	42000.0000
1	V= 52000. M=	0.000	280000.	.1620934	1689069.	52000.0000
1	V= 62000. M=	0.000	280000.	.2062154	2004949.	62000.0000

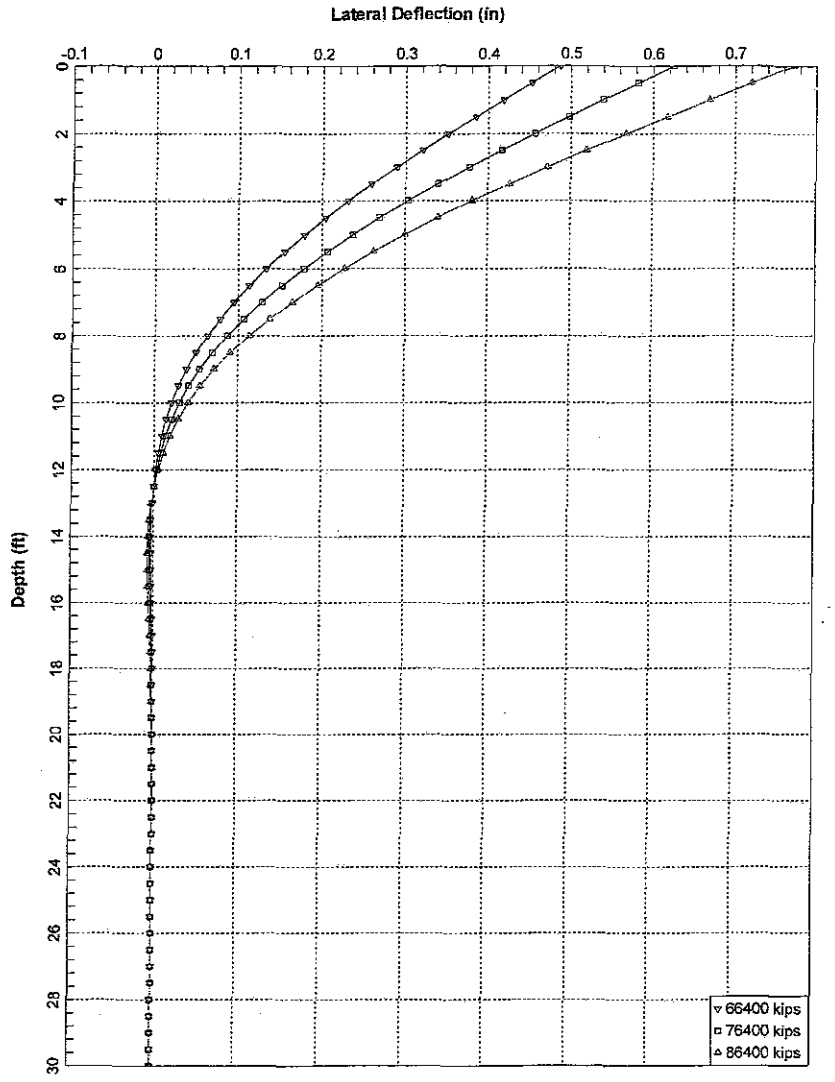
Retaining Wall No. 4
Profile based on Boring RW-202



24 in. CIDH Pile
I = 16286 in⁴
A = 452.39 in²



SR4 Segment 3A - Retaining WAll No. 4 - 24-in. CIDH Pile



SR4 Segment 3A - Retaining Wall No. 4 - 24-in. CIDH Pile

LPILE Plus for Windows, Version 5.0 (5.0.21)

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:

Gary Parikh
Parikh Consultants

Path to file locations: S:\Ongoing Projects\2006\206117 TYLIn Rte 4 Project\Retaining and Sound Walls\LPILE\
Name of input data file: Retaining Wall No. 4.lpd
Name of output file: Retaining Wall No. 4.lpo
Name of plot output file: Retaining Wall No. 4.lpp
Name of runtime file: Retaining Wall No. 4.lpr

Time and Date of Analysis

Date: July 14, 2009 Time: 20: 3:22

Problem Title

SR4- Segment 3A - Retaining Wall No. 10 - 24-in. CIDH PIle

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant 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 pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 60
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 360.00 in
Depth of ground surface below top of pile = -60.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	24.00000000	16286.0000	452.3900	3600000.
2	360.0000	24.00000000	16286.0000	452.3900	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 3 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -60.000 in
Distance from top of pile to bottom of layer = 90.000 in

Layer 2 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 90.000 in
Distance from top of pile to bottom of layer = 162.000 in
p-y subgrade modulus k for top of soil layer = 225.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 225.000 lbs/in**3

Layer 3 is stiff clay without free water
Distance from top of pile to top of layer = 162.000 in
Distance from top of pile to bottom of layer = 480.000 in

(Depth of lowest layer extends 120.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth is defined using 6 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-60.00	.07230
2	90.00	.07230
3	90.00	.07520
4	162.00	.07520
5	162.00	.07230
6	480.00	.07230

Shear Strength of Soils

Distribution of shear strength parameters with depth defined using 6 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction deg.	E50 or k_rm	RQD %
1	-60.000	20.83000	.00	.00500	.0
2	90.000	20.83000	.00	.00500	.0
3	90.000	.00000	40.00	------	------
4	162.000	.00000	40.00	------	------
5	162.000	34.72000	.00	.00400	.0
6	480.000	34.72000	.00	.00400	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.6000	1.0000
2	360.000	.6000	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 3

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)

Shear force at pile head = 66400.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 320000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 76400.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 320000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 86400.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 320000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 66400.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 320000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.486877	1.8081E-07	66400.0000	-.0057024	707.3543	-754.6881
6.000	.452663	395764.	61840.0213	-.0056821	998.9649	-765.3048
12.000	.418691	763900.	57221.2213	-.0056228	1270.2178	-774.2952
18.000	.385189	1104010.	52553.5373	-.0055272	1520.8213	-781.5995
24.000	.352365	1415767.	47847.2690	-.0053983	1750.5324	-787.1566
30.000	.320410	1698907.	43113.0902	-.0052389	1959.1585	-790.9030
36.000	.289498	1953241.	38362.0636	-.0050520	2146.5593	-792.7725
42.000	.259786	2178652.	33605.6588	-.0048406	2312.6483	-792.6958
48.000	.231411	2375097.	28855.7727	-.0046076	2457.3949	-790.5996
54.000	.204494	2542614.	24124.7553	-.0043560	2580.8264	-786.4062
60.000	.179139	2681321.	19425.4388	-.0040887	2683.0207	-780.0326
66.000	.155431	2791420.	14771.1727	-.0038086	2764.1537	-771.3895
72.000	.133436	2873200.	10175.8632	-.0035188	2824.4119	-760.3804
78.000	.113205	2927042.	5654.0194	-.0032220	2864.0843	-746.9009
84.000	.094772	2953421.	1220.8034	-.0029211	2883.5208	-730.8378
90.000	.078152	2952909.	-5115.0971	-.0026189	2883.1436	-1381.1290
96.000	.063345	2902096.	-12823.2689	-.0023193	2845.7033	-1188.2616
102.000	.050321	2807936.	-19371.3988	-.0020271	2776.3231	-994.4484
108.000	.039020	2677423.	-24778.1284	-.0017464	2680.1578	-807.7948
114.000	.029364	2517304.	-29103.8139	-.0014806	2562.1775	-634.1003
120.000	.021253	2333863.	-32437.7903	-.0012324	2427.0127	-477.2251
126.000	.014575	2132783.	-34887.9477	-.0010038	2278.8511	-339.4940

132.000	.009207	1919062.	-36572.5625	-.0007965	2121.3755	-222.0443
138.000	.005017	1696971.	-37613.9722	-.0006115	1957.7320	-125.0923
144.000	.001869	1470043.	-38133.6126	-.0004494	1790.5247	-48.1212
150.000	-.000376	1241093.	-38248.0051	-.0003107	1621.8281	9.9904
156.000	-.001859	1012260.	-38065.3812	-.0001954	1453.2169	50.8843
162.000	-.002721	785059.	-35872.4089	-.0001034	1285.8088	680.1065
168.000	-.003101	582188.	-31689.3149	-3.3475E-05	1136.3275	714.2581
174.000	-.003123	404916.	-27365.1228	1.7033E-05	1005.7082	727.1393
180.000	-.002896	253741.	-23008.7711	5.0736E-05	894.3182	724.9780
186.000	-.002514	128616.	-18701.5123	7.0301E-05	802.1222	710.7749
192.000	-.002053	29053.1701	-14516.1859	7.8368E-05	728.7615	684.3339
198.000	-.001573	-45879.2577	-10542.1374	7.7507E-05	741.1594	640.3490
204.000	-.001123	-97750.1078	-6855.5256	7.0158E-05	779.3794	588.5216
210.000	-.000732	-128415.	-3503.5459	5.8586E-05	801.9742	528.8049
216.000	-.000419	-140018.	161.8789	4.4850E-05	810.5233	693.0034
222.000	-.000193	-126645.	3199.2519	3.1205E-05	800.6697	319.4543
228.000	-4.50E-05	-101746.	4380.7320	1.9519E-05	782.3240	74.3724
234.000	4.09E-05	-74150.8182	4401.3527	1.0519E-05	761.9908	-67.4988
240.000	8.12E-05	-48970.5921	3796.3996	4.2186E-06	743.4372	-134.1522
246.000	9.15E-05	-28610.2228	2940.5524	2.4889E-07	728.4351	-151.1302
252.000	8.42E-05	-13684.9196	2069.9028	-1.9153E-06	717.4377	-139.0863
258.000	6.85E-05	-3764.0341	1313.1624	-2.8081E-06	710.1277	-113.1605
264.000	5.05E-05	2083.8125	723.4313	-2.8941E-06	708.8897	-83.4165
270.000	3.38E-05	4928.2545	305.8226	-2.5353E-06	710.9856	-55.7864
276.000	2.01E-05	5763.4195	38.9975	-1.9882E-06	711.6009	-33.1553
282.000	9.91E-06	5403.8595	-109.5806	-1.4168E-06	711.3360	-16.3707
288.000	3.07E-06	4453.8923	-173.8958	-9.1241E-07	710.6360	-5.0677
294.000	-1.04E-06	3320.6134	-183.9468	-5.1460E-07	709.8010	1.7173
300.000	-3.11E-06	2248.5065	-163.3928	-2.2964E-07	709.0110	5.1340
306.000	-3.80E-06	1360.7810	-129.1817	-4.4953E-08	708.3569	6.2697
312.000	-3.65E-06	698.4991	-92.2970	6.0417E-08	707.8689	6.0252
318.000	-3.07E-06	252.9853	-59.0055	1.0910E-07	707.5407	5.0720
324.000	-2.34E-06	-9.9860	-32.2028	1.2154E-07	707.3616	3.8622
330.000	-1.61E-06	-133.9150	-12.6283	1.1417E-07	707.4529	2.6626
336.000	-9.68E-07	-161.9645	.1557799	9.9035E-08	707.4736	1.5988
342.000	-4.23E-07	-132.4259	7.0500	8.3971E-08	707.4518	.6992807
348.000	3.99E-08	-77.6872	8.9501	7.3220E-08	707.4115	-.0658935
354.000	4.55E-07	-25.3053	6.4957	6.7950E-08	707.3729	-.7522627
360.000	8.55E-07	0.0000	0.0000	6.6655E-08	707.3543	-1.4130

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	.48687695 in
Computed slope at pile head	=	-.00570238
Maximum bending moment	=	2953421. lbs-in
Maximum shear force	=	66400.00000 lbs
Depth of maximum bending moment	=	84.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	19
Number of zero deflection points	=	4

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 76400.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 320000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.624970	5.4243E-07	76400.0000	-.0071348	707.3543	-803.2964
6.000	.582162	457639.	71545.1540	-.0071114	1044.5564	-814.9856
12.000	.539634	885849.	66625.1853	-.0070426	1380.0740	-825.0040
18.000	.497650	1284185.	61650.3107	-.0069316	1653.5795	-833.2876
24.000	.456455	1652270.	56631.1371	-.0067813	1924.7954	-839.7703
30.000	.416274	1989799.	51578.6766	-.0065950	2173.4964	-844.3832
36.000	.377316	2296539.	46504.3647	-.0063756	2399.5114	-847.0541
42.000	.339767	2572334.	41420.0819	-.0061265	2602.7251	-847.7068
48.000	.303798	2817106.	36338.1789	-.0058507	2783.0802	-846.2608
54.000	.269558	3030859.	31271.5061	-.0055515	2940.5796	-842.6301
60.000	.237180	3213682.	26233.4480	-.0052320	3075.2888	-836.7226
66.000	.206774	3365751.	21237.9624	-.0048953	3187.3379	-828.4393
72.000	.178436	3487335.	16299.6240	-.0045446	3276.9247	-817.6735
78.000	.152239	3578798.	11433.6719	-.0041831	3344.3173	-804.3105
84.000	.128239	3640602.	6656.0572	-.0038137	3389.8564	-788.2277
90.000	.106474	3673315.	-1156.5077	-.0034394	3413.9602	-1816.6273
96.000	.086966	3639908.	-11391.8918	-.0030652	3389.3446	-1594.5007
102.000	.069692	3548383.	-20248.9566	-.0026974	3321.9065	-1357.8542
108.000	.054597	3407278.	-27684.9173	-.0023415	3217.9364	-1120.7993
114.000	.041594	3225155.	-33729.2736	-.0020021	3083.7429	-893.9862
120.000	.030571	3010215.	-38465.5591	-.0016831	2925.3687	-684.7757
126.000	.021397	2770032.	-42013.3107	-.0013873	2748.3945	-497.8082
132.000	.013924	2511383.	-44513.6359	-.0011171	2557.8144	-335.6335
138.000	.007992	2240158.	-46118.2687	-.0008739	2357.9677	-199.2441
144.000	.003436	1961319.	-46981.4137	-.0006589	2152.5117	-88.4709
150.000	8.49E-05	1678911.	-47253.5874	-.0004727	1944.4249	-2.2536
156.000	-.002236	1396091.	-47076.7957	-.0003153	1736.0352	61.1842
162.000	-.003699	1115200.	-44689.5103	-.0001868	1529.0664	734.5776
168.000	-.004478	860535.	-40136.2808	-8.5740E-05	1341.4214	783.1655
174.000	-.004728	633894.	-35366.5278	-9.2719E-06	1174.4260	806.7521
180.000	-.004589	436172.	-30505.6344	4.5482E-05	1028.7386	813.5457
186.000	-.004182	267652.	-25642.8251	8.1496E-05	904.5680	807.3908
192.000	-.003611	128145.	-20855.7468	.0001017	801.7754	788.3020
198.000	-.002961	16982.2438	-16240.2767	.0001092	719.8747	750.1880
204.000	-.002301	-67157.3170	-11876.5902	.0001066	756.8377	704.3742
210.000	-.001682	-125936.	-7809.4406	9.6727E-05	800.1477	651.3423
216.000	-.001140	-161242.	-4082.1712	8.2033E-05	826.1621	591.0808
222.000	-.000698	-175237.	-740.4782	6.4816E-05	836.4742	522.8169
228.000	-.000362	-170377.	2624.5355	4.7131E-05	832.8928	598.8543
234.000	-.000132	-143924.	5075.3832	3.1049E-05	813.4016	218.0949
240.000	1.01E-05	-109591.	5679.6593	1.8077E-05	788.1043	-16.6695
246.000	8.49E-05	-75837.3333	5208.8540	8.5886E-06	763.2334	-140.2656
252.000	.000113	-47118.0293	4227.2585	2.2971E-06	742.0722	-186.9329
258.000	.000112	-25119.0517	3109.0474	-1.3992E-06	725.8627	-185.8041
264.000	9.64E-05	-9804.0878	2074.0504	-3.1862E-06	714.5782	-159.1948
270.000	7.42E-05	-218.2119	1228.5447	-3.6990E-06	707.5151	-122.6404
276.000	5.20E-05	4952.6532	603.0299	-3.4567E-06	711.0035	-85.8646
282.000	3.28E-05	7031.4212	183.0983	-2.8435E-06	712.5352	-54.1127
288.000	1.79E-05	7160.7522	-67.7197	-2.1173E-06	712.6305	-29.4934
294.000	7.35E-06	6226.9149	-192.6135	-1.4323E-06	711.9424	-12.1379
300.000	6.65E-07	4854.8905	-232.3238	-8.6525E-07	710.9315	-1.0989
306.000	-3.04E-06	3442.3513	-220.5747	-4.4069E-07	709.8907	5.0153
312.000	-4.62E-06	2209.6862	-182.6160	-1.5149E-07	708.9824	7.6376

318.000	-4.85E-06	1251.5407	-135.6479	2.5619E-08	708.2764	8.0184
324.000	-4.32E-06	581.8132	-90.2034	1.1943E-07	707.7830	7.1297
330.000	-3.42E-06	168.6413	-51.8618	1.5783E-07	707.4785	5.6508
336.000	-2.42E-06	-41.1344	-22.9068	1.6435E-07	707.3846	4.0008
342.000	-1.45E-06	-106.8718	-3.7265	1.5678E-07	707.4330	2.3926
348.000	-5.40E-07	-86.4549	6.1295	1.4689E-07	707.4180	.8927546
354.000	3.14E-07	-33.8819	7.2496	1.4073E-07	707.3792	-.5193841
360.000	1.15E-06	0.0000	0.0000	1.3900E-07	707.3543	-1.8972

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

Pile-head deflection	=	.62497041 in
Computed slope at pile head	=	-.00713478
Maximum bending moment	=	3673315. lbs-in
Maximum shear force	=	76400.00000 lbs
Depth of maximum bending moment	=	90.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	19
Number of zero deflection points	=	4

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 86400.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 320000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.772135	-3.4354E-06	86400.0000	-.0086416	707.3543	-846.9015
6.000	.720285	519748.	81280.6890	-.0086150	1090.3195	-859.5355
12.000	.668755	1008450.	76090.7161	-.0085368	1450.4095	-870.4555
18.000	.617844	1465617.	70840.5687	-.0084102	1787.2639	-879.5937
24.000	.567833	1890832.	65541.1491	-.0082384	2100.5742	-886.8795
30.000	.518983	2283747.	60203.7929	-.0080248	2390.0855	-892.2392
36.000	.471535	2644093.	54840.2893	-.0077727	2655.5988	-895.5953
42.000	.425710	2971677.	49462.9066	-.0074853	2896.9729	-896.8656
48.000	.381711	3266391.	44084.4209	-.0071661	3114.1265	-895.9630
54.000	.339717	3528208.	38718.1494	-.0068185	3307.0411	-892.7942
60.000	.299889	3757192.	33377.9895	-.0064457	3475.7628	-887.2591
66.000	.262369	3953496.	28078.4615	-.0060511	3620.4052	-879.2502
72.000	.227276	4117370.	22834.7569	-.0056382	3741.1524	-868.6513
78.000	.194711	4249163.	17662.7890	-.0052101	3838.2617	-855.3380
84.000	.164755	4349330.	12579.2420	-.0047701	3912.0673	-839.1777
90.000	.137470	4418431.	3354.4969	-.0043214	3962.9833	-2235.7373
96.000	.112898	4406178.	-9366.6371	-.0038699	3953.9548	-2004.6407
102.000	.091031	4320892.	-20593.8318	-.0034233	3891.1136	-1737.7576
108.000	.071818	4172198.	-30175.7290	-.0029888	3781.5513	-1456.2082
114.000	.055166	3970260.	-38076.3997	-.0025721	3632.7578	-1177.3487

120.000	.040952	3725158.	-44349.8936	-.0021784	3452.1593	-913.8492
126.000	.029026	3446425.	-49113.6889	-.0018114	3246.7809	-674.0492
132.000	.019215	3142749.	-52524.3129	-.0014742	3023.0237	-462.8255
138.000	.011335	2821794.	-54760.2637	-.0011690	2786.5348	-282.4915
144.000	.005187	2490115.	-56008.3091	-.0008972	2542.1440	-133.5236
150.000	.000568	2153140.	-56454.1062	-.0006597	2293.8508	-15.0754
156.000	-.002729	1815199.	-56275.2713	-.0004566	2044.8460	74.6871
162.000	-.004912	1479590.	-53685.2626	-.0002880	1797.5596	788.6491
168.000	-.006185	1172082.	-48771.8952	-.0001523	1570.9785	849.1400
174.000	-.006739	894912.	-43579.6766	-4.6560E-05	1366.7519	881.5995
180.000	-.006744	649305.	-38247.3873	3.2455E-05	1185.7809	895.8302
186.000	-.006350	435819.	-32870.8938	8.7980E-05	1028.4786	896.3343
192.000	-.005688	254516.	-27532.1787	.0001233	894.8892	883.2374
198.000	-.004870	104960.	-22333.4871	.0001417	784.6915	849.6598
204.000	-.003988	-14029.8707	-17359.6027	.0001463	717.6919	808.3017
210.000	-.003114	-103918.	-12654.9680	.0001403	783.9238	759.9099
216.000	-.002304	-166428.	-8260.6256	.0001265	829.9835	704.8709
222.000	-.001586	-203531.	-4216.4496	.0001076	857.3218	643.1877
228.000	-.001014	-217439.	-564.0600	8.6011E-05	867.5694	574.2755
234.000	-.000564	-210630.	2647.4979	6.4107E-05	862.5525	496.2438
240.000	-.000244	-185915.	5346.7061	4.3816E-05	844.3418	403.4923
246.000	-3.84E-05	-146638.	6747.5981	2.6800E-05	815.4012	63.4717
252.000	7.74E-05	-105047.	6554.6102	1.3922E-05	784.7557	-127.8010
258.000	.000129	-68035.7822	5533.6612	5.0652E-06	757.4850	-212.5154
264.000	.000138	-38662.1330	4211.4704	-3.9444E-07	735.8417	-228.2149
270.000	.000124	-17496.6226	2912.7382	-3.2680E-06	720.2463	-204.6959
276.000	9.89E-05	-3696.7255	1808.3652	-4.3524E-06	710.0781	-163.4284
282.000	7.17E-05	4220.4737	962.8466	-4.3256E-06	710.4640	-118.4111
288.000	4.70E-05	7874.0439	374.5884	-3.7068E-06	713.1561	-77.6750
294.000	2.72E-05	8729.7679	6.7849	-2.8572E-06	713.7866	-44.9262
300.000	1.27E-05	7966.4338	-191.0922	-2.0029E-06	713.2242	-21.0328
306.000	3.16E-06	6444.3530	-269.8521	-1.2655E-06	712.1027	-5.2205
312.000	-2.45E-06	4733.0676	-273.3496	-6.9355E-07	710.8417	4.0547
318.000	-5.16E-06	3166.8214	-235.5993	-2.8932E-07	709.6877	8.5287
324.000	-5.93E-06	1906.9873	-180.6420	-2.9703E-08	708.7594	9.7904
330.000	-5.52E-06	999.2317	-123.9182	1.1900E-07	708.0905	9.1176
336.000	-4.50E-06	419.5124	-74.2719	1.9160E-07	707.6634	7.4312
342.000	-3.22E-06	107.2327	-36.0208	2.1855E-07	707.4333	5.3192
348.000	-1.88E-06	-13.5766	-10.7677	2.2335E-07	707.3643	3.0985
354.000	-5.40E-07	-22.8379	1.2023	2.2148E-07	707.3711	.8915202
360.000	7.82E-07	0.0000	0.0000	2.2031E-07	707.3543	-1.2923

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

Pile-head deflection	=	.77213461 in
Computed slope at pile head	=	-.00864157
Maximum bending moment	=	4418431. lbs-in
Maximum shear force	=	86400.00000 lbs
Depth of maximum bending moment	=	90.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	22
Number of zero deflection points	=	4

Summary of Pile Response(s)

Retaining Wall No. 4.lpo

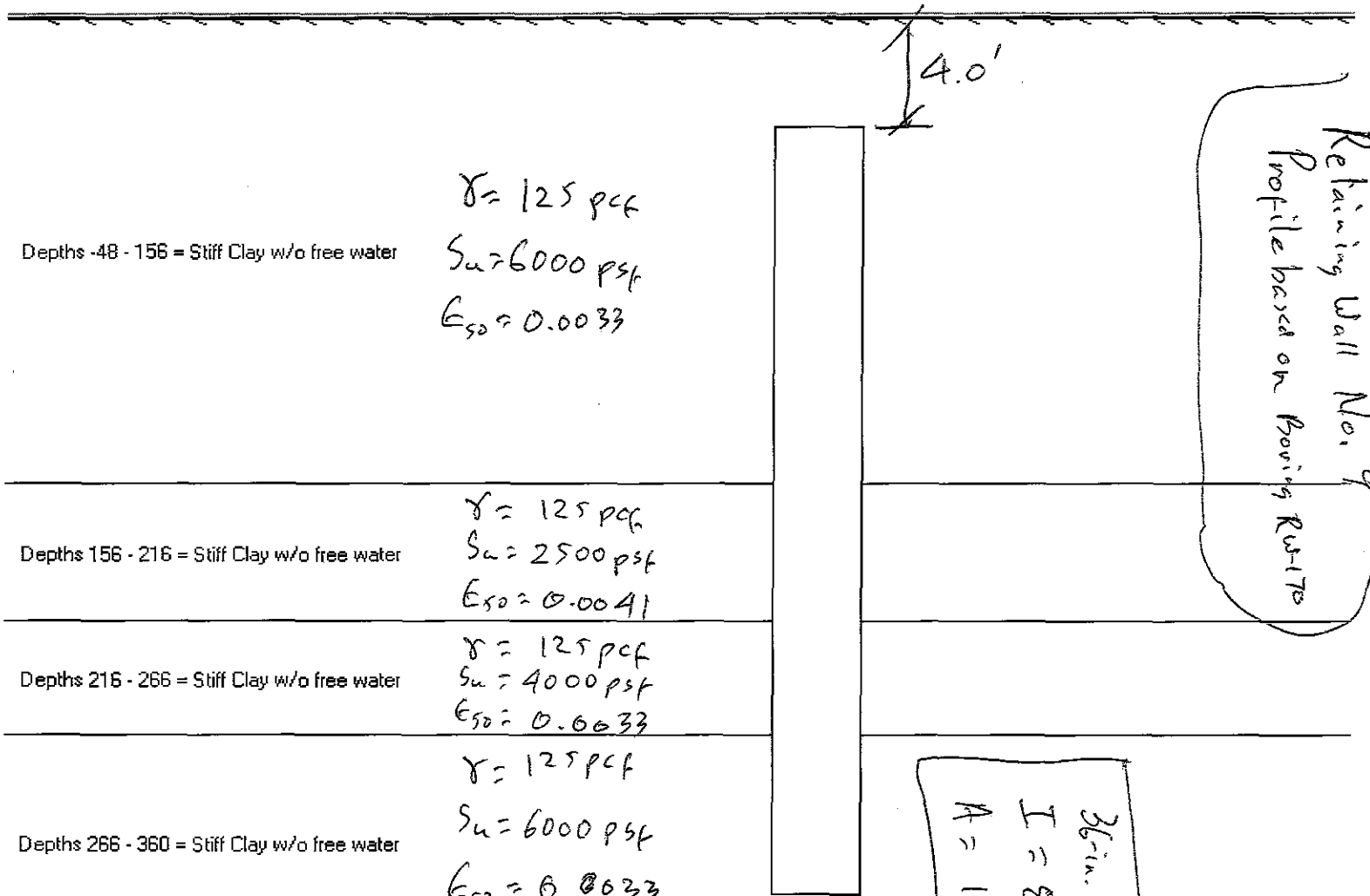
Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 66400. M=	0.000	320000.	.4868769	2953421.	66400.0000
1	V= 76400. M=	0.000	320000.	.6249704	3673315.	76400.0000
1	V= 86400. M=	0.000	320000.	.7721346	4418431.	86400.0000

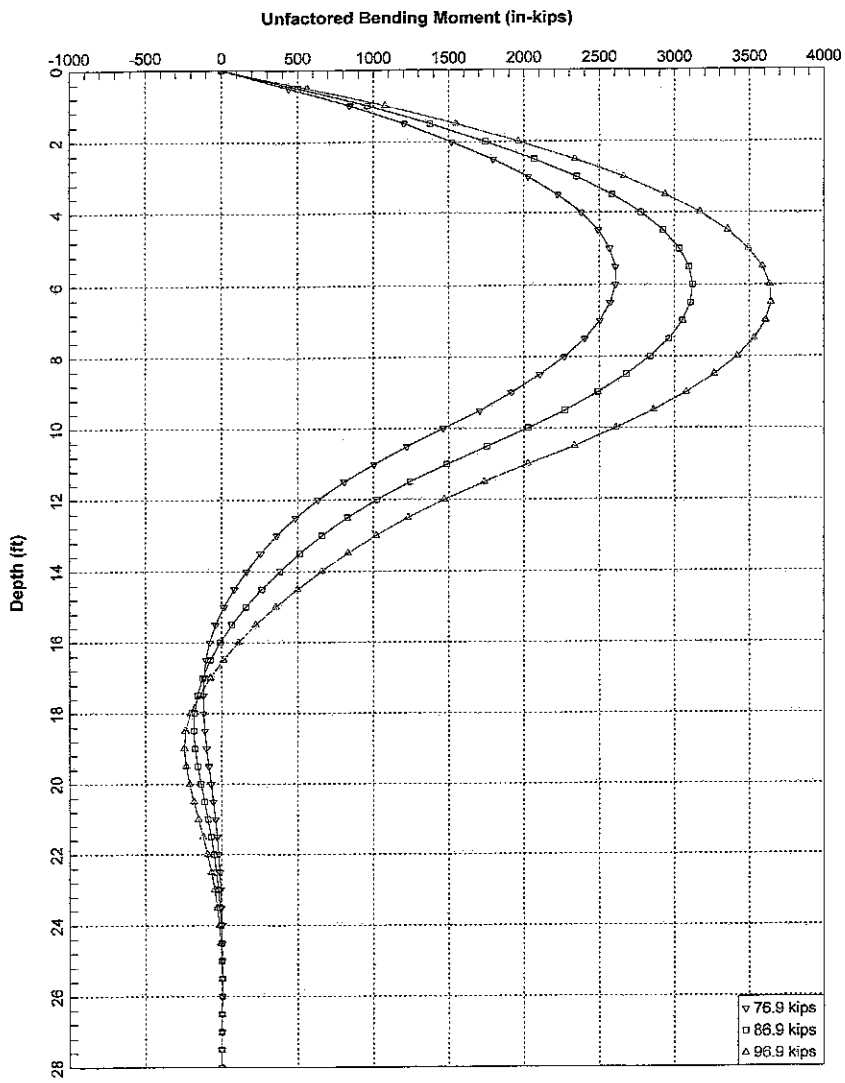
The analysis ended normally.

Retaining Wall No. 9
Profile based on Boring RW-170

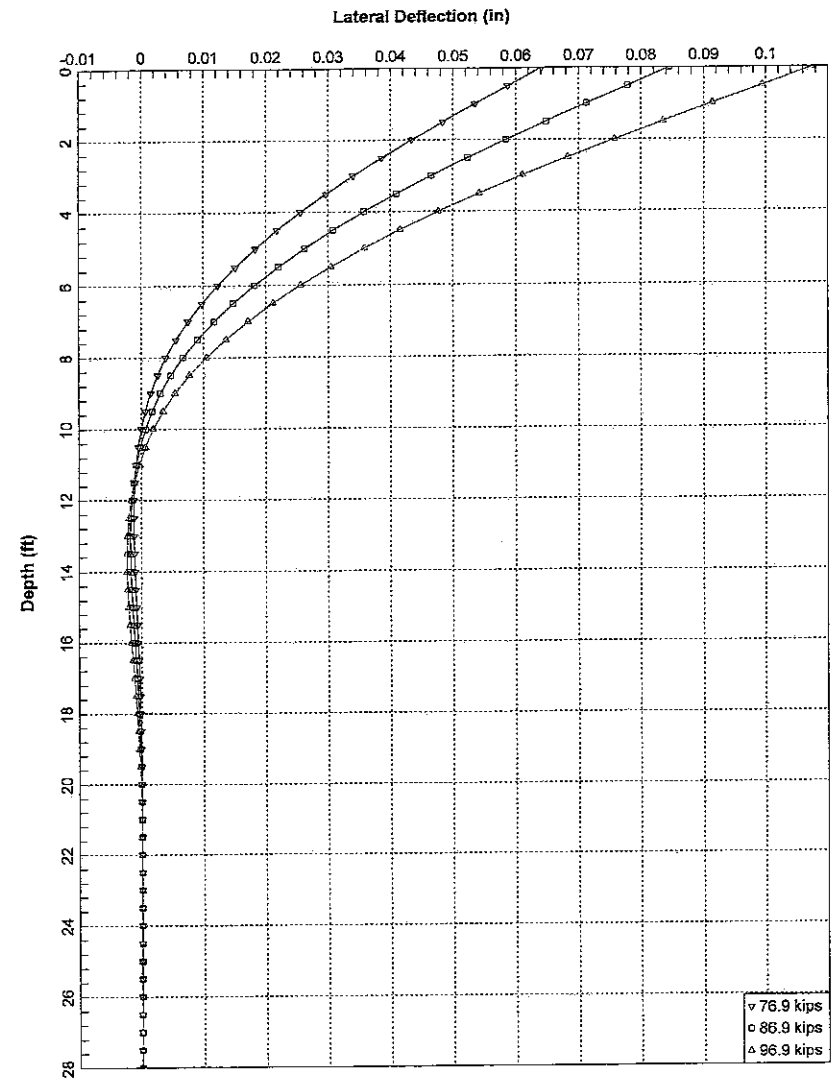


Depths -48 - 156 = Stiff Clay w/o free water	$\gamma = 125$ pcf $S_u = 6000$ psf $\epsilon_{50} = 0.0033$
Depths 156 - 216 = Stiff Clay w/o free water	$\gamma = 125$ pcf $S_u = 2500$ psf $\epsilon_{50} = 0.0041$
Depths 216 - 266 = Stiff Clay w/o free water	$\gamma = 125$ pcf $S_u = 4000$ psf $\epsilon_{50} = 0.0033$
Depths 266 - 360 = Stiff Clay w/o free water	$\gamma = 125$ pcf $S_u = 6000$ psf $\epsilon_{50} = 0.0033$

36-in. CIDH Pile
$I = 82448\ in^4$
$A = 1017.9\ in^2$



SR4 Segment 3A - Retaining Wall No. 9 - 36-in. CIDH Pile



SR4 Segment 3A - Retaining Wall No. 9 - 36-in. CIDH Pile

LPILE Plus for Windows, Version 5.0 (5.0.21)

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:

Gary Parikh
Parikh Consultants

Path to file locations: S:\Ongoing Projects\2006\206117 TYLIn Rte 4 Project\Retaining and Sound Walls\LPILE\
Name of input data file: Retaining Wall No. 9.lpd
Name of output file: Retaining Wall No. 9.lpo
Name of plot output file: Retaining Wall No. 9.lpp
Name of runtime file: Retaining Wall No. 9.lpr

Time and Date of Analysis

Date: July 14, 2009 Time: 18:16:33

Problem Title

SR4- Segment 3A - Retaining Wall No. 9 - 36-in. CIDH PIle

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant 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 pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 56
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 336.00 in
Depth of ground surface below top of pile = -48.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in*4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	36.00000000	82448.0000	1017.9000	3600000.
2	336.0000	36.00000000	82448.0000	1017.9000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -48.000 in
Distance from top of pile to bottom of layer = 156.000 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 156.000 in
Distance from top of pile to bottom of layer = 216.000 in

Layer 3 is stiff clay without free water
Distance from top of pile to top of layer = 216.000 in
Distance from top of pile to bottom of layer = 266.000 in

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 266.000 in
Distance from top of pile to bottom of layer = 360.000 in

(Depth of lowest layer extends 24.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth is defined using 8 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-48.00	.07230

2	156.00	.07230
3	156.00	.07230
4	216.00	.07230
5	216.00	.07230
6	266.00	.07230
7	266.00	.07230
8	360.00	.07230

Shear Strength of Soils

Distribution of shear strength parameters with depth defined using 8 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-48.000	41.67000	.00	.00330	.0
2	156.000	41.67000	.00	.00330	.0
3	156.000	17.36000	.00	.00410	.0
4	216.000	17.36000	.00	.00410	.0
5	216.000	27.78000	.00	.00330	.0
6	266.000	27.78000	.00	.00330	.0
7	266.000	41.67000	.00	.00330	.0
8	360.000	41.67000	.00	.00330	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.6000	1.0000
2	360.000	.6000	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 3

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 76900.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 300000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 86900.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 600000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 96900.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 600000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 76900.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 300000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.064068	-5.7210E-07	76900.0000	-.0008824	294.7244	-1150.2317
6.000	.058774	442284.	69987.7846	-.0008779	391.2836	-1153.8401
12.000	.053533	843014.	63062.1419	-.0008649	478.7707	-1154.7075
18.000	.048395	1202143.	56139.7583	-.0008442	557.1757	-1152.7537
24.000	.043403	1519730.	49237.8230	-.0008167	626.5110	-1147.8915
30.000	.038595	1795937.	42374.0711	-.0007832	686.8125	-1140.0258
36.000	.034004	2031039.	35566.8390	-.0007445	738.1396	-1129.0516
42.000	.029660	2225420.	28835.1324	-.0007015	780.5768	-1114.8506
48.000	.025586	2379586.	22198.7169	-.0006550	814.2342	-1097.2879
54.000	.021801	2494162.	15678.2371	-.0006057	839.2485	-1076.2054
60.000	.018318	2569905.	9295.3802	-.0005545	855.7846	-1051.4136
66.000	.015147	2607703.	3073.1076	-.0005022	864.0367	-1022.6773
72.000	.012292	2608590.	-2964.0071	-.0004495	864.2303	-989.6943
78.000	.009753	2573753.	-8789.2633	-.0003971	856.6247	-952.0578
84.000	.007527	2504548.	-14373.0095	-.0003458	841.5160	-909.1909
90.000	.005604	2402522.	-19681.2434	-.0002962	819.2416	-860.2204

96.000	.003973	2269440.	-24673.0349	-.0002489	790.1872	-803.7102
102.000	.002617	2107341.	-29295.2259	-.0002047	754.7980	-737.0202
108.000	.001516	1918634.	-33469.4684	-.0001640	713.5995	-654.3940
114.000	.000649	1706298.	-37921.2051	-.0001274	667.2425	-829.5182
120.000	-1.19E-05	1464038.	-40363.3088	-9.5320E-05	614.3523	15.4836
126.000	-.000495	1222282.	-38353.6857	-6.8168E-05	561.5723	654.3907
132.000	-.000830	1004039.	-34586.3982	-4.5666E-05	513.9257	601.3718
138.000	-.001043	807409.	-30841.0852	-2.7357E-05	470.9976	647.0659
144.000	-.001158	634045.	-26875.4466	-1.2788E-05	433.1487	674.8136
150.000	-.001196	484930.	-22778.0756	-1.4776E-06	400.5984	690.9767
156.000	-.001176	360713.	-19027.2185	7.0699E-06	373.4751	559.3090
162.000	-.001112	256598.	-16328.4449	1.3309E-05	350.7447	340.2822
168.000	-.001016	164724.	-14295.4185	1.7568E-05	330.6868	337.3933
174.000	-.000901	84989.6110	-12287.5389	2.0092E-05	313.2793	331.8999
180.000	-.000775	17200.8651	-10319.7918	2.1125E-05	298.4797	324.0158
186.000	-.000647	-38923.9390	-7898.9460	2.0905E-05	303.2223	482.9328
192.000	-.000524	-77661.7449	-5261.2481	1.9727E-05	311.6795	396.2998
198.000	-.000411	-102130.	-3129.0043	1.7909E-05	317.0214	314.4481
204.000	-.000309	-115274.	-1465.7831	1.5712E-05	319.8910	239.9589
210.000	-.000222	-119776.	-222.5508	1.3336E-05	320.8738	174.4518
216.000	-.000149	-117993.	790.7393	1.0933E-05	320.4846	163.3116
222.000	-9.09E-05	-110326.	1653.6489	8.6253E-06	318.8108	124.3249
228.000	-4.58E-05	-98189.1549	2216.7603	6.5179E-06	316.1591	63.3789
234.000	-1.27E-05	-83748.7192	2459.5941	4.6791E-06	313.0084	17.5657
240.000	1.03E-05	-68681.8703	2469.3081	3.1384E-06	309.7190	-14.3277
246.000	2.50E-05	-54128.3202	2322.3226	1.8971E-06	306.5417	-34.6675
252.000	3.31E-05	-40820.8291	2080.6150	9.3741E-07	303.6364	-45.9017
258.000	3.62E-05	-29164.3145	1792.1026	2.3004E-07	301.0916	-50.2691
264.000	3.59E-05	-19316.4255	1492.1042	-2.5997E-07	298.9416	-49.7304
270.000	3.31E-05	-11258.1283	1172.9915	-5.6900E-07	297.1823	-56.6405
276.000	2.90E-05	-5238.4788	852.2767	-7.3574E-07	295.8681	-50.2645
282.000	2.43E-05	-1028.1597	573.6924	-7.9908E-07	294.9489	-42.5970
288.000	1.94E-05	1648.7064	342.3924	-7.9280E-07	295.0844	-34.5030
294.000	1.48E-05	3083.4036	159.2098	-7.4497E-07	295.3976	-26.5579
300.000	1.05E-05	3561.9059	22.2637	-6.7781E-07	295.5021	-19.0909
306.000	6.65E-06	3353.0076	-71.7083	-6.0792E-07	295.4565	-12.2331
312.000	3.20E-06	2703.5943	-126.3045	-5.4670E-07	295.3147	-5.9656
318.000	8.83E-08	1839.3214	-144.7003	-5.0078E-07	295.1260	-.1663355
324.000	-2.80E-06	968.9934	-129.1703	-4.7240E-07	294.9360	5.3430
330.000	-5.58E-06	290.9785	-80.8873	-4.5966E-07	294.7880	10.7513
336.000	-8.32E-06	0.0000	0.0000	-4.5672E-07	294.7244	16.2111

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	.06406816 in
Computed slope at pile head	=	-.00088236
Maximum bending moment	=	2608590. lbs-in
Maximum shear force	=	76900.00000 lbs
Depth of maximum bending moment	=	72.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	16
Number of zero deflection points	=	3

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)

Specified shear force at pile head	=	86900.000 lbs
Specified moment at pile head	=	.000 in-lbs
Specified axial load at pile head	=	600000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.084511	-1.7163E-06	86900.0000	-.0011091	589.4489	-1232.6421
6.000	.077856	503205.	79488.6216	-.0011040	699.3083	-1237.8173
12.000	.071263	961812.	72054.3721	-.0010892	799.4311	-1240.2658
18.000	.064786	1375700.	64613.8533	-.0010655	889.7908	-1239.9071
24.000	.058476	1744850.	57184.1683	-.0010340	970.3836	-1236.6546
30.000	.052378	2069354.	49782.9608	-.0009955	1041.2291	-1230.4146
36.000	.046531	2349413.	42428.4645	-.0009508	1102.3714	-1221.0842
42.000	.040968	2585342.	35139.5644	-.0009009	1153.8792	-1208.5491
48.000	.035720	2777574.	27935.8773	-.0008467	1195.8473	-1192.6799
54.000	.030808	2926669.	20837.8567	-.0007891	1228.3975	-1173.3270
60.000	.026251	3033310.	13866.9346	-.0007288	1251.6793	-1150.3137
66.000	.022062	3098319.	7045.7179	-.0006668	1265.8721	-1123.4252
72.000	.018249	3122660.	398.2686	-.0006040	1271.1862	-1092.3912
78.000	.014815	3107447.	-6049.4829	-.0005410	1267.8649	-1056.8593
84.000	.011757	3053961.	-12269.1031	-.0004787	1256.1879	-1016.3474
90.000	.009070	2963665.	-18228.6288	-.0004179	1236.4744	-970.1611
96.000	.006742	2838226.	-23890.8027	-.0003593	1209.0888	-917.2302
102.000	.004759	2679561.	-29209.7718	-.0003035	1174.4492	-855.7595
108.000	.003101	2489894.	-34124.1252	-.0002512	1133.0411	-782.3583
114.000	.001744	2271881.	-38539.0795	-.0002031	1085.4446	-689.2931
120.000	.000663	2028888.	-43194.6296	-.0001596	1032.3944	-862.5569
126.000	-.000171	1754695.	-45102.7177	-.0001214	972.5328	226.5275
132.000	-.000793	1488529.	-42639.5150	-8.8611E-05	914.4237	594.5400
138.000	-.001235	1243658.	-38831.2743	-6.0996E-05	860.9637	674.8735
144.000	-.001525	1022993.	-34638.1844	-3.8086E-05	812.7881	722.8231
150.000	-.001692	828274.	-30209.5078	-1.9374E-05	770.2773	753.4024
156.000	-.001758	660618.	-26094.1861	-4.3254E-06	733.6747	618.3715
162.000	-.001744	515175.	-23096.7593	7.5588E-06	701.9217	380.7708
168.000	-.001667	383403.	-20809.0774	1.6641E-05	673.1531	381.7898
174.000	-.001544	265347.	-18524.5821	2.3198E-05	647.3792	379.7086
180.000	-.001389	160941.	-16261.0148	2.7507E-05	624.5854	374.8138
186.000	-.001214	70016.4272	-14034.7161	2.9841E-05	604.7348	367.2857
192.000	-.001031	-7690.7019	-11861.1638	3.0471E-05	591.1279	357.2317
198.000	-.000848	-72536.9307	-9755.3454	2.9660E-05	605.2851	344.7078
204.000	-.000675	-124968.	-7151.3357	2.7664E-05	616.7319	523.2955
210.000	-.000516	-158552.	-4364.8715	2.4798E-05	624.0639	405.5259
216.000	-.000377	-177525.	-1911.1478	2.1402E-05	628.2061	412.3820
222.000	-.000259	-181640.	390.6477	1.7771E-05	629.1044	354.8832
228.000	-.000164	-172966.	2135.0421	1.4187E-05	627.2106	226.5816
234.000	-8.92E-05	-156122.	3185.8015	1.0861E-05	623.5333	123.6715
240.000	-3.35E-05	-134814.	3696.0815	7.9204E-06	618.8814	46.4218
246.000	5.88E-06	-111826.	3810.8986	5.4275E-06	613.8626	-8.1494
252.000	3.17E-05	-89122.4634	3654.7225	3.3964E-06	608.9060	-43.9093
258.000	4.66E-05	-67993.4801	3328.9637	1.8084E-06	604.2932	-64.6769
264.000	5.34E-05	-49187.9187	2912.9128	6.2398E-07	600.1875	-74.0067
270.000	5.41E-05	-33043.0191	2413.2695	-2.0716E-07	596.6628	-92.5411
276.000	5.09E-05	-20227.1931	1871.3712	-7.4558E-07	593.8649	-88.0917
282.000	4.52E-05	-10581.1963	1369.4951	-1.0570E-06	591.7589	-79.2003
288.000	3.82E-05	-3785.6416	928.5420	-1.2022E-06	590.2753	-67.7840
294.000	3.07E-05	569.9630	559.4693	-1.2347E-06	589.5733	-55.2402
300.000	2.34E-05	2936.8795	266.2504	-1.1992E-06	590.0900	-42.4995

306.000	1.64E-05	3773.6021	48.4683	-1.1314E-06	590.2727	-30.0946
312.000	9.80E-06	3526.6456	-96.5281	-1.0576E-06	590.2188	-18.2376
318.000	3.66E-06	2622.8793	-171.9466	-9.9547E-07	590.0215	-6.9019
324.000	-2.15E-06	1470.4544	-180.3715	-9.5410E-07	589.7699	4.0936
330.000	-7.78E-06	465.2912	-123.0986	-9.3454E-07	589.5504	14.9974
336.000	-1.34E-05	0.0000	0.0000	-9.2983E-07	589.4489	26.0355

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

Pile-head deflection	=	.08451051 in
Computed slope at pile head	=	-.00110907
Maximum bending moment	=	3122660. lbs-in
Maximum shear force	=	86900.00000 lbs
Depth of maximum bending moment	=	72.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	18
Number of zero deflection points	=	3

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)

Specified shear force at pile head	=	96900.000 lbs
Specified moment at pile head	=	.000 in-lbs
Specified axial load at pile head	=	600000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.107578	-5.7210E-07	96900.0000	-.0013525	589.4489	-1309.2949
6.000	.099463	562702.	89024.2036	-.0013468	712.2975	-1315.9706
12.000	.091416	1077987.	81116.4864	-.0013302	824.7944	-1319.9351
18.000	.083501	1545677.	73193.3551	-.0013037	926.9001	-1321.1086
24.000	.075772	1965694.	65271.8109	-.0012682	1018.5980	-1319.4061
30.000	.068283	2338069.	57369.3840	-.0012247	1099.8948	-1314.7362
36.000	.061076	2662944.	49504.1769	-.0011741	1170.8213	-1306.9995
42.000	.054193	2940573.	41694.9184	-.0011175	1231.4331	-1296.0867
48.000	.047666	3171329.	33961.0322	-.0010557	1281.8116	-1281.8754
54.000	.041524	3355707.	26322.7272	-.0009897	1322.0648	-1264.2263
60.000	.035789	3494328.	18801.1161	-.0009205	1352.3285	-1242.9774
66.000	.030478	3587948.	11418.3775	-.0008489	1372.7676	-1217.9355
72.000	.025602	3637461.	4197.9811	-.0007759	1383.5772	-1188.8633
78.000	.021168	3643910.	-2834.9893	-.0007023	1384.9852	-1155.4601
84.000	.017175	3608497.	-9653.3565	-.0006290	1377.2539	-1117.3289
90.000	.013620	3532598.	-16227.1078	-.0005568	1360.6837	-1073.9215
96.000	.010493	3417781.	-22522.1893	-.0004866	1335.6169	-1024.4389
102.000	.007781	3265835.	-28498.4106	-.0004190	1302.4442	-967.6348
108.000	.005465	3078817.	-34105.4761	-.0003549	1261.6145	-901.3870
114.000	.003522	2859125.	-39274.4385	-.0002949	1213.6514	-821.6005
120.000	.001926	2609647.	-43894.9741	-.0002396	1159.1855	-718.5781
126.000	.000647	2334110.	-48616.2511	-.0001896	1099.0305	-855.1809

132.000	-.000349	2027617.	-49773.9884	-.0001455	1032.1171	469.2685
138.000	-.001100	1737870.	-46399.5556	-.0001075	968.8597	655.5425
144.000	-.001639	1471597.	-42225.1724	-7.5043E-05	910.7270	735.9186
150.000	-.002000	1231709.	-37660.6485	-4.7720E-05	858.3548	785.5893
156.000	-.002212	1020012.	-33338.1431	-2.4961E-05	812.1374	654.9125
162.000	-.002300	831819.	-30150.2800	-6.2434E-06	771.0510	408.0419
168.000	-.002287	658254.	-27686.6463	8.8173E-06	733.1585	413.1693
174.000	-.002194	499515.	-25203.4714	2.0519E-05	698.5028	414.5558
180.000	-.002040	355665.	-22721.8436	2.9163E-05	667.0973	412.6535
186.000	-.001844	226643.	-20260.6642	3.5049E-05	638.9295	407.7397
192.000	-.001620	112284.	-17837.5108	3.8474E-05	613.9627	399.9781
198.000	-.001382	12316.1423	-15469.2217	3.9734E-05	592.1377	389.4516
204.000	-.001143	-73632.5487	-13172.3204	3.9114E-05	605.5243	376.1822
210.000	-.000913	-146033.	-10963.3323	3.6894E-05	621.3308	360.1472
216.000	-.000700	-205458.	-7585.2602	3.3341E-05	634.3044	765.8768
222.000	-.000513	-237296.	-3183.5400	2.8866E-05	641.2553	701.3632
228.000	-.000354	-243868.	389.0854	2.4003E-05	642.6901	489.5119
234.000	-.000225	-232800.	2792.3731	1.9185E-05	640.2737	311.5840
240.000	-.000124	-210498.	4241.6739	1.4704E-05	635.4047	171.5163
246.000	-4.82E-05	-182006.	4956.7987	1.0737E-05	629.1843	66.8586
252.000	5.18E-06	-151094.	5135.8289	7.3702E-06	622.4356	-7.1819
258.000	4.02E-05	-120429.	4946.8673	4.6258E-06	615.7409	-55.8053
264.000	6.07E-05	-91764.7576	4526.9409	2.4810E-06	609.4829	-84.1701
270.000	7.00E-05	-66123.7676	3915.3047	8.8521E-07	603.8850	-119.7086
276.000	7.13E-05	-44787.4751	3185.7424	-2.3581E-07	599.2268	-123.4788
282.000	6.72E-05	-27893.1615	2461.9614	-9.7042E-07	595.5385	-117.7815
288.000	5.97E-05	-15236.9507	1790.9162	-1.4064E-06	592.7754	-105.9003
294.000	5.03E-05	-6392.0418	1202.0955	-1.6250E-06	590.8444	-90.3733
300.000	4.02E-05	-800.1051	711.8832	-1.6977E-06	589.6235	-73.0308
306.000	2.99E-05	2162.7801	327.5793	-1.6839E-06	589.9210	-55.0705
312.000	2.00E-05	3142.9708	50.9031	-1.6303E-06	590.1350	-37.1549
318.000	1.04E-05	2785.3557	-119.1369	-1.5703E-06	590.0570	-19.5251
324.000	1.11E-06	1724.6349	-184.0815	-1.5248E-06	589.8254	-2.1231
330.000	-7.93E-06	587.3558	-144.6204	-1.5014E-06	589.5771	15.2768
336.000	-1.69E-05	0.0000	0.0000	-1.4955E-06	589.4489	32.9300

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

Pile-head deflection	=	.10757755 in
Computed slope at pile head	=	-.00135245
Maximum bending moment	=	3643910. lbs-in
Maximum shear force	=	96900.00000 lbs
Depth of maximum bending moment	=	78.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	19
Number of zero deflection points	=	3

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in

Retaining Wall No. 9.lpo

Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 76900. M=	0.000	300000.	.0640682	2608590.	76900.0000
1	V= 86900. M=	0.000	600000.	.0845105	3122660.	86900.0000
1	V= 96900. M=	0.000	600000.	.1075775	3643910.	96900.0000

The analysis ended normally.

Depths -54 - 12 = Stiff Clay w/o free water

$\gamma = 125$ pcf
$S_u = 4500$ psf
$\epsilon_{50} = 0.004$

4.5'

Depths 12 - 144 = Stiff Clay w/o free water

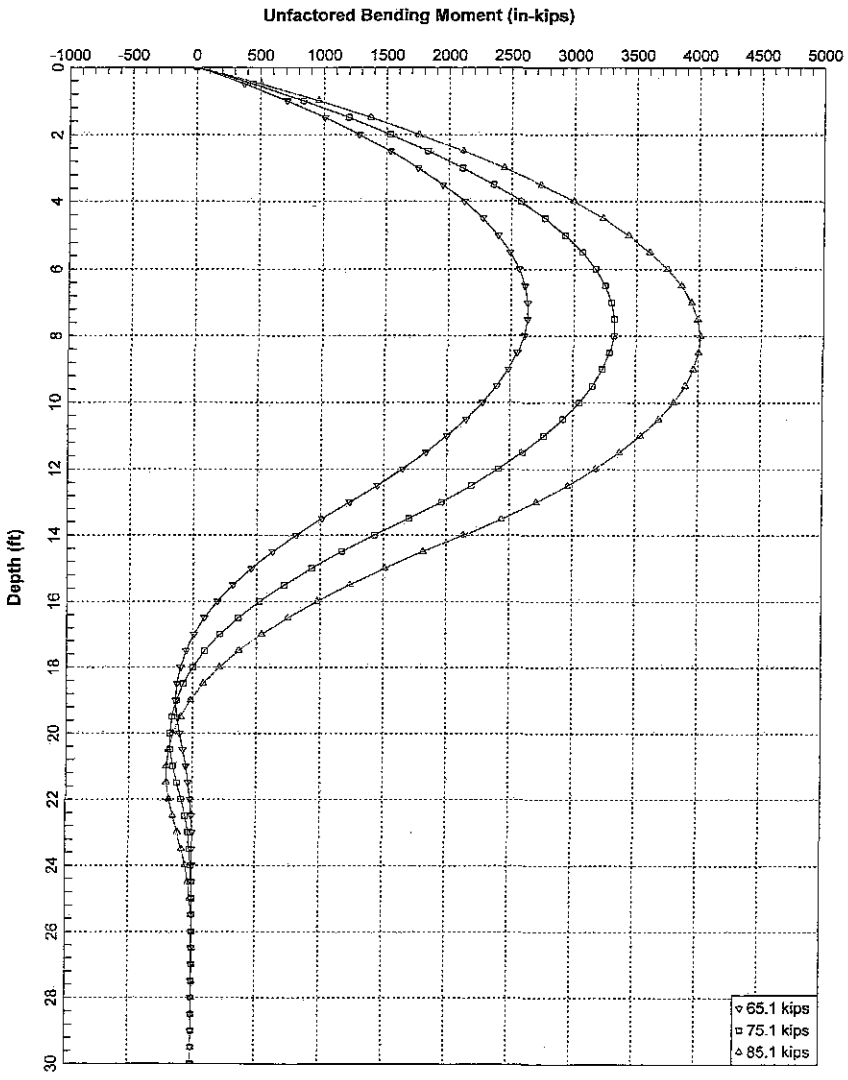
$\gamma = 125$ pcf
$S_u = 2500$ psf
$\epsilon_{50} = 0.005$

Depths 144 - 480 = Stiff Clay w/o free water

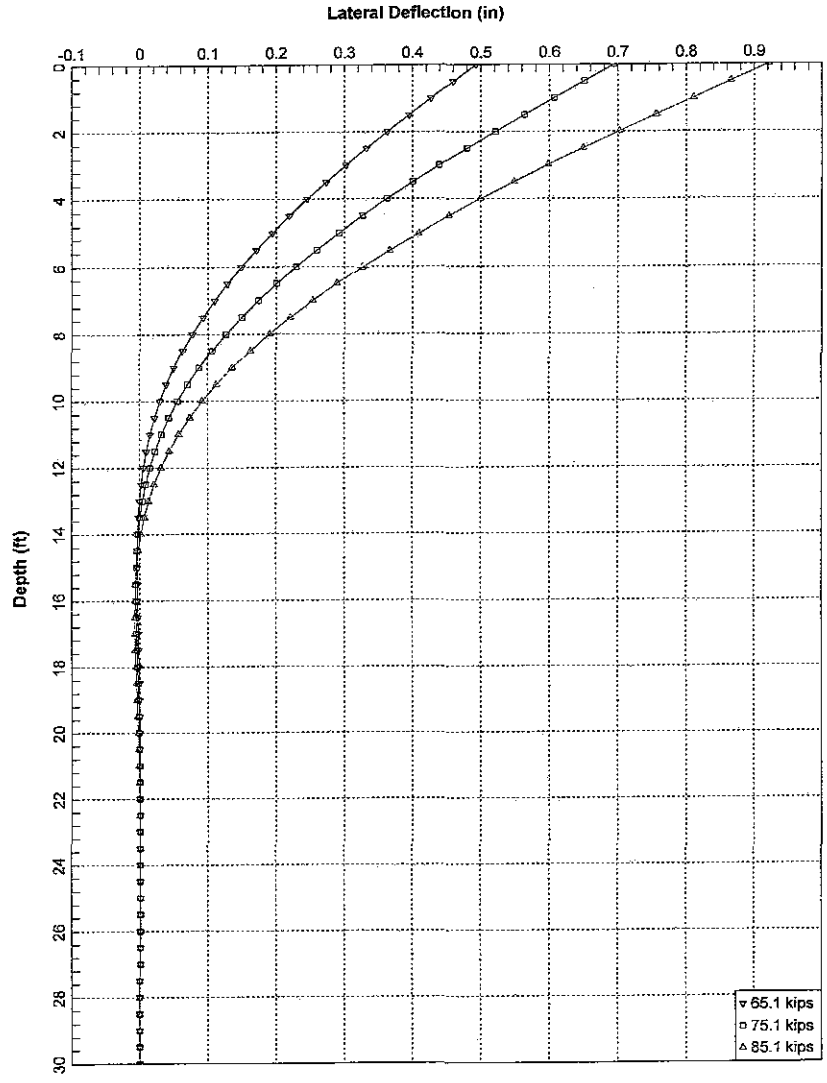
$\gamma = 125$ pcf
$S_u = 4000$ psf
$\epsilon_{50} = 0.004$

24-in. CIPH Pile
$I = 16286 \text{ in}^4$
$A = 452.39 \text{ in}^2$

Retaining Wall No. 10
Profile based on RW-174



SR4 Segment 3A - Retaining Wall No. 10 - 24-in. CIDH Pile



SR4 SEgment 3A - Retaining Wall No. 10 - 24-in. CIDH Pile

LPILE Plus for Windows, Version 5.0 (5.0.21)

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:

Gary Parikh
Parikh Consultants

Path to file locations: S:\Ongoing Projects\2006\206117 TYLIn Rte 4 Project\Retaining and Sound Walls\LPILE\
Name of input data file: Retaining Wall No. 10.lpd
Name of output file: Retaining Wall No. 10.lpo
Name of plot output file: Retaining Wall No. 10.lpp
Name of runtime file: Retaining Wall No. 10.lpr

Time and Date of Analysis

Date: July 14, 2009 Time: 17:50:55

Problem Title

SR4- Segment 3A - Retaining Wall No. 10 - 24-in. CIDH Pile

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant 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 pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 60
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 360.00 in
Depth of ground surface below top of pile = -54.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	24.00000000	16286.0000	452.3900	3600000.
2	360.0000	24.00000000	16286.0000	452.3900	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 3 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -54.000 in
Distance from top of pile to bottom of layer = 12.000 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 12.000 in
Distance from top of pile to bottom of layer = 144.000 in

Layer 3 is stiff clay without free water
Distance from top of pile to top of layer = 144.000 in
Distance from top of pile to bottom of layer = 480.000 in

(Depth of lowest layer extends 120.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth is defined using 6 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-54.00	.07230
2	12.00	.07230
3	12.00	.07230
4	144.00	.07230
5	144.00	.07230
6	480.00	.07230

Shear Strength of Soils

Distribution of shear strength parameters with depth defined using 6 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-54.000	31.25000	.00	.00400	.0
2	12.000	31.25000	.00	.00400	.0
3	12.000	17.36000	.00	.00500	.0
4	144.000	17.36000	.00	.00500	.0
5	144.000	27.78000	.00	.00400	.0
6	480.000	27.78000	.00	.00400	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.6000	1.0000
2	360.000	.6000	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 3

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 65100.000 lbs
Bending moment at pile head = .000 in-lbs

Axial load at pile head = 160000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 75100.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 320000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 85100.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 320000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 65100.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 160000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.493005	7.2324E-07	65100.0000	-.0054961	353.6771	-1144.7996
6.000	.460029	375270.	58179.8267	-.0054769	630.1869	-1161.9249
12.000	.427282	708674.	51813.7123	-.0054214	875.8485	-960.1133
18.000	.394971	1007444.	46870.3346	-.0053336	1095.9910	-687.6793
24.000	.363279	1281358.	42727.9503	-.0052165	1297.8192	-693.1155
30.000	.332373	1530195.	38557.2644	-.0050726	1481.1692	-697.1132
36.000	.302407	1753785.	34367.0499	-.0049046	1645.9169	-699.6250
42.000	.273518	1952016.	30166.3703	-.0047150	1791.9796	-700.6015
48.000	.245827	2124834.	25964.5927	-.0045064	1919.3168	-699.9910
54.000	.219441	2272243.	21771.4036	-.0042814	2027.9324	-697.7387
60.000	.194451	2394311.	17596.8292	-.0040426	2117.8754	-693.7861
66.000	.170930	2491167.	13451.2613	-.0037926	2189.2418	-688.0699
72.000	.148939	2563008.	9345.4890	-.0035340	2242.1763	-680.5209
78.000	.128522	2610098.	5290.7405	-.0032693	2276.8738	-671.0620
84.000	.109708	2632774.	1298.7369	-.0030010	2293.5819	-659.6059
90.000	.092510	2631445.	-2618.2353	-.0027317	2292.6028	-646.0515
96.000	.076927	2606600.	-6447.2266	-.0024636	2274.2961	-630.2789
102.000	.062946	2558809.	-10174.4870	-.0021993	2239.0821	-612.1412
108.000	.050535	2488729.	-13785.2674	-.0019411	2187.4452	-591.4522
114.000	.039653	2397112.	-17263.5206	-.0016911	2119.9395	-567.9655
120.000	.030243	2284814.	-20591.4284	-.0014515	2037.1944	-541.3371
126.000	.022235	2152802.	-23748.6055	-.0012244	1939.9245	-511.0553
132.000	.015550	2002181.	-26710.6480	-.0010118	1828.9426	-476.2922
138.000	.010093	1834217.	-29446.1702	-.0008155	1705.1817	-435.5485

144.000	.005763	1650393.	-32169.7061	-.0006372	1569.7348	-472.2968
150.000	.002447	1449404.	-35041.2990	-.0004786	1421.6403	-484.9008
156.000	2.01E-05	1230816.	-36564.6985	-.0003415	1260.5784	-22.8990
162.000	-.001651	1011283.	-35266.5357	-.0002267	1098.8201	455.6200
168.000	-.002701	808053.	-32326.2816	-.0001336	949.0743	524.4647
174.000	-.003255	623624.	-29075.5751	-6.0385E-05	813.1818	559.1041
180.000	-.003425	459262.	-25670.1790	-4.9747E-06	692.0749	576.0279
186.000	-.003314	315592.	-22199.2672	3.4674E-05	586.2144	580.9427
192.000	-.003009	192804.	-18726.9147	6.0688E-05	495.7410	576.5081
198.000	-.002586	90752.3128	-15304.9929	7.5197E-05	420.5461	564.1325
204.000	-.002107	9000.0938	-11978.8559	8.0301E-05	360.3087	544.5798
210.000	-.001622	-53148.1361	-8796.5173	7.8042E-05	392.8382	516.1997
216.000	-.001170	-96707.9544	-5820.6946	7.0374E-05	424.9344	475.7412
222.000	-.000778	-123132.	-3104.8130	5.9125E-05	444.4041	429.5527
228.000	-.000461	-134079.	11.5841	4.5964E-05	452.4706	609.2464
234.000	-.000226	-123081.	2736.6864	3.2805E-05	444.3667	299.1211
240.000	-6.72E-05	-101302.	3900.7251	2.1324E-05	428.3194	88.8918
246.000	2.96E-05	-76313.0730	4050.0473	1.2236E-05	409.9068	-39.1177
252.000	7.96E-05	-52724.9065	3617.1259	5.6330E-06	392.5264	-105.1894
258.000	9.72E-05	-32918.3777	2916.1540	1.2508E-06	377.9324	-128.4679
264.000	9.46E-05	-17733.4601	2155.6634	-1.3410E-06	366.7437	-125.0289
270.000	8.11E-05	-7047.8419	1458.9858	-2.6090E-06	358.8702	-107.1969
276.000	6.33E-05	-220.6215	886.4607	-2.9810E-06	353.8397	-83.6447
282.000	4.53E-05	3595.4103	455.7862	-2.8083E-06	356.3263	-59.9134
288.000	2.96E-05	5254.2050	158.7450	-2.3555E-06	357.5486	-39.1003
294.000	1.71E-05	5504.8726	-26.2108	-1.8049E-06	357.7333	-22.5516
300.000	7.92E-06	4943.1410	-125.2783	-1.2703E-06	357.3194	-10.4709
306.000	1.82E-06	4003.9725	-163.8972	-8.1250E-07	356.6274	-2.4021
312.000	-1.83E-06	2977.9349	-163.8528	-4.5525E-07	355.8714	2.4169
318.000	-3.65E-06	2038.6135	-142.1452	-1.9856E-07	355.1792	4.8189
324.000	-4.21E-06	1272.5740	-110.9892	-2.9128E-08	354.6148	5.5664
330.000	-4.00E-06	706.7994	-78.4471	7.2154E-08	354.1979	5.2810
336.000	-3.35E-06	331.0702	-49.3385	1.2526E-07	353.9211	4.4219
342.000	-2.49E-06	114.4964	-26.1906	1.4806E-07	353.7615	3.2941
348.000	-1.57E-06	16.4991	-10.0881	1.5476E-07	353.6893	2.0734
354.000	-6.35E-07	-6.8579	-1.3501	1.5526E-07	353.6822	.8392831
360.000	2.94E-07	0.0000	0.0000	1.5491E-07	353.6771	-.3892561

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	.49300520 in
Computed slope at pile head	=	-.00549610
Maximum bending moment	=	2632774. lbs-in
Maximum shear force	=	65100.00000 lbs
Depth of maximum bending moment	=	84.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	27
Number of zero deflection points	=	4

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 75100.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 320000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.694873	-1.4465E-06	75100.0000	-.0073270	707.3543	-1247.3607
6.000	.650911	442215.	67556.1766	-.0073044	1033.1914	-1267.2471
12.000	.607221	838723.	60609.5802	-.0072388	1325.3498	-1048.2850
18.000	.564045	1197327.	55209.4827	-.0071346	1589.5800	-751.7475
24.000	.521605	1528634.	50678.0887	-.0069952	1833.6962	-758.7171
30.000	.480104	1832326.	46109.2196	-.0068232	2057.4654	-764.2392
36.000	.439727	2108145.	41511.7028	-.0066216	2260.6973	-768.2664
42.000	.400645	2355893.	36894.6554	-.0063931	2443.2450	-770.7494
48.000	.363009	2575431.	32267.4964	-.0061408	2605.0069	-771.6369
54.000	.326955	2766684.	27639.9618	-.0058675	2745.9276	-770.8746
60.000	.292600	2929641.	23022.1231	-.0055760	2865.9996	-768.4049
66.000	.260043	3064361.	18424.4106	-.0052693	2965.2649	-764.1659
72.000	.229369	3170968.	13857.6428	-.0049502	3043.8163	-758.0900
78.000	.200641	3249662.	9333.0633	-.0046217	3101.7998	-750.1031
84.000	.173908	3300712.	4862.3882	-.0042865	3139.4156	-740.1219
90.000	.149202	3324470.	457.8684	-.0039475	3156.9211	-728.0514
96.000	.126538	3321365.	-3867.6290	-.0036075	3154.6332	-713.7811
102.000	.105913	3291912.	-8100.5088	-.0032691	3132.9308	-697.1789
108.000	.087309	3236712.	-12226.2930	-.0029350	3092.2585	-678.0825
114.000	.070693	3156466.	-16229.3981	-.0026079	3033.1309	-656.2858
120.000	.056015	3051974.	-20092.8030	-.0022902	2956.1377	-631.5158
126.000	.043211	2924147.	-23797.5299	-.0019844	2861.9512	-603.3932
132.000	.032202	2774024.	-27321.7845	-.0016928	2751.3359	-571.3583
138.000	.022897	2602786.	-30639.4163	-.0014177	2625.1631	-534.5189
144.000	.015189	2411795.	-34048.2425	-.0011611	2484.4350	-601.7565
150.000	.008963	2198666.	-37865.9429	-.0009252	2327.3956	-670.8103
156.000	.004087	1960956.	-41562.5701	-.0007124	2152.2440	-561.3988
162.000	.000415	1702651.	-44692.3135	-.0005249	1961.9170	-481.8490
168.000	-.002212	1426664.	-44641.0873	-.0003648	1758.5620	498.9244
174.000	-.003963	1168358.	-41382.3893	-.0002320	1568.2348	587.3082
180.000	-.004996	930966.	-37721.3951	-.0001246	1393.3174	633.0232
186.000	-.005458	716180.	-33848.0500	-4.0297E-05	1235.0566	658.0918
192.000	-.005479	524944.	-29864.7118	2.3210E-05	1094.1486	669.6876
198.000	-.005179	357714.	-25842.3583	6.8374E-05	970.9287	671.0969
204.000	-.004659	214574.	-21836.8358	9.7657E-05	865.4583	664.0773
210.000	-.004007	95297.3354	-17903.2377	.0001135	777.5721	647.1221
216.000	-.003297	-701.2007	-14112.9211	.0001184	707.8709	616.3168
222.000	-.002587	-74512.1956	-10523.7655	.0001145	762.2570	580.0584
228.000	-.001923	-127426.	-7167.7490	.0001042	801.2455	538.6037
234.000	-.001337	-160925.	-4076.4504	8.9417E-05	823.9287	491.8291
240.000	-.000850	-176687.	-1283.4790	7.2142E-05	837.5423	439.1614
246.000	-.000471	-176604.	1902.3796	5.4065E-05	837.4812	622.7915
252.000	-.000201	-154066.	4567.7826	3.7145E-05	820.8745	265.6761
258.000	-2.54E-05	-121933.	5465.6265	2.3022E-05	797.1982	33.6052
264.000	7.53E-05	-88566.7956	5267.9385	1.2251E-05	772.6129	-99.5012
270.000	.000122	-58765.0073	4487.2627	4.7126E-06	750.6540	-160.7241
276.000	.000132	-34737.7399	3482.3356	-7.1817E-08	732.9501	-174.2516
282.000	.000121	-16976.7047	2480.8259	-2.7180E-06	719.8632	-159.5849
288.000	9.92E-05	-4957.3915	1608.6527	-3.8403E-06	711.0070	-131.1395
294.000	7.46E-05	2341.8744	919.2229	-3.9741E-06	709.0798	-98.6705
300.000	5.15E-05	6088.5439	418.9050	-3.5428E-06	711.8405	-68.1022
306.000	3.21E-05	7382.3392	87.1720	-2.8535E-06	712.7938	-42.4755
312.000	1.73E-05	7145.5654	-108.7763	-2.1101E-06	712.6193	-22.8406
318.000	6.81E-06	6085.1265	-204.3137	-1.4331E-06	711.8380	-9.0052
324.000	8.22E-08	4699.3041	-231.6555	-8.8129E-07	710.8169	-.1087116

330.000	-3.76E-06	3308.6447	-217.0605	-4.7154E-07	709.7922	4.9737
336.000	-5.58E-06	2096.3884	-180.0273	-1.9497E-07	708.8990	7.3707
342.000	-6.10E-06	1149.0659	-133.7164	-2.8902E-08	708.2009	8.0662
348.000	-5.92E-06	491.9025	-86.0302	5.5064E-08	707.7167	7.8292
354.000	-5.44E-06	116.4919	-40.9643	8.6195E-08	707.4401	7.1928
360.000	-4.89E-06	0.0000	0.0000	9.2156E-08	707.3543	6.4619

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

Pile-head deflection	=	.69487340 in
Computed slope at pile head	=	-.00732700
Maximum bending moment	=	3324470. lbs-in
Maximum shear force	=	75100.00000 lbs
Depth of maximum bending moment	=	90.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	27
Number of zero deflection points	=	3

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 85100.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 320000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.921556	-1.6273E-06	85100.0000	-.0092571	707.3543	-1338.5821
6.000	.866013	504279.	77001.2270	-.0092313	1078.9219	-1361.0089
12.000	.810780	959463.	69537.6401	-.0091564	1414.3146	-1126.8534
18.000	.756136	1373892.	63730.3931	-.0090370	1719.6777	-808.8956
24.000	.702335	1758930.	58851.8171	-.0088767	2003.3852	-817.2964
30.000	.649615	2114200.	53927.1794	-.0086786	2265.1586	-824.2495
36.000	.598192	2439382.	48965.3061	-.0084456	2504.7620	-829.7083
42.000	.548268	2734215.	43975.3062	-.0081808	2722.0035	-833.6250
48.000	.500022	2998500.	38966.5820	-.0078875	2916.7365	-835.9497
54.000	.453618	3232102.	33948.8417	-.0075687	3088.8611	-836.6303
60.000	.409198	3434950.	28932.1158	-.0072275	3238.3255	-835.6117
66.000	.366888	3607041.	23926.7758	-.0068672	3365.1272	-832.8350
72.000	.326792	3748441.	18943.5588	-.0064908	3469.3151	-828.2373
78.000	.288998	3859288.	13993.5975	-.0061016	3550.9905	-821.7498
84.000	.253373	3939794.	9088.4579	-.0057025	3610.3096	-813.2968
90.000	.220568	3990247.	4240.1873	-.0052967	3647.4850	-802.7934
96.000	.190012	4011016.	-538.6232	-.0048873	3662.7878	-790.1434
102.000	.161920	4002551.	-5234.7570	-.0044773	3656.5508	-775.2346
108.000	.136285	3965392.	-9834.2628	-.0040696	3629.1705	-757.9340
114.000	.113085	3900167.	-14322.3028	-.0036671	3581.1112	-738.0794
120.000	.092280	3807606.	-18682.9402	-.0032727	3512.9091	-715.4664
126.000	.073813	3688539.	-22898.8251	-.0028891	3425.1774	-689.8285

132.000	.057611	3543914.	-26950.7157	-.0025190	3318.6134	-660.8017
138.000	.043585	3374803.	-30816.7045	-.0021650	3194.0080	-627.8613
144.000	.031630	3182427.	-34868.9824	-.0018295	3052.2594	-722.8980
150.000	.021631	2963401.	-39546.0690	-.0015150	2890.8746	-836.1309
156.000	.013450	2713692.	-44323.0840	-.0012245	2706.8817	-756.2075
162.000	.006936	2436226.	-48549.1774	-.0009610	2502.4368	-652.4903
168.000	.001918	2134792.	-51952.1604	-.0007271	2280.3314	-481.8373
174.000	-.001789	1815592.	-51954.4928	-.0005250	2045.1358	481.0598
180.000	-.004382	1513354.	-48674.0717	-.0003547	1822.4378	612.4139
186.000	-.006045	1232865.	-44811.8758	-.0002141	1615.7655	674.9847
192.000	-.006952	976434.	-40655.1094	-.0001011	1426.8193	710.6041
198.000	-.007258	745392.	-36333.1175	-1.2982E-05	1256.5811	730.0598
204.000	-.007107	540486.	-31929.2094	5.2815E-05	1105.6004	737.9095
210.000	-.006624	362039.	-27514.4908	9.8996E-05	974.1152	733.6633
216.000	-.005919	209932.	-23173.5653	.0001283	862.0385	713.3119
222.000	-.005085	83463.6605	-18973.4137	.0001433	768.8527	686.7387
228.000	-.004200	-18298.8145	-14949.1738	.0001466	720.8374	654.6746
234.000	-.003326	-96489.4074	-11132.4146	.0001407	778.4505	617.5784
240.000	-.002511	-152428.	-7552.6402	.0001280	819.6678	575.6797
246.000	-.001790	-187613.	-4238.7243	.0001106	845.5927	528.9589
252.000	-.001184	-203718.	-1220.7637	9.0576E-05	857.4594	477.0279
258.000	-.000703	-202610.	1466.5679	6.9785E-05	856.6429	418.7492
264.000	-.000347	-186387.	4097.2267	4.9881E-05	844.6895	458.1370
270.000	-.000105	-153634.	5886.1686	3.2482E-05	820.5566	138.1769
276.000	4.32E-05	-115877.	6129.4325	1.8692E-05	792.7362	-57.0890
282.000	.000120	-80152.9913	5483.2496	8.6609E-06	766.4133	-158.3053
288.000	.000147	-50111.7438	4424.0323	1.9954E-06	744.2781	-194.4671
294.000	.000144	-27061.4657	3271.6609	-1.9534E-06	727.2940	-189.9567
300.000	.000124	-10844.3124	2211.3433	-3.8930E-06	715.3447	-163.4825
306.000	9.70E-05	-510.3970	1336.2760	-4.4740E-06	707.7303	-128.2066
312.000	7.00E-05	5208.1798	674.1064	-4.2336E-06	711.1918	-92.5166
318.000	4.62E-05	7595.1372	213.3960	-3.5785E-06	712.9506	-61.0536
324.000	2.70E-05	7782.6729	-77.0300	-2.7916E-06	713.0888	-35.7551
330.000	1.27E-05	6681.4972	-234.6147	-2.0515E-06	712.2774	-16.7732
336.000	2.43E-06	4975.1742	-294.5768	-1.4551E-06	711.0201	-3.2142
342.000	-4.77E-06	3152.1625	-285.2991	-1.0392E-06	709.6769	6.3068
348.000	-1.00E-05	1555.5757	-226.5706	-7.9831E-07	708.5005	13.2694
354.000	-1.44E-05	436.3811	-129.8542	-6.9638E-07	707.6758	18.9694
360.000	-1.84E-05	0.0000	0.0000	-6.7405E-07	707.3543	24.3153

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

Pile-head deflection	=	.92155560 in
Computed slope at pile head	=	-.00925714
Maximum bending moment	=	4011016. lbs-in
Maximum shear force	=	85100.00000 lbs
Depth of maximum bending moment	=	96.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	33
Number of zero deflection points	=	3

Summary of Pile Response(s)

Retaining Wall No. 10.lpo

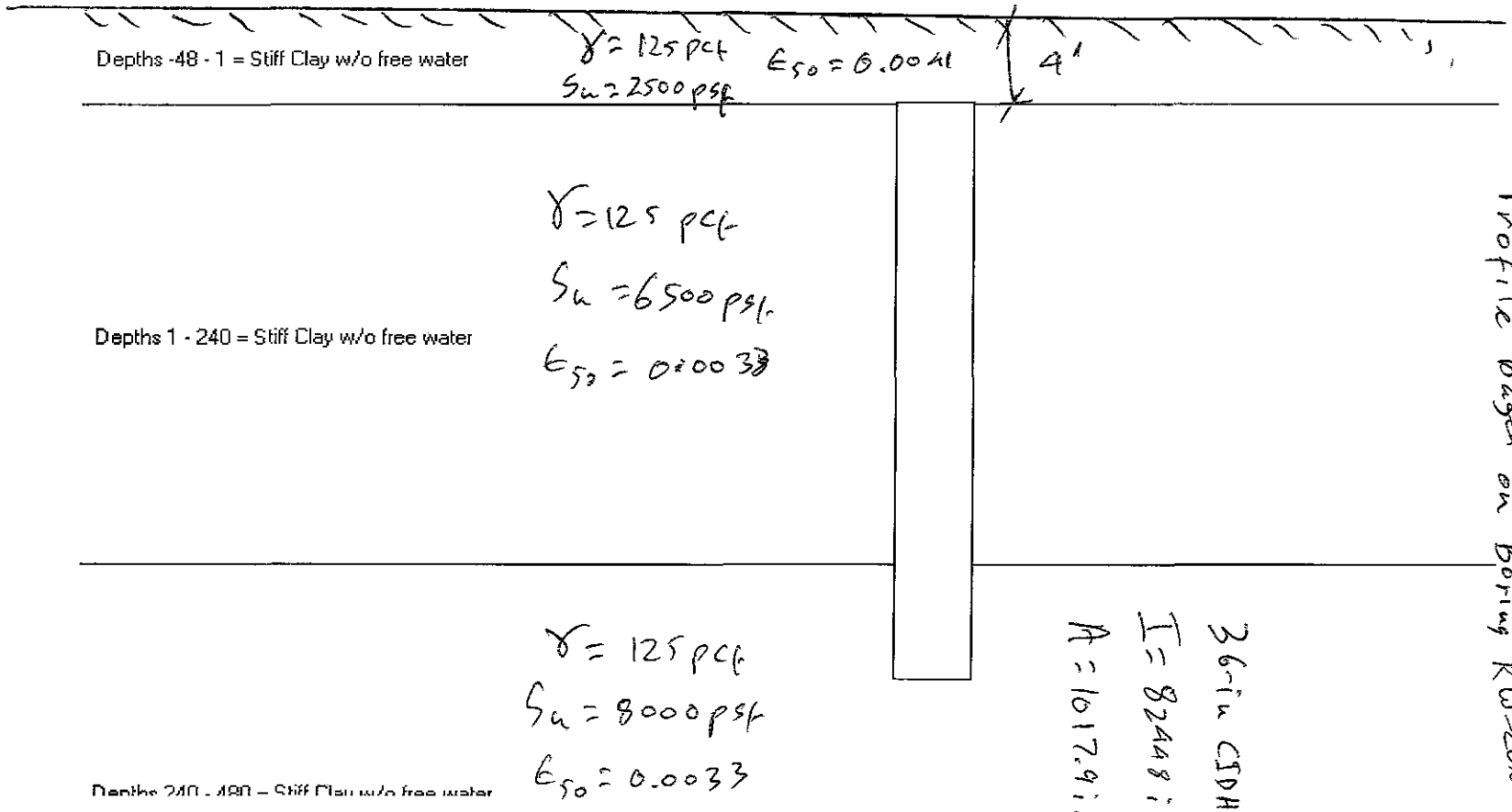
Definition of Symbols for Pile-Head Loading Conditions:

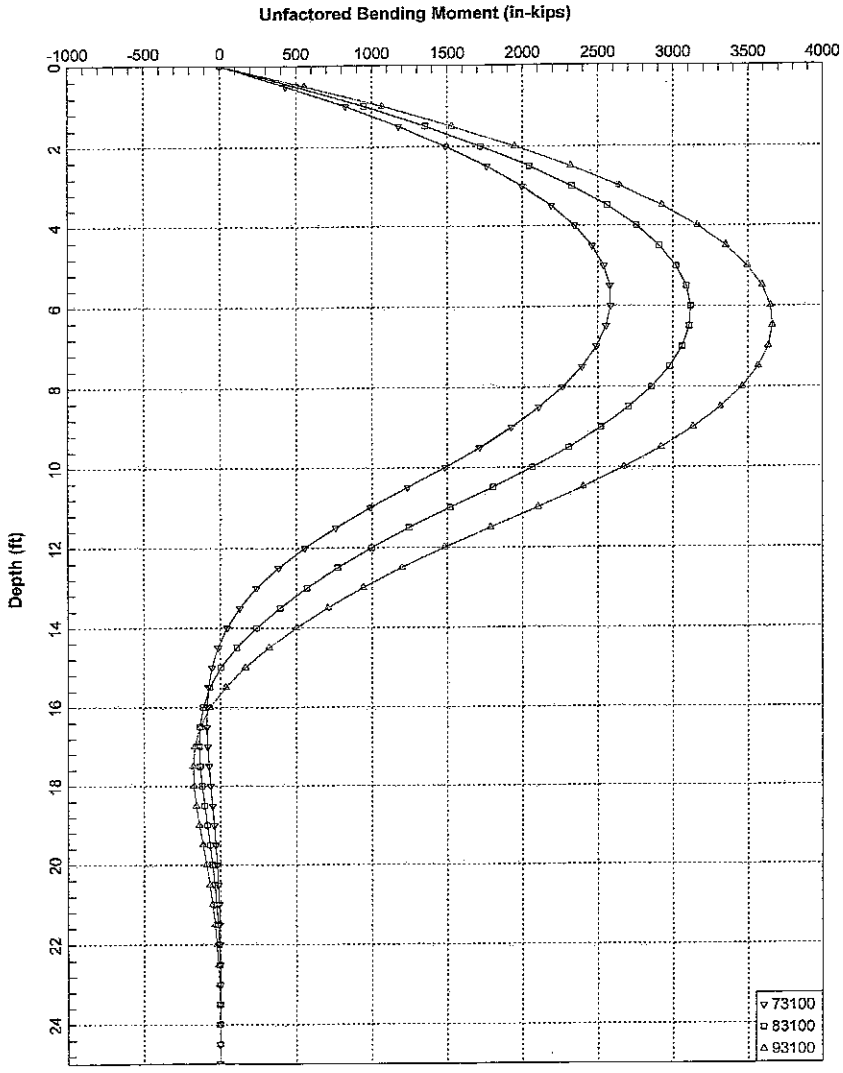
Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 65100.	M= 0.000	160000.	.4930052	2632774.	65100.0000
1	V= 75100.	M= 0.000	320000.	.6948734	3324470.	75100.0000
1	V= 85100.	M= 0.000	320000.	.9215556	4011016.	85100.0000

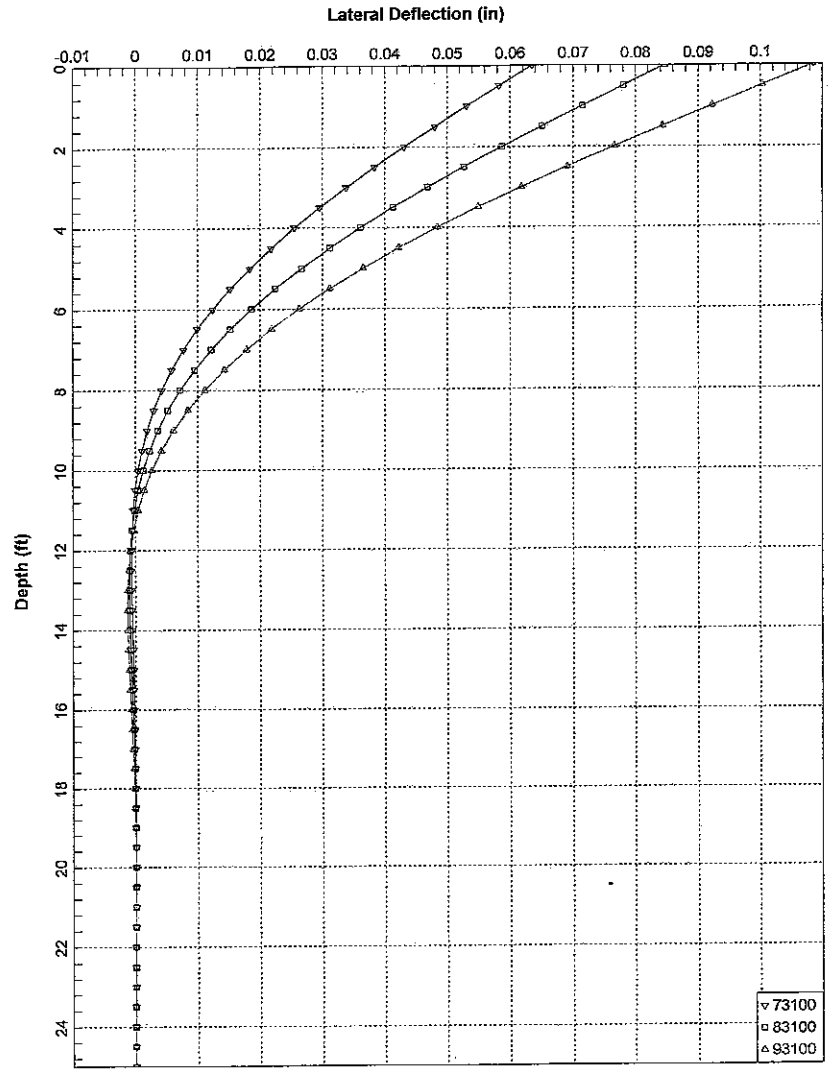
The analysis ended normally.

Retaining Wall No. 14
Profile based on Boring RW-206





SR4 Segment 3A - Retaining Wall No. 11 - 36-in. CIDH PIle



SR4 Segment 3A - REtaining Wall No. 11 - 36-in. CIDH PIle

LPILE Plus for Windows, Version 5.0 (5.0.21)

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:

Gary Parikh
Parikh Consultants

Path to file locations: S:\Ongoing Projects\2006\206117 TYLIn Rte 4 Project\Retaining and Sound Walls\LPILE\
Name of input data file: Retaining Wall No. 11.lpd
Name of output file: Retaining Wall No. 11.lpo
Name of plot output file: Retaining Wall No. 11.lpp
Name of runtime file: Retaining Wall No. 11.lpr

Time and Date of Analysis

Date: July 14, 2009 Time: 19:22:50

Problem Title

SR4- Segment 3A - Retaining Wall No. 11 - 36-in. CIDH Pile

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant 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 pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 50
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 300.00 in
Depth of ground surface below top of pile = -48.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	36.00000000	82448.0000	1017.9000	3600000.
2	300.0000	36.00000000	82448.0000	1017.9000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 3 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -48.000 in
Distance from top of pile to bottom of layer = 1.000 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 1.000 in
Distance from top of pile to bottom of layer = 240.000 in

Layer 3 is stiff clay without free water
Distance from top of pile to top of layer = 240.000 in
Distance from top of pile to bottom of layer = 480.000 in

(Depth of lowest layer extends 180.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth is defined using 6 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-48.00	.07230
2	1.00	.07230
3	1.00	.07230
4	240.00	.07230
5	240.00	.07230
6	480.00	.07230

Shear Strength of Soils

Distribution of shear strength parameters with depth defined using 6 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-48.000	17.36000	.00	.00410	.0
2	1.000	17.36000	.00	.00410	.0
3	1.000	45.14000	.00	.00330	.0
4	240.000	45.14000	.00	.00330	.0
5	240.000	55.56000	.00	.00330	.0
6	480.000	55.56000	.00	.00330	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.6000	1.0000
2	360.000	.6000	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 3

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 73100.000 lbs
Bending moment at pile head = .000 in-lbs

Axial load at pile head = 420000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 83100.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 840000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 93100.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 840000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

**** WARNING ****

An unreasonable input value for shear strength has been specified for layer 3 defined using the stiff clay without free water criteria. The input value is greater than 55.55 psi (8000 psf). You should check your input data for correctness.

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 73100.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 420000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.063490	-8.0094E-07	73100.0000	-.0008697	412.6142	-466.9414
6.000	.058272	432387.	68394.4601	-.0008653	507.0126	-1101.5719
12.000	.053106	825095.	61772.4179	-.0008526	592.7484	-1105.7755
18.000	.048041	1177953.	55133.6359	-.0008323	669.7841	-1107.1518
24.000	.043118	1490893.	48495.3543	-.0008054	738.1051	-1105.6087
30.000	.038377	1763956.	41875.3826	-.0007725	797.7200	-1101.0485
36.000	.033849	1997291.	35292.1404	-.0007344	848.6616	-1093.3656
42.000	.029564	2191163.	28764.7079	-.0006921	890.9877	-1082.4453
48.000	.025544	2345956.	22312.8906	-.0006462	924.7819	-1068.1605
54.000	.021809	2462175.	15957.3036	-.0005976	950.1548	-1050.3685
60.000	.018372	2540455.	9719.4832	-.0005471	967.2450	-1028.9050
66.000	.015244	2581566.	3622.0399	-.0004953	976.2202	-1003.5761
72.000	.012428	2586416.	-2311.1273	-.0004431	977.2791	-974.1463
78.000	.009927	2556065.	-8054.5176	-.0003911	970.6529	-940.3172
84.000	.007735	2491733.	-13580.5520	-.0003401	956.6079	-901.6943
90.000	.005846	2394813.	-18858.8083	-.0002907	935.4484	-857.7245

96.000	.004247	2266892.	-23854.7116	-.0002436	907.5209	-807.5766
102.000	.002923	2109784.	-28527.0885	-.0001993	873.2210	-749.8824
108.000	.001855	1925572.	-32823.0250	-.0001585	833.0040	-682.0964
114.000	.001020	1716707.	-36664.8305	-.0001217	787.4046	-598.5054
120.000	.000394	1486208.	-39987.5056	-8.9362E-05	737.0822	-509.0529
126.000	-5.21E-05	1237307.	-41308.9584	-6.1835E-05	682.7424	68.5683
132.000	-.000348	990812.	-39705.1510	-3.9314E-05	628.9277	466.0345
138.000	-.000524	761043.	-36166.2779	-2.1608E-05	578.7648	713.5899
144.000	-.000607	556925.	-31501.1542	-8.2865E-06	534.2018	841.4513
150.000	-.000623	383071.	-26342.6566	1.2144E-06	496.2461	878.0479
156.000	-.000593	240807.	-21161.9419	7.5202E-06	465.1871	848.8571
162.000	-.000533	129090.	-16288.1387	1.1259E-05	440.7971	775.7440
168.000	-.000458	45292.9600	-11930.7991	1.3021E-05	422.5025	676.7026
174.000	-.000377	-14145.1561	-8202.9839	1.3336E-05	415.7024	565.9025
180.000	-.000298	-53210.0610	-5143.4134	1.2655E-05	424.2310	453.9543
186.000	-.000225	-75929.8998	-2736.6093	1.1350E-05	429.1912	348.3137
192.000	-.000161	-86106.5778	-930.3827	9.7124E-06	431.4129	253.7619
198.000	-.000108	-87143.4425	349.6341	7.9613E-06	431.6393	172.9104
204.000	-6.59E-05	-81951.0942	1188.4409	6.2522E-06	430.5057	106.6919
210.000	-3.34E-05	-72913.6622	1672.9490	4.6869E-06	428.5327	54.8108
216.000	-9.69E-06	-61899.3286	1885.7899	3.3243E-06	426.1280	16.1362
222.000	6.50E-06	-50300.9375	1901.2913	2.1903E-06	423.5959	-10.9691
228.000	1.66E-05	-39094.8721	1783.2190	1.2867E-06	421.1494	-28.3883
234.000	2.19E-05	-28908.7941	1583.8957	5.9938E-07	418.9256	-38.0528
240.000	2.38E-05	-20091.1439	1337.1741	1.0412E-07	417.0005	-44.1878
246.000	2.32E-05	-12863.2296	1060.7162	-2.2897E-07	415.4225	-47.9649
252.000	2.10E-05	-7361.3957	784.5199	-4.3338E-07	414.2213	-44.1005
258.000	1.80E-05	-3446.8066	537.5636	-5.4263E-07	413.3667	-38.2182
264.000	1.45E-05	-907.8973	329.1149	-5.8664E-07	412.8124	-31.2647
270.000	1.09E-05	505.5283	163.6914	-5.9071E-07	412.7246	-23.8764
276.000	7.43E-06	1059.3762	42.7938	-5.7489E-07	412.8455	-16.4228
282.000	4.05E-06	1021.9511	-33.6518	-5.5385E-07	412.8373	-9.0591
288.000	7.89E-07	658.3463	-66.1872	-5.3687E-07	412.7579	-1.7860
294.000	-2.39E-06	230.4106	-55.0839	-5.2789E-07	412.6645	5.4871
300.000	-5.55E-06	0.0000	0.0000	-5.2556E-07	412.6142	12.8742

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	.06348975 in
Computed slope at pile head	=	-.00086965
Maximum bending moment	=	2586416. lbs-in
Maximum shear force	=	73100.00000 lbs
Depth of maximum bending moment	=	72.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	17
Number of zero deflection points	=	3

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 83100.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 840000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.084686	1.1442E-07	83100.0000	-.0011036	825.2284	-501.7888
6.000	.078064	495130.	78039.4400	-.0010986	933.3240	-1185.0645
12.000	.071503	947548.	70911.0089	-.0010841	1032.0964	-1191.0792
18.000	.065056	1356989.	63754.9445	-.0010608	1121.4856	-1194.2756
24.000	.058774	1723299.	56588.4297	-.0010296	1201.4581	-1194.5626
30.000	.052700	2046429.	49429.2116	-.0009915	1272.0037	-1191.8434
36.000	.046875	2326444.	42295.6381	-.0009473	1333.1364	-1186.0144
42.000	.041332	2563526.	35206.7037	-.0008979	1384.8959	-1176.9637
48.000	.036100	2757976.	28182.1073	-.0008441	1427.3481	-1164.5684
54.000	.031203	2910220.	21242.3279	-.0007868	1460.5859	-1148.6914
60.000	.026659	3020815.	14408.7228	-.0007269	1484.7310	-1129.1770
66.000	.022481	3090451.	7703.6610	-.0006651	1499.9340	-1105.8436
72.000	.018677	3119963.	1150.7070	-.0006023	1506.3769	-1078.4744
78.000	.015253	3110332.	-5225.1183	-.0005394	1504.2742	-1046.8007
84.000	.012205	3062698.	-11396.9523	-.0004770	1493.8750	-1010.4773
90.000	.009529	2978376.	-17335.4972	-.0004159	1475.4657	-969.0377
96.000	.007214	2858865.	-23008.0575	-.0003569	1449.3741	-921.8157
102.000	.005246	2705877.	-28376.8684	-.0003007	1415.9739	-867.7879
108.000	.003606	2521373.	-33395.9257	-.0002478	1375.6931	-805.2312
114.000	.002272	2307624.	-38004.1551	-.0001990	1329.0276	-730.8453
120.000	.001218	2067329.	-42107.3293	-.0001548	1276.5666	-636.8795
126.000	.000414	1803896.	-45652.8601	-.0001157	1219.0541	-544.9641
132.000	-.000170	1520661.	-46603.2814	-8.2075E-05	1157.2183	228.1570
138.000	-.000571	1245484.	-43586.9963	-5.4116E-05	1097.1419	777.2713
144.000	-.000820	998163.	-39400.7111	-3.1439E-05	1043.1467	618.1571
150.000	-.000948	772993.	-35590.7789	-1.3537E-05	993.9878	651.8203
156.000	-.000982	571210.	-31629.7015	4.9086E-08	949.9346	668.5388
162.000	-.000947	393436.	-27604.1834	9.7991E-06	911.1231	673.3006
168.000	-.000865	239861.	-23578.3385	1.6200E-05	877.5947	668.6477
174.000	-.000753	110333.	-19604.1234	1.9740E-05	849.3161	656.0907
180.000	-.000628	4412.2986	-14763.6735	2.0899E-05	826.1917	957.3926
186.000	-.000502	-67042.2330	-9559.1714	2.0266E-05	839.8650	777.4414
192.000	-.000385	-110502.	-5413.5873	1.8472E-05	849.3532	604.4199
198.000	-.000280	-132191.	-2258.4203	1.6019E-05	854.0884	447.3024
204.000	-.000192	-137765.	17.3312	1.3290E-05	855.3051	311.2814
210.000	-.000121	-132117.	1546.9330	1.0563E-05	854.0722	198.3858
216.000	-6.56E-05	-119308.	2470.4172	8.0213E-06	851.2756	109.2422
222.000	-2.47E-05	-102553.	2923.3846	5.7788E-06	847.6178	41.7469
228.000	3.72E-06	-84285.4651	3029.5240	3.8904E-06	843.6296	-6.3671
234.000	2.20E-05	-66238.2429	2896.1996	2.3690E-06	839.6895	-38.0744
240.000	3.21E-05	-49554.9490	2602.7801	1.1986E-06	836.0472	-59.7321
246.000	3.63E-05	-35016.9637	2198.1112	3.4380E-07	832.8733	-75.1575
252.000	3.63E-05	-23181.0805	1744.4864	-2.4443E-07	830.2893	-76.0508
258.000	3.34E-05	-14080.6631	1303.4332	-6.2105E-07	828.3025	-70.9670
264.000	2.88E-05	-7533.6221	904.3964	-8.3951E-07	826.8731	-62.0453
270.000	2.33E-05	-3219.4442	565.6397	-9.4819E-07	825.9313	-50.8736
276.000	1.74E-05	-736.3876	297.4269	-9.8818E-07	825.3892	-38.5307
282.000	1.15E-05	359.6391	104.8626	-9.9199E-07	825.3069	-25.6574
288.000	5.54E-06	531.9630	-9.7514	-9.8297E-07	825.3445	-12.5473
294.000	-3.26E-07	252.5302	-45.1493	-9.7505E-07	825.2835	.7480111
300.000	-6.16E-06	0.0000	0.0000	-9.7249E-07	825.2284	14.3018

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

Pile-head deflection	=	.08468626 in
Computed slope at pile head	=	-.00110364
Maximum bending moment	=	3119963. lbs-in
Maximum shear force	=	83100.00000 lbs
Depth of Maximum bending moment	=	72.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	19
Number of zero deflection points	=	3

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 93100.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 840000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.108426	2.0596E-06	93100.0000	-.0013531	825.2284	-533.7594
6.000	.100307	555812.	87713.6222	-.0013475	946.5730	-1261.6999
12.000	.092256	1066146.	80120.2852	-.0013311	1057.9888	-1269.4124
18.000	.084334	1530673.	72489.0965	-.0013049	1159.4041	-1274.3171
24.000	.076598	1949168.	64837.1741	-.0012697	1250.7697	-1276.3237
30.000	.069098	2321518.	57182.1911	-.0012265	1332.0608	-1275.3373
36.000	.061879	2647718.	49542.4084	-.0011763	1403.2767	-1271.2570
42.000	.054982	2927883.	41936.7145	-.0011199	1464.4422	-1263.9744
48.000	.048440	3162248.	34384.6760	-.0010584	1515.6085	-1253.3718
54.000	.042282	3351168.	26906.6033	-.0009926	1556.8535	-1239.3192
60.000	.036529	3495132.	19523.6337	-.0009234	1588.2836	-1221.6707
66.000	.031201	3594759.	12257.8439	-.0008517	1610.0342	-1200.2593
72.000	.026309	3650811.	5133.3994	-.0007785	1622.2714	-1174.8889
78.000	.021860	3664195.	-1828.2359	-.0007046	1625.1933	-1145.3229
84.000	.017855	3635974.	-8598.0022	-.0006307	1619.0321	-1111.2659
90.000	.014291	3567377.	-15148.8017	-.0005579	1604.0560	-1072.3340
96.000	.011160	3459812.	-21449.8164	-.0004869	1580.5726	-1028.0042
102.000	.008448	3314887.	-27466.3935	-.0004184	1548.9326	-977.5215
108.000	.006139	3134433.	-33158.1004	-.0003532	1509.5360	-919.7142
114.000	.004209	2920550.	-38475.0015	-.0002920	1462.8413	-852.5862
120.000	.002634	2675677.	-43349.5221	-.0002355	1409.3806	-772.2540
126.000	.001383	2402730.	-47674.2978	-.0001842	1349.7910	-669.3379
132.000	.000424	2105441.	-51386.1356	-.0001386	1284.8872	-567.9414
138.000	-.000280	1787493.	-51947.3694	-9.9238E-05	1215.4728	380.8635
144.000	-.000767	1483073.	-48981.3965	-6.6181E-05	1149.0121	607.7942
150.000	-.001074	1200383.	-45140.7991	-3.9059E-05	1087.2954	672.4049
156.000	-.001235	941778.	-40999.7961	-1.7407E-05	1030.8367	707.9294
162.000	-.001283	708561.	-36697.2455	-7.2637E-07	979.9211	726.2541
168.000	-.001244	501418.	-32321.6735	1.1503E-05	934.6977	732.2699
174.000	-.001145	320585.	-27939.4196	1.9812E-05	895.2184	728.4814
180.000	-.001006	165945.	-23604.9425	2.4729E-05	861.4575	716.3442
186.000	-.000848	37076.5962	-19365.5229	2.6781E-05	833.3230	696.7957
192.000	-.000685	-66711.0852	-14045.8323	2.6482E-05	839.7927	1076.4345
198.000	-.000530	-131740.	-8280.2497	2.4476E-05	853.9899	845.4264
204.000	-.000391	-166321.	-3844.7741	2.1463E-05	861.5395	633.0655
210.000	-.000273	-178094.	-603.5218	1.7982E-05	864.1098	447.3519
216.000	-.000175	-173744.	1614.7471	1.4426E-05	863.1602	292.0710
222.000	-9.94E-05	-158862.	2994.4820	1.1064E-05	859.9112	167.8406
228.000	-4.27E-05	-137922.	3717.1336	8.0644E-06	855.3395	73.0433
234.000	-2.66E-06	-114338.	3950.1207	5.5148E-06	850.1906	4.6191
240.000	2.35E-05	-90576.2024	3833.0358	3.4436E-06	845.0030	-43.6474
246.000	3.87E-05	-68376.3821	3462.1914	1.8370E-06	840.1563	-79.9674
252.000	4.55E-05	-49048.4222	2935.8846	6.5016E-07	835.9366	-95.4682
258.000	4.65E-05	-33152.3209	2353.3327	-1.8067E-07	832.4662	-98.7157
264.000	4.34E-05	-20806.6086	1777.1080	-7.2606E-07	829.7709	-93.3592
270.000	3.77E-05	-11819.7064	1250.0550	-1.0558E-06	827.8089	-82.3252
276.000	3.07E-05	-5795.3063	799.6528	-1.2339E-06	826.4936	-67.8089
282.000	2.29E-05	-2211.4348	442.2543	-1.3148E-06	825.7112	-51.3240
288.000	1.49E-05	-475.0010	186.8948	-1.3419E-06	825.3321	-33.7959
294.000	6.84E-06	44.8301	38.4525	-1.3463E-06	825.2382	-15.6849
300.000	-1.24E-06	0.0000	0.0000	-1.3458E-06	825.2284	2.8674

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

Pile-head deflection	=	.10842588 in
Computed slope at pile head	=	-.00135312
Maximum bending moment	=	3664195. lbs-in
Maximum shear force	=	93100.00000 lbs
Depth of maximum bending moment	=	78.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	20
Number of zero deflection points	=	3

Summary of Pile Response(s)

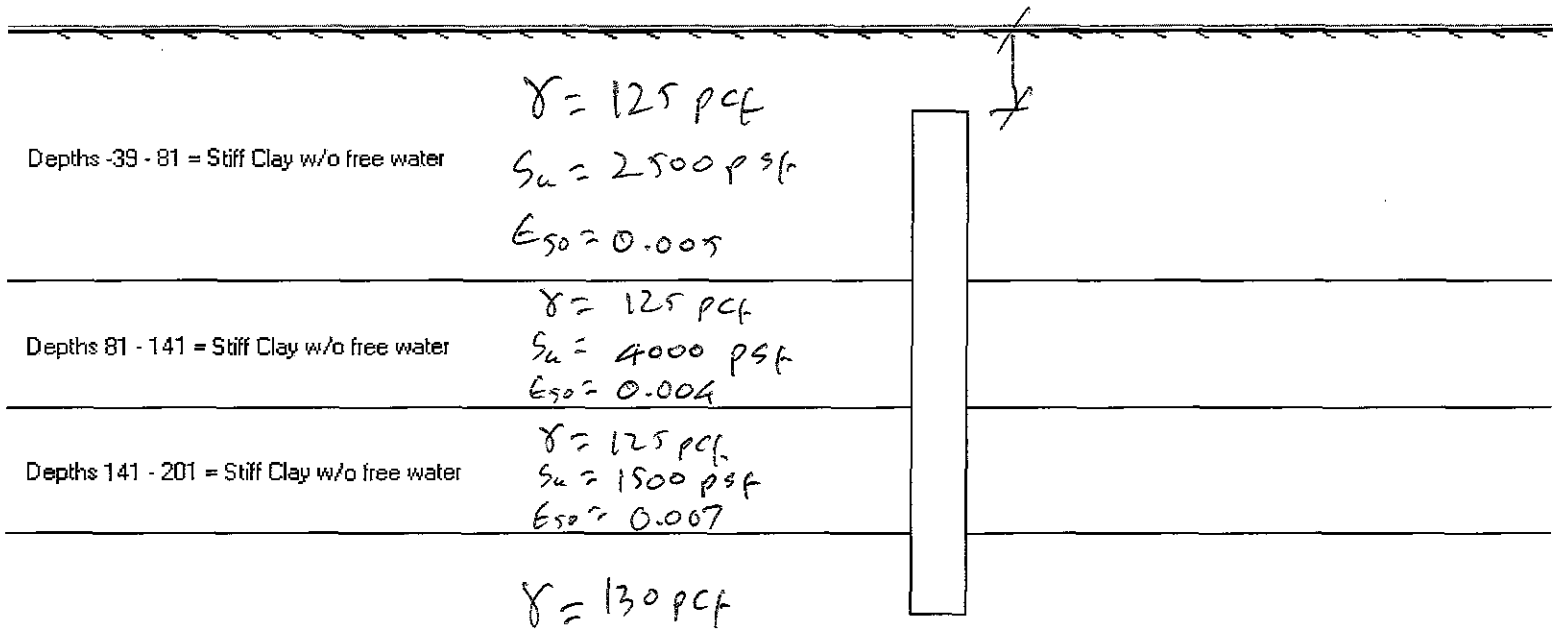
Definition of Symbols for Pile-Head Loading Conditions:

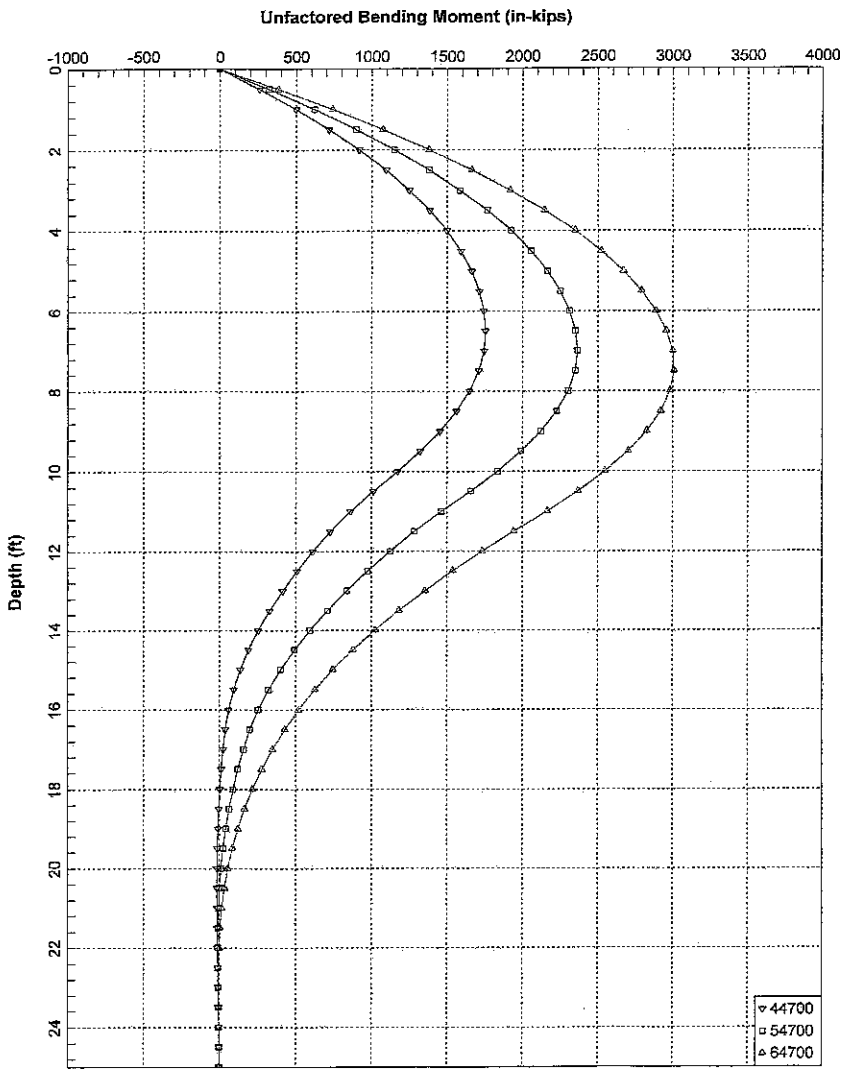
Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 73100.	M= 0.000	420000.	.0634897	2586416.	73100.0000
1	V= 83100.	M= 0.000	840000.	.0846863	3119963.	83100.0000
1	V= 93100.	M= 0.000	840000.	.1084259	3664195.	93100.0000

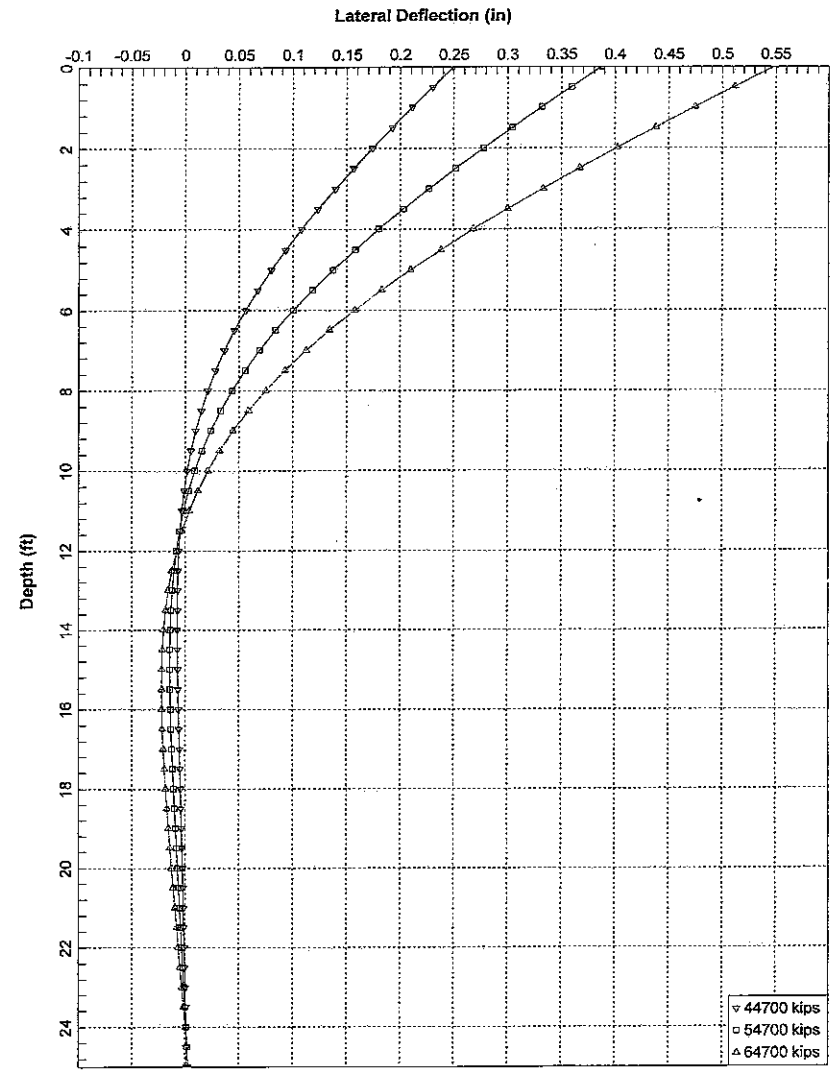
Retaining Wall No. 12
Profile based on Boring RW-210

24-in. CEDH Pile
$I = 16286 \text{ in}^4$
$A = 452.39 \text{ in}^2$





SR4 Segment 3A - Retaining Wall No. 12 - 24-in. CIDH Pile



SR4 Segment 3A - Retaining Wall No. 12 - 24-in. CIDH Pile

LPILE Plus for Windows, Version 5.0 (5.0.21)

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:

Gary Parikh
Parikh Consultants

Path to file locations: S:\Ongoing Projects\2006\206117 TYLIn Rte 4 Project\Retaining and Sound Walls\LPILE\
Name of input data file: Retaining Wall No. 12.lpd
Name of output file: Retaining Wall No. 12.lpo
Name of plot output file: Retaining Wall No. 12.lpp
Name of runtime file: Retaining Wall No. 12.lpr

Time and Date of Analysis

Date: July 14, 2009 Time: 18:55:50

Problem Title

SR4- Segment 3A - Retaining Wall No. 12 - 24-in. CIDH PIle

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant 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 pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 50
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 300.00 in
Depth of ground surface below top of pile = -39.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	24.00000000	16286.0000	452.3900	3600000.
2	300.0000	24.00000000	16286.0000	452.3900	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -39.000 in
Distance from top of pile to bottom of layer = 81.000 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 81.000 in
Distance from top of pile to bottom of layer = 141.000 in

Layer 3 is stiff clay without free water
Distance from top of pile to top of layer = 141.000 in
Distance from top of pile to bottom of layer = 201.000 in

Layer 4 is sand, p-y criteria by API RP-2A, 1987
Distance from top of pile to top of layer = 201.000 in
Distance from top of pile to bottom of layer = 480.000 in
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 180.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth is defined using 8 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-39.00	.07230
2	81.00	.07230
3	81.00	.07230
4	141.00	.07230
5	141.00	.07230
6	201.00	.07230
7	201.00	.07520
8	480.00	.07520

Shear Strength of Soils

Distribution of shear strength parameters with depth defined using 8 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-39.000	17.36000	.00	.00500	.0
2	81.000	17.36000	.00	.00500	.0
3	81.000	27.78000	.00	.00400	.0
4	141.000	27.78000	.00	.00400	.0
5	141.000	10.42000	.00	.00700	.0
6	201.000	10.42000	.00	.00700	.0
7	201.000	.00000	35.00	------	------
8	480.000	.00000	35.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.7000	1.0000
2	360.000	.7000	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 3

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 44700.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 90000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 54700.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 180000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 64700.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 180000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 44700.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 90000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.249518	1.2657E-06	44700.0000	-.0031946	198.9434	-553.5612
6.000	.230350	259961.	41350.0615	-.0031813	390.4902	-563.0850
12.000	.211342	499637.	37947.4148	-.0031424	567.0902	-571.1306
18.000	.192641	718724.	34501.1188	-.0030801	728.5200	-577.6347
24.000	.174381	916976.	31020.6214	-.0029964	874.5984	-582.5311
30.000	.156684	1094207.	27515.7802	-.0028935	1005.1873	-585.7493
36.000	.139659	1250291.	23996.8898	-.0027735	1120.1941	-587.2141
42.000	.123402	1385165.	20474.7174	-.0026387	1219.5737	-586.8433
48.000	.107996	1498837.	16960.5501	-.0024911	1303.3303	-584.5458
54.000	.093509	1591382.	13466.2565	-.0023330	1371.5204	-580.2187
60.000	.080000	1662952.	10004.3708	-.0021665	1424.2548	-573.7432
66.000	.067512	1713775.	6588.2069	-.0019937	1461.7025	-564.9781
72.000	.056076	1744163.	3232.0195	-.0018167	1484.0939	-553.7510
78.000	.045711	1754521.	-48.7633	-.0016377	1491.7256	-539.8433

84.000	.036423	1745347.	-3870.1669	-.0014586	1484.9660	-733.9579
90.000	.028207	1709654.	-8195.3037	-.0012818	1458.6665	-707.7543
96.000	.021041	1648388.	-12345.4628	-.0011100	1413.5236	-675.6321
102.000	.014887	1562707.	-16280.5603	-.0009457	1350.3919	-636.0671
108.000	.009693	1454042.	-19947.1815	-.0007913	1270.3243	-586.1400
114.000	.005391	1324196.	-23262.6631	-.0006492	1174.6496	-519.0205
120.000	.001903	1175592.	-26050.4565	-.0005213	1065.1536	-410.2439
126.000	-.000864	1012153.	-26251.7353	-.0004093	944.7276	343.1510
132.000	-.003009	861013.	-23779.6727	-.0003135	833.3628	480.8698
138.000	-.004626	727136.	-20693.5341	-.0002322	734.7184	547.8430
144.000	-.005796	612941.	-18240.3373	-.0001636	650.5763	269.8893
150.000	-.006589	508429.	-16594.5403	-.0001063	573.5684	278.7098
156.000	-.007071	413921.	-14907.3703	-5.9068E-05	503.9328	283.6803
162.000	-.007298	329604.	-13198.5025	-2.1023E-05	441.8052	285.9423
168.000	-.007323	255562.	-11482.0969	8.9191E-06	387.2490	286.1929
174.000	-.007191	191809.	-9768.8192	3.1810E-05	340.2740	284.8997
180.000	-.006941	138302.	-8066.9286	4.8702E-05	300.8483	282.3972
186.000	-.006607	94953.4200	-6382.9367	6.0637E-05	268.9078	278.9334
192.000	-.006214	61641.2342	-4722.0580	6.8650E-05	244.3624	274.6928
198.000	-.005783	38214.5823	-3088.5642	7.3759E-05	227.1010	269.8051
204.000	-.005329	24498.8033	-2083.2791	7.6968E-05	216.9948	65.2899
210.000	-.004859	13132.1078	-1703.2796	7.8894E-05	208.6195	61.3766
216.000	-.004382	3974.2432	-1348.1397	7.9769E-05	201.8717	57.0034
222.000	-.003902	-3131.7198	-1020.4203	7.9812E-05	201.2509	52.2365
228.000	-.003424	-8356.9974	-722.3114	7.9224E-05	205.1011	47.1332
234.000	-.002951	-11885.0197	-455.6889	7.8189E-05	207.7006	41.7410
240.000	-.002486	-13909.7082	-222.1737	7.6869E-05	209.1925	36.0974
246.000	-.002029	-14634.1226	-23.1945	7.5408E-05	209.7262	30.2290
252.000	-.001581	-14269.4837	139.9498	7.3929E-05	209.4576	24.1524
258.000	-.001142	-13034.5684	266.0302	7.2532E-05	208.5476	17.8743
264.000	-.000711	-11155.4564	353.8308	7.1294E-05	207.1631	11.3925
270.000	-.000286	-8865.5969	402.0997	7.0270E-05	205.4758	4.6971
276.000	.000133	-6406.1512	409.5080	6.9489E-05	203.6636	-2.2277
282.000	.000548	-4026.5484	374.6200	6.8955E-05	201.9103	-9.4017
288.000	.000960	-1985.1829	295.8771	6.8647E-05	200.4061	-16.8460
294.000	.001371	-550.1623	171.5985	6.8517E-05	199.3488	-24.5802
300.000	.001782	0.0000	0.0000	6.8489E-05	198.9434	-32.6192

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	.24951787 in
Computed slope at pile head	=	-.00319460
Maximum bending moment	=	1754521. lbs-in
Maximum shear force	=	44700.00000 lbs
Depth of maximum bending moment	=	78.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	27
Number of zero deflection points	=	2

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 54700.000 lbs

Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 180000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.387181	-1.0849E-06	54700.0000	-.0046239	397.8868	-617.8209
6.000	.359438	322073.	50958.5571	-.0046074	635.1996	-629.3267
12.000	.331892	621455.	47152.5601	-.0045591	855.7927	-639.3389
18.000	.304728	897752.	43291.1619	-.0044814	1059.3763	-647.7938
24.000	.278115	1150529.	39383.9063	-.0043766	1245.7034	-654.6247
30.000	.252209	1379812.	35440.7479	-.0042471	1414.5724	-659.7614
36.000	.227150	1585091.	31472.0782	-.0040954	1565.8283	-663.1285
42.000	.203064	1766323.	27488.7593	-.0039239	1699.3650	-664.6445
48.000	.180063	1923432.	23502.1667	-.0037351	1815.1276	-664.2197
54.000	.158243	2056417.	19524.2465	-.0035315	1913.1146	-661.7537
60.000	.137685	2165351.	15567.5899	-.0033155	1993.3805	-657.1319
66.000	.118457	2250389.	11645.5331	-.0030895	2056.0392	-650.2204
72.000	.100611	2311771.	7772.2946	-.0028561	2101.2669	-640.8591
78.000	.084184	2349826.	3963.1657	-.0026175	2129.3070	-628.8505
84.000	.069201	2364983.	-508.3032	-.0023763	2140.4749	-861.6391
90.000	.055669	2348859.	-5609.6256	-.0021351	2128.5946	-838.8017
96.000	.043580	2302279.	-10557.3243	-.0018971	2094.2730	-810.4312
102.000	.032904	2226269.	-15314.9240	-.0016654	2038.2666	-775.4353
108.000	.023595	2122097.	-19837.1463	-.0014429	1961.5097	-731.9721
114.000	.015589	1991340.	-24062.6557	-.0012324	1865.1639	-676.5310
120.000	.008806	1836007.	-27895.1023	-.0010366	1750.7103	-600.9512
126.000	.003151	1658837.	-31126.3015	-.0008577	1620.1665	-476.1152
132.000	-.001486	1464344.	-31346.0752	-.0006979	1476.8583	402.8573
138.000	-.005224	1284192.	-28443.0139	-.0005573	1344.1169	564.8299
144.000	-.008174	1124232.	-25866.0624	-.0004340	1226.2535	294.3540
150.000	-.010433	974737.	-24045.5619	-.0003266	1116.1012	312.6795
156.000	-.012093	836390.	-22134.1641	-.0002340	1014.1637	324.4531
162.000	-.013240	709632.	-20165.1209	-.0001549	920.7644	331.8946
168.000	-.013952	594744.	-18160.6261	-8.8117E-05	836.1112	336.2703
174.000	-.014298	491895.	-16136.7933	-3.2515E-05	760.3293	338.3406
180.000	-.014342	401172.	-14105.9590	1.3182E-05	693.4822	338.6041
186.000	-.014140	322595.	-12077.9272	5.0217E-05	635.5842	337.4065
192.000	-.013739	256129.	-10060.7240	7.9829E-05	586.6098	334.9946
198.000	-.013182	201694.	-8061.1069	.0001033	546.5007	331.5445
204.000	-.012500	159172.	-6607.0764	.0001217	515.1696	153.1324
210.000	-.011721	122146.	-5703.6130	.0001361	487.8875	148.0221
216.000	-.010867	90434.9649	-4835.5074	.0001470	464.5219	141.3464
222.000	-.009957	63802.4069	-4011.6256	.0001549	444.8983	133.2808
228.000	-.009008	41960.9074	-3239.8211	.0001603	428.8048	123.9873
234.000	-.008033	24578.3138	-2527.0257	.0001637	415.9968	113.6111
240.000	-.007044	11283.0045	-1879.3580	.0001655	406.2004	102.2781
246.000	-.006047	1668.4602	-1302.2450	.0001662	399.1161	90.0929
252.000	-.005049	-4702.9249	-800.5527	.0001660	401.3520	77.1379
258.000	-.004054	-8296.8266	-378.7192	.0001654	404.0001	63.4733
264.000	-.003065	-9604.7718	-40.8853	.0001645	404.9639	49.1380
270.000	-.002081	-9142.6885	208.9814	.0001635	404.6234	34.1509
276.000	-.001103	-7450.1621	366.9765	.0001627	403.3763	18.5141
282.000	-.000129	-5090.3030	429.1678	.0001620	401.8375	2.2163
288.000	.000841	-2650.0947	391.5284	.0001616	399.8394	-14.7628
294.000	.001810	-741.0538	249.9009	.0001614	398.4328	-32.4464
300.000	.002779	0.0000	0.0000	.0001614	397.8868	-50.8539

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

Pile-head deflection	=	.38718124 in
Computed slope at pile head	=	-.00462390
Maximum bending moment	=	2364983. lbs-in
Maximum shear force	=	54700.00000 lbs
Depth of maximum bending moment	=	84.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	30
Number of zero deflection points	=	2

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 64700.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 180000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total stress lbs/in**2	Soil Res p lbs/in
0.000	.548874	-1.4465E-06	64700.0000	-.0062107	397.8868	-674.1404
6.000	.511610	382773.	60615.4098	-.0061911	679.9251	-687.3896
12.000	.474580	740758.	56455.8541	-.0061337	943.6987	-699.1289
18.000	.438006	1073492.	52230.5847	-.0060408	1188.8670	-709.2942
24.000	.402090	1380573.	47949.2461	-.0059153	1415.1333	-717.8187
30.000	.367023	1661660.	43621.8945	-.0057596	1622.2463	-724.6319
36.000	.332975	1916476.	39259.0228	-.0055765	1810.0025	-729.6587
42.000	.300105	2144813.	34871.5922	-.0053687	1978.2479	-732.8182
48.000	.268551	2346532.	30471.0721	-.0051389	2126.8800	-734.0219
54.000	.238438	2521566.	26069.4920	-.0048898	2255.8504	-733.1715
60.000	.209874	2669928.	21679.5083	-.0046241	2365.1675	-730.1564
66.000	.182949	2791709.	17314.4928	-.0043447	2454.8981	-724.8486
72.000	.157738	2887086.	12988.6493	-.0040541	2525.1761	-717.0990
78.000	.134299	2956329.	8717.1743	-.0037551	2576.1964	-706.7260
84.000	.112676	2999803.	3677.0884	-.0034503	2608.2294	-973.3026
90.000	.092895	3007907.	-2102.8164	-.0031429	2614.2004	-953.3323
96.000	.074961	2981358.	-7747.0935	-.0028365	2594.6385	-928.0934
102.000	.058858	2921069.	-13221.6009	-.0025344	2550.2153	-896.7424
108.000	.044548	2828173.	-18485.7355	-.0022403	2481.7674	-857.9691
114.000	.031975	2704079.	-23488.2942	-.0019572	2390.3309	-809.5504
120.000	.021062	2550541.	-28158.5651	-.0016883	2277.2001	-747.2065
126.000	.011715	2369823.	-32382.4944	-.0014365	2144.0413	-660.7699
132.000	.003823	2165054.	-35898.6976	-.0012045	1993.1620	-511.2979
138.000	-.002739	1941640.	-35991.2899	-.0009944	1828.5438	480.4338
144.000	-.008109	1735307.	-33669.2866	-.0008062	1676.5114	293.5674
150.000	-.012413	1539350.	-31808.8582	-.0006387	1532.1248	326.5754
156.000	-.015773	1354980.	-29788.9078	-.0004906	1396.2755	346.7414
162.000	-.018300	1182943.	-27669.0574	-.0003607	1269.5135	359.8754
168.000	-.020101	1023730.	-25484.1534	-.0002478	1152.2011	368.4259
174.000	-.021273	877668.	-23257.8110	-.0001505	1044.5782	373.6882
180.000	-.021907	744962.	-21007.4185	-6.7463E-05	946.7962	376.4426
186.000	-.022083	625725.	-18746.4938	2.6727E-06	858.9390	377.1990

192.000	-.021875	519998.	-16485.9700	6.1298E-05	781.0364	376.3089
198.000	-.021347	427761.	-14234.9789	.0001098	713.0734	374.0214
204.000	-.020557	348941.	-12357.6946	.0001495	654.9967	251.7400
210.000	-.019553	279145.	-10861.9261	.0001817	603.5692	246.8495
216.000	-.018377	218205.	-9404.4686	.0002071	558.6669	238.9697
222.000	-.017068	165844.	-8002.3429	.0002268	520.0858	228.4056
228.000	-.015656	121688.	-6670.7854	.0002415	487.5497	215.4469
234.000	-.014170	85273.3336	-5423.3614	.0002521	460.7187	200.3611
240.000	-.012631	56062.7095	-4272.1137	.0002593	439.1954	183.3881
246.000	-.011058	33447.8608	-3227.7419	.0002639	422.5321	164.7358
252.000	-.009464	16759.8056	-2299.8011	.0002665	410.2359	144.5778
258.000	-.007861	5274.6974	-1496.9136	.0002676	401.7733	123.0514
264.000	-.006253	-1781.1434	-826.9836	.0002678	399.1992	100.2586
270.000	-.004647	-5227.4773	-297.4059	.0002674	401.7385	76.2673
276.000	-.003044	-5927.6116	84.7396	.0002668	402.2544	51.1146
282.000	-.001445	-4786.9659	312.5193	.0002663	401.4140	24.8120
288.000	.000151	-2752.5603	379.0100	.0002659	399.9149	-2.6484
294.000	.001746	-813.1921	277.2094	.0002657	398.4860	-31.2852
300.000	.003340	0.0000	0.0000	.0002657	397.8868	-61.1180

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

Pile-head deflection	=	.54887411 in
Computed slope at pile head	=	-.00621074
Maximum bending moment	=	3007907. lbs-in
Maximum shear force	=	64700.00000 lbs
Depth of maximum bending moment	=	90.00000000 in
Depth of maximum shear force	=	0.00000 in
Number of iterations	=	32
Number of zero deflection points	=	2

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

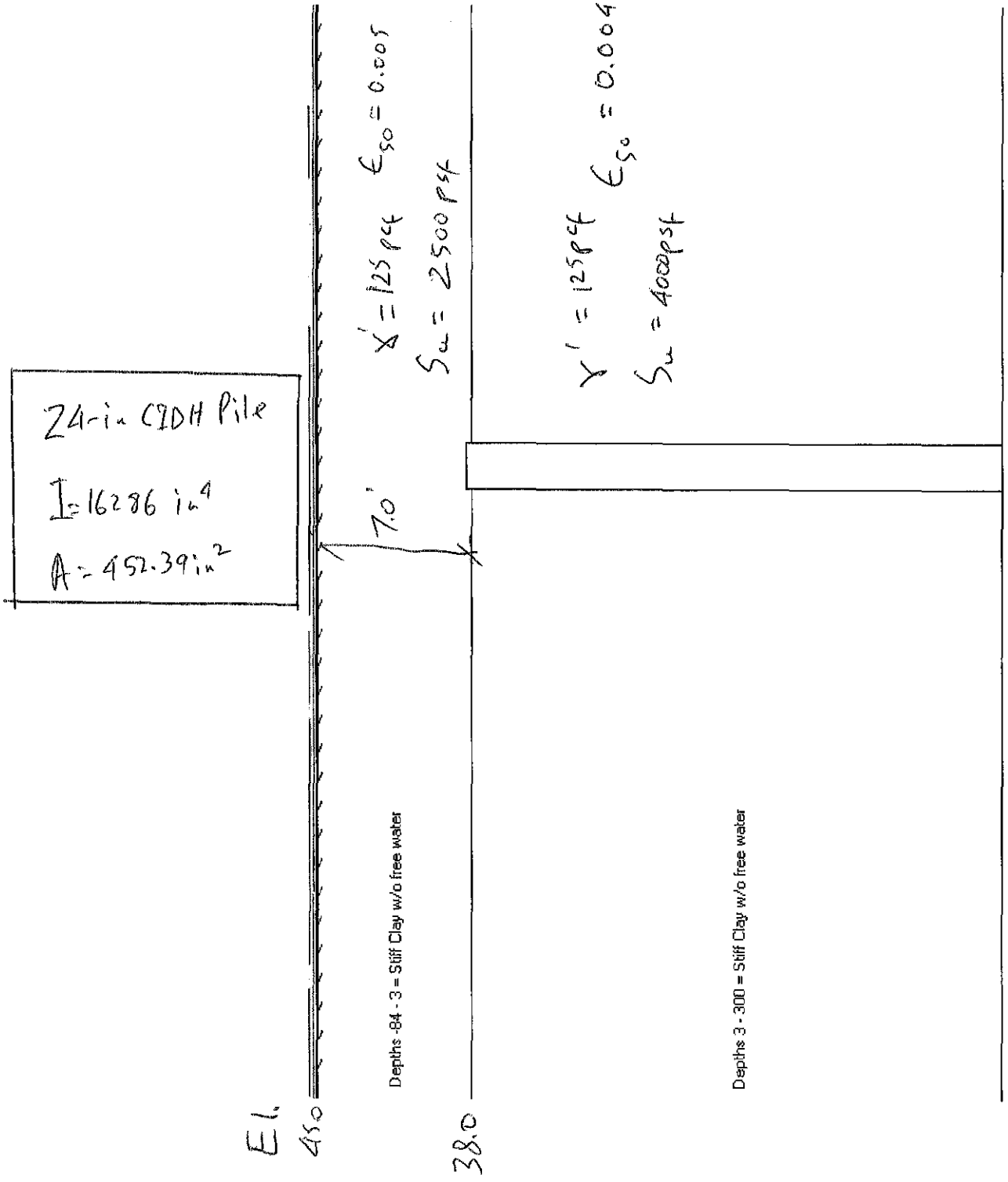
Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

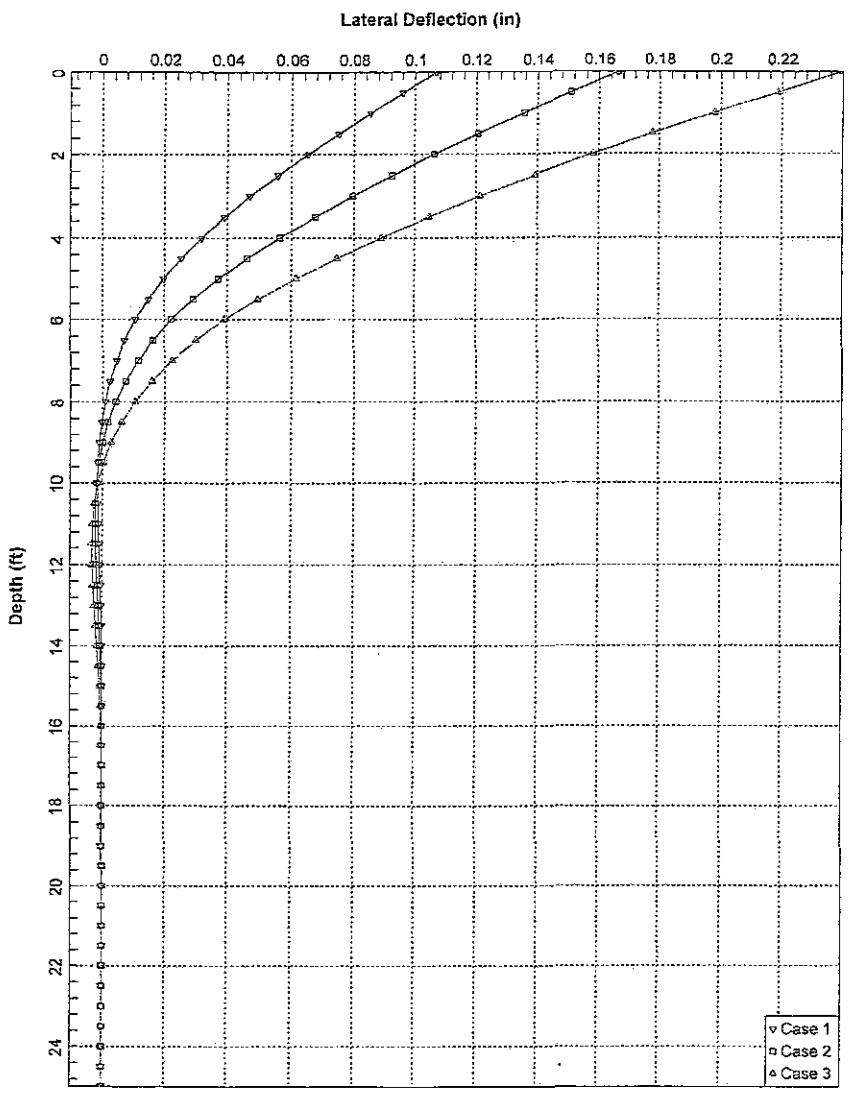
Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 44700. M=	0.000	90000.0000	.2495179	1754521.	44700.0000
1	V= 54700. M=	0.000	180000.	.3871812	2364983.	54700.0000
1	V= 64700. M=	0.000	180000.	.5488741	3007907.	64700.0000

The analysis ended normally.

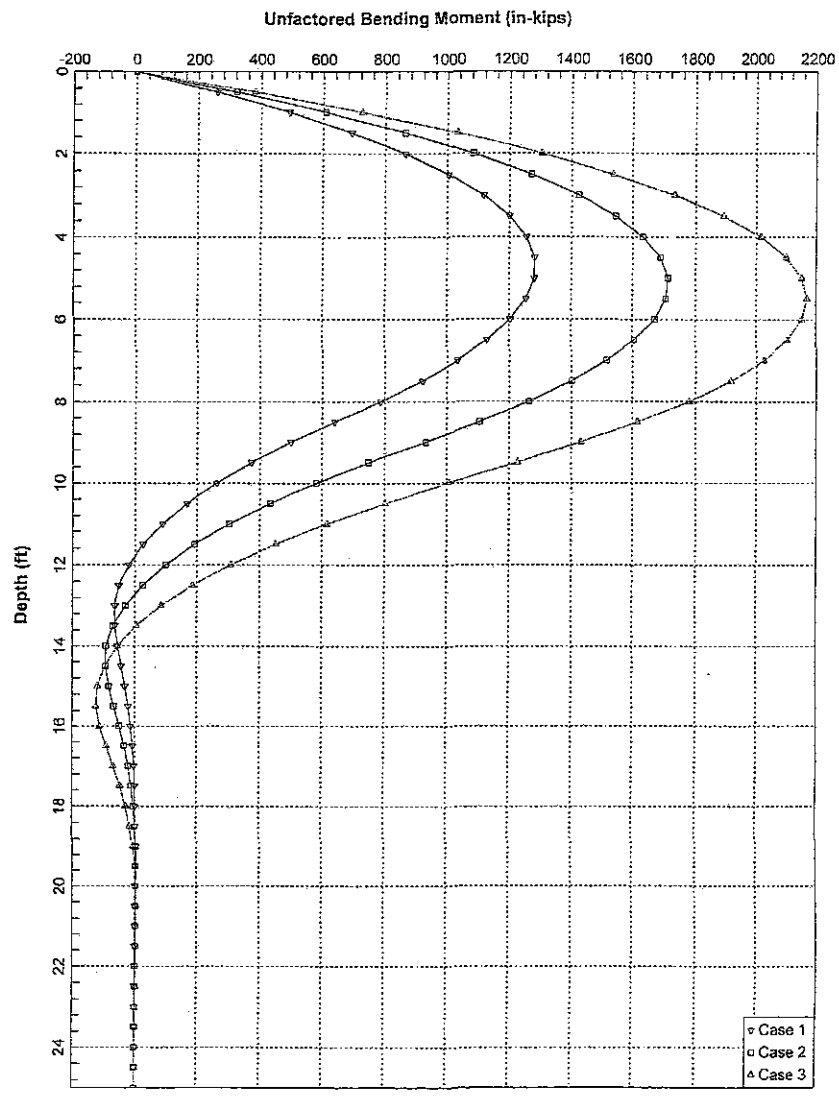
Retaining Wall No. 14

Profile based on Boring RW-192A





SR4 Segment 3A - Retaining Wall No. 14 - 24-in. CIDH Pile



SR4 Segment 3A - Retaining Wall No. 14 - 24-in. CIDH Pile

LPILE Plus for Windows, Version 5.0 (5.0.21)

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:

Gary Parikh
Parikh Consultants

Path to file locations: S:\Ongoing Projects\2006\206117 TYLIn Rte 4 Project\Retaining and Sound Walls\LPILE\
Name of input data file: Retaining Wall No. 14.lpd
Name of output file: Retaining Wall No. 14.lpo
Name of plot output file: Retaining Wall No. 14.lpp
Name of runtime file: Retaining Wall No. 14.lpr

Time and Date of Analysis

Date: February 3, 2010 Time: 17:17:39

Problem Title

SR4- Segment 3A - Retaining Wall No. 14 - 24-in. CIDH PIle

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant 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 pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 50
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 300.00 in
Depth of ground surface below top of pile = -84.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point No.	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	24.00000000	16286.0000	452.3900	3600000.
2	300.0000	24.00000000	16286.0000	452.3900	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -84.000 in
Distance from top of pile to bottom of layer = 3.000 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 3.000 in
Distance from top of pile to bottom of layer = 300.000 in

(Depth of lowest layer extends .00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth is defined using 4 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-84.00	.07230
2	3.00	.07230
3	3.00	.07230
4	300.00	.07230

Shear Strength of Soils

Distribution of shear strength parameters with depth defined using 4 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-84.000	17.36000	.00	.00500	.0
2	3.000	17.36000	.00	.00500	.0
3	3.000	27.78000	.00	.00400	.0
4	300.000	27.78000	.00	.00400	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

p-y Modification Factors

Distribution of p-y multipliers with depth defined using 2 points

Point No.	Depth X in	p-mult	y-mult
1	.000	.7000	1.0000
2	360.000	.7000	1.0000

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 3

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 45000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 90000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 55000.000 lbs

Bending moment at pile head = .000 in-lbs
Axial load at pile head = 180000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 65000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 180000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 45000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 90000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.106705	4.5203E-08	45000.0000	-.0017885	198.9434	-574.3422
6.000	.095974	260628.	40790.7630	-.0017752	390.9814	-828.7368
12.000	.085403	491406.	35813.7888	-.0017367	561.0259	-830.2545
18.000	.075133	692269.	30837.1291	-.0016761	709.0272	-828.6320
24.000	.065289	863262.	25879.9978	-.0015965	835.0201	-823.7451
30.000	.055975	1004553.	20962.3932	-.0015010	939.1273	-815.4565
36.000	.047277	1116432.	16105.1873	-.0013924	1021.5630	-803.6121
42.000	.039265	1199319.	11330.2471	-.0012739	1082.6367	-788.0346
48.000	.031990	1253771.	6660.6036	-.0011484	1122.7582	-768.5132
54.000	.025484	1280487.	2120.6977	-.0010188	1142.4433	-744.7887
60.000	.019765	1280319.	-2263.2457	-.0008877	1142.3200	-716.5258
66.000	.014832	1254286.	-6462.6168	-.0007580	1123.1382	-683.2646
72.000	.010669	1203587.	-10445.3855	-.0006323	1085.7811	-644.3249
78.000	.007245	1129625.	-14174.1515	-.0005129	1031.2838	-598.5971
84.000	.004514	1034051.	-17601.9874	-.0004022	960.8621	-544.0149
90.000	.002419	918835.	-20651.6877	-.0003022	875.9679	-475.8852
96.000	.000887	786437.	-23225.1282	-.0002150	778.4130	-378.5950
102.000	-.000161	640366.	-23884.6378	-.0001420	670.7835	158.7585
108.000	-.000816	499975.	-22249.7011	-8.3618E-05	567.3392	386.2204
114.000	-.001164	373460.	-19798.5242	-3.8926E-05	474.1193	430.8385
120.000	-.001283	262434.	-17154.9751	-6.3877E-06	392.3126	450.3445
126.000	-.001241	167607.	-14437.7142	1.5617E-05	322.4410	455.4091
132.000	-.001096	89164.8335	-11721.4654	2.8756E-05	264.6426	450.0072
138.000	-.000896	26918.1780	-9063.3522	3.4695E-05	218.7775	436.0306
144.000	-.000680	-19632.8644	-6511.8027	3.5068E-05	213.4095	414.4859
150.000	-.000475	-51261.3283	-3626.9100	3.1441E-05	236.7142	547.1450
156.000	-.000302	-63189.7405	-922.6374	2.5584E-05	245.5034	354.2792
162.000	-.000158	-62360.6088	741.8622	1.8160E-05	244.8925	200.5540
168.000	-7.23E-05	-54308.0869	1606.7904	1.3190E-05	238.9592	87.7554
174.000	-9.85E-06	-43093.3690	1906.5176	8.2064E-06	230.6958	12.1537
180.000	2.62E-05	-31438.7382	1844.5008	4.3927E-06	222.1084	-32.8259
186.000	4.29E-05	-20964.1031	1582.0091	1.7113E-06	214.3904	-54.6713

192.000	4.67E-05	-12456.4772	1236.4271	1.2130E-09	208.1217	-60.5227
198.000	4.29E-05	-6126.9789	885.4762	-9.4968E-07	203.4579	-56.4610
204.000	3.53E-05	-1829.7368	576.1133	-1.3568E-06	200.2916	-46.6600
210.000	2.66E-05	787.8464	330.6632	-1.4101E-06	199.5239	-35.1567
216.000	1.84E-05	2139.7450	152.3147	-1.2603E-06	200.5200	-24.2928
222.000	1.15E-05	2616.9837	33.9393	-1.0169E-06	200.8717	-15.1656
228.000	6.18E-06	2548.1148	-36.0450	-7.5264E-07	200.8209	-8.1625
234.000	2.44E-06	2185.2561	-70.2147	-5.1044E-07	200.5536	-3.2274
240.000	4.99E-08	1706.0891	-80.0951	-3.1132E-07	200.2005	-.0660088
246.000	-1.29E-06	1224.4515	-75.1610	-1.6137E-07	199.8456	1.7107
252.000	-1.89E-06	804.3315	-62.5481	-5.7559E-08	199.5360	2.4936
258.000	-1.98E-06	473.9370	-47.1961	7.8478E-09	199.2926	2.6237
264.000	-1.79E-06	237.9696	-32.2176	4.4275E-08	199.1187	2.3691
270.000	-1.45E-06	87.2777	-19.3460	6.0918E-08	199.0077	1.9214
276.000	-1.06E-06	5.7519	-9.3732	6.5678E-08	198.9476	1.4029
282.000	-6.65E-07	-25.2710	-2.5256	6.4679E-08	198.9620	.8796440
288.000	-2.85E-07	-24.6254	1.2441	6.2126E-08	198.9615	.3769348
294.000	8.00E-08	-10.4088	2.0575	6.0333E-08	198.9511	-.1057877
300.000	4.39E-07	0.0000	0.0000	5.9801E-08	198.9434	-.5800621

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	.10670479	in
Computed slope at pile head	=	-.00178852	
Maximum bending moment	=	1280487.	lbs-in
Maximum shear force	=	45000.00000	lbs
Depth of maximum bending moment	=	54.00000000	in
Depth of maximum shear force	=	0.00000	in
Number of iterations	=	22	
Number of zero deflection points	=	4	

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 2

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 55000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 180000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.166348	-4.9723E-07	55000.0000	-.0025793	397.8868	-641.7681
6.000	.150872	321234.	50290.8127	-.0025629	634.5812	-927.9610
12.000	.135593	609026.	44711.0205	-.0025153	846.6346	-931.9697
18.000	.120689	863199.	39116.5165	-.0024399	1031.9170	-932.8649
24.000	.106314	1083694.	33526.3431	-.0023403	1196.3842	-930.5262
30.000	.092605	1270570.	27960.2948	-.0022199	1334.0800	-924.8233
36.000	.079676	1424012.	22438.9874	-.0020820	1447.1407	-915.6125
42.000	.067621	1544335.	16983.9512	-.0019301	1535.7980	-902.7329
48.000	.056514	1631989.	11617.7561	-.0017676	1600.3838	-885.9988
54.000	.046410	1687566.	6364.1874	-.0015977	1641.3348	-865.1907
60.000	.037342	1711810.	1248.5002	-.0014238	1659.1985	-840.0384
66.000	.029325	1705624.	-3702.1987	-.0012489	1654.6400	-810.1946
72.000	.022355	1670081.	-8458.3451	-.0010762	1628.4515	-775.1875
78.000	.016411	1606448.	-12986.8975	-.0009085	1581.5645	-734.3300
84.000	.011453	1516201.	-17249.4772	-.0007487	1515.0680	-686.5299
90.000	.007426	1401072.	-21198.5803	-.0005995	1430.2372	-629.8378
96.000	.004259	1263113.	-24768.4854	-.0004631	1328.5853	-560.1306
102.000	.001868	1104850.	-27845.8602	-.0003420	1211.9726	-465.6610
108.000	.000156	929701.	-29712.9774	-.0002379	1082.9178	-156.7114
114.000	-.000986	748808.	-28943.3588	-.0001520	949.6305	413.2509
120.000	-.001668	582709.	-26261.0243	-8.3849E-05	827.2440	480.8606
126.000	-.001992	433857.	-23280.5507	-3.1833E-05	717.5653	512.6306
132.000	-.002050	303411.	-20163.7475	5.8925E-06	621.4492	526.3038
138.000	-.001922	191879.	-17001.7821	3.1236E-05	539.2690	527.6847
144.000	-.001675	99322.5619	-13860.5549	4.6136E-05	471.0705	519.3910
150.000	-.001368	25452.9545	-10794.1033	5.2521E-05	416.6413	502.7595
156.000	-.001045	-30320.1225	-7850.4214	5.2272E-05	420.2275	478.4678
162.000	-.000741	-68865.0090	-5074.7267	4.7197E-05	448.6285	446.7638
168.000	-.000479	-91318.7875	-1991.7503	3.9000E-05	465.1731	580.8950
174.000	-.000273	-92850.2525	760.7047	2.9577E-05	466.3016	336.5900
180.000	-.000124	-82254.2165	2236.4243	2.0617E-05	458.4941	155.3166
186.000	-2.53E-05	-66057.6933	2799.3001	1.3028E-05	446.5600	32.3087
192.000	3.26E-05	-48690.7557	2769.6435	7.1562E-06	433.7635	-42.1942
198.000	6.05E-05	-32837.4292	2403.8985	2.9845E-06	422.0824	-79.7207
204.000	6.84E-05	-19850.4201	1893.6212	2.8856E-07	412.5131	-90.3717
210.000	6.40E-05	-10114.5983	1368.6920	-1.2447E-06	405.3395	-84.6047
216.000	5.34E-05	-3423.4274	902.9928	-1.9374E-06	400.4093	-70.6284
222.000	4.08E-05	725.5005	529.4872	-2.0755E-06	398.4213	-53.8735
228.000	2.85E-05	2934.9019	254.7443	-1.8882E-06	400.0493	-37.7075
234.000	1.81E-05	3786.5099	69.8514	-1.5443E-06	400.6768	-23.9235
240.000	1.00E-05	3776.4537	-41.5574	-1.1573E-06	400.6694	-13.2128
246.000	4.21E-06	3290.3208	-97.8970	-7.9567E-07	400.3112	-5.5671
252.000	4.48E-07	2603.4086	-116.3742	-4.9410E-07	399.8050	-.5919694
258.000	-1.72E-06	1894.8977	-111.3396	-2.6392E-07	399.2830	2.2702
264.000	-2.72E-06	1267.9032	-93.7461	-1.0209E-07	398.8210	3.5943
270.000	-2.94E-06	770.1646	-71.2948	2.1986E-09	398.4543	3.8894
276.000	-2.69E-06	412.3609	-48.9481	6.2707E-08	398.1906	3.5595
282.000	-2.19E-06	182.6523	-29.5853	9.3153E-08	398.0214	2.8948
288.000	-1.58E-06	57.1361	-14.6552	1.0542E-07	397.9289	2.0819
294.000	-9.25E-07	6.5616	-4.7418	1.0868E-07	397.8916	1.2226
300.000	-2.71E-07	0.0000	0.0000	1.0902E-07	397.8868	.3579919

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 2:

Pile-head deflection	=	.16634775	in
Computed slope at pile head	=	-.00257931	
Maximum bending moment	=	1711810.	lbs-in
Maximum shear force	=	55000.00000	lbs
Depth of maximum bending moment	=	60.00000000	in
Depth of maximum shear force	=	0.00000	in
Number of iterations	=	22	
Number of zero deflection points	=	4	

Computed Values of Load Distribution and Deflection

for Lateral Loading for Load Case Number 3

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 65000.000 lbs
Specified moment at pile head = .000 in-lbs
Specified axial load at pile head = 180000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.239464	-2.7122E-07	65000.0000	-.0034835	397.8868	-702.9562
6.000	.218564	381109.	59837.0035	-.0034640	678.6989	-1018.0427
12.000	.197897	725526.	53709.8451	-.0034073	932.4756	-1024.3435
18.000	.177676	1032987.	47554.1686	-.0033173	1159.0217	-1027.5487
24.000	.158089	1303342.	41388.9004	-.0031978	1358.2269	-1027.5407
30.000	.139302	1536561.	35233.6970	-.0030525	1530.0697	-1024.1937
36.000	.121459	1732739.	29109.0030	-.0028852	1674.6197	-1017.3709
42.000	.104680	1892101.	23036.1270	-.0026997	1792.0420	-1006.9211
48.000	.089062	2015004.	17037.3422	-.0024998	1882.6007	-992.6738
54.000	.074682	2101949.	11136.0242	-.0022891	1946.6639	-974.4322
60.000	.061593	2153581.	5356.8435	-.0020714	1984.7082	-951.9614
66.000	.049826	2170705.	-273.9567	-.0018501	1997.3255	-924.9720
72.000	.039391	2154290.	-5728.1431	-.0016288	1985.2304	-893.0902
78.000	.030280	2105486.	-10974.8366	-.0014108	1949.2699	-855.8077
84.000	.022461	2025639.	-13979.4174	-.0011995	1890.4369	-812.3859
90.000	.015886	1916323.	-20701.5529	-.0009978	1809.8897	-761.6593
96.000	.010488	1779376.	-25091.2576	-.0008087	1708.9828	-701.5756
102.000	.006182	1616975.	-29079.6908	-.0006349	1589.3211	-627.9021
108.000	.002870	1431791.	-32550.8741	-.0004789	1452.8721	-529.1590
114.000	.000436	1227399.	-35482.4068	-.0003428	1302.2700	-448.0186
120.000	-.001244	1006742.	-35485.9560	-.0002285	1139.6840	446.8355
126.000	-.002306	802061.	-32550.3163	-.0001359	988.8686	531.7110
132.000	-.002875	616432.	-29236.9435	-6.3346E-05	852.0920	572.7466
138.000	-.003066	451354.	-25739.5004	-8.7085E-06	730.4578	593.0678
144.000	-.002980	307577.	-22160.8578	3.0125E-05	624.5185	599.8131
150.000	-.002704	185359.	-18572.9423	5.5348E-05	534.4647	596.1587
156.000	-.002315	84582.1883	-15033.2096	6.9161E-05	460.2094	583.7522
162.000	-.001875	4811.1018	-11591.4868	7.3735E-05	401.4317	563.4888
168.000	-.001431	-54674.9206	-8293.5967	7.1183E-05	438.1729	535.8079
174.000	-.001020	-94865.8148	-5183.8171	6.3531E-05	467.7867	500.7853
180.000	-.000668	-117018.	-2307.2713	5.2690E-05	484.1090	458.0633
186.000	-.000388	-122667.	551.7732	4.0425E-05	488.2713	494.9515
192.000	-.000183	-110484.	2748.8472	2.8495E-05	479.2946	237.4065
198.000	-4.61E-05	-89742.2626	3643.2475	1.8250E-05	464.0115	60.7269
204.000	3.58E-05	-66804.4433	3683.3523	1.0240E-05	447.1102	-47.3587
210.000	7.68E-05	-45564.1550	3236.9030	4.4898E-06	431.4598	-101.4576
216.000	8.97E-05	-27971.3056	2576.8041	7.2709E-07	418.4969	-118.5753
222.000	8.55E-05	-14644.0762	1882.1061	-1.4535E-06	408.6770	-112.9907
228.000	7.23E-05	-5382.8924	1256.5728	-2.4782E-06	401.8531	-95.5205
234.000	5.57E-05	440.1500	748.9674	-2.7311E-06	398.2111	-73.6813
240.000	3.95E-05	3610.6160	371.3251	-2.5239E-06	400.5472	-52.1994
246.000	2.55E-05	4901.5033	113.7828	-2.0883E-06	401.4983	-33.6480
252.000	1.44E-05	4980.5200	-44.3858	-1.5827E-06	401.5566	-19.0748
258.000	6.46E-06	4372.2925	-127.2421	-1.1041E-06	401.1084	-8.5440
264.000	1.18E-06	3455.9994	-157.5593	-7.0354E-07	400.4333	-1.5618
270.000	-1.98E-06	2483.1006	-154.3983	-3.9964E-07	399.7164	2.6154
276.000	-3.61E-06	1604.0825	-132.2203	-1.9030E-07	399.0687	4.7773
282.000	-4.26E-06	896.8685	-100.9770	-6.2534E-08	398.5476	5.6372
288.000	-4.36E-06	392.4937	-66.7580	3.4409E-09	398.1760	5.7692
294.000	-4.22E-06	95.7654	-32.7027	2.8424E-08	397.9573	5.5826
300.000	-4.02E-06	0.0000	0.0000	3.3325E-08	397.8868	5.3183

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 3:

Pile-head deflection	=	.23946442	in
Computed slope at pile head	=	-.00348345	
Maximum bending moment	=	2170705.	lbs-in
Maximum shear force	=	65000.00000	lbs
Depth of maximum bending moment	=	66.00000000	in
Depth of maximum shear force	=	0.00000	in
Number of iterations	=	23	
Number of zero deflection points	=	3	

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 45000.	M= 0.000	90000.0000	.1067048	1280487.	45000.0000
1	V= 55000.	M= 0.000	180000.	.1663478	1711810.	55000.0000
1	V= 65000.	M= 0.000	180000.	.2394644	2170705.	65000.0000

The analysis ended normally.

"CULVERT 4" RESULTS

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...Highway 4 East

PROJECT ACCOUNT NO.206118.GDR

SAMPLE LOCATION....SW-134 #2 @4.5 ft

TEST SAMPLE NO.....2

OPERATOR.....Ganga

TEST DATE.....01/31/2007

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.6 , WATER pH = 0.0 , SOIL pH = 7.6

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 1050 , WATER = 0 , SOIL = 1050

****

ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	25	33	40	50	75
16 0.064	33	41	48	58	83
14 0.079	40	48	55	65	90
12 0.109	56	64	71	81	106
10 0.138	71	79	86	96	121
08 0.168	86	94	101	111	136

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

CONCRETE AND RCP MITIGATION MEASURES FOR pH
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...Highway 4 East

PROJECT ACCOUNT NO.206118.GDR

SAMPLE LOCATION....RW/SW-136 # 3 @ 9.5 ft

TEST SAMPLE NO.....3

OPERATOR.....Ganga

TEST DATE.....01/31/2007

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.6 , WATER pH = 0.0 , SOIL pH = 7.6

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 800 , WATER = 0 , SOIL = 800

CHLORIDES, PPM... 57.8 , SULFATES, PPM... 32.7

****

ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	22	30	37	47	72
16 0.064	29	37	44	54	79
14 0.079	36	44	51	61	86
12 0.109	50	58	65	75	100
10 0.138	63	71	78	88	113
08 0.168	77	85	92	102	127

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

FOR SULFATE RESISTANT CONCRETE AND RCP
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...Highway 4 East

PROJECT ACCOUNT NO.206118.GDR

SAMPLE LOCATION....RW/SW-139 # 3 @ 11 ft

TEST SAMPLE NO.....3

OPERATOR.....Ganga

TEST DATE.....02/09/2007

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.7 , WATER pH = 0.0 , SOIL pH = 7.7

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 1470 , WATER = 0 , SOIL = 1470

****

ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	29	37	44	54	79
16 0.064	38	46	53	63	88
14 0.079	46	54	61	71	96
12 0.109	64	72	79	89	114
10 0.138	81	89	96	106	131
08 0.168	99	107	114	124	149

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

CONCRETE AND RCP MITIGATION MEASURES FOR pH
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...Highway 4 East

PROJECT ACCOUNT NO.206118.GDR

SAMPLE LOCATION....SW-140 #3 @ 9.5 ft

TEST SAMPLE NO.....3

OPERATOR.....Ganga

TEST DATE.....02/16/2007

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.9 , WATER pH = 0.0 , SOIL pH = 7.9

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 430 , WATER = 0 , SOIL = 430

CHLORIDES, PPM... 244.5 , SULFATES, PPM... 248.9

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	17	25	32	42	67
16 0.064	22	30	37	47	72
14 0.079	28	36	43	53	78
12 0.109	38	46	53	63	88
10 0.138	49	57	64	74	99
08 0.168	60	68	75	85	110

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

FOR SULFATE RESISTANT CONCRETE AND RCP
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...Highway 4 East

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....RW/SW-143 # 4 16 ft

TEST SAMPLE NO.....4

OPERATOR.....Ganga

TEST DATE.....02/09/2007

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.7 , WATER pH = 0.0 , SOIL pH = 7.7

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 1230 , WATER = 0 , SOIL = 1230

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	27	35	42	52	77
16 0.064	35	43	50	60	85
14 0.079	43	51	58	68	93
12 0.109	59	67	74	84	109
10 0.138	76	84	91	101	126
08 0.168	92	100	107	117	142

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

CONCRETE AND RCP MITIGATION MEASURES FOR pH
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...Highway 4 East

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....SW-148 # 4 @ 14.5 ft

TEST SAMPLE NO.....4

OPERATOR.....Ganga

TEST DATE.....02/09/2007

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.5 , WATER pH = 0.0 , SOIL pH = 7.5

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 880 , WATER = 0 , SOIL = 880

CHLORIDES, PPM... 205.2 , SULFATES, PPM... 90.6

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	23	31	38	48	73
16 0.064	30	38	45	55	80
14 0.079	37	45	52	62	87
12 0.109	52	60	67	77	102
10 0.138	66	74	81	91	116
08 0.168	80	88	95	105	130

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

FOR SULFATE RESISTANT CONCRETE AND RCP
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...Highway 4 East

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....RW/SW 149 # 7 # 28.5 ft

TEST SAMPLE NO.....7

OPERATOR.....Ganga

TEST DATE.....02/16/2007

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.9 , WATER pH = 0.0 , SOIL pH = 7.9

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 1470 , WATER = 0 , SOIL = 1470

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	29	37	44	54	79
16 0.064	38	46	53	63	88
14 0.079	46	54	61	71	96
12 0.109	64	72	79	89	114
10 0.138	81	89	96	106	131
08 0.168	99	107	114	124	149

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

CONCRETE AND RCP MITIGATION MEASURES FOR pH
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...SR4

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....STA 192+19 155.5'LT."E"LINE

TEST SAMPLE NO.....RW186#2@4.5'

OPERATOR.....O.GOUTHIER

TEST DATE.....09/17/2008

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.9 , WATER pH = 0.0 , SOIL pH = 7.9

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 800 , WATER = 0 , SOIL = 800

CHLORIDES, PPM... 78.8 , SULFATES, PPM... 221

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	22	30	37	47	72
16 0.064	29	37	44	54	79
14 0.079	36	44	51	61	86
12 0.109	50	58	65	75	100
10 0.138	63	71	78	88	113
08 0.168	77	85	92	102	127

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

FOR SULFATE RESISTANT CONCRETE AND RCP
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...SR4

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....STA192+32 106.4'RT."E" LINE

TEST SAMPLE NO.....RW-187#2@4.5'

OPERATOR.....O.GOUTHIER

TEST DATE.....09/17/2008

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.4 , WATER pH = 0.0 , SOIL pH = 7.4

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 560 , WATER = 0 , SOIL = 560

CHLORIDES, PPM... 80.9 , SULFATES, PPM... 276.2

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage	& in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18	0.052	19	27	34	44	69
16	0.064	25	33	40	50	75
14	0.079	31	39	46	56	81
12	0.109	43	51	58	68	93
10	0.138	55	63	70	80	105
08	0.168	66	74	81	91	116

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

FOR SULFATE RESISTANT CONCRETE AND RCP
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...SR4

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....195+97 12.0 RT."E" LINE

TEST SAMPLE NO.....AST154#2@8

OPERATOR.....O.GOUTHIER

TEST DATE.....12/08/08

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.5 , WATER pH = 0.0 , SOIL pH = 7.5

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 860 , WATER = 0 , SOIL = 860

CHLORIDES, PPM... 10.9 , SULFATES, PPM... 89.1

****

ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage	& mm	GALV. 57 g	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18	1.3	23	31	38	48	73
16	1.6	30	38	45	55	80
14	2.0	37	45	52	62	87
12	2.8	51	59	66	76	101
10	3.5	65	73	80	90	115
8	4.3	79	87	94	104	129

FLOW VEL. <1.5 m/s WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (1.3 mm) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

FOR SULFATE RESISTANT CONCRETE AND RCP
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...SR4

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....STA196+40 208.5'RT."E"LINE

TEST SAMPLE NO.....RW-189#3@8.5'

OPERATOR.....O.GOUTHIER

TEST DATE.....09/17/2008

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.7 , WATER pH = 0.0 , SOIL pH = 7.7

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 620 , WATER = 0 , SOIL = 620

CHLORIDES, PPM... 157.5 , SULFATES, PPM... 218.1

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	20	28	35	45	70
16 0.064	26	34	41	51	76
14 0.079	32	40	47	57	82
12 0.109	45	53	60	70	95
10 0.138	57	65	72	82	107
08 0.168	69	77	84	94	119

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

FOR SULFATE RESISTANT CONCRETE AND RCP
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...SR4

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....STA 201+07 173.9'RT."E"LINE

TEST SAMPLE NO.....RW-193#3@8.5'

OPERATOR.....O.GOUTHIER

TEST DATE.....09/17/2008

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.4 , WATER pH = 0.0 , SOIL pH = 7.4

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 830 , WATER = 0 , SOIL = 830

CHLORIDES, PPM... 53.1 , SULFATES, PPM... 214.1

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	23	31	38	48	73
16 0.064	30	38	45	55	80
14 0.079	37	45	52	62	87
12 0.109	50	58	65	75	100
10 0.138	64	72	79	89	114
08 0.168	78	86	93	103	128

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

FOR SULFATE RESISTANT CONCRETE AND RCP
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...SR4

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....STA 203+03 116.2'Rt."E" LINE

TEST SAMPLE NO.....RW-194#5@18.5

OPERATOR.....O.GOUTHIER

TEST DATE.....09/17/2008

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.8 , WATER pH = 0.0 , SOIL pH = 7.8

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 1450 , WATER = 0 , SOIL = 1450

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	29	37	44	54	79
16 0.064	37	45	52	62	87
14 0.079	46	54	61	71	96
12 0.109	63	71	78	88	113
10 0.138	81	89	96	106	131
08 0.168	98	106	113	123	148

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

CONCRETE AND RCP MITIGATION MEASURES FOR pH
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...SR4

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....STA 207+00 129.3'RT."E" LINE

TEST SAMPLE NO.....RW-197#2@4.5'

OPERATOR.....O.GOUTHIER

TEST DATE.....09/17/08

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.1 , WATER pH = 0.0 , SOIL pH = 7.1

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 240 , WATER = 0 , SOIL = 240

CHLORIDES, PPM... 607.7 , SULFATES, PPM... 240.2

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	11	19	26	36	61
16 0.064	14	22	29	39	64
14 0.079	17	25	32	42	67
12 0.109	24	32	39	49	74
10 0.138	31	39	46	56	81
08 0.168	37	45	52	62	87

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN MAY BE ADVERSELY
AFFECTED BY CHLORIDES. RECOMMENDED DESIGN IS:

FOR CHLORIDE RESISTANT RCP, ESTIMATED SERVICE LIFE, YEARS = 45
USING CEMENT CONTENT, sk/cy, C = 6
USING CONCRETE COVER, in, S = 2
USING TOTAL MIX WATER, % BY VOL., W = 15

FOR SULFATE RESISTANT CONCRETE AND RCP
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...SR4

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....STA212+67 98.0'LT."E" LINE

TEST SAMPLE NO.....SW-200#4@13.5'

OPERATOR.....O.GOUTHIER

TEST DATE.....09/17/2008

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.4 , WATER pH = 0.0 , SOIL pH = 7.4

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 2120 , WATER = 0 , SOIL = 2120

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	33	41	48	58	83
16 0.064	44	52	59	69	94
14 0.079	54	62	69	79	104
12 0.109	74	82	89	99	124
10 0.138	95	103	110	120	145
08 0.168	115	123	130	140	165

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

CONCRETE AND RCP MITIGATION MEASURES FOR pH
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, MAY BE USED
IF ABRASIVE CONDITIONS DO NOT EXIST
SITE CONDITIONS MEET CORROSION REQUIREMENTS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, MAY BE USED
SITE CONDITIONS MEET CORROSION REQUIREMENTS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...SR4

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....STA 213+97 121.4'RT."E" LINE

TEST SAMPLE NO.....RW-201#2@4.5'

OPERATOR.....O.GOUTHIER

TEST DATE.....09/17/2008

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.6 , WATER pH = 0.0 , SOIL pH = 7.6

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 540 , WATER = 0 , SOIL = 540

CHLORIDES, PPM... 81.2 , SULFATES, PPM... 522.6

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	19	27	34	44	69
16 0.064	25	33	40	50	75
14 0.079	31	39	46	56	81
12 0.109	42	50	57	67	92
10 0.138	54	62	69	79	104
08 0.168	65	73	80	90	115

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

FOR SULFATE RESISTANT CONCRETE AND RCP
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...SR4

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....STA 218+52 107.7'LT."E" LINE

TEST SAMPLE NO.....RW-204#3@8.5'

OPERATOR.....O.GOUTHIER

TEST DATE.....09/17/2008

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.8 , WATER pH = 0.0 , SOIL pH = 7.8

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 590 , WATER = 0 , SOIL = 590

CHLORIDES, PPM... 195.8 , SULFATES, PPM... 216.4

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	20	28	35	45	70
16 0.064	26	34	41	51	76
14 0.079	32	40	47	57	82
12 0.109	44	52	59	69	94
10 0.138	56	64	71	81	106
08 0.168	68	76	83	93	118

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

FOR SULFATE RESISTANT CONCRETE AND RCP
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...SR4

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....219+37 12.8 RT."E" LINE

TEST SAMPLE NO.....CAV-168#2@8.5

OPERATOR.....O.GOUTHIER

TEST DATE.....12/08/2006

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.6 , WATER pH = 0.0 , SOIL pH = 7.6

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 1450 , WATER = 0 , SOIL = 1450

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage	& mm	GALV. 57 g	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18	1.3	29	37	44	54	79
16	1.6	37	45	52	62	87
14	2.0	46	54	61	71	96
12	2.8	63	71	78	88	113
10	3.5	81	89	96	106	131
8	4.3	98	106	113	123	148

FLOW VEL. <1.5 m/s WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (1.3 mm) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

CONCRETE AND RCP MITIGATION MEASURES FOR pH
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...SR4

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....STA 223+11 108.8'LT."E" LINE

TEST SAMPLE NO.....RW 205#1@1.5'

OPERATOR.....O.GOUTHIER

TEST DATE.....09/17/2008

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.0 , WATER pH = 0.0 , SOIL pH = 7.0

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 750 , WATER = 0 , SOIL = 750

CHLORIDES, PPM... 238.9 , SULFATES, PPM... 136.2

****

ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	15	23	30	40	65
16 0.064	20	28	35	45	70
14 0.079	24	32	39	49	74
12 0.109	33	41	48	58	83
10 0.138	43	51	58	68	93
08 0.168	52	60	67	77	102

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

CONCRETE AND RCP MITIGATION MEASURES FOR pH
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01
MAXIMUM W/C RATIO OF 0.45

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...Highway 4 East

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....SW-170 # 1 @ 2 ft

TEST SAMPLE NO.....1

OPERATOR.....Ganga

TEST DATE.....12/19/2006

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 6.9 , WATER pH = 0.0 , SOIL pH = 6.9

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 3750 , WATER = 0 , SOIL = 3750

****

ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	24	32	39	49	74
16 0.064	31	39	46	56	81
14 0.079	38	46	53	63	88
12 0.109	53	61	68	78	103
10 0.138	67	75	82	92	117
08 0.168	82	90	97	107	132

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

CONCRETE AND RCP MITIGATION MEASURES FOR pH
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01
MAXIMUM W/C RATIO OF 0.45

A CORRUGATED ALUMINUM PIPE, CAP, MAY BE USED
IF ABRASIVE CONDITIONS DO NOT EXIST
SITE CONDITIONS MEET CORROSION REQUIREMENTS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, MAY BE USED
SITE CONDITIONS MEET CORROSION REQUIREMENTS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...SR4

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....STA 230+23 110.3'LT."E" LINE

TEST SAMPLE NO.....SW-207#3@8.5'

OPERATOR.....O.GOUTHIER

TEST DATE.....09/17/2008

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.7 , WATER pH = 0.0 , SOIL pH = 7.7

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 1130 , WATER = 0 , SOIL = 1130

****

ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	26	34	41	51	76
16 0.064	34	42	49	59	84
14 0.079	41	49	56	66	91
12 0.109	57	65	72	82	107
10 0.138	73	81	88	98	123
08 0.168	89	97	104	114	139

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

CONCRETE AND RCP MITIGATION MEASURES FOR pH
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...Highway 4 East

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....SW-172 #3 @9.5

TEST SAMPLE NO.....3

OPERATOR.....Ganga

TEST DATE.....02/09/2007

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.7 , WATER pH = 0.0 , SOIL pH = 7.7

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 2060 , WATER = 0 , SOIL = 2060

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	33	41	48	58	83
16 0.064	43	51	58	68	93
14 0.079	53	61	68	78	103
12 0.109	73	81	88	98	123
10 0.138	94	102	109	119	144
08 0.168	114	122	129	139	164

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

CONCRETE AND RCP MITIGATION MEASURES FOR pH
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, MAY BE USED
IF ABRASIVE CONDITIONS DO NOT EXIST
SITE CONDITIONS MEET CORROSION REQUIREMENTS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, MAY BE USED
SITE CONDITIONS MEET CORROSION REQUIREMENTS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...Highway 4 East

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....RW-173 # 5 @ 18.5

TEST SAMPLE NO.....5

OPERATOR.....Ganga

TEST DATE.....12/19/2007

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.9 , WATER pH = 0.0 , SOIL pH = 7.9

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 2060 , WATER = 0 , SOIL = 2060

****

ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	33	41	48	58	83
16 0.064	43	51	58	68	93
14 0.079	53	61	68	78	103
12 0.109	73	81	88	98	123
10 0.138	94	102	109	119	144
08 0.168	114	122	129	139	164

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

CONCRETE AND RCP MITIGATION MEASURES FOR pH
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, MAY BE USED
IF ABRASIVE CONDITIONS DO NOT EXIST
SITE CONDITIONS MEET CORROSION REQUIREMENTS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, MAY BE USED
SITE CONDITIONS MEET CORROSION REQUIREMENTS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...SR4

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....STA 236+38 108.4' LT."E" LINE

TEST SAMPLE NO.....RW/SW-209#3@8.5'

OPERATOR.....O.GOUTHIER

TEST DATE.....09/17/2008

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.7 , WATER pH = 0.0 , SOIL pH = 7.7

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 560 , WATER = 0 , SOIL = 560

CHLORIDES, PPM... 160.2 , SULFATES, PPM... 200.8

****

ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	19	27	34	44	69
16 0.064	25	33	40	50	75
14 0.079	31	39	46	56	81
12 0.109	43	51	58	68	93
10 0.138	55	63	70	80	105
08 0.168	66	74	81	91	116

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

FOR SULFATE RESISTANT CONCRETE AND RCP
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...Highway 4 East

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....SW-175 # 1 @ 2 ft

TEST SAMPLE NO.....1

OPERATOR.....Ganga

TEST DATE.....12/19/2006

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.8 , WATER pH = 0.0 , SOIL pH = 7.8

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 2570 , WATER = 0 , SOIL = 2570

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	36	44	51	61	86
16 0.064	47	55	62	72	97
14 0.079	58	66	73	83	108
12 0.109	80	88	95	105	130
10 0.138	102	110	117	127	152
08 0.168	124	132	139	149	174

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

CONCRETE AND RCP MITIGATION MEASURES FOR pH
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, MAY BE USED
IF ABRASIVE CONDITIONS DO NOT EXIST
SITE CONDITIONS MEET CORROSION REQUIREMENTS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, MAY BE USED
SITE CONDITIONS MEET CORROSION REQUIREMENTS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...SR4

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....STA 242+88 119.7 LT."E" LINE

TEST SAMPLE NO.....RW-211#2@4.5'

OPERATOR.....O.GOUTHIER

TEST DATE.....09/17/08

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.8 , WATER pH = 0.0 , SOIL pH = 7.8

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 990 , WATER = 0 , SOIL = 990

CHLORIDES, PPM... 20.8 , SULFATES, PPM... 113.8

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	24	32	39	49	74
16 0.064	32	40	47	57	82
14 0.079	39	47	54	64	89
12 0.109	54	62	69	79	104
10 0.138	69	77	84	94	119
08 0.168	84	92	99	109	134

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

FOR SULFATE RESISTANT CONCRETE AND RCP
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...SR4

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....STA 245+64 131'LT."E" LINE

TEST SAMPLE NO.....RW-212#3@8.5'

OPERATOR.....O.GOUTHIER

TEST DATE.....09/17/08

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.8 , WATER pH = 0.0 , SOIL pH = 7.8

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 960 , WATER = 0 , SOIL = 960

CHLORIDES, PPM... 35.7 , SULFATES, PPM... 90.4

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	24	32	39	49	74
16 0.064	31	39	46	56	81
14 0.079	39	47	54	64	89
12 0.109	54	62	69	79	104
10 0.138	68	76	83	93	118
08 0.168	83	91	98	108	133

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

FOR SULFATE RESISTANT CONCRETE AND RCP
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...Highway 4 East

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....SW-177 # 4 @ 15 ft

TEST SAMPLE NO.....4

OPERATOR.....Ganga

TEST DATE.....12/19/2006

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 8.0 , WATER pH = 0.0 , SOIL pH = 8.0

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 1660 , WATER = 0 , SOIL = 1660

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	30	38	45	55	80
16 0.064	39	47	54	64	89
14 0.079	49	57	64	74	99
12 0.109	67	75	82	92	117
10 0.138	86	94	101	111	136
08 0.168	104	112	119	129	154

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

CONCRETE AND RCP MITIGATION MEASURES FOR pH
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, MAY BE USED
IF ABRASIVE CONDITIONS DO NOT EXIST
SITE CONDITIONS MEET CORROSION REQUIREMENTS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, MAY BE USED
SITE CONDITIONS MEET CORROSION REQUIREMENTS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...SR4

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....STA 251+49 155.9'LT."E"LINE

TEST SAMPLE NO.....RW-214#3@8.5'

OPERATOR.....O.GOUTHIER

TEST DATE.....09/17/08

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.6 , WATER pH = 0.0 , SOIL pH = 7.6

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 910 , WATER = 0 , SOIL = 910

CHLORIDES, PPM... 33.3 , SULFATES, PPM... 136.4

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	24	32	39	49	74
16 0.064	31	39	46	56	81
14 0.079	38	46	53	63	88
12 0.109	52	60	67	77	102
10 0.138	67	75	82	92	117
08 0.168	81	89	96	106	131

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

FOR SULFATE RESISTANT CONCRETE AND RCP
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

MAINTENANCE-FREE SERVICE DESIGN ESTIMATES FOR DRAINAGE FACILITIES USING:
CALIFORNIA CULVERT CRITERIA AND CULVERT4.EXE, (RELEASE DATE 04-16-98)

PROJECT LOCATION...SR4

PROJECT ACCOUNT NO.206117.GDR

SAMPLE LOCATION....STA 255+40 112.3'LT."E"LINE

TEST SAMPLE NO.....SW-206#2@4.5'

OPERATOR.....O.GOUTHIER

TEST DATE.....09/17/2008

********** A DATA VALUE OF ZERO INDICATES NO DATA INPUT **********

CSP SITE pH = 7.4 , WATER pH = 0.0 , SOIL pH = 7.4

MINIMUM RESISTIVITY, OHM-CM: CSP SITE = 320 , WATER = 0 , SOIL = 320

CHLORIDES, PPM... 462.1 , SULFATES, PPM... 298

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ESTIMATED SERVICE LIFE OF CSP CULVERTS, YEARS
SEE CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 850

CSP THICK Gage & in	GALV. 2 oz	GALV.+ BIT COAT. (WATER SIDE)	GALV.+ BIT COAT & PAVED INV. (ABRASION)	GALV.+ BIT COAT (SOIL SIDE)	GALV.+ POLYMER 90 DEG INVERT
18 0.052	15	23	30	40	65
16 0.064	20	28	35	45	70
14 0.079	25	33	40	50	75
12 0.109	34	42	49	59	84
10 0.138	43	51	58	68	93
08 0.168	53	61	68	78	103

FLOW VEL. <5 fps WITH NON-ABRASIVE CONDITIONS, (DEFAULT VALUES)
CAP, 18 GAGE (0.052 in) CSP AND CASP MAY BE USED WITH THESE FLOW VELOCITIES

STANDARD REINFORCED CONCRETE PIPE DESIGN SHOULD BE
SUITABLE FOR THIS USER DEFINED LEVEL OF CHLORIDES

FOR SULFATE RESISTANT CONCRETE AND RCP
TYPE IP (MS) MODIFIED CEMENT OR TYPE II MODIFIED CEMENT
MINIMUM REQUIRED BY CALTRANS STD. SPECS. 90-1.01

A CORRUGATED ALUMINUM PIPE, CAP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

A CORRUGATED ALUMINIZED STEEL PIPE, CASP, SHOULD NOT BE USED
DUE TO CORROSIVE CONDITIONS

PLASTIC PIPE IS APPROVED FOR 50 YEARS SERVICE LIFE FOR
CORROSIVE CONDITIONS. ABRASION MUST BE EVALUATED. ALSO,
CONSIDER CONCRETE HEADWALLS AND CONCRETE OR METAL END
TREATMENT WHERE HIGH FIRE POTENTIAL EXISTS.

STRUCTURAL PAVEMENT DESIGN

Project: North Contra Costa County Project
Job No.: 206115, 206118 & 206117
Flexible pavement Design: Somerville Road to A Street - Phase 1, (Ultimate)

R-value (Soil) = 15
R-value (AB) = 78 (Class 2)
R-value (AS) = 50 (Class 4)

TI =	9.0	12.5	14.5
Total GE req (mm) =	745.9	1035.9	1201.7
Full Depth AC:			
Add SF (mm) =	30.0	30.0	30.0
GE req(AC) + SF (mm) =	775.9	1065.9	1231.7
(table 633.1) **t(AC) (mm)** =	**330.0**	**480.0**	**570.0**
Depth (AC & LCB):			
GE req(AC+LCB) (mm) =	745.9	1035.9	1201.7
40% of GE req (AC+LCB) (mm) =	298.4	414.4	480.7
Add SF (mm) =	60.0	60.0	60.0
GE req(AC) + SF (mm) =	358.4	474.4	540.7
(table 633.1) **t(AC) (mm)** =	**195.0**	**270.0**	**300.0**
(table 633.1) GE t(AC) (mm) =	397.0	508.0	548.0
GE req(LCB) (mm) =	348.9	527.9	653.7
(table 633.1) **t(LCB) (mm)** =	**195.0**	**285.0**	**345.0**
Depth (AC, LCB& AS):			
GE req(AC+LCB) (mm) =	438.8	609.4	706.9
40% of GE req (AC+LCB) (mm) =	175.5	243.8	282.8
Add SF (mm) =	60.0	60.0	60.0
GE req(AC) + SF (mm) =	235.5	303.8	342.8
(table 633.1) **t(AC) (mm)** =	**135.0**	**195.0**	**225.0**
(table 633.1) GE t(AC) (mm) =	255.0	329.0	374.0
GE req(LCB) (mm) =	183.8	280.4	332.9
Add SF (mm) =	60.0	60.0	60.0
GE req(LCB) + SF (mm) =	243.8	340.4	392.9
(table 633.1) **t(LCB) (mm)** =	**135.0**	**180.0**	**210.0**
GE t(LCB) (mm) =	257.0	342.0	399.0
GE t (AC+LCB) (mm) =	512.0	671.0	773.0
GE req(AS) (mm) =	233.9	364.9	428.7
(table 633.1) **t(AS) (mm)** =	**240.0**	**375.0**	**435.0**

Note: User must input all values in yellow and then reference chapter 600 to get the final values in gray
For full depth of AC section, 30 mm satety factor is taken whereas for AC with AB and As 60 mm factor of safery is added.

Project: Rte 4 East-A Street to Hillcrest, Contra Costa County

A Street to Hillcrest Avenue - Phase 2 (Ultimate)

R-value (soil) = 20
R-value (AS) = 50 (Class 4)

TI =	12.0	14.5	9.00	
Total GE req (ft) =	3.07	3.71	2.30	total GE of LC
Full Depth AC:				
Add SF (mm) =	0.1	0.1	0.1	Net GE of LC
GE req(AC) + SF (ft) =	3.17	3.81	2.40	
(table 633.1) **t(AC) (ft) =**	**1.45**	**1.75**	**1.05**	
Depth (AC & LCB):				
GE req(AC+LCB) (ft) =	3.07	3.71	2.30	
40% of GE req (AC+LCB) (ft) =	1.23	1.48	0.92	
Add SF (ft) =	0.20	0.20	0.20	
GE req(AC) + SF (mm) =	1.43	1.68	1.12	
(table 633.1) **t(AC) (ft) =**	**0.80**	**0.95**	**0.600**	
(table 633.1) GE t(AC) (ft) =	1.50	1.69	1.18	
GE req(LCB) (ft) =	1.57	2.02	1.12	
(table 633.1) **t(LCB) (mm) =**	**0.85**	**1.10**	**0.60**	
	1.65	**2.05**	**1.20**	
Depth (AC, LCB& AS):				
GE req(AC+LCB) (ft) =	1.92	2.32	1.44	
40% of GE req (AC+LCB) (ft) =	0.77	0.93	0.576	
Add SF (ft) =	0.2	0.2	0.2	
GE req(AC) + SF (ft) =	0.97	1.13	0.78	
(table 633.1) **t(AC) (ft) =**	**0.60**	**0.75**	**0.45**	
(table 633.1) GE t(AC) (ft) =	1.02	1.23	0.85	
GE req(LCB) (ft) =	0.90	1.09	0.59	
Add SF (ft) =	0.20	0.20	0.20	
GE req(LCB) + SF (ft) =	1.10	1.29	0.79	
(table 633.1) **t(LCB) (ft) =**	**0.60**	**0.70**	**0.45**	
GE t(LCB) (ft) =	1.1	1.3	0.86	
GE t (AC+LCB) (ft) =	2.16	2.56	1.71	
GE req(AS) (ft) =	0.91	1.15	0.59	
(table 633.1) **t(AS) (ft) =**	**1.00**	**1.2**	**0.60**	
	2.20	**2.65**	**1.50**	

Note: User must input all values in yellow and then reference chapter 600 to get the final values in gray
For full depth of AC section, 0.1 ft satety factor is taken whereas for AC with AB and As 0.20 ft factor of safery is added.

Project: Rte 4 East-Somersville Interchange, Contra Costa County
Job No: 2061175.GDR
A Street & Lone Tree Way

R-value (Soil) = 10
R-value (AS) = 50 (Class 4)

TI =	12.0	13.0	
Total GE req (ft) =	3.46	3.74	
Full Depth AC:			
Add SF (ft) =	0.10	0.10	
GE req(AC) + SF (ft) =	3.56	3.84	
(table 633.1) **t(AC) (ft) =**	**1.55**	**1.70**	
Depth (AC & LCB):			
GE req(AC+LCB) (ft) =	3.46	3.74	
40% of GE req (AC+LCB) (ft) =	1.38	1.50	
Add SF (ft) =	0.20	0.20	
GE req(AC) + SF (ft) =	1.58	1.70	
(table 633.1) **t(AC) (ft) =**	**0.85**	**0.90**	
(table 633.1) GE t(AC) (ft) =	1.63	1.70	
GE req(LCB) (ft) =	1.83	2.04	
(table 633.1) **t(LCB) (ft) =**	**1.00**	**1.10**	
Depth (AC, LCB & AS):			
GE req(AC+LCB) (ft) =	1.92	2.08	
40% of GE req (AC+LCB) (ft) =	0.77	0.83	
Add SF (ft) =	0.20	0.20	
GE req(AC) + SF (ft) =	0.97	1.03	
(table 633.1) **t(AC) (ft) =**	**0.60**	**0.65**	
(table 633.1) GE t(AC) (mm) =	1.02	1.09	
GE req(LCB) (mm) =	0.90	0.99	
Add SF (mm) =	0.2	0.2	
GE req(LCB) + SF (mm) =	1.10	1.19	
(table 633.1) **t(LCB) (mm) =**	**0.60**	**0.65**	
GE t(LCB) (mm) =	1.14	1.24	
GE t (AC+LCB) (mm) =	2.16	2.33	
GE req(AS) (mm) =	1.30	1.41	
(table 633.1) **t(AS) (mm) =**	**1.30**	**1.45**	

Note: User must input all values in yellow and then reference chapter 600 to get the final values in gray
For full depth of AC section, 0.1 ft satety factor is taken whereas for AC with AB and As 0.20 ft factor of safery is added.

Project: North Contra Costa County Project
Job No.: 206117.GDR
Flexible pavement Design (A Street on/off ramps)

	R-value (soil) = 15			R-value (soil) = 10	
	R-value (AB) = 78		(Class 2)	R-value (AB) = 78	
	R-value (AS) = 50		(Class 2)	R-value (AS) = 50	
	TI =	10.00		TI =	10.00
	Total GE req =	2.72		Total GE req =	2.88
Full Depth AC:	Add SF =	0.10		Add SF =	0.10
	GE req(HMA-A) + SF =	2.82		GE req(HMA-A) + SF =	2.98
(table 633.1)	**t(HMA-A)=**	**1.20**		**t(HMA-A)=**	**1.25**
Depth (AC & AB):	GE req(HMA-A) =	0.70		GE req(HMA-A) =	0.70
	Add SF =	0.20		Add SF =	0.20
	GE req(HMA-A) + SF =	0.90		GE req(HMA-A) + SF =	0.90
(table 633.1)	**t(HMA-A)=**	**0.50**		**t(HMA-A)=**	**0.50**
(table 633.1)	GE t(HMA-A)=	0.90		GE t(HMA-A)=	0.90
	GE req(AB) =	1.82		GE req(AB) =	1.98
(table 633.1)	**t(AB)=**	**1.70**		**t(AB)=**	**1.80**
		2.20			**2.30**
Depth (AC, AB& AS):	GE req(HMA-A) =	0.70		GE req(HMA-A) =	0.70
	Add SF =	0.20		Add SF =	0.20
	GE req(HMA-A) + SF =	0.90		GE req(HMA-A) + SF =	0.90
(table 633.1)	**t(HMA-A)=**	**0.50**		**t(HMA-A)=**	**0.50**
(table 633.1)	GE t(HMA-A)=	0.90		GE t(HMA-A)=	0.90
	GE req(HMA-A+AB) =	1.60		GE req(HMA-A+AB) =	1.60
	GE req(AB) =	0.70		GE req(AB) =	0.70
	Add SF =	0.20		Add SF =	0.20
	GE req(AB) + SF =	0.90		GE req(AB) + SF =	0.90
(table 633.1)	**t(AB)=**	**0.85**		**t(AB)=**	**0.85**
	GE t(AB)=	0.94		GE t(AB)=	0.94
	GE t (HMA-A+AB)	1.84		GE t (HMA-A+AB)	1.84
	GE req(AS) =	0.88		GE req(AS) =	1.04
(table 633.1)	**t(AS)=**	**0.90**		**t(AS)=**	**1.05**
		2.25			**2.40**

Note: User must input all values in yellow and then reference chapter 600 to get the final values in gray
For full depth of HMA-A section, 0.1 ft satety factor is taken whereas for HMA-A with AB and HMA-A with AB & AS sections, 0.20 ft factor of safery is added.

Project: North Contra Costa County Project
Job No.: 206117.GDR
Flexible pavement Design - Sunset Drive

R-value (soil) = 10
R-value (AB) = 78 (Class 2)
R-value (AS) = 50 (Class 2)

	TI =	8.00	
	Total GE req =	2.30	
Full Depth AC:	Add SF =	0.10	
	GE req(HMA-A) + SF =	2.40	
(table 633.1)	**t(HMA-A)=**	**1.00**	

Depth (AC & AB):	GE req(HMA-A) =	0.56	
	Add SF =	0.20	
	GE req(HMA-A) + SF =	0.76	
(table 633.1)	**t(HMA-A)=**	**0.40**	
(table 633.1)	GE t(HMA-A)=	0.80	
	GE req(AB) =	1.50	
(table 633.1)	**t(AB)=**	**1.40**	
		1.80	

Depth (AC, AB& AS):	GE req(HMA-A) =	0.56	
	Add SF =	0.20	
	GE req(HMA-A) + SF =	0.76	
(table 633.1)	**t(HMA-A)=**	**0.40**	
(table 633.1)	GE t(HMA-A)=	0.80	
	GE req(HMA-A+AB) =	1.28	
	GE req(AB) =	0.48	
	Add SF =	0.20	
	GE req(AB) + SF =	0.68	o
(table 633.1)	**t(AB)=**	**0.65**	
	GE t(AB)=	0.72	
	GE t (HMA-A+AB)	1.52	
	GE req(AS) =	0.78	
(table 633.1)	**t(AS)=**	**0.80**	
		1.85	

Note: User must input all values in yellow and then reference chapter 600 to get the final values in gray
For full depth of HMA-A section, 0.1 ft satety factor is taken whereas for HMA-A with AB and HMA-A with AB & AS sections, 0.20 ft factor of safery is added.

Project: North Contra Costa County Project
Job No.: 206117.GDR
Temporary Mainline

R-value (soil) = 15
R-value (AB) = 78 (Class 2)
R-value (AS) = 50 (Class 2)

	TI =	9.00	9.50
	Total GE req =	2.45	2.58
Full Depth AC:	Add SF =	0.10	0.10
	GE req(HMA-A) + SF =	2.55	2.68
(table 633.1)	**t(HMA-A)=**	**1.10**	**1.15**
Depth (AC & AB):	GE req(HMA-A) =	0.63	0.67
	Add SF =	0.20	0.20
	GE req(HMA-A) + SF =	0.83	0.87
(table 633.1)	**t(HMA-A)=**	**0.45**	**0.50**
(table 633.1)	GE t(HMA-A)=	0.85	0.90
	GE req(AB) =	1.60	1.68
(table 633.1)	**t(AB)=**	**1.45**	**1.55**
		1.90	**2.05**
Depth (AC, AB& AS):	GE req(HMA-A) =	0.63	0.67
	Add SF =	0.20	0.20
	GE req(HMA-A) + SF =	0.83	0.87
(table 633.1)	**t(HMA-A)=**	**0.45**	**0.50**
(table 633.1)	GE t(HMA-A)=	0.85	0.90
	GE req(HMA-A+AB) =	1.44	1.52
	GE req(AB) =	0.59	0.62
	Add SF =	0.20	0.20
	GE req(AB) + SF =	0.79	0.82
(table 633.1)	**t(AB)=**	**0.75**	**0.75**
	GE t(AB)=	0.83	0.83
	GE t (HMA-A+AB)	1.68	1.73
	GE req(AS) =	0.77	0.85
(table 633.1)	**t(AS)=**	**0.75**	**0.80**
		1.95	**2.05**

R-value (soil) = 20
R-value (AB) = 78
R-value (AS) = 50

TI =	9.00	9.50
Total GE req =	2.30	2.43
Add SF =	0.10	0.10
GE req(HMA-A) + SF =	2.40	2.53
t(HMA-A)=	**1.05**	**1.10**
GE req(HMA-A) =	0.63	0.67
Add SF =	0.20	0.20
GE req(HMA-A) + SF =	0.83	0.87
t(HMA-A)=	**0.45**	**0.50**
GE t(HMA-A)=	0.85	0.90
GE req(AB) =	1.45	1.53
t(AB)=	**1.35**	**1.40**
	1.80	**1.90**
GE req(HMA-A) =	0.63	0.67
Add SF =	0.20	0.20
GE req(HMA-A) + SF =	0.83	0.87
t(HMA-A)=	**0.45**	**0.50**
GE t(HMA-A)=	0.85	0.90
GE req(HMA-A+AB) =	1.44	1.52
GE req(AB) =	0.59	0.62
Add SF =	0.20	0.20
GE req(AB) + SF =	0.79	0.82
t(AB)=	**0.75**	**0.75**
GE t(AB)=	0.83	0.83
GE t (HMA-A+AB)	1.68	1.73
GE req(AS) =	0.62	0.70
t(AS)=	**0.65**	**0.70**
	1.85	**1.95**

Note: User must input all values in yellow and then reference chapter 600 to get the final values in gray
For full depth of HMA-A section, 0.1 ft satety factor is taken whereas for HMA-A with AB and HMA-A with AB & AS sections, 0.20 ft factor of safery is added.

APPENDIX D

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	CC	4	27.2/29.0		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER — Michele Johnson — No. C69115 — Exp. 06/30/10 — CIVIL — STATE OF CALIFORNIA

T Y LIN INTERNATIONAL
2010 CROW CANYON PLACE, SUITE 350
SAN RAMON, CA 94583

CCTA
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

NOTES:

1. DIMENSIONS OF THE PAVEMENT STRUCTURES (STRUCTURAL SECTIONS) ARE SUBJECT TO TOLERANCES SPECIFIED IN THE STANDARD SPECIFICATIONS.
2. SUPERELEVATIONS ARE SHOWN ON THE SUPERELEVATION DIAGRAMS.
3. SEE LAYOUT PLANS FOR LIMITS OF CURBS, HMA DIKE, HMA SIDE GUTTER AND MBGR.
4. SEE LAYOUT PLANS FOR Ret AND SOUND WALL LIMITS.
5. SEE SHEETS C-17 & C-18 FOR CITY OF ANTIOCH CURB, CURB AND GUTTER AND SIDEWALKS DETAILS.
6. SEE SHEETS C-22 & C-23 FOR MVP DETAILS.
7. 2.5' OF FILL MATERIAL UNDERNEATH PAVEMENT TO HAVE Min R-VALUE OF 20. SEE X-SHEETS FOR LOCATIONS WHERE EXISTING MATERIAL IS TO BE EXCAVATED AND REPLACED WITH SUBGRADE HAVING Min R-VALUE OF 20.
8. SEE SHEET C-19 FOR DETAILS ABOUT HMA PAVING UNDER DIKE.

PAVEMENT STRUCTURAL SECTIONS:

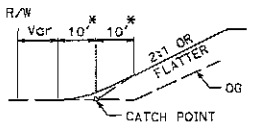
1. 1.00' JPCP
   0.35' LCB
   0.70' AS (CLASS 4)
2. Var 1.00' - 0.70' HMA-A
   0.35' LCB
   0.70' AS (CLASS 4)
3. 0.50' HMA-A
   0.90' AB (CLASS 3)
   1.00' AS (CLASS 4)
4. 0.65' HMA-A
   0.65' LCB
   1.45' AS (CLASS 4)
5. 1.70' HMA-A
6. 0.15' Min HMA-A
   GP1
   0.15' HMA-A
   COLD PLANE AC (0.10')
7. 0.60' HMA-A
   0.60' LCB
   1.30' AS (CLASS 4)
8. 1.55' HMA-A
9. 0.15' Min HMA-A
   GP1
   0.15' HMA-A
   COLD PLANE AC (0.20')
10. 0.40' HMA-A
    0.85' AB (CLASS 3)
    0.80' AS (CLASS 4)
11. 1.0' HMA-A
12. 0.50' HMA-A
    0.75' AB (CLASS 3)
    0.70' AS (CLASS 4)
13. 0.15' Min HMA-A
    COLD PLANE AC (CONFORM)
    (SEE SHEET C-19 FOR DETAIL)
14. 0.35' MINOR CONCRETE
    (TEXTURED PAVING)
    0.35' AB (CLASS 3)
15. 0.15' Min HMA-A
16. 0.20' HMA-A

DESIGN DESIGNATION (ROUTE 4 -A STREET TO HILLCREST AVENUE):

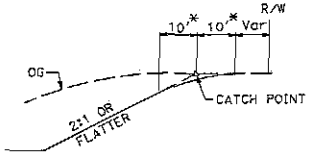
2006 ADT = 81,000 D = 20-30%
2030 ADT = 169,000 T = 5%
DHV = 11,405 V = 70 MPH

ABBREVIATIONS:

BFFT	BARRIER FOR FUTURE TRANSIT
C&G	CURB AND GUTTER
COA	CITY OF ANTIOCH
FC	FACE OF CURB
GP1	GEOSYNTHETIC PAVEMENT INTERLAYER
MVP	MAINTENANCE VEHICLE PULLOUT
RAC	RUBBERIZED ASPHALT CONCRETE
Rem	REMOVE
SMSC	STANDARD MEDIAN SPILL CURB

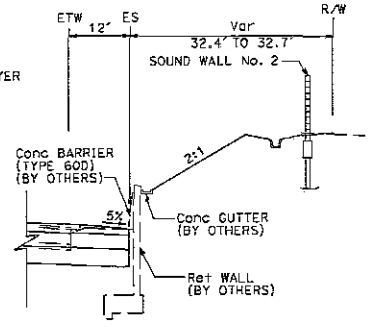


TYPICAL FILL SLOPE ROUNDING

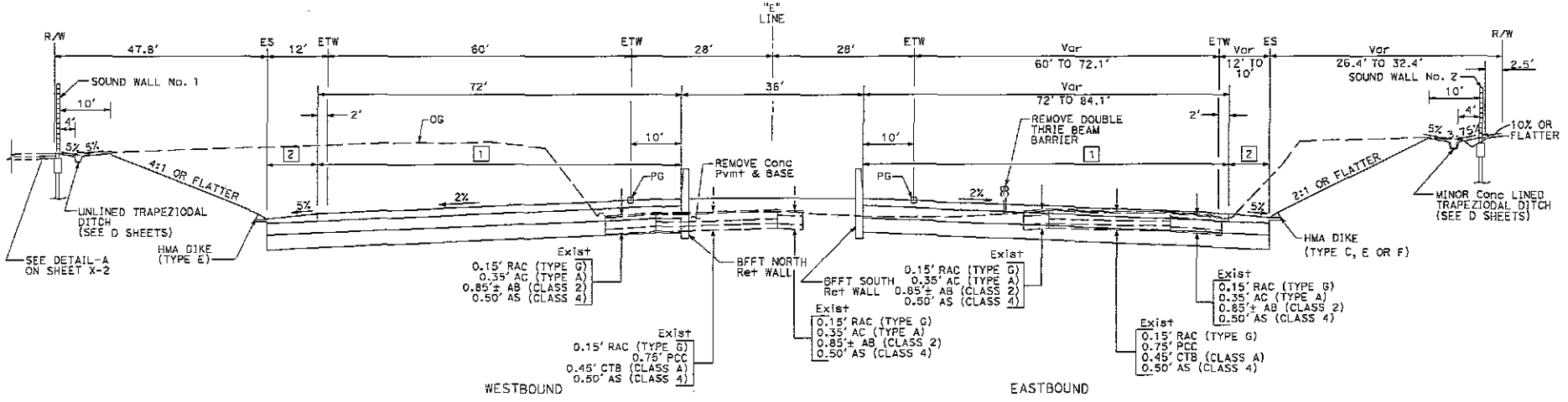


TYPICAL CUT SLOPE ROUNDING

*SPACE PERMITTING OR AS INSTRUCTED BY THE ENGINEER.



EASTBOUND
"E" 179+00 TO 179+50.00



WESTBOUND
"E" 179+00 TO 182+42.91

ROUTE 4

EASTBOUND
"E" 179+00 TO 185+56.32

TYPICAL CROSS SECTIONS

NO SCALE

X-1

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans
CONSULTANT FUNCTIONAL SUPERVISOR XXXXXXXXXX
CALCULATED-DESIGNED BY XXX
CHECKED BY XXX
REVISED BY XXX
DATE REVISED X/08

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CU 04275
EA 2285F1

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	CC	4	27.2/29.0		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Michele Johnson No. C69116 Exp. 06/30/10 CIVIL STATE OF CALIFORNIA

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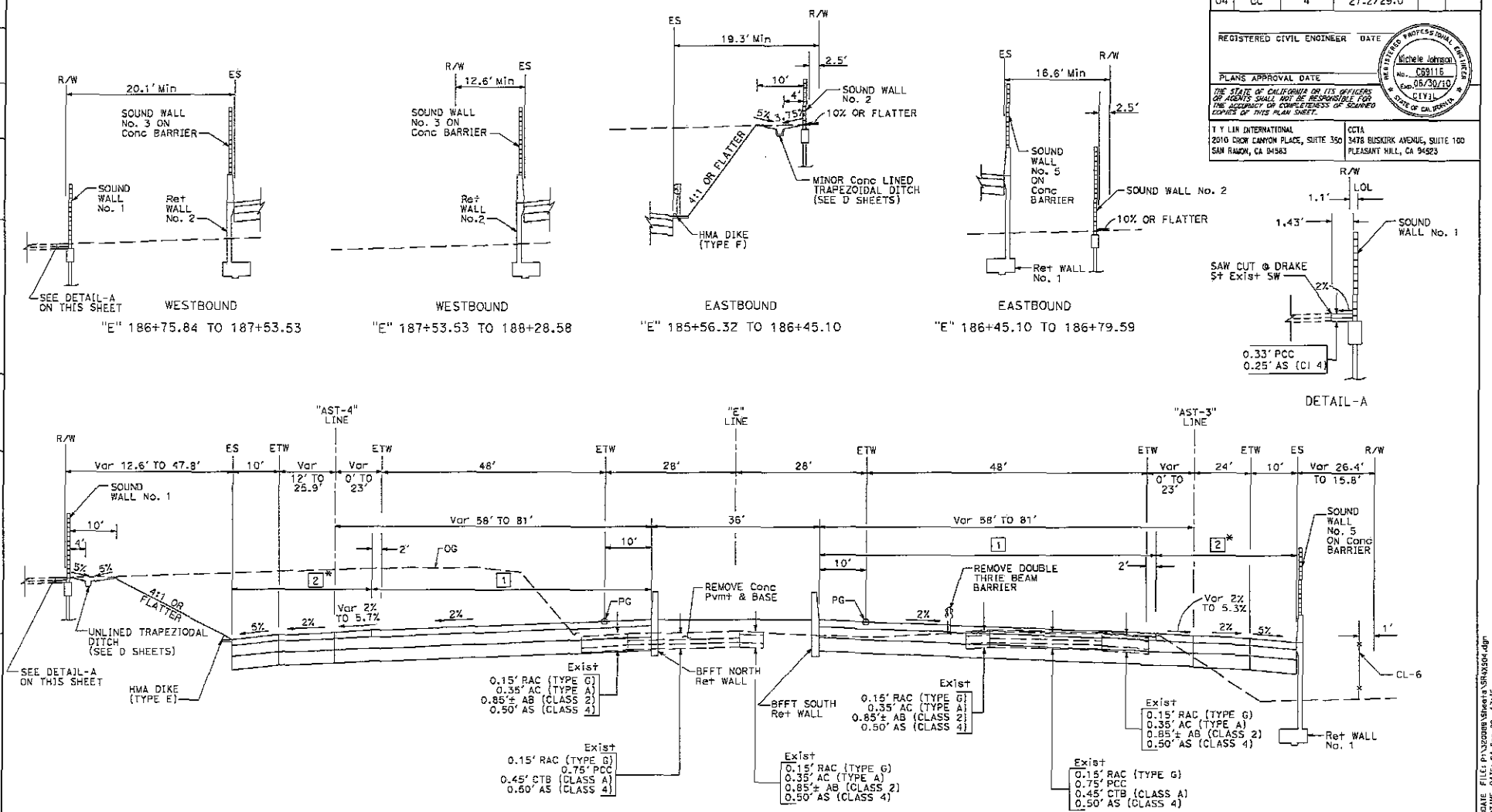
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523



FOR NOTES, ABBREVIATIONS AND/OR LEGEND, SEE SHEET X-1

TYPICAL CROSS SECTIONS

NO SCALE

X-2

REVISED BY	DATE REVISED	CALCULATED-DESIGNED BY	CHECKED BY
XXX	X/08	XXX	XXX

CONSULTANT FUNCTIONAL SUPERVISOR: XXXXXXXXXX

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

BORDER LAST REVISED 4/11/2008

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CU 04275

EA 2285F1

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	CC	4	27.2/29.0		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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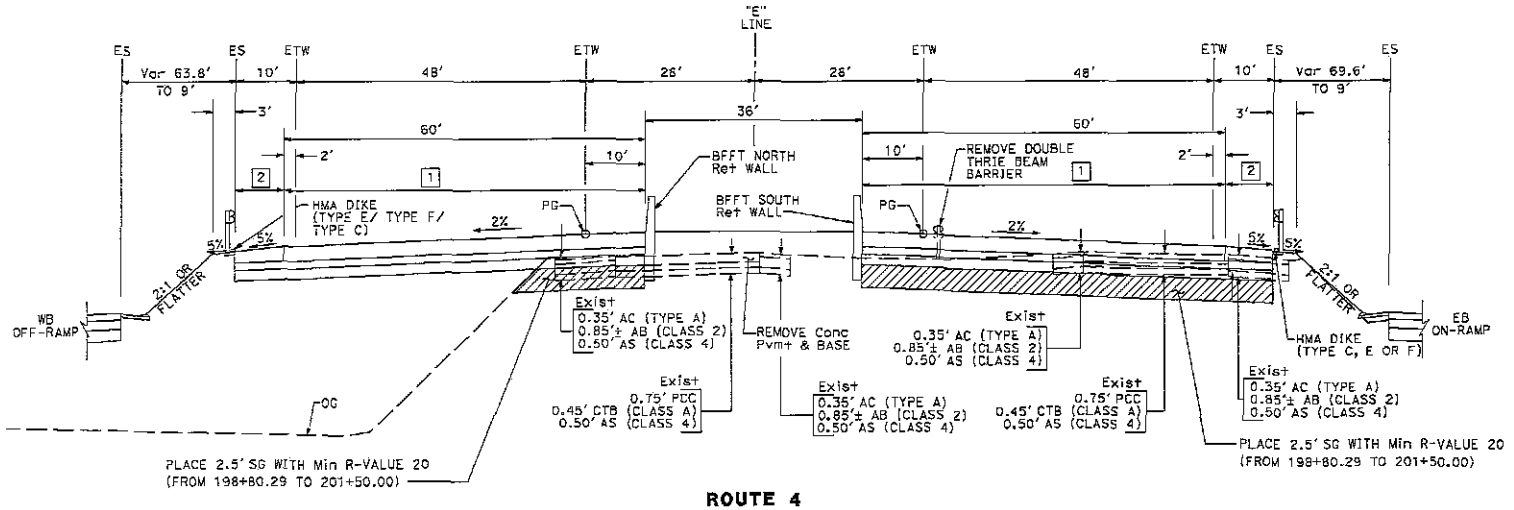
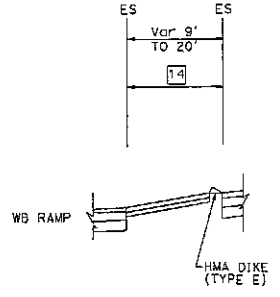


ROUTE 4

WESTBOUND
"E" 198+80.29 TO 206+65.58

EASTBOUND
"E" 198+80.29 TO 206+78.88



TEXTURED PAVING

WESTBOUND
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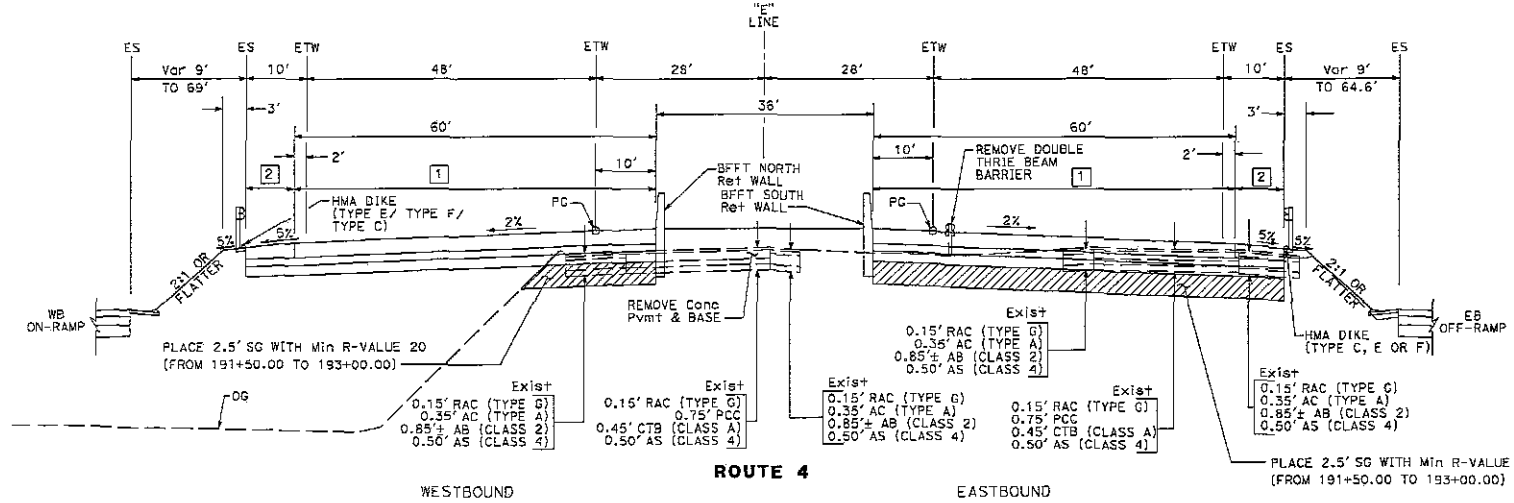
"E" 205+36.28 TO 206+65.58



ROUTE 4

WESTBOUND
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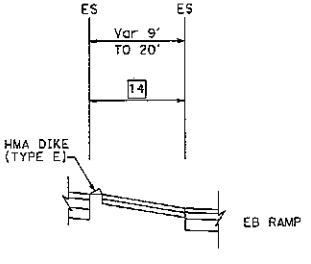
EASTBOUND
"E" 188+26.32 TO 196+20.29



TEXTURED PAVING

EASTBOUND
"E" 188+26.32 TO 189+55.62
"E" 205+33.70 TO 206+78.88

FOR NOTES, ABBREVIATIONS AND/OR LEGEND, SEE SHEET X-1

TYPICAL CROSS SECTIONS

NO SCALE

X-3

REVISED BY	DATE REVISED
XXX	X/08
XXX	XXX

CALCULATED-DESIGNED BY
CHECKED BY

CONSULTANT FUNCTIONAL SUPERVISOR XXXXXXXXXXX

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

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EA 2285F1

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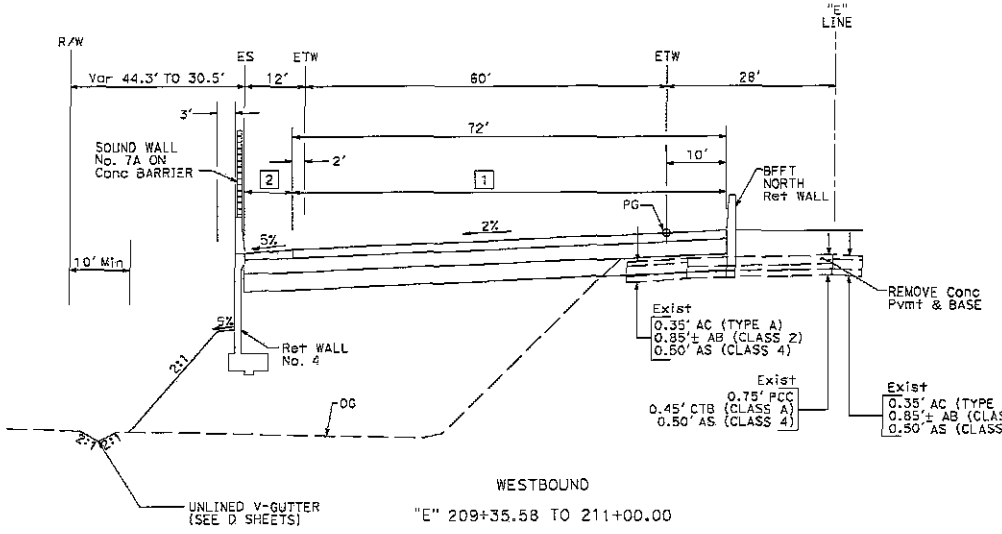

WESTBOUND

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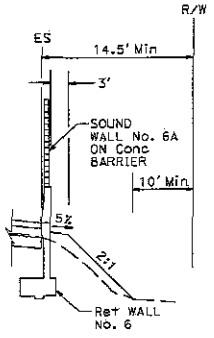

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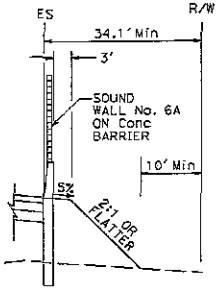

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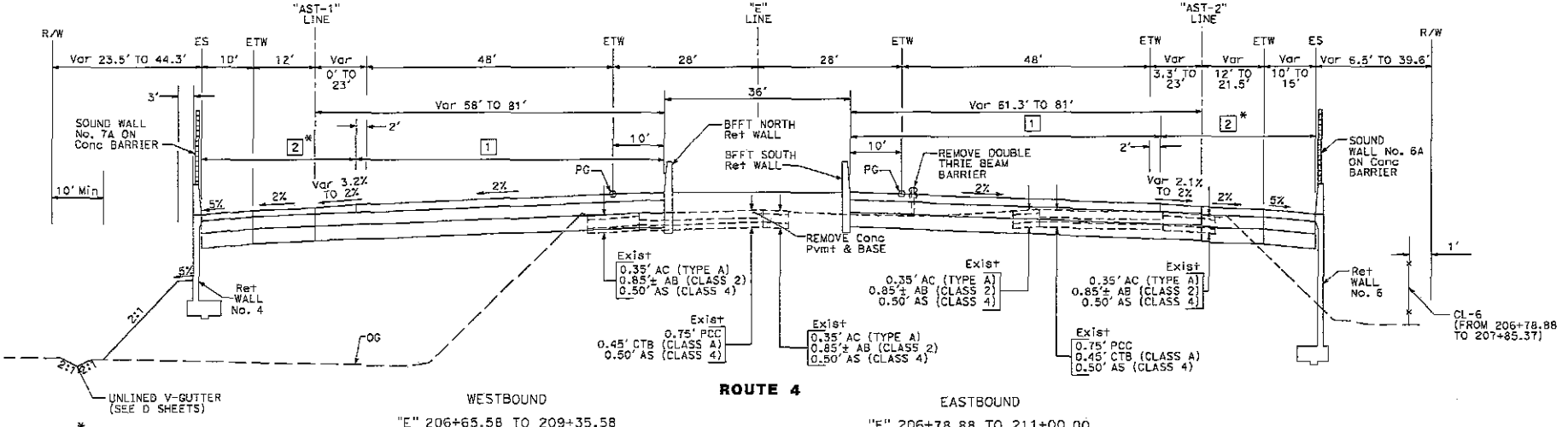

WESTBOUND

"E" 206+65.58 TO 209+35.58

ROUTE 4

EASTBOUND

"E" 206+78.88 TO 211+00.00

*FOR GORE PAVING, SEE DETAILS ON SHEET C-19

FOR NOTES, ABBREVIATIONS AND/OR LEGEND, SEE SHEET X-1

TYPICAL CROSS SECTIONS

NO SCALE

X-4

REVISED BY	DATE REVISED
XXX	X/08
XXX	XXX

CALCULATED-DESIGNED BY

CHECKED BY

CONSULTANT FUNCTIONAL SUPERVISOR XXXXXXXXXX

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Caltrans

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EA 2285F1

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	CC	4	27.2/29.0		

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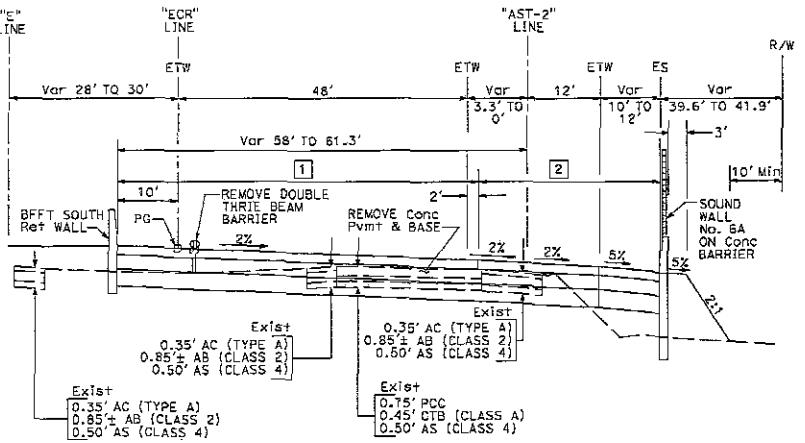
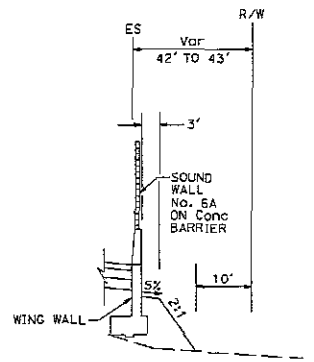


EASTBOUND

"ECR" 71+00.00 TO 72+64.56



EASTBOUND

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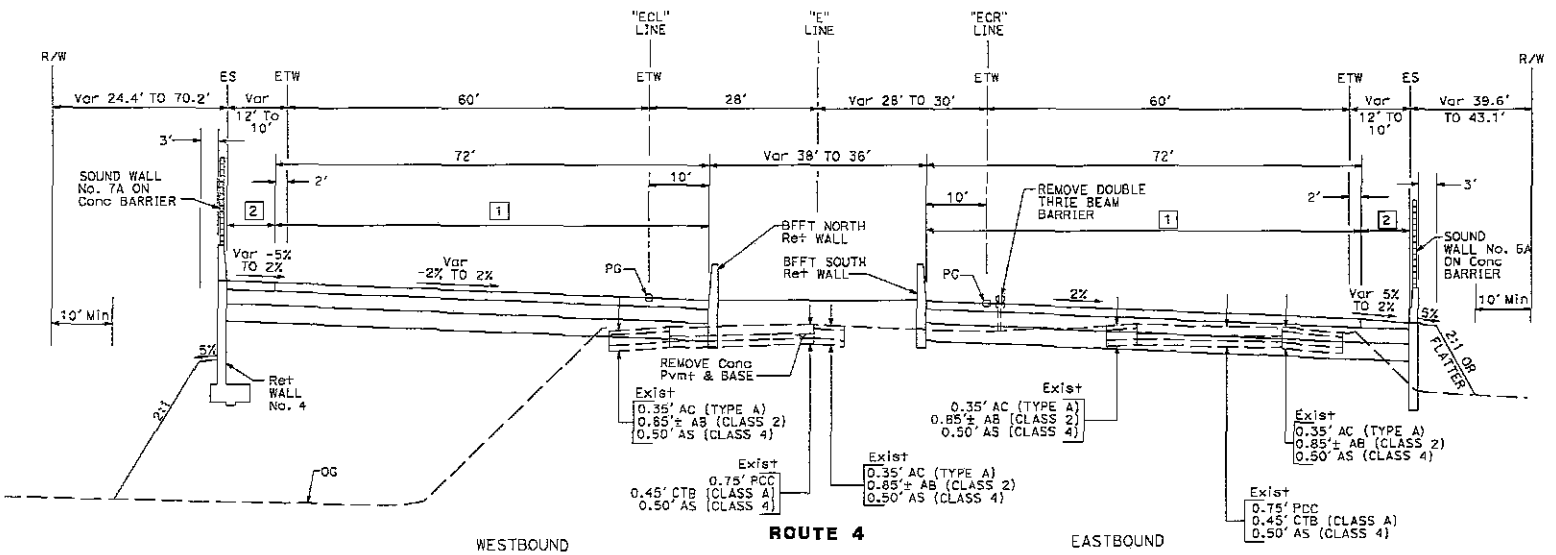

WESTBOUND

"ECL" 41+00.00 TO 49+52.62

ROUTE 4

EASTBOUND

"ECR" 71+00.00 TO 79+55.21

FOR NOTES, ABBREVIATIONS AND/OR LEGEND, SEE SHEET X-1

TYPICAL CROSS SECTIONS

NO SCALE

X-5

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION	CONSULTANT FUNCTIONAL SUPERVISOR	CALCULATED-DESIGNED BY	XXX
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		REVISED BY	XXX
		DATE REVISED	X/XX

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REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Michele Johnson No. C69116 Exp. 06/30/10 CIVIL STATE OF CALIFORNIA

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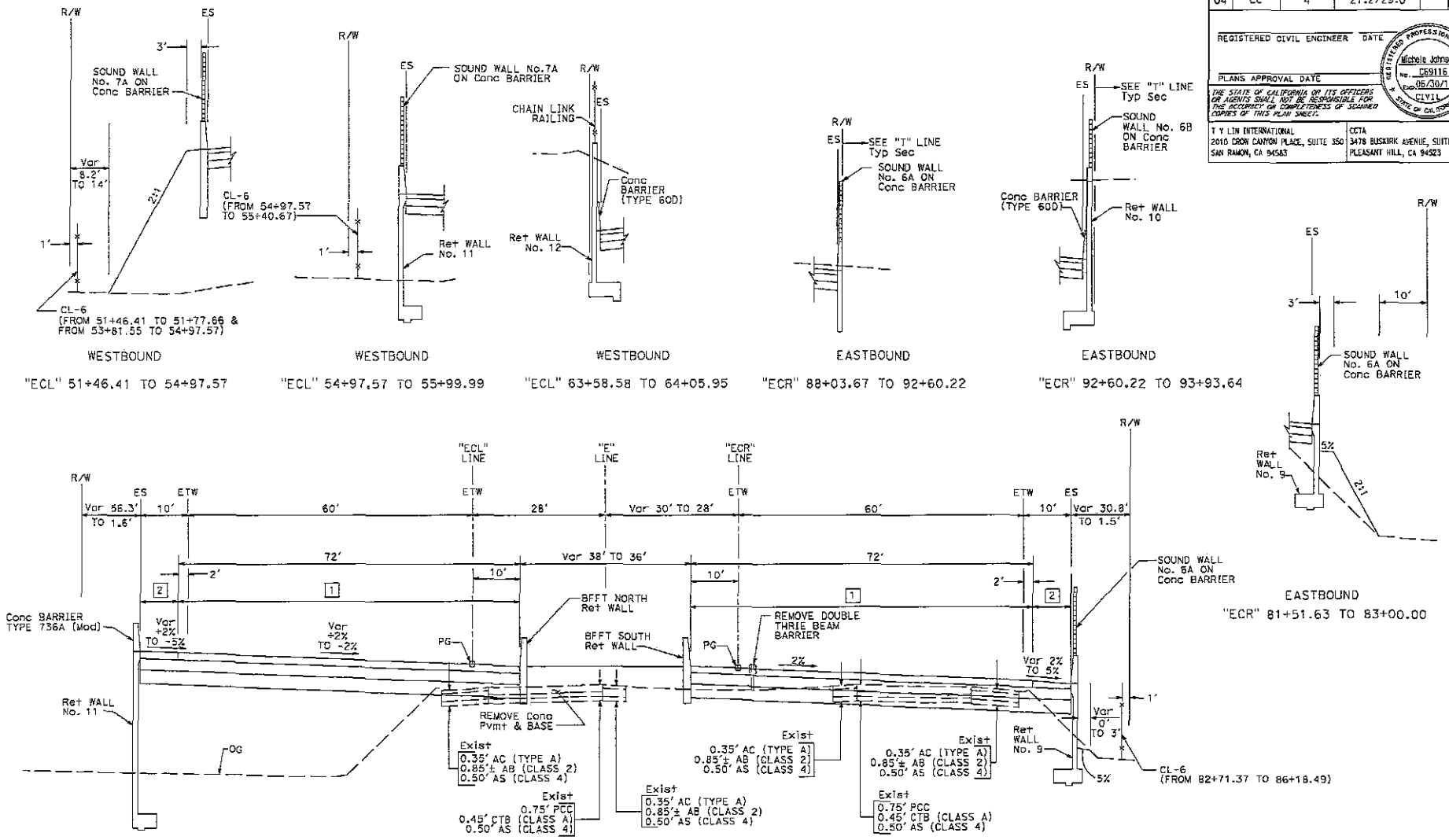

EASTBOUND
"ECR" 81+51.63 TO 83+00.00

FOR NOTES, ABBREVIATIONS AND/OR LEGEND, SEE SHEET X-1

TYPICAL CROSS SECTIONS

NO SCALE

X-6

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR XXXXXXXXXX

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REVISED BY XXX | DATE REVISED X/08

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CU 04275

EA 2285F1

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	CC	4	27.2/29.0		

REGISTERED CIVIL ENGINEER DATE

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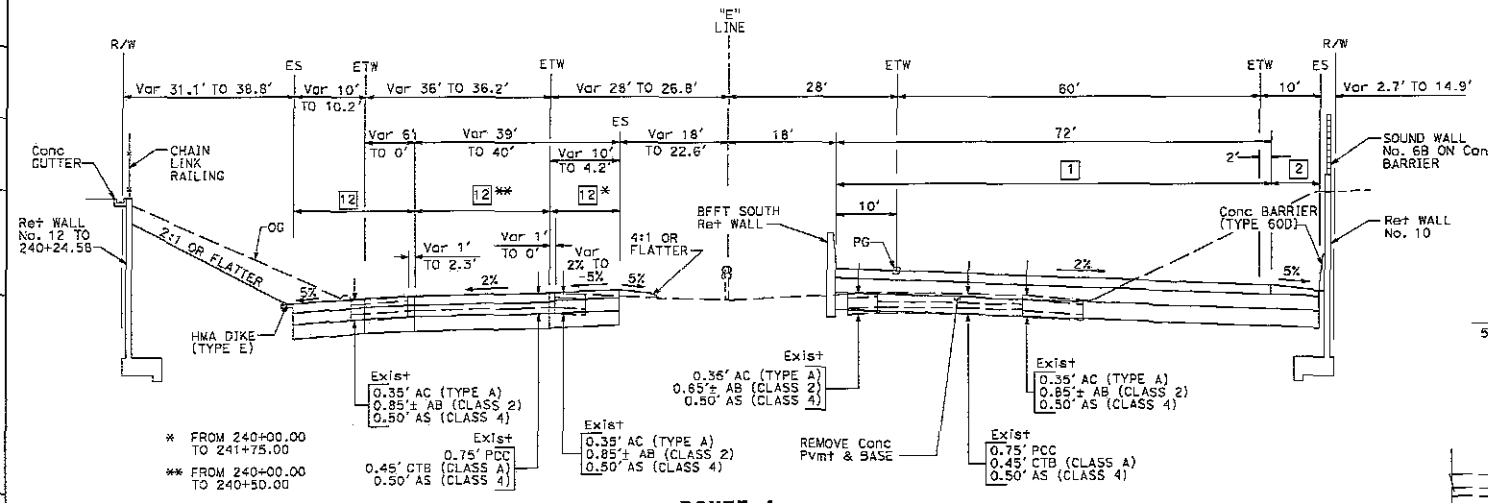
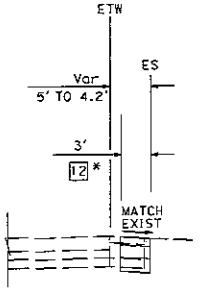


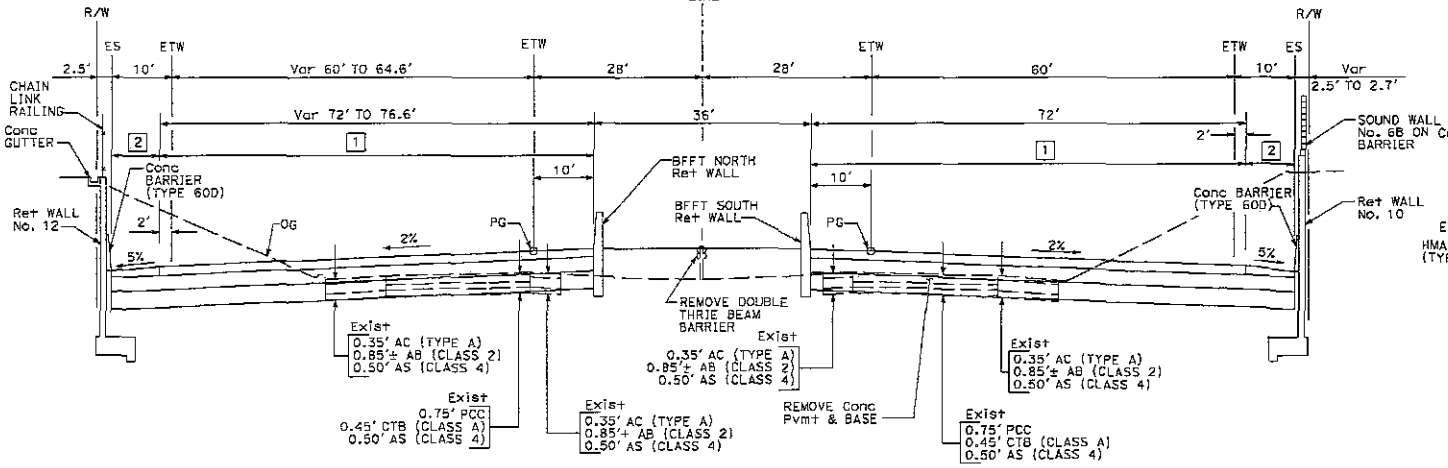
ROUTE 4

WESTBOUND
"E" 240+00.00 TO 243+13.01

EASTBOUND
"E" 240+00.00 TO 245+08.75



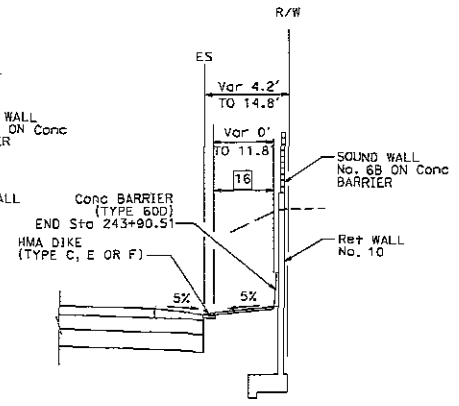
WESTBOUND
"E" 241+45.03 TO 243+13.01



ROUTE 4

WESTBOUND
"E" 234+00.00 TO 240+00.00

EASTBOUND
"E" 234+00.00 TO 240+00.00



EASTBOUND
"E" 243+17.61 TO 245+08.75

FOR NOTES, ABBREVIATIONS AND/OR LEGEND, SEE SHEET X-1

TYPICAL CROSS SECTIONS

NO SCALE

X-7

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR XXXXXXXXXXX
CALCULATED-DESIGNED BY
CHECKED BY
XXX XXX
REVISED BY X/DB
DATE REVISED XXX

LAST REVISION 00-00-00
DATE PLOTTED => @DATE FILE: P:\320088\Sheets\SR4X5DB.dgn
TIME PLOTTED => @TIME DATE: 24-Sep-09 17:46

BORDER LAST REVISED 4/11/2008
RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3
USERNAME => @USER
DGN FILE => @REQUEST
CU 04275
EA 2285F1

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	CC	4	27.2/29.0		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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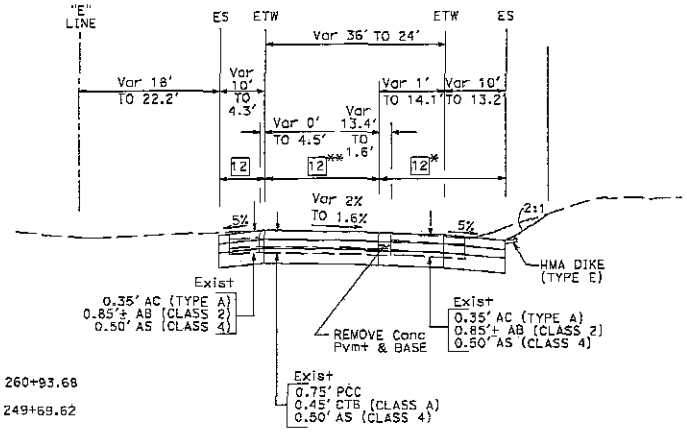
REGISTERED PROFESSIONAL ENGINEER Michele Johnson No. C69116 Exp. 06/30/10 CIVIL STATE OF CALIFORNIA

T Y LIN INTERNATIONAL
2010 CROW CANYON PLACE, SUITE 350
SAN RAMON, CA 94583

CCTA
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523



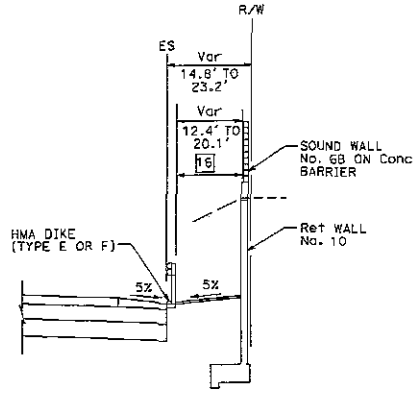
* FROM "E" 249+19.62 TO 260+93.68

** FROM "E" 249+19.62 TO 249+69.62

EASTBOUND

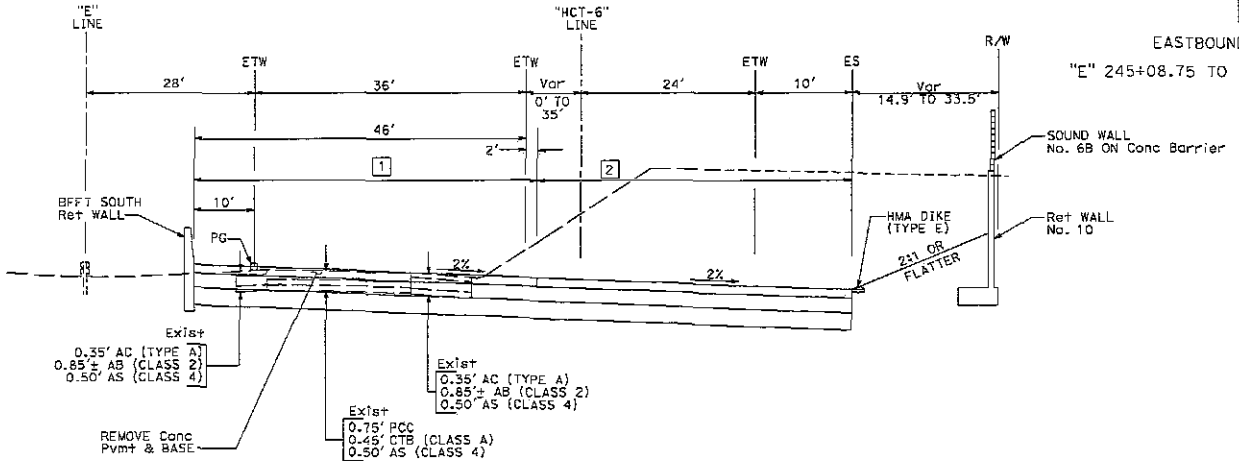
"E" 249+19.62 TO 261+38.63

ROUTE 4



EASTBOUND

"E" 245+08.75 TO 247+89.88



EASTBOUND

"E" 245+08.75 TO 249+19.62

ROUTE 4

FOR NOTES, ABBREVIATIONS AND/OR LEGEND, SEE SHEET X-1

TYPICAL CROSS SECTIONS

NO SCALE

X-8

REVISED BY	DATE REVISED
XXX	X/08

CALCULATED-DESIGNED BY	CHECKED BY
XXX	XXX

CONSULTANT FUNCTIONAL SUPERVISOR: XXXXXXXXXX

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

LAST REVISED 00-00-00 DATE PLOTTED => $DATE FILE: P:\32006\59\Shapes\SH4X10.dgn TIME PLOTTED => $TIME DATE: 24-Sep-09 17:48

BORDER LAST REVISED 4/11/2008 | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | USERNAME => $USER DGN FILE => $REQUEST | CU 04275 | EA 2285F1

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	CC	4	27.2/29.0		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Michele Johnson No. C69116 Exp. 06/30/10 CIVIL STATE OF CALIFORNIA

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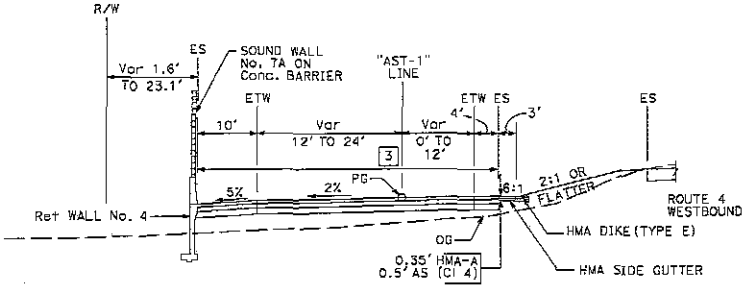
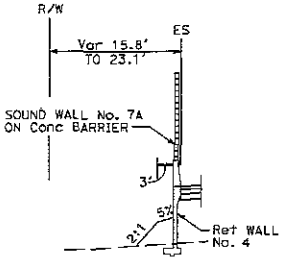
2010 CROW CANYON PLACE, SUITE 350
SAN RAMON, CA 94583

CCTA
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523

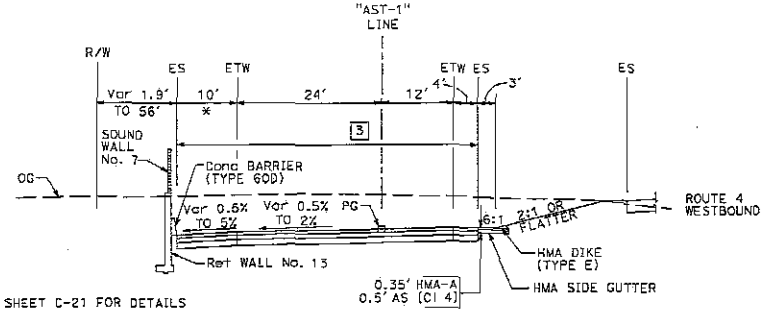


ROUTE 4 WESTBOUND OFF-RAMP AT A STREET

"AST-1" 500+33.10 TO 506+64.94



"AST-1" 505+79.30 TO 506+64.94



* SEE SHEET C-21 FOR DETAILS

ROUTE 4 WESTBOUND OFF-RAMP AT A STREET

"AST-1" 498+40.46 TO 500+33.10

FOR NOTES, ABBREVIATIONS AND/OR LEGEND, SEE SHEET X-1

TYPICAL CROSS SECTIONS

NO SCALE

X-9

REVISED BY	DATE REVISED
XXX	X/08

CALCULATED-DESIGNED BY	CHECKED BY
XXX	XXX

CONSULTANT FUNCTIONAL SUPERVISOR: XXXXXXXXXXX

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

LAST REVISION 00-00-00 DATE PLOTTED => <DATE> TIME PLOTTED => <TIME> FILE: P:\3260095\Sheets\SR4XS11.dgn DATE: 24-Sep-09 17:48

BORDER LAST REVISED 4/11/2008 | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | USERNAME => $USER DGN FILE => $REQUEST | CU 04275 | EA 2285F1

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	CC	4	27.2/29.0		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Michele Johnson No. C69116 Exp. 06/30/10 CIVIL STATE OF CALIFORNIA

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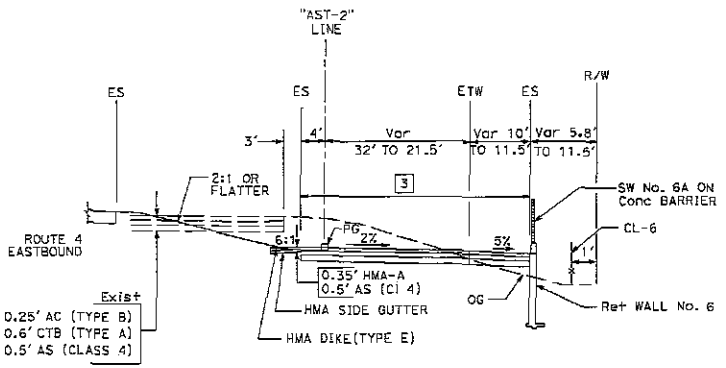
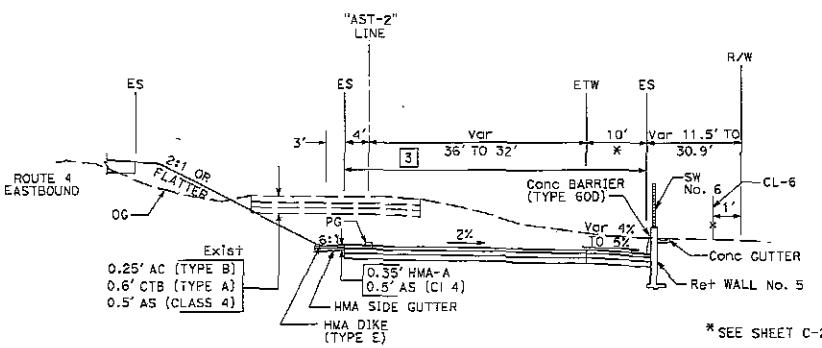
SAN RAMON, CA 94583

CCTA
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523



ROUTE 4 EASTBOUND ON-RAMP AT A STREET

"AST-2" 701+36.30 TO 706+78.57



*SEE SHEET C-21 FOR DETAILS

ROUTE 4 EASTBOUND ON-RAMP AT A STREET

"AST-2" 698+43.70 TO 701+36.30

FOR NOTES, ABBREVIATIONS AND/OR LEGEND, SEE SHEET X-1

TYPICAL CROSS SECTIONS

NO SCALE

X-10

REVISED BY	DATE REVISED
XXX	X/XX

CALCULATED-DESIGNED BY	CHECKED BY
XXX	XXX

CONSULTANT FUNCTIONAL SUPERVISOR: XXXXXXXXXX

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

LAST REVISED 00-00-00 DATE PLOTTED => $DATE FILE: p:\320089\Sheets\SR4X512.dgn TIME PLOTTED => $TIME DATE: 24-Sep-09 17:49

BORDER LAST REVISED 4/11/2008 | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | USERNAME => $USER DGN FILE => $REQUEST | CU 04275 | EA 2285F1

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	CC	4	27.2/29.0		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Michele Johnson No. C69116 Exp. 06/30/10 CIVIL STATE OF CALIFORNIA

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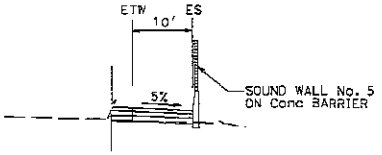
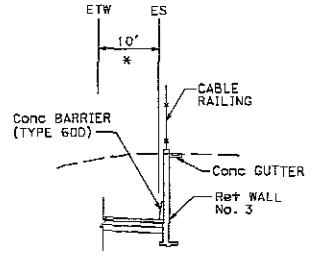
SAN RAMON, CA 94583

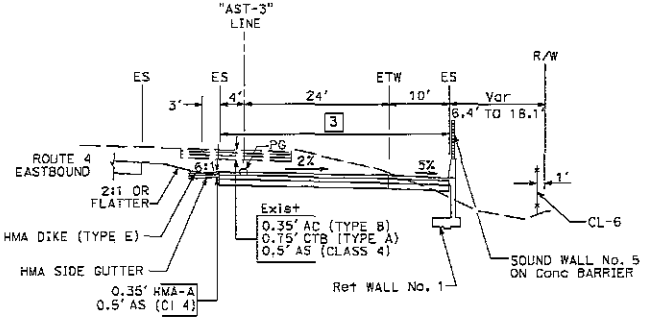
CCTA
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523



"AST-3" 888+99.32 TO 890+15.00

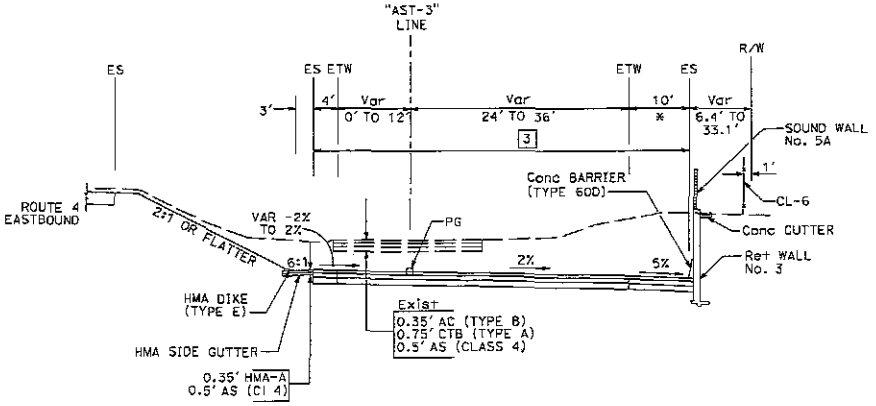


"AST-3" 896+28.24 TO 896+56.94



ROUTE 4 EASTBOUND OFF-RAMP AT A STREET

"AST-3" 888+26.96 TO 890+15.00



ROUTE 4 EASTBOUND OFF-RAMP AT A STREET

"AST-3" 890+15.00 TO 896+56.94

* SEE SHEET C-21 FOR DETAIL

FOR NOTES, ABBREVIATIONS AND/OR LEGEND, SEE SHEET X-1

TYPICAL CROSS SECTIONS

NO SCALE

X-11

REVISED BY	DATE REVISED	CALCULATED-DESIGNED BY	CHECKED BY
XXX	X/08	XXX	XXX

CONSULTANT FUNCTIONAL SUPERVISOR: XXXXXXXXXX

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

LAST REVISION 00-00-00

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TIME PLOTTED => @TIME DATE: 24-Sep-09 17:49

BORDER LAST REVISED 4/11/2008

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

USERNAME => @USER
DGN FILE => @REQUEST

CU 04275

EA 2285F1

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	CC	4	27.2/29.0		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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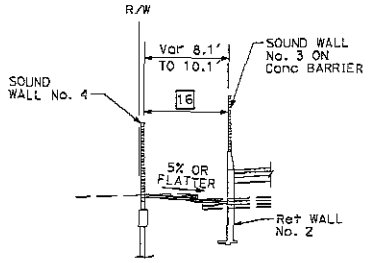
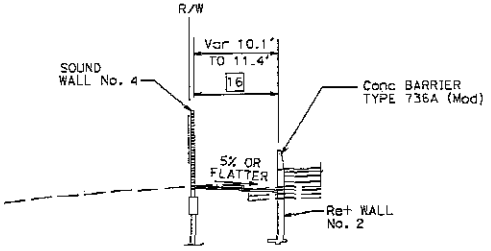
REGISTERED PROFESSIONAL ENGINEER Michele Johnson No. C69116 Exp. 06/30/10 CIVIL STATE OF CALIFORNIA

T Y LIN INTERNATIONAL
2010 CROW CANYON PLACE, SUITE 350
SAN RAMON, CA 94583

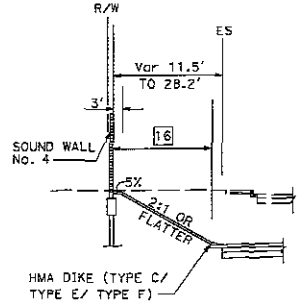
CCTA
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523



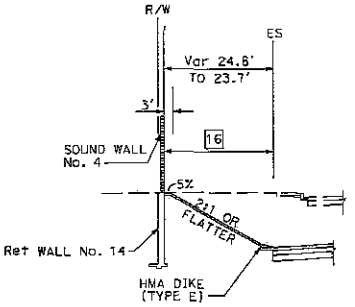
"AST-4" 992+27.02 TO 992+61.73



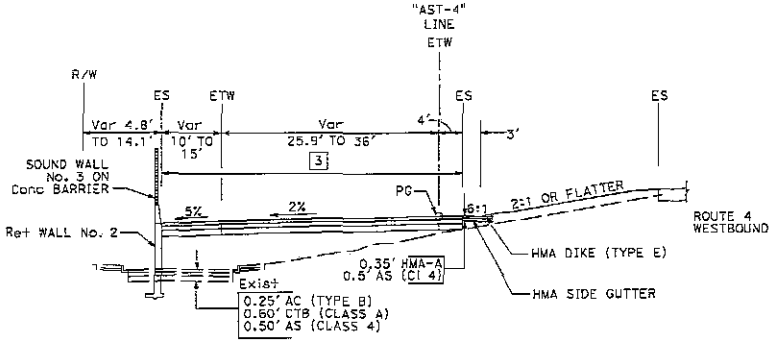
"AST-4" 992+61.73 TO 992+84.05



"AST-4" 992+84.05 TO 994+65.00

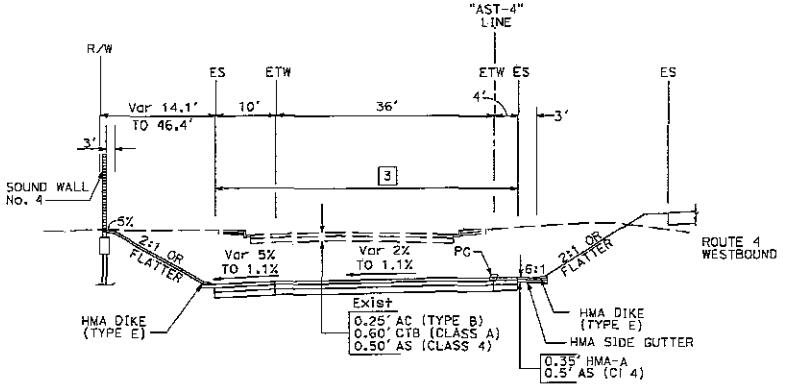


"AST-4" 996+54.15 TO 996+58.66



ROUTE 4 WESTBOUND ON-RAMP AT A STREET

"AST-4" 988+28.89 TO 992+84.05



ROUTE 4 WESTBOUND ON-RAMP AT A STREET

"AST-4" 992+84.05 TO 996+58.66

FOR NOTES, ABBREVIATIONS AND/OR LEGEND, SEE SHEET X-1

TYPICAL CROSS SECTIONS

NO SCALE

X-12

REVISED BY	DATE REVISED	CALCULATED-DESIGNED BY	CHECKED BY	CONSULTANT FUNCTIONAL SUPERVISOR
XXX	X/XX	XXX	XXX	XXXXXXXXXX

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

LAST REVISION 00-00-00 DATE PLOTTED => SEP-09 FILE: P:\320080\Sheets\SR4XS14.dgn TIME PLOTTED => 17:50 TIME: DATE: 24-Sep-09

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	CC	4	27.2/29.0		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Michele Johnson No. C69115 Exp. 06/30/10 CIVIL STATE OF CALIFORNIA

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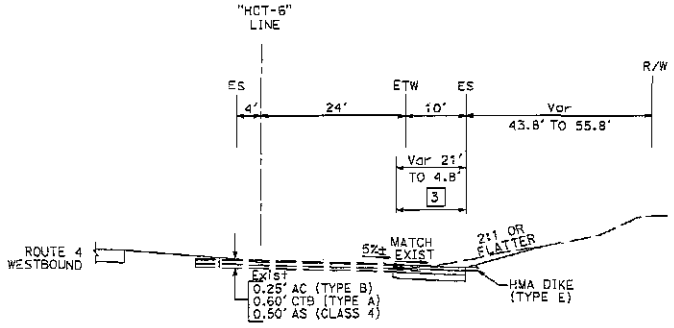
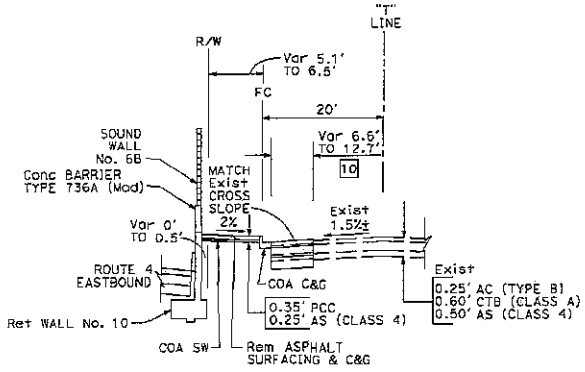
SAN RAMON, CA 94583

CCTA
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523



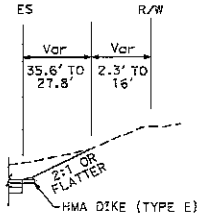
ROUTE 4 EASTBOUND OFF-RAMP AT HILLCREST

"HCT-6" 350+30.73 TO 353+00

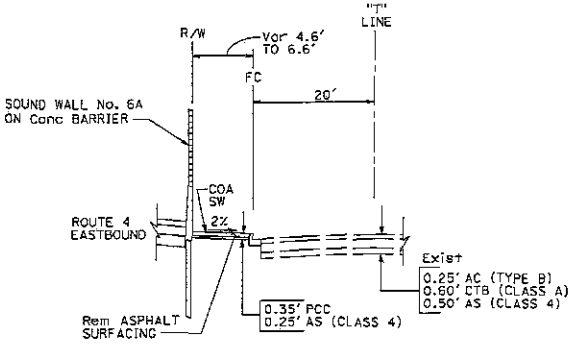


E TREGALLAS ROAD

"T" 22+47.09 TO 39+36.92

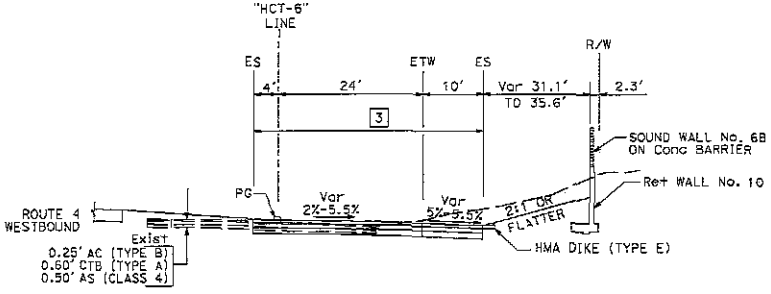


"HCT-6" 349+64.77 TO 350+30.73



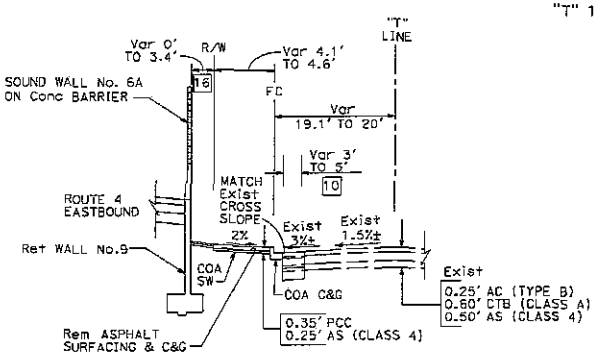
E TREGALLAS ROAD

"T" 17+90.55 TO 22+47.09



ROUTE 4 EASTBOUND OFF-RAMP AT HILLCREST

"HCT-6" 349+21.11 TO 350+30.73



E TREGALLAS ROAD

"T" 16+10.72 TO 17+90.55

FOR NOTES, ABBREVIATIONS AND/OR LEGEND, SEE SHEET X-1

TYPICAL CROSS SECTIONS

NO SCALE

X-13

REVISED BY	DATE REVISED
XXX	X/XX

CALCULATED-DESIGNED BY XXX
CHECKED BY XXX

CONSULTANT FUNCTIONAL SUPERVISOR XXXXXXXXXX

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION Caltrans

LAST REVISED DATE PLOTTED => 09/12 TIME PLOTTED => 17:59 FILE: P:\320089\Sheets\SRA\X13.dgn DATE: 24-Sep-09

BORDER LAST REVISED 4/11/2008 RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 USERNAME => $USER DGN FILE => $REQUEST CU 04275 EA 2285F1

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	CC	4	27.2/29.0		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Michele Johnson No. C69116 Exp. 06/30/10 CIVIL STATE OF CALIFORNIA

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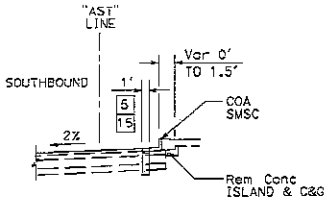
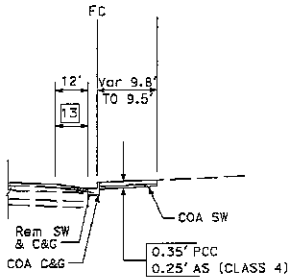
2010 CROW CANYON PLACE, SUITE 350
SAN RAMON, CA 94583

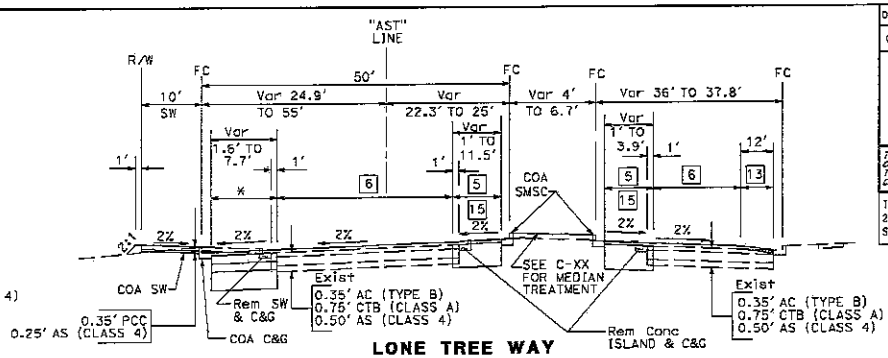
CCTA
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523



"AST" 18+23.93 TO 18+33.43



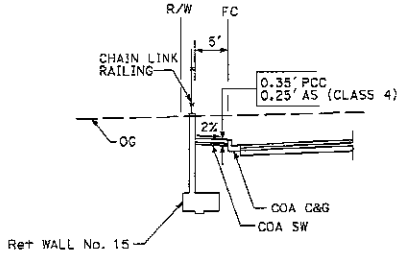
"AST" 18+31.00 TO 18+42.00



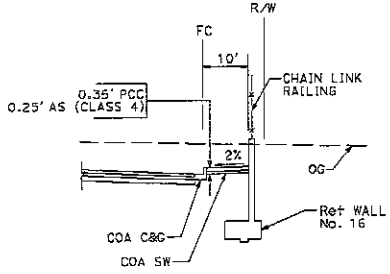
LONE TREE WAY

"AST" 15+84.85 TO 18+83.56

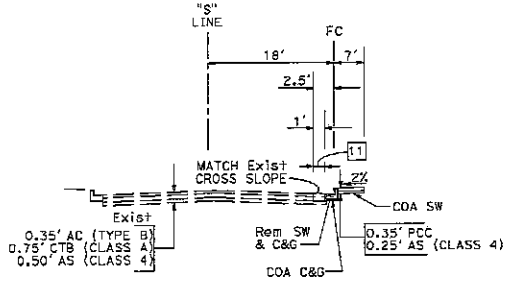
* 5 15 "AST" 15+84.85 TO 15+89.47
4 13 "AST" 15+89.47 TO 18+83.56



"S" 402+52.32 TO 404+09.95



"S" 402+58.05 TO 404+01.08



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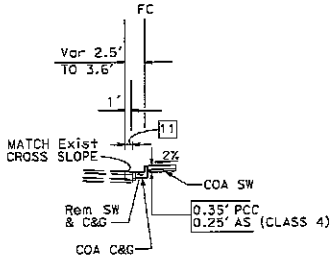

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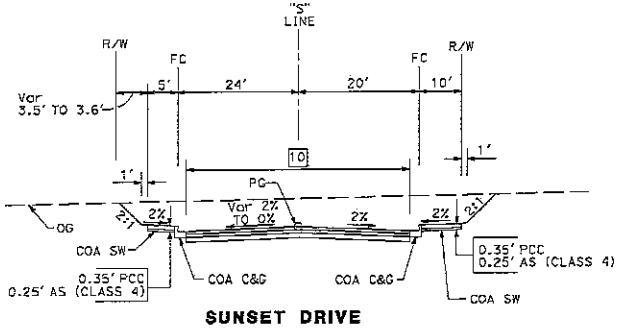

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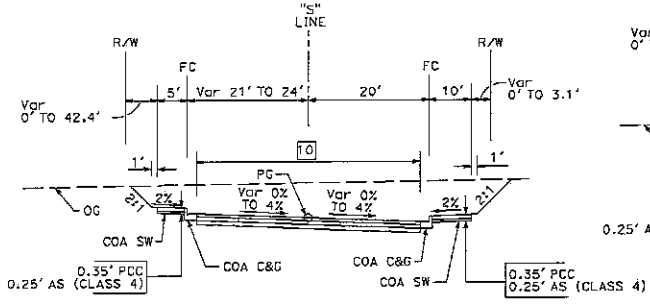

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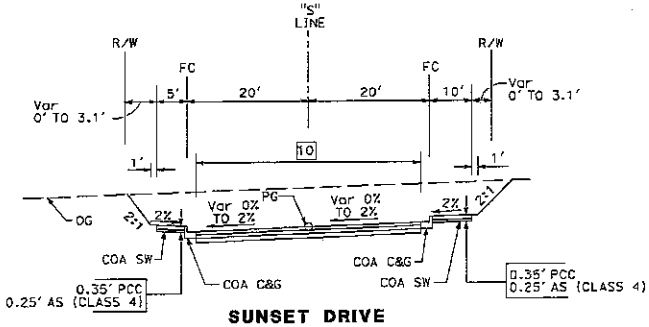

SUNSET DRIVE

"S" 403+45.92 TO 404+88.33

FOR NOTES, ABBREVIATIONS AND/OR LEGEND, SEE SHEET X-1

TYPICAL CROSS SECTIONS

NO SCALE

X-14

STATE OF CALIFORNIA — DEPARTMENT OF TRANSPORTATION	CONSULTANT / FUNCTIONAL SUPERVISOR	CALCULATED-DESIGNED BY	CHECKED BY	REVISED BY	DATE REVISED
Caltrans	XXXXXXXXXX	XXX	XXX	XXX	X/08

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	CC	4	27.2/29.0		

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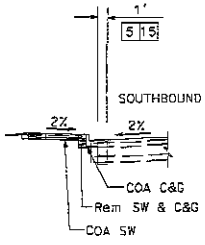
2010 CROW CANYON PLACE, SUITE 350
SAN RAMON, CA 94583

CCTA
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523



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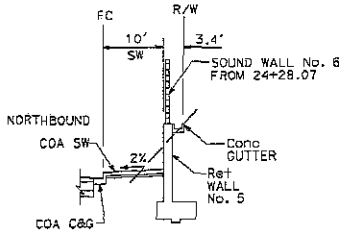

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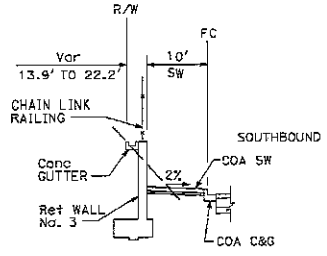

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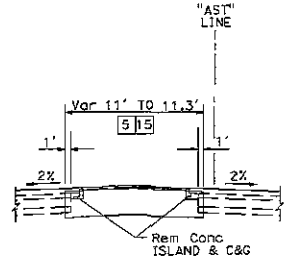

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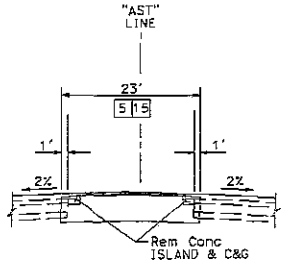

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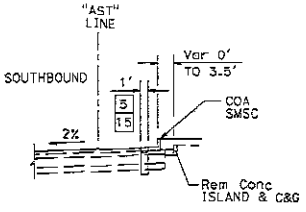

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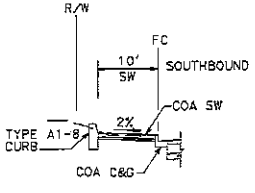

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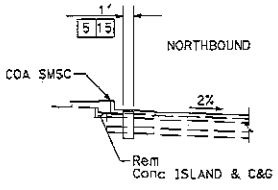

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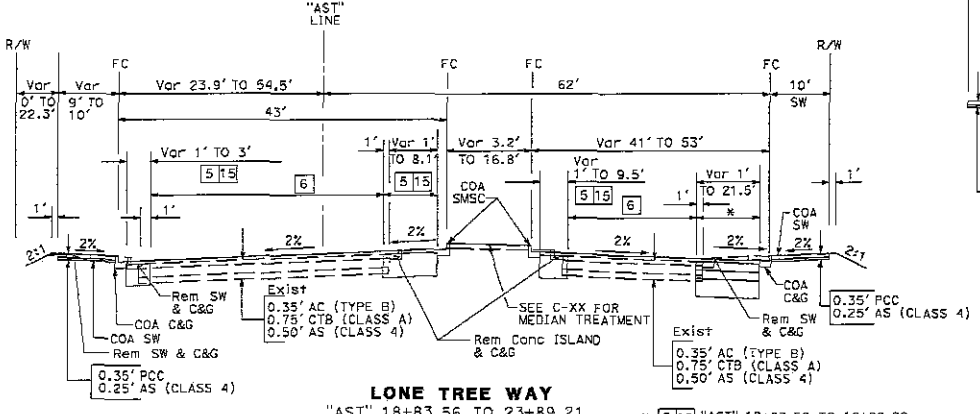

LONE TREE WAY

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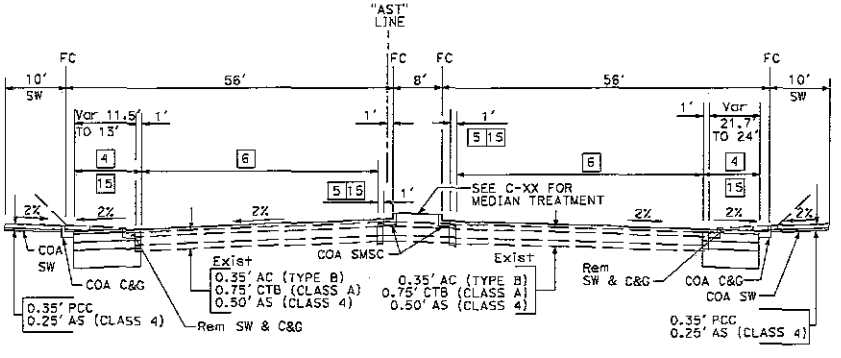
* 5 15 "AST" 18+83.56 TO 19+90.20

4 15 "AST" 19+90.20 TO 23+89.21



LONE TREE WAY

"AST" 23+89.21 TO 28+71.29

FOR NOTES, ABBREVIATIONS AND/OR LEGEND, SEE SHEET X-1

TYPICAL CROSS SECTIONS

NO SCALE

X-15

REVISED BY	DATE REVISED
XXX	X/08
XXX	XXX

CALCULATED-DESIGNED BY
CHECKED BY
CONSULTANT FUNCTIONAL SUPERVISOR XXXXXXXXXX
STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	CC	4	27-2/29.0		

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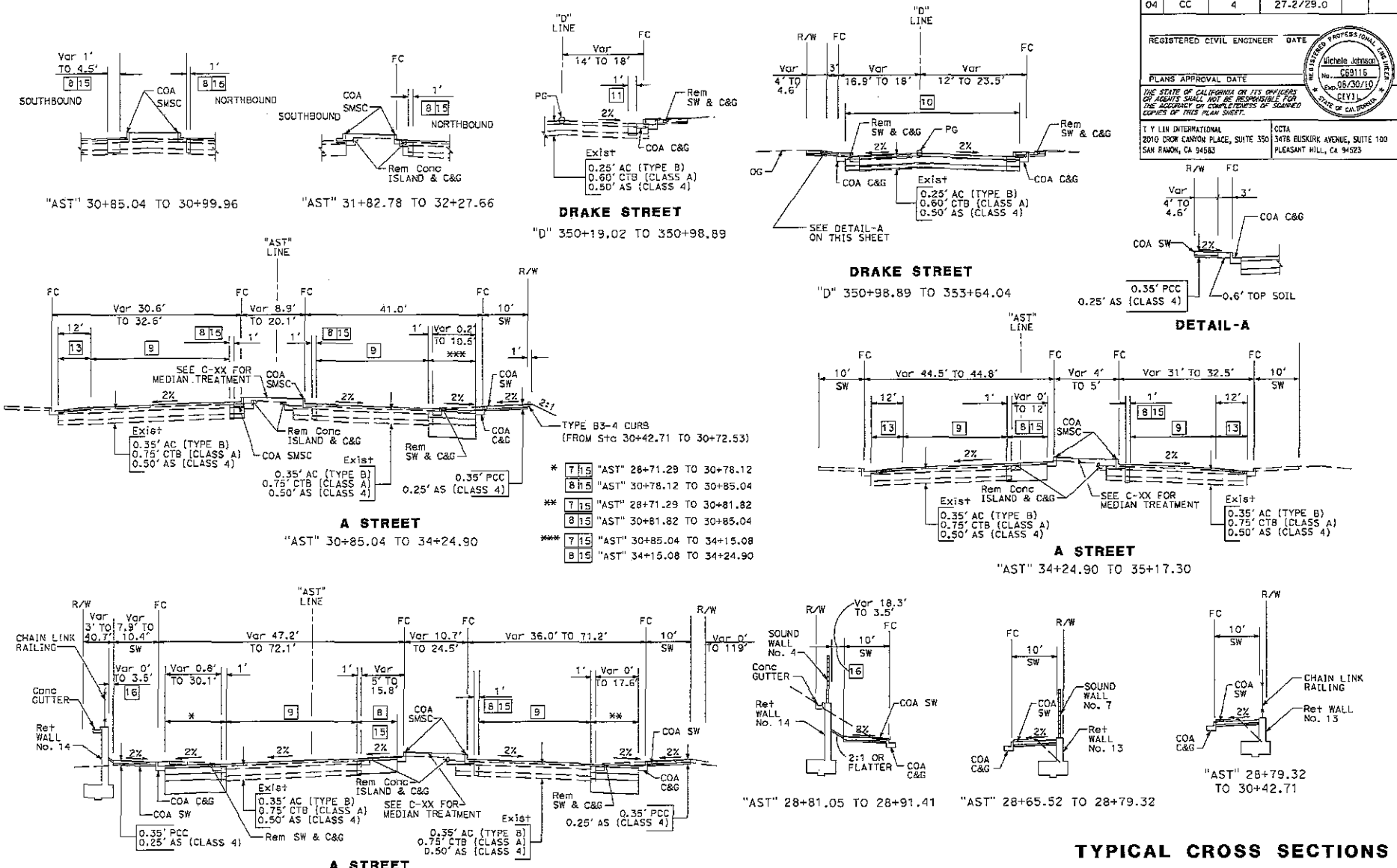
REGISTERED PROFESSIONAL ENGINEER — Michele Johnson — No. C69116 — Exp. 06/30/10 — CIVIL — STATE OF CALIFORNIA

T Y LIN INTERNATIONAL
2010 CROW CANYON PLACE, SUITE 350
SAN RAMON, CA 94583

CCTA
3478 BUSKIRK AVENUE, SUITE 100
PLEASANT HILL, CA 94523



TYPICAL CROSS SECTIONS

NO SCALE

FOR NOTES, ABBREVIATIONS AND/OR LEGEND, SEE SHEET X-1

X-16

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: XXXXXXXXXX

CALCULATED-DESIGNED BY: XXX

CHECKED BY: XXX

REVISED BY: XXX

DATE REVISED: X/08

LAST REVISED: 00-00-00

DATE PLOTTED => 08AUG FILE: P:\3209BB\Sheets\SB4X516.dgn

TIME PLOTTED => 07:TIME DATE: 24-Sep-09 17:54

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CU 04275

EA 2285F1

APPENDIX E

Agency:	Caltrans	**Responded By:**	
Review Unit:	Geotechnical Services	**Date Responded:**	
Comments By:	Ali Kaddoura	**JRT Meeting Date:**	
Date Reviewed:	2-19-09 & 2-23-09		

TECHNICAL COMMENT REVIEW AND RESPONSE

Title:	Submittal: **Comments to 65% PS&E plans**	

Revision Action Code: **A**-Will Comply; **B**-Consultant to Evaluate; **C**-Will Not Incorporate; **D**-CCTA to Evaluate

Item No.	Drawing or Page No.	Review Comments	Design Responses	Revision Action	JRT Disp.	Final Disp.
	PLAN SHEETS	***PLAN SHEETS***				
1	C-18, Section B-B	This typical section refers to Ret Wall #3. This should be Ret Wall #1 as per Sheet X-4 and Page 46 of the GDMR.				
2	SD-6	This is a special design overhead sign. Plans and details should be provided				
3	SQ-5 & SD-5	Sign No. H pile depth is 23' and not 25' as per page 50 of the GDMR				
4	SW-14	Typical section refers to 16" and 24" diameter piles. However, Page 35 of the GDMR recommends a 36" pile diameter.				
5	SW-24	Elevation view refers to 16" diameter piles. However, Page 35 of the GDMR recommends 24" diameter pile.				
6	SW-Sheets	All Standard Plan soundwall details sheets should be included				
4	SW-38	This sheet shows soundwall quantities for SW #7 on 16" Piles. However, the GDMR Page 38 and Table 8, on Page 47 mention that this wall will be founded on Retaining Walls #4 and #13 on spread footings				
5	Ret. Wall #3 General Plan #2	The typical section shows part of the wall will be constructed on piles. However, on Page 33 of the GDMR, It mentions that the wall will be constructed on Spread footing.				
6	Ret. Wall #4 Ret. Wall Details #4	The typical section shows part of the wall will be constructed on piles. However, on Page 34 of the GDMR, It mentions that the wall will be constructed on Spread footing.				
7	Ret. Wall #4 Ret. Wall Details #4	Specified and Design tip elevations should be filled out in the table				

Agency:	Caltrans	**Responded By:**	
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Item No.	Drawing or Page No.	Review Comments	Design Responses	Revision Action	JRT Disp.	Final Disp.
8	Ret. Wall #9 Ret. Wall Details	Specified and Design tip elevations should be filled out in the table				
9	Ret. Wall #10 Ret. Wall Details	Specified and Design tip elevations should be filled out in the table				
10	LOTB Sheets	Please post the LOTB sheets after each pertinrnt sound wall or retaining wall.				
	GDMR	***GDMR dated November 2008***				
		The follwowing comments were sent to Overcommer Hor of the OSFP Liaison on February 5, 2009 as comments on the Draft GDMR dated November 2008.				
1	P 5, Section 5.1 & P 17, Table 1B Appendix A	These pages refer to total of 50 borings drilled for this project. However, there are an additional 15 borings that were not mentioned or discussed and are attacahed to the LOTB sheets (RW/SW 141, 143, 175, 176 through 179, 211 through 214, SW 140 and 142). Please either remove these extra borings or discuss in the report.	The initial tables consisted of borings within the initial project boundaries (179+00 to 240+00). The tables have now been updated to include all the borings within the new project limits and are now consistent with the LOTB sheets presented.	A		

Agency:	Caltrans	**Responded By:**	
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TECHNICAL COMMENT REVIEW AND RESPONSE

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Item No.	Drawing or Page No.	Review Comments	Design Responses	Revision Action	JRT Disp.	Final Disp.
2	P 27	This section mentions the potential for liquefaction encountered in bornig RW/SW-173 drilled for retaing wall #10/Soundwall 6B. Please discuss liquefaction mitigation measures.	The effect of the potential liquefaction has been addressed in Section 8.4, Retaining Walls, under Wall No. 10.	A		
3	P 28, Section 8.2.3	This section mentions that material generated from the cuts may be used as fill. However, a special provision should be added regarding the use of expansive soils/low R-value allowing the use of this material up to 3 feet below subgrade only.	Agreed. Statements will be added in the Special Provisions section to that effect.	A		
4	P 30, Section 8.3.1	The required 30 day waiting period should be added to the project Special Provisions.	Agreed.	A		
5	P 32-P 39, Table 5	Based on the discussions on pages 32 through 39, there are several types mentioned for some of the proposed retaining walls. This table should be revised for the following retaining walls: Retaining Wall #2 wall type is 1SWB and 1SWBP, retaining wall #5 Types are 1SW and 7SW. Retaining wall #9 Types are 1SWB and CIDH piles. Retaining wall #10 Types are 7SWB and CIDH piles. Retaining wall #11 Types are 1, 5SWBP, and CIDH piles.	The table has been revised to indicate the wall types per the most current plans. Multiple wall types have been included as applicable.	A		
6	P 33 RW #2 & RW #3	Caltrans Standard Plans required ultimate bearing capacity for 12' high wall is 6.6 ksf not 7.3 ksf. Also, Caltrans Standard Plans required ultimate bearing capacity for 20' high wall is 9.9 ksf not 7.3 ksf.	Agreed. The text has been revised.	A		

Agency:	Caltrans	**Responded By:**	
Review Unit:	Geotechnical Services	**Date Responded:**	
Comments By:	Ali Kaddoura	**JRT Meeting Date:**	
Date Reviewed:	2-19-09 & 2-23-09		

TECHNICAL COMMENT REVIEW AND RESPONSE

Title:	Submittal: **Comments to 65% PS&E plans**	

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Item No.	Drawing or Page No.	Review Comments	Design Responses	Revision Action	JRT Disp.	Final Disp.
7	P 35 and P 36 RW #6, RW #9 & RW #11	Caltrans Standard Plans required ultimate bearing capacity for 14' high wall is 7.3 ksf not 7.6 ksf.	Agreed. The text has been revised.	A		
8	P 35 &P 36 RW #9, RW #10 & RW 11	Who will design the recommended 36 in and 24 in CIDH piles for portions of these walls?	Required pile tips were established and lateral load analyses were performed per the designer's input for RW nos. 2, 3, 9, 10, 11 and 12. The results are presented in Section 8.4 under appropriate Wall Nos.	A		
9	P 35 & P 36 RW #10	Based on boring RW/SW 173 that was drilled for this wall, there is a potential for liquefaction. This section should discuss the remedies for liquefaction.	It is judged that the liquefaction will have minimal effect on the wall, due to the depth of the potential liquefaction of the layer. This is discussed in the section.	A		
10	P 37 Wall #11 Paragraph C	Refer to Loading Case No (1?) as per Caltrans Standard Plans sheet B3-7.	Agreed. Text has been revised to include Loading Case No. I.	A		

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TECHNICAL COMMENT REVIEW AND RESPONSE

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Item No.	Drawing or Page No.	Review Comments	Design Responses	Revision Action	JRT Disp.	Final Disp.
11	P 38 and P 39 Wall #13 Paragraphs A & B	Refer to Loading Case No (1?) as per Caltrans Standard Plans sheet B3-1. Caltrans Standard Plans required ultimate bearing capacity for 12' high wall is6.6 ksf not 7.3 ksf.	Agreed. Text has been revised to include Loading Case No. I. (Second part of comment is repetition of Comment No 6, first part).	A		
12	P 47 Table 8	For SW 6A, in the Remarks column, reference is made to the use of 24" CIDH pile for about 20'. However, Page 36 of the report mentions the use of 36" CIDH pile between ECR Sta. 82+85 and 84+35 (150' long). Also, for SW 6B, in the Remarks column, reference is made to the use of 16" CIDH pile to avoid utility lines. However, Page 36 of the report mentions the use of 24" CIDH pile for this portion.	1. The 24-in CIDH piles noted in the Remarks column for SW 6A pertain to soundwall piles on either side of Roosevelt Lane PUC. The 36-in piles pertain to piles below Retaining Wall No. 9. They are in two different locations. 2. This portion of SW 6B if founded on 16—inch CIDH piles (utility lines are not mentioned in the Remarks column). The two different pile sizes are at different locations.	C		

Agency:	Caltrans	**Responded By:**	
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Item No.	Drawing or Page No.	Review Comments	Design Responses	Revision Action	JRT Disp.	Final Disp.
13	P 50 Table 9	For overhead sign H1, refrence is made to boring RW-210 as relevant to this sign. However, refreing to the LOTB sheets, it appears that boring RW-211 is closer to this sign structure. Also, for overhead sign I, refrence is made to boring RW-210 as relevant to this sign. However, refering at the LOTB sheets, it appears that boring RW-212 is closer to this sign structure.	1. Overhead sign H1 is between RW-210 and RW-211 (closer to RW-211). However, RW-210 shows softer/looser soils. Hence it is used. 2. Accepted. RW-212 is closer to Sign I. The report will be revised.	C A		
14	P 51, Paragraph 1	It appears that the structural designer for the proposed overhead signs has not provided the lateral and vertical loads. Thus, the foundation recommendations for these signs are based on some assumption. We will review the foundation recommendations based on actual loadings in the next submittal.	The vertical, lateral and torsional loads for the overhead sign structures will be similar to other similar standard structures. Therefore, the foundations should be acceptable.	C		
15	P 62 & P 49 Special Provisions	As per page 49 of this report, difficult pile installation is anticipated due to caving of sand and gravel layers and hard clays. This should be added to the special provisions. Also, See our comment #4 above.	Agreed.	A		
16	Appendix A	Refer to comment #2 above regarding the attached borings that were not discussed in the report.	The tables have been revised to be consistent with the borings in presented in LOTB sheets. See response to comment # 4 above.	A		

Agency:	Caltrans	**Responded By:**	
Review Unit:	Geotechnical Services	**Date Responded:**	
Comments By:	Ali Kaddoura	**JRT Meeting Date:**	
Date Reviewed:	2-19-09 & 2-23-09		

TECHNICAL COMMENT REVIEW AND RESPONSE

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Item No.	Drawing or Page No.	Review Comments	Design Responses	Revision Action	JRT Disp.	Final Disp.
		The following are additional commentson the Draft GDMR				
17	GENERAL	For future projects, especially those with structures, piezometers should be installed to monitor fluctuations in ground water levels. This would be helpful in determining seasonal groundwater fluctuations where piles foundations will be constructed.	It is judged to be not significant for this particular project, since the water table occurred at least 38 feet below ground surface, and trerefore, groundwater fluctuations is of little consequence.	C		
18	GENERAL	Where structures are to be constructed, soil profiles would be helpful for the design.	The general soil profile is discussed in Section 7.2 (Subsurface Soil Conditions): Hard alluvial clay soils with weathered siltstone/sandstone at around 70 feet. Specific soil profiles and properties are noted for the piles in the Calculations in Appendix C.	C		
19	Page 15-16 Section 5.1	The description of the SPT test should be changed to reflect the use of a 140 lb. hammer as is standard for the test.	Agreed. Text has been revised.	A		

Agency:	Caltrans	**Responded By:**	
Review Unit:	Geotechnical Services	**Date Responded:**	
Comments By:	Ali Kaddoura	**JRT Meeting Date:**	
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Item No.	Drawing or Page No.	Review Comments	Design Responses	Revision Action	JRT Disp.	Final Disp.
20	Page 20 & Plate 3	Check the reference to the Geology Map in the text with that on the map – they are inconsistent.	Agreed. The reference in the Map should indicate 'Contra Costa County' instead of 'Alameda County'. It has been revised to make it consistent with the text..	A		
21	Page 21 Section 7.1.1	The lithology section should be described in greater detail. Several tens of borings were drilled and logged during the project and significant information was gathered regarding the lithology of the subsurface materials. This should be summarized.	The geology and lithology sections have been revised to include discussions on the bedrock occurring 60 to 70 feet below ground surface in the deep borings.	A		
22	Page 22 Section 7.3.1.2	It is mentioned that erosion is considered but not applicable. Yet in the previous section it is mentioned that sloughing of slopes has occurred and in the construction considerations, you discuss that construction should take place in the dry season. These statements as they pertain to Section 7.3.1.2 are inconsistent. While it is true that slope conditions as described should be stable, some mention of erosion control should be added	Statements have been added in Section 7.3.2 that 'standard' erosion protection measures will be taken during construction.	A		
23	Page 22 & Page 23 Section 7.3.1.2	Groundwater elevations in the text (page 22) are inconsistent with that of Table 2.	Agreed. Text has been revised to remove the inconsistencies.	A		

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Item No.	Drawing or Page No.	Review Comments	Design Responses	Revision Action	JRT Disp.	Final Disp.
24	Page 24	In Table 3, "RLSS" actually stands for "right lateral strike slip" and not "right left strike slip.	Agreed. Text has been revised.	A		
	SPECIAL PROVISIONS	***SPECIAL PROVISIONS***				
1		Refer to items #3, #4 and #15 above				
2	Page SP-306	First Paragraph (#6), difficult pile installation is anticipated.... This should be edited to conform to actual field conditions and not in this generic form. Surely there is no soft bay mud present within the project limits! Also, blank spaces should be filled out in Paragrphs #8, #9 and #10.				

Responses to Caltrans Comments dated 6/16/2009 on the Materials Report dated 8/15/2008

Note: The Caltrans Comments are attached at the back of the responses. The report has been revised per the comments as appropriate.

Response to Comment No. 1

Accepted. Open graded HMA has been removed from the revised Table 12B and 12C for ramp and city street pavement sections.

Response to Comment No. 2

Accepted. A note has been added in the tables to indicate that full depth HMA options are to be used only for narrow widening, areas inaccessible to conventional equipment.

Response to Comment No. 3

Accepted. A note has been added in Table 12B that if JPCP option is chosen for Mainline, then for ramps, RHMA should be substituted with HMA. A similar statement has been included in the revised text of the report.

Also, the tables have been revised to reflect current nomenclature, e. g. RAC has been changed to RHMA-G, etc.

Response to Comment No. 4

Accepted. Table 12A in the revised report reflects the same structural section for all lanes, consistent with the typical cross-section per the designer. A note is added as suggested to indicate that the same structural section is used "for ease of construction, and to allow for offsetting of LCB joints from that of lane line joints, outside lane TI have been used in design of both inside and outside lane structural sections.

Response to Comment No. 5

Accepted. Table 12A has been revised as indicated in the comment: TI for outside shoulders has been left blank; HMA thickness for outside shoulders varies from 0.70 to 1.00 feet and 'hybrid shoulder' recommendation has been removed for median shoulder.

Response to Comment No. 6

Accepted. The calculation has been revised.

Response to Comment No. 7

Per the designers, the duration for temporary use is 2 years.

Response to Comment No. 8

Agreed. The text has been revised. The item will be included in the Special Provision recommendations to ensure the quality requirements used in the structural section design.

State of California
DEPARTMENT OF TRANSPORTATION

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: MR. RAY PANG
District Office Chief
Design, Contra Costa

Attention: B. Chow/ P. Engstrom

Date: June 16, 2009

File: 4-CC-4 PM R 27.4/28.7
4-228511
Route 4 Bypass Widening &
A Street I/C
(Segment 3A)

From: MANINDER KAUR
Materials Design Engineer
Engineering Services I - Materials A

Concurred By: TINU MISHRA, P.E.
District Materials Engineer
District Branch Chief, Materials A

Subject: Review of 65% PS&E (Segment 3A)

We received the Materials Report and 65% Project Plans for the project 'Segment 3A' that proposes construction of the 'A Street' Interchange and widening of Route 4 (East) with in above referenced post mile limits. 'Segment 3A' is a segment of the State Route 4 (East) Widening project which proposes the corridor widening from Loveridge Road to State Route 160 currently programmed under EA 228511. The actual work is planned to be accomplished in many segments (5 or 6 EA's), as funds become available, and segment 3A is one of these segments with no separate EA yet for this segment.

The Materials Report has not been finalized. Thus, review of the Project Plans is cursory, and a review of the special provisions will be provided at the next submittal. Our comments are as follows:

MATERIALS REPORT

1. We do not recommend use of open graded HMA or RHMA-O for city streets.

2. Proposed full depth HMA options should include a note that these are to be used only for narrow widenings, areas inaccessible to conventional equipment.

3. Include a note that if JPCP option is chosen for mainline, then for ramps, RHMA should be substituted with HMA as RHMA quantities would not be sufficient to warrant its use on this project. Use the current nomenclature; RAC is to be changed to RHMA-G etc.

4. The most recent submittal of the typical cross-section by the Design Engineer shows same structural section for all lanes. Our preference is that Materials Report Table 12 A

be revised to reflect this. A note may be included that for ease of construction, and to allow for offsetting of LCB joints from that of lane line joints, outside lane TI have been used in design of both inside and outside lane structural sections.

5. Table 12 A - - - For outside HMA shoulders leave the TI column blank. Show the HMA thickness to be var. from 0.70' to 1.00'. Do not propose hybrid shoulder design for median shoulder.

6. Table 12 C - - - Ramp structural section, option 3 should be adjusted to show 1.00' of AS and 0.90' AB.

7. For temporary structural sections for mainline a TI of 9.5 has been used, what is the duration for temporary use?

8. Section 13.2.2 - - - Imported borrow- Revise 2' to 2.5' to be consistent with the recommendations made on page 54. If local borrow can be used then provide the special provision recommendations to ensure that material placed with in 2.5' of the grading plane has the quality requirements used in the structural section design. Currently, no quantities are shown for imported borrow on the Project Plans or BEES.

PROJECT PLANS

Typical Cross-Sections

1. Delete structural section No. 2 as the current proposal is to use structural section no. 1 for all lanes.

2. Show over excavation and replacement of subgrade soils for a depth of 2.5' as recommended in the Materials Report between Sta. 191+50 and 193+00, and between Sta. 195+00 and 201+50.

3. Revise PRF to current- terminology.

4. Why HMA pavement is proposed for a short segment of the mainline?

5. Structural section no.8 is not adequate for traffic use. Re-evaluate.

6. Show a minimum thickness of HMA for structural section no. 15.

7. Abbreviations - - - Edit RAC and RHMA abbreviations.

Drainage Quantities

Sheet DQ-1

1. Delete Note 4.

2. Revise APC Table to be in accordance with recommendations made in the Materials Report.

If you have questions, please contact Maninder Kaur at 286-4827.

C: Daily File, Project File, dg

SR4 (East) Widening; Segment 3A – Lone Tree Way/A Street – EA 2285F1 CC-4-PM R27.4/R28.7

Agency:	Caltrans	**Responded By:**	
Review Unit:	Geotechnical Services	**Date Responded:**	
Comments By:	Ali Kaddoura /Rifaat Nashed	**JRT Meeting Date:**	
Date Reviewed:	6/1/2010		

TECHNICAL COMMENT REVIEW AND RESPONSE

Title:	Submittal: **Comments to 100% GDMR**	

Revision Action Code: **A**-Will Comply; **B**-Consultant to Evaluate; **C**-Will Not Incorporate; **D**-CCTA to Evaluate

	GDMR	***GDMR dated March 2010***				
Item No.	**Drawing or Page No.**	**Review Comments**	**Design Responses**	**Revision Action**	**JRT Disp.**	**Final Disp.**
		The following comments were sent to Paul Engstrom of the oversight PE on June 2, 2010 as comments on the Draft GDMR dated March 2010.				
1	P 9, Section 2, Existing Facilities and Proposed Improvement	The terrain elevation along the project alignment should be as follows: - from Sta. 170+00 to Sta. 180+00, the elevation average is 55 ft - from Sta. 180+00 to Sta. 220+00, the elevation average is 65 ft - from Sta. 220+00 to the end of the project, the elevation average is 50 ft	see Note (1) at bottom of page	C		
2	P 13, Section 4.5, Regional Geology and Seismicity	The Statement: "The regional structure.....of northwest-trending faults", should be replaced by the following statement: "The project area is located in Contra Costa County at the northeastern flanks of Mount Diabblo and south San Joaquin plain. Conta Costa county lies in parts of two geomorphic provinces. The major portion of the county is in the Coast Ranges province, with a small portion of the eastern end within the Great Valley provice, where the project area is located. The Great Valley Sequence is depositionally linked to the Coast Range Ophiolite. The Franciscan complex presumably underlies all of Contra Costa county. It was emplaced beloe the Coast Range Ophiolite (USGS OFR 94-622). Quaternary deposits in this area form a combination of eolian dune and river delta deposits (USGS, OFR 97-98).	Agreed. The text has been revised as indicated	A		

(1) The elevations noted in the Section are for terrain adjacent to the highway, e.g. outside the highway cut or embankment and appear to be correct.

Agency:	Caltrans	**Responded By:**	
Review Unit:	Geotechnical Services	**Date Responded:**	
Comments By:	Ali Kaddoura /Rifaat Nashed	**JRT Meeting Date:**	
Date Reviewed:	6/1/2010		

TECHNICAL COMMENT REVIEW AND RESPONSE

Title:	Submittal: **Comments to 100% GDMR**	

Revision Action Code: **A**-Will Comply; **B**-Consultant to Evaluate; **C**-Will Not Incorporate; **D**-CCTA to Evaluate

3	P16, Table 1B	- "offset" of Borings No. SW-142, RW-187, RW/SW –211, and RW/SW –212 should be corrected. - "Approx. Ground Elevation" for Borings No. SW-146, E-191should be corrected. - Borehole No. SW –176 is missing	Agreed. Text has been revised as indicated.	A		
4	P18, Table 1C	Boring depth of borehole No. AST-155 A is 130 ft not 100 ft. Should be corrected	Agreed.Revised	A		
5	P21, Section 7.2, Subsurface Soil Conditions	- Fat clay layers are also present in boreholes No. RW-SW 149 and SW-144. Should be included - Groundwater was encountered in **four** not three of the five 50-ft deep borings (RW/SW 173, SW 205, RW/SW 211, and RW-192). - The groundwater elevations at the project site ranged from 4.5 ft @ borehole No. CAV-169 to **18.4 ft @ borehole No. RW/SW-211**. The maximum depth should be correcte	Agreed. Text has been revised as indicated.	A		
6	P23 Section 3.2.2 Groundwater	- The number of the boreholes encountered groundwater and the maximum groundwater elevation should be corrected as noted above. - In table 2, the borehole No. RW/SW –211 is missing.	Agreed. Text revised.	A		
7	P26 Section 26, Liquefaction	- Groundwater depth in borehole No. RW/SW-173 is 38.0 ft i.e. less than 50 ft depth. According to FEMA 365, it should be taken in consideration.	See Note (2)at bottom of page	A		
8						
9						
10						

(2) Agreed. Text has been revised to indicate that the liquefaction potential exists in Boring No. RW/SW-173 and cannot be ignored per FEMA 365.

11. Information of Existing Ground Water Contamination Monitoring Wells

Keith Rhodes

From: Rick Day [day@geoconinc.com]
Sent: Thursday, March 03, 2011 4:56 PM
To: Andrew Plaine
Cc: Keith Rhodes; Trudy Presser; Carla Peccianti; Karen Laws
Subject: RE: Chevron Service Station, A Street, Antioch
Attachments: 40thlogo.jpg; 2413 A Street.pdf; 2413 A Street Well Details.xls

Hi Andy -

The impacted well locations for the 2413 A Street property are identified on the appended figure.

I confirmed with the RWQCB this morning that only one well (MW-11) will need to re-installed after construction of the Sunset Drive extension - we have a one-year timeframe following the abandonment of MW-11 for the well to be re-installed.

The following wells can be abandoned (without replacement):

Chevron
MW-5
MW-8
MW-10
MW-12
MW-13
MW-14

Olympian
MW-8

The appended excel table lists the well depths and casing sizes.

When doing your evaluation, please keep in mind that the responsible parties would be required to abandon these wells at some time in the future at their own expense.

My opinion of probable cost for the eight well abandonments is as follows:

Permitting $3,500
Driller $23,000
Consultant $5,000 (5 days fieldwork)
Drum Disposal $6,000
PM and Reporting $7,500

My opinion of probable cost for the re-installation of MW-11 is as follows:

Permitting $1,000
RWQCB Workplan $2,500
Utility Clearance $1,000 (1/2 day fieldwork plus utility sub)
Driller $4,500
Consultant $1,000 (1 day fieldwork)
Well Development $3,000
Laboratory Analysis $1,000
Drum Disposal $1,500
PM and Reporting $3,500

Also, I have been asked to coordinate with Keith Rhodes at TY Lin to determine the location for the MW-11 replacement well. I anticipate that the replacement well will be installed in City of Antioch right-of-way. I will keep you posted once I speak with Keith and we get concurrence from the City of Antioch.

Please let me know if you have questions.

Thanks,
Rick.

FYI - I will be on vacation from March 14 through March 21, returning on Tuesday, March 22.

Richard Day, PG, CEG, CHG | *Vice President*
Geocon Consultants, Inc.
6671 Brisa Street, Livermore, California 94550
Tel 925.371.5900, ext. 201 Fax 925.371.5915 Cell 925.872.5860
www.geoconinc.com

From: Andrew Plaine [mailto:acplaine@pacbell.net]
Sent: Monday, February 28, 2011 12:15 PM
To: Rick Day
Subject: RE: Chevron Service Station, A Street, Antioch

Hi Rick:

Hope all is well. Any news on the status of this location?

Many thanks,

Andy

Andrew C. Plaine, MAI, SRA
Andrew C. Plaine & Associates
1966 Tice Valley Boulevard, No. 423
Walnut Creek, CA 94595

(925) 977 8361 Direct/VM
(925) 831 0287 FAX

--- On **Wed, 2/16/11, Rick Day** <*day@geoconinc.com*> wrote:

From: Rick Day <day@geoconinc.com>
Subject: RE: Chevron Service Station, A Street, Antioch

To: "'Andrew Plaine'" <acplaine@pacbell.net>
Date: Wednesday, February 16, 2011, 3:22 PM

Hi Andy -

I received the updated geometry drawings yesterday afternoon from TY Lin and was able to start working on it today - I have already talked with Chevron's consultant and am hoping to hear back from the RWQCB soon.

When we looked at it in August 2009, there were seven Chevron (2413 A Street) and one Olympian (2310 A Street) wells that would be impacted. Per the RWQCB at that time, only one of the wells (Chevron MW-11) needed to be replaced - the other wells could be destroyed with no subsequent replacement.

I'll be back in touch after I speak with the RWQCB and confirm there are no changes - will also provide you with the well list and construction details, and opinion of probable cost for destruction and replacement.

Rick.

Richard Day, PG, CEG, CHG | ***Vice President***
Geocon Consultants, Inc.
6671 Brisa Street, Livermore, California 94550
Tel 925.371.5900, ext. 201 Fax 925.371.5915 Cell 925.872.5860
www.geoconinc.com

From: Andrew Plaine [mailto:acplaine@pacbell.net]
Sent: Wednesday, February 16, 2011 3:13 PM
To: day@geoconinc.com
Subject: Chevron Service Station, A Street, Antioch

Hi Rick:

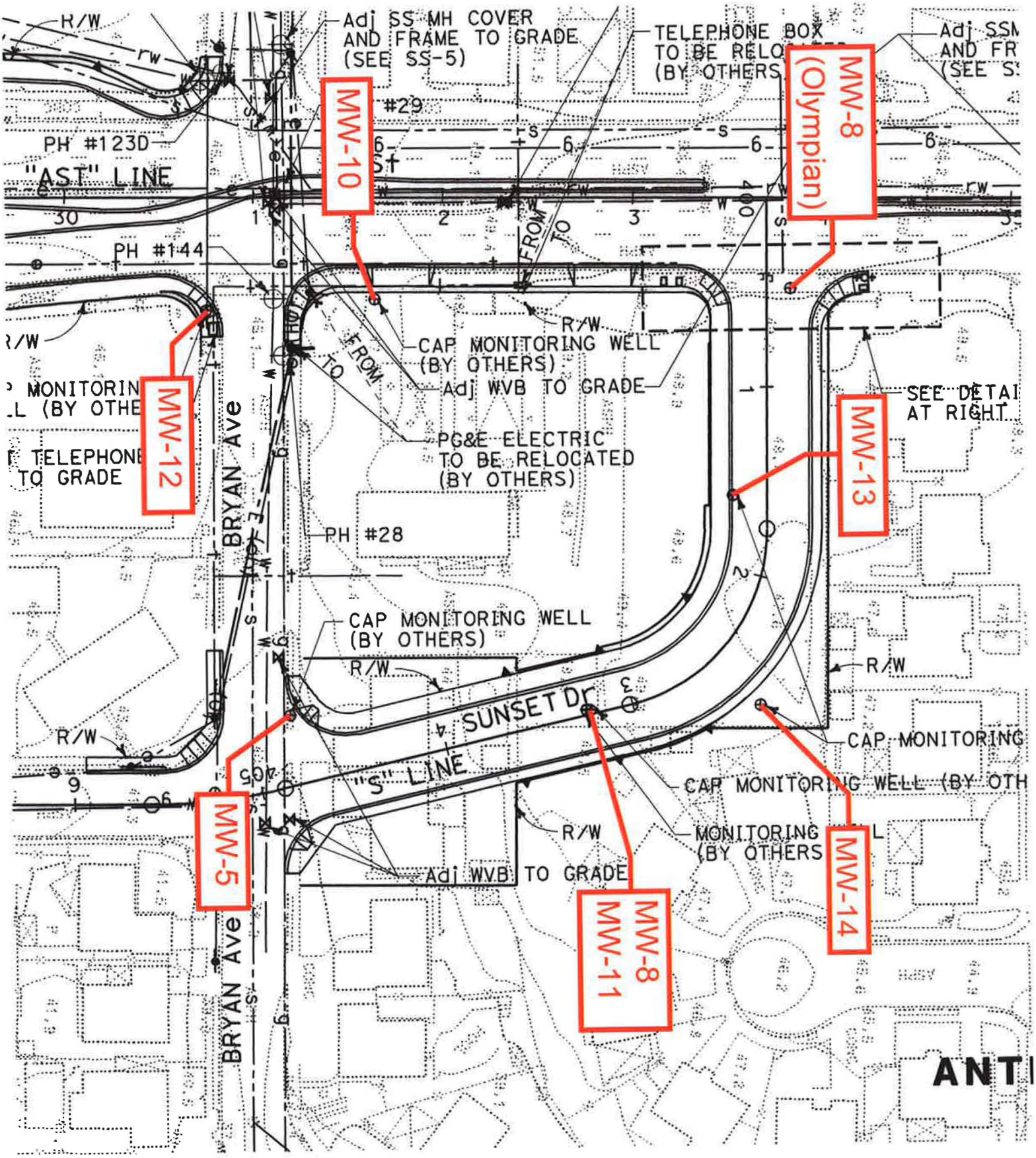
Just checking in to see whether you have any information regarding the status of the monitoring wells/remediation at the Chevron station on A Street in Antioch, or any environmental reports.

Best regards,

Andy

Andrew C. Plaine, MAI, SRA
Andrew C. Plaine & Associates
1966 Tice Valley Boulevard, No. 423
Walnut Creek, CA 94595

(925) 977 8361 Direct/VM
(925) 831 0287 FAX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(SEE S
MW-8
(Olympian)
MW-10
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TO GRADE
MW-12
PG&E ELECTRIC
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MW-13
BRYAN Ave
PH #28
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(BY OTHERS
MW-5
Adj WVB TO GRADE
MW-8
MW-11
MW-14
ANT

Well	Well Depth (ft)	Casing Diameter (in)
MW-5	50	2
MW-8	90	2
MW-10	50	2
MW-11	50	2
MW-12	50	2
MW-13	50	2
MW-14	50	2
MW-8 (Olympian)	50	2