

**GEOTECHNICAL EVALUATION  
SEPULVEDA FEEDER  
INTERCONNECTION PROJECT  
CULVER CITY, CALIFORNIA**

**PREPARED FOR:**

Tetra Tech, Inc.  
3475 East Foothill Boulevard, Suite 300  
Pasadena, California 91107

**PREPARED BY:**

Ninyo & Moore  
Geotechnical and Environmental Sciences Consultants  
475 Goddard, Suite 200  
Irvine, California 92618

February 9, 2009  
Project No. 207519001

February 9, 2009  
Project No. 207519001

Ms. Elisa Ventura  
Tetra Tech, Inc.  
3475 East Foothill Boulevard, Suite 300  
Pasadena, California 91107

Subject: Geotechnical Evaluation  
Sepulveda Feeder Interconnection Project  
Culver City, California

Dear Ms. Ventura:

In accordance with your request and authorization, Ninyo & Moore has performed a geotechnical evaluation for a new pipeline to be constructed along the south side of Venice Boulevard between Tuller Avenue and Sawtelle Boulevard and along Tuller Avenue in Culver City, California. The purpose of our study was to evaluate the geotechnical conditions along the proposed pipeline alignment and to provide geotechnical design parameters for the project. This report presents our geotechnical findings, conclusions, and recommendations for the design and construction of the proposed pipeline.

Ninyo & Moore appreciates the opportunity to be of service on this project.

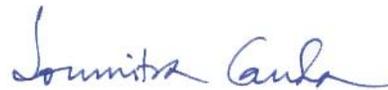
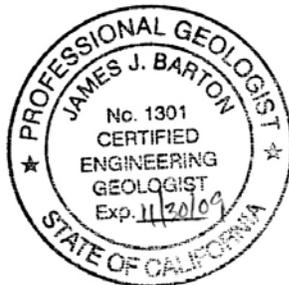
Sincerely,  
**NINYO & MOORE**



James J. Barton, C.E.G.  
Senior Geologist

JJB/SG/CAP/mlc/jad

Distribution: (1) Addressee



Soumitra Guha, Ph.D., G.E.  
Principal Engineer



---

**TABLE OF CONTENTS**

	<u>Page</u>
1. INTRODUCTION .....	1
2. SCOPE OF SERVICES .....	1
3. SITE DESCRIPTION .....	2
4. PROPOSED CONSTRUCTION .....	2
5. SUBSURFACE EVALUATION AND LABORATORY TESTING .....	2
6. GEOLOGY AND SUBSURFACE CONDITIONS .....	3
6.1. Regional Geologic Setting .....	3
6.2. Subsurface Conditions .....	4
6.3. Groundwater .....	5
7. FAULTING AND SEISMICITY .....	5
7.1. Surface Rupture .....	6
7.2. Ground Motion .....	7
7.3. Liquefaction .....	7
8. CONCLUSIONS .....	7
9. RECOMMENDATIONS .....	8
9.1. Pre-Construction Conference .....	8
9.2. Excavation Characteristics .....	9
9.3. Temporary Excavations and Shoring .....	9
9.4. Fill Material .....	10
9.5. Fill Placement and Compaction .....	11
9.6. Pipe Jacking .....	11
9.7. Lateral Pressures for Thrust Blocks .....	12
9.8. Modulus of Soil Reaction .....	13
9.9. Pipe Bedding .....	13
9.10. Trench Backfill .....	13
9.11. Seismic Design Considerations .....	14
9.12. Foundations .....	14
9.12.1. Mat Foundations .....	15
9.13. Below-Grade Retaining Walls .....	15
9.14. Corrosion .....	16
9.15. Concrete .....	16
9.16. Pavement Reconstruction .....	16
10. CONSTRUCTION OBSERVATION .....	16
11. LIMITATIONS .....	17
12. REFERENCES .....	19

**Tables**

Table 1 – Principal Active Faults .....	6
Table 2 – Loading on Jack-and-Bore Segment of Pipeline.....	12
Table 3 – 2007 California Building Code Seismic Design Criteria.....	14

**Figures**

Figure 1 – Site Location Map	
Figure 2 – Boring Location Map	
Figure 3 – Regional Geologic Map	
Figure 4 – Fault Location Map	
Figure 5 – Seismic Hazard Zones Map	
Figure 6 – Lateral Earth Pressures For Temporary Cantilevered Shoring	
Figure 7 – Lateral Earth Pressures For Braced Excavation (Stiff Clay)	
Figure 8 – Thrust Block Lateral Earth Pressure Diagram	
Figure 9 – Lateral Earth Pressures For Underground Structures	

**Appendices**

Appendix A – Boring Logs	
Appendix B – Laboratory Testing	

## **1. INTRODUCTION**

In accordance with your request and authorization, Ninyo & Moore has performed a geotechnical evaluation for the proposed Sepulveda Feeder Interconnection Project located on the south side of Venice Boulevard between Tuller Avenue and Sawtelle Boulevard and also extending to Tuller Avenue in Culver City, California (Figure 1). The purpose of our study was to evaluate the soil and geologic conditions along the proposed pipeline alignment and to develop geotechnical recommendations regarding the design and construction of the project. This report presents our findings, conclusions, and recommendations based on our background review, site reconnaissance, subsurface evaluation, laboratory testing, and geotechnical analyses.

## **2. SCOPE OF SERVICES**

Our scope of services for the geotechnical evaluation included the following:

- Project coordination and planning, including permit acquisition, and scheduling the subsurface exploration.
- Review of readily available background materials, including published geologic and seismic hazards maps, published literature, in-house information, stereoscopic aerial photographs, and reports and/or plans provided by the client.
- A site reconnaissance to locate proposed borings for utility clearance and coordinate with Underground Services Alert (USA) for underground utility location.
- Provide traffic control in general accordance with the Caltrans traffic control guidelines.
- Subsurface exploration consisting of drilling, logging, and sampling five small-diameter borings to depths ranging from approximately 16½ to 26½ feet below the paved surface.
- Laboratory testing of selected, representative soil samples obtained from the exploratory borings to evaluate in-situ moisture content and density, percentage of particles finer than the No. 200 sieve, Atterberg limits, direct shear strength, and R-value.
- Data compilation and geotechnical analysis of the field and laboratory data.
- Preparation of this geotechnical report presenting our findings, conclusions, and recommendations for design and construction of the proposed project.

### **3. SITE DESCRIPTION**

The project is located in a relatively flat area with elevations ranging from approximately 59 feet above mean sea level (MSL) near the beginning of the proposed pipeline alignment at the existing Metropolitan Water District, Venice Pressure Control Structure/Power Plant (PCS/PP) site on Tuller Avenue to approximately 68 feet MSL near the intersection of Sawtelle Boulevard and Venice Boulevard. The proposed alignment is within the existing pavement areas containing several utilities and crosses under the Interstate 405 freeway. Some landscaping, including a few large trees, is present along the edges of Tuller Avenue.

### **4. PROPOSED CONSTRUCTION**

The project includes the design and placement of approximately 1,000 lineal feet of a new 30-inch-diameter, high pressure, concrete mortar lined (CML) steel pipeline. The pipeline will be installed at depths ranging from approximately 6 to 14 feet below the street grade. In addition, a pressure reducing station consisting of a concrete-lined vault approximately 15-feet-wide by 35-feet-long with a depth of approximately 15 feet will be constructed. The water pipeline will extend from the existing Metropolitan Water District, Venice Pressure Control Structure/Power Plant (PCS/PP) site along Tuller Avenue and then onto Venice Boulevard for a distance of approximately 650 feet to Sawtelle Boulevard. A conical plug valve vault will be constructed approximately 325 feet southeast of the intersection of Tuller Avenue and Venice Boulevard. We understand that this vault will be located north of Metropolitan Water District's Venice PCS/PP site within their right-of-way. In addition, a pressure reducing vault and a tee vault will be constructed along the median at the intersection of Sawtelle Boulevard and Venice Boulevard. At the time of this report, conventional cut and cover trenching methods were being considered for the placement of the pipeline. Depending on other variables, including existing utilities within the pavement areas, some jack and bore methods may be considered.

### **5. SUBSURFACE EVALUATION AND LABORATORY TESTING**

Our subsurface exploration was conducted on January 9, 2009. The subsurface exploration consisted of drilling, logging, and sampling five small-diameter exploratory borings. The borings

were advanced to depths ranging from approximately 16½ feet to 26½ feet below the pavement surface using a truck-mounted drill rig with continuous-flight, hollow-stem augers. In addition, we reviewed a boring log, dated July 11, 1979, prepared by LeRoy Crandall and Associates in the vicinity of the proposed pressure reducing station. The approximate locations of the exploratory borings are shown on Figure 2.

The purpose of the exploratory borings was to observe the subsurface materials, evaluate the approximate depths to groundwater, and collect bulk and relatively undisturbed samples for laboratory testing. Representative samples were transported to our laboratory for geotechnical testing. Samples of near-surface site soils were also provided to VA Engineering for the evaluation of soil corrosivity. Logs of the exploratory borings are presented in Appendix A.

Geotechnical laboratory testing was performed on representative samples to evaluate the in-situ moisture content and dry density, percentage of particles finer than the No. 200 sieve, Atterberg limits, direct shear strength and R-value. Geotechnical laboratory results are presented on the boring logs in Appendix A and in Appendix B.

## **6. GEOLOGY AND SUBSURFACE CONDITIONS**

### **6.1. Regional Geologic Setting**

The subject site is located in the northwestern portion of the Los Angeles Basin, which is situated at the northwest end of the Peninsular Ranges geomorphic province of southern California. The Los Angeles Basin has been divided into four structural blocks, which are generally bounded by prominent northwest-trending fault systems: the Northwestern Block, the Southwestern Block, the Central Block, and the Northeastern Block (Norris and Webb, 1990). The northwest end of the basin is generally bounded by the roughly east-west trending Santa Monica-Hollywood-Raymond fault system. The site is located in the Southwestern Block, which is bounded by the Newport-Inglewood fault to the east and the Palos Verdes Hills fault to the southwest. The block is underlain by up to approximately

20,500 feet of Miocene-age or younger marine deposits over basement rock consisting of the Catalina Schist.

The alignment is situated on gently sloping alluvial fans derived from the Santa Monica Mountains (Figure 3). Regional geologic mapping indicates that the alignment is underlain by Quaternary alluvium consisting of unconsolidated gravel, sand, and silty clay with interbeds of gravelly and sandy stream deposits (Dibblee, 1991). Older alluvium is north of the alignment and is described as light gray to light brown, slightly consolidated, pebbly gravel, sand, and silty clay. Our review of geologic literature and stereoscopic aerial photographs generally did not indicate the presence of landslides at the site. Major structural fault systems in the vicinity of the project site include the Newport-Inglewood fault located approximately 2½ miles east of the site. In addition, the potentially active Charnock fault is mapped near the western portion of the pipeline alignment.

## **6.2. Subsurface Conditions**

The results of our subsurface evaluation indicate that the alignment is underlain predominantly by alluvial deposits covered by variable amounts of fill soil associated with construction of the roads or installation of utilities.

At the boring location, B-1, the pavement section along Tuller Avenue consisted of approximately 7 inches of asphalt concrete over approximately 4 inches of silty sand base material. The pavement along Venice Boulevard consisted of asphalt concrete with thicknesses ranging from approximately 4 inches at boring B-3 to approximately 6 inches at boring B-4. The asphalt concrete was underlain by concrete with a thickness ranging from approximately 8 to 9 inches. The asphalt concrete and concrete pavement were underlain by a base material consisting of silty sand with gravel with thicknesses ranging from approximately 4 to 9 inches.

The materials encountered during our subsurface exploration at the site generally consisted of stiff and hard, sandy and silty clay alluvium to depths of approximately 15 to 21 feet. Some clayey and silty sand fill soils were encountered to a depth of approximately 4 feet in

borings B-2 and B-5 overlying the alluvium. The clayey alluvium was generally underlain by dense to very dense, poorly to well graded sand in boring B-1 and boring B-C (LeRoy Crandall, 1979) between depths of approximately 15 and 25 feet. The sand was underlain by hard, sandy clay in boring B-1 to the explored depth of approximately 26½ feet. Detailed descriptions of the subsurface conditions are presented on the boring logs in Appendix A.

### **6.3. Groundwater**

Groundwater was not encountered in the borings drilled at the site. The historic high groundwater depth for the site is reported by the California Division of Mines and Geology (CDMG, 1998) as approximately 30 feet below the existing grade. Fluctuations in the level of groundwater may occur due to variations in ground surface topography, subsurface stratification, rainfall, irrigation practices, groundwater pumping, and other factors which may not have been evident at the time of our field evaluation.

## **7. FAULTING AND SEISMICITY**

The subject site is not located within a State of California Earthquake Fault Zone (formerly known as an Alquist-Priolo Special Studies Zone) (Hart and Bryant, 1997). However, the site is located in a seismically active area, as is the majority of southern California, and the potential for strong ground motion in the project areas is considered significant during the design life of the proposed pipeline and vault structure. Figure 4 shows the approximate site location relative to the major faults in the region. The active Newport-Inglewood fault is located approximately 2½ miles east of the site. A trace of the potentially active Charnock fault is mapped as concealed under the western portion of the pipeline alignment (County of Los Angeles, 1990). The Charnock fault is parallel to the active Newport-Inglewood fault zone farther to the east and is a strike-slip type fault. No surface exposures of the faults have been observed in the vicinity site. The fault was initially noted as a groundwater barrier where upper Pleistocene age materials were offset (Poland, et al., 1959). No Holocene age sediments (11,000 years or younger) are known to be displaced along this fault. Accordingly, the fault is considered potentially active (movement in last 1.6 million years).

Table 1 lists selected principal known active faults that may affect the subject site and the maximum moment magnitude ( $M_{max}$ ) as published by the Cao, et al. (2003) for the California Geological Survey (CGS). The approximate fault-to-site distances were calculated using the computer program FRISKSP (Blake, 2001).

**Table 1 – Principal Active Faults**

<b>Fault</b>	<b>Approximate Fault to Site Distance<sup>1</sup> miles (km)</b>	<b>Maximum Moment Magnitude<sup>2</sup> (<math>M_{max}</math>)</b>
Newport Inglewood (L.A. Basin)	2.5 (4.0)	7.1
Santa Monica	2.9 (4.7)	6.6
Hollywood	5.0 (8.1)	6.4
Malibu Coast	6.7 (10.8)	6.7
Puente Hills Blind Thrust	7.6 (12.3)	7.1
Palos Verdes	9.1 (14.6)	7.3
Upper Elysian Park Blind Thrust	9.8 (15.8)	6.4
Northridge (E. Oak Ridge)	10.1 (16.3)	7.0
Raymond	13.5 (21.7)	6.5
Verdugo	14.5 (23.4)	6.9
Anacapa-Dume	15.9 (25.6)	7.5
Sierra Madre	18.9 (30.4)	6.7
San Andreas (Mojave)	41.1 (66.2)	7.4
<b>Notes:</b>		
<sup>1</sup> Blake, 2001		
<sup>2</sup> Cao, et al., 2003		

The principal seismic hazards at the subject site are surface fault rupture, ground motion, and liquefaction. A brief description of these hazards and the potential for their occurrences are discussed below.

### **7.1. Surface Rupture**

Based on our review of the referenced literature and our site reconnaissance, no active faults are known to cross the site. Therefore, the probability of damage from surface fault rupture at this site is considered to be low. However, lurching or cracking of the ground surface as a result of nearby seismic events is possible.

## **7.2. Ground Motion**

The 2007 California Building Code (CBC) recommends that the design of structures be based on the horizontal peak ground acceleration (PGA) having a 2 percent probability of exceedance in 50 years which is defined as the Maximum Considered Earthquake (MCE). The statistical return period for  $PGA_{MCE}$  is approximately 2,475 years. The probabilistic  $PGA_{MCE}$  for the site was calculated as 0.68 g for the site, using the United States Geological Survey (USGS, 2008) ground motion calculator (web-based). The design PGA was estimated to be 0.45 g for the site. These estimates of ground motion do not include near-source factors that may be applicable in the design of the proposed pipeline and vault.

## **7.3. Liquefaction**

The site is not located in an area mapped as potentially liquefiable (Figure 5) on the State of California Seismic Hazard Zones Map (CDMG 1999). Based on our subsurface exploration and laboratory testing, the site is underlain by relatively dense sands and stiff to hard clays. The historic high groundwater table is located at a depth of approximately 30 feet below the ground surface. Accordingly, it is our opinion that liquefaction and liquefaction-related seismic hazards (e.g., dynamic settlement, ground subsidence, and/or lateral spreading) are not design considerations for the site.

## **8. CONCLUSIONS**

Based on the results of our geotechnical evaluation, the proposed construction is feasible from a geotechnical standpoint, provided the recommendations presented in this report are incorporated into the design and construction of the project. In general, the following conclusions were made regarding the site.

- The site is generally underlain by scattered fill soils (up to approximately 4 feet thick at the locations tested) overlying stiff to hard, clayey alluvial material. Considering the proposed depths of the pipeline and the vault, we anticipate that these structures will be founded on alluvial soils. The alluvial soils encountered in our borings are considered suitable as foundation materials for the proposed structures.
- The near-surface clayey soils are considered to be expansive.

- Excavations for foundations, pavements, and underground utilities should be feasible with heavy-duty earthmoving equipment in good operating condition. The earth materials generated from cuts may be re-used provided the soils meet the recommendations for fill materials presented in this report.
- We anticipate that implementation of the design site improvements will entail excavations for the pipeline and vault structure up to a depth of approximately 15 feet below the existing grade. Impacts associated with the excavation depths will vary, including the quantity of material for excavation, storage and disposal, depth of shoring, and potential settlement under adjacent improvements.
- Groundwater was not encountered during the subsurface evaluation. Published data indicate that the historic high groundwater level in the area is approximately 30 feet or more below the ground surface. However, some seepage should be anticipated during the excavations.
- Based on our review of aerial photographs and published geologic maps and literature, there are no known mapped active faults or landslides underlying the subject site. The site is not located within a State of California Earthquake Fault Zone (Alquist-Priolo Special Studies Zone) or a State of California Seismic Hazard Zone.
- We estimated a  $PGA_{MCE}$  of 0.68g at the subject site that has a 2 percent probability of exceedance in 50 years. The design PGA was estimated to be 0.45g.
- Liquefaction and liquefaction-induced hazards are not design considerations for the site.

## 9. RECOMMENDATIONS

Based on the results of our subsurface evaluation and our understanding of the proposed construction, the following geotechnical recommendations are provided relative to the design and construction of the proposed pipeline and vault structure. The proposed construction should also be performed in accordance with the requirements of applicable governing agencies.

### 9.1. Pre-Construction Conference

We recommend that a pre-construction conference be held. The owner and/or their representative, the governing agencies' representatives, the civil engineer, the geotechnical engineer, and the contractor should be in attendance to discuss the work plan, project schedule, earthwork, and shoring requirements.

## **9.2. Excavation Characteristics**

Based on our field exploration and experience, we anticipate that excavations within the fill and alluvial soils along the pipeline alignment may be accomplished with backhoe, excavators, or other trenching equipment in good working condition. Based on the results of our subsurface exploration, we anticipate that the soils along the proposed alignment will be variable and will include layers of clay, silt, and sand.

## **9.3. Temporary Excavations and Shoring**

We recommend that trenches and excavations be designed and constructed in accordance with Occupational Safety and Health Administration (OSHA) regulations. These regulations provide trench sloping and shoring design parameters for trenches up to 20 feet deep based on the soil types encountered. The soils at the site vary from fine, cohesive, clayey soils to granular soils with relatively little cohesion and a high potential for caving. For planning purposes, we recommend that on-site fill and alluvial soils be considered as OSHA soil Type C.

In our opinion, temporary slopes in the fill or alluvial soils should be stable at an inclination of approximately 1:1 (horizontal to vertical) up to a depth of about 4 feet. Excavations deeper than 4 feet should either be sloped at an inclination no steeper than 1.5:1 (horizontal to vertical) or shored. Some surficial sloughing may occur. Temporary slopes should be evaluated in the field in accordance with OSHA criteria.

Where temporary slopes are not possible, shoring will be appropriate. Shoring systems will be constructed through fill and alluvial deposits. The shoring system for the project may consist of trench shields or driven sheet piles. The shoring system should be designed using the lateral earth pressure values shown on Figures 6 or 7, as appropriate. The recommended design pressures are based on the assumptions that the shoring system is constructed without raising the ground surface elevation behind the shored sidewalls of the excavation, that there are no surcharge loads, such as soil stockpiles and construction materials, and that no loads act above a 1:1 (horizontal to vertical) plane ascending from the base of the shoring system.

For a shoring system subjected to the above-mentioned surcharge loads, the contractor should include the effect of these loads on the lateral earth pressures acting on the shored walls.

We anticipate that settlement of the ground surface will occur behind the shoring wall during excavation. The amount of settlement depends heavily on the type of shoring system, the contractor's workmanship, and soil conditions. Based on our experience, we anticipate that driving of shoring elements (e.g., sheet piles) may cause settlement and possible impact to structures within distances of up to approximately 50 feet from the shoring operation. We recommend that structures/improvements in the vicinity of the planned shoring installation be reviewed with regard to foundation support and tolerance to settlement. To reduce the potential for distress to adjacent structures, we recommend that the shoring system be designed to limit the ground settlement behind the shoring system to ½ inch or less. Possible causes of settlement that should be addressed include settlement during installation of the shoring elements, excavation for structure construction, construction vibrations, dewatering, and removal of the support system. We recommend that shoring installation be evaluated carefully by the contractor prior to construction and that ground vibration and settlement monitoring be performed during construction. To reduce the potential for settlement associated with removal of shoring, the benefit of leaving the shoring elements buried in-place may be considered.

The contractor should retain a qualified and experienced engineer to design the shoring system. The shoring parameters presented in this report are minimum requirements, and the contractor should evaluate the adequacy of these parameters and make the appropriate modifications for their design. We recommend that the contractor take appropriate measures to protect workers. OSHA requirements pertaining to worker safety should be observed.

#### **9.4. Fill Material**

In general, the on-site earth materials should be suitable for reuse as trench backfill provided they are free of trash, debris, roots, vegetation, or other deleterious materials. Fill should

generally be free of rocks or lumps of material in excess of 4 inches in diameter. Rocks or hard lumps larger than approximately 4 inches in diameter should be broken into smaller pieces or should be removed from the site.

Wall and structure backfill, as well as imported soil, should consist of clean, granular material that generally meets Standard Specifications for Public Works Construction (Greenbook) criteria for structure backfill. Soil should also be tested for corrosive properties prior to importing. We recommend that the imported materials meet the Caltrans (2003) criteria for non-corrosive soils (i.e., soils having a chloride concentration of 500 parts per million [ppm] or less, a soluble sulfate content of approximately 0.20 percent (2,000 ppm) or less, and a pH value of 5.5 or higher). Materials for use as fill should be evaluated by Ninyo & Moore prior to importing. The contractor should be responsible for the uniformity of import material brought to the site.

#### **9.5. Fill Placement and Compaction**

Fill should be placed and compacted in accordance with project specifications, and the requirements of Los Angeles County Department of Public Works, Caltrans, Culver City, and sound construction practices. Fill materials should be compacted to a relative compaction of 90 percent as evaluated by American Society for Testing and Materials (ASTM) D 1557. Aggregate base materials beneath pavements should be compacted to a relative compaction of 95 percent. Fill materials should generally be moisture conditioned to slightly above the optimum laboratory moisture content. The lift thickness for fill soils will vary depending on the type of compaction equipment used, but should generally be placed in horizontal lifts not exceeding 8 inches in loose thickness. Fill should be tested for specified compaction level by Ninyo & Moore.

#### **9.6. Pipe Jacking**

Depending on conflicts with existing utilities, a portion of the pipeline may be installed utilizing a jack-and-bore method. Jacking and receiving pits would be installed at each end of the jack-and-bore segment. The depth of the pits is not expected to be more than 15 feet.

Based on our subsurface evaluation, we anticipate the soils will generally consist predominantly of silty clay and sandy clay, with some areas consisting of poorly graded sand. We recommend that an experienced specialty contractor be used for the jack-and-bore operation.

Minor ground surface settlements may occur from the pipe jacking operation. However, due to the depth of the proposed pipeline, these settlements are not anticipated to impact the travel lanes and sidewalks of the streets below which the pipeline will extend or the existing near-surface utilities provided that an experienced contractor performs the work. Monitoring of the improvements, should be provided. In the event surface settlements exceed ½-inch, ground improvement measures such as a low-pressure grouting operation may be appropriate.

In order to evaluate the load factors on the proposed jack-and-bore segment of the water line, the loading presented in the following table should be used.

**Table 2 – Loading on Jack-and-Bore Segment of Pipeline**

Approximate Depth from Existing Ground Surface to Top of Pipeline (feet)	Load on Pipeline (pounds/lineal foot of pipe)
5	1,200
10	1,800
15	2,100
<p><b>Notes:</b></p> <p>1) Based on McCarthy, D. F., 2002, “Essentials of Soil Mechanics and Foundations: Basic Geotechnics,” Prentice Hall, 6<sup>th</sup> Edition.</p> <p>2) Linear interpolation may be used to obtain loading between the depths shown.</p> <p>3) Loading assumes 24-inch-diameter sleeve diameter of jack-and-bore section. Loading may need to be modified for a sleeve size other than that considered here.</p>	

**9.7. Lateral Pressures for Thrust Blocks**

Thrust restraint for buried pipelines may be achieved by transferring the thrust force to the soil outside the pipe through a thrust block. Thrust blocks may be designed using the magnitude and distribution of passive lateral earth pressures presented on Figure 8. Thrust blocks

should be backfilled with granular backfill material and compacted following the recommendations presented in this report.

#### **9.8. Modulus of Soil Reaction**

The modulus of soil reaction is used to characterize the stiffness of soil backfill placed at the sides of buried flexible pipelines for the purpose of evaluating lateral deflection caused by the weight of the backfill above the pipe. For pipelines constructed in silty and clayey fill and alluvial materials, we recommend that a modulus of soil reaction of 1,000 pounds per square inch (psi) be used for a soil cover depth of up to about 5 feet when backfilled with granular soils and compacted to a relative compaction of 90 percent as evaluated by ASTM D 1557. A soil reaction modulus of 1,400 psi may be used for trenches that provide a soil cover deeper than 5 feet.

#### **9.9. Pipe Bedding**

We recommend that the pipeline be supported on 6 or more inches of granular bedding material such as sand with a sand equivalent (SE) value of 30 or higher. Bedding material should be placed around the pipe and 12 inches or more above the top of the pipe in accordance with specifications of the Greenbook (Standard Specifications for Public Works Construction). Special care should be taken not to allow voids beneath the pipe. Bedding material and compaction requirements should be in accordance with the recommendations of this report, the project specifications, and applicable requirements of the appropriate governing agency. Based on our subsurface evaluation, on-site soils are not anticipated to be suitable as bedding material.

#### **9.10. Trench Backfill**

The soils encountered along the pipe alignment should generally be suitable for reuse as backfill provided they are free of organic material, clay lumps, debris, and rocks approximately 4 inches or more in diameter. Fill should be moisture-conditioned to at or slightly above the laboratory optimum moisture content. Wet soils should be allowed to dry to a

moisture content near the optimum prior to their placement as trench backfill. Trench backfill should be compacted to a relative compaction of 90 percent as evaluated by ASTM D 1557. Special care should be exercised to avoid damaging the pipe during compaction of the backfill.

### 9.11. Seismic Design Considerations

Design of the proposed improvements should comply with design for structures located in Seismic Zone 4 and should be designed in accordance with the requirements of governing jurisdictions and applicable building codes. Table 3 presents the seismic design parameters for the site in accordance with CBC (2007) guidelines and mapped spectral acceleration parameters (United States Geological Survey [USGS], 2008).

**Table 3 – 2007 California Building Code Seismic Design Criteria**

Seismic Design Factor	Value
Site Class	D
Site Coefficient, $F_a$	1.0
Site Coefficient, $F_v$	1.5
Mapped Spectral Acceleration at 0.2-second Period, $S_s$	1.695
Mapped Spectral Acceleration at 1.0-second Period, $S_1$	0.648
Spectral Acceleration at 0.2-second Period Adjusted for Site Class, $S_{MS}$	1.695
Spectral Acceleration at 1.0-second Period Adjusted for Site Class, $S_{M1}$	0.972
Design Spectral Response Acceleration at 0.2-second Period, $S_{DS}$	1.130
Design Spectral Response Acceleration at 1.0-second Period, $S_{D1}$	0.648

### 9.12. Foundations

Based on our understanding of the project, the proposed vault structure may be supported on a mat foundation bearing on competent alluvial soil. Foundations should be designed in accordance with structural considerations and the following recommendations. In addition, requirements of the appropriate governing jurisdictions and applicable building codes should be considered in the design of the structures.

### 9.12.1. Mat Foundations

Mat foundations for the proposed structure may be supported on low expansion potential competent alluvium prepared in accordance with the recommendations presented in this report. In the event soft or loose materials are encountered at the base of the excavations, we recommend that a 1-foot-thick crushed rock or lean concrete base course be placed at the bottom of the excavation prior to construction of the mat to provide a working surface. The mat foundation may be designed using a net allowable bearing capacity of 2,000 psf. The total and differential settlements corresponding to this allowable bearing load are estimated to be less than approximately 1 inch and ½ inch over a horizontal span of 40 feet, respectively.

Mat foundations typically experience some deflection due to loads placed on the mat and the reaction of the soils directly underlying the mat. A design modulus of subgrade reaction (K) of 120 tons per cubic foot (tcf) may be used for the subgrade soils in evaluating such deflections. This value is based on a unit square foot area and should be adjusted for large mats. Adjusted values of the modulus of subgrade reaction,  $K_v$ , can be obtained from the following equation for mats of various widths:

$$K_v = K[(B+1)/2B]^2 \quad (\text{tcf}); \text{ for } B \leq 20 \text{ feet};$$

$$K_v = (K/2)[(B+1)/B]^2 \quad (\text{tcf}); \text{ for } B \geq 40 \text{ feet};$$

B is the width of the mat in feet. For mats with intermediate widths, the modulus of subgrade reaction should be linearly interpolated.

### 9.13. Below-Grade Retaining Walls

Below-grade retaining walls may be considered to be restrained from lateral displacement under static loading conditions. Restrained walls subjected to lateral earth pressures from backfill soils should be designed using the parameters presented on Figure 9. The dynamic lateral earth pressure parameters may be ignored for walls with a retained height of less than 12 feet (CBC, 2007).

#### **9.14. Corrosion**

Representative samples of near-surface site soils obtained from our subsurface exploration were provided to VA Engineering for their evaluation of soil corrosivity. We anticipate that the corrosion characteristics of site soils would be addressed in a report by VA Engineering.

#### **9.15. Concrete**

The type of cement to be used for concrete construction should be evaluated based on the water-soluble sulfate content of the soil samples tested by VA Engineering. However, consideration should be given to using Type V cement with a water-cement ratio of 0.45 or less due to the possible use of reclaimed water.

#### **9.16. Pavement Reconstruction**

Trenching within the street rights-of-way will result in the replacement of pavements for the project. In general, pavement repair should conform to the material and compaction requirements of the adjacent pavement section. Aggregate base material and asphalt concrete should be compacted to 95 percent relative compaction as evaluated by ASTM D 1557. Actual pavement reconstruction should conform to the requirements of the appropriate governing agency.

For design purposes, we have sampled a representative, near-surface soil sample to evaluate the pavement subgrade characteristics. Accordingly, the sample was tested for resistance value (R-value) in order to provide design pavement structural sections, if warranted. Laboratory testing indicated an R-value of 8.

### **10. CONSTRUCTION OBSERVATION**

The conclusions and recommendations presented in this report are based on analysis of observed conditions in widely spaced exploratory borings. If conditions are found to vary from those described in this report, Ninyo & Moore should be notified, and additional recommendations will be provided upon request. We recommend that Ninyo & Moore observe and test fill placement

and compaction. Project plans should also be reviewed by Ninyo & Moore prior to the start of construction.

The recommendations provided in this report are based on the assumption that Ninyo & Moore will provide geotechnical observation and testing services during construction. In the event that the services of Ninyo & Moore are not utilized during construction, we request that the selected consultant provide the owner a letter (with a copy to Ninyo & Moore) indicating that they fully understand Ninyo & Moore's recommendations, and that they are in full agreement with the design parameters and recommendations contained in this report.

## **11. LIMITATIONS**

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

This report is intended for design purposes only. It does not provide sufficient data to prepare an accurate bid by contractors. It is suggested that the bidders and their geotechnical consultant

perform an independent evaluation of the subsurface conditions in the project areas. The independent evaluations may include, but not be limited to, review of other geotechnical reports prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing.

Our conclusions, recommendations, and opinions are based on an analysis of the observed site conditions. If geotechnical conditions different from those described in this report are encountered, our office should be notified, and additional recommendations, if warranted, will be provided upon request. It should be understood that the conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

## 12. REFERENCES

- Blake, T.F., 2001, FRISKSP (Version 4.00), A Computer Program for the Probabilistic Estimation of Peak Acceleration and Uniform Hazard Spectra Using 3-D Faults as Earthquake Sources.
- Building News, 2006, "Greenbook" Standard Specifications for Public Works Construction: BNi Publications, 2006 Edition.
- California Building Code, 2007, International Conference of Building Officials, dated January 1.
- California Department of Conservation, Division of Mines and Geology, 1986, State of California Special Studies Zones, Beverly Hills Quadrangle, 7.5 Minute Series: Scale 1:24,000, dated July 1.
- California Department of Conservation, Division of Mines and Geology, 1998, Maps of Known Active Fault Near-Source Zones in California and Adjacent Portions of Nevada: International Conference of Building Officials, dated February.
- California Department of Conservation, Division of Mines and Geology, State of California, 1998, Seismic Hazard Evaluation of the Beverly Hills 7.5-Minute Quadrangle, Los Angeles County, California: Open-File Report 023.
- California Department of Conservation, Division of Mines and Geology, State of California, 1999, Seismic Hazard Zones Official Map, Beverly Hills Quadrangle, 7.5-Minute Series: Scale 1:24,000, dated March 25.
- California Department of Transportation, 2003, Corrosion Guidelines, Version 1.0, dated September.
- Cao, T., Bryant, W.A., Rowshandel, B., Branum, D., and Wills, C.J., 2003, The Revised 2002 California Probabilistic Seismic Hazard Maps, dated June.
- City of Los Angeles, 1996, Safety Element of the Los Angeles City General Plan, adopted November 26.
- County of Los Angeles Department of Regional Planning, 1990, Los Angeles County Safety Element, Scale 1 inch = 2 miles.
- Dibblee, T.W., Jr., 1991, Geologic Map of the Beverly Hills and Van Nuys (South ½) Quadrangles, Los Angeles County, California: Dibblee Foundation, DF-31, Scale 1:24,000.
- Google Earth, 2009, Website for Aerial Photographs; website: <http://maps.google.com/>.
- Hart, E.W., 1990, Fault-Rupture Hazard Zones in California, Alquist-Priolo Special Studies Zone Act of 1972 with Index to Special Studies Zones Maps: California Division of Mines and Geology, Special Publication 42.

Jennings, C.W., 1994, Fault Activity Map of California and Adjacent Areas: California Division of Mines and Geology, California Geologic Data Map Series, Map No. 6, Scale 1:750,000.

LeRoy Crandall and Associates, 1979, Log of Boring, Boring C, dated July 11, 1979.

Ninyo & Moore, 2005, Revised Proposal for Geotechnical Consulting Services for Malibu Sepulveda Feeder Interconnection Project, City of Los Angeles, California, dated August 13.

Ninyo & Moore, Unpublished and Proprietary In-House Data.

Norris, R.M., and Webb, R.W., 1990, Geology of California, Second Edition: John Wiley & Sons.

Peterson, M.D., Bryant, W.A., Cramer, C.H., Cao, T., Reichle, M.S., Frankel, A.D., Lienkaemper, J.J., McCrory, P.A., and Schwartz, D.P., 1996, Probabilistic Seismic Hazard Assessment for the State of California: California Department of Conservation, Division of Mines and Geology Open File Report 96-08.

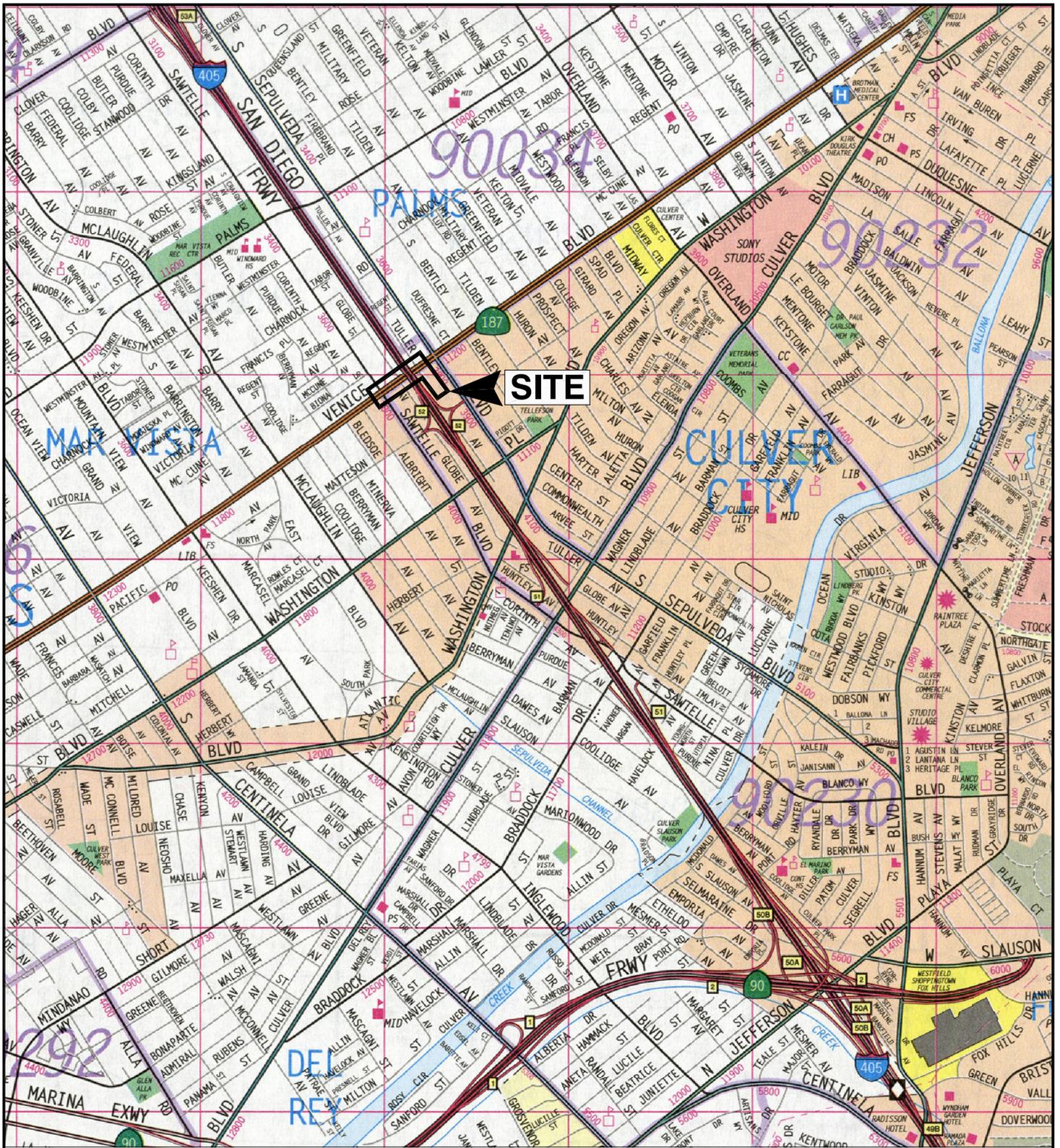
Poland, J.F., et al., 1959, Geology 1: Hydrology and Chemical Character of Groundwater in the Torrance-Santa Monica Area California; United States Geological Survey, Professional Paper 1461.

State of California, Department of Public Works, Division of Highways, 1966, As-Built Venice Boulevard Storm Drain Plans, Sheets 1 through 20 of 20, dated September 16.

United States Geological Survey, 1966 (Photorevised 1981), Beverly Hills, California Quadrangle Map, 7.5 Minute Series: Scale 1:24,000.

United States Geological Survey, 2008, Earthquake Ground Motion Parameter Java Application, Java Ground Motion Parameter Calculator – Version 5.0.8; <http://earthquake.usgs.gov/research/hazmaps/design/>.

<b>AERIAL PHOTOGRAPHS</b>				
<b>Source</b>	<b>Date</b>	<b>Flight</b>	<b>Numbers</b>	<b>Scale</b>
USDA	11-19-53	AXK-14K	65, 66	1:20,000



REFERENCE: 2007 THOMAS GUIDE FOR LOS ANGELES/ORANGE COUNTIES, STREET GUIDE AND DIRECTORY

APPROXIMATE SCALE IN FEET



NOTE: ALL DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.  
Map © Rand McNally, R.L.07-S-129



207519-A1.DWG

**Ninyo & Moore**

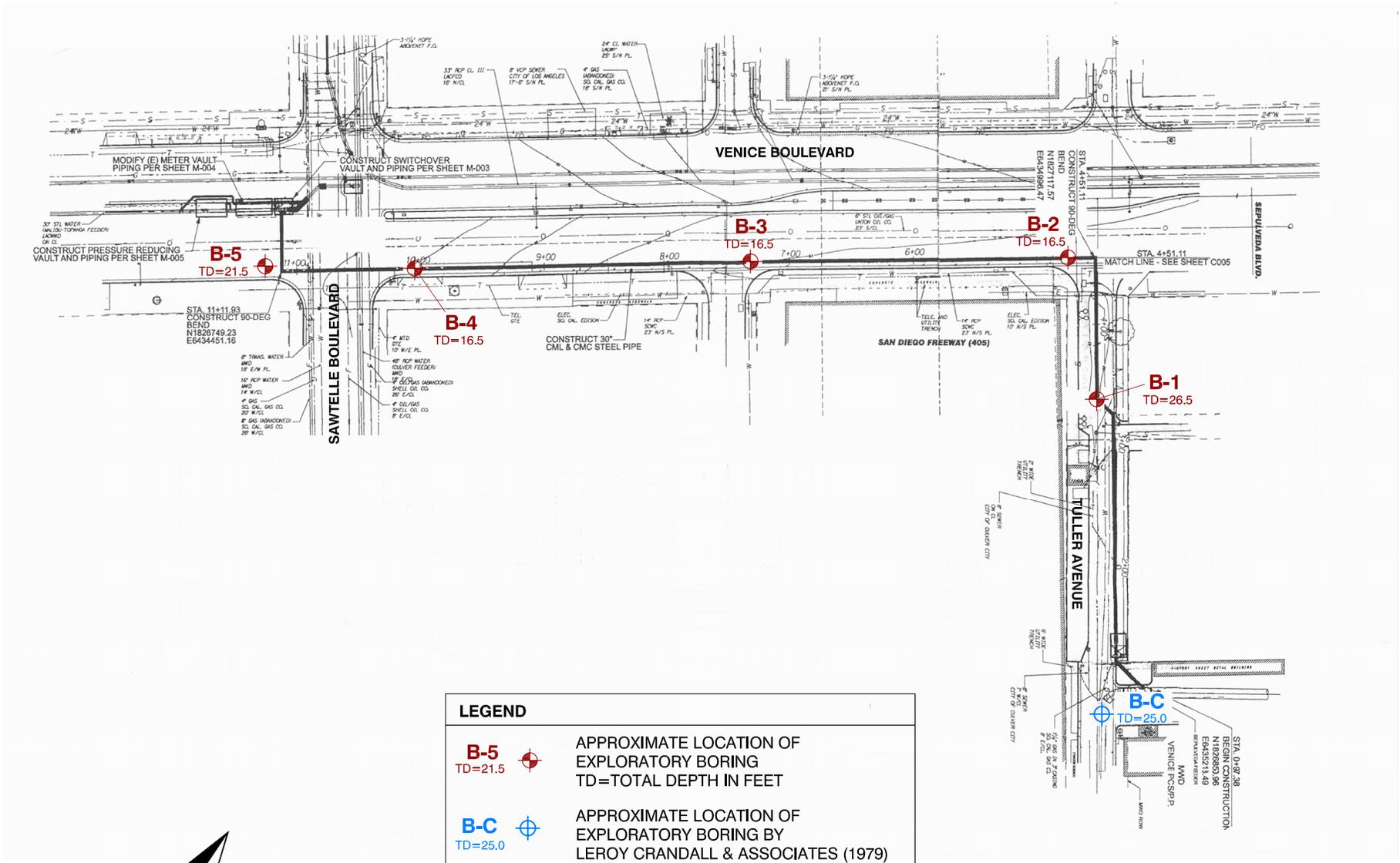
**SITE LOCATION MAP**

FIGURE

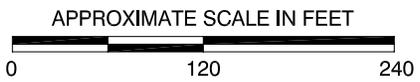
PROJECT NO.	DATE
207519001	2/09

SEPULVEDA FEEDER INTERCONNECTION PROJECT  
CULVER CITY, CALIFORNIA

**1**



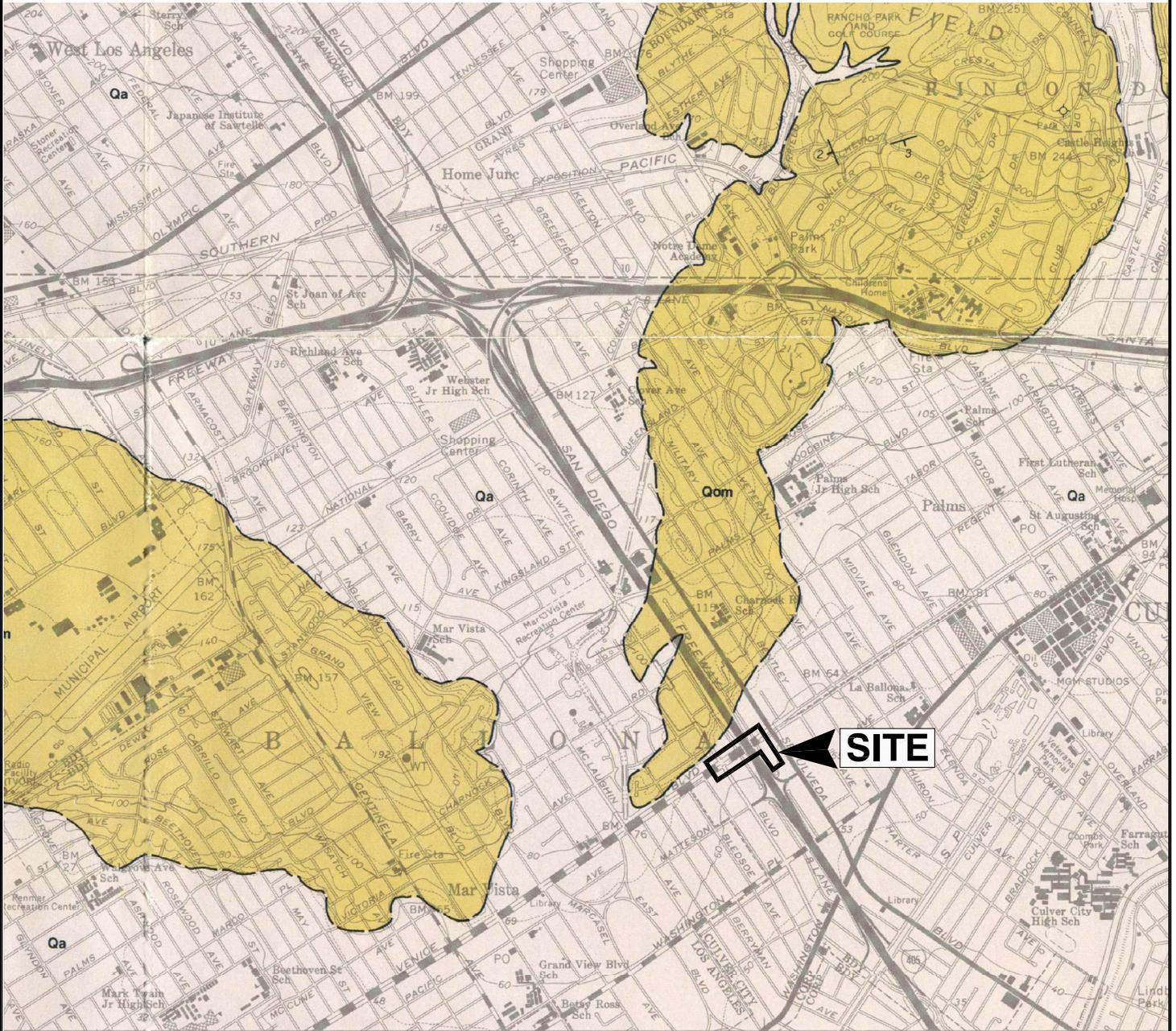
LEGEND	
<b>B-5</b> TD=21.5	APPROXIMATE LOCATION OF EXPLORATORY BORING TD=TOTAL DEPTH IN FEET
<b>B-C</b> TD=25.0	APPROXIMATE LOCATION OF EXPLORATORY BORING BY LEROY CRANDALL & ASSOCIATES (1979)



REFERENCE: PIPELINE PLAN AND PROFILE BY TETRA TECH, INC. UNDATED.

<b>Ninyo &amp; Moore</b>		<b>BORING LOCATION MAP</b>	FIGURE
PROJECT NO.	DATE		
207519001	2/09	SEPULVEDA FEEDER INTERCONNECTION PROJECT CULVER CITY, CALIFORNIA	

NOTE: ALL DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.



REFERENCE: GEOLOGIC MAP OF THE BEVERLY HILLS AND VAN NUYS (SOUTH 1/2) QUADRANGLES, LOS ANGELES COUNTY, CALIFORNIA BY THOMAS W. DIBBLEE, JR., 1991.



APPROXIMATE SCALE IN FEET



**LEGEND**

-  GEOLOGIC CONTACT
-  ALLUVIAL GRAVEL, SAND AND SILT-CLAY
-  MARINE DEPOSITS

NOTE: ALL DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.



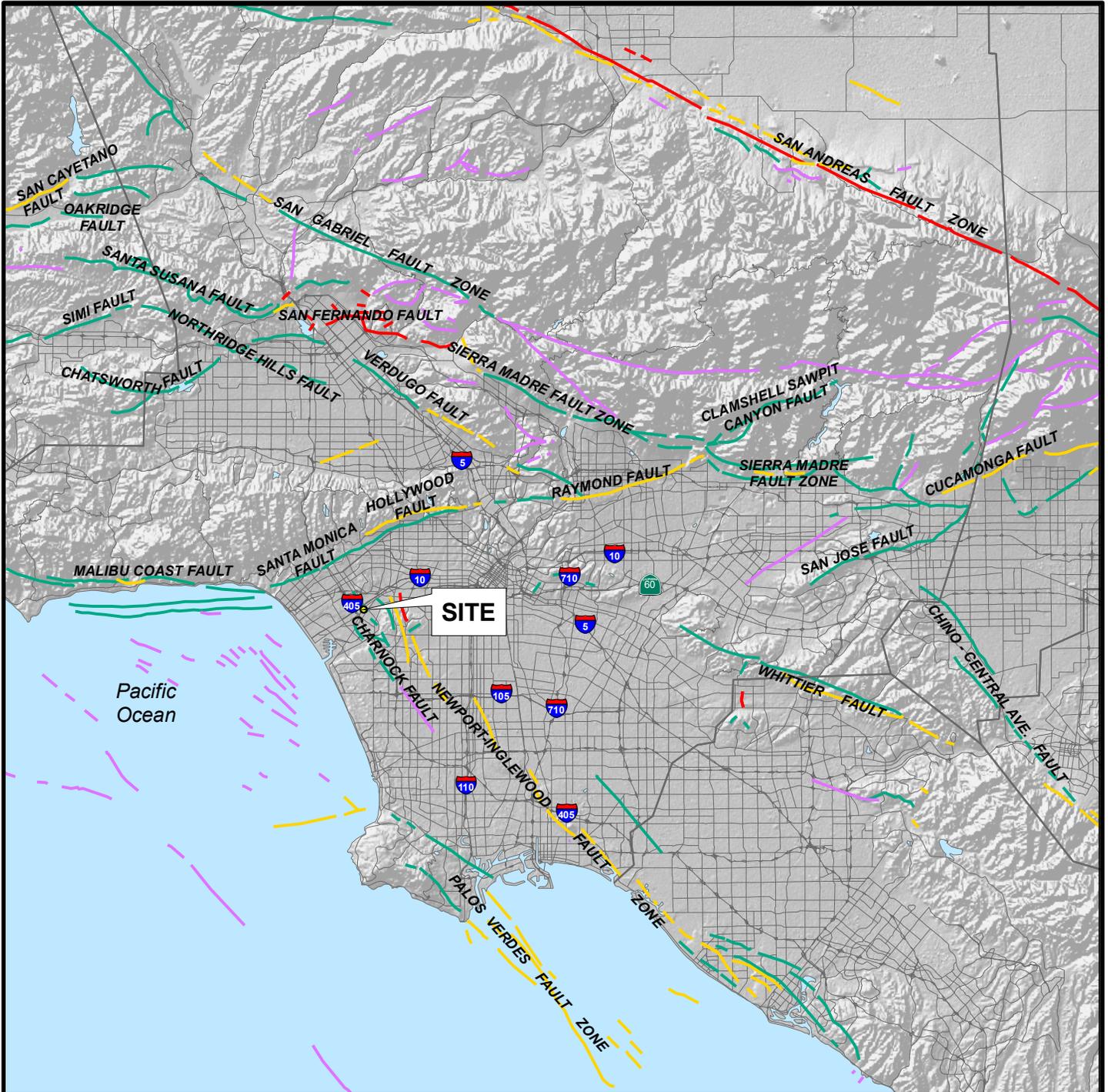
**REGIONAL GEOLOGIC MAP**

FIGURE

PROJECT NO.	DATE
207519001	2/09

SEPULVEDA FEEDER INTERCONNECTION PROJECT  
CULVER CITY, CALIFORNIA

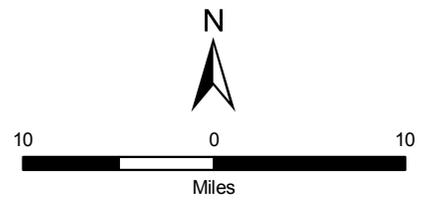
**3**



GIS DATA SOURCE: CALIFORNIA GEOLOGICAL SURVEY (CGS); ENVIRONMENTAL SYSTEMS RESEARCH INSTITUTE (ESRI)  
 REFERENCE: JENNINGS, 1994, FAULT ACTIVITY MAP OF CALIFORNIA AND ADJACENT AREAS

LEGEND	
<b>FAULT ACTIVITY:</b>	
	HISTORICALLY ACTIVE
	HOLOCENE ACTIVE
	COUNTY BOUNDARIES
	LATE QUATERNARY
	QUATERNARY

NOTE: ALL DIMENSIONS, DIRECTIONS, AND LOCATIONS ARE APPROXIMATE



207519001\_Fig.4.gis

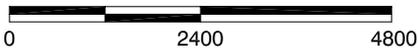
<b>Ninyo &amp; Moore</b>		<b>FAULT LOCATION MAP</b>	FIGURE
PROJECT NO.	DATE	SEPULVEDA FEEDER INTERCONNECTION PROJECT CULVER CITY, CALIFORNIA	<b>4</b>
207519001	2/09		



REFERENCE: STATE OF CALIFORNIA SEISMIC HAZARD ZONES, BEVERLY HILLS QUADRANGLE MAP, 1999.



APPROXIMATE SCALE IN FEET



NOTE: ALL DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

**LEGEND**



**Liquefaction**  
 Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

207519 - A3.DWG



**SEISMIC HAZARD ZONES MAP**

FIGURE

PROJECT NO.

DATE

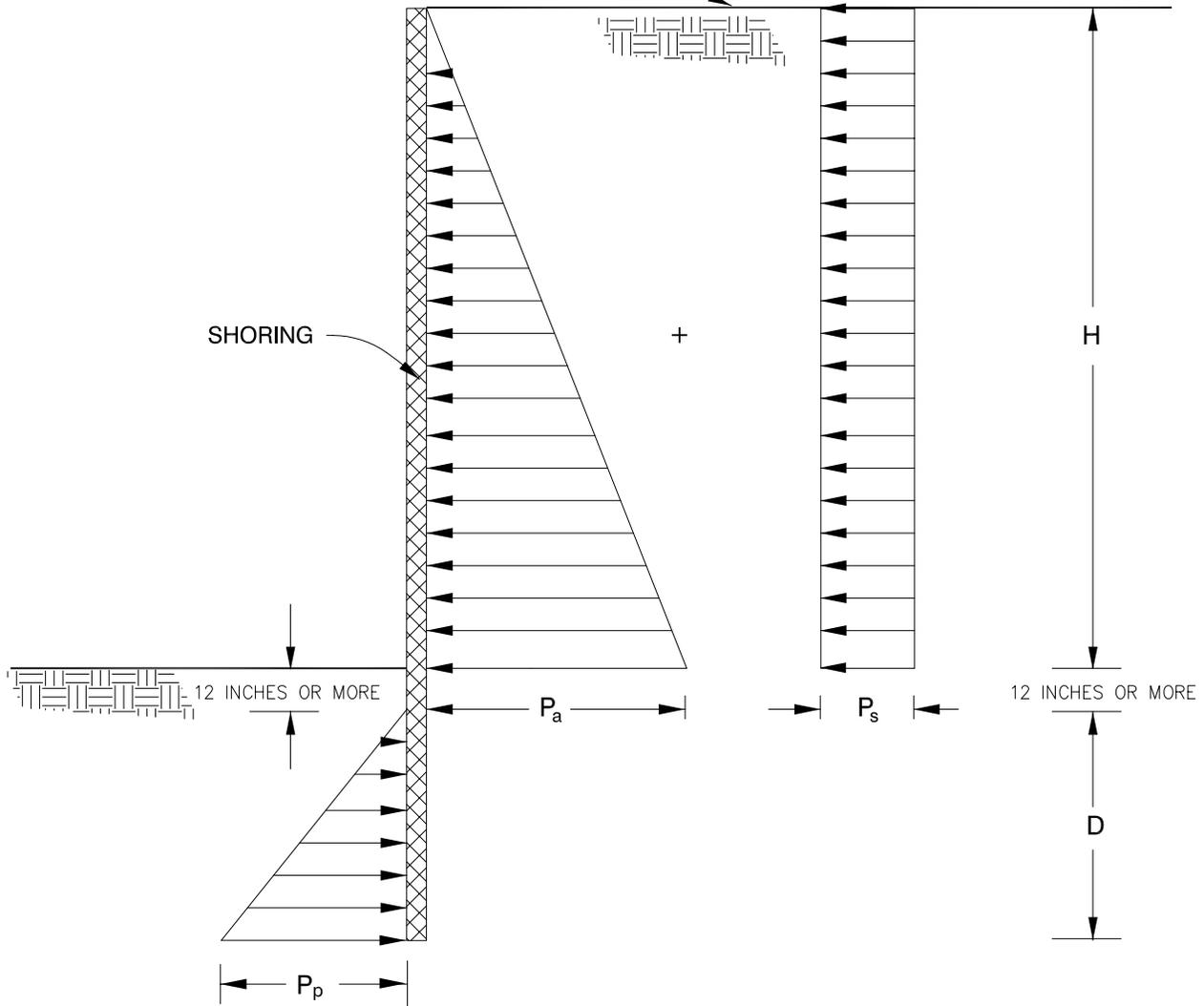
SEPULVEDA FEEDER INTERCONNECTION PROJECT  
 CULVER CITY, CALIFORNIA

**5**

207519001

2/09

GROUND SURFACE



NOTES:

1. ACTIVE LATERAL EARTH PRESSURE,  $P_a$   
 $P_a = 55 H$  psf
2. CONSTRUCTION TRAFFIC INDUCED SURCHARGE PRESSURE,  $P_s$   
 $P_s = 120$  psf
3. PASSIVE LATERAL EARTH PRESSURE,  $P_p$   
 $P_p = 260 D$  psf
4. ASSUMES GROUNDWATER IS NOT PRESENT
5. H AND D ARE IN FEET

NOT TO SCALE

207519\_A4.DWG

**Ninyo & Moore**

**LATERAL EARTH PRESSURES FOR TEMPORARY CANTILEVERED SHORING**

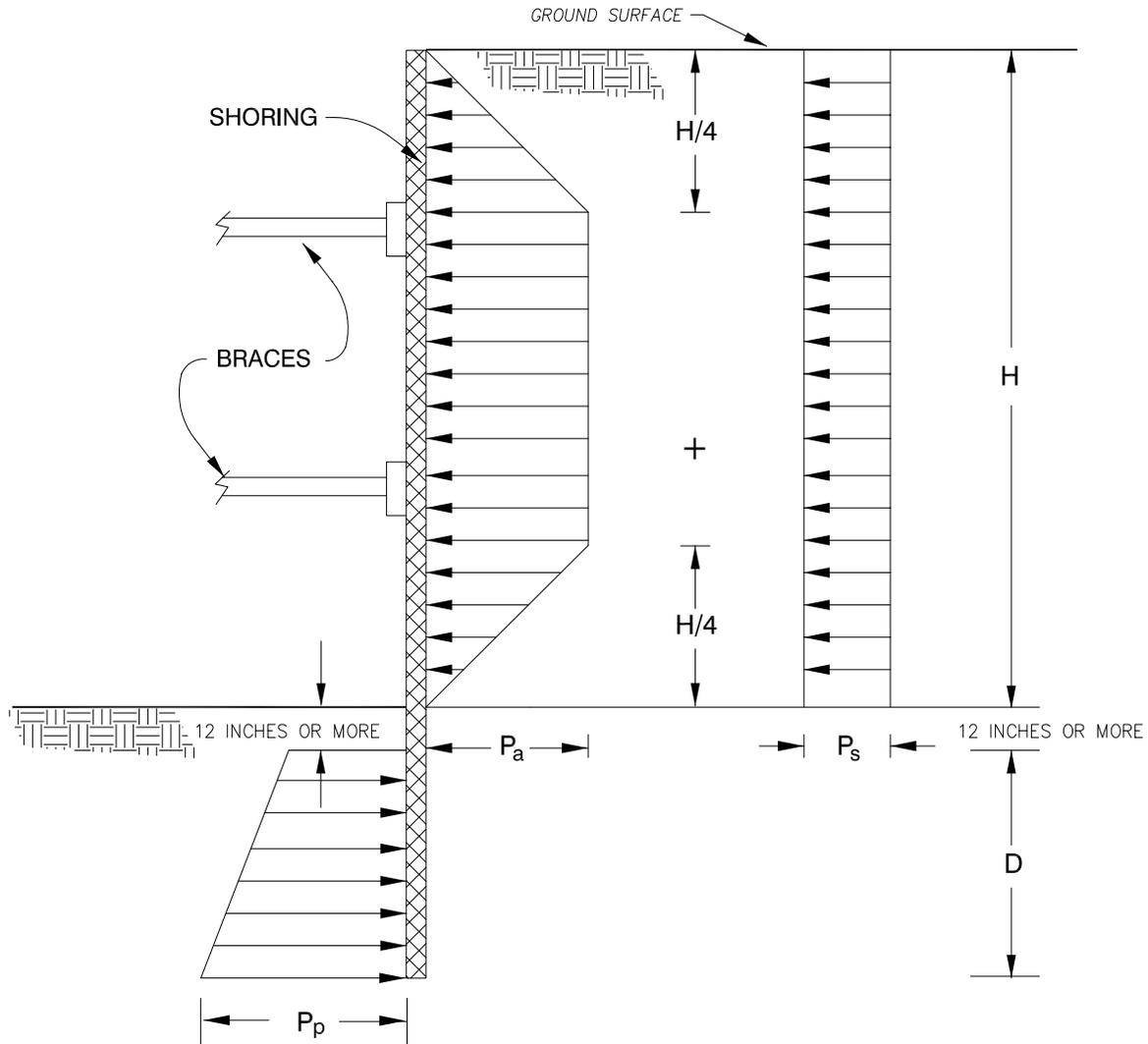
FIGURE

PROJECT NO.  
207519001

DATE  
2/09

SEPULVEDA FEEDER INTERCONNECTION PROJECT  
CULVER CITY, CALIFORNIA

**6**



NOTES:

1. APPARENT LATERAL EARTH PRESSURE,  $P_a$   
 $P_a = 48 H$  psf
2. CONSTRUCTION TRAFFIC INDUCED SURCHARGE PRESSURE,  $P_s$   
 $P_s = 120$  psf
3. PASSIVE LATERAL EARTH PRESSURE,  $P_p$   
 $P_p = 120 D + 200$  psf
4. ASSUMES GROUNDWATER IS NOT PRESENT
5. SURCHARGES FROM EXCAVATED SOIL OR CONSTRUCTION MATERIALS ARE NOT INCLUDED
6. H AND D ARE IN FEET

NOT TO SCALE

207519\_A5.DWG

**Ninyo & Moore**

**LATERAL EARTH PRESSURES FOR BRACED EXCAVATION (STIFF CLAY)**

FIGURE

PROJECT NO.

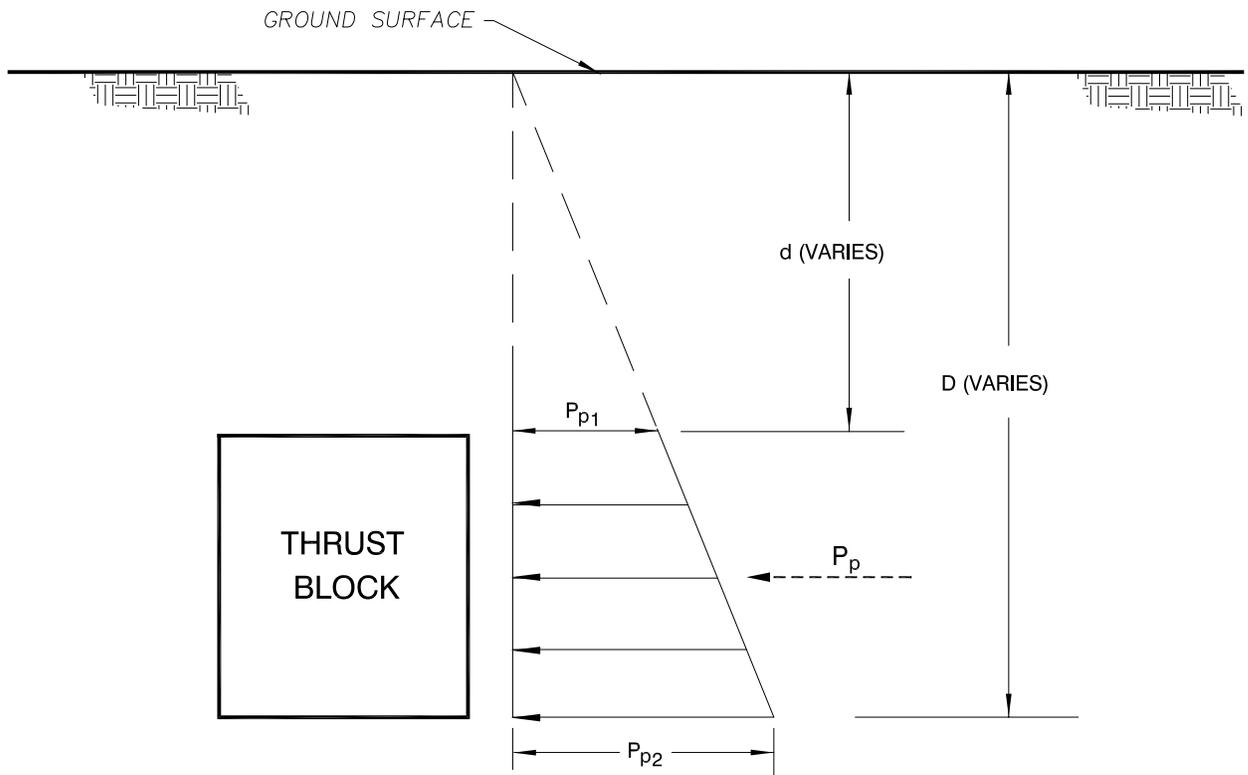
DATE

SEPULVEDA FEEDER INTERCONNECTION PROJECT  
CULVER CITY, CALIFORNIA

207519001

2/09

**7**



NOTES:

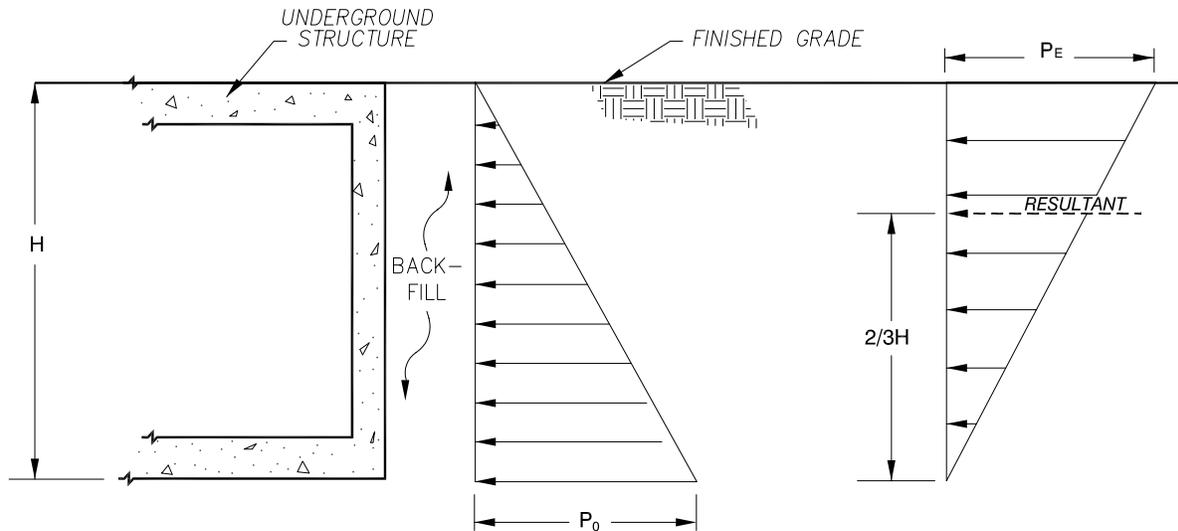
1. GROUNDWATER BELOW BLOCK  

$$P_p = 130(D^2 - d^2) \text{ lb/ft}$$
2. ASSUMES BACKFILL IS GRANULAR MATERIAL
3. ASSUMES THRUST BLOCK IS ADJACENT TO COMPETENT MATERIAL
4. D AND d ARE IN FEET

NOT TO SCALE

207519\_A6.DWG

<b>Ninyo &amp; Moore</b>		<b>THRUST BLOCK LATERAL EARTH PRESSURE DIAGRAM</b>	FIGURE
PROJECT NO.	DATE	SEPULVEDA FEEDER INTERCONNECTION PROJECT CULVER CITY, CALIFORNIA	<b>8</b>
207519001	2/09		



STATIC PRESSURE

DYNAMIC PRESSURE

NOTES:

1. APPARENT LATERAL EARTH PRESSURES,  $P_0$   
 $P_0 = 75 H$  psf
2. DYNAMIC LATERAL EARTH PRESSURE,  $P_E$ , IS BASED ON A PEAK GROUND ACCELERATION, OF 0.45 g  
 $P_E = 28 H$  psf
3. SURCHARGE PRESSURES CAUSED BY VEHICLES OR NEARBY STRUCTURES ARE NOT INCLUDED
4. H IS IN FEET

NOT TO SCALE

207519\_a7.dwg

**Ninyo & Moore**

**LATERAL EARTH PRESSURES FOR UNDERGROUND STRUCTURES**

FIGURE

PROJECT NO.

DATE

SEPULVEDA FEEDER INTERCONNECTION PROJECT  
 CULVER CITY, CALIFORNIA

207519001

2/09

**9**

## APPENDIX A

### BORING LOGS

#### **Field Procedure for the Collection of Disturbed Samples**

Disturbed soil samples were obtained in the field using the following methods.

##### **Bulk Samples**

Bulk samples of representative earth materials were obtained from the exploratory borings. The samples were bagged and transported to the laboratory for testing.

##### **The Standard Penetration Test (SPT) Sampler**

Disturbed drive samples of earth materials were obtained by means of a Standard Penetration Test sampler. The sampler is composed of a split barrel with an external diameter of 2 inches and an unlined internal diameter of  $1\frac{3}{8}$  inches. The sampler was driven into the ground 12 to 18 inches with a 140-pound hammer falling freely from a height of 30 inches in general accordance with ASTM D 1586. The blow counts were recorded for every 6 inches of penetration; the blow counts reported on the logs are those for the last 12 inches of penetration. Soil samples were observed and removed from the sampler, bagged, sealed and transported to the laboratory for testing.

#### **Field Procedure for the Collection of Relatively Undisturbed Samples**

Relatively undisturbed soil samples were obtained in the field using the following method.

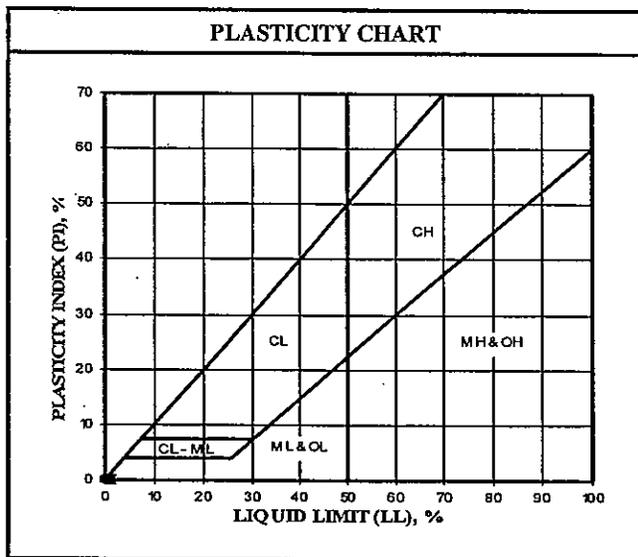
##### **The Modified Split-Barrel Drive Sampler**

The sampler, with an external diameter of 3 inches, was lined with 1-inch-long, thin brass rings with inside diameters of approximately 2.4 inches. The sampler barrel was driven into the ground with the weight of a 140-pound hammer mounted on the drill rig in general accordance with ASTM D 3550. The driving weight was permitted to fall freely. The approximate length of the fall, the weight of the hammer or bar, and the number of blows per foot of driving are presented on the boring logs as an index to the relative resistance of the materials sampled. The samples were removed from the sampler barrel in the brass rings, sealed, and transported to the laboratory for testing.

## U.S.C.S. METHOD OF SOIL CLASSIFICATION

MAJOR DIVISIONS	SYMBOL	TYPICAL NAMES
<b>COARSE-GRAINED SOILS</b> (More than 1/2 of soil >No. 200 sieve size)	<b>GRAVELS</b> (More than 1/2 of coarse fraction > No. 4 sieve size)	 GW Well graded gravels or gravel-sand mixtures, little or no fines
		 GP Poorly graded gravels or gravel-sand mixtures, little or no fines
		 GM Silty gravels, gravel-sand-silt mixtures
		 GC Clayey gravels, gravel-sand-clay mixtures
	<b>SANDS</b> (More than 1/2 of coarse fraction <No. 4 sieve size)	 SW Well graded sands or gravelly sands, little or no fines
		 SP Poorly graded sands or gravelly sands, little or no fines
		 SM Silty sands, sand-silt mixtures
		 SC Clayey sands, sand-clay mixtures
<b>FINE-GRAINED SOILS</b> (More than 1/2 of soil <No. 200 sieve size)	<b>SILTS &amp; CLAYS</b> Liquid Limit <50	 ML Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with
		 CL Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean
		 OL Organic silts and organic silty clays of low plasticity
	<b>SILTS &amp; CLAYS</b> Liquid Limit >50	 MH Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		 CH Inorganic clays of high plasticity, fat clays
		 OH Organic clays of medium to high plasticity, organic silty clays, organic silts
<b>HIGHLY ORGANIC SOILS</b>		Pt Peat and other highly organic soils

GRAIN SIZE CHART		
CLASSIFICATION	RANGE OF GRAIN SIZE	
	U.S. Standard Sieve Size	Grain Size in Millimeters
<b>BOULDERS</b>	Above 12"	Above 305
<b>COBBLES</b>	12" to 3"	305 to 76.2
<b>GRAVEL</b> Coarse Fine	3" to No. 4 3" to 3/4" 3/4" to No. 4	76.2 to 4.76 76.2 to 19.1 19.1 to 4.76
<b>SAND</b> Coarse Medium Fine	No. 4 to No. 200 No. 4 to No. 10 No. 10 to No. 40 No. 40 to No. 200	4.76 to 0.075 4.76 to 2.00 2.00 to 0.420 0.420 to 0.075
<b>SILT &amp; CLAY</b>	Below No. 200	Below 0.075



Ninyo & Moore

U.S.C.S. METHOD OF SOIL CLASSIFICATION

# BORING LOG EXPLANATION SHEET

DEPTH (feet)	Bulk Samples Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	
0	■						Bulk sample.
	■						Modified split-barrel drive sampler.
	■						No recovery with modified split-barrel drive sampler.
	■						Sample retained by others.
	■						Standard Penetration Test (SPT).
5	■						No recovery with a SPT.
	■	XX/XX					Shelby tube sample. Distance pushed in inches/length of sample recovered in inches.
	■						No recovery with Shelby tube sampler.
	■						Continuous Push Sample.
	■		○				Seepage.
10	■		○				Groundwater encountered during drilling.
	■		○				Groundwater measured after drilling.
	■				■	SM	ALLUVIUM: Solid line denotes unit change.
	■				---		Dashed line denotes material change.
15	■						Attitudes: Strike/Dip b: Bedding c: Contact j: Joint f: Fracture F: Fault cs: Clay Seam s: Shear bss: Basal Slide Surface sf: Shear Fracture sz: Shear Zone sbs: Sheared Bedding Surface
20	■						The total depth line is a solid line that is drawn at the bottom of the boring.



## BORING LOG

### EXPLANATION OF BORING LOG SYMBOLS

PROJECT NO.

DATE  
Rev. 01/03

FIGURE

DEPTH (feet)	SAMPLES	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED	BORING NO.	
							1/9/09	B-1	
							GROUND ELEVATION	SHEET	OF
							63' ± (MSL)	1	2
							METHOD OF DRILLING 8 inch Hollow-Stem Auger (Choice Drilling)		
							DRIVE WEIGHT	DROP	
							140 lbs. (Auto. Trip Hammer)	30"	
							SAMPLED BY	LOGGED BY	REVIEWED BY
							MCP	MCP	JJB/CAP
							DESCRIPTION/INTERPRETATION		
0							<b>ASPHALT CONCRETE:</b> Approximately 7 inches thick.		
						SM	<b>BASE:</b> Dark yellowish brown, damp to moist, medium dense, silty SAND; approximately 4 inches thick.		
						CL	<b>ALLUVIUM:</b> Dark brown to brown, damp to moist, very stiff, silty CLAY with sand.		
5		14	17.7	96.7					
10		13	19.0	98.0			Scattered lenses of clayey silt.		
15		27				SP	Yellowish to reddish brown, damp to moist, dense, poorly graded SAND; scattered lenses of clayey sand.		
20									

**Ninyo & Moore**

**BORING LOG**

SEPULVEDA FEEDER INTERCONNECTION PROJECT  
 CULVER CITY, CALIFORNIA

PROJECT NO.  
 207519001

DATE  
 2/09

FIGURE  
 A-1

DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED	BORING NO.				
	Bulk	Driven						1/9/09	B-1				
								GROUND ELEVATION	SHEET	OF			
								63' ± (MSL)	2	2			
								METHOD OF DRILLING	8 inch Hollow-Stem Auger (Choice Drilling)				
								DRIVE WEIGHT	140 lbs. (Auto. Trip Hammer)	DROP	30"		
								SAMPLED BY	MCP	LOGGED BY	MCP	REVIEWED BY	JJB/CAP
								<b>DESCRIPTION/INTERPRETATION</b>					
20			50/6"				SP	<u>ALLUVIUM: (Continued)</u> Yellowish to reddish brown, damp to moist, very dense, poorly graded SAND.					
25			21				CL	Reddish to grayish brown, damp to moist, hard, sandy CLAY.					
30								Total Depth = 26.5 feet. No groundwater encountered. Backfilled with soil cuttings and capped with quick-set concrete with black dye on 1/9/09.					
35								<u>Note:</u> Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.					
40													

**Ninyo & Moore**

**BORING LOG**

SEPULVEDA FEEDER INTERCONNECTION PROJECT  
 CULVER CITY, CALIFORNIA

PROJECT NO.  
 207519001

DATE  
 2/09

FIGURE  
 A-2

DEPTH (feet)	SAMPLES Bulk Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED	BORING NO.	
							1/9/09	B-2	
							GROUND ELEVATION	SHEET	OF
							63' ± (MSL)	1	1
							METHOD OF DRILLING 8 inch Hollow-Stem Auger (Choice Drilling)		
							DRIVE WEIGHT	DROP	
							140 lbs. (Auto. Trip Hammer)	30"	
							SAMPLED BY	LOGGED BY	REVIEWED BY
							MCP	MCP	JJB/CAP
							DESCRIPTION/INTERPRETATION		
0							<u>ASPHALT CONCRETE:</u> Approximately 5 inches thick.		
						SM	<u>PORTLAND CEMENT CONCRETE:</u> Approximately 8 inches thick.		
						SM	<u>AGGREGATE BASE:</u> Light yellow, damp to moist, medium dense, silty SAND with gravel; approximately 4 inches thick.		
							<u>FILL:</u> Reddish brown, damp to moist, medium dense, silty SAND.		
5		20	15.3	95.0		CL	<u>ALLUVIUM:</u> Dark yellowish brown, moist, very stiff, silty CLAY with sand.		
10		9					Stiff; sandy clay and clayey silt.		
15		42					Hard; increased gravel.		
20							Total Depth = 16.5 feet. No groundwater encountered. Backfilled with soil cuttings and capped with quick-set concrete with black dye on 1/9/09. <u>Note:</u> Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.		



**BORING LOG**

SEPULVEDA FEEDER INTERCONNECTION PROJECT  
 CULVER CITY, CALIFORNIA

PROJECT NO.  
207519001

DATE  
2/09

FIGURE  
A-3

DEPTH (feet)	Bulk Driven SAMPLES	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED	BORING NO.	
							1/9/09	B-3	
							GROUND ELEVATION	SHEET	OF
							63' ± (MSL)	1	1
							METHOD OF DRILLING 8 inch Hollow-Stem Auger (Choice Drilling)		
							DRIVE WEIGHT	DROP	
							140 lbs. (Auto. Trip Hammer)	30"	
							SAMPLED BY	LOGGED BY	REVIEWED BY
							MCP	MCP	JJB/CAP
							DESCRIPTION/INTERPRETATION		
0							<b>ASPHALT CONCRETE:</b> Approximately 4 inches thick.		
						SM	<b>PORTLAND CEMENT CONCRETE:</b> Approximately 8 inches thick.		
						CL	<b>AGGREGATE BASE:</b> Reddish brown, damp to moist, silty SAND with gravel; approximately 4 inches thick.		
							<b>ALLUVIUM:</b> Dark yellowish to reddish brown, damp, very stiff, silty CLAY.		
5		16	14.4	92.4					
10		11							
15		35					Hard; increased sand.		
20							Total Depth = 16.5 feet. No groundwater encountered. Backfilled with soil cuttings and capped with quick-set concrete with black dye on 1/9/09.		
							<b>Note:</b> Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.		



**BORING LOG**

SEPULVEDA FEEDER INTERCONNECTION PROJECT  
 CULVER CITY, CALIFORNIA

PROJECT NO.  
 207519001

DATE  
 2/09

FIGURE  
 A-4

DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED <u>1/9/09</u> BORING NO. <u>B-4</u>	
	Bulk	Driven						GROUND ELEVATION <u>66' ± (MSL)</u>	SHEET <u>1</u> OF <u>1</u>
								METHOD OF DRILLING <u>8 inch Hollow-Stem Auger (Choice Drilling)</u>	
								DRIVE WEIGHT <u>140 lbs. (Auto. Trip Hammer)</u> DROP <u>30"</u>	
								SAMPLED BY <u>MCP</u> LOGGED BY <u>MCP</u> REVIEWED BY <u>JJB/CAP</u>	
								<b>DESCRIPTION/INTERPRETATION</b>	
0								<u>ASPHALT CONCRETE:</u> Approximately 6 inches thick.	
							SM	<u>PORTLAND CEMENT CONCRETE:</u> Approximately 9 inches thick.	
							CL	<u>AGGREGATE BASE:</u> Light yellowish brown, damp to moist, medium dense, silty SAND with gravel; approximately 9 inches thick.	
								<u>ALLUVIUM:</u> Dark reddish brown, moist, stiff, sandy CLAY.	
5			6						
10			22	15.8	110.5			Very stiff.	
15			9					Stiff; clayey to sandy silt lens.	
20								Total Depth = 16.5 feet. No groundwater encountered. Backfilled with soil cuttings and capped with quick-set concrete with black dye on 1/9/09.	
								<u>Note:</u> Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.	

**Ninyo & Moore**

**BORING LOG**

SEPULVEDA FEEDER INTERCONNECTION PROJECT  
CULVER CITY, CALIFORNIA

PROJECT NO.  
207519001

DATE  
2/09

FIGURE  
A-5

DEPTH (feet)	BULK SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED	BORING NO.	
							1/9/09	B-5	
							GROUND ELEVATION	SHEET	OF
							68' ± (MSL)	1	2
							METHOD OF DRILLING		
							8 inch Hollow-Stem Auger (Choice Drilling)		
							DRIVE WEIGHT	DROP	
							140 lbs. (Auto. Trip Hammer)	30"	
							SAMPLED BY	LOGGED BY	REVIEWED BY
							MCP	MCP	JJB/CAP
							DESCRIPTION/INTERPRETATION		
0							<u>ASPHALT CONCRETE:</u> Approximately 5 inches thick.		
							<u>PORTLAND CEMENT CONCRETE:</u> Approximately 9 inches thick.		
						SC	<u>FILL:</u> Reddish brown, moist, medium dense, clayey SAND.		
							<u>ALLUVIUM:</u> Dark brown, moist, stiff, sandy CLAY.		
5		8				CL			
10		20	15.0	111.0			Very stiff.		
15		5					Firm to stiff; clayey to sandy silt lens.		
20									



**BORING LOG**

SEPULVEDA FEEDER INTERCONNECTION PROJECT  
 CULVER CITY, CALIFORNIA

PROJECT NO.  
 207519001

DATE  
 2/09

FIGURE  
 A-6

DEPTH (feet)	BULK DRIVEN	SAMPLES	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED	BORING NO.	
								1/9/09	B-5	
								GROUND ELEVATION	SHEET	OF
								68' ± (MSL)	2	2
								METHOD OF DRILLING		
								8 inch Hollow-Stem Auger (Choice Drilling)		
								DRIVE WEIGHT	DROP	
								140 lbs. (Auto. Trip Hammer)	30"	
								SAMPLED BY	LOGGED BY	REVIEWED BY
								MCP	MCP	JJB/CAP
								<b>DESCRIPTION/INTERPRETATION</b>		
20			26				CL	<u>ALLUVIUM</u> ; (Continued) Dark reddish brown, moist, very stiff, sandy CLAY.		
								Total Depth = 21.5 feet. No groundwater encountered. Backfilled with soil cuttings and capped with quick-set concrete with black dye on 1/9/09.		
								<u>Note:</u> Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.		
25										
30										
35										
40										



<b>BORING LOG</b>		
SEPULVEDA FEEDER INTERCONNECTION PROJECT CULVER CITY, CALIFORNIA		
PROJECT NO. 207519001	DATE 2/09	FIGURE A-7

**LEROY CRANDALL & ASSOCIATES**  
**BORING LOG**

**BORING C**

DATE DRILLED: July 11, 1979  
 EQUIPMENT USED: 16"-Diameter Bucket

ELEVATION 59.3

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
55	5	16.9	112	8		CL
						CL
		14.1	106	6		
50	10	12.6	102	5		
		16.5	115	10		
45	15					SP
		4.4	116	18		
40	20	3.9	113	19		
		3.4	117	24		
25						

4" Asphaltic Paving - 6" Base Course  
 SILTY CLAY - dark grey

Brown

SAND - fine, few gravel, brown

SAND - well graded, about 15% gravel, light brown

NOTE: Water not encountered. No caving.

**LOG OF BORING**

LeROY CRANDALL AND ASSOCIATES

PLATE A-1.3

## **APPENDIX B**

### **LABORATORY TESTING**

#### **Classification**

Soils were visually and texturally classified in accordance with the Unified Soil Classification System (USCS) in general accordance with ASTM D 2488. Soil classifications are indicated on the logs of the exploratory borings in Appendix A.

#### **In-Place Moisture and Density Tests**

The moisture content and dry density of relatively undisturbed samples obtained from the exploratory borings were evaluated in general accordance with ASTM D 2937. The test results are presented on the logs of the exploratory borings in Appendix A.

#### **200 Wash**

An evaluation of the percentage of particles finer than the No. 200 sieve in selected soil samples was performed in general accordance with ASTM D 1140. The results of the tests are presented on Figure B-1.

#### **Atterberg Limits**

Tests were performed on a selected representative fine-grained soil sample to evaluate the liquid limit, plastic limit, and a plasticity index in general accordance with ASTM D 4318. These test results were utilized to evaluate the soil classification in accordance with the USCS. The test results and classifications are shown on Figure B-2.

#### **Direct Shear Tests**

Direct shear tests were performed on relatively undisturbed samples in general accordance with ASTM D 3080 to evaluate the shear strength characteristics of selected materials. The samples were inundated during shearing to represent adverse field conditions. The results are shown on Figures B-3 and B-4.

#### **R-Value**

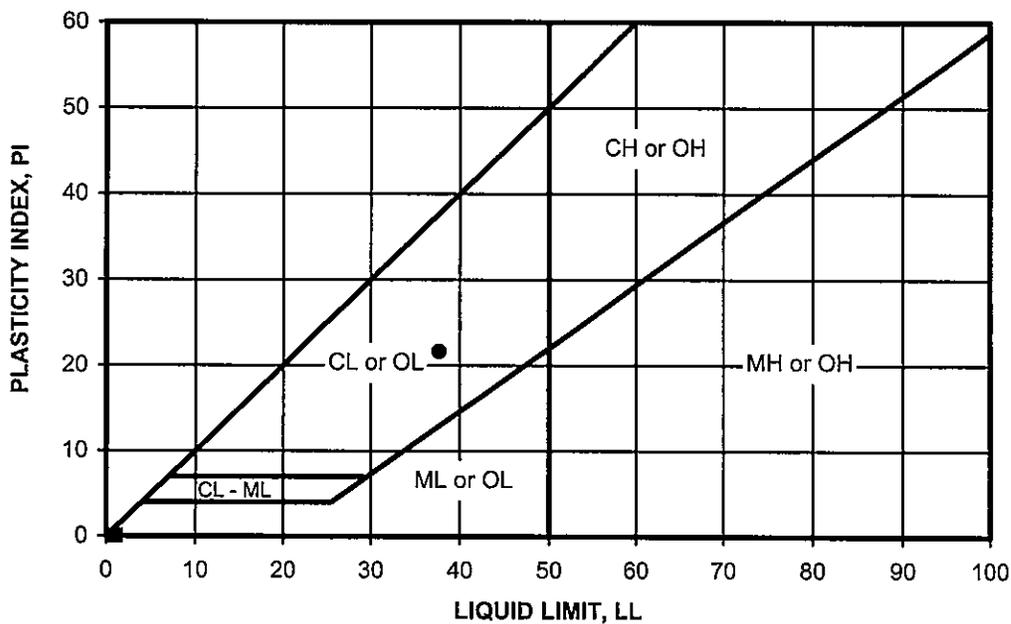
The resistance value, or R-value, of a representative sample of near-surface soils was evaluated in general accordance with California Test (CT) 301. Samples were prepared and tested for exudation pressure and expansion pressure. The equilibrium R-value is reported as the lesser of the two calculated results. The test result is shown on Figure B-5.

SAMPLE LOCATION	SAMPLE DEPTH (FT)	DESCRIPTION	PERCENT PASSING NO. 4	PERCENT PASSING NO. 200	USCS (TOTAL SAMPLE)
B-1	5.0-6.5	Silty CLAY with Sand	100	83	CL
B-2	5.0-6.5	Silty CLAY with Sand	100	82	CL
B-4	10.0-11.5	Sandy CLAY	100	62	CL
B-5	10.0-11.5	Sandy CLAY	100	60	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 1140-00

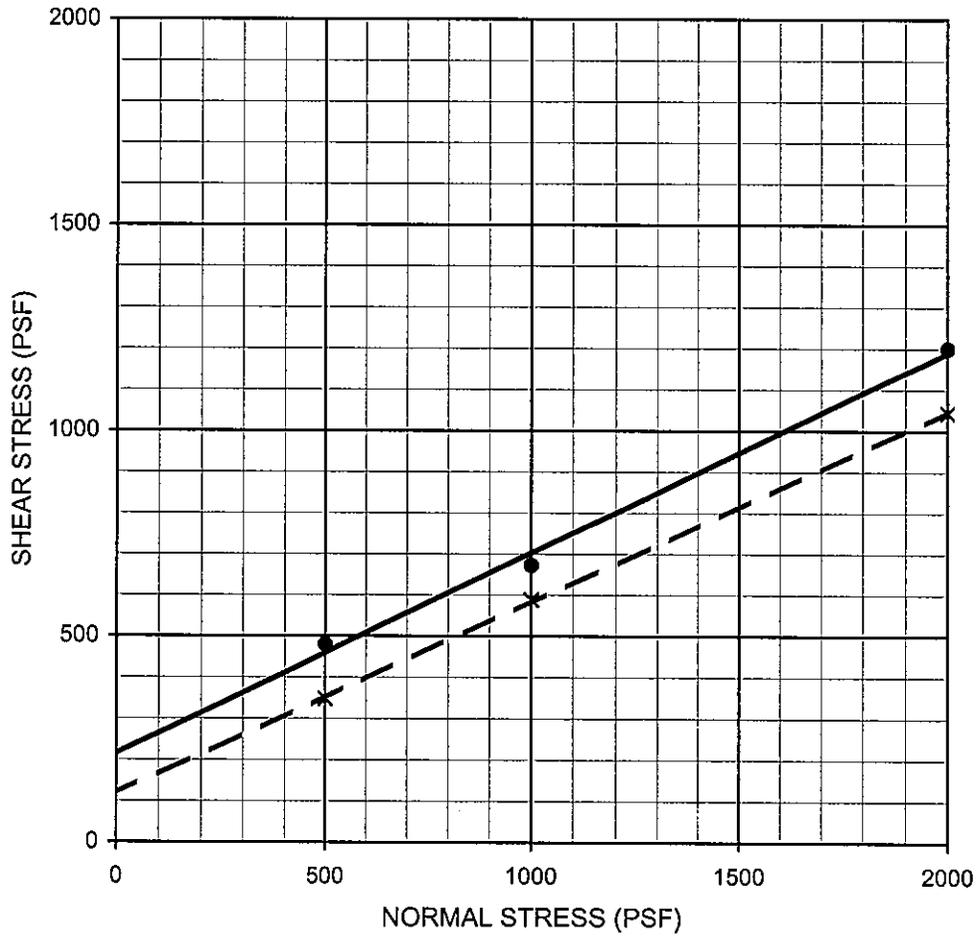
<b>Ninyo &amp; Moore</b>		<b>NO. 200 SIEVE ANALYSIS</b>	FIGURE  <b>B-1</b>
PROJECT NO.	DATE	SEPULVEDA FEEDER INTERCONNECTION PROJECT	
207519001	2/09	CULVER CITY, CALIFORNIA	

SYMBOL	LOCATION	DEPTH (FT)	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	USCS CLASSIFICATION (Fraction Finer Than No. 40 Sieve)	USCS (Entire Sample)
•	B-2	5.0-6.5	38	16	22	CL	CL



PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4318-05

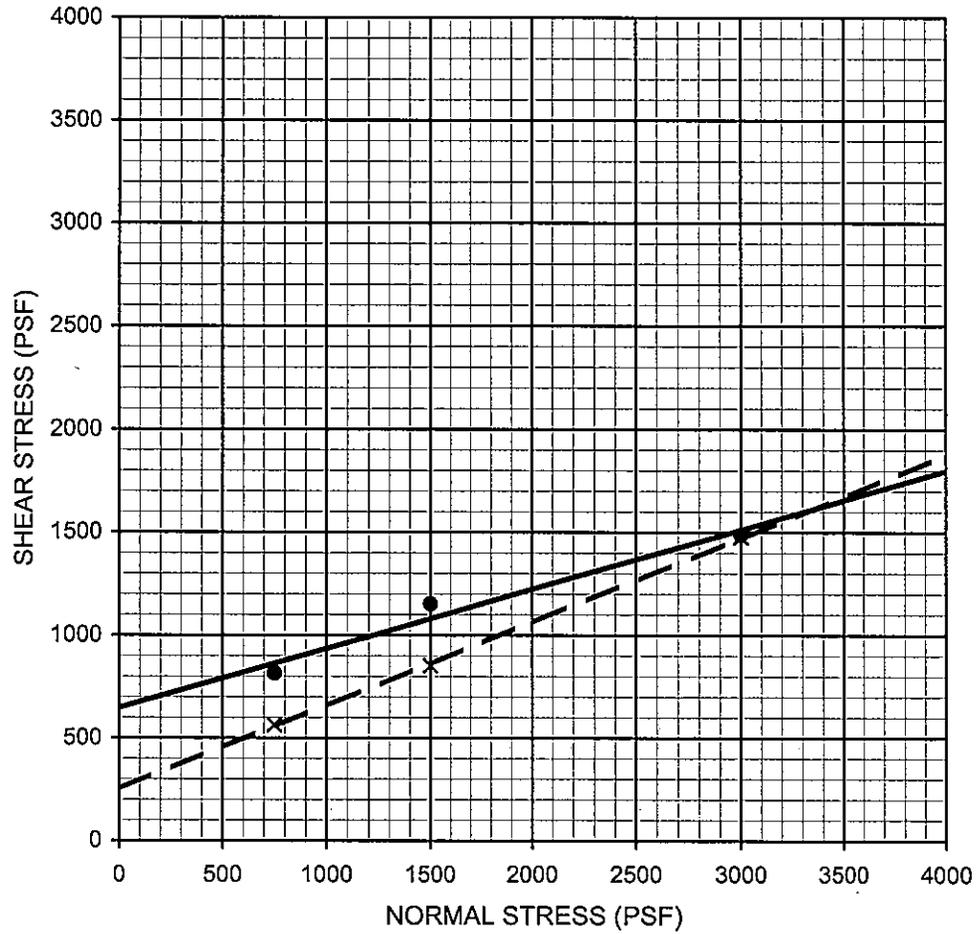
<b>Ninyo &amp; Moore</b>		<b>ATTERBERG LIMITS TEST RESULTS</b>		<b>FIGURE</b>  <b>B-2</b>
PROJECT NO.	DATE	SEPULVEDA FEEDER INTERCONNECTION PROJECT CULVER CITY, CALIFORNIA		
207519001	2/09			



Description	Symbol	Sample Location	Depth (ft)	Shear Strength	Cohesion, c (psf)	Friction Angle, $\phi$ (degrees)	Soil Type
Silty CLAY with Sand	—●—	B-1	5.0-6.5	Peak	216	26	CL
Silty CLAY with Sand	- - X - -	B-1	5.0-6.5	Ultimate	120	25	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 3080-04

<b>Ninyo &amp; Moore</b>		<b>DIRECT SHEAR TEST RESULTS</b>	FIGURE
PROJECT NO.	DATE		
207519001	2/09	SEPULVEDA FEEDER INTERCONNECTION PROJECT CULVER CITY, CALIFORNIA	<b>B-3</b>



Description	Symbol	Sample Location	Depth (ft)	Shear Strength	Cohesion, c (psf)	Friction Angle, $\phi$ (degrees)	Soil Type
Sandy CLAY	—●—	B-5	10.0-11.5	Peak	648	16	CL
Sandy CLAY	- - X - -	B-5	10.0-11.5	Ultimate	252	22	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 3080-04

<b>Ninyo &amp; Moore</b>		<b>DIRECT SHEAR TEST RESULTS</b>	FIGURE
PROJECT NO.	DATE		SEPULVEDA FEEDER INTERCONNECTION PROJECT CULVER CITY, CALIFORNIA
207519001	2/09	<b>B-4</b>	

SAMPLE LOCATION	SAMPLE DEPTH (FT)	SOIL TYPE	R-VALUE
B-2	5.0-8.0	CL	8

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2844-01/CT 301

<b><i>Ninyo &amp; Moore</i></b>		<b>R-VALUE TEST RESULTS</b>	<b>FIGURE B-5</b>
PROJECT NO.	DATE	SEPULVEDA FEEDER INTERCONNECTION PROJECT CULVER CITY, CALIFORNIA	
207519001	2/09		