PACIFIC SOILS ENGINEERING, INC.
3002 DOW AVENUE, SUITE 514, TUSTIN, CALIFORNIA 92780
TELEPHONE: (714) 730-2122, FAX: (714) 730-5191

SHEA HOMES
603 South Valencia Avenue
Brea, California 92823

May 18, 2005
Work Order 500653

Attention: Mr. Greg Kibble

Subject: **GEOTECHNICAL REVIEW OF 40-SCALE ROUGH GRADING PLAN**
Tentative Tract 16187
2800 North Farmers Drive
City of Santa Ana, California

References: Section 10.0

Gentlemen:

Pursuant to your request, Pacific Soils Engineering, Inc. (PSE), herein presents its geotechnical review of the 1-inch equals 40-foot scale Rough Grading Plan prepared by RBF Consulting, for Tentative Tract 16187, also known as The Retreat development, in the City of Santa Ana, California. This plan review has utilized the information in a geotechnical report prepared by others (Reference 1) and the geotechnical information collected during a recent subsurface investigation performed by PSE.

SUMMARY

The site is located southerly adjacent to the I-5 Freeway in Santa Ana, California. It is bound on the west by single-family residences off of Flower Street, and on the south by single-family residences off of West Memory Lane. Access to the site is provided via North Farmers Drive, which currently dead-ends at the southwest corner of the site. The site is currently vacant. Piles of debris are present at the site. These include piles of asphalt concrete and crushed concrete associated with the demolition of former improvements to the site. According to the 1-inch equals 40-foot scale Rough Grading Plan, it is proposed to construct 36 single-family residences as well as associated site infrastructure improvements on the site. It is also proposed to construct a sound wall adjacent to the freeway.

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Eleven exploratory trenches were excavated and logged by PSE to depths ranging from 5 to 10.5 feet below existing grades. Based on the exploratory trenches and on subsurface data obtained from previous studies, a majority of the site is underlain with recent alluvium consisting mostly of sandy silts and clays. Some deposits of fill of limited depth and aerial extent were encountered.

Based upon PSE's field and laboratory testing, development of the site, as proposed, is feasible from a geotechnical viewpoint. There are several key issues that should be considered with regard to site grading and development:

- Existing fill and underlying topsoil or unsuitable alluvial deposits should be removed. Generally, removal depths are anticipated to extend one (1) to five (5) feet below the current grade.
- Building areas should be overexcavated a minimum of five (5) feet below pad grade and street and parking areas two (2) feet below the subgrade.
- Numerous pieces of geotechnical fabric mixed with crushed asphalt associated with demolition of the exiting parking lot were encountered at the site, generally within approximately 6 inches of the surface. From a geotechnical perspective, PSE does not object to incorporating this material into fill due to the limited quantities of this material. However, from an aesthetic perspective, the presence of this material in the compacted fill may not be appealing to homeowners; therefore, PSE recommends that this material be collected and incorporated into the compacted fill placed within street areas.
- It is PSE's understanding that the pre-existing building was demolished and that concrete portions were crushed on site. Provided that the material meets the gradation and durability requirements for crushed miscellaneous base (CMB), PSE has no objection to its use. This material may also be incorporated into compacted fill; however, the placement of this mixture should be limited to within street areas or within building areas provided that it is greater than three feet below the finished grade in building areas.

We at Pacific Soils Engineering, Inc., appreciate the opportunity to be of service to you and your organization. Should you have any questions or require additional information, please do not hesitate to contact the undersigned at (714) 730-2122.

Respectfully submitted,
PACIFIC SOILS ENGINEERING, INC.

JOHN J. DONOVAN/RCE 65051
Reg. Exp.: 6-30-07
Registered Civil Engineer

CARISA ENDRIZZI-DAVIS/CEG 1987
Reg. Exp.: 12-31-05
Certified Engineering Geologist

Reviewed by:

RONALD A. REED/RGE 2524
RCE 53581/Reg. Exp.: 6-30-07
Manager of Geotechnical Services

Distribution: (6) Addressee
(3) RBF Consulting, Attn.: Mr. Patrick Revere
(1) ESI/FME, Attn.: Ms. Traci Wong

JJD:CED:RAR:rb-500653, May 18, 2005 (Shea, Santa Ana)

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Background and Purpose

A residential development is currently proposed at the site. Two geotechnical investigation reports have been published for the subject site. The most recent was completed by Group Delta Consultants, Inc. (Group Delta, 2001), and was provided to PSE to review. Group Delta's investigation included drilling ten borings with a hollow stem auger to depths of up to 102 feet. Laboratory testing was conducted on collected samples. Geocon completed an earlier investigation at the site in 2000. Although PSE has not reviewed this report, the logs of borings and laboratory test results from this investigation, and a plan showing the locations of these borings was included as part of the Group Delta's geotechnical report. According to the Logs of Borings, Geocon's borings were drilled to depths of up to 61.5 feet. The Logs of Borings and laboratory testing from both investigations are included in this report. The location of the borings drilled by Geocon and Group Delta are shown on the attached Geotechnical Maps (Plates 1 and 2).

Pacific Soils Engineering, Inc. (PSE) has performed a geotechnical investigation of the subject site in general conformance with our proposal dated October 12, 2004. The purpose of this report is to provide geotechnical recommendations for the design and construction of the project as we understand it and as reflected on the 1-inch equals 40-foot scale Rough Grading Plan for Tentative Tract No. 16187. The plan was provided by RBF Consultants. This report presents grading and preliminary design recommendations in support of developing the site.

1.2 Scope of Study

The scope of our study included the following tasks:

- Reviewing readily available geologic and geotechnical data pertinent to the site.
- Excavating and logging 11 exploratory trenches using a rubber-tired backhoe.

- Conducting laboratory testing to establish general engineering properties of the on-site subsurface materials.
- Presenting site-grading recommendations, including site demolition, remedial grading and utility trench backfill criteria.
- Providing preliminary recommendations relative to the design of foundations, retaining walls, concrete and asphalt concrete pavements, and use of concrete pavers.
- Evaluating groundwater conditions and the potential effects on the proposed construction.
- Compiling a limited seismicity study.
- Preparing this report, which presents this firm's findings, conclusions, and recommendations to be used in the preliminary design of the proposed development.

It should be noted that this study focused on the evaluation and analysis of the geotechnical conditions of the subject site. Investigation or assessment of the potential presence of toxic or hazardous substances is beyond the scope of our services.

1.3 Report Organization

This report has been organized to summarize geologic and geotechnical data and to present remedial grading recommendations relative to the 1-inch equals 40-foot scale Rough Grading Plan for Tentative Tract No. 16187. Subsurface exploration logs, laboratory test procedures and results, and data developed during this study, have been utilized in our analyses and selected data is presented in this document.

The main text of this report is divided into the following sections: Introduction, Project Description, Geologic Conditions, Material Properties, Earthwork Conclusions and Recommendations, Earthwork Considerations, Preliminary Design Recommendations, Closure and References. Included in this report are the following appendices:

Appendix A - Subsurface Exploration

Appendix B - Laboratory Testing

Appendix C – Logs of Borings and Laboratory Data by Others

Appendix D - Probabilistic Seismicity Analysis

Appendix E - Earthwork Specifications

Also accompanying this report, as a pocket enclosure is the 1-inch equals 40-foot Geotechnical Map. The Geotechnical Map uses the Rough Grading Plan for Tentative Tract No. 16187 prepared by RBF Consultants as a base. The plan depicts existing grades and improvements, and proposed grades. PSE has added the approximate trench locations; location of borings drilled by Geocon and Group Delta, and selected information associated with each of the trenches and borings.

1.4 Report Limitations

The conclusions and recommendations in this report are based on the data developed during this study and on the proposed development plan for 36 single-family residences. The conclusions presented herein are based upon the current design reflected on the enclosed Rough Grading Plan. Changes to the grading plan will necessitate further review and analyses.

Addressing the subject site environmental constraints is outside the scope of work of Pacific Soils Engineering, Inc. The geotechnical conclusions and recommendations presented in this report are intended to supersede those made in earlier investigations and reports.

2.0 PROJECT DESCRIPTION

2.1 Location and Existing Conditions

The site is located adjacent to the I-5 Freeway in the City of Santa Ana, California. It is bound on the northeast by the I-5 Freeway, on the west by single family residences off Flower Street, and on the south by single family residences off West Memory Lane. Access to the site is provided via North Farmers Drive, which currently dead-ends at the southwest corner of the site. A site location map is provided as Figure 1. The relatively flat site is currently vacant. Several piles of debris are present at the site, including small piles of asphalt concrete and a large stockpile of crushed concrete associated with the demolition of former improvements on the site.

2.2 Proposed Development

It is our understanding that the subject site is to be developed for residential use. According to the 1-inch equals 40-foot scale Rough Grading Plan for Tentative Tract No. 16187, development will consist of 36 single-family residences as well as associated site infrastructure improvements. It is also proposed to construct a sound wall adjacent to the freeway.

3.0 GEOLOGIC CONDITIONS

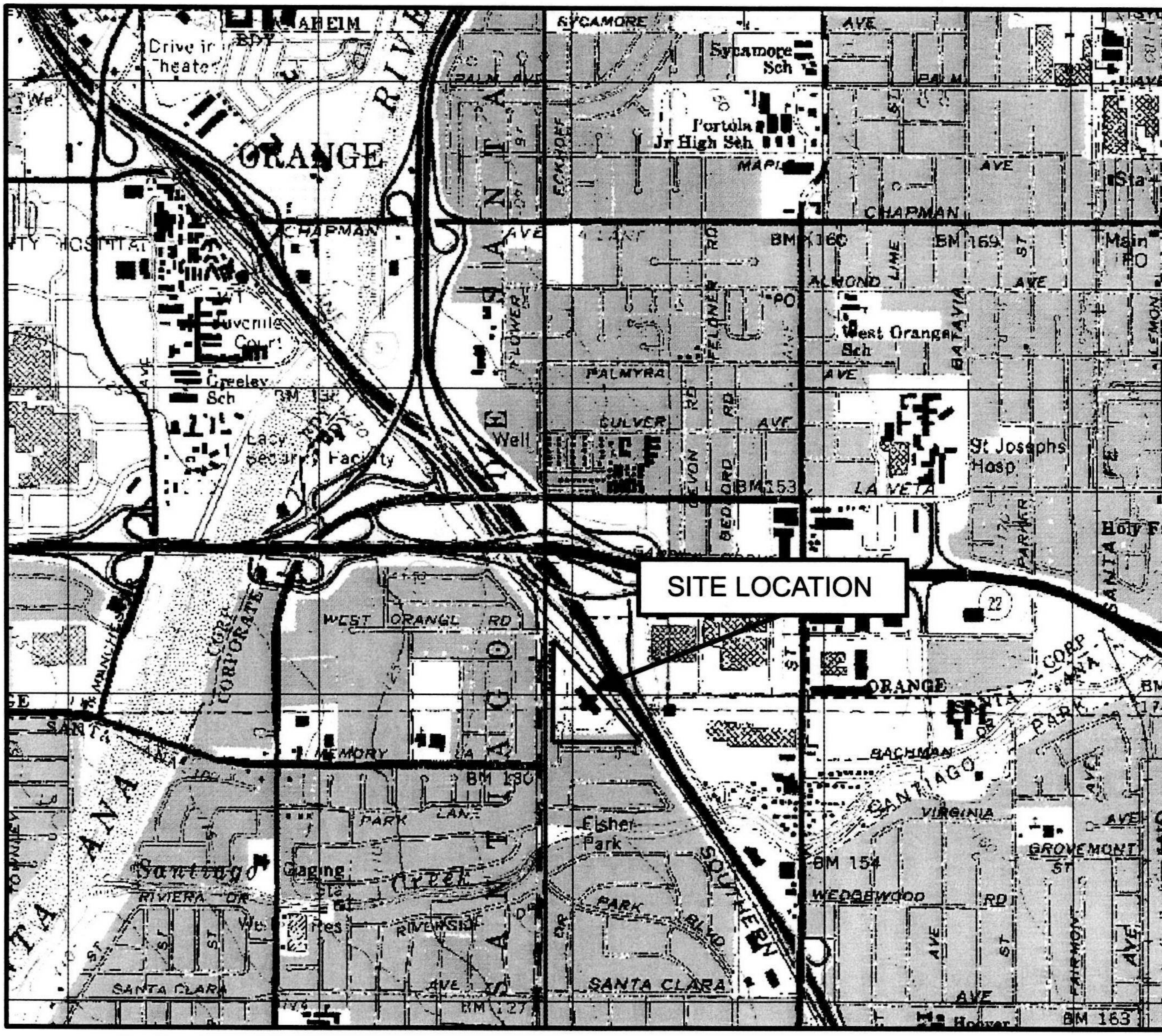
3.1 Geologic and Geomorphic Setting

The site is within a geomorphic province in California known as the Peninsular Ranges. This province is characterized by northwest trending valleys and mountains that, in part, owe their existence to regional northwest trending geologic structures. The site is at the southeastern end of the Los Angeles basin, which is bounded to the east by the Chino Hills and to the south by the Santa Ana Mountains and to the southeast by the San Joaquin Hills. The site lies within the broad, relatively flat alluvial plain associated with the Santa Ana River. The site is underlain by Quaternary alluvium associated with the Santa Ana River and the Santiago Creek drainage, which is located approximately ¼ mile south of the site. Bedrock may be located hundreds of feet below the site.

3.2 Stratigraphy

3.2.1 Undocumented Artificial Fill (af):

Undocumented fill was encountered during the current and previous investigations. Generally, undocumented fill was encountered along the



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SITE LOCATION MAP

TENTATIVE TRACT 16187
SANTA ANA, CALIFORNIA

FIGURE 1

SOURCE MAP: DeLORME 3-D TOPO QUADRANGLE
SITE LOCATED IN 7.5 MINUTE SANTA ANA QUADRANGLE

PACIFIC SOILS ENGINEERING, INC.
3002 DOW AVE. SUITE 514, TUSTIN, CA. 92780
TELEPHONE: (714) 730-2122, FAX: (714) 730-5191
W.O 500653
DATE: 5/18/05

northeastern boundary of the site and surrounding the former structure on the site. The depth of fill was generally found to be less than five feet, though deeper deposits may exist in localized areas. Some of this fill was removed during demolition of the structure on the site. Much of the remainder of the site is covered by a mixture of crushed asphalt and base material or loose topsoil, with depths that range from approximately 6 to 18 inches.

A pile of crushed concrete, up to approximately twenty feet in height, is located near the site of the previous structure.

3.2.2 Holocene-aged Alluvium (Qal):

Holocene-aged alluvial soils underlie the fill and are present throughout the rest of the site. The alluvium generally consisted of sandy silt to clay, with a consistency that ranged from soft at the surface to firm below approximately five (5) feet in depth.

3.3 Groundwater

Groundwater was not encountered during the current investigation. Groundwater was encountered at a depth of 87 feet in one of the borings drilled as part of the Group Delta investigation in 2001. Groundwater was not encountered during the Geocon investigation in 2000, which included borings drilled to depths of up to 61 feet.

According to the CDMG Seismic Hazard Zone Report for the Orange Quadrangle, the historical high groundwater table in the vicinity of the site is on the order of 30 to 40 feet below the ground surface. However, as indicated in Reference 1, data from nearby water wells indicates historical high groundwater levels on the order of 50± feet below ground surface. Goundwater is not expected to affect the proposed development.

3.4 Geologic Structure

Complex faulting and folding dominate the geologic structure of the Los Angeles Basin and surrounding mountain ranges. In addition to the more widely known and studied faults such as the nearby Newport-Inglewood and the Whittier-Elsinore, research conducted by Grant et al (1999, 2002) theorizes the existence of a local blind thrust fault known as the San Joaquin Hills Blind Thrust. Grant et al. propose that uplift of the nearby San Joaquin Hills was generated by movement on the above mentioned fault due to partitioned strike-slip and compressive shortening across the southern Newport Inglewood fault zone. However, the San Joaquin Hills Blind Thrust has not yet been studied in sufficient detail to determine the existence, location, or subsurface geometry of the fault let alone classify it as "active" pursuant to the guidelines of the Alquist-Priolo Earthquake Fault Zoning Act.

3.4.1 Regional Mapped Faults

The site is not within a State-defined Alquist-Priolo Fault Hazard Zone; however, the Whittier-Elsinore and Newport-Inglewood faults are active fault systems in the region near the project. These fault systems control the geologic structure of Orange County. The Whittier-Elsinore Fault is located approximately ten miles to the northeast at the base of the foothills. It is a well-defined strike-slip fault as is the Newport Inglewood fault, which is located approximately ten miles southwest of the site.

Whittier Fault Zone

Based on our FRISKSP (Blake, 2000) analysis, the Whittier fault zone is located approximately 16.6 kilometers northwest of the site and is a significant structural feature of the Los Angeles Basin. Significant vertical displacements (6,000 to 12,000 feet) as well as up to 15,000 feet of postulated, right slip are attributed to this feature (Schoellhamer et. al., 1954). Its historical seismicity and poorly understood merger with the

Elsinore Fault System necessitate special attention with respect to future activity.

Newport - Inglewood Fault System

Based on our FRISKSP (Blake, 2000) analysis, the Newport - Inglewood fault system is located approximately 16 kilometers southwesterly of the subject site. This fault system extends northwesterly from a point approximately 5 miles offshore of Laguna Beach to the Santa Monica Mountains. The Newport-Inglewood is a right-lateral fault system characterized by a series of en echelon (sub-parallel) faults. These faults exhibit considerable offset at depth with little or no evidence of surface displacement.

3.5 Earthquake Hazards

The subject site is located in southern California, which is a tectonically active area. The type and magnitude of seismic hazards affecting a site are dependent on the distance to the causative fault and the intensity and magnitude of the seismic event. The seismic hazard may be primary, such as surface rupture and/or ground shaking, or secondary such as liquefaction and/or ground lurching.

The State of California prohibits the location of most structures for human occupancy across the traces of active faults through the Alquist-Priolo Earthquake Fault Zoning Act (A-P). The State Geologist assists local agencies by delineating Earthquake Fault Zones in California. In order to protect public safety from the effects of strong ground shaking, liquefaction, landslides or other ground failure, and other hazards caused by earthquakes, the State of California passed the Seismic Hazards Mapping Act in 1991. Seismic hazards relating to these two acts are discussed below.

3.5.1 Surface Rupture

No active faults are known to exist on the subject site nor is the site located within a State-defined Alquist-Priolo Fault Hazard Zone. This is based on PSE's review of available literature and lack of evidence during our field exploration. Therefore, it is unlikely that ground surface fault rupture will occur on the subject site during the projected life of the proposed structures.

3.5.2 Liquefaction and Seismically Induced Landsliding

Based on the State of California Seismic Hazard Zone Map for the Orange Quadrangles, much of the subject site is located within a zone of required investigation for liquefaction. Groundwater was encountered at a depth of 87 feet below the ground surface during the previous (Reference 1) investigation. Additionally, in Reference 1, Group Delta indicated that historical high groundwater levels were greater than 50 feet. This historical high groundwater level was based on a review of historical records from nearby wells. Therefore, due to the depth of groundwater and the relative density of the cohesionless soils encountered during the previous investigations (based on SPT blow counts), the risk for liquefaction to adversely affect the proposed development is considered low.

3.5.3 Seiches

A seiche is a free or standing-wave oscillation on the surface of water in an enclosed or semi-enclosed basin. The wave can be initiated by an earthquake and can vary in height from several centimeters to a few meters. The potential for a seiche impacting the property is considered to be non-existent.

3.5.4 <u>Tsunami</u>

A tsunami is a great sea wave produced by a submarine earthquake or volcanic eruption. It is characterized by great speed of propagation and low observable amplitude on the open sea but can attain heights of up to 30 meters upon encountering shallow water. Significant damage can occur along coastal areas subjected to such a wave. Due to the site's distance from the coastline, a tsunami is not considered to pose a hazard.

3.5.5 <u>Seismic Ground Motions</u>

Southern California is a tectonically active region. Several faults in Southern California serve to alleviate stresses in the earth's crust that result from differential movements between the Pacific and North American Plates. A fault map (Figure D-2 in Appendix D) compiled by the CDMG in 1994 shows the known faults in this region.

The type or severity of seismic hazards affecting the site is chiefly dependent upon the distance to the causative fault, the intensity of the seismic event, and the soil characteristics. The seismic hazard may be primary, such as surface rupture and/or ground shaking, or secondary, such as liquefaction or dynamic settlement.

Seismic hazard maps of the area generated from the Seismic Hazard Evaluation of the Orange 7.5 Minute Quadrangle (Revised 2001), delineate contours of peak ground acceleration with 10% probability of Exceedence in fifty years for firm and soft rock conditions as well as for alluvium. For the subject site, values for alluvium would apply. The report indicates that the corresponding peak ground acceleration level under the proposed site is 0.37 for alluvium soil conditions. However, these published accelerations do not account for the San Joaquin Hills Blind Thrust Fault.

A probabilistic seismic hazard analysis of the site was performed using FRISKSP software (R. Blake, 1994-2000). We selected Boore (1997), Campbell and Bozognia (1997 Rev.), and Sadigh et al. (1997) attenuation relationships for alluvium-type condition considering the Design-Basis Earthquake (DBE) Ground Motion (10% probability if Exceedence in 50 years). These levels of ground motion correspond to a return period of approximately 475 years. The following discussion presents the accelerations calculated using an unpublished model of the San Joaquin Hills Blind Thrust Fault.

An average peak ground acceleration for the site was calculated, using the attenuation relationships listed above. The FRISK analysis resulted in an acceleration of 0.37g for the DBE with the postulated San Joaquin Hills Thrust Fault included. Included in Appendix D is the complete seismic analysis.

4.0 MATERIAL PROPERTIES

Presented herein is a general discussion of the analytic methods utilized in this report and the geotechnical properties of the various soil types and earth materials as summarized from the referenced reports.

4.1 Excavation Characteristics

Based on the subsurface exploration data, it is our opinion that on-site materials can be excavated with conventional earth moving equipment.

4.2 Compressibility

The on-site materials that are compressible include shallow alluvium and undocumented artificial fill. Compressible materials will require removal from fill areas prior to placement of fill and where exposed at grade in cut areas within the building area. Recommended removal depths are presented in Section 5.1.

4.3 Shear Strength

Shear strength tests were conducted on remolded samples as part of the laboratory testing for the current investigation. In addition, shear strength testing was conducted on samples of undisturbed alluvium during a previous investigation by Group Delta. The shear strength test results are reported in Table 4-1 below.

TABLE 4-1
SHEAR STRENGTH PARAMETERS

Material	Ultimate Strength	
	Cohesion, C (psf)	Friction Angle, ϕ (degrees)
Compacted Fill	400	32
Alluvium (In-situ)	450*	23*

* Strengths reported by Group Delta in their investigation

4.4 Expansion Potential

According to the results of tests presented in Appendix B, the expansion potential of the on-site materials is "low" when tested in accordance with UBC Standard 18-2 and classified in accordance with Table 18-I-B of the 1997 UBC. Test results from previous investigations indicated that the expansion potential of on-site materials varied from "low" to "medium" (Geocon, 2000, and Group Delta, 2001).

Foundation design recommendations presented in this report assume that the as-graded soils affecting the foundation will also be classified as "low" to "medium" in expansion potential. Further testing should be conducted during and upon completion of the grading operations to confirm the assumptions stated above or to modify the design recommendations accordingly.

4.5 Earthwork Adjustments

The following average earthwork adjustment factors are presented in the following table:

TABLE 4-2 EARTHWORK ADJUSTMENTS	
Geologic Unit	**Recommended Adjustment**
Undocumented Artificial Fill, Alluvium	10% shrinkage

The values may be used in an effort to balance the earthwork quantities. As is the case with every project, contingencies should be made to adjust the earthwork balance when grading is in-progress and actual conditions are better defined.

4.6 Chemical Analyses

The on-site soils are classified as having a "negligible" soluble sulfate exposure effect on concrete when classified in accordance with Table 19-A-4 of the 1997 UBC. Based upon these test results, sulfate resistant concrete is not necessary by current Code and/or industry standards. However, since sulfates may be introduced into the soil in the future, the use of sulfate resistant concrete should be considered.

The resistivity of onsite soils indicates that these soils are "corrosive" in nature with respect to ferrous metals. It is the opinion of PSE that plastic pipes or non-ferrous conduits should be utilized for underground utilities at the subject site. Consideration should be given to consulting with a Corrosion Engineer for a more comprehensive evaluation.

Upon completion of grading, samples should be collected and tested. Final recommendations should be based on the results of those tests.

5.0 EARTHWORK CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our geotechnical study, it is PSE's opinion that the subject site is suitable for the proposed development, provided the recommendations presented herein, and in supplemental reports are incorporated into the design and construction of the proposed development.

5.1 <u>Site Preparation and Removals</u>

All grading shall be accomplished under the observation and testing of the project geotechnical engineer and engineering geologist in accordance with the recommendations contained herein, the current **<u>Grading Code</u>** of the City of Santa Ana and this firm's **<u>Earthwork Specifications</u>** (Appendix E).

Highly compressible alluvium (Qal) and undocumented artificial fill (af) should be removed from fill areas prior to placement of fill and should be removed from shallow cut areas where exposed at finish grades. Guidelines to determine the depth of removals are presented below; however, the exact extent of the removals must be determined in the field during grading, when observation and evaluation of the greater detail afforded by those exposures can be performed by the geotechnical engineer and/or engineering geologist.

The bottoms of all removal areas should be observed, mapped and approved by the engineering geologist and City representatives (as required) prior to fill placement.

5.1.1 <u>Stripping</u>

Vegetation, debris, and other deleterious materials are unsuitable as structural fill material and <u>should be disposed of off-site</u> prior to commencing removals and placement of compacted fills. Organic debris such as root concentrations should be expected over most of the site, especially along the western and southern boundaries of the site, where several trees were located as part of the previous development. All heavy concentrations of roots, even in proposed parking areas, should be removed. Handpicking of roots and other deleterious materials may be necessary during fill operations.

5.1.2 Undocumented Artificial Fill

All existing artificial fills should be removed prior to fill placement. These fills are estimated to range in depth from 2 to 5 feet along the northeastern boundary of the site, and up to 2 feet elsewhere, but may be deeper in localized areas. Removals should extend below all undocumented fills until competent older alluvium is encountered.

5.1.3 Alluvium and Topsoil

PSE recommends that all topsoil and highly compressible alluvial soils be removed to expose competent alluvial deposits. Based on observations in the test pits, it is estimated that the upper 1 to 4 feet will require removal. Some areas may require deeper removals based on conditions exposed during grading. In general, onsite soils are suitable to be re-used as structural fill when properly moisture conditioned.

5.1.4 Removals Adjacent to Property Boundaries

Removals of unsuitable soils will be required below fills and shallow cut areas adjacent to the property line. Where possible, a 1:1 projection from the outside edge of grading to competent materials should be established. Where this is not possible due to property line restrictions or existing improvements, removals should be initiated at a distance of 2 feet from the existing improvements and at a 1:1 ratio inward to competent materials. Where these reduced removal criteria are implemented, a "restricted use" zone may be necessary. Possible "restricted use" zones may occur along the western and southern boundaries of the property. Structures located within these zones, such as perimeter walls, will be subject to special foundation recommendations, provided in Section 7.7.

5.1.5 Overexcavation of Building Areas

Building areas should be overexcavated a minimum of five (5) feet below pad grades extending to five (5) feet outside the perimeter footing. Where exterior continuous footings and interior spread and column footings are to be located, a minimum of three (3) feet of compacted fill shall be provided below the bottom of the footing. The geotechnical consultant should map as-graded conditions.

5.1.6 Overexcavation of Street and Parking Areas

Street and parking areas should be overexcavated a minimum of two (2) feet below proposed subgrades.

5.1.7 Overexcavation of Common Areas and Parks

Non-structural areas such as common areas and parks should be overexcavated a minimum of two (2) feet below proposed grades. Structures such as retaining walls, and perimeter walls located within these areas are subject to special foundation recommendations, provided in Section 7.7. To avoid designing improvements for these special design recommendations, consideration should be given performing overexcavations as recommended in Section 5.1.5.

6.0 EARTHWORK CONSIDERATIONS

6.1 Compaction Standards

All fill and processed natural ground should be compacted to a minimum relative compaction of 90 percent, as determined by ASTM Test Method: D-1557-91. Compaction shall be achieved at slightly above the optimum moisture content, and as generally discussed in the attached **"Earthwork Specifications"**.

Compaction shall be achieved with the use of sheepsfoot rollers or similar kneading type equipment. Mixing and moisture conditioning will be required in order to achieve the required moisture conditions.

6.2 Observation

All removal bottoms should be observed and approved by the engineering geologist and/or geotechnical engineer prior to fill placement.

6.3 Treatment of Removal Bottoms

At the completion of unsuitable soil removals, the exposed bottom should be scarified to a minimum depth of eight inches, moisture-conditioned to above optimum conditions, and compacted in-place to the standards set forth in this report.

6.4 Fill Placement

After removals, scarification, and compaction of in-place materials are completed, additional fill may be placed. Fill should be placed in thin lifts (8-inch bulk), moisture conditioned to slightly above optimum, compacted and tested as grading progresses until final grades are attained.

6.5 Mixing

In order to prevent layering of different soil types and/or different moisture contents, mixing of materials may be necessary. The mixing should be accomplished prior to and as part of compaction of each fill lift. Discing may be required when either excessively dry or wet materials are encountered.

6.6 Benching

Where the existing slope is steeper than 5-horizontal to 1-vertical and where designated by the project geotechnical engineer or geologist, compacted fill material shall be keyed and benched into competent natural soil

6.7 Oversized Materials

Although not encountered during the subsurface investigation, materials greater than 8-inches will be unsuitable for use in shallow (less than 13-feet) fills or within the depth of the deepest utility (whichever is greater). Oversized materials (material larger than 8-inches), may be crushed, or disposed of off-site.

6.8 Geofabric and Asphalt Associated with Demolition of Previous Parking Lot

Numerous pieces of geotechnical fabric mixed with crushed asphalt associated with demolition of the exiting parking lot were encountered at the site, generally within approximately 6 inches of the surface. From a geotechnical perspective, PSE does not object to incorporating this material into fill due to the limited quantities of this material. However, from an aesthetic perspective, the presence of this material in the compacted fill may not be appealing to homeowners; therefore, it is recommended that this material be stockpiled and incorporated into compacted fill placed within the street areas.

6.9 Crushed Concrete

The crushed concrete associated with the demolition of previous improvements on the site may either be used as crushed miscellaneous base (CMB), provided the material meets the gradation and durability requirements for CMB, or may be incorporated into compacted fill. However, if this material is incorporated into the compacted fill, its placement should be limited to depths greater than three feet below the finished grade in building areas. In street area no hold down depths are required for the crushed concrete.

6.10 Import Soils

Import soils should consist of clean, structural quality, compactible materials similar to the on-site soils and should be free of trash, debris or other objectionable materials.

PLANS AND SPECIFICATIONS SHOULD INDICATE THAT THE GRADING CONTRACTOR SHALL NOTIFY THE PROJECT GEOTECHNICAL ENGINEER NOT LESS THAN 72 HOURS IN ADVANCE OF THE LOCATION OF ANY SOILS PROPOSED FOR IMPORT. EACH PROPOSED IMPORT SOURCE SHALL BE SAMPLED, TESTED AND APPROVED PRIOR TO DELIVERY OF SOILS FOR USE ON THE SITE.

7.0 DESIGN RECOMMENDATIONS

7.1 Structural Design

According to the Rough Grading Plan for Tentative Tract No. 16187, the subject site will be utilized to construct 36 single-family residences with infrastructure improvements, including a 21-foot high sound wall adjacent to the freeway. Changes to the Rough Grading Plan should be evaluated by the Geotechnical Engineer of Record.

Based on the results of tests performed during this and previous investigations, the expansion potential of the on-site materials ranges from "low" to "medium" when classified in accordance with Table 18-I-B of the 1997 UBC. For fill composed of the on-site materials and graded in accordance with the recommendations presented in this report, support of the proposed improvements on spread and continuous footings is considered acceptable from the geotechnical point of view. Upon the completion of grading, pad subgrade samples should be collected and tested to provide specific recommendations. These test results and corresponding design recommendations will be presented in the Final Rough Grading Report. Final foundation design recommendations should be made based upon specific loading conditions and as-graded soil conditions. For preliminary budgeting purposes the following foundation design recommendations are presented, based upon an anticipated "low" to "medium" expansion potential.

7.1.1 Conventional Slab/Foundation Design Recommendations

The following minimum design recommendations are submitted for conventional shallow foundations and slabs in consideration of the expansion potential of the site soils. Conventional slab/foundations may be designed based on the anticipated "low" to "medium" expansion potential.

➢ Allowable bearing:	2,000 psf, based on a minimum depth width and depth. The bearing capacity can be increased by 250 psf for every foot of embedment depth and/or width to a maximum of 2,500 psf.
➢ Lateral Bearing:	300 psf/foot of depth to a maximum of 2,500 psf. These values assume a level condition at the toe.
➢ Sliding Coefficient:	0.30
➢ Minimum Embedment Depth:	18-inches from lowest adjacent grade within five (5 feet).
➢ Minimum Footing Width:	12-inches for continuous footings and 24-inches for isolated spread footings
➢ Minimum Footing Reinforcement (Exterior and Interior)	All continuous; four (4) No. 4 bars, two (2) near the top, and two (2) near the bottom.
➢ Minimum Slab Reinforcement:	No. 3 bars, at 18 inches on center each way.
➢ Minimum Slab Thickness:	4-inches (actual)
➢ Slab Subgrade Moisture:	Minimum of 120% of optimum moisture to a depth of 12 inches immediately prior to placing concrete.

The above values may be increased as allowed by Code to resist transient loads such as wind or seismic. Building code and structural design considerations may govern depth and reinforcement requirements and should be evaluated.

7.1.2 Preliminary Design Recommendations Post-Tensioned Mat Slab Foundation

It is our understanding that Shea Homes is considering utilizing thicker "mat"-type post-tensioned slab foundations for the subject project. As such, the following foundation design recommendations are presented for implementation by the slab designer when post-tensioned slab/foundation systems based on Sections 1816 and 1817 of the 1997 UBC are utilized for the buildings. Final recommendations will be provided on a lot-by-lot basis upon completion of grading.

The selection of methods used by the structural engineer for the design and analysis of the post-tensioned slab is outside the area of expertise of Pacific Soils Engineering, Inc. It is the responsibility of the post-tensioned slab designer to select the appropriate design methodology and properly design the foundation system for the soil conditions indicated herein. The slab designer should provide deflection potential to the architect and/or structural engineer for incorporation into the design of the structures.

The post-tensioned slab design parameters presented herein are based on output from VOLFLOW, a computer code that performs volume change and flow calculations for expansive soils. The code was developed in the early 1980's at Texas A&M and is distributed by the Post-Tensioning Institutes for use in conjunction with its PTSLAB program.

POST TENSION DESIGN PARAMETERS		
Expansion Potential	**"Very Low" to "Low"**	**"Medium"**
Minimum Edge Depth (inches)	12*	12*
Edge Moisture Variation (ft.) @ Edge lift, Em= @ Centerlift Em=	~3.25 ~5.00	~3.50 ~5.50
Differential Swell (inches)		
@ Edge lift Ym=	~.46	~0.65
@Centerlift Ym=	~1.67	~2.75
Slab Subgrade Moisture	120% of optimum moisture content to a depth of 12 inches.	140% of optimum moisture content to a depth of 12 inches.

The values of predicted lift presented in this table are based on Volflow Computer Code with corrections for vertical barriers at edge of slab as indicated. No other corrections (such as tree roots under the slab or horizontal barriers) are assumed. The design parameters are based on an assumed depth to Constant Suction of 7 feet, a Constant Suction Value of 3.6 pF, a Velocity of Moisture Flow of 0.7 in/month, no volume correction, a Velocity Distribution Factor of 0.5, and a Lateral Earth Pressure Coefficient of 0.67.

* 12-inch embedment depth may only be used if a "mat" type slab is constructed. Embedment depth can be measured from ultimate grade.

Provisions should be incorporated into the design and construction to minimize the moisture variation below the improvements. Such design, construction, and homeowner maintenance provisions may include:

- Establishing and maintaining positive drainage away from all foundations, walkways, driveways, patios and other hardscape improvements.
- Avoiding the construction of raised planters adjacent to structural improvements. Alternatively, raised planter side/bottoms can be sealed with an impermeable membrane and drained away from the improvements via subdrains into approved disposal areas.
- Sealing and maintaining construction/control joints within concrete slabs and walkways to reduce the potential for moisture infiltration into the subgrade soils.
- Utilizing landscaping schemes with vegetation that requires minimal watering. Alternatively, watering should be done in a uniform manner as equally as possible on all sides of the foundation, keeping soils "moist" but not allowing the soil to become saturated.

- Avoiding the placement of trees closer to the proposed structures than the distance of one-half the mature tree height.
- Observing the soils conditions around the perimeter of the structure during extremely dry/hot or unusually wet weather conditions so that modifications can be made to the irrigation programs to maintain relatively constant moisture conditions.

A detailed description of the recommended maintenance practices is presented in the Homeowners Maintenance and Improvement Considerations Manual (Appendix F).

7.2 Moisture and Vapor Retarding System

A moisture and vapor retarding system should be placed below all slabs-on-grade in living areas and other portions of the structures considered moisture sensitive. The retarder should be of suitable composition, thickness, strength and low permeability to effectively prevent the migration of water and reduce the transmission of water vapor to acceptable levels. Historically, a 10-mil plastic membrane, such as Visqueen placed between 2 to 4 inches of clean sand, has been used for this purpose. The use of this system or other systems, materials, or techniques can be considered, at the discretion of the designer, provided the system reduces the vapor transmission rates to acceptable levels.

7.3 Footing Excavations

Footing excavations for the building structures should be observed by a representative of the project Geotechnical Engineer of Record prior to the placement of forms and or steel. The excavations should be free of all loose and sloughed material at the time of concrete placement.

7.4 Deep Foundation Design Recommendations

According to the Rough Grading Plan, it is proposed to found the sound wall on 18-inch diameter caissons. The passive resistance to be used in the design should be 350 psf/foot to a maximum of 4,000 psf. Lateral bearing of the upper two feet should be ignored. Axial (vertical) load capacity of the drilled piles may be estimated using the attached Figure 2.

7.5 Settlement from Structural Loads

For foundations designed based on the above values and founded on the improved soils as recommended herein, total settlements under structural loads should be less than 1-inch and differential settlements under structural loads should be less than ½-inch across 20 feet.

7.6 Retaining Wall Design

On-site soils are generally "low" to "medium" in expansion potential when tested and classified in accordance with 1997 UBC Standard 18-2 and Table 18-I-B. Retaining walls should be founded on a minimum of three feet of compacted fill and the foundations may be designed in accordance with the recommendations presented in Section 7.1.1. Due to property line restrictions and existing improvements, some retaining walls located along the perimeter of the site may not be founded on a minimum of three feet of compacted fill. The foundations of these retaining walls may be designed in accordance with the recommendations presented in Section 7.7.

Unrestrained retaining walls, free to rotate at least 0.001 radians, may be designed to resist lateral pressures imposed by a fluid with a unit weight determined in accordance with Table 7-2. The table also presents design parameters for restrained retaining walls. These parameters may be used to design retaining walls that may be considered as restrained due to the method of construction or location (corner sections of unrestrained retaining walls). Retaining walls should be designed to resist lateral forces determined in accordance with the following figures and Table.

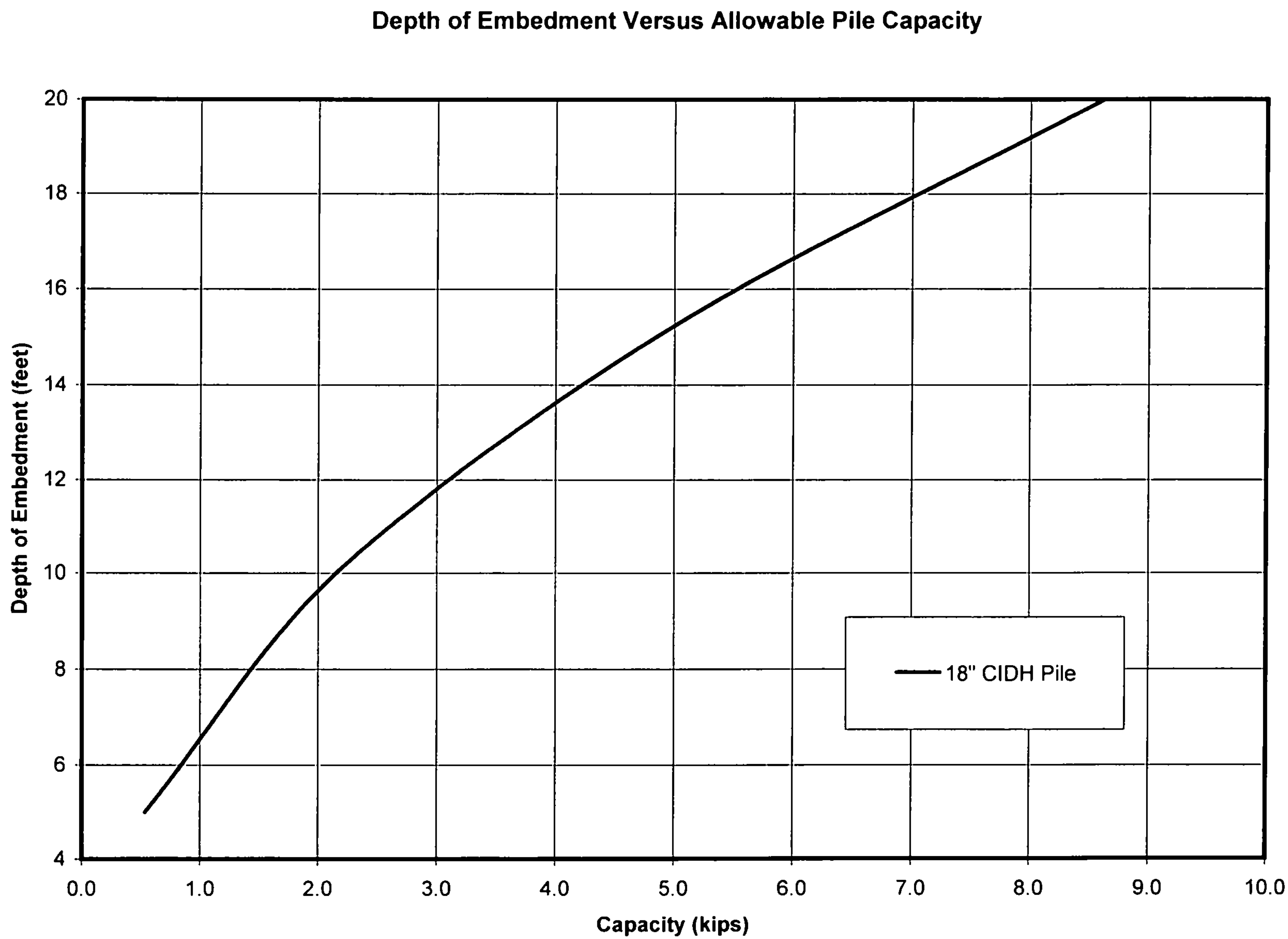
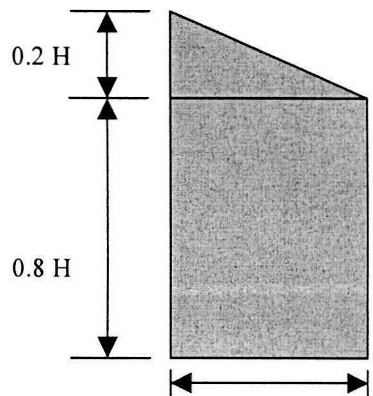
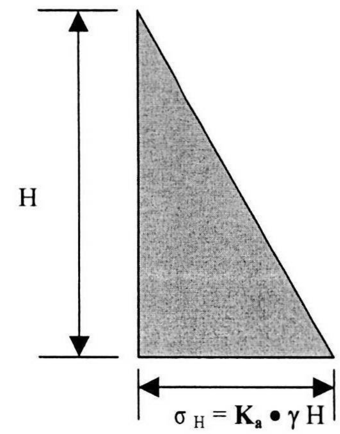


Figure 2- Drilled Pile Frictional Capacity



$\sigma_H = CH$
Restrained/Braced Walls



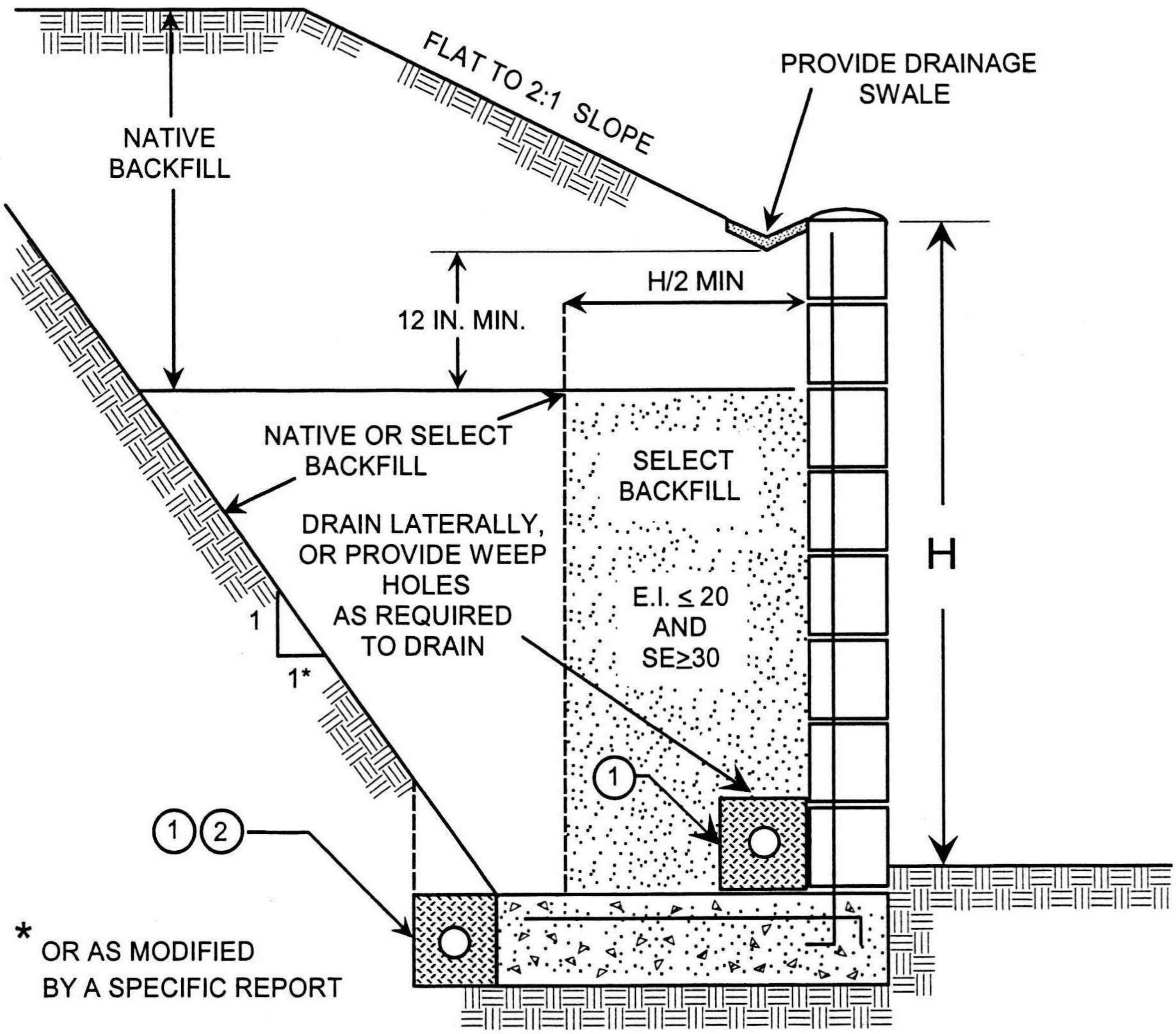
$\sigma_H = \mathbf{K_a} \bullet \gamma H$
Unrestrained Walls

TABLE 7-2 RETAINING WALL DESIGN PARAMETERS				
Slope of Retained Material (Horizontal:Vertical)	**Unrestrained, $K_a \bullet \gamma$ (pcf)**		**Restrained, C (pcf)**	
	Native Backfill	**Select Backfill**	**Native Backfill**	**Select Backfill**
Level	46	36	32	26

- The design loads presented in the above table are to be applied on the retaining wall in a horizontal fashion and as such friction between wall and retained soils should not be allowed in the retaining wall analyses.
- Additional allowances should be made in the retaining wall design to account for the influence of construction loads, temporary loads, and possible nearby structural loads.
- Unit weights of 115 pcf and 130 pcf may be used to model the dry and wet unit weight of on-site compacted fill materials.
- Select backfill should be granular, structural quality backfill with a Sand Equivalent of 30 or better and an ASCE Expansion Index of 20 or less. The select backfill must extend at least one-half the wall height behind the wall; otherwise, the values presented in the **Native Backfill** columns must be used for the design. Native backfill should have an ASCE Expansion Index of 50 or less. The upper one-foot of backfill should be comprised of native on-site soils. The recommended retaining wall backfill and drain system profile is shown on Plate A.

RETAINING WALL BACKFILL

N.T.S.



* OR AS MODIFIED BY A SPECIFIC REPORT

(1) 4 INCH PERFORATED PVC, SCHEDULE 40, SDR 35 OR APPROVED ALTERNATE, PLACE PERFORATIONS DOWN AND SURROUND WITH 1 CU. FT. PER FT. OF 3/4 INCH ROCK OR APPROVED ALTERNATE AND MIRAFI 140 FILTER FABRIC OR APPROVED EQUIVALENT

(2) OPTIONAL - PLACE DRAIN AS SHOWN WHERE MOISTURE MIGRATION IS UNDESIRABLE

PLATE A

PACIFIC SOILS ENGINEERING, INC
3002 DOW AVENUE, SUITE 514, TUSTIN CALIFORNIA 92780

VER. 4/00

- As a minimum, a 1-foot wide zone of select backfill should be placed behind the wall to provide drainage. Otherwise, the wall design should include the potential for hydrostatic forces to develop behind the wall.

- Retaining wall designs should include waterproofing (where appropriate) and backdrains or weep holes for relieving possible hydrostatic pressures. The backdrain should be comprised of a 4-inch perforated PVC pipe in a 1 ft. by 1 ft., ¾-inch gravel matrix, wrapped with a geofabric. The backdrain should be installed with a minimum gradient of 2 percent and should be outletted to an appropriate location.

7.7 Seismic Design Parameters

Presented in the table below are the Simple Prescribed Parameter Values (SPPV) for the proposed project, as determined in accordance with the 1997 Uniform Building Code.

TABLE 7-3
SEISMIC DESIGN PARAMETERS

Seismic Parameter	Recommended Value	UBC – 1997 Chapter 16 Table No.
Seismic Zone Factor (Z)	0.4	16-I
Soil Profile Type	S_D	16–J
Seismic Coefficient (C_a)	0.44	16-Q
Seismic Coefficient (C_v)	0.64	16-R
Near-Source Factors (N_a)	1.0	16-S
Near-Source Factors (N_v)	1.0	16-T
Seismic Source Type Newport-Inglewood (L.A. Basin) **Distance: ~16 kilometers**	B	16-U

7.8 Perimeter Walls and Walls Located Within Nonstructural Fill Areas

Retaining walls located along the perimeter of the project and walls located within non-structural fill areas, such as common areas, should incorporate the following considerations into their design and construction.

Based on our understanding the site will be mass graded prior to the construction of the perimeter walls. The recommended unsuitable soil removals, as presented in Section 5.1.4, should be initiated roughly two (2) horizontal feet from existing improvements along the property line and extend at a 1:1 (Horizontal:Vertical) down to the removal bottom. This removal procedure will aid in reducing the impact on the adjacent improvements during mass grading operations. It is anticipated that during subsequent onsite construction operations, the existing walls that are present on the westerly and southerly boundaries of the project will be demolished and replaced with new block walls. Soils that are disturbed during the demolition of the existing walls should be moisture conditioned, and compacted to a minimum of 90 percent relative compaction as determined in accordance with ASTM Test Method D:1557-91. Considering the (limited) removal procedures outlined above, combined with the unknown characteristics of the soils offsite, the following recommendations pertaining to the design of the perimeter retaining walls are presented. These recommendations are applicable to walls where three feet of compacted fill is not placed beneath the footings, such as walls located in common areas.

- Allowable Bearing: 1,000 psf, based on a minimum width of 12-inches.
- Lateral Bearing: 100 psf per foot of depth to a maximum of 1,000 psf. These values assume a level condition.
- Sliding Coefficient: 0.30
- Minimum Embedment Depth: 18 inches
- Minimum Foundation Reinforcement: All continuous; four (4) No. 4 bars, two (2) near the top, and two (2) near the bottom

The above values may be increased as allowed by Code to resist transient loads such as wind or seismic forces.

Perimeter retaining walls should be designed to resist lateral forces determined in accordance with the figures and table presented in Section 7.5. Due to the location of the walls along the property line, it may not be possible to place select backfill a distance of one-half the wall height behind the wall. In those cases where select backfill cannot/does not extend at least one-half the wall height behind the wall; then the values presented in the Native Backfill columns must be used for the design.

Other design and construction recommendations presented above for the interior retaining walls apply, unless specifically superceded in this section.

7.9 Exterior Flatwork

The minimum thickness of all exterior concrete should be 4 inches (actual). Subgrade soils should contain at least 125 percent of the optimum moisture content to a depth of 12-inches immediately prior to placing concrete. The need for reinforcement and doweling of exterior flatwork areas, raised porches and stairways should be evaluated by the structural engineer. Control joints should be provided at a minimum spacing of 10± ft.

7.10 Utility Trench Excavation and Backfill

All utility trenches should be shored or laid back in accordance with applicable OSHA standards. Mainline and lateral utility trench backfill should be compacted to at least 90 percent of maximum laboratory dry density as determined in accordance with ASTM Test Method: D 1557-91. On-site soils may not be suitable for use as bedding materials but will be suitable for use in backfill.

Compaction should be accomplished by mechanical means. Jetting of native soils will not be acceptable. Under-slab trenches should also be compacted to project specifications. If native soils are used, mechanical compaction is recommended. The geotechnical engineer should be notified for observation and testing prior to placement of the membrane and slab reinforcement.

It is suggested that the utility trenches be backfilled with concrete slurry where they intercept the perimeter footings (under the footing) to reduce the potential for moisture migration below the slab area.

7.11 Chemical Analyses

Chemical and corrosivity testing should be performed on selected samples during and after the conclusion of grading. Previous testing of site soils indicates "negligible" sulfate concentrations when classified in accordance with Table 19-A-4 of the Uniform Building Code. Based on laboratory test results the on-site soils should be considered "corrosive" towards ferrous metals.

7.12 Pavement Design

Testing of subgrade soils should be performed once driveway subgrades are achieved to determine the actual R-Value of the subgrade soils. For preliminary budgeting purposes, using an assumed R-Value of 10 and a range of traffic indices, estimated pavement structural sections are presented in Table 7-4.

TABLE 7-4
RECOMMENDED PAVEMENT SECTIONS

Traffic Index	Pavement Section
4.0	3 in. AC over 6 in. AB or CMB
4.5	3 in. AC over 8 in. AB or CMB
5.0	3 in. AC over 9 in. AB or CMB
5.5	3 in. AC over 11 in. AB or CMB
6.0	4 in. AC over 11 in. AB or CMB

AC = Asphalt Concrete
AB = Caltrans Class 2 Aggregate Base
CMB = Crushed Miscellaneous Base

Subgrade soils should be compacted to at least 90 percent of the laboratory maximum dry density as determined by ASTM Test Method: D 1557-91. Base materials should be compacted to at least 95 percent of the laboratory maximum dry density as determined by ASTM Test Method: D 1557-91.

7.13 Concrete Pavers

The plans indicate that concrete pavers are proposed for streets within the subject tract. Historically paver systems have experienced failures in areas where water has degraded the subgrade soils. Since paver systems are permeable and allow transmission of water through their joints and into the subgrade, it may be prudent to discuss with the paver designer/manufacture what methods may be employed to address the issue of potential water introduction in the subgrade soils. Under-drain systems, local subgrade reinforcement, or additional structural elements can be considered, particularly in high traffic areas and/or low areas where water will tend to collect. The recommendations of the designer/manufacturer should then be implemented into the design and construction of the paver system.

In lieu of the above, concrete pavers may be underlain by a minimum of one (1) inch of bedding sand, placed on six (6) inches of concrete over a minimum of 12 inches of compacted (fill) subgrade soils. Subgrade soils should be near optimum moisture content and be compacted to a minimum of 90 percent of the laboratory maximum density as determined in accordance with ASTM Test Method: D 1557-91 prior to placement of concrete.

7.14 Site Drainage

Final site grading should assure positive drainage away from structures. Planter areas should be provided with area drains to transmit irrigation and rain water away from structures. The use of gutters and down spouts to carry roof drainage well away from structures is recommended. Raised planters should be provided with a positive means to remove water through the face of the containment wall.

8.0 CLOSURE

8.1 Geotechnical Review

As is the case in any grading project, multiple working hypotheses are established utilizing the available data and the most probable model is used for the analysis.

Information collected during the grading operations is intended to evaluate the hypothesis and some of the assumptions summarized herein may need to be changed as more information becomes available. Some modification of the grading recommendations may become necessary, should the conditions encountered in the field differ significantly than those hypothesized to exist.

Pacific Soils Engineering, Inc. should review the pertinent plans and sections of the project specifications, to evaluate conformance with the intent of the recommendations contained in this report.

If the project description or final design varies from that described in this report, Pacific Soils Engineering, Inc., must be consulted regarding the applicability of, and the necessity for, any revisions to the recommendations presented herein. Pacific Soils Engineering, Inc., accepts no liability for any use of its recommendations if the project description or final design varies and Pacific Soils Engineering, Inc., is not consulted regarding the changes.

8.2 Limitations

This report is based on the project as indicated on the Rough Grading Plan for Tentative Tract No. 16187 and the information obtained from the borings at the approximate locations indicated on the plans. The findings are based on the results of the field, laboratory, and office investigations combined with an interpolation and extrapolation or conditions between and beyond the boring locations. The results reflect an interpretation of the direct evidence obtained. Services performed by Pacific Soils Engineering, Inc., have been conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, either expressed or implied, and no warranty or guarantee is included or intended.

The recommendations presented in this report are based on the assumption that an appropriate level of field review will be provided by geotechnical engineers and engineering geologists who are familiar with the design and site geologic conditions. That field review shall be sufficient to confirm that geotechnical and geologic conditions exposed during grading are consistent with the geologic representations and corresponding recommendations presented in this report. Pacific Soils Engineering, Inc., should be notified of any pertinent changes in the project plans or if subsurface conditions are found to vary from those described herein. Such changes or variations may require a re-evaluation of the recommendations contained in this report.

The data, opinions, and recommendations of this report are applicable to the specific design of this project as discussed in this report. They have no applicability to any other project or to any other location and any and all subsequent users accept any and all liability resulting from any use or reuse of the data, opinions, and recommendations without the prior written consent of Pacific Soils Engineering, Inc.

Pacific Soils Engineering, Inc., has no responsibility for construction means, methods, techniques, sequences, or procedures, or for safety precautions or programs in connection with the construction, for the acts or omissions of the CONTRACTOR, or any other person performing any of the construction, or for the failure of any of them to carry out the construction in accordance with the final design drawings and specifications.

10.0 REFERENCES

1. Geotechnical/Foundation Investigation, Proposed New Elementary No. 4 - Loren Griset Elementary, Santa Ana Unified School District, 2800 North Farmers Avenue, Santa Ana, California, by Group Delta Consultants, Inc., dated July 16, 2001 (Project No. I-283).

2. Preliminary Draft, Preliminary Environmental Assessment (PEA), Proposed Loren Griset New Elementary School #4 (a.k.a. Farmers Site), Santa Ana Unified School District; by ENSR International dated September 28, 2001 (Document No. 6052-01-400).

3. Division of Mines and Geology, 1997, Fault Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act, Special Publication 42.

4. California Department of Conservation, Division of Mines and Geology; Seismic Hazard Zone Report, for the Orange 7.5-Minute Quadrangle, Orange County, California, 1997 (Revised 2001).

APPENDIX A

SUBSURFACE INVESTIGATION

APPENDIX A

Subsurface Investigation

A rubber tire backhoe with a 24-inch bucket was used to excavate eleven (11) test pits on April 6, 2005, to depths ranging from 5 to 10.5 feet below existing grades. The approximate locations of the exploratory borings are shown on the accompanying Plates 1 and 2 and the Logs of Test Pits are attached.

Representative bulk soil samples were obtained and transported to PSE's laboratory for testing. Laboratory testing procedures and test results are presented in Appendix B of this report.

Work Order	500653
Date Excavated	4/6/05
Excavated by	TMC
Equipment	Rubber Tire Backhoe with 24-inch bucket

TABLE I

LOG OF TEST PITS

Test Pit No.	Depth (ft.)	USCS	Description
T-1	0.0 – 0.5	ML	**TOPSOIL (No Map Symbol):** SANDY SILT, brown, slightly moist, soft, disturbed
	0.5 – 5.0	ML	**ALLUVIUM (Qal):** SANDY SILT, fine-grained SAND, trace GRAVEL, brown, moist, soft to firm, roots @ 5 ft. – CLAY with SAND, brown, moist, soft, some roots TOTAL DEPTH 5 FEET NO GROUNDWATER ENCOUNTERED NO CAVING OBSERVED

Test Pit No.	Depth (ft.)	USCS	Description
T-2	0.0 – 1.0	GM	**ARTIFICIAL FILL (af):** GRAVEL and Crushed Asphalt Concrete, dry
	1.0 – 5.0	ML	**ALLUVIUM (Qal):** SANDY SILT, some CLAY, fine-grained SAND, light brown to brown, moist, soft to firm, some roots TOTAL DEPTH 5 FEET NO GROUNDWATER ENCOUNTERED NO CAVING OBSERVED

Work Order 500653

Test Pit No.	Depth (ft.)	USCS	Description
T-3	0.0 – 2.5	SM	**ARTIFICIAL FILL (af):** SILTY SAND, some GRAVEL, gray brown, slightly moist, loose to moderately dense, several roots
	2.5 – 5.0	ML	**ALLUVIUM (Qal):** SANDY SILT, fine-grained SAND, some CLAY, brown, moist, soft to firm @ 4 ft. – firm
			TOTAL DEPTH 5 FEET NO GROUNDWATER ENCOUNTERED NO CAVING OBSERVED

Test Pit No.	Depth (ft.)	USCS	Description
T-4	0.0 – 1.5	SM	**ARTIFICIAL FILL (af):** SILTY SAND, some GRAVEL, gray brown, slightly moist, loose to moderately dense
	1.5 – 2.0	ML	**ALLUVIUM (Qal):** SANDY SILT, fine-grained SAND, some CLAY, brown, moist, soft to firm, slightly porous, some roots
	2.0 – 5.0	CL	CLAY, with fine-grained SAND, moist, soft to firm, some roots @ 3 ft. – firm
			TOTAL DEPTH 5 FEET NO GROUNDWATER ENCOUNTERED NO CAVING OBSERVED

Test Pit No.	Depth (ft.)	USCS	Description
T-5	0.0 – 2.0	SM	**ARTIFICIAL FILL (af):** SILTY SAND, with GRAVEL, fine to coarse-grained, gray brown, slightly moist, dense
	2.0 – 5.0	CL	**ALLUVIUM (Qal):** CLAY, brown, moist, soft to firm, some roots @ 4 ft. – firm
			TOTAL DEPTH 5 FEET NO GROUNDWATER ENCOUNTERED NO CAVING OBSERVED

Test Pit No.	Depth (ft.)	USCS	Description
T-6	0.0 – 1.5	SM	**ARTIFICIAL FILL (af):** SILTY SAND, with GRAVEL, gray brown, slightly moist, loose to moderately dense, roots
	1.5 – 10.5	ML	**ALLUVIUM (Qal):** SANDY SILT, SOME CLAY, brown, firm, some roots
			TOTAL DEPTH 10.5 FEET NO GROUNDWATER ENCOUNTERED NO CAVING OBSERVED

Test Pit No.	Depth (ft.)	USCS	Description
T-7	0.0 – 1.0	SM	**ARTIFICIAL FILL (af):** SILTY SAND, with GRAVEL, fine to coarse-grained, gray brown, dry to slightly moist, loose to moderately dense
	1.0 – 10.0		**ALLUVIUM (Qal):** SANDY SILT, brown, slightly moist, firm, slightly porous @ 4 ft. – moderately porous, porous to 1/16 inch @ 8 ft. – slightly porous @ 10 ft. – some gravel, slightly mottled
			TOTAL DEPTH 10 FEET NO GROUNDWATER ENCOUNTERED NO CAVING OBSERVED

Test Pit No.	Depth (ft.)	USCS	Description
T-8	0.0 – 5.0	ML	**ALLUVIUM (Qal):** SILT, some CLAY, brown, moist, firm, slightly porous
			TOTAL DEPTH 5 FEET NO GROUNDWATER ENCOUNTERED NO CAVING OBSERVED

Test Pit No.	Depth (ft.)	USCS	Description
T-9	0.0 – 1.0	SM	**ARTIFICIAL FILL (af):** SILTY SAND, with GRAVEL, fine to coarse-grained, gray brown, slightly moist, loose to moderately dense
	1.0 – 6.0	CL	**ALLUVIUM (Qal):** CLAY, some GRAVEL, brown, moist, stiff, slightly porous, pinhole porosity
			TOTAL DEPTH 6 FEET NO GROUNDWATER ENCOUNTERED NO CAVING OBSERVED

Test Pit No.	Depth (ft.)	USCS	Description
T-10	0.0 – 1.0	GM	**ARTIFICIAL FILL (af):** GRAVEL and Crushed Asphalt Concrete, dry
	1.0 – 2.0	SM	SILTY SAND, fine to medium-grained, brown, moist, moderately dense
	2.0 – 6.0	CL	**ALLUVIUM (Qal):** CLAY, brown, moist, soft to firm
	6.0 – 8.0	ML	SILT, brown, moist, soft to firm, pinhole porosity
			TOTAL DEPTH 8 FEET NO GROUNDWATER ENCOUNTERED NO CAVING OBSERVED

Work Order 500653

Test Pit No.	Depth (ft.)	USCS	Description
T-11	0.0 – 1.5	GM	**ARTIFICIAL FILL (af):** GRAVEL and Crushed Asphalt Concrete, dry
	1.5 – 8.0	ML	SILT, some CLAY, slightly mottled, moist, soft, porous @ 5 ft. – slightly porous, pinhole porosity TOTAL DEPTH 8 FEET NO GROUNDWATER ENCOUNTERED NO CAVING OBSERVED

APPENDIX B

LABORATORY DATA

APPENDIX B

Laboratory Data

The results of laboratory testing performed during this study are enclosed within this Appendix. Table B-1 presents a summary of laboratory test results.

The following laboratory tests were performed on representative samples in accordance with the applicable latest standards or methods from the ASTM, Uniform Building Code (UBC) and California Department of Transportation.

Classification

Soils were classified with respect to the Unified Soil Classification System (USCS) in accordance with ASTM D-2487 and D-2488.

Direct Shear Tests

Direct shear tests were performed on two samples that were remolded to approximately 90 percent of the maximum dry density as determined by ASTM Test Method D-1557. Samples were saturated under a surcharge equal to the applied normal force during testing. The apparatus used is in conformance with the requirements outlined in ASTM Test Method: D-3080. The test specimens, 2.5-inches in diameter and 1-inch in height, were subjected to simple shear along a plane at mid-height.

The samples were sheared under various normal loads, a different specimen being used for each normal load. A strain of 0.050-inches per minute was used to evaluate shear strength values.

The specimens were sheared until the shear stress reached a constant value or until the sample deformation had reached approximately 10 percent of the original diameter.

The shear stress values obtained from the tests were plotted versus the applied normal pressures. The best-fitting straight lines were drawn through the plotted points to obtain the shear strength envelopes. The cohesion and angle of internal friction of the soil materials were evaluated from the shear strength envelopes. The direct shear test results are shown on Plate B-1.

Maximum Density/Optimum Moisture

The maximum dry density and optimum moisture content of a selected representative bulk sample were evaluated in accordance with ASTM D-1557-91/Method A. The results of this test are summarized in Table B-1.

Particle Size Analysis

Modified hydrometer portions of ASTM D 2442-72 were conducted to aid in classification of the soils. The results of the particle size analysis are presented in Table B-1.

Expansion Index Tests

An Expansion Index test was performed to evaluate the expansion potential of typical on-site soils. Testing was carried out according to UBC Method 18-2. The results are presented in Table B-1.

Chemical Analyses

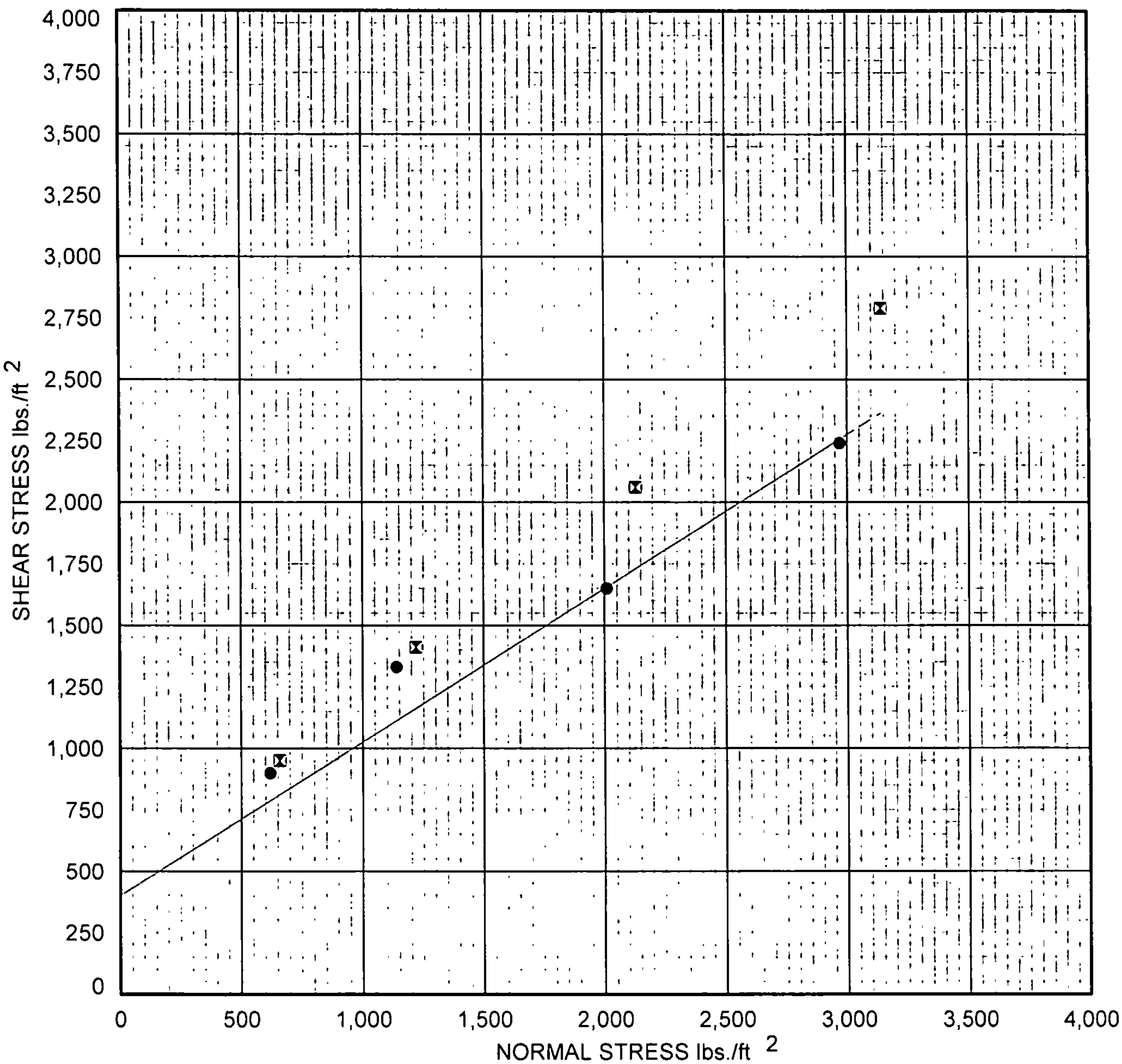
Resistivity and pH testing was performed by PSE to evaluate the corrosivity characteristics of on-site materials in accordance with ASTM Test Method G57. The sulfate content of selected samples was evaluated by KYH Co., Analytical Laboratory. The results of these tests are included in the following table.

CHEMICAL TEST RESULTS			
Sample	**Sulfate Content (% wt)***	**pH**	**Resistivity (ohm-cm)**
T-9 @ 1-3 feet	0.004	6.9	1,770
T-10 @ 7-8 feet	< 0.001	7.1	1,800
*Sulfate Content and Chloride Content tests by KYH Co. Analytical Laboratory, Santa Ana, California			

TABLE B-1
SUMMARY OF LABORATORY TEST DATA
W.O. 500653

BORING	DEPTH (FEET)	SOIL DESCRIPTION	GROUP SYMBOL	MAXIMUM DENSITY (PCF)	OPTIMUM MOISTURE CONTENT (%)	DIRECT SHEAR	PLUS NO.4 SEIVE (plus 4.76mm) (%)	SAND (4.76mm-0.075mm) (%)	SILT (0.075mm-0.005mm) (%)	CLAY (minus 0.005mm) (%)	EXPANSION INDEX UBC 18-2	OTHER TESTS REMARKS
T-10	7	Sandy Clay	CL	120.2	11.8	SEE PLATE B-1	0	15	53	32	31	
T-9	1	Sandy Silt	ML	129.8	9.1	SEE PLATE B-1	0	46	33	21	21	

DIRECT SHEAR TEST
Remolded at 90% Relative Compaction - Residual Strength



TYPICAL NAME: Remolded Samples	COHESION 400 psf.
GROUP SYMBOL:	FRICTION ANGLE 32 degrees

symbol	boring	depth	symbol	boring	depth	symbol	boring	depth	symbol	boring	depth
●	T-10	7.0	⊗			◆			✳		
⧗	T-9	1.0	⊕			◇			◘		
▲			□			×			◙		
★			⊖			✖			≡		
✕			◕			▣			◫		
✪			☆								
○			✿								
△			■								

PACIFIC SOILS ENGINEERING, INC.

W.O. 500653 PLATE B-1

APPENDIX C

LOGS OF BORINGS AND LABORATORY DATA BY OTHERS

APPENDIX C-1

LOGS OF BORINGS AND LABORATORY DATA BY GEOCON (2000)

APPENDIX A

FIELD INVESTIGATION

The field investigation was conducted on August 23, 2000, and included a site reconnaissance, geologic mapping and excavation of 5 small-diameter borings. The approximate locations of the borings are shown on the Geologic Map (Figure 2, map pocket). The borings were advanced using a CME 55 truck-mounted drill rig equipped with 10-inch-diameter hollow-stem augers. During drilling, relatively undisturbed samples were obtained by driving a 3-inch O.D. split-tube sampler into the undisturbed soil mass with a 140-pound hammer falling a distance of 30 inches. The sample was equipped with $2\frac{3}{8}$-inch-diameter brass rings to facilitate sampling and laboratory testing. Standard Penetration testing was also performed.

The soils encountered in the exploratory borings were visually examined, classified and logged. Logs of the borings are presented on Figures A-1 through A-8. The logs depict the soil and geologic conditions encountered and the depth at which samples were obtained.

CT NO. 06577-42-01

BORING SB 1

ELEV. (MSL.) ____________ DATE COMPLETED 8/23/00

EQUIPMENT CME55 HOLLOWSTEM 10"

SAMPLE NO.	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
		ASPHALT PAVEMENT/BASE (5" over 3")			
SB1-1	SM	FILL Loose, medium damp, dark brown, Silty, fine SAND, with some clay			
SB1-2	ML	ALLUVIUM Medium dense, moist, olive, Clayey SILT, with some fine sand	7	108.7	16.4
SB1-3			13	112.2	12.2
		-Gravel layer			
SB1-4	SM	Medium dense, damp, light brown, Silty, fine SAND	11	111.4	9.2
SB1-5	ML/SM	Medium dense, damp to moist, medium brown, Sandy SILT, with some clay	11	90.6	4.0
SB1-6	SM	Medium to dense, moist, medium brown, Silty, Gravelly, fine SAND	15	116.0	7.6
	CL/ML	Soft to stiff, very moist to wet, olive-brown, Silty CLAY (may perch groundwater seasonally)			

re A-1, Log of Boring SB 1

SAFIG

PLE SYMBOLS

- ☐ ... SAMPLING UNSUCCESSFUL
- ◫ ... STANDARD PENETRATION TEST
- ■ ... DRIVE SAMPLE (UNDISTURBED)
- ▩ ... DISTURBED OR BAG SAMPLE
- ◪ ... CHUNK SAMPLE
- ▼ ... WATER TABLE OR SEEPAGE

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

ECT NO. 06577-42-01

BORING SB 1

ELEV. (MSL.) ____________ DATE COMPLETED 8/23/00

EQUIPMENT CME55 HOLLOWSTEM 10"

SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
SB1-7			CL/ML	Soft to stiff, very moist to wet, olive, Silty CLAY	5		
SB1-8			GM	Dense, moist, medium brown, Sandy, fine to medium GRAVEL	23		
SB1-9			GM	Very dense, moist, medium brown, Sandy, coarse GRAVEL	26/6"		
SB1-10					43		
SB1-11					48		
SB1-12			CL	Very stiff, moist, reddish-brown, Sandy CLAY -Becomes olive, more silty	23		

re A-2, Log of Boring SB 1

SAFIG

MPLE SYMBOLS ☐ ... SAMPLING UNSUCCESSFUL ▨ ... DISTURBED OR BAG SAMPLE ◧ ... STANDARD PENETRATION TEST ◪ ... CHUNK SAMPLE ■ ... DRIVE SAMPLE (UNDISTURBED) ▼ ... WATER TABLE OR SEEPAGE

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

IECT NO. 06577-42-01

TH T	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	BORING SB 1 ELEV. (MSL.) ____ DATE COMPLETED 8/23/00 EQUIPMENT CME55 HOLLOWSTEM 10"	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
	SB1-13					17		
					BORING TERMINATED AT 61.5 FEET			

re A-3, Log of Boring SB 1

SAFIG

IPLE SYMBOLS ☐ ... SAMPLING UNSUCCESSFUL ◧ ... STANDARD PENETRATION TEST ■ ... DRIVE SAMPLE (UNDISTURBED)
⊠ ... DISTURBED OR BAG SAMPLE ◪ ... CHUNK SAMPLE ▽ ... WATER TABLE OR SEEPAGE

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

CT NO. 06577-42-01

BORING SB 2

ELEV. (MSL.) ____________ DATE COMPLETED 8/23/00

EQUIPMENT CME55 HOLLOWSTEM 10"

SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
				ASPHALT PAVEMENT/BASE (3" over 5")			
				ALLUVIUM Loose to medium dense, damp, olive-brown, very Clayey SILT, with some fine sand, porous			
SB2-1			ML/CL		8	112.7	15.0
SB2-2							
SB2-3					10		
SB2-4			SM	Medium dense, damp, light olive-brown, Silty, fine SAND, with thin layers of clean fine sand	10	110.5	7.4
				-6" to 8" wet, clayey silt layer (may perch groundwater seasonally)			
SB2-5				Dense, damp, medium brown, Gravelly, Silty, fine SAND	24	109.0	3.7
				Medium dense, moist, olive-brown, very Silty, Clayey, fine SAND to Sandy SILT			
SB2-6			SC/ML		10	114.8	13.6
				-Becomes more sandy			
			SM-GM				

re A-4, Log of Boring SB 2

SAFIG

IPLE SYMBOLS
- ☐ ... SAMPLING UNSUCCESSFUL
- ◧ ... STANDARD PENETRATION TEST
- ■ ... DRIVE SAMPLE (UNDISTURBED)
- ⊠ ... DISTURBED OR BAG SAMPLE
- ◪ ... CHUNK SAMPLE
- ▼ ... WATER TABLE OR SEEPAGE

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

IECT NO. 06577-42-01

TH T	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	BORING SB 2 ELEV. (MSL.) ______ DATE COMPLETED 8/23/00 EQUIPMENT CME55 HOLLOWSTEM 10"	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
	SB2-7			GM	Dense, moist, reddish-brown, Gravelly, fine SAND -Thin clay layer (<6") Dense, moist, reddish-brown, Sandy, medium to coarse GRAVEL, with some clay	30		
	SB2-8			GM	Very dense, damp, reddish-brown-olive, coarse GRAVEL	69		
					BORING TERMINATED AT 36.5 FEET			

re A-5, Log of Boring SB 2

SAFIG

IPLE SYMBOLS
- ☐ ... SAMPLING UNSUCCESSFUL
- ⊠ ... DISTURBED OR BAG SAMPLE
- ◧ ... STANDARD PENETRATION TEST
- ◩ ... CHUNK SAMPLE
- ■ ... DRIVE SAMPLE (UNDISTURBED)
- ▼ ... WATER TABLE OR SEEPAGE

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

ECT NO. 06577-42-01

SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	BORING SB 3 ELEV. (MSL.) ______ DATE COMPLETED 8/23/00 EQUIPMENT CME55 HOLLOWSTEM 10"	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
				MATERIAL DESCRIPTION			
				ASPHALT PAVEMENT/BASE (6" over 6")			
				ALLUVIUM Soft to stiff, moist, dark brown, very Silty CLAY to Clayey SILT -Massive			
SB3-1					6	102.4	19.7
SB3-2							
SB3-3			ML/CL		5		
SB3-4					7		
				BORING TERMINATED AT 11.5 FEET			

re A-6, Log of Boring SB 3

SAFIG

MPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

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

JECT NO. 06577-42-01

BORING SB 4

ELEV. (MSL.) ____________ DATE COMPLETED 8/23/00

EQUIPMENT CME55 HOLLOWSTEM 10"

SAMPLE NO.	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
		ASPHALT PAVEMENT/BASE (5" over 3")			
		ALLUVIUM Stiff, moist, dark brown-olive, very Clayey SILT, with some fine sand			
SB4-1	ML/CL		12	109.6	15.1
SB4-2					
SB4-3			9		
	SM/ML	Medium dense, damp, medium brown, very Silty, fine SAND			
SB4-4			14		
		BORING TERMINATED AT 16 FEET			

ure A-7, Log of Boring SB 4

SAFI

AMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

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

ECT NO. 06577-42-01

BORING SB 5

ELEV. (MSL.) ______ DATE COMPLETED 8/23/00

EQUIPMENT CME55 HOLLOWSTEM 10"

H	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					ASPHALT PAVEMENT/BASE (5" over 4")			
	SB5-1			ML/CL	**FILL** Soft to stiff, very moist to wet, dark olive, very Clayey SILT -Gravelly sand layer (<6")			
	SB5-2			ML/CL	**ALLUVIUM** Stiff, moist, olive to dark olive, very Clayey SILT	8		
	SB5-3					13	107.7	20.0
				SM/ML	Loose to medium, damp, medium brown, very Silty, fine SAND to Sandy SILT			
	SB5-4					5		
					BORING TERMINATED AT 16.5 FEET			

ure A-8, Log of Boring SB 5

SAFIG

MPLE SYMBOLS

☐ ... SAMPLING UNSUCCESSFUL ◧ ... STANDARD PENETRATION TEST ■ ... DRIVE SAMPLE (UNDISTURBED)

⊠ ... DISTURBED OR BAG SAMPLE ◩ ... CHUNK SAMPLE ▼ ... WATER TABLE OR SEEPAGE

APPENDIX B

APPENDIX B

LABORATORY TESTING

Laboratory tests were performed in accordance with generally accepted test methods of the American Society for Testing and Materials (ASTM) or other suggested procedures. Selected soil samples were tested for their in-place dry density and moisture content, maximum dry density and optimum moisture content, expansion potential, and gradation characteristics. Selected soils samples were also tested for pH, resistivity, and sulfate contents.

The results of our laboratory tests are presented as follows on Tables B-I through B-IV. The in-place dry density and moisture content results are indicated on the exploratory boring logs.

TABLE B-I
SUMMARY OF LABORATORY MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT TEST RESULTS ASTM D 1557

Sample No.	Description	Maximum Dry Density (pcf)	Optimum Moisture Content (% dry wt.)
SB2-2	Dark brown, clayey, fine to coarse SAND	126.9	10.5

TABLE B-II
SUMMARY OF LABORATORY EXPANSION INDEX TEST RESULTS

Sample No.	Moisture Content		Dry Density (pcf)	Expansion Index
	Before Test (%)	After Test (%)		
SB2-2	8.2	23.1	117.3	47
SB3-2	8.7	23.4	114.8	48
SB4-2	8.6	25.0	115.0	71

APPENDIX C-2

LOGS OF BORINGS AND LABORATORY DATA BY GROUP DELTA (2001)

APPENDIX A
FIELD EXPLORATION

A.1 Introduction

The subsurface conditions at the project site were investigated by Group Delta Consultants, Inc. (GDC) on June 13 and 14, 2001 by performing ten soil borings (B-1 through B-10). The borings were drilled to depths ranging from 6.5 to 101.5 feet ground surface. The boring locations are shown in Figure 2. A summary of the soil borings is presented in Table A-1.

A.2 Soil Drilling and Sampling

The borings were advanced using CME 75 Hollow-stem Auger (HSA). The borings had a hole diameter of about 6 inches. Bentonite mud was used in the boreholes to prevent caving. The borings were performed by ABC Drilling under a continuous technical supervision of a Group Delta field engineer, who visually inspected the soil samples, maintained detailed logs of the borings, interpreted stratigraphy, classified the soils, and obtained relatively undisturbed Modified California (CA) drive samples, as well as Standard Penetration Test (SPT) samples at about 5 feet intervals. The soils were classified in the field and further examined in the laboratory in accordance with the Unified Soil Classification System (see Figure A-1a). Field classifications were modified, where necessary, on the basis of laboratory test results.

Relatively undisturbed soil samples were obtained using 3.25-inch outside diameter sampler lined with brass rings, each 1-inch high and 2.42-inch inside diameter. The ring and tube samplers were driven with a 140-pound hammer dropping 30 inches. In addition, Standard Penetration Tests were performed in accordance with ASTM D1586-82 using a 2-inch outside diameter and 1.38-inch inside diameter split-spoon barrel sampler. The SPT sampler was driven with a 140-pound safety hammer released with automatic release dropping 30 inches.

The Standard Penetration Test consists of counting the number of hammer blows it takes to drive the sampler 1 foot into the ground. SPT blow counts are often used as an index of the relative density and resistance of the sampled materials. The blow counts obtained by driving the ring sampler can be converted to equivalent SPT blow counts using a multiplication factor of 0.67.

Pocket Penetrometer tests were also performed on cohesive soil samples to determine the undrained shear strength of the soil. The results are presented on the boring logs.

Detailed logs of the soil borings, including blow count data and in-situ moisture content and soil density are presented in Figures A-2 through A-11. Laboratory tests performed, other than the moisture content and dry density determination, are shown on the boring logs in the column "Other Tests". Descriptions and result summaries of laboratory tests performed are provided in Appendix B.

TABLE A-1
SUMMARY OF BORINGS
LOREN GRISET ELEMENTARY SCHOOL
SANTA ANA UNIFIED SCHOOL DISTRICT

Boring No.	Ground Surface Elev. (ft, MSL)	Boring Depth (ft)	Groundwater Depth (ft)	Drilling Method/ Equipment Used
B-1	+138	6.5	Not Encountered	Hollow-Stem Auger/ CME 75
B-2	+138	6.5	Not Encountered	Hollow-Stem Auger/ CME 75
B-3	+138	6.5	Not Encountered	Hollow-Stem Auger/ CME 75
B-4	+138	6.5	Not Encountered	Hollow-Stem Auger/ CME 75
B-5	+138	31.5	Not Encountered	Hollow-Stem Auger/ CME 75
B-6	+138	31.5	Not Encountered	Hollow-Stem Auger/ CME 75
B-7	+138	31.5	Not Encountered	Hollow-Stem Auger/ CME 75
B-8	+138	31.5	Not Encountered	Hollow-Stem Auger/ CME 75
B-9	+138	31.5	Not Encountered	Hollow-Stem Auger/ CME 75
B-10	+138	101.5	87.0	Hollow-Stem Auger/ CME 75

KEY FOR SOIL CLASSIFICATION

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

PRIMARY DIVISIONS			GROUP SYMBOL	SECONDARY DIVISIONS
COARSE GRAINED SOILS (< 50% fines content)	GRAVEL (% GRAVEL > % SAND)	CLEAN GRAVEL (Less than 5% fines)	GW	Well-graded gravel, gravel with sand, little or no fines
			GP	Poorly-graded gravel, gravel with sand, little or no fines
		"DIRTY" GRAVEL (More than 12% fines)	GM	Silty gravel, silty gravel with sand, silty or non-plastic fines
			GC	Clayey gravel, clayey gravel with sand, clayey or plastic fines
	SAND (% SAND ≥ % GRAVEL)	CLEAN SAND (Less than 5% fines)	SW	Well-graded sand, sand with gravel, little or no fines
			SP	Poorly-graded sand, sand with gravel, little or no fines
		"DIRTY" SAND (More than 12% fines)	SM	Silty sand, silty sand with gravel, silty or non-plastic fines
			SC	Clayey sand, clayey sand with gravel, clayey or plastic fines
FINE-GRAINED SOILS (> 50% fines content)	SILTS AND CLAYS (Liquid Limit less than 50)		ML	Inorganic silt, sandy silt, gravelly silt, or clayey silt with low plasticity
			CL	Inorganic clay of low to medium plasticity, sandy clay, gravelly clay, silty clay, Lean Clay
			OL	Low to medium plasticity Silt or Clay with significant organic content (vegetative matter)
	SILTS AND CLAYS (Liquid Limit 50 or more)		MH	Inorganic elastic silt, sandy silt, gravelly silt, or clayey silt of medium to high plasticity
			CH	Inorganic clay of high plasticity, Fat Clay
			OH	Medium to high plasticity Silt or Clay with significant organic content (vegetative matter)
HIGHLY ORGANIC SOILS			PT	Peat or other highly organic soils

Note: Dual symbols are used for coarse grained soils with 5 to 12% fines (ex: SP-SM), and for soils with Atterberg Limits falling in the CL-ML band in the Plasticity Chart.
Borderline classifications between groups may be indicated by two symbols separated by a slash (ex: CL/CH, SW/GW).

CONSISTENCY CLASSIFICATION

COARSE GRAINED SOILS		FINE GRAINED SOILS		
Blowcount SPT[1] (CAL)[2]	Consistency	Blowcount[3] SPT[1] (CAL)[2]	Consistency	Undrained Shear Strength[3], S_u (ksf)
0-4 (0-6)	Very Loose	<2 (<3)	Very Soft	< 0.25
		2-4 (3-6)	Soft	0.25 -0.50
5-10 (7-15)	Loose	5-8 (7-12)	Firm	0.50 - 1.0
11-30 (16-45)	Med. Dense	9-15 (13-22)	Stiff	1.0 - 2.0
31-50 (46-75)	Dense	16-30 (23-45)	Very Stiff	2.0 - 4.0
>50 (>75)	Very Dense	>30 (>45)	Hard	>4.0

CONSISTENCY NOTES:

1. Number of blows of a 140-lb. hammer falling 30-inches to drive a 2-inch O.D. (1.375-inch I.D.) SPT Sampler (ASTM D-1585) the final 12-inches of driving.
2. Number of blows of a 140-lb. hammer falling 30-inches to drive a 3-inch O.D. (2.42-inch I.D.) California Ring Sampler the final 12-inches of driving.
3. Undrained shear strength of cohesive soils predicted from field blowcounts is generally unreliable. Where possible, consistency should be based on S_u data from pocket penetrometer, torvane, or laboratory testing.

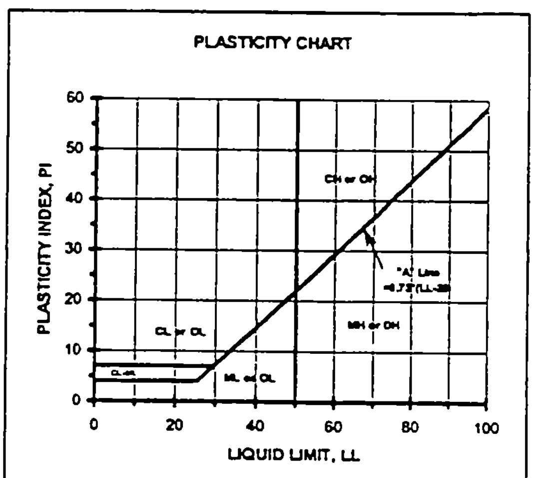
MOISTURE CLASSIFICATION

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

CLASSIFICATION CRITERIA BASED ON LABORATORY TESTS

Grain Size Classification

CLAY AND SILT	SAND			GRAVEL		COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Coarse		
US Std Sieve → No. 200	No. 40	No. 10	No. 4	3/4"	3"	12"	
Grain Size (mm) → 0.075	0.425	2	4.75	19.1	76.2	304.8	



Classification of earth materials shown on the logs is based on field inspection and should not be construed to imply laboratory analysis unless so stated.

Granular Soil Gradation Parameters

Coefficient of Uniformity: $C_u = D_{60} / D_{10}$

Coefficient of Curvature: $C_C = (D_{30})^2 / (D_{10} \times D_{60})$

D_{10}= 10% of the soil is finer than this diameter
D_{30}= 30% of the soil is finer than this diameter
D_{60}= 60% of the soil is finer than this diameter

Group Symbol	Gradation or Plasticity Requirement
SW	C_u>6 and C_c between 1 and 3
GW	C_u>4 and C_c between 1 and 3
GP or SP	Clean gravel or sand not meeting requirement for GW or SW
GM or SM	Plots below "A" Line on Plasticity Chart or PI < 4
GC or SC	Plots above "A" Line on Plasticity Chart and PI > 7

Metric Unit Conversion: 1" = 25.4 mm, 1.0 ksf = 47.88 kPa

LOG OF TEST BORING	PROJECT NAME: Santa Ana Unified School District	PROJECT NUMBER: I-283	BORING: LEGEND
SITE LOCATION: Santa Ana, California	START:	FINISH:	SHEET NO.: 1 of 1
DRILLING COMPANY:	DRILLING METHOD:	LOGGED BY:	CHECKED BY:
DRILLING EQUIPMENT:	BORING DIA. (in.):	TOTAL DEPTH (ft.): / GROUND ELEV (ft.):	DEPTH/ELEV. GROUND WATER (ft.): ⊻ / na
SAMPLING METHOD:	NOTES: Loren Griset Elementary School		

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS/ft.)	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	% PASSING (#200)	POCKET PEN (tsf)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
											GRAB, CAL, SPT - Refers to the sampling method as described below
5		GRAB (hand symbol)	1								GRAB - Refers to collecting sample by method of placing disturbed soil cuttings into a plastic bag
10		CAL (filled hourglass)	2								CAL (CALIFORNIA MODIFIED) - A 3.0" o.d. split tube sampler lined with 2.42" i.d. metal sample rings generally driven into the soil by a free falling hammer
15		SPT (X box)	3								SPT (STANDARD PENETRATION TEST) - A 2.0" o.d. split spoon sampler with a 1.375" i.d. generally driven into the soil with a 140# hammer free falling a height of 30"
20											ABBREVIATIONS FOR OTHER TESTS:
25											
30											

ABBREVIATIONS FOR OTHER TESTS:

AL = Atterberg Limits	GS = Grain Size Analyses
CN = Consolidation	PP = Pocket Pen
CO = Corrosivity	RV = R-Value
CP = Laboratory Compaction	SE = Sand Equivalent
DS = Direct Shear	WA = Wash on #200 Sieve
EI = Expansion Index	

LOG OF TEST BORING

PROJECT NAME Santa Ana Unified School District		**PROJECT NUMBER** I-283		**BORING** B- 1
SITE LOCATION Santa Ana, California	**START** 6/13/01	**FINISH** 6/13/01		**SHEET NO.** 1 of 1
DRILLING COMPANY ABC Drilling	**DRILLING METHOD** Hollow Stem Auger	**LOGGED BY** R. Mallari		**CHECKED BY** C. Amante
DRILLING EQUIPMENT CME 75	**BORING DIA. (in.)** 6	**TOTAL DEPTH (ft.)** 6.5	**GROUND ELEV (ft.)** 138	**DEPTH/ELEV. GROUND WATER (ft.)** ▼ / na
SAMPLING METHOD Hammer: 140 lbs., Drop: 30 in.	**NOTES** Loren Griset Elementary School			

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS/ft.)	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	% PASSING (#200)	POCKET PEN (tsf)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
0	138										Surface: 5" Asphalt over 3" Base: **Silty SAND (SM)**, brown, moist, with ~ 25% gravel **ALLUVIUM:** **Sandy SILT (ML)**, loose to medium dense, brown, moist
	135	Bulk	1		--	14.1	GS RV	54			
5		Drive	2	16	108.3	11.0					
											Boring terminated at 6.5 feet *Backfilled with cuttings* *Cold patch* *Groundwater not encountered*
10	130										
15	125										
20	120										
25	115										
30	110										
	105										

LOG OF TEST BORING

PROJECT NAME	PROJECT NUMBER	BORING
Santa Ana Unified School District	I-283	B- 2

SITE LOCATION	START	FINISH	SHEET NO.
Santa Ana, California	6/13/01	6/13/01	1 of 1

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
ABC Drilling	Hollow Stem Auger	R. Mallari	C. Amante

DRILLING EQUIPMENT	BORING DIA. (in.)	TOTAL DEPTH (ft.)	GROUND ELEV (ft.)	DEPTH/*ELEV.* GROUND WATER (ft.)
CME 75	6	6.5	138	⊻ / *na*

SAMPLING METHOD	NOTES
Hammer: 140 lbs., Drop: 30 in.	Loren Griset Elementary School

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS/ft.)	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	% PASSING (#200)	POCKET PEN (tsf)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
											Surface: 5" Asphalt over 4" Base: **Silty SAND (SM)**, brown, with ~ 25% gravel
	135	Hand	1		–	8.9	CP SE				**ALLUVIUM:** **Sandy SILT (ML)**, loose to medium dense, brown, moist
5			2	5	–	12.0					
											Boring terminated at 6.5 feet *Backfilled with cuttings* *Cold patch* *Groundwater not encountered*
	130										
10											
	125										
15											
	120										
20											
	115										
25											
	110										
30											
	105										

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Aliso Viejo, CA 92656

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FIGURE A-3

LOG OF TEST BORING

PROJECT NAME	PROJECT NUMBER	BORING
Santa Ana Unified School District	I-283	B- 3

SITE LOCATION	START	FINISH	SHEET NO.
Santa Ana, California	6/13/01	6/13/01	1 of 1

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
ABC Drilling	Hollow Stem Auger	R. Mallari	C. Amante

DRILLING EQUIPMENT	BORING DIA. (in.)	TOTAL DEPTH (ft.)	GROUND ELEV (ft.)	DEPTH/ELEV. GROUND WATER (ft.)
CME 75	6	6.5	138	⊻ / na

SAMPLING METHOD	NOTES
Hammer: 140 lbs., Drop: 30 in.	Loren Griset Elementary School

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS/ft.)	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	% PASSING (#200)	POCKET PEN (tsf)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
											Surface: 2" Asphalt over 5" Base: **Silty SAND (SM),** brown, with ~ 25% gravel
	135	(hand)	1		–	18.0	GS RV	66			**ALLUVIUM:** **Sandy SILT (ML),** loose to medium dense, brown, moist
5			2	11	105.1	19.1					
											Boring terminated at 6.5 feet *Backfilled with cuttings* *Cold patch* *Groundwater not encountered*
	130										
10											
	125										
15											
	120										
20											
	115										
25											
	110										
30											
	105										

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FIGURE A-4

LOG OF TEST BORING

PROJECT NAME	PROJECT NUMBER	BORING
Santa Ana Unified School District	I-283	B- 4

SITE LOCATION	START	FINISH	SHEET NO.
Santa Ana, California	6/14/01	6/14/01	1 of 1

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
ABC Drilling	Hollow Stem Auger	R. Mallari	C. Amante

DRILLING EQUIPMENT	BORING DIA. (in.)	TOTAL DEPTH (ft.)	GROUND ELEV (ft.)	DEPTH/ELEV. GROUND WATER (ft.)
CME 75	6	6.5	138	▼ / na

SAMPLING METHOD	NOTES
Hammer: 140 lbs., Drop: 30 in.	Loren Griset Elementary School

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS/ft.)	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	% PASSING (#200)	POCKET PEN (tsf)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
											Surface: 3" Asphalt over 5" Base: **Silty SAND (SM)**, brown, with ~ 25% gravel
	135		1		–	15.9	RV				**ALLUVIUM:** **Sandy SILT (ML)**, loose to medium dense, brown, moist
5			2	6	–	15.1					
	130										*Boring terminated at 6.5 feet* *Backfilled with cuttings* *Cold patch* *Groundwater not encountered*
10	125										
15	120										
20	115										
25	110										
30	105										

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FIGURE A-5

LOG OF TEST BORING

PROJECT NAME	PROJECT NUMBER	BORING
Santa Ana Unified School District	I-283	B-5

SITE LOCATION	START	FINISH	SHEET NO.
Santa Ana, California	6/13/01	6/13/01	1 of 1

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
ABC Drilling	Hollow Stem Auger	R. Mallari	C. Amante

DRILLING EQUIPMENT	BORING DIA. (in.)	TOTAL DEPTH (ft.)	GROUND ELEV (ft.)	DEPTH/*ELEV.* GROUND WATER (ft.)
CME 75	6	31.5	138	⊻ / *na*

SAMPLING METHOD	NOTES
Hammer: 140 lbs., Drop: 30 in.	Loren Griset Elementary School

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS/ft.)	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	% PASSING (#200)	POCKET PEN (tsf)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
											Surface: 5" Asphalt over 4" Base: **Silty SAND (SM)**, brown, with ~ 25% gravel
	135		1								**ALLUVIUM:** **Lean CLAY w/Sand (CL)**, firm, brown, moist, with some sand
5			2	9			CN		2.75		Becomes gravelly
10	130		3	10	–	19.8	AL				Becomes stiff (no gravel)
15	125		4	13	112.2	6.9	GS	26			**Silty SAND (SM)**, loose to medium dense, brown, moist
20	120		5	6	–	11.1					8" lens of SAND (SP), increasing with fines
25	115		6	21	123.0	5.5	GS	15			
	110										**Sandy CLAY (CL)**, firm, brown, wet
30			7	6	–	20.5					
	105										*Boring terminated at 31.5 feet* *Backfilled with cuttings* *Cold patch* *Groundwater not encountered*

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FIGURE A-6

LOG OF TEST BORING

PROJECT NAME	PROJECT NUMBER	BORING
Santa Ana Unified School District	I-283	B- 6

SITE LOCATION	START	FINISH	SHEET NO.
Santa Ana, California	6/13/01	6/13/01	1 of 1

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
ABC Drilling	Hollow Stem Auger	R. Mallari	C. Amante

DRILLING EQUIPMENT	BORING DIA. (in.)	TOTAL DEPTH (ft.)	GROUND ELEV (ft.)	DEPTH/*ELEV.* GROUND WATER (ft.)
CME 75	6	31.5	138	▼ / na

SAMPLING METHOD	NOTES
Hammer: 140 lbs., Drop: 30 in.	Loren Griset Elementary School

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS/ft.)	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	% PASSING (#200)	POCKET PEN (tsf)	DESCRIPTION AND CLASSIFICATION
0	138									Surface: 5" Asphalt over 3" Base: **Silty SAND (SM)**, brown, with ~ 25% gravel
										ALLUVIUM: **Lean CLAY (CL)**, firm, brown, moist
	135		1		–	15.2				
5			2	9	99.4	19.3	AL		2.25	
	130		3				CO			
10			4	7	–	17.7				Trace sand
	125									
15			5	17	106.1	8.1	GS	34		**Silty SAND (SM)**, medium dense, brown, moist, some clay
	120									
20			6	14	–	12.5				
										Poorly Graded SAND (SP), medium dense, brown, damp to moist, some fines
	115									**Silty SAND (SM)**, loose, brown, moist
25			7	12	105.7	7.8				
	110									**Sandy CLAY (CL)**, firm, brown, wet, trace sand
30			8	5	–	18.5				
	105									*Boring terminated at 31.5 feet* *Backfilled with cuttings* *Cold patch* *Groundwater not encountered*

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FIGURE A-7

LOG OF TEST BORING

PROJECT NAME	PROJECT NUMBER	BORING
Santa Ana Unified School District	I-283	B-7

SITE LOCATION	START	FINISH	SHEET NO.
Santa Ana, California	6/13/01	6/13/01	1 of 1

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
ABC Drilling	Hollow Stem Auger	R. Mallari	C. Amante

DRILLING EQUIPMENT	BORING DIA. (in.)	TOTAL DEPTH (ft.)	GROUND ELEV (ft.)	DEPTH/ELEV. GROUND WATER (ft.)
CME 75	6	31.5	138	⊻ / na

SAMPLING METHOD	NOTES
Hammer: 140 lbs., Drop: 30 in.	Loren Griset Elementary School

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS/ft.)	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	% PASSING (#200)	POCKET PEN (tsf)	DESCRIPTION AND CLASSIFICATION
0	138									Surface: 4" Asphalt over 3" Base: **Silty SAND (SM)**, brown, moist, with ~ 25% gravel
	135	Hand	1							<u>FILL:</u> **Sandy SILT (ML)**, brown, moist, with some clay
5		Bulk	2	2	–	20.1				<u>ALLUVIUM:</u> **Sandy SILT (ML)**, loose to medium dense, brown, moist
10	130	Drive	3	14	119.9	17.2	DS		3.25	
15	125	Bulk	4	7	–	12.3	GS	48		**Silty SAND (SM)**, loose to medium dense, brown, moist
20	120	Drive	5	16	115.7	8.3				Becomes gravelly
25	115	Bulk	6	11	–	4.2	WA	9		**Poorly Graded SAND w/Silt (SP-SM)**, medium dense, brown, damp to moist
30	110	Drive	7	8	109.4	15.6			< 2.5	**Sandy CLAY (CL)**, firm, brown, moist to wet, trace gravel
	105									*Boring terminated at 31.5 feet* *Backfilled with cuttings* *Cold patch* *Groundwater not encountered*

GDC LOG %PASSING I-283.GPJ GDC_WLOG.GDT 7/17/01

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FIGURE A-8

LOG OF TEST BORING

PROJECT NAME	PROJECT NUMBER	BORING
Santa Ana Unified School District	I-283	B-8

SITE LOCATION	START	FINISH	SHEET NO.
Santa Ana, California	6/14/01	6/14/01	1 of 1

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
ABC Drilling	Hollow Stem Auger	R. Mallari	C. Amante

DRILLING EQUIPMENT	BORING DIA. (in.)	TOTAL DEPTH (ft.)	GROUND ELEV (ft.)	DEPTH/ELEV. GROUND WATER (ft.)
CME 75	6	31.5	138	⊻ / na

SAMPLING METHOD	NOTES
Hammer: 140 lbs., Drop: 30 in.	Loren Griset Elementary School

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS/ft.)	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	% PASSING (#200)	POCKET PEN (tsf)
	135	Bulk (hand)	1		–	16.8	EI		
5		SPT	2	5	–	16.9	AL		
10		Ring	3	18	117.2	15.4			2.25
15		SPT	4	4	–	17.5			
20		Ring	5	10	104.0	8.9			
25		SPT	6	37	–	9.4			
30		Ring	7	8	118.4	12.2			

DEPTH (feet)	DESCRIPTION AND CLASSIFICATION
0	Surface: 5" Asphalt over 4" Base: **Silty SAND (SM),** brown, moist, with ~ 25% gravel
	ALLUVIUM: **Lean CLAY (CL),** firm, brown, moist
~7	Becomes sandy
~10	Becomes stiff
~15	Becomes soft, increasing sand
20	**Silty SAND (SM),** loose to dense, brown, moist
31.5	*Boring terminated at 31.5 feet* *Backfilled with cuttings* *Cold patch* *Groundwater not encountered*

GDC LOG %PASSING I-283.GPJ GDC_WLOG.GDT 7/17/01

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FIGURE A-9

LOG OF TEST BORING

PROJECT NAME	PROJECT NUMBER	BORING
Santa Ana Unified School District	I-283	B- 9

SITE LOCATION	START	FINISH	SHEET NO.
Santa Ana, California	6/13/01	6/13/01	1 of 1

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
ABC Drilling	Hollow Stem Auger	R. Mallari	C. Amante

DRILLING EQUIPMENT	BORING DIA. (in.)	TOTAL DEPTH (ft.)	GROUND ELEV (ft.)	DEPTH/ELEV. GROUND WATER (ft.)
CME 75	6	31.5	138	▼ / na

SAMPLING METHOD	NOTES
Hammer: 140 lbs., Drop: 30 in.	Loren Griset Elementary School

DEPTH (feet)	ELEVATION (feet)	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS/ft.)	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	% PASSING (#200)	POCKET PEN (tsf)	DESCRIPTION AND CLASSIFICATION
0	138								Surface: 2" Asphalt over 5" Base: **Silty SAND (SM),** firm, brown, damp to moist, with ~ 25% gravel
									FILL: **Sandy SILT (ML),** brown, damp
	135	1		–	15.5				
5		2	6	–	15.5	GS	75		ALLUVIUM: **Sandy SILT (ML),** loose to medium dense, brown, damp
	130	3							
10		4	18	112.0	13.4	DS			Becomes stiff
	125								
15		5	14	–	3.9	GS	10		**Well Graded SAND w/Silt (SW-SM),** medium dense, olive gray, damp
	120								
20		6	14	101.8	3.9				**Silty SAND (SM),** medium dense, brown, moist, some clay
	115								
25		7	16	–	2.8	WA	7	3.5	**Poorly Graded SAND w/Silt (SP-SM),** medium dense, brown, damp to moist
	110								
30		8	4	120.7	18.1				**Sandy CLAY (CL),** soft, brown, wet
	105								*Boring terminated at 31.5 feet* *Backfilled with cuttings* *Cold patch* *Groundwater not encountered*

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FIGURE A-10

LOG OF TEST BORING

PROJECT NAME	PROJECT NUMBER	BORING
Santa Ana Unified School District	I-283	B-10

SITE LOCATION	START	FINISH	SHEET NO.
Santa Ana, California	6/14/01	6/14/01	1 of 3

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
ABC Drilling	Hollow Stem Auger	R. Mallari	C. Amante

DRILLING EQUIPMENT	BORING DIA. (in.)	TOTAL DEPTH (ft.)	GROUND ELEV (ft.)	DEPTH/*ELEV.* GROUND WATER (ft.)
CME 75	6	101.5	138	▼ 87.0 / *51.0*

SAMPLING METHOD	NOTES
Hammer: 140 lbs., Drop: 30 in.	Loren Griset Elementary School

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS/ft.)	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	% PASSING (#200)	POCKET PEN (tsf)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
											Surface: 3" Asphalt over 5" Base
											FILL: **Silty SAND (SM) w/Gravel,** firm, brown, damp to moist, with sand, ~ 25% gravel
	135		1				CO EI				
5											ALLUVIUM: **Lean CLAY (CL),** firm, brown, moist
			2	10			AL CN		2.5		
	130										
10											**Sandy SILT (ML),** loose, brown, moist
			3	10	–	14.4	GS	64			
	125										
15											**Silty SAND (SM),** loose, brown, moist
			4	12	100.8	7.9					
	120										
20											6" lens of SAND (SP)
			5	5	–	14.8	CO WA	7			
	115										
25											Becomes medium dense
			6	19	109.3	7.5					
	110										Increasing fines
30											**Silty SAND w/Gravel (SM),** medium dense to very dense, brown, moist
			7	19	–	12.0	GS	38			
	105										

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FIGURE A-11 a

LOG OF TEST BORING

PROJECT NAME	PROJECT NUMBER	BORING
Santa Ana Unified School District	I-283	B-10

SITE LOCATION	START	FINISH	SHEET NO.
Santa Ana, California	6/14/01	6/14/01	2 of 3

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
ABC Drilling	Hollow Stem Auger	R. Mallari	C. Amante

DRILLING EQUIPMENT	BORING DIA. (in.)	TOTAL DEPTH (ft.)	GROUND ELEV (ft.)	DEPTH/ELEV. GROUND WATER (ft.)
CME 75	6	101.5	138	▼ 87.0 / *51.0*

SAMPLING METHOD	NOTES
Hammer: 140 lbs., Drop: 30 in.	Loren Griset Elementary School

SAMPLE NO.	PENETRATION RESISTANCE (BLOWS/ft.)	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	% PASSING (#200)	POCKET PEN (tsf)	DESCRIPTION AND CLASSIFICATION
8	87/11"	126.8	5.2				
							Well Graded SAND w/Silt & Gravel (SW-SM), dense to very dense, brown, moist
9	42	–	5.5	GS	10		
10	50/4"	–	5.0				Becomes very dense
							Silty CLAY (CL), hard, brown, moist, some sand
11	31	–	10.2				
12	23	112.7	16.8				Becomes very stiff
13	20	–	22.3				
							Sandy SILT (ML), very stiff, olive brown, moist
14	23	104.7	19.4				

Depth (feet) scale: 40, 45, 50, 55, 60, 65. Elevation (feet) scale: 100, 95, 90, 85, 80, 75, 70.

GDC LOG %PASSING I-283.GPJ GDC_WLOG.GDT 7/11/01

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FIGURE A-11 b

LOG OF TEST BORING

PROJECT NAME	PROJECT NUMBER	BORING
Santa Ana Unified School District	I-283	B-10

SITE LOCATION	START	FINISH	SHEET NO.
Santa Ana, California	6/14/01	6/14/01	3 of 3

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
ABC Drilling	Hollow Stem Auger	R. Mallari	C. Amante

DRILLING EQUIPMENT	BORING DIA. (in.)	TOTAL DEPTH (ft.)	GROUND ELEV (ft.)	DEPTH/*ELEV.* GROUND WATER (ft.)
CME 75	6	101.5	138	⊻ 87.0 / *51.0*

SAMPLING METHOD	NOTES
Hammer: 140 lbs., Drop: 30 in.	Loren Griset Elementary School

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS/ft.)	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	% PASSING (#200)	POCKET PEN (tsf)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
		☒	15	27	–	4.1					**Poorly Graded SAND (SP),** medium dense, olive, moist
	65										
75		■	16	48	103.1	23.1					**Sandy SILT (ML),** dense, brown, moist
	60										
80		☒	17	30	–	19.0					**Silty SAND (SM),** dense, brown, moist
	55										Increasing sand
85		■	18	41	96.6	23.0	WA	10			**Poorly Graded SAND w/Silt (SP-SM),** medium dense, olive brown, moist to wet
	50									⊻	
90		☒	19	35	–	15.2					**Silty SAND (SM),** medium dense, brown, wet
	45										Increasing sand
95		☒	20	18	–	18.5	WA	3			
	40										
100		☒	21	35	–	22.3					**Sandy SILT (ML),** medium dense, brown, wet
	35										*Boring terminated at 101.5 feet* *Backfilled with cuttings,* *Cold patch* *Groundwater encountered at 87 feet*

APPENDIX B
LABORATORY TESTING

APPENDIX B
LABORATORY TESTING

B.1 Introduction

Relatively undisturbed Modified California drive samples and Standard Penetration Test (SPT) samples were carefully sealed in the field to prevent moisture loss. These samples were then transported to our geotechnical laboratory for examination and testing. Tests were performed on selected samples as an aid in classifying the soils and to evaluate their physical properties, engineering characteristics, and identify specific contaminants that may be present in the soil samples. Details of the laboratory testing program and test results are discussed in the following sections. All tests were performed in general accordance with appropriate American Society for Testing and Materials (ASTM) Test Methods and California Department of Transportation (Caltrans) Test Methods (CTM). Brief descriptions of the laboratory testing program and test results are presented below.

B.2 Soil Classification

The subsurface materials were classified using the Unified Soil Classification System (USCS) in accordance with ASTM Test Methods D2487-85 and D2488-84. The soil classifications are presented on the boring logs in Appendix A.

B.3 Moisture Content and Dry Density

Moisture content and dry density were determined for selected samples. The drive samples were trimmed to obtain volume and wet weight then were dried in accordance with ASTM D2216-71. After drying, the weight of each sample was measured, and moisture content and dry density were calculated. The moisture content of selected SPT samples were also determined. Moisture content and dry density values are presented on the boring logs in Appendix A.

B.4 Grain Size Distribution and Fines Content

Representative samples were dried, weighed, soaked in water until individual soil particles were separated, and then washed on the #200 sieve. The portion of the material retained on the #200 sieve was oven-dried and then run through a standard set of sieves in accordance with ASTM D422-94. The results of grain size distribution tests performed are graphically shown in Figures B-1 through B-3. The relative proportion (or percentage) by weight of gravel, sand and fines (silt and clay) are determined from Figures B-1 through B-3 and summarized in Table B-1. Fines content or percent passing #200 sieve were performed on selected samples. The fines content is an important factor for evaluating the liquefaction potential of sandy soils. The test results are presented on the boring logs in Appendix A.

B.5 Atterberg Limits Tests

Liquid and plastic limits were determined for selected samples showing some plasticity properties in accordance with ASTM D4318-84. The test results are presented in Figure B-4.

B.6 Compaction Test

Compaction testing was performed on a representative bulk sample in accordance with ASTM D1557 in order to evaluate the maximum dry unit weight and optimum moisture content for the material tested. The test results are summarized in Table B-2.

B.7 R-value Test

R-value tests were performed on selected samples of the subgrade soils encountered in areas where traffic lanes are to be constructed. The tests were conducted in general accordance with CTM 301. The test results are summarized in Table B-3.

B.8 Corrosivity Tests

Selected samples were tested for corrosion potential and included soluble sulfate content (CTM 417), soluble chloride content (CTM 422), minimum electrical resistivity (CTM 643) and pH. The test results are presented in Table B-4.

B.9 Direct Shear Test

To determine the shear strength parameters of the on-site soils, direct shear tests were performed on selected in situ and remolded samples in accordance with ASTM D3080. After the initial weight and volume measurements were made, the sample was placed in the shear machine, and a selected normal load was applied. The sample was submerged, allowed to consolidate, and then was sheared to failure. Shear stress and sample deformations were monitored throughout the test. The process was repeated under two additional normal loads. The test results are presented in Figures B-5 and B-6.

B.10 Consolidation Test

One-dimensional consolidation test was performed on selected undisturbed samples in accordance with ASTM D2435-90. The test was performed on 1.0-inch high, 2.42-inch diameter sample. After trimming the ends, the sample was placed in the consolidometer and initial reading was recorded. The sample was saturated under loading; and thereafter, the sample was incrementally loaded. The results of the consolidation test are graphically shown in Figures B-7 and B-8.

B.11 Expansion Index Test

To evaluate the expansion potential of compacted soils, expansion index tests were performed on selected remolded samples in accordance with ASTM D4829-95. The sample is compacted into a metal ring such that the degree of saturation is between 40% and 60%. The sample is then placed in a consolidometer under a vertical confining pressure of 1 $lb/in.^2$ The sample is then inundated with distilled water. The deformation of the specimen is recorded for 24 hours or until the rate of deformation becomes less than 0.0002 in./hr, whichever occurs first. A minimum recording time of 3 hours is required. The classification of a potentially expansive soil is based on the following table:

Expansion Index, EI	*Potential Expansion*
0 – 20	Very Low
21 – 50	Low
51 – 90	Medium
91 – 130	High
> 130	Very High

The test results are presented in Table B-5.

B.12 Sand Equivalent Test

The sand equivalent test provides an indication of the relative proportions of detrimental fine dust or clay like material in soil or fine aggregates. Selected samples were tested using CTM 217. The prepared samples were poured into a calcium chloride solution in plastic cylinder. After a wetting period, the sample was agitated by 100 strokes in a manual shaker. Following cylinder irrigation and a 20-minute standing time, the height of the top of the sediment column was recorded as the clay reading. The sand reading was taken with a weighted foot that rests on the sand in the cylinder. The sand equivalent is calculated as one hundred times the sand reading divided by the clay reading. Table B-6 presents a summary of sand equivalent test results.

B.13 List of Attached Tables and Figures

The following tables and figures are attached and complete this appendix:

TABLE B-1
SUMMARY OF GRAIN SIZE DISTRIBUTION TEST RESULTS
LOREN GRISET ELEMENTARY SCHOOL
SANTA ANA UNIFIED SCHOOL DISTRICT

Boring No.	Sample Depth (feet)	USCS Soil Type	Gravel Content (%)	Sand Content (%)	Fines Content (%)
B-1	1 – 5	ML	14	32	54
B-3	1 – 5	ML	4	30	66
B-5	15 – 16.5	SM	2	72	26
B-5	25 – 26.5	SM	11	74	15
B-6	15 – 16.5	SM	5	61	34
B-7	15 – 16.5	SM	1	51	48
B-7	25 – 26.5	SP-SM	--	--	9
B-9	5 – 6.5	ML	0	25	75
B-9	15 – 16.5	SW-SM	12	78	10
B-9	25 – 26.5	SP-SM	--	--	7
B-10	10 – 11.5	ML	3	33	64
B-10	20 – 21.5	SP-SM	--	--	7
B-10	30 – 31.5	SM	17	55	38
B-10	40 – 41.5	SW-SM	44	46	10

TABLE B-2
SUMMARY OF COMPACTION TEST RESULTS
LOREN GRISET ELEMENTARY SCHOOL
SANTA ANA UNIFIED SCHOOL DISTRICT

Boring No.	Sample Depth (ft)	USCS Soil Type	Optimum Moisture Content (%)	Maximum Dry Density (pcf)
B-2	1 – 5	ML	9.5	128.5

TABLE B-3
SUMMARY OF R-VALUE TEST RESULTS
LOREN GRISET ELEMENTARY SCHOOL
SANTA ANA UNIFIED SCHOOL DISTRICT

Boring No.	Sample Depth (ft)	USCS Soil Type	R-value By Expansion	R-value By Exudation
B-1	1 – 5	ML	--	21
B-3	1 - 5	ML	--	12
B-4	1 - 5	ML	--	14

TABLE B-4
SUMMARY OF CORROSIVITY TEST RESULTS
LOREN GRISET ELEMENTARY SCHOOL
SANTA ANA UNIFIED SCHOOL DISTRICT

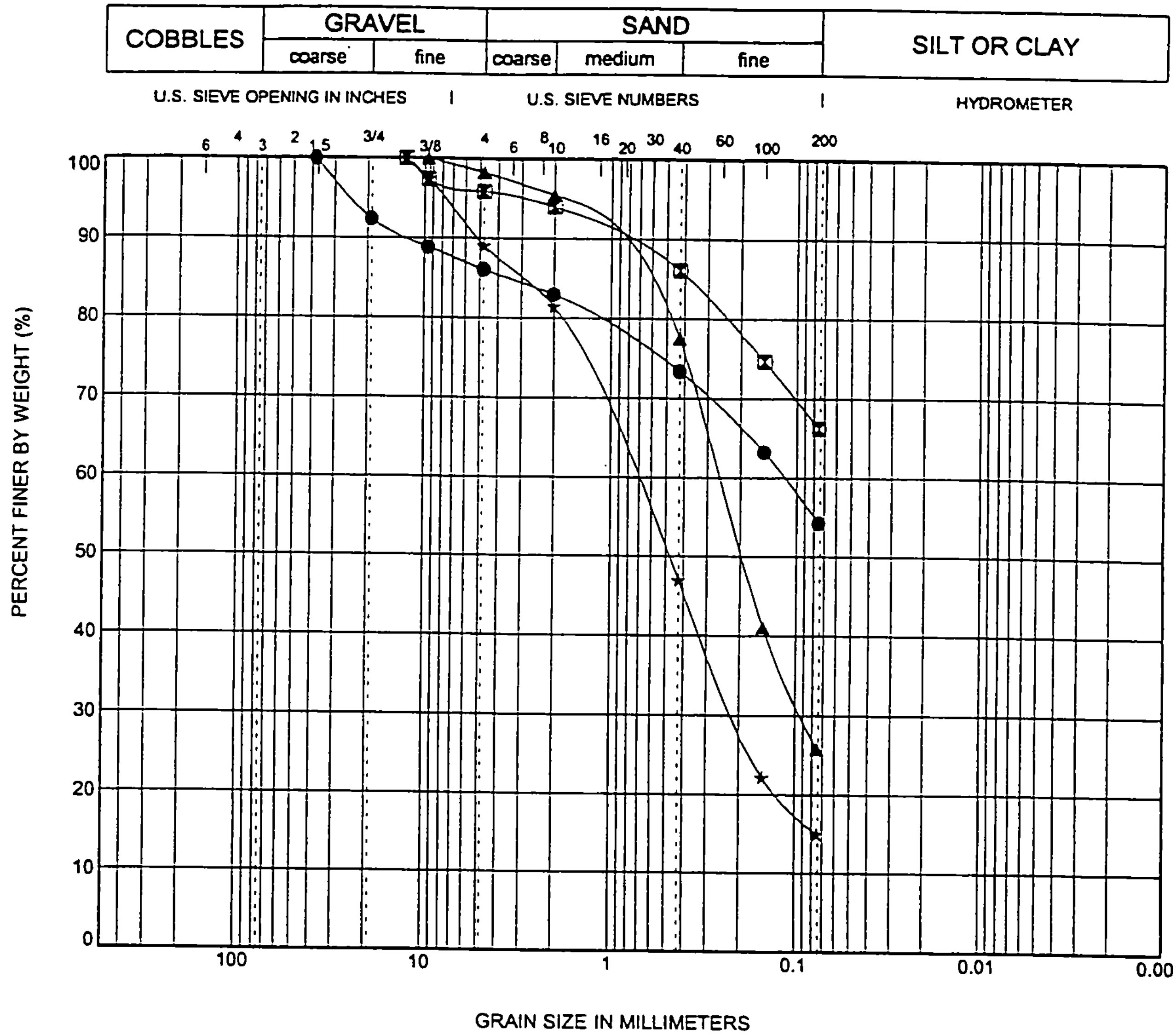
Boring No.	Sample Depth (feet)	USCS Soil Type	PH Value	Water Soluble Chloride Content CTM 422 (ppm)	Water Soluble Sulfate Content CTM 417 (ppm)	Minimum Electrical Resistivity CTM 643 (Ohm-cm)
B-6	6.5 – 9	CL	7.8	< 10	85	1,130
B-10	1 – 5	SM	8.0	< 10	200	2,000

TABLE B-5
SUMMARY OF EXPANSION INDEX TEST RESULTS
LOREN GRISET ELEMENTARY SCHOOL
SANTA ANA UNIFIED SCHOOL DISTRICT

Boring No.	Sample Depth (ft)	USCS Soil Type	Degree of Saturation (%)	Expansion Index
B-8	1 – 5	CL	55	45 (Low Expansion Potential)
B-10	1 – 5	SM	49	36 (Low Expansion Potential)

TABLE B-6
SUMMARY OF SAND EQUIVALENT TEST RESULTS
LOREN GRISET ELEMENTARY SCHOOL
SANTA ANA UNIFIED SCHOOL DISTRICT

Boring No.	Sample Depth (ft)	USCS Soil Type	Clay Reading (inches)	Sand Reading (inches)	Sand Equivalent (%)
B-2	1 – 5	ML	14.0	1.5	11



SYMBOL	BORING	DEPTH (ft)	DESCRIPTION
●	B- 1	1.0 - 5.0	(ML) Sandy SILT
⊠	B- 3	1.0 - 5.0	(ML) Sandy SILT
▲	B- 5	15.0 - 16.5	(SM) Silty SAND
★	B- 5	25.0 - 26.5	(SM) Silty SAND

SYMBOL	BORING	DEPTH (ft)	D100	D60	D30	D10	LL	PL	PI	Cc	Cu
●	B- 1	1.0 - 5.0	37.5	0.116							
⊠	B- 3	1.0 - 5.0	12.5								
▲	B- 5	15.0 - 16.5	9.5	0.258	0.091						
★	B- 5	25.0 - 26.5	12.5	0.762	0.208						

GDC GRAIN SIZE I-283.GPJ GDC WLOG.GDT 7/3/01

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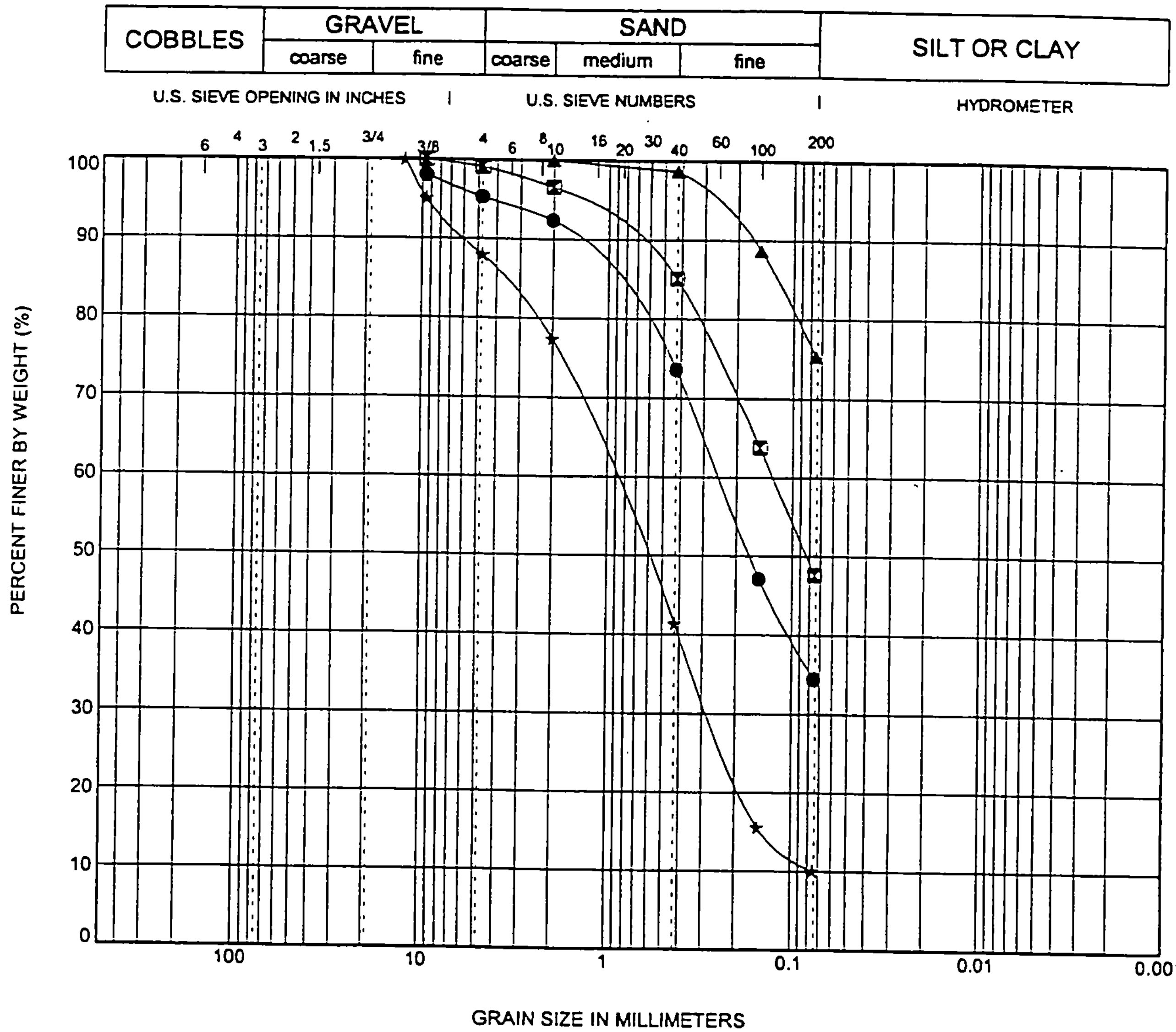
GRAIN SIZE DISTRIBUTION

Group Delta Consultants, Inc.

Project: Santa Ana Unified School District
Location: Santa Ana, California
Number: I-283

FIGURE B-1



SYMBOL	BORING	DEPTH (ft)	DESCRIPTION
●	B- 6	15.0 - 16.5	(SM) Silty SAND
⊠	B- 7	15.0 - 16.5	(SM) Silty SAND
▲	B- 9	5.0 - 6.5	(ML) Sandy SILT
★	B- 9	15.0 - 16.5	(SW-SM) Well Graded SAND w/Silt

SYMBOL	BORING	DEPTH (ft)	D100	D60	D30	D10	LL	PL	PI	Cc	Cu
●	B- 6	15.0 - 16.5	9.5	0.249							
⊠	B- 7	15.0 - 16.5	9.5	0.127							
▲	B- 9	5.0 - 6.5	2								
★	B- 9	15.0 - 16.5	12.5	0.946	0.268					1.03	12.77

GDC GRAIN SIZE I-283.GPJ GDC WLOG.GDT 7/3/01

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GRAIN SIZE DISTRIBUTION

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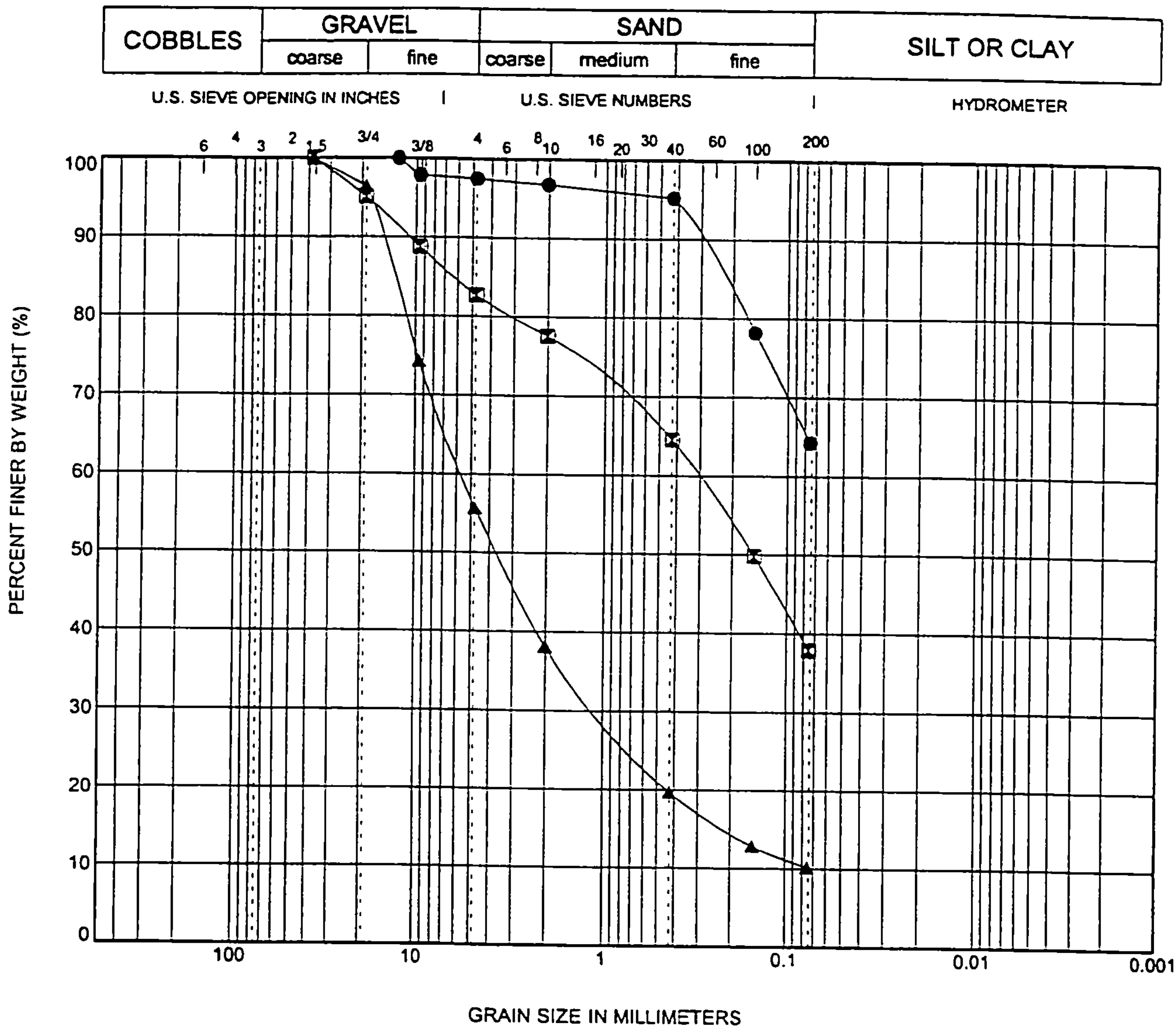
Location: Santa Ana, California

Number: I-283

FIGURE B-2



SYMBOL	BORING	DEPTH (ft)	DESCRIPTION
●	B-10	10.0 - 11.5	(ML) Sandy SILT
⊠	B-10	30.0 - 31.5	(SM) Silty SAND w/Gravel
▲	B-10	40.0 - 41.5	(SW-SM) Well Graded SAND w/Silt and Gravel

SYMBOL	BORING	DEPTH (ft)	D100	D60	D30	D10	LL	PL	PI	Cc	Cu
●	B-10	10.0 - 11.5	12.5								
⊠	B-10	30.0 - 31.5	37.5	0.307							
▲	B-10	40.0 - 41.5	37.5	5.576	1.011					2.58	78.26

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GRAIN SIZE DISTRIBUTION

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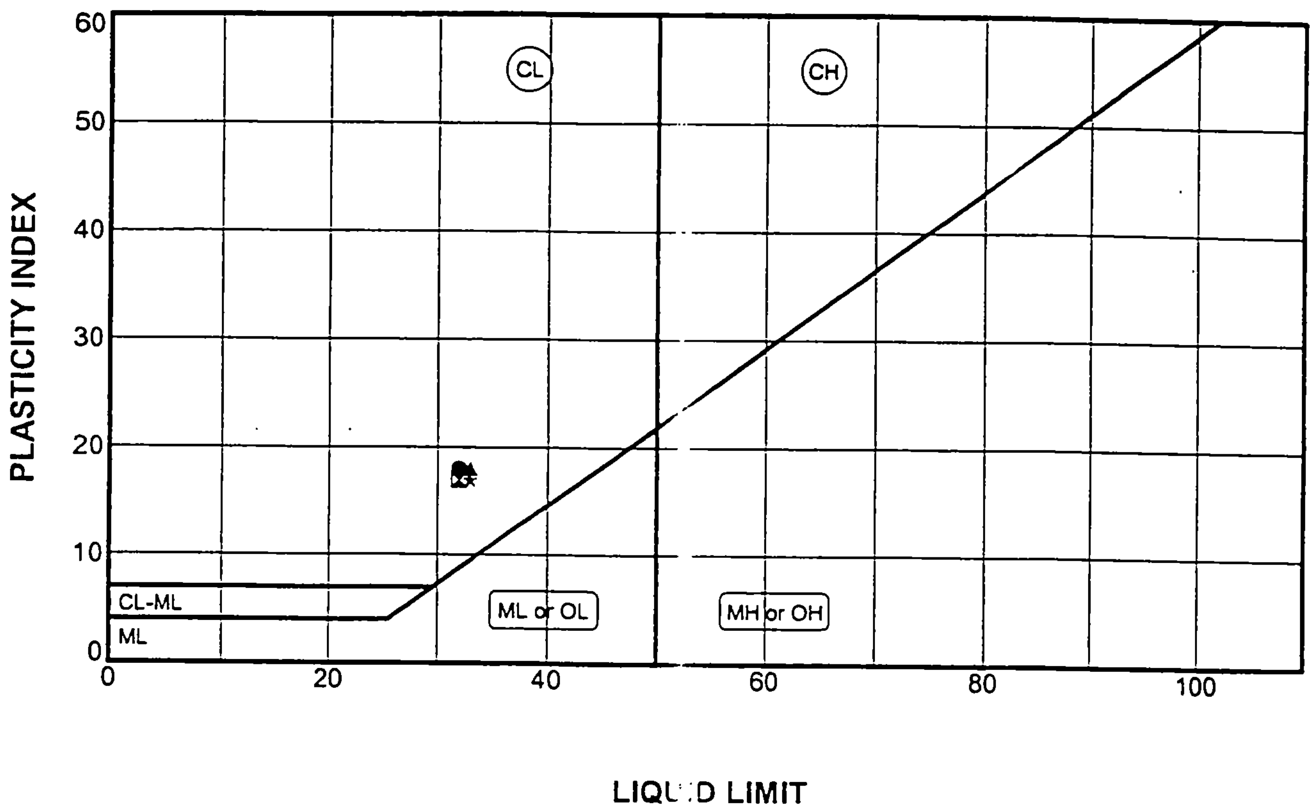
Project: Santa Ana Unified School District
Location: Santa Ana, California
Number: I-283

FIGURE B-3



SYMBOL	BORING	DEPTH (ft)	LL	PL	PI	LI	w%	DESCRIPTION
●	B-5	10.0 - 11.5	32	14	18	0.33	20	(CL) Lean CLAY w/Sand
⊠	B-6	5.0 - 6.5	32	15	17	0.24	19	(CL) Lean CLAY
▲	B-8	5.0 - 6.5	33	15	18	0.11	17	(CL) Lean CLAY
★	B-10	5.0 - 6.5	33	16	17			(CL) Lean CLAY

GDC ATTERBERG I-283.GPJ GDC WLOG.GDT 7/3/01

GROUP DELTA CONSULTANTS

ATTERBERG LIMITS

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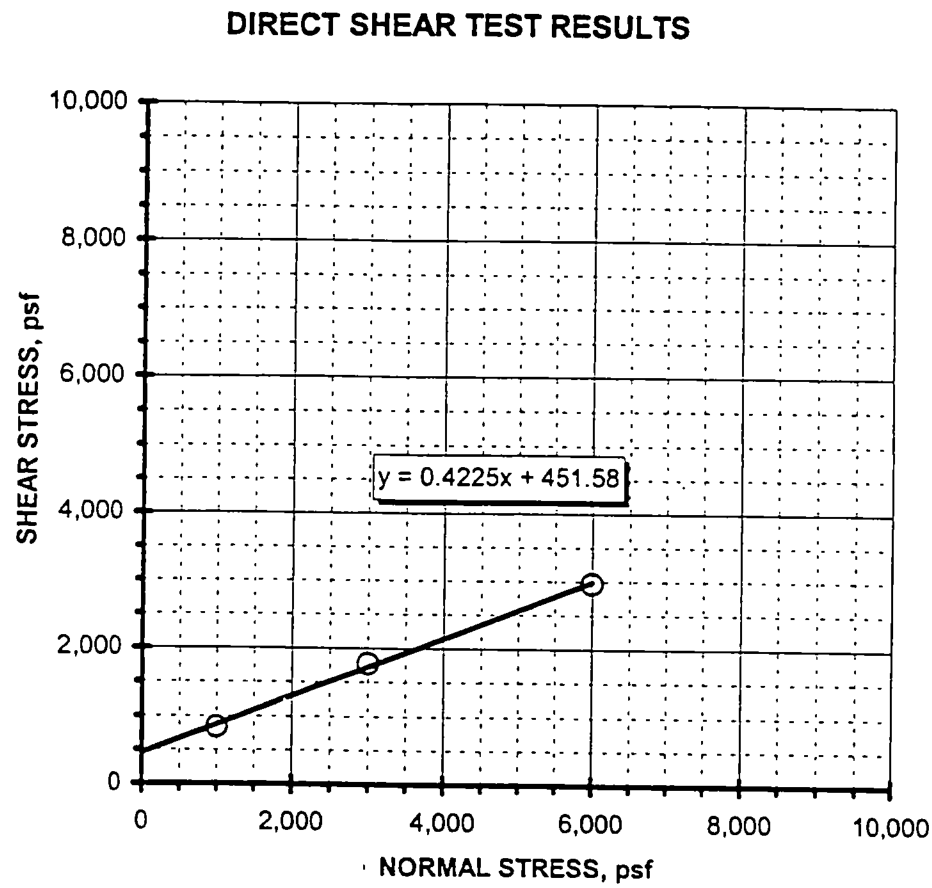
Location: Santa Ana, California

Number: I-283

FIGURE B-4



MOISTURE DENSITY DATA

Dry Density	Moisture, %	
pcf	before	after
119.9	17.2	21.5

TEST RESULTS

Point No.	Normal Stress psf	Peak Shear Stress psf
1	1,000	840
2	3,000	1,776
3	6,000	2,964

SHEAR STRENGTH PARAMETERS

Cohesion	Friction Angle
psf	degrees
452	23

Boring No.: B-7
Sample Depth, ft: 10 - 11.5

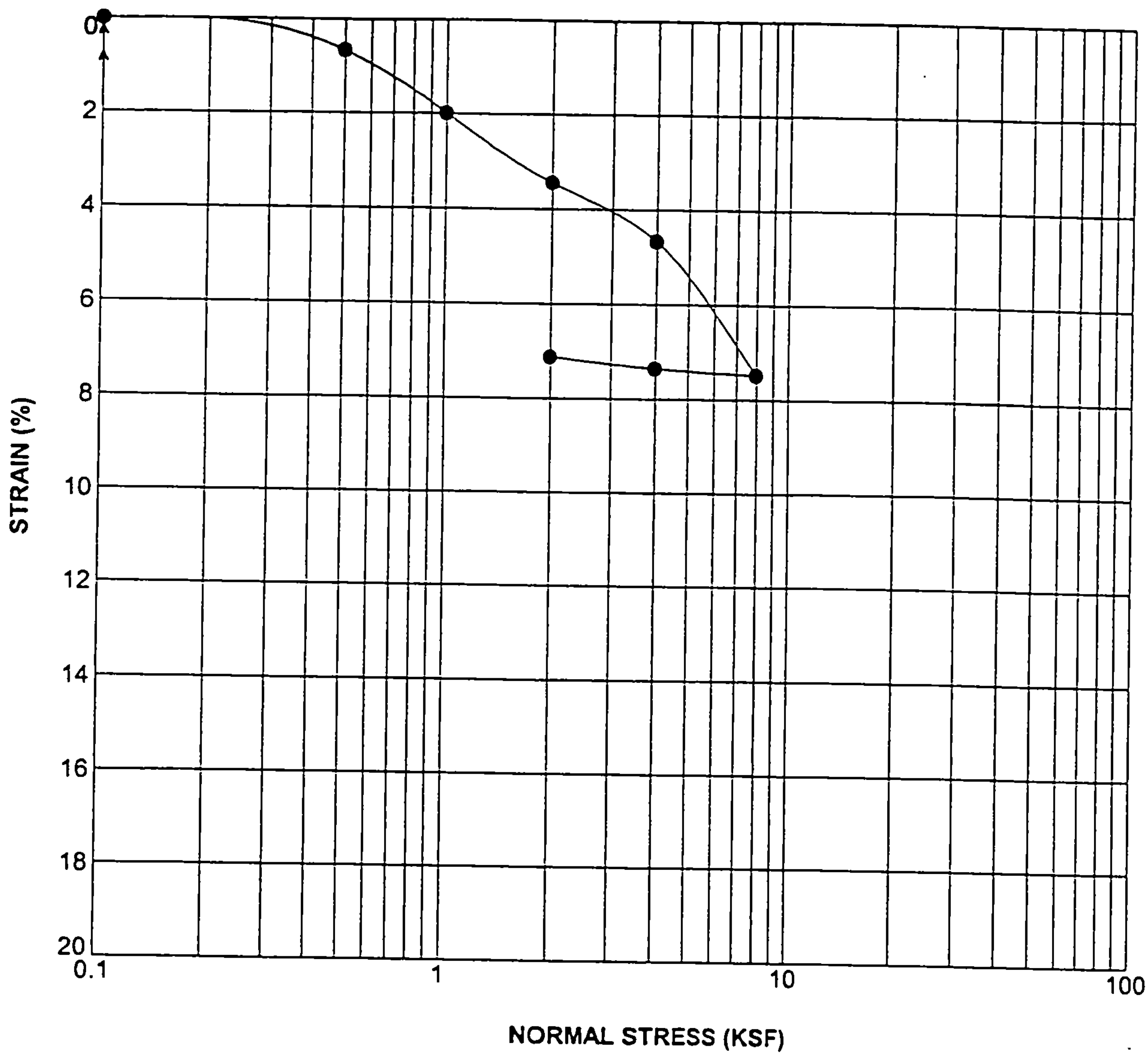
GROUP DELTA CONSULTANTS

DIRECT SHEAR TEST

Group Delta Consultants, Inc.

Project: Santa Ana Unified School District
Location: Santa Ana, California
Project No.: I-283

Figure B-5



SYMBOL	BORING	DEPTH (ft)	DESCRIPTION	Liquid Limit	Plastic Limit
●	B- 5	5.0 - 6.5	(CL) Lean CLAY w/Sand		

	Moisture Content (%)	Dry Density (pcf)	Percent Saturation (%)	Void Ratio
INITIAL		107.2		0.572
FINAL				

Specific Gravity: 2.7

Remark: SAMPLE SATURATED AT KSF

GROUP DELTA CONSULTANTS

CONSOLIDATION TEST

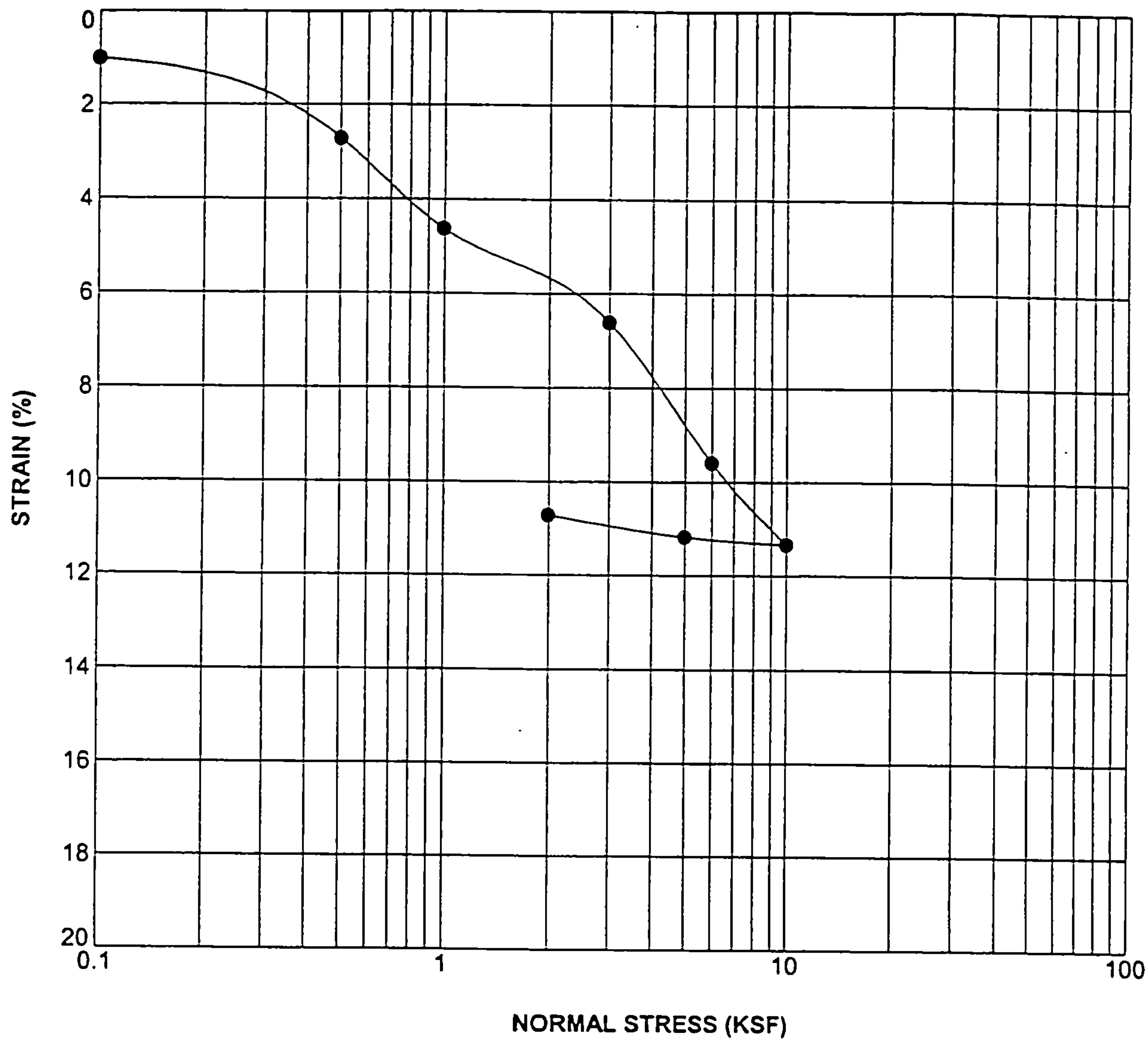
Group Delta Consultants, Inc.

Project: Santa Ana Unified School District

Location: Santa Ana, California

Number: I-283

FIGURE B-7



SYMBOL	BORING	DEPTH (ft)	DESCRIPTION	Liquid Limit	Plastic Limit
●	B-10	5.0 - 6.5	(CL) Lean CLAY	33	16

	Moisture Content (%)	Dry Density (pcf)	Percent Saturation (%)	Void Ratio
INITIAL		105.2		0.602
FINAL				

Specific Gravity: 2.7

Remark: SAMPLE SATURATED AT KSF

GROUP DELTA CONSULTANTS

CONSOLIDATION TEST

Group Delta Consultants, Inc.

Project: Santa Ana Unified School District
Location: Santa Ana, California
Number: I-283

FIGURE B-8

GDC CON STR I-283.GPJ GDC WLOG.GDT 7/3/01

APPENDIX D

PROBABILISTIC SEISMIC ANALYSIS

APPENDIX D

Probabilistic Seismic Analysis

Rationale

The classic "deterministic" approach to seismic hazard analysis usually begins with assignment of maximum probable (for design of most structures) and/or maximum credible (for high-rise structures) earthquakes to local active faults, followed by measurements of the shortest distance (site radius) between the subject site and each of those faults. Hypothetical design accelerations are then determined by using any of several dozen empirical ground acceleration attenuation equations that relate hypothetical site ground accelerations to postulated earthquakes and site radii.

Deterministic analyses of seismic hazard (site acceleration in this case) deal with absolutes, are not time-dependent, and assume a kind of "certainty". In essence, they assume a very large earthquake will occur along a given fault at precisely its closest point to the subject site, and they do not consider the likelihood of that earthquake occurring within a given exposure period (structure lifetime). Therefore, probabilistic methods of seismic risk determination that account for uncertainties in time, recurrence intervals, size, and location (along faults) of hypothetical earthquakes have been developed and are suitable for use with engineering analyses. These methods thus account for likelihood (rather than certainty) of occurrence and provide levels of ground acceleration that might be more reasonably hypothesized for a finite exposure period. For example, a commonly accepted level of risk for a school site is the "statistical" chance that certain acceleration will only have a 10 percent probability of being exceeded within a 100-year period (roughly the life of an average development). This level of risk is accepted, in principle, in the UBC (Blake, 1989, 1991, 1993, 1995). One reliable software program particularly suitable for this study is FRISKSP, developed from United States Geological Survey software (FRISKSP) by Blake (1998, 2000). Various attenuation curves, including the Boore et al. (1997), Sadigh et al (1997), Campbell and Borzognia (1997 Rev)) relationships used herein, can be employed. Also, various useful parameters of known regional and local faults are embedded in the source code. Accordingly, our analysis uses that software package. For complete discussion of the software and probabilistic methods, the reader is referred to Blake (1998, 2000).

Methodology

For this FRISKSP probabilistic analysis, this firm specified a search of the FRISKSP data base of major known active faults within a 100-kilometer radius; and then a 10% probability of Exceedence in a 50-year exposure period using three (3) different attenuation relations: Boore et al. (1997), Sadigh et.al. (1997), and Campbell and Borzognia (1997 Rev). FRISKSP found and analyzed input from 38 faults within a 100-kilometer radius from the subject site (Table D-1 and Figure D-1). A regional fault map has been included as Figure D-2. Blake (1998, 2000) discusses each fault, including maximum earthquakes, slip rates, recurrence intervals and constants; and the reviewer is so referred. FRISKSP does not account for, assuming regular recurrences cycles, whether each fault is early, median or late in its recurrence interval.

Results

FRISKSP computed the mean plus one sigma random horizontal acceleration that hypothetically has a UBC-consistent 10 percent chance of being exceeded in 50 years (DBE), the equivalent of approximately a 475-year average return period according to generally accepted probabilistic approach. By averaging the probability of Exceedence plots (Figures D-3 through D-5), a mean random horizontal peak ground acceleration of 0.37g was computed for the DBE.

In sum, these results are based upon many unavoidable geological and statistical uncertainties, but yet are consistent with current standard-of-practice. As engineering seismology evolves, and as more fault-specific geological data are gathered, more certainty and different methodologies may also evolve.

APPENDIX D

References

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2. Blake, T.F., 1998, FRISKSP Ver. 3.01b, and 2000, FRISKSP Ver. 4.00, "*A computer program for the probabilistic estimation of peak acceleration and uniform hazard spectra using 3-D faults as earthquake sources*", Thomas F. Blake, Newbury Park, California.

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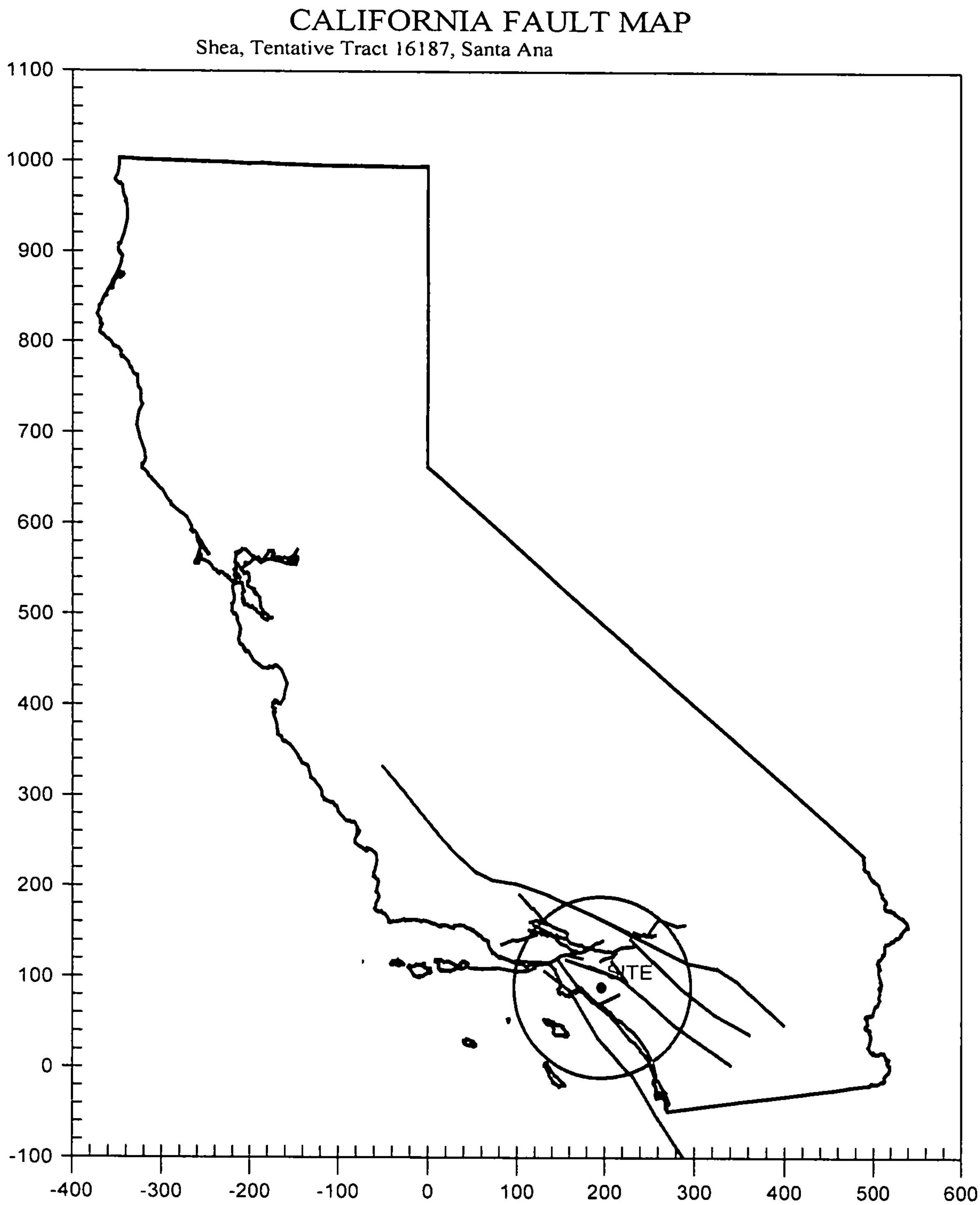
TABLE D-1, Distance To Selected Faults

	FAULT	DISTANCE
1	SAN JOAQUIN HILLS BT (6/03mod)	15.5 km
2	NEWPORT-INGLEWOOD LA Basin 6/03	16 km
3	WHITTIER	16.6 km
4	PUENTE HILLS-BT (6/03mod)	17.3 km
5	NEWPORT-INGLEWOOD Offshore 6/03	20.8 km
6	ELSINORE-GLEN IVY	23.7 km
7	CHINO-CENTRAL AVE. (Elsinore)	26.4 km
8	SAN JOSE	29.4 km
9	PALOS VERDES (6/03mod)	32.4 km
10	ELYSIAN PARK UPPER(6/03mod Blind	38.9 km
11	SIERRA MADRE (6/03mod)	40.1 km
12	CUCAMONGA (6/03mod)	41.2 km
13	RAYMOND (6/03 mod)	44.4 km
14	CLAMSHELL-SAWPIT	46.2 km
15	VERDUGO	47.3 km
16	HOLLYWOOD	50.5 km
17	ELSINORE-TEMECULA	50.8 km
18	CORONADO BANK	56.5 km
19	SANTA MONICA (6/03mod)	60.1 km
20	SAN JACINTO-SAN BERNARDINO	60.5 km
21	SAN JACINTO-SAN JACINTO VALLEY	64.8 km
22	SAN ANDREAS-Mojave (6/03 mod)	66.8 km
23	SAN ANDREAS-San Bernardino 6/03	66.9 km
24	SAN ANDREAS - Southern	67.2 km
25	MALIBU COAST	67.2 km
26	SAN ANDREAS - 1857 Rupture	67.5 km
27	SIERRA MADRE (San Fernando)	68.1 km
28	CLEGHORN	70.7 km
29	SAN GABRIEL	71.1 km
30	NORTHRIDGE (E. Oak Ridge)	74.6 km
31	ANACAPA-DUME	79.3 km
32	NORTH FRONTAL FAULT ZONE (West)	80.7 km
33	ROSE CANYON (6/03mod)	82.9 km
34	SANTA SUSANA	83.8 km
35	SAN JACINTO-ANZA	88.6 km
36	ELSINORE-JULIAN	91.1 km
37	HOLSER	94.8 km
38	SIMI-SANTA ROSA (6/03mod)	95.3 km

Shea Homes- Tentative Tract 16187, Santa Ana, California
W.O. 500653



PACIFIC SOILS ENGINEERING, INC. **FIGURE D-1**

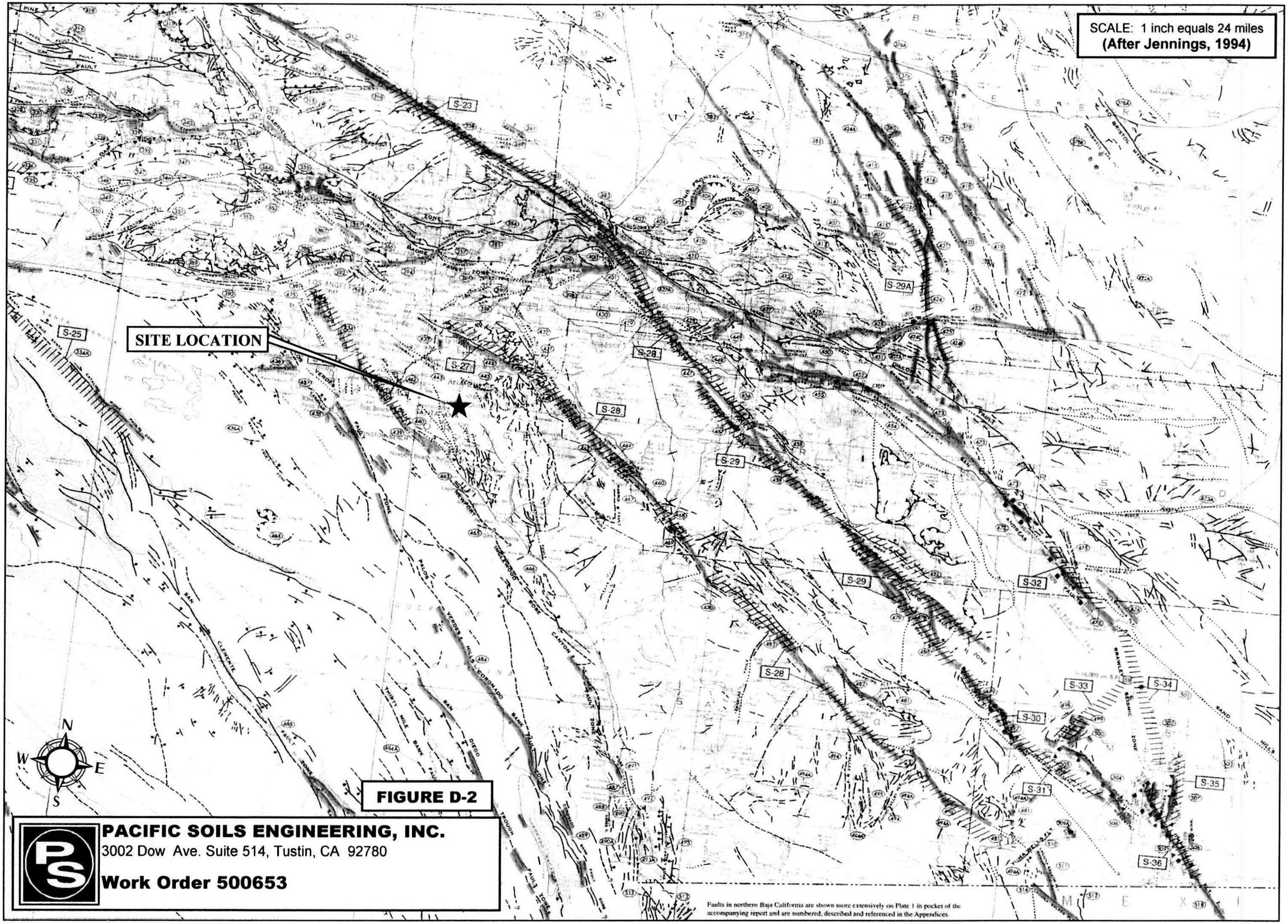
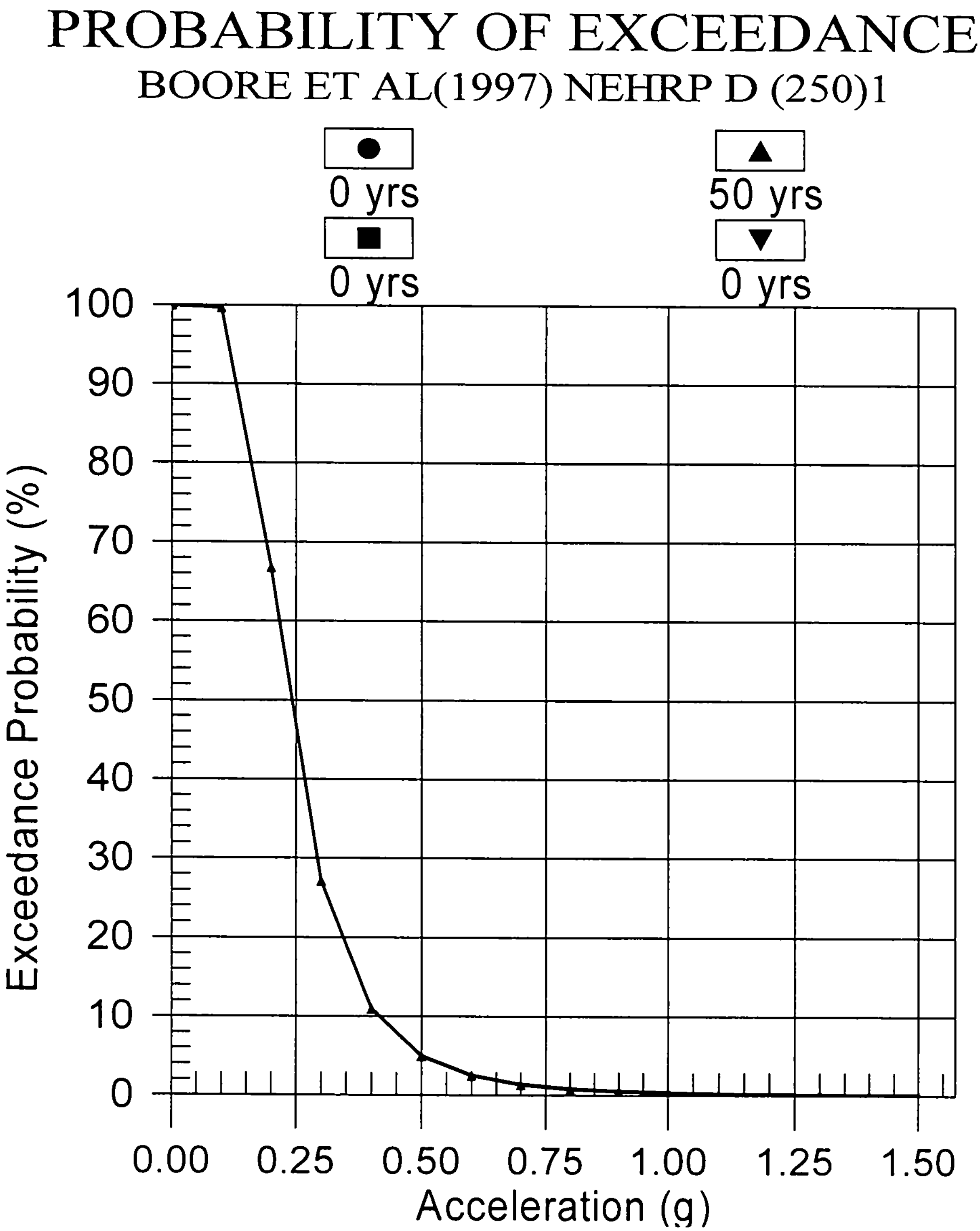


FIGURE D-2

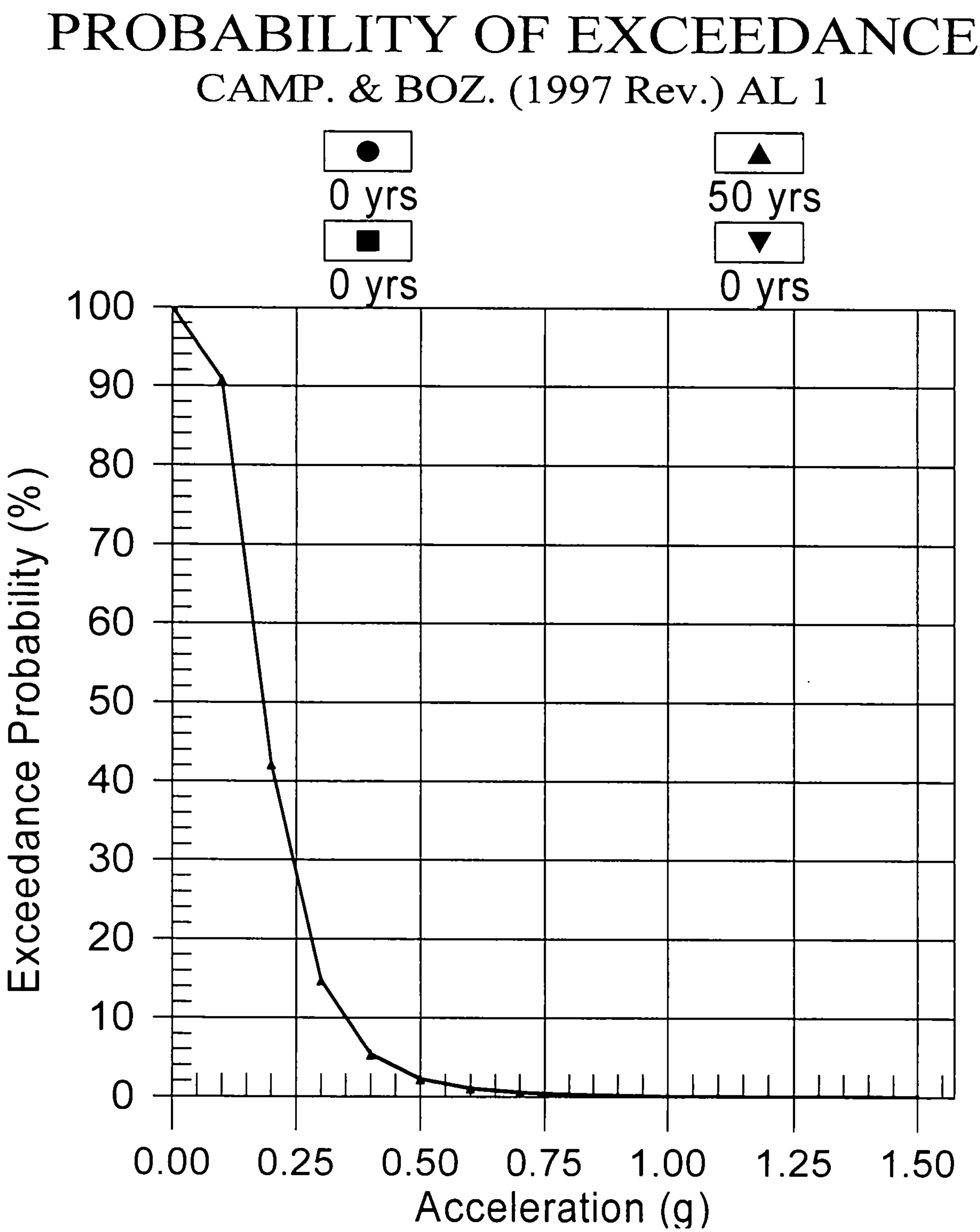
PACIFIC SOILS ENGINEERING, INC.
3002 Dow Ave. Suite 514, Tustin, CA 92780

Work Order 500653

Shea Homes- Tentative Tract 16187, Santa Ana, California
W.O. 500653



PACIFIC SOILS ENGINEERING, INC. FIGURE D-3


PROBABILITY OF EXCEEDANCE
CAMP. & BOZ. (1997 Rev.) AL 1
0 yrs
50 yrs
0 yrs
0 yrs
Exceedance Probability (%)
100
90
80
70
60
50
40
30
20
10
0
0.00
0.25
0.50
0.75
1.00
1.25
1.50
Acceleration (g)

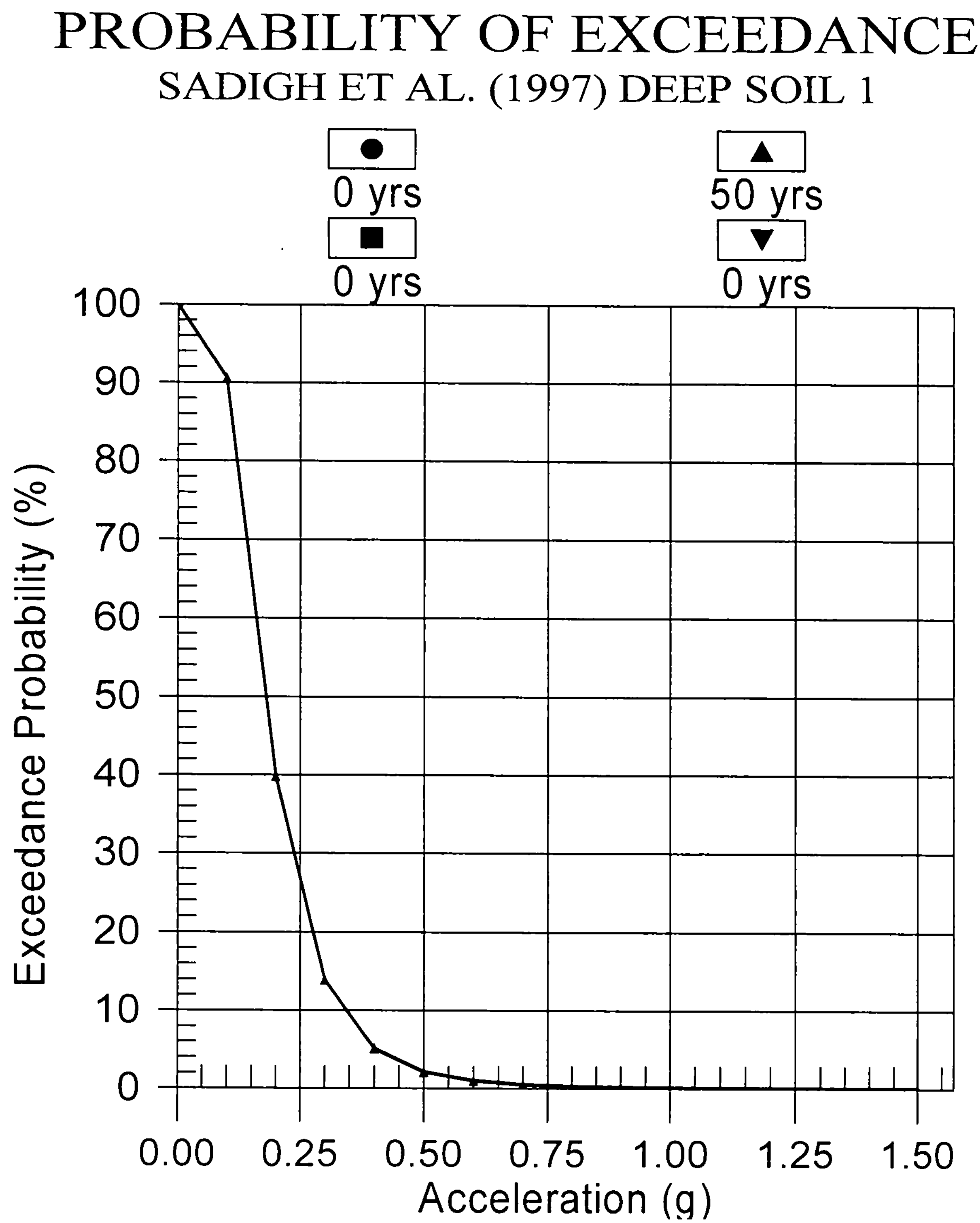

PROBABILITY OF EXCEEDANCE
SADIGH ET AL. (1997) DEEP SOIL 1
0 yrs
50 yrs
0 yrs
0 yrs
100
90
80
70
60
50
40
30
20
10
0
Exceedance Probability (%)
0.00
0.25
0.50
0.75
1.00
1.25
1.50
Acceleration (g)

FIGURE D-5

APPENDIX E

EARTHWORK SPECIFICATIONS

PACIFIC SOILS ENGINEERING, INC.
EARTHWORK SPECIFICATIONS

These specifications present generally accepted standards and minimum earthwork requirements for the development of the project. These specifications shall be the project guidelines for earthwork except where specifically superceded in preliminary geology and soils reports, grading plan review reports or by prevailing grading codes or ordinances of the controlling agency.

1. **GENERAL**

A. The contractor shall be responsible for the satisfactory completion of all earthwork in accordance with the project plans and specifications.

B. The project Soil Engineer and Engineering Geologist or their representatives shall provide testing services, and geotechnical consultation during the duration of the project.

C. All clearing, grubbing, stripping and site preparation for the project shall be accomplished by the Contractor to the satisfaction of the Soil Engineer.

D. It is the Contractor's responsibility to prepare the ground surface to receive the fills to the satisfaction of the Soil Engineer and to place, spread, mix and compact the fill in accordance with the job specifications and as required by the Soil Engineer. The Contractor shall also remove all material considered by the Soil Engineer to be unsuitable for use in the construction of compacted fill.

E. The Contractor shall have suitable and sufficient equipment in operation to handle the amount of fill being placed. When necessary, equipment will be shut down temporarily in order to permit proper compaction of fills.

II. **SITE PREPARATION**

A. Excessive vegetation and all deleterious material shall be disposed of offsite as required by the Soil Engineer. Existing fill, soil, alluvium or rock materials determined by the Soil Engineer as being unsuitable for placement in compacted fills shall be removed and wasted from the site. Where applicable, the Contractor may obtain the approval of the Soil Engineer and the controlling authorities for the project to dispose of the above described materials, or a portion thereof, in designated areas onsite.

After removals as described above have been accomplished, earth materials deemed unsuitable in their natural, in-place condition, shall be removed as recommended by the Soil Engineer/Engineering Geologist.

B. After the removals as delineated in Item II, A above, the exposed surfaces shall be disced or bladed by the Contractor to the satisfaction of the Soil Engineer. The prepared ground surfaces shall then be brought to the specified moisture condition, mixed as required, and compacted and tested as specified. In areas where it is necessary to obtain the approval of the controlling agency, prior to placing fill, it will be the contractor's responsibility to notify the proper authorities.

C. Any underground structures such as cesspools, cisterns, mining shafts, tunnels, septic tanks, wells, pipelines or others not located prior to grading are to be removed or treated in a manner prescribed by the Soil Engineer and/or the controlling agency for the project.

III. <u>COMPACTED FILLS</u>

A. Any materials imported or excavated on the property may be utilized in the fill, provided each material has been determined to be suitable by the Soil Engineer. Deleterious material not disposed of during clearing or demolition shall be removed from the fill as directed by the Soil Engineer.

B. Rock or rock fragments less than eight inches in the largest dimension may be utilized in the fill, provided they are not placed in concentrated pockets and the distribution of the rocks is approved by the Soil Engineer.

C. Rocks greater than eight inches in the largest dimension shall be taken offsite, or placed in accordance with the recommendations of the Soil Engineer in areas designated as suitable for rock disposal.

D. All fills, including onsite and import materials to be used for fill, shall be tested in the laboratory by the Soil Engineer. Proposed import materials shall be approved prior to importation.

E. The fill materials shall be placed by the Contractor in layers that when compacted shall not exceed six inches. Each layer shall be spread evenly and shall be thoroughly mixed during the spreading to obtain a near uniform moisture condition and a uniform blend of materials.

All compaction shall be achieved at optimum moisture content, or above, as determined by the applicable laboratory standard. No upper limit on the moisture content is necessary; however, the Contractor must achieve the necessary compaction and will be alerted when the material is too wet and compaction cannot be attained.

F. Where the moisture content of the fill material is below the limit specified by the Soil Engineer, water shall be added and the materials shall be blended until a uniform moisture content, within specified limits, is achieved. Where the moisture content of the fill material is above the limits specified by the Soil Engineer, the fill materials shall be aerated by discing, blading or other satisfactory methods until the moisture content is within the limits specified.

G. Each fill layer shall be compacted to minimum project standards, in compliance with the testing methods specified by the controlling governmental agency and in accordance with recommendations of the Soil Engineer.

In the absence of specific recommendations by the Soil Engineer to the contrary, the compaction standard shall be ASTM:D 1557-91.

H. Where a slope receiving fill exceeds a ratio of five-horizontal to one-vertical, the fill shall be keyed and benched through all unsuitable topsoil, colluvium, alluvium, or creep material, into sound bedrock or firm material , in accordance with the recommendations and approval of the Soil Engineer.

I. Side hill fills shall have a minimum key width of 15 feet into bedrock or firm materials, unless otherwise specified in the soil report and approved by the Soil Engineer in the field.

J. Drainage terraces and subdrainage devices shall be constructed in compliance with the ordinances of the controlling governmental agency and/or with the recommendations of the Soil Engineer and Engineering Geologist.

K. The contractor shall be required to maintain the specified minimum relative compaction out to the finish slope face of fill slopes, buttresses, and stabilization fills as directed by the Soil Engineer and/or the governing agency for the project. This may be achieved by either overbuilding the slope and cutting back to the compacted core, or by direct compaction of the slope face with suitable equipment, or by any other procedure which produces the designated result.

L. Fill-over-cut slopes shall be properly keyed through topsoil, colluvium or creep material into rock or firm material; and the transition shall be stripped of all soil or unsuitable materials prior to placing fill.

The cut portion should be made and evaluated by the Engineering Geologist prior to placement of fill above.

M. Pad areas in natural ground and cut shall be approved by the Soil Engineer. Finished surfaces of these pads may require scarification and recompaction.

IV. CUT SLOPES

A. The Engineering Geologist shall inspect all cut slopes and shall be notified by the Contractor when cut slopes are started.

B. If, during the course of grading, unforeseen adverse or potentially adverse geologic conditions are encountered, the Engineering Geologist and Soil Engineer shall investigate, analyze and make recommendations to treat these problems.

C. Non-erodible interceptor swales shall be placed at the top of cut slopes that face the same direction as the prevailing drainage.

D. Unless otherwise specified in soil and geological reports, no cut slopes shall be excavated higher or steeper than that allowed by the ordinances of controlling governmental agencies.

E. Drainage terraces shall be constructed in compliance with the ordinances of the controlling governmental agencies, and/or in accordance with the recommendations of the Soil Engineer or Engineering Geologist.

V. GRADING CONTROL

A. Fill placement shall be observed by the Soil Engineer and/or his representative during the progress of grading.

Field density tests shall be made by the Soil Engineer or his representative to evaluate the compaction and moisture compliance of each layer of fill. Density tests shall be performed at intervals not to exceed two feet of fill height. Where sheepsfoot rollers are used, the soil may be disturbed to a depth of several inches. Density determinations shall be taken in the compacted material below the disturbed surface at a depth determined by the Soil Engineer or his representative.

B. Where tests indicate that the density of any layer of fill, or portion thereof, is below the required relative compaction, or improper moisture is in evidence, the particular layer or portion shall be reworked until the required density and/or moisture content has been attained. No additional fill shall be placed over an area until the last placed lift of fill has been tested and found to meet the density and moisture requirements and that lift approved by the Soil Engineer.

C. Where the work is interrupted by heavy rains, fill operations shall not be resumed until field observations and tests by the Soil Engineer indicate the moisture content and density of the fill are within the limits previously specified.

D. During construction, the Contractor shall properly grade all surfaces to maintain good drainage and prevent ponding of water. The Contractor shall take remedial measures to control surface water and to prevent erosion of graded area until such time as permanent drainage and erosion control measures have been installed.

E. Observation and testing by the Soil Engineer shall be conducted during the filling and compacting operations in order that he will be able to state in his opinion all cut and filled areas are graded in accordance with the approved specifications.

F. After completion of grading and after the Soil Engineer and Engineering Geologist have finished their observations of the work, final reports shall be submitted. No further excavation or filling shall be undertaken without prior notification of the Soil Engineer and/or Engineering Geologist.

VI. <u>SLOPE PROTECTION</u>

All finished cut and fill slopes shall be planted and/or protected from erosion in accordance with the project specifications and/or as recommended by a landscape architect.

APPENDIX F

HOMEOWNERS MAINTENANCE AND IMPROVEMENT CONSIDERATIONS MANUAL

HOMEOWNERS MAINTENANCE AND IMPROVEMENT CONSIDERATIONS MANUAL

Irrigation and Drainage

Design, construction and homeowner maintenance provisions should include:

- Employing contractors for homeowner improvements who design and build in recognition of local building code and site-specific soils conditions.
- Establishing and maintaining positive drainage away from all foundations, walkways, driveways, patios, and other hardscape improvements.
- Avoiding the construction of planters adjacent to structural improvements. Alternatively, planter sides/bottoms can be sealed with an impermeable membrane and drained away from the improvements via subdrains into approved disposal areas.
- Sealing and maintaining construction/control joints within concrete slabs and walkways to reduce the potential for moisture infiltration into the subgrade soils.
- Utilizing landscaping schemes with vegetation that requires minimal watering. Alternatively, watering should be done in a uniform manner as equally as possible on all sides of the foundation, keeping the soil "moist" but not allowing the soil to become saturated.
- Maintaining positive drainage away from structures and providing roof gutters on all structures with downspouts installed to carry roof runoff directly into area drains or discharged well away from the structures.
- Avoiding the placement of trees closer to the proposed structures than a distance of one-half the mature height of the tree.
- Observation of the soil conditions around the perimeter of the structure during extremely hot/dry or unusually wet weather conditions so that modifications can be made in irrigation programs to maintain relatively constant moisture conditions.

Sulfates

On site soils were tested by others for the presence of soluble sulfates. Based on the results of that testing, the soluble sulfate exposure level was determined to be “negligible” when classified in accordance with the 1997 UBC. As such, no specific concrete mix design is required based on Table 19-A-4 of the 1997 UBC.

Homeowners and property managers should be cautioned against the import and use of certain fertilizers, soil amendments, and/or other soils from offsite sources in the absence of specific information relating to their chemical composition. Some fertilizers have been known to leach sulfate compounds into soils otherwise containing "negligible" sulfate concentrations and increase the sulfate concentrations in near-surface soils to "moderate" or "severe" levels. In some cases, concrete improvements constructed in soils containing high levels of soluble sulfates may be affected by deterioration and loss of strength.

Site Drainage

- The homeowners should be made aware of the potential problems that may develop when drainage is altered through construction of retaining walls, swimming pools, paved walkways and patios. Ponded water, drainage over the slope face, leaking irrigation systems, over-watering or other conditions which could lead to ground saturation must be avoided.
- No water should be allowed to flow over the slopes. No alteration of pad gradients should be allowed which will prevent pad and roof runoff from being directed to approved disposal areas.
- As part of site maintenance by the resident, all roof and pad drainage should be directed away from slopes and around structures to approved disposal areas. Berms and swales should be constructed as part of fine grading and should be maintained by the resident. The recommended drainage patterns have been established at the time of the fine grading and should be maintained throughout the life of the structure. No alterations to these drainage patterns should be made unless designed by qualified professionals in compliance with local code requirements.

Slope Drainage

- Residents should be made aware of the importance of maintaining and cleaning all interceptor ditches, drainage terraces, downdrains and any other drainage devices which have been installed to promote slope stability.
- Backdrain and subdrain outlet pipes may protrude through slope surfaces or retaining wall faces. These pipes, in conjunction with the graded features, are essential to slope and wall stability and must be protected in-place and not altered or damaged in any way.

Planting and Irrigation

- Seeding and planting of the slopes should be planned to achieve, as rapidly as possible, a well-established and deep-rooted vegetal cover requiring minimal watering.

- It should be the responsibility of the landscape architect to provide such plants initially and of the residents to maintain such planting. Alteration of such a planting scheme is at the resident's risk.

- The resident is responsible for proper irrigation and for maintenance and repair of properly installed irrigation systems. Leaks should be fixed immediately.

- Sprinklers should be adjusted to provide maximum uniform coverage with a minimum of water usage and overlap. Overwatering with consequent wasteful runoff and serious ground saturation must be avoided.

- If automatic sprinkler systems are installed, their use must be adjusted to account for natural rainfall conditions.

Burrowing Animals

Residents must undertake a program to eliminate burrowing animals. The burrowing animal control program should be conducted by a licensed exterminator and/or landscape professional with expertise in residential maintenance.

Geotechnical Review

Due to the fact that soil types may vary with depth, it is recommended that plans for the construction of rear yard improvements (swimming pools, spas, barbecue pits, patios, etc.), be reviewed by a geotechnical engineer who is familiar with local conditions and the current standard of practice in the City of Santa Ana.

IN ACCORD WITH APPLICABLE CITY STANDARDS

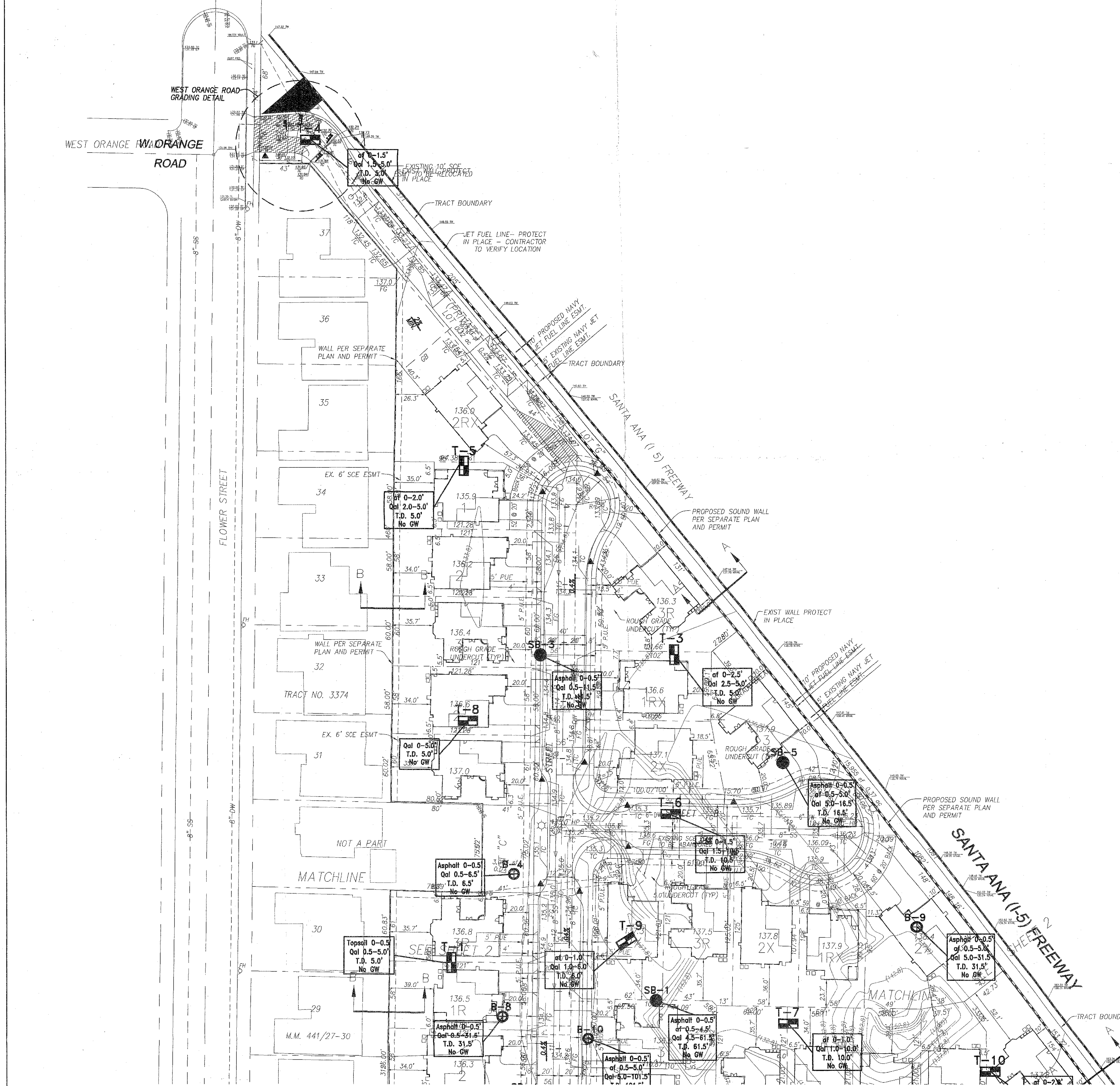
FILE NO.	REVISIONS	BENCHMARKS	REFERENCES	DESIGNED:	SCALE:
	NUMBER / DATE / INITIALS / DESCRIPTIONS / APPRVD			DRAWN:	DATE:
				CHECKED:	JOB NUMBER:

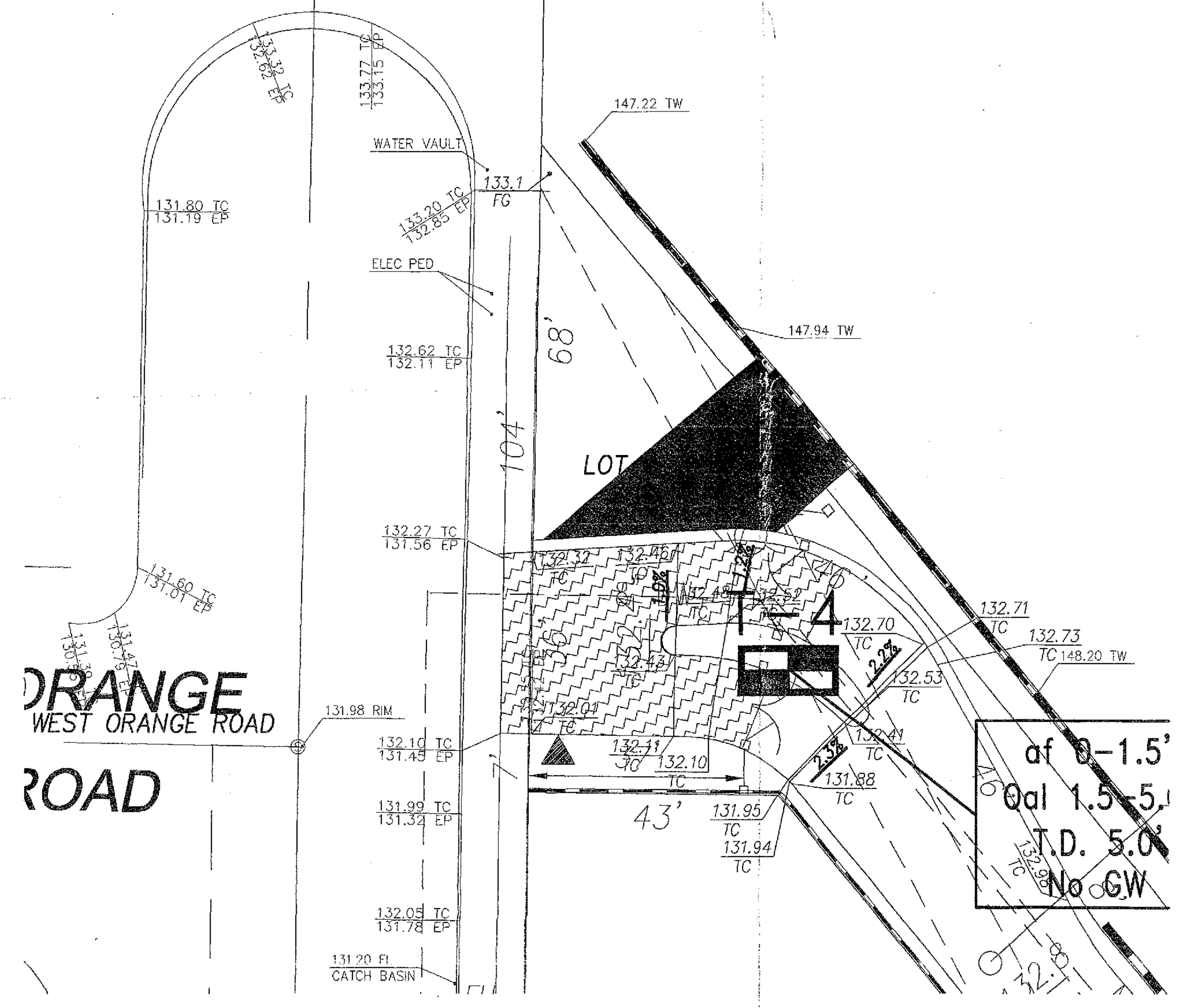
PLAN PREPARED BY: RBF CONSULTING — PLANNING ■ DESIGN ■ CONSTRUCTION
UNDER SUPERVISION OF: PATRICK F. REVERE
DATE: R.C.E. # 62921

PROJECT ADDRESS: 2800 N. FARMERS DRIVE, SANTA ANA, CA.
DP 01-007

ROUGH GRADING PLAN
TENTATIVE TRACT 16187

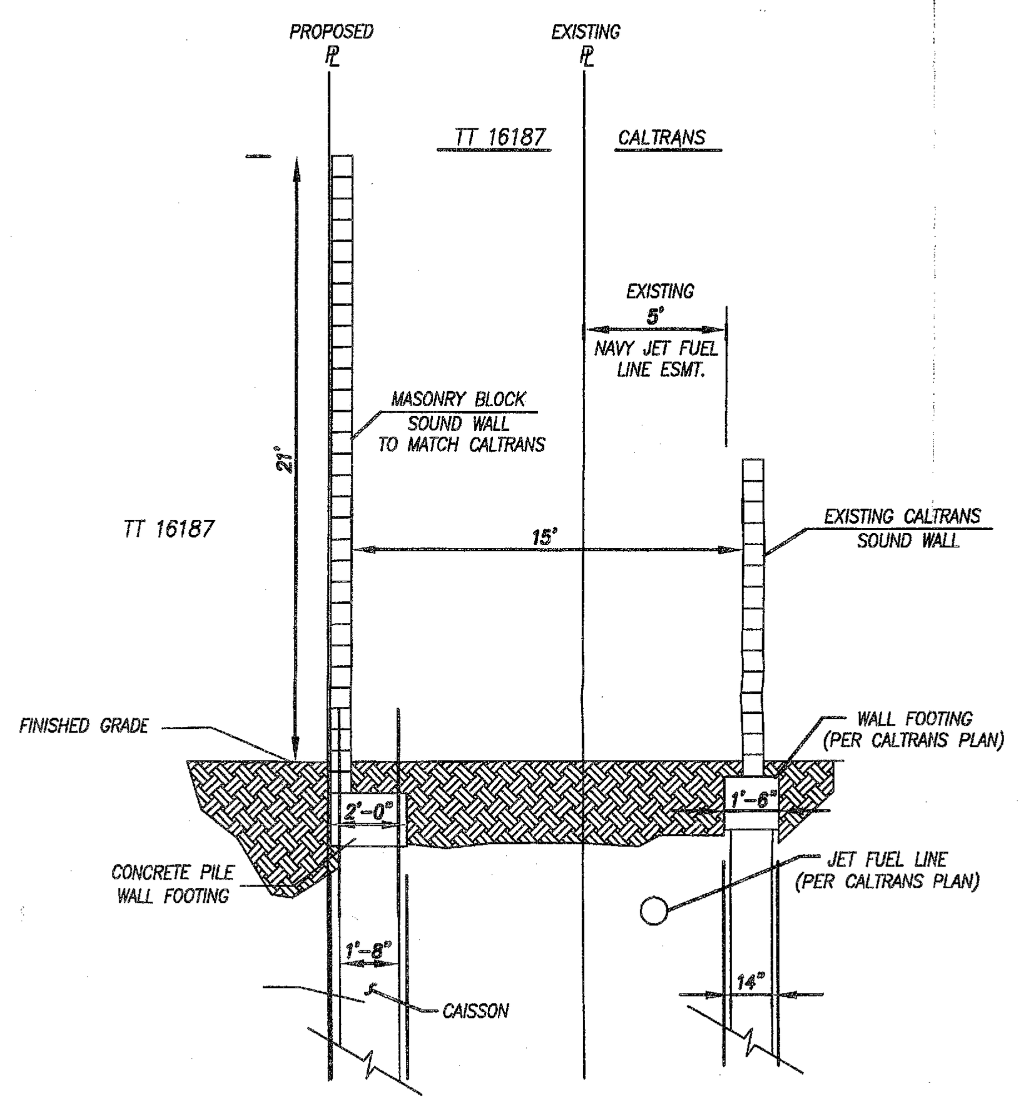
PUBLIC WORKS AGENCY
CITY OF SANTA ANA
SHEET 2 OF





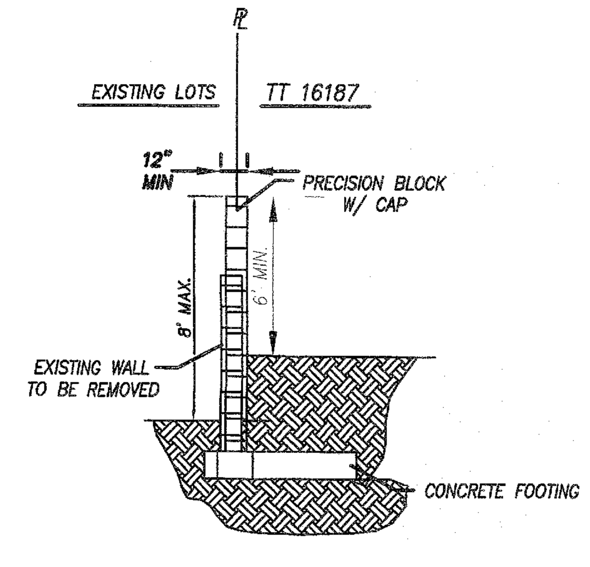
WEST ORANGE ROAD GRADING DETAIL

GRAPHIC SCALE: 1"=20'



SECTION A-A SOUNDWALL

NOT TO SCALE



SECTION B-B PERIMETER WALL

NOT TO SCALE

GEOTECHNICAL LEGEND

af	ARTIFICIAL FILL
Qal	ALLUVIUM
T-9	APPROXIMATE LOCATION OF PSE TEST PIT (CURRENT INVESTIGATION)
B-4	APPROXIMATE LOCATION OF GROUP DELTA BORING (2001)
SB-1	APPROXIMATE LOCATION OF GEOCON BORING (2000)

GRAPHIC SCALE: 1"=40'

PLATE 1 GEOTECHNICAL MAP

PACIFIC SOILS ENGINEERING, INC.
3002 DOW AVENUE, SUITE 514, TUSTIN, CA 92780
TELEPHONE: (714) 730-2122, FAX: (714) 730-5191
W.O. 500653 DATE: 5-18-05

IN ACCORD WITH APPLICABLE CITY STANDARDS

DP 01-007

PROJECT ADDRESS:
2800 N. FARMERS DRIVE
SANTA ANA, CA.

FILE NO.	REVISIONS	BENCHMARKS	REFERENCES
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DESIGNED: SCALE:
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PLAN PREPARED BY:
RBF CONSULTING — PLANNING ■ DESIGN ■ CONSTRUCTION
UNDER SUPERVISION OF:
PATRICK F. REVERE DATE: R.C.E # 62921

REGISTERED PROFESSIONAL ENGINEER PATRICK F. REVERE NO. 62921 Exp. 06-30-06 CIVIL STATE OF CALIFORNIA

ROUGH GRADING PLAN
TENTATIVE TRACT 16187

PUBLIC WORKS AGENCY
CITY OF SANTA ANA SHEET 3 OF