# Appendix F Geotechnical Assessment

Appendices

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December 19, 2018
**Project Number 1-0250**

Attention: Mr. George Basye

Subject: **EIR-LEVEL GEOTECHNICAL ASSESSMENT**
Brea Central Property, City of Brea
County of Orange, California

<u>References</u>: See Appendix A

Dear Mr. Basye:

In accordance with your request, Alta California Geotechnical, Inc. (Alta) is pleased to submit this geotechnical assessment in support of EIR submittals for the Brea Central Property, in the City of Brea, County of Orange, California. An initial geotechnical subsurface investigation was previously conducted onsite by Pacific Soils Engineering, Inc. (PSE, 1999) that included the excavation, logging, and sampling of bucket-auger borings and backhoe trenches. We reviewed the technical documents that are tabulated in Appendix A.

In this document, Alta first summarizes the investigative methodology and the geographic, geomorphic, and geologic setting of the Brea Central project and its environs. We then assess geological and geotechnical engineering issues applicable to EIR processing and offer potential mitigations for same. Included in the text of this report are a Site Location map (Figure 1), Geomorphic Province Map (Figure 2), Regional Geologic Map (Figure 3), Regional Fault Map (Figure 4), and Mineral Land Classification Map (Figure 5). Appendices include the reference list (Appendix A), previous subsurface investigation (Appendix B), and previous laboratory test results (Appendix C). A 200-scale Geologic Map is included as a pocket enclosure.

The project is considered feasible from a geologic and geotechnical perspective. The major geotechnical issues that could impact the development as conceived are discussed in Section 4.0 of this document and include: faulting and seismic hazards; erosion/mass wasting; slope stability; compressible/collapsible soils; expansive soils; infiltration characteristics; and corrosion. All these issues can be mitigated and alternatives for mitigation are presented in this report.

Alta appreciates the opportunity to provide you with geotechnical consulting services. If you have any questions or should you require any additional information, please contact the undersigned at (951) 509-7090.

Respectfully submitted,
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Distribution: (1) Addressee

SAG: -eg-1-0250, December 19, 2018 (EIR-Level Geotechnical Assessment)

# TABLE OF CONTENTS

# 1.0 INTRODUCTION

## 1.1 Background and Purpose

This report presents the results of Alta California Geotechnical, Inc's. (Alta) geotechnical assessment in support of EIR processing for the Brea Central project.

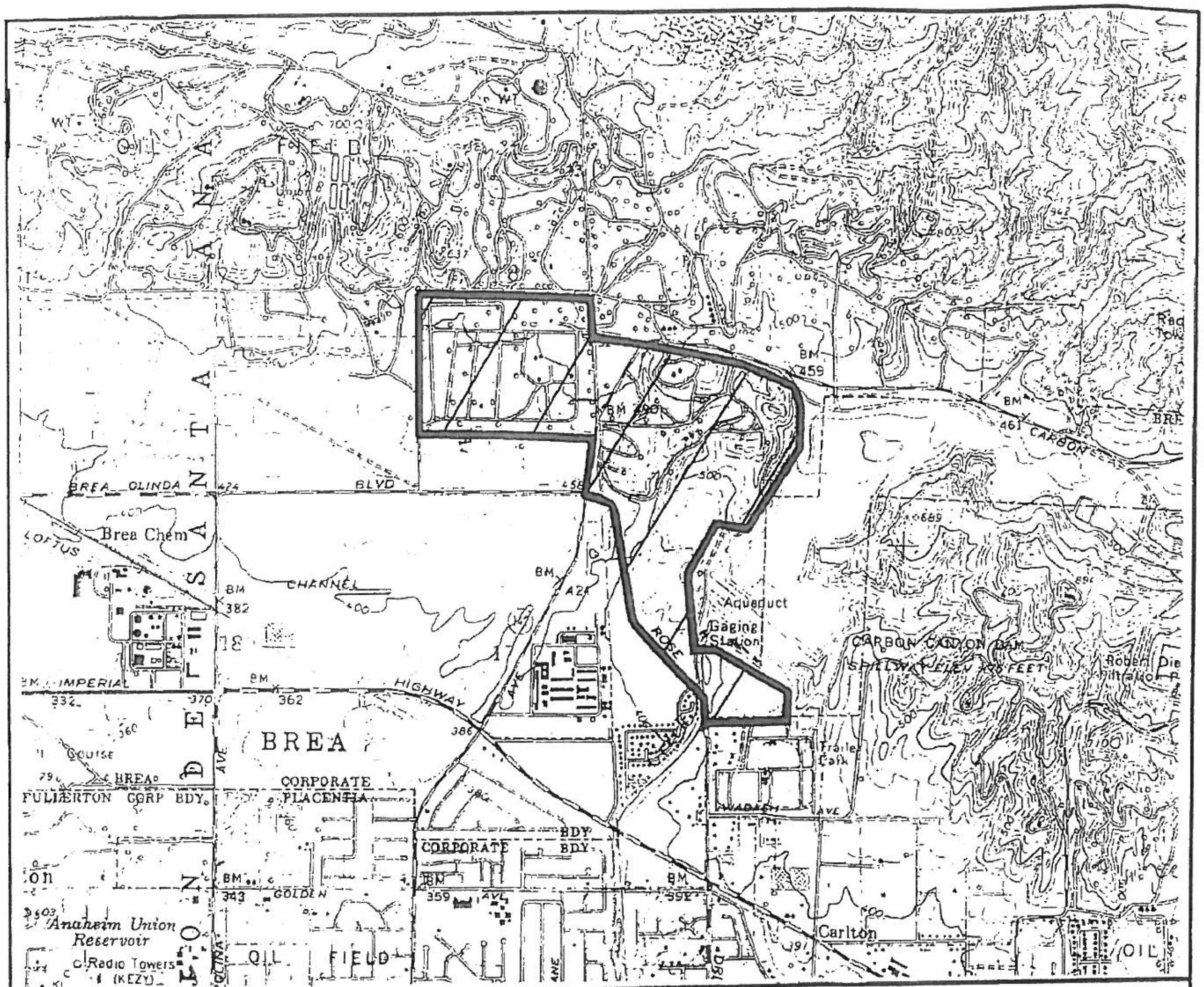
## 1.2 Scope of Work

Alta's scope of work consisted of the following:

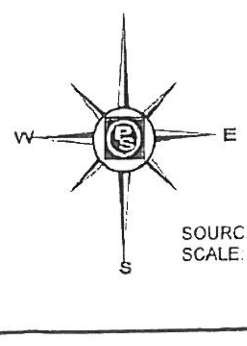
- Reviewing the cited geologic literature, maps, and aerial photographs;
- Site geologic mapping;
- Compiling of previous subsurface information (PSE, 1999), including twenty-one (21) backhoe trench logs and nine (9) bucket auger boring logs (Appendix B);
- Compiling previous laboratory test results (Appendix C);
- A limited seismic evaluation;
- Evaluating the general remedial grading requirements;
- Consolidating the geologic and geotechnical data and preparation of a geologic base map;
- Preparing of this report in support of your EIR submittals, with exhibits, summarizing our findings.

## 1.3 Site Location and Existing Conditions

The subject site is an inverted L shape property, which, for descriptive purposes, is divided herein into eastern and western portions (Figure 1). The eastern portion of the site is bound by Valencia Avenue and Rose Drive on the western side, and Carbon Canyon Regional Park on the eastern side. The northern boundary is at Carbon Canyon Road and the southern limits are at Blake Road. The western portion of the property, known as the "100 Acres", is bound by Birch Street on the south, Lambert Road on the north, Valencia Avenue on the




# SITE LOCATION MAP




SOURCE: YORBA LINDA QUAD
SCALE: 1" = 2000'

FIGURE 1

**ALTA CALIFORNIA GEOTECHNICAL, INC.**
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**PROJECT NUMBER:** 1-0250 **DATE:** 12-19-18

east and an existing housing development on the west. Access to the site is via paved and unpaved roads off of Valencia Avenue, Rose Drive and Blake Road.

Topographically the site is characterized by low-lying alluvial terraces with minimal relief on the southern portions of the site and on the western "100 Acres". The northeastern portion of the site consists of rounded hills and ridgelines of moderate height with intervening canyons and draws. A steep slope is present on the northeastern edge of the property above the Carbon Canyon stream bed. Drainage is by sheet flow to the canyons and draw areas, which drain to the south and southwest. Total relief onsite is approximately 201 feet and elevations range from 586 feet to 385 feet. The natural slopes onsite are gentle to very steep, and range from 1:1 to 5:1 (horizontal:vertical).

Vegetation onsite consists of native grasses, shrubs and trees. Vegetation varies from light to locally heavy, with the heavy vegetation and trees concentrated in the draws and canyons.

The subject site is currently being utilized for oil production and a nursery. Numerous roadways associated with oil field exploration and production exist throughout the site. The site was utilized extensively in the past for agricultural purposes. Small-scale sand and gravel quarrying has occurred onsite. The Carbon Canyon flood control dam and flood basin lies immediately offsite of the south-central portion of the site.

Several utilities cross the site within easements. A Metropolitan Water District easement crosses the far southern portion of the site to Rose Drive. A 30-inch high pressure gas line crosses the southern portion of the project below the Carbon Canyon dam, and a Mobil Oil gasoline line runs in a roughly north-south direction across the eastern portions of the site from Blake Road to Carbon Canyon Road. The Carbon Canyon Dam sewer line is present onsite within the fill prism labeled PSE-1 at the approximate location shown on Plate 1. Numerous other utilities associated with the existing oil field production and the nursery are located onsite.

### 1.4 Proposed Development

Residential building pads with attendant streets and utilities are proposed for the site at this time. Cut and fill mass grading will be required in order to develop lots onsite. Specific plans and details are not presently available.

## 2.0 PREVIOUS INVESTIGATIVE METHODOLOGY

The Brea Central property was the subject of a preliminary geotechnical constraints study prepared by GeoSoils, Inc. (GeoSoils, 1992). No subsurface exploration was conducted as a part of that study.

Pacific Soils Engineering, Inc. (PSE) conducted a subsurface investigation in 1999 (PSE, 1999) directed towards defining the on-site geologic relationships and collecting representative samples for geotechnical testing. Personnel of PSE excavated and logged twenty-one (21) backhoe excavations. The trenches ranged from 3 to 16 feet in depth and were excavated with a Case 580E backhoe. The materials exposed on the trench walls were classified in the field using tactile and visual methods. Logs of the exploratory trenches are presented in Appendix B, and the approximate locations are shown on Plate 1.

A truck mounted bucket auger drill rig equipped with a 30-inch bucket was used to advance nine (9) borings. The borings ranged in depth from 25 to 83 feet. Logs of the exploratory borings are presented in Appendix B, and the locations are shown on Plate 1.

Samples taken during the subsurface investigation were transported to PSE's laboratory for testing and analysis. The results of the laboratory testing are presented in Appendix C of this report.

PSE observed and tested grading operations for adjacent projects that encroached on the subject project, including the Shea Homes development to the northwest, and the Brea Sports Park development (PSE, 2008). PSE also observed and tested grading and trench backfill operations for the Carbon Canyon Dam Sewer project (PSE, 2009).

## 3.0 GEOLOGIC CONDITIONS

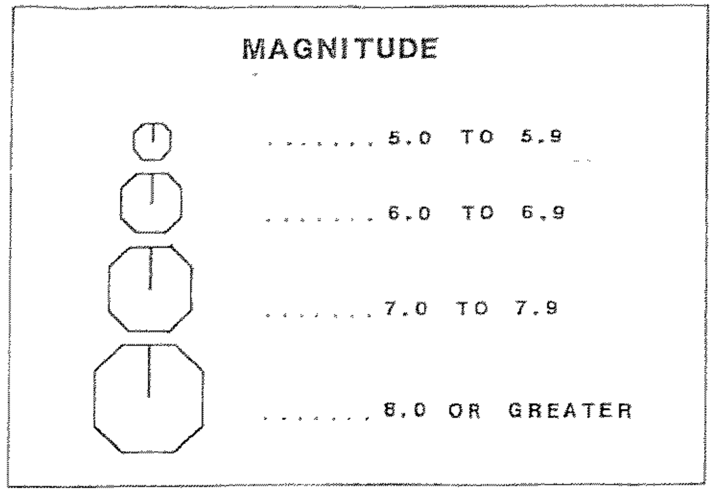
### 3.1 Geologic and Geomorphic Setting

The subject site is located on the southwestern flank of the Puente Hills (Figure 2). The Puente Hills form the western to northwestern margin of the Los Angeles Basin, which is located in Peninsular Ranges Geomorphic Province. The Puente Hills are bracketed by the Whittier and Chino Fault Zones and have been created by uplift along these faults. Approximately 13,000 feet of Miocene aged marine clastic sedimentary rocks underlies the Puente Hills. These sediments overlie approximately 16,000 feet of Cenozoic aged rock which are underlain by Mesozoic plutonic basement rocks (Yerkes, 1972).

Uplift of the Puente Hills in the late Pleistocene and Holocene have created erosional geomorphic features, which have been infilled with older alluvial and terrace materials. These older alluvium and terrace deposits underlie the broad alluvial plains adjacent to the Puente Hills on which the southern and western portions of the project lie. More recent accumulations of alluvium and colluvium are present in the canyons and draws onsite.

### 3.2 Stratigraphy

The site is underlain by engineered artificial fills, undocumented artificial fills, landslide debris, colluvium, alluvium, older alluvium, terrace deposits, upper and lower members of the Fernando Formation, and the Puente Formation (Figure 3). The geologic units and nomenclature are modeled after Yerkes, 1972. The as-mapped distribution is shown on Plate 1. Presented below is a brief description of the geologic units mapped onsite.

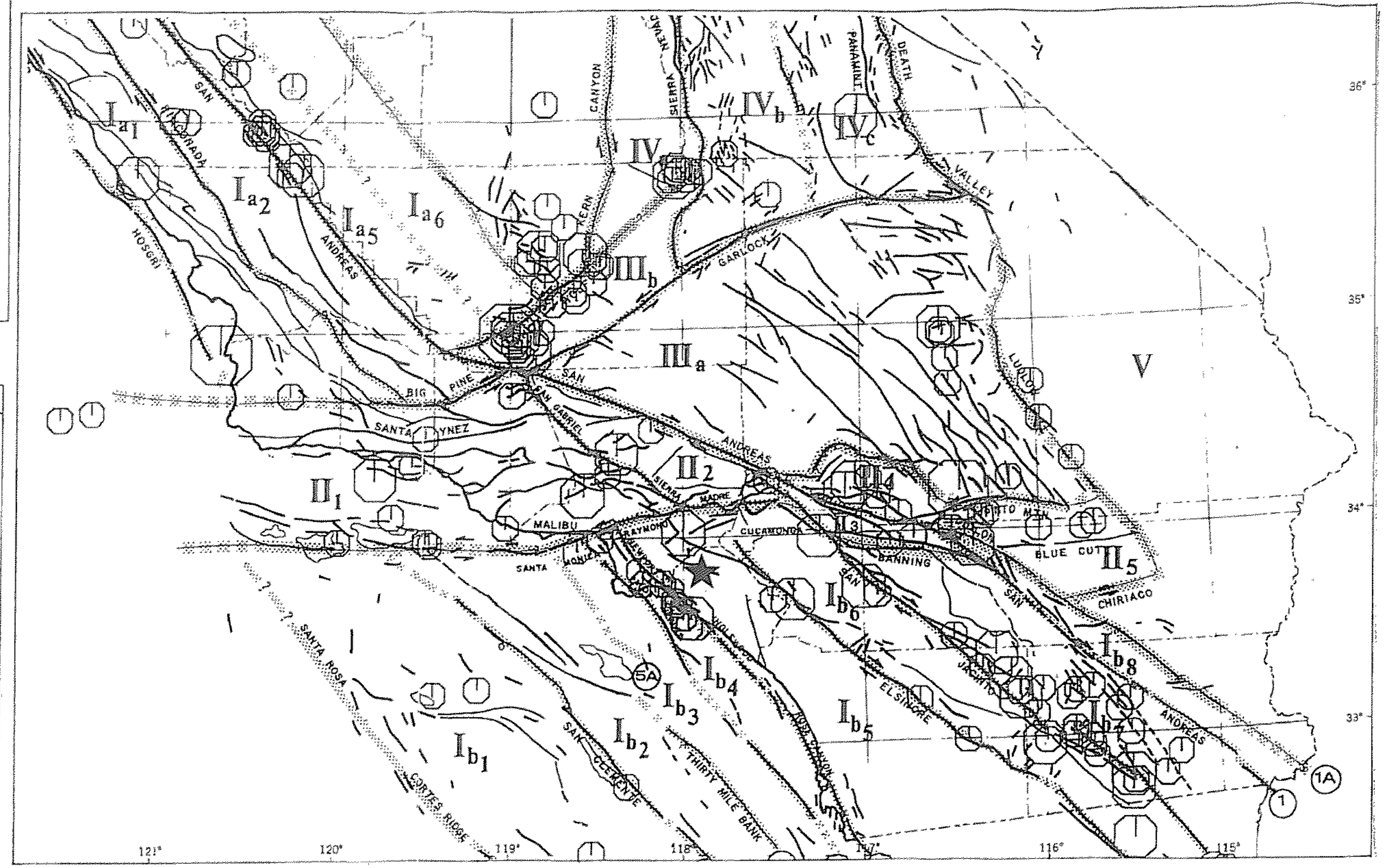


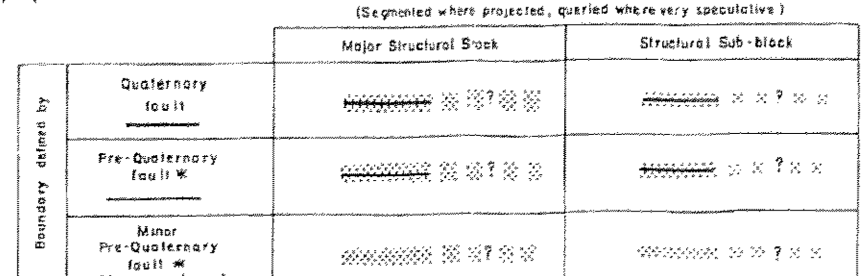

FAULT PATTERNS

(Defining Blocks and Sublocks)

| Structural Province | Predominant Fault Trend | | Blocks | | Sub-block |
|---|---|---|---|---|---|
| I | NW (San Andreas trend) | a | Coast Ranges | 1 | Santa Lucia |
| | | | | 2 | Gabilan |
| | | | | 3 | San Francisco |
| | | | | 4 | Berkeley |
| | | | | 5 | Diablo |
| | | | | 6 | Great Valley |
| | | | | 7 | Stonyford |
| | | b | Peninsular Ranges | 1 | San Clemente |
| | | | | 2 | Catalina |
| | | | | 3 | Palos Verdes |
| | | | | 4 | Inglewood-San Diego |
| | | | | 5 | Santa Ana |
| | | | | 6 | Riverside |
| | | | | 7 | San Jacinto |
| | | | | 8 | Indio Hills-Mecca Hills |
| II | E-W (Transverse trend) | | Transverse Ranges | 1 | Santa Ynez |
| | | | | 2 | San Gabriel |
| | | | | 3 | Banning |
| | | | | 4 | San Bernardino |
| | | | | 5 | Pinto Mtns. |
| III | NE (Garlock trend) | a | Mojave | | |
| | | b | Tehachapi | | |
| IV | N-S (Owens Valley trend) | a | Kern Canyon | | |
| | | b | Panamint | | |
| | | c | Death Valley | | |
| | | d | Warner | | |
| | | e | East Sierra | | |
| | | f | Cascade | | |
| | | g | Gorda | | |
| V | Multiple | | Sonoran Desert | | |
| VI | Complex | | Sierra Nevada | | |
| VII | Thrusts | | Klamath | | |
| VIII | Complex | | Modoc | 1 | Alturas |
| | | | | 2 | Eagle Lake |
| | | | | 3. | Diamond Mtns. |
| | | | | 4 | Medicine Lake |

## RELATIONSHIPS OF EARTHQUAKE EPICENTERS TO FAULTS IN SOUTHERN CALIFORNIA




* Pre-Quaternary faults may include a fault whose age is unknown or has not been evaluated; it may in fact, be Quaternary

0 50 100 MILES

0 50 100 KILOMETERS

AFTER JENNINGS (1985)

FIGURE 2

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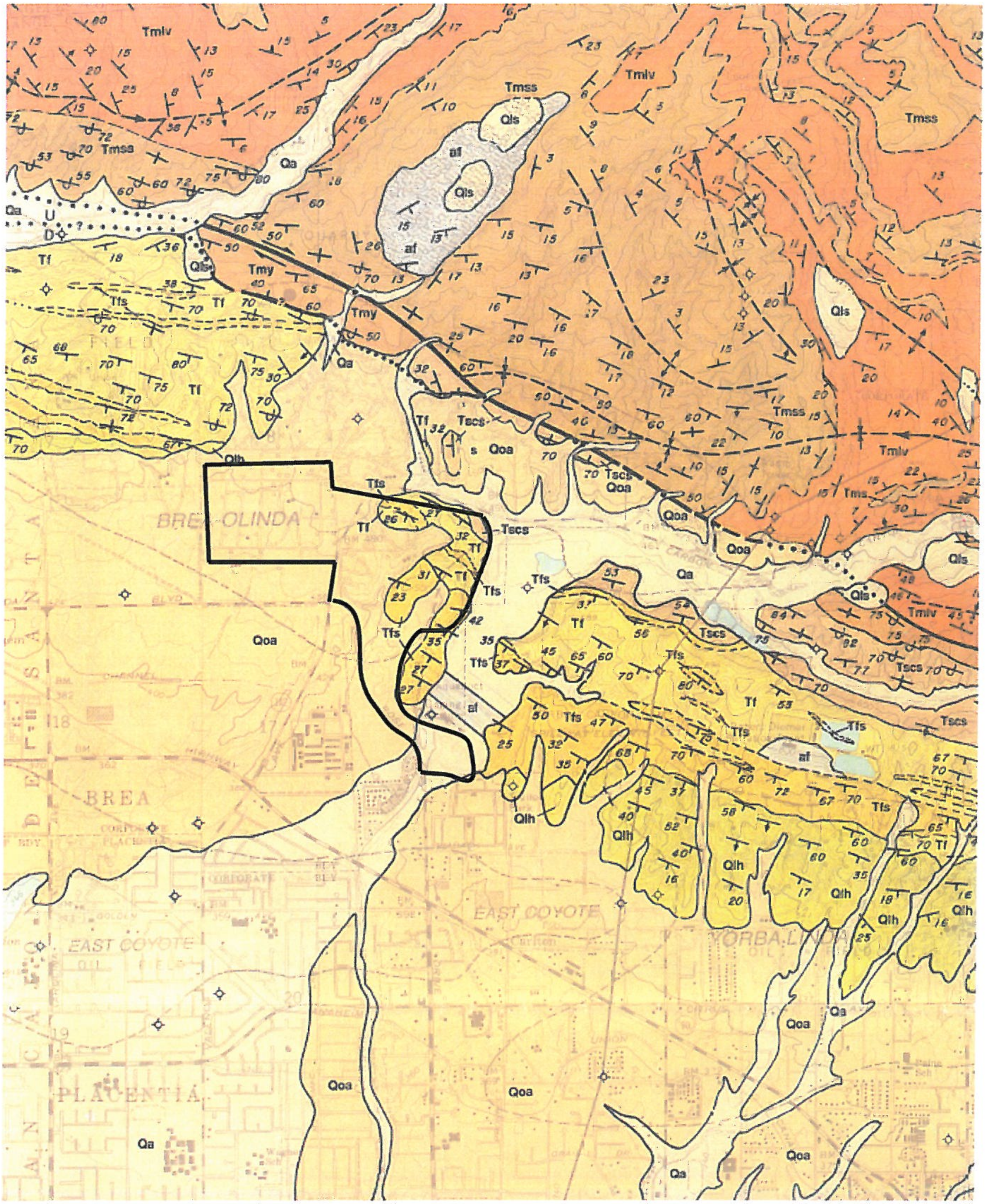


REGIONAL GEOLOGIC MAP (DIBBLEE, 2001)

FIGURE 3

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**3.2.1 Puente Formation – Sycamore Canyon Member (Tpsc):**

The Miocene aged Sycamore Canyon member of the Puente Formation is located on the far north side of the site. The Sycamore Canyon member onsite was not explored in the subsurface but based on observed outcrops and mapping by others it is composed of conglomerates. The rock is described in the reviewed literature as being moderately hard to hard, moist and moderately to well-cemented.

**3.2.2 Fernando Formation – Lower Member (Tfl):**

The Pliocene aged, Lower Member of the Fernando Formation can be found on the northeastern portion of the site. The lower member of the Fernando formation onsite is composed of siltstone and clayey siltstone with minor fine-grained sandstone beds. The rock is moderately hard to hard and slightly moist to moist.

**3.2.3 Fernando Formation – Upper Member (Tfu):**

The upper member of the Pliocene Fernando Formation is present on the northeasterly to easterly portions of the site. Onsite the upper member of the Fernando Formation is composed of interbedded siltstones and conglomerates. The conglomerates are made up of subrounded to rounded pebble to cobble sized clasts, which range in size from ½-inch to 6-inches in diameter. The cobbles are contained within a matrix, which is composed of coarse to very coarse sand. The conglomerate is hard, poorly to well cemented, and locally fossiliferous.

The siltstones of the upper member of the Fernando Formation are moist, moderately hard to hard with minor cemented zones. Minor fine-grained sandstone interbeds are present within the siltstones. The siltstone is generally massive with locally well-bedded zones associated with the sandstone interbeds.

**3.2.4 Terrace Deposits (Qt):**

Pleistocene-aged terrace deposits are located throughout the central, north central and western portions of the site. The terrace deposits are composed of sandy to clayey silts and silty sands, which are dark reddish brown, firm to stiff and dense, slightly moist to moist.

**3.2.5 Older Alluvium (Qoal):**

The late Pleistocene to early Holocene-aged older alluvium is present on the southeastern portion of the project. Onsite, the older alluvium is composed of silty to sandy clays and clayey to silty sands. The older alluvium is firm and medium dense to dense and stiff, slightly moist to moist, and predominantly dark reddish to yellowish brown in color.

**3.2.6 Alluvium (Qal):**

Recent alluvial soils are present in the draws and canyons throughout the site and within the Carbon Canyon channel area below the Carbon Canyon retention dam. The alluvium is composed of clayey to sandy silt, silty sand, and silty clay. The soils are loose and soft to firm and medium dense and dry to moist.

**3.2.7 Colluvium (Qcol):**

Recent colluvial soils are present on the slope flanks throughout the hillier portions of the project. The colluvium consists of silty to sandy clays, clayey slits, and silty sands in a slightly moist to moist and soft to firm condition.

**3.2.8 Landslide Debris (Qls):**

Two questioned landslides have been mapped on the northeast side of the site. The slides were mapped based on geomorphic expression and aerial photographic review and have not been explored previously. The landslide debris, if it exists, is derived from the siltstone member of the Fernando Formation.

**3.2.9 Undocumented Artificial Fill (Qaf):**

Undocumented artificial fills are scattered over the site. The fills are associated with access road construction, oil field exploration/production, and past and present agricultural uses. The fills are derived from the surrounding soils and are dry to slightly moist and loose/soft.

**3.2.10 Engineered Artificial Fill (afe1, afe2, afe3):**

Engineered artificial fill was placed onsite as part of the development of the adjacent Shea Homes project, the Brea Sports Park (PSE, 2008) and the Carbon Canyon Dam Sewer project (PSE, 2009).

## 3.3 Geologic Structure/Tectonic Setting - Rancho Los Flores

**3.3.1 Tectonic Framework:**

Jennings (1985) has defined eight structural provinces within California that have been classified by predominant regional fault trends and similar fold structure (Figure 2). These provinces are in turn divided into blocks and sub-blocks that are defined by "major Quaternary faults". These blocks and sub-blocks exhibit similar structural features. Within this framework, the subject site can be classified as belonging to Structural Province I, Peninsular Range Block, Santa Ana Sub-Block.

Structural Province I is controlled by the dominant northwest trend of the San Andreas Fault and is divided into two blocks, the Coast Range Block and the Peninsular Range Block. The Peninsular Range Block, in which this site is located, is characterized by a series of parallel, northwest trending faults that exhibit right lateral dip-slip movement. These faults are terminated by the Transverse Range Block to the north and extend southward to the Baja Peninsula. These northwest trending faults divide the Peninsular Range Block into eight sub-blocks. The Santa Ana Sub-block, one of the eight sub-blocks, is bound on the west by the Newport-Inglewood zone and on the east by the Elsinore/Whittier Fault zone. The subject site is located on the northeastern edge of the Santa Ana sub-block and lies approximately 19 miles northeasterly of the Newport-Inglewood fault zone and 2000 feet southwesterly of the Elsinore/Whittier fault zone.

### 3.3.2 Regionally Mapped Active Faults:

There are several large active fault systems in the region surrounding the subject site. These fault systems have been studied extensively and in a large part control the geologic structure of southern California. The prominent regional fault systems are the Whittier, Newport-Inglewood, Elsinore, San Jacinto, and San Andreas faults and Elysian Park seismic zone (Figure 4).

**Whittier Fault System:**

The Whittier fault system is located approximately 2000 feet northerly of the subject site. This fault is the main spur of the Elsinore fault system and extends northwesterly from Santa Ana Canyon through the Puente Hills to the Santa Monica Mountains. The Whittier fault system is a right lateral reverse fault that dips to the northeast.

**Elysian Park Seismic Zone:**

The Elysian Park Seismic Zone lies approximately 2 miles west to northwesterly of the project. The Elysian Park Seismic Zone is a part of the north Los Angeles Thrust Belt (Davis and Others, 1988; Hauksson, 1992 Bullard and Lettis, 1993). The belt is south-vergent and is marked

# REGIONAL FAULT MAP


SOURCE: Southern California Earthquake Data Center

★ - Brea Central Property

FIGURE 4

by blind (not reaching the earth's surface) thrust faults and associated anticlines which are expressed as the low hills that ring the north Los Angeles area.

**Newport-Inglewood Fault System:**

The Newport-Inglewood fault system is located approximately 19 miles 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 fault system is 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.

**San Andreas Fault System:**

The San Andreas fault system lies approximately 32 miles northeasterly of the subject site. In California, the San Andreas extends northwesterly from the Mexican border to Point Arena where it continues offshore before turning to the west in the vicinity of Cape Mendocino. The San Andreas is the major structural feature in California and defines a transform boundary between the Pacific and North American tectonic plates. Due to the length and complexity of this fault system, it has been divided into sections on the basis of general trend. The southern portion of the San Andreas, which extends from the Gulf of California to the Transverse Ranges, is closest to the subject site. Displacement along this section, as is characteristic of the entire length, is right lateral.

**San Jacinto Fault System:**

The San Jacinto Fault system lies approximately 47 miles easterly of the subject site. The San Jacinto is the major sub-member of the San Andreas fault system and can be traced from a point northerly of the San Gabriel Mountains, where it branches out from the San Andreas, southerly to the Mexican border. The San Jacinto fault parallels the San Andreas fault over the majority of its length and, like the San Andreas, movement is primarily right lateral.

### 3.3.3 Site Geologic Structure:

The subject site is on the northeasterly limb of the La Habra Syncline. The La Habra Syncline is the dominant structural feature in the area of the Puente Hills in which the site is located. The La Habra Syncline is controlled by the Whittier fault zone with the northern limb exhibiting very steep to overturned bedding.

The subject site is located on this northern limb and bedding onsite generally strikes to the northwest and dips to the southwest at gentle to steep angles. In general, the dip angle of the bedding increases to the north.

Two northerly trending faults have been mapped on the northeast and southeast portions of the project. The fault on the northeast portion of the site separates the upper and lower members of the Fernando Formation. The fault on the southeast portion of the site was mapped by others and is concealed by alluvium in Carbon Canyon channel. No direct evidence for this fault was observed. Aerial photograph review of the site did not reveal any geomorphic lineaments, which would suggest holocene activity on these faults. There are no faults onsite identified within Alquist-Priolo Earthquake Fault Zones nor is there any evidence suggesting the onsite presence of active faults as defined by the State of California.

### 3.3.4 Groundwater:

Groundwater was encountered during PSE's subsurface investigation in Boring B-3 at 51 feet. This boring was excavated in alluvial soils within the old Carbon Canyon channel area.

## 3.4 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 and earthquake induced landsliding.

The State of California Seismic Hazards Zone Maps identify areas which may be subject to seismically induced landsliding and liquefaction. The Seismic Hazards Zone Map for the Yorba Linda Quadrangle has identified areas onsite which may be subject to seismically induced landslides and liquefaction. Discussed in Sections 3.4.2 and 3.4.5 below are this firm's evaluation of the site's liquefaction and seismically induced landsliding potential.

### 3.4.1 Seismicity:

Neither active nor potentially active faults are known to exist along or across the property. The probability of primary surface rupture or deformation at the site is, therefore, considered very low. Ground shaking hazards caused by earthquakes along active regional faults, however, do exist.

A mean random horizontal acceleration of 0.55g has been determined for the site, this acceleration hypothetically has a UBC – consistent 10 percent chance of being exceeded in 50 years (the equivalent of a 475 year average return period). Details are presented in Appendix C. A seismic coefficient of 0.15g is generally held to be appropriate for pseudostatic stability analyses in this seismic region.

**3.4.2 Liquefaction:**

Liquefaction is the phenomenon where the buildup of excess pore pressures, in saturated granular soils due to seismic agitation, results in a temporary "quick" or "liquefied" condition. Based on the limited subsurface investigation, liquefaction potential of the subject site is considered low due to the depth of the groundwater (51 feet) measured onsite. The State of California Seismic Hazards Zone Map for the Yorba Linda Quadrangle (Reference 12) has identified areas on the eastern portion of the project which may have a potential for liquefaction. Additional subsurface investigation will be required in the future to further evaluate liquefaction potential onsite.

**3.4.3 Surface Rupture:**

Surface rupture is a break in the ground surface during or as a consequence of seismic activity. The potential for surface rupture on this site is low due to the lack of active faults at the site.

**3.4.4 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 very low.

**3.4.5 Seismically Induced Landsliding:**

The State of California Seismic Hazards Zone Map for The Yorba Linda quadrangle (Reference 11) has identified natural slopes onsite which may be subject to seismically induced landsliding. Further subsurface investigation will be required to evaluate natural slopes onsite, however upon accomplishment of site grading in conformance with codes and the current industry standards, seismically induced landsliding should pose no danger to improvements on this project.

## 3.5 Mineral Deposits

Based on the information presented on Figure 5 and in the cited references (Appendix A), the following discusses The Brea Central Property with regard to its potential as a source for concrete grade aggregate deposits.

### 3.5.1 Aggregate

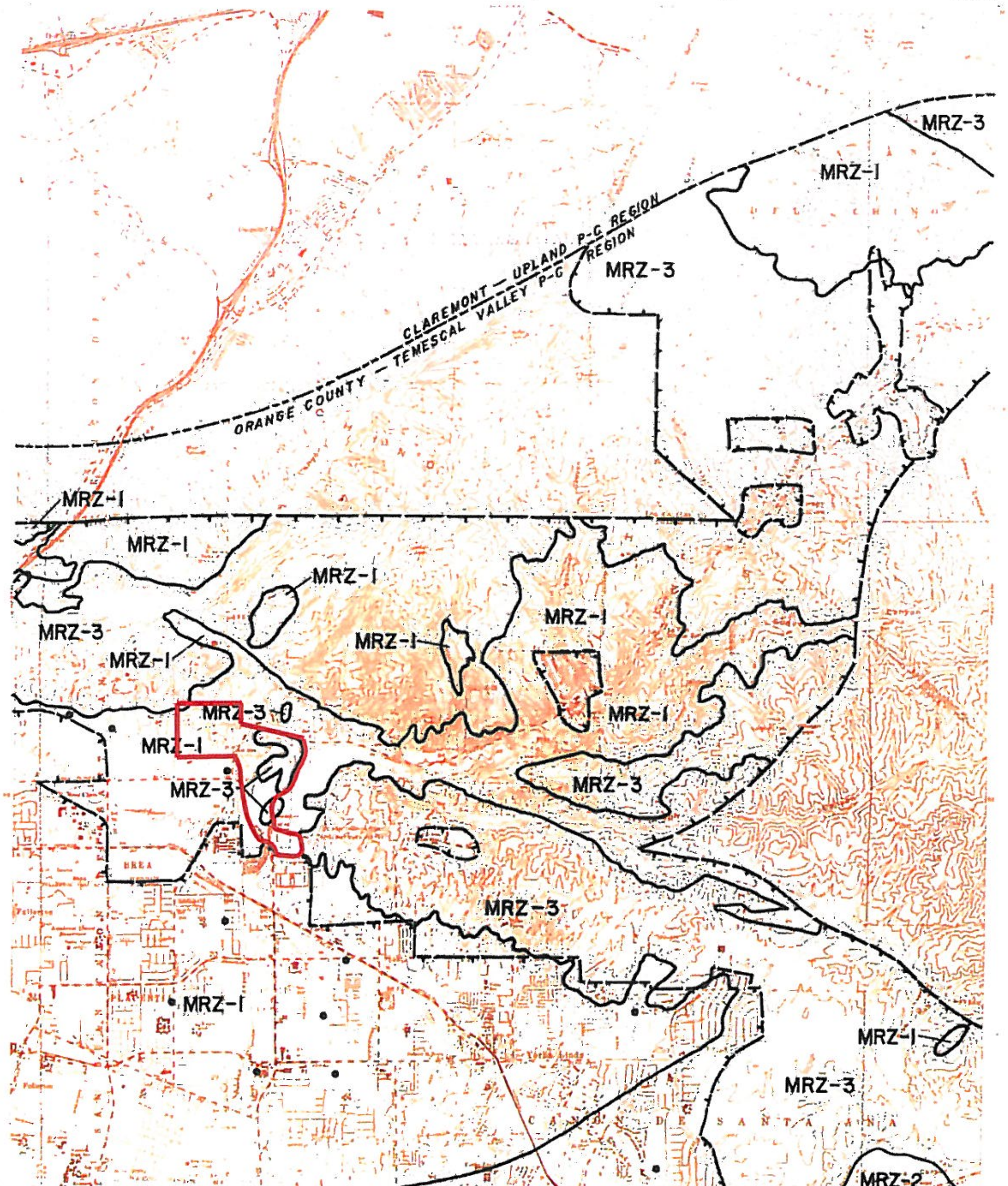
A review of CDMG Special Report 143 (Miller, 1981) places the Brea Central Property in Mineral Resource Zone (MRZ) 1 and 3 with respect to concrete-grade aggregate deposits (Figure 5). MRZ-1 is defined as: "Areas where adequate geologic information indicates that no significant construction aggregate deposits are present, or where it is judged that the likelihood exists for their presence". This zone is applied where well developed lines of reasoning, based on economic-geologic principals and adequate data, indicate that the likelihood for occurrence of significant mineral deposits is nil or slight. MRZ-3 is defined as "Areas containing construction aggregate deposits, the significance of which cannot be evaluated from available data". Further exploration work within these areas could result in the reclassification into other categories.

Neither category MRZ-1 not MRZ-3 are considered as an aggregate resource area.

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

TORBA LINDA QUADRANGLE
SPECIAL REPORT 143
PLATE 3.12




TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

## EXPLANATION

Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

EXISTING URBAN BOUNDARIES
Boundaries established by the Office of Planning and Research and by data supplied by local government agencies and other sources to reflect present conditions. Hachures lie within urban area.

PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

MRZ-2

MRZ-1 Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.

MRZ-2 Areas where adequate information indicates that significant mineral deposits are present or where it is judged that a high likelihood for their presence exists.

MRZ-3 Areas containing mineral deposits the significance of which cannot be evaluated from available data.

MRZ-4 Areas where available information is inadequate for assignment to any other MRZ zone.

See text for additional explanation of MRZ Symbols

Brea Central Property

MAGNETIC NORTH AND DECLINATION

TORBA LINDA, CALIF.

Figure 5

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PROJECT NUMBER: 1-0250 DATE: 12-19-18

# MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

STATE GEOLOGIST

## 4.0 GEOTECHNICAL ENVIRONMENTAL IMPACTS

Appendix G of the California Environmental Quality Act (CEQA) guidelines requires an evaluation of environmental conditions and the potential impacts of those conditions. That evaluation must classify the conditions as to whether there is "No Impact" or "Impact". If the condition "impacts" the site, then it needs to be classified as 1) "potentially significant"; 2) "less than significant with mitigation"; or 3) "less than significant".

The threshold for determining geotechnical impacts as outlined in Appendix G of the CEQA guidelines are described as follows:

*Would the project:*

*a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:*

*i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.*

*ii) Strong seismic ground shaking?*

*iii) Seismic-related ground failure, including liquefaction?*

*iv) Landslides?*

*b) Result in substantial soil erosion or the loss of topsoil?*

*c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?*

*d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?*

*e) Have soils incapable of adequately supporting the use of septic tanks or alternate waste water disposal systems where sewers are not available for the disposal of waste water?*

Presented in the following sections is our evaluation of the potential geotechnical impacts to the site based on the above classifications.

## 4.1 Fault and Seismic Hazards

### 4.1.1 Fault Rupture Potential

There are no State-imposed Alquist-Priolo Fault-Rupture Hazard Zones mapped onsite. Two northerly trending faults have been mapped on the northeast and southeast portions of the project. The fault on the northeast portion of the site separates the upper and lower members of the Fernando Formation. The fault on the southeast portion of the site was mapped by others and is concealed by alluvium in Carbon Canyon channel. No direct evidence for this fault was observed. Aerial photograph review of the site did not reveal any geomorphic lineaments, which would suggest holocene activity on these faults. Thus, the likelihood of surface fault rupture along this fault is considered remote.

***Level of Impact***

*The level of impact due to Fault Rupture Potential is considered to be less than significant with mitigation.*

***Mitigation Measures***

*The likelihood of active faulting onsite is considered remote at this time. If, through further investigation, the faults identified onsite are determined to be active, the typical mitigation would involve establishing a fault setback zone. A habitable structure setback measuring 50 feet from each side of the fault trace (i.e. a 100-foot wide zone) will be established. This mitigation measure is consistent with the intent of the California Alquist-Priolo Earthquake Fault Zoning Act and local building codes. It is possible that faults could be discovered during site grading. Such faults will require investigation and assessment of activity levels and, if necessary, mitigation in the form of setbacks, structural design, and/or combinations of those alternatives.*

#### 4.1.2 Seismic Ground Shaking

Southern California, in general, is a seismically active region and the proposed improvements are likely to be subjected to significant ground motion during the design life of the project. The site has been identified as "D" site class in accordance with Table 20.3-1 of ASCE 7-10. Utilizing this information, the computer program USGS Seismic Design Maps Version 3.1.0 and ASCE 7-10 criterion, the spectral response accelerations that can be utilized for the project were calculated. An average PGA of 0.80g was computed for earthquake ground motions having 2% probability of exceedance in 50 years. Such is consistent with typical residential and commercial developments. More stringent standards are typically composed on institutional structures such as schools, hospitals, and fire facilities as well as bridges. Each such facility will require specific assessment when sitings are available.

***Level of Impact***

*The level of impact due to seismic shaking is considered to be less than significant with mitigation.*

***Mitigation Measures***

*Seismic shaking can be mitigated through the design of the structures in compliance with prevailing seismic codes outlined in California Building Code (CBC). Remedial grading to further mitigate seismic hazards may also be required. Because estimates of potential ground shaking motion could vary across a large site, site specific refinement of ground motion estimates will be required as specific plans as available. Remedial grading could include:*

- *The removal and replacement, with engineered fill, of loose and/or compressible soils; and*

- *The removal and recompaction of the cut and shallow fill portions of building lots that exhibit unfavorable geologic conditions. These lots will be identified as a part of future geotechnical grading plan reviews and during construction of the improvements based on exposed geologic conditions in the field.*

**4.1.3 Liquefaction and Dynamic Settlement**

Liquefaction is the phenomenon where the buildup of excess pore pressures, in saturated granular soils due to seismic agitation, results in a temporary "quick" or "liquefied" condition. Based on the limited subsurface investigation, liquefaction potential of the subject site is considered low due to the depth of the groundwater (51 feet) measured onsite. The State of California Seismic Hazards Zone Map for the Yorba Linda Quadrangle (State of California, 1980) has identified areas on the eastern portion of the project which may have a potential for liquefaction. Additional subsurface investigation will be required in the future to further evaluate liquefaction potential onsite.

***Level of Impact***

*The level of impact due to liquefaction and dynamic settlement is considered to be less than significant with mitigation.*

***Mitigation Measures***

*Mitigation measures for liquefaction/dynamic settlement potential include removal and replacement with compacted, drained fills; ground modification; and/or designing for potential settlement of liquefiable materials. While this issue is of economic significance, it is not a technical constraint to development. Adherence to State policy regarding liquefaction analyses will be required during the design and construction process, but upon implementation, can suitably mitigate this hazard.*

### 4.1.4 Earthquake Induced Landsliding

The State of California Seismic Hazards Zone Map for The Yorba Linda quadrangle (State of California, 1980) has identified natural slopes onsite which may be subject to seismically induced landsliding. Further subsurface investigation will be required to evaluate natural slopes onsite, however upon accomplishment of site grading in conformance with codes and the current industry standards, seismically induced landsliding should pose no danger to improvements on this project.

***Level of Impact***

*The level of impact due to earthquake induced landsliding is considered to be less than significant with mitigation.*

***Mitigation Measures***

*Areas susceptible to earthquake-induced landsliding can be mitigated utilizing common earthwork remedial grading techniques such as construction of drained shear keys, replacement with manufactured buttress fills, slope laybacks, or structural setbacks.*

### 4.1.5 Seiches and Tsunamis

Seiches are periodic oscillations within a large enclosed body of water. Any enclosed body of water such as an artificial lake, reservoir, or tank could be susceptible to seiche oscillations. A tsunami is a large oceanic wave generated from an earthquake or undersea landsliding.

***Level of Impact***

*The elevation and distance inland of the development precludes inundation resulting from tsunamis, and therefore, has no impact on the project. The potential for a seiche impacting the property is considered very low.*

***Mitigation Measures***

*Mitigation is not anticipated to be necessary.*

## 4.2 Rock Excavation Characteristics

The eastern portion of the site is underlain by the Puente Formation, which may require moderate to heavy ripping to excavate. Blasting is unlikely, but locally possible. All other geologic units mapped onsite should be readily excavatable with conventional earth moving equipment and will not require blasting during the course of rough grading.

***Level of Impact***

*While unlikely, it is possible that blasting may be required for efficient excavation in the Puente Formation. The level of impact due to the blasting of hard rock is considered to be less than significant with mitigation.*

***Mitigation Measures***

*The impacts of the use of explosives include noise, vibration, and flying debris. Those impacts can be mitigated through the use experienced blasting contractors who would submit a blasting plan to the City of Brea for approval. Additionally, numerous small charges are typically used in the blasting process and overburden is typically left-in-place to improve the effects of the detonation. This process, combined with the remote location of areas that would require blasting, can significantly reduce the impacts of noise, vibration, and flying debris.*

## 4.3 Soil Erosion/Mass Wasting

Soil erosion or mass wasting is the process in which earthen materials are transported down slope by gravity. Large scale mass wasting is not present onsite and is not anticipated to be a hazard to the project.

***Level of Impact***

*Due to the relatively flat nature of the site in the western and southeastern portions of the site, and the proposed site improvements and grading in the northeastern portion of the site, soil erosion or mass wasting is deemed be less than significant with mitigation. Due to the lack of soil development on the property, the loss of topsoil is considered to be less than significant.*

***Mitigation Measures***

*Control of surface drainage and diversion of flows to non-erodible devices are the principle mitigation measures typically employed and can be accomplished with compliance with design standards outlined in the CBC. Mitigation of slope surface erosion of highly granular soils can be accomplished by establishing appropriate surface drainage patterns, judicious landscaping, and, when necessary, use of surface erosion control products such as "jute mesh" or "straw waddles" in compliance with erosion control standards outlined in the California Water Code.*

## 4.4 Slope Stability

Cut, fill and natural slope stability can be affected by several factors including geologic structure, strength of materials, and height, inclination, and orientation of design slopes. Recognition of the inter-relationships of the various combinations of slope configuration, geologic structure, and material strength characteristics can reduce costs associated with remedial grading requirements and/or design restrictions.

### 4.4.1 Cut Slopes

Typically, cut slopes exposing fractured or faulted bedrock, alluvium, or colluvium are surficially and/or grossly unstable and will require remediation in the form of replacement (stabilization) fills. Cut slopes that are oriented in the same direction and are steeper than the exposed bedding planes typically require replacement with engineered buttress fills or construction at flatter (layback) angles. Conversely, cut slopes oriented contrary to the bedding direction and made in competent, unfaulted, bedrock can be stable to considerable heights. Recognition of the presence of the various geologic units and structural features including faults, synclines, anticlines and regional bedding trends can be an effective planning tool.

The bedrock onsite strikes northwesterly and dips at low to moderate angles to the southwest. In general, southerly, southwesterly, and westerly facing cut slopes may require replacement with a buttress/stabilization fill section. The cut slopes exposing an out of slope (daylighted) bedding condition will require replacement with a designed buttress slope which will be supported on a keyway with a width of approximately 1.25 time the height of slope. Cut slopes exposing faulted, fractured bedrock conditions will likely require replacement with a stabilization fill section supported on a keyway with a width of approximately ½ times the height.

***Level of Impact***

*The level of impact due to cut slope instability is considered to be less than significant with mitigation.*

***Mitigation Measures***

*Stability of proposed cut slopes will be of minor to moderate economic importance to the proposed development. Mitigation of unstable slopes may be required and will likely include overexcavation and replacement with either drained stabilization fill or buttress fills. Stabilization fills should be utilized when cut slopes expose loose or highly erosive soils or faulted and fractured bedrock. In the case where bedding dips in the* *same direction and at shallower angles than the cut slope face, particularly where lower strength beds exist, engineering analysis will be required to adequately size keyways for buttress fills. Where grading limits are not constrained, cut slope instability can be mitigated by constructing slopes at flatter angles than the underlying geologic structure. All cut slopes will require evaluation during the design process as well as during construction.*

**4.4.2 Fill Slopes**

Based on the engineering characteristics defined by previous laboratory testing, the onsite earth materials are generally considered suitable for use as compacted fill and, when properly constructed and maintained, can be expected to perform satisfactorily in code compliant embankments and fill slopes (typically 2:1 or flatter).

***Level of Impact***

*The level of impact due to the design and construction of fill slopes is considered to be less than significant with mitigation.*

***Mitigation Measures***

*Fill slopes should be designed at a 2:1 (horizontal to vertical) or flatter ratios. Locally steeper fill slopes can be considered but should be constructed with geosynthetics to enhance the shear strength of fill materials. Higher compaction standards (typically 93 percent) of the laboratory maximum density) should be implemented in deeper fills (>50 feet) to enhance engineering characteristics and reduce the amount of potential settlement. Subsurface drainage devices should be installed below fills to intercept and direct water that may seep from the bedrock or be introduced from the surface.*

### 4.4.3 Natural Slope Stability

The northeastern side of the site can be characterized as moderate to locally steep hillside terrain with eroded canyons. Natural slopes in these canyon areas vary in slope ratio from approximately 1:1 to 5:1 (horizontal to vertical). From a grading design standpoint, natural slopes pose similar geotechnical constraints as design cut slopes. Therefore, the stability of natural slopes is primarily a function of the underlying bedrock structure and the slope steepness. Natural slopes, which expose daylighted bedding, or are inclined at the approximate angle of bedding, may not satisfy normal factors of safety and may be considered grossly unstable. Daylighted natural slopes which either ascend or descend from proposed development will probably require remediation in the form of buttress fills or shear keys.

A steep natural slope exists on the northeasterly portion of the site. The bedrock in this region generally dips in a favorable direction, however due to the steep nature of the slope, some form of structural setback will likely be required to protect structures from surficial slope stability issues. The structure setback will likely be in the form of a California Building Code (CBC) consistent, height of slope divided by three (H/3), not to exceed 40 feet. Future grading concepts should be developed such that natural slopes oriented in unfavorable directions are minimized.

***Level of Impact***

*The level of impact due to natural slope stability is considered less than significant with mitigation.*

***Mitigation Measures***

*Where adverse bedding, faulted, or fractured bedrock, highly erosive soils, or other similar conditions exist on natural slopes in proximity to planned development, mitigation of the potential hazard will be required. Mitigation techniques may include structural setbacks, removal and replacement, or fill buttressing. Support of adverse bedding can be achieved by construction of drained buttress fills or elimination of adverse bedding by slope layback.*

## 4.5 Compressible/Collapsible Soils

Based upon the data obtained from the previous subsurface investigation and laboratory testing, weathered older alluvium and terrace deposits, highly weathered bedrock, colluvium, alluvium, undocumented artificial fill, and the landslide debris are likely to be compressible.

The colluvium, alluvium, as well as portions of the older alluvium and terrace deposits are subject to hydro-collapse based on the laboratory test results presented in Appendix C. Hydro-collapse is the process in which loose dry soils undergo rapid consolidation (collapse) when wetted. Unmitigated, the presence of compressible and collapsible soils below fills and where exposed in cuts can produce significant settlements that can be manifested differentially on engineered structures.

***Level of Impact***

*The level of impact due to collapsible soils is considered to be less than significant with mitigation.*

***Mitigation Measures***

*Typically, compressible and collapsible soils can be mitigated using a combination of overexcavation of the susceptible soils and recompaction as engineered fills. These techniques may be used in conjunction with enhanced foundation design.*

*Based upon Alta's review of the laboratory test data, the colluvium, portions of the alluvium, portions of the older alluvium and terrace deposits, and weathered bedrock will require removal and recompaction prior to fill placement and where exposed in cuts. The use of post-tension or mat slab foundations will likely be required for structures founded over alluvium. All undocumented fills will also require removal and recompaction.*

## 4.6 Expansive Soils

The expansion potential of the vast majority of soils that will be encountered onsite during grading will likely range from "very low" to "high". Expansive soils can increase in volume upon the introduction of water and decrease in volume (shrink) upon drying. These volume changes can produce stresses on engineered structures than can result in cosmetic distress and even structural damage.

### *Level of Impact*

*The level of impact due to expansive soils is considered to be less than significant with mitigation.*

### *Mitigation Measures*

*The presence of expansive soils is commonly and effectively mitigated by various techniques including: 1) proper design of foundations, slabs, streets, and other improvements subject to the influence of the soils; 2) overexcavation of the expansive soils/bedrock and replacement with less expansive fill soils; 3) utilizing selective grading techniques to place more highly expansive soils well below foundation elements; 4) employment of presaturation techniques to lessen expansion potential; 5) control of surface and subsurface drainages to prevent moisture variations; and 6) combinations of these various techniques.*

## 4.7 Percolation Characteristics of Site Soils

Current development plans for the site call for a sanitary sewage system to handle waste. At this time no septic systems are planned for the site.

***Level of Impact***

*Currently septic systems are not planned for this site, therefore the percolation characteristics of the site soils are deemed to have "No Impact" on the site development.*

## 4.8 Corrosion

The presence of soluble sulfates in soils can be detrimental to concrete. Low resistivity and high chloride soils can have a detrimental effect on metals.

***Level of Impact***

*The level of impact due to corrosive soils is considered to be less than significant with mitigation.*

***Mitigations Measures***

*Concrete mix designs shall be in compliance with the recommendations presented in ACI 318-14 for sulfate concentrations. During future design studies, consultation with a Corrosion Engineer can be considered in order to mitigate the potential corrosive effects on metal portions of structures and should be accomplished in compliance with CBC. Final mitigations should be based on testing of as-graded soil conditions.*

# 5.0 FUTURE GEOTECHNICAL ANALYSIS

Prior to approval of each grading plan, a geotechnical report shall be prepared by a licensed Engineering Geologist and Geotechnical Engineer and submitted to the City for review and approval. This report shall be prepared in accordance with city standards and shall evaluate the proposed development in relation to site soils and geologic conditions. Recommendations shall be provided to specifically identify and mitigate any hazards related to faulting and seismicity, collapsible soils, expansive soils, settlement from grading operations, corrosion, and slope stability.

# APPENDIX A

## Cited References

## APPENDIX A

### Cited References


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**APPENDIX B**

**Subsurface Investigation**

**(PSE, 1999)**

# GEOTECHNICAL BORING LOG



| | | | | | |
|---|---|---|---|---|---|
| PROJECT NO. | 500503 | PROJECT NAME | BREA CENTRAL | | |
| DATE STARTED | 3/4/99 | GROUND ELEV. | 500 | BORING DESIG. | B-1 |
| DATE FINISHED | 3/4/99 | GW DEPTH (FT) | | LOGGED BY | SEC |
| DRILLER | LEDEZMA | DRIVE WT. | VARIES | NOTE | |
| TYPE OF DRILL RIG | 30" BUCKET | DROP | 12 in. | | |

| DEPTH (Feet) | ELEV | SAMPLE TYPE | SAMPLE | BLOWS/FT | LITHOLOGY | GROUP SYMBOL | GEOTECHNICAL DESCRIPTION | MOISTURE CONT (%) | DRY (pcf) DENSITY | SAT-URATION (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 500 | | | | | CL | **TERRACE DEPOSITS (Qt):** SILTY CLAY, dark reddish-brown, slightly moist, firm | | | | |
| 5 | 495 | | | | | SC | SILTY CLAYEY SAND, dark brown, slightly moist, medium dense, roots, pin sized voids | | | | |
| 10 | 490 | R | | 10 | | | | 6.9 | 117 | 42 | |
| | | B | | | | SC | | | | | MAX DSR HY EI |
| | | B | | | | ML | SANDY SILT, reddish brown, slightly moist, stiff, few cobbles | | | | |
| 15 | 485 | | | | | | SANDY SILT, reddish to light brown, slightly moist, firm, pin sized voids | | | | |
| 20 | 480 | R | | 7 for 6" | | SM | CLAYEY SILTY SAND, light reddish brown, slightly moist, medium dense, pin sized voids | 8.4 | 115 | 49 | CON HY |
| 25 | 475 | B | | | | | CLAYEY SILTY SAND, light orangish tan, slightly moist, medium dense, pin sized voids, caliche stringers | | | | |
| 30 | 470 | R | | 13 | | SM | | 6.8 | 113 | 37 | CON HY |
| | | | | | | ML | SANDY SILT, yellow to tan, slightly moist, stiff, caliche stringers, pin sized voids | | | | |
| 35 | 465 | | | | | | | | | | |
| | 460 | | | | | | | | | | |

SAMPLE TYPES:
[R] RING (DRIVE) SAMPLE
[S] SPT (SPLIT SPOON) SAMPLE
[B] BULK SAMPLE [T] TUBE SAMPLE

GROUNDWATER
SEEPAGE

PACIFIC SOILS ENGINEERING, INC.

PLATE A-1

# GEOTECHNICAL BORING LOG



| | | | | | |
|---|---|---|---|---|---|
| PROJECT NO. | 500503 | PROJECT NAME | BREA CENTRAL | | |
| DATE STARTED | 3/4/99 | GROUND ELEV. | 500 | BORING DESIG. | B-1 |
| DATE FINISHED | 3/4/99 | GW DEPTH (FT) | | LOGGED BY | SEC |
| DRILLER | LEDEZMA | DRIVE WT. | VARIES | NOTE | |
| TYPE OF DRILL RIG | 30" BUCKET | DROP | 12 in. | | |

| DEPTH (Feet) | ELEV | SAMPLE TYPE | SAMPLE | BLOWS/FT | LITHOLOGY | GROUP SYMBOL | GEOTECHNICAL DESCRIPTION | MOISTURE CONT (%) | DRY (pcf) DENSITY | SAT-URATION (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 460 | R | | 12 | | ML | SANDY SILT, yellow to tan, slightly moist, stiff, caliche, fine to coarse grained quartz, rare cobble to pebble sized clasts of igneous/metamorphic rocks | 8.0 | 118 | 51 | |
| | | B | | | | | | | | | |
| | | | | | | | SANDY SILT, yellow to tan, slightly moist, stiff, pin sized voids | | | | |
| 45 | 455 | | | | | | | | | | |
| | | | | | | | SANDY SILT, yellow to tan, slightly moist, stiff, pin sized voids, caliche | | | | |
| 50 | 450 | R | | 15 | | | | 6.2 | 113 | 34 | |
| | | | | | | | TOTAL DEPTH = 51 feet<br>NO WATER<br>NO CAVING<br>Kelly Bar Wts.:<br>0 - 24' 3548#<br>24 - 47' 2577#<br>47 - 73' 1648#<br>73 - 95' 810# | | | | |

SAMPLE TYPES:
- [R] RING (DRIVE) SAMPLE
- [S] SPT (SPLIT SPOON) SAMPLE
- [B] BULK SAMPLE [T] TUBE SAMPLE

GROUNDWATER

SEEPAGE

PACIFIC SOILS ENGINEERING, INC.

PLATE A-1

# GEOTECHNICAL BORING LOG



PROJECT NO. 500503
DATE STARTED 3/5/99
DATE FINISHED 3/5/99
DRILLER LEDEZMA
TYPE OF DRILL RIG 30" BUCKET

PROJECT NAME BREA CENTRAL
GROUND ELEV. 395
GW DEPTH (FT)
DRIVE WT. VARIES
DROP 12 in.

BORING DESIG. B-2
LOGGED BY SEC
NOTE

| DEPTH (Feet) | ELEV | SAMPLE TYPE | SAMPLE | BLOWS/FT | LITHOLOGY | GROUP SYMBOL | GEOTECHNICAL DESCRIPTION | MOISTURE CONT (%) | DRY (pcf) DENSITY | SAT-URATION (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 395 | | | | | SM | ALLUVIUM (Qal): SILTY SAND, light brown, moist, soft, tar | | | | |
| 5 | 390 | | | | | CL | SILTY CLAY, brown to dark brown, wet, soft, roots, organic odor | | | | |
| 10 | 385 | R | | PUSH | | | | 17.1 | 103 | 72 | |
| | | | | | | ML | SANDY SILT, brown to dark brown, wet, soft | | | | |
| 15 | 380 | | | | | | SANDY SILT, light brown, moist, firm | | | | |
| | | | | | | ML | CLAYEY SILT, dark brown, moist, soft, caliche | | | | |
| 20 | 375 | R | | PUSH | | ML | | 16.6 | 108 | 81 | CON HY |
| | | B | | | | | | | | | |
| 25 | 370 | | | | | | CLAYEY SILT, brown, moist, firm, caliche stringers, pin sized voids | | | | |
| 30 | 365 | R | | 2 | | ML | SANDY SILT, brown, moist, firm, caliche, rare pebble to gravel sized clasts of igneous and metamorphic rock | 12.5 | 113 | 68 | |
| | | B | | | | | | | | | |
| 35 | 360 | | | | | SM | SILTY fine to coarse SAND, light brown, moist, medium dense, caliche | | | | |
| | 355 | | | | | | | | | | |

SAMPLE TYPES:
R RING (DRIVE) SAMPLE
S SPT (SPLIT SPOON) SAMPLE
B BULK SAMPLE
T TUBE SAMPLE

GROUNDWATER
SEEPAGE

PACIFIC SOILS ENGINEERING, INC.

PLATE A-2

# GEOTECHNICAL BORING LOG



| | | | |
|---|---|---|---|
| PROJECT NO. 500503 | PROJECT NAME BREA CENTRAL | | |
| DATE STARTED 3/5/99 | GROUND ELEV. 395 | BORING DESIG. | B-2 |
| DATE FINISHED 3/5/99 | GW DEPTH (FT) | LOGGED BY | SEC |
| DRILLER LEDEZMA | DRIVE WT. VARIES | NOTE | |
| TYPE OF DRILL RIG 30" BUCKET | DROP 12 in. | | |

| DEPTH (Feet) | ELEV | SAMPLE TYPE | SAMPLE | BLOWS/FT | LITHOLOGY | GROUP SYMBOL | GEOTECHNICAL DESCRIPTION | MOISTURE CONT (%) | DRY (pcf) DENSITY | SAT-URATION (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 355 | R | | 3 | | SM | | 11.1 | 96 | 40 | CON HY |
| | | B | | | | | SILTY SAND, light brown, moist, medium dense, fine grained quartz and feldspar | | | | |
| 45 | 350 | | | | | | | | | | |
| 50 | 345 | R | | 4 | | | SILTY SAND, yellow to brown, moist, medium dense, fine to medium grained quartz and feldspar, rare pebble to cobble sized clasts of igneous and metamorphic rock, clasts are well rounded | 23.5 | 99 | 89 | |
| 55 | 340 | | | | | | few SILTSTONE clasts, yellow brown | | | | |
| | | | | | | | SILTY SAND, fine grained, yellow to brown, moist, medium dense, rare pebble to cobble sized clasts of sedimentary, igneous and metamorphic rocks, clasts are well rounded | | | | |
| 60 | 335 | R | | 12 | | | | 11.7 | 111 | 62 | |
| | | B | | | | | increase in gravel | | | | |
| 65 | 330 | | | | | | approximately 1 foot diameter boulder, well rounded | | | | |
| | | | | | | | SILTY SAND, fine to coarse grained, yellow brown, moist, dense, pebble to cobble sized clasts of igneous, metamorphic and sedimentary rocks, clasts are well rounded, quartz and feldspar | | | | |
| 70 | 325 | | | | | | | | | | |
| | | B | | | | | | | | | |
| 75 | 320 | | | | | | | | | | |
| | | | | | | SP | pebbly fine to coarse SAND, light brown, moist, dense, pebble to cobble sized clasts of igneous, metamorphic and sedimentary (SILTSTONES) rocks, clasts are well rounded | | | | |
| | 315 | | | | | | | | | | |

SAMPLE TYPES:
- [R] RING (DRIVE) SAMPLE
- [S] SPT (SPLIT SPOON) SAMPLE
- [B] BULK SAMPLE [T] TUBE SAMPLE

▽ GROUNDWATER
➤ SEEPAGE

PACIFIC SOILS ENGINEERING, INC.

PLATE A-2

# GEOTECHNICAL BORING LOG



| | | | | | |
|---|---|---|---|---|---|
| PROJECT NO. | 500503 | PROJECT NAME | BREA CENTRAL | | |
| DATE STARTED | 3/5/99 | GROUND ELEV. | 395 | BORING DESIG. | B-2 |
| DATE FINISHED | 3/5/99 | GW DEPTH (FT) | | LOGGED BY | SEC |
| DRILLER | LEDEZMA | DRIVE WT. | VARIES | NOTE | |
| TYPE OF DRILL RIG | 30" BUCKET | DROP | 12 in. | | |

| DEPTH (Feet) | ELEV | SAMPLE TYPE | SAMPLE | BLOWS/FT | LITHOLOGY | GROUP SYMBOL | GEOTECHNICAL DESCRIPTION | MOISTURE CONT (%) | DRY (pcf) DENSITY | SAT-URATION (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 315 | | | | | SP | pebbly fine to coarse SAND, light brown, moist, dense, pebble to cobble sized clasts of igneous, metamorphic and sedimentary (SILTSTONES) rocks, clasts are well rounded | | | | |
| | | | | | | | TOTAL DEPTH = 83 feet<br>NO WATER<br>NO CAVING<br>Kelly Bar Wts.:<br>0 - 24' 3548#<br>24 - 47' 2577#<br>47 - 73' 1648#<br>73 - 95' 810# | | | | |

SAMPLE TYPES:
- [R] RING (DRIVE) SAMPLE
- [S] SPT (SPLIT SPOON) SAMPLE
- [B] BULK SAMPLE [T] TUBE SAMPLE

GROUNDWATER

SEEPAGE

PACIFIC SOILS ENGINEERING, INC.

PLATE A-2

# GEOTECHNICAL BORING LOG



| | | | |
|---|---|---|---|
| PROJECT NO. | 500503 | PROJECT NAME | BREA CENTRAL |
| DATE STARTED | 3/5/99 | GROUND ELEV. | 405 |
| DATE FINISHED | 3/5/99 | GW DEPTH (FT) | 51.00 |
| DRILLER | LEDEZMA | DRIVE WT. | VARIES |
| TYPE OF DRILL RIG | 30" BUCKET | DROP | 12 in. |
| BORING DESIG. | B-3 | LOGGED BY | SEC |
| NOTE | | | |

| DEPTH (Feet) | ELEV | SAMPLE TYPE | SAMPLE | BLOWS/FT | LITHOLOGY | GROUP SYMBOL | GEOTECHNICAL DESCRIPTION | MOISTURE CONT (%) | DRY (pcf) DENSITY | SAT-URATION (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 405 | | | | | ML | **ALLUVIUM (Qal):** SANDY SILT, light tan, dry, soft, roots | | | | |
| 5 | 400 | | | | | | SANDY SILT, light tan, dry, soft, caliche | | | | |
| 10 | 395 | R | | 1 | | | SANDY SILT, light tan, dry to slightly moist, soft to firm, caliche, roots | 5.0 | 93 | 17 | |
| 15 | 390 | | | | | CL | SILTY CLAY, brown, moist, soft to firm | | | | |
| 20 | 385 | R | | 2 | | SM | SILTY SAND, light brown, moist, medium dense, pebble to cobble sized clasts of igneous and metamorphic rock, fine to coarse grained quartz and feldspar | 7.5 | 96 | 27 | |
| | | B | | | | | | | | | |
| 25 | 380 | | | | | | SILTY SAND, moist, medium dense, pebble to cobble sized clasts of SILTSTONE, igneous and metamorphic rock, clasts are well rounded, fine to coarse grained quartz and feldspar | | | | |
| 30 | 375 | R | | 4 | | | | 8.8 | 95 | 31 | |
| | | B | | | | | | | | | |
| 35 | 370 | | | | | | SILTY SAND, moist, stiff, rare pebble to cobble sized clasts of igneous, metamorphic rocks, fine to coarse grained quartz and feldspar | | | | |
| | | | | | | ML | SANDY SILT, light brown, moist, firm | | | | |
| | 365 | | | | | | | | | | |

SAMPLE TYPES:
- [R] RING (DRIVE) SAMPLE
- [S] SPT (SPLIT SPOON) SAMPLE
- [B] BULK SAMPLE
- [T] TUBE SAMPLE

GROUNDWATER

SEEPAGE

PACIFIC SOILS ENGINEERING, INC.

PLATE A-3

# GEOTECHNICAL BORING LOG



| | | | |
|---|---|---|---|
| PROJECT NO. | 500503 | PROJECT NAME | BREA CENTRAL |
| DATE STARTED | 3/5/99 | GROUND ELEV. | 405 |
| DATE FINISHED | 3/5/99 | GW DEPTH (FT) | 51.00 |
| DRILLER | LEDEZMA | DRIVE WT. | VARIES |
| TYPE OF DRILL RIG | 30" BUCKET | DROP | 12 in. |

BORING DESIG. B-3
LOGGED BY SEC
NOTE

| DEPTH (Feet) | ELEV | SAMPLE TYPE | SAMPLE | BLOWS/FT | LITHOLOGY | GROUP SYMBOL | GEOTECHNICAL DESCRIPTION | MOISTURE CONT (%) | DRY (pcf) DENSITY | SAT-URATION (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 365 | R | | 3 | | ML | SANDY SILT, light brown, moist, firm | 10.4 | 98 | 39 | |
| | | | | | | CL | SILTY CLAY, brown, moist, firm | | | | |
| 45 | 360 | | | | | | | | | | |
| 50 | 355 | R | | 1 | | | CLAYEY SILT, brown, wet, firm | 27.4 | 92 | 90 | |
| | | | | | | SM | SILTY SAND, saturated, medium dense, fine to coarse grained quartz and feldspar, some pebble sized clasts | | | | |
| 55 | 350 | | | | | | | | | | |
| | | R | | 5 | | | | 17.1 | 108 | 83 | |
| | | B | | | | | | | | | |

TOTAL DEPTH = 59 feet
WATER AT 51 feet
CAVING AT 54 feet
Kelly Bar Wts.:

| | |
|---|---|
| 0 - 24' | 3548# |
| 24 - 47' | 2577# |
| 47 - 73' | 1648# |
| 73 - 95' | 810# |

SAMPLE TYPES:
[R] RING (DRIVE) SAMPLE
[S] SPT (SPLIT SPOON) SAMPLE
[B] BULK SAMPLE [T] TUBE SAMPLE

GROUNDWATER
SEEPAGE

PACIFIC SOILS ENGINEERING, INC.

PLATE A-3

# GEOTECHNICAL BORING LOG



| | | | | | |
|---|---|---|---|---|---|
| PROJECT NO. | 500503 | PROJECT NAME | BREA CENTRAL | | |
| DATE STARTED | 3/8/99 | GROUND ELEV. | 485 | BORING DESIG. | B-4 |
| DATE FINISHED | 3/8/99 | GW DEPTH (FT) | | LOGGED BY | SEC |
| DRILLER | LEDEZMA | DRIVE WT. | VARIES | NOTE | |
| TYPE OF DRILL RIG | 30" BUCKET | DROP | 12 in. | | |

| DEPTH (Feet) | ELEV | SAMPLE TYPE | SAMPLE | BLOWS/FT | LITHOLOGY | GROUP SYMBOL | GEOTECHNICAL DESCRIPTION | MOISTURE CONT (%) | DRY (pcf) DENSITY | SAT-URATION (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 | | | | | ML | **ALLUVIUM (Qal):** SANDY SILT, brown, moist, firm | | | | |
| 5 | 480 | | | | | | | | | | |
| | | | | | | ML | CLAYEY SILT, light brown to dark brown, moist, firm, caliche | | | | |
| 10 | 475 | R | | 1 | | | | 14.6 | 114 | 82 | |
| | | | | | | | changes to reddish color | | | | |
| | | | | | | ML | **TERRACE DEPOSITS (Qt):** CLAYEY SILT, reddish brown, moist, stiff, caliche, thin beds of SILTY SAND, light brown | | | | |
| 15 | 470 | B | | | | | | | | | |
| 20 | 465 | R | | 2 | | | | 17.3 | 105 | 77 | |
| | | B | | | | | CLAYEY SILT, reddish brown, moist, stiff, caliche | | | | |
| 25 | 460 | R | | 3 | | | | 26.1 | 92 | 84 | |
| | | | | | | | TOTAL DEPTH = 26 feet<br>NO WATER<br>NO CAVING<br>Kelly Bar Wts.:<br>0 - 24' 3548#<br>24 - 47' 2577#<br>47 - 73' 1648#<br>73 - 95' 810# | | | | |

SAMPLE TYPES:
[R] RING (DRIVE) SAMPLE
[S] SPT (SPLIT SPOON) SAMPLE
[B] BULK SAMPLE [T] TUBE SAMPLE

GROUNDWATER
SEEPAGE

PACIFIC SOILS ENGINEERING, INC.

PLATE A-4

# GEOTECHNICAL BORING LOG



| | | | | | |
|---|---|---|---|---|---|
| PROJECT NO. | 500503 | PROJECT NAME | BREA CENTRAL | | |
| DATE STARTED | 3/8/99 | GROUND ELEV. | 480 | BORING DESIG. | B-5 |
| DATE FINISHED | 3/8/99 | GW DEPTH (FT) | | LOGGED BY | SEC |
| DRILLER | LEDEZMA | DRIVE WT. | VARIES | NOTE | |
| TYPE OF DRILL RIG | 30" BUCKET | DROP | 12 in. | | |

| DEPTH (Feet) | ELEV | SAMPLE TYPE | SAMPLE | BLOWS/FT | GROUP SYMBOL | GEOTECHNICAL DESCRIPTION | MOISTURE CONT (%) | DRY (pcf) DENSITY | SAT-URATION (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|---|
| | 480 | | | | CL | **ARTIFICIAL FILL (Qaf):** SILTY CLAY, dark brown, moist, firm, concrete, lumber, pvc pipe | | | | |
| | | | | | ML | **ALLUVIUM (Qal):** CLAYEY SILT, dark brown, moist, firm, caliche, roots | | | | |
| 5 | 475 | | | | | | | | | |
| | | | | | ML | SANDY SILT, light brown, moist, firm, trace amounts of pebbles, caliche, pin sized voids | | | | |
| | | B | | | ML | | | | | MAX DSR HY EI |
| 10 | 470 | R | | 1 | SM | SILTY SAND, light brown, moist, medium dense, pebble sized clasts of igneous and metamorphic rocks | 6.8 | 100 | 27 | |
| 15 | 465 | B | | | | SILTY SAND, light brown, moist, medium dense | | | | |
| | | | | | ML | SANDY SILT, dark brown, moist, firm | | | | |
| 20 | 460 | R | | 1 | ML | | 13.4 | 108 | 64 | CON HY |
| | | | | | ML | CLAYEY SILT, dark brown, moist, firm | | | | |
| 25 | 455 | | | | | | | | | |
| | | | | | SM | SILTY SAND, light brown, moist, medium dense, fine grained quartz, trace amount of pebble sized igneous and metamorphic rocks<br>trace amount of organic debris | | | | |
| 30 | 450 | R | | 2 | ML | SANDY SILT, brown, moist to wet, firm, caliche, organic debris | 16.0 | 96 | 58 | CON HY |
| | | B | | | | | | | | |
| 35 | 445 | | | | | SANDY SILT, brown, moist to wet, firm, organic debris | | | | |
| | 440 | | | | | | | | | |

SAMPLE TYPES:
- [R] RING (DRIVE) SAMPLE
- [S] SPT (SPLIT SPOON) SAMPLE
- [B] BULK SAMPLE
- [T] TUBE SAMPLE

GROUNDWATER

SEEPAGE

PACIFIC SOILS ENGINEERING, INC.

PLATE A-5

# GEOTECHNICAL BORING LOG



| | | | | | |
|---|---|---|---|---|---|
| PROJECT NO. | 500503 | PROJECT NAME | BREA CENTRAL | | |
| DATE STARTED | 3/8/99 | GROUND ELEV. | 480 | BORING DESIG. | B-5 |
| DATE FINISHED | 3/8/99 | GW DEPTH (FT) | | LOGGED BY | SEC |
| DRILLER | LEDEZMA | DRIVE WT. | VARIES | NOTE | |
| TYPE OF DRILL RIG | 30" BUCKET | DROP | 12 in. | | |

| DEPTH (Feet) | ELEV | SAMPLE TYPE | SAMPLE | BLOWS/FT | LITHOLOGY | GROUP SYMBOL | GEOTECHNICAL DESCRIPTION | MOISTURE CONT (%) | DRY (pcf) DENSITY | SAT-URATION (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 440 | R | | 1 | | ML | SANDY SILT, brown, moist to wet, firm | 22.9 | 99 | 88 | |
| 45 | 435 | | | | | | | | | | |
| | | | | | | ML | **TERRACE DEPOSITS (Qt):** CLAYEY SANDY SILT, dark brown, to reddish brown, moist, firm, caliche, some pebble sized clasts | | | | |
| | | R | | 4 | | | | 13.5 | 109 | 66 | |
| 50 | 430 | B | | | | | | | | | |
| | | | | | | | TOTAL DEPTH = 51 feet<br>NO WATER<br>NO CAVING<br>Kelly Bar Wts.:<br>0 - 24' 3548#<br>24 - 47' 2577#<br>47 - 73' 1648#<br>73 - 95' 810# | | | | |

SAMPLE TYPES:
- [R] RING (DRIVE) SAMPLE
- [S] SPT (SPLIT SPOON) SAMPLE
- [B] BULK SAMPLE
- [T] TUBE SAMPLE

GROUNDWATER

SEEPAGE

PACIFIC SOILS ENGINEERING, INC.

PLATE A-5

# GEOTECHNICAL BORING LOG



| | | | | | |
|---|---|---|---|---|---|
| PROJECT NO. | 500503 | PROJECT NAME | BREA CENTRAL | | |
| DATE STARTED | 3/8/99 | GROUND ELEV. | 465 | BORING DESIG. | B-6 |
| DATE FINISHED | 3/8/99 | GW DEPTH (FT) | | LOGGED BY | SEC |
| DRILLER | LEDEZMA | DRIVE WT. | VARIES | NOTE | |
| TYPE OF DRILL RIG | 30" BUCKET | DROP | 12 in. | | |

| DEPTH (Feet) | ELEV | SAMPLE TYPE | SAMPLE | BLOWS/FT | LITHOLOGY | GROUP SYMBOL | GEOTECHNICAL DESCRIPTION | MOISTURE CONT (%) | DRY (pcf) DENSITY | SAT-URATION (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 465 | | | | | ML | ARTIFICIAL FILL (Qaf): CLAYEY SILT, light to dark brown, moist, firm, trace sand and pebbles | | | | |
| 5 | 460 | | | | | ML | ALLUVIUM (Qal): CLAYEY SILT with trace SAND and pebbles, light to dark brown, moist, firm, caliche | | | | |
| | | | | | | ML | TERRACE DEPOSITS(Qt): CLAYEY SILT with trace SAND, dark brown to reddish brown, moist to wet, firm, caliche, roots | | | | |
| | | B | | | | | | | | | |
| 10 | 455 | R | | 2 | | | | 26.3 | 94 | 90 | |
| 15 | 450 | | | | | | CLAYEY SILT with trace SAND, light brown to reddish brown, moist to wet, stiff, caliche | | | | |
| 20 | 445 | R | | 3 | | ML | CLAYEY SANDY SILT, dark brown to reddish brown, moist, stiff, caliche | 16.7 | 109 | 83 | |
| | | R | | 3 | | | | 14.2 | 105 | 64 | |
| 25 | 440 | B | | | | | | | | | |
| | | | | | | | TOTAL DEPTH = 26 feet<br>NO WATER<br>NO CAVING<br>Kelly Bar Wts.:<br>0 - 24' 3548#<br>24 - 47' 2577#<br>47 - 73' 1648#<br>73 - 95' 810# | | | | |

SAMPLE TYPES:
- [R] RING (DRIVE) SAMPLE
- [S] SPT (SPLIT SPOON) SAMPLE
- [B] BULK SAMPLE [T] TUBE SAMPLE

GROUNDWATER

SEEPAGE

PACIFIC SOILS ENGINEERING, INC.

PLATE A-6

# GEOTECHNICAL BORING LOG



| | | | |
|---|---|---|---|
| PROJECT NO. | 500503 | PROJECT NAME | BREA CENTRAL |
| DATE STARTED | 3/8/99 | GROUND ELEV. | 485 |
| DATE FINISHED | 3/8/99 | GW DEPTH (FT) | |
| DRILLER | LEDEZMA | DRIVE WT. | VARIES |
| TYPE OF DRILL RIG | 30" BUCKET | DROP | 12 in. |

BORING DESIG. B-7
LOGGED BY SEC
NOTE

| DEPTH (Feet) | ELEV | SAMPLE TYPE | SAMPLE | BLOWS/FT | LITHOLOGY | GROUP SYMBOL | GEOTECHNICAL DESCRIPTION | MOISTURE CONT (%) | DRY (pcf) DENSITY | SAT-URATION (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 | | | | | ML | **ARTIFICIAL FILL (Qaf):** SANDY SILT, brown, moist, firm, trash, debris | | | | |
| 5 | 480 | | | | | ML | **ALLUVIUM(Qal):** CLAYEY SILT, dark brown, moist, firm, organic debris<br>SANDY CLAYEY SILT, dark brown to reddish brown, moist, firm, trace amounts of pebbles | | | | |
| | | B | | | | | | | | | |
| | | | | | | ML | **TERRACE DEPOSITS (Qt):** SANDY SILT, reddish brown to dark brown, moist, firm, trace amounts of pebbles | | | | |
| 10 | 475 | R | | 2 | | | | 14.1 | 116 | 85 | |
| 15 | 470 | | | | | | | | | | |
| | | B | | | | | | | | | |
| 20 | 465 | R | | 4 for 10" | | SM | SILTY SAND, reddish brown, moist, medium dense, trace amounts of pebbles | 8.5 | 111 | 44 | CON HY |
| | | B | | | | | | | | | |
| 25 | 460 | | | | | | TOTAL DEPTH = 25 feet<br>NO WATER<br>NO CAVING<br>Kelly Bar Wts.:<br>0 - 24' 3548#<br>24 - 47' 2577#<br>47 - 73' 1648#<br>73 - 95' 810# | | | | |

SAMPLE TYPES:
- [R] RING (DRIVE) SAMPLE
- [S] SPT (SPLIT SPOON) SAMPLE
- [B] BULK SAMPLE [T] TUBE SAMPLE

GROUNDWATER
SEEPAGE

PACIFIC SOILS ENGINEERING, INC.

PLATE A-7

# GEOTECHNICAL BORING LOG



| | | | |
|---|---|---|---|
| PROJECT NO. 500503 | PROJECT NAME BREA CENTRAL | | |
| DATE STARTED 3/8/99 | GROUND ELEV. 515 | BORING DESIG. B-8 | |
| DATE FINISHED 3/8/99 | GW DEPTH (FT) | LOGGED BY SEC | |
| DRILLER LEDEZMA | DRIVE WT. VARIES | NOTE | |
| TYPE OF DRILL RIG 30" BUCKET | DROP 12 in. | | |

| DEPTH (Feet) | ELEV | SAMPLE TYPE | SAMPLE | BLOWS/FT | LITHOLOGY | GROUP SYMBOL | GEOTECHNICAL DESCRIPTION | MOISTURE CONT (%) | DRY (pcf) DENSITY | SAT-URATION (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 515 | | | | | SM | ARTIFICIAL FILL (Qaf): SILTY SAND, tan, moist, medium dense | | | | |
| | | | | | | ML | CLAYEY SILT, brown, moist, firm, poorly layered, trash, pvc | | | | |
| 5 | 510 | | | | | | | | | | |
| | | | | | | ML | ALLUVIUM (Qal): CLAYEY SILT, dark brown to black, moist, soft, trace SAND and pebbles | | | | |
| 10 | 505 | R | | PUSH | | | | 21.9 | 100 | 86 | |
| | | B | | | | | | | | | |
| | | | | | | CL | SILTY CLAY, dark brown to black, moist, firm, trace amounts of SAND and pebbles, caliche, pin sized voids | | | | |
| 15 | 500 | | | | | | | | | | |
| | | | | | | | color becomes more red | | | | |
| 20 | 495 | R | | 2 | | SM | TERRACE DEPOSITS(Qt): SILTY SAND, dark brown with reddish tint, moist, medium dense, trace of CLAY and pebbles, caliche | 12.1 | 111 | 64 | CON HY |
| | | B | | | | | | | | | |
| 25 | 490 | | | | | | | | | | |
| | | | | | | ML | SANDY SILT, reddish brown, moist, firm, caliche nodules and stringers, some pebble sized clasts of igneous and metamorphic rocks | | | | |
| 30 | 485 | R | | 4 | | ML | SANDY SILT, light brown with reddish tint, moist, stiff, caliche nodules and stringers, some pebble sized clasts of igneous and metamorphic rocks | 14.2 | 106 | 65 | CON HY |
| 35 | 480 | | | | | | | | | | |
| | | | | | | | SANDY SILT, orangish brown to light brown, moist, firm, some trace amounts pebble sized clasts of igneous and metamorphic rocks | | | | |
| | 475 | | | | | | | | | | |

SAMPLE TYPES:
- [R] RING (DRIVE) SAMPLE
- [S] SPT (SPLIT SPOON) SAMPLE
- [B] BULK SAMPLE
- [T] TUBE SAMPLE

GROUNDWATER

SEEPAGE

PACIFIC SOILS ENGINEERING, INC.

PLATE A-8

# GEOTECHNICAL BORING LOG

| | | | | | |
|---|---|---|---|---|---|
| PROJECT NO. | 500503 | PROJECT NAME | BREA CENTRAL | | |
| DATE STARTED | 3/8/99 | GROUND ELEV. | 515 | BORING DESIG. | B-8 |
| DATE FINISHED | 3/8/99 | GW DEPTH (FT) | | LOGGED BY | SEC |
| DRILLER | LEDEZMA | DRIVE WT. | VARIES | NOTE | |
| TYPE OF DRILL RIG | 30" BUCKET | DROP | 12 in. | | |

| DEPTH (Feet) | ELEV | SAMPLE TYPE | SAMPLE | BLOWS/FT | LITHOLOGY | GROUP SYMBOL | GEOTECHNICAL DESCRIPTION | MOISTURE CONT (%) | DRY (pcf) DENSITY | SAT-URATION (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 475 | R | | 4 | | ML | SANDY SILT, orangish brown to light brown, moist, firm, some trace amounts pebble sized clasts of igneous and metamorphic rocks | 11.4 | 113 | 63 | |
| | | B | | | | | | | | | |
| | | | | | | | TOTAL DEPTH = 42 feet<br>NO WATER<br>NO CAVING<br>Kelly Bar Wts.:<br>0 - 24' 3548#<br>24 - 47' 2577#<br>47 - 73' 1648#<br>73 - 95' 810# | | | | |

SAMPLE TYPES:
[R] RING (DRIVE) SAMPLE
[S] SPT (SPLIT SPOON) SAMPLE
[B] BULK SAMPLE [T] TUBE SAMPLE

GROUNDWATER
SEEPAGE

PACIFIC SOILS ENGINEERING, INC.

PLATE A-8

# GEOTECHNICAL BORING LOG



| | | | |
|---|---|---|---|
| PROJECT NO. | 500503 | PROJECT NAME | BREA CENTRAL |
| DATE STARTED | 3/8/99 | GROUND ELEV. | 500 |
| DATE FINISHED | 3/8/99 | GW DEPTH (FT) | |
| DRILLER | LEDEZMA | DRIVE WT. | VARIES |
| TYPE OF DRILL RIG | 30" BUCKET | DROP | 12 in. |

BORING DESIG. B-9
LOGGED BY SEC
NOTE

| DEPTH (Feet) | ELEV | SAMPLE TYPE | SAMPLE | BLOWS/FT | LITHOLOGY | GROUP SYMBOL | GEOTECHNICAL DESCRIPTION | MOISTURE CONT (%) | DRY (pcf) DENSITY | SAT-URATION (%) | OTHER TESTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 500 | | | | | ML | **ALLUVIUM (Qal):** SANDY SILT, brown, moist, soft to firm | | | | |
| 5 | 495 | | | | | ML | CLAYEY SILT, dark brown, moist, soft | | | | |
| | | | | | | ML | SANDY SILT, light brown, moist, soft, trace amount of pebbles | | | | |
| 10 | 490 | R | | 1 | | ML | CLAYEY SILT, light brown to dark brown, moist, soft, caliche, roots, pin sized voids | 13.0 | 104 | 56 | |
| | | B | | | | | | | | | |
| 15 | 485 | | | | | | color becomes more red | | | | |
| | | | | | | SM | **TERRACE DEPOSITS (Qt)?:** SILTY SAND, light brown to reddish brown, moist, loose, caliche stringers, pin sized voids, fine grained quartz and feldspar | | | | |
| 20 | 480 | R | | 1 | | SM | | 13.9 | 107 | 65 | CON HY |
| | | B | | | | ML | CLAYEY SANDY SILT, light brown to reddish brown, moist, firm, caliche, some trace pebbles | | | | |
| 25 | 475 | | | | | | | | | | |
| | | | | | | | CLAYEY SANDY SILT, light brown to orangish brown, moist, firm, caliche | | | | |
| 30 | 470 | R | | 2 | | | | 12.2 | 97 | 45 | |
| | | | | | | | TOTAL DEPTH = 31 feet<br>NO WATER<br>NO CAVING<br>Kelly Bar Wts.:<br>0 - 24' 3548#<br>24 - 47' 2577#<br>47 - 73' 1648#<br>73 - 95' 810# | | | | |

SAMPLE TYPES:
R RING (DRIVE) SAMPLE
S SPT (SPLIT SPOON) SAMPLE
B BULK SAMPLE
T TUBE SAMPLE

GROUNDWATER
SEEPAGE

PACIFIC SOILS ENGINEERING, INC.

PLATE A-9

## TABLE A-1

## LOG OF TEST PITS

| T-1 | Depth | Description |
|---|---|---|
| | 0-3 ½ ' | COLLUVIUM (Qcol): SANDY CLAY, dark reddish brown, slightly moist, firm to stiff, rootlets. |
| | 3 ½-7'' | FERNANDO FORMATION-Upper Member (Tfu): SANDSTONE, medium to coarse grained, moist, hard, massive common pebbles, upper 3' weathered, caliche. |
| | | Total Depth 7' |

| T-2 | Depth | Description |
|---|---|---|
| | 0-2' | COLLUVIUM (Qcol): SANDY CLAY, brown, moist, firm, roots and rootlets, pin voids, caliche. |
| | 2-5' | TERRACE DEPOSITS (Qt): SANDY to CLAYEY SILT, reddish brown, slightly moist to moist, firm to stiff, blocky, minor caliche and black organic staining on ped faces upper 2'. |
| | | Total Depth 5' |

| T-3 | Depth | Description |
|---|---|---|
| | 0-3' | FERNANDO FORMATION-Upper Member (Tfu): SANDSTONE, coarse grained, reddish to yellow brown, moist, hard, friable, massive, rounded pebble clasts, cobbles. |
| | | Total Depth 3' |

| T-4 | Depth | Description |
|---|---|---|
| | 0-4' | COLLUVIUM (Qcol): CLAYEY SILT/SILTY CLAY, brown, slightly moist, soft, roots, voids. |
| | 4-12' | OLDER ALLUVIUM (Qoa): SILTY CLAY, with sand, dark red brown, slightly moist to moist, firm to stiff, pin voids, some hair roots, clay film on ped faces, occasional pebbles. |
| | | @ 10' becomes stiff, decrease in size and volume of pin voids, some still present. |
| | | Total Depth 12' |

## TABLE A-1

## LOG OF TEST PITS

| T-5 | Depth | Description |
|---|---|---|
| | 0-1' | **ARTIFICIAL FILL (Qaf):** SANDY SILT, brown, slightly moist, soft, oily, tar. |
| | 1-6' | **TERRACE DEPOSITS (Qt):** SILT, dark red brown, slightly moist to moist, firm to stiff, some pin voids, clay film on ped faces, some sand, upper 3' weathered. |
| | | Total Depth 6' |

| T-6 | Depth | Description |
|---|---|---|
| | 0-2' | **COLLUVIUM (Qcol):** SANDY CLAY, dark brown, moist, soft to firm, voids. |
| | 2-11' | **OLDER ALLUVIUM (Qoa):** SANDY SILT/CLAY, yellow to red brown, moist, firm to stiff, pin voids, some caliche, pebbles. |
| | | Total Depth 11' |

| T-7 | Depth | Description |
|---|---|---|
| | 0-4' | **COLLUVIUM (Qcol):** SANDY CLAY, brown, moist, soft, roots and voids, some pebbles. |
| | | @2' SANDY SILT, brown, moist, firm, pin voids. |
| | 4-7' | **OLDER ALLUMIUM (Qoa):** SANDY SILT, dark red brown, moist, firm to stiff, pin voids, pebbles. |
| | 7-10' | **FERNANDO FORMATION –Upper Member (Tfu):** SILTSTONE, tan, moist, moderately hard to hard, upper 2' weathered, iron oxide stained. |
| | | Total Depth 10' |

| T-8 | Depth | Description |
|---|---|---|
| | 0-1 ½' | **COLLUVIUM (Qcol):** SILTY SAND, brown, dry, loose, roots. |
| | 1 ½-3' | **FERNANDO FORMATION-Upper Member (Tfu):** PEBBLE CONGLOMERATE, yellow to red brown, slightly moist, very hard, massive, moderately well cemented, rounded clasts, medium grained silty matrix. |
| | | Total Depth 3' |

## TABLE A-1

## LOG OF TEST PITS

| T-9 | Depth | Description |
|---|---|---|
| | 0-5' | **COLLUMIUM (Qcol):** SANDY SILT, brown, slightly moist to moist, soft, roots. |
| | 5-8' | **FERNANDO FORMATION-Upper Member (Tfu):** SANDSTONE, fine to medium grained, light reddish yellow, slightly moist, hard to very hard, moderately well cemented, platy, upper 2' weathered. |
| | | Total Depth 8' |

| T-10 | Depth | Description |
|---|---|---|
| | 0-4' | **COLLUMIUM (Qcol):** SANDY CLAY, reddish brown, moist, firm, pebbles, 2-3' cut by roadway, some roots. |
| | 4-6' | **FERNANDO FORMATION-Upper Member (Tfu):** SANDSTONE, fine grained, yellow, slightly moist, hard to very hard, massive, upper 1-1 ½' weathered. |
| | | Total Depth 6' |

| T-11 | Depth | Description |
|---|---|---|
| | 0-6' | **COLLUVIUM (Qcol):** SANDY CLAY, brown, moist, soft to firm, roots, voids, some cobbles, becomes reddish brown @ 3', common cobbles and pebbles 3-6'. |
| | 6-8' | **FERNANDO FORMATION-Lower Member (Tfl):** SILTSTONE, yellow, moist, hard, upper 1' weathered. |

| T-12 | Depth | Description |
|---|---|---|
| | 0-7' | **COLLUVIUM (Qcol):** SANDY CLAY, brown, slightly moist, roots, voids, some pebbles, becomes reddish brown @ 5'. |
| | 7-8 ½' | **FERNANDO FORMATION-Upper Member (Tfu):** PEBBLE to COBBLE CONGLOMERATE, brown, slightly moist, hard, massive, rounded clasts, silty coarse sand matrix, weathered. |
| | | Total Depth 8 ½' |

## TABLE A-1

## LOG OF TEST PITS

| T-13 | Depth | Description |
|---|---|---|
| | 0-7' | **COLLUVIUM (Qcol):** SILTY CLAY, brown, moist, soft to firm, voids, roots, some sand. |
| | 7-8 ½' | **FERNANDO FORMATION-Lower Member (Tfl):** SILTSTONE, yellow, moist, hard, upper 1' weathered. |
| | | Total Depth 8 ½' |

| T-14 | Depth | Description |
|---|---|---|
| | 1-7' | **ALLUVIUM (Qal):** SILTY SAND, tan brown, moist, loose, some pebbles. |
| | 7-11' | CLAYEY SILT, brown, moist, soft. |
| | 11-13' | SILTY SAND, light brown, moist, loose. |
| | | Total Depth 13' |

| T-15 | Depth | Description |
|---|---|---|
| | 0-4' | **COLLUVIUM (Qcol):** SILTY CLAY with sand, brown, slightly moist to moist, soft to firm, voids, hair roots. |
| | 4-7' | **OLDER ALLUVIUM (Qoa):** SILTY to SANDY CLAY, reddish brown, slightly moist, firm to stiff, pin voids. |
| | 7-9'+ | CLAYEY SAND, yellowish brown, moist, dense. |
| | | Total Depth 9' |

| T-16 | Depth | Description |
|---|---|---|
| | 0-3' | **COLLUVIUM (Qcol):** SANDY CLAY, brown, slightly moist, soft, pin voids, rootlets. |
| | 3-10' | **OLDER ALLUVIUM (Qoa):** SANDY CLAY, reddish brown, moist, firm to stiff, pin voids, clay film on ped faces. |
| | | @ 7' decrease in voids. |
| | | Total Depth 10' |

# TABLE A-1

## LOG OF TEST PITS

| T-17 | Depth | Description |
|---|---|---|
| | 0-4' | COLLUVIUM (Qcol): SANDY CLAY, brown, firm, voids. |
| | 4-10 ½'+ | OLDER ALLUVIUM (Qoa): SILTY SAND, yellow brown, moist, medium dense. |
| | | Total Depth 10 ½' (5-6' removals) |

| T-18 | Depth | Description |
|---|---|---|
| | 0-9' | ALLUVIUM (Qal): SILTY SAND, yellow, moist, loose to medium dense, minor caliche stringers. |
| | | Total Depth 9' |

| T-19 | Depth | Description |
|---|---|---|
| | 0-1' | ARTIFICIAL FILL (Qaf): SILTY to CLAYEY SAND, brown, slightly moist, loose, oil, rootlets. |
| | 1-5' | COLLUVIUM (Qcol): SILTY CLAY, dark brown, slightly moist to moist, firm, common voids. |
| | 5-10' | TERRACE DEPOSITS (Qt): SILTY CLAY, moist, firm to stiff, black organic stained, slightly petroliferous odor. |

| T-20 | Depth | Description |
|---|---|---|
| | 0-6' | COLLUVIUM (Qcol): SANDY SILT, brown, moist, firm, roots. |
| | 6-11'+ | TERRACE DEPOSITS (Qt): SILT with some sand, yellowish tan, moist, firm, weathered with abundant caliche and voids top 3'. |
| | | Total Depth 11' |

| T-21 | Depth | Description |
|---|---|---|
| | 0-3' | COLLUVIUM (Qcol): SANDY CLAY, dark brown, moist, firm to stiff, roots, voids. |
| | 3-6 ½' | TERRACE DEPOSITS (Qt): SANDY SILT, brown, moist, stiff, upper 2' weathered with abundant caliche, voids. |
| | | Total Depth 6 ½' |

# APPENDIX C

## Laboratory Analysis

## (PSE, 1999)

# APPENDIX C

## LABORATORY ANALYSES

The results of laboratory testing performed during PSE's investigation are enclosed within this Appendix. Table C-1 presents a summary of laboratory test results.

### Moisture and In-place Density

The filed moisture content and in-situ dry density were established on relatively undisturbed ring samples obtained from the borings. The moisture content was obtained in accordance with ASTM Test Method: D-2216. The in-situ dry density was computed using the net weight of the entire sample. The results of these tests are presented on the boring logs, Plates A-1 through A-9.

### Classification

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

### Consolidation Tests

Consolidation tests were performed on ten relatively undisturbed soil samples in accordance with procedures outlined in ASTM D-2435. Samples were placed in a consolidometer and loads were applied incrementally in geometric progression. The sample (2.42 and 2.5-inches in diameter and 1-inch in height) was permitted to consolidate under each load increment until the slope of the characteristic linear secondary compression portion of the thickness versus log of time plot was apparent.

The percent consolidation for each load cycle was recorded as the ratio of the amount of vertical compression to the original 1-inch height. Hydroconsolidation (collapse) and expansion characteristics were also evaluated by monitoring the change in volume with saturation while the specimen was confined under constant normal stress. The consolidation test results are shown on Plates B-1 through B-10.

**Direct Shear Tests**

Direct shear tests were performed on two remolded samples that 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, 2.42 and 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 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 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 Plates B-11 and B-12.

**Maximum Density/Optimum Moisture**

The maximum dry density and optimum moisture content of selected representative bulk samples 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 portion ASTM D2422-72 were conducted to aid in classification of the soils. The results of the particle size analysis are presented in Table B-1.

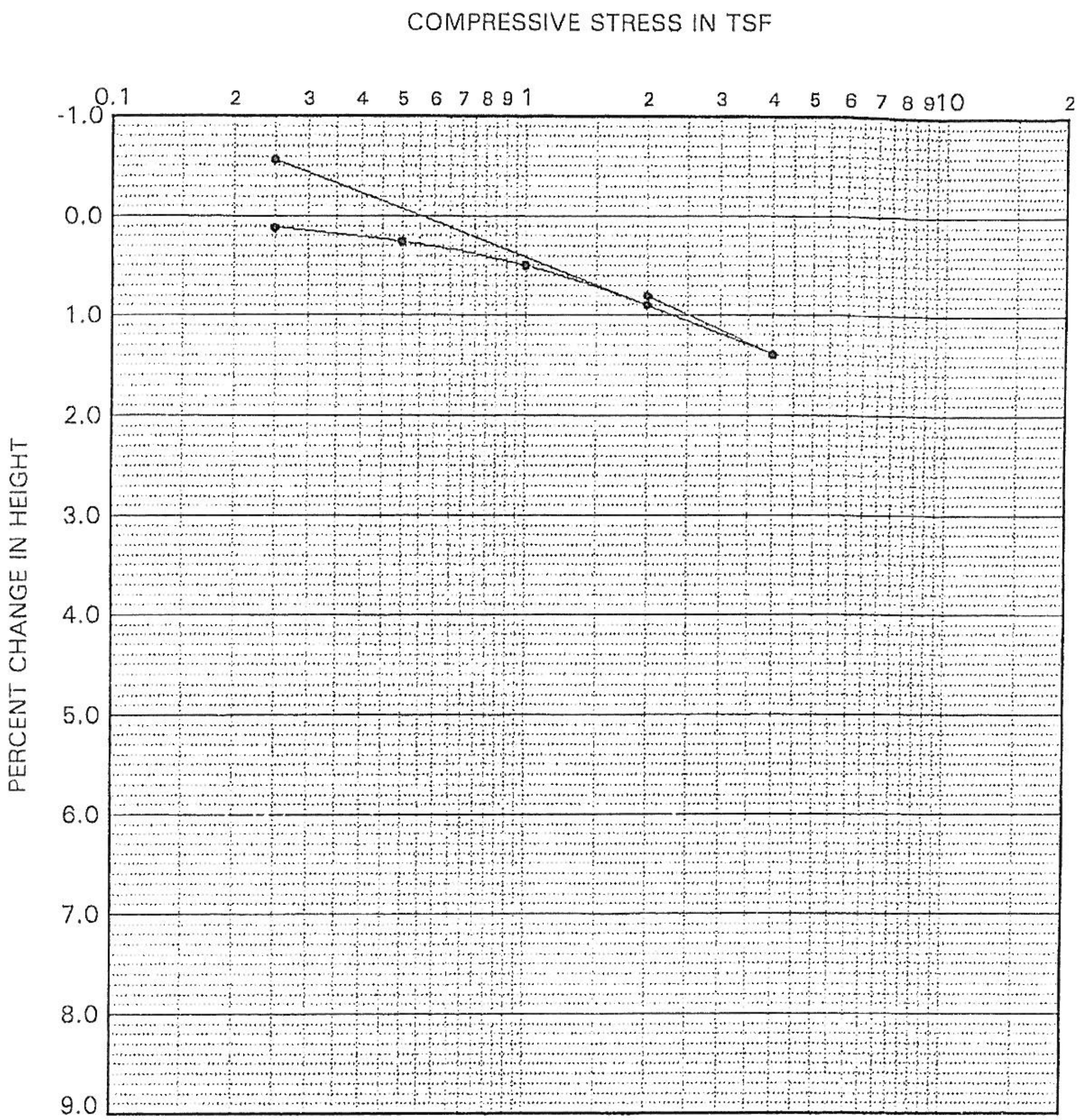
**Expansion Index Tests**

One expansion index tests 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.

TABLE B-1

Summary of Laboratory Test Data

| Boring/Pit No. | Depth | Soil Description | Group Symbol - Unified Soil Classification System | Maximum Dry Density | | Grain Size Analysis | | | | | Expansion Index, UBC 18-2 | Sand Equivalent | R-Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Maximum Density (pcf) | Optimum Moisture (%) | % + No. 4 Screen | % Coarse Sand | % Med.- Fine Sand | %Silt (0.074 to 0.005mm) | % Clay (-0.005 mm) | | | |
| 5 | 8 | Sandy Silt Qal | ML | 121.5 | 11.4 | 0 | 0 | 45 | 30 | 25 | 50 | | |
| 1 | 11 | Clayes Sand (Qt) | SC | 122.5 | 10.5 | 0 | 0.7 | 50.3 | 24 | 25 | 41 | | |
| 2 | 40 | Sandy Silt Qal | SM | | | 0 | 0 | 63 | 24 | 13 | | | |
| 9 | 20 | Silty Sand Qt | SM | | | 0 | 0 | 50 | 28 | 22 | | | |
| 8 | 20 | Silty Sand Qt | SM | | | 0 | 0 | 55 | 25 | 20 | | | |
| 5 | 20 | Sandy Silt Qal | ML | | | 0 | 0 | 48 | 29 | 23 | | | |
| 7 | 20 | Silty Sand Qt | SM | | | 0 | 0 | 67 | 21 | 12 | | | |
| 8 | 30 | Sandy Silt Qt | ML | | | 0 | 0 | 47 | 31 | 22 | | | |
| 1 | 20 | Silty Sand Qt | SM | | | 0 | 0 | 58 | 30 | 12 | | | |
| 5 | 30 | Sandy Silt Qal | ML | | | 0 | 0 | 48 | 27 | 25 | | | |
| 1 | 30 | Silty Sand Qt | SM | | | 0 | 0 | 53 | 27 | 20 | | | |
| 2 | 20 | Clayey Sandy Silt Qal | ML | | | 0 | 1 | 34 | 35 | 30 | | | |



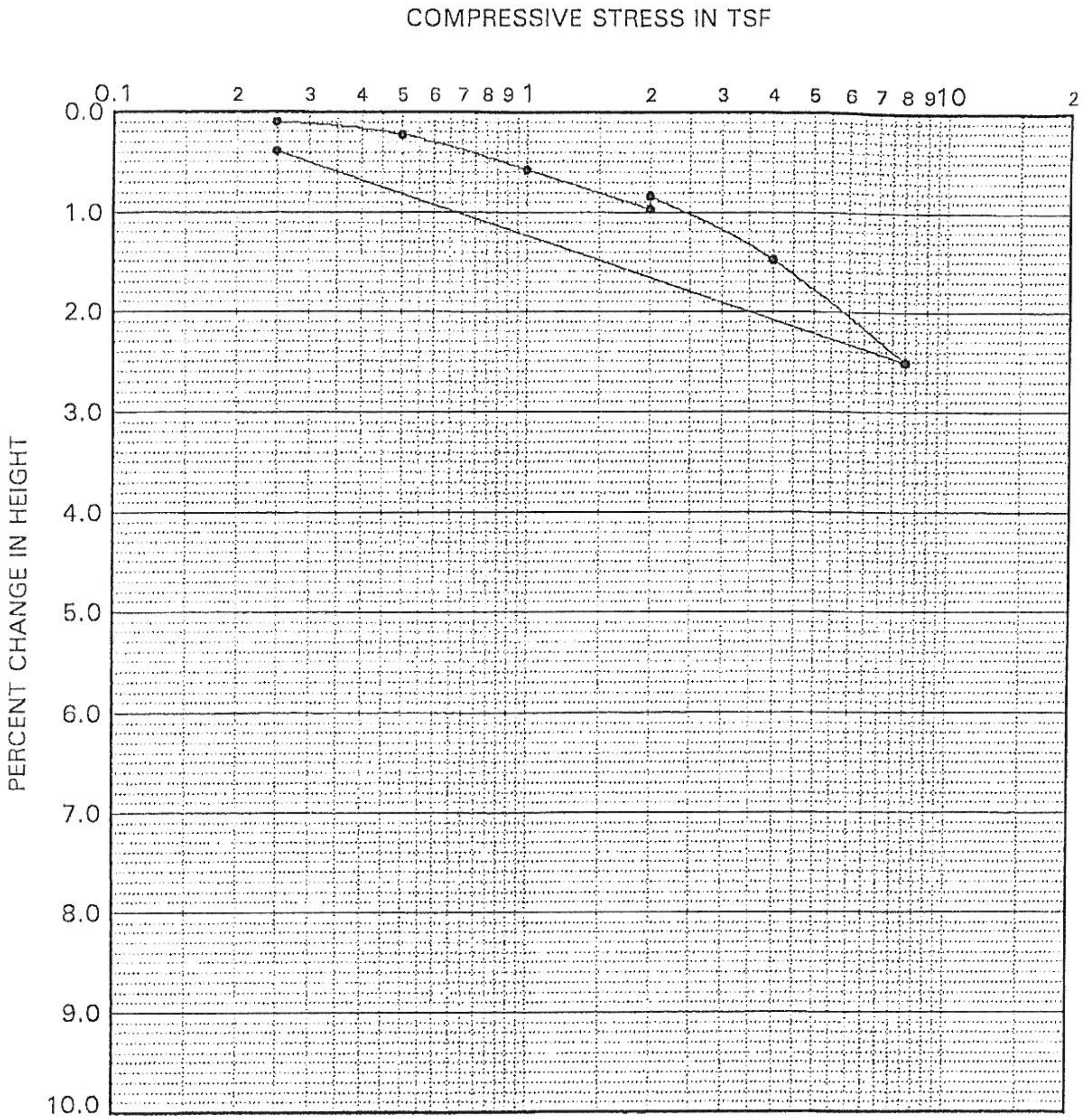

| boring | depth (ft.) | dry density | in situ moist. | -200 sieve | group symbol | typical names |
|---|---|---|---|---|---|---|
| B-1 | 20.0 | 114.9 | 8.4 | | SM | Silty Sand (Qt) |

REMARKS: WATER ADDED AT 2 TSF

CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
3002 DOW AVE., TUSTIN, CA 92680 714-730-2122

W.O. 500503 PLATE B-1



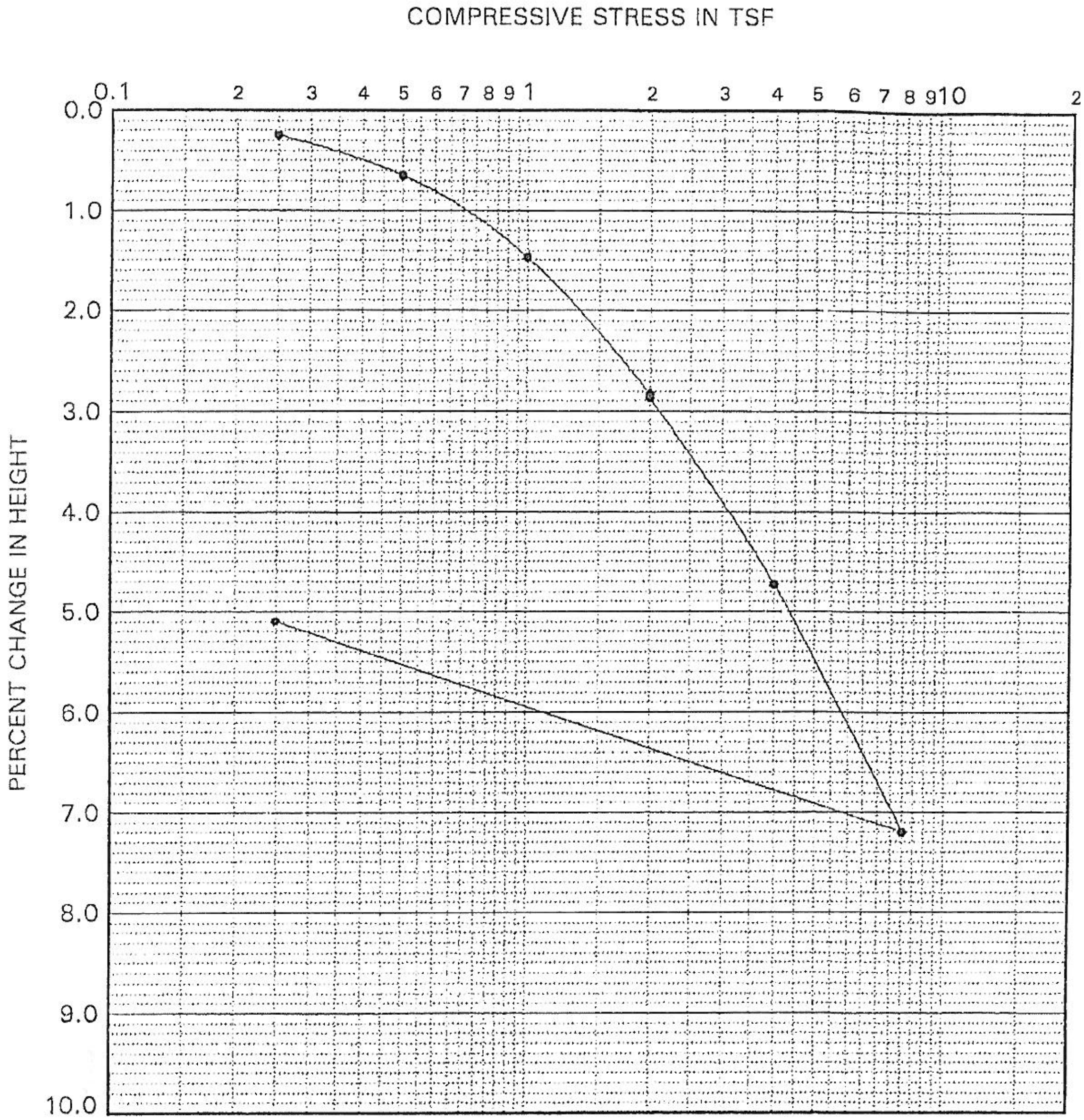

| boring | depth (ft.) | dry density | in situ moist. | -200 sieve | group symbol | typical names |
|---|---|---|---|---|---|---|
| B-1 | 30.0 | 113.1 | 6.8 | | SM | Silty Sand (Qt) |

REMARKS: WATER ADDED AT 2 TSF

CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
3002 DOW AVE., TUSTIN, CA 92680 714-730-2122

W.O. 500503 PLATE B-2



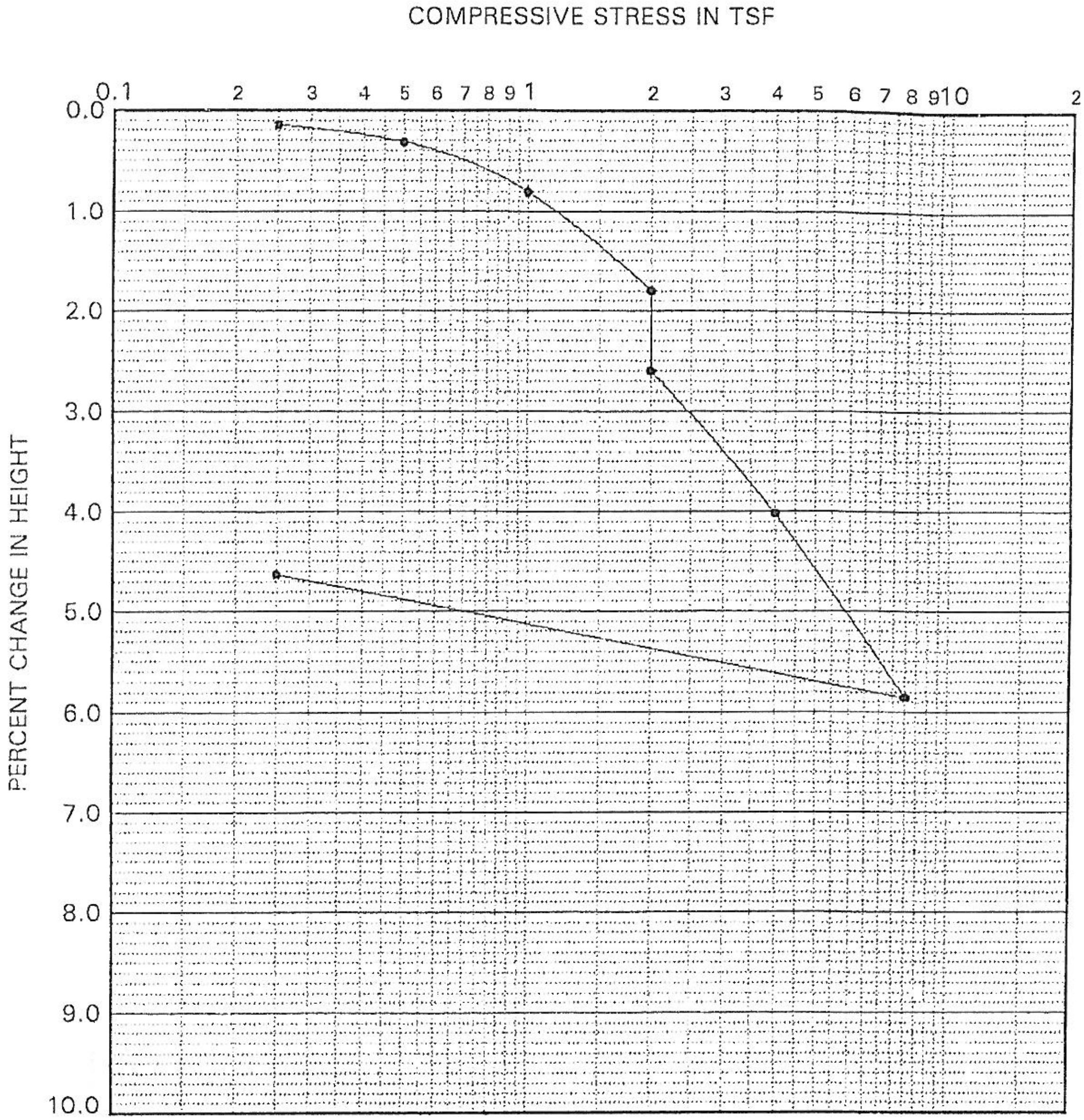

| boring | depth (ft.) | dry density | in situ moist. | -200 sieve | group symbol | typical names |
|---|---|---|---|---|---|---|
| B-2 | 20.0 | 108.5 | 16.6 | | ML | Clayey Silt (Qal) |

REMARKS: WATER ADDED AT 2 TSF

CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
3002 DOW AVE., TUSTIN, CA 92680 714-730-2122

W.O. 500503 PLATE B-3




| boring | depth (ft.) | dry density | in situ moist. | -200 sieve | group symbol | typical names |
|---|---|---|---|---|---|---|
| B-2 | 40.0 | 96.3 | 11.1 | | SM | Silty Sand (Qal) |

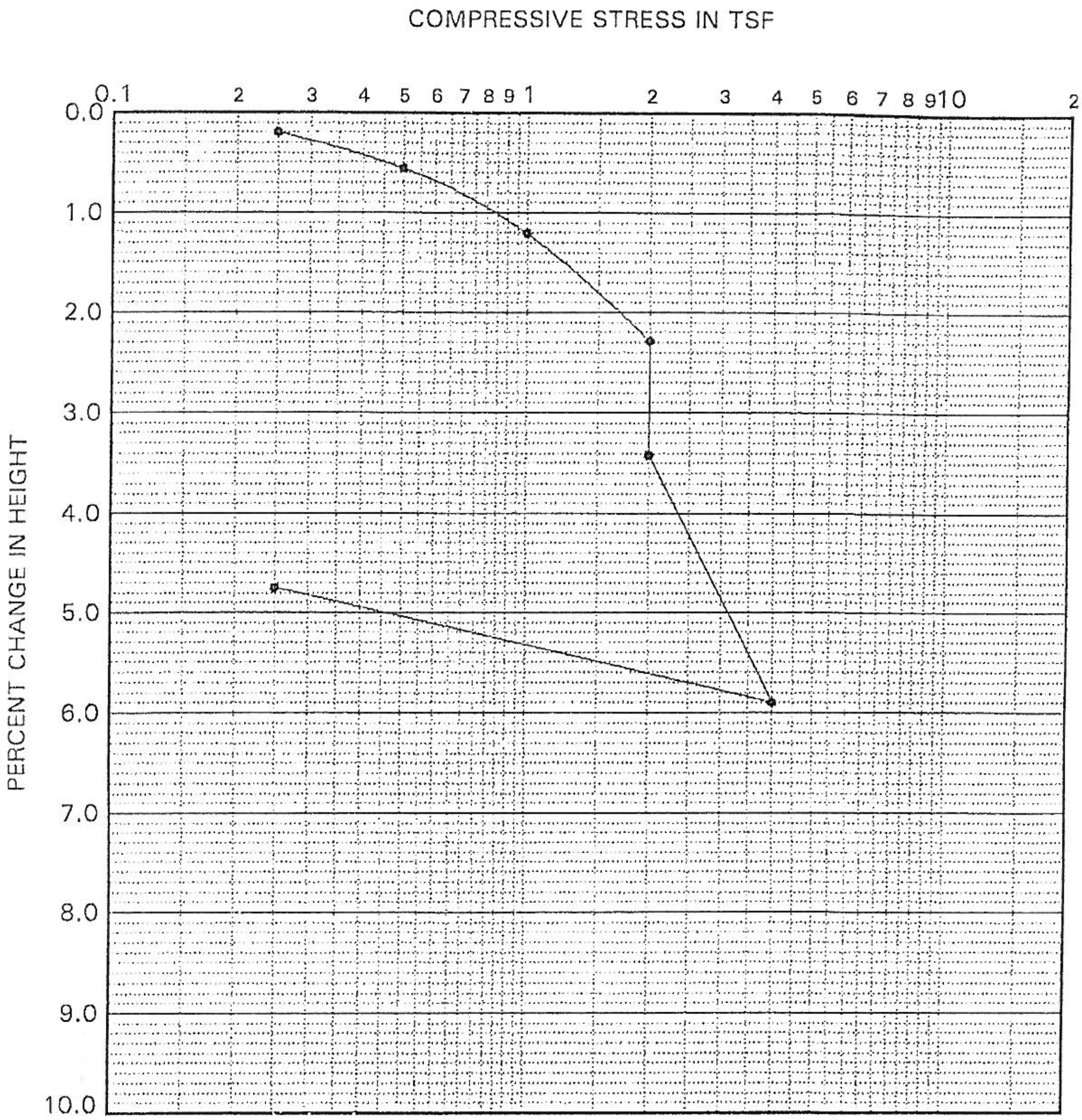
REMARKS: WATER ADDED AT 2 TSF

CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.

3002 DOW AVE., TUSTIN, CA 92680 714-730-2122

W.O. 500503 PLATE B-4




| boring | depth (ft.) | dry density | in situ moist. | -200 sieve | group symbol | typical names |
|---|---|---|---|---|---|---|
| B-5 | 20.0 | 107.7 | 13.4 | | ML | Sandy Silt (Qal) |

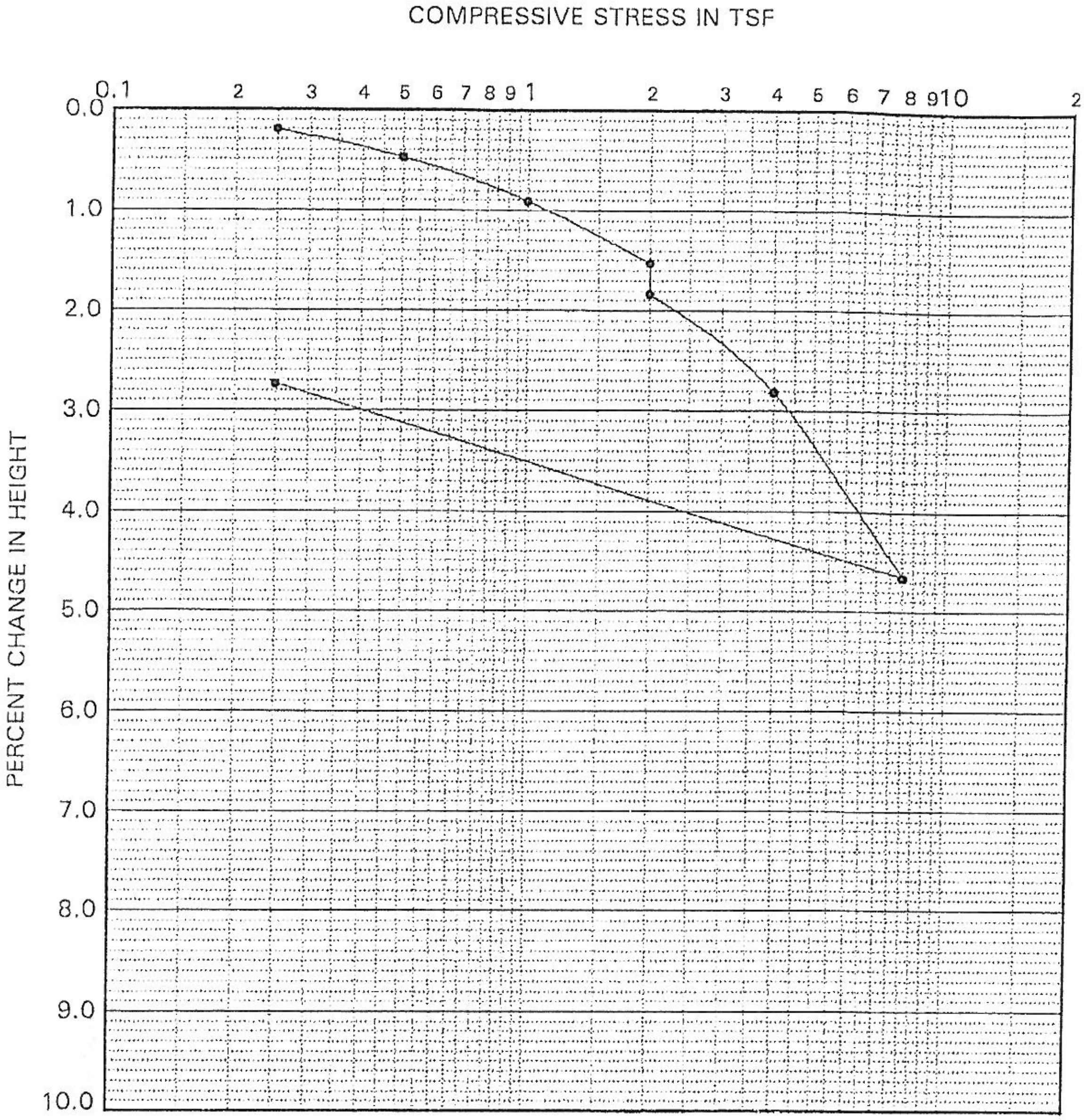
REMARKS: WATER ADDED AT 2 TSF

CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.

3002 DOW AVE., TUSTIN, CA 92680 714-730-2122

W.O. 500503 PLATE B-5




| boring | depth (ft.) | dry density | in situ moist. | -200 sieve | group symbol | typical names |
|---|---|---|---|---|---|---|
| B-5 | 30.0 | 96.4 | 16.0 | | ML | Sandy Silt (Qal) |

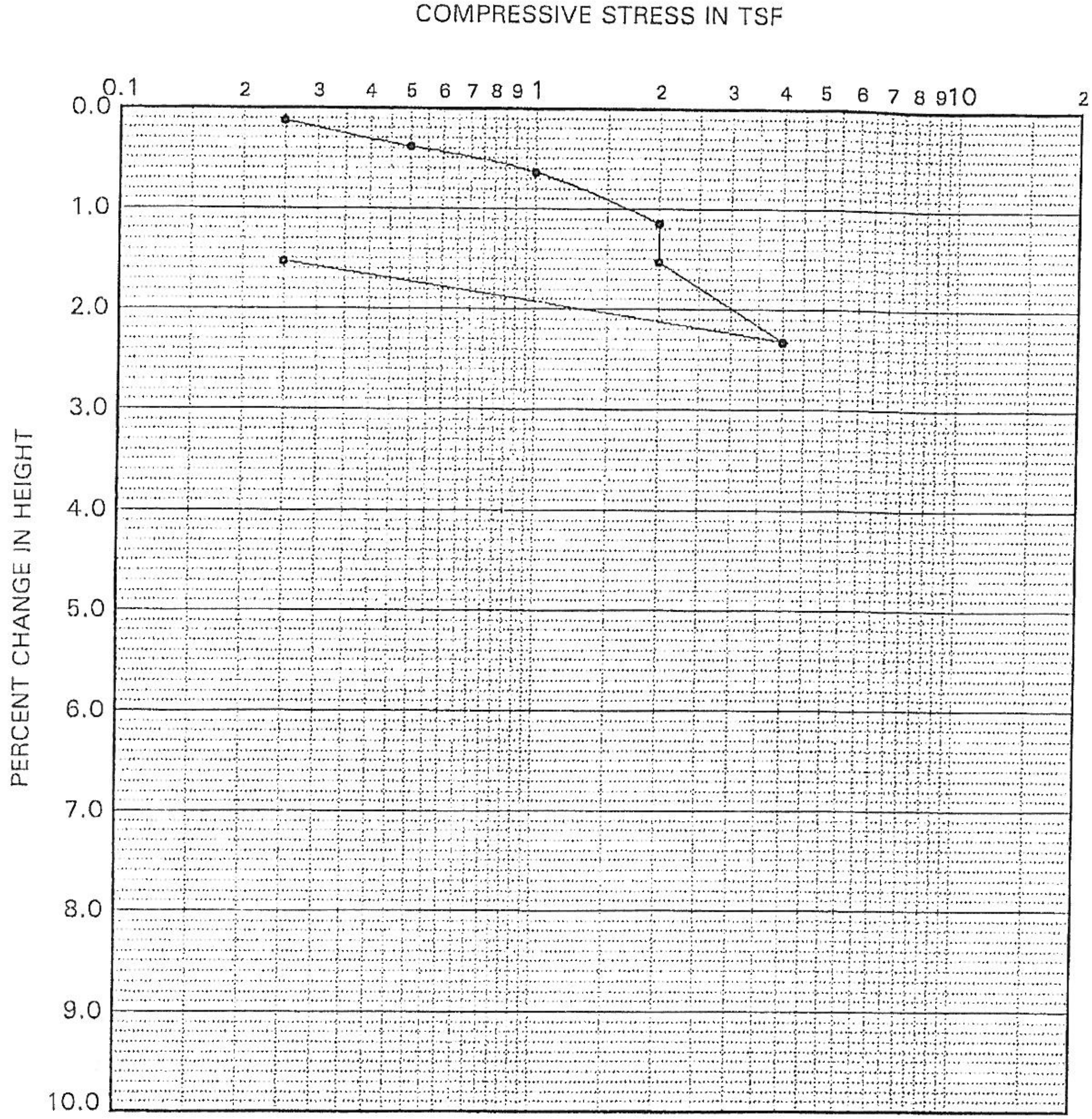
REMARKS: WATER ADDED AT 2 TSF

CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.

3002 DOW AVE., TUSTIN, CA 92680 714-730-2122

W.O. 500503 PLATE B-6




| boring | depth (ft.) | dry density | in situ moist. | -200 sieve | group symbol | typical names |
|---|---|---|---|---|---|---|
| B-7 | 20.0 | 110.6 | 8.5 | | SM | Silty Sand (Qt) |

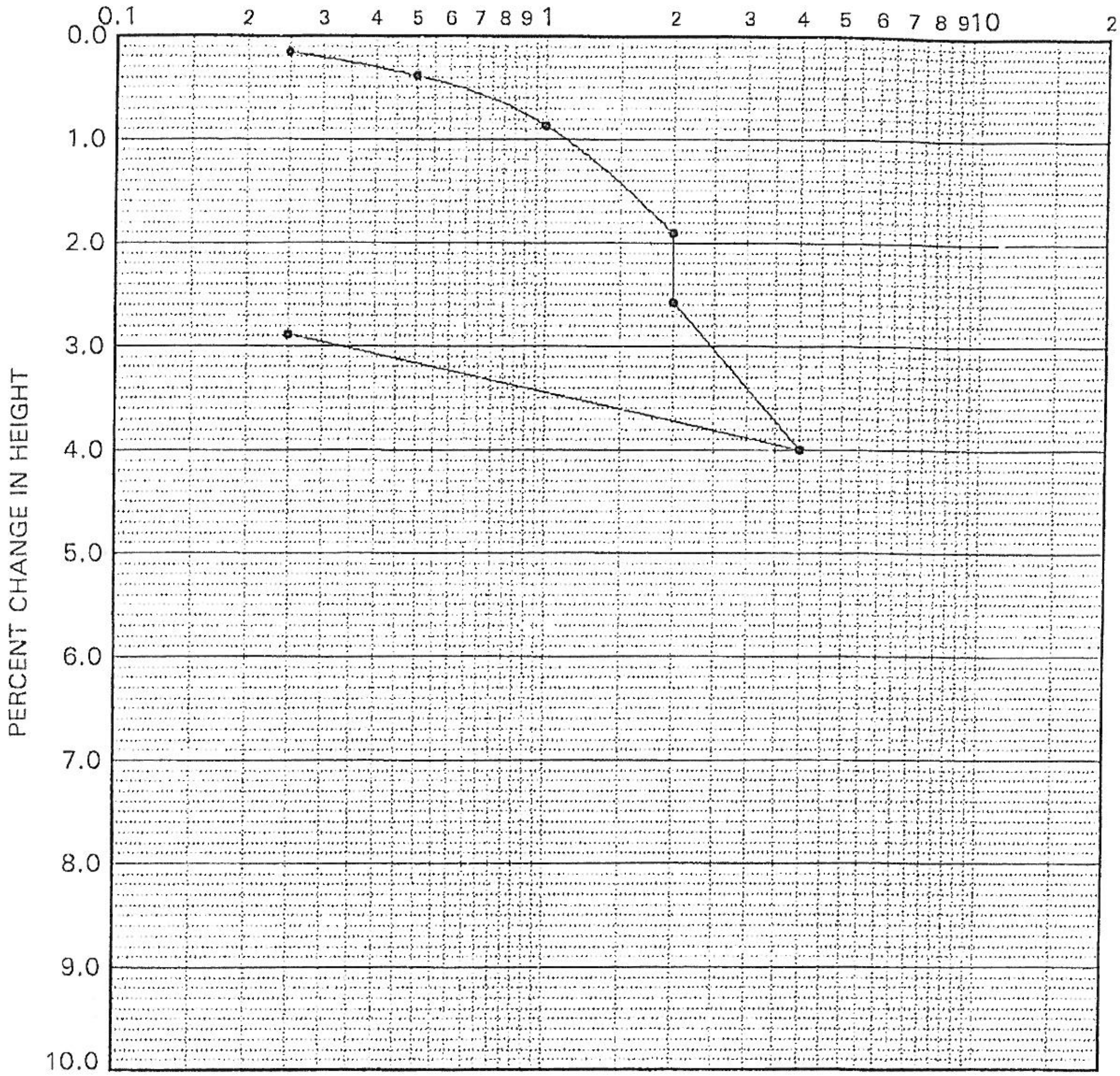
REMARKS: WATER ADDED AT 2 TSF

CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
3002 DOW AVE., TUSTIN, CA 92680 714-730-2122

W.O. 500503

PLATE B-7



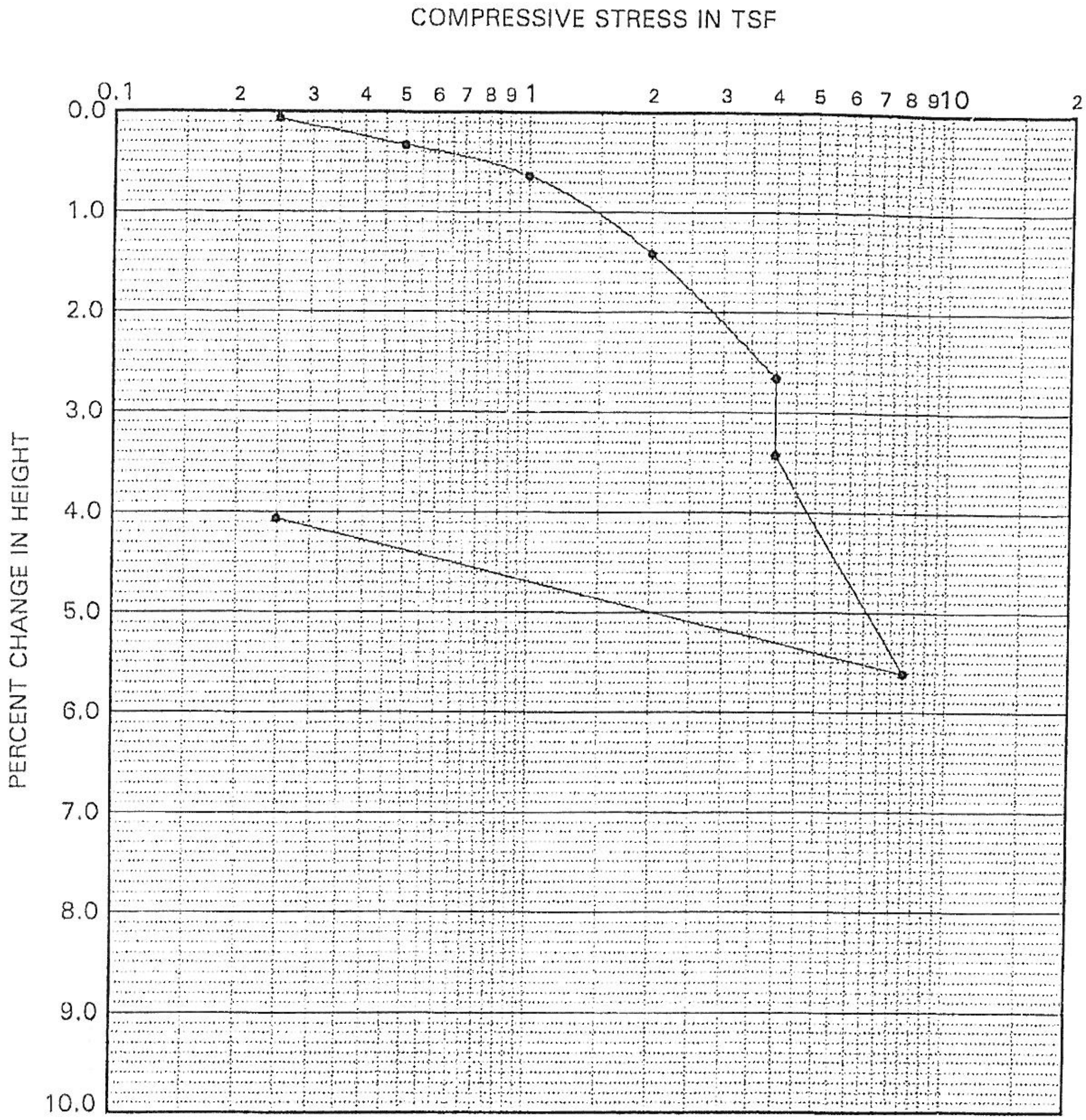

| boring | depth (ft.) | dry density | in situ moist. | -200 sieve | group symbol | typical names |
|---|---|---|---|---|---|---|
| B-8 | 20.0 | 111.4 | 12.1 | | SM | Silty Sand (Qt) |

REMARKS: WATER ADDED AT 2 TSF

CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
3002 DOW AVE., TUSTIN, CA 92680 714-730-2122

W.O. 500503 PLATE B-8

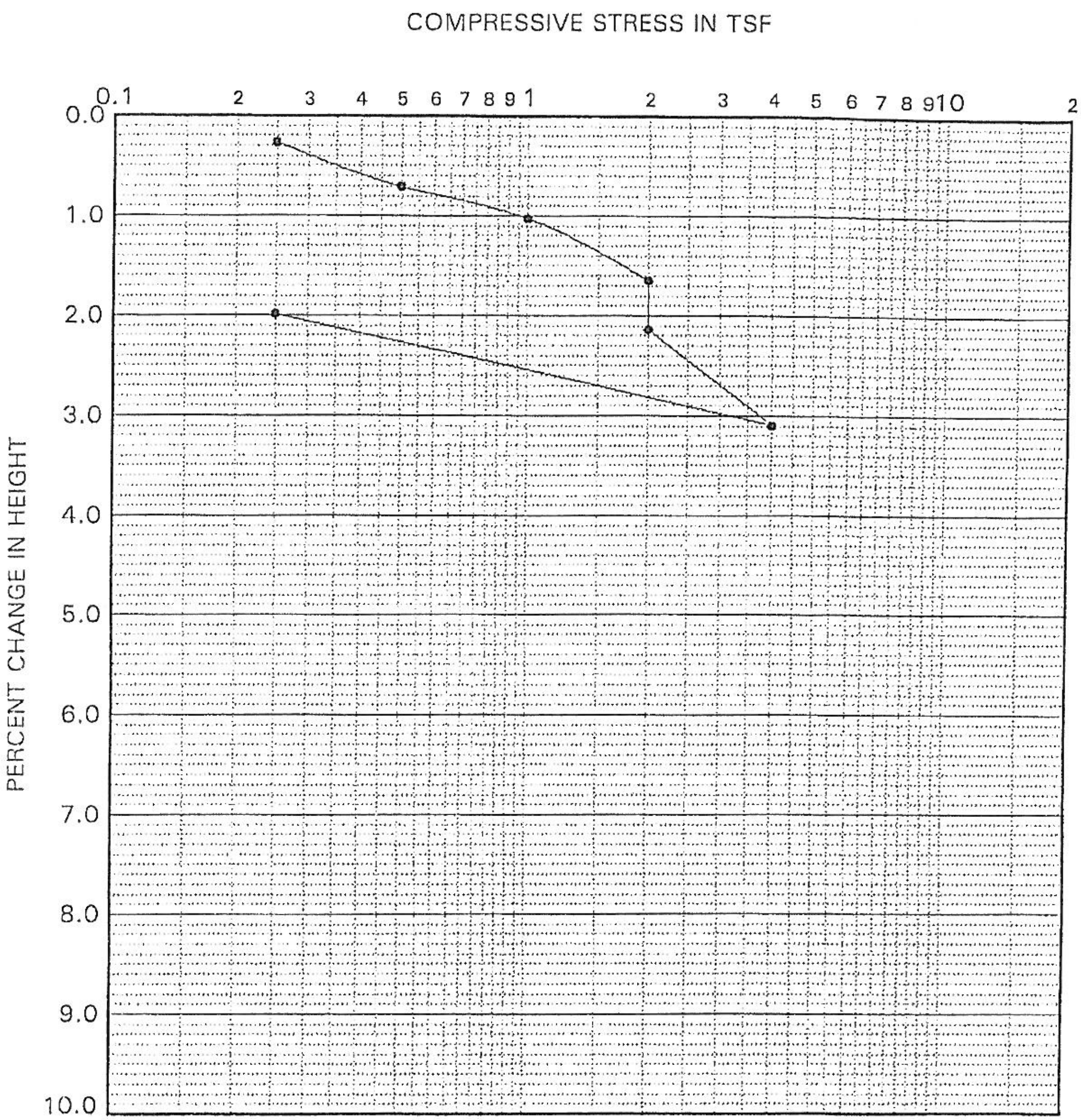



| boring | depth (ft.) | dry density | in situ moist. | -200 sieve | group symbol | typical names |
|---|---|---|---|---|---|---|
| B-8 | 30.0 | 106.1 | 14.2 | | ML | Sandy Silt (Qt) |

REMARKS: WATER ADDED AT 4 TSF

CONSOLIDATION CURVE

PACIFIC SOILS ENGINEERING, INC.
3002 DOW AVE., TUSTIN, CA 92680 714-730-2122
W.O. 500503 PLATE B-9




| boring | depth (ft.) | dry density | in situ moist. | -200 sieve | group symbol | typical names |
|---|---|---|---|---|---|---|
| B-9 | 20.0 | 106.8 | 13.9 | | SM | Silty Sand (Qt) |

REMARKS: WATER ADDED AT 2 TSF

CONSOLIDATION CURVE

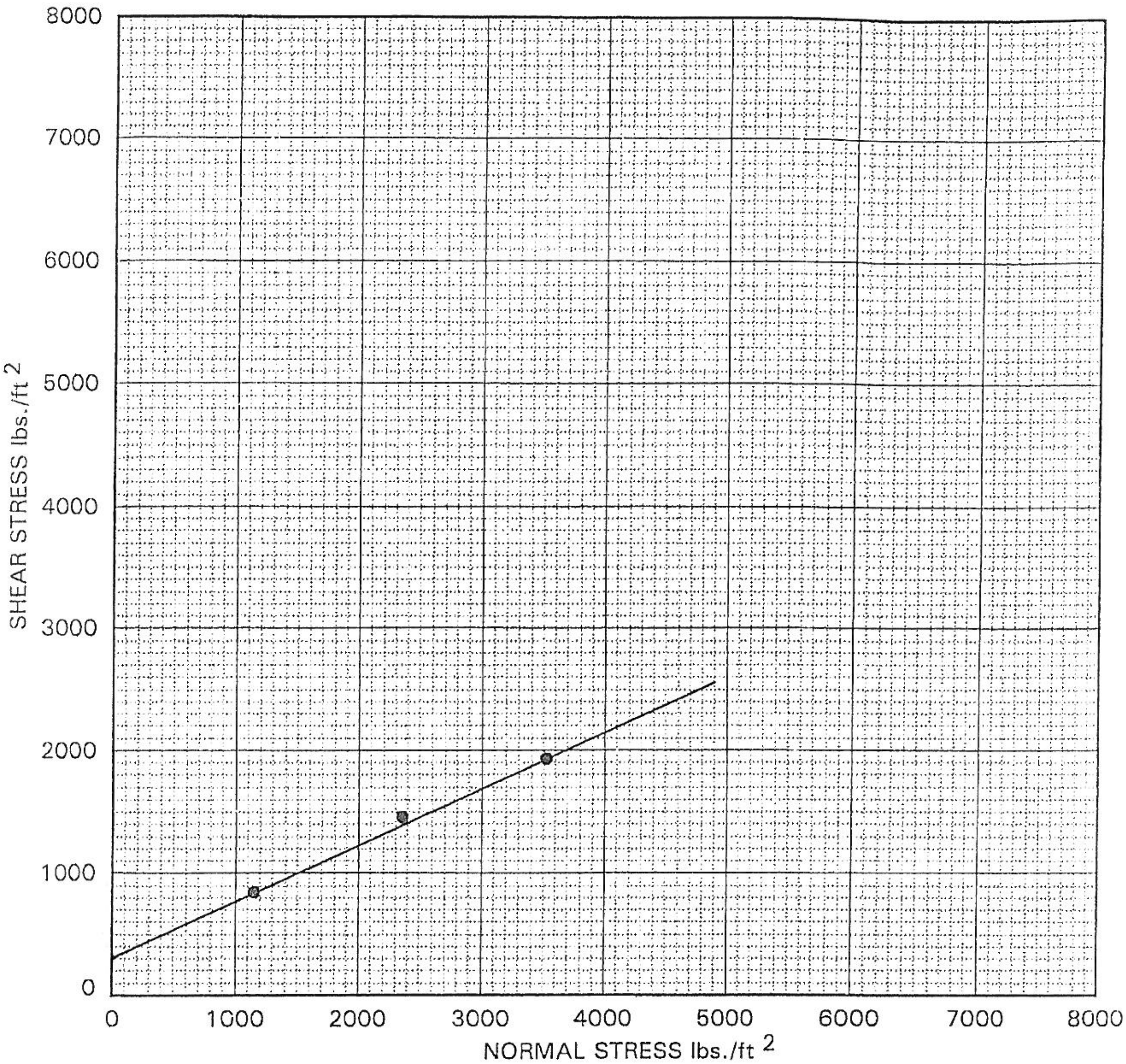
PACIFIC SOILS ENGINEERING, INC.

3002 DOW AVE., TUSTIN, CA 92680 714-730-2122

W.O. 500503

PLATE B-10

DIRECT SHEAR TEST
REMOLDED




| | |
|---|---|
| Clayey Sand (Qt) | COHESION 300 psf. |
| SC | FRICTION ANGLE 25.0 degrees |

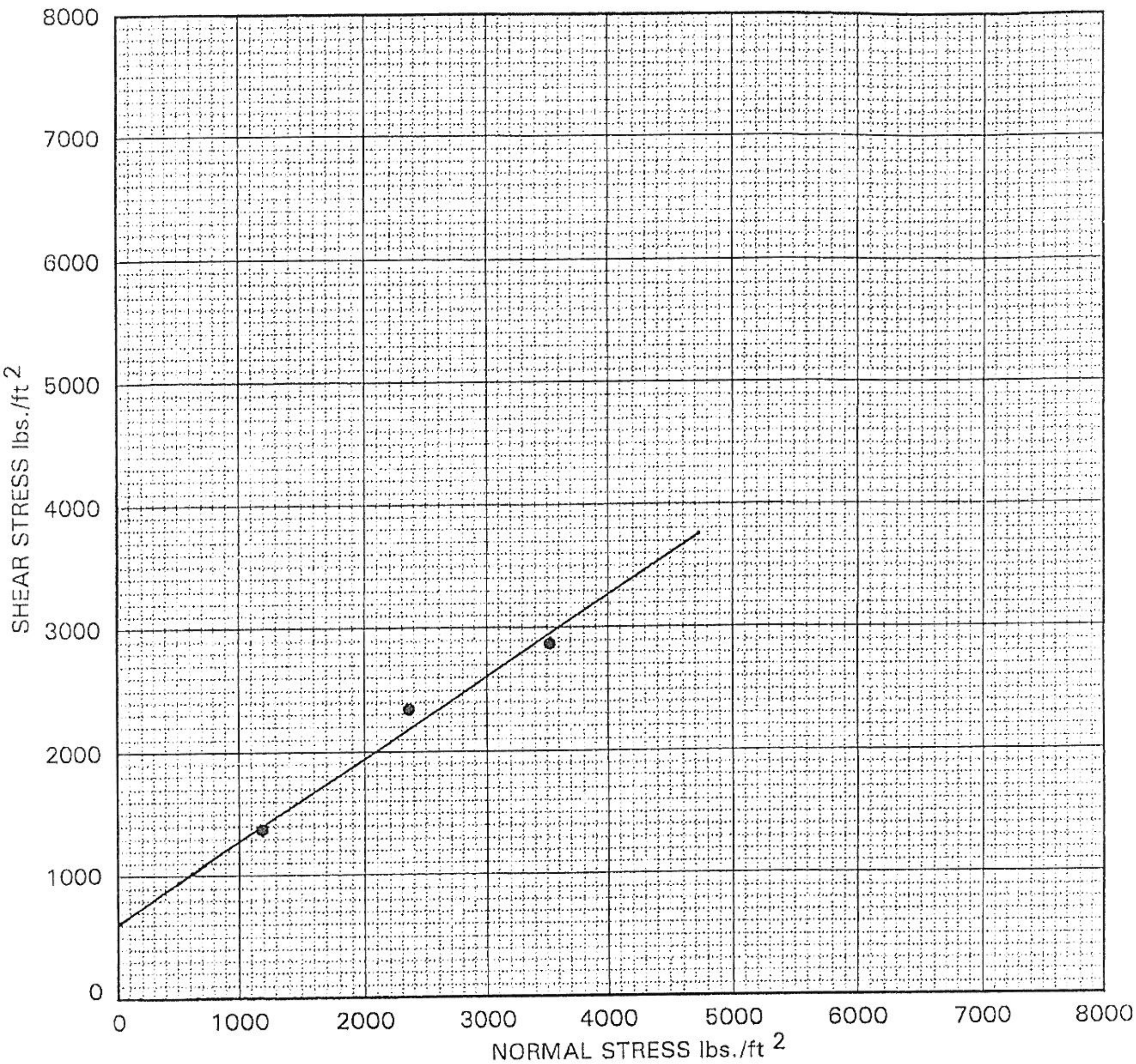
| symbol | boring | depth (ft.) | symbol | boring | depth (ft.) |
|---|---|---|---|---|---|
| ● | B-1 | 11.00 | | | |
| | | | | | |
| | | | | | |
| | | | | | |

DIRECT SHEAR TEST

PACIFIC SOILS ENGINEERING, INC.
3002 DOW AVE., TUSTIN, CA 92680 714-730-2122

W.O. 500503 PLATE B-11

# DIRECT SHEAR TEST
REMOLDED




| Sandy Silt (Qal) | COHESION 600 psf. |
|---|---|
| ML | FRICTION ANGLE 33.0 degrees |

| symbol | boring | depth (ft.) | symbol | boring | depth (ft.) |
|---|---|---|---|---|---|
| ● | B-5 | 8.00 | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

DIRECT SHEAR TEST


PACIFIC SOILS ENGINEERING, INC.
3002 DOW AVE., TUSTIN, CA 92680 714-730-2122


W.O. 500503 PLATE B-12

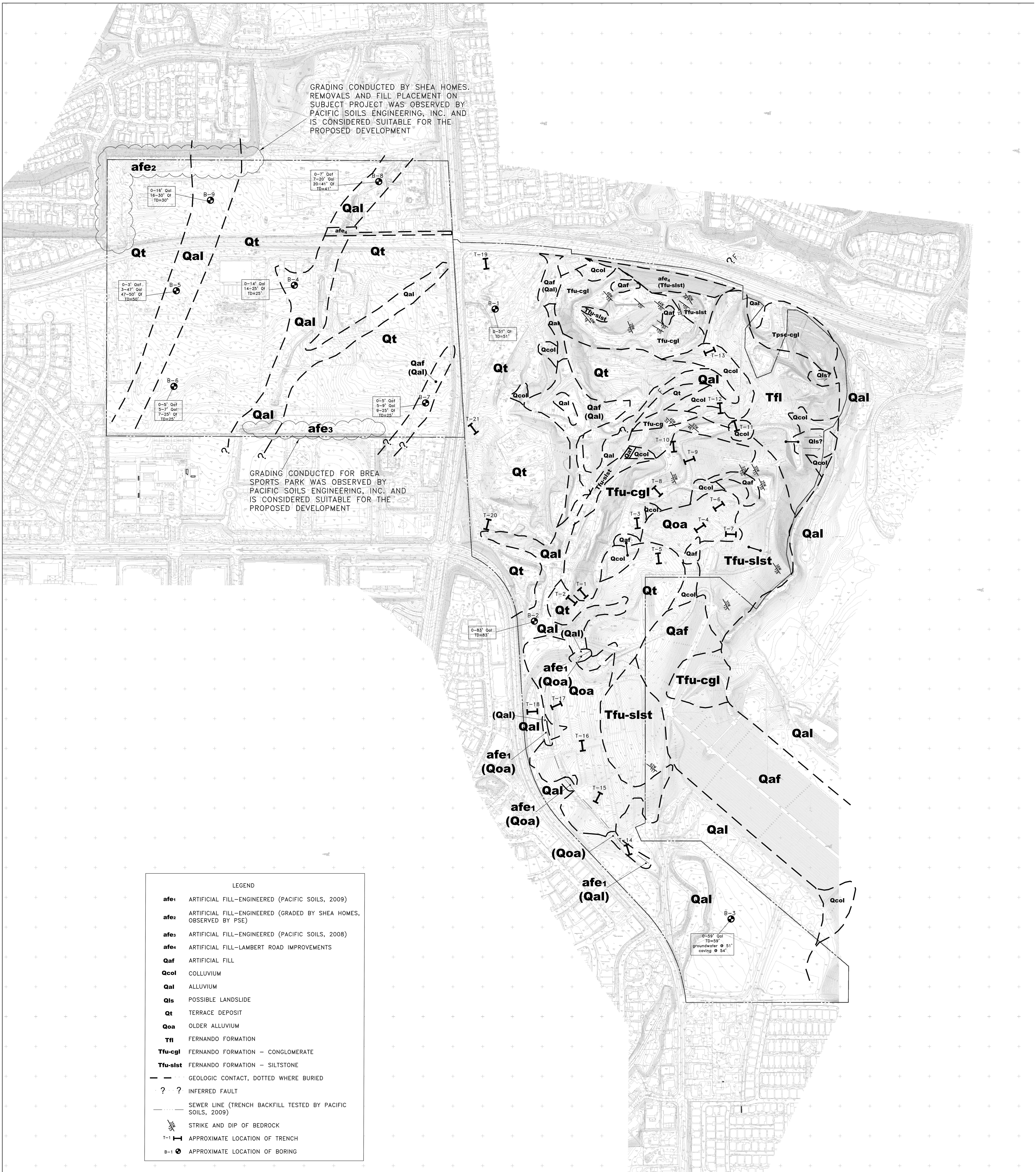



PLATE 1

ALTA CALIFORNIA GEOTECHNICAL, INC.
170 N. MAPLE STREET, STE 108, CORONA, CA 92880
TELEPHONE: (951) 509-7090
PROJECT NUMBER: 1-0250
DATE: 12-19-18

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