GEOTECHNICAL EVALUATION
SAN ELIJO JOINT POWERS AUTHORITY
FINAL DESIGN OF
LAND OUTFALL REPLACEMENT
CARDIFF BY THE SEA, CALIFORNIA

PREPARED FOR:
Kennedy/Jenks Consultants, Inc.
9665 Granite Ridge Drive, Suite 210
San Diego, California 92123

PREPARED BY:
Ninyo & Moore
Geotechnical and Environmental Sciences Consultants
5710 Ruffin Road
San Diego, California 92123

January 29, 2016
Project No. 108030001

Ninyo & Moore
Geotechnical and Environmental Sciences Consultants

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Ms. Sarah Williams
Kennedy/Jenks Consultants, Inc.
9665 Granite Ridge Drive, Suite 210
San Diego, California 92123

Subject: Geotechnical Evaluation
San Elijo Joint Powers Authority
Final Design of Land Outfall Replacement
Cardiff by the Sea, California

Dear Ms. Williams:

In accordance with your authorization, we have performed a geotechnical evaluation for San Elijo Joint Powers Authority's proposed Final Design of Land Outfall Replacement project in Cardiff by the Sea, California. This report presents our geotechnical findings, conclusions, and recommendations regarding the proposed project. Our report was prepared in accordance with our proposal dated June 23, 2015. We appreciate the opportunity to be of service on this project.

Sincerely,
NINYO & MOORE

Jason M. Moore
No. 2434
Exp. 12/31/16

Jason M. Moore, PG, CEG
Senior Geologist

William R. Morrison

William R. Morrison
No. 2468
Exp. 12/31/16

William Morrison, PE, GE
Senior Engineer

Gregory T. Farrand
No. 1087

Gregory T. Farrand, PG, CEG
Principal Geologist

JMM/WRM/GTF/KHM/gg

Distribution: (1) Addressee (via e-mail)

5710 Ruffin Road • San Diego, California 92123 • Phone (858) 576-1000 • Fax (858) 576-9600
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1. INTRODUCTION

In accordance with your request and our proposal dated June 23, 2015, we have performed a geotechnical evaluation for San Elijo Joint Powers Authority's (SEJPA) proposed Final Design of Land Outfall Replacement project in Cardiff by the Sea, California (Figure 1). This report presents our conclusions regarding the geotechnical conditions at the subject site and our recommendations for the design of this project.

2. SCOPE OF SERVICES

The scope of our geotechnical services included the following:

- Reviewing readily available published and in-house geotechnical literature pertaining to the site and the general site area, including geologic and fault maps.
- Coordinating and mobilizing for a geotechnical reconnaissance to observe the existing site conditions and to mark-out boring locations for utility clearance by Underground Service Alert (USA).
- Obtaining a boring permit from the County of San Diego Department of Environmental Health (DEH).
- Performing a subsurface exploration program consisting of excavating, logging, and sampling of one exploratory boring in the project area. Bulk and relatively undisturbed drive samples of soil were collected at selected intervals from the boring and transported to our in-house geotechnical laboratory for testing.
- Performing geotechnical laboratory testing on selected soil samples to evaluate their pertinent geotechnical design parameters.
- Performing geotechnical analysis of the data obtained from our site reconnaissance, subsurface exploration, and laboratory testing.
- Preparing this report presenting our findings, conclusions, and recommendations pertaining to the design and construction of the proposed project. We understand that recommendations for horizontal directional drilling (HDD) will be provided by others. Consequently, no recommendations pertaining to HDD are provided herein.

3. SITE AND PROJECT DESCRIPTION

Based on the San Elijo Joint Power Authority Outfall Preliminary Design Report, SEJPA owns the San Elijo Water Reclamation Facility (SEWRF), which utilizes an ocean outfall for effluent discharge (Kennedy Jenks, 2015a). The existing SEWRF outfall system consists of approximately 3,000 linear feet of 30-inch asbestos cement pipe across the San Elijo Lagoon, along with the portion of the outfall that extends into the Pacific Ocean, which is comprised of 4,192 linear feet of 30-inch reinforced concrete pipe (RCP) and 4,000 linear feet of 48-inch RCP. The outfall portion on land crosses the San Elijo Lagoon, the existing railroad tracks, and Highway 101. Under the railroad tracks the pipe is encased for 90 feet in a steel casing, in which the annulus is filled with sand. SEJPA recently completed its Facility Master Plan desktop assessment of the existing outfall system, which indicates the pipe is likely nearing the end of its useful life.

Other projects are currently in planning and design that will affect the lagoon in the vicinity of the outfall. San Diego Association of Governments (SANDAG) plans to expand the existing railroad tracks that cross the lagoon and the existing outfall pipe as part of a project referred to as the Double Track. The railroad work is being planned simultaneously with the North Coast Corridor expansion of the I-5 Freeway. In addition, the Lagoon Restoration project is planned in the area. Plans for these projects include construction of levees, grading and altering the water level within the lagoon. SEJPA plans to replace or rehabilitate the outfall prior to or concurrently with these proposed construction projects (Kennedy Jenks, 2015a).

We understand that SEJPA plans to replace the outfall using a trenchless installation consisting of Horizontal Directional Drilling (HDD). The installation of the new outfall will begin on the beach just west of Highway 101 and will include a 60-inch diameter steel casing at least 5 feet deep under the roadway. The HDD alignment will pass under the San Elijo Lagoon and railroad tracks at a depth of approximately 70 feet below the existing ground surface (bgs) and terminate within the SEWRF. A relatively short spur of the pipe will begin within the SEWRF and cross Manchester Avenue through an open cut trench to reach a new pressure-regulating valve near the San Elijo Lagoon Nature Center. A new, 30-inch inside diameter polyvinyl chloride (PVC) or high density polyethylene (HDPE) outfall pipe will be placed in the HDD bore and the pipe spur trench (Kennedy Jenks, 2015b).

The project site extends along the HDD alignment between the proposed connection points with the existing outfall and includes the spur. Elevations along the proposed pipeline alignment range from approximately 26 feet above mean sea level (MSL) on the eastern portion of the alignment within the SEWRF to approximately 15 MSL on the beach west of Highway 101. Vegetation generally consists of grass, weeds, and bushes, on undeveloped portions of the pipeline alignment.

4. PREVIOUS GEOTECHNICAL WORK

Ninyo & Moore has conducted geotechnical evaluations for other projects in the general vicinity of the site. In 2007, Ninyo & Moore conducted a geotechnical evaluation for the San Elijo Lagoon Nature Center (Ninyo & Moore, 2007), which included the drilling of two borings near the Center to depths up to 20 feet bgs (Figure 2). In 2012, Ninyo & Moore conducted geotechnical evaluations for the proposed San Elijo Lagoon Double Track project that included borings located north and south of the pipeline alignment within the existing railroad alignment to depths of 107 and 128 feet bgs, respectively (Ninyo & Moore, 2014).

5. FIELD EXPLORATION AND LABORATORY TESTING

Our subsurface exploration for the final design of the Land Outfall Replacement was conducted on October 12, 2015, and consisted of drilling, logging, and sampling of one exploratory boring. Boring B-1 was drilled north of the proposed pipeline alignment on the east side of Highway 101 in an unpaved parking lot south of the Las Olas Restaurant. The boring was drilled to a depth of approximately 50 feet below existing grade with a truck mounted, mud rotary drill rig. Soil samples were obtained at selected intervals from the boring. The samples were then transported to our in-house geotechnical laboratory for testing. The approximate location of the exploratory boring is shown on Figure 2. A log of the boring is included in Appendix A.

Laboratory testing of representative soil samples included in-situ dry density and moisture content, gradation, Atterberg limits, direct shear strength, and soil corrosivity. The results of the in-situ dry density and moisture content tests are presented on the boring logs in Appendix A. The results of the other laboratory tests are presented in Appendix B.

Boring logs and laboratory test results from two previous evaluations near the alignment (Leighton and Associates, 1991; Allied Geotechnical Engineers, 2006) are presented in Appendix C.

6. GEOLOGY AND SUBSURFACE CONDITIONS

Our findings regarding regional and site geology and groundwater conditions at the project site are provided in the following sections.

6.1. Regional Geologic Setting

The project area is situated in the coastal section of the Peninsular Ranges Geomorphic Province. This geomorphic province encompasses an area that extends approximately 900 miles from the Transverse Ranges and the Los Angeles Basin south to the southern tip of Baja California (Norris and Webb, 1990; Harden, 2004). The province varies in width from approximately 30 to 100 miles. In general, the province consists of rugged mountains underlain by Jurassic metavolcanic and metasedimentary rocks, and Cretaceous igneous rocks of the southern California batholith. The portion of the province in San Diego County that includes the project area is underlain by Tertiary and Quaternary age sedimentary rock (Figure 3).

The Peninsular Ranges Province is traversed by a group of sub-parallel faults and fault zones trending roughly northwest. Several of these faults, which are shown on Figure 4, are considered active faults. The Elsinore, San Jacinto, and San Andreas faults are active fault systems located northeast of the project area and the Rose Canyon, Coronado Bank, San Diego Trough, and San Clemente faults are active faults located west of the project area. The Rose Canyon Fault Zone, the nearest active fault system, has been mapped approximately 2.4 miles west of the location of our subsurface exploration near the HDD alignment crossing of Highway 101 (USGS, 2008). Major tectonic activity associated with these faults within this regional tectonic framework consists primarily of right-lateral, strike-slip movement. Further discussion of faulting relative to the site is provided in the Faulting and Seismicity and Seismic Hazards section of this report.

6.2. Site Geology

Geologic units encountered during our subsurface evaluation include fill and late Holocene age paralic estuarine deposits. Regional geologic maps show the middle Eocene age Delmar Formation as underlying these deposits (Kennedy and Tan, 2008). A geologic cross section is presented on Figure 5. Generalized descriptions of the earth units encountered are provided in the subsequent sections. Additional descriptions of the subsurface units are provided on the boring log in Appendix A.

6.2.1. Fill

Fill was encountered in boring B-1 to a depth of approximately 3 feet. As encountered, the fill consists of brown to reddish brown, moist to wet, loose, silty sand with gravel. Geotechnical literature documenting the placement/compaction of the fill was not available for review.

6.2.2. Paralic Estuarine Deposits

Paralic estuarine deposits were encountered in boring B-1 beneath the fill to the explored depth of approximately 50 feet. As encountered, the paralic estuarine deposits generally consist of reddish brown to gray, wet, very loose to very dense, poorly graded sand with silt. Traces of coarse gravel or cobbles up to 3 inches in diameter were encountered within these deposits in a nearby boring (Leighton and Associates, 1991). These deposits have previously been logged by others as lagoonal deposits (Leighton and Associates, 1991), estuary deposits (Allied, 2006), and alluvium (Ninyo & Moore, 2014), as shown in Appendix C. We refer to them herein as paralic estuarine deposits to be consistent with Kennedy and Tan (2008).

6.2.3. Delmar Formation

Materials of the Delmar Formation are anticipated at a depth of more than 100 feet bgs at the location of boring B-1. As encountered in nearby borings, the Delmar Formation generally consists of reddish brown, yellowish brown, and olive brown, saturated, moderately indurated silty and sandy claystone, along with moderately cemented clayey and silty sandstone and sandy siltstone (Ninyo & Moore, 2014). The Delmar Formation is mapped at or near the ground surface along the HDD alignment from about the San Elijo Lagoon Nature Center to the north side of Manchester Avenue (Kennedy and Tan, 2008).

6.2.4. Torrey Sandstone

The middle Eocene age Torrey Sandstone is mapped at or near the ground surface along the HDD alignment from about the north side of Manchester Avenue to the end of the HDD alignment within the SWERF (Kennedy and Tan, 2008). The Torrey Sandstone is generally described as white to light-brown, moderately to strongly cemented sandstone.

6.3. Groundwater

Groundwater was encountered at a depth of approximately 3 feet in boring B-1 during our subsurface exploration, which roughly corresponds to mean sea level. Fluctuations in the groundwater level and perched conditions typically occur due to variations in precipitation, ground surface topography, subsurface stratification, irrigation, and other factors.

7. GEOLOGIC HAZARDS

In general, hazards associated with seismic activity include strong ground motion, ground surface rupture, and liquefaction. These considerations and other geologic hazards are discussed in the following sections.

7.1. Faulting and Seismicity

The project area is considered to be seismically active. Based on our review of the referenced geologic maps as well as on our geologic field mapping, the subject site is not underlain by known active or potentially active faults (i.e., faults that exhibit evidence of ground displacement in the last 11,000 years and 2,000,000 years, respectively). However, the site is located in a seismically active area, as is the majority of southern California, and the potential for strong ground motion is considered significant during the design life of the proposed structure. The nearest known active fault is the maximum moment magnitude 6.9 Rose Canyon Fault located approximately 2.4 miles west of the site (Figure 4) (USGS, 2008).

In general, hazards associated with seismic activity include ground surface rupture, strong ground motion, ground surface rupture, liquefaction, and seismically induced settlement. These hazards are discussed in the following sections.

7.1.1. Ground Rupture

There are no known active faults crossing the subject site, and the potential for ground rupture due to faulting is considered low. The potential for surface ground cracking related to shaking from distant events is also considered low.

7.1.2. Ground Motion

The 2013 California Building Code (CBC) specifies that the Risk-Targeted, Maximum Considered Earthquake (MCE_R) ground motion response accelerations be used to evaluate seismic loads for design of buildings and other structures. The MCE_R ground motion response accelerations are based on the spectral response accelerations for 5 percent damping in the direction of maximum horizontal response and incorporate a target risk for structural collapse equivalent to 1 percent in 50 years with deterministic limits for near-source effects. The horizontal peak ground acceleration (PGA) that corresponds to the MCE_R for the site was calculated as 0.49g using the United States Geological Survey (USGS, 2015) seismic design tool (web-based). Spectral response acceleration parameters, consistent with the 2013 CBC, are also provided in Section 9.2 for the evaluation of seismic loads on buildings and other structures.

The 2013 CBC specifies that the potential for liquefaction and soil strength loss be evaluated, where applicable, for the Maximum Considered Earthquake Geometric Mean (MCE$_G$) peak ground acceleration with adjustment for site class effects in accordance with the American Society of Civil Engineers (ASCE) 7-10 Standard. The MCE$_G$ peak ground acceleration is based on the geometric mean peak ground acceleration with a 2 percent probability of exceedance in 50 years. The MCE$_G$ peak ground acceleration with adjustment for site class effects (PGA$_M$) was calculated as 0.51g using the USGS (USGS, 2015) seismic design tool that yielded a mapped MCE$_G$ peak ground acceleration of 0.51g for the site and a site coefficient (F$_{PGA}$) of 1.0 for Site Class D.

7.1.3. Liquefaction

Liquefaction is the phenomenon in which loosely deposited granular soils with silt and clay contents of less than approximately 35 percent and non-plastic silts located below the water table undergo rapid loss of shear strength when subjected to strong earthquake-induced ground shaking. Ground shaking of sufficient duration results in the loss of grain-to-grain contact due to a rapid rise in pore water pressure, and causes the soil to behave as a fluid for a short period of time. Liquefaction is known generally to occur in saturated or near-saturated cohesionless soils at depths shallower than 50 feet below the ground surface. Factors known to influence liquefaction potential include composition and thickness of soil layers, grain size, relative density, groundwater level, degree of saturation, and both intensity and duration of ground shaking.

Our subsurface exploration indicates that the site is underlain by soils that are susceptible to liquefaction during a nearby seismic event. Accordingly, the liquefaction potential of subsurface soils was evaluated using Standard Penetration Test data obtained from our subsurface exploration. The liquefaction analysis was based on the NCEER procedure (Youd et al., 2001) using the computer program LIQUEFYPro (CivilTech, 2008). Our analysis indicates that some zones within the paralic estuarine deposits below the groundwater table are potentially liquefiable up to a depth of approximately 26 feet in the vicinity of our exploratory boring B-1, given the ground motion presented in the above section.

Our evaluation also included the estimation of the amount of post-earthquake settlement that can be expected to result from liquefaction. Our seismic settlement evaluation utilized the method proposed by Tokimatsu and Seed (1987), where the seismically induced cyclic stress ratios and corrected sampler blow counts (N-values) are related to the volumetric strain of the soil. The amount of soil settlement during a strong seismic event depends on the thickness of the liquefiable layers and the density and/or consistency of the soils. Based on our evaluation, we estimate that less than 2 inches of dynamic settlement could occur in the vicinity of the Highway 101 alignment crossing as the result of a major nearby seismic event. Differential settlement may be estimated to be approximately 1/2 of the total dynamic settlement over a 40-foot span.

7.1.4. Tsunamis

Tsunamis are long wavelength seismic sea waves (long compared to ocean depth) generated by the sudden movements of the ocean floor during submarine earthquakes, landslides, or volcanic activity. Based on our review of the tsunami inundation map prepared by the California Geological Survey (2009), other than the area from the connection point in the SEWRF to immediately southwest of the San Elijo Lagoon Nature Center, the planned replacement outfall is situated within a mapped tsunami inundation area. The tsunami inundation area shown on the California Geological Survey's map (2009) is based on an elevation where one or more estimated tsunami event could be expected to extend. However, no probability is assigned to the mapped tsunami run-up line.

7.2. Landsliding

No landslides or indications of deep-seated landslides were noted underlying the project site during our field exploration or our review of available geologic literature and topographic maps. However, our review of Tan and Giffen (1995) indicates that the proposed pipeline alignment traverses areas that are mapped as possessing landslide hazards ranging from marginally susceptible to most susceptible.

8. CONCLUSIONS AND RECOMMENDATIONS

Based on our geotechnical evaluation, it is our opinion that construction of the proposed project is feasible from a geotechnical standpoint, provided the following conclusions and recommendations are incorporated into the design and construction of the project. The following includes geotechnical considerations and conclusions for the project:

- The project area is underlain by fill, paralic estuarine deposits, Delmar Formation, and Torrey Sandstone materials.

- Groundwater was encountered during our subsurface exploration at depth of 3 feet in boring B-1, which roughly corresponds to mean sea level. Groundwater will be a constraint during this project. The contractor should anticipate dewatering excavations.

- Preconstruction distress evaluation should be conducted prior to dewatering operations.

- Loose, wet paralic estuarine deposits were encountered within boring B-1, unstable excavation bottoms and caving soils should be anticipated. The contractor should anticipate and be prepared to address these conditions.

- Based on the results of our exploratory borings, referenced recent exploratory borings for and by others, and our experience with similar soils, it is our opinion that the on-site fill, paralic estuarine deposits, Delmar Formation, and Torrey Sandstone materials can be excavated using heavy duty earthmoving equipment in good working condition. In addition, loose, wet paralic estuarine deposits could be encountered during excavations.

- While not encountered within boring B-1, traces of coarse gravel or cobbles up to 3 inches in diameter were reportedly encountered within paralic estuarine deposits in a nearby boring. Based on our experience, cobbles and strongly cemented zones should be anticipated within the Delmar Formation and Torrey Sandstone. Due to the presence of these materials, the contractor may encounter difficulties with performing excavations and drilling operations.

- Wet soils encountered on the site will require additional handling prior to disposal or being reused as fill.

- The results of our geotechnical evaluation indicate that the planned outfall replacement is underlain by soils susceptible to liquefaction. Our analysis of the subsurface data indicates that up to approximately 2 inches of seismically induced settlement could occur near the Highway 101 crossing during a major seismic event. Greater amounts of seismic settlement are possible in other areas along the alignment within the paralic estuarine deposits.

- Based on the potential for liquefaction along the alignment, consideration should be given to the use of flexible couplings for pipes.

- As noted above, the planned replacement outfall is generally situated within a mapped tsunami inundation area (California Geological Survey, 2009).

- Based on the laboratory test results, ACI 318, and Caltrans (2012) criteria, the site soils are considered corrosive.

9. RECOMMENDATIONS

Based on our understanding of the project, the following recommendations are provided for the design and construction of the proposed project. We understand that recommendations for horizontal directional drilling (HDD) will be provided by others. Consequently, no recommendations pertaining to HDD are provided herein.

9.1. Earthwork

In general, earthwork should be performed in accordance with the recommendations presented in this report. Ninyo & Moore should be contacted for questions regarding the recommendations or guidelines presented herein.

9.1.1. Pre-Construction Conference

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

9.1.2. Site Preparation

Prior to performing excavations or other earthwork, the work area should be cleared of abandoned utilities (if present) and stripped of rubble, debris, vegetation, any loose, wet, or otherwise unstable soils, as well as surface soils containing organic material. Materials generated from the clearing operations should be removed from the site and disposed of at a legal dumpsite away from the project area.

9.1.3. Temporary Excavations

For temporary excavations, we recommend that the following Occupational Safety and Health Administration (OSHA) soil classifications be used:

Fill and Paralic Estuarine Deposits	*Type C*
Delmar Formation and Torrey Sandstone	*Type B*

Upon making the excavations, the soil classifications and excavation performance should be evaluated in the field by a competent person in accordance with the OSHA regulations. Temporary excavations should be constructed in accordance with OSHA recommendations. For trench or other excavations, OSHA requirements regarding personnel safety should be met using appropriate shoring (including trench boxes) or by laying back the slopes to no steeper than 1.5:1 (horizontal to vertical) in fill and paralic estuarine deposits and 1:1 in the Delmar Formation and Torrey Sandstone. Temporary excavations that encounter seepage may be shored or stabilized by placing sandbags or gravel along the base of the seepage zone. Excavations encountering seepage should be evaluated on a case-by-case basis. On-site safety of personnel is the responsibility of the contractor.

9.1.4. Shoring and Braced Excavations

We anticipate that shoring systems will be installed for the site excavations (including the open cut trench across Manchester Avenue and other excavations associated with the outfall replacement). Shoring systems will be constructed through fill, paralic estuarine deposits, Delmar Formation, and Torrey Sandstone. The shoring system should be designed using the lateral earth pressures shown on Figure 6 for cantilevered shoring and

Figure 7 for braced shoring. The recommended design pressures are based on the assumptions that the shoring system is constructed without raising the ground surface elevation behind the shoring, that there are no surcharge loads, such as soil stockpiles and construction materials, and that no loads act above a 1:1 plane extending up and back from the base of the sheet pile system. The contractor should include the effect of any surcharge loads on the lateral pressures against the sheet pile wall.

Settlement of the ground surface may occur behind the shoring wall during excavation. The amount of settlement depends heavily on the type of shoring system, the shoring contractor’s workmanship, and soil conditions. We recommend that structures/improvements in the vicinity of the planned shoring installation be reviewed with regard to foundation support and tolerance to settlement. To reduce the potential for distress to adjacent improvements, we recommend that the shoring system be designed to reduce the ground settlement behind the shoring system to ½-inch or less. Possible causes of settlement that should be addressed include settlement during shoring installation, excavations, construction vibrations, dewatering, and removal of the support system.

The contractor should retain a qualified and experienced engineer to design the shoring system, evaluate the adequacy of these parameters and provide modifications for the design. Shoring plans should be reviewed by the design engineer. We recommend that the contractor take appropriate measures to protect workers. OSHA requirements pertaining to worker safety should be observed.

9.1.5. Construction Dewatering

During our subsurface exploration, groundwater was encountered at approximately 3 feet bgs in our exploratory boring B-1. As previously discussed, fluctuations in the groundwater levels may occur at the site. Dewatering measures during excavation operations should be prepared by the contractor’s engineer in conjunction with a specialty dewatering contractor and reviewed by the design engineer. Considerations for construction dewatering should include anticipated drawdown, piping of soils, volume of pumping, potential for settlement, and groundwater discharge. Preconstruction distress evaluation should be conducted prior to dewatering operations. Disposal of groundwater should be performed in accordance with guidelines of the Regional Water Quality Control Board (RWQCB).

9.1.6. Mitigation of Unstable Excavation Bottoms

We anticipate that some of the bottoms of excavations (including those for connections to the existing outfall) will be close to or below the groundwater and will be unstable. In general, unstable bottom conditions may be mitigated by overexcavating the excavation bottom to suitable depths (as evaluated in the field by Ninyo & Moore's representative) and replacing with gravel wrapped with a geosynthetic fabric. Specific recommendations for stabilizing excavation bottoms should be based on evaluation in the field by Ninyo & Moore at the time of construction.

9.1.7. Materials for Fill

On-site soils with an organic content of less than approximately 3 percent by volume (or 1 percent by weight) are considered suitable for reuse as fill. Fill material should generally not contain rocks or lumps over approximately 4 inches, and generally not more than approximately 30 percent larger than ¾-inch. Utility trench backfill material should not contain rocks or lumps over approximately 3 inches in general. Soils classified as silts or clays should not be used for backfill in the pipe zone. Larger chunks, if generated during excavation, may be broken into acceptably sized pieces or disposed of off site. Imported fill material, if needed for the project, should generally be granular soils with a very low to low expansion potential (i.e., an EI of 50 or less as evaluated by the American Society for Testing and Materials [ASTM] Test Method D 4829). Import material should also be non-corrosive in accordance with the Caltrans (2012) corrosion guidelines. Materials for use as fill should be evaluated by Ninyo & Moore's representative prior to filling or importing.

9.1.8. Compacted Fill

Prior to placement of compacted fill, the contractor should request an evaluation of the exposed ground surface by Ninyo & Moore. Unless otherwise recommended, the exposed ground surface should then be scarified to a depth of approximately 8 inches and moisture conditioned by wetting or aeration to generally above the optimum moisture content. The scarified materials should then be compacted to 90 percent of their modified Proctor density as evaluated by ASTM D 1557. The evaluation of compaction by the geotechnical consultant should not be considered to preclude any requirements for observation or approval by governing agencies. It is the contractor's responsibility to notify this office and the appropriate governing agency when project areas are ready for observation, and to provide reasonable time for that review.

Fill materials should be moisture conditioned to generally above the laboratory optimum moisture content prior to placement. The optimum moisture content will vary with material type and other factors. Moisture conditioning of fill soils should be generally consistent within the soil mass.

Prior to placement of additional compacted fill material following a delay in the grading operations, the exposed surface of previously compacted fill should be prepared to receive fill. Preparation may include scarification, moisture conditioning, and recompaction.

Compacted fill should be placed in horizontal lifts of approximately 8 inches in loose thickness. Prior to compaction, each lift should be moisture conditioned to generally above the laboratory optimum, mixed, and then compacted by mechanical methods, using sheepsfoot rollers, multiple-wheel pneumatic-tired rollers or other appropriate compacting rollers, to 90 percent of its modified Proctor density as evaluated by ASTM D 1557. Successive lifts should be treated in a like manner until the desired finished grades are achieved.

9.1.9. Lateral Pressures for Thrust Blocks

Thrust restraint for buried pipelines may be achieved by transferring the thrust force to the soil outside the pipe through a thrust block. Thrust blocks may be designed using the lateral passive earth pressures presented on Figure 8. Thrust blocks should be backfilled with granular backfill material, and compacted in accordance with recommendations presented in this report.

9.1.10. Pipe Bedding and Modulus of Soil Reaction (E')

It is our recommendation that the new pipelines (pipes), where constructed in open excavations, be supported on 6 or more inches of granular bedding material overlying prepared subgrade in accordance with the recommendations presented in Section 9.1.6. Granular pipe bedding should be provided to distribute vertical loads around the pipe. Bedding material and compaction requirements should be in accordance with this report. Pipe bedding typically consists of graded aggregate with a coefficient of uniformity of three or greater.

The modulus of soil reaction (*E’*) is used to characterize the stiffness of soil backfill placed at the sides of buried flexible pipes for the purpose of evaluating deflection caused by the weight of the backfill over the pipe (Hartley and Duncan, 1987). A soil reaction modulus of 1,200 pounds per square inch (psi) may be used for excavation depths less than 5 feet and 1,800 psi may be used for excavation depths of 5 feet to 10 feet, backfilled with granular soil compacted to 90 percent based on ASTM D 1557. A soil reaction modulus of 2,100 psi may be used for trenches deeper than 10 feet.

9.1.11. Pipe Connections

As noted above in Section 7.1.3, where the project site is underlain by potentially liquefiable fill and paralic estuarine deposits the estimated total seismic settlement is approximately 2 inches. Greater amounts of seismic settlement could occur in other locations within the alignment. In light of this, we recommend that consideration be given to the use of flexible couplings/connections for pipes.

9.1.12. Pipe Zone Backfill

The pipe zone backfill should be placed on top of the pipe bedding material and extend to 1 foot or more above the top of the pipe in accordance with the recent edition of the Standard Specifications for Public Works Construction (“Greenbook”). Pipe zone backfill should have a Sand Equivalent (SE) of 30 or greater, and be placed around the sides and top of the pipe. Special care should be taken not to allow voids beneath and around the pipe. Compaction of the pipe zone backfill should proceed up both sides of the pipe.

It has been our experience that the voids within a crushed rock material are sufficiently large to allow fines to migrate into the voids, thereby creating the potential for sinkholes and depressions to develop at the ground surface. If open-graded gravel is utilized as pipe zone backfill, this material should be wrapped with a geosynthetic filter fabric.

9.1.13. Utility Trench and Excavation Backfill

Based on our subsurface evaluation, the on-site earth materials should be generally suitable for re-use as backfill for trenches and excavations, provided they are free of organic material, clay lumps, debris, and rocks greater than approximately 3 inches in diameter. Fill should be moisture-conditioned to generally above the laboratory optimum. Trench backfill should be compacted to 90 percent of its modified Proctor density as evaluated by ASTM D 1557 except for the upper 12 inches of the backfill in pavement or flatwork areas that should be compacted to 95 percent of its modified Proctor density as evaluated by ASTM D 1557. Lift thickness for backfill will depend on the type of compaction equipment utilized, but fill should generally be placed in lifts not exceeding 8 inches in loose thickness. Special care should be exercised to avoid damaging the pipe during compaction of the backfill.

9.2. Seismic Design Considerations

Design of the proposed improvements should be performed in accordance with the requirements of governing jurisdictions and applicable building codes. Table 1 presents the seismic design parameters for the location of our subsurface exploration near the HDD alignment crossing of Highway 101 in accordance with the CBC (2013) guidelines and adjusted MCE_R spectral response acceleration parameters (USGS, 2015).

Table 1 – 2013 California Building Code Seismic Design Criteria

Site Coefficients and Spectral Response Acceleration Parameters	Values
Site Class	D
Site Coefficient, F_a	1.020
Site Coefficient, F_v	1.534
Mapped Short Period Spectral Acceleration at 0.2-second Period, S_S	1.201g
Mapped One-Second Period Spectral Acceleration at 1.0-second Period, S_1	0.466g
Short Period Spectral Acceleration at 0.2-second Period Adjusted For Site Class, S_{MS}	1.225g
One-Second Period Spectral Acceleration at 1.0-second Period Adjusted For Site Class, S_{M1}	0.715g
Design Short Period Spectral Acceleration at 0.2-second Period, S_{DS}	0.816g
Design One-Second Period Spectral Acceleration at 1.0-second Period, S_{D1}	0.477g

9.3. Underground Structures

The triple box culvert and other underground structures may be designed for lateral pressures represented by the pressure diagram on Figure 9. For preliminary design purposes, we recommend that the groundwater level be assumed at Mean Sea Level for evaluation of lateral pressures and calculating the factor of safety against uplift. It is recommended that the exterior of underground walls, and horizontal and vertical construction joints be waterproofed, as indicated by the project civil engineer and/or architect. For pipe wall penetrations into the triple box culvert and other structures, standard “water-tight” penetration design should be utilized. To reduce the potential for relative pipe to wall differential settlement, which could cause pipe shearing, we recommend that a pipe joint be located close to the exterior of the wall. The type of joint should be such that minor relative movement can be accommodated without distress.

9.4. Uplift and Special Design Considerations

We recommend that the triple box culvert and other underground structures be designed to resist hydrostatic uplift in accordance with Figure 10. Alternative design measures for resisting the anticipated uplift pressure could include installation of vertical anchors, creating a flange by extending the base of the structure, or increasing mass of the structure.

The resistance to uplift may then be taken as the sum of the weight of the structure and the weight of the soil wedge within the zone of influence of the flanges shown on Figure 10.

9.5. Corrosivity

Laboratory testing was performed on a representative sample of near-surface soil to evaluate soil pH, electrical resistivity, water-soluble chloride content, and water-soluble sulfate content. The soil pH and electrical resistivity tests were performed in general accordance with California Test (CT) 643. Chloride content tests were performed in general accordance with CT 422. Sulfate testing was performed in general accordance with CT 417. The laboratory test results are presented in Appendix C.

The results of the soil corrosivity testing from this evaluation indicated an electrical resistivity of 430 ohm-cm and a soil pH of 8.9. The chloride content of the tested sample was approximately 1,400 parts per million (ppm). The sulfate content of the tested sample was approximately 0.018 percent (i.e. 180 ppm). Based on the laboratory test results, American Concrete Institute (ACI) 318, Caltrans (2012) criteria, and our experience with similar soils, the site is classified as corrosive, which is defined as soil with an electrical resistivity less than 1,000, a chloride content more than 500 ppm, more than 0.10 percent sulfates, and/or a pH less than 5.5.

9.6. Concrete

Concrete in contact with soil or water that contains high concentrations of soluble sulfates can be subject to chemical deterioration. Laboratory testing indicated a sulfate content of approximately 0.018 percent for the tested sample, which is considered to represent a negligible potential for sulfate attack (ACI, 318). Type II cement may be used; however, due to the potential for variability of soils and presence of salt and brackish water, consideration should be given to using Type II/V cement for concrete structures in contact with soil and a water-to-cement ratio of no more than 0.45.

10. CONSTRUCTION OBSERVATION

The recommendations provided in this report are based on our understanding of the proposed project and on our evaluation of the data collected based on subsurface conditions disclosed by widely spaced exploratory borings and data from others. It is imperative that the interpolated subsurface conditions be checked by our representative during construction. Observation and testing of compacted fill and backfill should be performed by our representative during construction. In addition, we should review the project plans and specifications prior to construction. It should be noted that, upon review of these documents, some recommendations presented in this report might be revised or modified.

During construction we recommend that our duties include, but not be limited to:

- Observing removals and excavation bottoms.
- Observing the placement and compaction of fill, including trench backfill.
- Observing HDD drilling.
- Evaluating on-site and imported materials prior to their use as fill.
- Performing laboratory and field tests to evaluate fill compaction.

The recommendations provided in this report assume that Ninyo & Moore will be retained as the geotechnical consultant during the construction phase of this project. If another geotechnical consultant is selected, we request that the selected consultant indicate to the owner and to our firm in writing that our recommendations are understood and that they are in full agreement with our recommendations.

11. LIMITATIONS

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. Our report incorporates data from our current evaluation of this project, our past evaluations of projects for others in the area, and data prepared by and for others in different time-frames. Based on data evaluated, the planned HDD alignment will go through fill and paralic estuarine deposits that range from very loose to very dense and cemented sandstones, siltstones, and claystones of the Delmar Formation and Torrey Sandstone. Based on these and other conditions described herein, in our previous reports, and in geotechnical evaluations prepared by others, the contractor may encounter difficulties drilling along the proposed alignment.

No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

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

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

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

12. REFERENCES

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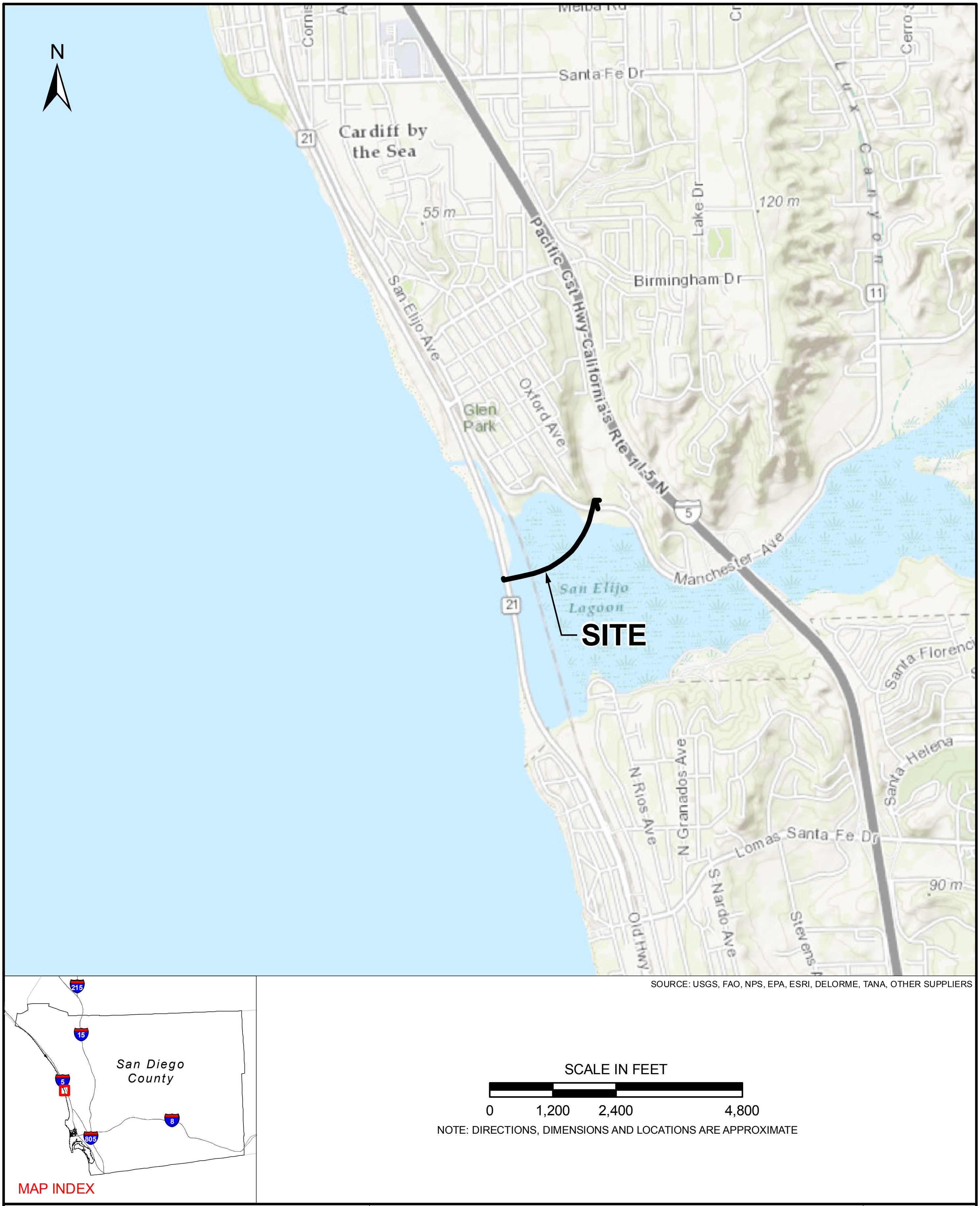
AERIAL PHOTOGRAPHS				
Source	**Date**	**Flight**	**Numbers**	**Scale**
USDA	4-11-1953	AXN-8M	79 and 80	1:20,000



SOURCE: USGS, FAO, NPS, EPA, ESRI, DELORME, TANA, OTHER SUPPLIERS

SCALE IN FEET

0 1,200 2,400 4,800

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE

1_108030001_SL_93.mxd AOB

Ninyo & Moore

SITE LOCATION

KENNEDY JENKS/SEJPA LAND OUTFALL
CARDIFF BY THE SEA, CALIFORNIA

PROJECT NO.	DATE
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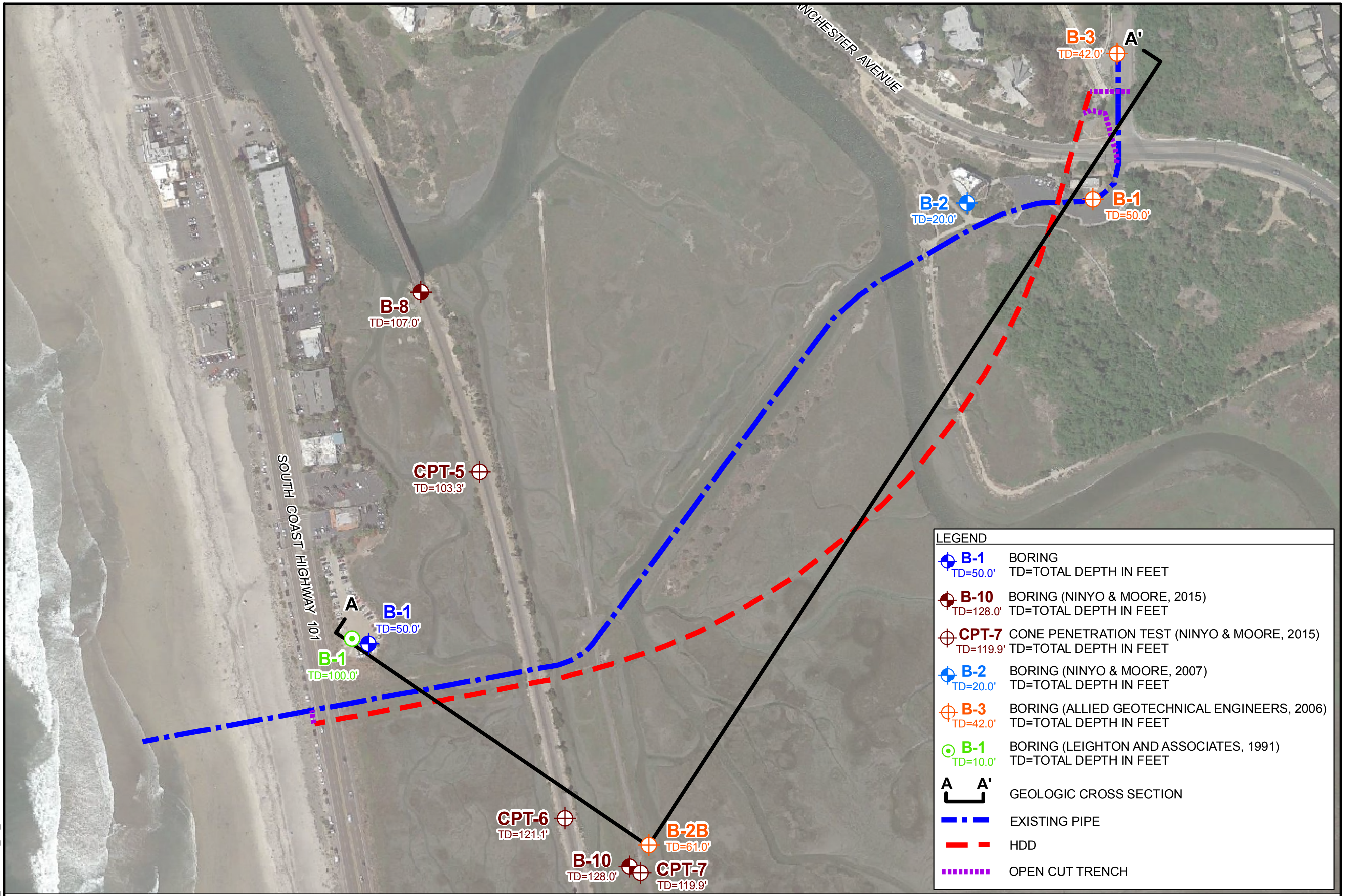
FIGURE

1



SOURCE: GOOGLE EARTH, 2015.

N

SCALE IN FEET

0 150 300 600

NOTE: ALL DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE

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PROJECT NO.	DATE
108030001	1/16

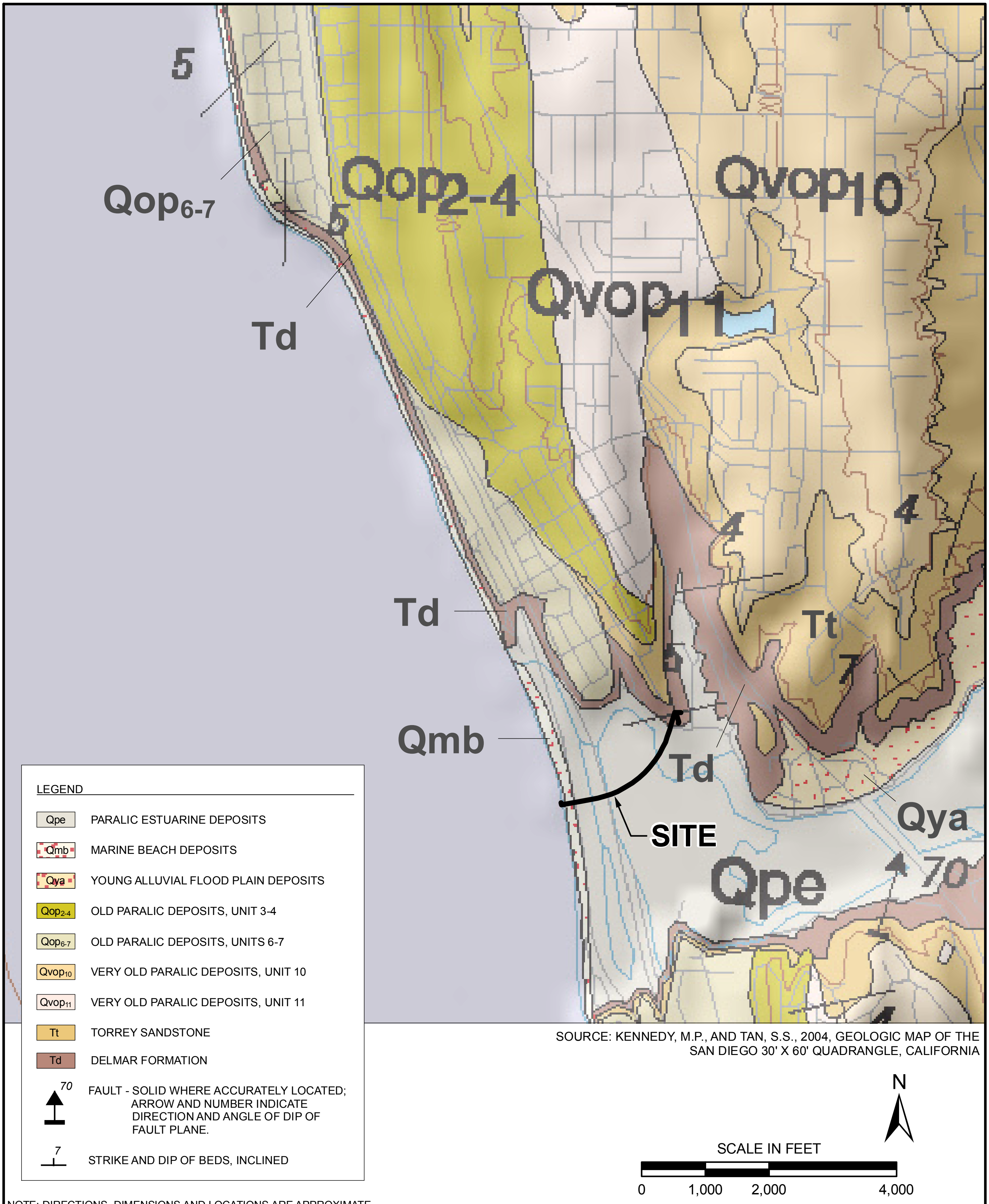
BORING LOCATION

KENNEDY JENKS/SEJPA LAND OUTFALL
CARDIFF BY THE SEA, CALIFORNIA

FIGURE

2

2_108030001_BL_93.mxd AOB



LEGEND

Qpe	PARALIC ESTUARINE DEPOSITS
Qmb	MARINE BEACH DEPOSITS
Qya	YOUNG ALLUVIAL FLOOD PLAIN DEPOSITS
Qop_{2-4}	OLD PARALIC DEPOSITS, UNIT 3-4
Qop_{6-7}	OLD PARALIC DEPOSITS, UNITS 6-7
$Qvop_{10}$	VERY OLD PARALIC DEPOSITS, UNIT 10
$Qvop_{11}$	VERY OLD PARALIC DEPOSITS, UNIT 11
Tt	TORREY SANDSTONE
Td	DELMAR FORMATION
70	FAULT - SOLID WHERE ACCURATELY LOCATED; ARROW AND NUMBER INDICATE DIRECTION AND ANGLE OF DIP OF FAULT PLANE.
7	STRIKE AND DIP OF BEDS, INCLINED

SOURCE: KENNEDY, M.P., AND TAN, S.S., 2004, GEOLOGIC MAP OF THE SAN DIEGO 30' X 60' QUADRANGLE, CALIFORNIA

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

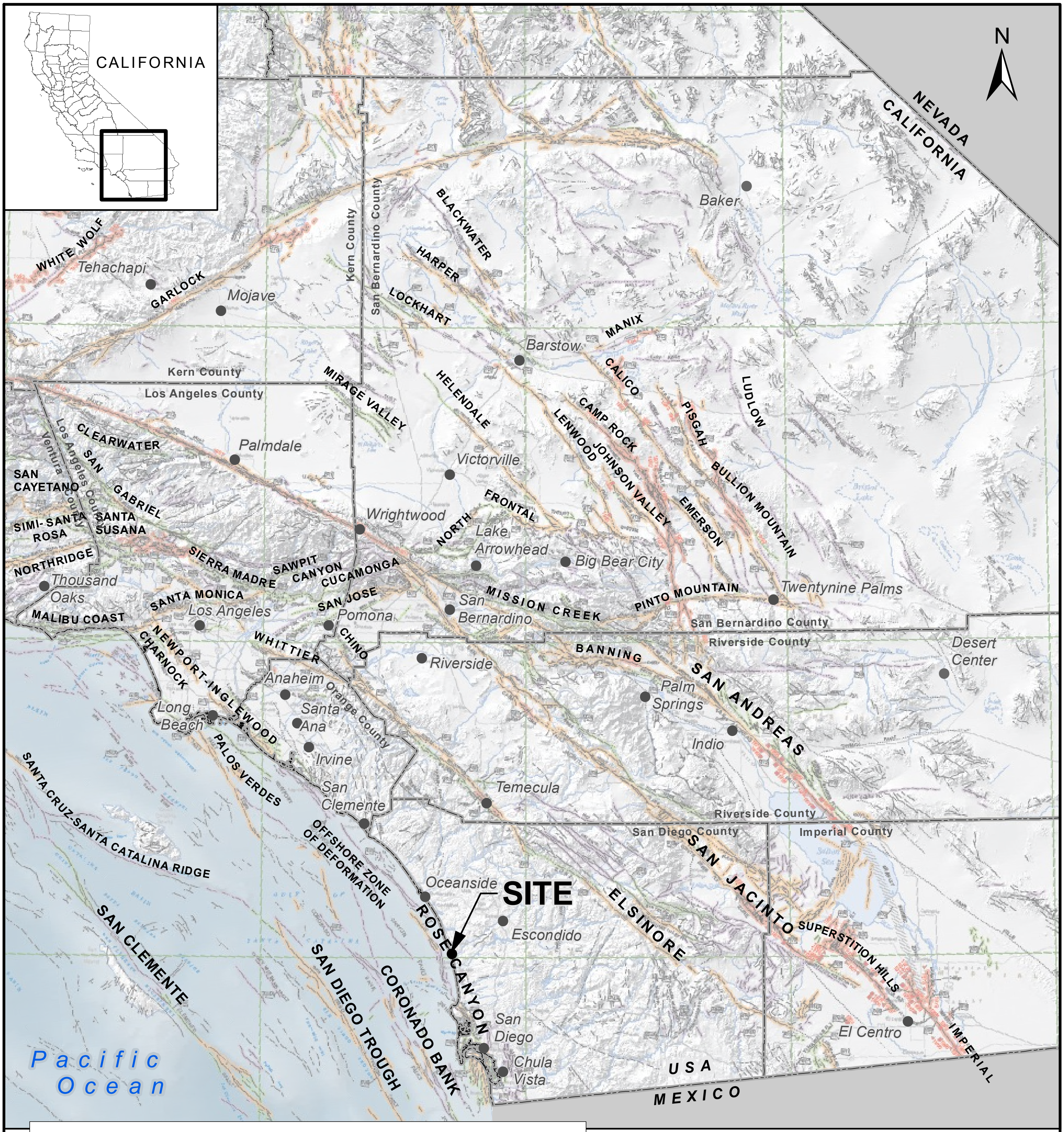
Ninyo & Moore

GEOLOGY

KENNEDY JENKS/SEJPA LAND OUTFALL
CARDIFF BY THE SEA, CALIFORNIA

PROJECT NO.	DATE	FIGURE
108030001	1/16	3

3_108030001_G.mxd AOB



LEGEND

CALIFORNIA FAULT ACTIVITY

- HISTORICALLY ACTIVE
- HOLOCENE ACTIVE
- LATE QUATERNARY (POTENTIALLY ACTIVE)
- QUATERNARY (POTENTIALLY ACTIVE)
- STATE/COUNTY BOUNDARY

SOURCE: JENNINGS, C.W., AND BRYANT, W.A., 2010, FAULT ACTIVITY MAP OF CALIFORNIA, CALIFORNIA GEOLOGICAL SURVEY.

SCALE IN MILES

0 30 60

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

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FAULT LOCATIONS

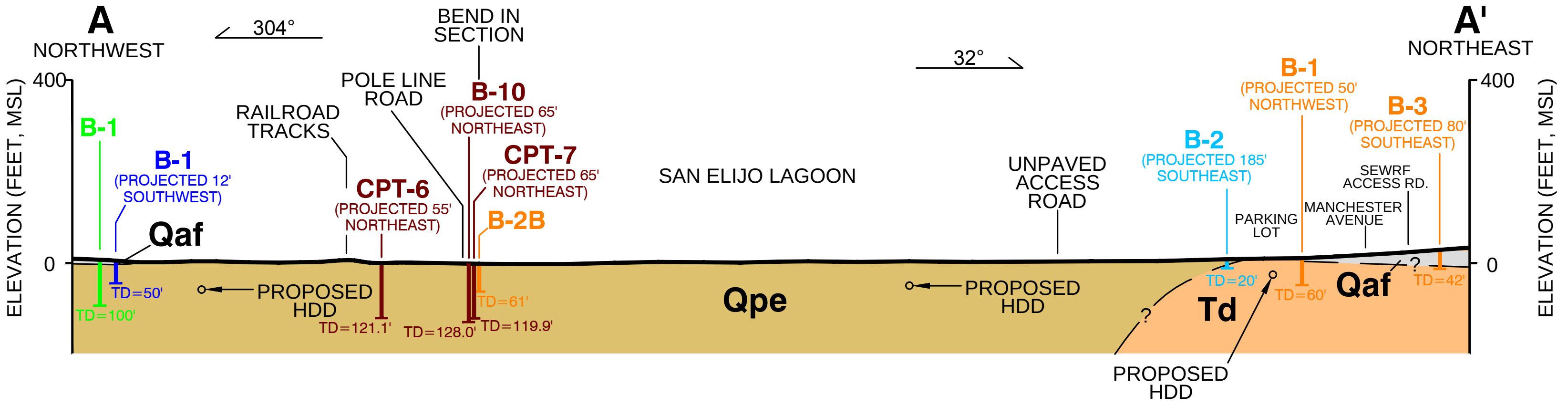
PROJECT NO.	DATE
108030001	1/16

KENNEDY JENKS/SEJPA LAND OUTFALL
CARDIFF BY THE SEA, CALIFORNIA

FIGURE

4

4_108030001_F_93.mxd AOB



LEGEND

B-1 TD=50'	BORING TD=TOTAL DEPTH IN FEET
B-10 TD=128.0'	BORING (NINYO & MOORE, 2015) TD=TOTAL DEPTH IN FEET
CPT-7 TD=119.9'	CONE PENETRATION TEST (NINYO & MOORE, 2015) TD=TOTAL DEPTH IN FEET
B-2 TD=20'	BORING (NINYO & MOORE, 2007) TD=TOTAL DEPTH IN FEET
B-3 TD=42'	BORING (ALLIED GEOTECHNICAL ENGINEERS, 2006) TD=TOTAL DEPTH IN FEET
B-1 TD=100'	BORING (LEIGHTON AND ASSOCIATES, 1991) TD=TOTAL DEPTH IN FEET
Qaf	FILL
Qpe	PARALIC ESTUARINE DEPOSITS
Td	DEL MAR FORMATION
—— ? ——	GEOLOGIC CONTACT, QUERIED WHERE UNCERTAIN

NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE

SCALE IN FEET
0 400 800

5 108030001 cs a-a'.dwg

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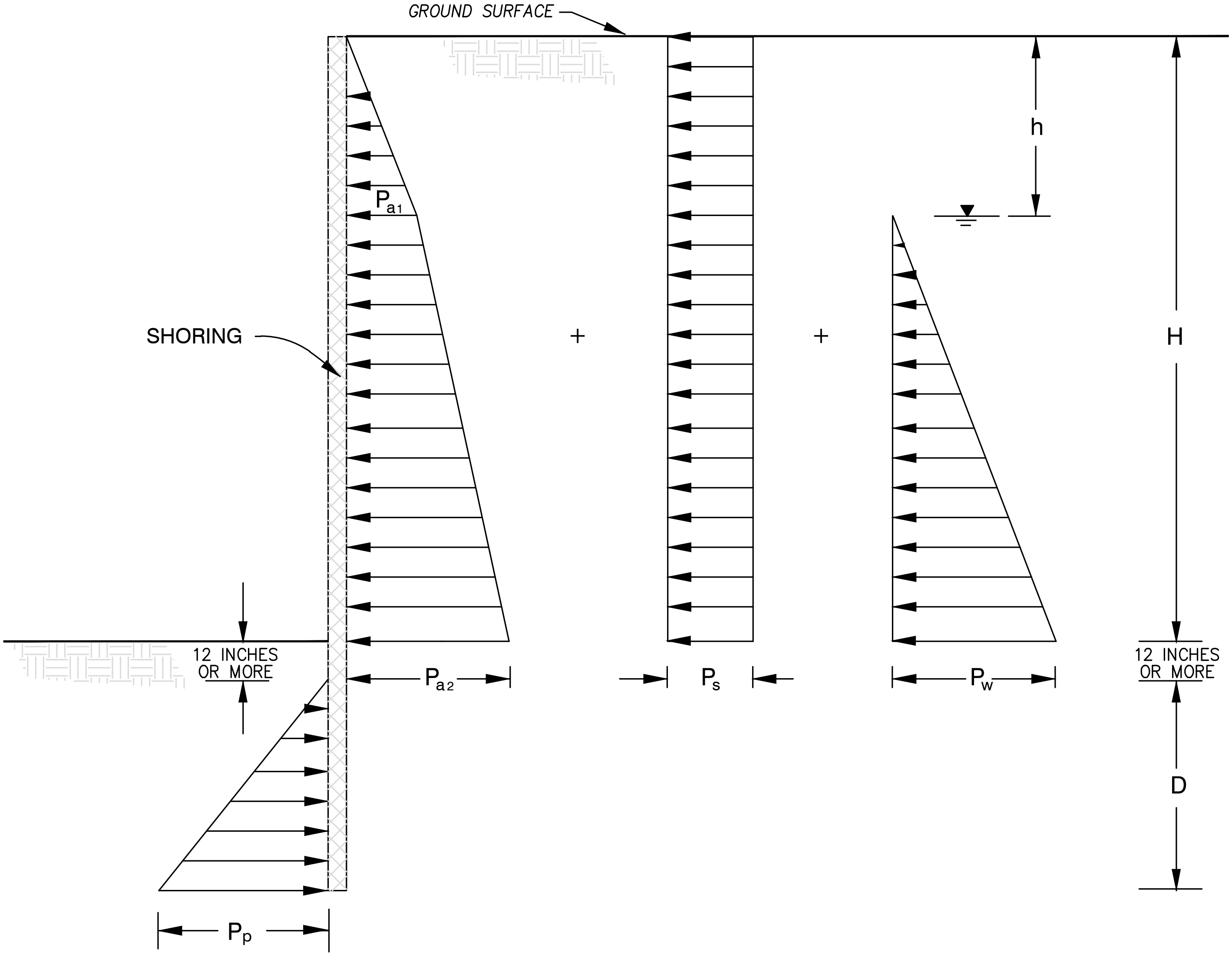
GEOLOGIC CROSS SECTION A-A'

PROJECT NO.	DATE
108030001	1/16

KENNEDY JENKS/SEJPA LAND OUTFALL
CARDIFF BY THE SEA, CALIFORNIA

FIGURE
5



NOTES:

1. ACTIVE LATERAL EARTH PRESSURE, P_a
   P_{a1} = 40 H psf; P_{a2} = P_{a1} + 19 (H - h) psf
2. CONSTRUCTION TRAFFIC INDUCED SURCHARGE PRESSURE, P_s
   P_s = 120 psf
3. HYDROSTATIC PRESSURE, P_w
   P_w =62.4 (H - h) psf
4. PASSIVE LATERAL EARTH PRESSURE, P_p
   P_p = 170 D psf
5. SURCHARGES FROM EXCAVATED SOIL OR CONSTRUCTION MATERIALS ARE NOT INCLUDED
6. H, h AND D ARE IN FEET
7. ▽ GROUNDWATER TABLE

NOT TO SCALE

6 108030001 d-csbg.dwg

Ninyo & Moore

LATERAL EARTH PRESSURES FOR TEMPORARY CANTILEVERED SHORING BELOW GROUNDWATER

FIGURE

6

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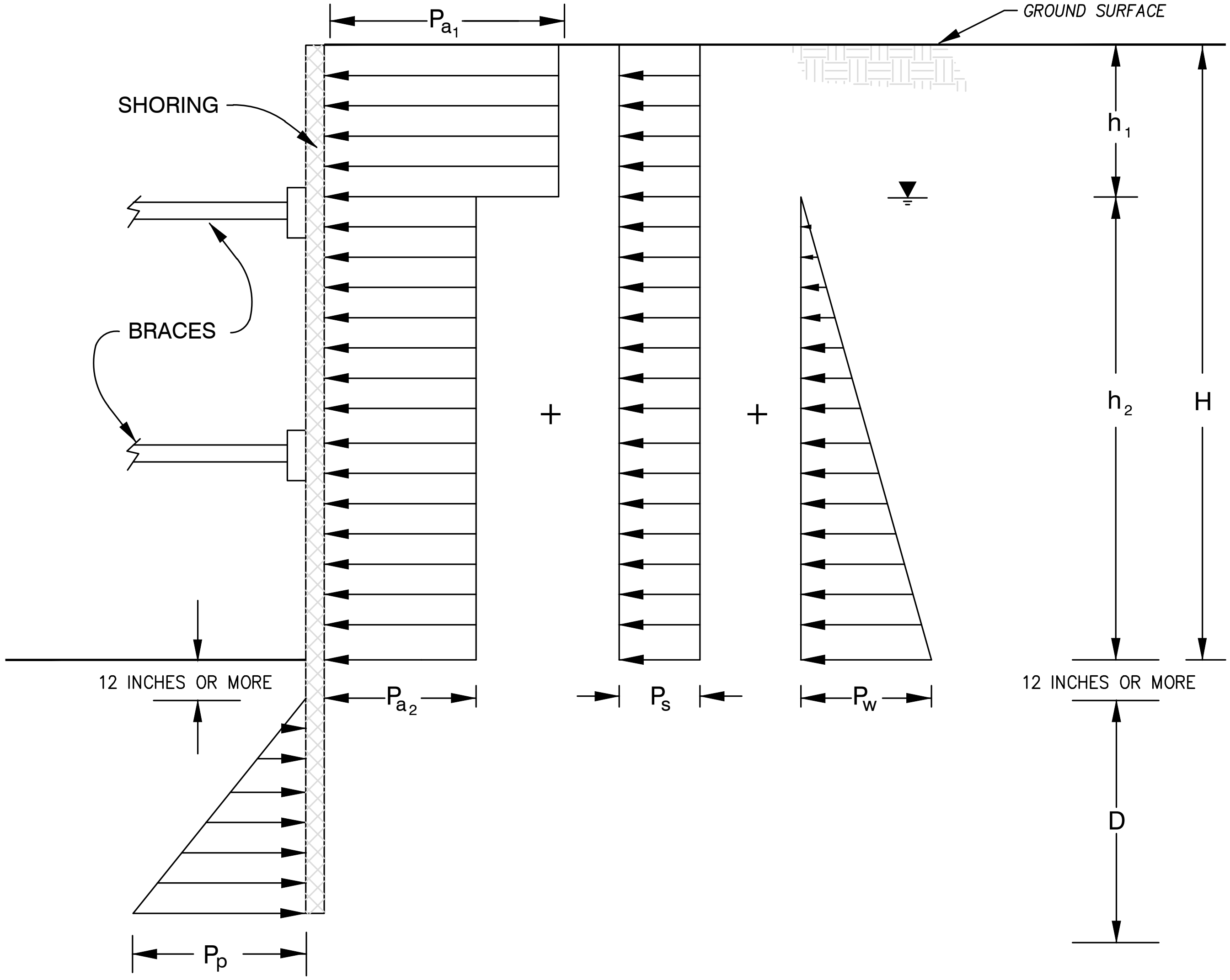
KENNEDY JENKS/SEJPA LAND OUTFALL
CARDIFF BY THE SEA, CALIFORNIA



NOTES:

1. APPARENT LATERAL EARTH PRESSURES, P_{a1} AND P_{a2}
   P_{a_1} = 26 H psf
   P_{a_2} = 13 H psf
2. CONSTRUCTION TRAFFIC INDUCED SURCHARGE PRESSURE, P_s
   P_s = 120 psf
3. WATER PRESSURE, P_w
   P_w= 62.4 h_2 psf
4. PASSIVE PRESSURE, P_p
   P_p = 170 D psf
5. SURCHARGES FROM EXCAVATED SOIL OR CONSTRUCTION MATERIALS ARE NOT INCLUDED
6. H, h_1, h_2 AND D ARE IN FEET
7. ▽ GROUNDWATER TABLE

NOT TO SCALE

7 108030001 d-begsbg.dwg

Ninyo & Moore

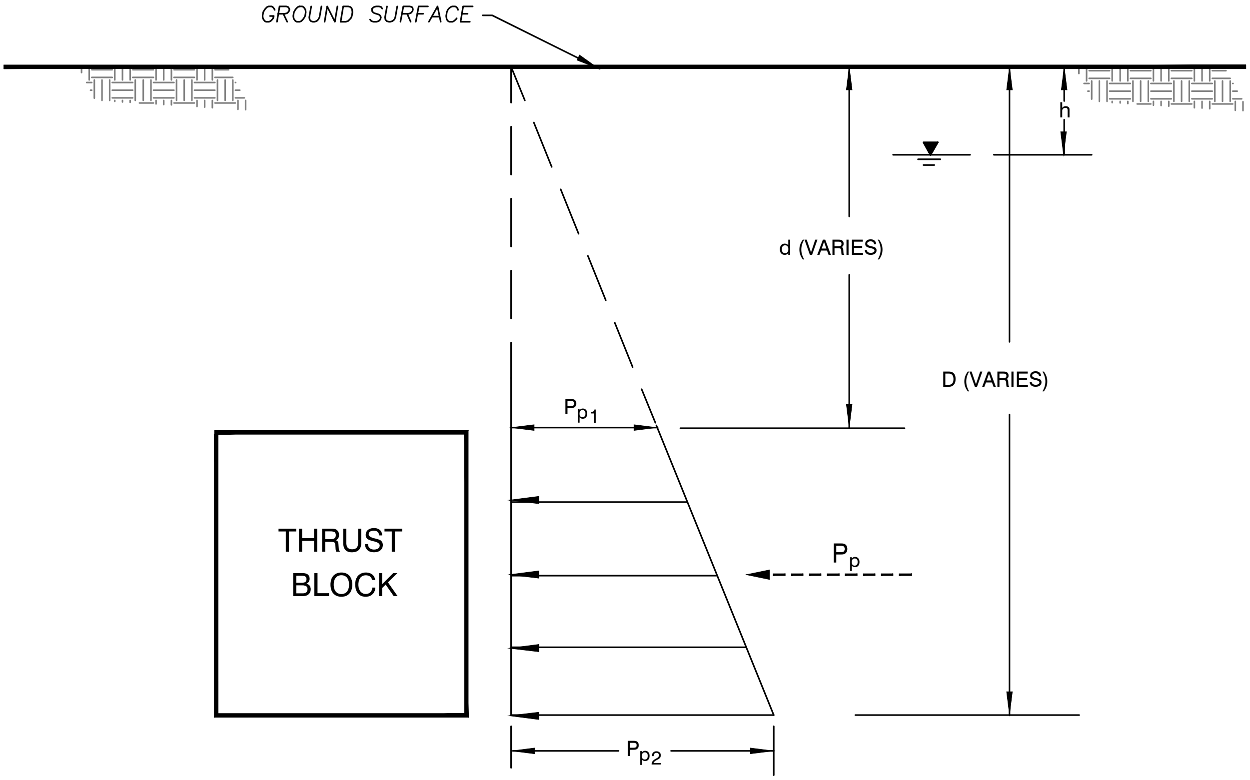
LATERAL EARTH PRESSURES FOR BRACED EXCAVATION BELOW GROUNDWATER

PROJECT NO.	DATE
108030001	1/16

KENNEDY JENKS/SEJPA LAND OUTFALL
CARDIFF BY THE SEA, CALIFORNIA

FIGURE

7



NOTES:

1. GROUNDWATER BELOW BLOCK

   $P_p = 175\ (D^2 - d^2)$ lb/ft

2. GROUNDWATER ABOVE BLOCK

   $P_p = 1.4\ (D - d)[\ 124.8h + 58\ (D+d)]$ lb/ft

3. ASSUMES BACKFILL IS GRANULAR MATERIAL
4. ASSUMES THRUST BLOCK IS ADJACENT TO COMPETENT MATERIAL
5. D, d AND h ARE IN FEET
6. ▼ GROUNDWATER TABLE

8 108030001 d-tb.dwg

NOT TO SCALE

Ninyo & Moore

THRUST BLOCK LATERAL EARTH PRESSURE DIAGRAM

PROJECT NO.	DATE
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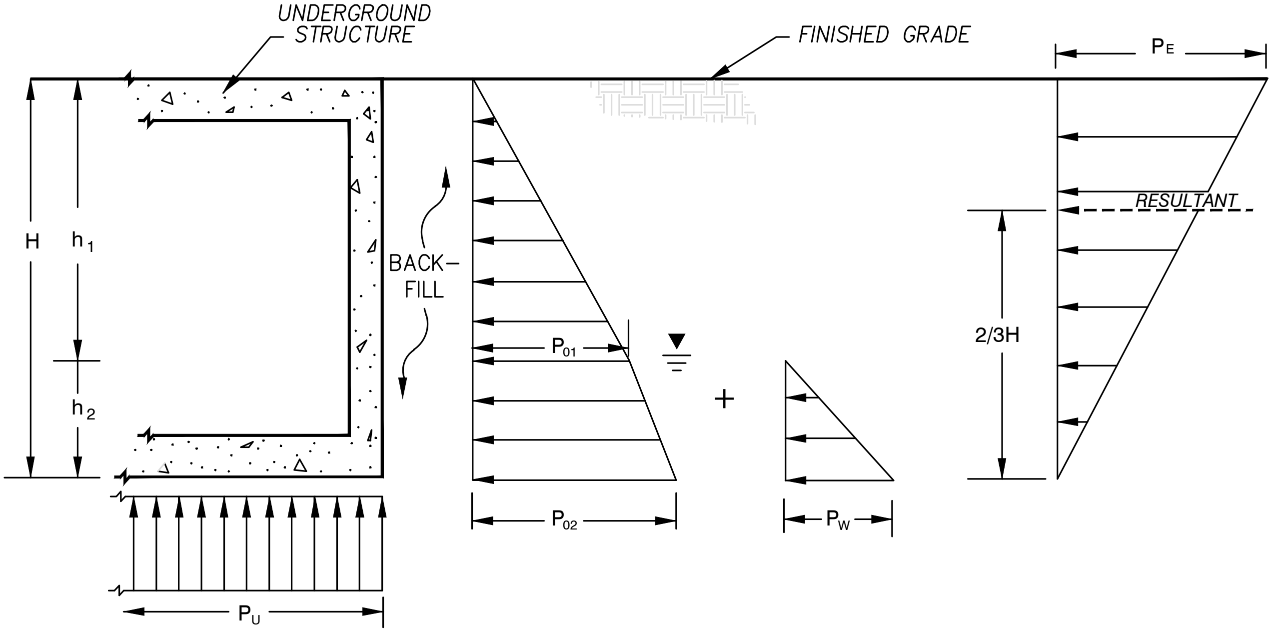
KENNEDY JENKS/SEJPA LAND OUTFALL
CARDIFF BY THE SEA, CALIFORNIA

FIGURE

8



UPLIFT PRESSURE

STATIC PRESSURE

WATER PRESSURE

DYNAMIC PRESSURE

NOTES:

1. APPARENT LATERAL EARTH PRESSURES, P_{01} AND P_{02}
   $P_{01} = 60\ h_1$ psf
   $P_{02} = 60\ h_1 + 29\ h_2$ psf
2. WATER PRESSURE, P_w
   $P_w = 62.4\ h_2$ psf
3. DYNAMIC LATERAL EARTH PRESSURE IS BASED ON A PEAK GROUND ACCELERATION OF 0.51 g
   $P_E = 23\ H$ psf
4. UPLIFT PRESSURE, P_u
   $P_u = 62.4\ h_2$ psf
5. SURCHARGE PRESSURES CAUSED BY VEHICLES OR NEARBY STRUCTURES ARE NOT INCLUDED
6. H, h_1 AND h_2 ARE IN FEET
7. ▼ GROUNDWATER TABLE

NOT TO SCALE

9 108030001 d-us.dwg

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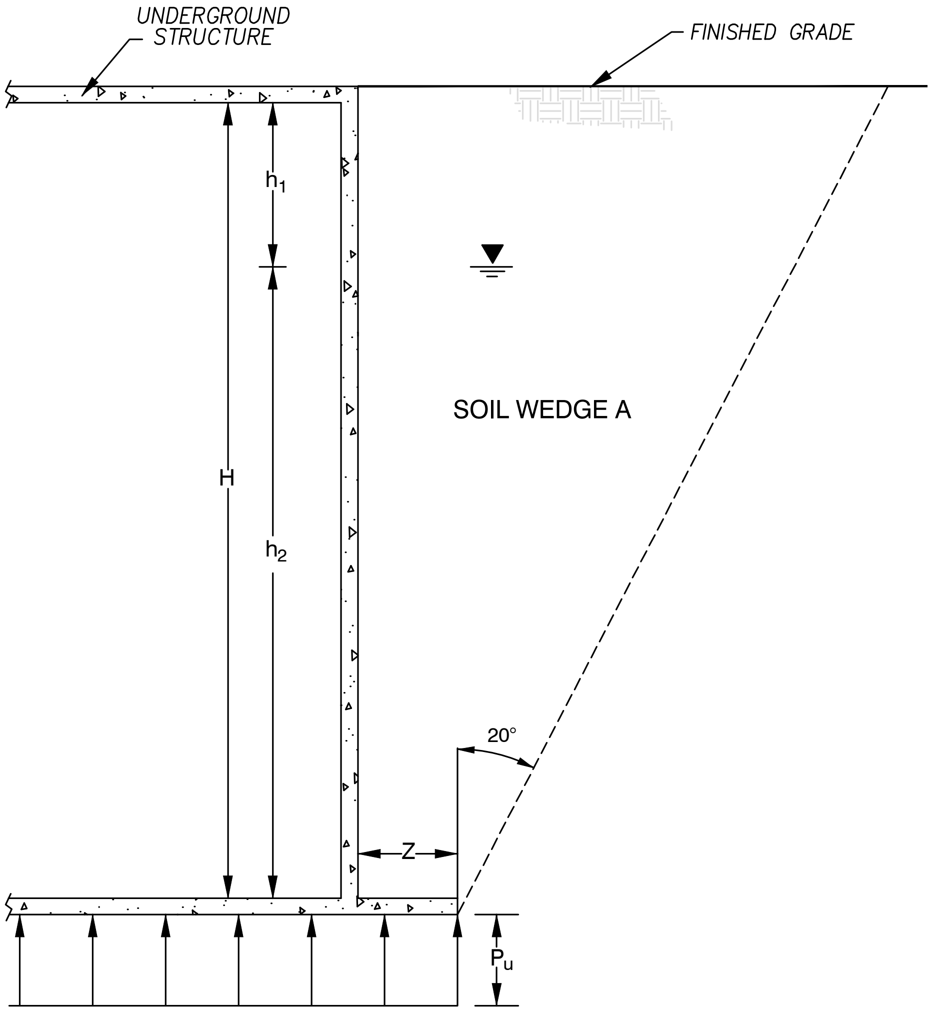
LATERAL EARTH PRESSURES FOR UNDERGROUND STRUCTURES

PROJECT NO.	DATE
108030001	1/16

KENNEDY JENKS/SEJPA LAND OUTFALL
CARDIFF BY THE SEA, CALIFORNIA

FIGURE

9



RESISTANCE TO UPLIFT = WEIGHT OF STRUCTURE + WEIGHT OF SOIL WEDGE A

NOTES:

1. UNIT WEIGHT OF SOILS, γ OR γ_b
   γ = 120 pcf ABOVE GROUNDWATER TABLE
   γ_b = 58 pcf BELOW GROUNDWATER TABLE
2. UPLIFT PRESSURE, P_u
   $P_u = 62.4\ h_2$ psf
3. H, Z, h_1 AND h_2 ARE IN FEET
4. ▼ GROUNDWATER TABLE

NOT TO SCALE

10 108030001 d-ur.dwg

Ninyo & Moore

UPLIFT RESISTANCE DIAGRAM
FOR UNDERGROUND STRUCTURES

FIGURE

10

PROJECT NO.
108030001

DATE
1/16

KENNEDY JENKS/SEJPA LAND OUTFALL
CARDIFF BY THE SEA, CALIFORNIA

APPENDIX A

BORING LOG

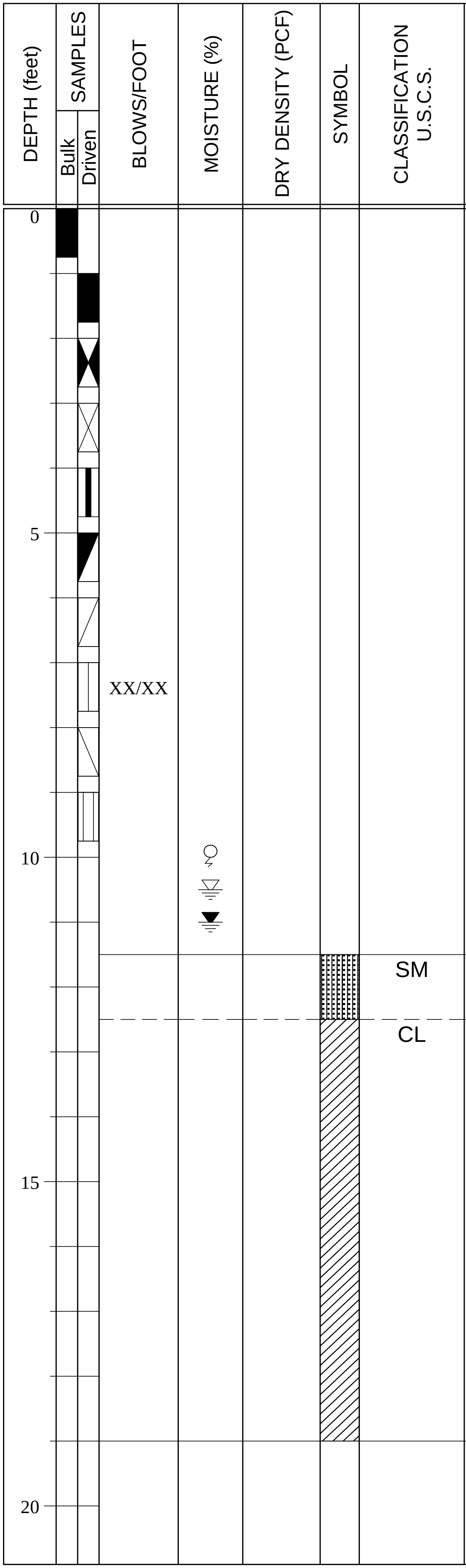
Field Procedure for the Collection of Disturbed Samples

Disturbed soil samples of representative earth materials was obtained from the cuttings of the exploratory boring. The sample was bagged and transported to the laboratory for testing.

Field Procedure for the Collection of Relatively Undisturbed Samples

Relatively undisturbed soil samples were obtained in the field using a modified split-barrel drive sampler. The sampler, with an external diameter of 3.0 inches, was lined with 1-inch long, thin brass rings with inside diameters of approximately 2.4 inches. The sample barrel was driven into the ground with the weight of a 140-pound hammer, in general accordance with ASTM D 3550. The driving weight was permitted to fall freely. The approximate length of the fall, the weight of the hammer, and the number of blows per foot of driving are presented on the boring logs as an index to the relative resistance of the materials sampled. The samples were removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

BORING LOG EXPLANATION SHEET



Bulk sample.

Modified split-barrel drive sampler.

2-inch inner diameter split-barrel drive sampler.

No recovery with modified split-barrel drive sampler, or 2-inch inner diameter split-barrel drive sampler.

Sample retained by others.

Standard Penetration Test (SPT).

No recovery with a SPT.

Shelby tube sample. Distance pushed in inches/length of sample recovered in inches.

No recovery with Shelby tube sampler.

Continuous Push Sample.

Seepage.

Groundwater encountered during drilling.

Groundwater measured after drilling.

MAJOR MATERIAL TYPE (SOIL):
Solid line denotes unit change.

Dashed line denotes material change.

Attitudes: Strike/Dip
b: Bedding
c: Contact
j: Joint
f: Fracture
F: Fault
cs: Clay Seam
s: Shear
bss: Basal Slide Surface
sf: Shear Fracture
sz: Shear Zone
sbs: Shear Bedding Surface

The total depth line is a solid line that is drawn at the bottom of the boring.

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BORING LOG

Explanation of Boring Log Symbols

PROJECT NO.	DATE	FIGURE

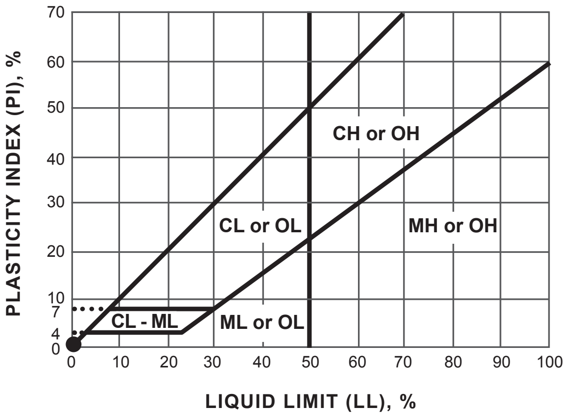
SOIL CLASSIFICATION CHART PER ASTM D 2488

PRIMARY DIVISIONS			SECONDARY DIVISIONS	
			GROUP SYMBOL	GROUP NAME
COARSE-GRAINED SOILS more than 50% retained on No. 200 sieve	**GRAVEL** more than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVEL less than 5% fines	GW	well-graded GRAVEL
			GP	poorly graded GRAVEL
		GRAVEL with DUAL CLASSIFICATIONS 5% to 12% fines	GW-GM	well-graded GRAVEL with silt
			GP-GM	poorly graded GRAVEL with silt
			GW-GC	well-graded GRAVEL with clay
			GP-GC	poorly graded GRAVEL with clay
		GRAVEL with FINES more than 12% fines	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND 50% or more of coarse fraction passes No. 4 sieve	CLEAN SAND less than 5% fines	SW	well-graded SAND
			SP	poorly graded SAND
		SAND with DUAL CLASSIFICATIONS 5% to 12% fines	SW-SM	well-graded SAND with silt
			SP-SM	poorly graded SAND with silt
			SW-SC	well-graded SAND with clay
			SP-SC	poorly graded SAND with clay
		SAND with FINES more than 12% fines	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOILS 50% or more passes No. 200 sieve	**SILT and CLAY** liquid limit less than 50%	INORGANIC	CL	lean CLAY
			ML	SILT
			CL-ML	silty CLAY
		ORGANIC	OL (PI > 4)	organic CLAY
			OL (PI < 4)	organic SILT
	SILT and CLAY liquid limit 50% or more	INORGANIC	CH	fat CLAY
			MH	elastic SILT
		ORGANIC	OH (plots on or above "A"-line)	organic CLAY
			OH (plots below "A"-line)	organic SILT
	Highly Organic Soils		PT	Peat

GRAIN SIZE

DESCRIPTION		SIEVE SIZE	GRAIN SIZE	APPROXIMATE SIZE
Boulders		> 12"	> 12"	Larger than basketball-sized
Cobbles		3 - 12"	3 - 12"	Fist-sized to basketball-sized
Gravel	Coarse	3/4 - 3"	3/4 - 3"	Thumb-sized to fist-sized
	Fine	#4 - 3/4"	0.19 - 0.75"	Pea-sized to thumb-sized
Sand	Coarse	#10 - #4	0.079 - 0.19"	Rock-salt-sized to pea-sized
	Medium	#40 - #10	0.017 - 0.079"	Sugar-sized to rock-salt-sized
	Fine	#200 - #40	0.0029 - 0.017"	Flour-sized to sugar-sized
Fines		Passing #200	< 0.0029"	Flour-sized and smaller

PLASTICITY CHART



APPARENT DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPOOLING CABLE OR CATHEAD		AUTOMATIC TRIP HAMMER	
	SPT (blows/foot)	MODIFIED SPLIT BARREL (blows/foot)	SPT (blows/foot)	MODIFIED SPLIT BARREL (blows/foot)
Very Loose	≤ 4	≤ 8	≤ 3	≤ 5
Loose	5 - 10	9 - 21	4 - 7	6 - 14
Medium Dense	11 - 30	22 - 63	8 - 20	15 - 42
Dense	31 - 50	64 - 105	21 - 33	43 - 70
Very Dense	> 50	> 105	> 33	> 70

CONSISTENCY - FINE-GRAINED SOIL

CONSIS-TENCY	SPOOLING CABLE OR CATHEAD		AUTOMATIC TRIP HAMMER	
	SPT (blows/foot)	MODIFIED SPLIT BARREL (blows/foot)	SPT (blows/foot)	MODIFIED SPLIT BARREL (blows/foot)
Very Soft	< 2	< 3	< 1	< 2
Soft	2 - 4	3 - 5	1 - 3	2 - 3
Firm	5 - 8	6 - 10	4 - 5	4 - 6
Stiff	9 - 15	11 - 20	6 - 10	7 - 13
Very Stiff	16 - 30	21 - 39	11 - 20	14 - 26
Hard	> 30	> 39	> 20	> 26

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USCS METHOD OF SOIL CLASSIFICATION

Explanation of USCS Method of Soil Classification

PROJECT NO.	DATE	FIGURE

DATE DRILLED 10/12/15 BORING NO. B-1

GROUND ELEVATION 7' ± (MSL) SHEET 1 OF 2

METHOD OF DRILLING Mud Rotary (Tri-County) (CME-75)

DRIVE WEIGHT 140 lbs. DROP 30"

SAMPLED BY LLB LOGGED BY LLB REVIEWED BY JMM

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0	■						SM	<u>FILL:</u> Brown to reddish brown, moist to wet, loose, silty SAND with gravel.
	■			▽				Reddish brown; wet; very loose; micaceous.
		■	3	17.7				
							SP-SM	<u>PARALIC ESTUARINE DEPOSITS:</u> Dark gray, wet, medium dense, poorly graded SAND with silt; scattered organics; strong organic odor.
10		■	33	28.1	94.3			
								Gray to dark gray; dense; micaceous; few gravel.
		■	51	21.5	102.1			
20		■	40	26.9	97.1			@ 20' to 40': Fluid loss of approximately 40 gallons. Dark gray; trace to few rounded gravel; scattered shells.
		■	37	31.2				
							SP	Dark gray, wet, very dense, poorly graded fine to medium SAND; trace silt; micaceous; few rounded gravel; scattered shells.
30		■	60	26.6	97.7			
		■	55	21.1	102.4			Dense.
40								

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BORING LOG

KENNEDY JENKS/SEJPA LAND OUTFALL
CARDIFF BY THE SEA, CALIFORNIA

PROJECT NO.	DATE	FIGURE
108030001	1/16	A-7

DATE DRILLED 10/12/15 BORING NO. B-1
GROUND ELEVATION 7' ± (MSL) SHEET 2 OF 2
METHOD OF DRILLING Mud Rotary (Tri-County) (CME-75)
DRIVE WEIGHT 140 lbs. DROP 30"
SAMPLED BY LLB LOGGED BY LLB REVIEWED BY JMM

DEPTH (feet)	SAMPLES Bulk	 Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
40		■	72	22.1	102.9	▨	SP	<u>PARALIC ESTUARINE DEPOSITS:</u> (Continued) Gray to dark gray, wet, very dense, poorly graded SAND; micaceous; trace silt; few gravel. @ 40' to 50': Fluid loss of approximately 100 gallons. Based on cuttings observed in circulation tank, the deposits are similar from approximately 40 to 50 feet.
50								Total Depth = 50 feet. Groundwater encountered at approximately 3 feet during drilling. Backfilled with bentonite grout shortly after drilling on 10/12/15. <u>Note:</u> Groundwater may rise to a level higher than that measured in borehole due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents. Total fluid loss of approximately 600 gallons.
60								
70								
80								

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BORING LOG

KENNEDY JENKS/SEJPA LAND OUTFALL
CARDIFF BY THE SEA, CALIFORNIA

PROJECT NO.	DATE	FIGURE
108030001	1/16	A-8

APPENDIX B

LABORATORY TESTING

Classification

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

In-Place Moisture and Density Tests

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

Gradation Analysis

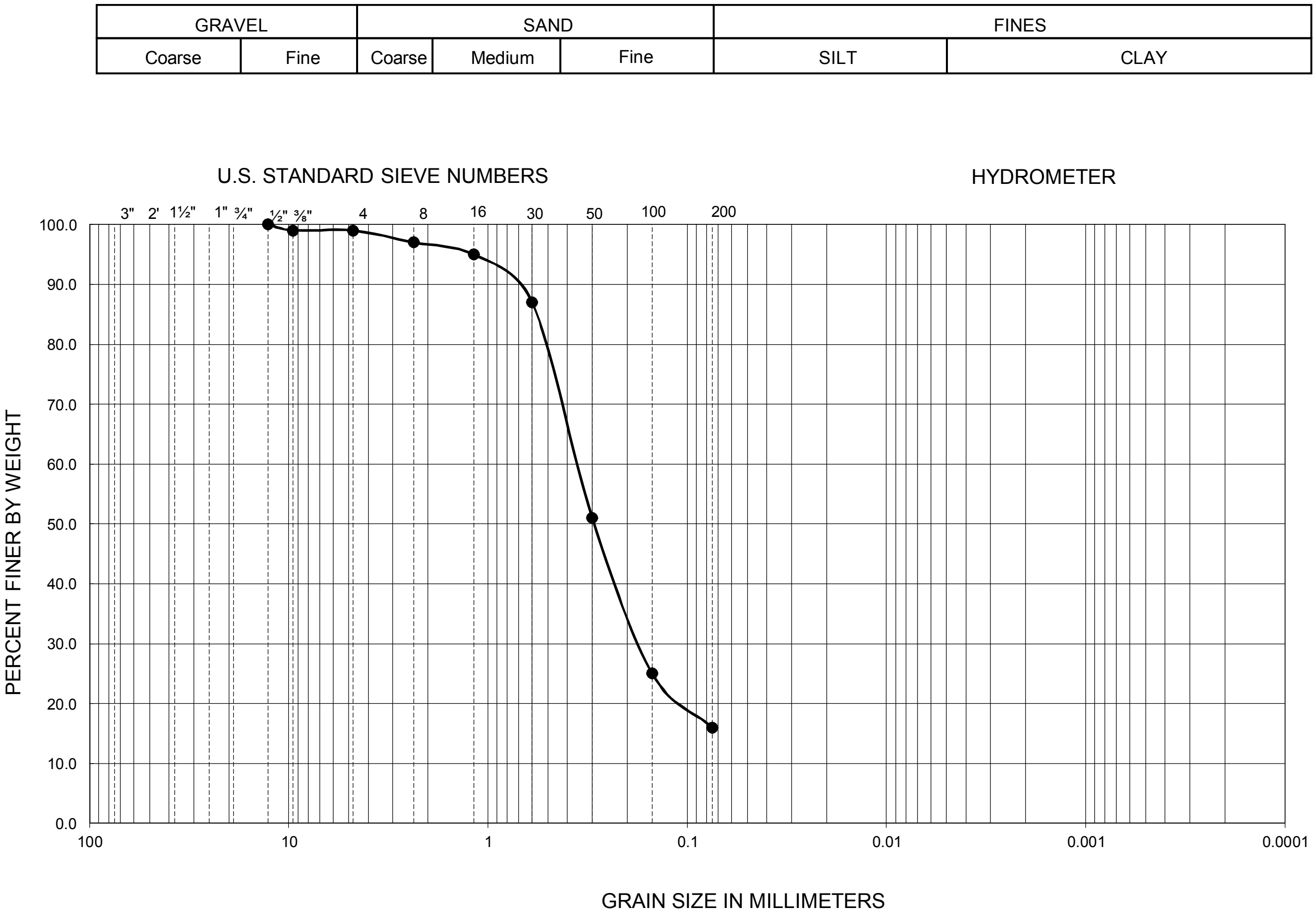
Gradation analysis tests were performed on selected representative soil samples in general accordance with ASTM D 422. The grain-size distribution curves are shown on Figures B-1 through B-3. The test results were utilized in evaluating the soil classifications in accordance with the USCS.

Direct Shear Tests

Direct shear tests were performed on selected representative soil samples in general accordance with ASTM D 3080 to evaluate the shear strength characteristics of the selected material. The samples were inundated during shearing to represent adverse field conditions. The test results are shown on Figures B-4 and B-5.

Soil Corrosivity Tests

Soil pH, and electrical resistivity tests were performed on a representative sample in general accordance with CT 643. The chloride content of the selected sample was evaluated in general accordance with CT 422. The sulfate content of the selected sample was evaluated in general accordance with CT 417. The test results are presented on Figure B-6.



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-1	5.0-6.5	--	--	--	--	--	--	--	--	16	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

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GRADATION TEST RESULTS

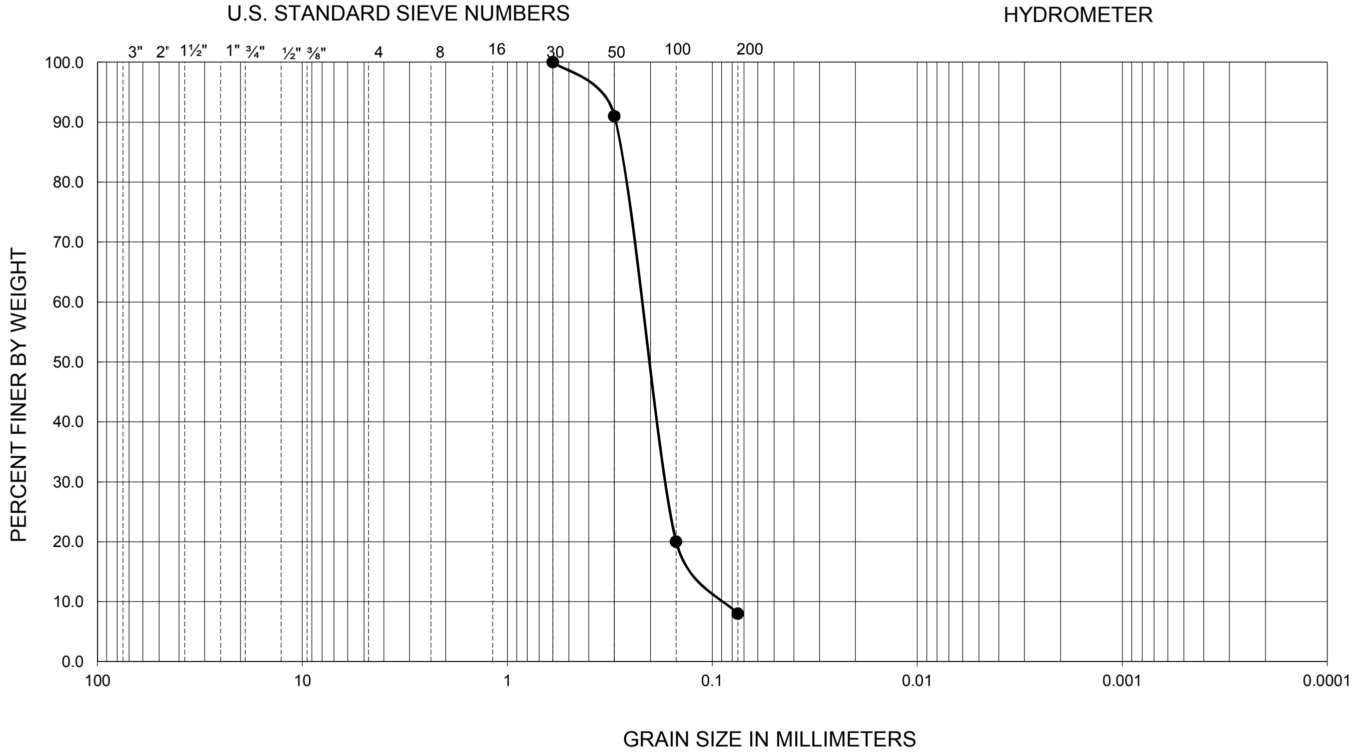
PROJECT NO.	DATE
108030001	1/16

KENNEDY JENKS/SEJPA LAND OUTFALL
CARDIFF BY THE SEA, CALIFORNIA 92007

FIGURE

B-1

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-1	15.0-16.5	--	--	--	0.09	0.17	0.22	2.4	1.4	8	SP-SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore

GRADATION TEST RESULTS

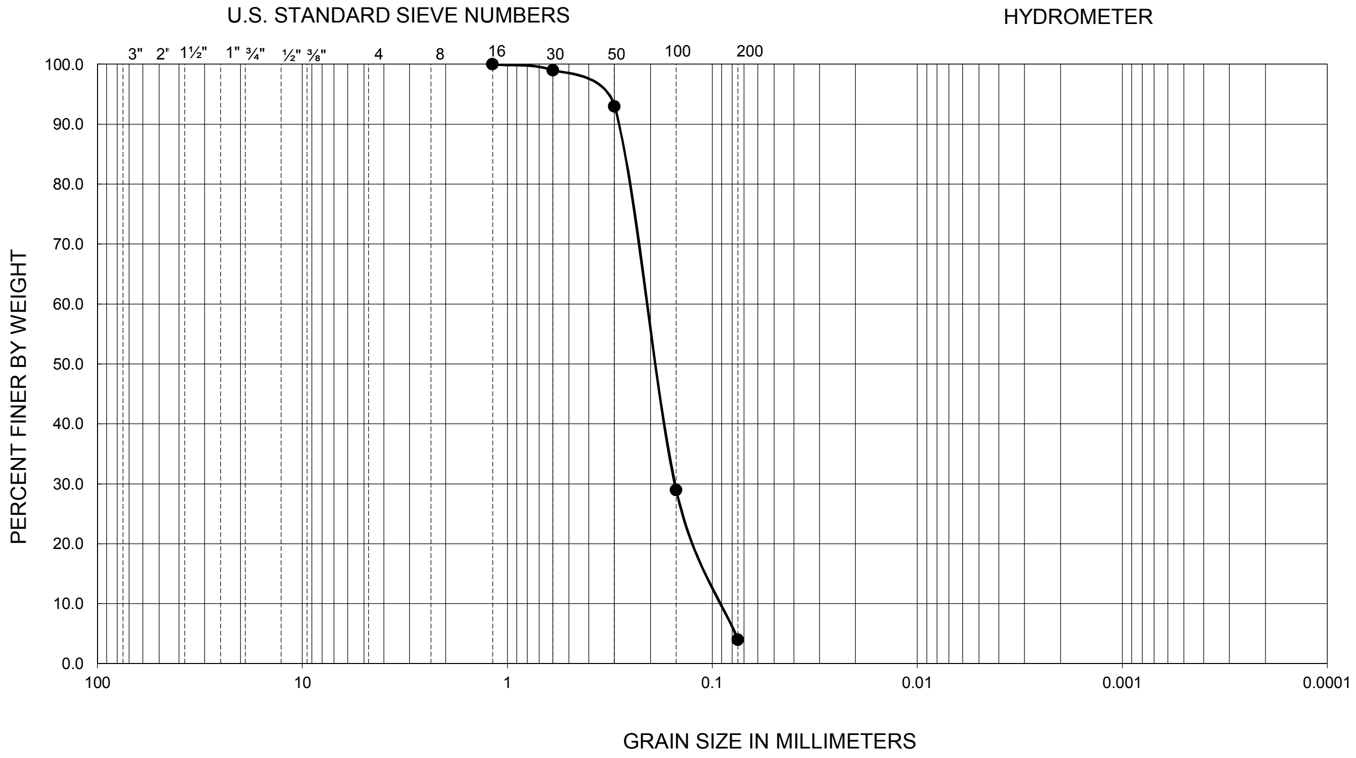
PROJECT NO.	DATE
108030001	1/16

KENNEDY JENKS/SEJPA LAND OUTFALL
CARDIFF BY THE SEA, CALIFORNIA 92007

FIGURE

B-2

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-1	30.0-31.5	--	--	--	0.09	0.15	0.21	2.3	1.2	4	SP

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore

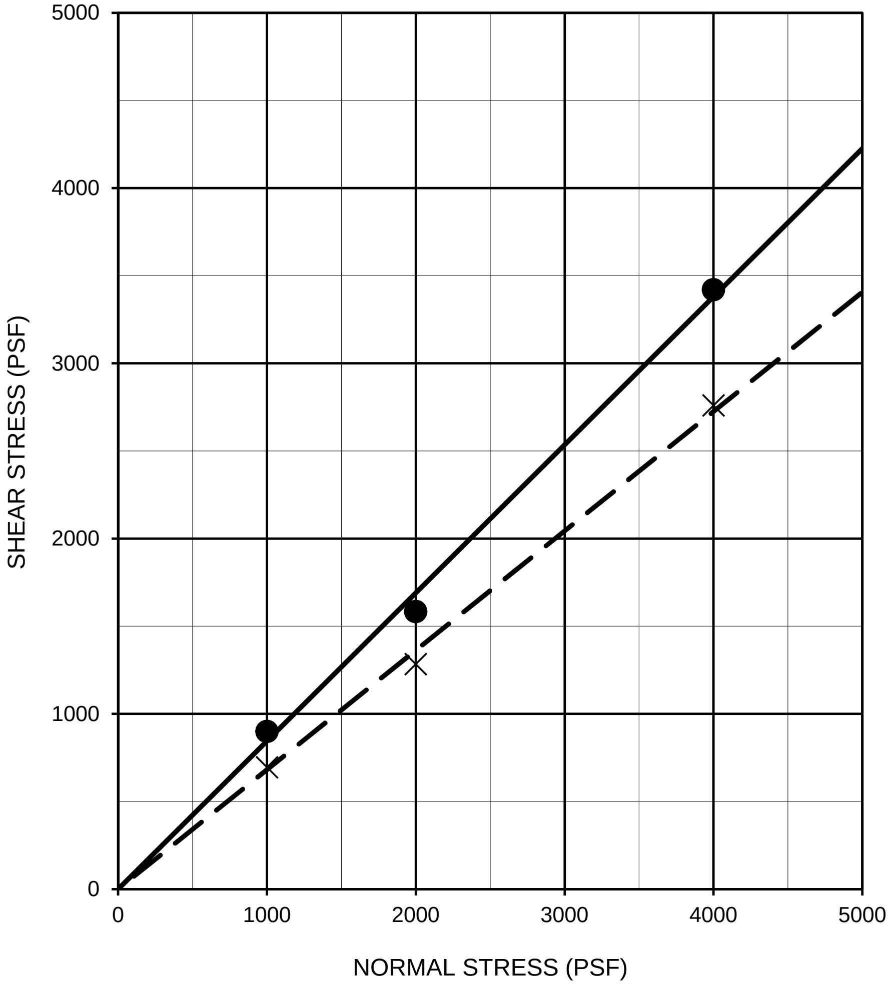
GRADATION TEST RESULTS

PROJECT NO.	DATE
108030001	1/16

KENNEDY JENKS/SEJPA LAND OUTFALL
CARDIFF BY THE SEA, CALIFORNIA 92007

FIGURE

B-3



Description	Symbol	Sample Location	Depth (ft)	Shear Strength	Cohesion, c (psf)	Friction Angle, ϕ (degrees)	Soil Type
SAND with Silt	—●—	B-1	10.0-11.5	Peak	0	43	SP-SM
SAND with Silt	- - x - -	B-1	10.0-11.5	Ultimate	0	38	SP-SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 3080

Ninyo & Moore

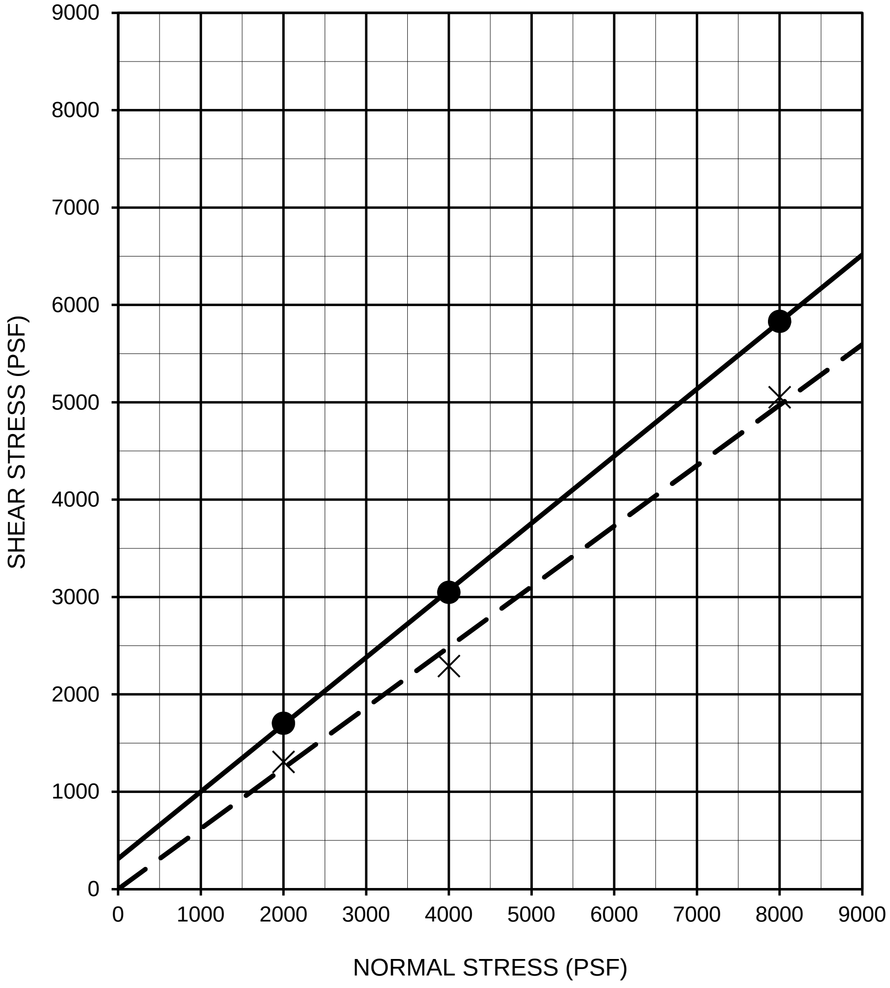
DIRECT SHEAR TEST RESULTS

FIGURE

B-4

PROJECT NO.	DATE
108030001	1/16

KENNEDY JENKS/SEJPA LAND OUTFALL
CARDIFF BY THE SEA, CALIFORNIA 92007



Description	Symbol	Sample Location	Depth (ft)	Shear Strength	Cohesion, c (psf)	Friction Angle, ϕ (degrees)	Soil Type
SAND with Silt	—●—	B-1	20.0-21.5	Peak	310	35	SP-SM
SAND with Silt	- - x - -	B-1	20.0-21.5	Ultimate	0	32	SP-SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 3080

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DIRECT SHEAR TEST RESULTS

FIGURE

PROJECT NO.	DATE
108030001	1/16

KENNEDY JENKS/SEJPA LAND OUTFALL
CARDIFF BY THE SEA, CALIFORNIA 92007

B-5

SAMPLE LOCATION	SAMPLE DEPTH (FT)	pH [1]	RESISTIVITY [1] (Ohm-cm)	SULFATE CONTENT [2]		CHLORIDE CONTENT [3] (ppm)
				(ppm)	(%)	
B-1	0.0-5.0	8.9	430	180	0.018	1,400

[1] PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 643

[2] PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 417

[3] PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 422

Ninyo & Moore

CORROSIVITY TEST RESULTS

PROJECT NO.	DATE
108030001	1/16

KENNEDY JENKS/SEJPA LAND OUTFALL
CARDIFF BY THE SEA, CALIFORNIA 92007

FIGURE

B-6

APPENDIX C

LEIGHTON AND ASSOCIATES INC., 1991 REPORT SELECTED LOG AND LABORATORY TEST RESULTS

ALLIED GEOTECHNICAL INC., 2006 REPORT SELECTED LOG AND LABORATORY TEST RESULTS

NINYO & MOORE, 2014, REPORT SELECTED LOG AND LABORATORY TEST RESULTS

GEOTECHNICAL BORING LOG

Date July 26, 1990 Drill Hole No. B-1 Sheet 1 of 4
Project HYA/San Elijo Project No. 8891814-01
Drilling Co. A&W Type of Rig Rotary Mud
Hole Diameter ±6 in. Drive Weight 140 pounds Drop 30 in.
Elevation Top of Hole ±7′ Ref. or Datum Mean Sea Level

Depth (Feet)	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density (pcf)	Moisture Content, %	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION Logged by DLL/RFW Sampled by DLL/RFW
0							SM	UNDOCUMENTED FILL: Orange-brown, moist, loose, slightly silty, fine-grained sand; massive; friable; slightly micaceous
			1	6				
			2	3				
5								
			3	push			SM	LAGOONAL DEPOSIT: Dark gray to black, very moist to wet, very loose, slightly silty, fine- to medium-grained sand; massive; very friable
			4	3			SM/ SC	@ 7′ Encountered ground water @ 8′ Interbedded, fine, sandy and silty to clayey sand; layers approximately 3 to 4 inches thick
10			5	1				@ 10′ Black, wet, very loose, silty to clayey sand; some gravel up to 1/4-inch in diameter
			6	2 No Recovery				
15			7	15 No Recovery			SM	@ 14′ Light gray, saturated, medium dense, silty, fine-grained sand; massive; friable
			8	23				
			9	20				@ 18′ Dark gray to black, saturated, medium dense, gravelly, silty, fine- to medium-grained sand; rounded gravel
20							GM	@ 20′ Dark gray, saturated, medium dense, clayey to sandy gravel; rounded
			10	22			SM	@ 21.5′ Dark gray, saturated, medium dense to dense, silty sand; micaceous; massive; minor pebbles and few gravels
25			11	20 No Recovery				
			12	39				@ 26′ Gray, saturated, silty, dense, silty, fine to medium sand; micaceous; few gravels; massive
			13	36				@ 28′ Same as at 26 feet, but medium dense; occasional rounded cobbles up to 3 inches in diameter
30								

GEOTECHNICAL BORING LOG

Date July 26, 1990 Drill Hole No. B-1 Sheet 2 of 4
Project HYA/San Elijo Project No. 8891814-01
Drilling Co. A&W Type of Rig Rotary Mud
Hole Diameter ±6 in. Drive Weight 140 pounds Drop 30 in.
Elevation Top of Hole ±7' Ref. or Datum Mean Sea Level

Depth (Feet)	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density (pcf)	Moisture Content, %	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION Logged by DLL Sampled by DLL
30							SM	LAGOONAL DEPOSITS:
			14	36				@ 30' Contains no gravel or cobbles
35			15	26				
40			16	54				@ 40' Gray, saturated, dense to very dense, silty, fine to medium sand; micaceous; massive
45			17	50	No Recovery			
50			18	95/ 6"	No Recovery			
55			19	43				@ 55' Same as above
60								

GEOTECHNICAL BORING LOG

ate July 26, 1990
Drill Hole No. B-1
Sheet 3 of 4
Project HYA/San Elijo
Project No. 8891814-01
Drilling Co. A&W
Type of Rig Rotary Mud
Hole Diameter ±6 in.
Drive Weight 140 pounds
Drop 30 in.
Elevation Top of Hole +7′
Ref. or Datum Mean Sea Level

Depth (Feet)	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density (pcf)	Moisture Content, %	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION Logged by DLL Sampled by DLL
60			20	60			SM	LAGOONAL DEPOSITS: @ 60′ Same as above
65			21	30				@ 65′ Gray, saturated, medium dense to dense, silty, fine sand; micaceous; massive; contains occasional rounded cobbles up to 3 inches in diameter
70			22	57				@ 70′ Decrease in fine cobbles
								@ 74′ Scattered broken shells and gravel observed in cuttings
75								
80			23	50 No Recovery				
85			24	55 No Recovery				
90								

GEOTECHNICAL BORING LOG

Date July 26, 1990 Drill Hole No. B-1 Sheet 4 of 4
Project HYA/San Elijo Project No. 8891814-01
Drilling Co. A&W Type of Rig Rotary Mud
Hole Diameter ±6 in. Drive Weight 140 pounds Drop 30 in.
Elevation Top of Hole ±7′ Ref. or Datum Mean Sea Level

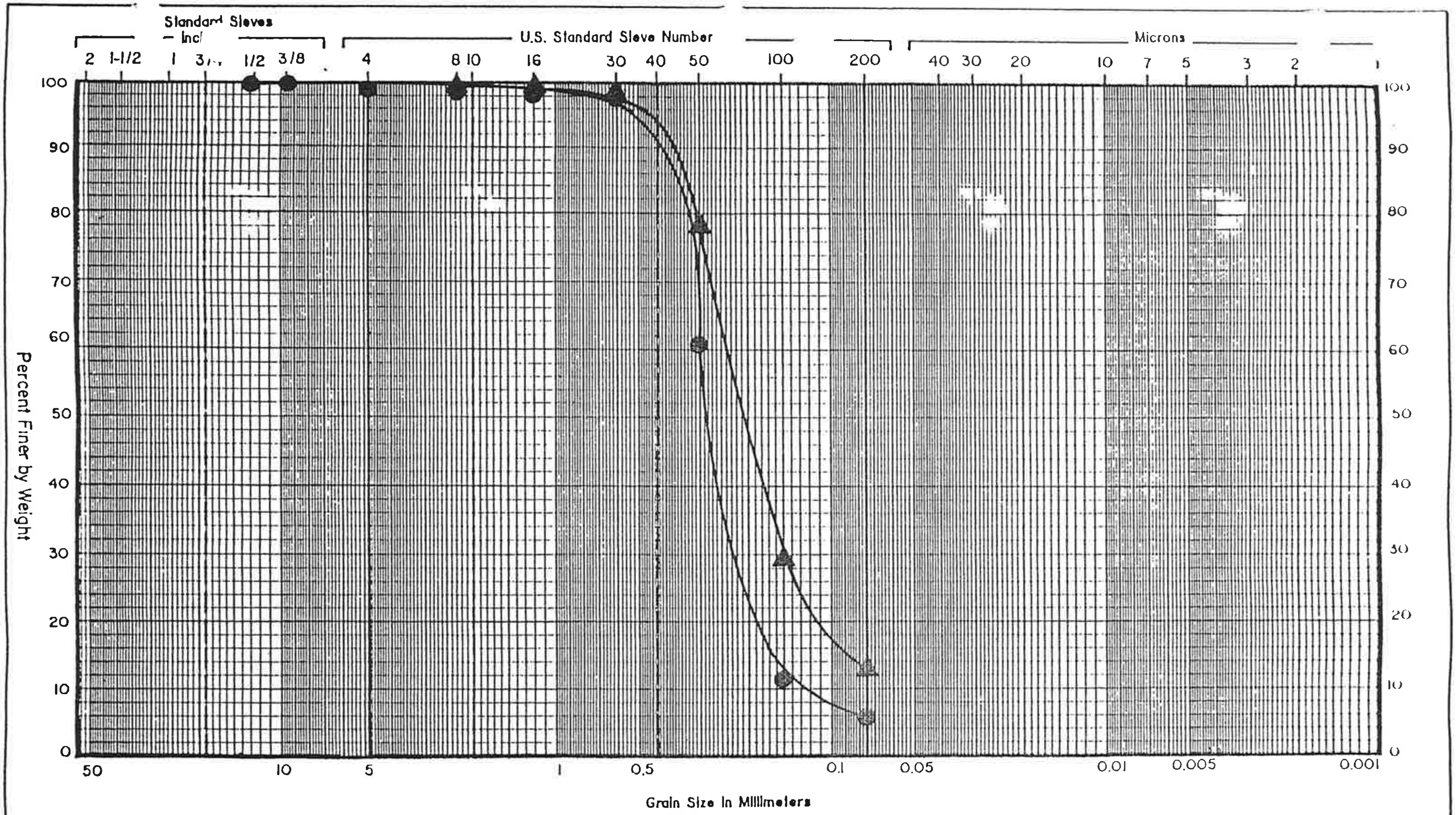
Depth (Feet)	Graphic Log	Attitudes	Tube Sample No.	Blows Per Foot	Dry Density (pcf)	Moisture Content, %	Soil Class. (U.S.C.S.)	GEOTECHNICAL DESCRIPTION Logged by DLL Sampled by DLL
90			25	135			SM	LAGOONAL DEPOSITS: @ 90′ Gray, saturated, very dense, silty, fine to medium sand; micaceous; massive; occasional shell fragments
95							SC	@ 95′ Becomes clayey, fine- to medium-grained sand
100			26	50	No Recovery		SM	@ 99′ Grades back into silty, fine- to medium-grained sand
								Total Depth = 101 Feet Ground Water Encountered at 7 Feet Backfilled 6/26/90
105								
110								
115								
120								

APPENDIX C

LABORATORY TESTING PROCEDURES AND TEST RESULTS

Moisture and Density Tests: Moisture content and dry density determinations were performed on relatively undisturbed samples obtained from the test borings and/or trenches. The results of these tests are presented in the boring and/or trench logs. Where applicable, only moisture content was determined from "undisturbed" or disturbed samples.

Classification Tests: Typical materials were subjected to mechanical grain-size analysis by wet sieving from U.S. Standard brass screens (ASTM D422). Hydrometer analyses were performed where appreciable quantities of fines were encountered. The data was evaluated in determining the classification of the materials. The grain-size distribution curves are presented in the test data and the Unified Soil Classification is presented in both the test data and the boring and/or trench logs.

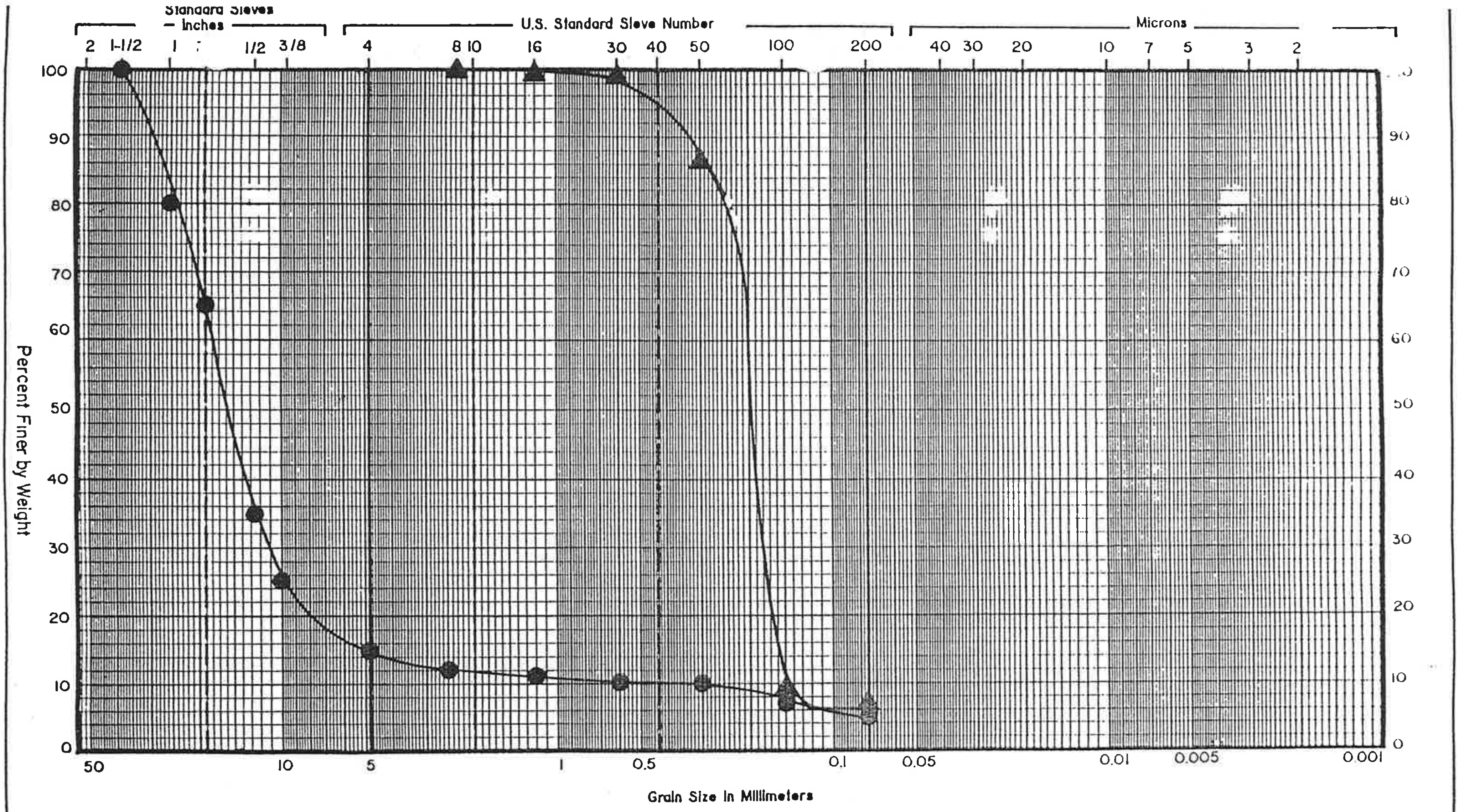


Gravel		Sand			Silt or Clay
Coarse	Fine	Coarse	Medium	Fine	

Symbol	Sample Location	Sample No.	Field Moisture (%)	LL (%)	PI (%)	Activity PI/-2u	Cu D_{60}/D_{10}	Cc $\frac{(D_{30})^2}{D_{10} \times D_{60}}$	Percent Passing No.200	Percent Passing 2u	U.S.C.S.
●	B-1	7 & 8	N/A	-	-	-	-	-	3.7	-	SP
▲	B-1	10	N/A	-	-	-	-	-	10.7	-	SM

GRADATION TEST RESULTS

Project No. 8891814-01
Project Name San Elijo Outfall
Date 8/2/90 Figure No. G 1



Gravel				Sand								Silt or Clay
Coarse		Fine		Coarse		Medium			Fine			
Symbol	Sample Location	Sample No.	Field Moisture (%)	LL (%)	PI (%)	Activity PI/-2u	Cu D_{60}/D_{10}	Cc $\frac{(D_{30})^2}{D_{10} \times D_{60}}$	Percent Passing No.200	Percent Passing 2u	U.S.C.S.	
●	B1	22	N/A	-	-	-	-	-	5.8	-	SM	
▲	B1	14	N/A	-	-	-	-	-	4.2	-	SP	

GRADATION TEST RESULTS

Project No. 8891814-01
Project Name San Elijo Outfall
Date 8/2/90 Figure No. C-2

KEY TO LOG OF BORING
(CONTINUED)

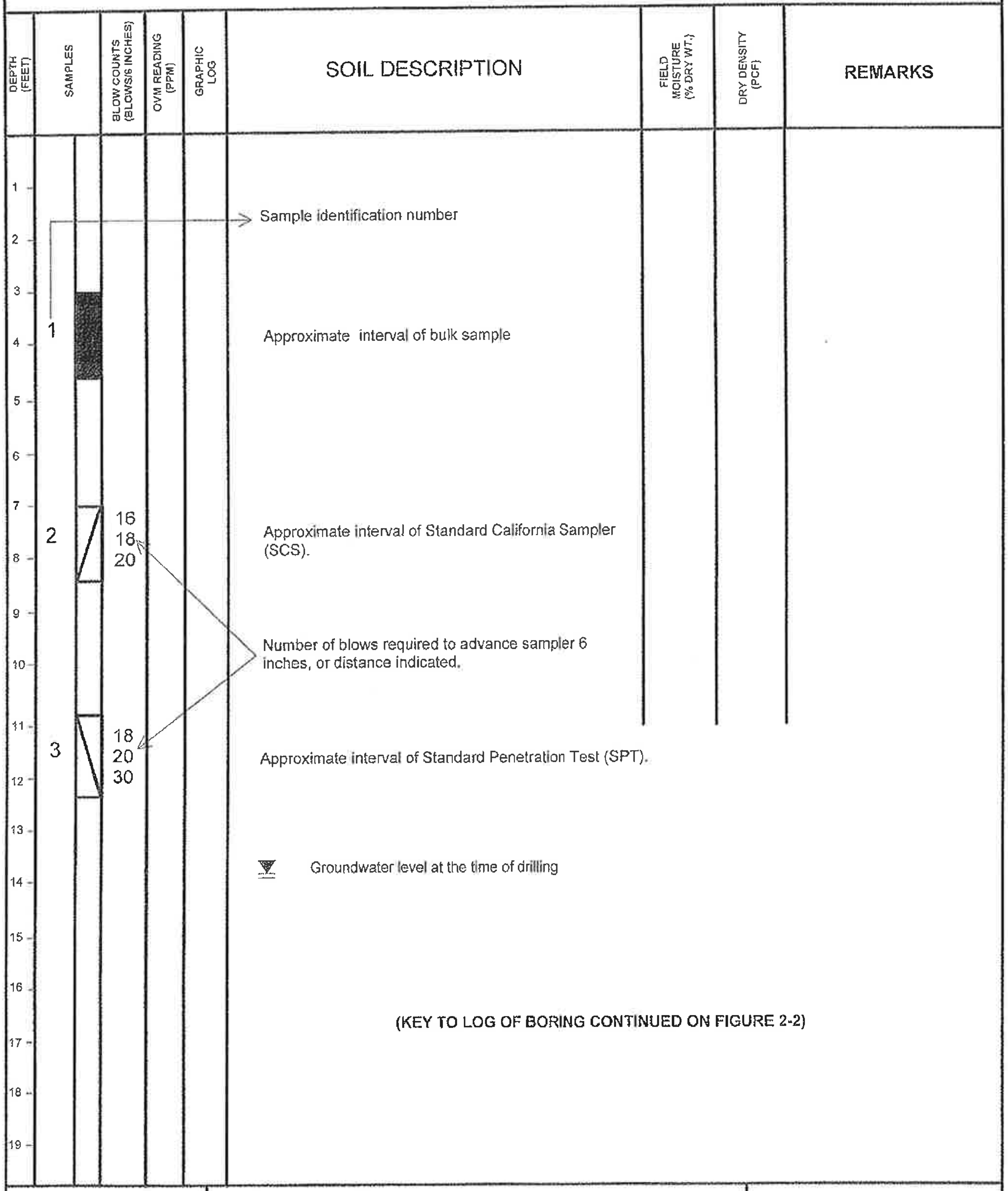
DEPTH (FEET)	SAMPLES	BLOW COUNTS (BLOWS/FOOT)	OVM READING (PPM)	GRAPHIC LOG	SOIL DESCRIPTION	FIELD MOISTURE (% DRY WT.)	DRY DENSITY (PCF)	REMARKS
1					–?– ——?– APPROXIMATE GEOLOGIC CONTACT			
2				☐	FILL			
3				⠿	SAND			
4				‖	SILT			
5				▨	CLAY			
6				△	GRAVEL/SHELL FRAGMENTS			
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								

GENERAL NOTES

1. Approximate location and elevation of the borings are based on a topographic map provided by Dudek & Associates, Inc., undated.
2. Soil descriptions are based on visual classification made during the field exploration and, where deemed appropriate, have been modified based on the results of laboratory tests.
3. Description on the boring logs apply only at the specific boring locations and at the time the borings were performed. They are not warranted to be representative of subsurface conditions at other locations or times.

PROJECT NO. 29C301	ALLIED GEOTECHNICAL ENGINEERS, INC.	FIGURE 2-2

KEY TO LOG OF BORING



Sample identification number

Approximate interval of bulk sample

Approximate interval of Standard California Sampler (SCS).

Number of blows required to advance sampler 6 inches, or distance indicated.

Approximate interval of Standard Penetration Test (SPT).

▼ Groundwater level at the time of drilling

(KEY TO LOG OF BORING CONTINUED ON FIGURE 2-2)

PROJECT NO. 29C301	ALLIED GEOTECHNICAL ENGINEERS, INC.	FIGURE 2-1

BORING NO. B-1

DATE OF DRILLING: OCTOBER 21, 2003
TOTAL BORING DEPTH: 60 FEET
GENERAL LOCATION: DRIVEWAY OF CARDIFF PUMP STATION AT 2710 MANCHESTER AVENUE
APPROXIMATE SURFACE ELEV.: +8 FEET MSL
DRILLING CONTRACTOR: WEST HAZMAT DRILLING COMPANY
DRILLING METHOD: HOLLOW-STEM AUGER
LOGGED BY: R. BLAETTLER

DEPTH (FEET)	SAMPLES	BLOW COUNTS BLOWS/FOOT	OVM READING (PPM)	GRAPHIC LOG	SOIL DESCRIPTION	FIELD MOISTURE % DRY WT.	DRY DENSITY LBS./CU. FT.	REMARKS
					PAVEMENT SECTION: 3" A.C. and 9" misc. base			
1								
2					**FILL**			
3					Pale red brown, very moist, firm fine to medium sandy clay (CL)			
4								
5					Light yellow brown, very moist, medium dense silty fine sand (SM)			
6								
7								
8					Light gray brown, very moist, soft to firm fine to medium sandy clay (CL)			
9			?		? ?			?
10								
11	1	50	0		**DEL MAR FORMATION**	14.6		
12					Pale red, damp, hard bedded siltstone (ML) with some thin, fine grained sandstone (SM) interbeds			
13								
14								
15								
16	2	100+	0		Color becomes light grayish yellow	13.7	122.5	
17	3							
18								
19								
20								
21	4	100+	0		Pale yellow, moist, very dense fine grained sandstone (SM)	12.2		
22								
23								
24								
25	5	100+	0		Pale yellow, moist, very dense fine grained sandstone (SM) with medium grained sandstone (SW) interbeds	13.4	115.5	
26								
27								
28								
29								
30	6	100+	0		Light yellowish gray, wet, very dense fine grained sandstone (SM)	17.7		
31								
32								
33								
34					▼			

PROJECT NO.
29C301

ALLIED GEOTECHNICAL ENGINEERS, INC.

FIGURE 3-1

BORING NO. B-1 (Continued)

DEPTH (FEET)	SAMPLES	BLOW COUNTS BLOWS/FOOT	OVM READING (PPM)	GRAPHIC LOG	SOIL DESCRIPTION	FIELD MOISTURE % DRY WT.	DRY DENSITY LBS./CU. FT.	REMARKS
	7	100+	0		**DEL MAR FORMATION** Light yellow gray, wet, very dense fine to medium grained sandstone (SM) with some coarse beds (SC)	16.4	116.9	Est. quartz content is 90%; consisting of subangular to angular particles.
40	8	100+	0		Dark gray, wet, very dense interbedded fine grained sandstone (SM) and siltstone (ML)	24.2		
45	9	100+	0		Yellow gray, wet, very dense sandy\ mudstone (SC)	14.0	123.2	
50	10	100+	0		Gray, wet, very dense fine grained sandstone (SM) with some thin siltstone (ML) interbeds	18.8		
55	11	100+	0		Dark gray, wet, very dense to hard interbedded fine grained sandstone (SM) and siltstone (ML)	17.8	111.8	
60	12	100+	0		Yellow, wet, very dense fine grained sandstone (SM)	25.9		Est. quartz content is 90%; consisting of subangular to angular particles.

NOTES:

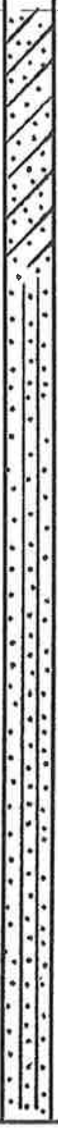
Bottom of borehole at 60 feet.

Seepage was observed at depth of 35 feet below ground surface (BGS). The depth (elevation) of the groundwater table beneath the project site is unknown but may be assumed to be close to the elevation of the water surface in San Elijo Lagoon which is estimated to be on the order of 8 to 9 feet BGS. The low permeability characteristics of the formational materials may explain why seepage was not observed until a depth of 35 feet BGS.

PROJECT NO. 29C301	**ALLIED GEOTECHNICAL ENGINEERS, INC.**	**FIGURE 3-2**

BORING NO. B-2a

DATE OF DRILLING: OCTOBER 21, 2003
TOTAL BORING DEPTH: 30 FEET
GENERAL LOCATION: EAST SHOULDER OF DIRT ACCESS ROAD AT APPROXIMATE STATION 31+00 OF THE SOLANA BEACH FORCEMAIN
APPROXIMATE SURFACE ELEV.: +2 FEET MSL
DRILLING CONTRACTOR: WEST HAZMAT DRILLING COMPANY
DRILLING METHOD: HOLLOW-STEM AUGER
LOGGED BY: R. BLAETTLER



DEPTH (FEET)	SAMPLES	BLOW COUNTS BLOWS/FOOT	OVM READING (PPM)	GRAPHIC LOG	SOIL DESCRIPTION	FIELD MOISTURE % DRY WT.	DRY DENSITY LBS/CU. FT.	REMARKS
1					**FILL** Medium sized crushed rocks up to 8 inches in size with sandy clay (CL) and silty sand (SM) infill			
2			?		▼ ? ?			?
3					**ESTUARY DEPOSITS**			
4					Dark gray, wet, soft fine sandy clay (CL)			
5								
6								
7								
8								
9								
10	1	50	0		Gray, wet, medium dense silty fine sand (SM)			No sample recovery
11								
12								
13								
14								
15								
16	2	35	0					
17								
18								
19								
20								
21	3	16	0					
22								
23								
24								
25								
26	4	30	0					
27								
28								
29								
30								

NOTES:

Boring terminated at depth of 30 feet below ground surface due to heavy sanding inside the auger.

Water was encountered at a depth of 2 feet below ground surface.

PROJECT NO. 29C301

ALLIED GEOTECHNICAL ENGINEERS, INC.

FIGURE 4

BORING NO. B-2b

DATE OF DRILLING: NOVEMBER 3, 2003
TOTAL BORING DEPTH: 61 FEET
GENERAL LOCATION: EAST SHOULDER OF DIRT ACCESS ROAD AT APPROXIMATE STATION 31+00 OF THE SOLANA BEACH FORCEMAIN
APPROXIMATE SURFACE ELEV.: +2 FEET MSL
DRILLING CONTRACTOR: WEST HAZMAT DRILLING COMPANY
DRILLING METHOD: MUD ROTARY
LOGGED BY: R. BLAETTLER

DEPTH (FEET)	SAMPLES	BLOW COUNTS BLOWS/FOOT	OVM READING (PPM)	GRAPHIC LOG	SOIL DESCRIPTION	FIELD MOISTURE % DRY WT.	DRY DENSITY LBS./CU. FT.	REMARKS
1					**FILL** Medium sized crushed rocks up to 8 inches in dimension with sandy clay (CL) and silty sand (SM) infill			
2			?		▼ ? ?			?
3					**ESTUARY DEPOSITS**			
4					Gray, wet, medium dense silty fine to medium sand (SM)			
5								
6	1	37	0			25.9		
7								
8								
9								
10								
11	2	60	0		Gray, wet, dense silty fine sand (SM) with approximately 30% to 50% small shell fragments (less than 1/4")	23.5		
12								
13								
14								
15								
16	3	46	0			26.9	96.4	
17								
18								
19					Gravel layer or shell bed encountered between 18 and 19 feet			
20								
21	4	46	0		Gray, wet, dense silty fine sand (SM)	28.3		
22								
23								
24								
25	5	100+	0			23.2	103.2	
26					Gray, wet, dense, silty fine sand (SM) with approximately 30% to 50 % small shell fragments (less than 1/4")			
27								
28								
29								
30								
31	6	93	0		Gray, wet, very dense silty fine sand (SM)	25.2		Est. quartz content is 80%; consisting of subangular to subrounded particles.
32								
33								
34								

PROJECT NO.
29C301

ALLIED GEOTECHNICAL ENGINEERS, INC.

FIGURE 5-1

BORING NO. B-2b (Continued)

DEPTH (FEET)	SAMPLES	BLOW COUNTS BLOWS/FOOT	OVM READING (PPM)	GRAPHIC LOG	SOIL DESCRIPTION	FIELD MOISTURE % DRY WT.	DRY DENSITY LBS./CU. FT.	REMARKS
36					**ESTUARY DEPOSITS**			
37					Gray, wet, very dense silty sand (SM)			
38								
39								
40								
41	8	100+	0			22.7		
42								
43								
44								
45	9	100+	0			27.1	96.9	
46								
47								
48								
49								
50	10	100+	0			24.6		
51								
52								
53								
54								
55	11	100+	0			25.6	99.3	
56								
57								
58								
59					Gray, wet, very dense silty sand (SM) 50% to 70% shell fragments between #4 and #40 sieves. Negligible shell fragments observed in materials passing the #40 sieve.			Est. quartz content is 80%; consisting of subangular to subrounded particles.
60	12	100+	0			21.2		
61								

NOTES:

Bottom of borehole at 61 feet.

Water was encountered at a depth of 2 feet below ground surface.

BORING NO. B-3

DATE OF DRILLING: MARCH 6, 2006
TOTAL BORING DEPTH: 42 FEET
GENERAL LOCATION: SEJPA FACILITY; APPROXIMATE STATION 10+50
APPROXIMATE SURFACE ELEV.: +25 FEET MSL
DRILLING CONTRACTOR: TESTAMERICA DRILLING CORP.
DRILLING METHOD: HSA TO 42'
LOGGED BY: S. SUTANTO

DEPTH (FEET)	SAMPLES	BLOW COUNTS BLOWS/FOOT	OVM READING (PPM)	GRAPHIC LOG	SOIL DESCRIPTION	FIELD MOISTURE % DRY WT.	DRY DENSITY LBS./CU. FT.	REMARKS
1					FILL			Note:
2					Yellowish brown to reddish brown, moist to wet, silty sand (SM) with occasional small pieces of asphaltic concrete			The upper 10 feet was excavated manually with a hand auger
3								
4								
5					▼			
6								
7								
8								
9								
10					Dark gray to yellowish gray, wet, medium dense silty to clayey sand (SM-SC)			
11	1	6 7 9	0			21.4		
12								
13								
14								
15	2	11 13	0			23.8	99.8	
16								
17								
18								
19								
20	3	10 11 11	0		Light gray, wet, medium dense, silty very fine to fine sand (SM) with traces of clay binder	19.0		
21								
22								
23								
24	4	6 8	0			34.2	95.0	
25					Light gray to gray, wet, stiff sandy clay (CL)			Liquid Limit = 41 Plastic Limit = 21 Plastic Index = 20 Expansion Index = 83
26								
27								
28								
29								
30	5	6 10 11	0		Dark gray, wet, very stiff sandy clay (CL) with small chunks of yellowish brown sandstone	54.5		Liquid Limit = 48 Plastic Limit = 26 Plastic Index = 22
31								
32								
33								
34								

Continue on Figure 6-2

PROJECT NO.
29C301

ALLIED GEOTECHNICAL ENGINEERS, INC.

FIGURE 6-1

BORING NO. B-3 (Continued)

DEPTH (FEET)	SAMPLES	BLOW COUNTS BLOWS/FOOT	OVM READING (PPM)	GRAPHIC LOG	SOIL DESCRIPTION	FIELD MOISTURE % DRY WT.	DRY DENSITY LBS./CU. FT.	REMARKS
36 37	6	10 11	0		FILL Dark gray, wet, very stiff sandy silt (ML) with some organic matter	23.2	92.3	Liquid Limit = NP Plastic Limit = NP Plastic Index = NP NP - Non-plastic
38			?		? ?			?
39 40 41 42	7	10 20 28	0		DEL MAR FORMATION Light gray, wet, very dense silty to clayey very fine to fine sand (SM-SC)	28.8		

NOTES:

Bottom of borehole at 42 feet.

Water level measured at an approximate depth of 5 feet bgs upon completion of the drilling and sampling activities.

PROJECT NO. 29C301

ALLIED GEOTECHNICAL ENGINEERS, INC.

FIGURE 6-2

APPENDIX A

GEOTECHNICAL LABORATORY TEST RESULTS

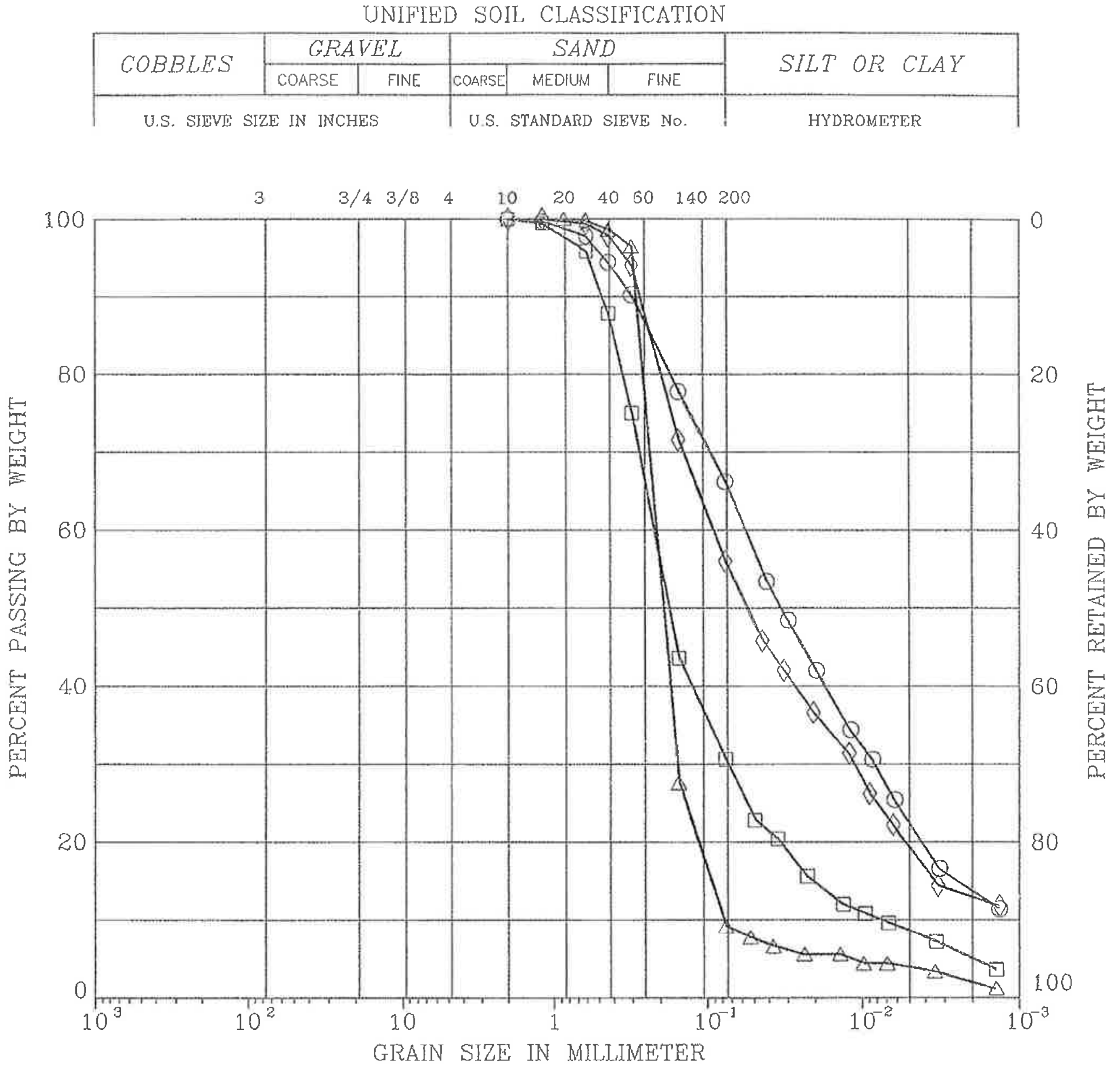
APPENDIX A

GEOTECHNICAL LABORATORY TEST RESULTS

TABLE A-1

UNCONFINED COMPRESSIVE STRENGTH

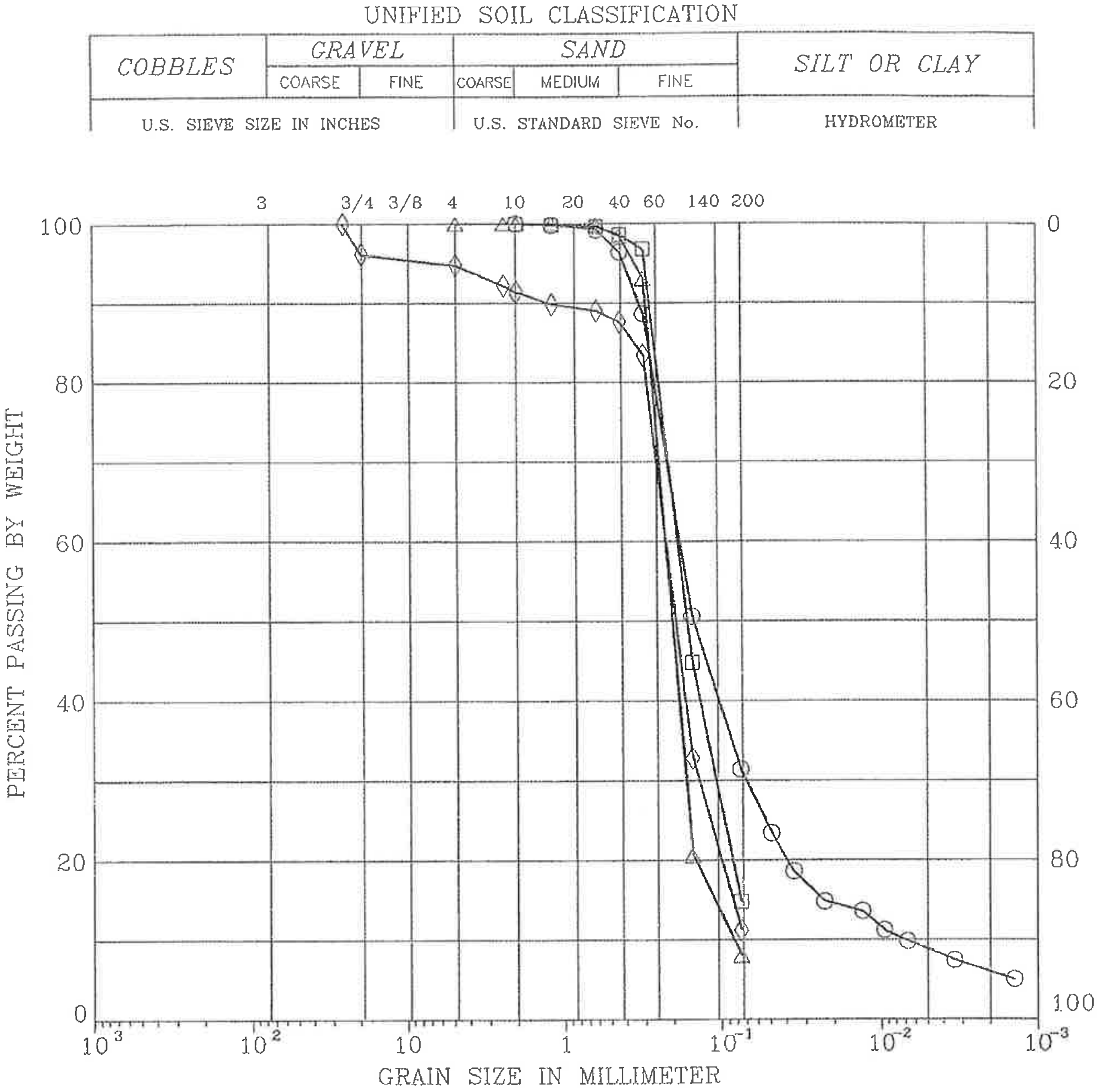
SAMPLE NO.	DEPTH (feet)	STRENGTH INTERCEPT (C) (ksf)	FRICTION ANGLE (degree)	UNCONFINED COMPRESSIVE STRENGTH (ksf)
1-2	16	0.75	35	1.6
1-9	45	0.34	50	0.7
1-11	55	0.73	34	1.6



SYMBOL	BORING	DEPTH (ft)	LL (%)	PI (%)	DESCRIPTION
○	1-2	15-16	45	27	SANDY CLAY (CL)
□	1-4	20-21			SILTY SAND (SM)
△	1-8	40-41			POORLY-GRADED SAND (SP)
◇	1-10	50-51	31	19	SANDY CLAY (CL)

Remark : No shell fragments in samples

Project No. 29C3	SOLANA BEACH FORCE MAIN
ALLIED GEOTECHNICAL ENGINEERS, INC.	GRAIN SIZE DISTRIBUTION Figure A-1



SYMBOL	BORING	DEPTH (ft)	LL (%)	PI (%)	DESCRIPTION
○	1-12	60-61			SILTY SAND (SM)
□	2b-8	40-41.5			SILTY, CLAYEY SAND (SM)
△	2b-10	50-51			POORLY-GRADED SAND (SP)
◇	2b-12	60-61			POORLY-GRADED SAND (SP)

Remark : 20 to 70% shell fragments in B-2b samples

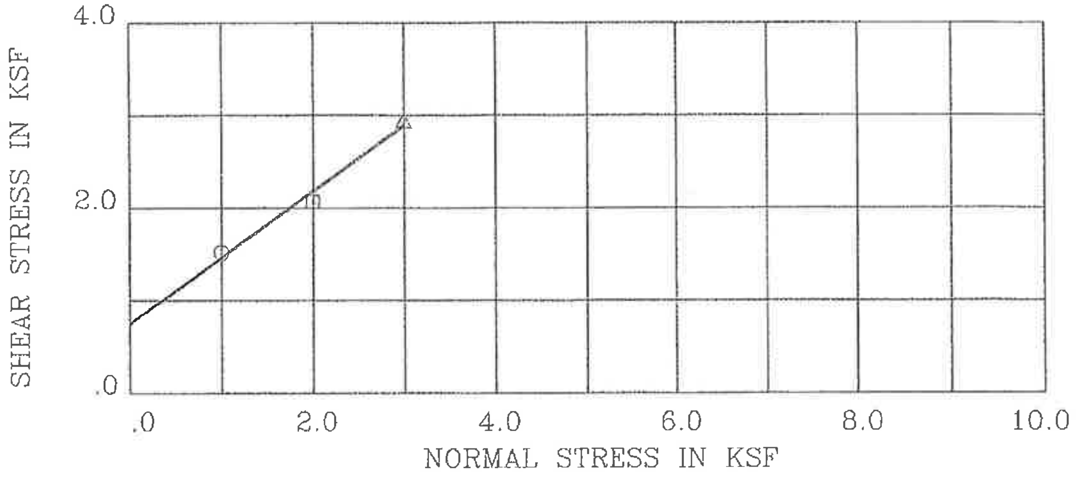
Project No. 29C3

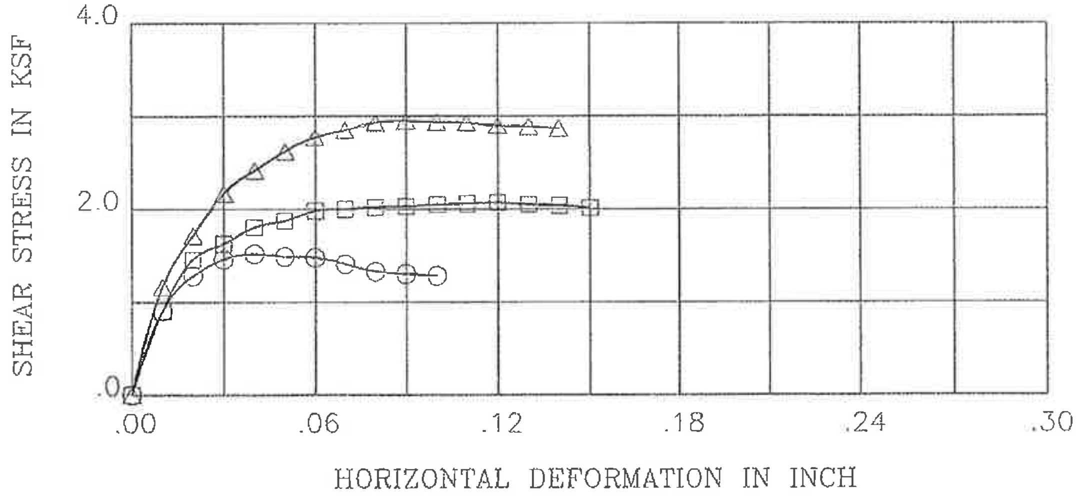
SOLANA BEACH FORCE MAIN

ALLIED GEOTECHNICAL ENGINEERS, INC.

GRAIN SIZE DISTRIBUTION

Figure A-2



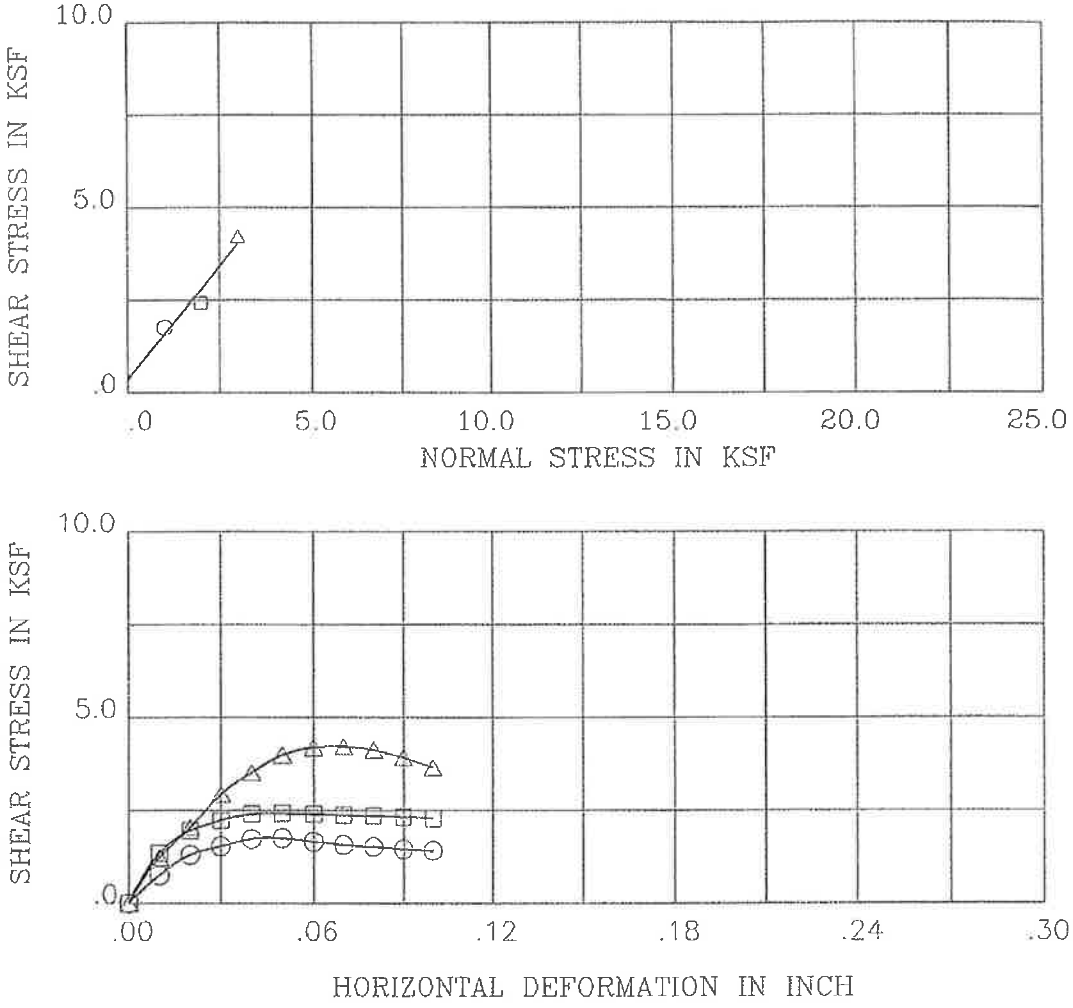


BORING/SAMPLE : 1-2 DEPTH (ft) : 15-16
DESCRIPTION : GRAY CLAYSTONE (CH)
STRENGTH INTERCEPT (C) : .749 KSF
FRICTION ANGLE (PHI) : 35.5 DEG
(PEAK STRENGTH)

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	VOID RATIO	NORMAL STRESS (ksf)	PEAK SHEAR (ksf)	RESIDUAL SHEAR (ksf)
○	14.7	118.7	.419	1.00	1.52	1.28
□	12.2	123.9	.359	2.00	2.07	2.01
△	14.1	124.8	.350	3.00	2.95	2.87

Remark :

Project No. 29C3	SOLANA BEACH FORCE MAIN
ALLIED GEOTECHNICAL ENGINEERS, INC.	DIRECT SHEAR TEST Figure A-3



BORING/SAMPLE : 1-9 DEPTH (ft) : 45-46

DESCRIPTION : GRAY CLAYSTONE (CH)

STRENGTH INTERCEPT (C) : .340 KSF

FRICTION ANGLE (PHI) : 50.8 DEG

(PEAK STRENGTH)

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	VOID RATIO	NORMAL STRESS (ksf)	PEAK SHEAR (ksf)	RESIDUAL SHEAR (ksf)
○	13.1	127.2	.324	1.00	1.76	1.41
□	15.9	120.5	.398	2.00	2.42	2.29
△	13.0	121.9	.382	3.00	4.21	3.65

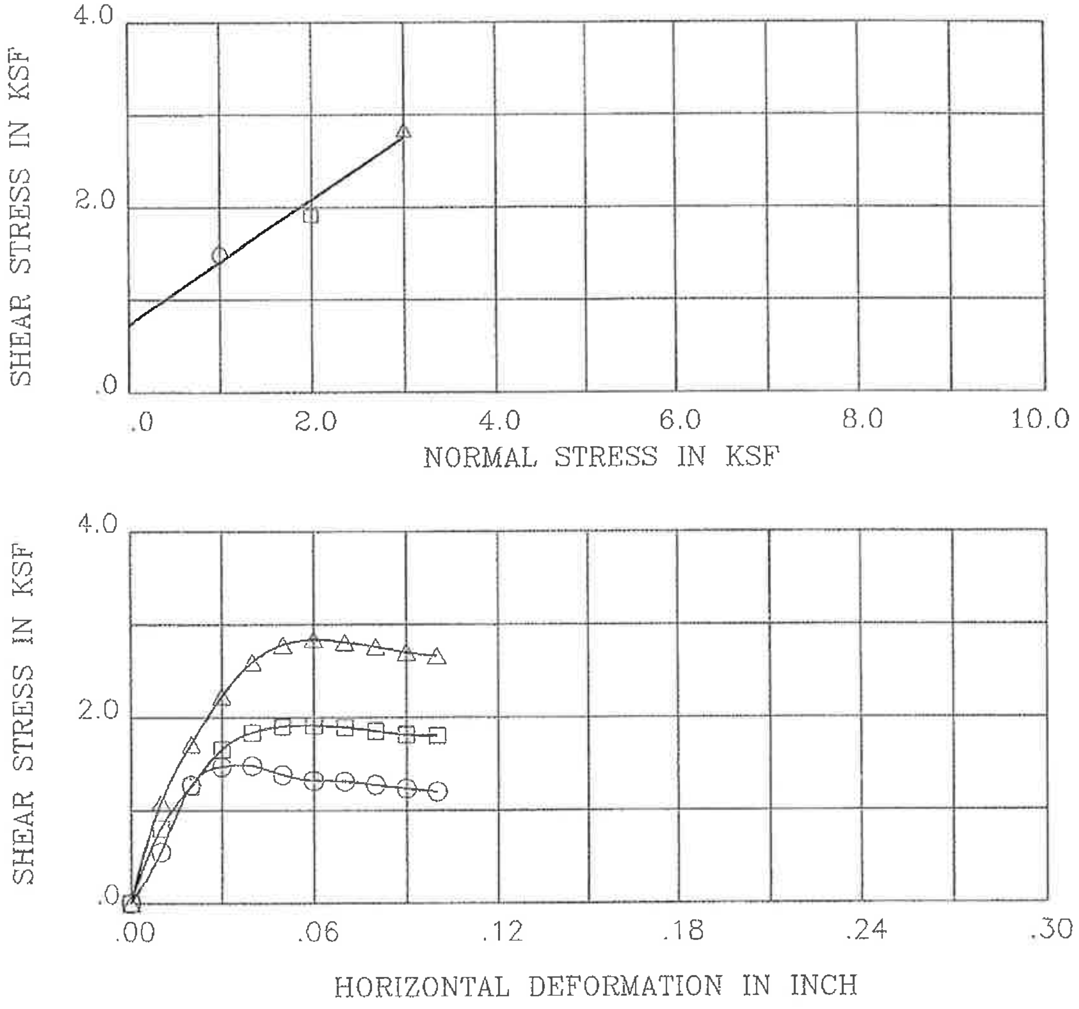
Remark :

Project No. 29C3

SOLANA BEACH FORCE MAIN

ALLIED GEOTECHNICAL
ENGINEERS, INC.

DIRECT SHEAR TEST Figure A-4



BORING/SAMPLE : 1-11 DEPTH (ft) : 55-56

DESCRIPTION : GRAY SANDSTONE (SM)

STRENGTH INTERCEPT (C) : .727 KSF

FRICTION ANGLE (PHI) : 34.1 DEG

(PEAK STRENGTH)

SYMBOL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	VOID RATIO	NORMAL STRESS (ksf)	PEAK SHEAR (ksf)	RESIDUAL SHEAR (ksf)
○	18.4	110.8	.521	1.00	1.49	1.20
□	18.1	110.8	.520	2.00	1.91	1.80
△	17.5	112.7	.495	3.00	2.84	2.66

Remark :

Project No. 29C3	SOLANA BEACH FORCE MAIN
ALLIED GEOTECHNICAL ENGINEERS, INC.	DIRECT SHEAR TEST Figure A-5

DATE DRILLED 10/29/11 BORING NO. B-8

GROUND ELEVATION 20'± (MSL) SHEET 1 OF 3

METHOD OF DRILLING 4" Sonic Boring (Cascade Drilling)

DRIVE WEIGHT N/A DROP N/A

SAMPLED BY RDH LOGGED BY RDH REVIEWED BY JG

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							CL+SM	FILL: Brown and gray, damp, loose, silty SAND and sandy CLAY; some gravel.
							CL/SC	Interlayered brown and gray, moist to wet, stiff, sandy CLAY and medium dense, clayey SAND.
10								
								@ 17' to 27': 5% recovery. Sandy clay with gravel.
20								
				▽				
							SM/SP	ALLUVIUM: Gray, saturated, medium dense, silty fine SAND.
							ML/SM	Interbedded gray, saturated, medium dense, sandy SILT and silty SAND.
							SP-SM	Gray, saturated, medium dense, poorly graded fine SAND with silt.
30	■							
							SM/ML	Interbedded gray, saturated, medium dense, silty SAND and sandy SILT.
40								

BORING LOG

SAN ELIJO LAGOON DOUBLE TRACK PROJECT
ENCINITAS AND SOLANA BEACH, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105991023	9/14	A-12

DATE DRILLED 10/29/11 BORING NO. B-8

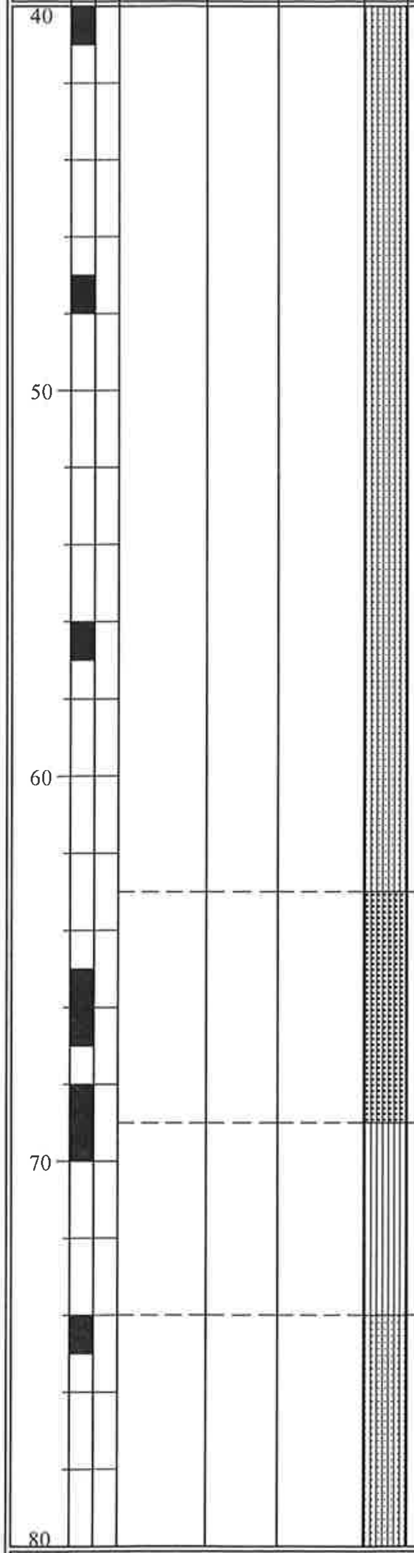
GROUND ELEVATION 20'± (MSL) SHEET 2 OF 3

METHOD OF DRILLING 4" Sonic Boring (Cascade Drilling)

DRIVE WEIGHT N/A DROP N/A

SAMPLED BY RDH LOGGED BY RDH REVIEWED BY JG

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION



SP-SM

ALLUVIUM: (Continued)
Gray, saturated, medium dense, slightly silty to silty, fine SAND; cohesionless; slightly micaceous.

Loose to medium dense; trace to slightly silty; cohesionless.

SM

Gray, saturated, loose to medium dense, silty fine SAND; cohesionless.

ML

Gray, saturated, soft, clayey SILT; shell fragments.

SM/SP

Gray, saturated, medium dense, slightly silty SAND; cohesionless.

Ninyo & Moore

BORING LOG

SAN ELIJO LAGOON DOUBLE TRACK PROJECT
ENCINITAS AND SOLANA BEACH, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105991023	9/14	A-13

DATE DRILLED 10/29/11 BORING NO. B-8

GROUND ELEVATION 20'± (MSL) SHEET 3 OF 3

METHOD OF DRILLING 4" Sonic Boring (Cascade Drilling)

DRIVE WEIGHT N/A DROP N/A

SAMPLED BY RDH LOGGED BY RDH REVIEWED BY JG

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
80							SM	<u>ALLUVIUM</u>: (Continued) Gray, saturated, medium dense, silty fine SAND.
								Moderately silty; small shell fragments.
							SP	Gray, saturated, medium dense, fine SAND; trace to slightly silty.
90								
								<u>DEL MAR FORMATION</u>: Sharp contact to mottled olive and gray, and brown, saturated, weakly indurated, silty CLAYSTONE.
								Dark gray, saturated, weakly cemented, silty, fine-grained SANDSTONE.
100								
								Olive brown, saturated, weakly indurated, silty CLAYSTONE.
								Gray and brown mottled, saturated, weakly cemented, silty, fine-grained SANDSTONE; trace clay.
								Less silty; finely bedded.
								Total Depth = 107 feet. Groundwater encountered at approximately 23 feet at time of drilling. Backfilled with 9 cubic feet of bentonite grout on 10/30/11.
110								<u>Note</u>: Groundwater may rise to a level higher than that measured in the borehole due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
120								

Ninyo & Moore

BORING LOG

SAN ELIJO LAGOON DOUBLE TRACK PROJECT
ENCINITAS AND SOLANA BEACH, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105991023	9/14	A-14

DATE DRILLED 10/31/11 BORING NO. B-10

GROUND ELEVATION 5'± (MSL) SHEET 1 OF 4

METHOD OF DRILLING 4" Sonic Boring (Cascade Drilling)

DRIVE WEIGHT N/A DROP N/A

SAMPLED BY RDH/NMM LOGGED BY RDH/ REVIEWED BY JG

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0				▽			SM CL	ALLUVIUM: Dark gray, saturated, loose, silty fine SAND. Gray, saturated, soft, silty CLAY.
							SM	Gray, saturated, loose, silty fine SAND; trace clay.
	■							Less clay; cohesionless. No bedding/lamination.
10								Trace shell fragments from 10' to 14'.
	■							
							SP	Gray, saturated, loose, silty fine, poorly graded SAND.
20								
								One gravel (rounded, 2.5 inch diameter).
	■							Medium dense.
30								
	■							
							SM	Gray, saturated, medium dense, silty fine SAND.
40								

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BORING LOG

SAN ELIJO LAGOON DOUBLE TRACK PROJECT
ENCINITAS AND SOLANA BEACH, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105991023	9/14	A-15

DATE DRILLED 10/31/11 BORING NO. B-10

GROUND ELEVATION 5'± (MSL) SHEET 2 OF 4

METHOD OF DRILLING 4" Sonic Boring (Cascade Drilling)

DRIVE WEIGHT N/A DROP N/A

SAMPLED BY RDH/NMM LOGGED BY RDH/ REVIEWED BY JG

DEPTH (feet)	SAMPLES Bulk / Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
40						SM	<u>ALLUVIUM</u>: (Continued) Gray, saturated, medium dense, silty fine SAND.
							Trace shell fragments from 45' to 48'.
50							
							Trace shell pieces up to 1 inch diameter.
60							Trace shell fragments.
							Poorly sorted.
							Trace shell fragments.
70							
						ML	Gray, saturated, stiff, SILT; trace fine sand; trace shell fragments.
						ML-SM	Interbedded gray, saturated, medium dense, silty fine SAND and sandy SILT; trace shell fragments.
80							

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BORING LOG

SAN ELIJO LAGOON DOUBLE TRACK PROJECT
ENCINITAS AND SOLANA BEACH, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105991023	9/14	A-16

DATE DRILLED 10/31/11 BORING NO. B-10

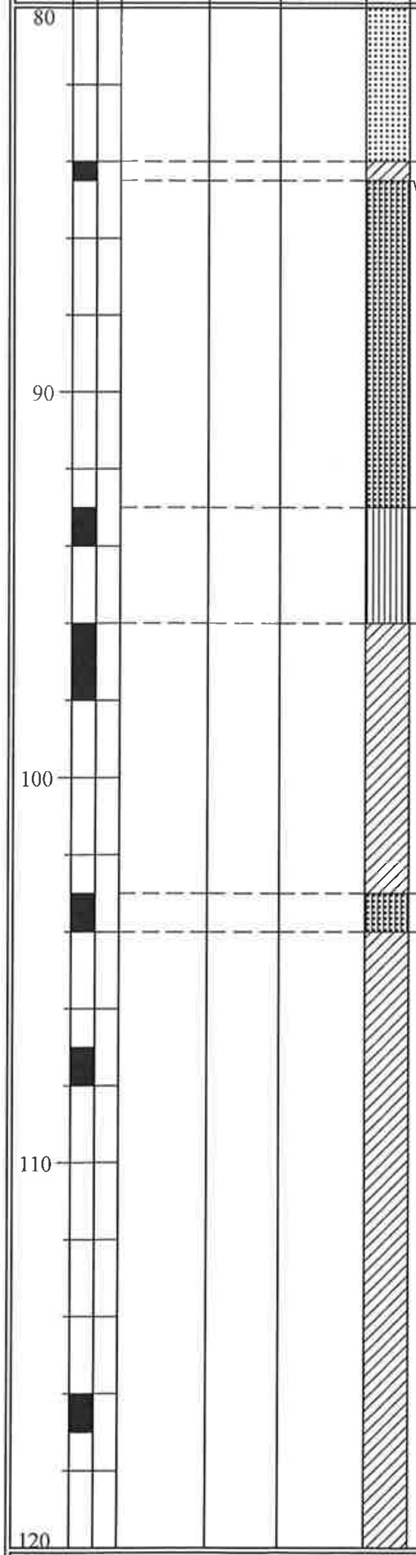
GROUND ELEVATION 5'± (MSL) SHEET 3 OF 4

METHOD OF DRILLING 4" Sonic Boring (Cascade Drilling)

DRIVE WEIGHT N/A DROP N/A

SAMPLED BY RDH/NMM LOGGED BY RDH/ REVIEWED BY JG

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION



ALLUVIUM: (Continued)
Gray, saturated, dense, silty SAND; shell fragments.

Very silty sand; cohesive.

CL — Gray, saturated, very stiff, CLAY; finely laminated.

SM — Gray, saturated, dense, silty fine SAND; shell fragments; cohesionless.

Medium dense; trace shell fragments; cohesionless.

ML — Gray, saturated, stiff, SILT; trace shell pieces; fine sand interbeds.

CL — Gray, saturated, stiff CLAY; finely laminated; silty interbeds; organic odor; trace shell fragments.

@ 98' to 108': 50% recovery.

SM — Gray, saturated, medium dense, silty fine, SAND; cohesionless.

CL — Gray, saturated, stiff CLAY; finely laminated; organic odor; trace shell fragments; trace fine sand.

Interbedded silts; micaceous.

1-inch thick fine silty sand.
Approximately 85% recovery.
Micaceous; organic odor.

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BORING LOG

SAN ELIJO LAGOON DOUBLE TRACK PROJECT
ENCINITAS AND SOLANA BEACH, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105991023	9/14	A-17

DATE DRILLED 10/31/11 BORING NO. B-10

GROUND ELEVATION 5'± (MSL) SHEET 4 OF 4

METHOD OF DRILLING 4" Sonic Boring (Cascade Drilling)

DRIVE WEIGHT N/A DROP N/A

SAMPLED BY RDH/NMM LOGGED BY RDH/ REVIEWED BY JG

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
120						▨	CL	<u>ALLUVIUM (Continued)</u>: Gray, saturated, stiff CLAY; trace shell fragments; trace fine sand; organic odor.
	■					▨		
	■					▦	SM	Gray, saturated, medium dense, silty fine SAND; clay interbeds; trace shell fragments.
								Total Depth = 128 Feet. Groundwater encountered at surface during drilling. Backfilled with 11 cubic feet of bentonite grout on 10/31/11. <u>Note</u>: Groundwater may rise to a level higher than that measured in borehole due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
130								
140								
150								
160								

Ninyo & Moore

BORING LOG

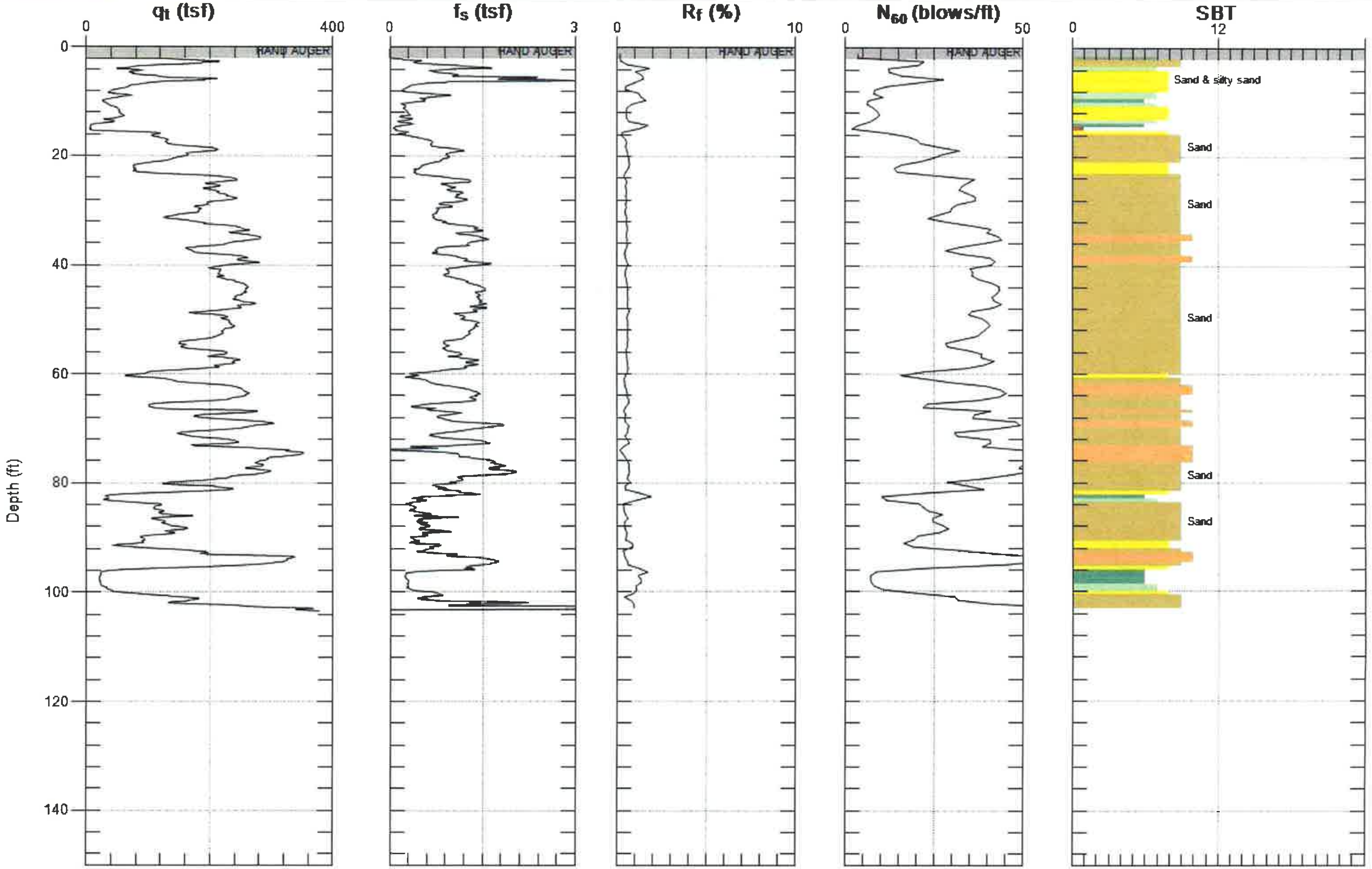
SAN ELIJO LAGOON DOUBLE TRACK PROJECT
ENCINITAS AND SOLANA BEACH, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105991023	9/14	A-18

NINYO & MOORE

Site: SAN ELIJO LAGOON
Sounding: CPT-5

Engineer: R.HALLUM
Date: 9/30/2011 12:59



Max. Depth: 103.346 (ft)
Avg. Interval: 0.656 (ft)

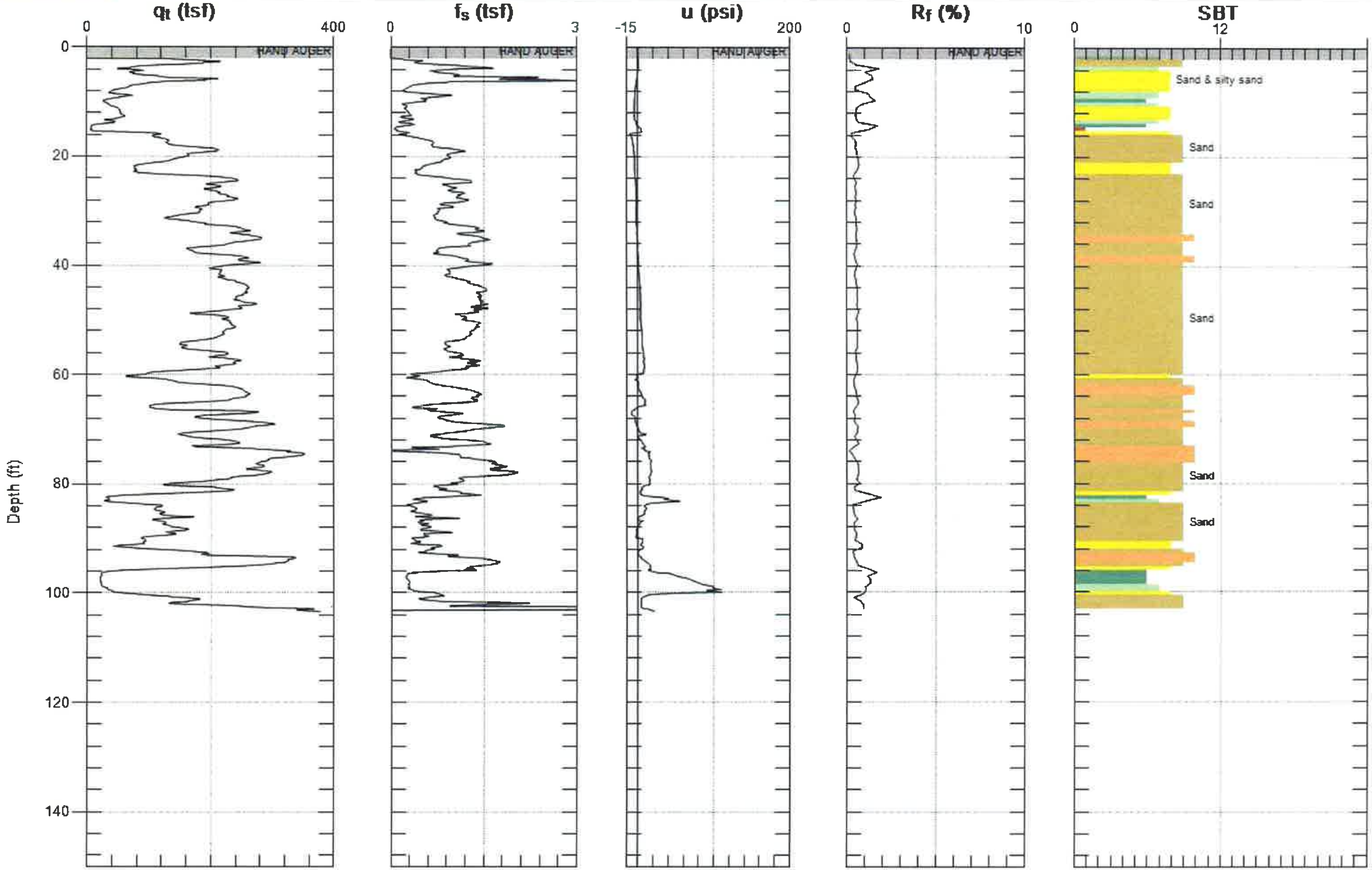
SBT: Soil Behavior Type (Robertson 1990)

GREGG

NINYO & MOORE

Site: SAN ELIJO LAGOON
Sounding: CPT-5

Engineer: R.HALLUM
Date: 9/30/2011 12:59



Max. Depth: 103.346 (ft)
Avg. Interval: 0.656 (ft)

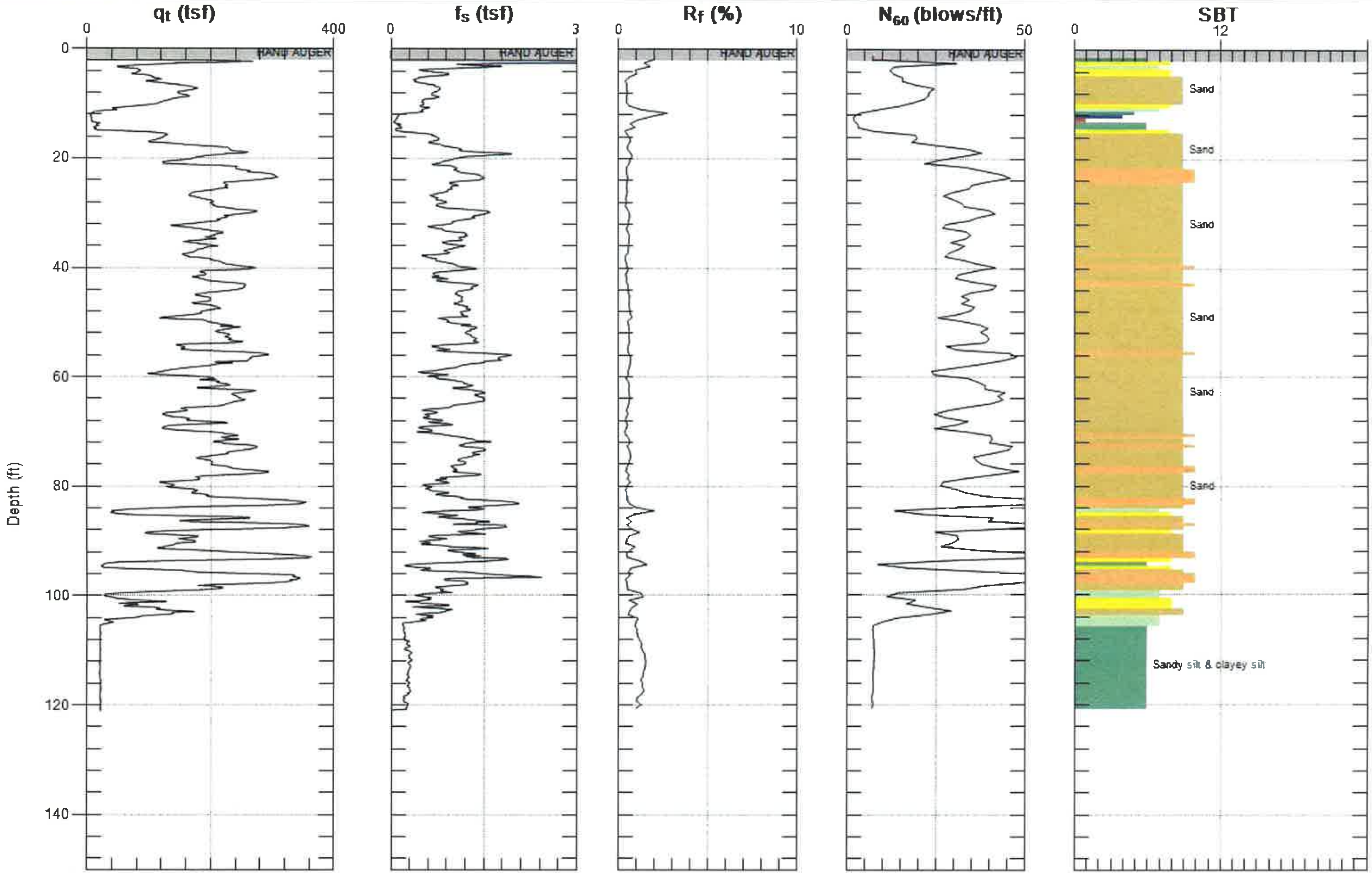
SBT: Soil Behavior Type (Robertson 1990)

GREGG

NINYO & MOORE

Site: SAN ELIJO LAGOON
Sounding: CPT-6

Engineer: R.HALLUM
Date: 9/30/2011 02:02



Max. Depth: 121.063 (ft)
Avg. Interval: 0.656 (ft)

SBT: Soil Behavior Type (Robertson 1990)

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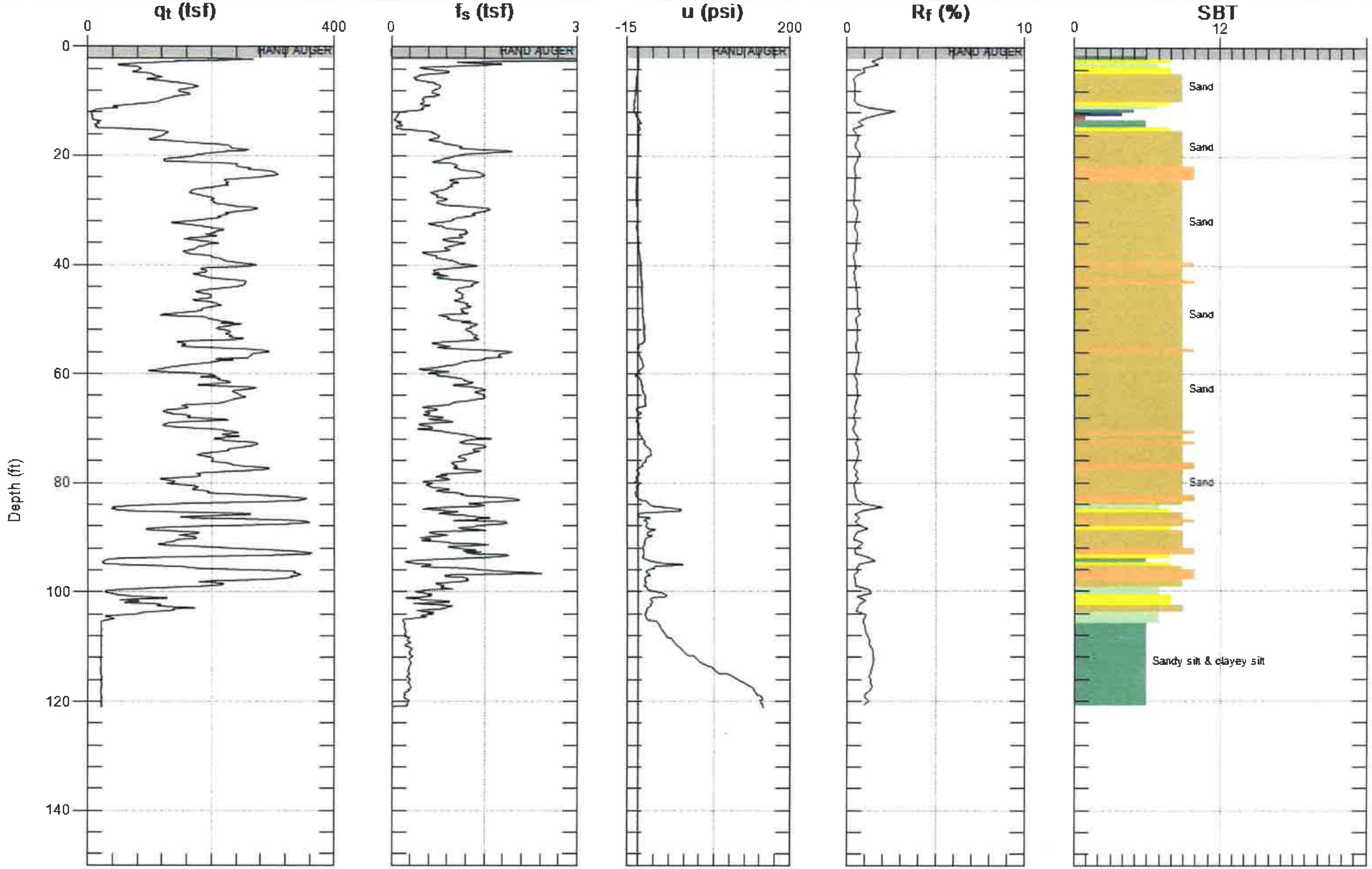


Max. Depth: 121.063 (ft)
Avg. Interval: 0.656 (ft)

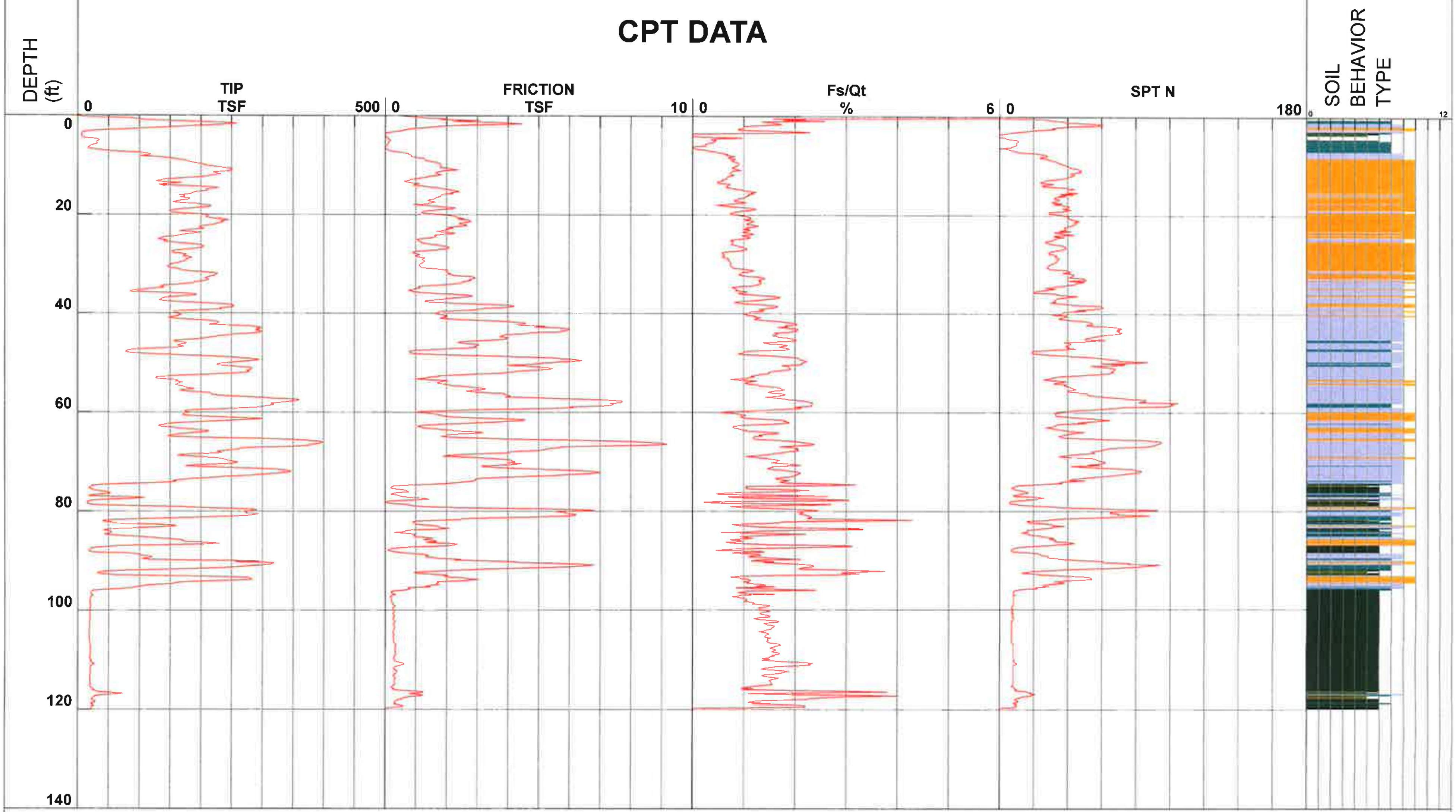
SBT: Soil Behavior Type (Robertson 1990)

Ninyo & Moore Geotechnical

Project	San Elijo Lagoon	Operator	RS/JC	Filename	SDF(485).cpt
Job Number	105991013	Cone Number	DDG1185	GPS	
Hole Number	CPT-07	Date and Time	9/20/2011 8:52:28 AM	Maximum Depth	119.91 ft
Water Table Depth	5.00 ft				

Net Area Ratio .8

CPT DATA



▨ 1 - sensitive fine grained	■ 4 - silty clay to clay	■ 7 - silty sand to sandy silt	🟥 10 - gravelly sand to sand
■ 2 - organic material	🟩 5 - clayey silt to silty clay	■ 8 - sand to silty sand	■ 11 - very stiff fine grained (*)
■ 3 - clay	■ 6 - sandy silt to clayey silt	■ 9 - sand	■ 12 - sand to clayey sand (*)

Cone Size 10cm squared

*Soil behavior type and SPT based on data from UBC-1983

APPENDIX B

LABORATORY TESTING

Classification

Soils were visually and texturally classified in accordance with the Unified Soil Classification System (USCS) in general accordance with American Society for Testing and Materials (ASTM) Test Method D 2488. Soil classifications are indicated on the logs in Appendix A.

In-Place Moisture and Density Tests

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

Gradation Analysis

Gradation analysis tests were performed on selected representative soil samples in general accordance with ASTM D 422. The grain-size distribution curves are shown on Figures B-1 through B-36. These test results were utilized in evaluating the soil classifications in accordance with USCS.

200 Wash

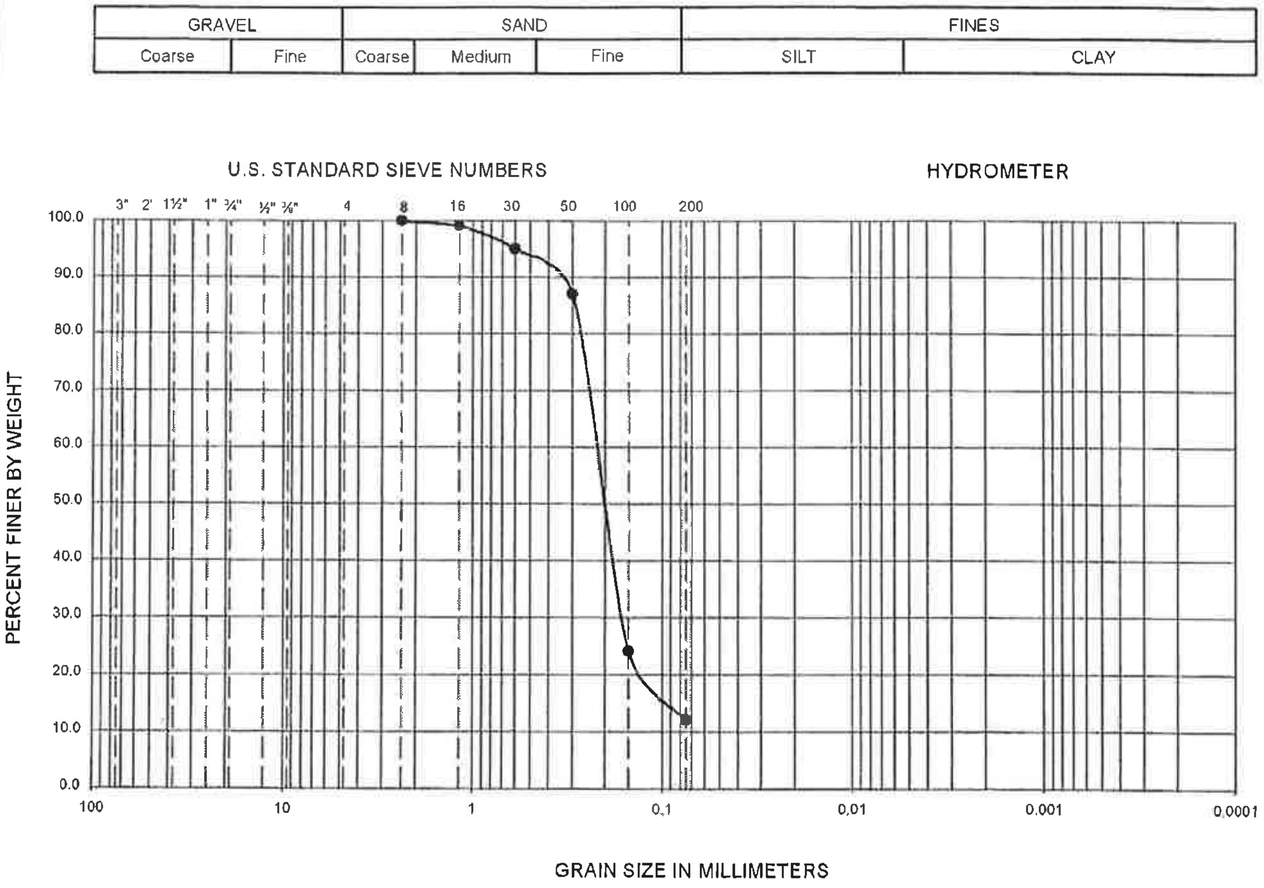
An evaluation of the percentage of particles finer than the No. 200 sieve in selected soil samples was performed in general accordance with ASTM D 1140. The results of the tests are presented on Figure B-37.

Atterberg Limits

Tests were performed on selected representative fine-grained soil samples to evaluate the liquid limit, plastic limit, and plasticity index in general accordance with ASTM D 4318. These test results were utilized to evaluate the soil classification in accordance with the USCS. The test results and classifications are shown on Figure B-38.

Soil Corrosivity Tests

Soil pH and resistivity tests were performed on representative samples in general accordance with California Test (CT) 643. The soluble sulfate and chloride content of selected samples were evaluated in general accordance with CT 417 and CT 422, respectively. The test results are presented on Figure B-39 and B-40.



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-8	30.0-31.0	--	--	--	0.06	0.18	0.22	3.7	2.5	12	SP-SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore

GRADATION TEST RESULTS

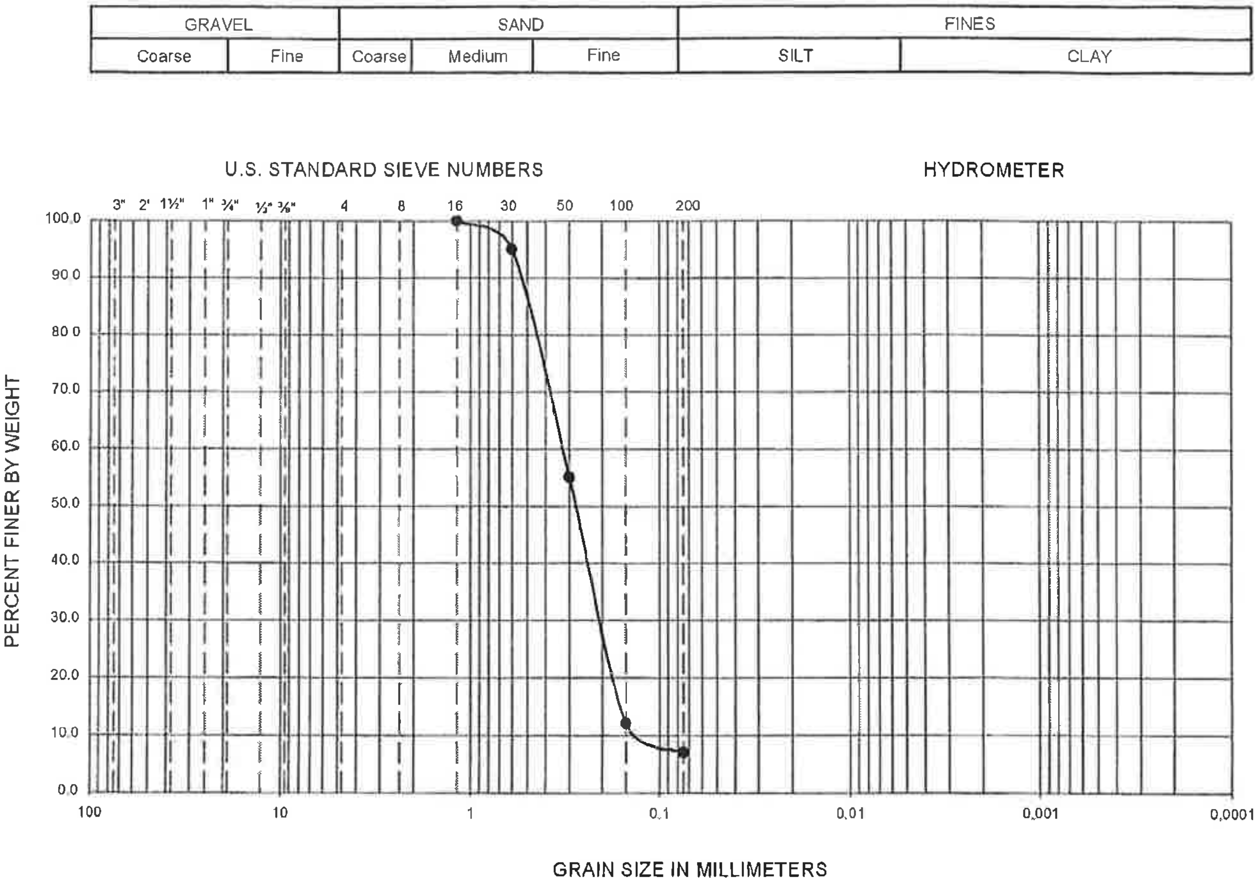
PROJECT NO.	DATE
105991023	9/14

SAN ELIJO LAGOON DOUBLE TRACK PROJECT
ENCINITAS AND SOLANA BEACH, CALIFORNIA

FIGURE

B-5

105991023 SIEVE B-8 @ 30.0-31.0.xls



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-8	47.0-48.0	--	--	--	0.14	0.22	0.33	2.4	1.0	7	SP-SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore

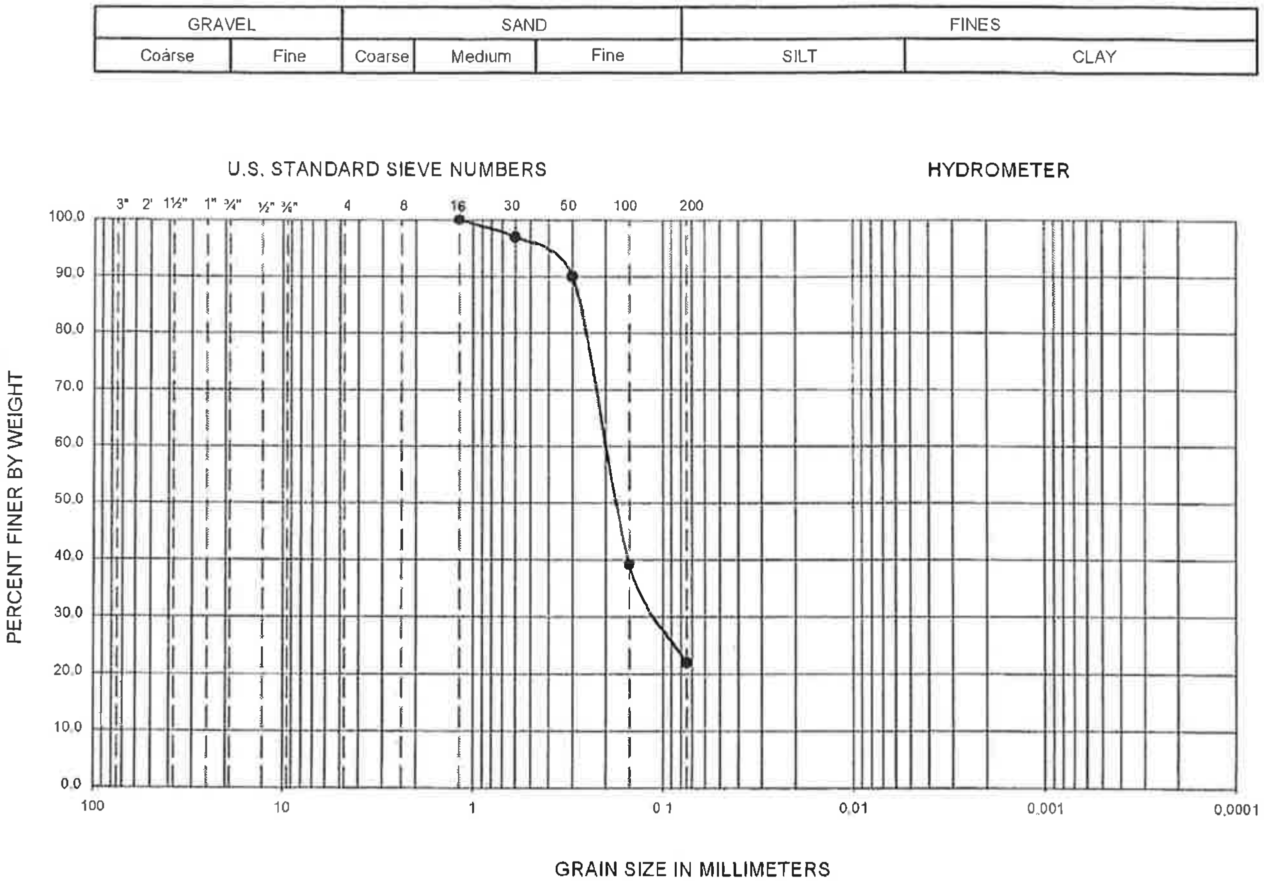
GRADATION TEST RESULTS

PROJECT NO.	DATE
105991023	9/14

SAN ELIJO LAGOON DOUBLE TRACK PROJECT
ENCINITAS AND SOLANA BEACH, CALIFORNIA

FIGURE

B-6



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-8	65.0-67.0	--	--	--	--	--	--	--	--	22	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore

GRADATION TEST RESULTS

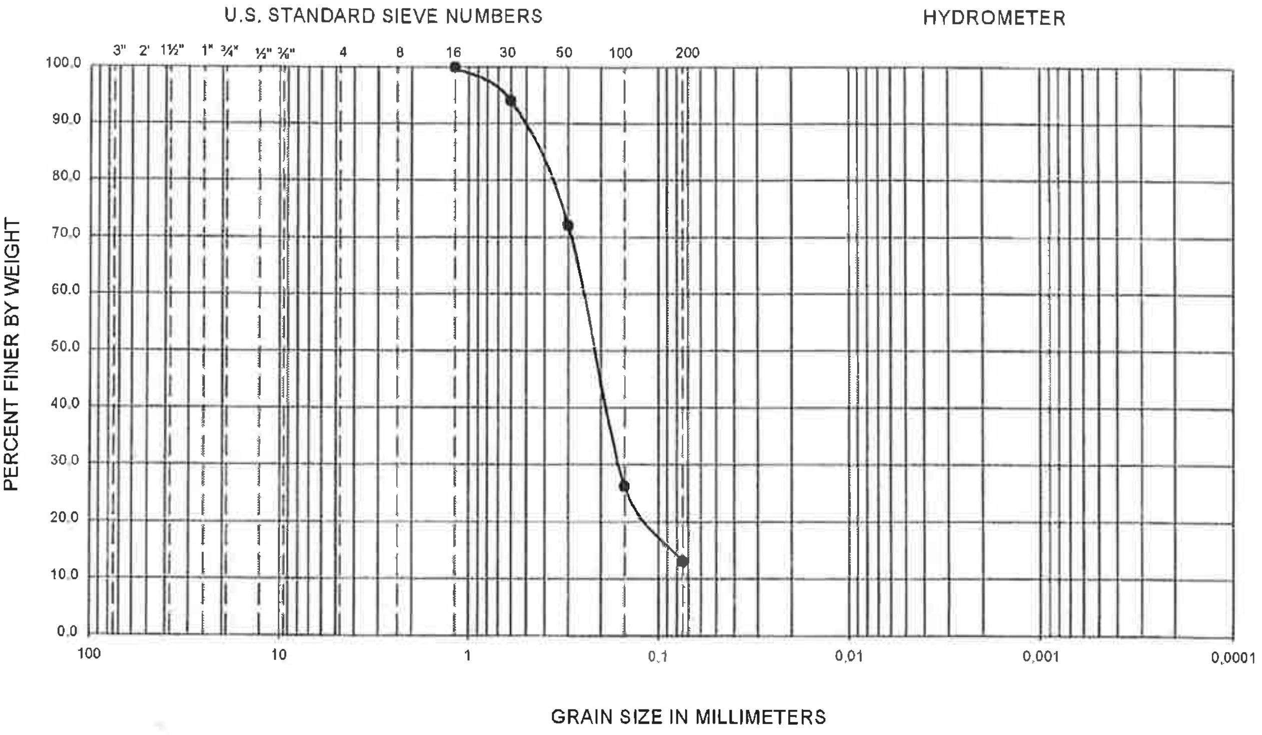
PROJECT NO.	DATE
105991023	9/14

SAN ELIJO LAGOON DOUBLE TRACK PROJECT
ENCINITAS AND SOLANA BEACH, CALIFORNIA

FIGURE

B-7

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-8	81.0-83.0	--	--	--	--	--	--	--	--	13	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore

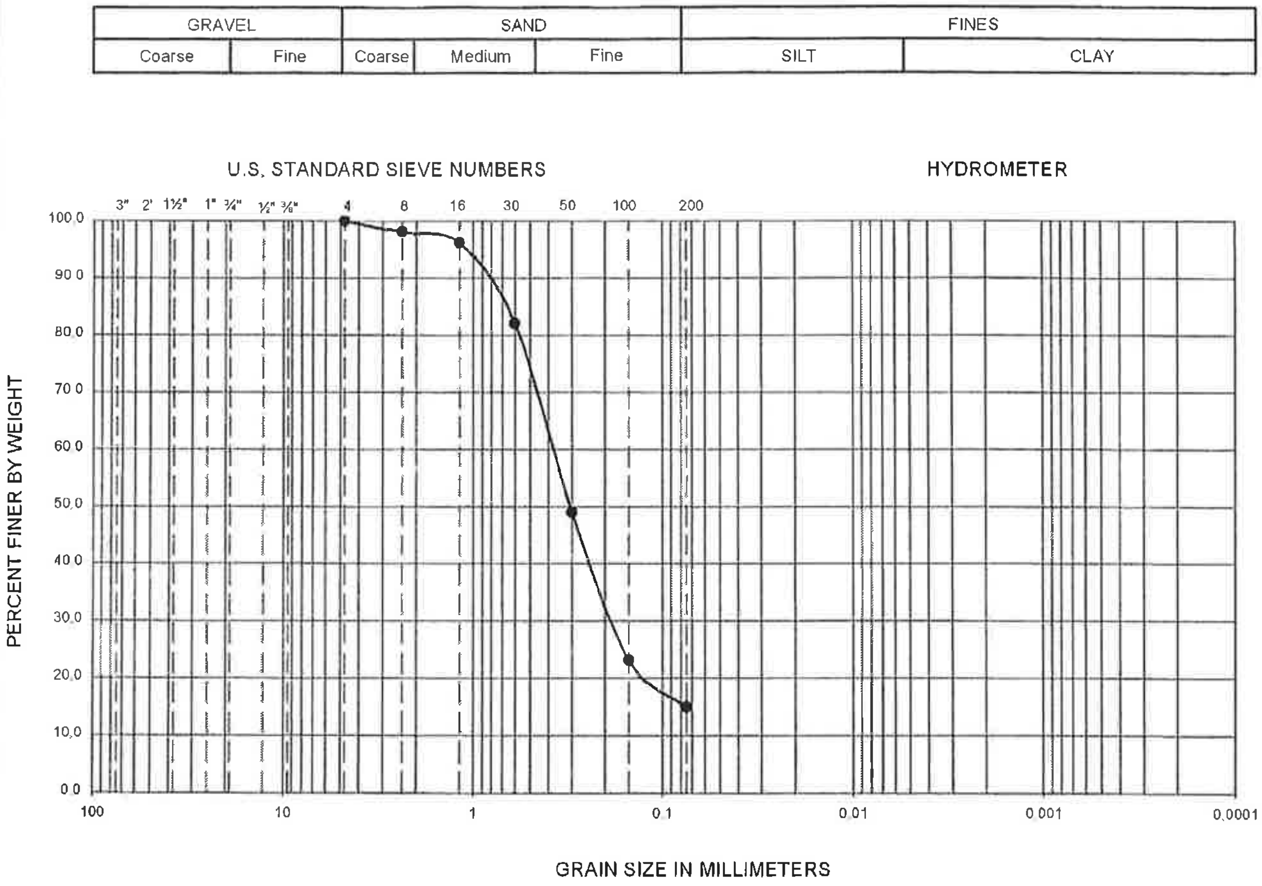
GRADATION TEST RESULTS

FIGURE

B-8

PROJECT NO.	DATE
105991023	9/14

SAN ELIJO LAGOON DOUBLE TRACK PROJECT
ENCINITAS AND SOLANA BEACH, CALIFORNIA



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-10	12.0-14.0	--	--	--	--	--	--	--	--	15	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore

GRADATION TEST RESULTS

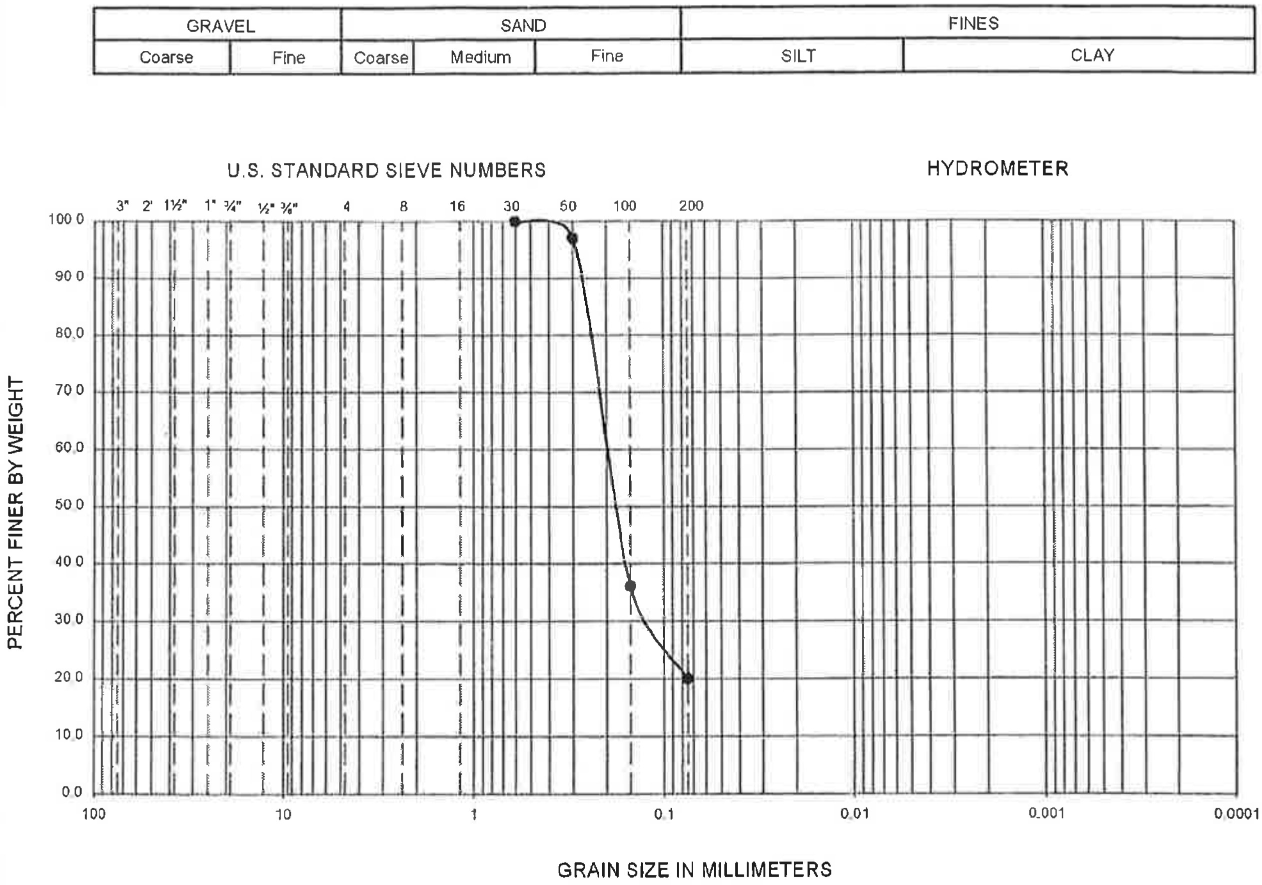
PROJECT NO.	DATE
105991023	9/14

SAN ELIJO LAGOON DOUBLE TRACK PROJECT
ENCINITAS AND SOLANA BEACH, CALIFORNIA

FIGURE

B-9

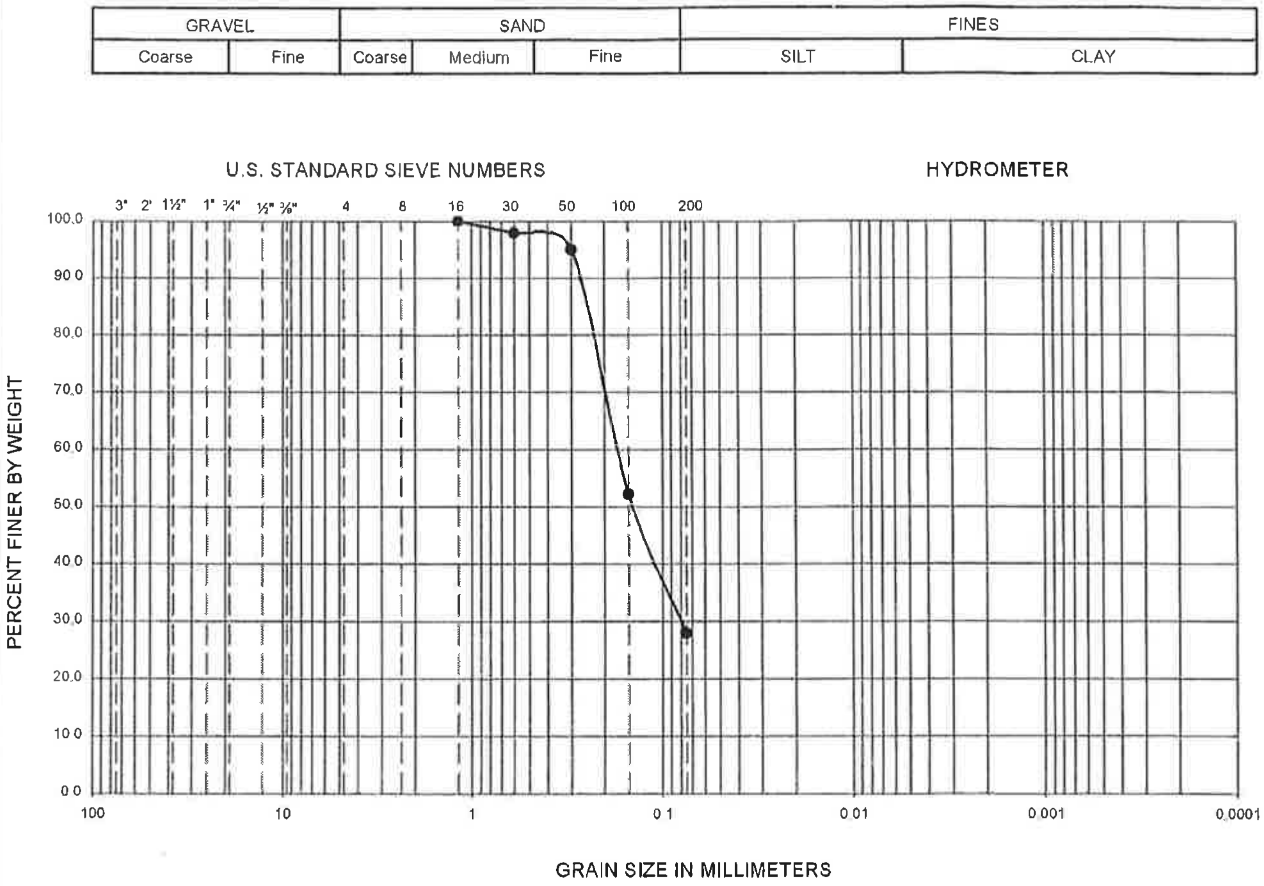
105991023 SIEVE B-10 @ 12.0-14.0.xls



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-10	27.0-28.0	--	--	--	--	--	--	--	--	20	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore		GRADATION TEST RESULTS	FIGURE
PROJECT NO.	DATE	SAN ELIJO LAGOON DOUBLE TRACK PROJECT ENCINITAS AND SOLANA BEACH, CALIFORNIA	B-10
105991023	9/14		

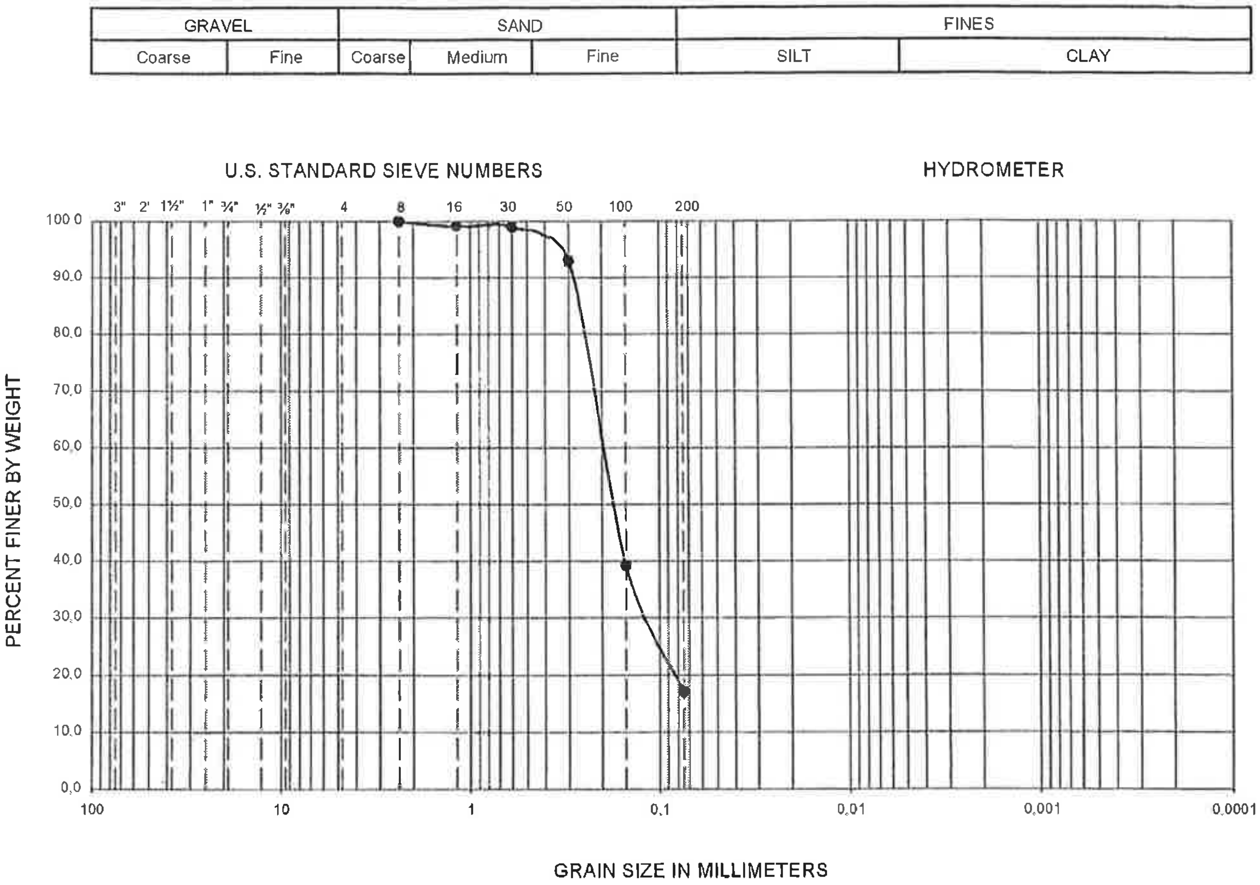


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-10	42.0-43.0	--	--	--	--	--	--	--	--	28	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore		GRADATION TEST RESULTS	FIGURE
PROJECT NO.	DATE	SAN ELIJO LAGOON DOUBLE TRACK PROJECT ENCINITAS AND SOLANA BEACH, CALIFORNIA	B-11
105991023	9/14		

105991023 SIEVE B-10 @ 42.0-43.0.xls



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-10	69.0-70.0	--	--	--	--	--	--	--	--	17	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore

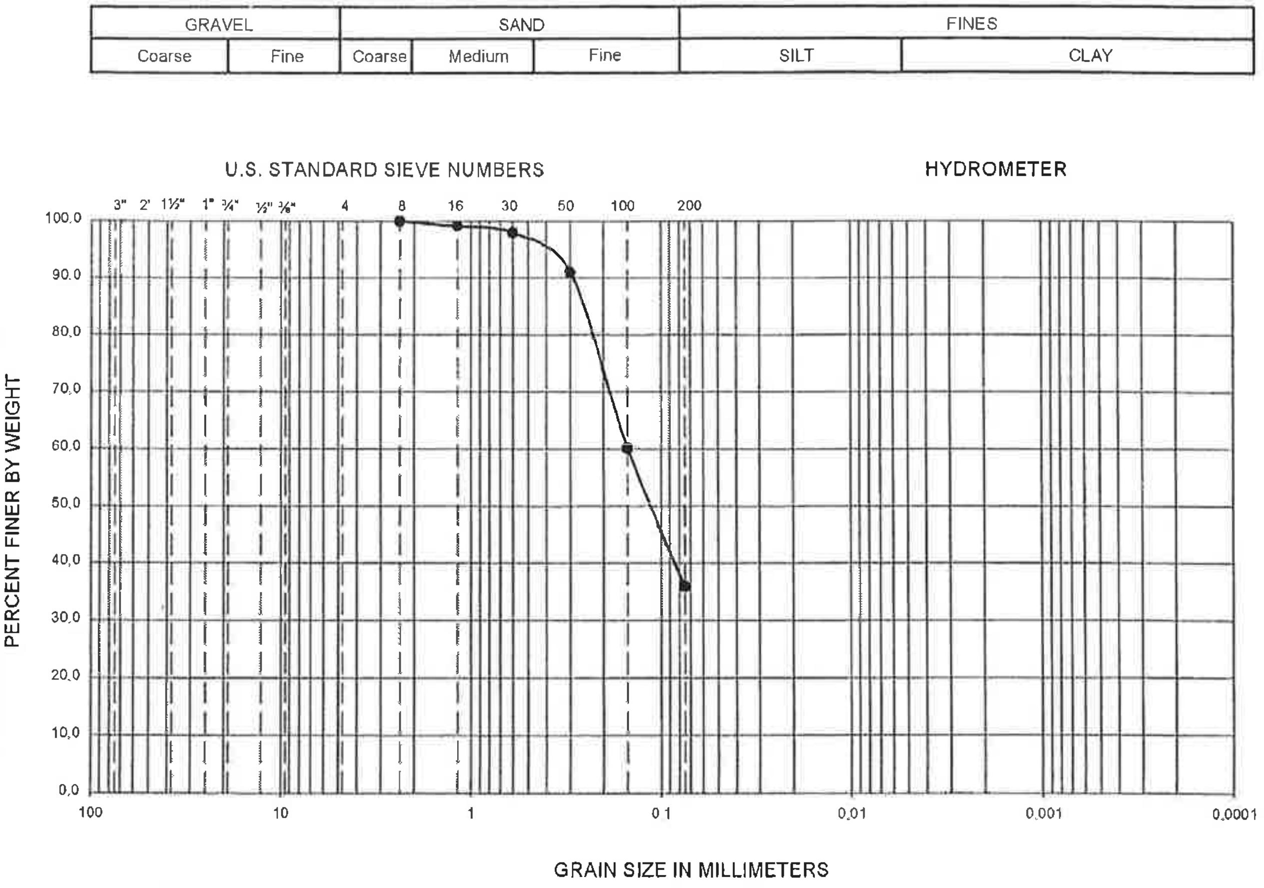
GRADATION TEST RESULTS

PROJECT NO.	DATE
105991023	9/14

SAN ELIJO LAGOON DOUBLE TRACK PROJECT
ENCINITAS AND SOLANA BEACH, CALIFORNIA

FIGURE

B-12



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-10	93.0-94.0	--	--	--	--	--	--	--	--	36	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore

GRADATION TEST RESULTS

PROJECT NO.	DATE
105991023	9/14

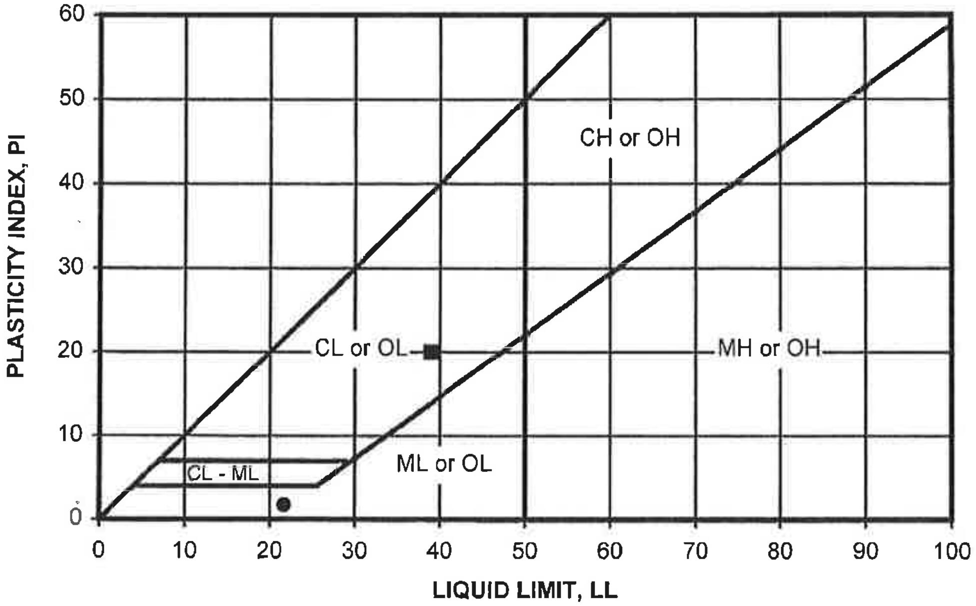
SAN ELIJO LAGOON DOUBLE TRACK PROJECT
ENCINITAS AND SOLANA BEACH, CALIFORNIA

FIGURE

B-13

SYMBOL	LOCATION	DEPTH (FT)	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	USCS CLASSIFICATION (Fraction Finer Than No. 40 Sieve)	USCS (Entire Sample)
●	B-8	68.0-70.0	22	20	2	ML	ML
■	B-10	84.0-85.0	39	19	20	CL	CL

NP - INDICATES NON-PLASTIC



PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4318

Ninyo & Moore

ATTERBERG LIMITS TEST RESULTS

PROJECT NO.	DATE
105991023	9/14

SAN ELIJO LAGOON DOUBLE TRACK PROJECT
ENCINITAS AND SOLANA BEACH, CALIFORNIA

FIGURE

B-38

SAMPLE LOCATION	SAMPLE DEPTH (FT)	pH [1]	RESISTIVITY [1] (Ohm-cm)	SULFATE CONTENT [2]		CHLORIDE CONTENT [3] (ppm)
				(ppm)	(%)	
B-1	55.0-57.0	8.2	110	4,200	0.420	3,300
B-2	5.0-6.5	7.0	2,100	180	0.018	85
B-2	20.0-21.4	6.6	700	180	0.018	95
B-8	30.0-31.0	6.4	115	960	0.096	3,850
B-8	47.0-48.0	6.6	105	1000	0.100	3,700
B-10	7.0-8.0	5.9	120	1650	0.165	4,300
B-10	36.0-37.0	5.8	130	1680	0.168	4,800
B-14	0.5-5.0	7.1	3,000	30	0.003	210

[1] PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 643

[2] PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 417

[3] PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 422

Ninyo & Moore

CORROSIVITY TEST RESULTS

PROJECT NO.	DATE
105991023	9/14

SAN ELIJO LAGOON DOUBLE TRACK PROJECT
ENCINITAS AND SOLANA BEACH, CALIFORNIA

FIGURE

B-39