GEOTECHNICAL EVALUATION
PERRIS II DESALINATION FACILITY
1301 CASE ROAD
PERRIS, CALIFORNIA

PREPARED FOR:
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October 28, 2005
Project No. 105707001

Ninyo & Moore
Geotechnical and Environmental Sciences Consultants

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Mr. John G. O'Donnell, P.E.
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San Diego, California 92101

Subject: Geotechnical Evaluation
Perris II Desalination Facility
1301 Case Road
Perris, California

Dear Mr. O'Donnell:

Please find enclosed Ninyo & Moore's geotechnical evaluation for the subject project. This study was conducted in general accordance with our proposal dated March 19, 2005. This report presents our findings, conclusions, and geotechnical recommendations for the project.

We appreciate the opportunity to be of service on this project.

Respectfully submitted,
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1. INTRODUCTION

In accordance with your request and authorization, Ninyo & Moore has performed a preliminary geotechnical evaluation for the subject project, located near the southwest portion of the Perris Valley Regional Water Reclamation Facility, 1301 Case Road, in Perris, California (Figure 1). The purposes of our study were to provide conclusions and geotechnical recommendations for preliminary design of the joint US Army Corps of Engineers (USACE) and Eastern Municipal Water District (EMWD), Perris II Desalination Facility.

2. SCOPE OF SERVICES

The scope of services for this study included the following:

- Reviewing readily available background data, including geotechnical data, geologic and topographic maps, and stereoscopic aerial photographs.
- Performing a site reconnaissance to observe site conditions and to mark out proposed exploratory excavation locations.
- Coordinating with Underground Service Alert (USA), and on-site personnel to mark underground utilities near the proposed borings.
- Performing a subsurface evaluation consisting of drilling, logging, and sampling of six exploratory borings with a truck-mounted, hollow-stem auger drill rig, to depths of up to approximately 51.5 feet below the existing ground surface. Relatively undisturbed drive samples, standard penetration tests (SPT), and bulk samples were collected from the borings at selected intervals. The soil samples were then transported to our laboratory for testing.
- Performing laboratory testing of selected samples to evaluate in-place dry density and moisture content, expansion, grain size analyses, consolidation, shear strength, R-value, and soil corrosivity.
- Geological and engineering analysis of the data obtained.
- Preparing of this report presenting our findings, conclusions, and geotechnical recommendations for the subject project.

3. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

As discussed, the project site is located near the southwest portion of the Perris Valley Regional Water Reclamation Facility, just north of Watson Road, in Perris, California. The proposed site is situated on approximately 3 acres of relatively flay-lying, alluvial deposits of the Perris Valley, at an elevation of approximately 1,415 feet above mean sea level (MSL). The San Jacinto River drainage is located just north-northwest of the site. At the time of our study, the site was being utilized for agricultural purposes.

We understand that the project will include the design of a proposed desalination (desalter) facility. The purpose of the facility will be to reduce the salinity of groundwater in the Perris South Subbasin by using a process of pre-treatment, reverse osmosis (RO), and post-treatment of the groundwater. The facility would include a large water storage tank embedded approximately 10 to 20 feet below grade, a fiberglass decarbonator tank approximately 20 to 30 feet above ground, a chlorine disinfection tank approximately 10 to 15 feet above ground, pump forebay tanks, and structures to house the RO skids. Other improvements will include asphalt covered truck loading/unloading areas, asphalt access roads, and three new pipelines, a feedwater pipeline and a brine discharge pipeline. The approximately 1/2 mile long pipelines would be installed roughly parallel to Watson Road at depths of about 4 feet below the existing grade.

Due to the relatively close proximity of the San Jacinto River and associated flood plain, we understand that during grading, import material will be utilized to elevate the site approximately 10 feet above the existing ground surface. The proposed plant structures will generally be founded on the graded fill pad, with the exception of wet wells, canisters for vertical pumps, clearwells, etc., where excavations of up to 20 feet below pad grade are anticipated.

4. SUBSURFACE EXPLORATION AND LABORATORY TESTING

Our subsurface exploration, was performed on September 21, 2005 and consisted of the excavation, logging, and sampling of six small-diameter borings. The borings were drilled with a truck-mounted, hollow-stem auger drill rig, to depths of up to approximately 50.5 feet below the existing ground surface. Relatively undisturbed, modified split-barrel drive samples, SPT samples,

and bulk samples were obtained at selected intervals from the borings. The samples were transported to our laboratory for testing. The excavations were backfilled with bentonite grout in general accordance with County standards. Logs of the borings are included in Appendix A. The approximate locations of the borings are shown on Figure 2.

Laboratory testing of representative soil samples to evaluate in-situ moisture content and dry density, expansion, grain size analyses, consolidation, shear strength, R-value, and soil corrosivity. The laboratory tests were performed in our in-house laboratory. The results of the in-situ moisture content and dry density tests are shown at the corresponding sample depth on the boring logs in Appendix A. The results of the other laboratory tests performed are presented in Appendix B.

5. GEOLOGY AND SUBSURFACE CONDITIONS

Our findings regarding regional and site geology, including faulting and seismicity, landslides, and groundwater conditions are provided in the following sections.

5.1. Regional Geologic Setting

The project area is situated in the southwestern Riverside County 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 (Harden, 1998; Norris and Webb, 1990). 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 Riverside County that includes the project area consists generally of the broad San Jacinto River drainage.

The Peninsular Ranges Province is traversed by a group of sub-parallel faults and fault zones trending roughly northwest. Several of these faults are considered active faults. The Whittier-Elsinore, Rose Canyon, San Clemente, and the Agua Blanca-Coronado Bank faults,

are active fault systems located west of the project area, and the San Jacinto and San Andreas faults are active fault systems located east of the project area (Figure 3). Major tectonic activity associated with these and other 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 section of this report.

5.2. Site Geology

Geologic units encountered during our subsurface evaluation include fill, agricultural topsoil, and alluvial deposits. Detailed descriptions of the earth units encountered are provided in Appendix A, and generalized descriptions are provided in the subsequent sections.

5.2.1. Fill

Fill materials were encountered in Boring B-6 to a depth of up to approximately 2 feet below the existing ground surface. In general the material consisted of brown, damp, loose, gravelly, fine to coarse sandy silt.

5.2.2. Agricultural Topsoil

Agricultural topsoil was encountered in Borings B-1 through B-5, to depths of up to approximately 1-foot below the existing ground surface. In general, the material consisted of brown, light brown and reddish brown, damp, loose, clayey to gravelly, fine sandy silt.

5.2.3. Alluvium

Alluvium was encountered underlying the fill and agricultural topsoil materials in each of the borings to the depths explored. As encountered, the material generally consisted of brown, damp to moist, loose to very dense, fine sandy silt, brown, reddish brown, and brownish red, damp to moist, stiff to very stiff, fine to coarse sandy clay, and brown, light brown, light yellowish brown, reddish brown, and brownish red, damp to saturated, medium dense to very dense, clayey and silty fine to coarse sand.

5.3. Groundwater

Groundwater was encountered during our subsurface exploration in Boring B-1 at a depth of approximately 37 feet below the existing ground surface, or approximately 1,378 feet above MSL. However, water seepage into proposed trenches may occur as the result of perched water zones in some areas. Groundwater levels will fluctuate due to seasonal variations and prolonged climatic conditions, such as flow in the San Jacinto River during wet weather, groundwater withdrawal or injection, or other factors.

6. GEOLOGIC HAZARDS

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

6.1. Faulting and Seismicity

The subject site is considered to be in a seismically active area. Our review of readily available published geological maps and literature indicates that there are no 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), underlying the subject site. Major known active faults in the region consist generally of en-echelon, northwest-striking, right-lateral, strike-slip faults. These include the Whittier-Elsinore, Rose Canyon, San Clemente, Agua Blanca-Coronado Bank, located west of the site, and the San Andreas and San Jacinto faults, located east of the site.

The closest known active fault is the Temecula segment of the Whittier-Elsinore Fault, which can generate an earthquake magnitude of up to 6.8 (California Geological Survey [CGS], 1998). It is located approximately 18 kilometers (km) west of the site.

6.1.1. Strong Ground Motion

Based on a Probabilistic Seismic Hazard Assessment for the Western United States, issued by the United States California Geological Survey (2002), the project site is

located in a zone where the horizontal peak ground acceleration having a 10 percent probability of exceedance in 50 years is 0.44g (44 percent of the acceleration of gravity). Based on probabilistic seismic hazard analysis software developed by Thomas F. Blake (FRISKSP 4.00), the estimated peak horizontal ground acceleration corresponding to an earthquake with recurrence interval of 10,000 years is approximately 0.71g. The requirements of the governing jurisdictions and the 2001 California Building Code (CBC) should be considered in the project design.

6.1.2. Surface Rupture

Ground surface rupture due to active faulting is not considered likely in the project area due to the absence of any known active faults underlying the site. Lurching or cracking of the ground surface as a result of nearby or distant seismic events is also considered unlikely.

6.2. Liquefaction

Liquefaction of cohesionless soils can be caused by strong vibratory motion due to earthquakes. Research and historical data indicate that loose, granular soils with clay contents of less than 20 percent, saturated by a relatively shallow groundwater table, are more susceptible to liquefaction. When these sediments are shaken, such as during an earthquake, a sudden increase in pore water pressure is generated. As this pore water pressure rises, grain-to-grain contact stresses approach zero and the granular material temporarily behaves as a liquid rather than a solid. Excess water pressure is vented upward through fissures and soil cracks causing a water-soil slurry to bubble onto the ground surface. The resulting features are called sand boils, sand blows, or "sand volcanoes." Ground failure caused by liquefaction is a major cause of earthquake damage. Based on the relatively dense nature of the subsurface materials it is our opinion that the potential for liquefaction at the site is low.

6.3. Lateral Spreading

Lateral displacement of surficial blocks of sediment as the result of liquefaction in a subsurface layer is called a lateral spread. Once liquefaction transforms the subsurface layer into a fluidized mass, gravity plus inertial forces that result from the earthquake may cause the mass to move downslope towards a cut slope or free face (such as a river channel or a canal). Due to the relatively low potential for liquefaction at the site, lateral spreading is not a design consideration.

6.4. Landsliding

Based on the flat-lying topography, our geologic reconnaissance, and review of referenced geologic maps, topographic maps, and stereoscopic aerial photographs, no indications of deep-seated landsliding were noted underlying the site. Accordingly, the potential for significant large-scale slope instability at the site is unlikely.

7. CONCLUSIONS

It is our opinion that there are no known geotechnical constraints that would preclude construction of the planned project development provided consideration is given to the recommendations presented in this report and appropriate construction practices are followed. Geotechnical considerations include the following:

- The proposed site is generally underlain by agricultural topsoil and alluvium. The topsoil is not considered suitable in its current state for support of the proposed structures.
- Groundwater was encountered at a depth of approximately 37 feet below the existing ground surface. Groundwater is anticipated to be variable due to the site's proximity to the San Jacinto River.
- No active faults, landslides, or other geologic hazards are reported to be underlying the project site. The closest known active fault is the Temecula segment of the Whittier-Elsinore Fault, located approximately 18 km west of the site.
- The potential for strong ground motions to occur at the site is significant. The site is located in Seismic Zone 4 according to the 2001 CBC. Accordingly, the potential for relatively

strong seismic accelerations will need to be considered in the design of proposed improvements.

- Import soil will be utilized to create building pads for the proposed project. Import material should generally consist of granular, very low to low expansive material.
- Due to the potential for shallow perched groundwater, dewatering during construction activities should be anticipated.
- It is our understanding that the proposed improvements will include; a large water storage tank embedded approximately 10 to 20 feet below the proposed grade, a fiberglass decarbonator tank approximately 20 to 30 feet above grade, a chlorine disinfection tank approximately 10 to 15 feet above grade, pump forebay tanks, and structures to house the RO skids. Foundation loads from these structures may induce settlements unless deep foundations or soil improvement methods such as preloading are employed.

8. RECOMMENDATIONS

This section discusses the general considerations pertaining to the engineering properties of the on-site soils, and their application to the proposed project. The analyses were conducted based on engineering parameters obtained from our subsurface exploration and laboratory testing as well as our professional experience.

As discussed the site is underlain by shallow fill or agricultural topsoil, overlying alluvium. Based on our subsurface evaluation and on our understanding of the proposed project, up to approximately 10 feet of fill will be added to the existing grade. The proposed at-grade structures will be founded on fill materials. Due to the potential for differential settlement, we recommend that building foundations not straddle different material types. In addition, we recommend that existing fill or agricultural topsoil be removed to relatively dense alluvial materials, prior to the placement of engineered/compacted fill.

8.1. Site Preparation and Earthwork

In general, earthwork should be performed in accordance with the recommendations presented in our Typical Earthwork Guidelines (Appendix C). Where the specific recommendations presented in this report differ from that presented in Appendix C, the rec-

ommendations presented in this report govern. The geotechnical consultant should be contacted for clarification if there are any questions regarding interpretation or implementation of the guidelines presented herein. Earthwork should be observed by the geotechnical consultant to assess conformance with the recommendations contained in this report.

8.1.1. Site Preparation

Site preparation should begin with the removal of deleterious matter and vegetation. Loose soil should be removed or reworked and compacted. Demolition debris and other unsuitable material generated from on-site operations should be removed off the property. This includes rocks or debris greater than approximately 6 inches in diameter. Underground utilities located within the proposed limits of the construction should be removed or abandoned, capped off or relocated so as not to interfere with earthwork operations.

8.1.2. Removal, Scarifying, and Recompaction

As discussed, we recommend that existing fill and agricultural topsoil be removed below proposed improvements including paved areas and exterior flatwork, and be replaced with compacted fill. In general, the removal area should extend 5 feet or more beyond the outer edge of the building footprint. Loose, unconsolidated materials should be removed prior to placing fill materials at the site. The geotechnical consultant should observe the bottom of the excavation prior to filling to evaluate the need for deeper removals. Deeper removals may be needed if unsuitable materials are exposed during grading.

The soils encountered at the project site should be generally suitable for reuse as fill or backfill provided they are free of organic material, contaminated material, clay lumps, and rocks or debris greater than 6 inches in diameter. Based on field exploration, the potential for expansive conditions of on-site soils was evaluated to be generally low. However, pockets of expansive materials (expansion index higher than 50) may be encountered. We recommend that expansive materials, if encountered, be removed from the site.

After removal of the upper existing soil, the resulting surface should be scarified to a depth of approximately 8 inches, moisture conditioned, and compacted to 90 or more percent relative compaction, in accordance with American Society for Testing and Materials (ASTM) D 1557. Fill should be placed in horizontal lifts approximately 8 inches in loose thickness and compacted by appropriate mechanical methods to 90 or more percent relative compaction in accordance with ASTM D 1557, at a moisture content near optimum. In roadway areas, slab subgrade fill should be compacted to 95 or more percent relative compaction. Density testing and probing should be performed as needed during compaction activities to evaluate the relative compaction with respect to project specifications.

8.1.3. Excavation and Shoring

Site soils should be considered to be "Type C" in accordance with the California Title 8 Construction Safety Orders, due to the sandy nature of the materials. The subsurface soils should generally be excavatable by standard, heavy-duty earthmoving equipment, however, zones of gravel and cobble may be encountered and may be difficult to excavate and will likely involve heavy ripping. In addition, portions of the alluvium may contain layers of abundant cobbles which may impact trenching operations. Occupational Safety and Health Administration (OSHA) requirements pertaining to worker safety should be met. We further recommend that the construction method provided herein be carefully evaluated by a qualified specialty contractor prior to commencement of the construction. The responsibility for equipment selection, temporary excavation support, and project safety should rest with the contractor. During construction, provisions should be made to reduce the potential for surface water to drain into excavations.

Stabilizing excavations by bracing or retaining systems may not be needed for excavations that are not deeper than 5 feet below the grade existing at time of excavation. For excavations deeper than 5 feet, the sides may be laid back at a slope of 1.5:1 (horizontal:vertical), or flatter; or the excavation may be stabilized by installing bracing or retaining systems based on recommendations from the geotechnical consultant.

Lateral earth pressures exerted on temporary braced shoring walls are indicated on Figure 4. Based on subsurface evaluation, the groundwater level may be assumed to be at a depth of approximately 37 feet below the existing ground surface for evaluating lateral earth pressures. As discussed, the groundwater level will fluctuate because of seasonal variations and other factors. Accordingly, higher groundwater conditions may be anticipated during or after construction activities. These lateral earth pressures should be evaluated by a structural engineer for the design of the wall shoring systems.

These design earth pressures assume that spoils from the excavations, or other surcharge loads, will not be placed above the excavations within a 1:1 plane extending up and back from the base of the excavation. For bracing subjected to surcharge loads, such as soil stockpiles or construction materials/equipment, an additional horizontal uniform pressure of 0.70q may be applied to the full height of the excavation, where "q" is the surcharge pressure.

8.1.4. Construction Dewatering

Based our understanding of the project, some below grade tanks and other structures will be installed. Although groundwater was encountered at a depth of approximately 37 feet below the existing grade, shallow, perched water conditions may be encountered during construction. Accordingly, groundwater dewatering should be anticipated. If utilized, dewatering may affect groundwater levels outside of the excavation. This will result in an increase of effective stresses and may induce settlement of soils underlying adjacent areas. In addition, vibrations from construction activities can also induce settlement. Therefore, some distress to nearby buildings, concrete flatwork, and asphalt concrete streets is possible. Should movement be observed, dewatering or construction activities should stop and the methods re-evaluated.

Discharge of water from excavations may involve securing a National Pollution Discharge Elimination System (NPDES) permit. Compliance with the permit requirements may involve testing and treatment of the water prior to discharge to storm drains.

8.2. Import Soil

We recommend that import material, consist of generally granular, very low to low expansive material (expansion index of 50 or less) with low corrosivity potential. The import material should have an organic content of less than 3 percent by volume (1 percent by weight), not contain rocks or lumps over 3 inches in largest dimension, and not more than 40 percent by weight larger than 3/4-inch. The import material should also have low corrosion potential (electrical resistivity greater than 1,000 ohm-cm, and soluble sulfate content of less than 0.2 percent). Import material should be evaluated by the geotechnical consultant at the borrow site for its suitability as fill prior to importation to the project site.

8.3. Fill Surcharge

As discussed, deep foundations or soil improvement methods may be employed to reduce settlement induced by the proposed fiberglass decarbonator tank and chlorine disinfection tank. We recommend that a surcharge fill approximately 8 to 10 feet in thickness be placed at the proposed locations of these two tanks to preload the foundation soil. The thickness, location, and area extent of the fill surcharges should be evaluated by the geotechnical consultant prior to their placement based on the planned grading and configuration of the improvements. Settlement induced by the fill surcharge should be monitored and reported to the geotechnical consultant on a periodic basis for the evaluation of settlement rate prior to the removal of surcharge fill.

8.4. CBC Seismic Design Parameters

According to the 2001 CBC, the proposed site is within Seismic Zone 4. Based on the distance from the site to the nearest active fault, the site is not within a Near-Source Zone. Table 1 includes the seismic design parameters for the site as defined in the 2001 edition of the CBC.

Table 1 – Seismic Design Parameters

Parameter	Value	2001 CBC Reference
Seismic Zone Factor, Z	0.40	Table 16 – I
Soil Profile Type	S_D	Table 16 – J
Seismic Coefficient C_a	0.44	Table 16 – Q
Seismic Coefficient C_v	0.64	Table 16 – R
Near-Source Factor, N_a	1.0	Table 16 – S
Near-Source Factor, N_v	1.0	Table 16 – T
Seismic Source Type	B	Table 16 – U

8.5. Foundations

As discussed, based on our understanding, the proposed facility would include large water storage and chemical tanks, pump forebay tanks, and structures to house the RO skids. We anticipate the structures will be supported by a mat foundation founded on fill soils overlying alluvial materials. Proposed structures should not be founded on alluvium or undocumented fill materials.

The following foundation design parameters are provided as recommendations based on preliminary analysis. The foundations are not intended to preclude differential movement of the soils. Minor cracking (considered tolerable) of slabs and flatwork may occur. The following preliminary recommendations may be utilized for construction. More specific recommendations may be provided after review of proposed building plans. We are presenting foundation recommendations for soils of very low to low expansion potential. Expansion potential of finish grade soils should be further evaluated after site grading.

8.5.1. Shallow Foundations

For at grade structures, continuous and/or spread footings should be founded in compacted fill. Footings founded as recommended may be designed using an allowable bearing capacity of 2,500 pounds per square foot (psf). The allowable bearing pressures may be increased by one-third when considering loading of short duration such as wind or seismic forces. Recommendations for lateral resistance for footings are presented in Section 7.4.3.

Foundations should have an embedment depth of 18 inches or more below the lowest adjacent grade. Continuous footings should be 18 inches or more wide and spread foundations should be 24 inches or more square. Footings should be reinforced in accordance with the structural engineer's recommendations. From a geotechnical standpoint, we recommend that footings founded in very low or low expensive granular materials be reinforced with four No. 4 or larger reinforcing bars, two placed near the top and two near the bottom of the footings.

8.5.2. Mat Foundations

Where groundwater is encountered at the bottom of the foundation excavations, we suggest that a 1-foot thick gravel or lean concrete mud mat be installed in the bottom of excavation to provide a firm working surface, prior to construction of a mat foundation. Any loose, soft, or otherwise deleterious material found at finish grade should be removed prior to placement of the mud mat. When tested in accordance with ASTM D 422-63, after being compacted during construction, the graded aggregate should conform to the requirements for Caltrans Class II Permeable Material, with the grading presented in Table 2.

Table 2 – Caltrans Class II Permeable Material Gradation

Sieve Size	Percent Passing
1-inch	100
3/4-inch	90-100
3/8-inch	40-100
No. 4	25-40
No. 8	18-33
No. 30	5-15
No. 50	0-7
No. 200	0-3

The proposed structures may be founded on a mat foundation supported on native material or improved alluvium, using an allowable bearing capacity of 2,500 pounds psf. This allowable bearing capacity may be increased by one-third when considering loads of

a short duration such as wind or seismic forces. Thickness and reinforcement of the mat foundation should be in accordance with the recommendations of a structural engineer.

Mat foundations typically experience some deflection due to loads placed on the mat and the reaction of the soils underlying the mat. A design coefficient of subgrade reaction, $\mathbf{K_{v1}}$, of 115 pounds per cubic inch (pci) may be used for evaluating such deflections at the building site. This value is based on a unit square foot area and should be adjusted for the planned mat size. The coefficient of subgrade reaction $\mathbf{K_b}$ for a mat of a specific width, may be evaluated using the following equation:

$$\mathbf{K_b = K_{v1}[(b+1)/2b]^2}$$

where **b** is the width of the foundation.

8.5.3. Foundation Lateral Resistance

For resistance of foundations to lateral loads, we recommend that an allowable passive pressure exerted by equivalent fluid weights of 230 pounds per cubic foot (pcf) above the water table, and 115 pcf below the water table be used. This value assumes that the ground is horizontal for a distance of 10 feet or more, or three times the height generating the passive pressure, whichever is greater. We recommend that the upper 1 foot of soil not protected by pavement or a concrete slab be neglected when calculating passive resistance.

For frictional resistance to lateral loads, we recommend a coefficient of friction of 0.30 be used between soil and concrete. The allowable lateral resistance can be taken as the sum of the frictional resistance and passive resistance provided the passive resistance does not exceed one-half of the total allowable resistance. The passive resistance values may be increased by one-third when considering loads of short duration such as wind or seismic forces.

8.5.4. Settlement

Based on our subsurface evaluation and laboratory testing, the alluvial materials encountered during our subsurface exploration, are not particularly susceptible to liquefaction and dynamic settlement in the event of a large nearby earthquake. However, some settlement of the alluvium due to additional loading may be anticipated. We estimate that the proposed structures will undergo total settlements of less than approximately 1 inch. Differential settlements are typically less than about one-half of the total settlement. To reduce to effect of settlement we recommend that settlement sensitive structures be founded on a mat foundation

8.6. Slabs-on-Grade

We recommend that conventional, slab-on-grade floors, underlain by very low to low expansive compacted fill, be 5 or more inches in thickness and be reinforced with No. 3 or larger reinforcing bars spaced 24 inches on center each way. The reinforcing bars should be placed near the mid-point of the slabs. As a means to help reduce shrinkage cracks, we recommend that the slabs be provided with expansion joints at intervals of approximately 12 feet, each way or as recommended by the structural engineer. The slab reinforcement and expansion joint spacing should be designed by the structural engineer.

If moisture sensitive floor coverings are to be used, we recommend that slabs be underlain by a vapor retarder and capillary break system consisting of a 10-mil polyethylene (or equivalent) membrane placed over 4 inches of medium to coarse clean sand or pea gravel and overlain by an additional 2 inches of sand to help protect the membrane from puncture during placement and to aid in concrete curing. The exposed subgrade should be moistened just prior to the placement of concrete.

Exterior concrete flatwork should be 5 inches or more in thickness and should be reinforced with No. 3 reinforcing bars placed at 24 inches on-center both ways. The vapor retarder may be deleted for exterior flatwork.

8.7. Seismic Response Spectra

Seismic response spectra were constructed using the general empirical approach and amplification factors recommended by Newmark and Hall (1982). Horizontal peak ground accelerations of 0.44g and 0.71g were selected as representative of earthquakes with recurrence intervals of approximately 475 years and 10,000 years, respectively for the construction of response spectra. The following site and magnitude dependent ground-motion-parameter relationships were used in the construction of the spectra:

$$v/a = 48 \text{ in/sec/g}$$

$$ad/v^2 = 6$$

Where **a** is acceleration, **v** is velocity, and **d** is displacement

Median (50 percentile) structural amplification factors were used together with the peak ground motion parameters to evaluate spectral values of acceleration, velocity, and displacement. Seismic response spectra for 0.5, 1.0, 2.0, 5.0, and 10.0 percent structural damping are shown on Figures 5 and 6.

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

It is our recommendation that new pipeline (pipe), where constructed in open excavations, be supported on 4 or more inches of granular bedding material. 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, the Standard Specifications for Public Works Construction (Public Works Standards, Inc., 2000), known as the "Greenbook," and the Water Agency Standard (WAS). Section 306-1.2.1 in the Greenbook defines bedding requirements for the installation of pipe. The trench excavation should provide 6 to 8 inches of lateral clearance between the trench wall and the side of the pipe. Pipe bedding typically consists of graded aggregate. The pipe bedding and pipe zone backfill should conform to the following gradation limits:

Sieve Sizes	Percentage Passing Sieves
1"	100%
3/4"	90-100%
No. 4	50-95%
No. 30	25-45%
No. 200	3-9%

Pipe bedding and pipe zone backfill should have a Sand Equivalent (SE) of 30 or greater, and be placed around the sides and top of the pipe. In addition, the pipe zone backfill should extend 1 foot or more above the top of the pipe.

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 and surcharge loads above the finish grade. A soil reaction modulus of 1,800 pounds per square inch (psi) may be used for a 5- to 10-foot deep excavation 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 up to 15-feet deep.

8.9. Thrust Blocks

Thrust blocks should be designed for the support of pipelines in accordance with the pressure diagram on Figure 7. Thrust block excavations should be backfilled with compacted granular material in accordance with the recommendations included in Section 7.1.

8.10. Pavements

Laboratory testing was performed on a sample of the on-site soils to evaluate the resistance value, or R-value. The test was in general accordance with California Test Method 301 and the results are presented in Appendix B.

The test results indicated that the R-value of the soil sample was approximately 23. We have used this R-value for the preliminary basis for design of flexible pavements at the project site. Actual pavement recommendations should be based on R-value tests performed on bulk

samples of the soils that are exposed at the finished subgrade elevations across the site at the completion of the grading operations.

We understand that traffic will consist primarily of automobiles and large trucks with heavy loads. For design we have used a Traffic Index (TI) of 5.0 for parking and 6.0 for drive lanes. We recommend that the geotechnical consultant re-evaluate the pavement design, based on the R-value of the subgrade material exposed at the time of construction. The preliminary recommended pavement sections are as follows:

Table 3 – Recommended Pavement Sections

Area	R-Value	Traffic Index	Asphalt Concrete (inches)	Class 2 Aggregate Base (inches)
Parking	23	5.0	3	7
Drive Lanes	23	6.0	3	10

In addition, we recommend that the upper 12 inches of the subgrade be moisture conditioned to near the optimum moisture content and compacted to a relative compaction of 95 or more of the modified Proctor dry density as evaluated by the latest version of ASTM D 1557. The above pavement sections should provide an approximate pavement life of 20 years. If traffic loads are different from those assumed, the pavement design should be re-evaluated.

We suggest that consideration be given to using portland cement concrete pavements in areas where dumpsters will be stored and where refuse trucks will stop and load. Experience indicates that refuse truck traffic can significantly shorten the useful life of asphalt concrete sections. We recommend that in these areas, 6 inches of 600 psi flexural strength portland cement concrete reinforced with No. 3 bars, 18 inches on center, be placed over 6 inches or more of Class II aggregate base compacted to a relative compaction of 95 percent.

8.11. Soil Corrosivity

Laboratory testing was performed on a sample of the on-site soils to evaluate pH and electrical resistivity, as well as chloride and sulfate contents. The pH and electrical resistivity tests

were performed in accordance with California Test Method 643, and the sulfate and chloride tests were performed in accordance with California Test Methods 417 and 422, respectively. These laboratory test results are presented in Appendix B.

The results of the corrosivity testing indicated that the electrical resistivity of the sample tested was approximately 2140 ohm-cm. The soil pH of the sample was 7.6, which is considered near neutral. The chloride content of the tested sample was approximately 25 ppm, and the sulfate content was approximately 0.01 percent. Based on Caltrans criteria, the site would not be classified as a corrosive site, which is defined as soil with more than 500 ppm chlorides or more than 0.20 percent sulfates.

8.12. Concrete Placement

In order to reduce the potential for shrinkage cracks in the concrete during curing, we recommend that the concrete for slabs or flatwork be placed with a slump of 4 inches or less. The slump should be checked at the site by a representative of a qualified materials testing laboratory prior to placement. Concrete should be placed in accordance with the American Concrete Institute (ACI) and project specifications.

8.13. Site Drainage

Drainage improvements, including subsurface drain lines and graded slopes and swales, should be provided and maintained to convey surface water runoff away from structures and off of pavement surfaces. Surface water should not drain toward the structures or pond adjacent to foundations. Positive drainage is defined as a slope of approximately 2 percent over a distance of about 5 feet.

8.14. Construction Observation and Testing

The conclusions and recommendations presented in this report are based on the results of our subsurface evaluation, laboratory testing, our site observations, and our experience with similar materials. If conditions are found to vary from those described in this report, the geo-

technical consultant should be notified and additional recommendations will be provided upon request. Project plans should also be reviewed by the geotechnical consultant prior to the start of construction.

The geotechnical consultant should perform appropriate observation and testing services during construction operations, including observation of foundation excavations and evaluation of subgrade conditions in areas where flatwork or settlement-sensitive improvements are to be constructed. The geotechnical consultant should also observe and test the placement and compaction of fill soils.

The recommendations provided in this report are based on the assumption that Ninyo & Moore will provide geotechnical observation and testing services during construction. In the event that it is decided not to utilize the services of Ninyo & Moore during construction, we request that the selected consultant provide the client with a letter (with a copy to Ninyo & Moore) indicating that they fully understand Ninyo & Moore's recommendations, and that they are in full agreement with the design parameters and recommendations contained in this report. Construction of proposed improvements should be performed by qualified subcontractors utilizing appropriate techniques and construction materials.

9. LIMITATIONS

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

project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

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

This report is intended for design purposes only. It does not provide sufficient data to prepare an accurate bid by contractors. It is suggested that the bidders and their geotechnical consultant perform an independent evaluation of the subsurface conditions in the project areas. The independent evaluations may include, but not be limited to, review of other geotechnical reports prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing.

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

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

10. SELECTED REFERENCES

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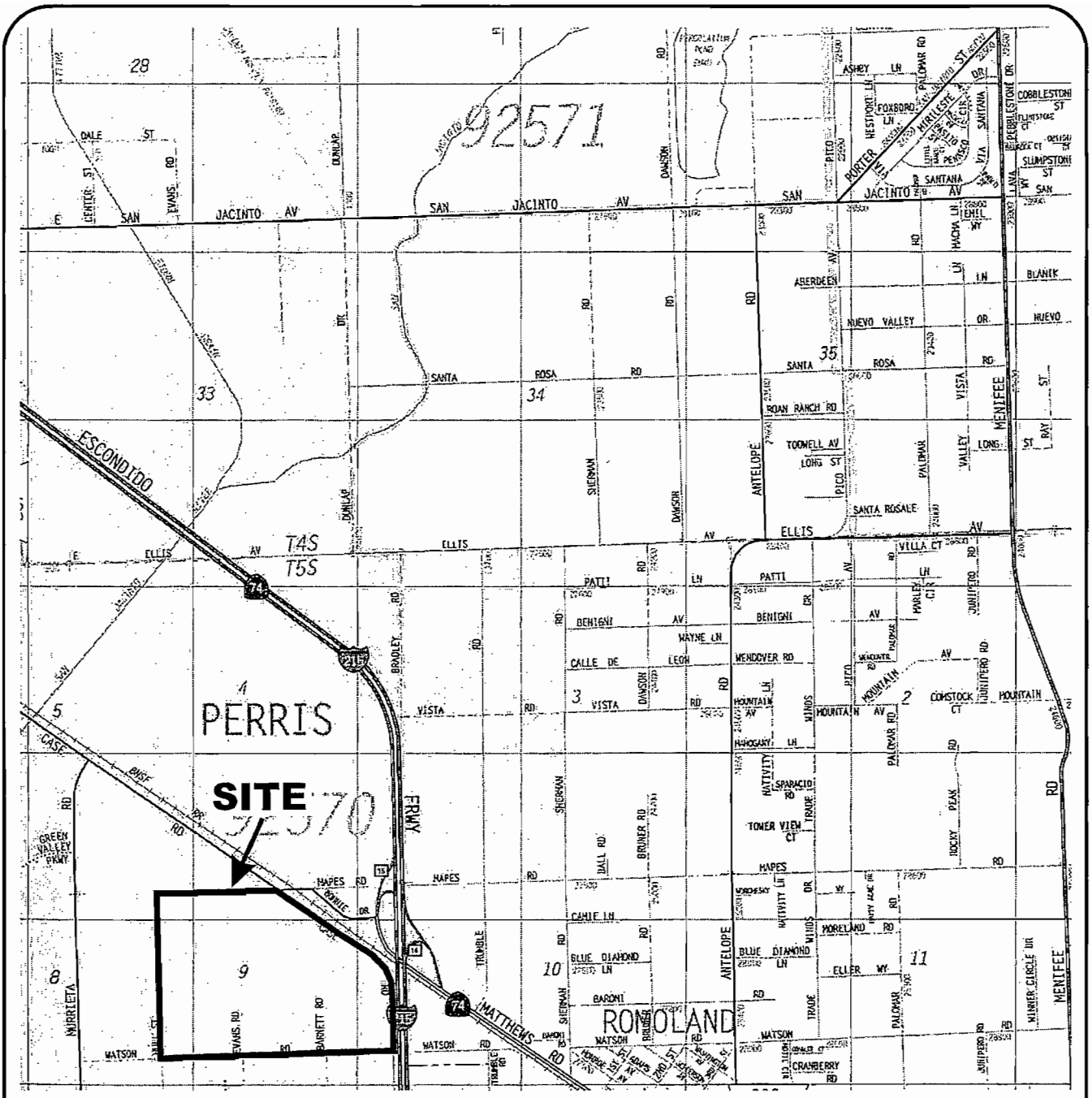
AERIAL PHOTOGRAPHS				
Source	**Date**	**Flight**	**Numbers**	**Scale**
USDA	8-28-53	AXM-2K	115 and 116	1:20,000



0 2400 4800

Approximate Scale in Feet

N

REFERENCE: 2005 THOMAS GUIDE FOR SAN BERNARDINO AND RIVERSIDE COUNTIES, STREET GUIDE AND DIRECTORY.

105707001 sim Fig 1

Ninyo & Moore

SITE LOCATION MAP

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	1

LEGEND

B-6 Approximate location of proposed boring

Site boundary

Not to Scale

Ninyo & Moore

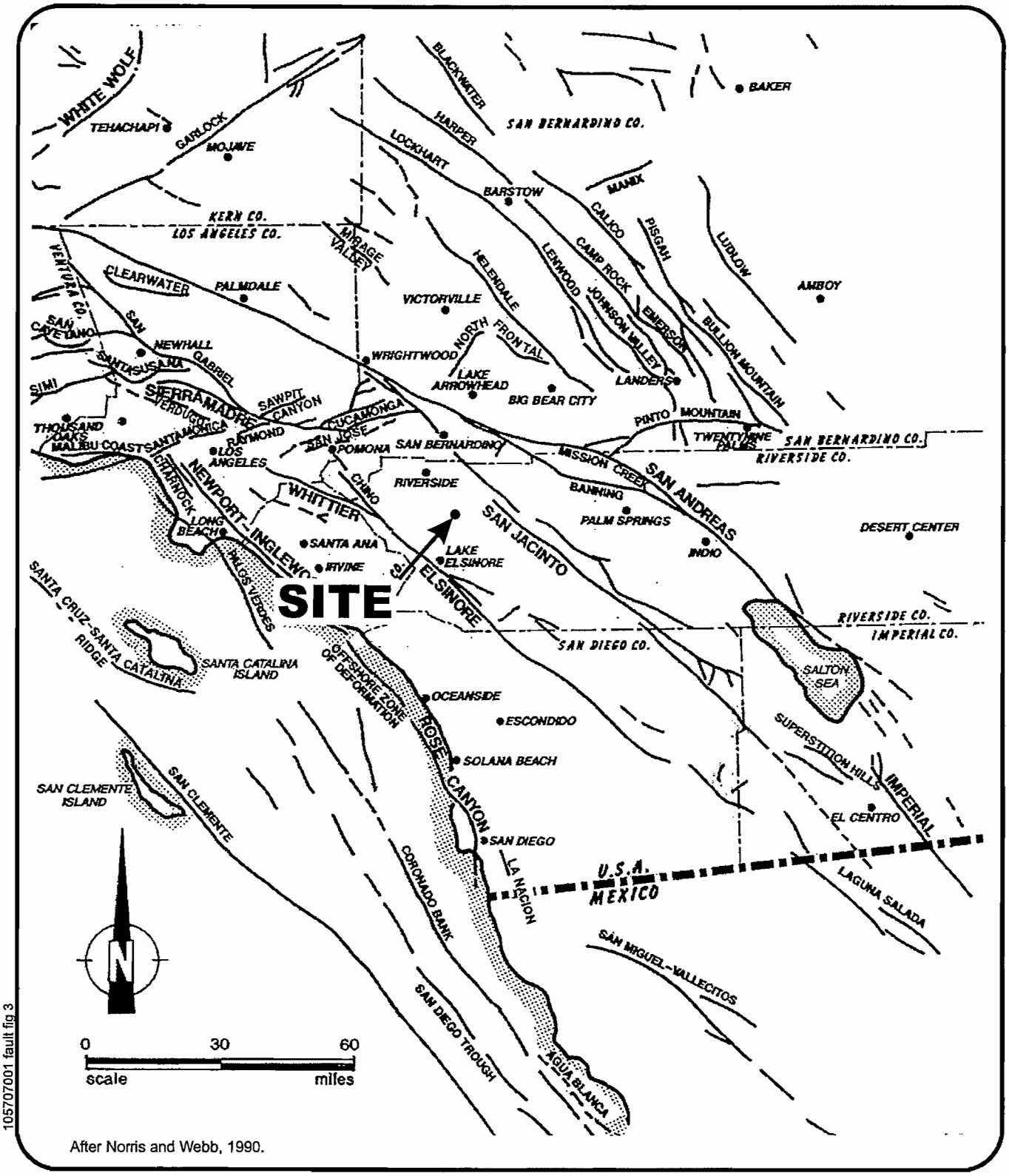
BORING LOCATION MAP

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	2

REFERENCE: 2005 Google Earth Image.

105707001 blm fig 2



After Norris and Webb, 1990.

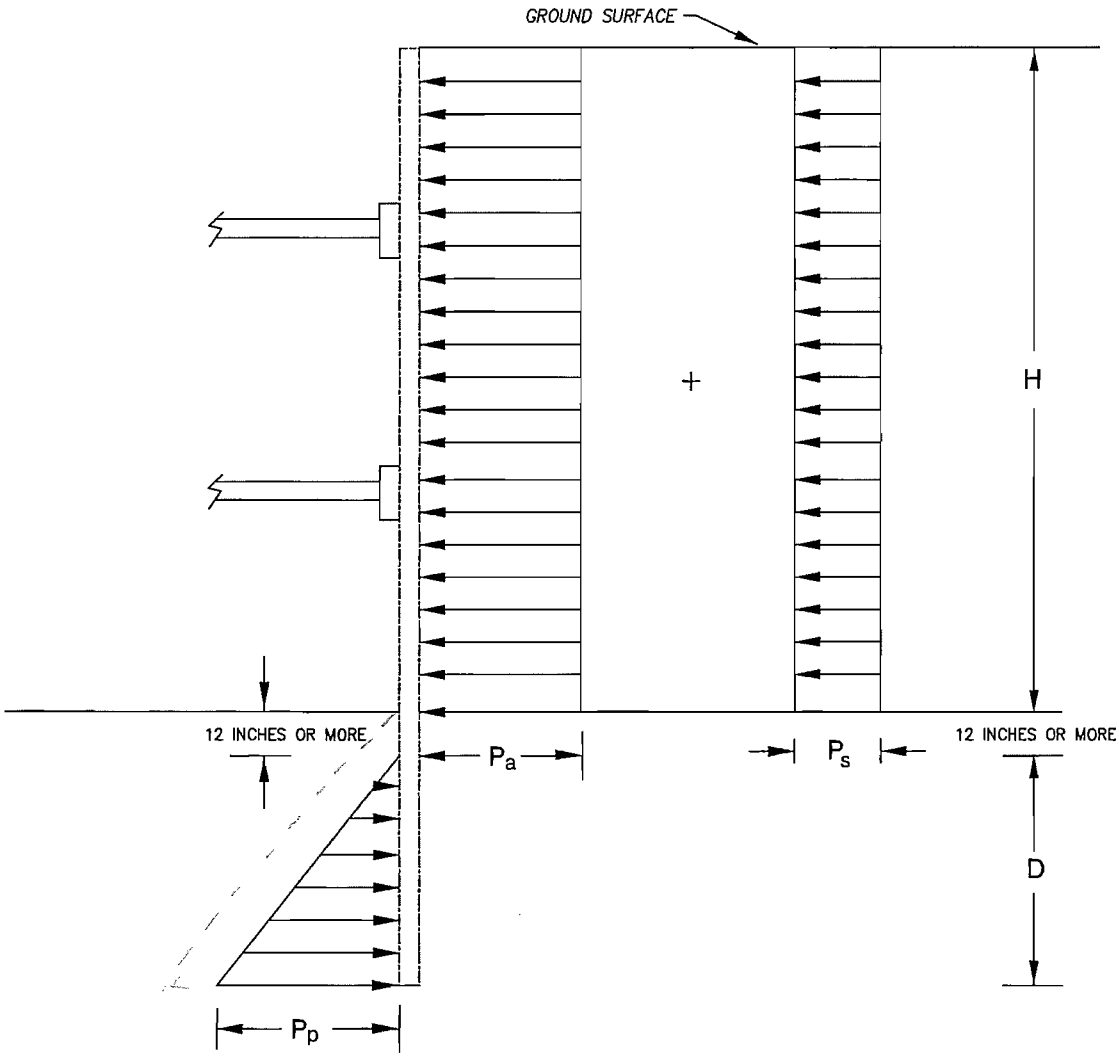
105707001 fault fig 3

Ninyo & Moore

FAULT LOCATION MAP

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	3



NOTES:

1. APPARENT LATERAL EARTH PRESSURE, P_a
   $P_a = 45H$ psf
2. CONSTRUCTION TRAFFIC INDUCED SURCHARGE PRESSURE, P_s
   $P_s = 120$ psf
3. PASSIVE LATERAL EARTH PRESSURE, P_p
   $P_p = 230D$ psf
4. ASSUMES GROUNDWATER NOT PRESENT
5. SURCHARGES FROM EXCAVATED SOIL OR CONSTRUCTION MATERIALS ARE NOT INCLUDED
6. H AND D ARE IN FEET

NOT TO SCALE

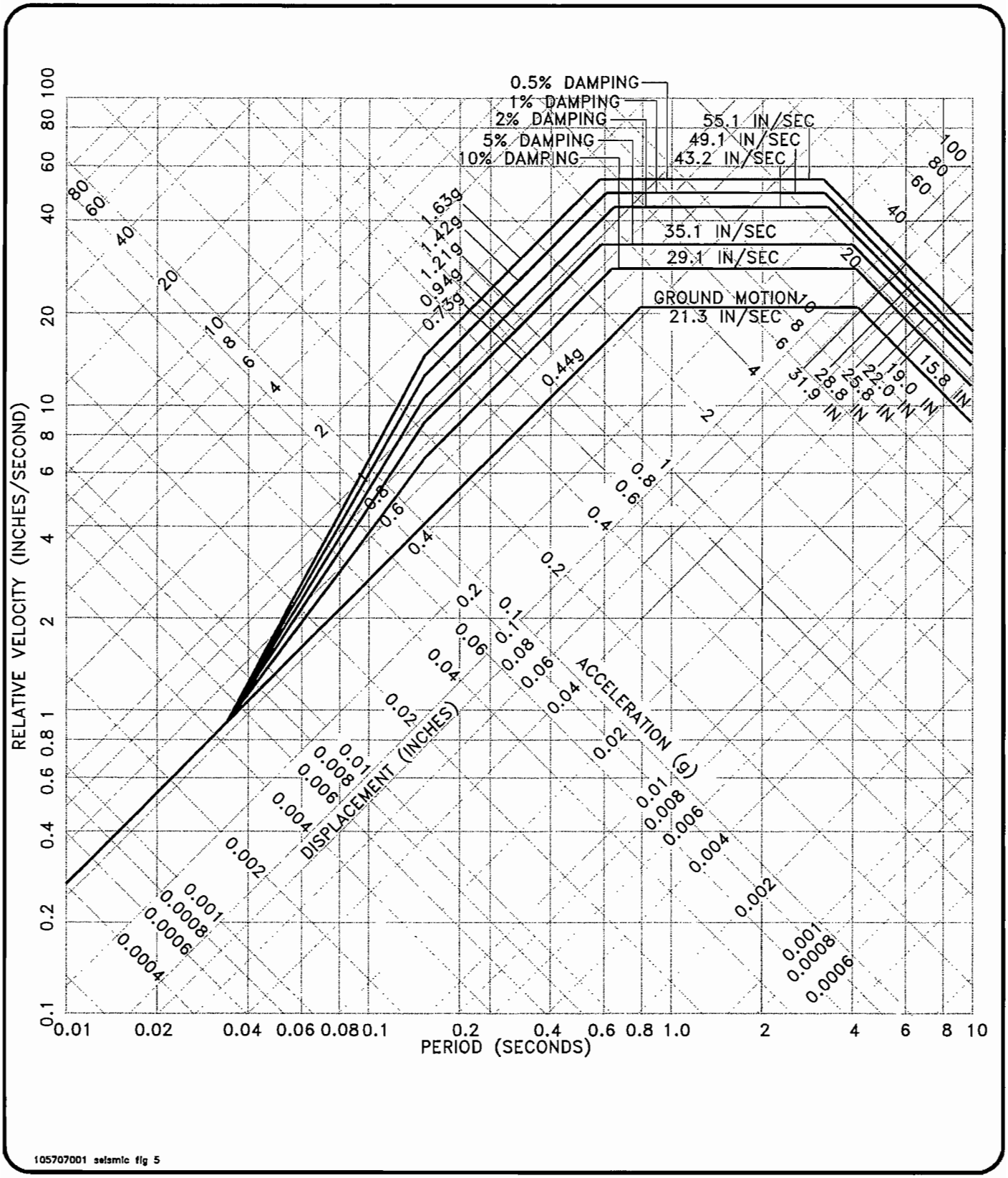
EARTH-PRESS4.dwg

Ninyo & Moore

LATERAL EARTH PRESSURES FOR TEMPORARY BRACED SHORING (GRANULAR SOIL)

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	4



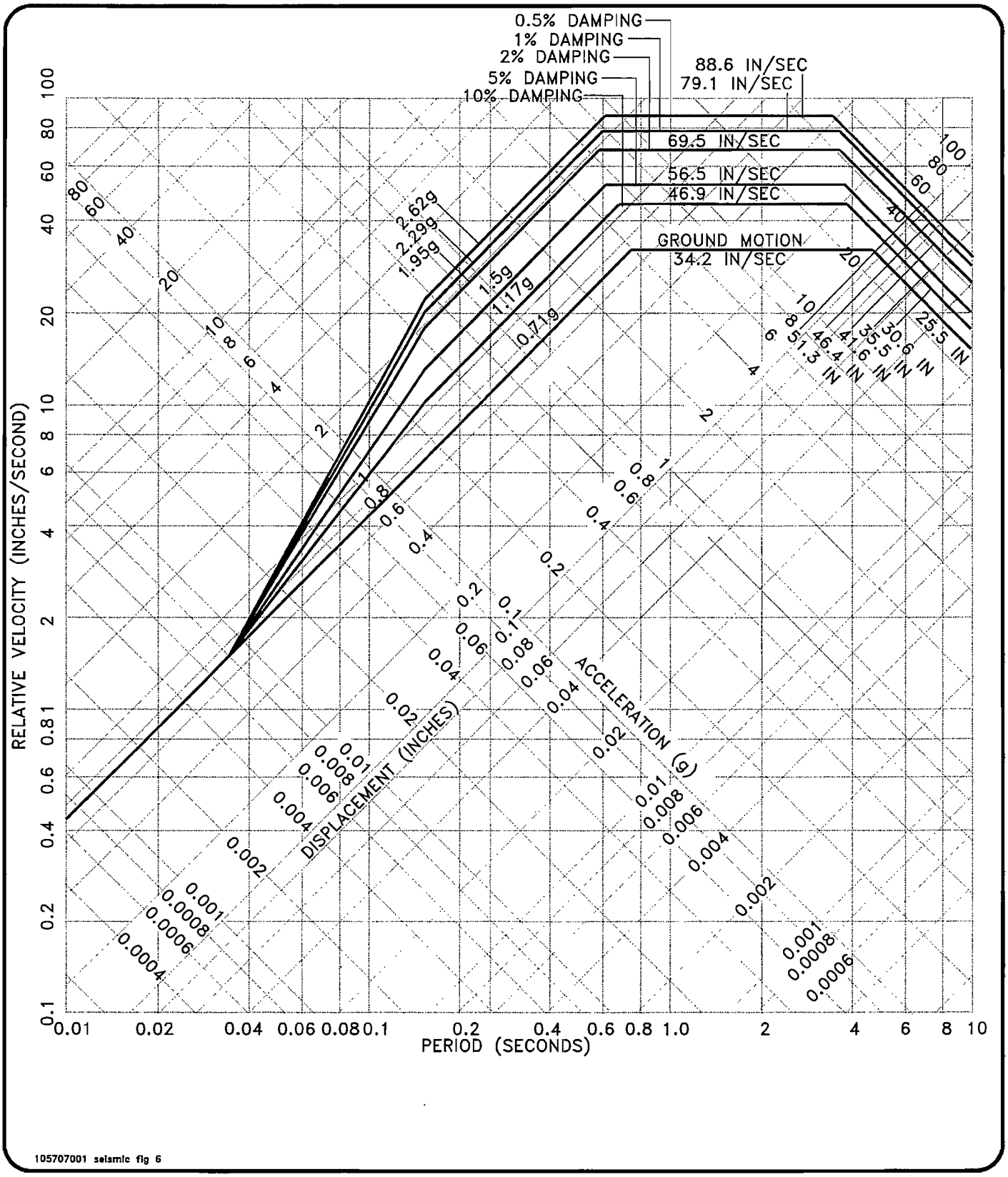
105707001 seismic fig 5

Ninyo & Moore

SEISMIC RESPONSE SPECTRA
0.44g PEAK GROUND ACCELERATION

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	5



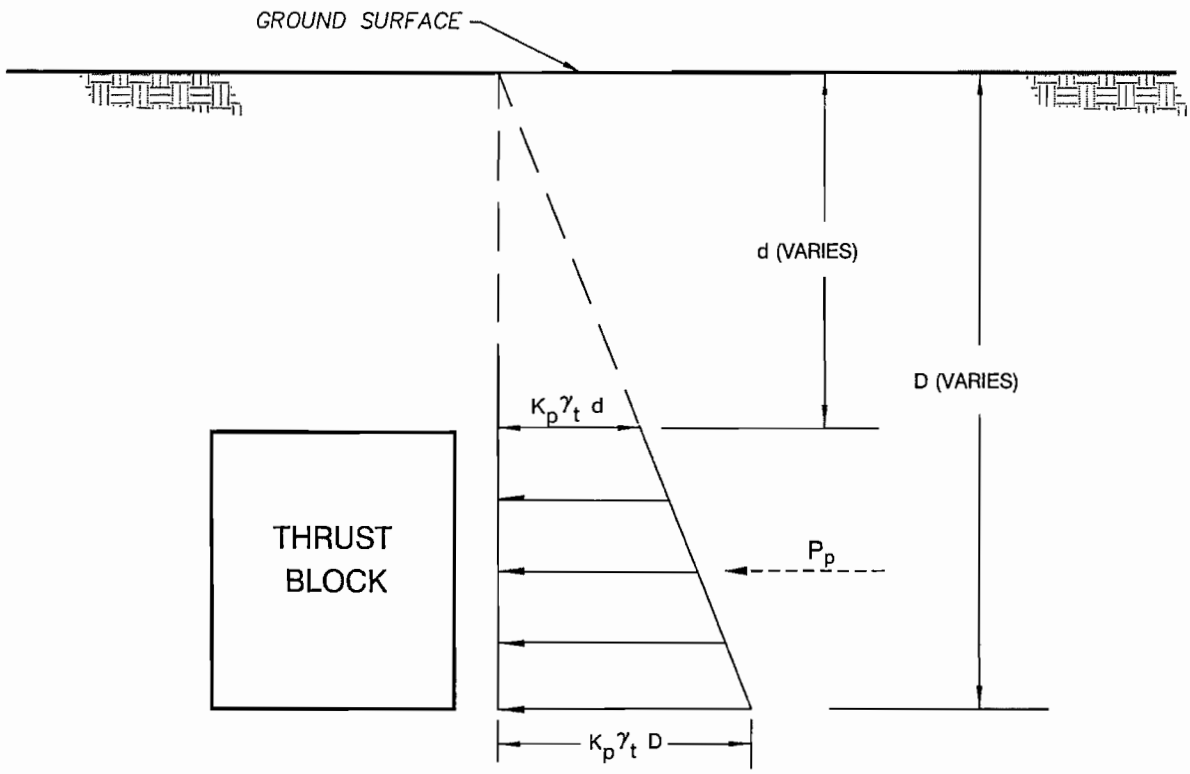
105707001 seismic fig 6

Ninyo & Moore

SEISMIC RESPONSE SPECTRA
0.71g PEAK GROUND ACCELERATION

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	6



NOTES:

1. GROUNDWATER BELOW BLOCK
   $P_p = (1/2) K_p \gamma_t (D^2 - d^2) = 115 (D^2 - d^2)$ lb/ft
2. GROUNDWATER ABOVE BLOCK
   $P_p = 58 (D^2 - d^2)$ lb/ft
3. d AND D ARE IN FEET
4. ASSUMES BACKFILL IS GRANULAR MATERIAL
5. ASSUMES THRUST BLOCK IS ADJACENT TO COMPETENT MATERIAL

NOT TO SCALE

105707001 thrust fig 7

Ninyo & Moore

THRUST BLOCK LATERAL EARTH PRESSURE DIAGRAM

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	7

APPENDIX A

BORING LOGS

Field Procedure for the Collection of Disturbed Samples

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

Bulk Samples

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

The Standard Penetration Test (SPT) Spoon

Disturbed drive samples of earth materials were obtained by means of a Standard Penetration Test spoon sampler. The sampler is composed of a split barrel with an external diameter of 2 inches and an unlined internal diameter of 1-3/8 inches. The spoon was driven into the ground 12 to 18 inches with a 140-pound hammer free-falling from a height of 30 inches in general accordance with ASTM D 1586-99. The blow counts were recorded for every 6 inches of penetration; the blow counts reported on the logs are those for the last 12 inches of penetration. Soil samples were observed and removed from the spoon, bagged, sealed and transported to the laboratory for testing.

Field Procedure for the Collection of Relatively Undisturbed Samples

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

The Modified Split-Barrel Drive Sampler

The sampler, with an external diameter of 3.0 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 a weight in general accordance with ASTM D 3550-84. The driving weight was permitted to fall freely. The approximate length of the fall, the weight, 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.

DATE DRILLED 09/21/05 BORING NO. B-1

GROUND ELEVATION 1415' ± (MSL) SHEET 1 OF 3

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (Mobile B-61)

DRIVE WEIGHT 140 lbs. (Auto-Trip Hammer) DROP 30"

SAMPLED BY CAT LOGGED BY CAT REVIEWED BY FOM

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						ML	AGRICULTURAL TOPSOIL: Reddish brown, damp, loose, clayey, fine to medium sandy SILT; micaceous.
		17				SC	ALLUVIUM: Reddish brown, damp, medium dense to dense, clayey fine SAND; micaceous; trace of coarse sand.
5		28	14.4	109.3			Moist.
10		19					Medium dense; fine to coarse sand; few fine gravel.
15		33	24.0	102.7			Wet.
						SM	Brownish red, wet, medium dense to dense, silty fine to coarse SAND; trace of clay; few fine gravel; micaceous.
20						SC	Brownish red, moist, dense, clayey fine to coarse SAND; micaceous.

Ninyo & Moore

BORING LOG

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	A-1

DATE DRILLED 09/21/05 BORING NO. B-1

GROUND ELEVATION 1415' ± (MSL) SHEET 2 OF 3

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (Mobile B-61)

DRIVE WEIGHT 140 lbs. (Auto-Trip Hammer) DROP 30"

SAMPLED BY CAT LOGGED BY CAT REVIEWED BY FOM

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20			23				SC	ALLUVIUM (Continued): Brownish red, moist, dense, clayey fine to coarse SAND; micaceous.
25			78					Very dense; few fine gravel.
30			42				SM	Light yellowish brown, moist, very dense, silty fine to coarse SAND; micaceous; few fine gravel; cohesionless.
								Increase in clay content.
								Dense.
35			61					Brownish red.
				▽				Saturated.
							SC+SM	Light brown with reddish brown mottled, saturated, dense, clayey fine SAND interlayered with silty SAND; micaceous; fine gravel.
40								

Ninyo & Moore

BORING LOG

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	A-2

DATE DRILLED 09/21/05 BORING NO. B-1

GROUND ELEVATION 1415' ± (MSL) SHEET 3 OF 3

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (Mobile B-61)

DRIVE WEIGHT 140 lbs. (Auto-Trip Hammer) DROP 30"

SAMPLED BY CAT LOGGED BY CAT REVIEWED BY FOM

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
40			27				SC+SM	ALLUVIUM (Continued): Light brown with reddish brown mottling, saturated, dense, clayey fine SAND interlayered with silty fine SAND; micaceous; few gravel.
45			50/6"				SM	Light brown, saturated, very dense, silty fine to coarse SAND; micaceous.
50			45				ML	Reddish brown, saturated, very dense, sandy SILT; with clay.
55								Total Depth = 51.5 feet. Groundwater encountered during drilling at approximately 37 feet. Backfilled with bentonite grout on 09/21/05.
60								

Ninyo & Moore

BORING LOG

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	A-3

DATE DRILLED 09/21/05 BORING NO. B-2

GROUND ELEVATION 1415' ± (MSL) SHEET 1 OF 2

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (Mobile B-61)

DRIVE WEIGHT 140 lbs. (Auto-Trip Hammer) DROP 30"

SAMPLED BY CAT LOGGED BY CAT REVIEWED BY FOM

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							ML	AGRICULTURAL TOPSOIL: Brown, damp, loose, gravelly, fine sandy SILT.
			50/6"	6.2	114.2		SM	ALLUVIUM: Reddish brown, damp, very dense, silty fine SAND; micaceous.
5			18					Medium dense; silty fine to medium sand; some clay.
							CL+SC	Reddish brown, damp, medium dense, clayey fine to coarse SAND interlayered with very stiff fine to coarse sandy CLAY; micaceous.
10			23	12.8	122.0			
15			8					Moist; a few fine gravel.
							SC	Reddish brown, damp, dense, clayey fine to coarse SAND; micaceous; few fine gravel.
20								

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BORING LOG

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	A-4

DATE DRILLED 09/21/05 BORING NO. B-2

GROUND ELEVATION 1415' ± (MSL) SHEET 2 OF 2

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (Mobile B-61)

DRIVE WEIGHT 140 lbs. (Auto-Trip Hammer) DROP 30"

SAMPLED BY CAT LOGGED BY CAT REVIEWED BY FOM

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20		■	61				SC	ALLUVIUM (Continued): Reddish brown, damp, dense, clayey fine to coarse SAND; micaceous; few fine gravel.
								Total Depth = 21.5 feet. Groundwater not encountered during drilling. Backfilled with bentonite grout on 09/21/05.
25								
30								
35								
40								

Ninyo & Moore

BORING LOG

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	A-5

DATE DRILLED 09/21/05 BORING NO. B-3

GROUND ELEVATION 1415' ± (MSL) SHEET 1 OF 2

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (Mobile B-61)

DRIVE WEIGHT 140 lbs. (Auto-Trip Hammer) DROP 30"

SAMPLED BY CAT LOGGED BY CAT REVIEWED BY FOM

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							ML	AGRICULTURAL TOPSOIL: Light brown, damp, loose, gravelly, fine sandy SILT.
			22				SM	ALLUVIUM: Brown, damp, dense, silty, fine to coarse SAND.
5			73	10.3	118.0		ML	Brown, damp, very dense, fine to coarse sandy SILT; micaceous.
10			14					Medium dense; with clay.
15			26	13.8	115.3		SC	Brown, moist, medium dense, clayey fine to coarse SAND.
20							CL	Brownish red, damp, very stiff, silty fine sandy CLAY; micaceous.

Ninyo & Moore

BORING LOG

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	A-6

DATE DRILLED 09/21/05 BORING NO. B-3

GROUND ELEVATION 1415' ± (MSL) SHEET 2 OF 2

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (Mobile B-61)

DRIVE WEIGHT 140 lbs. (Auto-Trip Hammer) DROP 30"

SAMPLED BY CAT LOGGED BY CAT REVIEWED BY FOM

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20		■	19				CL	ALLUVIUM (Continued): Brownish red, damp, very stiff, silty, fine sandy CLAY; micaceous.
								Total Depth = 21.5 feet. Groundwater not encountered during drilling. Backfilled with bentonite grout on 09/21/05.
25								
30								
35								
40								

Ninyo & Moore

BORING LOG

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	A-7

DATE DRILLED 09/21/05 BORING NO. B-4

GROUND ELEVATION 1415' ± (MSL) SHEET 1 OF 2

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (Mobile B-61)

DRIVE WEIGHT 140 lbs. (Auto-Trip Hammer) DROP 30"

SAMPLED BY CAT LOGGED BY CAT REVIEWED BY FOM

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						ML	AGRICULTURAL TOPSOIL: Brown, damp, loose, gravelly, fine sandy SILT.
		27	6.7	102.3		ML	ALLUVIUM: Brown, damp, medium dense, fine sandy SILT.
5		16					Trace of clay.
10		12	15.9	109.8			Moist; loose; clayey; micaceous.
15		12				CL	Brown, moist, very stiff, fine to coarse sandy CLAY.
20						SC	Reddish brown, moist, dense, clayey fine to medium SAND; micaceous.

Ninyo & Moore

BORING LOG

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	A-8

DATE DRILLED 09/21/05 BORING NO. B-4

GROUND ELEVATION 1415' ± (MSL) SHEET 2 OF 2

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (Mobile B-61)

DRIVE WEIGHT 140 lbs. (Auto-Trip Hammer) DROP 30"

SAMPLED BY CAT LOGGED BY CAT REVIEWED BY FOM

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20			59				SC	ALLUVIUM (Continued): Reddish brown, moist, dense, clayey fine to medium SAND; micaceous.
								Total Depth = 21.5 feet. Groundwater not encountered during drilling. Backfilled with bentonite grout on 09/21/05.
25								
30								
35								
40								

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BORING LOG

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	A-9

DATE DRILLED 09/21/05 BORING NO. B-5

GROUND ELEVATION 1415' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING 8" Diameter Hollow Stem Auger (Mobile B-61)

DRIVE WEIGHT 140 lbs. (Auto-Trip Hammer) DROP 30"

SAMPLED BY CAT LOGGED BY CAT REVIEWED BY FOM

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						ML	AGRICULTURAL TOPSOIL: Brown, damp, loose, gravelly, fine sandy SILT.
		32				SM	ALLUVIUM: Brown, damp, dense, silty fine to medium SAND.
5		26	9.6	110.3			Medium dense; trace of clay.
10		16					
							Total Depth = 11.5 feet. Groundwater not encountered during drilling. Backfilled on 09/21/05.
15							
20							

Ninyo & Moore

BORING LOG

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	A-10

DATE DRILLED 09/21/05 BORING NO. B-6

GROUND ELEVATION 1415' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING Manual

DRIVE WEIGHT N/A DROP N/A

SAMPLED BY CAT LOGGED BY CAT REVIEWED BY FOM

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0	■						ML	FILL: Brown, damp, loose, gravelly, fine to coarse sandy SILT.
							CL	ALLUVIUM: Brown, damp, stiff, fine to coarse sandy CLAY.
							SC	Brown, damp, medium dense, clayey, fine to coarse SAND.
5		■						
								Total Depth = 6 feet. Groundwater not encountered. Backfilled on 09/21/05.
10								
15								
20								

Ninyo & Moore

BORING LOG

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	A-11

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 2488-93. Soil classifications are indicated on the logs of the exploratory excavations in Appendix A.

In-Place Moisture and Density Tests

The moisture content and dry density of relatively undisturbed samples obtained from the exploratory excavations were evaluated in general accordance with ASTM D 2937-94. The test results are presented on the logs of the exploratory excavations in Appendix A.

Gradation Analysis

Gradation analysis tests were performed on selected representative soil samples in general accordance with ASTM D 422-63. The grain-size distribution curves are shown on Figures B-1 and B-2. These test results were utilized in evaluating the soil classifications in accordance with the Unified Soil Classification System.

Consolidation Test

A consolidation test was performed on selected relatively undisturbed soil sample in general accordance with ASTM D 2435-03. The sample was inundated during testing to represent adverse field conditions. The percent of consolidation for each load cycle was recorded as a ratio of the amount of vertical compression to the original height of the sample. The results of the test are shown on Figure B-3.

Shear Strength Tests

Shear strength tests were performed on undisturbed samples in general accordance with ASTM D 3080-03 to evaluate the shear strength characteristics of selected materials. The samples were inundated during shearing to represent adverse field conditions. The results are summarized on Figure B-4.

Expansion Index Test

The expansion index of selected material was evaluated in general accordance with U.B.C. Standard No. 18-2. The specimen was molded under a specified compactive energy at approximately 50 percent saturation (plus or minus 1 percent). The prepared 1-inch thick by 4-inch diameter specimen was loaded with a surcharge of 144 pounds per square foot and was inundated with tap water. Readings of volumetric swell were made for a period of 24 hours. The results of the test are presented on Figure B-5.

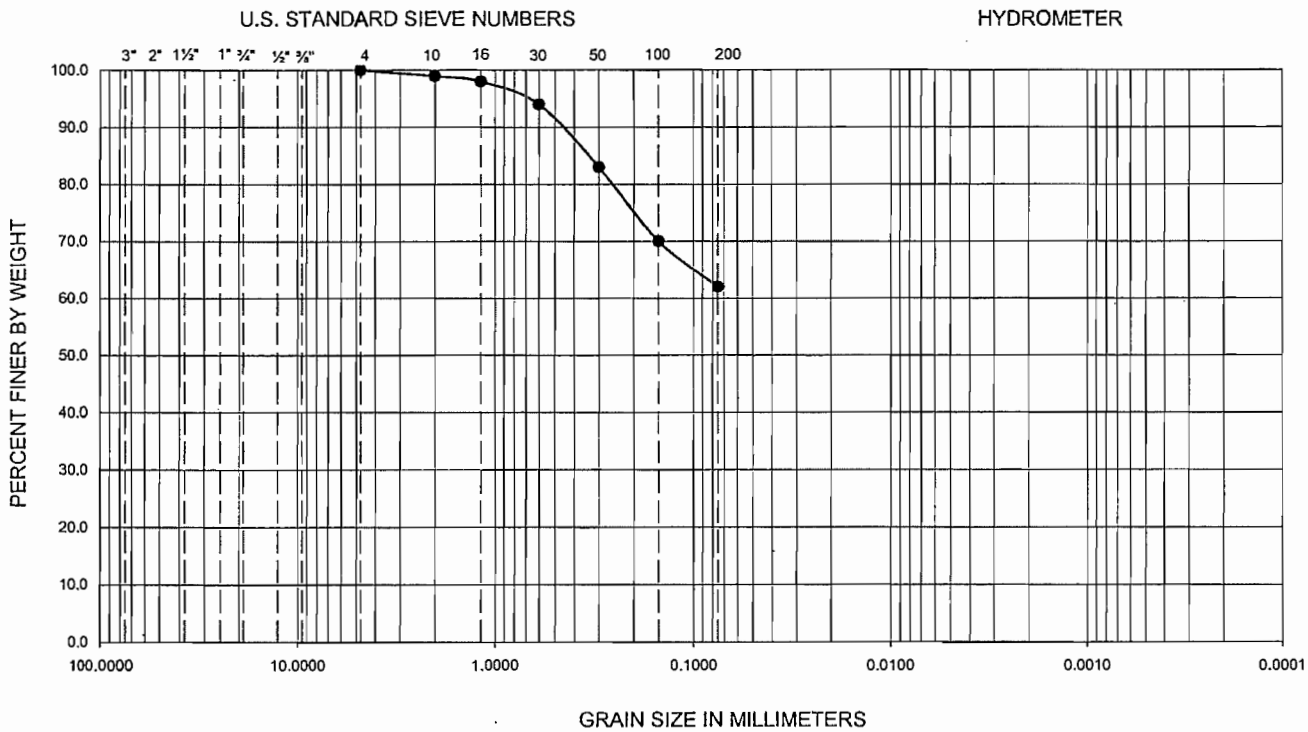
Soil Corrosivity Tests

Soil pH, and minimum resistivity tests were performed on a representative soil sample in general accordance with California Test (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.

R-Value

The resistance value, or R-value, for site soils was evaluated in general accordance with California Test Method 301. A representative soil sample was prepared and evaluated for exudation pressure and expansion pressure. The equilibrium R-value is reported as the lesser or more conservative of the two calculated results. The test results are shown on 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 (%)	U.S.C.S
●	B-1	50.0-51.5	--	--	--	--	--	--	--	--	62	ML

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422-63 (02)

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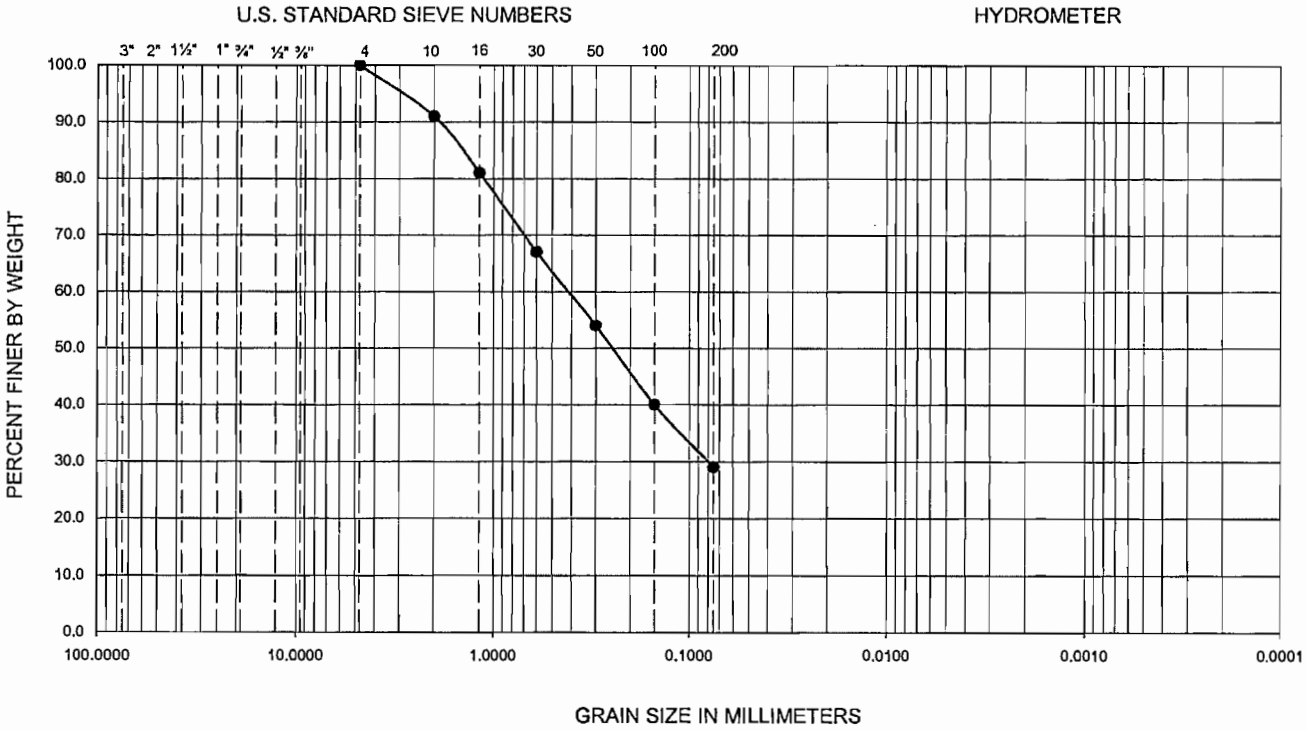
GRADATION TEST RESULTS

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	B-1

105707001 SIEVE, B-1@50.0-51.5.xls

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 (%)	U.S.C.S
●	B-5	10.0-11.5	--	--	--	--	--	--	--	--	29	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422-63 (02)

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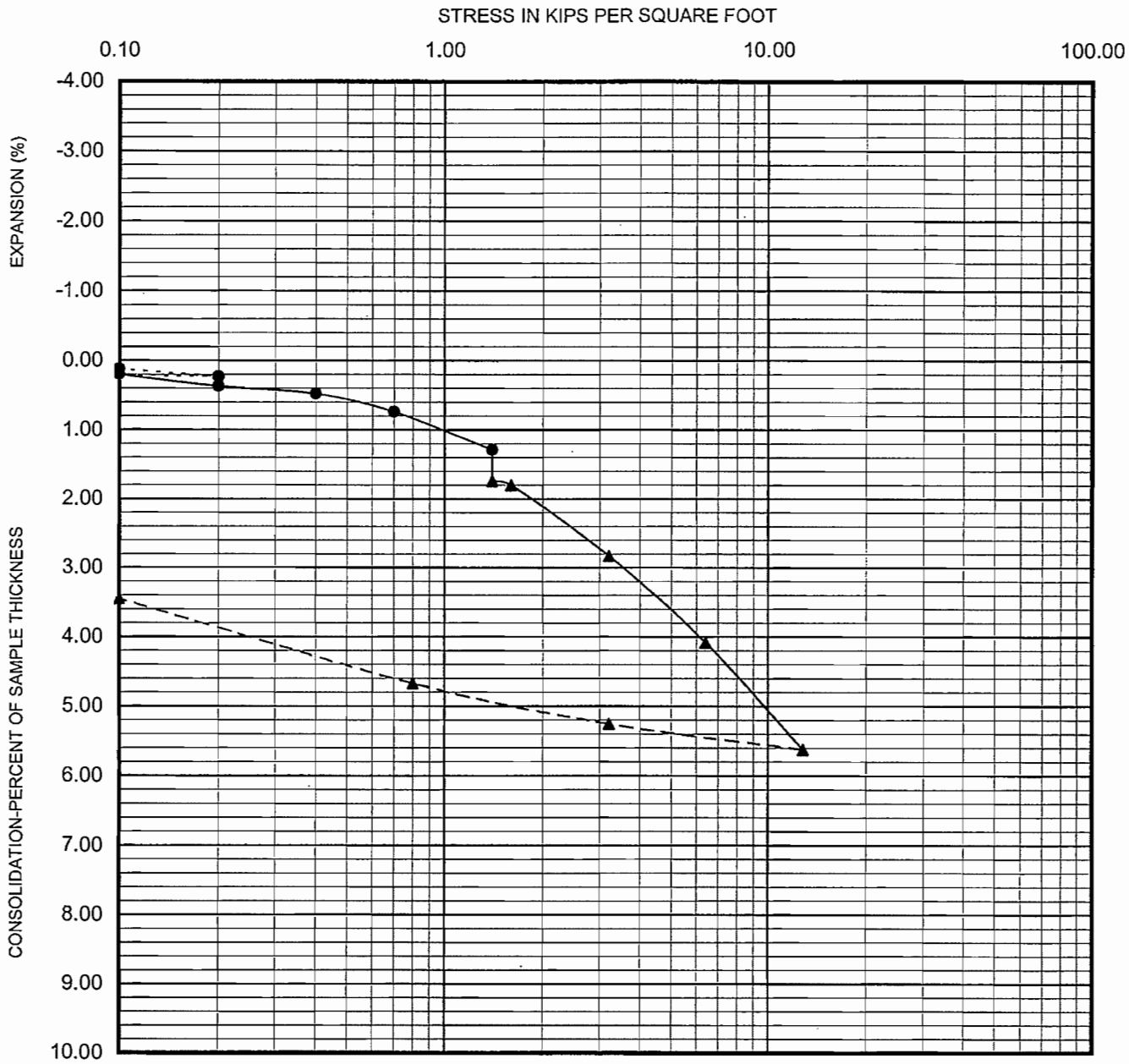
GRADATION TEST RESULTS

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	B-2

105707001 SIEVE, B-5@10.0-11.5.xls



---●---	Seating Cycle	Boring No.	B-2
—●—	Loading Prior to Inundation	Depth (ft.)	10.0-11.5
—▲—	Loading After Inundation	Soil Type	SC
---▲---	Rebound Cycle		

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435-03

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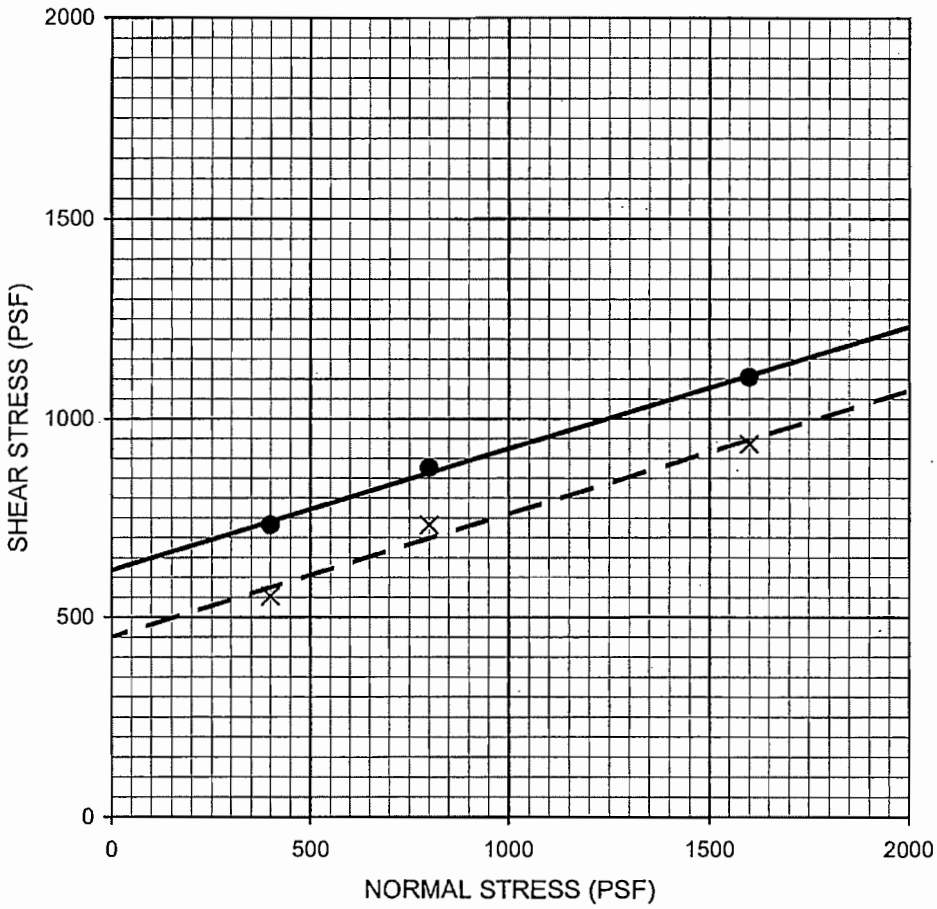
CONSOLIDATION TEST RESULTS

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	B-3



Description	Symbol	Sample Location	Depth (ft)	Shear Strength	Cohesion, c (psf)	Friction Angle, ϕ (degrees)	Soil Type
Clayey SAND	—●—	B-1	5.0-6.5	Peak	620	17	SC
Clayey SAND	- - X - -	B-1	5.0-6.5	Ultimate	450	17	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 3080-03

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DIRECT SHEAR TEST RESULTS

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	B-4

105707001 SHEAR, B-1@5.0-6.5.xls

EXPANSION INDEX TEST RESULTS

SAMPLE LOCATION	SAMPLE DEPTH (FT)	INITIAL MOISTURE (%)	COMPACTED DRY DENSITY (PCF)	FINAL MOISTURE (%)	VOLUMETRIC SWELL (IN)	EXPANSION INDEX	EXPANSION POTENTIAL
B-6	4.0-6.0	7.8	117.6	15.8	0.037	37	Low

PERFORMED IN GENERAL ACCORDANCE WITH UBC STANDARD 18-2
PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4829-03

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EXPANSION INDEX TEST RESULTS

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	B-5

CORROSIVITY TEST RESULTS

SAMPLE LOCATION	SAMPLE DEPTH (FT)	pH *	RESISTIVITY * (ohm-cm)	WATER-SOLUBLE SULFATE CONTENT IN SOIL ** (%)	CHLORIDE CONTENT *** (ppm)
B-2	0.0-5.0	7.6	2,140	0.01	25

* PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 643
** PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 417
*** PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 422

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CORROSIVITY TEST RESULTS

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	B-6

R-VALUE TEST RESULTS

SAMPLE LOCATION	SAMPLE DEPTH (FT)	SOIL TYPE	R-VALUE
B-2	0.0-5.0	SM	23

PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 301

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R-VALUE TEST RESULTS

PERRIS II DESALINATION FACILITY
PERRIS, CALIFORNIA

PROJECT NO.	DATE	FIGURE
105707001	10/05	B-7

APPENDIX C

TYPICAL EARTHWORK GUIDELINES

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Figure D – Oversized Rock Placement Detail
Figure E – Slope Drainage Detail
Figure F – Shear Key Detail
Figure G – Drain Detail

TYPICAL EARTHWORK GUIDELINES FOR SLOPES

1. GENERAL

These guidelines and the standard details attached hereto are presented as general procedures for earthwork construction. They are to be utilized in conjunction with the project grading plans. These guidelines are considered a part of the geotechnical report, but are superseded by recommendations in the geotechnical report in the case of conflict. Evaluations performed by the consultant during the course of grading may result in new recommendations which could supersede these specifications and/or the recommendations of the geotechnical report. It is the responsibility of the contractor to read and understand these guidelines as well as the geotechnical report and project grading plans.

1.1. The contractor shall not vary from these guidelines without prior recommendations by the geotechnical consultant and the approval of the client or the client's authorized representative. Recommendations by the geotechnical consultant and/or client shall not be considered to preclude requirements for approval by the jurisdictional agency prior to the execution of any changes.

1.2. The contractor shall perform the grading operations in accordance with these specifications, and shall be responsible for the quality of the finished product notwithstanding the fact that grading work will be observed and tested by the geotechnical consultant.

1.3. It is the responsibility of the grading contractor to notify the geotechnical consultant and the jurisdictional agencies, as needed, prior to the start of work at the site and at any time that grading resumes after interruption. Each step of the grading operations shall be observed and documented by the geotechnical consultant and, where necessary, reviewed by the appropriate jurisdictional agency prior to proceeding with subsequent work.

1.4. If, during the grading operations, geotechnical conditions are encountered which were not anticipated or described in the geotechnical report, the geotechnical consultant shall be notified immediately and additional recommendations, if applicable, may be provided.

1.5. An as-graded report shall be prepared by the geotechnical consultant and signed by a registered engineer and registered engineering geologist. The report documents the geotechnical consultants' observations, and field and laboratory test results, and

provides conclusions regarding whether or not earthwork construction was performed in accordance with the geotechnical recommendations and the grading plans. Recommendations for foundation design, pavement design, subgrade treatment, etc., may also be included in the as-graded report.

1.6. For the purpose of evaluating quantities of materials excavated during grading and/or locating the limits of excavations, a licensed land surveyor or civil engineer shall be retained.

1.7. Definitions of terms utilized in the remainder of these specifications have been provided in Section 11.

2. OBLIGATIONS OF PARTIES

The parties involved in the projects earthwork activities shall be responsible as outlined in the following sections.

2.1. The client is ultimately responsible for the aspects of the project. The client or the client's authorized representative has a responsibility to review the findings and recommendations of the geotechnical consultant. The client shall authorize the contractor and/or other consultants to perform work and/or provide services. During grading the client or the client's authorized representative shall remain on site or remain reasonably accessible to the concerned parties to make the decisions that may be needed to maintain the flow of the project.

2.2. The contractor is responsible for the safety of the project and satisfactory completion of grading and other associated operations, including, but not limited to, earthwork in accordance with the project plans, specifications, and jurisdictional agency requirements. During grading, the contractor or the contractor's authorized representative shall remain on site. The contractor shall further remain accessible during non-working hours times, including at night and during days off.

2.3. The geotechnical consultant shall provide observation and testing services and shall make evaluations to advise the client on geotechnical matters. The geotechnical consultant shall report findings and recommendations to the client or the client's authorized representative.

2.4. Prior to proceeding with any grading operations, the geotechnical consultant shall be notified two working days in advance to schedule the needed observation and testing services.

2.4.1. Prior to any significant expansion or reduction in the grading operation, the geotechnical consultant shall be provided with two working days notice to make appropriate adjustments in scheduling of on-site personnel.

2.4.2. Between phases of grading operations, the geotechnical consultant shall be provided with two working days notice in advance of commencement of additional grading operations.

3. SITE PREPARATION

Site preparation shall be performed in accordance with the recommendations presented in the following sections.

3.1. The client, prior to any site preparation or grading, shall arrange and attend a pre-grading meeting between the grading contractor, the design engineer, the geotechnical consultant, and representatives of appropriate governing authorities, as well as any other involved parties. The parties shall be given two working days notice.

3.2. Clearing and grubbing shall consist of the substantial removal of vegetation, brush, grass, wood, stumps, trees, tree roots greater than 1/2-inch in diameter, and other deleterious materials from the areas to be graded. Clearing and grubbing shall extend to the outside of the proposed excavation and fill areas.

3.3. Demolition in the areas to be graded shall include removal of building structures, foundations, reservoirs, utilities (including underground pipelines, septic tanks, leach fields, seepage pits, cisterns, etc.), and other manmade surface and subsurface improvements, and the backfilling of mining shafts, tunnels and surface depressions. Demolition of utilities shall include capping or rerouting of pipelines at the project perimeter, and abandonment of wells in accordance with the requirements of the governing authorities and the recommendations of the geotechnical consultant at the time of demolition.

3.4. The debris generated during clearing, grubbing and/or demolition operations shall be removed from areas to be graded and disposed of off site at a legal dump site. Clearing, grubbing, and demolition operations shall be performed under the observation of the geotechnical consultant.

3.5. The ground surface beneath proposed fill areas shall be stripped of loose or unsuitable soil. These soils may be used as compacted fill provided they are generally free of organic or other deleterious materials and evaluated for use by the geotechnical consultant. The resulting surface shall be evaluated by the geotechnical consultant prior to proceeding. The cleared, natural ground surface shall be scari-

fied to a depth of approximately 8 inches, moisture conditioned, and compacted in accordance with the specifications presented in Section 5. of these guidelines.

3.6. Where fills are to be constructed on hillsides or slopes, topsoil, slope wash, colluvium, and other materials deemed unsuitable shall be removed. Where the exposed slope is steeper than 5 horizontal units to 1 vertical unit, or where recommended by the geotechnical consultant, the slope of the original ground on which the fill is to be placed shall be benched and a key as shown on Figure A of this document shall be provided by the contractor in accordance with the specifications presented in Section 7. of this document. The benches shall extend into the underlying bedrock or, where bedrock is not present, into suitable compacted fill as evaluated by the geotechnical consultant.

4. REMOVALS AND EXCAVATIONS

Removals and excavations shall be performed as recommended in the following sections.

4.1. Removals

4.1.1. Materials which are considered unsuitable shall be excavated under the observation of the geotechnical consultant in accordance with the recommendations contained herein. Unsuitable materials include, but may not be limited to, dry, loose, soft, wet, organic, compressible natural soils, fractured, weathered, soft bedrock, and undocumented or otherwise deleterious fill materials.

4.1.2. Materials deemed by the geotechnical consultant to be unsatisfactory due to moisture conditions shall be excavated in accordance with the recommendations of the geotechnical consultant, watered or dried as needed, and mixed to a generally uniform moisture content in accordance with the specifications presented in Section 5. of this document.

4.2. Excavations

4.2.1. Temporary excavations no deeper than 5 feet in firm fill or natural materials may be made with vertical side slopes. To satisfy CAL OSHA requirements, any excavation deeper than 5 feet shall be shored or laid back at a 1:1 (horizontal:vertical) inclination or flatter, depending on material type, if construction workers are to enter the excavation.

5. COMPACTED FILL

Fill shall be constructed as specified below or by other methods recommended by the geotechnical consultant. Unless otherwise specified, fill soils shall be compacted to 90 percent or greater relative compaction, as evaluated in accordance with ASTM Test Method D 1557-02.

5.1. Prior to placement of compacted fill, the contractor shall request an evaluation of the exposed ground surface by the geotechnical consultant. Unless otherwise recommended, the exposed ground surface shall then be scarified to a depth of approximately 8 inches and watered or dried, as needed, to achieve a generally uniform moisture content at or near the optimum moisture content. The scarified materials shall then be compacted to 90 percent or greater relative compaction. The evaluation of compaction by the geotechnical consultant shall not be considered to preclude any requirements for observation or approval by governing agencies. It is the contractor's responsibility to notify the geotechnical consultant and the appropriate governing agency when project areas are ready for observation, and to provide reasonable time for that review.

5.2. Excavated on-site materials which are in general compliance with the recommendations of the geotechnical consultant may be utilized as compacted fill provided they are generally free of organic or other deleterious materials and do not contain rock fragments greater than 6 inches in dimension. During grading, the contractor may encounter soil types other than those analyzed during the preliminary geotechnical study. The geotechnical consultant shall be consulted to evaluate the suitability of any such soils for use as compacted fill.

5.3. Where imported materials are to be used on site, the geotechnical consultant shall be notified three working days in advance of importation in order that it may sample and test the materials from the proposed borrow sites. No imported materials shall be delivered for use on site without prior sampling, testing, and evaluation by the geotechnical consultant.

5.4. Soils imported for on-site use shall preferably have very low to low expansion potential (based on UBC Standard 18-2 test procedures). Lots on which expansive soils may be exposed at grade shall be undercut 3 feet or more and capped with very low to low expansion potential fill. Details of the undercutting are provided in the Transition and Undercut Lot Details, Figure B of these guidelines. In the event expansive soils are present near the ground surface, special design and construction considerations shall be utilized in general accordance with the recommendations of the geotechnical consultant.

5.5. Fill materials shall be moisture conditioned to near optimum moisture content prior to placement. The optimum moisture content will vary with material type and other

factors. Moisture conditioning of fill soils shall be generally uniform in the soil mass.

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

5.7. Compacted fill shall be placed in horizontal lifts of approximately 8 inches in loose thickness. Prior to compaction, each lift shall be watered or dried as needed to achieve near optimum moisture condition, mixed, and then compacted by mechanical methods, using sheepsfoot rollers, multiple-wheel pneumatic-tired rollers, or other appropriate compacting rollers, to the specified relative compaction. Successive lifts shall be treated in a like manner until the desired finished grades are achieved.

5.8. Fill shall be tested in the field by the geotechnical consultant for evaluation of general compliance with the recommended relative compaction and moisture conditions. Field density testing shall conform to ASTM D 1556-00 (Sand Cone method), D 2937-00 (Drive-Cylinder method), and/or D 2922-96 and D 3017-96 (Nuclear Gauge method). Generally, one test shall be provided for approximately every 2 vertical feet of fill placed, or for approximately every 1000 cubic yards of fill placed. In addition, on slope faces one or more tests shall be taken for approximately every 10,000 square feet of slope face and/or approximately every 10 vertical feet of slope height. Actual test intervals may vary as field conditions dictate. Fill found to be out of conformance with the grading recommendations shall be removed, moisture conditioned, and compacted or otherwise handled to accomplish general compliance with the grading recommendations.

5.9. The contractor shall assist the geotechnical consultant by excavating suitable test pits for removal evaluation and/or for testing of compacted fill.

5.10. At the request of the geotechnical consultant, the contractor shall "shut down" or restrict grading equipment from operating in the area being tested to provide adequate testing time and safety for the field technician.

5.11. The geotechnical consultant shall maintain a map with the approximate locations of field density tests. Unless the client provides for surveying of the test locations, the locations shown by the geotechnical consultant will be estimated. The geotechnical consultant shall not be held responsible for the accuracy of the horizontal or vertical location or elevations.

5.12. Grading operations shall be performed under the observation of the geotechnical consultant. Testing and evaluation by the geotechnical consultant does not preclude the need for approval by or other requirements of the jurisdictional agencies.

5.13. Fill materials shall not be placed, spread or compacted during unfavorable weather conditions. When work is interrupted by heavy rains, the filling operation shall not be resumed until tests indicate that moisture content and density of the fill meet the project specifications. Regrading of the near-surface soil may be needed to achieve the specified moisture content and density.

5.14. Upon completion of grading and termination of observation by the geotechnical consultant, no further filling or excavating, including that planned for footings, foundations, retaining walls or other features, shall be performed without the involvement of the geotechnical consultant.

5.15. Fill placed in areas not previously viewed and evaluated by the geotechnical consultant may have to be removed and recompacted at the contractor's expense. The depth and extent of removal of the unobserved and undocumented fill will be decided based upon review of the field conditions by the geotechnical consultant.

5.16. Off-site fill shall be treated in the same manner as recommended in these specifications for on-site fills. Off-site fill subdrains temporarily terminated (up gradient) shall be surveyed for future locating and connection.

5.17. Prior to placement of a canyon fill, a subdrain shall be installed in bedrock or compacted fill along the approximate alignment of the canyon bottom if recommended by the geotechnical consultant. Details of subdrain placement and configuration have been provided in the Canyon Subdrain Detail, Figure C, of these guidelines.

5.18. Transition (cut/fill) lots shall generally be undercut 3 feet or more below finished grade to provide a generally uniform thickness of fill soil in the pad area. Where the depth of fill on a transition lot greatly exceeds 3 feet, overexcavation may be increased at the discretion of the geotechnical consultant. Details of the undercut for transition lots are provided in the Transition and Undercut Lot Detail, Figure B, of these guidelines.

6. OVERSIZED MATERIAL

Oversized material shall be placed in accordance with the following recommendations.

6.1. During the course of grading operations, rocks or similar irreducible materials greater than 6 inches in dimension (oversized material) may be generated. These materials shall not be placed within the compacted fill unless placed in general accordance with the recommendations of the geotechnical consultant.

6.2. Where oversized rock (greater than 6 inches in dimension) or similar irreducible material is generated during grading, it is recommended, where practical, to waste such material off site, or on site in areas designated as "nonstructural rock disposal

areas." Rock designated for disposal areas shall be placed with sufficient sandy soil to generally fill voids. The disposal area shall be capped with a 5-foot thickness of fill which is generally free of oversized material.

6.3. Rocks 6 inches in dimension and smaller may be utilized within the compacted fill, provided they are placed in such a manner that nesting of rock is not permitted. Fill shall be placed and compacted over and around the rock. The amount of rock greater than 3/4-inch in dimension shall generally not exceed 40 percent of the total dry weight of the fill mass, unless the fill is specially designed and constructed as a "rock fill."

6.4. Rocks or similar irreducible materials greater than 6 inches but less than 4 feet in dimension generated during grading may be placed in windrows and capped with finer materials in accordance with the recommendations of the geotechnical consultant, the approval of the governing agencies, and the Oversized Rock Placement Detail, Figure D, of these guidelines. Selected native or imported granular soil (Sand Equivalent of 30 or higher) shall be placed and flooded over and around the windrowed rock such that voids are filled. Windrows of oversized materials shall be staggered so that successive windrows of oversized materials are not in the same vertical plane. Rocks greater than 4 feet in dimension shall be broken down to 4 feet or smaller before placement, or they shall be disposed of off site.

7. SLOPES

The following sections provide recommendations for cut and fill slopes.

7.1. Cut Slopes

7.1.1. Unless otherwise recommended by the geotechnical consultant and accepted by the building official, permanent cut slopes shall not be steeper than 2:1 (horizontal:vertical). The recommended height of a cut slope shall be evaluated by the geotechnical consultant. Slopes in excess of 30 feet high shall be provided with terrace drains (swales) in accordance with the recommendations presented in the Uniform Building Code, Section 3315 and the details provided in Figure E of these guidelines.

7.1.2. The geotechnical consultant shall observe cut slopes during excavation. The geotechnical consultant shall be notified by the contractor prior to beginning slope excavations.

7.1.3. If excavations for cut slopes expose loose, cohesionless, significantly fractured, or otherwise unsuitable materials, overexcavation of the unsuitable material and replacement with a compacted stabilization fill shall be evaluated and may be recommended by the geotechnical consultant. Unless

otherwise specified by the geotechnical consultant, stabilization fill construction shall be in general accordance with the details provided on Figure F of these guidelines.

7.1.4. If, during the course of grading, adverse or potentially adverse geotechnical conditions are encountered in the slope which were not anticipated in the preliminary evaluation report, the geotechnical consultant shall evaluate the conditions and provide appropriate recommendations.

7.2. Fill Slopes

7.2.1. When placing fill on slopes steeper than 5:1 (horizontal:vertical), topsoil, slope wash, colluvium, and other materials deemed unsuitable shall be removed. Near-horizontal keys and near-vertical benches shall be excavated into sound bedrock or firm fill material, in accordance with the recommendation of the geotechnical consultant. Keying and benching shall be accomplished in general accordance with the details provided on Figure A of these guidelines. Compacted fill shall not be placed in an area subsequent to keying and benching until the area has been observed by the geotechnical consultant. Where the natural gradient of a slope is less than 5:1, benching is generally not recommended. However, fill shall not be placed on compressible or otherwise unsuitable materials left on the slope face.

7.2.2. Within a single fill area where grading procedures dictate two or more separate fills, temporary slopes (false slopes) may be created. When placing fill adjacent to a temporary slope, benching shall be conducted in the manner described in Section 7.2.1. A 3-foot or higher near-vertical bench shall be excavated into the documented fill prior to placement of additional fill.

7.2.3. Unless otherwise recommended by the geotechnical consultant and by the building official, permanent fill slopes shall not be steeper than 2:1 (horizontal:vertical). The height of a fill slope shall be evaluated by the geotechnical consultant. Slopes in excess of 30 feet high shall be provided with terrace drains (swales) and backdrains in accordance with the recommendations presented in the Uniform Building Code, Section 3315 and the details provided in Figure E of these guidelines.

7.2.4. Unless specifically recommended otherwise, compacted fill slopes shall be overbuilt and cut back to grade, exposing firm compacted fill. The actual amount of overbuilding may vary as field conditions dictate. If the desired results are not achieved, the existing slopes shall be overexcavated and reconstructed in accordance with the recommendations of the geotechnical consultant. The degree of overbuilding may be increased until the desired compacted slope face condition is achieved. Care shall be taken by the con-

tractor to provide mechanical compaction as close to the outer edge of the overbuilt slope surface as practical.

7.2.5. If access restrictions, property line location, or other constraints limit overbuilding and cutting back of the slope face, an alternative method for compaction of the slope face may be attempted by conventional construction procedures including backrolling at intervals of 4 feet or less in vertical slope height, or as dictated by the capability of the available equipment, whichever is less. Fill slopes shall be backrolled utilizing a conventional sheeps foot-type roller. Care shall be taken to maintain the specified moisture conditions and/or reestablish the same, as needed, prior to backrolling. .

7.2.6. The placement, moisture conditioning and compaction of fill slope materials shall be done in accordance with the recommendations presented in Section 5. of these guidelines.

7.2.7. The contractor shall be ultimately responsible for placing and compacting the soil out to the slope face to obtain a relative compaction of 90 percent or greater as evaluated by ASTM D 1557-02 and a moisture content in accordance with Section 5. The geotechnical consultant shall perform field moisture and density tests at intervals of one test for approximately every 10,000 square feet of slope face and/or approximately every 10 feet of vertical height of slope.

7.2.8. Backdrains shall be provided in fill slopes in accordance with the details presented on Figure A of these guidelines, or as recommended by the geotechnical consultant.

7.3. Top-of-Slope Drainage

7.3.1. For pad areas above slopes, positive drainage shall be established away from the top of slope. This may be accomplished utilizing a berm and pad gradient of 2 percent or steeper at the top-of-slope areas. Site runoff shall not be permitted to flow over the tops of slopes.

7.3.2. Gunite-lined brow ditches shall be placed at the top of cut slopes to redirect surface runoff away from the slope face where drainage devices are not otherwise provided.

7.4. Slope Maintenance

7.4.1. In order to enhance surficial slope stability, slope planting shall be accomplished at the completion of grading. Slope plants shall consist of deep-rooting, variable root depth, drought-tolerant vegetation. Native vegetation is generally desirable. Plants native to semiarid and arid areas may also be ap-

propriate. Large-leafed ice plant should not be used on slopes. A landscape architect shall be consulted regarding the actual types of plants and planting configuration to be used.

7.4.2. Irrigation pipes shall be anchored to slope faces and not placed in trenches excavated into slope faces. Slope irrigation shall be maintained at a level just sufficient to support plant growth. Property owners shall be made aware that over watering of slopes is detrimental to slope stability. Slopes shall be monitored regularly and broken sprinkler heads and/or pipes shall be repaired immediately.

7.4.3. Periodic observation of landscaped slope areas shall be planned and appropriate measures taken to enhance growth of landscape plants.

7.4.4. Graded swales at the top of slopes and terrace drains shall be installed and the property owners notified that the drains shall be periodically checked so that they may be kept clear. Damage to drainage improvements shall be repaired immediately. To reduce siltation, terrace drains shall be constructed at a gradient of 3 percent or steeper, in accordance with the recommendations of the project civil engineer.

7.4.5. If slope failures occur, the geotechnical consultant shall be contacted immediately for field review of site conditions and development of recommendations for evaluation and repair.

8. TRENCH BACKFILL

The following sections provide recommendations for backfilling of trenches.

8.1. Trench backfill shall consist of granular soils (bedding) extending from the trench bottom to 1 or more feet above the pipe. On-site or imported fill which has been evaluated by the geotechnical consultant may be used above the granular backfill. The cover soils directly in contact with the pipe shall be classified as having a very low expansion potential, in accordance with UBC Standard 18-2, and shall contain no rocks or chunks of hard soil larger than 3/4-inch in diameter.

8.2. Trench backfill shall, unless otherwise recommended, be compacted by mechanical means to 90 percent or greater relative compaction as evaluated in accordance with ASTM D 1557-02. Backfill soils shall be placed in loose lifts 8-inches thick or thinner, moisture conditioned, and compacted in accordance with the recommendations of Section 5. of these guidelines. The backfill shall be tested by the geotechnical consultant at vertical intervals of approximately 2 feet of backfill placed and at spacings along the trench of approximately 100 feet in the same lift.

8.3. Jetting of trench backfill materials is generally not a recommended method of densification, unless the on-site soils are sufficiently free-draining and provisions have been made for adequate dissipation of the water utilized in the jetting process.

8.4. If it is decided that jetting may be utilized, granular material with a sand equivalent greater than 30 shall be used for backfilling in the areas to be jetted. Jetting shall generally be considered for trenches 2 feet or narrower in width and 4 feet or shallower in depth. Following jetting operations, trench backfill shall be mechanically compacted to the specified compaction to finish grade.

8.5. Trench backfill which underlies the zone of influence of foundations shall be mechanically compacted to 90 percent or greater relative compaction, as evaluated in accordance with ASTM D 1557-02. The zone of influence of the foundations is generally defined as the roughly triangular area within the limits of a 1:1 projection from the inner and outer edges of the foundation, projected down and out from both edges.

8.6. Trench backfill within slab areas shall be compacted by mechanical means to a relative compaction of 90 percent or greater relative compaction, as evaluated in accordance with ASTM D 1557-02. For minor interior trenches, density testing may be omitted or spot testing may be performed, as deemed appropriate by the geotechnical consultant.

8.7. When compacting soil in close proximity to utilities, care shall be taken by the grading contractor so that mechanical methods used to compact the soils do not damage the utilities. If the utility contractors indicate that it is undesirable to use compaction equipment in close proximity to a buried conduit, then the grading contractor may elect to use light mechanical compaction equipment or, with the approval of the geotechnical consultant, cover the conduit with clean granular material. These granular materials shall be jetted in place to the top of the conduit in accordance with the recommendations of Section 8.4 prior to initiating mechanical compaction procedures. Other methods of utility trench compaction may also be appropriate, upon review by the geotechnical consultant and the utility contractor, at the time of construction.

8.8. Clean granular backfill and/or bedding materials are not recommended for use in slope areas unless provisions are made for a drainage system to mitigate the potential for buildup of seepage forces or piping of backfill materials.

8.9. The contractor shall exercise the specified safety precautions, in accordance with OSHA Trench Safety Regulations, while conducting trenching operations. Such precautions include shoring or laying back trench excavations at 1:1 or flatter, depending on material type, for trenches in excess of 5 feet in depth. The geotechnical consultant is not responsible for the safety of trench operations or stability of the trenches.

9. DRAINAGE

The following sections provide recommendations pertaining to site drainage.

9.1. Canyon subdrain systems recommended by the geotechnical consultant shall be installed in accordance with the Canyon Subdrain Detail, Figure C, provided in these guidelines. Canyon subdrains shall be installed to conform to the approximate alignment and details shown on project plans. The actual subdrain location shall be evaluated by the geotechnical consultant in the field during grading. Materials specified in the attached Canyon Subdrain Detail shall not be changed or modified unless so recommended by the geotechnical consultant. Subdrains shall be surveyed by a licensed land surveyor/civil engineer for line and grade after installation. Sufficient time shall be allowed for the surveys prior to commencement of filling over the subdrains.

9.2. Typical backdrains for stability, side hill, and shear key fills shall be installed in accordance with the details provided on Figure A, Figure F, and Figure G of these guidelines.

9.3. Roof, pad, and slope drainage shall be such that it is away from slopes and structures to suitable discharge areas by nonerodible devices (e.g., gutters, downspouts, concrete swales, etc.).

9.4. Positive drainage adjacent to structures shall be established and maintained. Positive drainage may be accomplished by providing drainage away from the foundations of the structure at a gradient of 2 percent or steeper for a distance of 5 feet or more outside the building perimeter, further maintained by a graded swale leading to an appropriate outlet, in accordance with the recommendations of the project civil engineer and/or landscape architect.

9.5. Surface drainage on the site shall be provided so that water is not permitted to pond. A gradient of 2 percent or steeper shall be maintained over the pad area and drainage patterns shall be established to remove water from the site to an appropriate outlet.

9.6. Care shall be taken by the contractor during finish grading to preserve any berms, drainage terraces, interceptor swales or other drainage devices of a permanent nature on or adjacent to the property. Drainage patterns established at the time of finish grading shall be maintained for the life of the project. Property owners shall be made very clearly aware that altering drainage patterns may be detrimental to slope stability and foundation performance.

10. SITE PROTECTION

The site shall be protected as outlined in the following sections.

10.1. Protection of the site during the period of grading shall be the responsibility of the contractor unless other provisions are made in writing and agreed upon among the concerned parties. Completion of a portion of the project shall not be considered to preclude that portion or adjacent areas from the need for site protection, until such time as the project is finished as agreed upon by the geotechnical consultant, the client, and the regulatory agency.

10.2. The contractor is responsible for the stability of temporary excavations. Recommendations by the geotechnical consultant pertaining to temporary excavations are made in consideration of stability of the finished project and, therefore, shall not be considered to preclude the responsibilities of the contractor. Recommendations by the geotechnical consultant shall also not be considered to preclude more restrictive requirements by the applicable regulatory agencies.

10.3. Precautions shall be taken during the performance of site clearing, excavation, and grading to protect the site from flooding, ponding, or inundation by surface runoff. Temporary provisions shall be made during the rainy season so that surface runoff is away from and off the working site. Where low areas cannot be avoided, pumps shall be provided to remove water as needed during periods of rainfall.

10.4. During periods of rainfall, plastic sheeting shall be used as needed to reduce the potential for unprotected slopes to become saturated. Where needed, the contractor shall install check dams, desilting basins, riprap, sandbags or other appropriate devices or methods to reduce erosion and provide the recommended conditions during inclement weather.

10.5. During periods of rainfall, the geotechnical consultant shall be kept informed by the contractor of the nature of remedial or precautionary work being performed on site (e.g., pumping, placement of sandbags or plastic sheeting, other labor, dozing, etc.).

10.6. Following periods of rainfall, the contractor shall contact the geotechnical consultant and arrange a walk-over of the site in order to visually assess rain-related damage. The geotechnical consultant may also recommend excavation and testing in order to aid in the evaluation. At the request of the geotechnical consultant, the contractor shall make excavations in order to aid in evaluation of the extent of rain-related damage.

10.7. Rain- or irrigation-related damage shall be considered to include, but may not be limited to, erosion, silting, saturation, swelling, structural distress, and other adverse conditions noted by the geotechnical consultant. Soil adversely affected shall be classified as "Unsuitable Material" and shall be subject to overexcavation and

replacement with compacted fill or to other remedial grading as recommended by the geotechnical consultant.

10.8. Relatively level areas where saturated soils and/or erosion gullies exist to depths greater than 1 foot shall be overexcavated to competent materials as evaluated by the geotechnical consultant. Where adverse conditions extend to less than 1 foot in depth, saturated and/or eroded materials may be processed in-place. Overexcavated or in-place processed materials shall be moisture conditioned and compacted in accordance with the recommendations provided in Section 5. If the desired results are not achieved, the affected materials shall be overexcavated, moisture conditioned, and compacted until the specifications are met.

10.9. Slope areas where saturated soil and/or erosion gullies exist to depths greater than 1 foot shall be overexcavated and replaced as compacted fill in accordance with the applicable specifications. Where adversely affected materials exist to depths of 1 foot or less below proposed finished grade, remedial grading by moisture conditioning in-place and compaction in accordance with the appropriate specifications may be attempted. If the desired results are not achieved, the affected materials shall be overexcavated, moisture conditioned, and compacted until the specifications are met. As conditions dictate, other slope repair procedures may also be recommended by the geotechnical consultant.

10.10. During construction, the contractor shall grade the site to provide positive drainage away from structures and to keep water from ponding adjacent to structures. Water shall not be allowed to damage adjacent properties. Positive drainage shall be maintained by the contractor until permanent drainage and erosion reducing devices are installed in accordance with project plans.

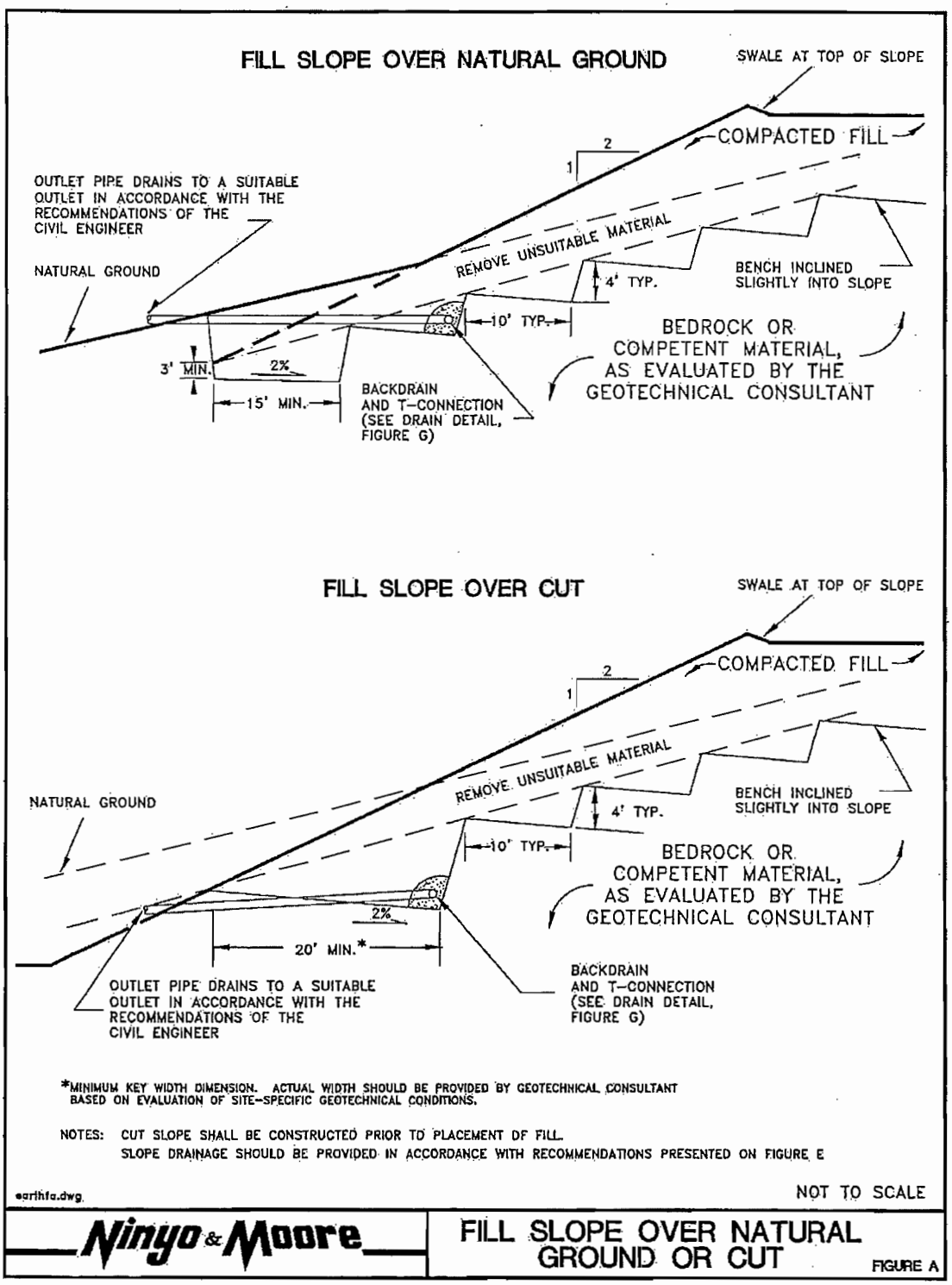
11. DEFINITIONS OF TERMS

ALLUVIUM:	Unconsolidated detrital deposits deposited by flowing water; includes sediments deposited in river beds, canyons, flood plains, lakes, fans at the foot of slopes, and in estuaries.
AS-GRADED (AS-BUILT):	The site conditions upon completion of grading.
BACKCUT:	A temporary construction slope at the rear of earth-retaining structures such as buttresses, shear keys, stabilization fills, or retaining walls.
BACKDRAIN:	Generally a pipe-and-gravel or similar drainage system placed behind earth-retaining structures such as buttresses, stabilization fills, and retaining walls.
BEDROCK:	Relatively undisturbed in-place rock, either at the surface or beneath surficial deposits of soil.
BENCH:	A relatively level step and near-vertical riser excavated into sloping ground on which fill is to be placed.
BORROW (IMPORT):	Any fill material hauled to the project site from off-site areas.
BUTTRESS FILL:	A fill mass, the configuration of which is designed by engineering calculations, to retain slopes containing adverse geologic features. A buttress is generally specified by a key width and depth and by a backcut angle. A buttress normally contains a back drainage system.
CIVIL ENGINEER:	The Registered Civil Engineer or consulting firm responsible for preparation of the grading plans and surveying, and evaluating as-graded topographic conditions.
CLIENT:	The developer or a project-responsible authorized representative. The client has the responsibility of reviewing the findings and recommendations made by the geotechnical consultant and authorizing the contractor and/or other consultants to perform work and/or provide services.
COLLUVIUM:	Generally loose deposits, usually found on the face or near the base of slopes and brought there chiefly by gravity through slow continuous downhill creep (see also Slope Wash).
COMPACTION:	The densification of a fill by mechanical means.

CONTRACTOR:	A person or company under contract or otherwise retained by the client to perform demolition, grading, and other site improvements.
DEBRIS:	The products of clearing, grubbing, and/or demolition, or contaminated soil material unsuitable for reuse as compacted fill, and/or any other material so designated by the geotechnical consultant.
ENGINEERED FILL:	A fill which the geotechnical consultant or the consultant's representative has observed and/or tested during placement, enabling the consultant to conclude that the fill has been placed in substantial compliance with the recommendations of the geotechnical consultant and the governing agency requirements.
ENGINEERING GEOLOGIST:	A geologist registered by the state licensing agency who applies geologic knowledge and principles to the exploration and evaluation of naturally occurring rock and soil, as related to the design of civil works.
EROSION:	The wearing away of the ground surface as a result of the movement of wind, water, and/or ice.
EXCAVATION:	The mechanical removal of earth materials.
EXISTING GRADE:	The ground surface configuration prior to grading; original grade.
FILL:	Any deposit of soil, rock, soil-rock blends, or other similar materials placed by man.
FINISH GRADE:	The as-graded ground surface elevation that conforms to the grading plan.
GEOFABRIC:	An engineering textile utilized in geotechnical applications such as subgrade stabilization and filtering.
GEOTECHNICAL CONSULTANT:	The geotechnical engineering and engineering geology consulting firm retained to provide technical services for the project. For the purpose of these specifications, observations by the geotechnical consultant include observations by the geotechnical engineer, engineering geologist and other persons employed by and responsible to the geotechnical consultant.

GEOTECHNICAL ENGINEER:	A licensed civil engineer and geotechnical engineer, registered by the state licensing agency, who applies scientific methods, engineering principles, and professional experience to the acquisition, interpretation, and use of knowledge of materials of the earth's crust to the resolution of engineering problems. Geotechnical engineering encompasses many of the engineering aspects of soil mechanics, rock mechanics, geology, geophysics, hydrology, and related sciences.
GRADING:	Any operation consisting of excavation, filling, or combinations thereof and associated operations.
LANDSLIDE DEPOSITS:	Material, often porous and of low density, produced from instability of natural or manmade slopes.
OPTIMUM MOISTURE:	The moisture content that is considered optimum to compaction operations.
RELATIVE COMPACTION:	The degree of compaction (expressed as a percentage) of a material as compared to the dry density obtained from ASTM test method D 1557-02.
ROUGH GRADE:	The ground surface configuration at which time the surface elevations approximately conform to the approved plan.
SHEAR KEY:	Similar to a subsurface buttress; however, it is generally constructed by excavating a slot within a natural slope in order to stabilize the upper portion of the slope without encroaching into the lower portion of the slope.
SITE:	The particular parcel of land where grading is being performed.
SLOPE:	An inclined ground surface, the steepness of which is generally specified as a ratio of horizontal units to vertical units.
SLOPE WASH:	Soil and/or rock material that has been transported down a slope by gravity assisted by the action of water not confined to channels (see also Colluvium).
SLOUGH:	Loose, uncompacted fill material generated during grading operations.
SOIL:	Naturally occurring deposits of sand, silt, clay, etc., or combinations thereof.

STABILIZATION FILL:	A fill mass, the configuration of which is typically related to slope height and is specified by the standards of practice for enhancing the stability of locally adverse conditions. A stabilization fill is normally specified by a key width and depth and by a backcut angle. A stabilization fill may or may not have a back drainage system specified.
SUBDRAIN:	Generally a pipe-and-gravel or similar drainage system placed beneath a fill along the alignment of buried canyons or former drainage channels.
TAILINGS:	Non-engineered fill which accumulates on or adjacent to equipment haul roads.
TERRACE:	A relatively level bench constructed on the face of a graded slope surface for drainage and maintenance purposes.
TOPSOIL:	The upper zone of soil or bedrock materials, which is usually dark in color, loose, and contains organic materials.
WINDROW:	A row of large rocks buried within engineered fill in accordance with guidelines set forth by the geotechnical consultant.


FILL SLOPE OVER NATURAL GROUND
SWALE AT TOP OF SLOPE
COMPACTED FILL
2
1
OUTLET PIPE DRAINS TO A SUITABLE OUTLET IN ACCORDANCE WITH THE RECOMMENDATIONS OF THE CIVIL ENGINEER
NATURAL GROUND
REMOVE UNSUITABLE MATERIAL
4' TYP.
BENCH INCLINED SLIGHTLY INTO SLOPE
10' TYP.
BEDROCK OR COMPETENT MATERIAL, AS EVALUATED BY THE GEOTECHNICAL CONSULTANT
3' MIN.
2%
15' MIN.
BACKDRAIN AND T-CONNECTION (SEE DRAIN DETAIL, FIGURE G)
FILL SLOPE OVER CUT
SWALE AT TOP OF SLOPE
COMPACTED FILL
2
1
REMOVE UNSUITABLE MATERIAL
NATURAL GROUND
4' TYP.
BENCH INCLINED SLIGHTLY INTO SLOPE
10' TYP.
BEDROCK OR COMPETENT MATERIAL, AS EVALUATED BY THE GEOTECHNICAL CONSULTANT
2%
20' MIN.*
OUTLET PIPE DRAINS TO A SUITABLE OUTLET IN ACCORDANCE WITH THE RECOMMENDATIONS OF THE CIVIL ENGINEER
BACKDRAIN AND T-CONNECTION (SEE DRAIN DETAIL, FIGURE G)
*MINIMUM KEY WIDTH DIMENSION. ACTUAL WIDTH SHOULD BE PROVIDED BY GEOTECHNICAL CONSULTANT BASED ON EVALUATION OF SITE-SPECIFIC GEOTECHNICAL CONDITIONS.
NOTES: CUT SLOPE SHALL BE CONSTRUCTED PRIOR TO PLACEMENT OF FILL.
SLOPE DRAINAGE SHOULD BE PROVIDED IN ACCORDANCE WITH RECOMMENDATIONS PRESENTED ON FIGURE E
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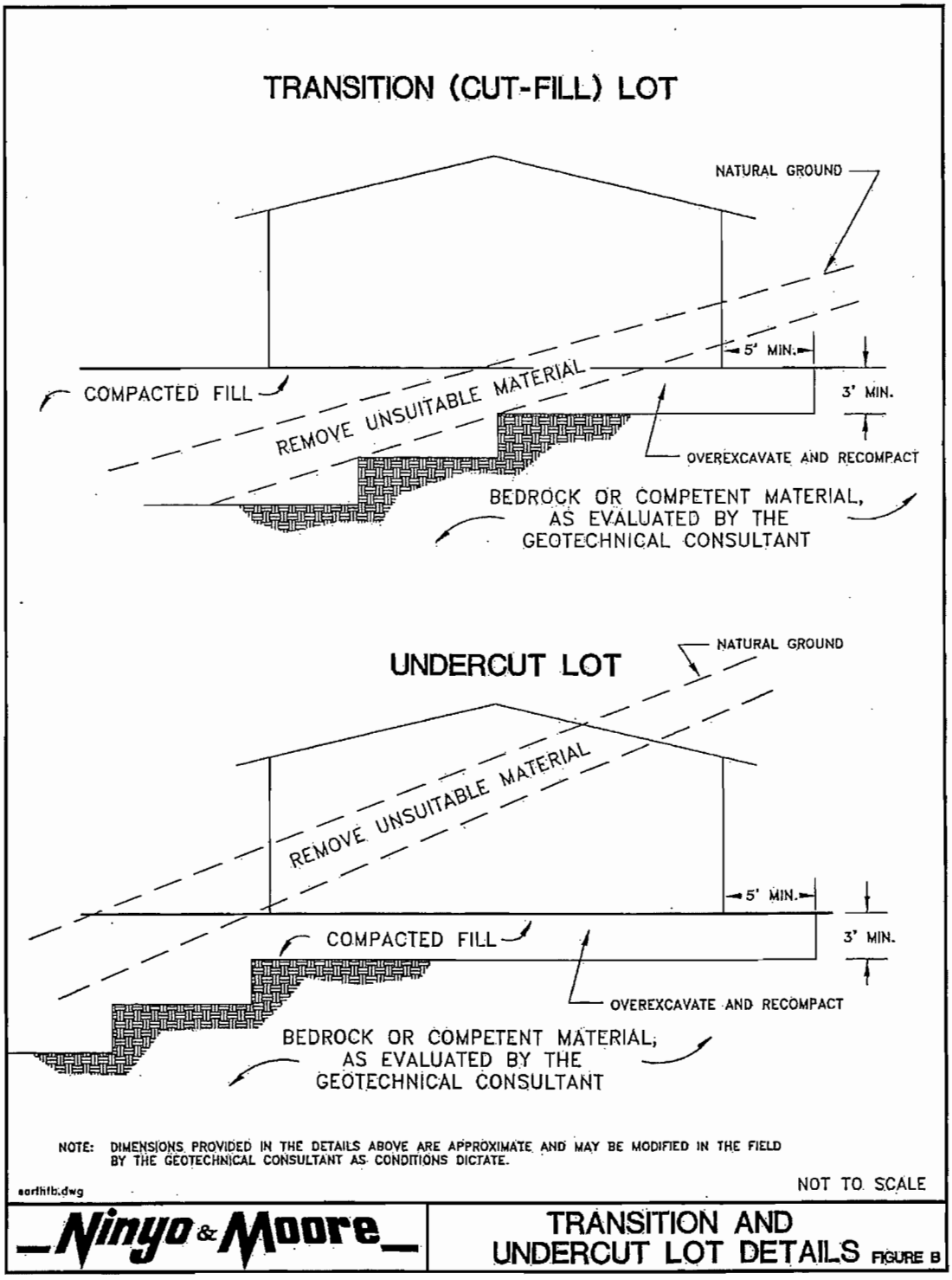
NOT TO SCALE
Ninyo & Moore
FILL SLOPE OVER NATURAL GROUND OR CUT
FIGURE A


TRANSITION (CUT-FILL) LOT
NATURAL GROUND
5' MIN.
3' MIN.
COMPACTED FILL
REMOVE UNSUITABLE MATERIAL
OVEREXCAVATE AND RECOMPACT
BEDROCK OR COMPETENT MATERIAL, AS EVALUATED BY THE GEOTECHNICAL CONSULTANT
UNDERCUT LOT
NATURAL GROUND
REMOVE UNSUITABLE MATERIAL
5' MIN.
3' MIN.
COMPACTED FILL
OVEREXCAVATE AND RECOMPACT
BEDROCK OR COMPETENT MATERIAL, AS EVALUATED BY THE GEOTECHNICAL CONSULTANT
NOTE: DIMENSIONS PROVIDED IN THE DETAILS ABOVE ARE APPROXIMATE AND MAY BE MODIFIED IN THE FIELD BY THE GEOTECHNICAL CONSULTANT AS CONDITIONS DICTATE.
NOT TO SCALE
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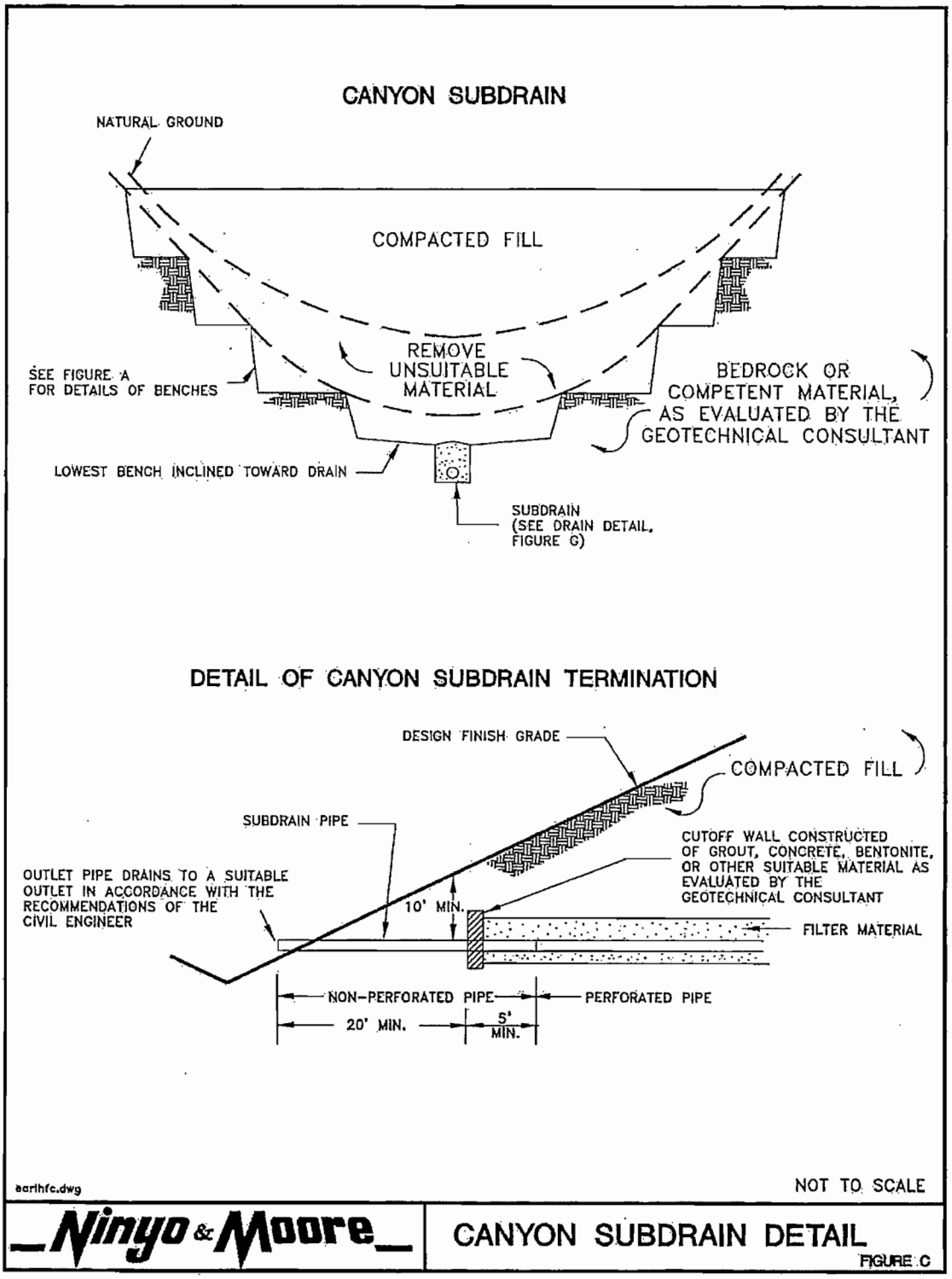
TRANSITION AND UNDERCUT LOT DETAILS
FIGURE B


CANYON SUBDRAIN
NATURAL GROUND
COMPACTED FILL
REMOVE UNSUITABLE MATERIAL
SEE FIGURE A FOR DETAILS OF BENCHES
BEDROCK OR COMPETENT MATERIAL, AS EVALUATED BY THE GEOTECHNICAL CONSULTANT
LOWEST BENCH INCLINED TOWARD DRAIN
SUBDRAIN (SEE DRAIN DETAIL, FIGURE G)
DETAIL OF CANYON SUBDRAIN TERMINATION
DESIGN FINISH GRADE
COMPACTED FILL
SUBDRAIN PIPE
CUTOFF WALL CONSTRUCTED OF GROUT, CONCRETE, BENTONITE, OR OTHER SUITABLE MATERIAL AS EVALUATED BY THE GEOTECHNICAL CONSULTANT
OUTLET PIPE DRAINS TO A SUITABLE OUTLET IN ACCORDANCE WITH THE RECOMMENDATIONS OF THE CIVIL ENGINEER
10' MIN.
FILTER MATERIAL
NON-PERFORATED PIPE
PERFORATED PIPE
20' MIN.
5' MIN.
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NOT TO SCALE
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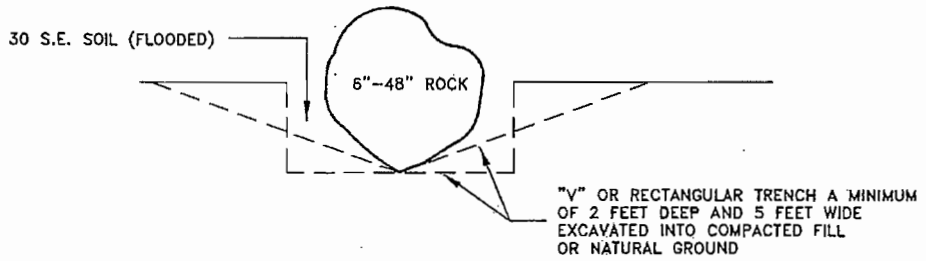
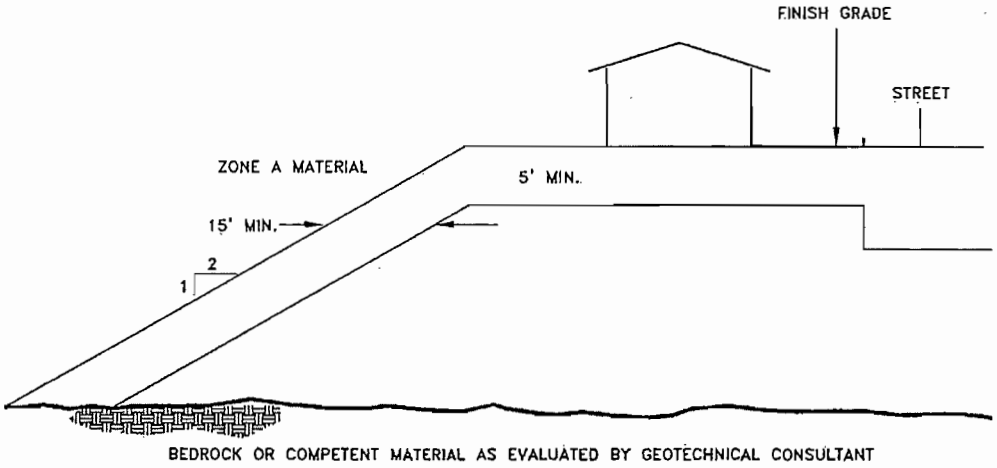
CANYON SUBDRAIN DETAIL
FIGURE C

WINDROW SECTION



PAD SECTION



ZONE A: COMPACTED FILL WITH ROCK FRAGMENTS NO GREATER THAN 6 INCHES IN DIAMETER.

ZONE B: COMPACTED FILL WITH ROCK FRAGMENTS BETWEEN 6 AND 48 INCHES IN DIAMETER MAY BE PLACED IN STAGGERED WINDROWS UP TO 100' LONG IN THIS ZONE AND SURROUNDED BY GRANULAR SOIL (30 SAND EQUIVALENT) DENSIFIED BY FLOODING. ROCK FRAGMENTS LESS THAN 6 INCHES IN DIAMETER MAY BE PLACED IN COMPACTED FILL SOIL.

NOTE: SLOPE DRAINAGE SHOULD BE PROVIDED IN ACCORDANCE WITH RECOMMENDATIONS PRESENTED ON FIGURE E.

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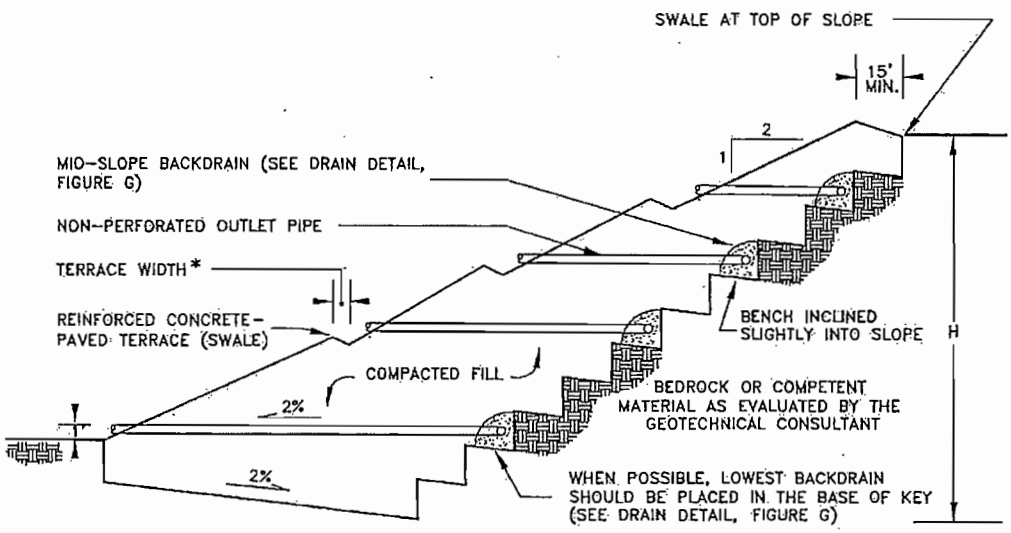
OVERSIZED ROCK PLACEMENT DETAIL

FIGURE D



MAXIMUM VERTICAL SLOPE HEIGHT, H (FEET)	* TERRACE WIDTH AND LOCATION
LESS THAN 30	NO TERRACE REQUIRED
60	ONE TERRACE AT LEAST 6 FEET WIDE AT MIDHEIGHT
120	ONE TERRACE AT LEAST 12 FEET WIDE AT APPROXIMATELY MIDHEIGHT AND 6-FOOT WIDE TERRACES CENTERED IN REMAINING SLOPES
GREATER THAN 120	DESIGNED BY CIVIL ENGINEER WITH APPROVAL OF GOVERNING AUTHORITIES

NOTES:
1. MID-SLOPE BACKDRAINS SHOULD BE PLACED IN FILL SLOPES IN CONJUNCTION WITH EACH TERRACE.
2. TERRACES SHOULD HAVE AT LEAST A 5-PERCENT GRADIENT, AND RUN OFF SHOULD BE DIRECTED TO AN APPROPRIATE SURFACE DRAINAGE COLLECTOR.
3. TERRACES SHOULD BE CLEANED OF DEBRIS AND VEGETATION TO ALLOW UNRESTRICTED FLOW OF WATER.
4. TERRACES SHOULD BE KEPT IN GOOD REPAIR.
5. REFER TO UBC CHAPTER 70 FOR ADDITIONAL REQUIREMENTS.

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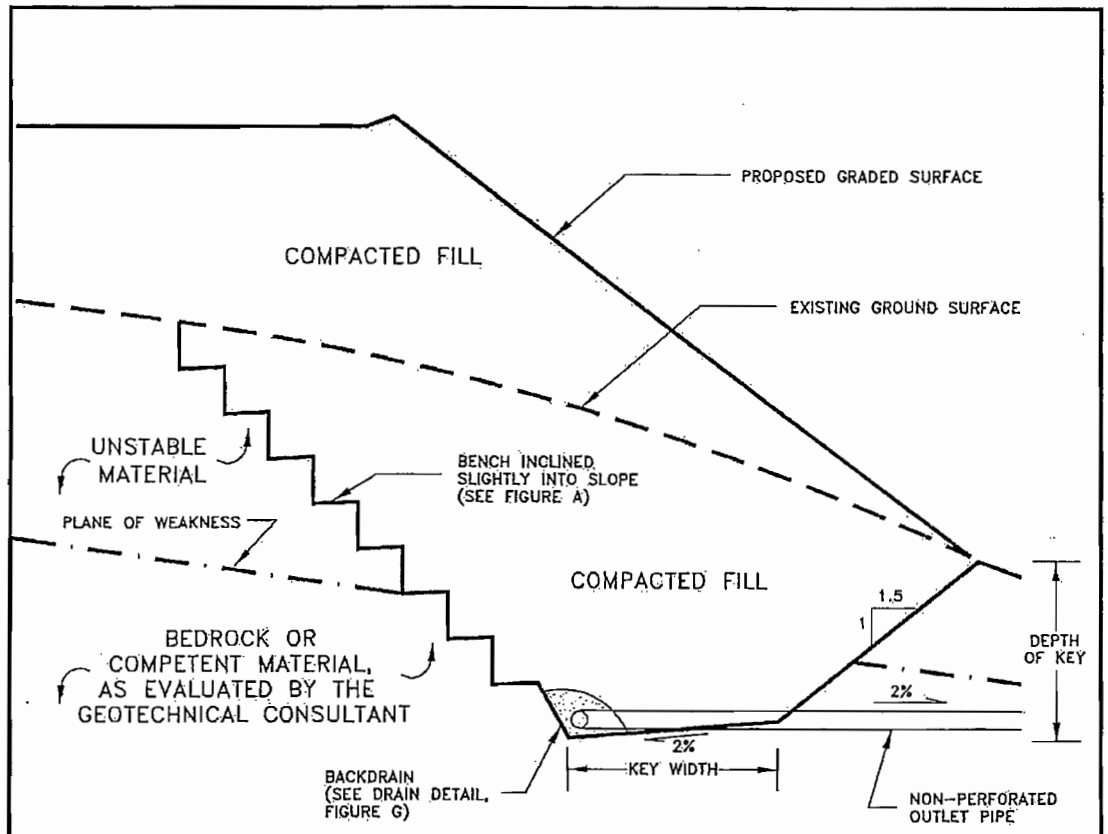
SLOPE DRAINAGE DETAIL

FIGURE E



NOTES:
1. THE DEPTH AND WIDTH OF KEY WILL BE PROVIDED BY THE GEOTECHNICAL CONSULTANT BASED ON ANALYSIS OF SITE-SPECIFIC GEOTECHNICAL CONDITIONS.
2. AN ADDITIONAL MID-SLOPE BACKDRAIN AND TERRACE DRAIN MAY BE RECOMMENDED FOR SLOPES OVER 30 FEET HIGH. SEE SLOPE DRAINAGE DETAIL, FIGURE E.
3. SLOPE DRAINAGE SHOULD BE PROVIDED IN ACCORDANCE WITH RECOMMENDATIONS PRESENTED ON FIGURE E.

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NOT TO SCALE

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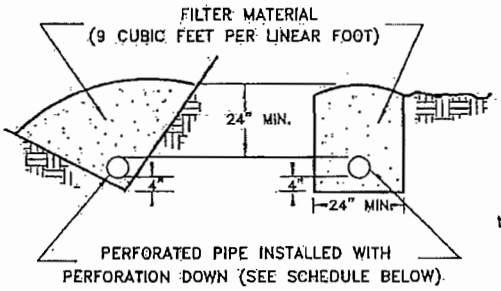
SHEAR KEY DETAIL

FIGURE F

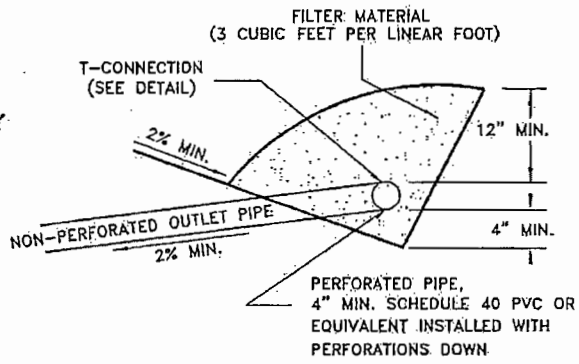
SUBDRAIN CONFIGURATION

ALTERNATIVE A* ALTERNATIVE B

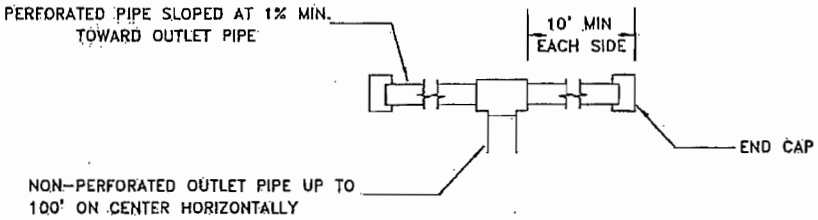


* ALTERNATIVE A SUBDRAIN CONFIGURATION MAY BE USED IN FILLS LESS THAN 25 FEET DEEP

BACKDRAIN CONFIGURATION



T-CONNECTION DETAIL



FILTER MATERIAL

FILTER MATERIAL SHALL BE CLASS II PERMEABLE MATERIAL PER STATE OF CALIFORNIA STANDARD SPECIFICATIONS OR APPROVED ALTERNATE GEOFABRIC DRAIN SYSTEM.

CLASS II GRADATIONS

SIEVE SIZE	PERCENT PASSING
1"	100
3/4"	90-100
3/8"	40-100
No. 4	25-40
No. 8	18-33
No. 30	5-15
No. 50	0-7
No. 200	0-3

NOTE: AS AN ALTERNATIVE THE FILTER MATERIAL MAY CONSIST OF UP TO 1" DIAMETER OPEN-GRADED GRAVEL WRAPPED IN AN APPROVED GEOFABRIC WITH 6-INCH OR MORE OVERLAP.

PIPE SCHEDULE

PERFORATED AND NON-PERFORATED PIPE SHALL BE SCHEDULE 40 POLYVINYL CHLORIDE (PVC) OR ACRYLONITRILE BUTADIENE STYRENE (ABS) OR EQUIVALENT, AND WILL HAVE A MINIMUM CRUSHING STRENGTH OF 1000 PSI FOR DEPTHS OF FILL UP TO 50 FEET. FOR DEEPER FILLS, PERFORATED AND NON-PERFORATED PIPE SHOULD BE DESIGNED WITH ADEQUATE CRUSHING STRENGTH.

THE PIPE DIAMETER WILL GENERALLY MEET THE FOLLOWING CRITERIA, BUT MAY BE MODIFIED IN THE FIELD BY THE GEOTECHNICAL CONSULTANT AS CONDITIONS DICTATE. THE LENGTH OF RUN IS MEASURED FROM THE HIGHEST ELEVATION.

LENGTH OF RUN	PIPE DIAMETER
0-500'	4"
500-1500'	6"
> 1500'	8"

NOT TO SCALE

earthfg.dwg

Ninyo & Moore

DRAIN DETAIL

FIGURE G

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