Appendix E:
Preliminary Soil Investigation

GeoMat Testing Laboratories, Inc.

Soil Engineering, Environmental Engineering, Materials Testing, Geology

January 23, 2017

Project No. 16193-01

TO:
Kingsfield Development
7111 Indiana Avenue, Suite 300
Riverside, California 92504

ATTENTION: Ms. Carol Carter

SUBJECT: Preliminary Soil Investigation Report, Hawthorne Heights Project, Single Family Homes, APNs 233-170-001 and 233-180-007, City of Riverside, California

Introduction

In accordance with your authorization, GeoMat Testing Laboratories, Inc. has conducted a preliminary soil investigation for the subject site. This report should be considered only preliminary in nature; its purpose is to determine the general foundation system for the structures described herein. The following presents a summary of our findings, conclusions, recommendations, and limitations of our work for the proposed construction.

Scope of Work

- Review soils, seismic, groundwater data, and maps in our files.
- Exploration of the site at accessible location by means of a drill rig.
- Field engineer for logging, observe drilling resistance/caving.
- Sampling of select soils.
- Conduct laboratory testing of select soil samples for classification, direct shear, soluble sulfate content, and hydrocollapse.
- Prepare CBC seismic design parameters.
- Preparation of a soil investigation report to include: Site preparation recommendations, Liquefaction Analysis, Overexcavation depth, Allowable soil bearing value, Foundation recommendations, Slab-on-grade recommendations, Earth pressures, Grading specifications, Pavement design, Site Class, CBC seismic design parameters.

Existing Site Condition

The subject site is located in a residential neighborhood, on the south side of Indiana Avenue between Jackson Street and Gibson Street, in the city of Riverside, California. Access on site is on Indiana Avenue which is a paved street with concrete curb and gutter.

The site is bordered by a vacant lot on the west, residential homes on the east, and BNSF railroad tracks and Riverside Canal on the south. The geographical relationship of the site and surrounding vicinity is shown on our Site Location Map, Figure 1.

Currently, the site has an old abandoned elementary school on it. The school consists of approximately 6 single story wood framed buildings, asphalt and concrete drives and play areas, and grass fields. There are several mature trees on site. Historic aerial photos (Google Earth) show construction debris, woodchips, sand, and possibly soil stockpiled on site, mostly on the east end. The site is approximately 6.74 acres.

Proposed Development

We understand that the site is proposed for a development of single family homes. The residential structures are expected to be light weight wood frame construction. Proposed site grades are not anticipated to change significantly from existing grades. A grading plan is not available, however based on flat/level site topography, we have assumed that minor cut and/or fill grading not exceeding three feet may be proposed. We should be provided with a copy of the grading plans when available to review the recommendations contained herein.

Our recommendations are based upon the assumed grading information. We should be notified if the actual loads and/or grades change significantly during the project design to either confirm or modify our recommendations

Field Work

Seven exploratory boreholes were drilled on January 14, 18, 19, 20, and 21, 2017, and one borehole drilled on October 24, 2015, to a maximum depth of 50 feet below existing ground surface utilizing a CME 45 equipped with 6-inch hollows stem augers and a Dames and Moore California Ring Sampler. A field engineer from this office observed the drilling and prepared the boring logs. Stratification lines on the logs represent the approximate boundary between soil types, although the transitions may actually be gradual. Refer to Plate 1 for location of exploratory borehole.

Sampling with Drill Rig

Relatively undisturbed samples were obtained with the California Ring Sampler (ASTM D 1587). This sampler has three inches external diameter, 2.5 inches inside diameter, and is lined with one inch high brass rings, with an inside diameter of 2.41-inches. The sample barrel is driven into the ground at the bottom of the boring with 140-pound hammer with a free fall of approximately 30-inches.

Sampler driving resistance, expressed as blows per six inches of penetration, is presented on the boring logs at the respective sampling depths. Ring samples were retained in close-fitting, moisture tight canisters for transport to our laboratory for testing. A bulk sample was also collected from the auger cuttings during drilling. The sample was collected in a plastic bag, tied, and tagged for the location and depth.

Sampling with Dames and Moore

Exploratory boreholes were drilled utilizing a gas operated limited access drill equipped with solid stem augers. Sampling was conducted by Dames and Moore California Ring Sampler (see Exploratory Boring Location Map, Plate 1). This sampler has three inches external diameter, 2.5 inches inside diameter, and is lined with one inch high brass rings, with an inside diameter of 2.41-inches.

The sample barrel was driven into the ground at the bottom of the excavation with 35-pound hammer with a free fall of approximately 36-inches. Sampler driving resistance, expressed as number of blows for 12-inch of penetration, was recorded. Ring samples were retained in close-fitting, moisture tight canisters for transport to our laboratory for testing. A bulk sample was collected in sealable from the auger cuttings during drilling.

To convert the field blow count to an SPT equivalent, we have utilized the conversion formula by D.M. Burmister, 1948, "The importance and practical use of relative density in soil mechanics: *Proceedings of ASTM, v. 48:1249."*

$$N_{(corrected)} = N_{(raw)} \times \frac{W. \times H}{(140)\,(30)} \times \frac{[(2)^2 - (1.375)^2]}{(D_o)^2 - (D_i)^2}$$

W: hammer weight=35 (lb), H: Drop Height 36 in D_o: Diameter of sample barrel= 3 in D_i: Diameter of drive sample= 2.4 in

The geotechnical boring log is presented in Appendix B and may include a description and classification of each stratum, sample locations, blow counts, groundwater conditions encountered during drilling, results from selected types of laboratory tests, and coring information.

Each boring, unless noted otherwise, was backfilled with cuttings at the completion of the logging and sampling. The backfill, however, may settle with time, and it is the responsibility of owner to ensure that such settlement does not become a liability.

Subsurface Findings

Based on our exploratory borings, the exposed surficial material is generally classified as medium dense silty sand (USCS "SM"). Underlying the silty sand is lateral layering of medium dense sand with silt and sand (USCS "SP-SM", "SW-SM", and "SP"), medium dense silty sand (USCS "SM"), and very firm sandy silt (USCS "ML"). No groundwater, or perched water, was encountered during any of the borings.

Loose silty sand was encountered at 5 feet below ground surface on the south end of the site (see borehole B-6). From our past experience, loose sandy soil is anticipated north of the BNSF railroad tracks in this area of riverside.

Approximately one foot thick layer of wood chips was encountered at the surface in borehole B-3, and appeared to be spread out on the northeast section of the site.

Laboratory Testing

Laboratory tests were performed on selected soil samples. The tests consisted primarily of moisture, density, sieve analysis, direct shear, sulfate content, and hydrocollapse.

The soil classifications are in conformance with the Unified Soil Classifications System (USCS), as outlined in the Classification and Symbols Chart (Appendix B). A summary of our laboratory testing and ASTM designation is presented in Appendix C.

Groundwater

Groundwater study is not within the scope of this work. Groundwater was not encountered in our exploratory borings drilled at the site up to 50 feet below ground surface. Depth to groundwater is not expected to impact site grading.

Highest historical groundwater records were researched utilizing the State of California, Department of Water Resources, Steve Mains' Cooperative Well Measuring Program, USGS Groundwater Watch, and USGS National Water Information System. The following information was obtained:

Resource	Well No.	Highest Historical Depth (ft)	Water Surface Elevation (ft)	Date
Steve Mains	3S5W7J002S	43	768	01/24/2001
	3S5W18B	40	780	04/01/1994
CDWR	3S5W8E002S	30	755	11/29/2012
USGS	No Pertinent Information obtained			
Site's lowest elevation is approximately 835 feet (Google Earth)				

A contour map showing minimum depths to ground water in the Santa Ana River Valley Region was constructed by the United States Geological Survey (USGS) and subsequently, a report (USGS Map MF-1802) was published in 1985. The map was constructed by contouring the shallowest water level measurements reported to the California Department of Water Resources (CDWR) for the period from 1973-1979. Based on our review of the map, the minimum depth to ground water in the project site area, during this period, was indicated to be around 30 feet below ground surface.

Please note that the potential for rain or irrigation water locally seeping through from elevated areas and showing up near grades cannot be precluded. Our experience indicates that surface or near-surface groundwater conditions can develop in areas where groundwater conditions did not exist prior to site development, especially in areas where a substantial increase in surface water infiltration results from landscape irrigation. Fluctuations in perched water elevations are likely to occur in the future due to variations in precipitation, temperature, consumptive uses, and other factors including mounding of perched water over bedrock. Mitigation for nuisance shallow seeps moving from elevated lower areas will be needed if encountered. These mitigations may include subdrains, horizontal drains, toe drains, french drains, heel drains or other devices.

Shrinkage

Based on laboratory test results, we estimate that shrinkage of soils onsite should be approximately 12 (±5) percent. Shrinkage is defined as the decrease in volume of soil upon removal and recompaction expressed as a percentage of the in-place volume. This shrinkage is exclusive of any losses due to removal of roots or any underground structures and is based on an average 92 percent relative compaction. An increase in relative compaction obtained would increase the shrinkage factor.

Furthermore, a subsidence of approximately 0.10 (± 0.05) feet may also be considered during site preparation. The above shrinkage and subsidence estimates should be used with caution since they are not absolute values. We recommend that an earthwork balance area should be designated to allow for variations in the indicated shrinkage and subsidence estimates.

Collapsible Soil

Soil hydroconsolidation is a phenomenon that results in relatively rapid settlement of soil deposits due to addition of water. This generally occurs in soils having a loose particle structure cemented together with soluble minerals or with small quantities of clay. Water infiltration into such soils can break down the interparticle cementation, resulting in collapse of the soil structure. Collapsible soils are found primarily in Holocene alluvial fan deposits.

A representative soil sample representing the upper ten feet of soil was tested in the laboratory for collapse potential. Test result indicates that hydrocollapse potential is less the 1.0%, a negligible value, see Appendix C.

Soil Type

In accordance with OSHA, the surficial older alluvium may be classified as Soil Type “B”.

Excavation Characteristics

The upper subgrade soil is generally medium dense silty sand. This material is not expected to exhibit hard excavation resistance for typical grading equipment.

Temporary Excavations

General

All excavations must comply with applicable local, state, and federal safety regulations including the current OSHA Excavation and Trench Safety Standards. Construction site safety generally is the sole responsibility of the Contractor, who should also be solely responsible for the means, methods, and sequencing of construction operations.

Safe Vertical Cut

Temporary un-surcharged excavations of 7 feet high may be made at a vertical gradient for short period of time. Temporary un-surcharged excavations greater than 7 feet may be trimmed at 1H:1V gradient.

Exposed condition during construction should be verified by the project geotechnical engineer. No excavations should take place without the direct supervision of the project geotechnical engineer.

All applicable requirements of the California Construction and general Industry Safety Orders, the Occupational Safety and Health Act, and current amendments, and the Construction safety Act should be met. Cuts should be observed during excavation by the project's geotechnical consultant. If potentially unstable soil conditions are encountered, modifications of slope ratios for temporary cuts may be required.

Precaution for Excavations

The Contractor should be aware that unsupported excavation depths should in no case exceed those specified in local, state, and/or federal safety regulations (e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations).

Such regulations are strictly enforced and, if they are not followed, the Owner, Contractor, and/or earthwork and utility subcontractors could be liable for substantial penalties. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures.

Sloping the sides of temporary excavations should be required beyond the recommended safe cut where trench/excavation is expected to be left open for a long time or where trench/excavation is along foundation or where adjacent utilities exist or public right-of-way. Temporary excavation should not extend below a 1H:1V plane extending beyond and down from the bottom of the existing utility lines or structures.

Geologic Findings

Topographically, the site is relatively flat and slopes down to the north toward Indiana Avenue at a rate of approximately 1.8 percent. Total relief on site is approximately 8 feet. The lot is underlain by alluvial material. Based on the USGS Geologic map of the Riverside West/South 1/2 of Fontana Quadrangles, Figure 2, the regional area prior to development was mapped as old alluvial fan deposits. The alluvium is generally indurated; dissected alluvial fan deposits derived from local terrains of plutonic rocks and generally consist of tan to light reddish brown sand and minor gravel.

Seismicity Considerations

Active faults

The site is not located within an Alquist-Priolo Earthquake Fault Zone. According to the California Department of Conservation, Fault Activity Map, the site is located approximately 9.7 miles northeast of the Elsinore Fault, see Figure 3.

Ground Shaking

Although there are no known active surface faults within or adjacent to the site that will significantly impact the project, the project is located in a region with active earthquakes and strong seismic motion of those earthquakes could affect the project, see Figure 4. The structures that are proposed to be constructed on the site will be required to meet and comply with all applicable city and State building codes to reduce seismic ground shaking at the site to less-than-significant.

Surface Rupture Zones

The site is not within a currently established Earthquake Fault Zone for surface fault rupture hazards. Therefore, the potential for surface rupture is very low. It is probable that not all-active or potentially active faults in the region have been identified. Furthermore, seismic potential of the smaller and less notable faults is not sufficiently developed for assignment of maximum magnitudes and associated levels of ground shaking that might occur at the site due to these faults.

Tsunamis, Seiches

The setting is inland and no large bodies of water are located within the sites vicinity, therefore, the potential of Tsunamis or seiches affecting the site is considered low.

Slope Stability

There are no slopes on site and no slopes are proposed.

Landslides

The site and the surrounding properties are flat and not prone to slope instability hazards, such as landslides. The project will not be impacted by a landslide or impact adjacent properties due to a project generated landslide.

Liquefaction

According to the City of Riverside's General Plan, the site is mapped in an area with high liquefaction potential. The potential for liquefaction and dynamic settlement has been evaluated as outlined in Chapter 6 of the California Division of Mines and Geology (DMC) Special Publication 117 ("Guidelines for Evaluation and Mitigation of Seismic Hazards in California") and "Recommended Procedures for Implementation of DMG Special Publication 117 - Guidelines for Analyzing and Mitigating Liquefaction in California", published by the Southern California Earthquake Center, 2008 edition.

The design and construction recommendations presented below in this report include results of liquefaction and dynamic settlement evaluation. The analysis results are included in Appendix E.

The analysis indicates that 0.31 inch total dynamic settlement is estimated during large earthquake episode. An estimated dynamic differential settlement of 1/2 of total settlement may be anticipated. The safety factor against liquefaction on all layers is above 1 for all layers to a depth of 50 feet below ground surface. Safety factor less than one is an indication for liquefaction potential. The historical high ground water during a seismic event has been assumed at 25 feet below existing ground surface.

Based on SCEC (1999) guidelines, a potential for loss of bearing capacity due to liquefaction is not expected at the site since there is not an upper potentially liquefiable layer at a depth shallower than the estimated depth where the induced vertical stress in the soil is 10% of the bearing pressure imposed by the proposed foundation systems. Furthermore, tied foundation systems are designed to dissipate structural loads. Therefore no loss of bearing capacity is expected for grade beams or lightly loaded slabs-on-grade.

In significant conformance with Youd, Hanson, and Bartlett (ASCE Geotechnical Jr. April 1995, and Lecture by Youd on July 7, 1999), no lateral spreading due to liquefaction is expected at this site due to the following reasons:

- Alluvial subsurface soils are essentially horizontally layered.
- There is not a free-face toward which liquefied soils could move laterally.
- No saturated liquefiable sand with values of N1(60) <15 exist at the site, refer to Geotechnical logs in Appendix B.

If loose clean sand exists between sampling intervals, their occurrence is expected to be thin and considered to be scattered or have minimal occurrence throughout the site, and cannot reasonably be connected_to form a hypothetical “continuous” line of significant length that could reasonably be expected to “exit” on a slope or a free-face, or move significantly below the gentle slope of the site.

Although it is extremely difficult to predict the overall behavior of any site during seismic shaking, it is our opinion that proper design of foundation can substantially improve the structure’s resistance to deformation. This is most commonly accomplished by providing adequate lateral connections between all footings with reinforced grade beams and strengthened stem walls. If the owner wishes a higher degree of confidence, then the structures should be designed for higher probable events.

Please note that foundation design is under the purview of the structural engineer. All foundations should be designed by a qualified structural engineer in accordance with the CBC and the latest applicable building codes and structural considerations may govern.

Site Class

The proposed building is less than 25 feet in height, of conventional light frame construction, and a fundamental period of vibration of less than 0.5 seconds. Accordingly site specific evaluation to determine spectral acceleration for liquefiable soils is not required and therefore the structure need not be designed as if it is Seismic Site Class “F:” It is our opinion that structures should be designed in accordance with the current seismic building code for Site Class “D”

Ground Motion And Seismic Design Parameters:

The peak ground acceleration (PGA) and 2013 CBC seismic design parameters are presented in Appendix D.

Expansive Soil Characteristics

Based on visual observations and laboratory classification the upper foundation soils are sandy and considered to be very low in expansion potential.

Conclusions

- Based on laboratory classification, the expansion potential of onsite soils is expected to be very low (EI<20). This would require verification subsequent to completion of new footing excavations.

- The site is located in a region of generally high seismicity, as is all of southern California. During its design life, the site is expected to experience strong ground motions from earthquakes on regional and/or local causative faults. Therefore typical structural design mitigations should be considered by the structural engineer.

- The potential for seismically induced dynamic settlement of the onsite soils is low.

- The use of shallow foundation is feasible for the proposed construction.

- No groundwater and/or seepage were encountered during our subsurface investigation. However, the potential for rain or irrigation water moving through from adjacent and elevated areas cannot be precluded. Our experience indicates that surface or near-surface groundwater conditions can develop in areas where groundwater conditions did not exist prior to site excavation, especially in areas where a substantial increase in surface water infiltration results from landscape irrigation. We therefore recommend that local landscape irrigation and landscape irrigation from surrounding areas be kept to the minimum necessary to maintain plant vigor and that any leaking pipes/sprinklers, etc. should be promptly repaired. We have no way of predicting depth to the groundwater which may fluctuate with seasonal changes and from one year to the next. Subdrains, horizontal drains, French drains or other devices may be recommended in future for graded areas that exhibit nuisance seepage.

- Overall, the geologic setting of the property is favorable for the use intended, provided the engineering designs are properly carried out.

Recommendations

Building Pad Preparation

All grading should be performed in accordance with our General Earthwork and Grading Specifications presented in Appendix F except as modified within the text of this report.

All debris, abandoned utility lines, roots, irrigation appurtenances, underground structures, leach lines, seepage pits, deleterious materials, etc., should be removed and hauled offsite. Seepage pits should be backfilled with one sac sand-cement slurry. Cavities created during site clearance should be backfilled in a controlled manner. Old fills associated with site previous use should be traced and removed prior to its use as compacted fill.

Subsequent to site clearance, proposed building pad area should be overexcavated to a depth of at least seven feet below existing ground surface or proposed finished grade, whichever is greater. This overexcavation may be extended deeper if loose soil is encountered in the bottom of the overexcavation. The lateral extent of overexcavation should be equal to the depth of fill but no less than five feet.

Because loose soil was encountered and is expected on site, special care should be taken to ensure that the bottom of the overexcavations are into firm, competent, native soil, before proceeding with grading operations. A representative from GeoMat will require full-time observation during all grading activities.

After any overexcavation, the exposed surfaces should be observed and then scarified to a depth of at least 12-inches, moisture conditioned as necessary and recompacted to at least 90 percent of the maximum dry density, as determined by ASTM D1557 Test Method; prior to placement of fill.

Compacted Fills/Imported Soils

Any soils to be placed as fill, whether presently onsite or import, should be approved by the soil engineer or his representative prior to its placement. All onsite soils to be used as fill should be cleansed of any roots, or other deleterious materials. Material larger than 6-inches in diameter should not be placed in the vicinity of foundations and utility lines trenches.

All fills should be placed in 6- to -8 inch loose lifts, thoroughly watered, or aerated to near optimum moisture content, mixed and compacted to at least 90 percent relative compaction. This is relative to the maximum dry density determined by ASTM D1557 Test Method.

Any imported soils should be sandy (preferably USCS "SM" or "SW", and very low in expansion potential) and approved by the soil engineer. The soil engineer or his representative should observe the placement of all fill and take sufficient tests to verify the moisture content and the uniformity and degree of compaction obtained.

Tentative Foundation Recommendations

The use of shallow spread footings in compacted fill is feasible. A maximum allowable bearing value of 2000 psf is recommended for the following residential footing system.

- Footing system soil should be designed and constructed in a manner that will minimize damage to structure from movement of the soil that occur in the moisture variation depth zone.
- Depth of continuous footings below natural and finish grade in liquefaction zones should be at least 24 inches. Pad footings should be at least 24 inch square and 24 inches below lowest adjacent firm grade.
- Footing reinforcement should be determined by the structural engineer; however, minimum reinforcement should be at least two No. 4 reinforcing bars, top and bottom.
- Expansion potential of foundation soils should be verified subsequent to completion of rough grading.
- The above recommended bearing value may be increased by one third for temporary (wind or seismic) loads.

Resistance to lateral footing will be provided by passive earth pressure and base friction. For footings bearing against firm native material, passive earth pressure may be considered to be developed at a rate of 260 psf per foot of depth to a maximum of 2000 psf. Base friction may be computed at 0.40 times the normal load. If passive earth pressure and friction are combined to provide required resistance to lateral forces, the value of the passive pressure should be reduced to two-thirds the value.

Foundation design comes under the purview of the structural engineer. The above recommendations should not preclude more restrictive structural requirements. The structural engineer should determine the actual footing sizes and reinforcement to resist vertical, horizontal, and uplift forces under static and seismic conditions.

Reinforcement and size recommendations presented in this report are considered the minimum necessary for the soil conditions present at foundation level and are not intended to supersede the design of the project structural engineer or criteria of the governing agencies for the project.

Retaining Walls

The following lateral earth pressures and soil parameters in conjunction with the above allowable soil bearing value for shallow foundation may be used for design of conventional retaining walls with free draining compacted backfills.

If passive earth pressure and friction are combined to provide required resistance to lateral forces, the value of the passive pressure should be reduced to two-thirds the following recommendations.

Active Earth Pressure with level backfill (P_a)	37 psf (EFP) drained, yielding
At Rest Pressure (P_0)	56 psf (EFP), drained, non-yielding (part of building wall)
Passive Earth Pressure (P_p)	260 psf (EFP), drained, maximum of 1800 psf
Horizontal Coefficient of Friction (μ)	0.40
Unit Soil Weight (γ_t)	110 pcf

We recommend drainage for retaining walls to be provided in accordance with the attached Plate 2. Drainage pipes and ditches should be connected to an approved drainage device. Maximum precautions should be taken when placing drainage materials and during backfilling.

Wall backfill should be properly compacted to at least 90 percent relative compaction. Back-cut distance behind the top of wall should be at least 18 inches or other practical distance to facilitate compaction. Retaining walls part of building walls should be provided with waterproofing per the project Architect recommendations.

Slabs-on-Grade

Interior slabs-on-grade may be at least four inches thick, reinforced with at least No 4 bars at 12-inches on-center both ways, properly centered in mid thickness of slabs. Slab-on-grades should be underlain with four inches of sand. If moisture intrusion is objectionable, the concrete slab should be provided by a 10-mil Visqueen moisture barrier placed and sealed over the sand. This slab recommendation meets California Green Residential Code.

Slab-on-grade thickness and reinforcement should be evaluated by the structural engineer and designed in compliance with applicable codes. Excess soils generated from foundation excavations should not be placed on any building pads without proper moisture and compaction.

All slab subgrades should be verified to be saturated to a depth of 12 inches prior to placement of slab building materials. Moisture content should be tested in the field by the soil engineer. Slabs subgrade should be kept moist and the surface should not be allowed to desiccate.

The addition of fiber mesh in the concrete and careful control of water/cement ratios may lessen the potential for slab cracking. In hot or windy weather, the contractor must take appropriate curing precautions after the placement of concrete.

The use of mechanically compacted low slump concrete (not exceeding 4 inches at the time of placement) is recommended. We recommend that a slipsheet (or equivalent) be utilized if grouted tiles or other crack sensitive flooring (such as marble tiles) is planned directly on concrete slabs.

Total Settlement

The foundation will be embedded into compacted fill. Native soils below the fill possess relatively high strengths and will not be subject to significant stress increases from the foundations of the new structure. Therefore settlements are expected to be within tolerable limits. Total long-term settlement between similarly loaded adjacent foundation systems should not exceed one inch. The structures should be designed to tolerate a differential settlement on the order of 1/2 to 3/4-inch.

Cement Type

Laboratory testing conducted for a soil sample showed that water soluble sulfate is less than 0.015 percent (negligible sulfate exposure risk). We recommend Type II cement for all concrete work in contact with soil. Ferrous metal pipes should be protected from potential corrosion by bituminous coating, etc. We recommend that all utility pipes be nonmetallic and/or corrosion resistant.

Recommendations should be verified by soluble sulfate and corrosion testing of soil samples obtained from specific locations at the completion of grading.

Trench Backfill

All utility trenches and retaining wall backfills should be mechanically compacted to the minimum requirements of at least 90 percent relative compaction.

Onsite soils derived from trench excavations can be used as trench backfill. Backfills should be placed in thin lifts and compacted by mechanical means. Material with sand equivalent of at least 30 should be utilized for the pipe zone. No jetting, ponding, or flooding should be permitted within the building area or where trenches are in zone of influence of footing loads. Excavated material from footing trenches should not be placed in slab-on-grade areas unless properly compacted and tested.

Site Drainage

Positive drainage should be provided and maintained for the life of the project around the perimeter of all structures and all foundations toward streets or approved drainage devices to minimize water infiltrating into the underlying natural and engineered fill soils, and prevent erosion. In addition, finish subgrade adjacent to exterior footings should be sloped down (at least 2%) and away to facilitate surface drainage. Roof drainage should be collected and directed away from foundations via nonerosive devices. Water, either natural or by irrigation, should not be permitted to pond or saturate the foundation soils.

Planter areas and large trees adjacent to the foundations are not recommended. All planters and terraces should be provided with drainage devices. Internal drainage should be directed to approve drainage collection devices, per the civil engineer recommendations. Location of drainage devices should be in accordance with the design civil engineers drainage and erosion control recommendations.

The owner should be made aware of the potential problems, which may develop when drainage is altered through construction of retaining walls, patios and other devices. Ponded water, leaking irrigation systems, over watering or other conditions which could lead to ground saturation should be avoided. Surface and subsurface runoff from adjacent properties should be controlled. Area drainage collection should be directed away from structures through approved drainage devices. Drainage devices should be maintained.

Tentative Asphalt Pavement

On the basis of classifications of onsite soils, an assumed Traffic Indices, and estimated R-value of 15, the minimum recommended pavement thickness is as follows:

Location	Traffic Index	Minimum Recommended Pavement Section
Private Drives	5.0	3.0” AC over 8.5” Class 2 Base

Street subgrade should be overexcavated 12 inches below proposed grade or existing grade, whichever is deeper. The exposed bottom should be scarified an additional 12 inches, watered as necessary, and compacted to at least 90 percent of the maximum density as determined by ASTM D1557 test method. Aggregate base should be compacted to at least 95 percent of the maximum density as determined by ASTM D1557 test method.

Final pavement design recommendations should be based on laboratory test results of representative pavement subgrade soils upon the completion of rough grading.

We Should be Retained for Plan Reviews

The recommendations provided in this report are based on preliminary information and subsurface conditions as interpreted from limited exploratory boreholes at the site. We should be retained to review final grading and foundation plans to revise our conclusions and recommendations, as necessary. Professional fees will apply for each review.

Our conclusions and recommendations should also be reviewed and verified during site grading, and revised accordingly if exposed geotechnical conditions vary from our preliminary findings and interpretations.

Additional Observation and/or Testing

GeoMat Testing Laboratories, Inc. should observe and/or test at the following stages of construction.

- During overexcavation and backfills.
- Following footing excavation and prior to placement of footing materials.
- During wetting of slab subgrade and prior to placement of slab materials.
- During all trench and wall backfill.
- When any unusual conditions are encountered.

Final Report of Compaction During Grading

A final report of compaction control should be prepared subsequent to the completion of grading. The report should include a summary of work performed, laboratory test results, and the results and locations of field density tests performed during grading.

Geotechnical Risk

The concept of risk is an important aspect of the geotechnical evaluation. The primary reason for this is that the analytical methods used to develop geotechnical recommendations do not comprise an exact science. The analytical tools which geotechnical engineers use are generally empirical and must be used in conjunction with engineering judgment and experience. Therefore, the solutions and recommendations presented in the geotechnical evaluation should not be considered risk-free and, more importantly, are not a guarantee that the interaction between the soils and the proposed structure will perform as planned.

The engineering recommendations presented in the preceding sections constitute GeoMat Testing Laboratories professional estimate of those measures that are necessary for the proposed structure to perform according to the proposed design based on the information generated and referenced during this evaluation, and GeoMat Testing Laboratories experience in working with these conditions.

Limitation Of Investigation

This report was prepared for the exclusive use on the subject site. The use by others, or for the purposes other than intended, is at the user’s sole risk.

Our investigation was performed using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable Geotechnical Engineers practicing in this or similar locations within the limitations of scope, schedule, and budget. No other warranty, expressed or implied, is made as to the conclusions and professional advice included in this report.

The field and laboratory test data are believed representative of the project site; however, soil conditions can vary significantly. As in most projects, conditions revealed during grading may be at variance with preliminary findings. If this condition occurs, the possible variations must be evaluated by the Project Geotechnical Engineer and adjusted as required or alternate design recommended.

This report is issued with the understanding that it is the responsibility of the owner, or his representative, to ensure that the information and recommendations contained herein are brought to the attention of the architect and engineer for the project and incorporated into the plans, and the necessary steps are taken to see that the contractor and subcontractor carry out such recommendations in the field. This firm does not practice or consult in the field of safety engineering. We do not direct the contractor's operations, and we cannot be responsible for other than our own personnel on the site; therefore, the safety of others is the responsibility of the contractor.

The contractor should notify the owner if he considers any of the recommended actions presented herein to be unsafe. The findings, conclusions, and recommendations presented herein are based on our understanding of the project and on subsurface conditions observed during our site work, and are valid as of the present date. However, changes in the conditions of a property can occur with the passage of time, whether they be due to natural processes or the works of man on this or adjacent properties. In additions, changes in applicable or appropriate standards may occur, whether they result from legislation or the broadening of knowledge.

If you should have any questions regarding this report, please do not hesitate to call our office. We appreciate this opportunity to be of service.

Submitted for GeoMat Testing Laboratories, Inc.

Haytham Nabilsi, GE 2375
Principal Engineer

REGISTERED PROFESSIONAL ENGINEER
HAYTHAM NABILSI
No. 2375
Exp. 12/31/18
GEOTECHNICAL
STATE OF CALIFORNIA

Art Martinez
Staff Engineer

Distribution: [3] Addressee

Attachments:

Figure 1	Site Location Map
Figure 2	Geologic Map
Figure 3	Regional Fault Map
Figure 4	Ground Shaking Map
Plate 1	Exploratory Borehole Location Map
Plate 2	Retaining Wall Drainage Detail
Appendix A	References
Appendix B	Exploratory Borehole Logs
Appendix C	Laboratory Test Results
Appendix D	2013 CBC Seismic Design Parameters
Appendix E	Liquefaction Analysis
Appendix F	General Earthwork and Grading Specifications

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TN

MN (11.9°E)

Figure 1

Scale 1 : 25,000

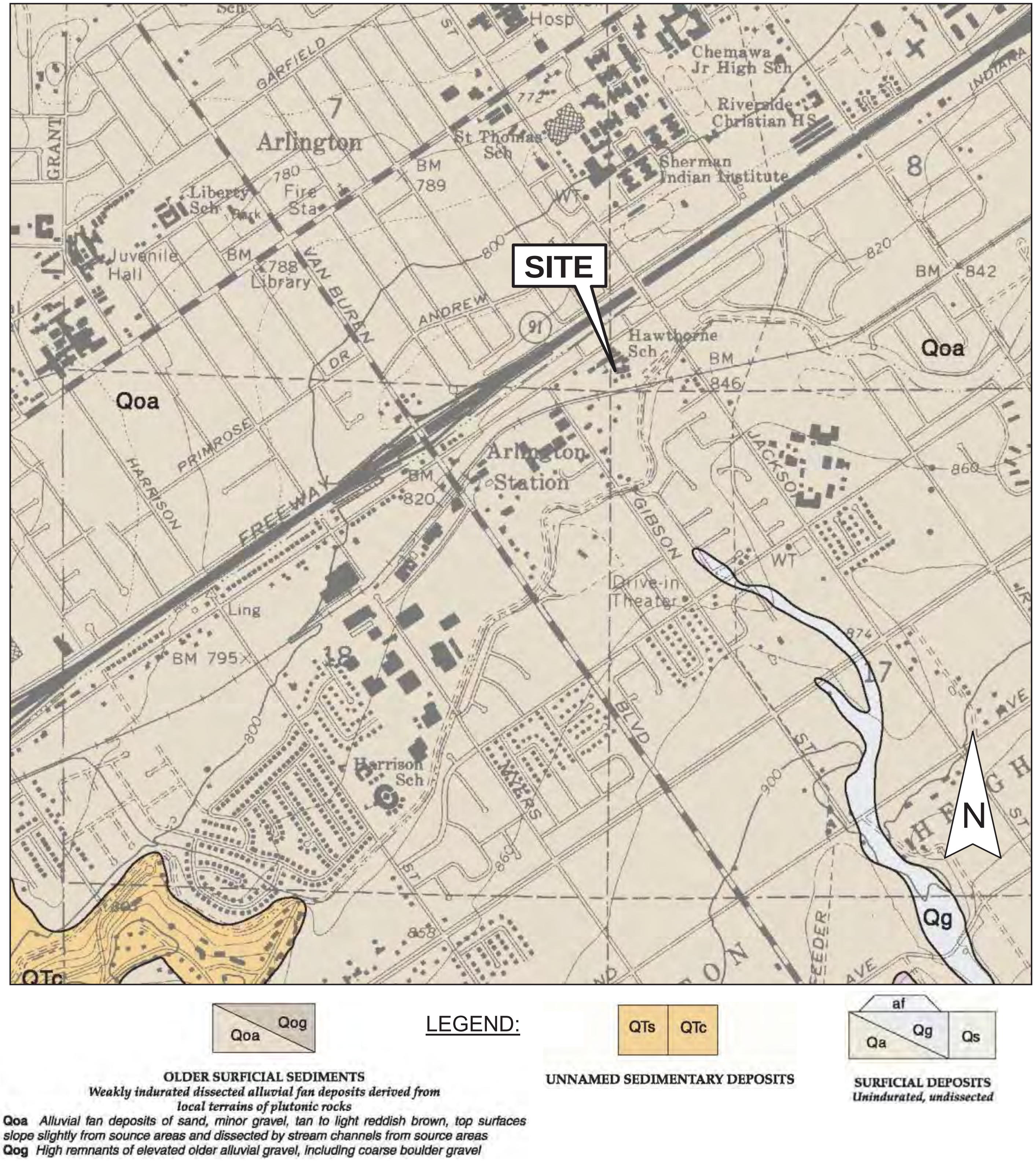
0 600 1200 1800 2400 3000 ft

0 200 400 600 800 1000 m

1" = 2,083.3 ft

Data Zoom 13-0

REGIONAL GEOLOGY MAP



LEGEND:

OLDER SURFICIAL SEDIMENTS
Weakly indurated dissected alluvial fan deposits derived from local terrains of plutonic rocks

Qoa *Alluvial fan deposits of sand, minor gravel, tan to light reddish brown, top surfaces slope slightly from source areas and dissected by stream channels from source areas*

Qog *High remnants of elevated older alluvial gravel, including coarse boulder gravel*

UNNAMED SEDIMENTARY DEPOSITS

SURFICIAL DEPOSITS
Unindurated, undissected

From: "Dibblee, T.W., and Minch, J.A., 2004, Geologic map of the Riverside West/south 1/2 of Fontana quadrangles, San Bernardino and Riverside County, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-128, scale 1:24,000"

PROJECT: APNs 233-180-007 and 233-170-001, Riverside, California

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PROJECT NO: 16193-01

DATE: January 19, 2017

FIGURE 2

REGIONAL FAULT MAP

From: "Fault Activity Map of California," compiled by Charles W. Jennings and William A. Bryant, California Geological Survey, Map No. 6, California Geologic Data Map Series, 2010

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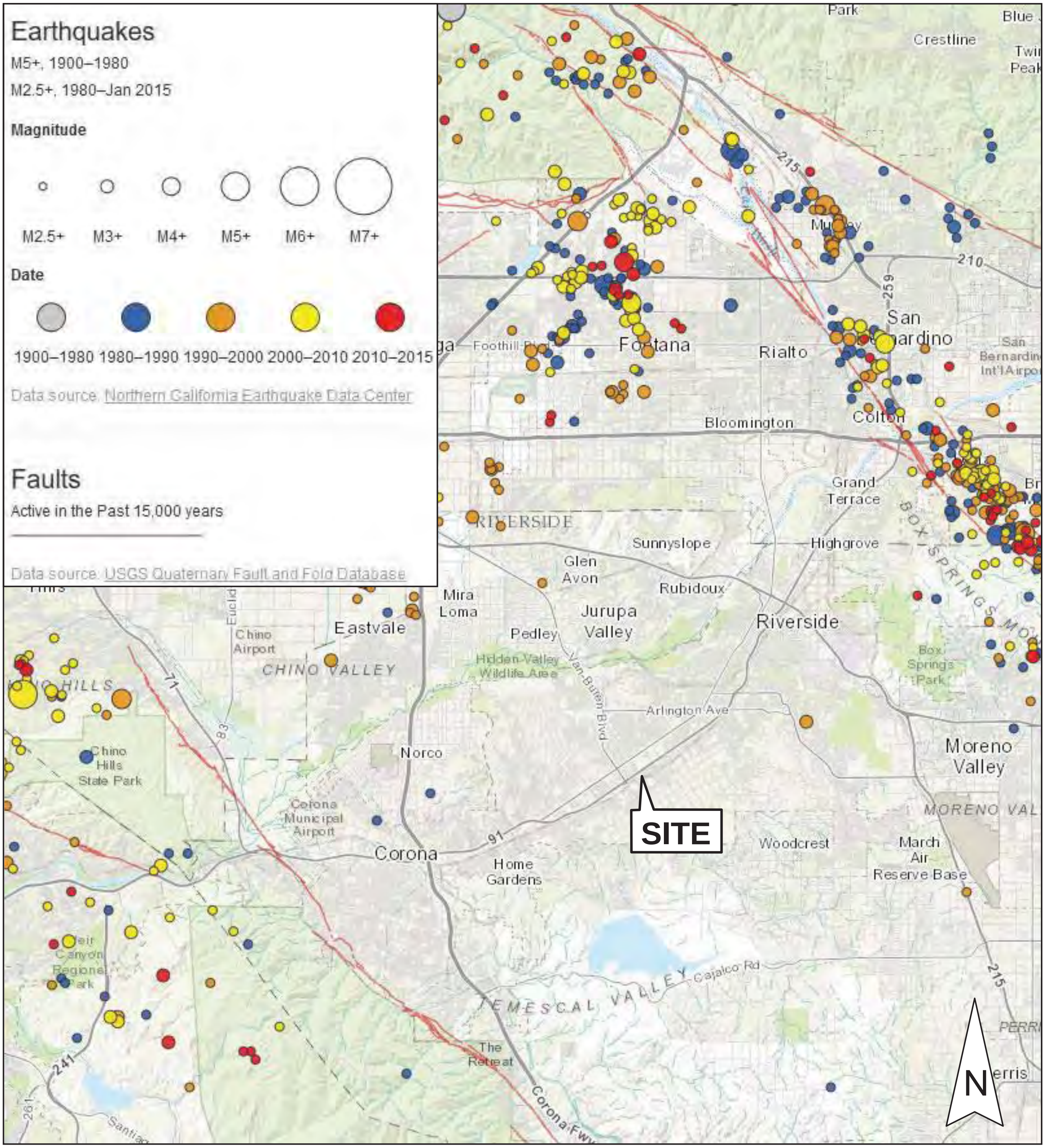
geomat

PROJECT NO: 16193-01

DATE: January 19, 2017

FIGURE 3

GROUND SHAKING MAP



From: USGS, Earthquake Hazards Program, Faults and Earthquake Probability Maps

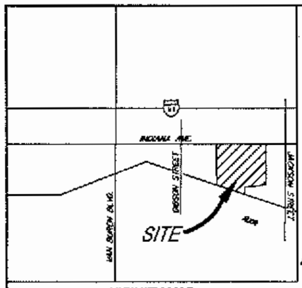
PROJECT: APNs 233-180-007 and 233-170-001, Riverside, California

geomat

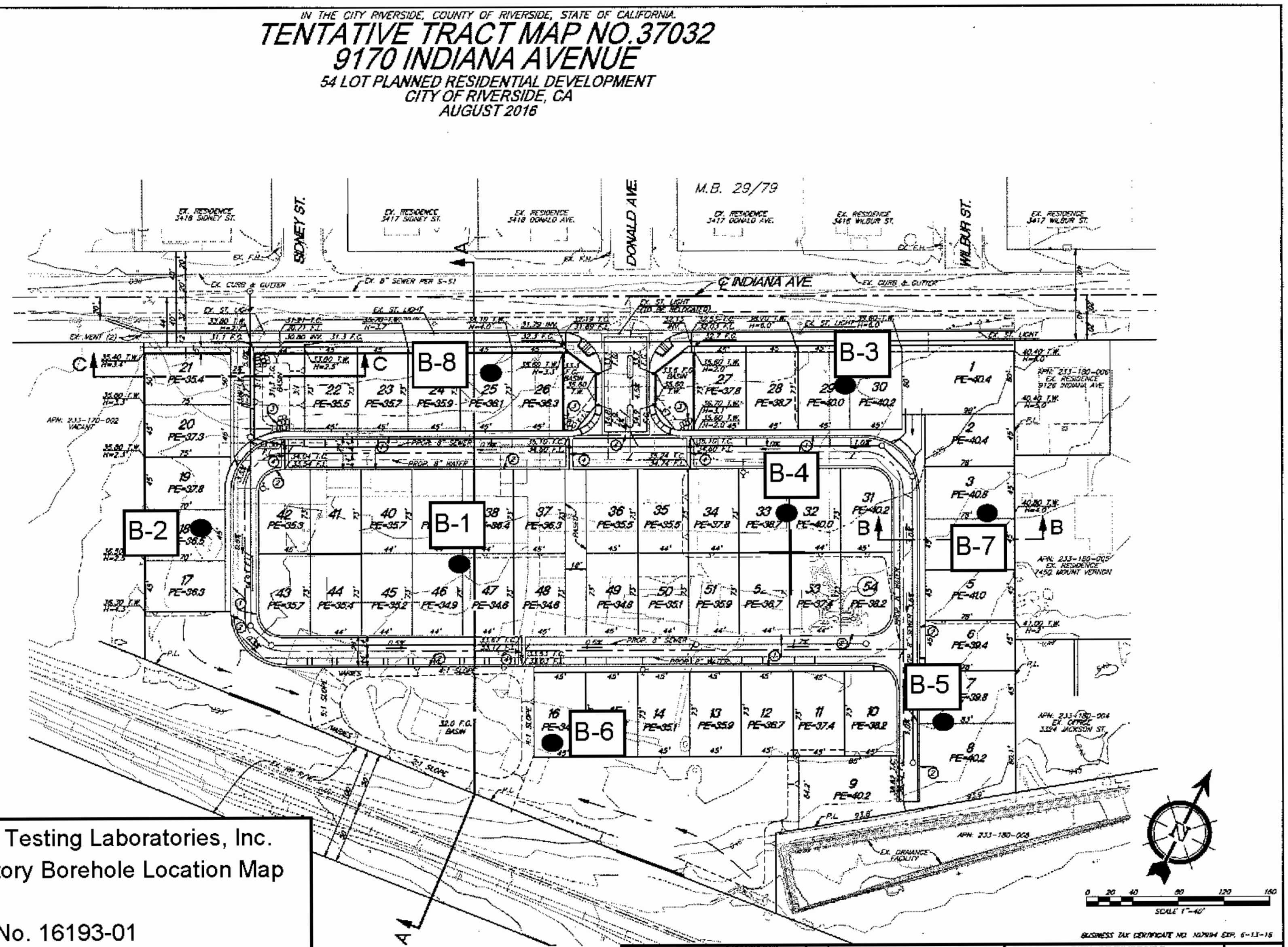
PROJECT NO: 16193-01

DATE: January 19, 2017

FIGURE 4



VICINITY MAP
NOT TO SCALE
THOMAS GUIDE PAGE: 715 GRID: A6



OWNER/APPLICANT

STEVEN WALKER COMMUNITIES, INC.
7167 INDIANA AVE., STE. 300
RIVERSIDE, CA 92504
951-274-3678

ENGINEER

SDH & ASSOCIATES, INC
5225 CANYON CREST DRIVE 71439
RIVERSIDE, CA 92507
VOICE: (951) 683-3691
FAX: (951) 788-2314

ASSESSOR'S PARCEL NO.

233-180-007-6
233-170-001-9

PROJECT INFO

AREA OF SITE = 6.85 AC.
NUMBER OF UNITS = 54
LOT AREA = 186,685 S.F.
STREET AREA = 49,697 S.F.
COMMON OPEN SPACE = 52,352 S.F.

GENERAL PLAN DESIGNATION

EXISTING - BUSINESS PARK (B/OP)
PROPOSED - RESIDENTIAL (MHDR)

ZONING

EXISTING - PF-PUBLIC FACILITIES
PROPOSED - R-1-7000

SCHOOL DISTRICT

RIVERSIDE UNIFIED
SCHOOL DISTRICT

UTILITY PURVEYORS

WATER..................CITY OF RIVERSIDE
GAS....................SO. CALIF. GAS
ELECTRICAL.............CITY OF RIVERSIDE
TELEPHONE..............PACIFIC BELL
SEWER..................CITY OF RIVERSIDE
CABLE ....CHARTER COMM.

LEGAL DESCRIPTION

A PORTION OF LOT 1 IN BLOCK 30 OF THE LANDS OF THE RIVERSIDE LAND AND IRRIGATION COMPANY, AS SHOWN BY MAP ON FILE IN BOOK 1 OF MAPS, AT PAGE 70, RECORDS OF SAN BERNARDINO COUNTY.

SOURCE OF TOPO

FIELD SURVEY BY RALSTON SURVEY SEPT. 2015
AERIAL PHOTOGRAMMETRY BY INLAND AERIAL SEPT. 2015

CONSTRUCTION NOTES

① CONSTRUCT 3" OVER 5" BASE PAVING
② CONSTRUCT 6" CURB & GUTTER
③ CONSTRUCT 6"-12" DIA RIP RAP
④ CONSTRUCT CROSS GUTTER
⑤ CONSTRUCT RETAINING WALL (5' MAX)

LEGEND

T.B. - TOP OF BERM
F.G. - FINISHED GRADE
F.L. - FLOW LINE
H.P. - HIGH POINT
EXIST. - EXISTING
P.E. - PAD ELEVATION
G.B. - GRADE BREAK

TRACT BOUNDARY
CENTERLINE
CURB AND GUTTER
1260 EXISTING CONTOUR LINE
LOT LINE
SLOPE

LOT INFO

LOT	AREA (S.F.)
1	5,880
2	3,510
3	3,510
4	3,510
5	3,510
6	3,510
7	3,735
8	5,661
9	4,809
10	3,272
11	3,285
12	3,285
13	3,285
14	3,285
15	3,285
16	3,285
17	3,150
18	3,150
19	3,256
20	3,175
21	3,750
22	3,285
23	3,285
24	3,285
25	3,285
26	3,285
27	3,285
28	3,285
29	3,285
30	3,370
31	3,199
32	3,212
33	3,212
34	3,212
35	3,212
36	3,285
37	3,285
38	3,212
39	3,212
40	3,212
41	3,212
42	3,199
43	3,199
44	3,212
45	3,212
46	3,212
47	3,212
48	3,285
49	3,285
50	3,212
51	3,212
52	3,212
53	3,212
54	3,199

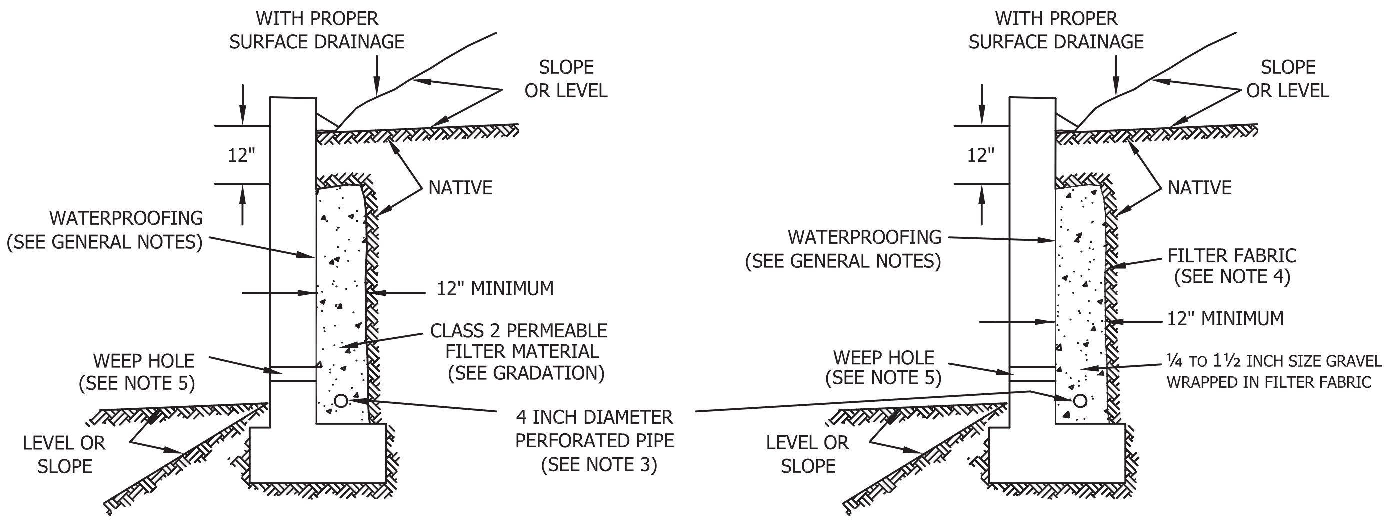
GeoMat Testing Laboratories, Inc.
Exploratory Borehole Location Map
Plate 1
Project No. 16193-01
January 23, 2017

SEAL:
ROBERT C. VAN ZANTEN
PREPARED BY:
SDH AND ASSOCIATES INC.
5225 CANYON CREST DRIVE 71439
Riverside, California 92507
TEL: (951) 683-3691 FAX (951) 788-2314
SCALE 1"=40'
DATE: FEBRUARY 2016
BENCHMARK
CITY OF RIVERSIDE
TTM 37032
9170 INDIANA AVENUE
1 OF 2 SHEETS

SUBDRAIN OPTIONS AND BACKFILL WHEN NATIVE MATERIAL HAS EXPANSION INDEX OF ≤50

OPTION 1: PIPE SURROUNDED WITH CLASS 2 PERMEABLE MATERIAL

OPTION 2: GRAVEL WRAPPED IN FILTER FABRIC



Class 2 Filter Permeable Material Gradation
Per Caltrans Specifications

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

GENERAL NOTES:

* Waterproofing should be provided where moisture nuisance problem through the wall is undesirable.
* Water proofing of the walls is not under purview of the geotechnical engineer
* All drains should have a gradient of 1 percent minimum
*Outlet portion of the subdrain should have a 4-inch diameter solid pipe discharged into a suitable disposal area designed by the project engineer. The subdrain pipe should be accessible for maintenance (rodding)
*Other subdrain backfill options are subject to the review by the geotechnical engineer and modification of design parameters.

Notes:

1) Sand should have a sand equivalent of 30 or greater and may be densified by water jetting.
2) 1 Cu. ft. per ft. of 1/4- to 1 1/2-inch size gravel wrapped in filter fabric
3) Pipe type should be ASTM D1527 Acrylonitrile Butadiene Styrene (ABS) SDR35 or ASTM D1785 Polyvinyl Chloride plastic (PVC), Schedule 40, Armco A2000 PVC, or approved equivalent. Pipe should be installed with perforations down. Perforations should be 3/8 inch in diameter placed at the ends of a 120-degree arc in two rows at 3-inch on center (staggered)
4) Filter fabric should be Mirafi 140NC or approved equivalent.
5) Weephole should be 3-inch minimum diameter and provided at 10-foot maximum intervals. If exposure is permitted, weepholes should be located 12 inches above finished grade. If exposure is not permitted such as for a wall adjacent to a sidewalk/curb, a pipe under the sidewalk to be discharged through the curb face or equivalent should be provided. For a basement-type wall, a proper subdrain outlet system should be provided.
6) Retaining wall plans should be reviewed and approved by the geotechnical engineer.
7) Walls over six feet in height are subject to a special review by the geotechnical engineer and modifications to the above requirements.

RETAINING WALL BACKFILL AND SUBDRAIN DETAIL

WHEN NATIVE MATERIAL HAS EXPANSION INDEX OF ≤50

Plate 2

Appendix A

REFERENCES

Dibblee, T.W., and Minch, J.A., 2004, Geologic map of the Riverside West/south 1/2 of Fontana Quadrangles, San Bernardino and Riverside County, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-128, scale 1:24,000

City of Riverside, General Plan, Safety Element.

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USGS, National Water Information System

USGS, Groundwater Watch, California Active Water Level Network.

Steve Mains, Hydrologist, Cooperative Well Measuring Program.

USGS, Contour Map Showing Minimum Depth to Ground Water, Upper Santa Ana River Valley, California, 1973-1979, Scott E. Carson and Jonathan C. Matti, 1985.

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Bay Area Earthquake Alliance, California Map of Earthquake Magnitudes and Faults Compiled from the Northern California Earthquake Data Center and USGS Quaternary Fault and Fold Database.

State of California, Department of Conservation, CGS Information Warehouse: Regulatory Maps

USGS, Earthquake Hazards Program, U.S. Seismic Design Maps

Department of the Navy, Design Manual 7.01, Soil Mechanics, September 1986.

Department of the Navy, Design Manual 7.02, Foundation and Earth Structures, September 1986.

Department of the Army, US Army Corps of Engineers, Engineering and Design, Bearing Capacity of Soils, EM 1110-1-1905.

ASCE, Journal of Geotechnical Engineering, Vol 118, 1987, "Evaluation of Settlements in Sand Due to Earthquake Shaking.", by K. Tokimatsu and H.B. Seed, p. 871, 876.

Foundation Design, D. Cudoto, Second Edition, 2000.

Principals of Foundation Design, Braja Das.

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Robert Day, Geotechnical Engineer’s Portable Handbook.

Robert Day, Geotechnical Foundation Handbook.

Appendix B

Geo
Mat

General Notes

DRILLING NOTES

WATER LEVEL MEASUREMENTS

Water levels indicated on the boring logs are levels measured in the borings at the times indicated. In permeable materials, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels is not possible with only short-term observations.

WATER LEVEL OBSERVATION DESIGNATION

W.D.	While Drilling
A.B.	After Boring
B.C.R.	Before Casing Removal
A.C.R.	After Casing Removal
24 hr.	Water level taken approximately 24 hrs. after boring completion

DRILLING AND SAMPLING SYMBOLS

AS	Auger Sample
CS	Continuous Sampler
DB	Diamond Bit -NX unless otherwise noted
HA	Hand Auger
HS	Hollow Stem Auger
PA	Power Auger
RB	Rock Bit
SS*	Split-Barrel
ST	Shelby Tube - 2" (51mm) unless otherwise noted
WB	Wash Bore
CR	Calfornia Ring Sampler 3" O.D., Lined with 2.5"X1" Rings

*The Standard Penetration Test is conducted in conjunction with the split-barrel sampling procedure. The "N" value corresponds to the number of blows required to drive the last 1 foot (0.3m) of an 18 in. (0.46m) long, 2 in. (51mm) O.D. split-barrel sampler with a 140 lb. (63.5 kg) hammer falling a distance of 30 in. (0.76m). The Standard Penetration Test is carried out according to ASTM D-1586. (See "N" Value below.)

SOIL PROPERTIES & DESCRIPTIONS

TEXTURE

PARTICLE	SIZE	
Clay	< 0.002 mm	(< 0.002 mm)
Silt	< #200 Sieve	(0.075 mm)
Sand	#4 to #200 Sieve	(4.75 to 0.075 mm)
Gravel	3 in. to #4 Sieve	(75 mm to 4.75 mm)
Cobbles	12 in. to 3 in.	(300 mm to 75 mm)
Boulders	> 12 in.	(300 mm)

COMPOSITION

SAND & GRAVEL

Description	% by Dry Weight
trace	< 15
with	15 - 29
modifer	> 30

FINES

Description	% by Dry Weight
trace	< 5
with	5 - 12
modifier	> 12

Soil descriptions are based on the Unified Soil Classification System (USCS) as outlined in ASTM Designations D-2487 and D-2488. The USCS group symbol shown on the boring logs correspond to the group names listed below. The description includes soil constituents, consistency, relative density, color and other appropriate descriptive terms. Geologic description of bedrock, when encountered, also is shown in the description column.

GROUP SYMBOL	GROUP NAME	GROUP SYMBOL	GROUP NAME
GW	Well Graded Gravel	CL	Lean Clay
GP	Poorly Graded Gravel	ML	Silt
GM	Silty Gravel	OL	Organic Clay or Silt
GC	Clayey Gravel	CH	Fat Clay
SW	Well Graded Sand	MH	Elastic Silt
SP	Poorly Graded Sand	OH	Organic Clay or Silt
SM	Silty Sand	PT	Peat
SC	Clayey Sand	CL-CH	Lean to Fat Clay

COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (Qu) (psf)	(kPa)
Very Soft	< 500	(< 24)
Soft	500 - 1000	(24 - 48)
Medium	1001 - 2000	(48 - 96)
Stiff	2001 - 4000	(96 - 192)
Very Stiff	4001 - 8000	(192 - 383)
Hard	> 8001	(> 383)

PLASTICITY

Description	Liquid Limit (%)
Lean	< 45%
Lean to Fat	45 to 49%
Fat	≥ 50%

Cohessive Soils

Consistency	"N" value
Very Soft	<2
Soft	2-4
Medium	4-8
Stiff (Firm)	8-15
Very Stiff (Very Firm)	15-30
Hard	>30

COHESIONLESS SOILS

RELATIVE DENSITY	"N" VALUE*
Very Loose	0 - 3
Loose	4 - 9
Medium Dense	10 - 29
Dense	30 - 49
Very Dense	≥ 50

BEDROCK PROPERTIES & DESCRIPTIONS

ROCK QUALITY DESIGNATION (RQD**)

DESCRIPTION OF ROCK QUALITY	RQD (%)
Very Poor	0 - 25
Poor	25 - 50
Fair	50 - 75
Good	75 - 90
Excellent	90 - 100

**RQD is defined as the total length of sound core pieces, 4 inches (102mm) or greater in length, expressed as a percentage of the total length cored. RQD provides an indication of the integrity of the rock mass and relative extent of seams and bedding planes.

DEGREE OF WEATHERING

Slightly Weathered	Slight decomposition of parent material in joints and seams.
Weathered	Well-developed and decomposed joints and seams.
Highly Weathered	Rock highly decomposed, may be extremely broken.

SOLUTION AND VOID CONDITIONS

Solid	Contains no voids.
Vuggy	Containing small pits or cavities < 1/2" (13mm).
Porous	Containing numerous voids which may be interconnected.
Cavernous	Containing cavities, sometimes quite large.

When classification of rock materials has been estimated from disturbed samples, core samples and petrographic analysis may reveal other rock types.

HARDNESS & DEGREE OF CEMENTATION

LIMESTONE

Hard	Difficult to scratch with knife.
Moderately Hard	Can scratch with knife but not with fingernail.
Soft	Can be scratched with fingernail.

SHALE

Hard	Can scratch with knife but not with fingernail.
Moderately Hard	Can be scratched with fingernail.
Soft	Can be molded easily with fingers

SANDSTONE

Well Cemented	Capable of scratching a knife blade.
Cemented	Can be scratched with knife.
Poorly Cemented	Can be broken apart easily with fingers.

BEDDING CHARACTERISTICS

TERM	THICKNESS (inches)	THICKNESS (mm)
Very Thick Bedded	> 36	> 915
Thick Bedded	12 - 36	305 - 915
Medium Bedded	4 - 12	102 - 305
Thin Bedded	1 - 4	25 - 102
Very Thin Bedded	0.4 - 1	10 - 25
Laminated	0.1 - 0.4	2.5 - 10
Thinly Laminated	< 0.1	< 2.5

Bedding Planes	Planes dividing the individual layers, beds or strata of rocks.
Joint	Fracture in rock, generally more or less vertical or transverse to the bedding.
Seam	Applies to bedding plane with an unspecified degree of weathering.

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Project Name: Hawthorne Heights Project, Riverside, CA
Project No.: 16193-01
Boring No.: **B-1** Page 1 of 2

Boring Location:	See Plate 1	Drilling Co.	GeoMat	Logged By:	AM
Drilling Date(s):	1/14/2017	Drill Rig:	CME 45	Groundwater Depth:	-- ft
Drilling Method:	Hollow Stem Auger			Depth to Bedrock:	-- ft
Hammer Weight/Drop:	140 lbs./30-inches	Hammer Type:	Automatic	Total Depth:	50 ft

Sampler Type: ▦ Auger Cuttings (C) ☒ California Ring (R) □ Split Spoon (S)

DEPTH (feet)	SAMPLES Sample Type	 Sample	BLOWCOUNTS 0 - 6"	 6" - 12"	 12" - 18"	 SPT "N" Value	USGS	MATERIAL DESCRIPTION	LABORATORY TEST DATA Moisture Content (%)	 Dry Density (pcf)	 Fines (%)	 Liquid Limit	 Plastic Limit	 Plast. Index
							SM	**SILTY SAND (SM)**						
1														
								medium brown silty fine grained sand						
2														
3														
								becoming coarse to fine grained silty sand						
4														
5														
	R	☒	8	16	21	24		medium dense	7	107				
6														
7														
8														
9														
10														
	S	□	5	6	7	13		medium dense	3		29			
11														
12														
13														
14														
							SPSM	**SAND WITH SILT**						
15														
	R	☒	15	20	23	28		gray poorly-graded sand with silt	3	114				
16														
								medium dense						
17														
18														
19														
20														
	S	□	5	6	7	13	SWSM	gray well-graded sand with silt	4		12			
21														
								medium dense						
22														
23														
24														
25														
	S	□	5	7	8	15	SM	**SILTY SAND (SM)**	5		27			
26														
								medium brown silty fine grained sand						
27														
								medium dense						
28														
29														
30														
	S	□	7	7	11	18		medium dense						
31														
32														
33														
34														

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ, the transition may be gradual.

geomat

Project Name: Hawthorne Heights Project, Riverside, CA
Project No.: 16193-01
Boring No.: **B-1** Page 2 of 2

Boring Location:	See Plate 1	Drilling Co.	GeoMat	Logged By:	AM
Drilling Date(s):	1/14/2017	Drill Rig:	CME 45	Groundwater Depth:	-- ft
Drilling Method:	Hollow Stem Auger			Depth to Bedrock:	-- ft
Hammer Weight/Drop:	140 lbs./30-inches	Hammer Type:	Automatic	Total Depth:	50 ft

Sampler Type: ▨ Auger Cuttings (C) ☒ California Ring (R) ▢ Split Spoon (S)

LABORATORY TEST DATA

DEPTH (feet)	SAMPLES Sample Type	 Sample	BLOWCOUNTS 0 - 6"	 6" - 12"	 12" - 18"	 SPT "N" Value	USGS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Fines (%)	Liquid Limit	Plastic Limit	Plast. Index
	S	▢	10	12	15	27	SPSM	**SAND WITH SILT (SP-SM)**	2		5			
36								gray poorly-graded sand with silt						
37								medium dense						
38														
39														
40														
	S	▢	10	13	15	28	SM	**SILTY SAND (SM)**	6		27			
41								gray-brown silty sand						
42								medium dense						
43														
44														
45														
	S	▢	9	11	13	24	ML	**SANDY SILT (ML)**	13		60			
46								gray sandy silt, moist						
47								very firm						
48														
49														
50														
	S	▢	7	13	15	28		very firm						
51														
52								TD = 50'						
53														
54														
55														
56														
57														
58														
59														
60														
61														
62														
63														
64														
65														
66														
67														
68														
69														

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ, the transition may be gradual.

Project Name: Hawthorne Heights Project, Riverside, CA
Project No.: 16193-01
Boring No.: **B-2** Page 1 of 1

Boring Location:	See Plate 1	Drilling Co.	GeoMat	Logged By:	AM
Drilling Date(s):	1/19/2017	Drill Rig:	--	Groundwater Depth:	-- ft
Drilling Method:	Manual with Dames and Moore			Depth to Bedrock:	-- ft
Hammer Weight/Drop:	35 lbs./36-inches	Hammer Type:	Automatic	Total Depth:	15 ft

Sampler Type: ▨ Auger Cuttings (C) ☒ California Ring (R) ☐ Split Spoon (S)

DEPTH (feet)	SAMPLES		BLOWCOUNTS				USGS	MATERIAL DESCRIPTION	LABORATORY TEST DATA					
	Sample Type	Sample	0 - 6"	6" - 12"	12" - 18"	SPT "N" Value			Moisture Content (%)	Dry Density (pcf)	Fines (%)	Liquid Limit	Plastic Limit	Plast. Index
							SM	**SILTY SAND (SM)**						
1								medium brown silty fine grained sand						
2														
3														
4														
5														
	R	☒				27		medium dense	4	100				
6														
								becoming coarse to fine grained silty sand						
7														
8														
9														
10														
11							SP	**SAND WITH SILT (SP)**						
12														
	R	☒				13		poorly-graded sand	2	110	2			
13														
								medium dense, dry						
14														
15														
								TD = 15'						
16														
17														
18														
19														
20														
21														
22														
23														
24														
25														
26														
27														
28														
29														
30														
31														
32														
33														
34														

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ, the transition may be gradual.

Project Name:	Hawthorne Heights Project, Riverside, CA			Boring No.:	**B-3**	Page	1 of 1
Project No.:	16193-01						
Boring Location:	See Plate 1	Drilling Co.	GeoMat	Logged By:	AM		
Drilling Date(s):	1/18/2017	Drill Rig:	--	Groundwater Depth:	--	ft	
Drilling Method:	Manual with Dames and Moore			Depth to Bedrock:	--	ft	
Hammer Weight/Drop:	35 lbs./36-inches	Hammer Type:	Automatic	Total Depth:	6	ft	

Sampler Type: ▦ Auger Cuttings (C) ☒ California Ring (R) ☐ Split Spoon (S)

	SAMPLES		BLOWCOUNTS						LABORATORY TEST DATA					
DEPTH (feet)	Sample Type	Sample	0 - 6"	6" - 12"	12" - 18"	SPT "N" Value	USGS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Fines (%)	Liquid Limit	Plastic Limit	Plast. Index
								FILL (WOODCHIPS)						
1														
							SM	**SILTY SAND (SM)**						
2														
								medium brown silty fine grained sand						
3														
4														
								becoming coarse to fine grained silty sand						
5														
	R	☒				23		medium dense	5	102				
6														
7														
								TD = 6'						
8														
9														
10														
11														
12														
13														
14														
15														
16														
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30														
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32														
33														
34														

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ, the transition may be gradual.

Project Name:	Hawthorne Heights Project, Riverside, CA	Boring No.:	**B-4**	Page	1 of 1
Project No.:	16193-01				

Boring Location:	See Plate 1	Drilling Co.	GeoMat	Logged By:	AM
Drilling Date(s):	1/18/2017	Drill Rig:	--	Groundwater Depth:	-- ft
Drilling Method:	Manual with Dames and Moore			Depth to Bedrock:	-- ft
Hammer Weight/Drop:	35 lbs./36-inches	Hammer Type:	Automatic	Total Depth:	12' ft

Sampler Type: ▨ Auger Cuttings (C) ☒ California Ring (R) ☐ Split Spoon (S)

	SAMPLES		BLOWCOUNTS						LABORATORY TEST DATA					
DEPTH (feet)	Sample Type	Sample	0 - 6"	6" - 12"	12" - 18"	SPT "N" Value	USGS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Fines (%)	Liquid Limit	Plastic Limit	Plast. Index
							SM	**SILTY SAND (SM)**						
1								medium brown silty fine grained sand						
2														
3								becoming coarse to fine grained silty sand						
4														
5														
6														
7														
	R	☒				22		medium dense						
8								sample disturbed						
9														
10														
11														
12														
	R	☒				18		medium dense	6	107				
13														
14								TD = 12'						
15														
16														
17														
18														
19														
20														
21														
22														
23														
24														
25														
26														
27														
28														
29														
30														
31														
32														
33														
34														

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ, the transition may be gradual.

Project Name: Hawthorne Heights Project, Riverside, CA
Project No.: 16193-01
Boring No.: **B-5** Page 1 of 1

Boring Location:	See Plate 1	Drilling Co.	GeoMat	Logged By:	AM
Drilling Date(s):	1/18/2017	Drill Rig:	--	Groundwater Depth:	-- ft
Drilling Method:	Manual with Dames and Moore			Depth to Bedrock:	-- ft
Hammer Weight/Drop:	35 lbs./36-inches	Hammer Type:	Automatic	Total Depth:	13' ft

Sampler Type: ▨ Auger Cuttings (C) ☒ California Ring (R) ☐ Split Spoon (S)

	SAMPLES		BLOWCOUNTS						LABORATORY TEST DATA					
DEPTH (feet)	Sample Type	Sample	0 - 6"	6" - 12"	12" - 18"	SPT "N" Value	USGS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Fines (%)	Liquid Limit	Plastic Limit	Plast. Index
							SM	**SILTY SAND (SM)**						
1								medium brown silty fine grained sand						
2														
3								becoming coarse to fine grained silty sand						
4														
5	R	☒				28		medium dense	5	108				
6														
7														
8														
9														
10														
11														
12	R	☒				20		**SAND WITH SILT (SP-SM)**	3	109				
13								poorly-graded sand with silt						
14								medium dense						
15														
16								TD = 13'						
17														
18														
19														
20														
21														
22														
23														
24														
25														
26														
27														
28														
29														
30														
31														
32														
33														
34														

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ, the transition may be gradual.

Project Name:	Hawthorne Heights Project, Riverside, CA	Boring No.:	**B-6**	Page 1 of 1
Project No.:	16193-01			

Boring Location:	See Plate 1	Drilling Co.	GeoMat	Logged By:	AM	
Drilling Date(s):	1/21/2017	Drill Rig:	CME 45	Groundwater Depth:	--	ft
Drilling Method:	Hollow Stem Auger			Depth to Bedrock:	--	ft
Hammer Weight/Drop:	140 lbs./30-inches	Hammer Type:	Automatic	Total Depth:	15'	ft

Sampler Type: ▦ Auger Cuttings (C) ☒ California Ring (R) ▭ Split Spoon (S)

DEPTH (feet)	SAMPLES		BLOWCOUNTS				USGS	MATERIAL DESCRIPTION	LABORATORY TEST DATA					
	Sample Type	Sample	0 - 6"	6" - 12"	12" - 18"	SPT "N" Value			Moisture Content (%)	Dry Density (pcf)	Fines (%)	Liquid Limit	Plastic Limit	Plast. Index
							SM	**SILTY SAND (SM)**						
1								medium brown silty fine grained sand						
2														
3								becoming more coarse grained						
4														
5	S	▭	2	3	4	7		loose						
6														
7							SPSM	**SAND WITH SILT (SP-SM)**						
8								brown poorly-graded sand with silt						
9								dry						
10	S	▭	8	11	12	23	SM	**SILTY SAND (SM)**						
11								medium brown silty fine grained sand						
12								medium dense						
13														
14														
15	S	▭	7	9	10	19		medium dense						
16														
17								TD = 15'						
18														
19														
20														
21														
22														
23														
24														
25														
26														
27														
28														
29														
30														
31														
32														
33														
34														

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ, the transition may be gradual.

Project Name: Hawthorne Heights Project, Riverside, CA
Project No.: 16193-01

Boring No.: **B-7** Page 1 of 1

Boring Location:	See Plate 1	Drilling Co.	GeoMat	Logged By:	AM
Drilling Date(s):	1/21/2017	Drill Rig:	CME 45	Groundwater Depth:	-- ft
Drilling Method:	Hollow Stem Auger			Depth to Bedrock:	-- ft
Hammer Weight/Drop:	140 lbs./30-inches	Hammer Type:	Automatic	Total Depth:	15' ft

Sampler Type: ▦ Auger Cuttings (C) ☒ California Ring (R) ▒ Split Spoon (S)

DEPTH (feet)	SAMPLES Sample Type	 Sample	BLOWCOUNTS 0 - 6"	 6" - 12"	 12" - 18"	 SPT "N" Value	USGS	MATERIAL DESCRIPTION	LABORATORY TEST DATA Moisture Content (%)	 Dry Density (pcf)	 Fines (%)	 Liquid Limit	 Plastic Limit	 Plast. Index
							SM	**SILTY SAND (SM)**						
1								medium brown silty fine grained sand						
2														
3								becoming more coarse grained						
4														
5	S	▒	9	11	11	22		medium dense						
6														
7														
8														
9														
10	S	▒	8	7	8	15		medium dense						
11														
12							SPSM	**SAND WITH SILT (SP-SM)**						
13								brown poorly-graded sand with silt						
14								dry						
15	S	▒	5	6	7	13	SM	**SILTY SAND (SM)**						
16								medium brown silty fine grained sand						
17														
18								TD = 15'						
19														
20														
21														
22														
23														
24														
25														
26														
27														
28														
29														
30														
31														
32														
33														
34														

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ, the transition may be gradual.

BORHOLE LOG BH-8

Project No.	16193-01	**Sheet**	1 OF 1
		Date	10/24/2015
Project	Steven Walker Homes - Hawthorne Heights	**Drilling Co.**	GeoMat
Client	Steven Walker Homes	**Sampler**	Cal Mod. And SPT
Location	APN 233-170-001 and 233-180-007, Riverside, California	**Method**	Hollow Stem
		Hammer Type	140 lb
Coodinate		**Surface Elev.**	
Notes		**Total Depth**	15'

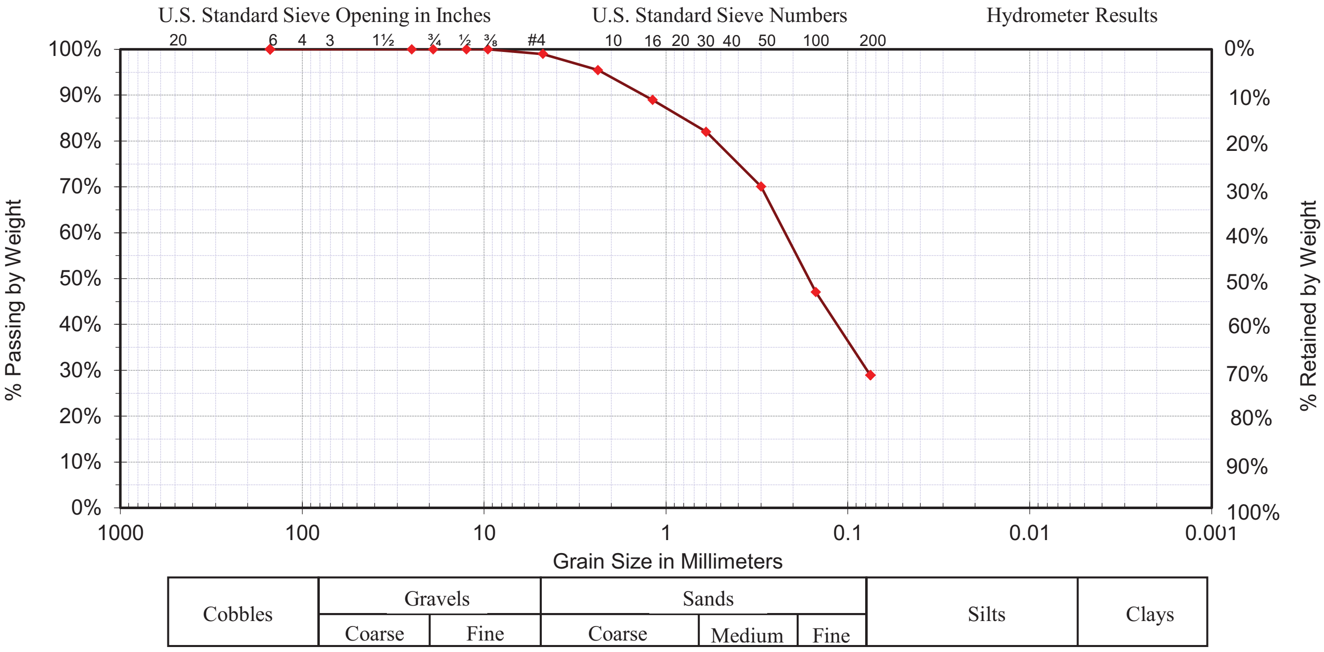
Type/Symbol	Casing	Split Spoon		Ring Sampler		Cutting		Date	Time	Water Depth (ft)	Casing Size (in)	Casing Depth (ft)	Hole Depth (ft)	Symbol
I.D.		S	▮	R	⧗	C	▥							
O.D.								10/24/2015		None				
Length														
Hammer Wt.														
Hammer Fall														

Depth Below Surface (ft)	Elevation (ft)	Graphic	Soil Sample Type	Soil Sample Number	Soil Sample Symbol	Soil Sample Depth	Blows 0-152.4 mm	Blows 152.4-304.8 mm	Blows 304.8-457.2 mm	N-Value	N60	(N1)60	VISUAL MATERIAL CLASSIFICATION AND REMARKS	Moisture (%)	Dry Density (pcf)	Test
0		░											**SILTY SAND (SM)**			
1		░											medium brown silty sand, moist			
2		░														
3		░														
4		░														
5		░	R		⧗		4	5	7	8			loose	8	124	
6		░											becoming more coarse grained			
7		░														
8		▦											**WELL-GRADED SAND (SW)**			
9		▦											gray-brown sand with silt, dry			
10		▦	R		⧗		5	8	11	12			medium dense	2	111	
11		▦											% Passing No. 200 Sieve = 3			
12		▦														
13		▦														
14		░											**SILTY SAND (SM)**			
15		░	S		▮		8	10	10	20			medium brown silty sand, moist	6		
16													medium dense			
17													% Passing No. 200 Sieve = 21			
18																
19																
20																
21																
22																
23																
24																

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ, the transition may be gradual.

Appendix C

LABORATORY TEST RESULTS



Date : 01/14/17
Sample #:
Sample ID: B1 @ 10'
Source: SPT
Project: APNs 233-180-007 & 233-170-001
Location: Riverside, California
Boring #: B1
Depth: 10'

D_{10} = 0.03
D_{30} = 0.08
D_{60} = 0.23
C_C = 1.04
C_{U} = 9.02
Liquid Limit= n/a
Plastic Limit= n/a
Plasticity Index= n/a

Classification
SM, Silty Sand

Specifications
custom specs 1

Fineness Modulus
1.18

% Gravel
1.04%
% Sand
70.08%
% Silt & Clay
28.88%

Sample Moisture
3.4%

Coarse Section		Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
Sieve Size US	Metric				
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00	100.0%	100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	100.0%	100.0%		
5/8"	16.00		100.0%		
1/2"	12.50	100.0%	100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30		99.3%		
#4	4.75	99.0%	99.0%		

Fines Section		Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
Sieve Size US	Metric				
#4	4.750	99.0%	99.0%		
#8	2.360	95.5%	95.5%		
#10	2.000		93.5%		
#16	1.180	88.9%	88.9%		
#20	0.850		85.0%		
#30	0.600	82.0%	82.0%		
#40	0.425		75.0%		
#50	0.300	70.1%	70.1%		
#60	0.250		62.4%		
#80	0.180		51.7%		
#100	0.150	47.1%	47.1%		
#140	0.106		36.4%		
#170	0.090		32.5%		
#200	0.075	28.9%	28.9%		
#270	0.053				

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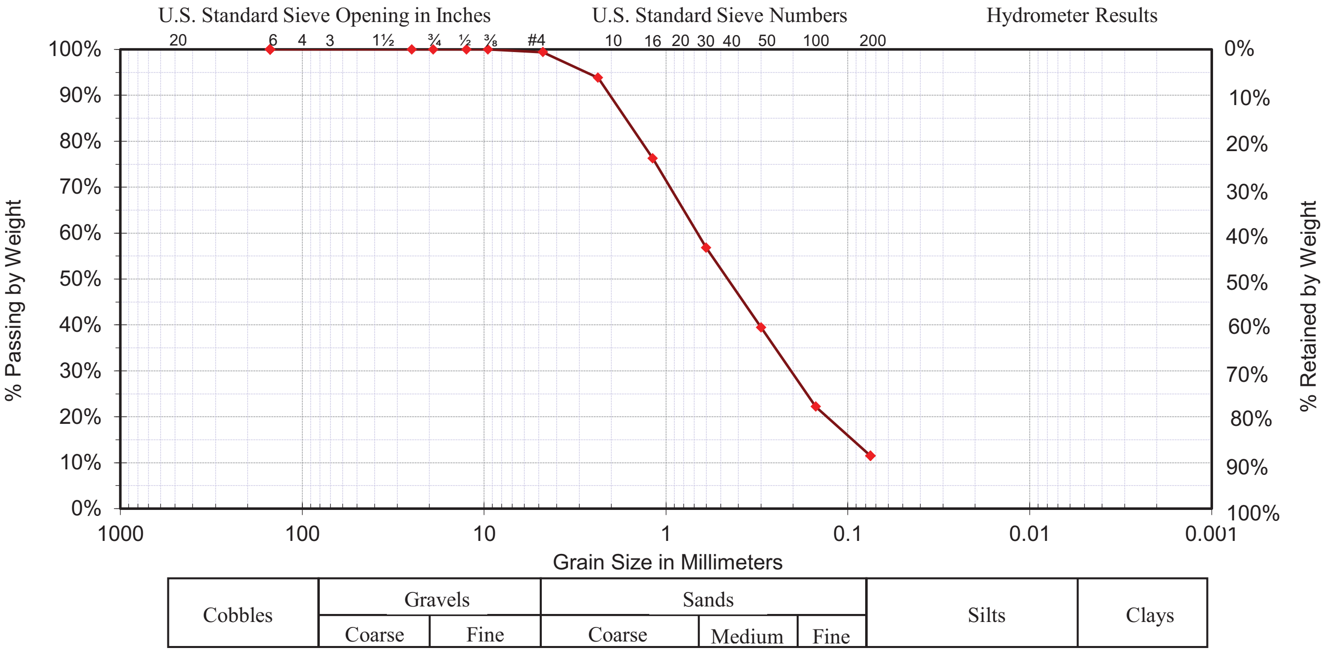
LABORATORY TEST RESULTS



Date : 01/14/17
Sample #:
Sample ID: B1 @ 20'
Source: SPT
Project: APNs 233-180-007 & 233-170-001
Location: Riverside, California
Boring #: B1
Depth: 20'

D_{10} = 0.07
D_{30} = 0.22
D_{60} = 0.70
C_C = 1.05
$C_{U =}$ 10.65
Liquid Limit= n/a
Plastic Limit= n/a
Plasticity Index= n/a

Classification
SW-SM, Well-graded Sand with Silt

Specifications
custom specs 1

Fineness Modulus
2.12

% Gravel
0.62%
% Sand
87.89%
% Silt & Clay
11.48%

Sample Moisture
3.8%

Coarse Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00	100.0%	100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	100.0%	100.0%		
5/8"	16.00		100.0%		
1/2"	12.50	100.0%	100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30		99.6%		
#4	4.75	99.4%	99.4%		

Fines Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
#4	4.750	99.4%	99.4%		
#8	2.360	93.8%	93.8%		
#10	2.000		88.5%		
#16	1.180	76.3%	76.3%		
#20	0.850		65.2%		
#30	0.600	56.8%	56.8%		
#40	0.425		46.7%		
#50	0.300	39.5%	39.5%		
#60	0.250		33.7%		
#80	0.180		25.6%		
#100	0.150	22.2%	22.2%		
#140	0.106		15.9%		
#170	0.090		13.6%		
#200	0.075	11.5%	11.5%		
#270	0.053				

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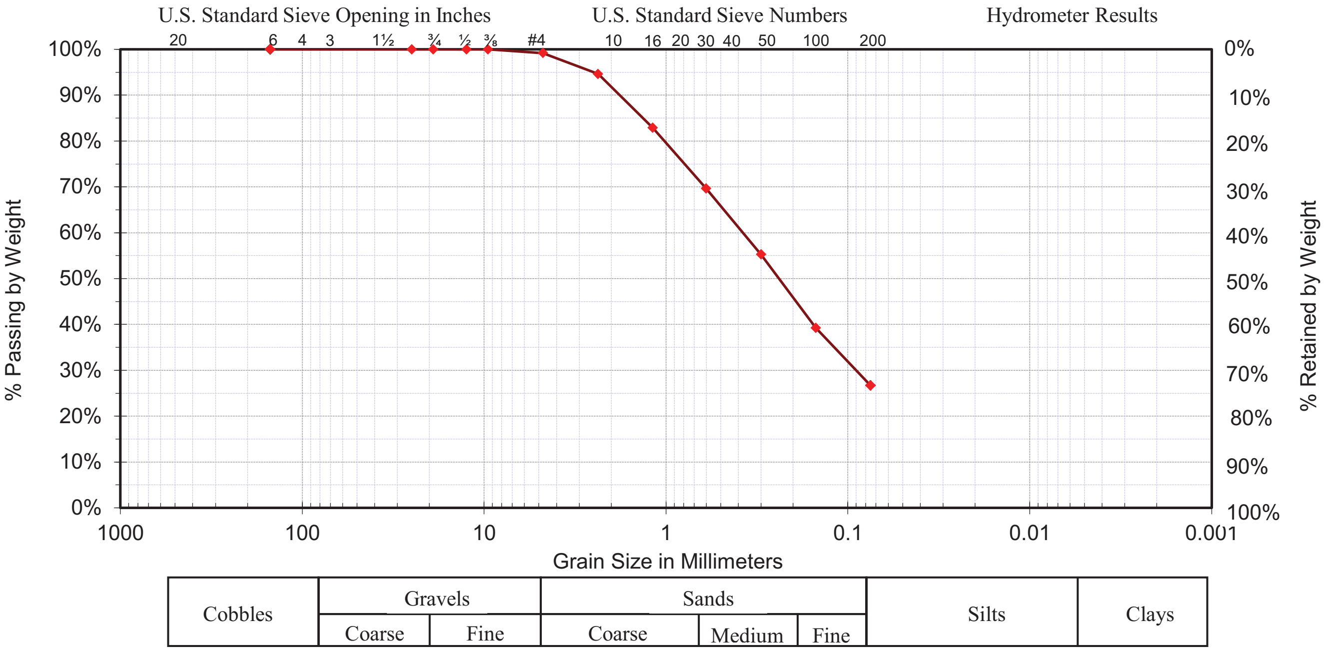
LABORATORY TEST RESULTS



Date : 01/14/17
Sample #:
Sample ID: B1 @ 25'
Source: SPT
Project: APNs 233-180-007 & 233-170-001
Location: Riverside, California
Boring #: B1
Depth: 25'

D_{10} = 0.03
D_{30} = 0.09
D_{60} = 0.40
C_C = 0.80
$C_{U =}$ 14.21
Liquid Limit= n/a
Plastic Limit= n/a
Plasticity Index= n/a

Classification
SM, Silty Sand

Specifications
custom specs 1

Fineness Modulus
1.59

% Gravel
0.82%
% Sand
72.48%
% Silt & Clay
26.71%

Sample Moisture
5.3%

Coarse Section Sieve Size US	Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00	100.0%	100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	100.0%	100.0%		
5/8"	16.00		100.0%		
1/2"	12.50	100.0%	100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30		99.5%		
#4	4.75	99.2%	99.2%		

Fines Section Sieve Size US	Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	99.2%	99.2%		
#8	2.360	94.6%	94.6%		
#10	2.000		91.0%		
#16	1.180	82.9%	82.9%		
#20	0.850		75.3%		
#30	0.600	69.6%	69.6%		
#40	0.425		61.2%		
#50	0.300	55.2%	55.2%		
#60	0.250		49.9%		
#80	0.180		42.4%		
#100	0.150	39.2%	39.2%		
#140	0.106		31.9%		
#170	0.090		29.2%		
#200	0.075	26.7%	26.7%		
#270	0.053				

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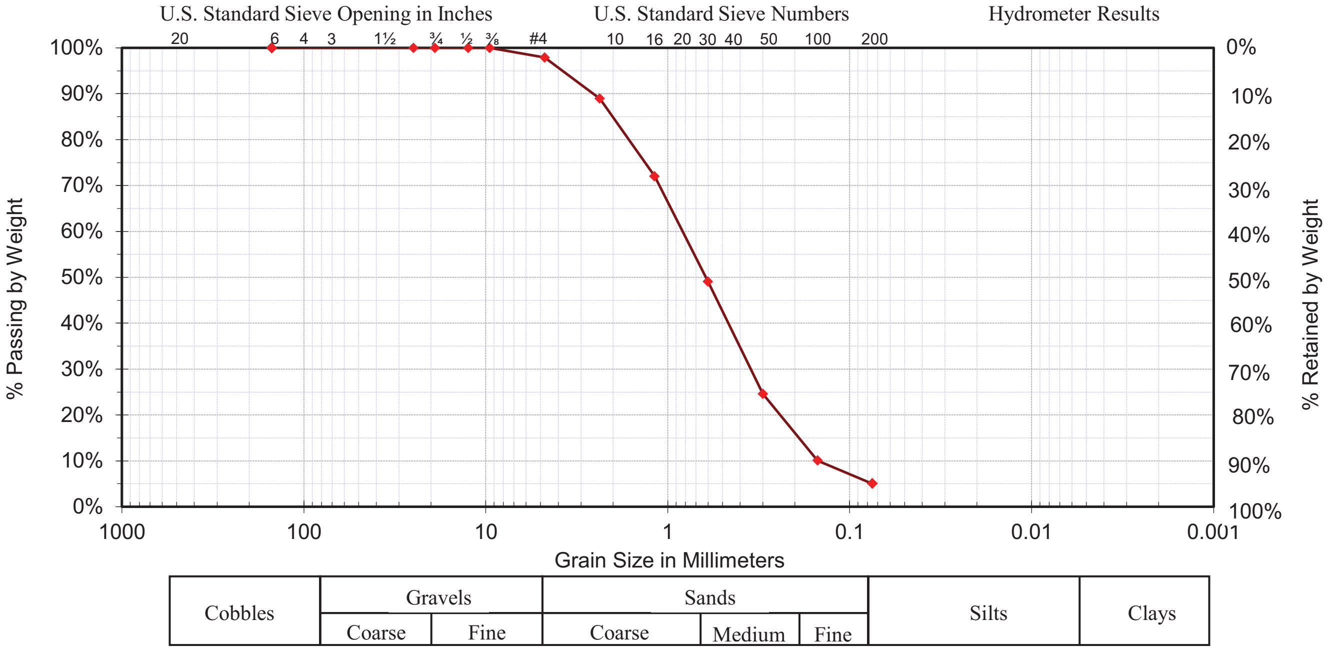
LABORATORY TEST RESULTS



Date :	01/14/17	D_{10} =	0.15	**Classification**	% Gravel
Sample #:		D_{30} =	0.37	SP-SM, Poorly graded Sand with Silt	2.13%
Sample ID:	B1 @ 35'	D_{60} =	0.88		% Sand
Source:	SPT	C_C =	1.03	**Specifications**	92.85%
Project:	APNs 233-180-007 & 233-170-001	C_U =	5.87	custom specs 1	% Silt & Clay
Location:	Riverside, California	Liquid Limit=	n/a		5.03%
Boring #:	B1	Plastic Limit=	n/a	Fineness Modulus	Sample Moisture
Depth:	35'	Plasticity Index=	n/a	2.57	**2.2%**

Coarse Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00	100.0%	100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	100.0%	100.0%		
5/8"	16.00		100.0%		
1/2"	12.50	100.0%	100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30		98.6%		
#4	4.75	97.9%	97.9%		

Fines Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
#4	4.750	97.9%	97.9%		
#8	2.360	88.9%	88.9%		
#10	2.000		83.8%		
#16	1.180	72.0%	72.0%		
#20	0.850		58.9%		
#30	0.600	49.0%	49.0%		
#40	0.425		34.8%		
#50	0.300	24.6%	24.6%		
#60	0.250		19.8%		
#80	0.180		13.0%		
#100	0.150	10.1%	10.1%		
#140	0.106		7.1%		
#170	0.090		6.0%		
#200	0.075	5.0%	5.0%		
#270	0.053				

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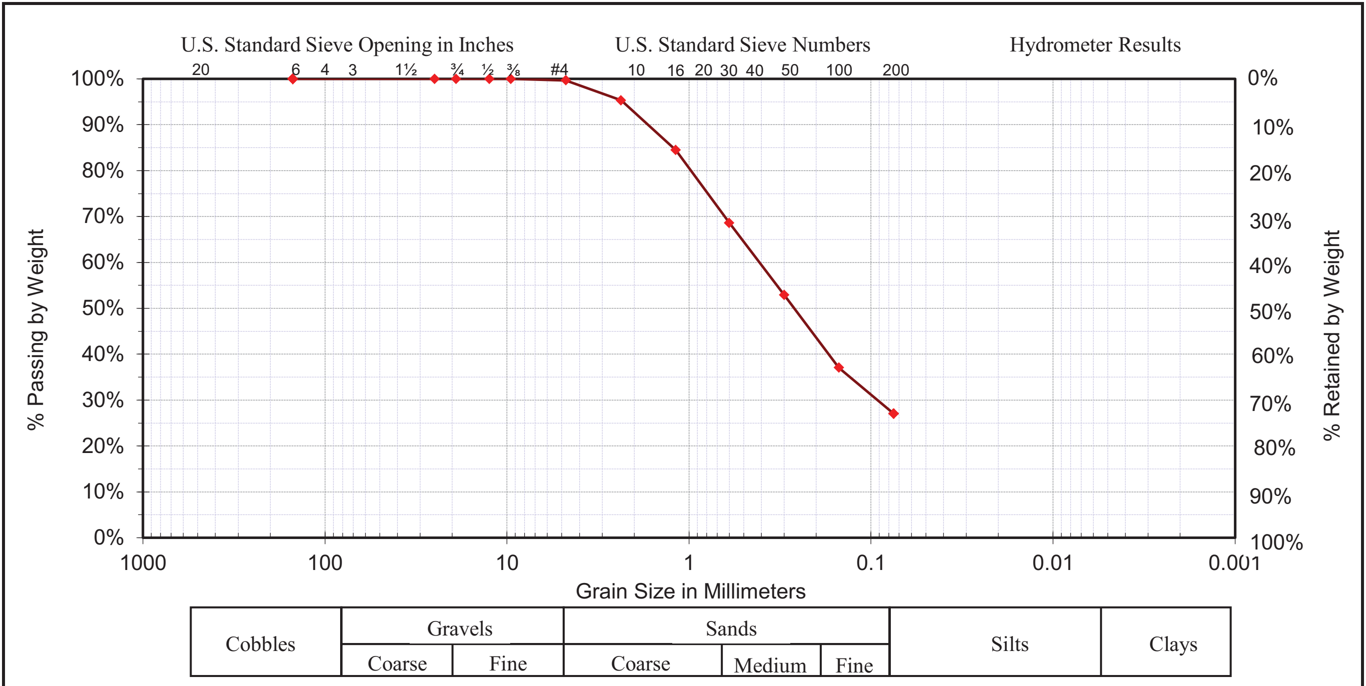
LABORATORY TEST RESULTS



Date : 01/14/17
Sample #:
Sample ID: B1 @ 40'
Source: SPT
Project: APNs 233-180-007 & 233-170-001
Location: Riverside, California
Boring #: B1
Depth: 40'

D_{10} = 0.03
D_{30} = 0.10
D_{60} = 0.44
C_C = 0.78
C_{U} = 15.70
Liquid Limit= n/a
Plastic Limit= n/a
Plasticity Index= n/a

Classification
SM, Silty Sand

Specifications
custom specs 1

Fineness Modulus
1.62

% Gravel
0.33%
% Sand
72.62%
% Silt & Clay
27.05%
Sample Moisture
6.3%

Coarse Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00	100.0%	100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	100.0%	100.0%		
5/8"	16.00		100.0%		
1/2"	12.50	100.0%	100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30		99.8%		
#4	4.75	99.7%	99.7%		

Fines Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
#4	4.750	99.7%	99.7%		
#8	2.360	95.3%	95.3%		
#10	2.000		92.0%		
#16	1.180	84.5%	84.5%		
#20	0.850		75.5%		
#30	0.600	68.6%	68.6%		
#40	0.425		59.5%		
#50	0.300	52.9%	52.9%		
#60	0.250		47.6%		
#80	0.180		40.2%		
#100	0.150	37.1%	37.1%		
#140	0.106		31.2%		
#170	0.090		29.0%		
#200	0.075	27.0%	27.0%		
#270	0.053				

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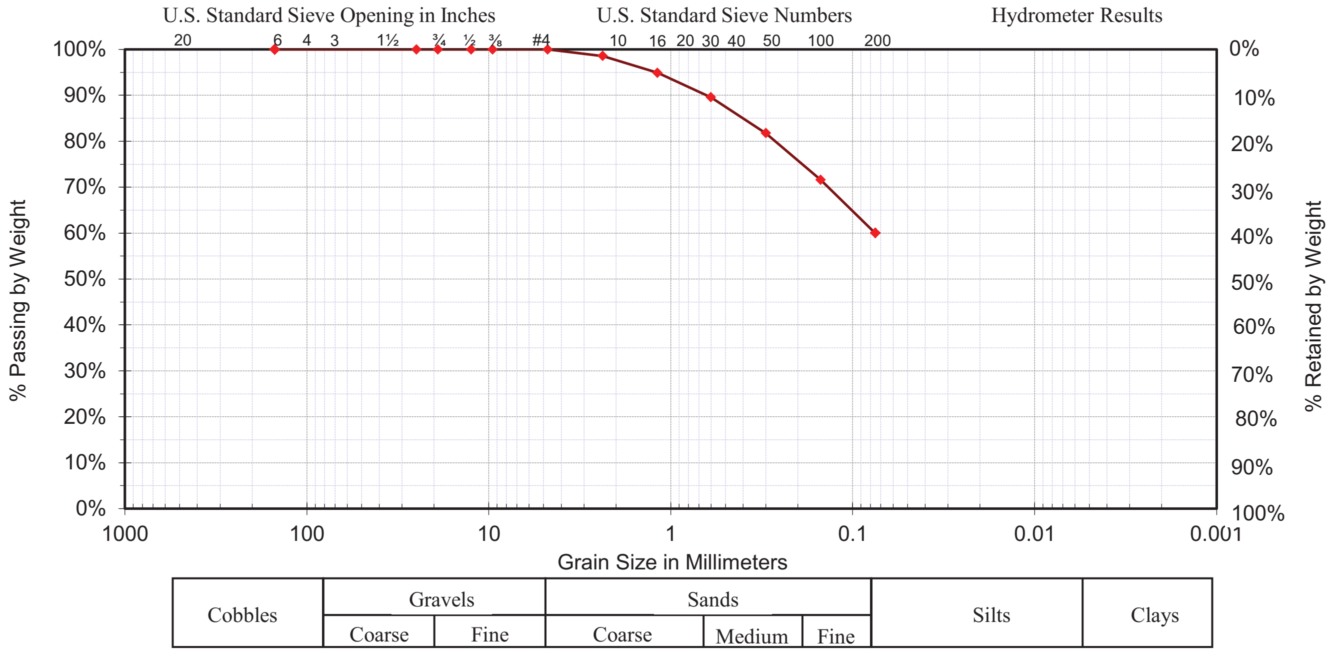
LABORATORY TEST RESULTS



Date : 01/14/17
Sample #:
Sample ID: B1 @ 45'
Source: SPT
Project: APNs 233-180-007 & 233-170-001
Location: Riverside, California
Boring #: B1
Depth: 45'

D_{10} = 0.01
D_{30} = 0.04
D_{60} = 0.08
C_C = 1.50
C_U = 6.00
Liquid Limit= n/a
Plastic Limit= n/a
Plasticity Index= n/a

Classification
ML, Sandy Silt

Specifications
custom specs 1

Fineness Modulus
0.64

% Gravel
0.00%
% Sand
40.00%
% Silt & Clay
60.00%
Sample Moisture
13.4%

Coarse Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00	100.0%	100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	100.0%	100.0%		
5/8"	16.00		100.0%		
1/2"	12.50	100.0%	100.0%		
3/8"	9.50	100.0%	100.0%		
1/4"	6.30		100.0%		
#4	4.75	100.0%	100.0%		

Fines Section		Actual Cumulative	Interpolated Cumulative		
Sieve Size		Percent	Percent	Specs	Specs
US	Metric	Passing	Passing	Max	Min
#4	4.750	100.0%	100.0%		
#8	2.360	98.6%	98.6%		
#10	2.000		97.4%		
#16	1.180	94.9%	94.9%		
#20	0.850		91.9%		
#30	0.600	89.6%	89.6%		
#40	0.425		85.0%		
#50	0.300	81.7%	81.7%		
#60	0.250		78.4%		
#80	0.180		73.6%		
#100	0.150	71.6%	71.6%		
#140	0.106		64.8%		
#170	0.090		62.3%		
#200	0.075	60.0%	60.0%		
#270	0.053				

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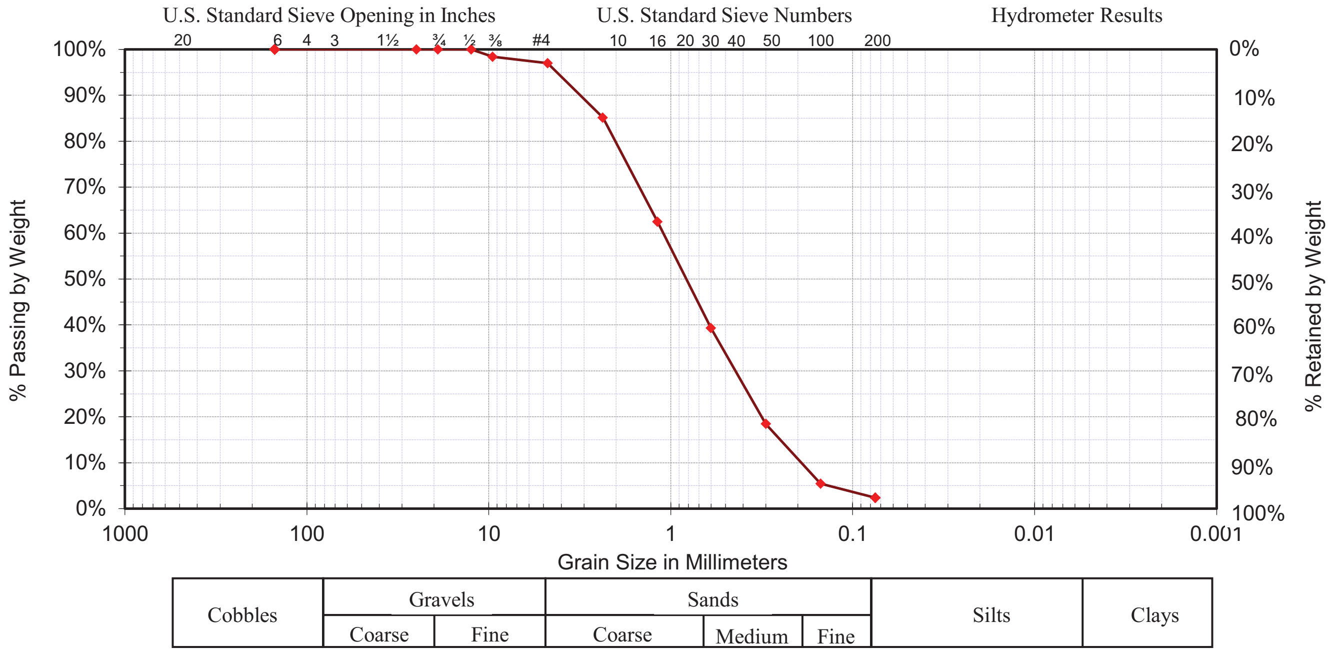
LABORATORY TEST RESULTS



Date :	01/19/17	D_{10} =	0.20	**Classification**	% Gravel
Sample #:		D_{30} =	0.47	SP, Poorly graded Sand	3.00%
Sample ID:	B2 @ 12'	D_{60} =	1.12		% Sand
Source:	Ring	C_C =	0.96	**Specifications**	94.64%
Project:	APNs 233-180-007 & 233-170-001	$C_{U=}$	5.52	custom specs 1	% Silt & Clay
Location:	Riverside, California	Liquid Limit=	n/a		2.35%
Boring #:	B2	Plastic Limit=	n/a	Fineness Modulus	Sample Moisture
Depth:	12'	Plasticity Index=	n/a	2.94	**2.1%**

Coarse Section Sieve Size US	Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
6.00"	150.00		100.0%		
4.00"	100.00		100.0%		
3.00"	75.00		100.0%		
2.50"	63.00		100.0%		
2.00"	50.00		100.0%		
1.75"	45.00		100.0%		
1.50"	37.50		100.0%		
1.25"	31.50		100.0%		
1.00"	25.00	100.0%	100.0%		
7/8"	22.40		100.0%		
3/4"	19.00	100.0%	100.0%		
5/8"	16.00		100.0%		
1/2"	12.50	100.0%	100.0%		
3/8"	9.50	98.4%	98.4%		
1/4"	6.30		97.4%		
#4	4.75	97.0%	97.0%		

Fines Section Sieve Size US	Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
#4	4.750	97.0%	97.0%		
#8	2.360	85.1%	85.1%		
#10	2.000		78.2%		
#16	1.180	62.4%	62.4%		
#20	0.850		49.3%		
#30	0.600	39.3%	39.3%		
#40	0.425		27.1%		
#50	0.300	18.4%	18.4%		
#60	0.250		14.1%		
#80	0.180		8.0%		
#100	0.150	5.4%	5.4%		
#140	0.106		3.6%		
#170	0.090		3.0%		
#200	0.075	2.4%	2.4%		
#270	0.053				

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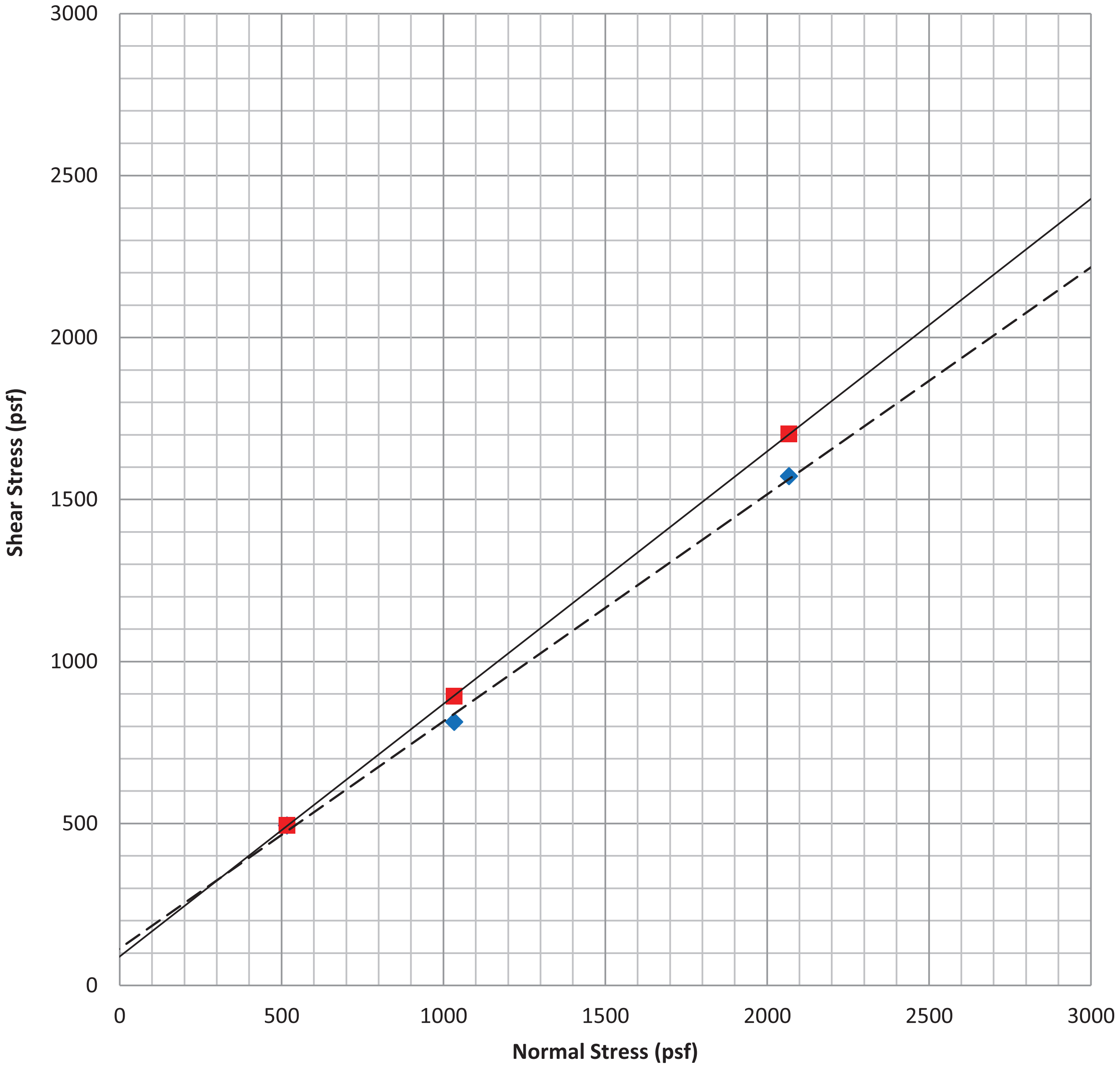
DIRECT SHEAR TEST RESULTS



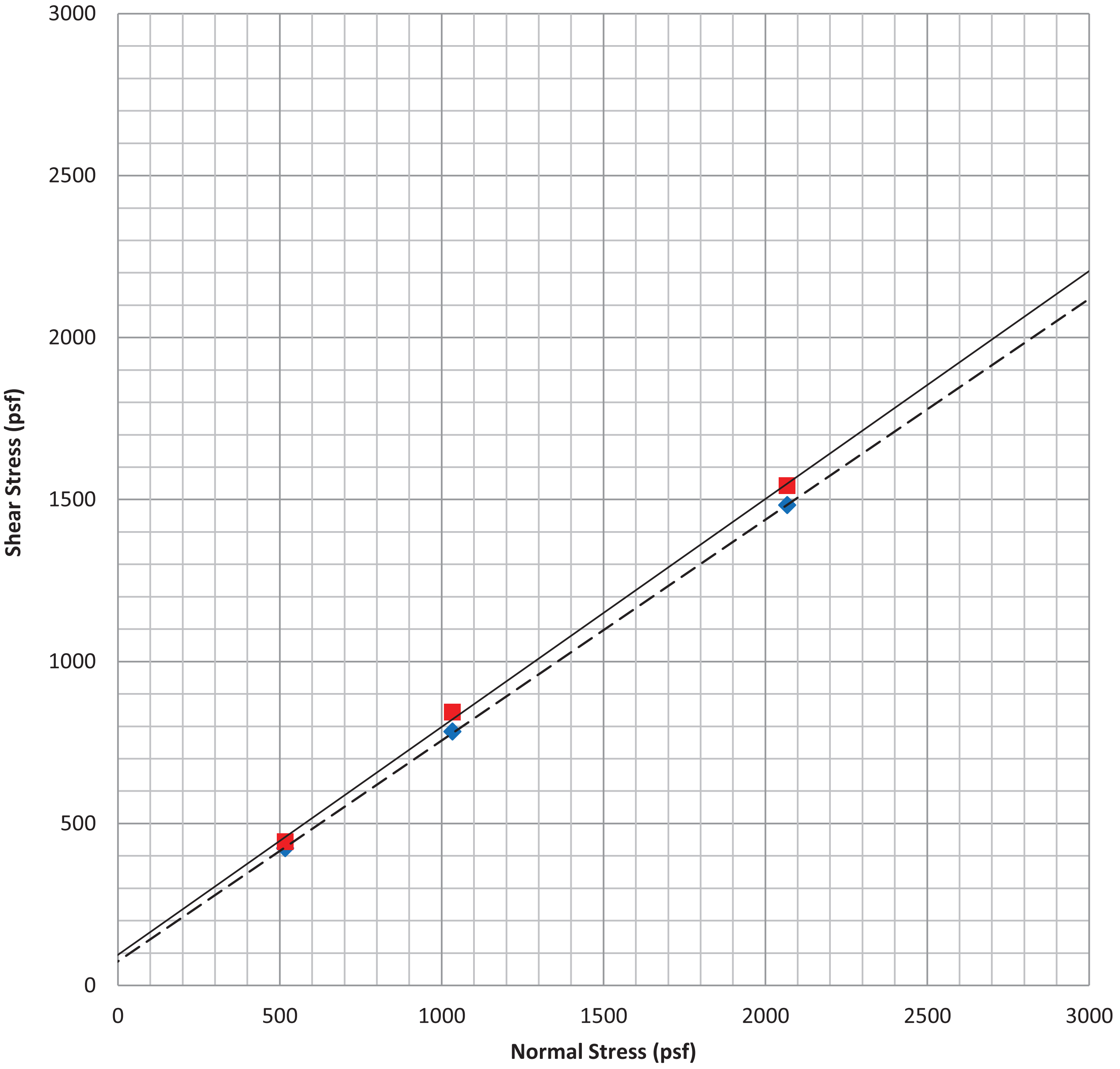
Sample	Symbol	Description	Soil Type [USCS]	Shear Strength	Friction Angle, ϕ [degrees]	Cohesion, c [psf]
B1 @ 5'	—■—	Medium Brown	SM	Peak	37.9	89
B1 @ 5'	– –◆– –	Medium Brown	SM	Ultimate	35.0	114

Sample Moisture [%]	Saturated Moisture [%]	Dry Unit Weight [pcf]
6.6	19.8	107.1

ASTM D-3080

geomat

DIRECT SHEAR TEST RESULTS



Sample	Symbol	Description	Soil Type [USCS]	Shear Strength	Friction Angle, ϕ [degrees]	Cohesion, c [psf]
B2 @ 5'	—■—	Brown Silty Sine Sand	SM	Peak	35.1	94
B2 @ 5'	– –◆– –	Brown Silty Sine Sand	SM	Ultimate	34.3	74

Sample Moisture [%]	Saturated Moisture [%]	Dry Unit Weight [pcf]
7.3	24.3	97.0

ASTM D-3080

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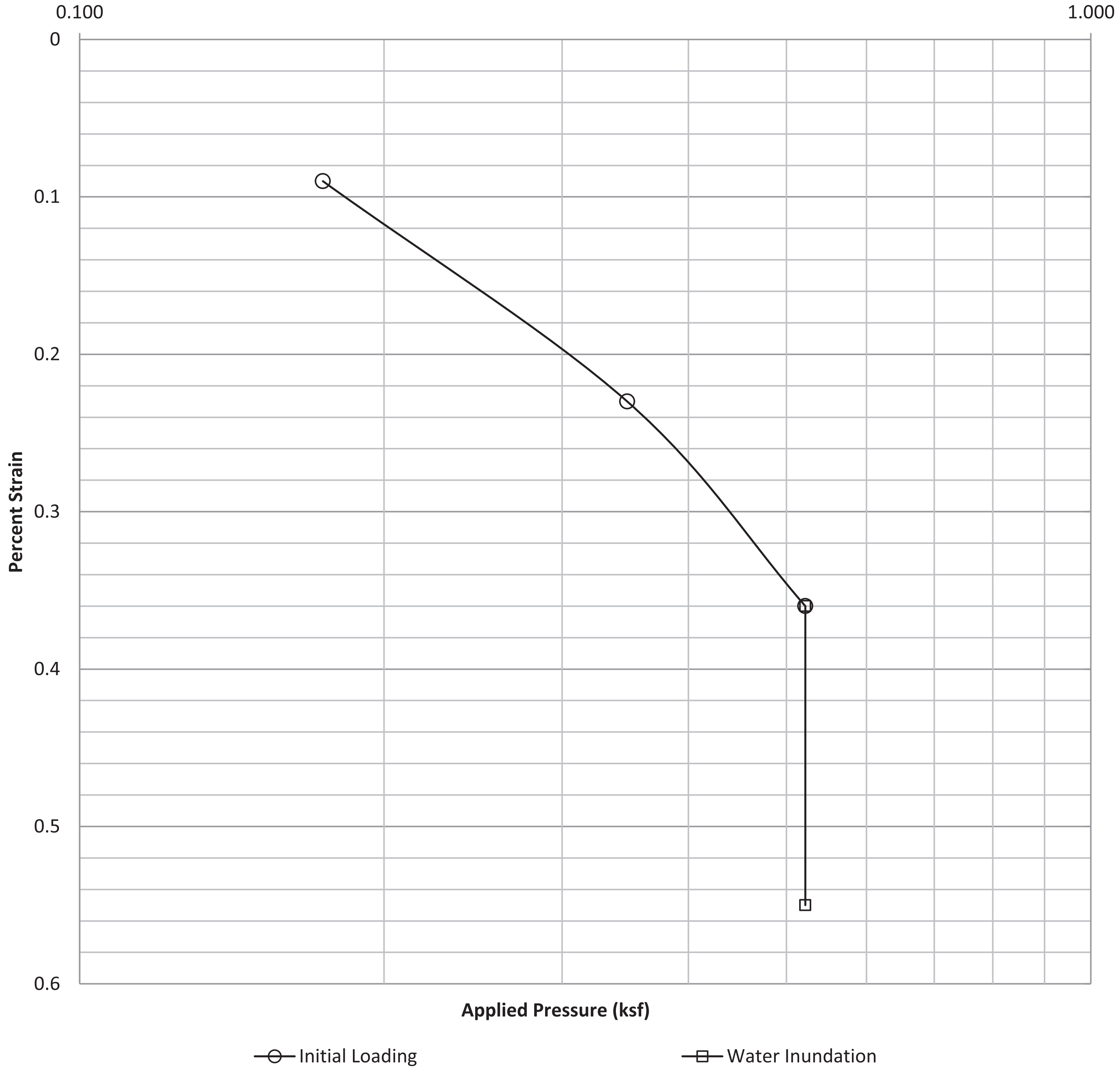
CONSOLIDATION TEST REPORT



Sampler Type:	California Ring Sampler				
Diameter(in):	2.41	Height(in):	1.0		
Overburden Pressure, P_0	0.275	tsf			
Preconsol. Pressure, P_c	--	ksf			
LL:	--	PL:	--	PI:	--
% Collapse:	0.19 %				
Sample Location:	B2 @ 5'				
Soil Classification:	SM				

Condition:	Before Test			After Test		
Water Content:	w_0	3.5	%	w_f	23.2	%
Void Ratio:	e_0	0.637		e_f	0.628	
Saturation:	S_0	14.4	%	S_f	100.0	%
Dry Density:	γ_d	99.0	pcf	γ_d	99.0	pcf
Specific Gravity, G_S	2.6	(Assumed)				

Collapse Test

GeoMat Testing Laboratories, Inc.

Soil Engineering, Environmental Engineering, Materials Testing, Geology

SOLUBLE SULFATEAND CHLORIDE TEST RESULTS

Project Name Hawthorne Heights Project, Riverside, CA
Test Date 1/18/2017
Project No. 16193-01
Date Sampled 1/14/2017
Project Location Hawthorne Heights Project, Riverside, CA
Sampled By MN
Location in Structure B1 @ 0-3'
Sample Type Bulk
Sampled Classification SM
Tested By AM

TESTING INFORMATION

Sample weight before drying
Sample weight after drying
Sample Weight Passing No. 10 Sieve
Moisture

Location	**Mixing Ratio**	**Dilution Factor**	**Sulfate Reading (ppm)**	**Sulfate Content**	
				(ppm)	**(%)**
B1	3	1	<50	<150	<0.015
			Average		

Chloride Reading (ppm)	**Chloride Content**	
	(ppm)	**(%)**
Average		

pH	
Average	

ACI 318-05 Table 4.3.1 Requirements for Concrete Exposed to Sulfate-Containing Solutions

Sulfate Exposure	**Water-Soluble Sulfate (SO_4) In Soil, % by Mass**	**Sulfate (SO_4) In Water ppm**	**Cement Type**	**Maximum w/cm by Mass**	**Minimum Design Compressive Strength fc, MPa (psi)**
Negligible	< 0.10	< 150	No Special Type	--	--
Moderate (see water)	0.10 to 0.20	150 to 1500	II IP(MS), IS(MS), P(MS), I(PM)(MS), I(SM)(MS)	0.50	28 (4000)
Severe	0.20 to 2.00	1500 to 10,000	V	0.45	31 (4500)
Very Severe	> 2.00	>10,000	V + pozz	0.45	31 (4500)

Caltrans classifies a site as corrosive to structural concrete as an area where soil and/or water contains >500pp chloride, >2000ppm sulfate, or has a pH <5.5. A minimum resistivity of less than 1000 ohm-cm indicates the potential for corrosive environment requiring testing for the above criteria.

The 2007 CBC Section 1904A references ACI 318 for material selection and mix design for reinforced concrete dependant on the onsite corrosion potential, soluble chloride content, and soluble sulfate content in soil

Comments: Sec 4.3 of ACI 318 (2005) Soil environment is detrimental to concrete if it has soluble sulfate >1000ppm and/or pH<5.5. Soil environment is corrosive to reinforcement and steel pipes if Chloride ion >500ppm or pH <4.0.

The information in this form is not intended for corrosion engineering design. If corrosion is critical, a corrosion specialist should be contacted to provide further recommendations.

Signature
Date

Print Name
Title

Appendix D

USGS Design Maps Detailed Report

ASCE 7-10 Standard (33.91714°N, 117.43535°W)

Site Class D – "Stiff Soil", Risk Category I/II/III

Section 11.4.1 — Mapped Acceleration Parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) and 1.3 (to obtain S_1). Maps in the 2010 ASCE-7 Standard are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 11.4.3.

From Figure 22-1 [1]	S_S = 1.500 g
From Figure 22-2 [2]	S_1 = 0.600 g

Section 11.4.2 — Site Class

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Chapter 20.

Table 20.3–1 Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index *PI* > 20, • Moisture content *w* ≥ 40%, and • Undrained shear strength $\bar{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 11.4.3 — Site Coefficients and Risk–Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameters

Table 11.4–1: Site Coefficient F_a

Site Class	Mapped MCE $_R$ Spectral Response Acceleration Parameter at Short Period				
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	$\boxed{1.0}$
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = D and S_S = 1.500 g, F_a = 1.000

Table 11.4–2: Site Coefficient F_v

Site Class	Mapped MCE $_R$ Spectral Response Acceleration Parameter at 1–s Period				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	$\boxed{1.5}$
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.600 g, F_v = 1.500

Equation (11.4–1): $S_{MS} = F_aS_S = 1.000 \text{ x } 1.500 = 1.500 \text{ g}$

Equation (11.4–2): $S_{M1} = F_vS_1 = 1.500 \text{ x } 0.600 = 0.900 \text{ g}$

Section 11.4.4 — Design Spectral Acceleration Parameters

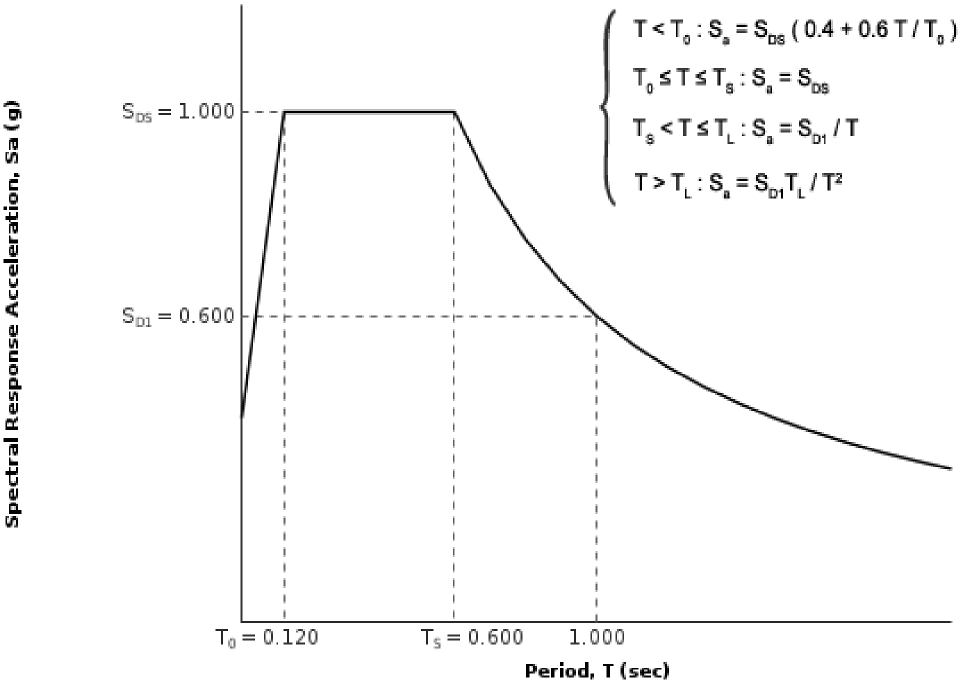
Equation (11.4–3): $S_{DS} = ⅔\ S_{MS} = ⅔ \text{ x } 1.500 = 1.000 \text{ g}$

Equation (11.4–4): $S_{D1} = ⅔\ S_{M1} = ⅔ \text{ x } 0.900 = 0.600 \text{ g}$

Section 11.4.5 — Design Response Spectrum

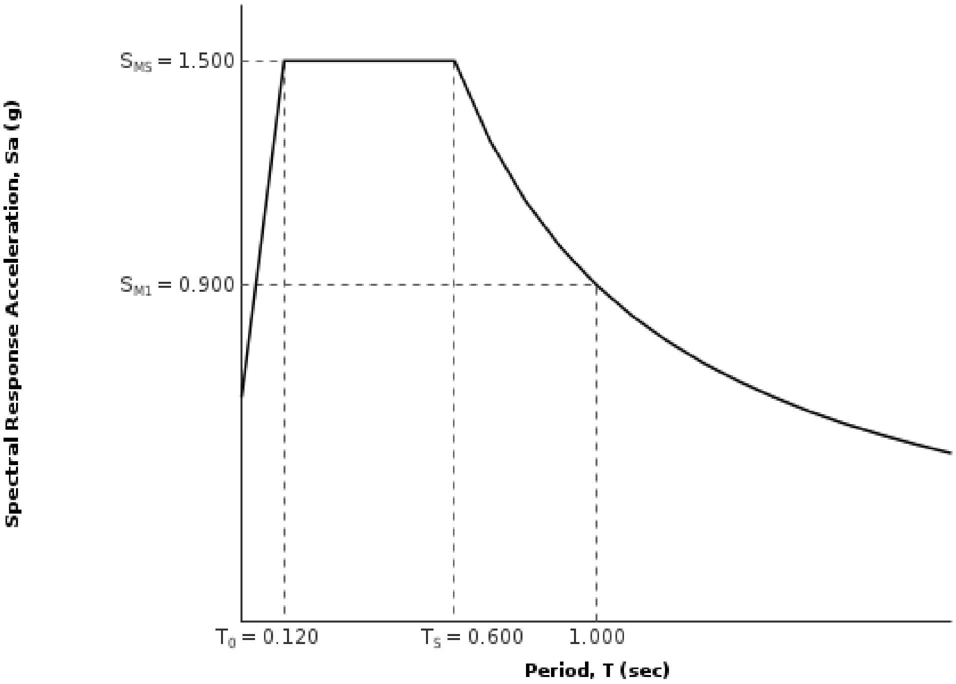
From Figure 22-12 [3] $T_L = 8$ seconds

Figure 11.4–1: Design Response Spectrum



Section 11.4.6 — Risk-Targeted Maximum Considered Earthquake (MCE_R) Response Spectrum

The MCE_R Response Spectrum is determined by multiplying the design response spectrum above by 1.5.



Section 11.8.3 — Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

From Figure 22-7 [4] PGA = 0.500

Equation (11.8–1): $PGA_M = F_{PGA}PGA = 1.000 \times 0.500 = 0.5$ g

Table 11.8–1: Site Coefficient F_{PGA}

Site Class	Mapped MCE Geometric Mean Peak Ground Acceleration, PGA				
	PGA ≤ 0.10	PGA = 0.20	PGA = 0.30	PGA = 0.40	PGA ≥ 0.50
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	$\boxed{1.0}$
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of PGA

For Site Class = D and PGA = 0.500 g, F_{PGA} = 1.000

Section 21.2.1.1 — Method 1 (from Chapter 21 – Site-Specific Ground Motion Procedures for Seismic Design)

From Figure 22-17 [5] C_{RS} = 1.100

From Figure 22-18 [6] C_{R1} = 1.072

Section 11.6 — Seismic Design Category

Table 11.6-1 Seismic Design Category Based on Short Period Response Acceleration Parameter

VALUE OF S_{DS}	**RISK CATEGORY**		
	I or II	**III**	**IV**
$S_{DS} < 0.167g$	A	A	A
$0.167g \le S_{DS} < 0.33g$	B	B	C
$0.33g \le S_{DS} < 0.50g$	C	C	D
$0.50g \le S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 1.000 g, Seismic Design Category = D

Table 11.6-2 Seismic Design Category Based on 1-S Period Response Acceleration Parameter

VALUE OF S_{D1}	**RISK CATEGORY**		
	I or II	**III**	**IV**
$S_{D1} < 0.067g$	A	A	A
$0.067g \le S_{D1} < 0.133g$	B	B	C
$0.133g \le S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.600 g, Seismic Design Category = D

Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

Seismic Design Category ≡ "the more severe design category in accordance with Table 11.6-1 or 11.6-2" = D

Note: See Section 11.6 for alternative approaches to calculating Seismic Design Category.

References

1. *Figure 22-1*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-1.pdf
2. *Figure 22-2*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-2.pdf
3. *Figure 22-12*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-12.pdf
4. *Figure 22-7*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-7.pdf
5. *Figure 22-17*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-17.pdf
6. *Figure 22-18*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-18.pdf

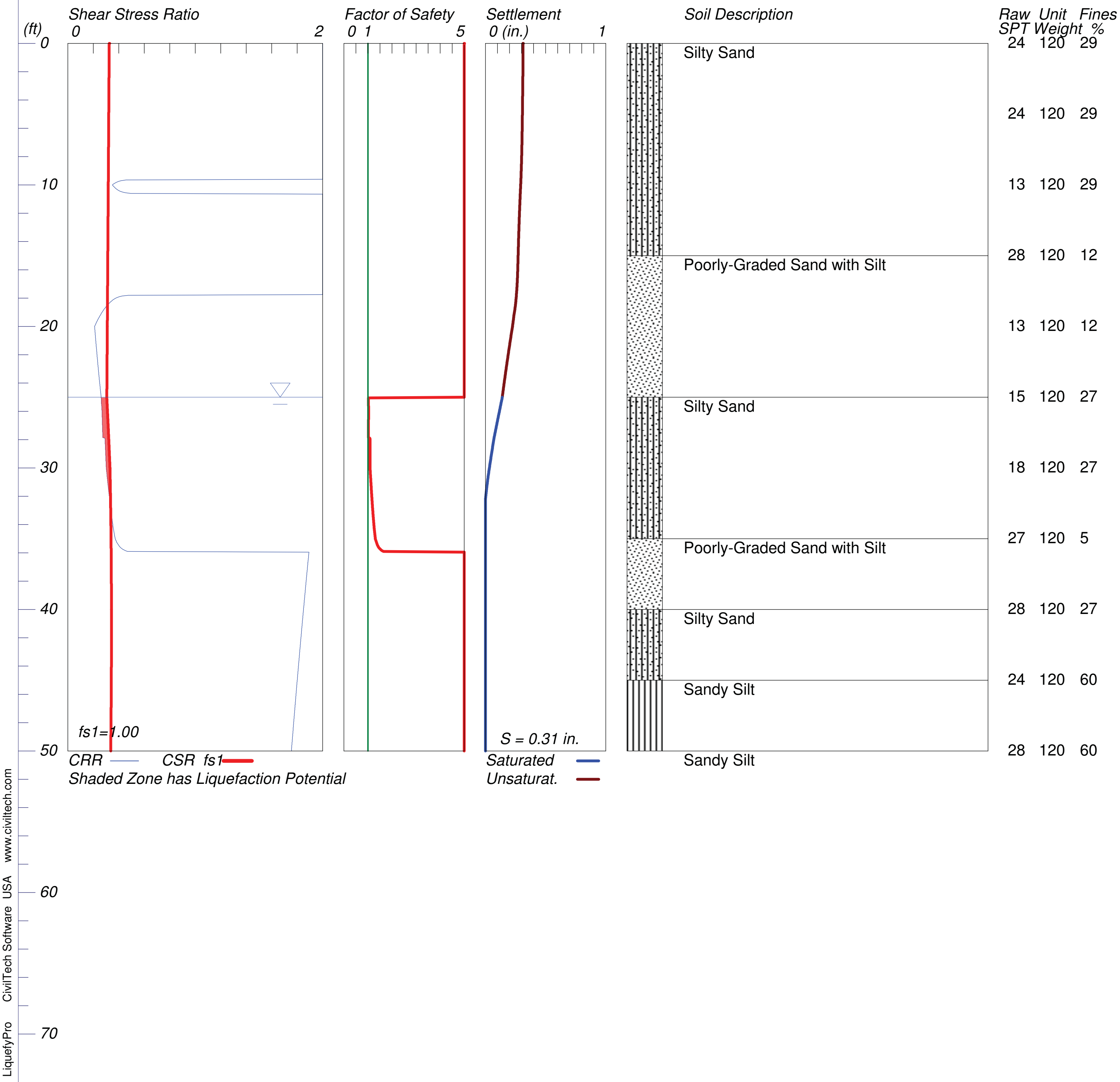
Appendix E

LIQUEFACTION ANALYSIS

Hawthorne Heights

Hole No.=B-1 Water Depth=25 ft

Magnitude=7
Acceleration=0.5g



LIQUEFACTION ANALYSIS CALCULATION SUMMARY SHEET

```
      Title:  Hawthorne Heights
      Subtitle:  16193-01

 Input Data:
      Surface Elev.=
      Hole No.=B-1
      Depth of Hole=50.0 ft
      Water Table during Earthquake= 25.0 ft
      Water Table during In-Situ Testing= 50.0 ft
      Max. Acceleration=0.5 g
      Earthquake Magnitude=7.0

      1. SPT or BPT Calculation.
      2. Settlement Analysis Method: Tokimatsu / Seed
      3. Fines Correction for Liquefaction: Stark/Olson et al.*
      4. Fine Correction for Settlement: During Liquefaction*
      5. Settlement Calculation in: All zones*
      6. Hammer Energy Ratio, Ce = 1.25
      7. Borehole Diameter, Cb= 1.05
      8. Sampling Method, Cs= 1.2
      9. User request factor of safety (apply to CSR) ,   User= 1.0
         Plot one CSR curve (fs1=User)
      10. Use Curve Smoothing: Yes*
      * Recommended Options

      In-Situ Test Data:
      Depth SPT   gamma Fines
      ft          pcf   %
      ____________________________________
      0.0   24.0  120.0 29.0
      5.0   24.0  120.0 29.0
      10.0  13.0  120.0 29.0
      15.0  28.0  120.0 12.0
      20.0  13.0  120.0 12.0
      25.0  15.0  120.0 27.0
      30.0  18.0  120.0 27.0
      35.0  27.0  120.0 5.0
      40.0  28.0  120.0 27.0
      45.0  24.0  120.0 60.0
      50.0  28.0  120.0 60.0
      ____________________________________

Output Results:
      Settlement of Saturated Sands=0.14 in.
      Settlement of Unsaturated Sands=0.17 in.
      Total Settlement of Saturated and Unsaturated Sands=0.31 in.
      Differential Settlement=0.156 to 0.206 in.
```

```
Depth CRRv  CSRm  F.S.  S_sat.      S_dry S_all
ft                      in.   in.   in.
_____________________________________________________________
0.00   2.00   0.32   5.00   0.14   0.17   0.31
1.00   2.00   0.32   5.00   0.14   0.17   0.31
2.00   2.00   0.32   5.00   0.14   0.17   0.31
3.00   2.00   0.32   5.00   0.14   0.17   0.31
4.00   2.00   0.32   5.00   0.14   0.17   0.31
5.00   2.00   0.32   5.00   0.14   0.17   0.31
6.00   2.00   0.32   5.00   0.14   0.17   0.31
7.00   2.00   0.32   5.00   0.14   0.16   0.30
8.00   2.00   0.32   5.00   0.14   0.16   0.30
9.00   2.00   0.32   5.00   0.14   0.16   0.30
10.00  0.35   0.32   5.00   0.14   0.15   0.29
11.00  2.00   0.32   5.00   0.14   0.15   0.29
12.00  2.00   0.32   5.00   0.14   0.14   0.28
13.00  2.00   0.32   5.00   0.14   0.14   0.28
14.00  2.00   0.31   5.00   0.14   0.14   0.27
15.00  2.00   0.31   5.00   0.14   0.13   0.27
16.00  2.00   0.31   5.00   0.14   0.13   0.27
17.00  2.00   0.31   5.00   0.14   0.12   0.26
18.00  0.38   0.31   5.00   0.14   0.12   0.25
19.00  0.27   0.31   5.00   0.14   0.10   0.24
20.00  0.21   0.31   5.00   0.14   0.09   0.22
21.00  0.22   0.31   5.00   0.14   0.07   0.21
22.00  0.23   0.31   5.00   0.14   0.05   0.19
23.00  0.24   0.31   5.00   0.14   0.03   0.17
24.00  0.25   0.31   5.00   0.14   0.02   0.16
25.00  0.26   0.31   5.00   0.14   0.00   0.14
26.00  0.27   0.31   1.03   0.12   0.00   0.12
27.00  0.27   0.32   1.02   0.09   0.00   0.09
28.00  0.29   0.32   1.08   0.07   0.00   0.07
29.00  0.30   0.33   1.08   0.05   0.00   0.05
30.00  0.30   0.33   1.09   0.03   0.00   0.03
31.00  0.31   0.33   1.12   0.02   0.00   0.02
32.00  0.33   0.33   1.16   0.00   0.00   0.00
33.00  0.34   0.34   1.20   0.00   0.00   0.00
34.00  0.35   0.34   1.25   0.00   0.00   0.00
35.00  0.37   0.34   1.31   0.00   0.00   0.00
36.00  1.89   0.34   5.00   0.00   0.00   0.00
37.00  1.88   0.34   5.00   0.00   0.00   0.00
38.00  1.87   0.34   5.00   0.00   0.00   0.00
39.00  1.86   0.34   5.00   0.00   0.00   0.00
40.00  1.85   0.34   5.00   0.00   0.00   0.00
41.00  1.84   0.34   5.00   0.00   0.00   0.00
42.00  1.83   0.34   5.00   0.00   0.00   0.00
43.00  1.82   0.34   5.00   0.00   0.00   0.00
44.00  1.81   0.34   5.00   0.00   0.00   0.00
45.00  1.80   0.34   5.00   0.00   0.00   0.00
46.00  1.79   0.34   5.00   0.00   0.00   0.00
47.00  1.78   0.34   5.00   0.00   0.00   0.00
48.00  1.77   0.34   5.00   0.00   0.00   0.00
49.00  1.76   0.34   5.00   0.00   0.00   0.00
50.00  1.75   0.34   5.00   0.00   0.00   0.00
_____________________________________________________________
* F.S.<1, Liquefaction Potential Zone
(F.S. is limited to 5, CRR is limited to 2,  CSR is limited to 2)

Depth = ft, Stress or Pressure = tsf (atm), Unit Weight = pcf, Settlement = in.
_______________________________________________________________________
CRRv           Cyclic resistance ratio from soils
CSRm           Cyclic stress ratio induced by a given earthquake (with user request
               factor of safety)
F.S.           Factor of Safety against liquefaction, F.S.=CRRv/CSRm
S_sat          Settlement from saturated sands
S_dry          Settlement from Unsaturated Sands
S_all          Total Settlement from Saturated and Unsaturated Sands
NoLiq          No-Liquefy Soils
```

LIQUEFACTION ANALYSIS CALCULATION DETAIL SHEET

```
     Title:  Hawthorne Heights
     Subtitle:  16193-01

Input Data:
     Surface Elev.=
     Hole No.=B-1
     Depth of Hole=50.0 ft
     Water Table during Earthquake= 25.0 ft
     Water Table during In-Situ Testing= 50.0 ft
     Max. Acceleration=0.5 g
     Earthquake Magnitude=7.0

     1. SPT or BPT Calculation.
     2. Settlement Analysis Method: Tokimatsu / Seed
     3. Fines Correction for Liquefaction: Stark/Olson et al.*
     4. Fine Correction for Settlement: During Liquefaction*
     5. Settlement Calculation in: All zones*
     6. Hammer Energy Ratio, Ce = 1.25
     7. Borehole Diameter, Cb= 1.05
     8. Sampling Method, Cs= 1.2
     9. User request factor of safety (apply to CSR) ,   User= 1.0
        Plot one CSR curve (fs1=User)
     10. Use Curve Smoothing: Yes*
     * Recommended Options

     In-Situ Test Data:
     Depth SPT   Gamma Fines
     ft          pcf   %
     ____________________________________
     0.0   24.0  120.0 29.0
     5.0   24.0  120.0 29.0
     10.0  13.0  120.0 29.0
     15.0  28.0  120.0 12.0
     20.0  13.0  120.0 12.0
     25.0  15.0  120.0 27.0
     30.0  18.0  120.0 27.0
     35.0  27.0  120.0 5.0
     40.0  28.0  120.0 27.0
     45.0  24.0  120.0 60.0
     50.0  28.0  120.0 60.0
     ____________________________________


Output Results:
     Calculation segment, dz=0.050 ft
     User defined Print Interval, dp=1.00 ft
```

```
CSR Calculation:
Depth   gamma   sigma   gamma'  sigma'   rd     CSR     fs1     CSRfs
ft      pcf     tsf     pcf     tsf                             *fs1
____________________________________________________________________
0.00    120.0   0.000   120.0   0.000   1.00    0.32    1.0     0.32
1.00    120.0   0.060   120.0   0.060   1.00    0.32    1.0     0.32
2.00    120.0   0.120   120.0   0.120   1.00    0.32    1.0     0.32
3.00    120.0   0.180   120.0   0.180   0.99    0.32    1.0     0.32
4.00    120.0   0.240   120.0   0.240   0.99    0.32    1.0     0.32
5.00    120.0   0.300   120.0   0.300   0.99    0.32    1.0     0.32
6.00    120.0   0.360   120.0   0.360   0.99    0.32    1.0     0.32
7.00    120.0   0.420   120.0   0.420   0.98    0.32    1.0     0.32
8.00    120.0   0.480   120.0   0.480   0.98    0.32    1.0     0.32
9.00    120.0   0.540   120.0   0.540   0.98    0.32    1.0     0.32
10.00   120.0   0.600   120.0   0.600   0.98    0.32    1.0     0.32
11.00   120.0   0.660   120.0   0.660   0.97    0.32    1.0     0.32
12.00   120.0   0.720   120.0   0.720   0.97    0.32    1.0     0.32
13.00   120.0   0.780   120.0   0.780   0.97    0.32    1.0     0.32
14.00   120.0   0.840   120.0   0.840   0.97    0.31    1.0     0.31
15.00   120.0   0.900   120.0   0.900   0.97    0.31    1.0     0.31
16.00   120.0   0.960   120.0   0.960   0.96    0.31    1.0     0.31
17.00   120.0   1.020   120.0   1.020   0.96    0.31    1.0     0.31
18.00   120.0   1.080   120.0   1.080   0.96    0.31    1.0     0.31
19.00   120.0   1.140   120.0   1.140   0.96    0.31    1.0     0.31
20.00   120.0   1.200   120.0   1.200   0.95    0.31    1.0     0.31
21.00   120.0   1.260   120.0   1.260   0.95    0.31    1.0     0.31
22.00   120.0   1.320   120.0   1.320   0.95    0.31    1.0     0.31
23.00   120.0   1.380   120.0   1.380   0.95    0.31    1.0     0.31
24.00   120.0   1.440   120.0   1.440   0.94    0.31    1.0     0.31
25.00   120.0   1.500   120.0   1.500   0.94    0.31    1.0     0.31
26.00   120.0   1.560   57.6    1.530   0.94    0.31    1.0     0.31
27.00   120.0   1.620   57.6    1.559   0.94    0.32    1.0     0.32
28.00   120.0   1.680   57.6    1.588   0.93    0.32    1.0     0.32
29.00   120.0   1.740   57.6    1.617   0.93    0.33    1.0     0.33
30.00   120.0   1.800   57.6    1.646   0.93    0.33    1.0     0.33
31.00   120.0   1.860   57.6    1.674   0.92    0.33    1.0     0.33
32.00   120.0   1.920   57.6    1.703   0.91    0.33    1.0     0.33
33.00   120.0   1.980   57.6    1.732   0.91    0.34    1.0     0.34
34.00   120.0   2.040   57.6    1.761   0.90    0.34    1.0     0.34
35.00   120.0   2.100   57.6    1.790   0.89    0.34    1.0     0.34
36.00   120.0   2.160   57.6    1.818   0.88    0.34    1.0     0.34
37.00   120.0   2.220   57.6    1.847   0.87    0.34    1.0     0.34
38.00   120.0   2.280   57.6    1.876   0.86    0.34    1.0     0.34
39.00   120.0   2.340   57.6    1.905   0.86    0.34    1.0     0.34
40.00   120.0   2.400   57.6    1.934   0.85    0.34    1.0     0.34
41.00   120.0   2.460   57.6    1.962   0.84    0.34    1.0     0.34
42.00   120.0   2.520   57.6    1.991   0.83    0.34    1.0     0.34
43.00   120.0   2.580   57.6    2.020   0.82    0.34    1.0     0.34
44.00   120.0   2.640   57.6    2.049   0.82    0.34    1.0     0.34
45.00   120.0   2.700   57.6    2.078   0.81    0.34    1.0     0.34
46.00   120.0   2.760   57.6    2.106   0.80    0.34    1.0     0.34
47.00   120.0   2.820   57.6    2.135   0.79    0.34    1.0     0.34
48.00   120.0   2.880   57.6    2.164   0.78    0.34    1.0     0.34
49.00   120.0   2.940   57.6    2.193   0.78    0.34    1.0     0.34
50.00   120.0   3.000   57.6    2.222   0.77    0.34    1.0     0.34
___________________________________________________________________________
CSR is based on water table at 25.0 during earthquake
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CRR Calculation from SPT or BPT data:

Depth   SPT     Cebs    Cr      sigma'  Cn      (N1)60  Fines   d(N1)60 (N1)60f CRR7.5
ft                              tsf                     %
_____________________________________________________________________________________________
0.00    24.00   1.58    0.75    0.000   1.70    48.20   29.00   5.76    53.96   2.00
1.00    24.00   1.58    0.75    0.060   1.70    48.20   29.00   5.76    53.96   2.00
2.00    24.00   1.58    0.75    0.120   1.70    48.20   29.00   5.76    53.96   2.00
3.00    24.00   1.58    0.75    0.180   1.70    48.20   29.00   5.76    53.96   2.00
4.00    24.00   1.58    0.75    0.240   1.70    48.20   29.00   5.76    53.96   2.00
5.00    24.00   1.58    0.75    0.300   1.70    48.19   29.00   5.76    53.96   2.00
6.00    21.80   1.58    0.75    0.360   1.67    42.92   29.00   5.76    48.68   2.00
7.00    19.60   1.58    0.75    0.420   1.54    35.72   29.00   5.76    41.48   2.00
8.00    17.40   1.58    0.75    0.480   1.44    29.67   29.00   5.76    35.43   2.00
9.00    15.20   1.58    0.85    0.540   1.36    27.69   29.00   5.76    33.45   2.00
10.00   13.00   1.58    0.85    0.600   1.29    22.47   29.00   5.76    28.23   0.35
11.00   16.00   1.58    0.85    0.660   1.23    26.37   25.60   4.94    31.31   2.00
12.00   19.00   1.58    0.85    0.720   1.18    29.98   22.20   4.13    34.10   2.00
13.00   22.00   1.58    0.85    0.780   1.13    33.35   18.80   3.31    36.66   2.00
14.00   25.00   1.58    0.85    0.840   1.09    36.52   15.40   2.50    39.01   2.00
15.00   28.00   1.58    0.95    0.900   1.05    44.16   12.00   1.68    45.84   2.00
16.00   25.00   1.58    0.95    0.960   1.02    38.18   12.00   1.68    39.86   2.00
17.00   22.00   1.58    0.95    1.020   0.99    32.59   12.00   1.68    34.27   2.00
18.00   19.00   1.58    0.95    1.080   0.96    27.36   12.00   1.68    29.04   0.38
19.00   16.00   1.58    0.95    1.140   0.94    22.42   12.00   1.68    24.10   0.27
20.00   13.00   1.58    0.95    1.200   0.91    17.76   12.00   1.68    19.44   0.21
21.00   13.40   1.58    0.95    1.260   0.89    17.86   15.00   2.40    20.26   0.22
22.00   13.80   1.58    0.95    1.320   0.87    17.97   18.00   3.12    21.09   0.23
23.00   14.20   1.58    0.95    1.380   0.85    18.09   21.00   3.84    21.93   0.24
24.00   14.60   1.58    0.95    1.440   0.83    18.20   24.00   4.56    22.76   0.25
25.00   15.00   1.58    0.95    1.500   0.82    18.33   27.00   5.28    23.61   0.26
26.00   15.60   1.58    0.95    1.560   0.80    18.69   27.00   5.28    23.97   0.27
27.00   16.20   1.58    0.95    1.620   0.79    19.04   27.00   5.28    24.32   0.27
28.00   16.80   1.58    1.00    1.680   0.77    20.41   27.00   5.28    25.69   0.29
29.00   17.40   1.58    1.00    1.740   0.76    20.78   27.00   5.28    26.06   0.30
30.00   18.00   1.58    1.00    1.800   0.75    21.13   27.00   5.28    26.41   0.31
31.00   19.80   1.58    1.00    1.860   0.73    22.87   22.60   4.22    27.09   0.32
32.00   21.60   1.58    1.00    1.920   0.72    24.55   18.20   3.17    27.72   0.34
33.00   23.40   1.58    1.00    1.980   0.71    26.19   13.80   2.11    28.30   0.35
34.00   25.20   1.58    1.00    2.040   0.70    27.79   9.40    1.06    28.84   0.37
35.00   27.00   1.58    1.00    2.100   0.69    29.34   5.00    0.00    29.34   0.39
36.00   27.20   1.58    1.00    2.160   0.68    29.15   9.40    1.06    30.20   2.00
37.00   27.40   1.58    1.00    2.220   0.67    28.96   13.80   2.11    31.08   2.00
38.00   27.60   1.58    1.00    2.280   0.66    28.79   18.20   3.17    31.96   2.00
39.00   27.80   1.58    1.00    2.340   0.65    28.62   22.60   4.22    32.85   2.00
40.00   28.00   1.58    1.00    2.400   0.65    28.47   27.00   5.28    33.75   2.00
41.00   27.20   1.58    1.00    2.460   0.64    27.31   33.60   6.86    34.18   2.00
42.00   26.40   1.58    1.00    2.520   0.63    26.19   40.20   7.20    33.39   2.00
43.00   25.60   1.58    1.00    2.580   0.62    25.10   46.80   7.20    32.30   2.00
44.00   24.80   1.58    1.00    2.640   0.62    24.04   53.40   7.20    31.24   2.00
45.00   24.00   1.58    1.00    2.700   0.61    23.00   60.00   7.20    30.20   2.00
46.00   24.80   1.58    1.00    2.760   0.60    23.51   60.00   7.20    30.71   2.00
47.00   25.60   1.58    1.00    2.820   0.60    24.01   60.00   7.20    31.21   2.00
48.00   26.40   1.58    1.00    2.880   0.59    24.50   60.00   7.20    31.70   2.00
49.00   27.20   1.58    1.00    2.940   0.58    24.98   60.00   7.20    32.18   2.00
50.00   28.00   1.58    1.00    3.000   0.58    25.46   60.00   7.20    32.66   2.00
_______________________________________________________________________________________________
CRR is based on water table at 50.0 during In-Situ Testing
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Factor of Safety,  - Earthquake Magnitude= 7.0:

Depth   sigC'   CRR7.5  Ksigma  CRRv    CSRfs   MSF     CSRm    F.S.
ft      tsf     tsf             tsf     tsf             tsf     CRRv/CSRm
_____________________________________________________________________________
0.00    0.00    2.00    1.00    2.00    0.32    1.19    0.27    5.00
1.00    0.04    2.00    1.00    2.00    0.32    1.19    0.27    5.00
2.00    0.08    2.00    1.00    2.00    0.32    1.19    0.27    5.00
3.00    0.12    2.00    1.00    2.00    0.32    1.19    0.27    5.00
4.00    0.16    2.00    1.00    2.00    0.32    1.19    0.27    5.00
5.00    0.20    2.00    1.00    2.00    0.32    1.19    0.27    5.00
6.00    0.23    2.00    1.00    2.00    0.32    1.19    0.27    5.00
7.00    0.27    2.00    1.00    2.00    0.32    1.19    0.27    5.00
8.00    0.31    2.00    1.00    2.00    0.32    1.19    0.27    5.00
9.00    0.35    2.00    1.00    2.00    0.32    1.19    0.27    5.00
10.00   0.39    0.35    1.00    0.35    0.32    1.19    0.27    5.00
11.00   0.43    2.00    1.00    2.00    0.32    1.19    0.27    5.00
12.00   0.47    2.00    1.00    2.00    0.32    1.19    0.26    5.00
13.00   0.51    2.00    1.00    2.00    0.32    1.19    0.26    5.00
14.00   0.55    2.00    1.00    2.00    0.31    1.19    0.26    5.00
15.00   0.59    2.00    1.00    2.00    0.31    1.19    0.26    5.00
16.00   0.62    2.00    1.00    2.00    0.31    1.19    0.26    5.00
17.00   0.66    2.00    1.00    2.00    0.31    1.19    0.26    5.00
18.00   0.70    0.38    1.00    0.38    0.31    1.19    0.26    5.00
19.00   0.74    0.27    1.00    0.27    0.31    1.19    0.26    5.00
20.00   0.78    0.21    1.00    0.21    0.31    1.19    0.26    5.00
21.00   0.82    0.22    1.00    0.22    0.31    1.19    0.26    5.00
22.00   0.86    0.23    1.00    0.23    0.31    1.19    0.26    5.00
23.00   0.90    0.24    1.00    0.24    0.31    1.19    0.26    5.00
24.00   0.94    0.25    1.00    0.25    0.31    1.19    0.26    5.00
25.00   0.98    0.26    1.00    0.26    0.31    1.19    0.26    5.00
26.00   1.01    0.27    1.00    0.27    0.31    1.19    0.26    1.03
27.00   1.05    0.27    1.00    0.27    0.32    1.19    0.27    1.02
28.00   1.09    0.29    0.99    0.29    0.32    1.19    0.27    1.08
29.00   1.13    0.30    0.99    0.30    0.33    1.19    0.27    1.08
30.00   1.17    0.31    0.98    0.30    0.33    1.19    0.28    1.09
31.00   1.21    0.32    0.97    0.31    0.33    1.19    0.28    1.12
32.00   1.25    0.34    0.97    0.33    0.33    1.19    0.28    1.16
33.00   1.29    0.35    0.96    0.34    0.34    1.19    0.28    1.20
34.00   1.33    0.37    0.96    0.35    0.34    1.19    0.28    1.25
35.00   1.37    0.39    0.95    0.37    0.34    1.19    0.28    1.31
36.00   1.40    2.00    0.95    1.89    0.34    1.19    0.29    5.00
37.00   1.44    2.00    0.94    1.88    0.34    1.19    0.29    5.00
38.00   1.48    2.00    0.94    1.87    0.34    1.19    0.29    5.00
39.00   1.52    2.00    0.93    1.86    0.34    1.19    0.29    5.00
40.00   1.56    2.00    0.92    1.85    0.34    1.19    0.29    5.00
41.00   1.60    2.00    0.92    1.84    0.34    1.19    0.29    5.00
42.00   1.64    2.00    0.91    1.83    0.34    1.19    0.29    5.00
43.00   1.68    2.00    0.91    1.82    0.34    1.19    0.29    5.00
44.00   1.72    2.00    0.91    1.81    0.34    1.19    0.29    5.00
45.00   1.76    2.00    0.90    1.80    0.34    1.19    0.29    5.00
46.00   1.79    2.00    0.90    1.79    0.34    1.19    0.29    5.00
47.00   1.83    2.00    0.89    1.78    0.34    1.19    0.28    5.00
48.00   1.87    2.00    0.89    1.77    0.34    1.19    0.28    5.00
49.00   1.91    2.00    0.88    1.76    0.34    1.19    0.28    5.00
50.00   1.95    2.00    0.88    1.75    0.34    1.19    0.28    5.00
______________________________________________________________________________
* F.S.<1: Liquefaction Potential Zone.  (If above water table:
F.S.=5)
^ No-liquefiable Soils.
(F.S. is limited to 5, CRR is limited to 2,   CSR is limited to 2)
```

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CPT convert to SPT for Settlement Analysis:
Fines Correction for Settlement Analysis:

Depth   Ic      qc/N60  qc1     (N1)60  Fines   d(N1)60 (N1)60s
ft                      tsf             %
_________________________________________________________________
0.00    -       -       -       53.96   29.0    0.00    53.96
1.00    -       -       -       53.96   29.0    0.00    53.96
2.00    -       -       -       53.96   29.0    0.00    53.96
3.00    -       -       -       53.96   29.0    0.00    53.96
4.00    -       -       -       53.96   29.0    0.00    53.96
5.00    -       -       -       53.96   29.0    0.00    53.96
6.00    -       -       -       48.68   29.0    0.00    48.68
7.00    -       -       -       41.48   29.0    0.00    41.48
8.00    -       -       -       35.43   29.0    0.00    35.43
9.00    -       -       -       33.45   29.0    0.00    33.45
10.00   -       -       -       28.23   29.0    0.00    28.23
11.00   -       -       -       31.31   25.6    0.00    31.31
12.00   -       -       -       34.10   22.2    0.00    34.10
13.00   -       -       -       36.66   18.8    0.00    36.66
14.00   -       -       -       39.01   15.4    0.00    39.01
15.00   -       -       -       45.84   12.0    0.00    45.84
16.00   -       -       -       39.86   12.0    0.00    39.86
17.00   -       -       -       34.27   12.0    0.00    34.27
18.00   -       -       -       29.04   12.0    0.00    29.04
19.00   -       -       -       24.10   12.0    0.00    24.10
20.00   -       -       -       19.44   12.0    0.00    19.44
21.00   -       -       -       20.26   15.0    0.00    20.26
22.00   -       -       -       21.09   18.0    0.00    21.09
23.00   -       -       -       21.93   21.0    0.00    21.93
24.00   -       -       -       22.76   24.0    0.00    22.76
25.00   -       -       -       23.61   27.0    0.00    23.61
26.00   -       -       -       23.97   27.0    0.00    23.97
27.00   -       -       -       24.32   27.0    0.00    24.32
28.00   -       -       -       25.69   27.0    0.00    25.69
29.00   -       -       -       26.06   27.0    0.00    26.06
30.00   -       -       -       26.41   27.0    0.00    26.41
31.00   -       -       -       27.09   22.6    0.00    27.09
32.00   -       -       -       27.72   18.2    0.00    27.72
33.00   -       -       -       28.30   13.8    0.00    28.30
34.00   -       -       -       28.84   9.4     0.00    28.84
35.00   -       -       -       29.34   5.0     0.00    29.34
36.00   -       -       -       30.20   9.4     0.00    30.20
37.00   -       -       -       31.08   13.8    0.00    31.08
38.00   -       -       -       31.96   18.2    0.00    31.96
39.00   -       -       -       32.85   22.6    0.00    32.85
40.00   -       -       -       33.75   27.0    0.00    33.75
41.00   -       -       -       34.18   33.6    0.00    34.18
42.00   -       -       -       33.39   40.2    0.00    33.39
43.00   -       -       -       32.30   46.8    0.00    32.30
44.00   -       -       -       31.24   53.4    0.00    31.24
45.00   -       -       -       30.20   60.0    0.00    30.20
46.00   -       -       -       30.71   60.0    0.00    30.71
47.00   -       -       -       31.21   60.0    0.00    31.21
48.00   -       -       -       31.70   60.0    0.00    31.70
49.00   -       -       -       32.18   60.0    0.00    32.18
50.00   -       -       -       32.66   60.0    0.00    32.66
_________________________________________________________________
(N1)60s has been fines corrected in liquefaction analysis,
therefore d(N1)60=0.
Fines=NoLiq means the soils are not liquefiable.
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Settlement of Saturated Sands:
Settlement Analysis Method: Tokimatsu / Seed

Depth   CSRm    F.S.    Fines   (N1)60s Dr      ec      dsz     dsp     S
ft                      %               %       %       in.     in.     in.
_____________________________________________________________________________
49.95   0.28    5.00    60.0    32.64   96.35   0.000   0.0E0   0.000   0.000
49.00   0.28    5.00    60.0    32.18   95.22   0.000   0.0E0   0.000   0.000
48.00   0.28    5.00    60.0    31.70   94.03   0.000   0.0E0   0.000   0.000
47.00   0.28    5.00    60.0    31.21   92.86   0.000   0.0E0   0.000   0.000
46.00   0.29    5.00    60.0    30.71   91.69   0.000   0.0E0   0.000   0.000
45.00   0.29    5.00    60.0    30.20   90.52   0.000   0.0E0   0.000   0.000
44.00   0.29    5.00    53.4    31.24   92.93   0.000   0.0E0   0.000   0.000
43.00   0.29    5.00    46.8    32.30   95.51   0.000   0.0E0   0.000   0.000
42.00   0.29    5.00    40.2    33.39   98.29   0.000   0.0E0   0.000   0.000
41.00   0.29    5.00    33.6    34.18   100.00  0.000   0.0E0   0.000   0.000
40.00   0.29    5.00    27.0    33.75   99.21   0.000   0.0E0   0.000   0.000
39.00   0.29    5.00    22.6    32.85   96.88   0.000   0.0E0   0.000   0.000
38.00   0.29    5.00    18.2    31.96   94.66   0.000   0.0E0   0.000   0.000
37.00   0.29    5.00    13.8    31.08   92.54   0.000   0.0E0   0.000   0.000
36.00   0.29    5.00    9.4     30.20   90.52   0.000   0.0E0   0.000   0.000
35.00   0.28    1.31    5.0     29.34   88.60   0.000   0.0E0   0.000   0.000
34.00   0.28    1.25    9.4     28.84   87.51   0.000   0.0E0   0.000   0.000
33.00   0.28    1.20    13.8    28.30   86.35   0.000   0.0E0   0.000   0.000
32.00   0.28    1.16    18.2    27.72   85.13   0.104   6.2E-4  0.002   0.002
31.00   0.28    1.12    22.6    27.09   83.83   0.125   7.5E-4  0.014   0.016
30.00   0.28    1.09    27.0    26.41   82.47   0.148   8.9E-4  0.016   0.033
29.00   0.27    1.08    27.0    26.06   81.77   0.151   9.1E-4  0.018   0.051
28.00   0.27    1.08    27.0    25.69   81.06   0.155   9.3E-4  0.018   0.069
27.00   0.27    1.02    27.0    24.32   78.44   0.198   1.2E-3  0.023   0.092
26.00   0.26    1.03    27.0    23.97   77.77   0.199   1.2E-3  0.024   0.116
25.05   0.26    1.02    27.0    23.62   77.12   0.201   1.2E-3  0.023   0.139
_____________________________________________________________________________
Settlement of Saturated Sands=0.139 in.
qc1 and (N1)60 is after fines correction in liquefaction analysis
dsz is per each segment, dz=0.05 ft
dsp is per each print interval,  dp=1.00 ft
S is cumulated settlement at this depth
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Settlement of Unsaturated Sands:

Depth   sigma'  sigC'   (N1)60s CSRfs   Gmax    g*Ge/Gm g_eff   ec7.5   Cec     ec      dsz     dsp     S
ft      tsf     tsf                     tsf                     %               %       in.     in.     in.
_____________________________________________________________________________________________________________________
25.00   1.50    0.98    23.61   0.31    1265.4  3.6E-4  0.0881  0.0699  0.93    0.0650  7.80E-4 0.001   0.001
24.00   1.44    0.94    22.76   0.31    1225.0  3.6E-4  0.0869  0.0723  0.93    0.0672  8.06E-4 0.016   0.017
23.00   1.38    0.90    21.93   0.31    1184.3  3.6E-4  0.0856  0.0748  0.93    0.0695  8.34E-4 0.016   0.033
22.00   1.32    0.86    21.09   0.31    1143.4  3.6E-4  0.0843  0.0774  0.93    0.0719  8.63E-4 0.017   0.050
21.00   1.26    0.82    20.26   0.31    1102.3  3.5E-4  0.0828  0.0802  0.93    0.0745  8.94E-4 0.018   0.068
20.00   1.20    0.78    19.44   0.31    1060.9  3.5E-4  0.0813  0.0831  0.93    0.0771  9.26E-4 0.018   0.086
19.00   1.14    0.74    24.10   0.31    1110.8  3.2E-4  0.1078  0.0832  0.93    0.0773  9.28E-4 0.016   0.102
18.00   1.08    0.70    29.04   0.31    1150.4  2.9E-4  0.0808  0.0483  0.93    0.0449  5.38E-4 0.014   0.116
17.00   1.02    0.66    34.27   0.31    1181.4  2.7E-4  0.0638  0.0290  0.93    0.0269  3.23E-4 0.008   0.124
16.00   0.96    0.62    39.86   0.31    1205.3  2.5E-4  0.0521  0.0166  0.93    0.0154  1.85E-4 0.005   0.129
15.00   0.90    0.59    45.84   0.31    1222.6  2.3E-4  0.0438  0.0138  0.93    0.0129  1.54E-4 0.003   0.133
14.00   0.84    0.55    39.01   0.31    1119.4  2.4E-4  0.0459  0.0155  0.93    0.0144  1.73E-4 0.003   0.136
13.00   0.78    0.51    36.66   0.32    1056.6  2.3E-4  0.0445  0.0176  0.93    0.0163  1.96E-4 0.004   0.140
12.00   0.72    0.47    34.10   0.32    991.0   2.3E-4  0.0432  0.0198  0.93    0.0184  2.21E-4 0.004   0.144
11.00   0.66    0.43    31.31   0.32    922.2   2.3E-4  0.0421  0.0224  0.93    0.0208  2.50E-4 0.005   0.149
10.00   0.60    0.39    28.23   0.32    849.4   2.2E-4  0.0412  0.0256  0.93    0.0238  2.86E-4 0.005   0.154
9.00    0.54    0.35    33.45   0.32    852.7   2.0E-4  0.0336  0.0160  0.93    0.0148  1.78E-4 0.005   0.158
8.00    0.48    0.31    35.43   0.32    819.5   1.9E-4  0.0359  0.0153  0.93    0.0142  1.70E-4 0.004   0.162
7.00    0.42    0.27    41.48   0.32    807.9   1.7E-4  0.0304  0.0096  0.93    0.0089  1.07E-4 0.003   0.165
6.00    0.36    0.23    48.68   0.32    788.9   1.5E-4  0.0256  0.0081  0.93    0.0075  9.04E-5 0.002   0.167
5.00    0.30    0.20    53.96   0.32    745.3   1.3E-4  0.0219  0.0069  0.93    0.0064  7.73E-5 0.002   0.168
4.00    0.24    0.16    53.96   0.32    666.6   1.2E-4  0.0192  0.0061  0.93    0.0056  6.75E-5 0.001   0.170
3.00    0.18    0.12    53.96   0.32    577.3   1.0E-4  0.0202  0.0064  0.93    0.0059  7.10E-5 0.002   0.171
2.00    0.12    0.08    53.96   0.32    471.4   8.2E-5  0.0146  0.0046  0.93    0.0043  5.16E-5 0.001   0.172
1.00    0.06    0.04    53.96   0.32    333.3   5.8E-5  0.0089  0.0028  0.93    0.0026  3.14E-5 0.001   0.173
0.00    0.00    0.00    53.96   0.32    4.3     7.6E-7  0.0010  0.0003  0.93    0.0003  3.58E-6 0.000   0.174
_____________________________________________________________________________________________________________________
Settlement of Unsaturated Sands=0.174 in.
dsz is per each segment, dz=0.05 ft
dsp is per each print interval,  dp=1.00 ft
S is cumulated settlement at this depth

Total Settlement of Saturated and Unsaturated Sands=0.312 in.
Differential Settlement=0.156 to 0.206 in.
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Depth = ft, Stress or Pressure = tsf (atm), Unit Weight = pcf, Settlement = in.

SPT	Field data from Standard Penetration Test (SPT)
BPT	Field data from Becker Penetration Test (BPT)
qc	Field data from Cone Penetration Test (CPT)
fs	Friction from CPT testing
gamma	Total unit weight of soil
gamma'	Effective unit weight of soil
Fines	Fines content [%]
D50	Mean grain size
Dr	Relative Density
sigma	Total vertical stress [tsf]
sigma'	Effective vertical stress [tsf]
sigC'	Effective confining pressure [tsf]
rd	Stress reduction coefficient
CRR7.5	Cyclic resistance ratio (M=7.5)
Ksigma	Overburden stress correction factor for CRR7.5
CRRv	CRR after overburden stress correction, CRRv=CRR7.5 * Ksigma
F.S.	Calculated factor of safety against liquefaction F.S.=CRRv/CSRm
User	User request factor of safety, which may apply to CSR
fs1	First CSR curve in graphic defined in #9 of Advanced page
fs2	2nd CSR curve in graphic defined in #9 of Advanced page
CSR	Cyclic stress ratio induced by earthquake
CSRfs	CSRfs=CSR*fs1, fs1=1 or User, defined in #9 of Advanced page
MSF	Magnitude scaling factor for CSR
CSRm	After magnitude scaling correction CSRm=CSRfs/MSF
Cebs	Energy Ratio, Borehole Dia., and Sampling Method Corrections
Cr	Rod Length Corrections
Cn	Overburden Pressure Correction
(N1)60	SPT after corrections, (N1)60=SPT * Cr * Cn * Cebs
d(N1)60	Fines correction of SPT
(N1)60f	(N1)60 after fines corrections, (N1)60f=(N1)60 + d(N1)60
Cq	Overburden stress correction factor
qc1	CPT after Overburden stress correction
dqc1	Fines correction of CPT
qc1f	CPT after Fines and Overburden correction, qc1f=qc1 + dqc1
qc1n	CPT after normalization in Robertson's method
Kc	Fine correction factor in Robertson's Method
qc1f	CPT after Fines correction in Robertson's Method
Ic	Soil type index in Suzuki's and Robertson's Methods
(N1)60s	(N1)60 after settlement fines corrections
ec	Volumetric strain for saturated sands
dz	Calculation segment, dz=0.050 ft
dsz	Settlement in each segment, dz
dp	User defined print interval
dsp	Settlement in each print interval, dp
Gmax	Shear Modulus at low strain
g_eff	gamma_eff, Effective shear Strain
g*Ge/Gm	gamma_eff * G_eff/G_max, Strain-modulus ratio
ec7.5	Volumetric Strain for magnitude=7.5
Cec	Magnitude correction factor for any magnitude
ec	Volumetric strain for unsaturated sands, ec=Cec * ec7.5
NoLiq	No-Liquefy Soils

References:

1. NCEER Workshop on Evaluation of Liquefaction Resistance of Soils. Youd, T.L., and Idriss, I.M., eds., Technical Report NCEER 97-0022.

SP117. Southern California Earthquake Center. Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Liquefaction in California. University of Southern California. March 1999.

2. RECENT ADVANCES IN SOIL LIQUEFACTION ENGINEERING AND SEISMIC SITE RESPONSE EVALUATION, Paper No. SPL-2, PROCEEDINGS: Fourth International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics, San Diego, CA, March 2001.

3. RECENT ADVANCES IN SOIL LIQUEFACTION ENGINEERING: A UNIFIED AND CONSISTENT FRAMEWORK, Earthquake Engineering Research Center, Report No. EERC 2003-06 by R.B Seed and etc. April 2003.

Appendix F

TABLE OF CONTENT

GENERAL

The guidelines contained herein and the standard details attached hereto represent this firm's standard recommendation for grading and other associated operations on construction projects. These guidelines should be considered a portion of the project specifications.
All plates attached hereto shall be considered as part of these guidelines.
The Contractor should not vary from these guidelines without prior recommendation by the Geotechnical Consultant and the approval of the Client or his authorized representative. Recommendation by the Geotechnical Consultant and/or Client should not be considered to preclude requirements for the approval by the controlling agency prior to the execution of any changes.
These Standard Grading Guidelines and Standard Details may be modified and/or superseded by recommendations contained in the text of the preliminary Geotechnical Report and/or subsequent reports.
If disputes arise out of the interpretation of these grading guidelines or standard details, the Geotechnical Consultant shall provide the governing interpretation.

DEFINITION OF TERMS

ALLUVIUM
Unconsolidated soil deposits resulting from flow of water, including sediments deposited in river beds, canyons, flood plains, lakes, fans and estuaries.
AS-GRADED (AS-BUILT): The surface and subsurface conditions at 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 buttresses, stabilization fills, and retaining walls.
BEDROCK: Relatively undisturbed formational rock, more or less solid, either at the surface or beneath superficial deposits of soil.
BENCH: A relatively level step and near vertical rise 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 slope conditions containing adverse geologic features. A buttress is generally specified by minimum key width and depth and by maximum 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, surveying and verifying as-graded topographic conditions.
CLIENT: The Developer or his authorized representative who is chiefly in charge of the project. He shall have the responsibility of reviewing the findings and recommendations made by the Geotechnical Consultant and shall authorize the Contractor and/or other consultants to perform work and/or provide services.
COLLUVIUM: Generally loose deposits usually found near the base of slopes and brought there chiefly by gravity through slow continuous downhill creep (also see Slope Wash).
COMPACTION : Densification of man-placed 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: All products of clearing, grubbing, demolition, and contaminated soil materials unsuitable for reuse as compacted fill, and/or any other material so designated by the Geotechnical Consultant.
ENGINEERING GEOLOGIST: A Geologist holding a valid certificate of registration in the specialty of Engineering Geology.
ENGINEERED FILL: A fill of which the Geotechnical Consultant or his representative, during grading, has made sufficient tests to enable him to conclude that the fill has been placed in substantial compliance with the recommendations of the Geotechnical Consultant and the governing agency requirements.
EROSION: The wearing away of 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.
FILL: Any deposits of soil, rock, soil-rock blends or other similar materials placed by man.
FINISH GRADE: The ground surface configuration at which time the surface elevations conform to the approved plan.

GEOFABRIC: Any engineering textile utilized in geotechnical applications including subgrade stabilization and filtering.
GEOLOGIST: A representative of the Geotechnical Consultant educated and trained in the field of geology.
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 Soil Engineer, Geotechnical Engineer, Engineering Geologist and those performed by persons employed by and responsible to the Geotechnical Consultants.
GEOTECHNICAL ENGINEER: A licensed Geotechnical Engineer or Civil Engineer who applies scientific methods, engineering principles and professional experience to the acquisition, interpretation and use of knowledge of materials of the earth's crust for the evaluation 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.
LANDSIDE DEBRIS: Material, generally porous and of low density, produced from instability of natural or man-made slopes.
MAXIMUM DENSITY: Standard laboratory test for maximum dry unit weight. Unless otherwise specified, the maximum dry unity weight shall be determined in accordance with ASTM Method of Test D 1557-91.
OPTIMUM MOISTURE – Soil moisture content at the test maximum density.
RELATIVE COMPACTION: The degree of compaction (expressed as a percentage) of dry unit weight of a material as compared to the maximum dry unit weight of the material.
ROUGH GRADE: The ground surface configuration at which time the surface elevations approximately conform to the approved plan.
SITE: The particular parcel of land where grading is being performed.
SHEAR KEY: Similar to 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 grading encroaching into the lower portion of the slope.
SLOPE: An inclined ground surface, the steepness of which is generally specified as a ration of horizontal:vertical (e.g., 2:1)
SLOPE WASH: Soil and/or rock material that has been transported down a slope by action of gravity assisted by runoff water not confined by channels (also see Colluvium).
SOIL: Naturally occurring deposits of sand, silt, clay, etc., or combinations thereof.
SOIL ENGINEER: Licensed Geotechnical Engineer or Civil Engineer experienced in soil mechanics (also see Geotechnical Engineer).
STABILIZATION FILL: A fill mass, the configuration of which is typically related to slope height and specified by the standards of practice for enhancing the stability of locally adverse conditions. A stabilization fill is normally specified by minimum key width and depth and by maximum backcut angle. A stabilization fill may or may not have a backdrainage system specified.
SUBDRAIN: Generally a pipe and gravel or similar drainage system placed beneath a fill in the alignment of canyons or formed drainage channels.
SLOUGH: Loose, non-compacted fill material generated during grading operations.
TAILINGS: Non-engineered fill which accumulates on or adjacent to equipment haul-roads.
TERRACE: Relatively level step constructed in the face of a graded slope surface for drainage control and maintenance purposes.
TOPSOIL: The presumable fertile upper zone of soil, which is usually darker in color and loose.
WINDROW: A string of large rocks buried within engineered fill in accordance with guidelines set forth by the Geotechnical Consultant.

OBLIGATIONS OF PARTIES

The Geotechnical Consultant should provide observation and testing services and should make evaluations in order to advise the Client on Geotechnical matters. The Geotechnical Consultant should report his findings and recommendations to the Client or his authorized representative.
The client should be chiefly responsible for all aspects of the project. He or his authorized representative has the responsibility of reviewing the findings and recommendations of the Geotechnical Consultant. He shall authorize or cause to have authorized the Contractor and/or other consultants to perform work and/or provide services.

During grading the Client or his authorized representative should remain on-site or should remain reasonably accessible to all concerned parties in order to make decisions necessary to maintain the flow of the project.

The Contractor should be responsible for the safety of the project and satisfactory completion of all grading and other associated operations on construction projects, including but not limited to, earthwork in accordance with the project plans, specifications and controlling agency requirements. During grading, the Contractor or his authorized representative should remain on-site. Overnight and on days off, the Contractor should remain accessible.

SITE PREPARATION

The Client, prior to any site preparation or grading, should arrange and attend a meeting among the Grading Contractor, the Design Engineer, the Geotechnical Consultant, representatives of the appropriate governing authorities as well as any other concerned parties. All parties should be given at least 48 hours notice.

Clearing and grubbing should consist of the removal of vegetation such as brush, grass, woods, stumps, trees, roots of trees and otherwise deleterious natural materials from the areas to be graded. Clearing and grubbing should extend to the outside of all proposed excavation and fill areas.

Demolition should include removal of buildings, structures, foundations, reservoirs, utilities (including underground pipelines, septic tanks, leach fields, seepage pits, cisterns, mining shafts, tunnels, etc.) and man-made surface and subsurface improvements from the areas to be graded. Demolition of utilities should include proper capping and/or re-routing pipelines at the project perimeter and cutoff and capping of wells in accordance with the requirements of the governing authorities and the recommendations of the Geotechnical Consultant at the time of the demolition.

Trees, plants or man-made improvements not planned to be removed or demolished should be protected by the Contractor from damage or injury.

Debris generated during clearing, grubbing and/or demolition operations should be wasted from areas to be graded and disposed off-site. Clearing, grubbing and demolition operations should be performed under the observation of the Geotechnical Consultant.

The Client or Contractor should obtain the required approvals for the controlling authorities for the project prior, during and/or after demolition, site preparation and removals, etc. The appropriate approvals should be obtained prior to proceeding with grading operations.

SITE PROTECTION

Protection of the site during the period of grading should 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 should not be considered to preclude that portion or adjacent areas from the requirements for site protection until such time as the entire project is complete as identified by the Geotechnical Consultant, the Client and the regulating agencies.

The Contractor should be responsible for the stability of all temporary excavations. Recommendations by the Geotechnical Consultant pertaining to temporary excavations (e.g., backcuts) are made in consideration of stability of the completed project and therefore, should not be considered to preclude the responsibilities of the Contractor. Recommendations by the Geotechnical Consultant should not be considered to preclude more restrictive requirements by the regulating agencies.

Precautions should be taken during the performance of site clearing, excavations and grading to protect the work site from flooding, ponding, or inundation by poor or improper surface drainage. Temporary provisions should be made during the rainy season to adequately direct surface drainage away from and off the work site. Where low areas can not be avoided, pumps should be kept on hand to continually remove water during periods of rainfall.

During periods of rainfall, plastic sheeting should be kept reasonably accessible to prevent unprotected slopes from becoming saturated. Where necessary during periods of rainfall, the Contractor should install check-dams de-silting basins, rip-rap, sandbags or other devices or methods necessary to control erosion and provide safe conditions.

During periods of rainfall, the Geotechnical Consultant should be kept informed by the Contractor as to the nature of remedial or preventative work being performed (e.g., pumping, placement of sandbags or plastic sheeting, other labor, dozing, etc.).

Following periods of rainfall, the Contractor should 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 excavations and testing in order to aid in his assessments. At the request of the Geotechnical Consultant, the Contractor shall make excavations in order to evaluate the extent of rain related damage.

Rain-related damage should be considered to include, but may not be limited to, erosion, silting, saturation, swelling, structural distress and other adverse conditions identified by the Geotechnical Consultant. Soil adversely affected should be classified as Unsuitable Materials and should be subject to overexcavation and replaced with compacted fill or other remedial grading as recommended by the Geotechnical Consultant.

Relatively level areas, where saturated soils and/or erosion gullies exist to depths greater then 1 foot, should be overexcavated to unaffected, competent material. Where less than 1 foot in depth, unsuitable materials may be processed in-place to achieve near optimum moisture conditions, then thoroughly recompacted in accordance with the applicable specifications. If the desired results are not achieved, the affected materials should be overexcavated then replaced in accordance with the applicable specifications.

In slope areas, where saturated soil and/or erosion gullies exist to depths of greater than 1 foot, should be over-excavated to unaffected, competent material. Where affected materials exist to depths of 1 foot or less below proposed finished grade, remedial grading by moisture conditioning in-place, followed by thorough recompaction in accordance with the applicable grading guidelines herein may be attempted. If the desired results are not achieved, all affected materials should be overexcavated and replaced as compacted fill in accordance with the slope repair recommendations herein. As field conditions dictate, other slope repair procedures may be recommended by the Geotechnical Consultant.

EXCAVATIONS

UNSUITABLE MATERIALS:

Materials which are unsuitable should be excavated under observation and recommendations of the Geotechnical Consultant. Unsuitable materials include, but may not be limited to dry, loose, soft, wet, organic compressible natural soils and fractured, weathered, soft, bedrock and nonengineered or otherwise deleterious fill materials.

Materials identified by the Geotechnical Consultant as unsatisfactory due to its moisture conditions should be overexcavated, watered or dried, as needed, and thoroughly blended to uniform near optimum moisture condition (per Moisture guidelines presented herein) prior to placement as compacted fill.

CUT SLOPES:

Unless otherwise recommended by the Geotechnical Consultant and approved by the regulating agencies, permanent cut slopes should not be steeper than 2:1 (horizontal:vertical).

If excavations for cut slopes expose loose, cohesionless, significantly fractured or otherwise suitable material, overexcavation and replacement of the unsuitable materials with a compacted stabilization fill should be accomplished as recommended by the Geotechnical Consultant. Unless otherwise specified by the Geotechnical Consultant, stabilization fill construction should conform to the requirements of the Standard Details.

The Geotechnical Consultant should review cut slopes during excavation. The Geotechnical Consultant should be notified by the contractor prior to beginning slope excavations.

If during the course of grading, adverse or potentially adverse geotechnical conditions are encountered which were not anticipated in the preliminary report, the Geotechnical Consultant should explore, analyze and make recommendations to treat these problems.

When cuts slopes are made in the direction of the prevailing drainage, a non-erodible diversion swale (brow ditch) should be provided at the top-of-cut.

PAD AREAS:

All lot pad areas, including side yard terraces, above stabilization fills or buttresses should be over-excavated to provide for a minimum of 3-feet (refer to Standard Details) of compacted fill over the entire pad area. Pad areas with both fill and cut materials exposed and pad areas containing both very shallow (less than 3-feet) and deeper fill should be over- thickness (refer to Standard Details).

Cut areas exposing significantly varying material types should also be overexcavated to provide for at least a 3-foot thick compacted fill blanket. Geotechnical conditions may require greater depth of overexcavation. The actual depth should be delineated by the Geotechnical Consultant during grading.

For pad areas created above cut or natural slopes, positive drainage should be established away from the top-of-slope. This may be accomplished utilizing a berm and/or an appropriate pad gradient. A gradient in soil areas away from the top-of-slope of 2 percent or greater is recommended.

COMPACTED FILL

All fill materials should be compacted as specified below or by other methods specifically recommended by the Geotechnical Consultant. Unless otherwise specified, the minimum degree of compaction (relative compaction) should be 90 percent of the laboratory maximum density.

PLACEMENT

Prior to placement of compacted fill, the Contractor should request a review by the Geotechnical Consultant of the exposed ground surface. Unless otherwise recommended, the exposed ground surface should then be scarified (6-inches minimum), watered or dried as needed, thoroughly blended to achieve near optimum moisture conditions, then thoroughly compacted to a minimum of 90 percent of the maximum density. The review by the Geotechnical Consultants should not be considered to preclude requirements of inspection and approval by the governing agency.

Compacted fill should be placed in thin horizontal lifts not exceeding 8-inches in loose thickness prior to compaction. Each lift should be watered or dried as needed, thoroughly blended to achieve near optimum moisture conditions then thoroughly compacted by mechanical methods to a minimum of 90 percent of laboratory maximum dry density. Each lift should be treated in a like manner until the desired finished grades are achieved.

The Contractor should have suitable and sufficient mechanical compaction equipment and watering apparatus on the job site to handle the amount of fill being placed in consideration of moisture retention properties of the materials. If necessary, excavation equipment should be “shut down” temporarily in order to permit proper compaction of fills. Earth moving equipment should only be considered a supplement and not substituted for conventional compaction equipment.

When placing fill in horizontal lifts adjacent to areas sloping steeper than 5:1 (horizontal:vertical), horizontal keys and vertical benches should be excavated into the adjacent slope area. Keying and benching should be sufficient to provide at least 6-foot wide benches and minimum of 4-feet of vertical bench height within the firm natural ground, firm bedrock or engineered compacted fill. No compacted fill should be placed in an area subsequent to keying and benching until the area has been reviewed by the Geotechnical Consultant. Material generated by the benching operation should be moved sufficiently away from the bench area to allow for the recommended review of the horizontal bench prior to placement of fill. Typical keying and benching details have been included within the accompanying Standard Details.

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 false slope, benching should be conducted in the same manner as above described. At least a 3-foot vertical bench should be established within the firm core of adjacent approved compacted fill prior to placement of additional fill. Benching should proceed in at least 3-foot vertical increments until the desired finished grades are achieved.

Fill should be tested for compliance with the recommended relative compaction and moisture conditions. Field density testing should conform to ASTM Method of Testing D 1556-64, D 2922-78 and/or D2937-71. Tests should be provided for about every 2 vertical feet or 1,000 cubic yards of fill placed. Actual test intervals may vary as field conditions dictate. Fill found not to be in conformance with the grading recommendations should be removed or otherwise handled as recommended by the Geotechnical Consultant.

The Contractor should assist the Geotechnical Consultant and/or his representative by digging test pits for removal determinations and/or for testing compacted fill.

As recommended by the Geotechnical Consultant, the Contractor should “shutdown” or remove any grading equipment from an area being tested.

The Geotechnical Consultant should maintain a plan with estimated locations of field tests. Unless the client provides for actual surveying of test locations, by the Geotechnical Consultant should only be considered rough estimates and should not be utilized for the purpose of preparing cross sections showing test locations or in any case for the purpose of after-the-fact evaluating of the sequence of fill placement.

MOISTURE

For field testing purposes, “near optimum” moisture will vary with material type and other factors including compaction procedures. “Near optimum” may be specifically recommended in Preliminary Investigation Reports and/or may be evaluated during grading.

Prior to placement of additional compacted fill following an overnight or other grading delay, the exposed surface of previously compacted fill should be processed by scarification, watered or dried as needed, thoroughly blended to near-optimum moisture conditions, then recompacted to a minimum of 90 percent of laboratory maximum dry density. Where wet or other dry or other unsuitable materials exist to depths of greater than one foot, the unsuitable materials should be overexcavated.

Following a period of flooding, rainfall or overwatering by other means, no additional fill should be placed until damage assessments have been made and remedial grading performed as described herein.

FILL MATERIAL

Excavated on-site materials which are acceptable to the Geotechnical Consultant may be utilized as compacted fill, provided trash, vegetation and other deleterious materials are removed prior to placement.

Where import materials are required for use on-site, the Geotechnical Consultant should be notified at least 72 hours in advance of importing, in order to sample and test materials from proposed borrow sites. No import materials should be delivered for use on-site without prior sampling and testing by Geotechnical Consultant.

Where oversized rock 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 placed in disposal areas should be placed with sufficient fines to fill voids. The rock should be compacted in lifts to an unyielding condition. The disposal area should be covered with at least 3-feet of compacted fill, which is free of oversized material. The upper 3-feet should be placed in accordance with the guidelines for compacted fill herein.

Rocks 3 inches in maximum dimension and smaller may be utilized within the compacted fill, provided they are placed in such a manner that nesting of the rock in avoided. Fill should be placed and thoroughly compacted over and around all rock. The amount of rock should not exceed 40 percent by dry weight passing the $^{3}/_{4}$-inch sieve size. The 3-inch and 40 percent recommendations herein may vary as field conditions dictate.

During the course of grading operations, rocks or similar irreducible materials greater than 3-inch maximum dimension (oversized material) may be generated. These rocks should not be placed within the compacted fill unless placed as recommended by the Geotechnical Consultant.

Where rocks or similar irreducible materials of greater that 3-inches but less than 4-feet of maximum dimension are generated during grading, or otherwise desired to be placed within an engineered fill, special handling in accordance with the accompanying Standard Details is recommended. Rocks greater than 4 feet should be broken down or disposed off-site. Rocks up to 4-feet maximum dimension should be placed below the upper 10-feet of any fill and should not be closer than 20-feet to any slope face. These recommendations could vary as locations of improvements dictate. Where practical, oversized material should not be placed below areas where structures of deep utilities are proposes.

Oversized material should be placed in windrows on a clean, overexcavated or unyielding compacted fill or firm natural ground surface. Select native or imported granular soil (S.E. 30 or higher) should be placed and thoroughly flooded over and around all windrowed rock, such that voids are filled. Windrows of oversized material should be staggered so that successive strata of oversized material are not in the same vertical plane.

It may be possible to dispose of individual larger rock as field conditions dictate and as recommended by the Geotechnical Consultant at time of placement.

Material that is considered unsuitable by the Geotechnical Consultant should not be utilized in the compacted fill.

During grading operations, placing and mixing the materials from the cut and/or borrow areas may result in soil mixtures which possess unique physical properties. Testing may be required of samples obtained directly from the fill areas in order to verify conformance with the specifications. Processing of these additional samples may take two or more working days. The Contractor may elect to move the operation to other areas within the project, or may continue placing compacted fill pending laboratory and field test results. Should he elect the second alternative, fill placed is done so at the Contractor’s risk.

Any fill placed in areas not previously reviewed and evaluated by the Geotechnical Consultant, and/or in other areas, without prior notification to the Geotechnical Consultant may require removal and recompaction at the Contractor's expense. Determination of overexcavations should be made upon review of field conditions by the Geotechnical Consultant.

FILL SLOPES

Unless otherwise recommended by the Geotechnical Consultant and approved by the regulating agencies, permanent fill slopes should not be steeper than 2:1 (horizontal to vertical).

Except as specifically recommended otherwise or as otherwise provided for in these grading guidelines (Reference Fill Materials), compacted fill slopes should be overbuilt and cut back to grade, exposing the firm, compacted fill inner core. The actual amount of overbuilding may vary as field conditions dictate. If the desired results are not achieved, the existing slopes should be overexcavated and reconstructed under the guidelines of the Geotechnical Consultant. The degree of overbuilding shall be increased until the desired compacted slope surface condition is achieved. Care should be taken by the Contractor to provide thorough mechanical compaction to the outer edge of the overbuilt slope surface.

Although no construction procedure produces a slope free from risk of future movement, overfilling and cutting back of slope to a compacted inner core is, given no other constraints, the most desirable procedure. Other constraints, however, must often be considered. These constraints may include property line situations, access, the critical nature of the development, and cost. Where such constraints are identified, slope face compaction may be attempted by conventional construction procedures including backrolling techniques upon specific recommendations by the Geotechnical Consultant.

As a second best alternative for slopes of 2:1 (horizontal to vertical) or flatter, slope construction may be attempted as outlined herein. Fill placement should proceed in thin lifts, (i.e., 6 to 8 inch loose thickness). Each lift should be moisture conditioned and thoroughly compacted. The desired moisture condition should be maintained and/or reestablished, where necessary, during the period between successive lifts. Selected lifts should be tested to ascertain that desired compaction is being achieved. Care should be taken to extend compactive effort to the outer edge of the slope. Each lift should extend horizontally to the desired finished slope surface or more as needed to ultimately establish desired grades. Grade during construction should not be allowed to roll off at the edge of the slope. It may be helpful to elevate slightly the outer edge of the slope. Slough resulting from the placement of individual lifts should not be allowed to drift down over previous lifts. At intervals not exceeding 4-feet in vertical slope height or the capability of available equipment, whichever is less, fill slopes should be thoroughly backrolled utilizing a conventional sheepsfoot-type roller. Care should be taken to maintain the desired moisture conditions and/or reestablishing same as needed prior to backrolling. Upon achieving final grade, the slopes should again be moisture conditioned and thoroughly backrolled. The use of a side-boom roller will probably be necessary and vibratory methods are strongly recommended. Without delay, so as to avoid (if possible) further moisture conditioning, the slopes should then be grid-rolled to achieve a relatively smooth surface and uniformly compact condition.

In order to monitor slope construction procedures, moisture and density tests will be taken at regular intervals. Failure to achieve the desired results will likely result in a recommendation by the Geotechnical Consultant to overexcavate the slope surfaces followed by reconstruction of the slopes utilizing overfilling and cutting back procedures and/or further attempt at the conventional backrolling approach. Other recommendations may also be provided which would be commensurate with field conditions.

Where placement of fill above a natural slope or above a cut slope is proposed, the fill slope configuration as presented in the accompanying standard Details should be adopted.

For pad areas above fill slopes, positive drainage should be established away from the top-of-slope. This may be accomplished utilizing a berm and pad gradients of at least 2-percent in soil area.

OFF-SITE FILL

Off-site fill should be treated in the same manner as recommended in these specifications for site preparation, excavation, drains, compaction, etc.

Off-site canyon fill should be placed in preparation for future additional fill, as shown in the accompanying Standard Details.

Off-site fill subdrains temporarily terminated (up canyon) should be surveyed for future relocation and connection.

DRAINAGE

Canyon sub-drain systems specified by the Geotechnical Consultant should be installed in accordance with the Standard Details.

Typical sub-drains for compacted fill buttresses, slope stabilization or sidehill masses, should be installed in accordance with the specifications of the accompanying Standard Details.

Roof, pad and slope drainage should be directed away from slopes and areas of structures to suitable disposal areas via non-erodible devices (i.e., gutters, downspouts, concrete swales).

For drainage over soil areas immediately away from structures (i.e., within 4-feet), a minimum of 4 percent gradient should be maintained. Pad drainage of at least 2 percent should be maintained over soil areas. Pad drainage may be reduced to at least 1 percent for projects where no slopes exist, either natural or man-made, or greater than 10-feet in height and where no slopes are planned, either natural or man-made, steeper than 2:1 (horizontal to vertical slope ratio).

Drainage patterns established at the time of fine grading should be maintained throughout the life of the project. Property owners should be made aware that altering drainage patterns can be detrimental to slope stability and foundation performance.

STAKING

In all fill areas, the fill should be compacted prior to the placement of the stakes. This particularly is important on fill slopes. Slope stakes should not be placed until the slope is thoroughly compacted (backrolled). If stakes must be placed prior to the completion of compaction procedures, it must be recognized that they will be removed and/or demolished at such time as compaction procedures resume.

In order to allow for remedial grading operations, which could include overexcavations or slope stabilization, appropriate staking offsets should be provided. For finished slope and stabilization backcut areas, we recommend at least 10-feet setback from proposed toes and tops-of-cut.

SLOPE MAINTENANCE LANDSCAPE PLANTS

In order to enhance superficial slope stability, slope planting should be accomplished at the completion of grading. Slope planting should consist of deep-rooting vegetation requiring little watering. Plants native to the Southern California area and plants relative to native plants are generally desirable. Plants native to other semiarid and arid areas may also be appropriate. A Landscape Architect would be the best party to consult regarding actual types of plants and planting configuration.

IRRIGATION

Irrigation pipes should be anchored to slope faces, not placed in trenches excavated into slope faces.

Slope irrigation should be minimized. If automatic timing devices are utilized on irrigation systems, provisions should be made for interrupting normal irrigation during periods of rainfall.

Though not a requirement, consideration should be give to the installation of near-surface moisture monitoring control devices. Such devices can aid in the maintenance of relatively uniform and reasonably constant moisture conditions.

Property owners should be made aware that overwatering of slopes is detrimental to slope stability.

MAINTENANCE

Periodic inspections of landscaped slope areas should be planned and appropriate measures should be taken to control weeds and enhance growth of the landscape plants. Some areas may require occasional replanting and/or reseeding.

Terrace drains and downdrains should be periodically inspected and maintained free of debris. Damage to drainage improvements should be repaired immediately.

Property owners should be made aware that burrowing animals can be detrimental to slope stability. A preventative program should be established to control burrowing animals.

As a precautionary measure, plastic sheeting should be readily available, or kept on hand, to protect all slope areas from saturation by periods of heavy or prolonged rainfall. This measure is strongly recommended, beginning with the period of time prior to landscape planting.

REPAIRS

If slope failures occur, the Geotechnical Consultant should be contacted for a field review of site conditions and development of recommendations for evaluation and repair.

If slope failure occurs as a result of exposure to periods of heavy rainfall, the failure areas and currently unaffected areas should be covered with plastic sheeting to protect against additional saturation.

In the accompanying Standard Details, appropriate repair procedures are illustrated for superficial slope failures (i.e., occurring typically within the outer 1 foot to 3 feet of a slope face).

TRENCH BACKFILL

Utility trench backfill should, unless otherwise recommended, be compacted by mechanical means. Unless otherwise recommended, the degree of compaction should be a minimum of 95 percent of the laboratory maximum density.

Approved granular material (sand equivalent greater than 30) should be used to bed and backfill utilities to a depth of at least 1 foot over the pipe. This backfill should be uniformly watered, compacted and/or wheel-rolled from the surface to a firm condition for pipe support.

The remainder of the backfill shall be typical on-site soil or imported soil which should be placed in lifts not exceeding 8 inches in thickness, watered or aerated to at least 3 percent above the optimum moisture content, and mechanically compacted to at least 95 percent of maximum dry density (based on ASTM D1557).

Backfill of exterior and interior trenches extending below a 1:1 projection from the outer edge of foundations should be mechanically compacted to a minimum of 95 percent of the laboratory maximum density.

Within slab areas, but outside the influence of foundations, trenches up to 1 foot wide and 2 feet deep may be backfilled with sand and consolidated by uniformly watering or by mechanical means. If on-site materials are utilized, they should be wheel-rolled, tamped or otherwise compacted to a firm condition. For minor interior trenches, density testing may be deleted or spot testing may be elected if deemed necessary, based on review of back-fill operations during construction.

If utility contractors indicate that it is undesirable to use compaction equipment in close proximity to a buried conduit, the Contractor may elect the utilization of light weight compaction equipment and/or shading of the conduit with clean, granular material, which should be thoroughly jetted in-place above the conduit, prior to initiating mechanical compaction procedures. Other methods of utility trench compaction may also be appropriate, upon review by the Geotechnical Consultant at the time of construction.

In cases where clean granular materials are proposed for use in lieu of native materials or where flooding or jetting is proposed, the procedures should be considered subject to review by the Geotechnical Consultant.

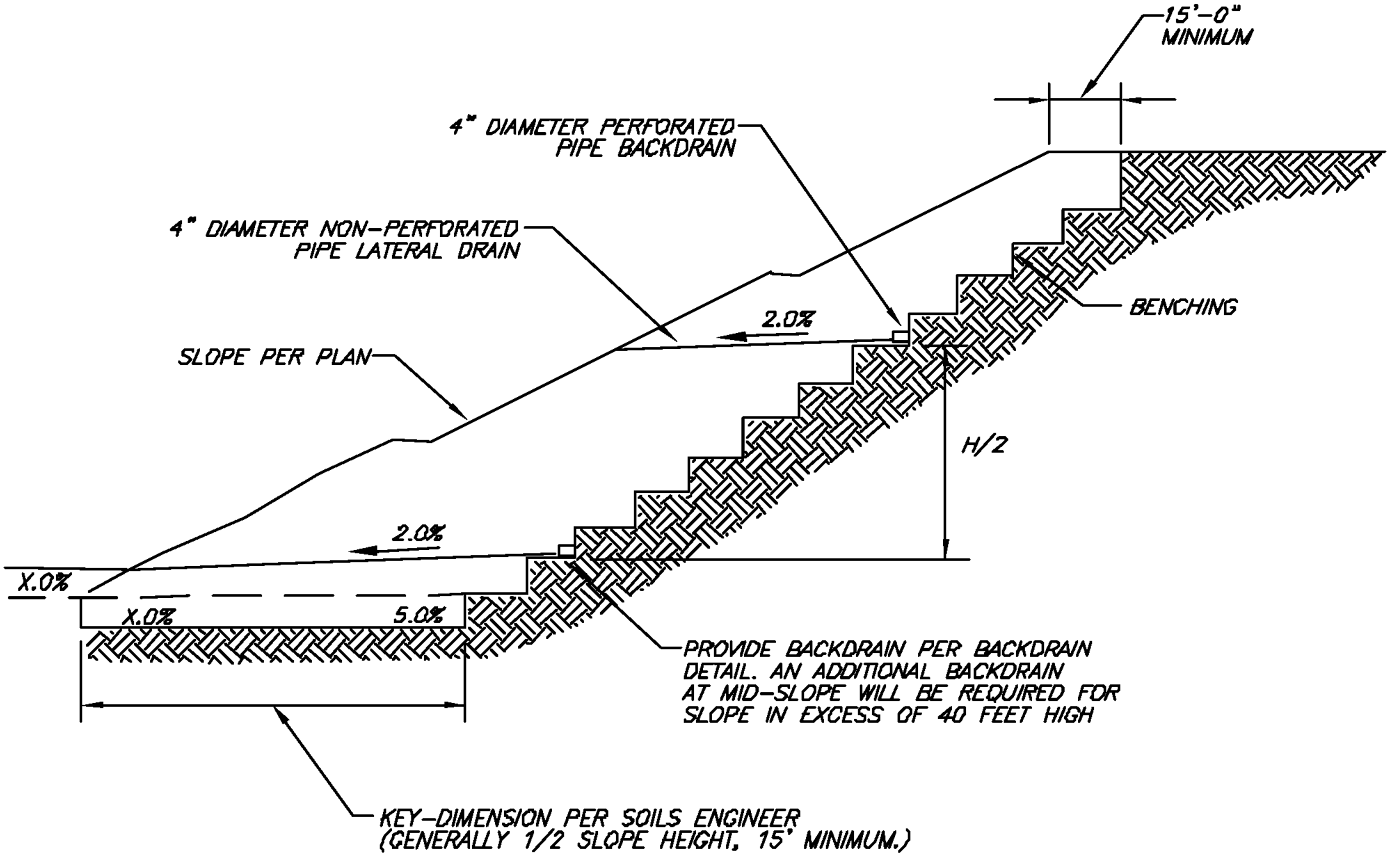
Clean Granular backfill and/or bedding are not recommended in slope areas unless provisions are made for a drainage system to mitigate the potential build-up of seepage forces.

STATUS OF GRADING

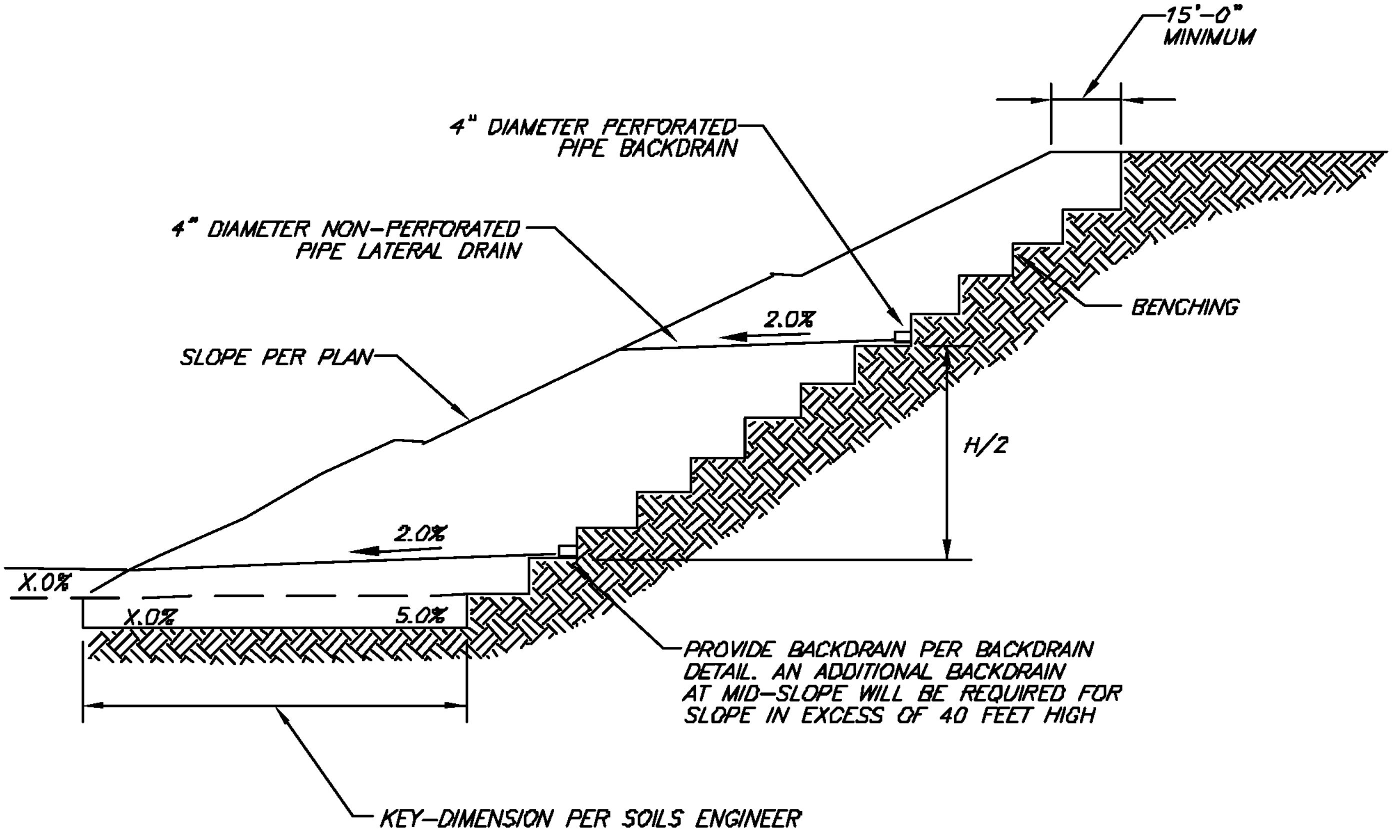
Prior to proceeding with any grading operation, the Geotechnical Consultant should be notified at least two working days in advance in order to schedule the necessary observation and testing services.

Prior to any significant expansion of cut back in the grading operation, the Geotechnical Consultant should be provided with adequate notice (i.e., two days) in order to make appropriate adjustments in observation and testing services.

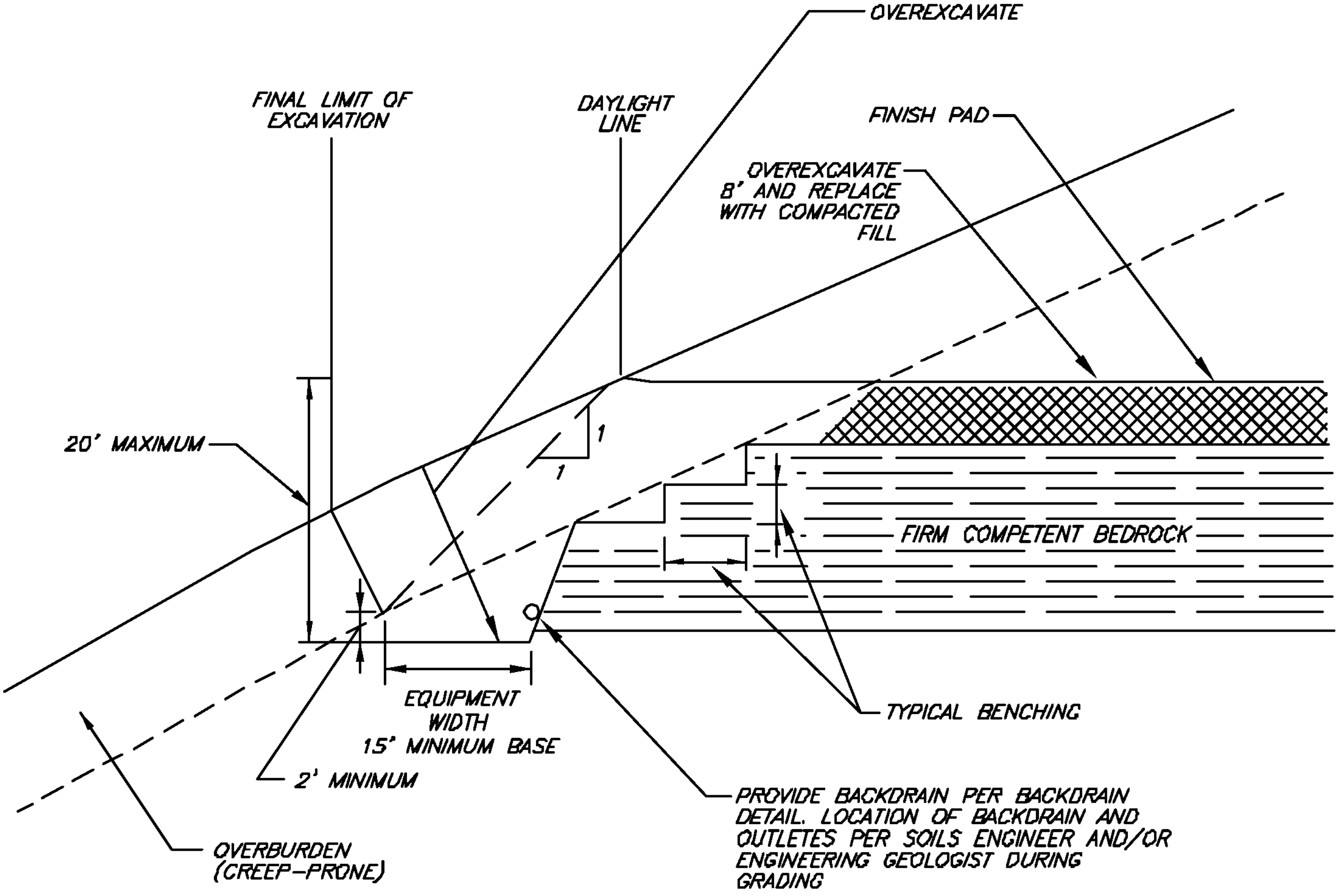
Following completion of grading operations and/or between phases of a grading operation, the Geotechnical Consultant should be provided with at least two working days notice in advance of commencement of additional grading operations.



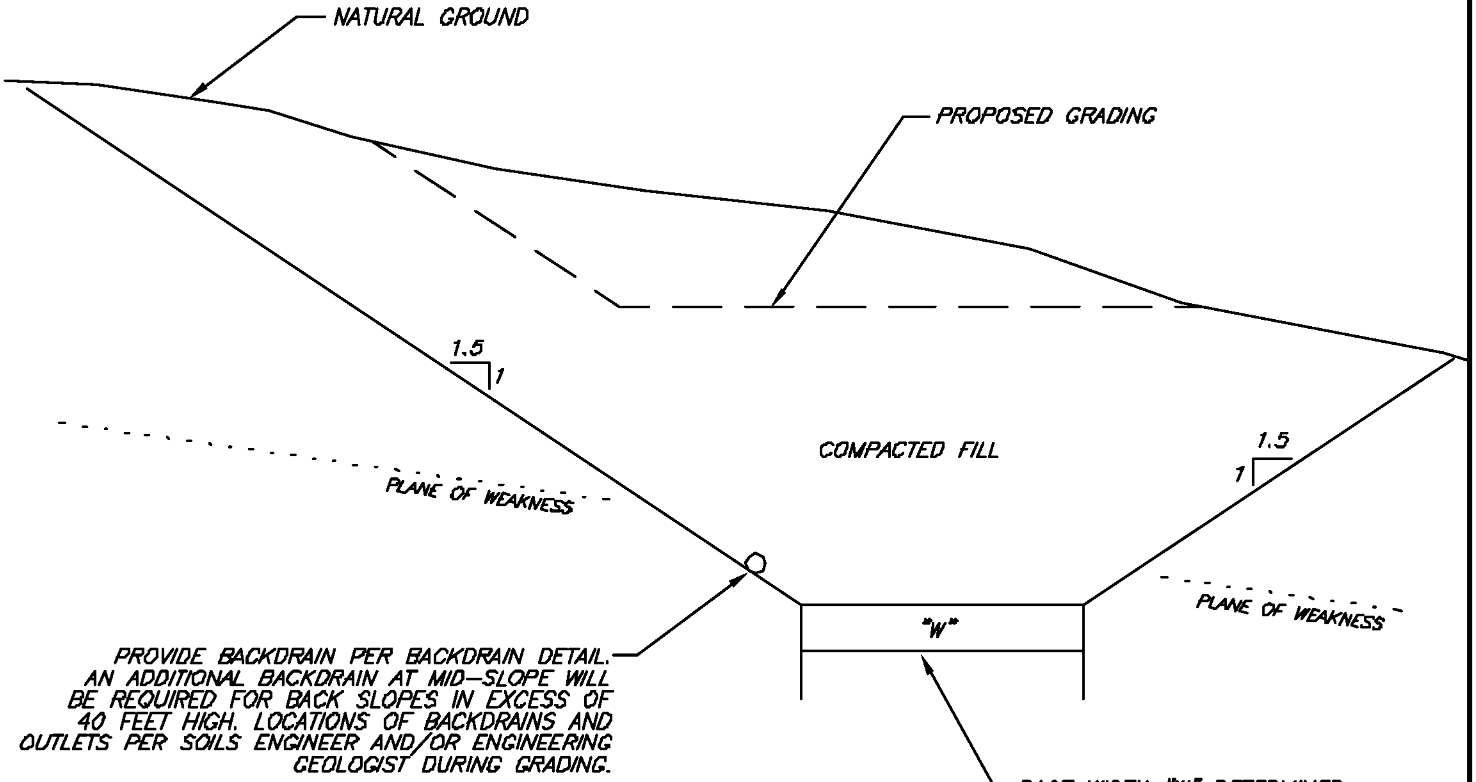
TYPICAL STABILIZATION FILL DETAIL



TYPICAL BUTTRESS FILL DETAIL



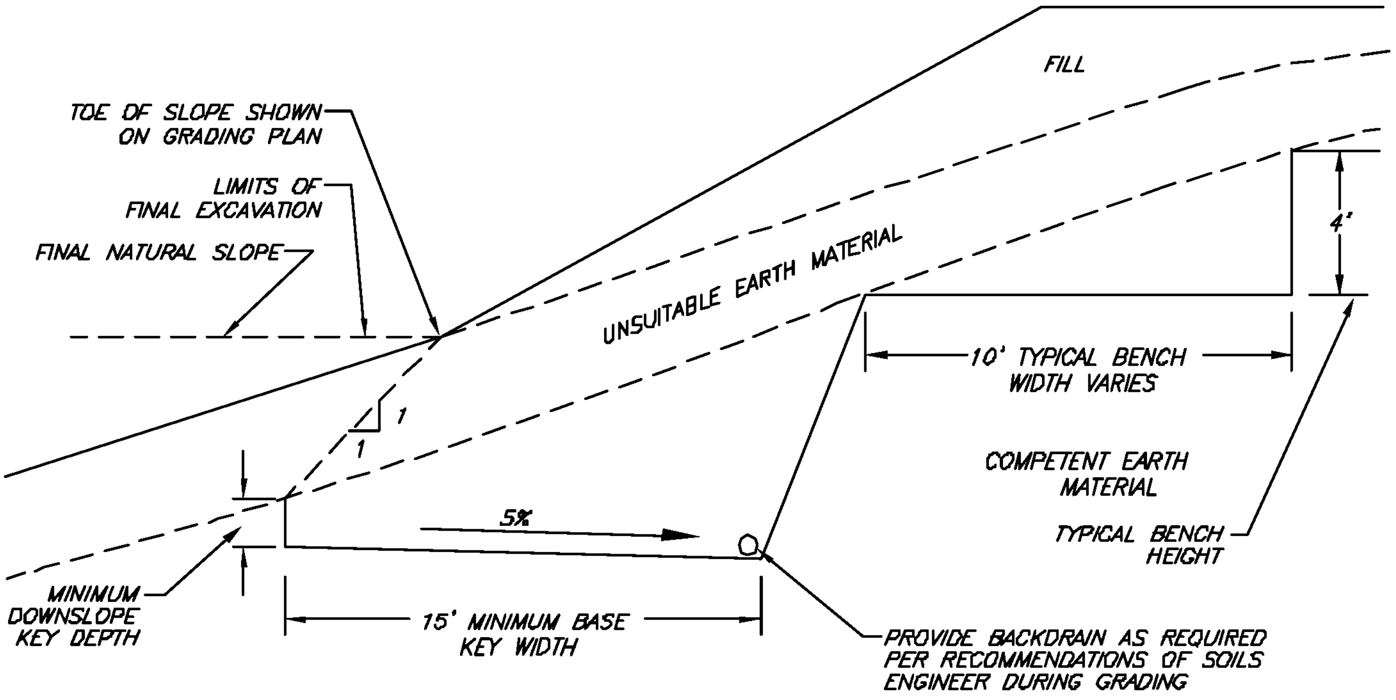
DAYLIGHT SHEAR KEY DETAIL



PROVIDE BACKDRAIN PER BACKDRAIN DETAIL. AN ADDITIONAL BACKDRAIN AT MID-SLOPE WILL BE REQUIRED FOR BACK SLOPES IN EXCESS OF 40 FEET HIGH. LOCATIONS OF BACKDRAINS AND OUTLETS PER SOILS ENGINEER AND/OR ENGINEERING GEOLOGIST DURING GRADING.

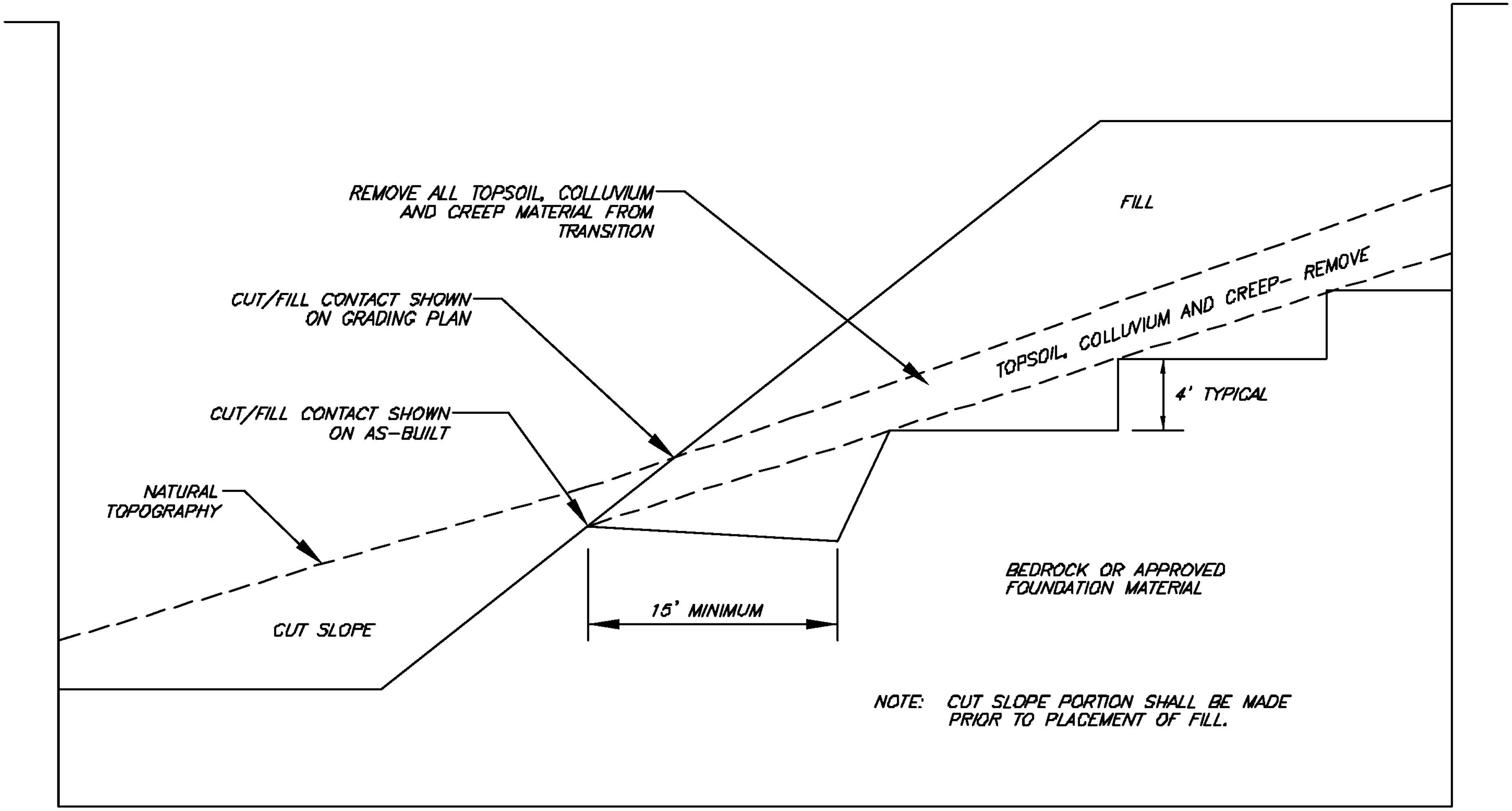
BASE WIDTH "W" DETERMINED BY SOILS ENGINEER

TYPICAL SHEAR KEY DETAIL



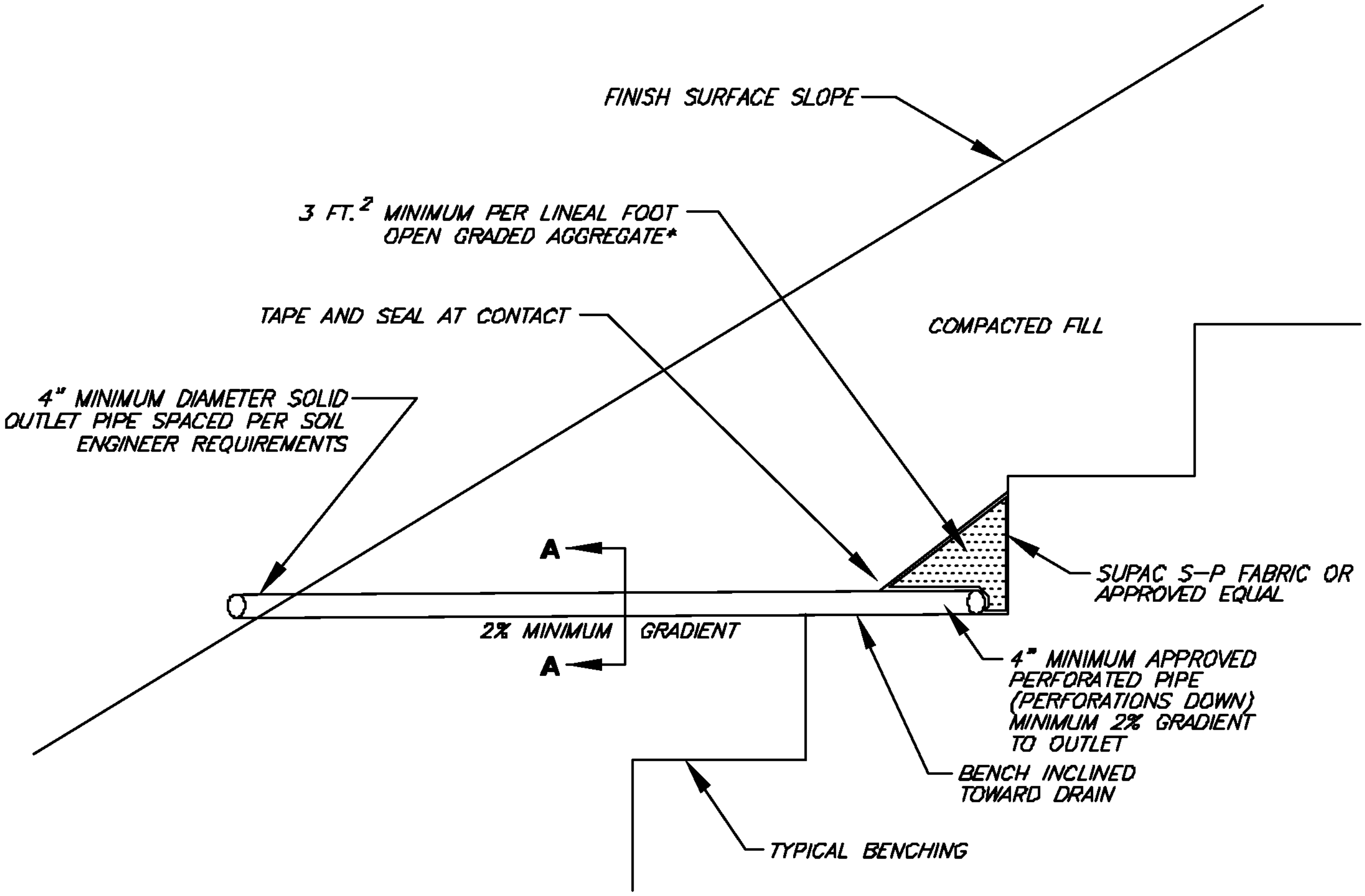
WHERE NATURAL SLOPE IS 5:1 OR LESS, BENCHING IS NOT NECESSARY, HOWEVER, FILL IS NOT TO BE PLACED ON COMPRESSIBLE OR UNSUITABLE MATERIAL.

FILL SLOPE ABOVE NATURAL GROUND DETAIL

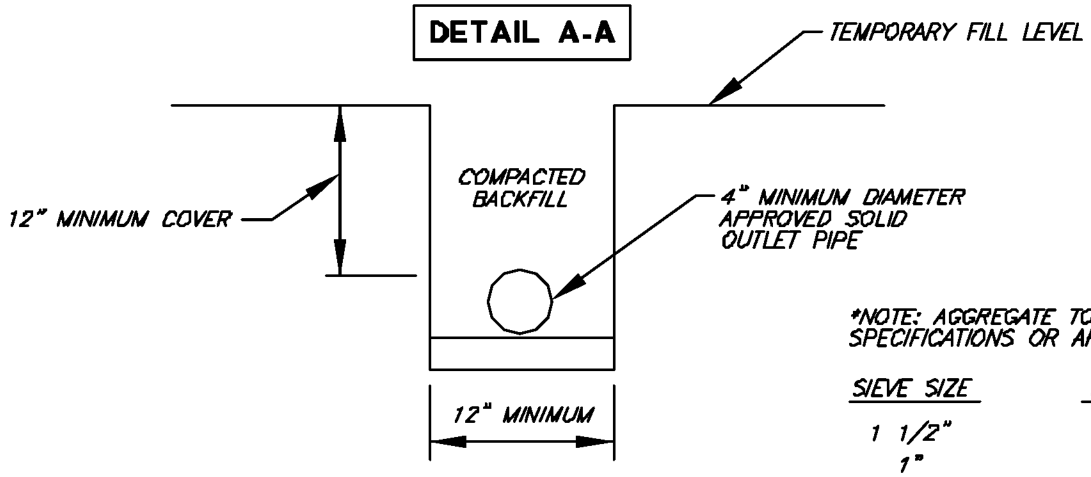


NOTE: CUT SLOPE PORTION SHALL BE MADE PRIOR TO PLACEMENT OF FILL.

FILL SLOPE ABOVE CUT SLOPE DETAIL



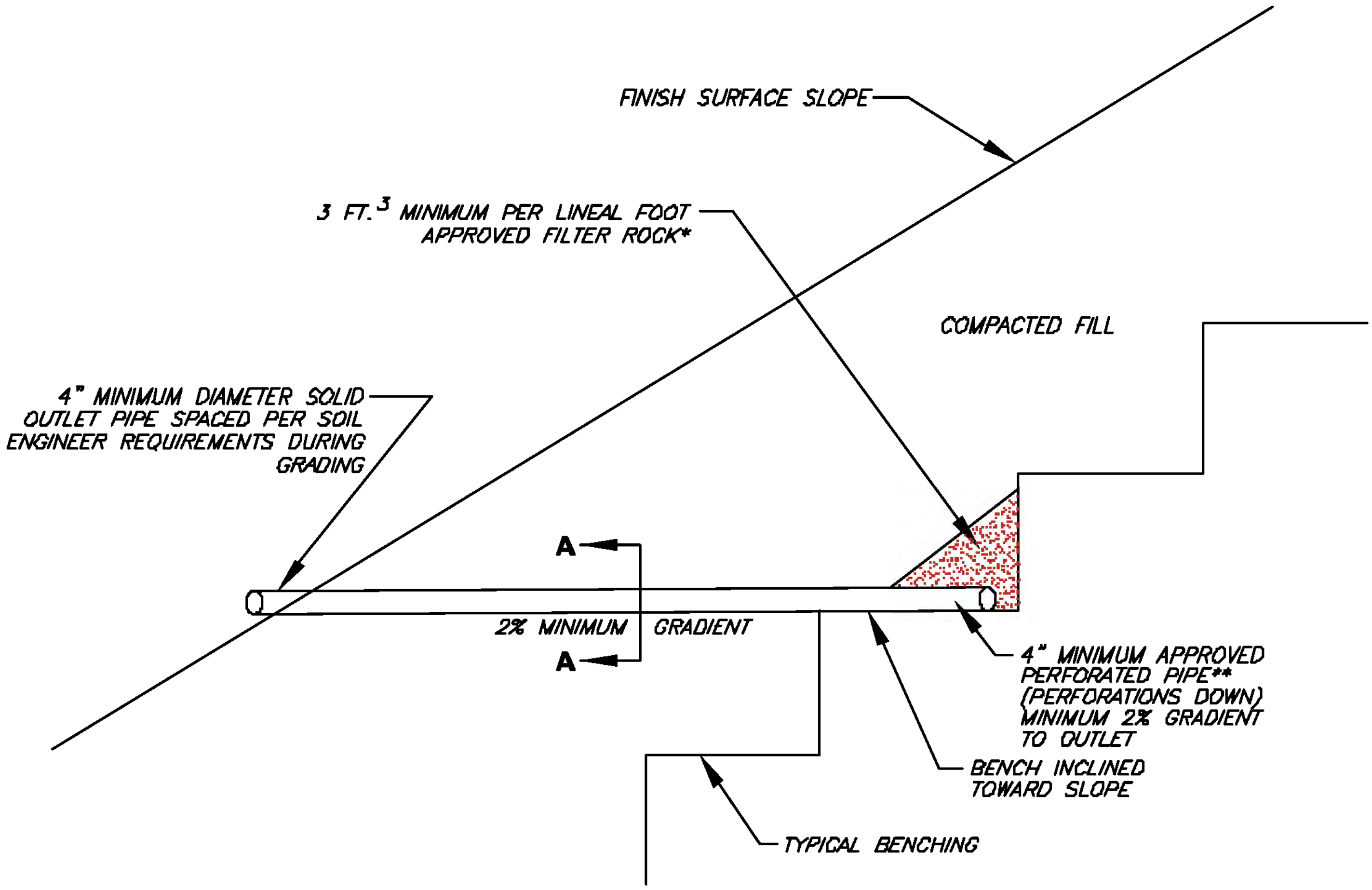
DETAIL A-A



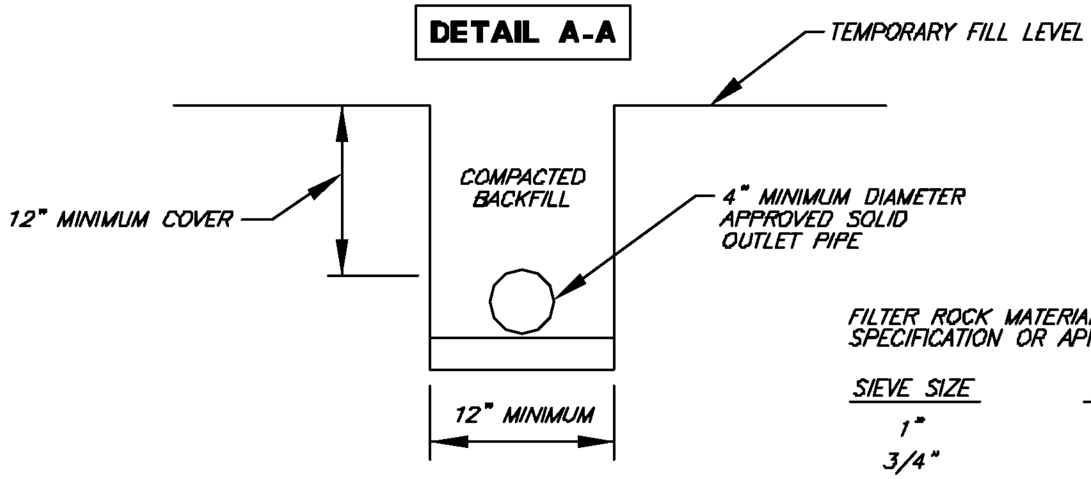
*NOTE: AGGREGATE TO MEET FOLLOWING SPECIFICATIONS OR APPROVED EQUAL:

SIEVE SIZE	PERCENTAGE PASSING
1 1/2"	100
1"	5-40
3/4"	0-17
3/8"	0-7
NO. 200	0-3

BACKDRAIN DETAIL (GEOFABRIC)



DETAIL A-A



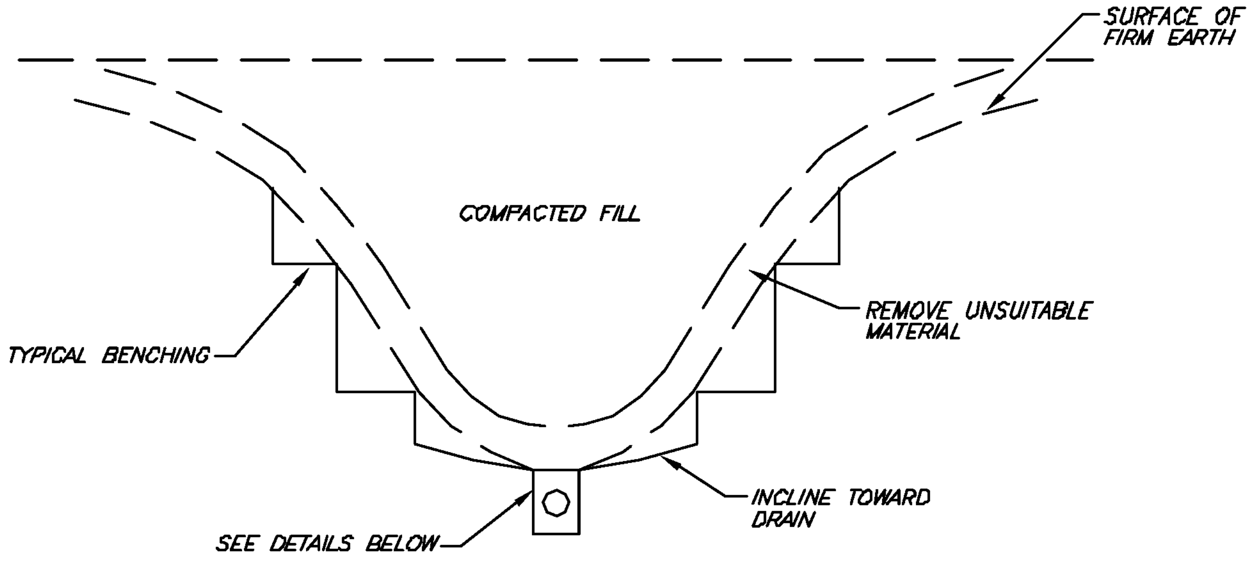
FILTER ROCK MATERIAL TO MEET FOLLOWING SPECIFICATION OR APPROVED EQUAL:

SIEVE SIZE	PERCENTAGE
1"	100
3/4"	90–100
3/8"	40–100
NO. 4	25–40
NO. 30	5–15
NO. 50	0–7
NO. 200	0–3

**APPROVED PIPE TYPE:

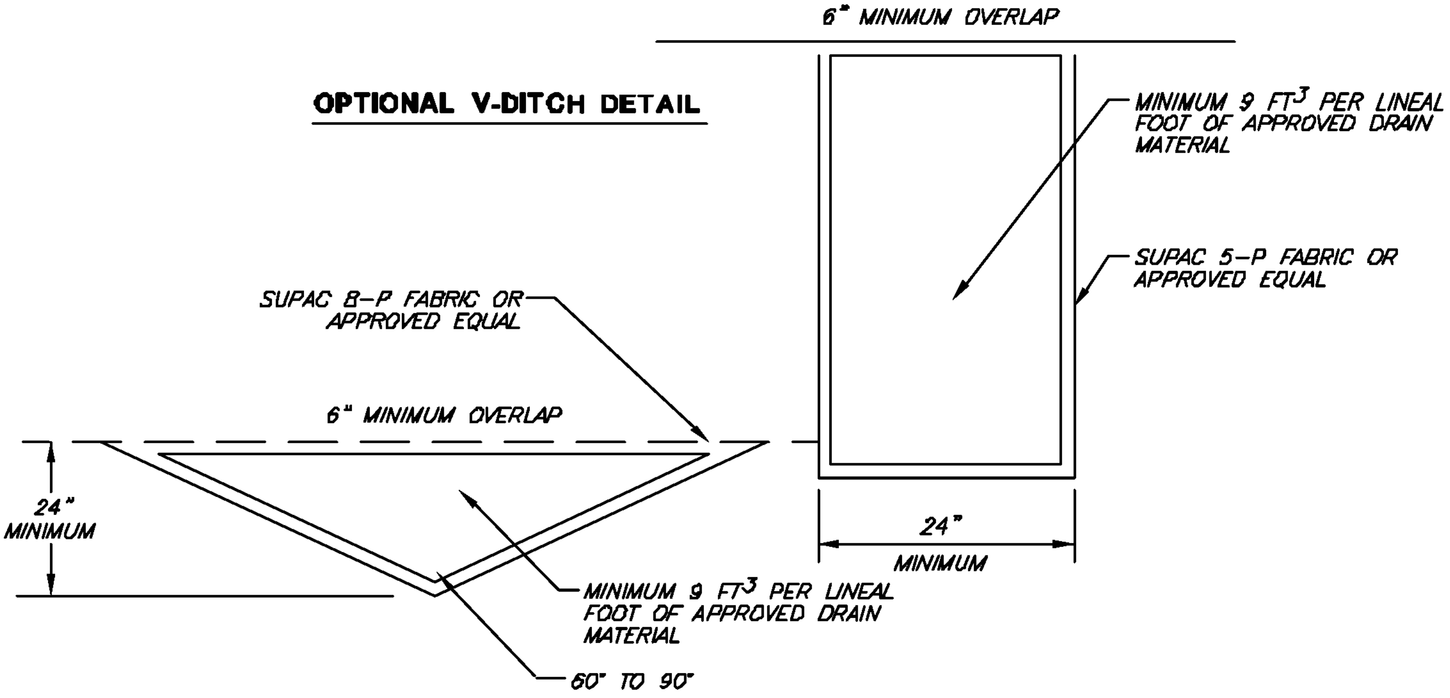
SCHEDULE 40 POLYVINYL CHLORIDE (P.V.C.) OR APPROVED EQUAL.
MINIMUM CRUSH STRENGTH 1000 PSI.

TYPICAL BACKDRAIN DETAIL



TRENCH DETAIL

OPTIONAL V-DITCH DETAIL



DRAIN MATERIAL TO MEET FOLLOWING SPECIFICATION OR APPROVED EQUAL:

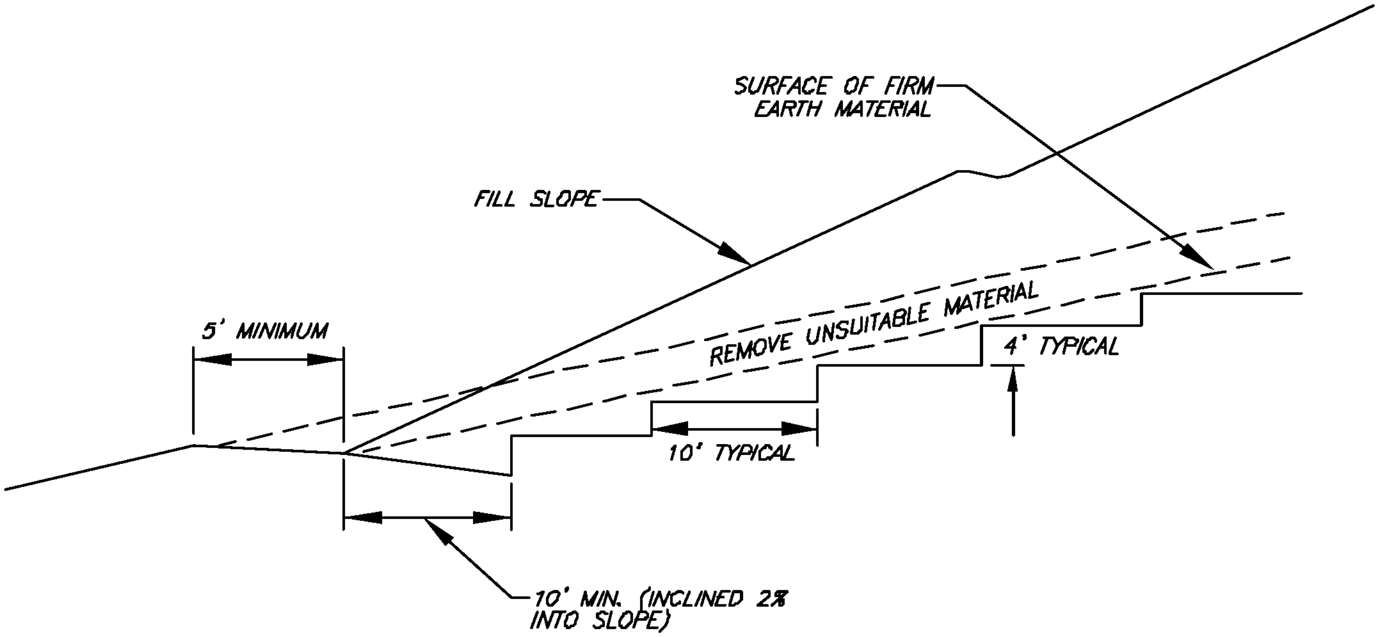
SIEVE SIZE	PERCENTAGE PASSING
1-1/2"	88-100
1"	5-40
3/4"	0-17
3/8"	0-7
NO.:200	0-3

ADD MINIMUM 4" DIAMETER APPROVED PERFORATED PIPE WHEN GRADIENT IS LESS THAN 2%

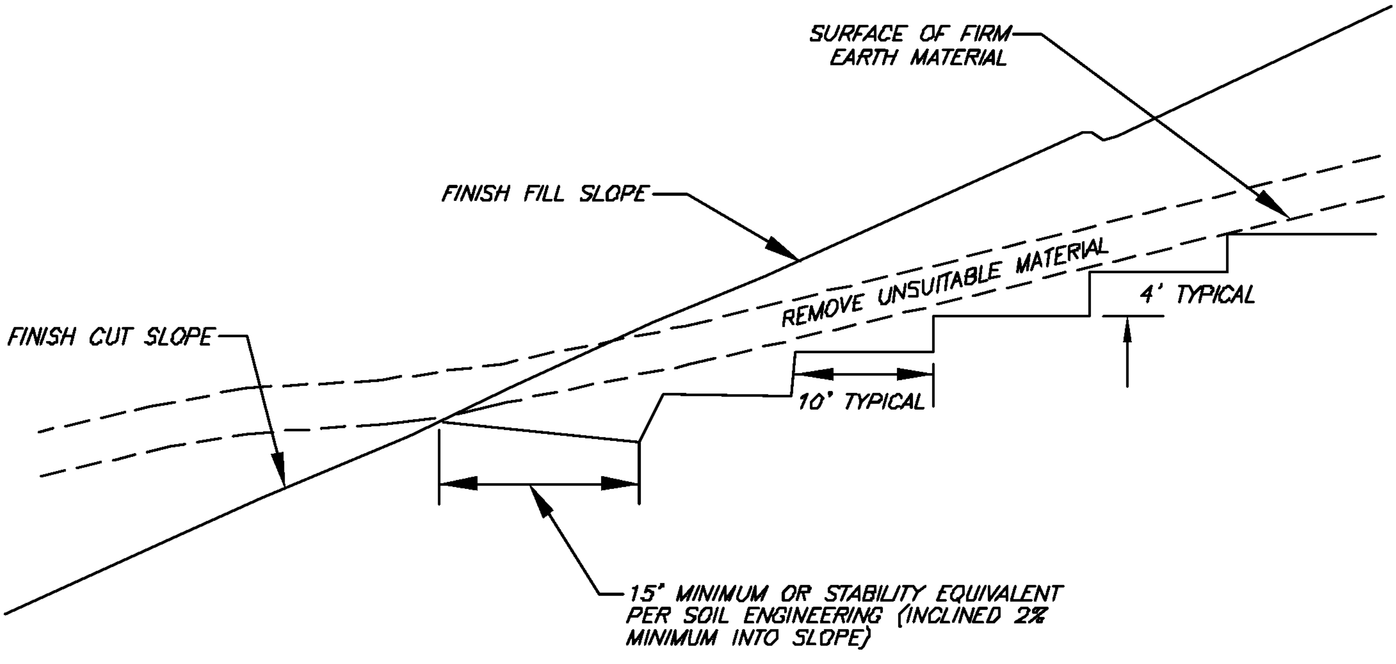
APPROVED PIPE TO BE SCHEDULE 40 POLY-VINYL-CHLORIDE (P.V.C.) OR APPROVED EQUAL. MINIMUM CRUSH STRENGTH 1000 psi.

GEOFABRIC SUBDRAIN DETAIL

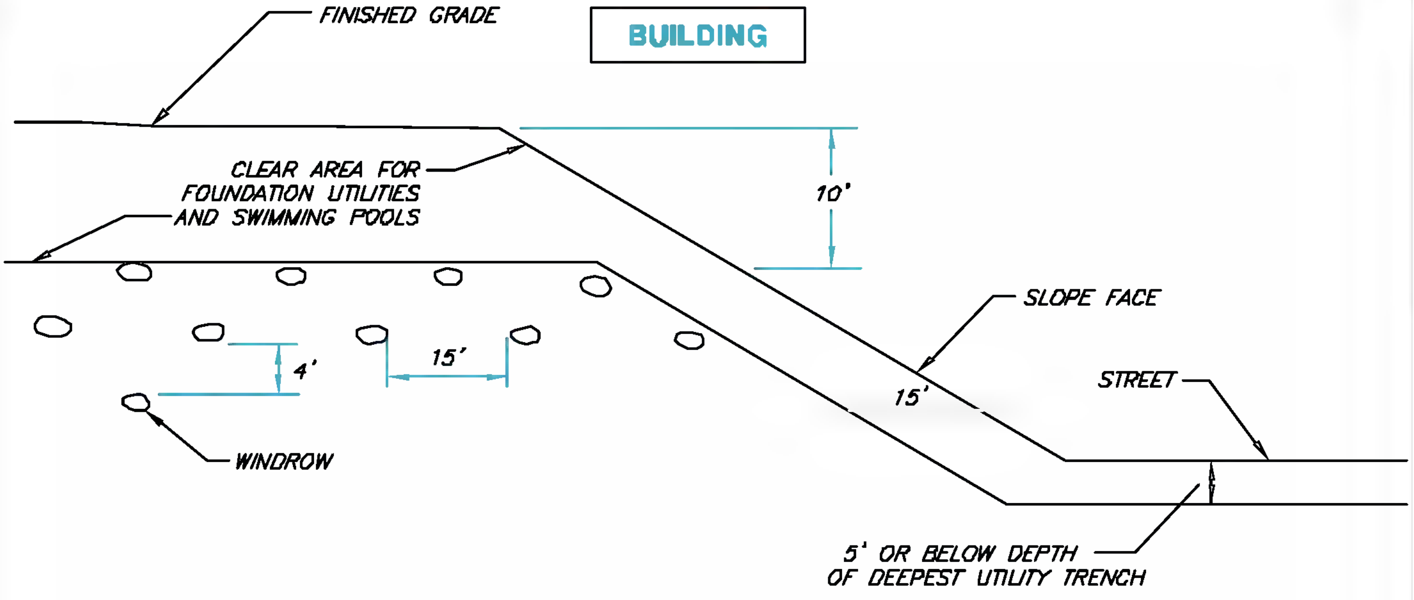
BENCHING FILL OVER NATURAL



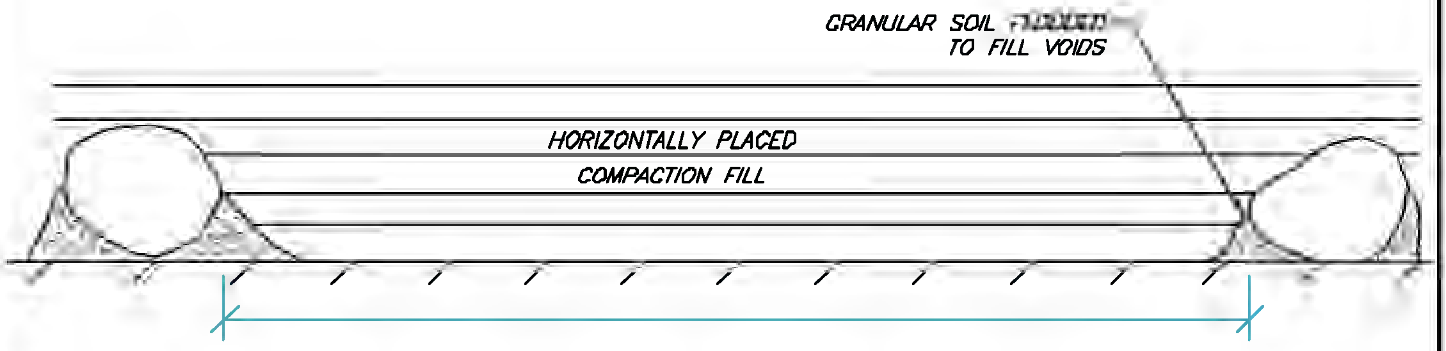
BENCHING FILL OVER CUT



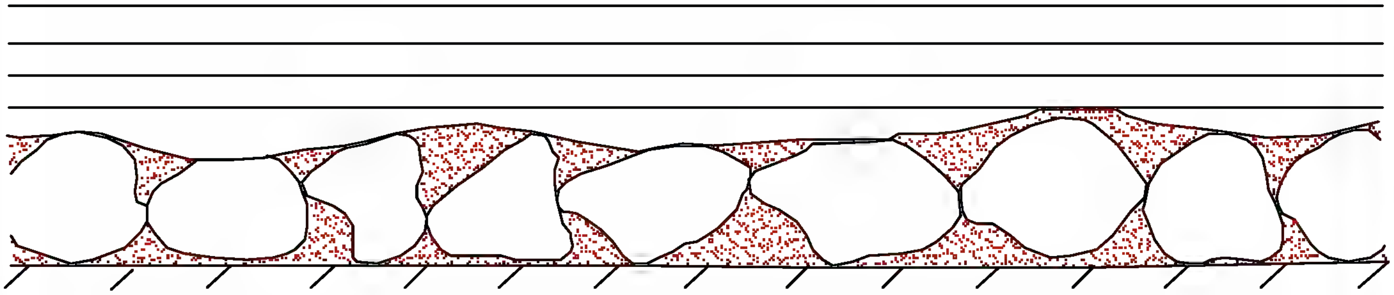
BENCHING FOR COMPACTED FILL DETAIL



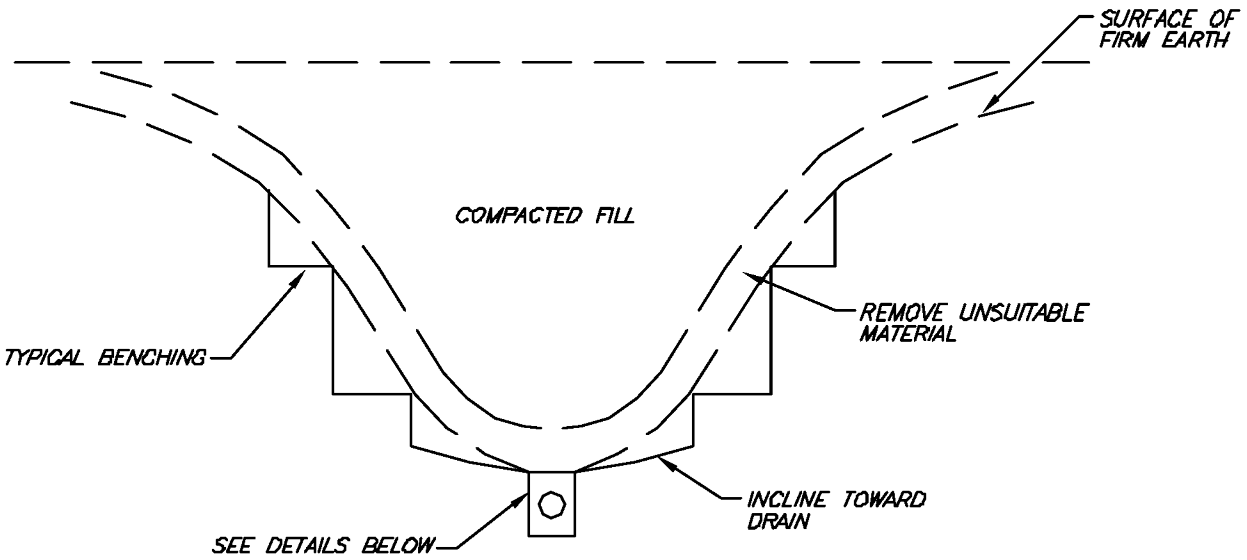
TYPICAL WINDROW DETAIL (EDGE VIEW)



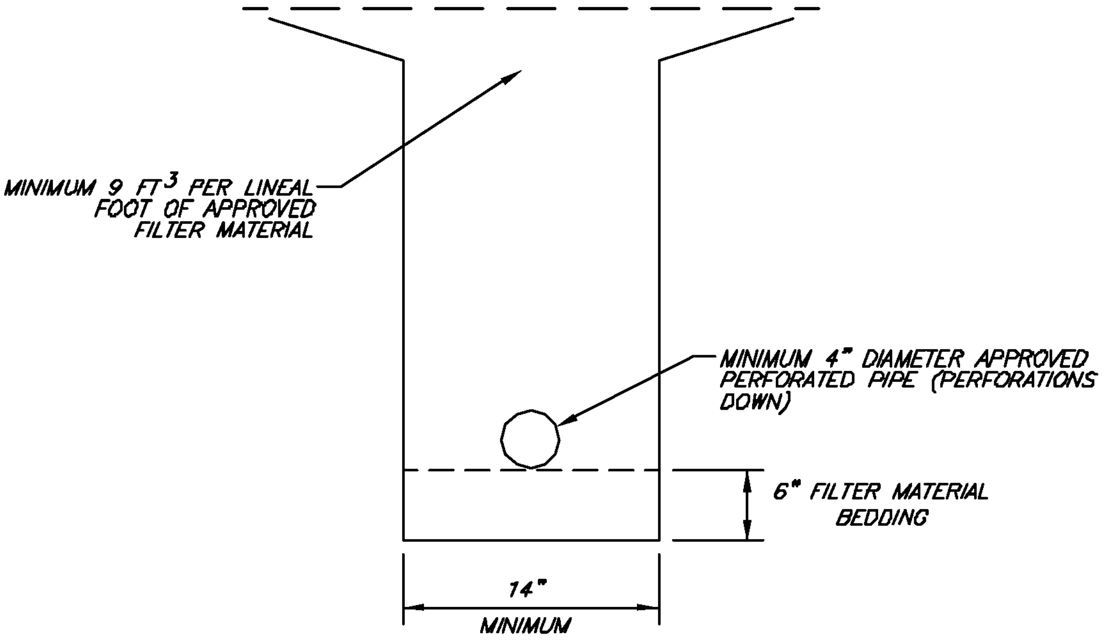
PROFILE VIEW



ROCK DISPOSAL DETAIL



TRENCH DETAIL



FILTER MATERIAL TO MEET FOLLOWING SPECIFICATION OR APPROVED EQUAL:

SIEVE SIZE	PERCENTAGE
1"	100
3/4"	90–100
3/8"	40–100
NO. 4	25–40
NO. 30	5–15
NO. 50	0–7
NO. 200	0–3

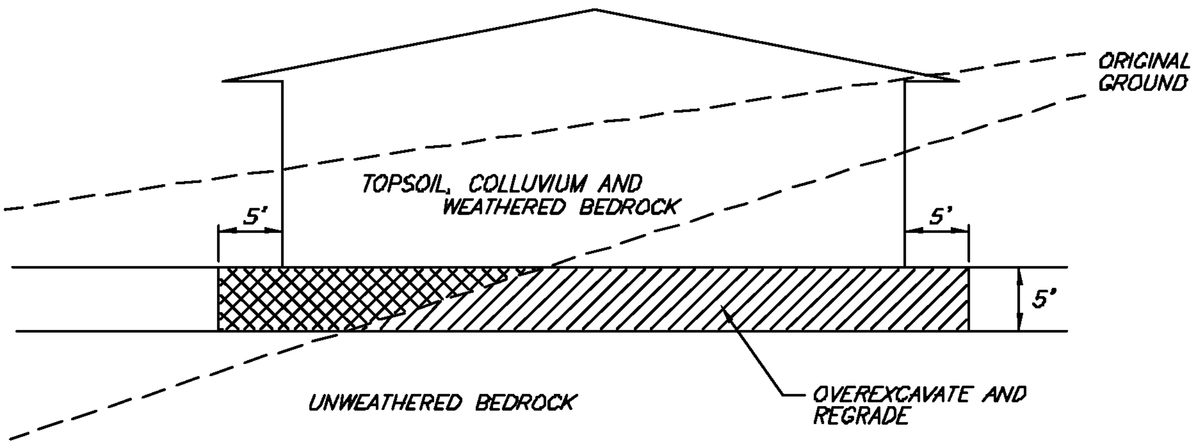
APPROVED PIPE TO BE SCHEDULE 40 POLY-VINYL-CHLORIDE (P.V.C.) OR APPROVED EQUAL. MINIMUM CRUSH STRENGTH 1000 psi.

PIPE DIAMETER TO MEET THE FOLLOWING CRITERIA. SUBJECT TO FIELD REVIEW BASED ON ACTUAL GEOTECHNICAL CONDITIONS ENCOUNTERED DURING GRADING.

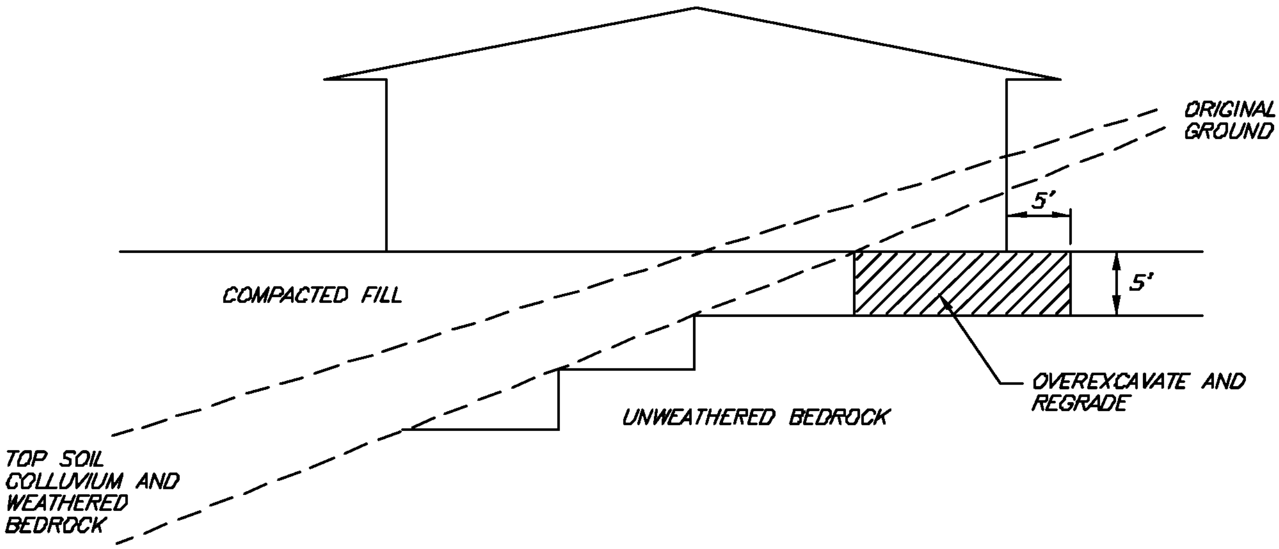
LENGTH OF RUN	PIPE DIAMETER
UPPER 500'	4"
NEXT 1000'	6"
> 1500'	8"

TYPICAL CANYON SUBDRAIN DETAIL

CUT LOT



CUT/FILL LOT (TRANSITION)



TRANSITION LOT DETAIL