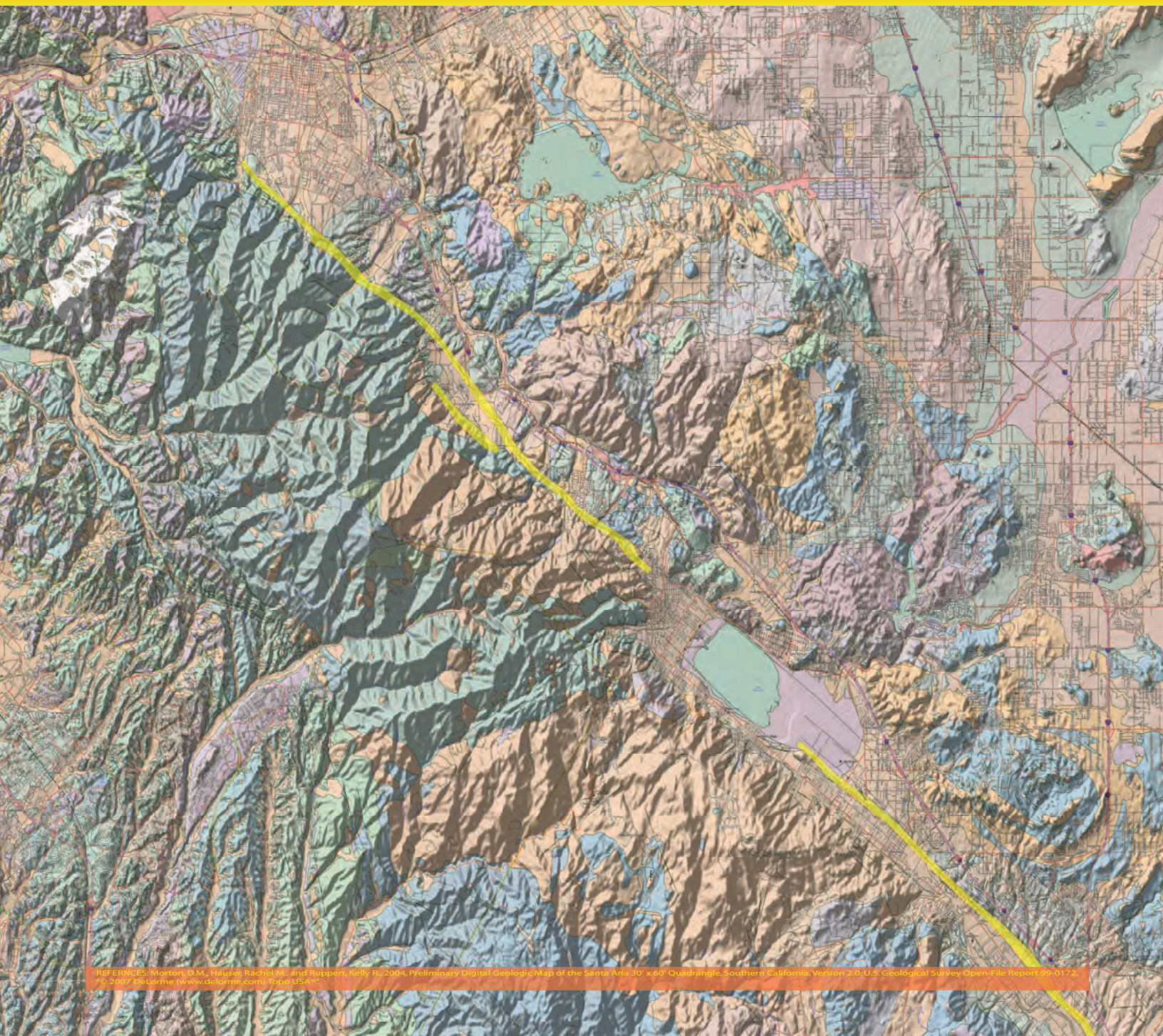


**REVISED PRELIMINARY  
GEOTECHNICAL  
INTERPRETIVE REPORT**

PROPOSED P & F PROPERTY RESIDENTIAL  
DEVELOPMENT, ASSESSOR'S PARCEL  
NUMBER 245-300-001, LOCATED ON THE  
NORTH SIDE OF IRIS AVENUE AND WEST  
SIDE OF CHICAGO AVENUE, RIVERSIDE  
AREA, RIVERSIDE COUNTY, CALIFORNIA

PROJECT NO. 15735-10A

ISSUED: APRIL 27, 2015







April 27, 2015

Project No. 15735-10A

Mr. Pete Pitassi  
**DIVERSIFIED PACIFIC**  
10621 Civic Center Drive  
Rancho Cucamonga, CA 91730

Subject: **Revised Preliminary Geotechnical Interpretive Report, Proposed P & F Property Residential Development, Assessor's Parcel Number 245-300-001, Located on the North Side of Iris Avenue and West Side of Chicago Avenue, Riverside Area, Riverside County, California**

Earth-Strata is pleased to present our preliminary geotechnical interpretive report for the proposed P & F Property residential development, located at the above referenced site. This work was performed in accordance with the scope of work described in our proposal, dated January 27, 2015. The purpose of this study is to evaluate the nature, distribution, engineering properties, and geologic strata underlying the site with respect to the proposed development.

Earth-Strata appreciates the opportunity to offer our consultation and advice on this project. In the event that you have any questions, please do not hesitate to contact the undersigned at your earliest convenience.

Respectfully submitted,

EARTH-STRATA, Inc.

Stephen M. Poole, PE, GE  
Principal Engineer

SMP/ca

Distribution: (2) Addressee

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Attachments:

- Figure 1 – Vicinity Map (Page 2)
- Figure 2 – Regional Geologic Map (Page 5)
- APPENDIX A – References (Rear of Text)
- APPENDIX B – Exploratory Logs (Rear of Text)
- APPENDIX C – Laboratory Procedures and Test Results (Rear of Text)
- APPENDIX D – Seismicity (Rear of Text)
- APPENDIX E – General Earthwork and Grading Specifications (Rear of Text)
- Plate 1 – Geotechnical Map (In Pocket)

## **INTRODUCTION**

Earth-Strata is pleased to present our preliminary geotechnical interpretive report for the proposed development. The purpose of this study was to evaluate the nature, distribution, engineering properties, and geologic strata underlying the site with respect to the proposed development, and then provide preliminary grading and foundation design recommendations based on the plans you provided. The general location of the subject property is indicated on the Vicinity Map, Figure 1. The plans you provided were used as the base map to show geologic conditions within the subject site, see Geotechnical Map, Plate 1.

## **SITE DESCRIPTION**

The subject property is located on the north side of Iris Avenue and the west side of Chicago Avenue at 15701 Chicago Avenue in the Riverside area, Riverside County, California. The approximate location of the site is shown on the Vicinity Map, Figure 1.

The subject property is mostly a citrus orchard comprised of approximately 140 acres of undeveloped land. The site has not been graded, with the exception of minor grading associated with the existing orchards and existing buildings. Topographic relief at the subject property is relatively low to moderate with the terrain being generally gently sloping. Elevations at the site range from approximately 1,415 to 1,571 feet above mean sea level (msl), for a difference of about 101± feet across the entire site. Drainage within the subject property generally flows to the west.

The site is currently bordered by open land and single family residences. Most of the vegetation on the site consists of sparse to moderate amounts of annual weeds/grasses, along with some scattered small to large trees and the orchard.

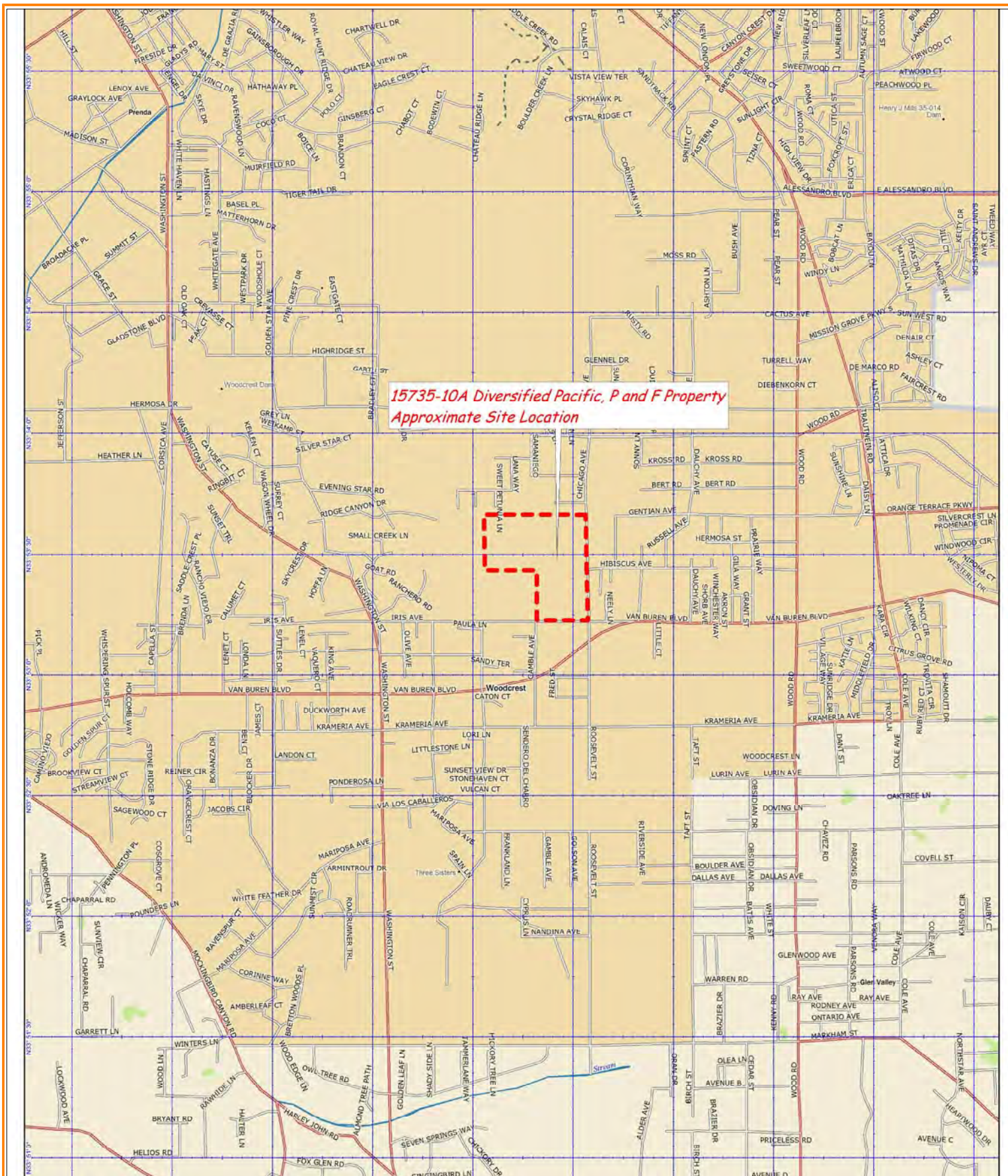
## **PROPOSED DEVELOPMENT AND GRADING**

The proposed residential development is expected to consist of concrete, wood or steel framed one-and/or two-story structures utilizing slab on grade construction with associated streets, landscape areas, and utilities. The current development plans include numerous building pads positioned throughout the site.

The plans provided by you were utilized in our exploration and form the base for our Geotechnical Map, Plate 1.

Formal plans have not been prepared and await the conclusions and recommendations of this report.





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## **FIELD EXPLORATION AND LABORATORY TESTING**

### **Field Exploration**

Subsurface exploration within the subject site was performed in May 2015 for the exploratory excavations. A truck mounted hollow-stem-auger drill rig was utilized to drill 8 borings throughout the site to a maximum depth of 10 feet. A backhoe was utilized to excavate 18 test pits to a maximum depth of 6 feet. An underground utilities clearance was obtained from Underground Service Alert of Southern California, prior to the subsurface exploration.

Earth materials encountered during exploration were classified and logged in general accordance with the Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) of ASTM D 2488. Upon completion of laboratory testing, exploratory logs and sample descriptions may have been reconciled to reflect laboratory test results with regard to ASTM D 2487.

Associated with the subsurface exploration was the collection of bulk (disturbed) samples and relatively undisturbed samples of earth materials for laboratory testing and analysis. The relatively undisturbed samples were obtained with a 3 inch outside diameter modified California split-spoon sampler lined with 1 inch high brass rings. Samples obtained using a hollow stem auger drill rig, were mechanically driven with successive 30 inch drops of a 140-pound trip safety hammer. The blow count per one foot increment was recorded in the boring logs. The central portions of the driven samples were placed in sealed containers and transported to our laboratory for testing and analysis. The approximate exploratory locations are shown on Plate 1 and descriptive logs are presented in Appendix B.

### **Laboratory Testing**

Maximum dry density/optimum moisture content, expansion potential, R-value, pH, resistivity, sulfate content, chloride content, and in-situ density/moisture content were determined for selected undisturbed and bulk samples of earth materials, considered representative of those encountered. An evaluation of the test data is reflected throughout the Conclusions and Recommendations section of this report. A brief description of laboratory test criteria and summaries of test data are presented in Appendix C.

## **FINDINGS**

### **Regional Geology**

Regionally, the site is located in the Peninsular Ranges Geomorphic Province of California. The Peninsular Ranges are characterized by northwest trending steep mountain ranges separated by sediment filled elongated valleys. The dominant structural geologic features reflect the northwest trend of the province. Associated with and subparallel to the San Andreas Fault are the San Jacinto Fault, Newport-Inglewood, and the Whittier-Elsinore Fault. The Santa Ana Mountains abut the west side of the Elsinore Fault while the Perris Block forms the other side of the fault zone to the east. The Perris Block is bounded to the east by the San Jacinto Fault. The northern perimeter of the Los Angeles basin forms part

of a northerly dipping blind thrust fault at the boundary between the Peninsular Ranges Province and the Transverse Range Province.

The mountainous regions within the Peninsular Ranges Province are comprised of Pre-Cretaceous, metasedimentary, and metavolcanic rocks along with Cretaceous plutonic rocks of the Southern California Batholith. The low lying areas are primarily comprised of Tertiary and Quaternary non-marine alluvial sediments consisting of alluvial deposits, sandstones, claystones, siltstones, conglomerates, and occasional volcanic units. A map illustrating the regional geology is presented on the Regional Geologic Map, Figure 2.

### **Local Geology**

The earth materials on the site are primarily comprised of Quaternary Alluvium and bedrock. A general description of the dominant earth materials observed on the site is provided below:

- Quaternary Alluvium (map symbol Qal): Quaternary alluvium was encountered to a maximum depth explored. These alluvial deposits consist predominately of brown, fine to coarse grained silty sand. These deposits were generally noted to be in a moist to very moist, loose to medium dense state.
- Cretaceous Val Verde Tonalite (map symbol Kvt): The Val Verde Tonalite was mapped within the site. Tonalite has a similar chemical composition to gabbro, but includes a higher percentage of quartz. The Val Verde Tonalite was generally noted to be light gray to dark gray, slightly moist and was found to be in a moderately hard to very hard state. Typically, the upper 1 to 3 feet of this unit is more weathered and not as hard.

### **Geologic Structure**

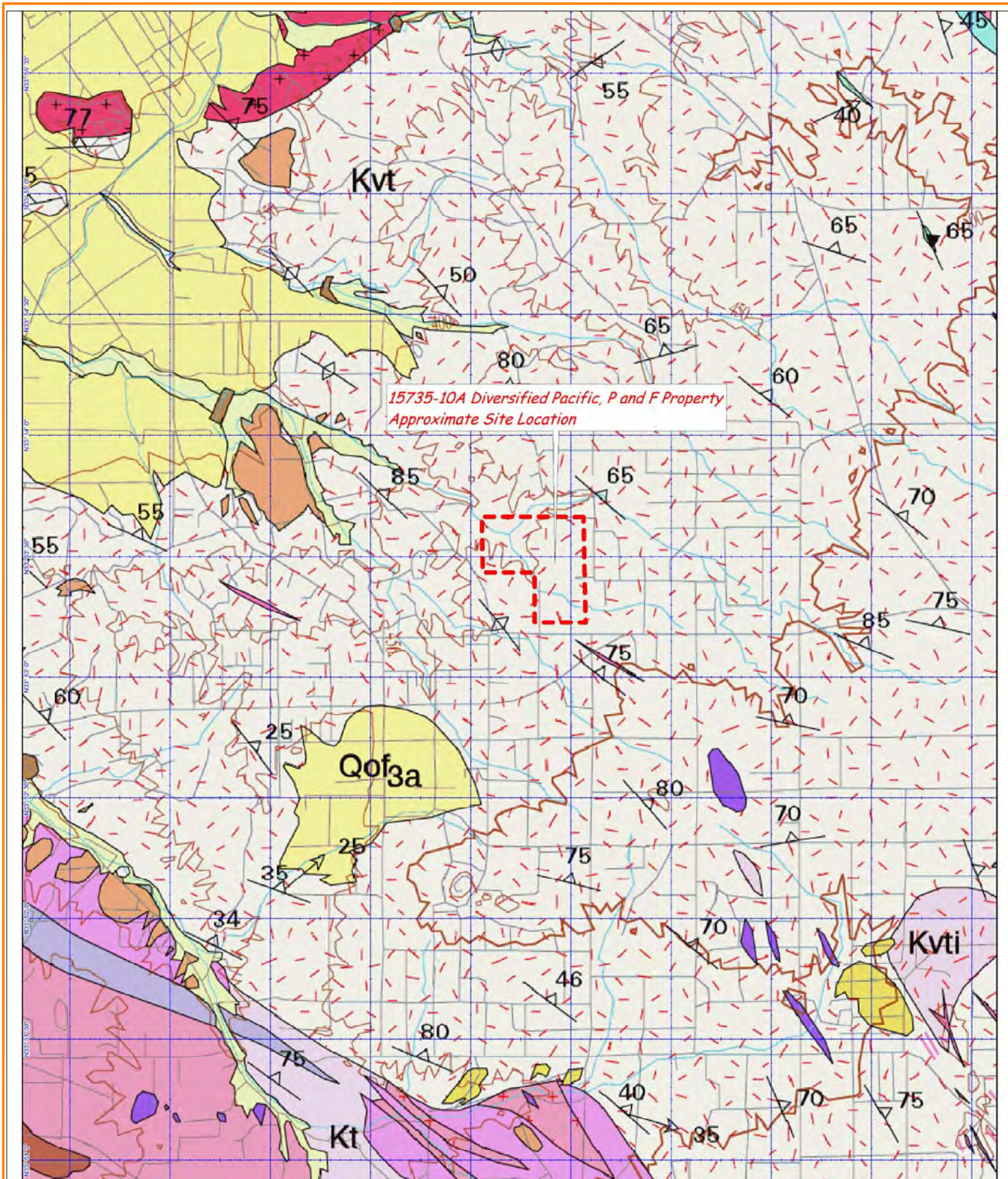
The bedrock is generally massive and lacks significant structural planes.

### **Faulting**

The project is located in a seismically active region and as a result, significant ground shaking will likely impact the site within the design life of the proposed project. The geologic structure of the entire southern California area is dominated by northwest-trending faults associated with the San Andreas Fault system, which accommodates for most of the right lateral movement associated with the relative motion between the Pacific and North American tectonic plates. Known active faults within this system include the Newport-Inglewood, Whittier-Elsinore, San Jacinto and San Andreas Faults.

No active faults are known to project through the site and the site is not located within an Alquist-Priolo Earthquake Fault Zone, established by the State of California to restrict the construction of new habitable structures across identifiable traces of known active faults. An active fault is defined by the State of California as having surface displacement within the past 11,000 years or during the Holocene geologic time period.





REFERENCES: Morton, D.M., Hauser, Rachel M., and Ruppert, Kelly R., 2004, Preliminary Digital Geologic Map of the Santa Ana 30' x 60' Quadrangle, Southern California, Version 2.0: U.S. Geological Survey Open-File Report 99-0172.

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Geotechnical, Environmental and Materials Testing Consultants

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DIVERSIFIED PACIFIC, P AND F PROPERTY 15735-10A  
REGIONAL GEOLOGIC MAP SEE BAR SCALE  
APRIL 2015 FIGURE 2



Based on our review of regional geologic maps and the computer program (USGS 2002 Interactive Deaggregation), the Elsinore Fault with an approximate source to site distance of 17 kilometers is the closest known active fault anticipated to produce the highest ground accelerations, with an anticipated maximum modal magnitude of 6.77. Based on the data compiled during the preparation of this report, it is our interpretation that the potential for surface rupture to adversely impact the proposed structures is very low to remote.

### **Landslides**

Landslide debris was not observed during our subsurface exploration and no ancient landslides are known to exist on the site.

## **CONCLUSIONS AND RECOMMENDATIONS**

### **General**

From geotechnical and engineering geologic points of view, the subject property is considered suitable for the proposed development, provided the following conclusions and recommendations are incorporated into the plans and are implemented during construction.

### **Earthwork**

#### **Earthwork and Grading**

The provisions of the 2013 California Building Code (CBC), including Appendix J Grading, should be applied to all earthwork and grading operations, as well as in accordance with all applicable grading codes and requirements of the appropriate reviewing agency. Unless specifically revised or amended herein, grading operations should also be performed in accordance with applicable provisions of our General Earthwork and Grading Specifications within the last appendix of this report.

#### **Clearing and Grubbing**

Vegetation including trees, grasses, weeds, brush, shrubs, or any other debris should be stripped from the areas to be graded and properly disposed of offsite. In addition, laborers should be utilized to remove any roots, branches, or other deleterious materials during grading operations.

Earth-Strata should be notified at the appropriate times to provide observation and testing services during Clearing and Grubbing operations. Any buried structures or unanticipated conditions should be brought to our immediate attention.

#### **Excavation Characteristics**

Based on the results of our exploration where the backhoe and drill rig met shallow refusal in bedrock and experience with similar projects in similar settings, the near surface earth materials

except in areas of rock outcrops, will be readily excavated with conventional earth moving equipment. Excavation difficulty is a function of the degree of weathering and amount of fracturing within the bedrock. Bedrock generally becomes harder and more difficult to excavate with increasing depth. Some sewer lines maybe in excess of 25 feet deep on the west portion of the proposed development. The rock rippability should be further evaluated by seismic lines in order to supplement our field investigation.

### **Groundwater**

Groundwater was not observed during our subsurface exploration however, there was water within the blue line stream areas. Groundwater may be encountered within the existing drainage areas.

### **Ground Preparation For Fill Areas**

For each area to receive compacted fill, the removal of low density, compressible earth materials, such as topsoil, upper alluvial materials, and undocumented artificial fill, should continue until firm competent bedrock is encountered. Removal excavations are subject to verification by the project engineer, geologist or their representative. Prior to placing compacted fills, the exposed bottom in each removal area should be scarified to a depth of 6 inches or more, watered or air dried as necessary to achieve near optimum moisture conditions and then compacted to a minimum of 90 percent of the maximum dry density determined by ASTM D 1557.

The intent of remedial grading is to diminish the potential for hydro-consolidation, slope instability, and/or settlement. Remedial grading should extend beyond the perimeter of the proposed structures a horizontal distance equal to the depth of excavation or a minimum of 5 feet, whichever is greater. For cursory purposes the anticipated removal depths are shown on the enclosed Geotechnical Map, Plate 1. In general, the anticipated removal depths should vary from 2 to 4 feet below existing grade within the open areas and 6 to 8 feet below grade for the orchard areas.

### **Wet Removals**

Wet alluvial materials may be encountered within the low lying areas of the site. If removals of wet alluvial materials are required, special grading equipment and procedures can greatly reduce overall costs. Careful planning by an experienced grading contractor can reduce the need for special equipment, such as swamp cats, draglines, excavators, pumps, and top loading earthmovers. Possible solutions may include the placement of imported angular rock and/or geotextile ground reinforcement. More specific recommendations can be provided based on the actual conditions encountered. Drying or mixing of wet materials with dry materials will be needed to bring the wet materials to near optimum moisture prior to placing wet materials into compacted fills.

### **Oversize Rock**

Oversize rock is expected to be encountered during grading. Oversize rock that is encountered (i.e., rock exceeding a maximum dimension of 12 inches) should be disposed of offsite or



stockpiled onsite and crushed for future use. The disposal of oversize rock is discussed in greater detail in General Earthwork and Grading Specifications within the last appendix of this report.

### **Compacted Fill Placement**

Compacted fill materials should be placed in 6 to 8 inch maximum (uncompacted) lifts, watered or air dried as necessary to achieve uniform near optimum moisture content and then compacted to a minimum of 90 percent of the maximum dry density determined by ASTM D 1557.

### **Import Earth Materials**

Should import earth materials be needed to achieve final design grades, all potential import materials should be free of deleterious/oversize materials, non-expansive, and approved by the project geotechnical consultant prior to delivery onsite.

### **Fill Slopes**

When properly constructed, fill slopes up to 20 feet high with inclinations of 2:1 (h:v) or flatter are considered to be grossly stable. Keyways are required at the toe of all fill slopes higher than 5 feet and steeper than 5:1 (h:v). Keyways should be a minimum of 10 feet wide and 2 feet into bedrock materials, as measured on the downhill side. In order to establish keyway removals, backcuts should be cut no steeper than 1:1 or as recommended by the geotechnical engineer or engineering geologist. Compacted fill should be benched into bedrock materials.

### **Cut Slopes**

When properly constructed, cut slopes into bedrock up to 20 feet high with inclinations of 2:1 (h:v) or flatter are considered grossly stable. Cut slopes should be observed by the engineering geologist or his representative during grading, but are anticipated to be stable.

### **Stabilization Fills**

Currently, stabilization fills will not be required for cut slopes in the bedrock. Our engineering geologist or his representative should be called to evaluate all slopes during grading. In the event that unfavorable geologic conditions are encountered, recommendations for stabilization fills or flatter slopes will be provided.

### **Fill Over Cut Slopes**

The fill portion of fill over cut slopes should not be constructed until the cut portion of the slope has been cut to finish grade. The earth materials and geologic structure exposed along the cut slope should be evaluated with regard to suitability for compacted fills or foundations and for stability. If the cut materials are determined to be competent, then the construction of the keyway and subdrain system may commence or additional remedial recommendations will be provided.

## **Temporary Backcuts**

It is the responsibility of the grading contractor to follow all Cal-OSHA requirements with regard to excavation safety. Where existing developments are upslope, adequate slope stability to protect those developments must be maintained. Temporary backcuts will be required to accomplish removals of unsuitable materials and possibly, to perform canyon removals, stabilization fills, and/or keyways. Backcuts should be excavated at a gradient of 1:1 (h:v) or flatter. Flatter backcuts may be required where geologic structure or earth materials are unfavorable. It is imperative that grading schedules minimize the exposure time of the unsupported excavations. All excavations should be stabilized within 30 days of initial excavation.

## **Cut/Fill Transitions**

Cut/fill transitions should be eliminated from all building areas where the depth of fill placed within the "fill" portion exceeds proposed footing depths. This is to diminish distress to structures resulting from excessive differential settlement. The entire foundation of each structure should be founded on a uniform bearing material. This should be accomplished by overexcavating the "cut" portion and replacing the excavated materials as properly compacted fill. Refer to the following table for recommended depths of overexcavation.

<b>DEPTH OF FILL ("fill" portion)</b>	<b>DEPTH OF OVEREXCAVATION ("cut" portion)</b>
Up to 5 feet	Equal Depth
5 to 10 feet	5 feet
Greater than 10 feet	One-half the thickness of fill placed on the "fill" portion (10 feet maximum)

Overexcavation of the "cut" portion should extend beyond the building perimeter a horizontal distance equal to the depth of overexcavation or a minimum of 5 feet, whichever is greater.

## **Cut Areas**

Where low density surficial earth materials such as any undocumented artificial fills, topsoil, colluvium and/or alluvium are not removed in their entirety in cut areas, the entire lot should overexcavated a minimum of 3 feet below the proposed foundations and replaced with compacted fill. Final determination of areas that require overexcavation due to transition conditions should be determined in the field by a representative of Earth-Strata.

## **Shrinkage, Bulking and Subsidence**

Volumetric changes in earth material quantities will occur when poorly consolidated earth materials are replaced with properly compacted fill. Estimates of the percent shrinkage/bulking factors for the various geologic units observed on the subject property are based on in-place densities and on the estimated average percent of relative compaction achieved during grading.

<b>GEOLOGIC UNIT</b>	<b>SHRINKAGE (%)</b>
Artificial Fill	5 to 10
Bedrock	0 to 5

Subsidence from scarification and recompaction of exposed bottom surfaces is expected to be negligible to approximately 0.01 foot.

The estimates of shrinkage/bulking and subsidence are intended as an aid for project engineers in determining earthwork quantities. Since many variables can affect the accuracy of these estimates, they should be used with caution and contingency plans should be in place for balancing the project.

### **Geotechnical Observations**

Clearing operations, removal of unsuitable materials, and general grading procedures should be observed by the project geotechnical consultant or his representative. No compacted fill should be placed without observations by the geotechnical consultant or his representative to verify the adequacy of the removals.

The project geotechnical consultant or his representative should be present to observe grading operations and to check that minimum compaction requirements and proper lift thicknesses are being met, as well as to verify compliance with the other recommendations presented herein.

### **Post Grading Considerations**

#### **Slope Landscaping and Maintenance**

Adequate slope and building pad drainage is essential for the long term performance of the subject site. The gross stability of graded slopes should not be adversely affected, provided all drainage provisions are properly constructed and maintained. Engineered slopes should be landscaped with deep rooted, drought tolerant maintenance free plant species, as recommended by the project landscape architect.

#### **Site Drainage**

Control of site drainage is important for the performance of the proposed project. Roof gutters are recommended for the proposed structures. Pad and roof drainage should be collected and transferred to driveways, adjacent streets, storm-drain facilities, or other locations approved by the building official in non-erosive drainage devices. Drainage should not be allowed to pond on the pad or against any foundation or retaining wall. Drainage should not be allowed to flow uncontrolled over any descending slope. Planters located within retaining wall backfill should be sealed to prevent moisture intrusion into the backfill. Planters located next to structures should be sealed to the depth of the footings. Drainage control devices require periodic cleaning, testing and maintenance to remain effective.



At a minimum, pad drainage should be designed at the minimum gradients required by the CBC. To divert water away from foundations, the ground surface adjacent to foundations should also be graded at the minimum gradients required per the CBC.

### **Utility Trenches**

All utility trench backfill should be compacted at near optimum moisture to a minimum of 90 percent of the maximum dry density determined by ASTM test method D 1557-00. For utility trench backfill within pavement areas the upper 6 inches of subgrade materials should be compacted to 95 percent of the maximum dry density determined by ASTM D 1557-00. This includes within the street right-of-ways, utility easements, under footings, sidewalks, driveways and building floor slabs, as well as within or adjacent to any slopes. Backfill should be placed in approximately 6 to 8 inch maximum loose lifts and then mechanically compacted with a hydro-hammer, rolling with a sheepsfoot, pneumatic tampers, or similar equipment. The utility trenches should be tested by the project geotechnical engineer or their representative to verify minimum compaction requirements are obtained.

In order to minimize the penetration of moisture below building slabs, all utility trenches should be backfilled with compacted fill, lean concrete or concrete slurry where they undercut the perimeter foundation. Utility trenches that are proposed parallel to any building footings (interior and/or exterior trenches), should not be located within a 1:1 (h:v) plane projected downward from the outside bottom edge of the footing.

## **SEISMIC DESIGN CONSIDERATIONS**

### **Ground Motions**

Structures are required to be designed and constructed to resist the effects of seismic ground motions as provided in the 2013 California Building Code Section 1613. The design is dependent on the site class, occupancy category I, II, III, or IV, mapped spectral accelerations for short periods ( $S_s$ ), and mapped spectral acceleration for a 1-second period ( $S_1$ ).

In order for structural design to comply with the 2013 CBC, a computer program, Earthquake Ground Motion Parameters, Version 5.1.0, dated February 10, 2011, was used to compile spectral accelerations for the subject property based on data and maps jointly compiled by the United States Geological Survey (USGS) and the California Geological Survey (CGS). The data found in the following table is based on the Maximum Considered Earthquake (MCE) with 5% damped ground motions having a 2% probability of being exceeded in 50 years (2,475 year return period).

The seismic design coefficients were determined by a combination of the site class, mapped spectral accelerations, and occupancy category. The following seismic design coefficients should be implemented during design of the proposed structures. Summaries of the Seismic Hazard Deaggregation graphs and test data are presented in Appendix D.

2013 CBC	FACTOR
Site Location	Latitude: 33.890183° (North) Longitude: - 117.352000° (West)
Site Class	D
Mapped Spectral Accelerations for short periods, $S_s$	1.500
Mapped Spectral Accelerations for 1-Second Period, $S_1$	0.600
Maximum Considered Earthquake Spectral Response Acceleration for Short Periods, $S_{ms}$	1.500
Maximum Considered Earthquake Spectral Response Acceleration for 1-Second Period, $S_{m1}$	0.900
Design Spectral Response Acceleration for Short Periods, $S_{Ds}$	1.000
Design Spectral Response Acceleration for 1-Second Period, $S_{D1}$	0.600
Seismic Design Category	D
Importance Factor Based on Occupancy Category	II

We performed the probabilistic seismic hazard assessment for the site in accordance with the 2013 CBC, Section 1805.5.11 and 1803.5.12. The probabilistic seismic hazard maps and data files were jointly prepared by the United States Geological Survey (USGS) and the California Geological Survey (CGS) and can be found at the CGS Probabilistic Seismic Hazards Mapping Ground Motion Page. Actual ground shaking intensities at the site may be substantially higher or lower based on complex variables such as the near source directivity effects, depth and consistency of earth materials, topography, geologic structure, direction of fault rupture, and seismic wave reflection, refraction, and attenuation rates. The mean peak ground acceleration was calculated to be 0.600g.

### **Secondary Seismic Hazards**

Secondary effects of seismic shaking considered as potential hazards include several types of ground failure as well as induced flooding. Different types of ground failure, which could occur as a consequence of severe ground shaking at the site, include landslides, ground lurching, shallow ground rupture, and liquefaction/lateral spreading. The probability of occurrence of each type of ground failure depends on the severity of the earthquake, distance from faults, topography, the state of subsurface earth materials, groundwater conditions, and other factors. Based on our experience, subsurface exploration, and laboratory testing, all of the above secondary effects of seismic activity are considered unlikely.

Seismically induced flooding is normally a consequence of a tsunami (seismic sea wave), a seiche (i.e., a wave-like oscillation of surface water in an enclosed basin that may be initiated by a strong earthquake) or failure of a major reservoir or retention system up gradient of the site. Since the site is at an elevation of more than 1,200 feet above mean sea level and is located more than 30 miles inland from the nearest

coastline of the Pacific Ocean, the potential for seismically induced flooding due to a tsunamis is considered nonexistent. Since no enclosed bodies of water lie adjacent to or up gradient of the site, the likelihood for induced flooding due to a seiche overcoming the dams freeboard is considered nonexistent. It is considered remote that any major reservoir or retention system up gradient of the site would be compromised to a point of failure.

### **Liquefaction and Lateral Spreading**

Liquefaction occurs as a result of a substantial loss of shear strength or shearing resistance in loose, saturated, cohesionless earth materials subjected to earthquake induced ground shaking. Potential impacts from liquefaction include loss of bearing capacity, liquefaction related settlement, lateral movements, and surface manifestation such as sand boils. Seismically induced settlement occurs when loose sandy soils become denser when subjected to shaking during an earthquake. The three factors determining whether a site is likely to be subject to liquefaction include seismic shaking, type and consistency of earth materials, and groundwater level. The proposed structures will be supported by compacted fill and competent bedrock, with groundwater at a depth of over 50 feet. As such, the potential for earthquake induced liquefaction and lateral spreading beneath the proposed structures is considered very low to remote due to the recommended compacted fill, relatively low groundwater level, and the dense nature of the deeper onsite earth materials.

### **Ground Lurching**

The physics of ground lurching are not well understood, but it is generally thought to effect lightly loaded structures such as pavement, pipelines, and sidewalks. Heavier structures typically resist damage from ground lurching. Loose cohesionless earth materials near the surface are prone to ground lurching. Due to the recommendations herein and the lack of loose cohesionless earth materials near the surface, the potential for ground lurching is not expected to occur.

### **Ground Subsidence**

Groundwater or oil withdrawal from sedimentary earth materials can cause the permanent collapse of pore space previously occupied by the fluid. The consolidation of subsurface sediments resulting from fluid withdrawal could cause the ground surface to subside. If sufficient differential subsidence occurs it can significantly damage engineered structures. Since no excessive withdrawal of fluids is planned in the vicinity of the proposed project, the potential for subsidence is considered low to remote.

## **TENTATIVE FOUNDATION DESIGN RECOMMENDATIONS**

### **General**

Provided grading is performed in accordance with the recommendations of this report, shallow foundations are considered feasible for support of the proposed structures. Tentative foundation recommendations are provided herein and graphic presentations of relevant recommendations may also be included on the enclosed map.



## **Allowable Bearing Values**

An allowable bearing value of 2,000 pounds per square foot (psf) is recommended for design of 24 inch square pad footings and 12 inch wide continuous footings founded at a minimum depth of 12 inches below the lowest adjacent final grade. This value may be increased by 20 percent for each additional 1-foot of width and/or depth to a maximum value of 3,000psf. Recommended allowable bearing values include both dead and frequently applied live loads and may be increased by one third when designing for short duration wind or seismic forces.

## **Settlement**

Based on the settlement characteristics of the earth materials that underlie the building sites and the anticipated loading, we estimate that the maximum total settlement of the footings will be less than approximately  $\frac{3}{4}$  inch. Differential settlement is expected to be about  $\frac{1}{2}$  inch over a horizontal distance of approximately 20 feet, for an angular distortion ratio of 1:480. It is anticipated that the majority of the settlement will occur during construction or shortly after the initial application of loading.

The above settlement estimates are based on the assumption that the grading and construction are performed in accordance with the recommendations presented in this report and that the project geotechnical consultant will observe or test the earth material conditions in the footing excavations.

## **Lateral Resistance**

Passive earth pressure of 250 psf per foot of depth to a maximum value of 2,500 psf may be used to establish lateral bearing resistance for footings. For areas coved with hardscape, passive earth pressure maybe taken from the surface. For areas without hardscape, the first 3 feet of the soil profile must be neglected when calculating passive earth pressure. A coefficient of friction of 0.36 times the dead load forces may be used between concrete and the supporting earth materials to determine lateral sliding resistance. The above values may be increased by one-third when designing for short duration wind or seismic forces. When combining passive and friction for lateral resistance, the passive component should be reduced by one third. In no case shall the lateral sliding resistance exceed one-half the dead load for clay, sandy clay, sandy silty clay, silty clay, and clayey silt.

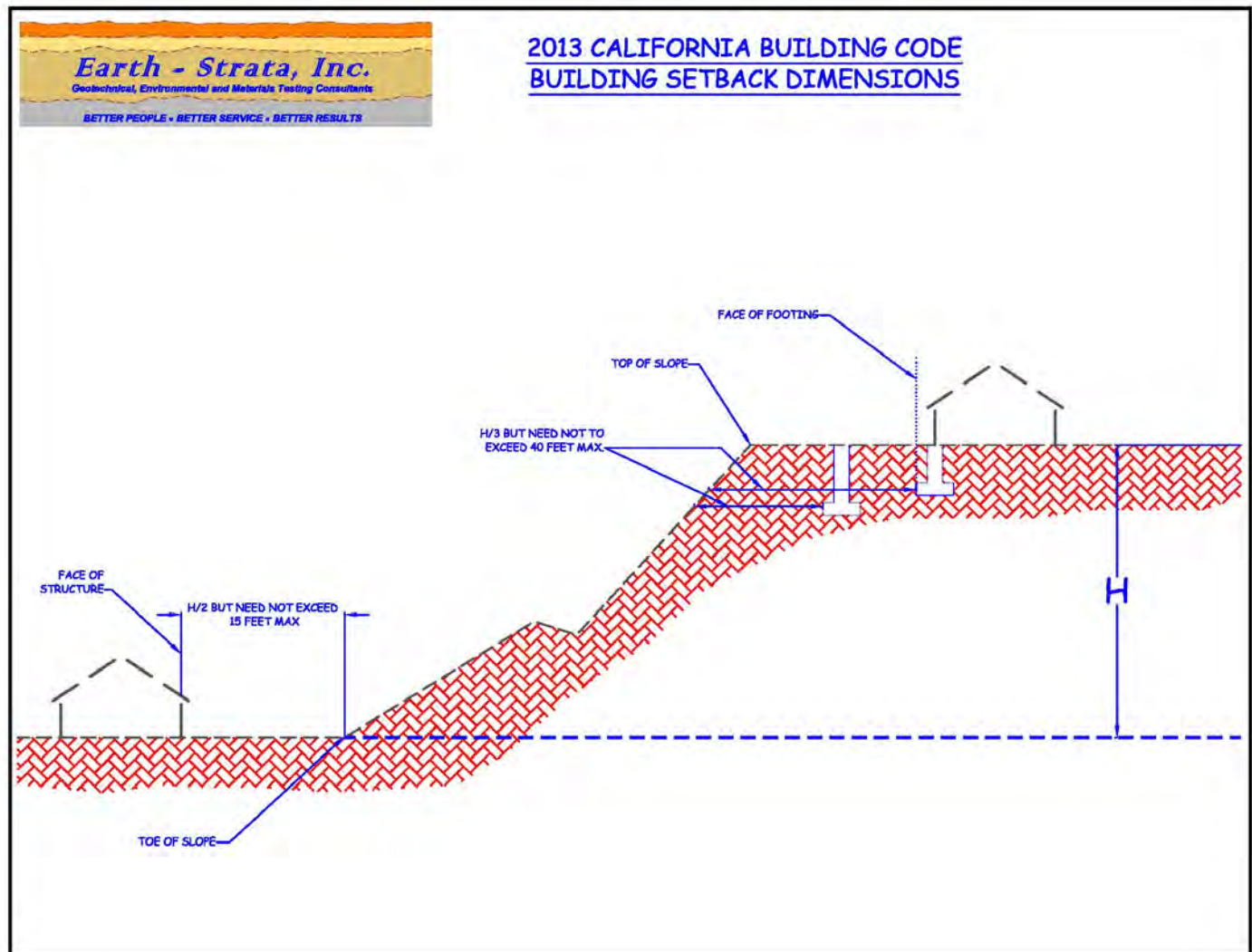
The above lateral resistance values are based on footings for an entire structure being placed directly against either compacted fill or competent bedrock.

## **Structural Setbacks and Building Clearance**

Structural setbacks are required per the 2013 California Building Code (CBC). Additional structural setbacks are not required due to geologic or geotechnical conditions within the site. Improvements constructed in close proximity to natural or properly engineered and compacted slopes can, over time, be affected by natural processes including gravity forces, weathering, and long term secondary settlement. As a result, the CBC requires that buildings and structures be setback or footings deepened to resist the influence of these processes.

For structures that are planned near ascending and descending slopes, the footings should be embedded to satisfy the requirements presented in the CBC, Section 1808.7 as illustrated in the following Foundation Clearances From Slopes diagram.

### FOUNDATION CLEARANCES FROM SLOPES



When determining the required clearance from ascending slopes with a retaining wall at the toe, the height of the slope shall be measured from the top of the wall to the top of the slope. The structural setback for pools may be reduced by one-half.

### Foundation Observations

In accordance with the 2013 CBC and prior to the placement of forms, concrete, or steel, all foundation excavations should be observed by the geologist, engineer, or his representative to verify that they have been excavated into competent bearing materials. The excavations should be per the approved plans, moistened, cleaned of all loose materials, trimmed neat, level, and square. Any moisture softened earth materials should be removed prior to steel or concrete placement.

Earth materials from foundation excavations should not be placed in slab on grade areas unless the materials are tested for expansion potential and compacted to a minimum of 90 percent of the maximum dry density.

### **Expansive Soil Considerations**

Preliminary laboratory test results indicate onsite earth materials exhibit an expansion potential of **VERY LOW to LOW** as classified in accordance with 2013 CBC Section 1803.5.3 and ASTM D4829-03. Additional, testing for expansive soil conditions should be conducted upon completion of rough grading. The following recommendations should be considered the very minimum requirements, for the earth materials tested. It is common practice for the project architect or structural engineer to require additional slab thickness, footing sizes, and/or reinforcement. The preliminary design and construction recommendations herein are intended for the various levels of expansion potential anticipated at the completion of rough grading.

### **Very Low Expansion Potential (Expansion Index of 20 or Less)**

Our laboratory test results indicate that the earth materials onsite exhibit a **VERY LOW** expansion potential as classified in accordance with 2013 CBC Section 1803.5.3 and ASTM D4829-03. Since the onsite earth materials exhibit expansion indices of 20 or less, the design of slab on ground foundations is exempt from the procedures outlined in Section 1808.6.1 or 1808.6.2.

#### **Footings**

- Exterior continuous footings may be founded at the minimum depths below the lowest adjacent final grade (i.e. 12 inch minimum depth for one-story, 18 inch minimum depth for two-story, and 24 inch minimum depth for three-story construction). Interior continuous footings for one-, two-, and three-story construction may be founded at a minimum depth of 12 inches below the lowest adjacent final grade. All continuous footings should have a minimum width of 12, 15, and 18 inches, for one-, two-, and three-story structures, respectively per Table 1809.7 of the 2013 CBC, and should be reinforced with a minimum of two (2) No. 4 bars, one (1) top and one (1) bottom.
- Exterior pad footings intended to support roof overhangs, such as second story decks, patio covers and similar construction should be a minimum of 24 inches square and founded at a minimum depth of 18 inches below the lowest adjacent final grade. No special reinforcement of the pad footings will be required.

#### **Building Floor Slabs**

- Building floor slabs should be a minimum of 4 inches thick and reinforced with a minimum of No. 3 bars spaced a maximum of 24 inches on center, each way. All floor slab reinforcement should be supported on concrete chairs or bricks to ensure the desired placement at mid-depth.
- Interior floor slabs, within living or moisture sensitive areas, should be underlain by a

minimum 10-mil thick moisture/vapor barrier to help reduce the upward migration of moisture from the underlying earth materials. The moisture/vapor barrier used should meet the performance standards of an ASTM E 1745 Class A material, and be properly installed in accordance with ACI publication 318-05. It is the responsibility of the contractor to ensure that the moisture/vapor barriers are free of openings, rips, or punctures prior to placing concrete. As an option for additional moisture reduction, higher strength concrete, such as a minimum 28-day compressive strength of 5,000 pounds per square inch (psi) may be used. Ultimately, the design of the moisture/vapor barrier system and recommendations for concrete placement and curing are the purview of the foundation engineer, taking into consideration the project requirements provided by the architect and owner.

- Garage floor slabs should be a minimum of 4 inches thick and should be reinforced in a similar manner as living area floor slabs. Garage floor slabs should be placed separately from adjacent wall footings with a positive separation maintained with  $\frac{3}{8}$  inch minimum felt expansion joint materials and quartered with weakened plane joints. A 12 inch wide turn down founded at the same depth as adjacent footings should be provided across garage entrances. The turn down should be reinforced with a minimum of two (2) No. 4 bars, one (1) top and one (1) bottom.
- The subgrade earth materials below all floor slabs should be pre-watered to promote uniform curing of the concrete and minimize the development of shrinkage cracks, prior to placing concrete. The pre-watering should be verified by Earth-Strata during construction.

### **Low Expansion Potential (Expansion Index of 21 to 50)**

Our laboratory test results indicate that the earth materials onsite exhibit a **LOW** expansion potential as classified in accordance with 2013 CBC Section 1803.5.3 and ASTM D4829-03. Accordingly, the CBC specifies that slab on ground foundations (floor slabs) resting on earth materials with expansion indices greater than 20, require special design considerations in accordance with 2013 CBC Sections 1808.6.1 and 1808.6.2. The design procedures are based on the thickness and plasticity index of the various earth materials within the upper 15 feet of the proposed structure. For preliminary design purposes, we have assumed an effective plasticity index of 12.

### **Footings**

- Exterior continuous footings may be founded at the minimum depths below the lowest adjacent final grade (i.e. 12 inch minimum depth for one-story, 18 inch minimum depth for two-story, and 24 inch minimum depth for three-story construction). Interior continuous footings for one-, two-, and three-story construction may be founded at a minimum depth of 12 inches below the lowest adjacent final grade. All continuous footings should have a minimum width of 12, 15, and 18 inches, for one-, two-, and three-story structures, respectively, and should be reinforced with a minimum of two (2) No. 4 bars, one (1) top and one (1) bottom.
- Exterior pad footings intended to support roof overhangs, such as second story decks, patio covers and similar construction should be a minimum of 24 inches square and founded at a minimum depth of 18 inches below the lowest adjacent final grade. The pad footings should be reinforced with a minimum of No. 4 bars spaced a maximum of 18 inches on center, each way, and should be placed near the bottom-third of the footings.



### **Building Floor Slabs**

- The project architect or structural engineer should evaluate minimum floor slab thickness and reinforcement in accordance with 2013 CBC Section 1808.6.2 based on an assumed effective plasticity index of 12. Building floor slabs should be a minimum of 4 inches thick and reinforced with a minimum of No. 3 bars spaced a maximum of 18 inches on center, each way. All floor slab reinforcement should be supported on concrete chairs or bricks to ensure the desired placement at mid-depth.
- Interior floor slabs, within living or moisture sensitive areas, should be underlain by a minimum 10-mil thick moisture/vapor barrier to help reduce the upward migration of moisture from the underlying earth materials. The moisture/vapor barrier used should meet the performance standards of an ASTM E 1745 Class A material, and be properly installed in accordance with ACI publication 318-05. It is the responsibility of the contractor to ensure that the moisture/vapor barriers are free of openings, rips, or punctures prior to placing concrete. As an option for additional moisture reduction, higher strength concrete, such as a minimum 28-day compressive strength of 5,000 pounds per square inch (psi) may be used. Ultimately, the design of the moisture/vapor barrier system and recommendations for concrete placement and curing are the purview of the foundation engineer, taking into consideration the project requirements provided by the architect and owner.
- Garage floor slabs should be a minimum of 4 inches thick and should be reinforced in a similar manner as living area floor slabs. Garage floor slabs should be placed separately from adjacent wall footings with a positive separation maintained with  $\frac{3}{8}$  inch minimum felt expansion joint materials and quartered with weakened plane joints. A 12 inch wide turn down founded at the same depth as adjacent footings should be provided across garage entrances. The turn down should be reinforced with a minimum of two (2) No. 4 bars, one (1) top and one (1) bottom.
- The subgrade earth materials below all floor slabs should be pre-watered to achieve a moisture content that is at least equal or slightly greater than optimum moisture content, prior to placing concrete. This moisture content should penetrate a minimum depth of 12 inches into the subgrade earth materials. The pre-watering should be verified by Earth-Strata during construction.

### **Post Tensioned Slab/Foundation Design Recommendations**

In lieu of the proceeding foundation recommendations, post tensioned slabs may be used to support the proposed structures. We recommend that the foundation engineer design the foundation system using the Preliminary Post Tensioned Foundation Slab Design table below. These parameters have been provided in general accordance with Post Tensioned Design. Alternate designs addressing the effects of expansive earth materials are allowed per 2013 CBC Section 1808.6.2. When utilizing these parameters, the foundation engineer should design the foundation system in accordance with the allowable deflection criteria of applicable codes and per the requirements of the structural engineer/architect.

It should be noted that the post tensioned design methodology is partially based on the assumption that soil moisture changes around and underneath post tensioned slabs, are influenced only by climate

conditions. Soil moisture change below slabs is the major factor in foundation damages relating to expansive soil. However, the design methodology has no consideration for presaturation, owner irrigation, or other non-climate related influences on the moisture content of subgrade earth materials. In recognition of these factors, we modified the geotechnical parameters determined from this methodology to account for reasonable irrigation practices and proper homeowner maintenance. Additionally, we recommend that prior to excavating footings, slab subgrades be presoaked to a depth of 12 inches and maintained at above optimum moisture until placing concrete. Furthermore, we recommend that the moisture content of the earth materials around the immediate perimeter and below the slab be presaturated to at least 1% above optimum moisture content just prior to placing concrete. The pre-watering should be verified and tested by Earth-Strata during construction.

The following geotechnical parameters assume that areas adjacent to the foundations, which are planted and irrigated, will be designed with proper drainage to prevent water from ponding. Water ponding near the foundation causes significant moisture change below the foundation. Our recommendations do not account for excessive irrigation and/or incorrect landscape design. Planters placed adjacent to the foundation, should be designed with an effective drainage system or liners, to prevent moisture infiltration below the foundation. Some lifting of the perimeter foundation beam should be expected even with properly constructed planters. Based on our experience monitoring sites with similar earth materials, elevated moisture contents below the foundation perimeter due to incorrect landscaping irrigation or maintenance, can result in uplift at the perimeter foundation relative to the central portion of the slab.

Future owners should be informed and educated of the importance in maintaining a consistent level of moisture within the earth materials around the structures. Future owners should also be informed of the potential negative consequences of either excessive watering, or allowing expansive earth materials to become too dry. Earth materials will shrink as they dry, followed by swelling during the rainy winter season, or when irrigation is resumed. This will cause distress to site improvements and structures.

## **Preliminary Post Tensioned Foundation Slab Design**

PARAMETER		VALUE	
Expansion Index		Very Low <sup>1</sup>	Low <sup>1</sup>
Percent Finer than 0.002 mm in the Fraction Passing the No. 200 Sieve		< 20 percent (assumed)	< 20 percent (assumed)
Type of Clay Mineral		Montmorillonite (assumed)	Montmorillonite (assumed)
Thornthwaite Moisture Index		+20	+20
Depth to Constant Soil Suction		7 feet	7 feet
Constant Soil Suction		P.F. 3.6	P.F. 3.6
Moisture Velocity		0.7 inches/month	0.7 inches/month
Center Lift	Edge moisture variation distance, e <sub>m</sub> Center lift, y <sub>m</sub>	5.5 feet 1.5 inches	5.5 feet 2.0 inches
Edge Lift	Edge moisture variation distance, e <sub>m</sub> Edge lift, y <sub>m</sub>	2.5 feet 0.4 inches	3.0 feet 0.8 inches
Soluble Sulfate Content for Design of Concrete Mixtures in Contact with Earth Materials		Negligible	Negligible
Modulus of Subgrade Reaction, k (assuming presaturation as indicated below)		200 pci	200 pci
Minimum Perimeter Foundation Embedment		12	18
Under Slab Moisture/Vapor Barrier and Sand Layer		10-mil thick moisture/vapor barrier meeting the requirements of a ASTM E 1745 Class A material	
1. Obtained by laboratory testing. 2. Recommendations for foundation reinforcement are ultimately the purview of the foundation/structural engineer based upon the geotechnical criteria presented in this report, and structural engineering considerations.			

### **Corrosivity**

Corrosion is defined by the National Association of Corrosion Engineers (NACE) as “a deterioration of a substance or its properties because of a reaction with its environment.” From a geotechnical viewpoint, the “substances” are the reinforced concrete foundations or buried metallic elements (not surrounded by concrete) and the “environment” is the prevailing earth materials in contact with them. Many factors can contribute to corrosivity, including the presence of chlorides, sulfates, salts, organic materials, different oxygen levels, poor drainage, different soil types, and moisture content. It is not considered practical or realistic to test for all of the factors which may contribute to corrosivity.

The potential for concrete exposure to chlorides is based upon the recognized Caltrans reference standard “Bridge Design Specifications”, under Subsection 8.22.1 of that document, Caltrans has determined that “Corrosive water or soil contains more than 500 parts per million (ppm) of chlorides”. Based on limited preliminary laboratory testing, the onsite earth materials have chloride contents *less* than 500 ppm. As such, specific requirements resulting from elevated chloride contents are not required.

Specific guidelines for concrete mix design are provided in 2013 CBC Section 1904.1 and ACI 318, Section 4.3 Table 4.3.1 when the soluble sulfate content of earth materials exceeds 0.1 percent by weight. Based

on limited preliminary laboratory testing, the onsite earth materials are classified in accordance with Table 4.3.1 as having a *negligible* sulfate exposure condition. Therefore, structural concrete in contact with onsite earth materials should utilize Type I or II.

Based on our laboratory testing of resistivity, the onsite earth materials in contact with buried steel should be considered *corrosive to very corrosive*. Additionally, pH values below 9.7 are recognized as being corrosive to most common metallic components including, copper, steel, iron, and aluminum. The pH values for the earth materials tested were *lower* than 9.7. Therefore, any steel or metallic materials that are exposed to the earth materials should be encased in concrete or other measures should be taken to provide corrosion protection.

If building slabs are to be post tensioned, the post tensioning cables should be encased in concrete and/or encapsulated in accordance with the Post Tensioning Institute Guide Specifications. Post tensioning cable end plate anchors and nuts also need to be protected if exposed. If the anchor plates and nuts are in a recess in the edge of the concrete slab, the recess should be filled in with a non-shrink, non-porous, moisture-insensitive epoxy grout so that the anchorage assembly and the end of the cable are completely encased and isolated from the soil. A standard non-shrink, non-metallic cementitious grout may be used only when the post tension anchoring assembly is polyethylene encapsulated similar to that offered by Hayes Industries, LTD or O'Strand, Inc.

The preliminary test results for corrosivity are based on limited samples, and the initiation of grading may blend various earth materials together. This blending or imported material could alter and increase the detrimental properties of the onsite earth materials. Accordingly, additional testing for chlorides and sulfates along with testing for pH and resistivity should be performed upon completion of grading. Laboratory test results are presented in Appendix C.

## **RETAINING WALLS**

### **Active and At-Rest Earth Pressures**

Foundations may be designed in accordance with the recommendations provided in the Tentative Foundation Design Recommendation section of this report. The following table provides the minimum recommended equivalent fluid pressures for design of retaining walls a maximum of 8 feet high. The active earth pressure should be used for design of unrestrained retaining walls, which are free to tilt slightly. The at-rest earth pressure should be used for design of retaining walls that are restrained at the top, such as basement walls, curved walls with no joints, or walls restrained at corners. For curved walls, active pressure may be used if tilting is acceptable and construction joints are provided at each angle point and at a minimum of 15 foot intervals along the curved segments.

MINIMUM STATIC EQUIVALENT FLUID PRESSURES (pcf)		
PRESSURE TYPE	BACKSLOPE CONDITION	
	LEVEL	2:1 (h:v)
Active Earth Pressure	40	63
At-Rest Earth Pressure	60	95



The retaining wall parameters provided do not account for hydrostatic pressure behind the retaining walls. Therefore, the subdrain system is a very important part of the design. All retaining walls should be designed to resist surcharge loads imposed by other nearby walls, structures, or vehicles should be added to the above earth pressures, if the additional loads are being applied within a 1.5:1 (h:v) plane projected up from the heel of the retaining wall footing. As a way of minimizing surcharge loads and the settlement potential of nearby buildings, the footings for the building can be deepened below the 1.5:1 (h:v) plane projected up from the heel of the retaining wall footing.

Upon request and under a separate scope of work, more detailed analyses can be performed to address equivalent fluid pressures with regard to stepped retaining walls, actual retaining wall heights, actual backfill inclinations, specific backfill materials, higher retaining walls requiring earthquake design motions, etc.

### **Subdrain System**

We recommend a perforated pipe and gravel subdrain system be provided behind all proposed retaining walls to prevent the buildup of hydrostatic pressure behind the proposed retaining walls. The perforated pipe should consist of 4 inch minimum diameter Schedule 40 PVC or ABS SDR-35, placed with the perforations facing down. The pipe should be surrounded by 1 cubic foot per foot of  $\frac{3}{4}$ - or  $1\frac{1}{2}$  inch open graded gravel wrapped in filter fabric. The filter fabric should consist of Mirafi 140N or equivalent to prevent infiltration of fines and subsequent clogging of the subdrain system.

In lieu of a perforated pipe and gravel subdrain system, weep holes or open vertical masonry joints may be provided in the lowest row of block exposed to the air to prevent the buildup of hydrostatic pressure behind the proposed retaining walls. Weep holes should be a minimum of 3 inches in diameter and provided at intervals of at least every 6 feet along the wall. Open vertical masonry joints should be provided at a minimum of 32 inch intervals. A continuous gravel fill, a minimum of 1 cubic foot per foot, should be placed behind the weep holes or open masonry joints. The gravel should be wrapped in filter fabric consisting of Mirafi 140N or equivalent.

The retaining walls should be adequately coated on the backfilled side of the walls with a proven waterproofing compound by an experienced professional to inhibit infiltration of moisture through the walls.

### **Temporary Excavations**

All excavations should be made in accordance with Cal-OSHA requirements. Earth-Strata is not responsible for job site safety.

### **Retaining Wall Backfill**

Retaining wall backfill materials should be approved by the geotechnical engineer or his representative prior to placement as compacted fill. Retaining wall backfill should be placed in lifts no greater than 6 to 8 inches, watered or air dried as necessary to achieve near optimum moisture contents. All retaining wall

backfill should be compacted to a minimum of 90 percent of the maximum dry density as determined by ASTM D 1557. Retaining wall backfill should be capped with a paved surface drain.

## **CONCRETE FLATWORK**

### **Thickness and Joint Spacing**

Concrete sidewalks and patio type slabs should be at least 3½ inches thick and provided with construction or expansion joints every 6 feet or less, to reduce the potential for excessive cracking. Concrete driveway slabs should be at least 4 inches thick and provided with construction or expansion joints every 10 feet or less.

### **Subgrade Preparation**

In order to reduce the potential for unsightly cracking, subgrade earth materials underlying concrete flatwork should be compacted at near optimum moisture to a minimum of 90 percent of the maximum dry density determined by ASTM test method D 1557-00 and then moistened to at least optimum or slightly above optimum moisture content. This moisture should extend to a depth of at least 12 inches below subgrade and be maintained prior to placement of concrete. Pre-watering of the earth materials prior to placing concrete will promote uniform curing of the concrete and minimize the development of shrinkage cracks. The project geotechnical engineer or his representative should verify the density and moisture content of the earth materials and the depth of moisture penetration prior to placing concrete.

Cracking within concrete flatwork is often a result of factors such as the use of too high a water to cement ratio and/or inadequate steps taken to prevent moisture loss during the curing of the concrete. Concrete distress can be reduced by proper concrete mix design and proper placement and curing of the concrete. Minor cracking within concrete flatwork is normal and should be expected.

The subgrade earth materials immediately below the aggregate base (base) should be compacted to a minimum of 95 percent of the maximum dry density determined by ASTM D 1557 to a minimum depth of 12 inches. Base materials should be compacted to a minimum of 95 percent of the maximum dry density determined by ASTM D 1557.

Base materials should consist of Class 2 aggregate base conforming to Section 26-1.02B of the State of California Standard Specifications or crushed aggregate base conforming to Section 200-2 of the Standard Specifications for Public Works Construction (Greenbook). Base materials should be compacted at or slightly below optimum moisture content. Asphaltic concrete materials and construction operations should conform to Section 203 of the Greenbook.

## **GRADING PLAN REVIEW AND CONSTRUCTION SERVICES**

This report has been prepared for the exclusive use of **Diversified Pacific** and their authorized representative. It likely does not contain sufficient information for other parties or other uses. Earth-Strata should be engaged to review the final design plans and specifications prior to construction. This is to verify that the recommendations contained in this report have been properly incorporated into the

project plans and specifications. Should Earth-Strata not be accorded the opportunity to review the project plans and specifications, we are not responsible for misinterpretation of our recommendations.

We recommend that Earth-Strata be retained to provide geologic and geotechnical engineering services during grading and foundation excavation phases of the work. In order to allow for design changes in the event that the subsurface conditions differ from those anticipated prior to construction.

Earth-Strata should review any changes in the project and modify and approve in writing the conclusions and recommendations of this report. This report and the drawings contained within are intended for design input purposes only and are not intended to act as construction drawings or specifications. In the event that conditions encountered during grading or construction operations appear to be different than those indicated in this report, this office should be notified immediately, as revisions may be required.

### **REPORT LIMITATIONS**

Our services were performed using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable soils engineers and geologists, practicing at the time and location this report was prepared. No other warranty, expressed or implied, is made as to the conclusions and professional advice included in this report.

Earth materials vary in type, strength, and other geotechnical properties between points of observation and exploration. Groundwater and moisture conditions can also vary due to natural processes or the works of man on this or adjacent properties. As a result, we do not and cannot have complete knowledge of the subsurface conditions beneath the subject property. No practical study can completely eliminate uncertainty with regard to the anticipated geotechnical conditions in connection with a subject property. The conclusions and recommendations within this report are based upon the findings at the points of observation and are subject to confirmation by Earth-Strata based on the conditions revealed during grading and construction.

This report was prepared with the understanding that it is the responsibility of the owner or their representative, to ensure that the conclusions and recommendations contained herein are brought to the attention of the other project consultants and are incorporated into the plans and specifications. The owners' contractor should properly implement the conclusions and recommendations during grading and construction, and notify the owner if they consider any of the recommendations presented herein to be unsafe or unsuitable.

# **APPENDIX A**

## **REFERENCES**



## APPENDIX A

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**APPENDIX B**  
**EXPLORATORY LOGS**

# Geotechnical Boring Log B-1

Date: March 25, 2015	Project Name: P & F Prpoerty	Page: 1 of 1
Project Number: 15735-10A	Logged By: GWG	
Drilling Company: Drilling It	Type of Rig: CME 45B	
Drive Weight (lbs): 140	Drop (in): 30	Hole Diameter (in): 8
Top of Hole Elevation (ft):	Hole Location: See Geotechnical Map	

Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u>
					SM	Silty SAND; light orange brown, dry to slightly moist, medium dense
	70	1	105.1	10.3		<u>Cretaceous Val Verde Tonalite (Kvt)</u>
					SC	Clayey Sandstone; light tan brown, moist, hard to very hard
5	50/4"	2	81.4	19.6	SC	Clayey SAND; light grey, moist, grainitic bedrock
						Dark grey, moist, coarse, very hard
10						End of Boring at 10 feet
						No Groundwater
15						
20						
25						
30						

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# Geotechnical Boring Log B-2

Date: March 25, 2015	Project Name: P & F Prpoerty	Page: 1 of 1
Project Number: 15735-10A	Logged By: GWG	
Drilling Company: Drilling It	Type of Rig: CME 45B	
Drive Weight (lbs): 140	Drop (in): 30	Hole Diameter (in): 8
Top of Hole Elevation (ft):	Hole Location: See Geotechnical Map	

Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u>
					SC	Clayey SAND; reddish brown, dry
						<u>Cretaceous Val Verde Tonalite (Kvt)</u>
	68	1	118.6	8.9	SC	Clayey Sandstone; light tan brown, moist, hard to very hard
5						
	50/8"	2	91.6	4.6		
10						End of Boring at 10 feet
						No Groundwater
15						
20						
25						
30						

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# Geotechnical Boring Log B-3

Date: March 31, 2015	Project Name: P & F Prpoerty	Page: 1 of 1
Project Number: 15735-10A	Logged By: GWG	
Drilling Company: Drilling It	Type of Rig: CME 45B	
Drive Weight (lbs): 140	Drop (in): 30	Hole Diameter (in): 8
Top of Hole Elevation (ft):	Hole Location: See Geotechnical Map	

Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u>
					ML	Sandy SILT; light brown, dense
						<u>Cretaceous Val Verde Tonalite (Kvt)</u>
5					SC	Clayey Sandstone; light tan brown, moist, hard to very hard
						End of Boring at 5.5 feet
						No Groundwater
10						
15						
20						
25						
30						

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# Geotechnical Boring Log B-4

Date: March 31, 2015	Project Name: P& F Prpoerty	Page: 1 of 1
Project Number: 15735-10A	Logged By: GWG	
Drilling Company: Drilling It	Type of Rig: CME 45B	
Drive Weight (lbs): 140	Drop (in): 30	Hole Diameter (in): 8
Top of Hole Elevation (ft):	Hole Location: See Geotechnical Map	

Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u> Sandy SILT; light brown, dense
	88/10"	1				<u>Cretaceous Val Verde Tonalite (Kvt)</u>
5					SC	Clayey Sandstone; light tan brown, moist, hard to very hard
10						End of Boring at 10 feet No Groundwater
15						
20						
25						
30						

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# Geotechnical Boring Log B-5

Date: March 31, 2015	Project Name: P & F Prpoerty	Page: 1 of 1
Project Number: 15735-10A	Logged By: GWG	
Drilling Company: Drilling It	Type of Rig: CME 45B	
Drive Weight (lbs): 140	Drop (in): 30	Hole Diameter (in): 8
Top of Hole Elevation (ft):	Hole Location: See Geotechnical Map	

Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u>
						Sandy SILT; light brown, dense
						<u>Cretaceous Val Verde Tonalite (Kvt)</u>
	96/8"	1			SC	Clayey Sandstone; light tan brown, moist, hard to very hard
5						
10						End of Boring at 7.5
						No Groundwater
15						
20						
25						
30						

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# Geotechnical Boring Log B-6

Date: March 31, 2015	Project Name: P & F Prpoerty	Page: 1 of 1
Project Number: 15735-10A	Logged By: GWG	
Drilling Company: Drilling It	Type of Rig: CME 45B	
Drive Weight (lbs): 140	Drop (in): 30	Hole Diameter (in): 8
Top of Hole Elevation (ft):	Hole Location: See Geotechnical Map	

Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u>
					ML	Sandy SILT; light brown, dense
						<u>Cretaceous Val Verde Tonalite (Kvt)</u>
	110/3"	1			SC	Clayey Sandstone; light tan brown, moist, hard to very hard
5						
	50/1"	2				
						End of Boring at 6 feet
						No Groundwater
10						
15						
20						
25						
30						

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# Geotechnical Boring Log B-7

Date: March 31, 2015	Project Name: P & F Prpoerty	Page: 1 of 1
Project Number: 15735-10A	Logged By: GWG	
Drilling Company: Drilling It	Type of Rig: CME 45B	
Drive Weight (lbs): 140	Drop (in): 30	Hole Diameter (in): 8
Top of Hole Elevation (ft):	Hole Location: See Geotechnical Map	

Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u>
						Sandy SILT; light brown, dense
						<u>Cretaceous Val Verde Tonalite (Kvt)</u>
	50/4"	1			SM	Silty SAND (weathered bedrock);
5						
10						End of Boring at 10 feet
						No Groundwater
15						
20						
25						
30						

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# Geotechnical Boring Log B-8

Date: March 31, 2015	Project Name: P & F Prpoerty	Page: 1 of 1
Project Number: 15735-10A	Logged By: DV	
Drilling Company: Drilling It	Type of Rig: CME 45B	
Drive Weight (lbs): 140	Drop (in): 30	Hole Diameter (in): 8
Top of Hole Elevation (ft):	Hole Location: See Geotechnical Map	

Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u>
						Sandy SILT; reddish brown, dense
						<u>Cretaceous Val Verde Tonalite (Kvt)</u>
	50/2"	1			SC	Clayey Sandstone; light tan brown, moist, hard to very hard
5						
						End of Boring at 6 feet
						No Groundwater
10						
15						
20						
25						
30						

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# Geotechnical Boring Log TP-1

Date: March 27, 2015	Project Name: P & F Properties	Page: 1 of 1
Project Number: 15735-10A	Logged By: SMP	
Drilling Company: Drilling It	Type of Rig: Mini Excavator	
Drive Weight (lbs): 140	Drop (in): 30	Hole Diameter (in): 8
Top of Hole Elevation (ft):	Hole Location: See Geotechnical Map	

Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u>
					SM	Silty SAND; reddish brown, slightly moist, with weathered rock
5						<u>Tonalite (Kvt):</u>
					SP	Sand with SILT and weathered rock, gravel size; grey and light brown
						End of Boring at 6 feet
						No Groundwater
10						
15						
20						
25						
30						

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Geotechnical Boring Log TP-2						
Date: March 28, 2015			Project Name: P & F Properties			Page: 1 of 1
Project Number: 15735-10A			Logged By: SMP			
Drilling Company: Drilling It			Type of Rig: Mini Excavator			
Drive Weight (lbs): 140			Drop (in): 30		Hole Diameter (in): 8	
Top of Hole Elevation (ft):			Hole Location: See Geotechnical Map			
Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u>
					SM	Silty SAND; reddish brown, dry, medium dense
						<u>Tonalite (Kvt):</u>
					SP	SAND with fine GRAVEL (weathered rock); light grey
5						End of Boring at 4.9 feet
						No Groundwater
10						
15						
20						
25						
30						

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# Geotechnical Boring Log TP-4

Date: March 28, 2015	Project Name: P & F Properties	Page: 1 of 1
Project Number: 15735-10A	Logged By: SMP	
Drilling Company: Drilling It	Type of Rig: Mini Excavator	
Drive Weight (lbs): 140	Drop (in): 30	Hole Diameter (in): 8
Top of Hole Elevation (ft):	Hole Location: See Geotechnical Map	

Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u>
					SM	Silty SAND; reddish brown, dry, medium dense
5						<u>Tonalite (Kvt):</u>
					SP	SAND with SILT; reddish brown, dry, medium dense
						End of Boring at 6 feet
						No Groundwater
10						
15						
20						
25						
30						

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Geotechnical Boring Log TP-5						
Date: March 27, 2015			Project Name: P & F Properties			Page: 1 of 1
Project Number: 15735-10A			Logged By: SMP			
Drilling Company: Drilling It			Type of Rig: Mini Excavator			
Drive Weight (lbs): 140			Drop (in): 30		Hole Diameter (in): 8	
Top of Hole Elevation (ft):			Hole Location: See Geotechnical Map			
Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<b>Topsoil:</b>
					SM	Silty SAND; reddish brown, dry, loose to medium dense
						<b>Tonalite (Kvt):</b>
					SP	SAND (weathered bedrock); light grey with black spots, very dense
5						End of Boring at 4.7 feet No Groundwater
10						
15						
20						
25						
30						

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Geotechnical Boring Log TP-6						
Date: March 27, 2015			Project Name: P & F Properties			Page: 1 of 1
Project Number: 15735-10A			Logged By: SMP			
Drilling Company: Drilling It			Type of Rig: Mini Excavator			
Drive Weight (lbs): 140			Drop (in): 30		Hole Diameter (in): 8	
Top of Hole Elevation (ft):			Hole Location: See Geotechnical Map			
Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u>
					SM	Silty SAND; reddish brown, dry, loose
						<u>Tonalite (Kvt):</u>
					SP	SAND (weathered bedrock); light grey, dry, very dense
5						End of Boring 5 feet
						No Groundwater
10						
15						
20						
25						
30						

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# Geotechnical Boring Log TP-7

Date: March 27, 2015	Project Name: P & F Properties	Page: 1 of 1
Project Number: 15735-10A	Logged By: SMP	
Drilling Company: Drilling It	Type of Rig: Mini Excavator	
Drive Weight (lbs): 140	Drop (in): 30	Hole Diameter (in): 8
Top of Hole Elevation (ft):	Hole Location: See Geotechnical Map	

Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u>
					SM	Silty SAND; brown, dry, medium dense
						<u>Tonalite (Kvt):</u>
					SP	SAND (weathered bedrock) with gravel; light grey, very dense
5						End of Boring at 2.5 feet
						No Groundwater
10						
15						
20						
25						
30						

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# Geotechnical Boring Log TP-8

Date: April 7, 2015	Project Name: P & F Properties	Page: 1 of 1
Project Number: 15735-10A	Logged By: SMP	
Drilling Company: Drilling It	Type of Rig: Backhoe	
Drive Weight (lbs): 140	Drop (in): 30	Hole Diameter (in): 8
Top of Hole Elevation (ft):	Hole Location: See Geotechnical Map	

Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<b>Topsoil:</b>
					SM	Silty SAND; Reddish brown, dry, loose
5						
						<b>Tonalite (Kvt):</b>
					SP	SAND (weathered bedrock); light grey, dry, very dense
						End of Boring at 5.1 feet
						No Groundwater
10						
15						
20						
25						
30						

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# Geotechnical Boring Log TP-9

Date: April 7, 2015	Project Name: P & F Properties	Page: 1 of 1
Project Number: 15735-10A	Logged By: SMP	
Drilling Company: Drilling It	Type of Rig: Backhoe	
Drive Weight (lbs): 140	Drop (in): 30	Hole Diameter (in): 8
Top of Hole Elevation (ft):	Hole Location: See Geotechnical Map	

Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u>
					SM	Silty SAND; reddish brown, dry, loose
5						
						<u>Tonalite (Kvt):</u>
					SP	SAND (weathered bedrock); light grey, hard, dry, very dense
						End of Boring at 6 feet
						No Groundwater
10						
15						
20						
25						
30						

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# Geotechnical Boring Log TP-10

Date: April 7, 2015	Project Name: P & F Properties	Page: 1 of 1
Project Number: 15735-10A	Logged By: SMP	
Drilling Company: Drilling It	Type of Rig: Backhoe	
Drive Weight (lbs): 140	Drop (in): 30	Hole Diameter (in): 8
Top of Hole Elevation (ft):	Hole Location: See Geotechnical Map	

Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u>
					SM	Silty SAND; reddish brown, dry, loose
5						<u>Tonalite (Kvt):</u>
					SP	SAND (wethered bedrock); light grey, hard, dry, very dense
						End of Boring at 5 feet
						No Groundwater
10						
15						
20						
25						
30						

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# Geotechnical Boring Log TP-11

Date: April 7, 2015	Project Name: P & F Properties	Page: 1 of 1
Project Number: 15735-10A	Logged By: SMP	
Drilling Company: Drilling It	Type of Rig: Backhoe	
Drive Weight (lbs): 140	Drop (in): 30	Hole Diameter (in): 8
Top of Hole Elevation (ft):	Hole Location: See Geotechnical Map	

Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u>
					SM	Silty SAND; reddish brown, dry, loose
						<u>Tonalite (Kvt):</u>
					SP	SAND (wethered bedrock); light grey, hard, dry, very dense
5						End of Boring at 2.1 feet
						No Groundwater
10						
15						
20						
25						
30						

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# Geotechnical Boring Log TP-12

Date: April 7, 2015	Project Name: P & F Properties	Page: 1 of 1
Project Number: 15735-10A	Logged By: SMP	
Drilling Company: Drilling It	Type of Rig: Backhoe	
Drive Weight (lbs): 140	Drop (in): 30	Hole Diameter (in): 8
Top of Hole Elevation (ft):	Hole Location: See Geotechnical Map	

Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u>
					SM	Silty SAND; reddish brown, loose, moist
5						<u>Tonalite (Kvt):</u>
					SP	SAND (weathered bedrock); light grey, moist, very dense
						End of Boring at 5 feet
						No Groundwater
10						
15						
20						
25						
30						

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# Geotechnical Boring Log TP-14A

Date: April 7, 2015	Project Name: P & F Properties	Page: 1 of 1
Project Number: 15735-10A	Logged By: SMP	
Drilling Company: Drilling It	Type of Rig: Backhoe	
Drive Weight (lbs): 140	Drop (in): 30	Hole Diameter (in): 8
Top of Hole Elevation (ft):	Hole Location: See Geotechnical Map	

Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u>
					SM	Silty SAND; brown, dry, hard, medium-dense
					SP	<u>Tonalite (Kvt):</u>
5						SAND (weathered bedrock); brown, dry, very dense
						End of Boring at 3 feet
						No Groundwater
10						
15						
20						
25						
30						

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# Geotechnical Boring Log TP-14

Date: April 7, 2015	Project Name: P & F Properties	Page: 1 of 1
Project Number: 15735-10A	Logged By: SMP	
Drilling Company: Drilling It	Type of Rig: Backhoe	
Drive Weight (lbs): 140	Drop (in): 30	Hole Diameter (in): 8
Top of Hole Elevation (ft):	Hole Location: See Geotechnical Map	

Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u>
					SM	Silty SAND; reddish brown, dry, loose
5						<u>Tonalite (Kvt):</u>
					SP	SAND (weathered bedrock); light grey, hard, dry, very dense
						End of Boring at 6 feet
						No Groundwater
10						
15						
20						
25						
30						

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Geotechnical Boring Log TP-15							
Date: April 7, 2015				Project Name: P & F Properties			
Project Number: 15735-10A				Logged By: SMP			
Drilling Company: Drilling It				Type of Rig: Backhoe			
Drive Weight (lbs): 140				Drop (in): 30      Hole Diameter (in): 8			
Top of Hole Elevation (ft):				Hole Location: See Geotechnical Map			
Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION	
0						<u>Topsoil:</u>	
					SM	Silty SAND; reddish brown, dry, loose	
						-----	
						<u>Tonalite (Kvt):</u>	
					SP	SAND (weathered bedrock); light grey, hard, dry, very dense	
5						End of Boring at 5 feet	
						No Groundwater	
10							
15							
20							
25							
30							

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Geotechnical Boring Log TP-16							
Date: April 7, 2015				Project Name: P & F Properties Page: 1 of 1			
Project Number: 15735-10A				Logged By: SMP			
Drilling Company: Drilling It				Type of Rig: Backhoe			
Drive Weight (lbs): 140				Drop (in): 30		Hole Diameter (in): 8	
Top of Hole Elevation (ft):				Hole Location: See Geotechnical Map			
Depth (ft)	Bow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol		
0						<b>MATERIAL DESCRIPTION</b>	
						<b>Topsoil:</b>	
					SM	Silty SAND; reddish brown, dry, loose	
						<b>Tonalite (Kvt):</b>	
5					SP	SAND (weathered bedrock); light grey, hard, dry, very dense	
						End of Boring at 3.2 feet	
						No Groundwater	
10							
15							
20							
25							
30							

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Geotechnical Boring Log TP-17						
Date: April 7, 2015			Project Name: P & F Properties			Page: 1 of 1
Project Number: 15735-10A			Logged By: SMP			
Drilling Company: Drilling It			Type of Rig: Backhoe			
Drive Weight (lbs): 140			Drop (in): 30		Hole Diameter (in): 8	
Top of Hole Elevation (ft):			Hole Location: See Geotechnical Map			
Depth (ft)	Blow Count Per Foot	Sample Number	Dry Density (pcf)	Moisture (%)	Classification Symbol	MATERIAL DESCRIPTION
0						<u>Topsoil:</u>
					SM	Silty SAND; reddish brown, dry, loose
5						<u>Tonalite (Kvt):</u>
					SP	SAND (weathered bedrock); light grey, hard, dry, very dense
						End of Boring at 5.2 feet
						No Groundwater
10						
15						
20						
25						
30						

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## **APPENDIX C**

### **LABORATORY PROCEDURES AND TEST RESULTS**

## APPENDIX C

### **Laboratory Procedures and Test Results**

Laboratory testing provided quantitative and qualitative data involving the relevant engineering properties of the representative earth materials selected for testing. The representative samples were tested in general accordance with American Society for Testing and Materials (ASTM) procedures and/or California Test Methods (CTM).

**Soil Classification:** Earth materials encountered during exploration were classified and logged in general accordance with the Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) of ASTM D 2488. Upon completion of laboratory testing, exploratory logs and sample descriptions were reconciled to reflect laboratory test results with regard to ASTM D 2487.

**Moisture and Density Tests:** For select samples moisture content was determined using the guidelines of ASTM D 2216 and dry density determinations were made using the guidelines of ASTM D 2937. These tests were performed on relatively undisturbed samples and the test results are presented on the exploratory logs.

**Maximum Density Tests:** The maximum dry density and optimum moisture content of representative samples were determined using the guidelines of ASTM D 1557. The test results are presented in the table below.

SAMPLE LOCATION	MATERIAL DESCRIPTION	MAXIMUM DRY DENSITY (pcf)	OPTIMUM MOISTURE CONTENT (%)
B-1 @ 0 to 2 feet	Olive Brown SAND with SILT	133.0	7.5
B-2 @ 0 to 2 feet	Dark Yellowish Brown Silty SAND with trace CLAY	127.0	8.0
TP-1 @ 0 to 3 feet	Dark Brown Silty SAND	125.0	11.5
TP-1 @ 4 to 5 feet	Olive Brown Silty SAND	108.5	10.0

**Expansion Index:** The expansion potential of representative samples was evaluated using the guidelines of ASTM D 4829. The test results are presented in the table below.

SAMPLE LOCATION	MATERIAL DESCRIPTION	EXPANSION INDEX	EXPANSION POTENTIAL
B-1 @ 0 to 2 feet	Olive Brown SAND with SILT	0	Very Low
B-2 @ 0 to 2 feet	Dark Yellowish Brown Silty SAND with trace CLAY	7	Very Low
TP-1 @ 0 to 3 feet	Dark Brown Silty SAND	29	Low
TP-1 @ 4 to 5 feet	Olive Brown Silty SAND	7	Very Low

**Minimum Resistivity and pH Tests:** Minimum resistivity and pH Tests of select samples were performed using the guidelines of CTM 643. The test results are presented in the table below.

SAMPLE LOCATION	MATERIAL DESCRIPTION	pH	MINIMUM RESISTIVITY (ohm-cm)
B-1 @ 0 to 2 feet	Olive Brown SAND with SILT	7.3	1,000
B-2 @ 0 to 2 feet	Dark Yellowish Brown Silty SAND with trace CLAY	7.1	440
TP-1 @ 0 to 3 feet	Dark Brown Silty SAND	7.2	400
TP-1 @ 4 to 5 feet	Olive Brown Silty SAND	7.8	1,100

**Soluble Sulfate:** The soluble sulfate content of select samples was determined using the guidelines of CTM 417. The test results are presented in the table below.

SAMPLE LOCATION	MATERIAL DESCRIPTION	SULFATE CONTENT (% by weight)	SULFATE EXPOSURE
B-1 @ 0 to 2 feet	Olive Brown SAND with SILT	0.002	Negigible
B-2 @ 0 to 2 feet	Dark Yellowish Brown Silty SAND with trace CLAY	0.029	Negigible
TP-1 @ 0 to 3	Dark Brown Silty SAND	0.002	Negigible
TP-1 @ 4 to 5 feet	Olive Brown Silty SAND	0.002	Negigible

**Chloride Content:** Chloride content of select samples was determined using the guidelines of CTM 422. The test results are presented in the table below.

SAMPLE LOCATION	MATERIAL DESCRIPTION	CHLORIDE CONTENT (ppm)
B-1 @ 0 to 2 feet	Olive Brown SAND with SILT	50
B-2 @ 0 to 2 feet	Dark Yellowish Brown Silty SAND with trace CLAY	70
TP-1 @ 0 to 3 feet	Dark Brown Silty SAND	60
TP-1 @ 4 to 5 feet	Olive Brown Silty SAND	20

# **APPENDIX D**

## **SEISMICITY**



**USGS** Design Maps Detailed Report

2009 NEHRP Recommended Seismic Provisions (33.89018°N, 117.352°W)

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

**Section 11.4.1 — Mapped Acceleration Parameters and Risk Coefficients**

Note: Ground motion values contoured on Figures 22-1, 2, 5, & 6 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  $S_{SUH}$  and  $S_{SD}$ ) and 1.3 (to obtain  $S_{IUH}$  and  $S_{ID}$ ). Maps in the Proposed 2015 NEHRP Provisions are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 11.4.3.

Figure 22-1: Uniform-Hazard (2% in 50-Year) Ground Motions of 0.2-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B

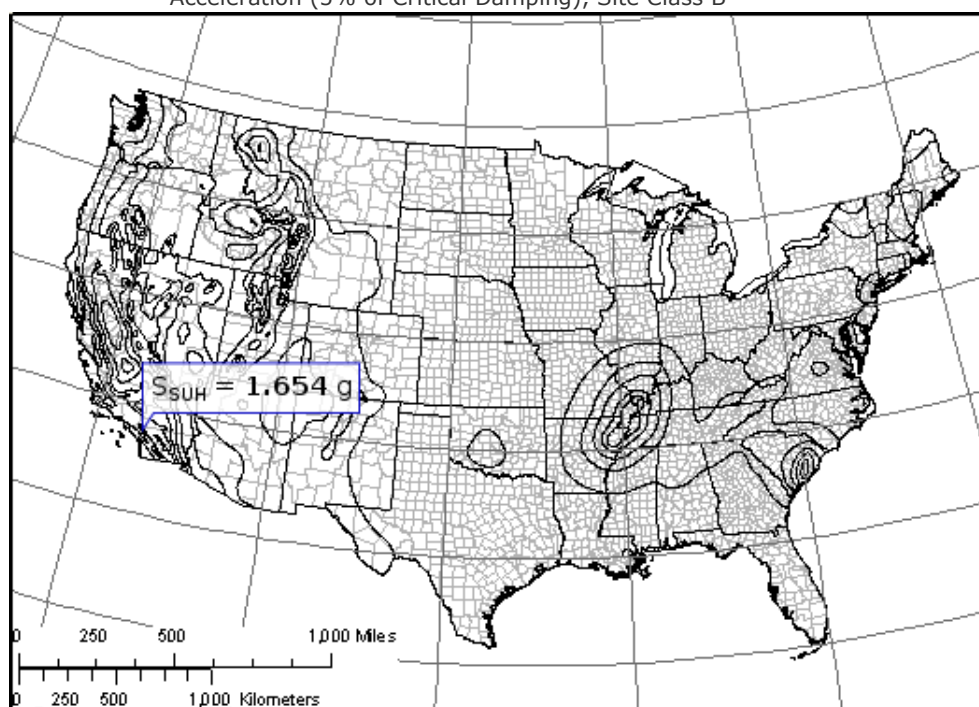
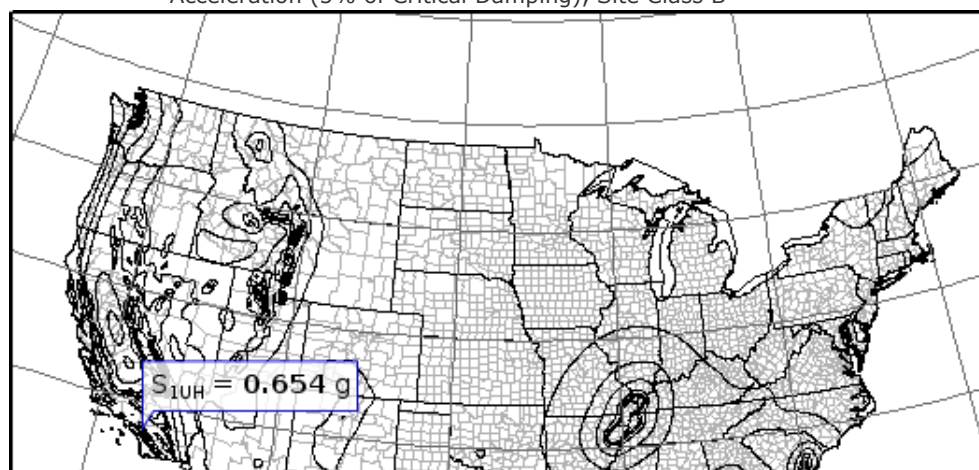


Figure 22-2: Uniform-Hazard (2% in 50-Year) Ground Motions of 1.0-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B



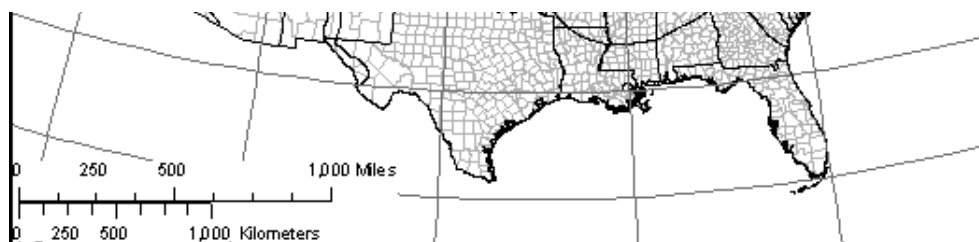


Figure 22-3: Risk Coefficient at 0.2-Second Spectral Response Period

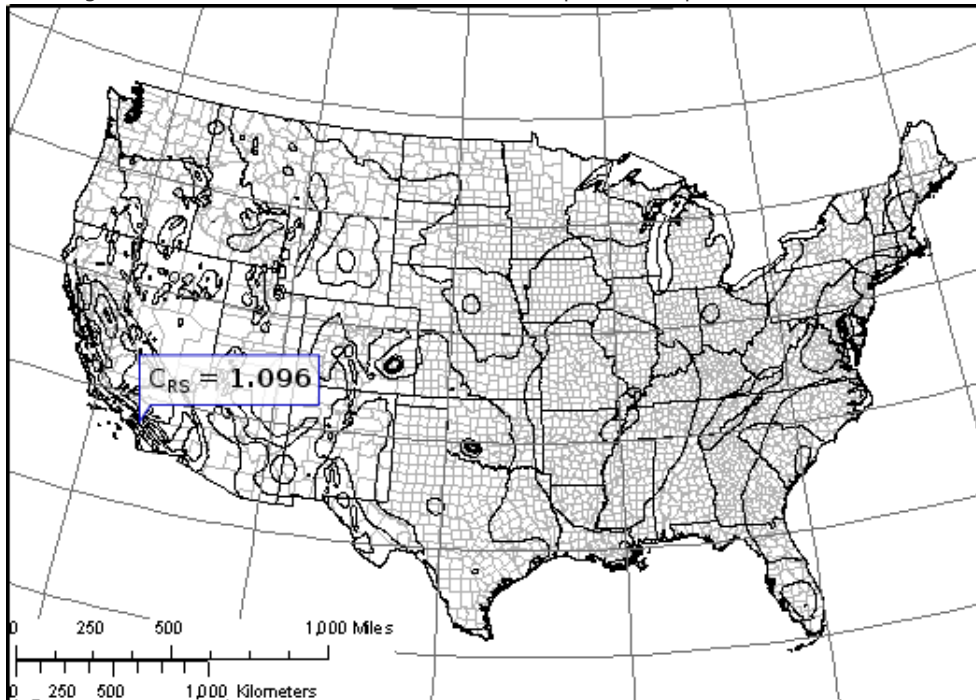


Figure 22-4: Risk Coefficient at 1.0-Second Spectral Response Period

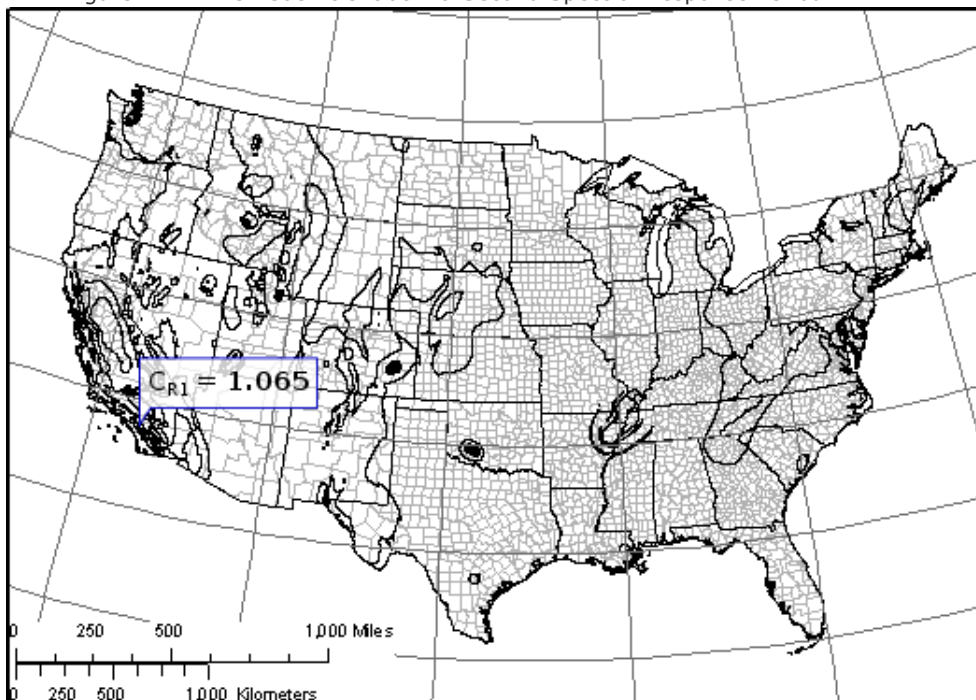


Figure 22-5: Deterministic Ground Motions of 0.2-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B

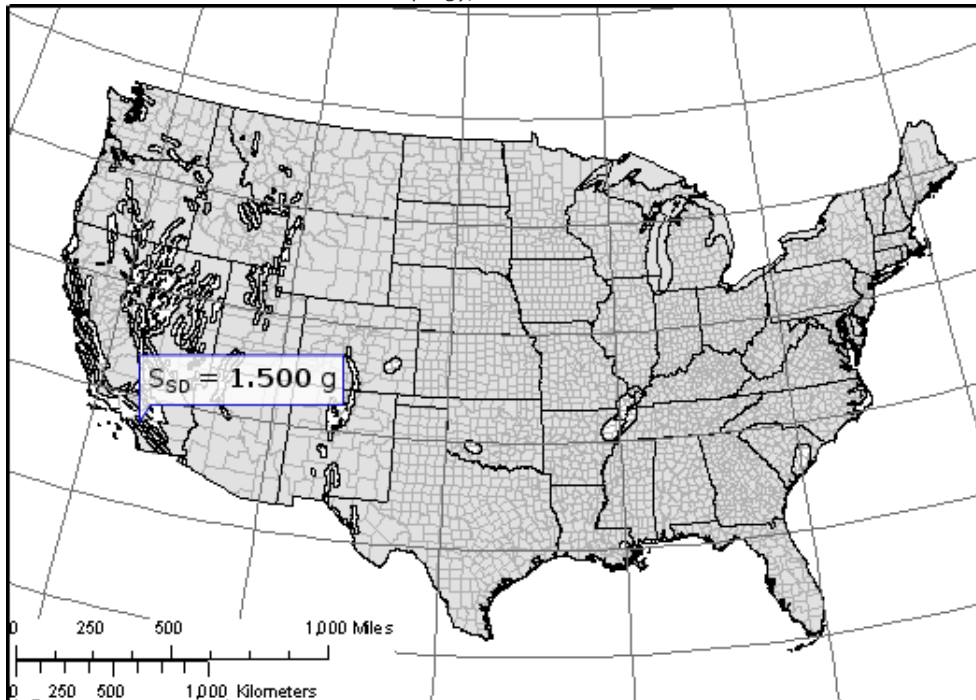
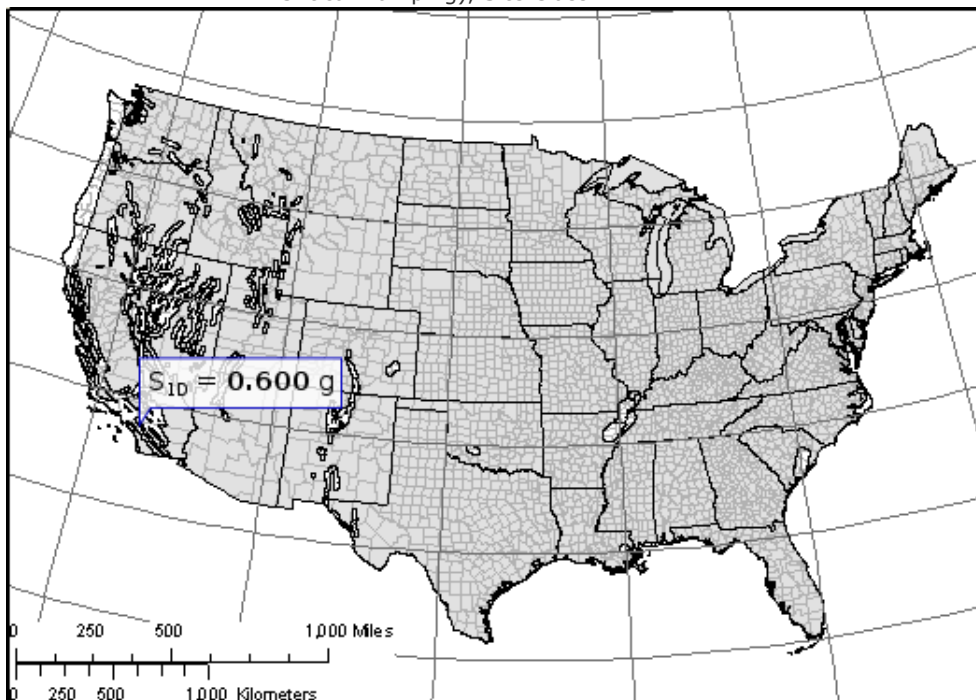


Figure 22-6: Deterministic Ground Motions of 1.0-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B



## 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: <ul style="list-style-type: none"> <li>• Plasticity index <math>PI &gt; 20</math>,</li> <li>• Moisture content <math>w \geq 40\%</math>, and</li> <li>• Undrained shear strength <math>\bar{s}_u &lt; 500</math> psf</li> </ul>			
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/ft<sup>2</sup> = 0.0479 kN/m<sup>2</sup>

## Section 11.4.3 — Site Coefficients, Risk Coefficients, and Risk-Targeted Maximum Considered Earthquake ( $MCE_R$ ) Spectral Response Acceleration Parameters

---

**Equation (11.4–1):**  $C_{RS}S_{SUH} = 1.096 \times 1.654 = 1.814 \text{ g}$

---

**Equation (11.4–2):**  $S_{SD} = 1.500 \text{ g}$

---

$S_s \equiv \text{"Lesser of values from Equations (11.4–1) and (11.4–2)"} = 1.500 \text{ g}$

---

**Equation (11.4–3):**  $C_{R1}S_{1UH} = 1.065 \times 0.654 = 0.697 \text{ g}$

---

**Equation (11.4–4):**  $S_{1D} = 0.600 \text{ g}$

---

$S_1 \equiv \text{"Lesser of values from Equations (11.4–3) and (11.4–4)"} = 0.600 \text{ g}$

---

Table 11.4-1: Site Coefficient  $F_a$ 

Site Class	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	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	Spectral Response Acceleration Parameter at 1-Second 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	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 (11.4-5):**

$$S_{MS} = F_a S_s = 1.000 \times 1.500 = 1.500 \text{ g}$$

**Equation (11.4-6):**

$$S_{M1} = F_v S_1 = 1.500 \times 0.600 = 0.900 \text{ g}$$

#### Section 11.4.4 — Design Spectral Acceleration Parameters

**Equation (11.4-7):**

$$S_{DS} = \frac{2}{3} S_{MS} = \frac{2}{3} \times 1.500 = 1.000 \text{ g}$$

**Equation (11.4-8):**

$$S_{D1} = \frac{2}{3} S_{M1} = \frac{2}{3} \times 0.900 = 0.600 \text{ g}$$

#### Section 11.4.5 — Design Response Spectrum

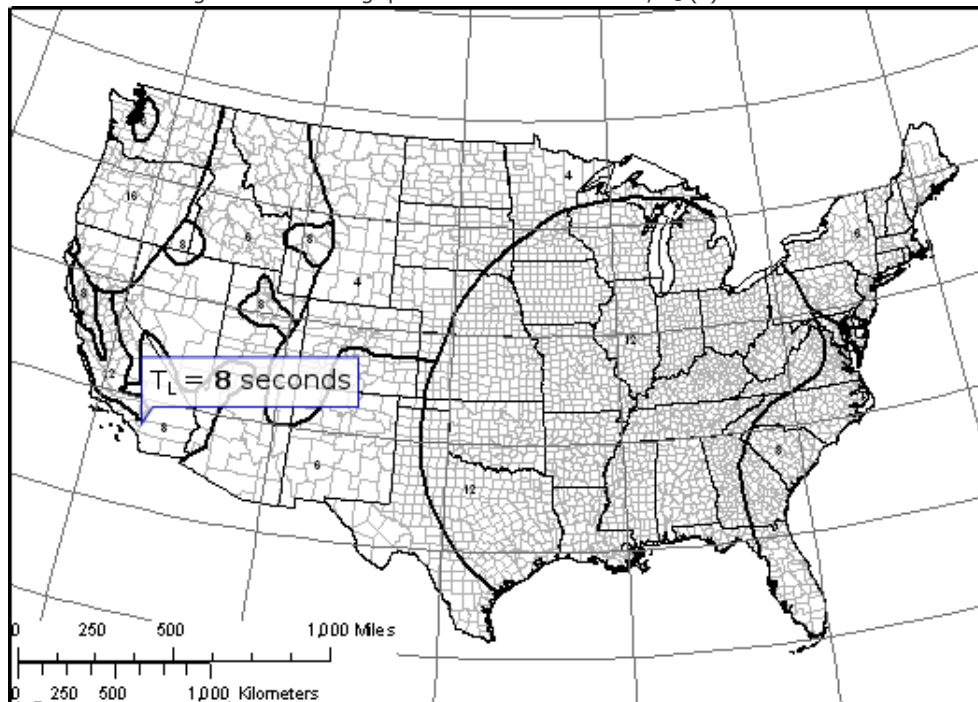
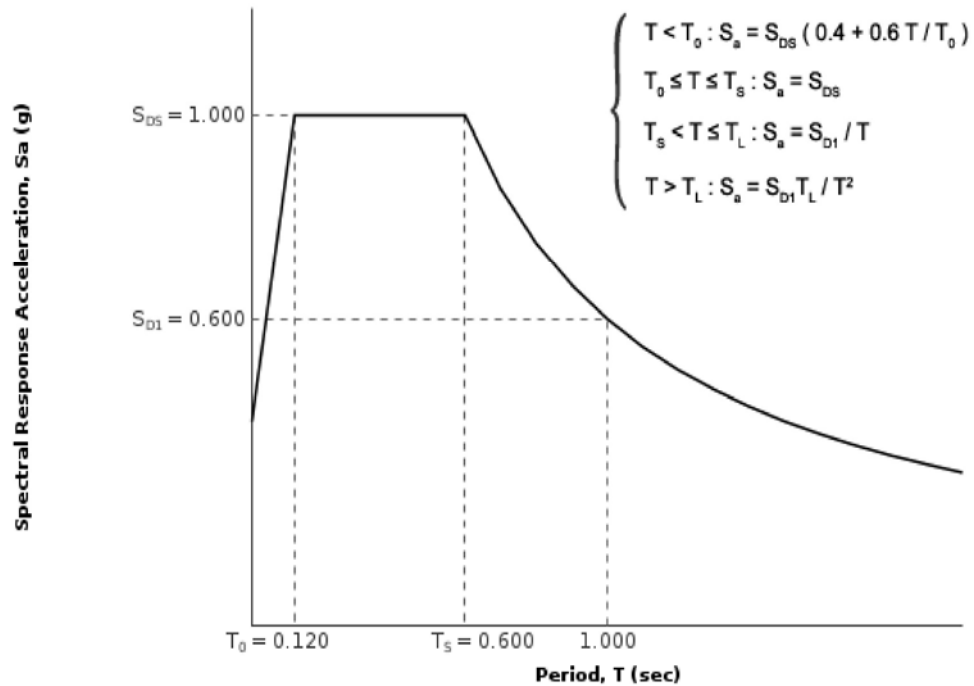
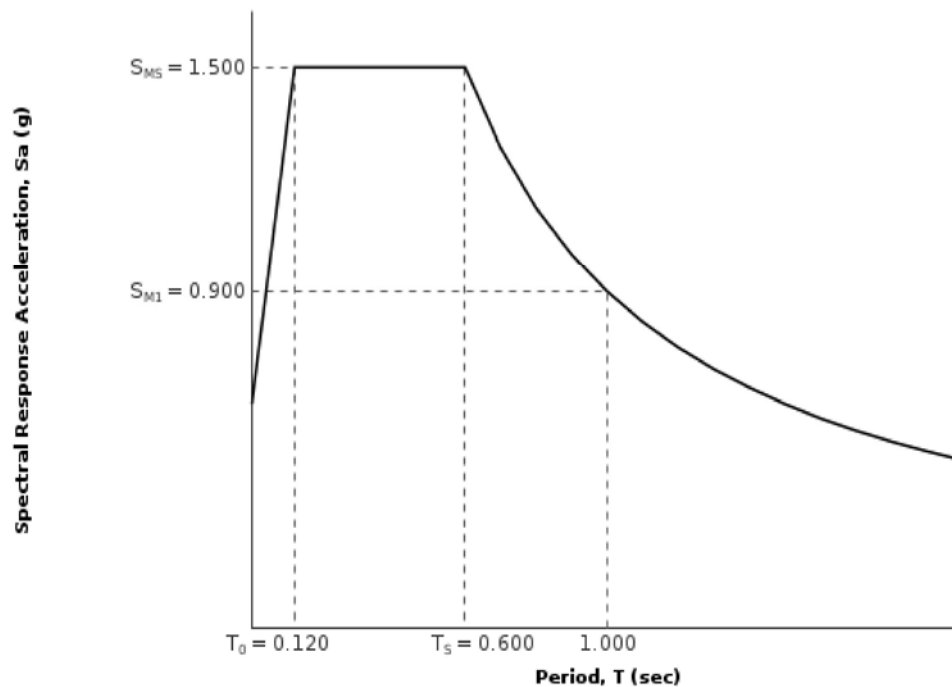
Figure 22-7: Long-period Transition Period,  $T_L$  (s)

Figure 11.4-1: Design Response Spectrum



### Section 11.4.6 — $MCE_R$ 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

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	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 = 0.600 g,  $F_{PGA} = 1.000$**

**Mapped PGA**

PGA = 0.600 g

**Equation (11.8-1):**

$$PGA_M = F_{PGA} PGA = 1.000 \times 0.600 = 0.600 \text{ g}$$

# **Design Maps Summary Report**

## User-Specified Input

**Report Title** P&F

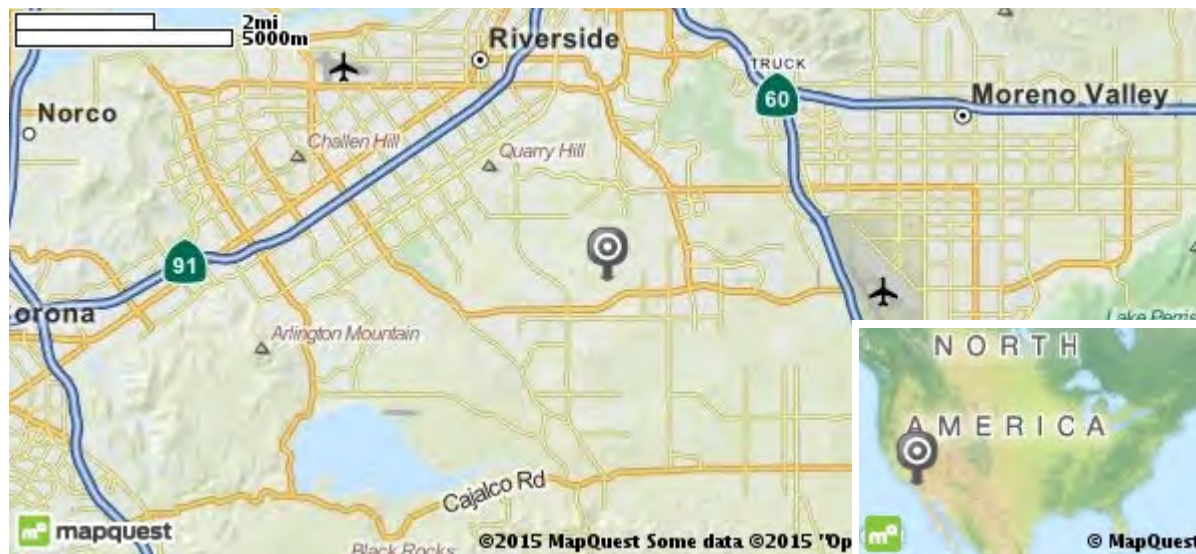
Tue April 14, 2015 20:59:20 UTC

**Building Code Reference Document** 2009 NEHRP Recommended Seismic Provisions  
(which utilizes USGS hazard data available in 2008)

**Site Coordinates** 33.89018°N, 117.352°W

**Site Soil Classification** Site Class D – “Stiff Soil”

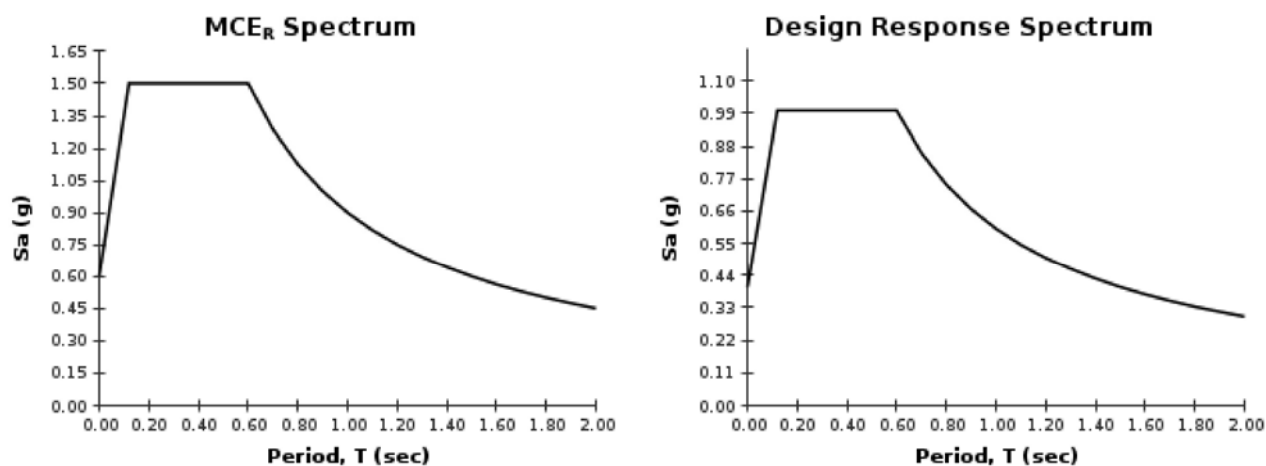
**Risk Category** I/II/III



## USGS-Provided Output

$S_s = 1.500 \text{ g}$	$S_{MS} = 1.500 \text{ g}$	$S_{DS} = 1.000 \text{ g}$
$S_1 = 0.600 \text{ g}$	$S_{M1} = 0.900 \text{ g}$	$S_{D1} = 0.600 \text{ g}$

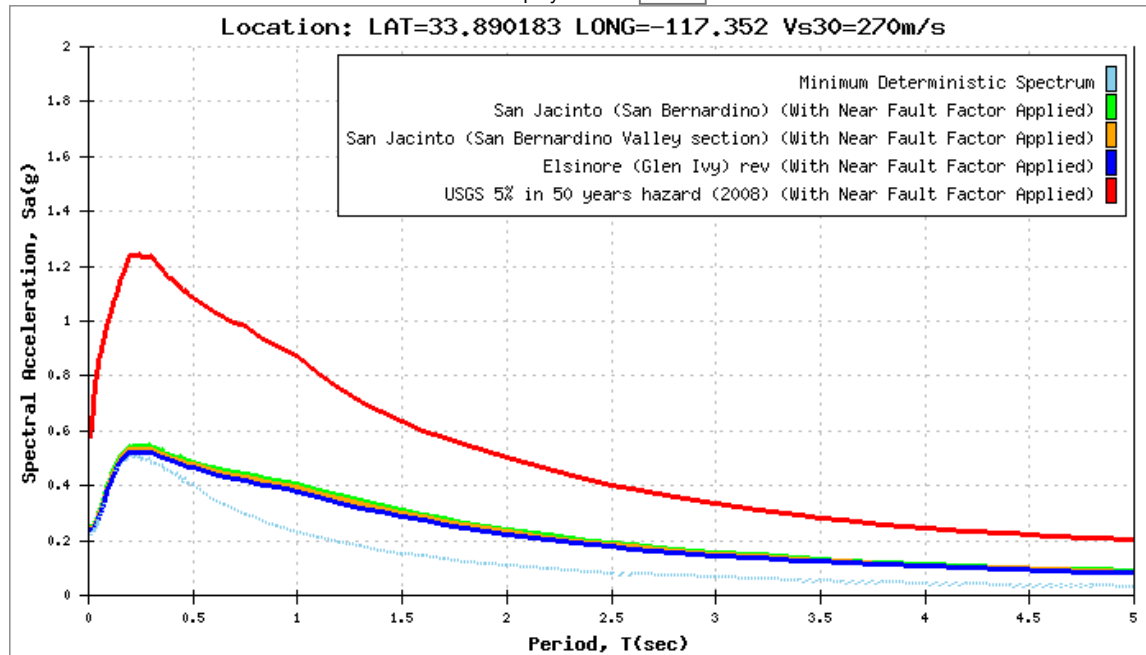
For information on how the  $S_s$  and  $S_1$  values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please [view the detailed report](#).



For  $PGA_M$ ,  $T_L$ ,  $C_{RS}$ , and  $C_{R1}$  values, please [view the detailed report](#).

## CALCULATED SPECTRA

Display Curves: 3 ▾



Tabular Data

Envelope Only

Hide Near Fault

Axis Scale

Show Basin

**Apply Near Fault Adjustment To:**

NOTE: Caltrans SDC requires application of a Near Fault Adjustment factor for sites less than 25 km (Rrup) from the causative fault.

☒ Deterministic Spectrum Using Km San Jacinto (San Bernardino) Km San Jacinto (San Bernardino Valley section) Km Elsinore (Glen Ivy) rev☒ Probabilistic Spectrum Using Km (Recommend Performing Deaggregation To Verify)☒ Show Spectrum with Adjustment Only☐ Show Spectrum with and without near fault Adjustment

**APPENDIX E**  
**GENERAL EARTHWORK AND GRADING**  
**SPECIFICATIONS**

## **EARTH-STRATA**

### **General Earthwork and Grading Specifications**

#### **General**

**Intent:** These General Earthwork and Grading Specifications are intended to be the minimum requirements for the grading and earthwork shown on the approved grading plan(s) and/or indicated in the geotechnical report(s). These General Earthwork and Grading Specifications should be considered a part of the recommendations contained in the geotechnical report(s) and if they are in conflict with the geotechnical report(s), the specific recommendations in the geotechnical report shall supersede these more general specifications. Observations made during earthwork operations by the project Geotechnical Consultant may result in new or revised recommendations that may supersede these specifications and/or the recommendations in the geotechnical report(s).

**The Geotechnical Consultant of Record:** The Owner shall employ a qualified Geotechnical Consultant of Record (Geotechnical Consultant), prior to commencement of grading or construction. The Geotechnical Consultant shall be responsible for reviewing the approved geotechnical report(s) and accepting the adequacy of the preliminary geotechnical findings, conclusions, and recommendations prior to the commencement of the grading or construction.

Prior to commencement of grading or construction, the Owner shall coordinate with the Geotechnical Consultant, and Earthwork Contractor (Contractor) to schedule sufficient personnel for the appropriate level of observation, mapping, and compaction testing.

During earthwork and grading operations, the Geotechnical Consultant shall observe, map, and document the subsurface conditions to confirm assumptions made during the geotechnical design phase of the project. Should the observed conditions differ significantly from the interpretive assumptions made during the design phase, the Geotechnical Consultant shall recommend appropriate changes to accommodate the observed conditions, and notify the reviewing agency where required.

The Geotechnical Consultant shall observe the moisture conditioning and processing of the excavations and fill materials. The Geotechnical Consultant should perform periodic relative density testing of fill materials to verify that the attained level of compaction is being accomplished as specified.

**The Earthwork Contractor:** The Earthwork Contractor (Contractor) shall be qualified, experienced, and knowledgeable in earthwork logistics, preparation and processing of earth materials to receive compacted fill, moisture-conditioning and processing of fill, and compacting fill. The Contractor shall be provided with the approved grading plans and geotechnical report(s) for his review and acceptance of responsibilities, prior to commencement of grading. The Contractor shall be solely responsible for performing the grading in accordance with the approved grading plans and geotechnical report(s). Prior to commencement of grading, the Contractor shall prepare and submit to the Owner and the Geotechnical Consultant a work plan that indicates the sequence of earthwork grading, the number of "equipment" of work and the estimated quantities of daily earthwork contemplated for the site. The Contractor shall inform the Owner and the Geotechnical Consultant of work schedule changes and revisions to the work plan at least 24 hours in advance of such changes so that appropriate personnel will be available for observation and testing. No assumptions shall be made by the Contractor with regard to whether the Geotechnical Consultant is aware of all grading operations.

It is the sole responsibility of the Contractor to provide adequate equipment and methods to accomplish the earthwork operations in accordance with the applicable grading codes and agency ordinances, these specifications, and the recommendations in the approved geotechnical report(s) and grading plan(s). At the sole discretion of the Geotechnical Consultant, any unsatisfactory conditions, such as unsuitable earth materials, improper moisture conditioning, inadequate compaction, insufficient buttress keyway size, adverse weather conditions, etc., resulting in a quality of work less than required in the approved grading plans and geotechnical report(s), the Geotechnical Consultant shall reject the work and may recommend to the Owner that grading be stopped until conditions are corrected.

### **Preparation of Areas for Compacted Fill**

**Clearing and Grubbing:** Vegetation, such as brush, grass, roots, and other deleterious material shall be sufficiently removed and properly disposed in a method acceptable to the Owner, Geotechnical Consultant, and governing agencies.

The Geotechnical Consultant shall evaluate the extent of these removals on a site by site basis. Earth materials to be placed as compacted fill shall not contain more than 1 percent organic materials (by volume). No compacted fill lift shall contain more than 10 percent organic matter.

Should potentially hazardous materials be encountered, the Contractor shall stop work in the affected area, and a hazardous materials specialist shall immediately be consulted to evaluate the potentially hazardous materials, prior to continuing to work in that area.

It is our understanding that the State of California defines most refined petroleum products (gasoline, diesel fuel, motor oil, grease, coolant, etc.) as hazardous waste. As such, indiscriminate dumping or spillage of these fluids may constitute a misdemeanor, punishable by fines and/or imprisonment, and shall be prohibited. The contractor is responsible for all hazardous waste related to his operations. The Geotechnical Consultant does not have expertise in this area. If hazardous waste is a concern, then the Owner should contract the services of a qualified environmental assessor.

**Processing:** Exposed earth materials that have been observed to be satisfactory for support of compacted fill by the Geotechnical Consultant shall be scarified to a minimum depth of 6 inches. Exposed earth materials that are not observed to be satisfactory shall be removed or alternative recommendations may be provided by the Geotechnical Consultant. Scarification shall continue until the exposed earth materials are broken down and free of oversize material and the working surface is reasonably uniform, flat, and free of uneven features that would inhibit uniform compaction. The earth materials should be moistened or air dried to near optimum moisture content, prior to compaction.

**Overexcavation:** The Cut Lot Typical Detail and Cut/Fill Transition Lot Typical Detail, included herein provides a graphic illustration that depicts typical overexcavation recommendations made in the approved geotechnical report(s) and/or grading plan(s).

**Keyways and Benching:** Where fills are to be placed on slopes steeper than 5:1 (horizontal to vertical units), the ground shall be thoroughly benched as compacted fill is placed. Please see the three Keyway and Benching Typical Details with subtitles Cut Over Fill Slope, Fill Over Cut Slope, and Fill Slope for a graphic illustration. The lowest bench or smallest keyway shall be a minimum of 15 feet wide (or  $\frac{1}{2}$  the proposed slope height) and at least 2 feet into competent earth materials as advised by the Geotechnical Consultant. Typical benches shall be excavated a minimum height of 4 feet into competent earth materials or as recommended by the Geotechnical Consultant. Fill placed on slopes steeper than 5:1 should be thoroughly benched or otherwise excavated to provide a flat subgrade for the compacted fill.

**Evaluation/Acceptance of Bottom Excavations:** All areas to receive compacted fill (bottom excavations), including removal excavations, processed areas, keyways, and benching, shall be observed, mapped, general elevations recorded, and/or tested prior to being accepted by the Geotechnical Consultant as suitable to receive compacted fill. The Contractor shall obtain a written acceptance from the Geotechnical Consultant prior to placing compacted fill. A licensed surveyor shall provide the survey control for determining elevations of bottom excavations, processed areas, keyways, and

benching. The Geotechnical Consultant is not responsible for erroneously located, fills, subdrain systems, or excavations.

## **Fill Materials**

**General:** Earth material to be used as compacted fill should to a large extent be free of organic matter and other deleterious substances as evaluated and accepted by the Geotechnical Consultant.

**Oversize:** Oversize material is rock that does not break down into smaller pieces and has a maximum diameter greater than 8 inches. Oversize rock shall not be included within compacted fill unless specific methods and guidelines acceptable to the Geotechnical Consultant are followed. For examples of methods and guidelines of oversize rock placement see the enclosed Oversize Rock Disposal Detail. The inclusion of oversize materials in the compacted fill shall only be acceptable if the oversize material is completely surrounded by compacted fill or thoroughly jetted granular materials. No oversize material shall be placed within 10 vertical feet of finish grade or within 2 feet of proposed utilities or underground improvements.

**Import:** Should imported earth materials be required, the proposed import materials shall meet the requirements of the Geotechnical Consultant. Well graded, very low expansion potential earth materials free of organic matter and other deleterious substances are usually sought after as import materials. However, it is generally in the Owners best interest that potential import earth materials are provided to the Geotechnical Consultant to determine their suitability for the intended purpose. At least 48 hours should be allotted for the appropriate laboratory testing to be performed, prior to starting the import operations.

## **Fill Placement and Compaction Procedures**

**Fill Layers:** Fill materials shall be placed in areas prepared to receive fill in nearly horizontal layers not exceeding 8 inches in loose thickness. Thicker layers may be accepted by the Geotechnical Consultant, provided field density testing indicates that the grading procedures can adequately compact the thicker layers. Each layer of fill shall be spread evenly and thoroughly mixed to obtain uniformity within the earth materials and consistent moisture throughout the fill.

**Moisture Conditioning of Fill:** Earth materials to be placed as compacted fill shall be watered, dried, blended, and/or mixed, as needed to obtain relatively uniform moisture contents that are at or slightly above optimum. The maximum density and optimum moisture content tests should be performed in accordance with the American Society of Testing and Materials (ASTM test method D1557-00).



**Compaction of Fill:** After each layer has been moisture-conditioned, mixed, and evenly spread, it should be uniformly compacted to a minimum of 90 percent of maximum dry density as determined by ASTM test method D1557-00. Compaction equipment shall be adequately sized and be either specifically designed for compaction of earth materials or be proven to consistently achieve the required level of compaction.

**Compaction of Fill Slopes:** In addition to normal compaction procedures specified above, additional effort to obtain compaction on slopes is needed. This may be accomplished by backrolling of slopes with sheepsfoot rollers as the fill is being placed, by overbuilding the fill slopes, or by other methods producing results that are satisfactory to the Geotechnical Consultant. Upon completion of grading, relative compaction of the fill and the slope face shall be a minimum of 90 percent of maximum density per ASTM test method D1557-00.

**Compaction Testing of Fill:** Field tests for moisture content and relative density of the compacted fill earth materials shall be periodically performed by the Geotechnical Consultant. The location and frequency of tests shall be at the Geotechnical Consultant's discretion based on field observations. Compaction test locations will not necessarily be random. The test locations may or may not be selected to verify minimum compaction requirements in areas that are typically prone to inadequate compaction, such as close to slope faces and near benching.

**Frequency of Compaction Testing:** Compaction tests shall be taken at minimum intervals of every 2 vertical feet and/or per 1,000 cubic yards of compacted materials placed. Additionally, as a guideline, at least one (1) test shall be taken on slope faces for each 5,000 square feet of slope face and/or for each 10 vertical feet of slope. The Contractor shall assure that fill placement is such that the testing schedule described herein can be accomplished by the Geotechnical Consultant. The Contractor shall stop or slow down the earthwork operations to a safe level so that these minimum standards can be obtained.

**Compaction Test Locations:** The approximate elevation and horizontal coordinates of each test location shall be documented by the Geotechnical Consultant. The Contractor shall coordinate with the Surveyor to assure that sufficient grade stakes are established. This will provide the Geotechnical Consultant with sufficient accuracy to determine the approximate test locations and elevations. The Geotechnical Consultant can not be responsible for staking erroneously located by the Surveyor or Contractor. A minimum of two grade stakes should be provided at a maximum horizontal distance of 100 feet and vertical difference of less than 5 feet.

## **Subdrain System Installation**

Subdrain systems shall be installed in accordance with the approved geotechnical report(s), the approved grading plan, and the typical details provided herein. The Geotechnical Consultant may recommend additional subdrain systems and/or changes to the subdrain systems described herein, with regard to the extent, location, grade, or material depending on conditions encountered during grading or other factors. All subdrain systems shall be surveyed by a licensed land surveyor (except for retaining wall subdrain systems) to verify line and grade after installation and prior to burial. Adequate time should be allowed by the Contractor to complete these surveys.

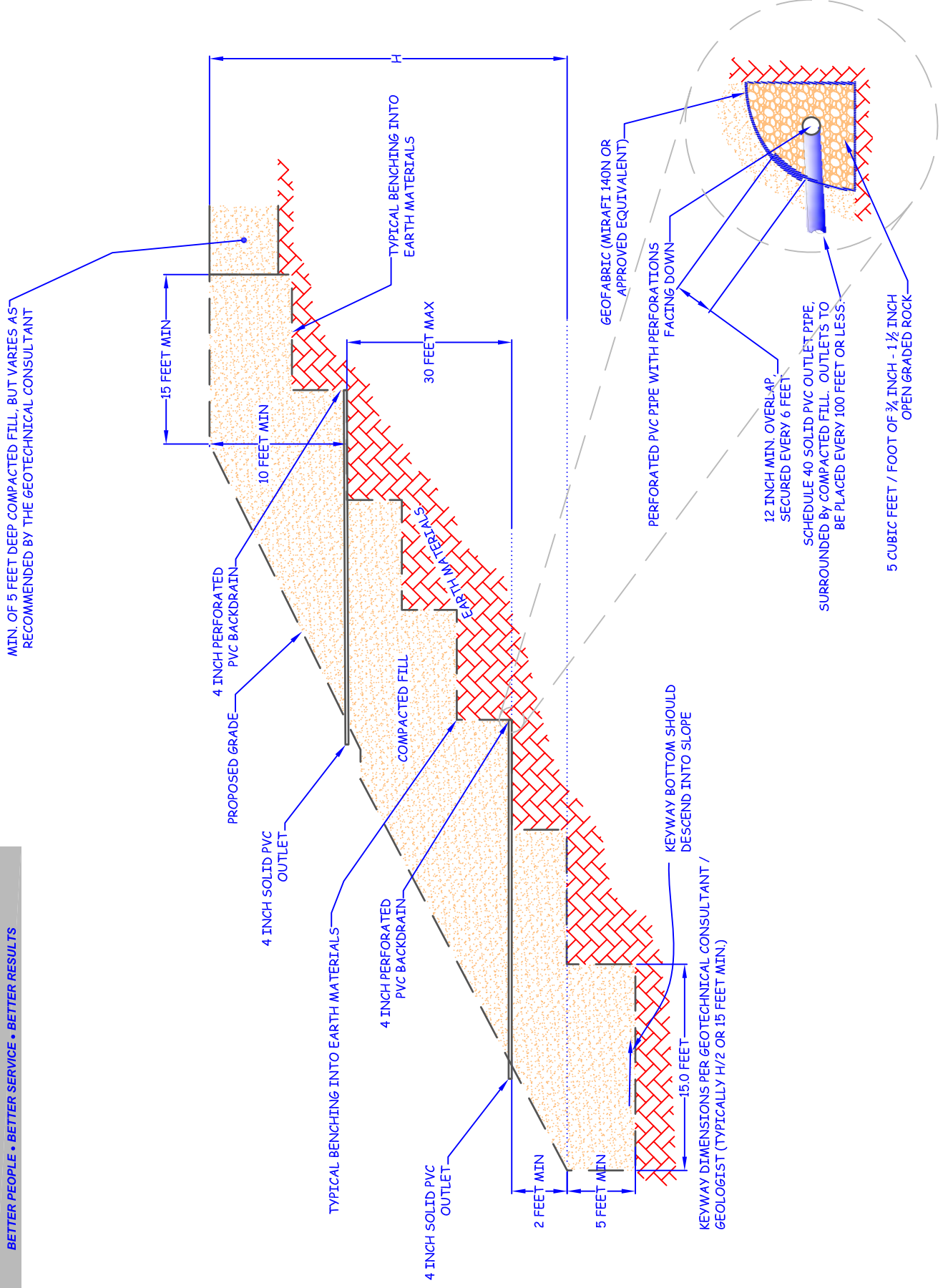
## **Excavation**

All excavations and over-excavations for remedial purposes shall be evaluated by the Geotechnical Consultant during grading operations. Remedial removal depths indicated on the geotechnical plans are estimates only. The actual removal depths and extent shall be determined by the Geotechnical Consultant based on the field evaluation of exposed conditions during grading operations. Where fill over cut slopes are planned, the cut portion of the slope shall be excavated, evaluated, and accepted by the Geotechnical Consultant prior to placement of the fill portion of the proposed slope, unless specifically addressed by the Geotechnical Consultant. Typical details for cut over fill slopes and fill over cut slopes are provided herein.

## **Trench Backfill**

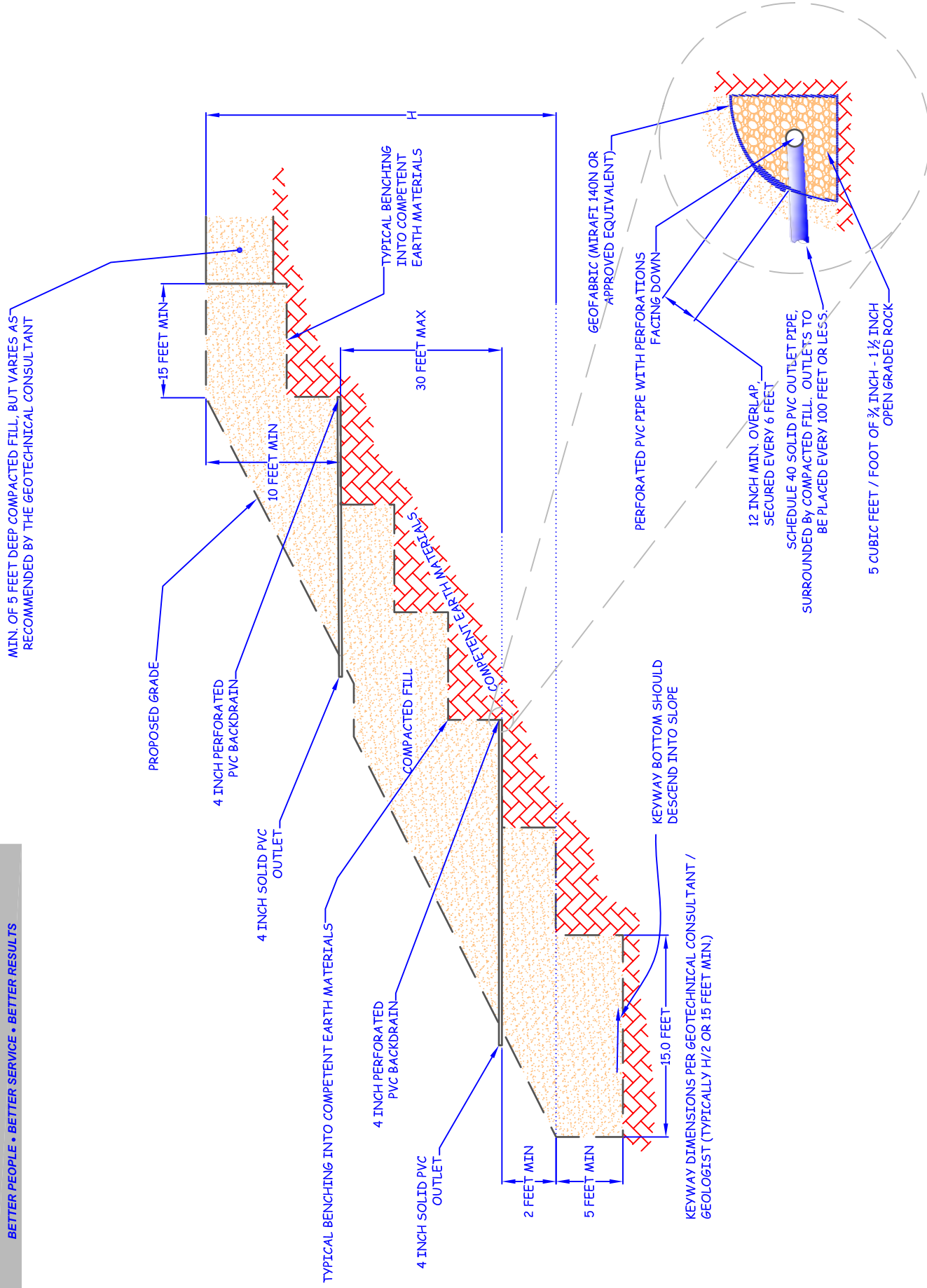
- 1) The Contractor shall follow all OHSA and Cal/OSHA requirements for trench excavation safety.
- 2) Bedding and backfill of utility trenches shall be done in accordance with the applicable provisions in the Standard Specifications of Public Works Construction. Bedding materials shall have a Sand Equivalency more than 30 (SE>30). The bedding shall be placed to 1 foot over the conduit and thoroughly jetting to provide densification. Backfill should be compacted to a minimum of 90 percent of maximum dry density, from 1 foot above the top of the conduit to the surface.
- 3) Jetting of the bedding materials around the conduits shall be observed by the Geotechnical Consultant.
- 4) The Geotechnical Consultant shall test trench backfill for the minimum compaction requirements recommended herein. At least one test should be conducted for every 300 linear feet of trench and for each 2 vertical feet of backfill.
- 5) For trench backfill the lift thicknesses shall not exceed those allowed in the Standard Specifications of Public Works Construction, unless the Contractor can demonstrate to the Geotechnical Consultant that the fill lift can be compacted to the minimum relative compaction by his alternative equipment or method.

## STABILIZATION FILL TYPICAL DETAIL

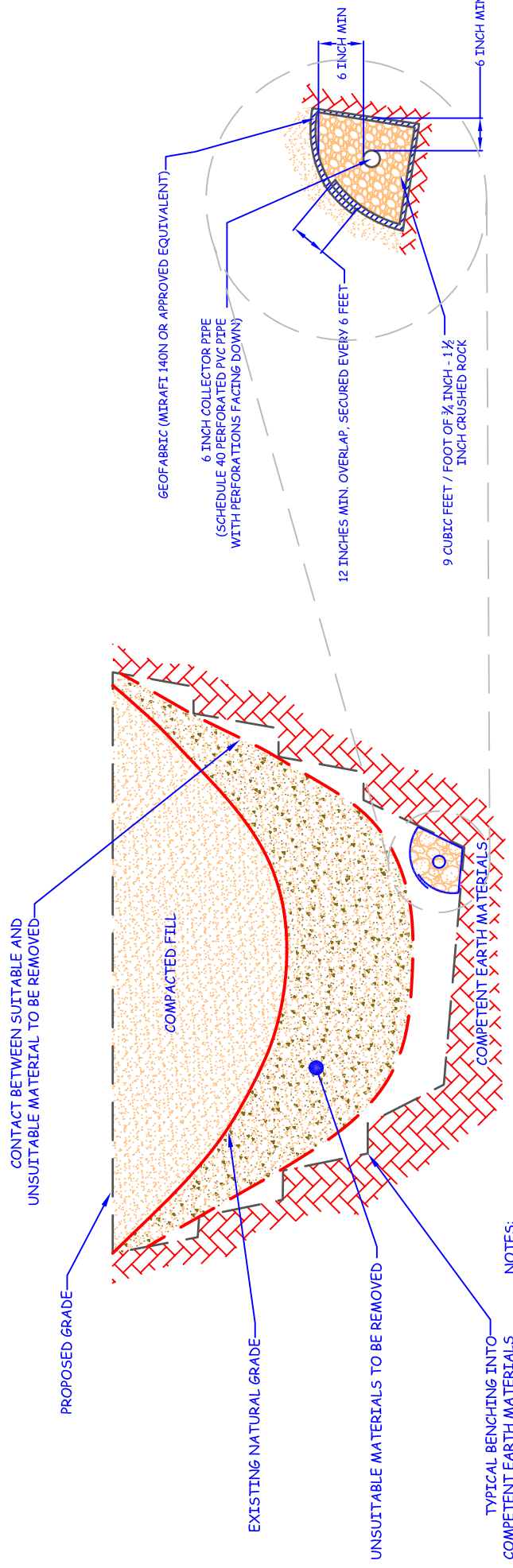


## BUTTRESS TYPICAL DETAIL

MIN. OF 5 FEET DEEP COMPACTED FILL, BUT VARIES AS  
RECOMMENDED BY THE GEOTECHNICAL CONSULTANT



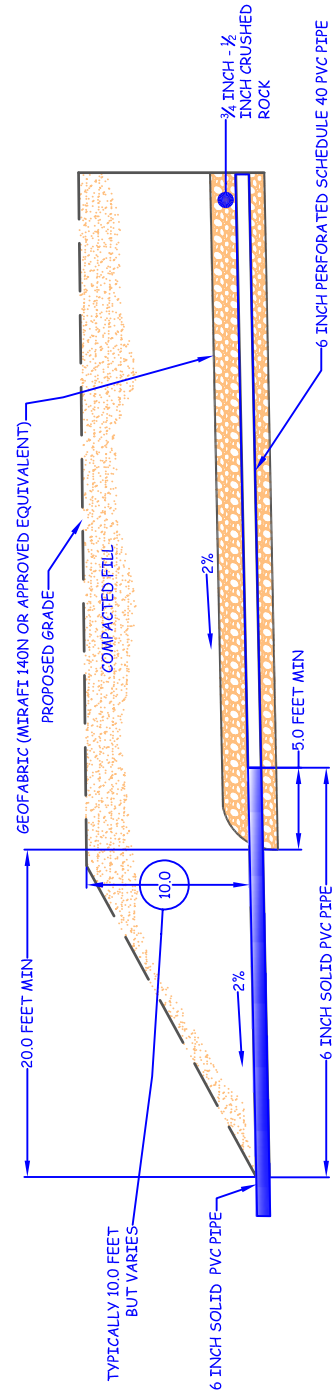
## CANYON SUBDRAIN SYSTEM TYPICAL DETAIL



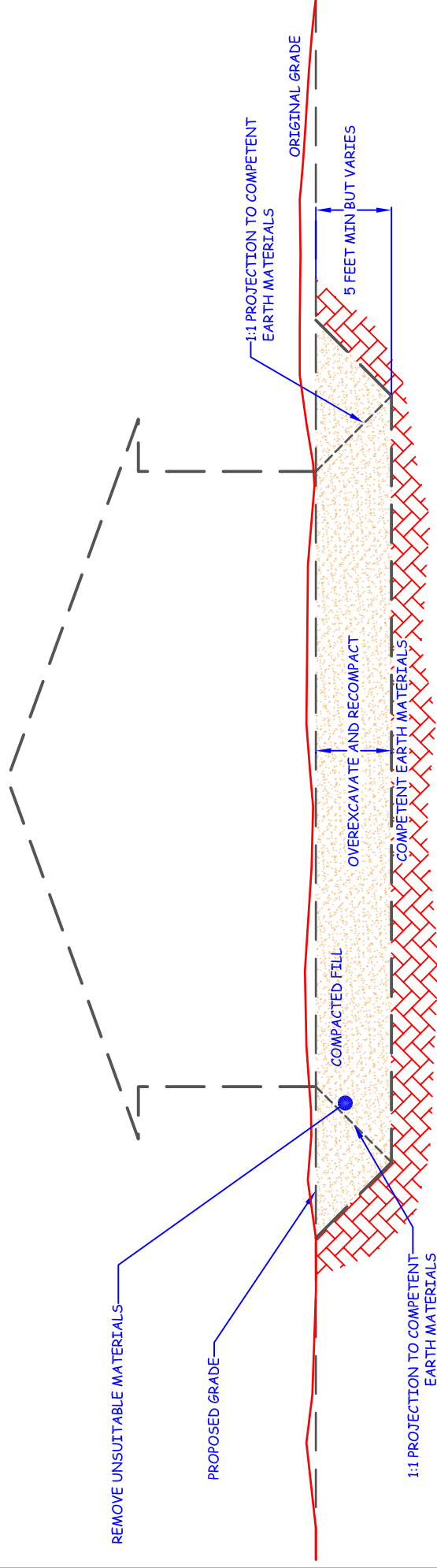
NOTES:  
1 - CONTINUOUS RUNS IN EXCESS OF 500 FEET  
LONG WILL REQUIRE AN 8 INCH DIAMETER PIPE.

2 - FINAL 20 FEET OF PIPE AT OUTLET WILL BE SOLID AND BACKFILLED WITH COMPACTED FINE-GRAINED EARTH MATERIALS.

## CANYON SUBDRAIN TYPICAL OUTLET



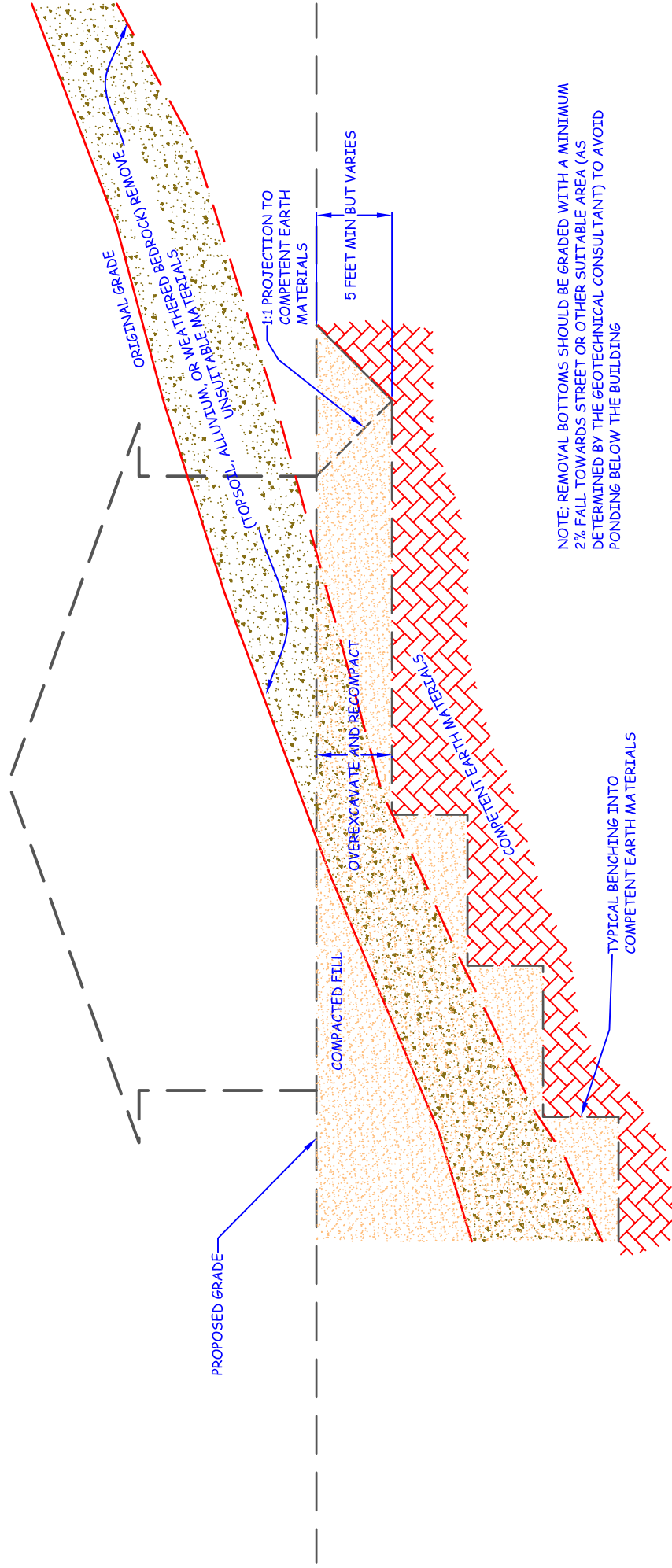
## CUT LOT TYPICAL DETAIL



NOTE: REMOVAL BOTTOMS SHOULD BE GRADED WITH A MINIMUM 2% FALL TOWARDS STREET OR OTHER SUITABLE AREA (AS DETERMINED BY THE GEOTECHNICAL CONSULTANT) TO AVOID PONDING BELOW THE BUILDING

NOTE: WHERE DESIGN CUT LOTS ARE EXCAVATED ENTIRELY INTO COMPETENT EARTH MATERIALS, OVEREXCAVATION MAY STILL BE NEEDED FOR HARD-ROCK CONDITIONS OR MATERIALS WITH VARIABLE EXPANSION POTENTIALS

## CUT / FILL TRANSITION LOT TYPICAL DETAIL

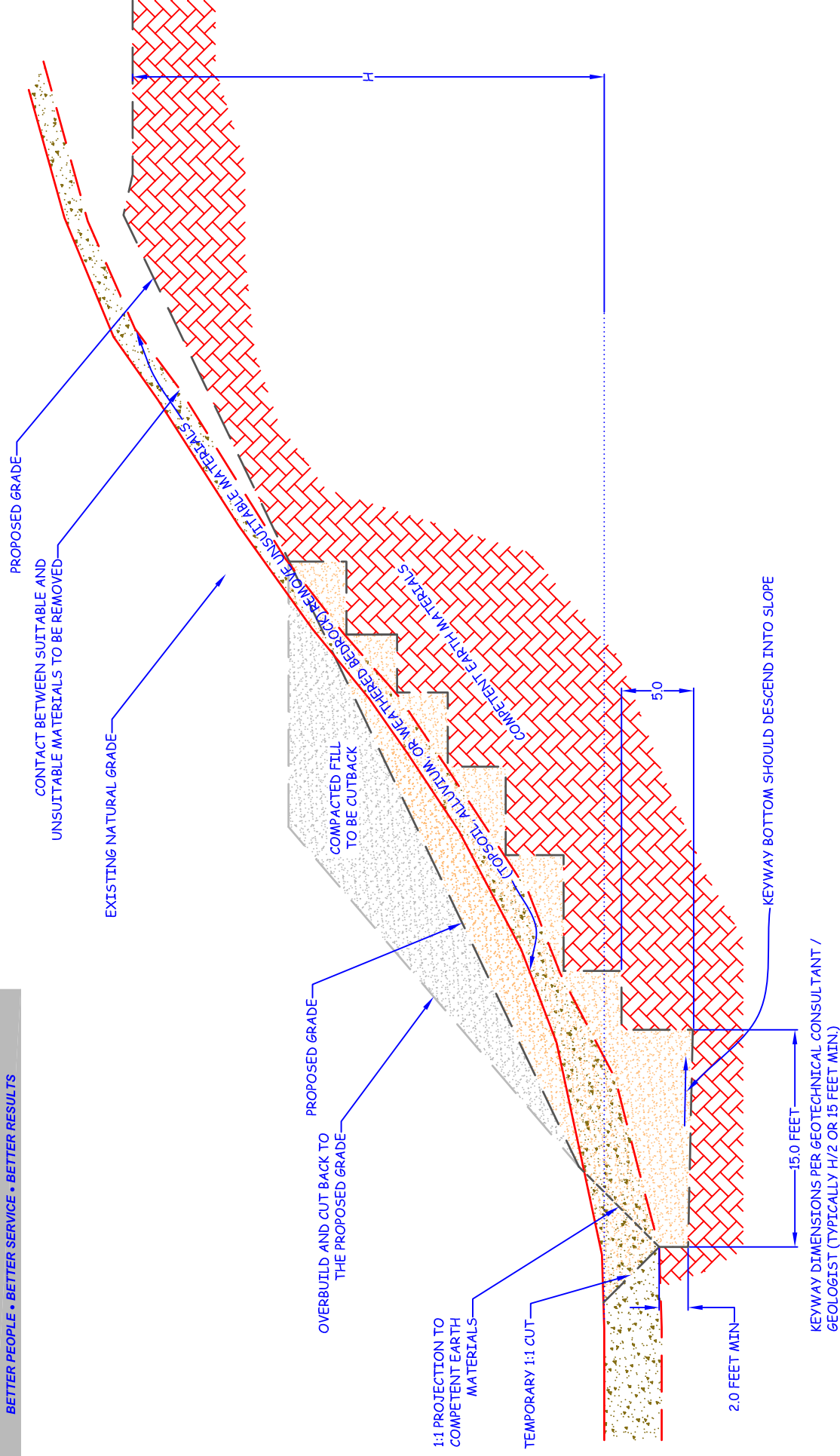


NOTE: REMOVAL BOTTOMS SHOULD BE GRADED WITH A MINIMUM 2% FALL TOWARDS STREET OR OTHER SUITABLE AREA (AS DETERMINED BY THE GEOTECHNICAL CONSULTANT) TO AVOID PONDING BELOW THE BUILDING

NOTE: WHERE DESIGN CUT LOTS ARE EXCAVATED ENTIRELY INTO COMPETENT EARTH MATERIALS, OVEREXCAVATION MAY STILL BE NEEDED FOR HARD-ROCK CONDITIONS OR MATERIALS WITH VARIABLE EXPANSION POTENTIALS



## KEYWAY & BENCHING TYPICAL DETAILS CUT OVER FILL SLOPE

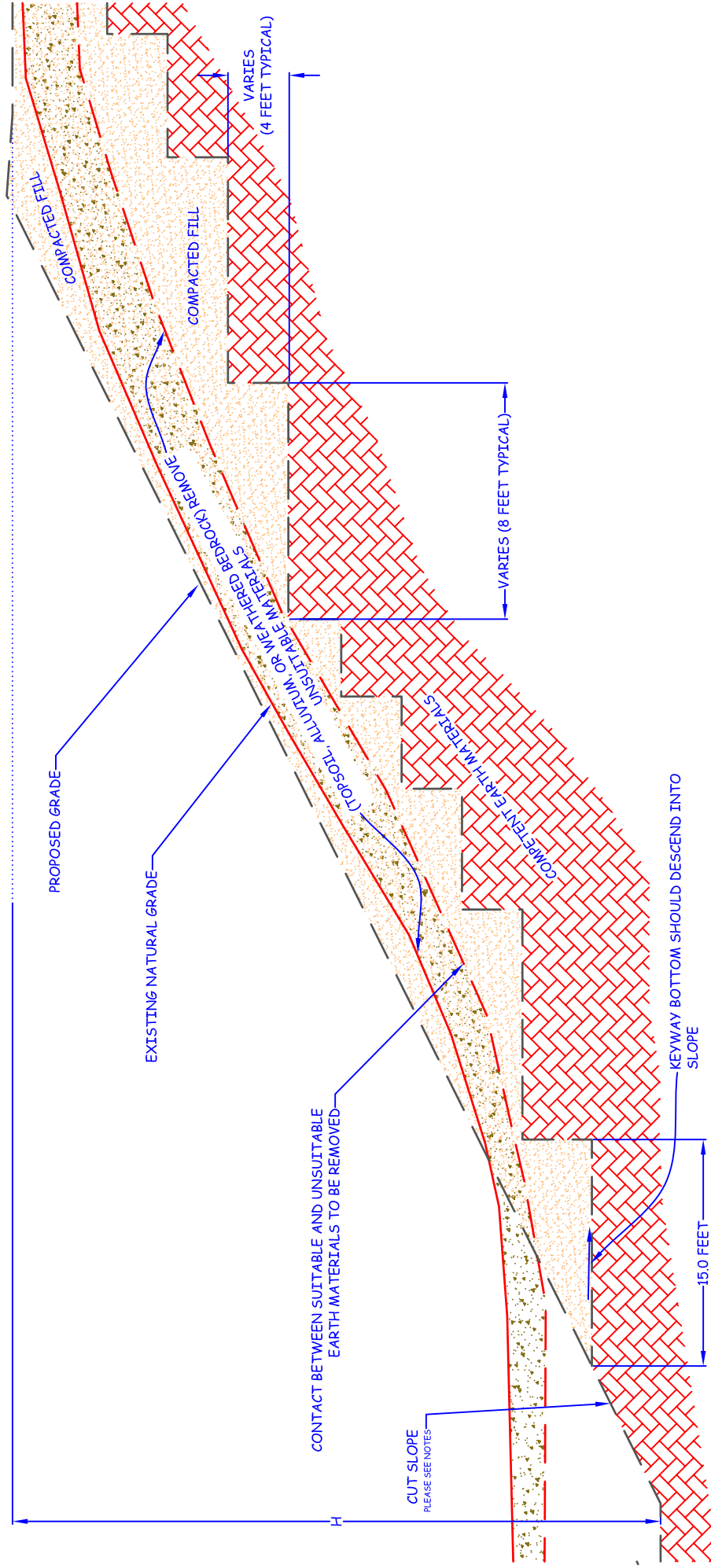


NOTE:

NATURAL SLOPES STEEPER THAN 5:1 (H:V) MUST BE BENCHED INTO COMPETENT EARTH MATERIALS



## KEYWAY & BENCHING TYPICAL DETAILS FILL OVER CUT SLOPE

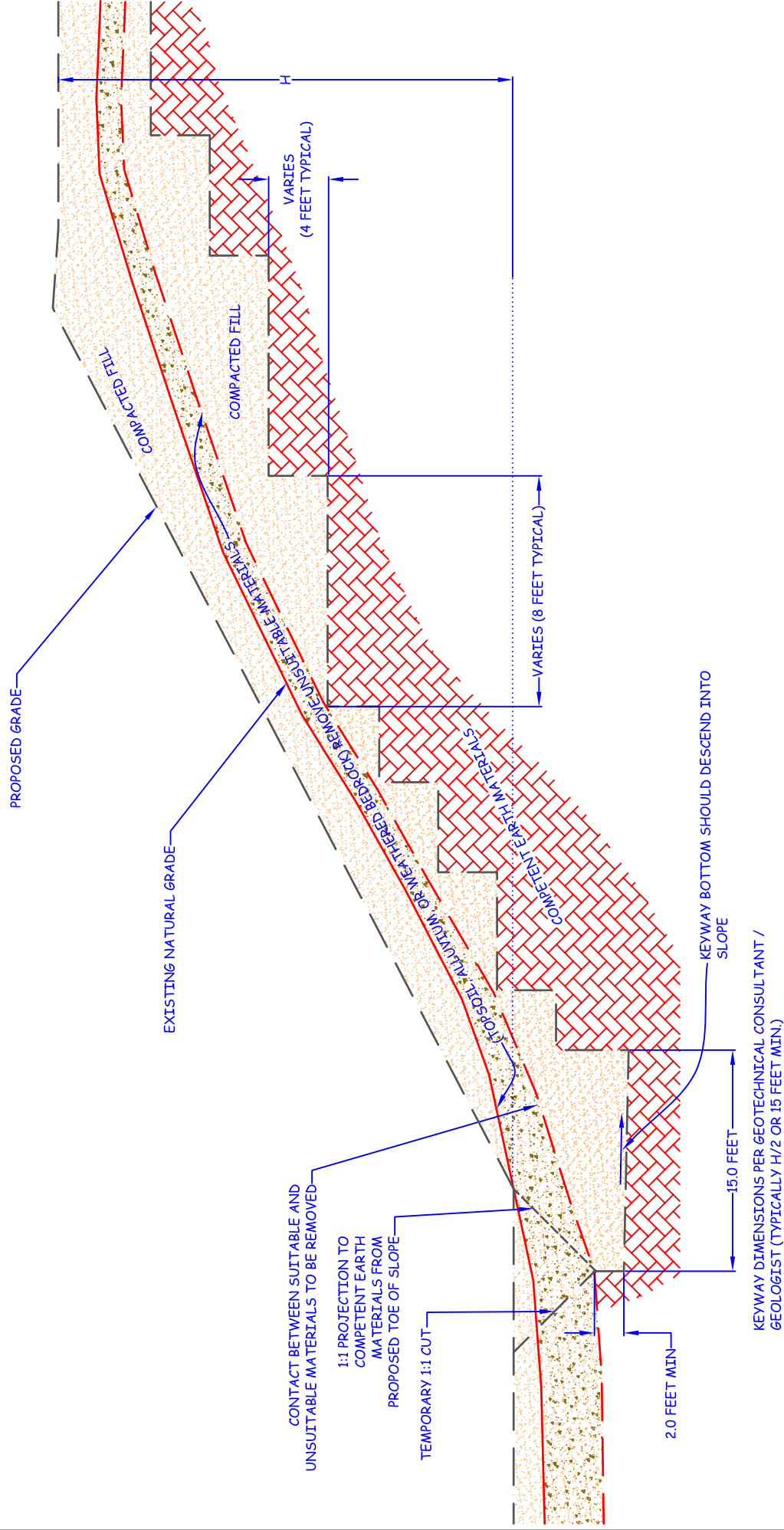


NOTES:

- NATURAL SLOPES STEEPER THAN 5:1 (H:V) MUST BE BENCHING INTO COMPETENT EARTH MATERIALS
- THE CUT SLOPE MUST BE CONSTRUCTED FIRST

KEYWAY DIMENSIONS PER GEOTECHNICAL CONSULTANT / GEOLOGIST (TYPICALLY H/2 OR 15 FEET MIN.)

## FILL SLOPE



NOTES:

NATURAL SLOPES STEEPER THAN 5:1 (H:V) MUST BE BENCHED INTO COMPETENT EARTH MATERIALS

## OVERSIZE ROCK TYPICAL DETAIL

