Appendix E-6

Geotechnical Due-Diligence/Feasibility Assessment

October 18, 2021
P.N. 21-303

SHOPOFF ADVISORS, LP
2 Park Plaza, Suite 700
Irvine, California 92614

Attention: Mr. David Graves

Subject: **Desktop Geotechnical Due-Diligence/Feasibility Assessment, *Mesa Verde Project*, Approximately 1,492 Acres West of the I-10 Freeway, Adjacent and South of the San Bernardino/Riverside County Line and Approximately One-Mile North of San Timoteo Road, Revised Tentative Tract Map 33931, City of Calimesa, Riverside County, California**

References:

Hushmand Associates, Inc. and Petra Geotechnical, Inc., 2004, Limited Geotechnical Investigation in Support of EIR Activities for Oak Valley at Calimesa, Riverside County, California, dated June 7.

Petra Geotechnical, Inc. and Hushmand Associates, Inc., 2004, Fault Investigation, Oak Valley at Calimesa, Riverside County, California, J.N. 04-238 dated October 20.

Petra Geotechnical, Inc., 2006, Response to a Review Sheet prepared by Arroyo Geotechnical for Fault Investigation Report, Oak Valley Development, Geotechnical Investigation Report, J.N. 04-238 dated July 10.

_______, 2014, Preliminary Geotechnical Investigation, Phase 1 of the Mesa Verde Project, City of Calimesa, Riverside County, California, J.N. 13-546 dated November 18.

Dear Mr. Graves:

In accordance with your request, **Petra Geosciences, Inc. (Petra)** has performed a desktop geotechnical evaluation of the subject, approximately 1500-acre site in the city of Calimesa, California. This report presents our findings and professional opinions with respect to the geotechnical feasibility of the proposed, mixed use residential/logistics operations development, geotechnical constraints that should be taken into consideration during the development of the site, and potential mitigation measures to bring the site to compliance from a geotechnical engineering viewpoint.

It must be emphasized that this report is intended as a ***feasibility****-level geotechnical assessment only and is based solely on a review of the referenced background geologic literature and our knowledge of the site. As such, the contents of this report are not suitable for submittal to regulatory agencies, nor should the findings or conclusions provided herein be relied upon for earthwork, quantity calculation or procedure, or structural engineering design. This geotechnical evaluation does not address soil contamination or other environmental issues affecting the property, which will be provided under separate cover.*

SITE GENERAL OVERVIEW

The 1,492-acre property consists of 14 parcels in Riverside County and 2 parcels in San Bernardino County, and is situated within the limits of the City of Calimesa. The site is located west of the Interstate 10 (I-10) Freeway, south of W. County Line Road/Lane, north of San Timoteo Canyon Road, and southeast of Live Oak Canyon Road in Riverside County, California, see Figure 1. A small area along the north-central portion of the site lies within San Bernardino County. Unimproved dirt roads provide access to the site. Aa plan showing prominent features and man-made improvements within the site is included as Figure 2.

According to the California Department of Conservation Geologic Energy Management Division's (CalGEM) online mapping application Well Finder (2021), the site is located within portions of Sections 14 through 17, 22 and 23, Township 02 South, Range 02 West, San Bernardino Base and Meridian. Topographically, onsite elevations range between approximately 2,040± to 2,390± feet above mean sea level (amsl).

DUE DILIGENCE ASSESSMENT

Literature Review

Petra has reviewed the referenced reports and available published and unpublished geologic/geotechnical maps and literature, as well as online aerial imagery in the general area of the project site.

Site Reconnaissance

A representative of Petra conducted a site reconnaissance and performed photo documentation on July 30, 2021 and again on September 18, 2021 to observe the current surface conditions at the subject site.

FINDINGS

Proposed Development

It is our understanding that the proposed development is anticipated to include residential dwellings and recreational areas, industrial parks including several large-scale (on the order of ½ million square feet) logistics operations and associated public streets and utility lines.

Site Reconnaissance

A representative of Petra conducted a site reconnaissance and performed photo documentation on July 30, 2021 and again on September 18, 2021 to observe the current surface conditions at subject site.

Access to the westerly half of the site is currently via a dirt road off the Henry N. Wochholz Wastewater Treatment Plant on West County Line Road. Access to the easterly half of the property is via a dirt road off Sandalwood Drive, 7th Street, and the paved Shady Brook Road.

The subject property is undeveloped land that has been dissected by deeply incised, northeast to southwest flowing natural drainages. The exception is the west-flowing drainage along the southeast property boundary, which ultimately flows southerly below the subject property boundary. The subject property consists of relatively level hilltops/mesas with intermittent narrow to broad natural drainages. Dirt roads are common throughout the site. Asphalt-paved roads exist in the northeast corner of the property (W. County Line Road and Lane); in the easterly portion of the site (Sandalwood Drive); and in the southeast corner of the property (Shady Brook Road).

Overall, the subject property appears to be in a natural condition with generally minor manmade features. In addition to existing fills associated with the improved perimeter roadways, there are approximately six earthen embankments scattered within drainages onsite, likely related to historical erosion control in canyons utilized as grazing meadows and watering holes for cattle. Piles of concrete rubble and lumber, likely remnants of former ranching/farming structures, were observed near the former olive grove orchard in the northeastern portion of the site. Also in this area were two rather long windrows of concrete rubble, that is our understanding, were derived from the demolition of a concrete culvert in the northern portion of the central creek. The two abutments were observed to remain in-place. Concrete rubble associated with what appeared to be a third ranch structure was observed near the subject site boundary in the southeast central portion of the subject property. Dates of 1950 and 1951 were etched in the mortar at two locations of the southern ranch area. Three main areas of off-road tracks were noted within the site boundary: two within the western portion of the site and one in the central area near the main creek.

What appeared to be a relatively small, graded basin was observed in the central portion of the site. An old backhoe test pit was noted in the basin. Considering historical records, this appeared to be the area of an inactive oil well (i.e., mud sump). Two inactive water wells were observed within the site: one near the north-central property boundary and one near the southern edge of Shady Brook Road. Two small pits and remnants of underground electrical conduits, including a concrete transformer pad with PVC riser, were observed near the northern well area which was also a pump station. The southern well was enclosed by corrugated metal siding, with a relatively large basin and outlet pipe to the south.

Within localized areas of the property, small to relatively large areas of dumped trash, concrete rubble, and debris were observed. For example, Shady Brook Road contained roll-off dumpsters; stockpiled asphaltic concrete spoils from grinding operations; abundant concrete rubble; paint containers; buckets of waste oil and “other” fluids; landscape wastes; and rubber tires. A homeless tent was also observed. Typical household debris was observed in and around the main creek near the concrete abutments (in the northeasterly portion of the site), consisting of furniture, plastic, lumber, carpet, glass, paper, clothing, drywall, and other general trash. Concrete, asphalt, and brick rubble, as well as large diameter concrete storm drain pipes were noted in the canyon area southeast of the offsite trailer park, near the east central site limits. In addition, a couple of areas were found to contain spent shotgun shells and general trash; a washing machine; old truck bed; and abandoned vehicle.

At the time of our site reconnaissance, thin dry grasses covered the mesas of the property. Areas of heavy native brush were also common on the canyon slopes. Small clusters of oak trees were observed in a few areas. Remnants of an olive orchard were observed in the northeasterly portion of the property.

Overhead power poles were observed in the northeasterly portion of the property; along W. County Line Road; near the northeasterly end of the onsite creek, where remnants of demolished farm/ranch structures were observed; and along 7th Street.

Selective pictures of the site taken during our site reconnaissance are provided in Appendix A and an aerial photograph location map showing prominent and manmade features is presented on Figure 2.

Literature Review

Petra has reviewed the available geotechnical reports of record for the site prepared by a joint effort between Hushmand and Associates, Inc. and Petra Geotechnical, Inc. dated June 7, 2004 (HAI/PGI, 2004), Petra Geotechnical, Inc. and Hushmand and Associates, Inc. dated October 20, 2004 (PGI/HAI, 2004) and that by Petra Geotechnical, Inc. dated November 18, 2014 (PGI, 2014), (see references). Noteworthy findings made from reviewing these reports are discussed herein with any commentary by Petra in *italics* and parentheses.

HAI/PGI Limited Geotechnical Investigation Report (2004)

- This report describes a limited geotechnical investigation performed in support of environmental impact report (EIR) activities for the Oak Valley at Calimesa development.
- The project area comprises about 1539 acres, which is the northern part of the larger Oak Valley project that constitutes about 6725 acres primarily between the I-10 freeway and San Timoteo Canyon Road and from the San Bernardino/Riverside county line on the north near Yucaipa to the Beaumont area on the south. This area was previously referred to as the Phase 1 area of the Oak Valley project.

- The scope of work included collection and review of readily available literature and maps, drilling 9 exploratory hollow-stem auger borings to depths ranging from approximately 20 to a maximum of 50 feet, performing appropriate laboratory analyses, preparing a geotechnical map and performing geologic and engineering analyses.

- Geological investigations in the region have been performed since the 1920s (e.g., Frick, 1921); these studies are summarized in the EIR (MBA, 1988).

- There is little published information available on the specific project area. The EIR is a principal source of background information for this geotechnical investigation.

- Other investigations include that by Dames & Moore (1987) and of Rasmussen Associates (1984, 1988) both of which conducted fault trenching investigations. The research conducted since the EIR was prepared include the work of Albright (1999) and Kendrick et al (2003). *(Petra: Please see the Cited References list.)*

- There are a few local areas with artificial fill within the site. Generally, these are small berms or dams built to retain water for livestock. These are widely scattered throughout the site.

- The only area with significant fill is the valley just south of the trailer park in the eastern part of the site near 7th Street. This area presently serves as an equipment storage area and has been a borrow area. These activities have resulted in dirt, brush, and trash having been disturbed and pushed into the arroyo.

- Several other areas along the creeks also have local accumulations of trash; like many rural areas, it appears to have been a common practice to dump trash into small canyons and creek beds.

- There is one fault known within the site. The Cherry Valley fault extends into the southeast corner of the site and crosses the site to at least Covington Canyon.

- The age of latest displacement on this fault is uncertain. It appears to have been very active in late-Quaternary time, but it is not known whether the fault has displaced latest Holocene young alluvium. The degree of scarp degradation indicates that the fault is not highly active.

- In view of the uncertainty and its projection through two proposed school sites, 100-foot setback zones on either side of the fault were recommended. Before habitable structures, including schools, can be built within this zone, additional fault studies (preferably trenching) should be conducted.

- There are few landslides within the site region. Although there is a potential for landsliding within the site, the hazard in general does not appear to be great.

- A few small slides were observed along the major stream channels where erosion and undercutting locally destabilized the adjacent slopes.

- Many of the slides appear to be shallow earth flows or debris flows.

- The report indicated that, liquefaction and dynamic settlement resulting from the effects of strong ground shaking are not expected to be widespread at the site due to the great depth to ground water and the density of the underlying soils.

- Water levels in three wells were reported greater than 100 feet below the ground surface.

- The report indicated that based on the limited exploratory borings, surficial deposits of man-made fill, colluvium, alluvium, older alluvium, and sedimentary bedrock materials of the San Timoteo Formation within the lower topographic areas of the site are expected to be readily excavatable with conventional heavy-duty earthmoving equipment.

- The hills and mesas of the site are underlain primarily by bedrock belonging to the San Timoteo Formation that consists of sandstone, siltstone, and conglomerate (see Figure 3). Light to heavy ripping can be expected during excavation of this bedrock formation.

- The San Timoteo formation contains abundant cobbles and some boulders which may produce significant quantities of oversized rock.

- Cuts made into the San Timoteo Formation can be expected to generate a significant amount of cobbles greater than 6 inches in diameter and some boulders to about 2 and possibly 3 feet in diameter with the total percentage of oversize rock being on the order of 5 percent or less.

- All low-density surficial soils including any artificial fill deposits, alluvium, colluvium, and highly weathered surficial bedrock should be removed to underlying competent bedrock or competent native soils.

- Canyon subdrains should be installed along the axes of all major canyons and tributaries to be filled where the depth of fill exceeds approximately 15 feet.

- Oversize rock generated during grading operations should be removed from the site or placed in the lower portions of the deeper fills, individually or in wind rows, in a manner to avoid nesting.

- Depending on the degree of compaction achieved in the field, an average shrinkage factor of 15 to 20 percent for existing fill and alluvium/colluvium materials should be anticipated. A bulking factor of up to 3 percent should be anticipated for San Timoteo Formation bedrock. *(Petra: These values may be refined by further subsurface investigation for various areas of the project site.)*

- Exposed cut slopes in the bedrock belonging to the San Timoteo Formation may require construction of stability buttresses depending on adverse bedding conditions.

- Limited laboratory tests indicate site soils are Very Low to Medium in expansion potential, non-corrosive to concrete, mildly corrosive to metals in concrete and corrosive to buried metallic objects. *(Petra: site specific expansion potential and corrosion characteristics should be performed at the completion of grading.)*

- *(Petra: Shallow soils may be subject to collapse, in excess of 2 percent, upon wetting. A site geologic map is depicted in Figure 3)*

PGI/HAI Fault Investigation Report (2004)

- The scope of work included excavation of 20 exploratory trenches to depths ranging from approximately 6 to 18 feet to evaluate the location and degree of activity of the Cherry Valley Fault between Interstate 10 on the east and Covington Canyon on the west, a distance of approximately 1.75 miles.
- This fault represents the westernmost extension of the San Gorgonio Pass fault zone that apparently dies out south of a series of northeast trending faults in the Crafton Hills area.
- Motion across the Cherry Valley fault is primarily reverse (rocks above the fault move upwards), with a relatively minor component of strike-slip (horizontal motion).
- The fault generally dips towards the north approximately 30 degrees across the site.
- Based on evaluation of the data acquired during the field investigation, the Cherry Valley fault within the property has been subdivided into two sections based on recency of activity along the fault. These two sections are called the Western and Eastern fault zones and are shown on Figure 4.
- Fault data acquired during their study suggests that in the western portion of the site (Western Fault Zone) the fault was inactive during the Holocene. The age of most recent faulting in the Eastern Fault Zone was found to be either indeterminate or geologic evidence was suggestive of possible Holocene activity.
- The age of the alluvium within the western portion of the site was estimated to be no younger than latest Pleistocene near the bottom of the Covington Canyon channel based on the presence of a well-developed soil profile near the ground surface.
- Early Holocene faulting for the eastern portion of the site cannot be ruled out because slightly older sediments with ages closer to the Holocene/Pleistocene boundary are not present. Therefore, setbacks for habitable structures were recommended (see Figure 4).
- It was recommended that the setback zone on the hanging wall (north side of the fault) be at least 150 feet wide and the setback on the footwall (south side of the fault) be a minimum of 75 feet wide. These setbacks should be measured from the location of the mapped trace of the main strand of the fault (see Figure 4).
- No structural setbacks were recommended for residential structures along the western portion of the site. However, fault setbacks would be required for schools and other public buildings (fire station, post office, etc.) along this portion of the fault.
- The final location of fault setbacks will shift during grading due to the new finish ground surface elevations.
- Cutting or lowering the grade over the fault will result in the fault location (and setbacks) migrating toward the north at a ratio of approximately 2:1 (i.e. the fault location will move northward approximately 2 feet for each foot of cut).

PGI/ Response to City Review Sheet (2006)

- PGI prepared a response to the City of Calimesa consultant (Arroyo Geotechnical) review sheet with regard to their review of the 2004 Fault Investigation, (PGI/HAI Fault Investigation Report (2004)) that included clarifications and/or addressed 8 review comments.

- City Comment No. 5 requested recommendations for overexcavation for house foundations within the "Western Fault" portion of the site where setbacks were not required. Petra indicated grading mitigation measures for foundations that are determined to be potentially overlying variations in bedrock structure associated with faulting would be addressed during the grading plan review. In addition, field mapping during grading should be performed to evaluate lot conditions.

PGI Preliminary Geotechnical Investigation (2014)

- The report presents the results of a preliminary geotechnical investigation performed for development of Phase 1 of the Mesa Verde Project (formerly, the Oak Valley Project).

- Phase 1 comprises approximately 267 acres of the 1492-acre Mesa Verde Project (MVP).

- The 1492-acre MVP lies west of the I-10 freeway, south of the San Bernardino/Riverside County line, and about one mile north of San Timoteo Road.

- The scope of work included collection and review of readily available literature and maps, drilling 9 exploratory hollow-stem auger borings to depths ranging from approximately 30 to a maximum of 60 feet, excavating 34 exploratory test pits to depths ranging from 5 to 20 feet, performing appropriate laboratory analyses, preparing geotechnical maps and performing geologic and engineering analyses.

- The mass grading plan prepared by VA Consulting (undated) indicates the site will initially be mass graded to create large super pads and access streets. Proposed maximum vertical depths of cut and fill are both on the order of approximately 50 feet. However, alluvial removals in canyon areas will locally increase the maximum fill depths to approximately 80 to 85 feet.

- Settlement monitoring will be required in selected deep fill areas (greater than 40 feet of fill) in order to evaluate the amount of time for primary consolidation to take place and the magnitude of any remaining long-term secondary consolidation.

- An average shrinkage factor of 12 to 15 percent for topsoil, existing fill and alluvium/colluvium materials should be anticipated. A bulking factor of up to 3 percent should be anticipated for San Timoteo Formation bedrock. *(Petra: These values may be refined by further subsurface investigation for various areas of the project site.)*

- Limited laboratory tests indicate site soils are Very Low to Medium in expansion potential, non-corrosive to concrete, mildly corrosive to metals encased in concrete and highly corrosive to buried metallic objects. *(Petra: Site specific expansion potential and corrosion characteristics should be performed during site rough grading.)*

- Boring HS-9 drilled in the area of the proposed stormwater infiltration basin encountered approximately 20 feet of native alluvial soils overlying bedrock of the Sam Timoteo formation. Based on the granular nature of native soils, average infiltration rates of the native soils and bedrock materials are estimated at approximately 5.0 and 0.5 inches/hour, respectively. *(Petra: Site-specific infiltration testing is recommended to determine accurate infiltration rates for the basin design.)*

- *(Petra: Site specific seismic design parameters and foundation design recommendations are based on 2013 California Building code (2013 CBC). This information should be updated in accordance with 2019 CBC.)*

- *(Petra: Excerpts from "Geology" and the "Conclusions and Recommendations" sections of the referenced Petra Geotechnical, Inc. 2014 report are provided in Appendix B of this report. Plates 1 and 2 of this 2014 report (attached) depict various soil boundaries, boring and test pit locations and approximate depth of removal at exploration points.)*

Site Geological Conditions

Compressible Soils/Collapsible Soils/Soft Bedrock

Near-surface soils including artificial fill, topsoil, alluvium, and colluvium consist of silty sands to sandy silts and were found to be loose to medium dense or very soft to soft, dry to slightly moist, occasionally with roots up to 1 inch in diameter, somewhat porous and, therefore, subject to collapse upon wetting. These conditions were observed to depths of 20 feet or deeper at certain areas. Bedrock materials were found to be weathered and moderately soft at shallow depths. All existing low-density surficial soils should be removed to underlying competent bedrock or competent native soils approved by the project geotechnical consultant prior to being moisture conditioned and placed as engineered fill.

Competent materials are defined as undisturbed, relatively unweathered and non-porous bedrock materials and dense native soils possessing an in-place relative compaction of at least 85 percent and a degree of saturation of at least 70 percent; however, where these materials exhibit a relative compaction of 90 percent or greater, no specific degree of saturation is necessary.

Following removal of the unsuitable surficial soils and prior to replacing these soils as engineered fill, the exposed bottom surfaces in each removal area should first be scarified to a depth of 6 inches, watered as necessary to achieve a slightly-above optimum moisture content, and then recompacted to a minimum relative compaction of 90 percent of the applicable laboratory maximum density standard as determined in accordance with the current version of ASTM Test Method No. D 1557.

Localized areas of deeper excavation/removal of unsuitable soils may be necessary and contingencies should be planned for. To mitigate the potential build-up of hydrostatic pressures below compacted fills due to infiltration of surface waters, subdrains should be installed along the axes of all major canyons and tributaries to be filled where the depth of fill exceeds approximately 15 feet.

Groundwater

Data from the South Mesa No. 5 well near the northern property line indicates the water table in June 1984 was approximately 270 feet below the surface. A regional hydrogeologic study by Bloyd (1971) suggests that the water table beneath the site slopes to the west at a gradient of approximately 150 feet per mile. Integration of the well data with water gradient interpretations by Bloyd (1971) suggests that water levels could be approximately 140 feet below the lowest ground surface in the easternmost portion of the site. There has been no analysis of the possible effect of faults on the ground water, and data are of insufficient quantity to determine any such effects. The presence of thick caliche zones near the reverse/thrust fault suggests that this fault has been a ground-water barrier in the past.

Groundwater was not encountered in previous borings to the maximum explored depth of approximately 60 feet below grade. Historic high groundwater is expected to be on the order of 100 feet below ground surface. Groundwater is not anticipated to impact the proposed development.

Faulting

The Cherry Valley fault enters the southeast corner of the property from the east and extends northwesterly across the site. PGI/HAI, 2004, investigated the fault by excavating and logging 20 trenches across the fault and recommended a 150-foot setback northerly of the fault and a 75-foot setback southerly of the fault within the “Eastern Fault Zone” (see Figure 4). Setbacks for residential structures were not called for within the “Western Fault Zone”, however, fault setbacks would be required for schools and other public buildings (fire station, post office, etc.) along this portion of the fault. The location of the fault and the limits of the Restricted Building Zone are presented on Figure 4.

Strong Ground Motions

The site is located in a seismically active area of Southern California and will likely be subjected to very strong seismically related ground shaking during the anticipated life span of the project. Structures within the site should therefore be designed and constructed to resist the effects of strong ground motion in accordance with the 2019 California Building Code (2019 CBC).

Liquefaction and Dynamic Settlement Potential

As stated earlier, regional groundwater depths for the site is expected be in excess of 100 feet below ground surface or more. Based on the groundwater information and high fines contents of the site soils, the potential for liquefaction and seismic (dynamic) settlement at this site was considered to be negligible.

CONCLUSIONS AND RECOMMENDATIONS

Based on our recent site reconnaissance and literature review of the reference reports, the development of the subject project site is considered feasible from a geotechnical engineering standpoint. It is recommended that the following geotechnical issues be considered by the Client during this due diligence period.

Primary Geotechnical Considerations

Our professional opinion, from a geotechnical engineering viewpoint, regarding various aspects of site condition and/or proposed development is presented herein. The following presents the salient points of our due diligence assessment that we recommend be considered for future site development.

- Design Level Geotechnical Report and Grading Plan Review Report: The City of Calimesa will require a formal geotechnical report during the review and approval process including a geotechnical review of the final grading plans. As such, the process may include a conceptual-level plan study (large scale plan), a tentative tract-level plan study (100-scale) and a rough grade tract-level plan study (40-scale). Any of such studies require subsurface investigation, laboratory testing and geotechnical engineering analyses pertinent to the level of the study. These studies for each level may be performed in phases covering a portion of the entire site. Any formal geotechnical report should include recommendations for site rough grading, reduction of potential for surficial soils settlement, post-grading improvements, and preliminary building foundation design based on the current 2019 California Building Code (2019 CBC).

- Cherry Valley Fault Setback Zone: The Cherry Valley fault enters the southeast corner of the property from the east and extends northwesterly across the site. A "Building Restriction Zone" has been designated within the "Eastern Fault Zone", that extends 150-foot north of the fault and 75-foot south of the fault (see Figure 4). Setbacks for residential structures were not called for within the "Western Fault Zone", however, fault setbacks would be required for schools and other public buildings (fire station, post office, etc.) along this portion of the fault if proposed. The location of the fault and the limits of the Restricted Building Zone are presented on Figure 4. Site planning should avoid placing habitable (human occupancy greater than 2,000 hours) structures in this Building Restriction Zone. Other uses such as parking or open space are permitted there.

- Demolition, Clearing and Grubbing: Prior to commencement of site grading activities, all existing trash, debris, site improvements, underground utility lines and/or structures (if encountered) will need to be demolished and removed from the site. In addition, the possibility may exist that other unknown underground structures may be found below current grades. It is recommended that all vegetation (including the root ball) encountered on site be removed and disposed in accordance with current local regulations.

- Removal of Unsuitable Soil and Bedrock Materials: Artificial fill soils, and native alluvial and colluvial soils to a variable depth that may be up to 30 feet below ground surface in some areas may also be found compressible and at low density and; generally unsuitable for support of fill or structures and should be removed to competent alluvium exhibiting at least 85 percent in-situ relative density and 70 percent saturation. Additionally, weathered bedrock materials that are determined by the project geologist not considered suitable for support of fill and structures, should be removed to competent bedrock level at the discretion of project geologist.

  The bottom of all remedial excavations, except for competent bedrock, should be properly processed in-place before fill placement. Subdrains should be installed along the axes of all major canyons and tributaries to be filled where the depth of fill exceeds approximately 15 feet.

  Settlement monitoring will be required in selected deep fill areas (greater than 40 feet of fill) in order to evaluate the amount of time for primary consolidation to take place and the magnitude of any remaining long-term secondary consolidation. A monitoring period of at least 3 to 6 months will likely be required prior to the commencement of residential construction.

- Excavation Characteristics: Surficial deposits of artificial fill, colluvium, alluvium, older alluvium, and sedimentary bedrock materials of the San Timoteo Formation within the lower topographic areas of the site are expected to be readily excavatable with conventional heavy-duty earthmoving equipment. The hills and mesas of the site are underlain primarily by the San Timoteo Formation bedrock consisting of sandstone, siltstone, and conglomerate. Light to heavy ripping can be expected during excavation.

  Cuts made into the San Timoteo Formation can be expected to generate a significant number of cobbles greater than 6 inches in diameter and some boulders to 2 to 3 feet in diameter. The total percentage of oversize rock, irreducible to 12 inches in greatest dimension, is on the order of 5 percent or less.

- Stability Buttress Fill: Exposed cut slopes in bedrock belonging to the San Timoteo Formation may exhibit adverse bedding conditions that could potentially require construction of stability fills/buttresses. We recommend additional bucket auger drilling and slope stability analyses during future phases of investigation.

- Suitability of Onsite Soils and Bedrock for Fill: All onsite soils consisting of "clean", artificial fill, topsoil, native alluvium, colluvium and bedrock fragments less than 6 inches in greatest dimension are considered suitable for use in engineering fill provided they are free of organics or other deleterious materials.

  Oversize rock generated during grading operations should be removed from the site or placed in the lower portions of the deeper fills, individually or in wind rows, in a manner to avoid nesting.

- Shrinkage/Importing of Fill: Although grading plans and preliminary grading quantities are not yet determined, all earthwork calculations should take into account soil shrinkage, bedrock bulking and site subsidence during remedial removals and replacement as compacted fill. Estimated shrinkage of artificial fill and native soils were estimated to vary from 12 to 20 percent in the previous investigations. However, preliminarily an average value on the order of 15 percent when removed and replaced as properly compacted fill appears to be reasonable at this time. Bulking of excavated bedrock should be estimated to be on the order of 3 percent and site overall subsidence could be on the order of 0.1 to 0.2 feet. These estimates are tentative, based on limited data that depend on the degree of compaction and should be examined for each phase of the project. One method of practical verification is to select several areas of the site and perform a small grading operation, like those suitable for one spread, to gather more accurate shrinkage and bulking information.

In an unlikely event that import soils are required, they should be identified and submitted for approval by Petra before placement onsite.

- Deep Utility Trenching: Based on the soil types, any deep trenching for utility lines may need to be laid back at a maximum slope ratio of 1.5:1 (horizontal to vertical) or flatter. Trench shields may also be required for added protection for workers entering the trenches.

- Expansion and Corrosion Potential of Site Soils: Limited laboratory testing indicated site soils to be very low to medium in expansion potential and have a non-corrosive level of soluble sulfates and chloride. Additionally, site soils are considered highly corrosive to buried metallic elements. Additional sampling and laboratory testing should be performed during grading operations for expansion and general corrosion potential for the purposes of providing final foundation and other design recommendations.

- Building Foundation Design: Based on the observed soils types and anticipated engineered grading, either conventional or post-tensioned foundations are expected to be feasible. Final foundation design would be provided at the completion of site grading depending on the as-graded conditions and expansion potential of soils at or near finish grades. Very low to medium expansive soils are anticipated across the site at this time.

- Pavement Design: Based on the observed soil types, (i.e., sand, silts and silty sands), a preliminary pavement design of 4 inches of asphalt over 6 inches of base for in-tract streets and 4 inches of asphalt over 8 inches of base for the industrial park area may be utilized for budgeting purposes only. Final pavement design should be provided at the completion of site and street grading based on final sampling and testing of subgrade soils for R-value.

- Onsite Stormwater Infiltration: Based on the soil types, sandy silts and silty sands with generally moderate to high fines content, we expect to have marginal percolation or infiltration rates at certain locations and, therefore, onsite stormwater infiltration systems may not be effective everywhere within the site for transmitting water into the subsurface. Once basin locations and depths are known, field infiltration testing should be performed, and the required setback from structures established.

REPORT LIMITATIONS

This report is based on the existing conditions of the subject property and the geotechnical observations made during our site reconnaissance and the review of the referenced reports. The soil conditions observed in the referenced investigations are expected to be representative of the general area conditions; however, soil conditions can vary in characteristics between excavations, both laterally and vertically. As such, we recommend supplemental test pits and boreholes and the associated laboratory testing and engineering analyses for further evaluation during the design phase of the project. The conclusions and opinions contained in this report are based on the results of the described geotechnical evaluations and represent our professional judgment.

This report has been prepared consistent with that level of care being provided by other professionals providing similar services at the same locale and in the same time period. The contents of this report are professional opinions and as such, are not to be considered a guaranty or warranty.

This report should be reviewed and updated after a period of one year or if the site ownership or project concept changes from that described herein. This report has not been prepared for use by parties or projects other than those named or described herein. This report may not contain sufficient information for other parties or other purposes.

This opportunity to be of service is sincerely appreciated. If you have any additional questions or concerns, please feel free contact this office.

Respectfully submitted,

PETRA GEOSCIENCES, INC.

10/18/21

Siamak Jafroudi, PhD
Senior Principal Engineer
GE 2024

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Attachments: Cited References
Figure 1 – Site Location Map
Figure 2 – Aerial Photograph Location Map
Figure 3 – Geologic Map
Figure 4 – Fault Location and Setback Map
Appendix A – Selective Pictures of the Site
Appendix B – Excerpts from Petra Geotechnical, Inc. 2014 Report

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CITED REFERENCES

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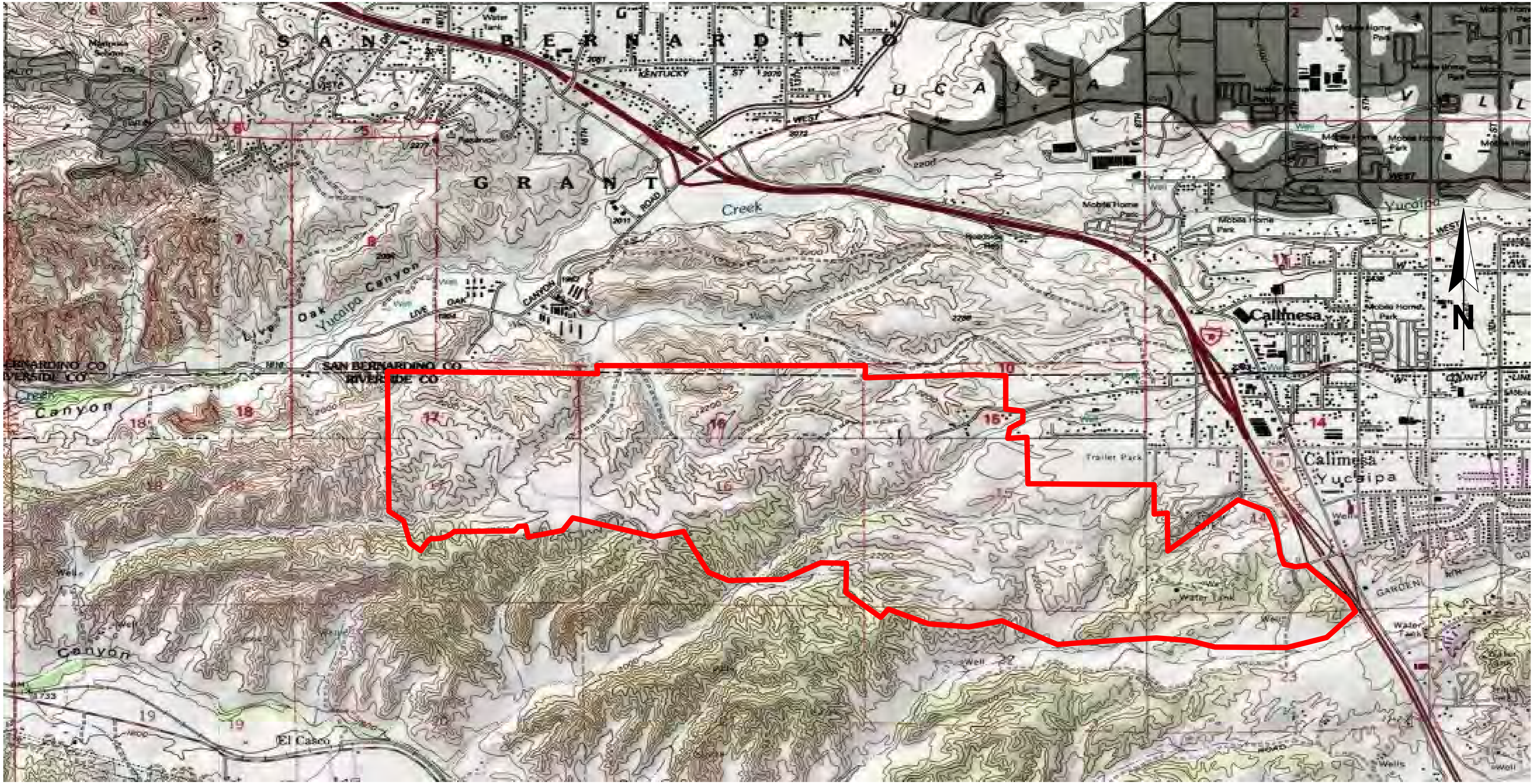
FIGURES



LEGEND

Approximate Location of Property Boundary

Base Map Reference: BLM Geocommunicator Website, Map dated 2-14-2011

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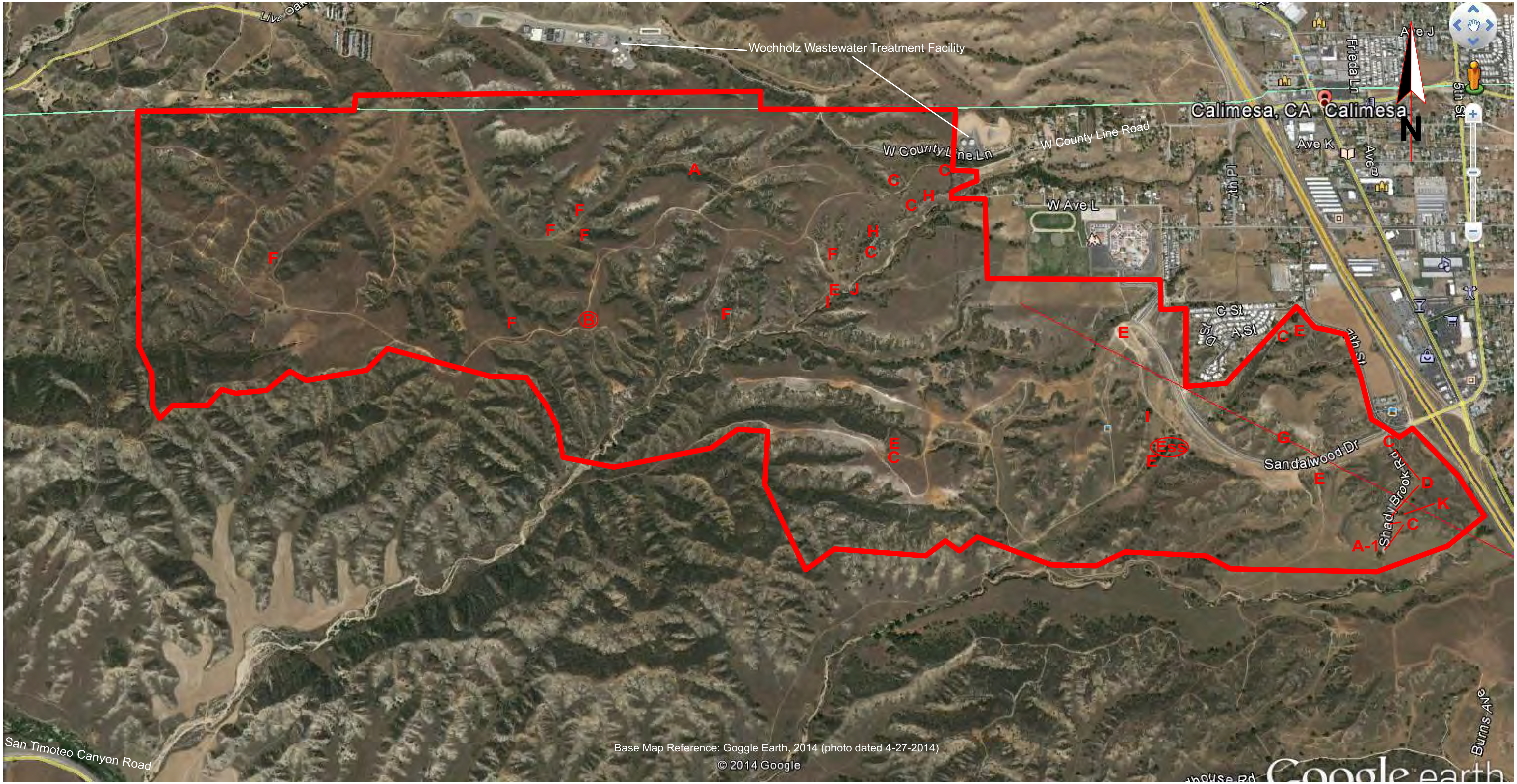
COSTA MESA TEMECULA VALENCIA PALM DESERT CORONA

Site Location Map

1,492 Acre Mesa Verde Project, Calimesa
Riverside & San Bernardino Counties, California

PETRA GEOSCIENCES INC.	DATE: October, 2021	**Figure 1**
	J.N.: 21-303	



LEGEND

(red line)	Approximate Location of Property Boundary
A	Approximate Location of Water Well
A-1	Approximate Location of Water Well & Basin
Ⓑ	Approximate Location of Oil Well & Sump
C	Approximate Location of Dumped Concrete Rubble
D	Approximate Location of Trash Bins, Waste Asphalt, Oil & Paint Containers
E	Approximate Location of Dumped Trash/Debris
Ess	Approximate Location of Dumped Trash/Debris with Surface Staining
F	Approximate Location of Earthen Embankment
G	Approximate Location of Cherry Hill Fault
H	Approximate Location of Olive Orchard
I	Approximate Location of Dumped Metal Objects
J	Approximate Location of Concrete Culvert Foundations
K	Approximate Location of Homeless Encampment

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Aerial Photograph Location Map

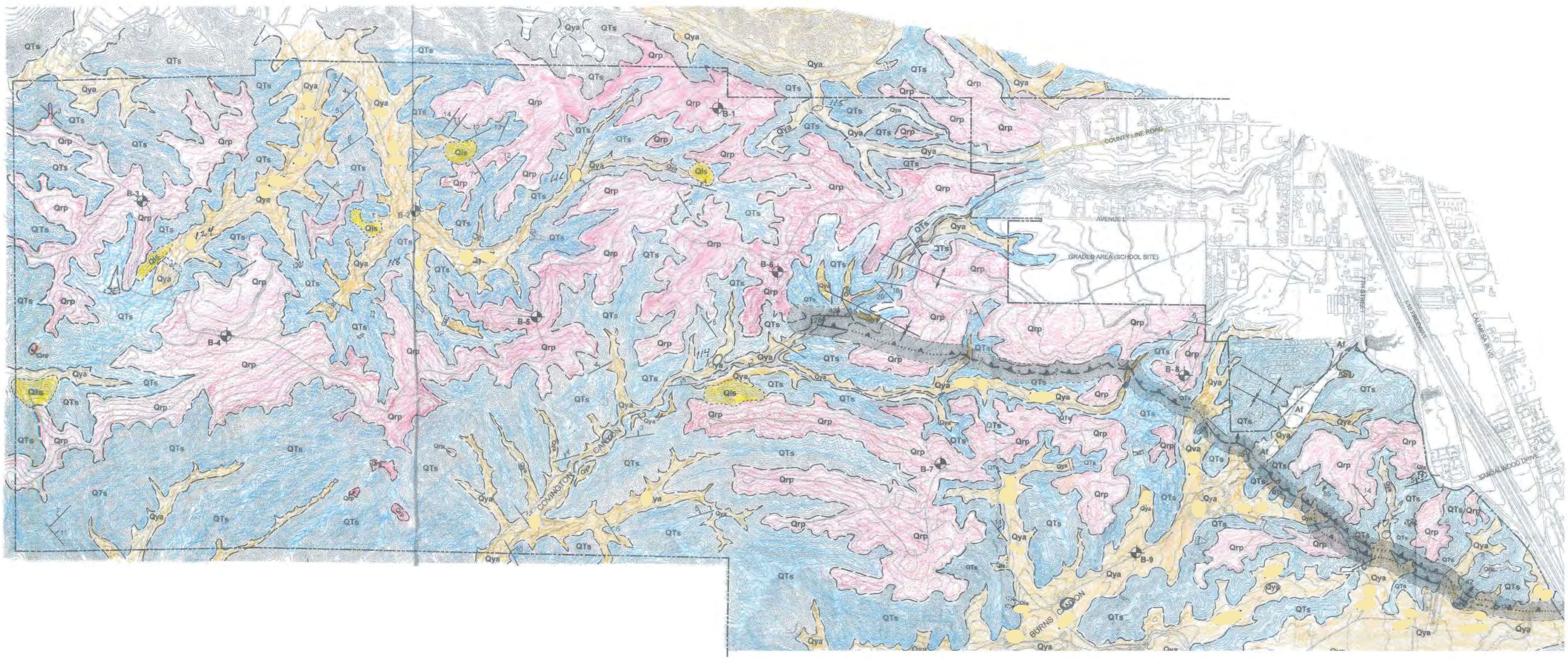
1,492 Acre Mesa Verde Project, Calimesa
Riverside & San Bernardino Counties, California

PETRA GEOTECHNICAL INC.

DATE: October 2021

J.N.: 21-303

Figure 2



EXPLANATION

Af	Artificial Fill
Qls	Possible Landslide
Qya	Stream and Valley Alluvium (Holocene)
Qrp	Relic Paleosol (Pleistocene)
Qts	San Timoteo Formation (Pleistocene-Pliocene)

30 — Orientation of Bedding
Number indicates Dip of Bedding

Approximate Geologic Contact

Anticline: Upward Folded Strata

Syncline: Downward Folded Strata

30 — Approximate Location of Fault Place: Arrow with Number Indicates Dip of Fault Place, Teeth Indicate Upper Plate of Thrust Fault.
Shaded Area Represents Restricted Building Zone

B-1 — Approximate Location of Boring

Property Line

N

0 600 1200
Scale: 1" = 1200'

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GEOLOGIC MAP

Mesa Verde Project
Calimesa, California

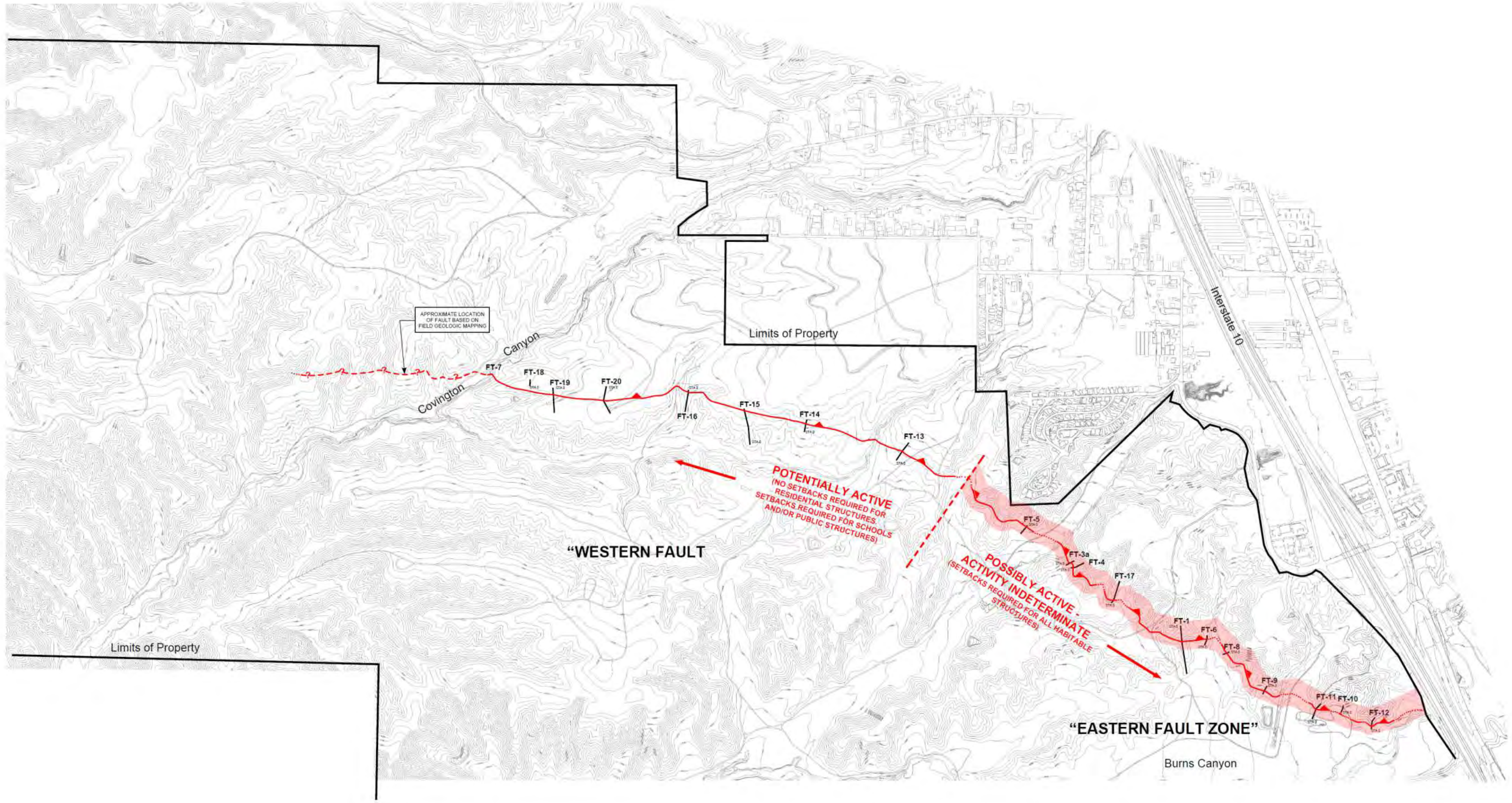
PETRA GEOSCIENCES INC.

DATE: October, 2021
J.N.: 21-303

Figure 3

EXPLANATION

Approximate Fault Location, Dotted Where Buried,   Queried Where Uncertain:
Teeth Indicate Hanging Wall of Thrust Fault, Shaded Area Indicates



N

0 600 1200

Scale: 1" = 1200'

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FAULT LOCATION AND SETBACK MAP

Mesa Verde Project
Calimesa, California

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DATE: October, 2021
J.N.: 21-303

Figure 4

APPENDIX A

SELECTIVE PICTURES OF THE SITE

Photo #1 – North view of dumped concrete and homeless tent in the southeastern portion of the Site along Shady Brook Road.

Photo #2 – Aerial view of basin and water well remnants west of Shady Brook Road in southeast portion of the Site.

Photo # 3 – north view of upper portion of Shady Brook Road. Note stockpiled asphalt and soil in background behind trash bins.

Photo # 4 – south view of dumped concrete, clay pipe, and brick in canyon south of the olive orchard in the northeastern portion of the Site. What appears to be a metal water line is visible in foreground.

Photo # 5 – northerly view of dumped debris in east portion of Site. School is visible in background.

Photo # 6 – east view of dumped household debris in eastern portion of the Site. Sandalwood Drive visible in left background.

Photo # 7 – dumped debris in canyon area in eastern portion of the Site west of Sandalwood Drive.

Photo # 8 – Stockpiled concrete pipe, brick, cobbles and general debris along dirt road below trailer park.

Photo # 9 – east view of central portion of the subject property.

Photo # 10 – typical dirt road activity in northeastern portion of Site. Abandoned olive grove is visible in upper left photo.

Photo # 11 – northwest view of the north central portion of the Site. W. County Line Lane visible in right photo. Abandoned olive orchard visible in lower left photo.

Photo # 12 – northerly view of one of the off-road tracks located in the northeastern portion of the Site. School field is visible in the upper right photo.

Photo # 13 – dumped debris along dirt road in central portion of the Site. Note waste oil containers.

Photo # 14 – east view of conditions within south central portion of the Site.

Photo # 15 – west view of conditions within the western portion of the Site. Note minimal dirt road activity.

Photo # 16 – abandoned vehicle in canyon area within eastern portion of the Site.

Photo # 17 – northerly view of property conditions within olive grove in northeast portion of Site.

Photo # 18 – east view of property entrance on W. County Line Road.

Photo # 19 – southerly view of slope associated with oil well sump in west central area of property.

Photo # 20 – westerly view of oil well sump in west central area of property.

APPENDIX B

EXCERPTS FROM PETRA GEOTECHNICAL, INC. 2014 REPORT

LOCATION AND SITE DESCRIPTION

The area comprising Phase 1 is generally characterized by a series of east-west and north-south trending ridges transected by northerly, westerly, and southwesterly draining valleys and narrow canyons. The elevations along the ridges are all about the same and range from about 2,280 feet to 2,330 feet above mean sea level (msl).

The valleys and narrow canyons in the northern part of the property drain toward the north and are tributaries of Yucaipa Creek. The valleys and narrow canyons in the southern part of the site drain primarily westerly and southwesterly and are tributaries of Burns Canyon and ultimately San Timoteo Creek. Burns Canyon is the major valley which traverses the southeast corner of the site. Maximum topographic relief between drainages and the adjacent ridge tops is on the order of about 100 feet.

Valley and canyon profiles range from sharp and V-shaped in the smaller canyon to somewhat broad and U-shaped across the larger valleys. Although commonly steep, the valley walls are mostly covered with slopewash (colluvium) which provides soil that supports vegetation well. The slopewash and the vegetation obscure the nature of the underlying bedrock material.

The flat floors of the larger valleys are incised in some places by narrow second-order ravines or arroyos with nearly vertical walls. In this report, the term arroyo is reserved for these recent, vertically sided, narrow incisions into the valley bottoms. In the largest canyons, these arroyos are up to about 40 or 50 feet deep, cutting through the valley alluvium and into the San Timoteo Formation providing some of the better views of the bedrock character.

Some of the smaller canyons also have these second-order arroyos but these are mostly on the order of 10 feet deep (± 5 feet), but also commonly expose San Timoteo bedrock in the bottom.

SITE GEOLOGY

Site Physiography

The Mesa Verde Project area is along the western edge of the Beaumont Plain and near the eastern edge of a region referred to as the San Timoteo Badlands. The site is generally a well-vegetated grassland and somewhat more similar to a savanna or wooded savanna than to true badlands which are characterized by little vegetation. The locally rugged relief in parts of the site is probably mainly a result of the area being capped by a hard, erosion-resistant, impermeable, ancient soil with a well-developed carbonate horizon. This hard surface protects the area from erosion, but once the cap is breached, the underlying uncemented materials are susceptible to erosion and formation of steep-sided canyons.

Site Stratigraphy

The geologic units at the site consist of three basic units. The distribution of these units is shown on Plates 1 and 2. The predominant unit is the San Timoteo Formation (map symbol QTs) which underlies the entire site and can be considered the bedrock unit. The San Timoteo Formation is overlain by young Quaternary alluvium (Qya) in the canyons and gullies. These deposits consist primarily of local erosional and weathering byproducts of QTs which have washed into the valleys from the surrounding slopes and mesas. The third unit (Qrp) is not really a stratigraphic deposit but rather a soil formed by long-term, deep weathering of the San Timoteo Formation. These units are described further below.

San Timoteo Formation

The San Timoteo Formation is Pliocene (4-5 million years) to Pleistocene (0.5 to 0.8 million years) in age and commonly contains vertebrate fossils (Reynolds and Reeder, 1981; Smith 1983; Albright 1999). No fossils were found onsite during this investigation and none are reported in the previous investigations. The formation is divided into three members (Shuler, 1953). The formation onsite represents the upper member. The middle and lower members are present in the deep subsurface, and the entire formation along with probable older sediments reach a total thickness of over 5,000 feet beneath parts of the Oak Valley development. An oil well drilled in 1922 on the Shutt Ranch just west of the site reached a total depth of 5,358 feet in sedimentary rock, and a well drilled in 1933 on the Haskell Ranch south of the site reached 3,180 feet in sedimentary rocks (Dames & Moore, 1987).

The San Timoteo Formation is chiefly of fluvial (river) origin with local lacustrine (lake) deposits and is composed of beds of siltstone, sandstone, silty sandstone, claystone, and poorly sorted gravelly to bouldery sandstone and conglomerate. Gravels in the unit are composed of quartz, plutonic (e.g., granite, diorite), metasedimentary, metaigneous, and metavolcanic rock types. The rock fragments are subangular to subrounded indicating short transport distance. These deposits were principally derived from rocks to the north and northeast in the San Gabriel and San Bernardino Mountains (Albright, 1999). The sediments in outcrop are generally friable to moderately indurated, and easily to moderately erodible. Bedding is generally poorly developed, gradational, and lenticular.

Alluvium

The canyons and valleys within the site contain young alluvium of probable Holocene age. This alluvium appears to be primarily locally derived and is mapped as Qya on Plates 1 and 2. The material is generally composed of dark reddish-brown and dark brown, nonindurated, sand to silty sand with minor amounts of gravelly and bouldery sands. The alluvium is poorly bedded.

The young alluvium is generally relatively thin in small tributary canyons and thicker in the larger drainages and at the canyon mouths. The arroyos in the narrower parts of smaller valleys indicate thicknesses of only about 5 feet to as much as 20 feet. Two borings drilled in the middle parts of two of the larger canyons indicated about 40 feet of alluvium, but the relationships were not clear because the alluvium is derived from the San Timoteo Formation (QTs), and therefore is very similar. When the alluvium overlies weathered QTs, it is difficult to distinguish between them, especially in small-diameter borehole samples.

Parts of some of the most-recently incised arroyos have thin, loose, stream-channel sand and gravel alluvium in the very bottom of the channel. These deposits are the youngest deposits and are generally of historical or modem age. However, these are so thin and so widely scattered that they were not individually mapped and are included with the Qya map unit on Plates 1 and 2.

Relict Soil

The mesas and ridges throughout much of the site are underlain by red clayey and white carbonate-rich soils. This material is primarily a product of long-term weathering of the San Timoteo Formation, although locally there may be some remnants of old alluvial deposits that once covered the Qrp surface and which underwent similar weathering and soil formation. Areas occupied by this Qrp unit have been mapped as old alluvial deposits (Qoa) by several previous investigators but close scrutiny reveals that the material is conformable with and generally grades imperceptibly into the underlying San Timoteo Formation. Some additional Holocene-latest Pleistocene weathering and soil formation has overprinted some of the older relict soils but the younger soils are relatively thin (1-2 feet).

The relatively flat surface of the tops of the ridges and mesas occupied by the Qrp unit are remnants of an ancient geomorphic surface which was stable for a long period of time, undergoing very little deposition or erosion. After lying stable for several tens of thousands to a few hundred thousand years, the area underwent uplift which led to erosion, downcutting, and some minor tectonic deformation.

The uppermost part of the Qrp unit is characterized by dark red (2.5YR and 5YR hues I) silty and sandy clays with scattered pebbles. This red zone represents an argillic B soil horizon. The dark red color gradually gives way with depth to yellowish-brown or strong-brown (7.5YR and 10YR hues) silts, silty sands, and gravelly sands which represent less-weathered but strongly oxidized San Timoteo Formation. The lowest part of the Qrp unit and the uppermost part of the San Timoteo Formation consist of white to very-palebrown (10YR) calcareous silts, sands, and gravelly sands. This lower zone represents a pedogenic carbonate soil horizon or K Horizon. This carbonate horizon occupies much of the ground surface in the eastern and northeastern part of the site where it commonly is characterized by nearly horizontal, hard, impermeable layers. These carbonate soils represent a Stage III or Stage IV plugged K Horizon.

All together the Qrp unit ranges from a few inches thick to several feet thick (locally up to about 20 feet thick). Much of the site area, primarily the northeastern part is characterized by the white surface cap consisting of the calcareous zone. The calcareous materials were probably overlain by an A soil horizon and the dark red B soil horizon at one time, but these have been stripped away by erosion as the region underwent uplift and the resulting incision that led to the present valley-and-ridge topography. The high degree and great thickness of mature soil development within this unit indicates great age, perhaps on the order of a few hundred thousand years. This unit is similar to the Qvoa and Q3 unit of Matti et al (1992a), Kendrick et al (2003), and Albright (1999) who estimate an age on the order of about 300,000 to 500,000 years.

The geotechnical properties of the Qrp unit vary depending upon which of the zones is present. In general the unit is very firm and hard and will provide good foundation support. The red clayey upper zone exhibits a polygonal cracking indicative of a high clay content which may have an expansive character. The light-colored calcareous zone may be corrosive to some materials.

GEOLOGICAL HAZARDS

Surface Faulting

There is one fault known within the site. The Cherry Valley fault extends into the southeast corner of the site and crosses the site to at least Covington Canyon (Plate 1). The age of latest displacement on this fault is uncertain. It appears to have been very active in late-Quaternary time but whether that activity continued into the early Holocene time has not been established. The fault is not known to displace latest Holocene young Alluvium (Qya) but it is not overlain by Qya in many places.

The degree of scarp degradation indicates that the fault is not highly active. However, the possibility of early Holocene displacement cannot be ruled out based on the present data. In view of the uncertainty and its projection through two proposed school sites, we recommend various setback zones on each side of the fault. Before habitable structures, including schools, can be built within this zone, additional fault studies should be conducted.

Erosion

The steep-sided canyons and the mesa/valley-type topography of the site vicinity indicate that the geologic formations in the area, specifically the San Timoteo Formation (QTs), are susceptible to erosion. Although the San Timoteo Formation materials are quite dense and hard compared to the Qya deposits, they are not cemented and are friable. Consequently, when they are subjected to flowing water they are erodible.

Landslides

There are few landslides within the site region. Although there is a potential for landsliding within the site, the hazard in general does not appear to be great. Bedding in the predominant geologic formation, the San Timoteo Formation, is poorly developed and the formation is not highly fractured so there are few planes of weakness that would promote widespread landsliding. Furthermore, the orientation of the bedding is generally horizontal to very low angle (less than 5 degrees) which is not prone to substantial landsliding.

A few small slides are observed along the major stream channels where erosion and undercutting occasionally destabilize the adjacent slopes. Undoubtedly, there are more small slides and earth flows that are not shown on the map. Slopes throughout the site are commonly steep; the EIR (MBA, 1987) provides maps showing areas with slope gradients greater than 15 percent and 25 percent which includes most of the slopes along the sides of the canyons and valleys. Any building planned for the areas above or below these slopes should account for the landsliding hazard by setting structures back from the tops of the slopes and away from the bottom of the slopes in accordance with applicable building codes (see Geotechnical Engineering Recommendations).

Many of the slides appear to be shallow earth flows or debris flows. These are generally shallow (less than about 10 feet thick). These features appear to be relatively random and not structurally controlled; rather they appear to be related to downslope flow of thicker accumulations of slope wash within small side slope gullies and swales. During intense periods of rainfall they become saturated. Although these are generally not devastating events, the larger ones can damage buildings and facilities that lie in their path. These types of features also commonly fail during strong seismic events. Rasmussen Associates (1984) reports evidence for deep-seated and large translational and/or rotational landslides. Some of the deep-seated landslides were interpreted to represent ancient landslides with now have little geomorphic expression. Some of the older, larger and deep-seated landslides identified by Rasmussen Associates exhibit little geomorphic expression and therefore other similar subtle landslides may exist on the site. Reactivation of older landsides onsite is a potential hazard and could be aggravated in some situations by grading.

If structures for human occupancy are to be placed adjacent to the known or suspected landslides or next to the steep slopes, subsurface borings or test pits will be necessary to determine the extent and subsurface geometry of the landslides. If any development, including roadways, is planned in the immediate vicinity of the landslides or the steep slopes, mitigating measures such as buttressing of the slopes or reducing slope gradients, should be implemented.

Liquefaction

State of California Seismic Hazard Zones Maps have not been issued for the quadrangles where the subject site is located. Previous investigations (e.g., EIR) indicated that all of the valleys had a high liquefaction potential. However, based on our field investigation, liquefaction and dynamic settlement resulting from the effects of strong ground shaking are not expected to be widespread at the site due to the great depth to groundwater and the relative density of the underlying soils. Many of the smaller valleys identified in previous reports as having a liquefaction potential are underlain by firm bedrock (QTs) at shallow depths (e.g. 5 feet) and therefore might easily be developed providing that the recommendations given in the Geotechnical Engineering Recommendations section of this report are followed.

HYDROLOGY

Surface Water

There are no major perennial streams passing through the site. The site is crossed by several ephemeral streams that may flow during times of heavy precipitation such as the winter rainy season or during the occasional summer monsoonal thunder showers. Drainage within these local channels in the northern part of the site is toward the north whereas drainage in the rest of the site is toward the southwest. The two largest valleys are Covington Valley in the central part of the site and Burns Valley in the southeastern part of Phase 1.

There are no lakes within the site but there are several small dams and water-retaining berms that have been used for stock watering. At the time of this investigation, these were nearly all dry and many were dysfunctional.

Severe erosion that led to the arroyo cutting within some existing canyons (e.g. Covington Canyon) indicate that substantial volumes of runoff occasionally occur at the site during prolonged and intense precipitation. However, the flow appears to have been completely contained within the existing valleys so the flooding hazard for sites built on high ground appears minimal.

Groundwater

Water wells south of the site produce water from deep within the San Timoteo Formation (Rasmussen Associates, 1984). Water levels in three wells are currently from greater than 100 feet below the ground surface. Data from the South Mesa No. 5 well near the northern property line indicates the water table in June 1984 was approximately 270 feet below the surface. A regional hydrogeologic study by Bloyd (1971) suggests that the water table beneath the site slopes to the west at a gradient of approximately 150 feet per mile. Integration of the well data with water gradient interpretations by Bloyd (1971) suggests that water levels could be approximately 140 feet below the lowest ground surface in the easternmost portion of the site. There has been no analysis of the possible effect of faults on the ground water, and data are of insufficient quantity to determine any such effects. The presence of thick caliche zones near the reverse/thrust fault suggests that this fault has been a ground-water barrier in the past.

Areas of artesian groundwater conditions have occurred both north and south of the site area during the early 1900s (Mendenhall, 1905). Yucaipa Valley was an artesian groundwater basin a few decades ago but over-pumping has severely reduced groundwater levels in the valley. Artesian conditions also occurred in San Timoteo Canyon

No groundwater was encountered in borings drilled for this investigation which extended to a maximum depth of about 60 feet. No springs or evidence for an existing shallow ground-water body was observed during this investigation. The fine-grained units of the San Timoteo Formation exposed in the very bottom of several local canyons were moist where protected from direct sunlight, perhaps as a result of rains within the past couple months. Ground water may become perched following prolonged periods of high precipitation. Such perching is expected to be local because of the poor lateral continuity of strata.

CONCLUSIONS AND RECOMMENDATIONS

Based on our review of available literature, subsurface investigation and geotechnical engineering and engineering geologic analyses, development of the site is considered feasible from a geotechnical point of view. It is our opinion that the building sites will be free of hazard from landslide, settlement and slippage provided that the following general recommendations are incorporated into the design criteria and project specifications. However, the project is still in the conceptual stage and specific grading plans and development plans have not been developed. More-specific recommendations will require additional more-extensive geotechnical investigations.

Earthwork Recommendations

General Earthwork and Grading Specifications

All earthwork and grading should be performed in accordance with the recommendations of this report and all applicable requirements of the Grading Code of the County of Riverside.

Site Clearing

All weeds, grasses, brush, shrubs, trees and similar vegetation existing within areas to be graded should be stripped and removed from the site. Clearing operations should include the removal of all trash and debris. Trees and large shrubs, when removed, should be grubbed out so as to include their stumps and major root systems, and these organic materials removed from the site. During site grading, laborers should clear from fill soils any roots, tree branches, and other deleterious materials missed during initial clearing and grubbing operations.

The project geotechnical consultant should be notified at the appropriate times to provide observation and testing services during clearing operations to verify compliance with the above recommendations. In addition, should any buried structures or unusual or adverse soil conditions be encountered during grading that are not described or anticipated herein, these conditions should be brought to the immediate attention of the project geotechnical consultant for corrective recommendations.

Excavation Characteristics and Potential for Generation of Oversize Rock

Based on our limited exploratory borings, surficial deposits of man-made fill, colluvium, alluvium, and older alluvium are expected to be readily excavatable with conventional heavy-duty earthmoving equipment.

The ridges are underlain primarily by the San Timoteo Formation consisting of sandstone, siltstone, and conglomerate. Light to heavy ripping can be expected in this formation. The formation contains abundant cobbles and some boulders which may produce significant numbers of oversized rock. Cuts made into the San Timoteo Formation can be expected to generate a significant amount of cobbles greater than 6 inches in diameter, and some boulders to about 2 feet and possibly 3 feet in diameter with the total percentage of oversized rock being on the order of 5 percent or less.

Any rock exceeding 12 inches in maximum dimension should either be disposed of offsite or buried in the deeper fills in accordance with Plate SG-4, Appendix C (Standard Grading Specifications). The "Disposal of Oversize Rock" is discussed in a subsequent section.

Removal of Existing Fill Deposits

All existing deposits of artificial fill should be removed to competent underlying native soils or bedrock. The actual limits and depths of removal of existing unsuitable fill materials will have to be determined during grading. The excavated fill materials may be replaced as properly compacted fill within the site provided that they are first cleared of any trash, construction debris or oversize rock.

Removals and Canyon Cleanouts

All existing low-density surficial soils in areas to receive compacted fill should be removed to underlying competent bedrock or competent native soils approved by the project geotechnical consultant. In general, low-density surficial soils include any artificial fill deposits, alluvium, colluvium, and highly weathered surficial bedrock formation. Throughout the majority of the site, recommended depths of remedial removal will extend into competent bedrock or competent native soils. Competent materials are defined as undisturbed, relatively unweathered and non-porous bedrock materials and dense native soils possessing an in-place relative compaction of at least 85 percent and a degree of saturation of at least 70 percent; however, where these materials exhibit a relative compaction of 90 percent or greater, no specific degree of saturation is necessary.

Groundwater

Static groundwater is not expected to be encountered during grading; however, minor amounts of perched groundwater overlying dense bedrock or fine-grained materials may be encountered during canyon cleanouts, especially if grading is performed during the winter months. Temporary diversion and control of locally perched groundwater may be necessary during installation of canyon subdrains and initial placement of compacted fill, particularly in the lower portions of the canyon drainages. If encountered, drying of wet or saturated soils excavated from canyon bottom areas may be necessary to obtain near-optimum moisture content in order to achieve proper compaction.

Canyon Subdrains

To mitigate the potential build-up of hydrostatic pressures below compacted fills due to infiltration of surface waters, subdrains should be installed along the axes of all major canyons and tributaries to be filled where the depth of fill exceeds approximately 15 feet. Those portions of the ends of the subdrains that are underlain by compacted fill materials rather than suitable native materials should be constructed with solid pipe rather than perforated pipe.

Settlement Monitoring of Deep Fills

Ultimate fill depths will range from a few feet to a maximum estimated at approximately 80-85 feet. Settlement monitoring will be required in selected deep fill areas (greater than 40 feet of fill) in order to evaluate the amount of time for primary consolidation to take place and the magnitude of any remaining long term secondary consolidation. The locations of recommended near-surface settlement monuments should be determined by the project geotechnical consultant during and upon completion of rough grading. At least two settlement monuments should be constructed in bedrock to serve as control points. A monitoring period of at least 3 to 6 months will likely be required prior to the commencement of residential construction.

Benching

Fills placed against canyon walls, on natural slope surfaces inclining at 5:1, horizontal to vertical, or steeper, and against temporary backcut slopes associated with construction of stabilization fills should be placed on a series of level benches excavated into competent bedrock or competent native soil materials. These benches should be provided at vertical intervals of approximately 3 to 5 feet. Typical benching details are shown on Plates SG-5 through SG-8, Appendix C.

Disposal of Oversize Rock

As noted previously, oversize rock is expected to be encountered during grading operations. Oversize rock is defined as hard boulders or irreducible cemented bedrock fragments exceeding 12 inches in maximum dimension. Oversize rock generated during grading operations should be removed from the site or placed in the lower portions of the deeper fills. Any oversize materials buried on site should be placed individually or in wind rows, and in a manner to avoid nesting, and then completely covered with finer-grained onsite earth materials. The finer-grained materials should be thoroughly watered and rolled to ensure closure of all voids. Oversize rock should not be placed within the upper 10 feet of finish grade within the building areas or street areas where they may interfere with footing and utility trenches, or in areas where they may interfere with the future construction of swimming pools and/or spas. Based on this investigation and prior studies, oversize rock quantities should be less than 5 percent of total excavated materials.

Processing of Cut Areas

In shallow cut areas where unsuitable surficial materials are not removed in their entirety, these materials should be overexcavated to underlying competent materials and then brought back to grade with properly compacted fill. In deep cut areas where competent materials are exposed at grade, no special remedial work such as scarification or recompaction will be required.

Cut/Fill Transitions

To mitigate distress to building structures related to the potential adverse effects of excessive differential settlement, cut/fill transitions should be eliminated from all building sites where the depth of fill placed within the "fill" portion exceeds proposed footing depths (e.g., 12 inches and 18 inches for one-story and two-story structures, respectively). This should be accomplished by overexcavating the "cut" portions and replacing the excavated materials as properly compacted fill. Recommended depths of overexcavation will depend on maximum depths of compacted fill placed on the "fill" portions, but will generally follow the guidelines provided below. Horizontal limits of overexcavation should extend beyond the perimeter building lines to a distance of 5 feet or to a distance equal to the required depth of overexcavation, whichever is greater. It is anticipated that finalized building locations will be unknown at the time the initial mass grading is performed to create the super pads. Therefore, elimination of cut/fill transitions will likely have to be performed when final grading operations are performed to develop individual building sites. If this is the case, cut/fill transition lines should be accurately shown on the as-built mass grading plans.

Recommended Depths of Overexcavation

Depth of Fill	Depth of Overexcavation
Up to 3 feet	Equal Depth
3 to 6 feet	3 feet
Greater than 6 feet	One-half of greatest fill depth placed on the "fill" portion; to 15 feet maximum

Additional building sites may require overexcavation due to cut/fill transitions created during grading such as unsuitable material removal, incised haul road areas through cut areas, construction of stabilization fills, etc. The required depths of overexcavation should be based on actual conditions encountered during grading using the guidelines presented above.

Deep Fill/Shallow Fill Transitions

To mitigate the detrimental effects of excessive differential settlement, deep fill/ shallow fill transitions should also be eliminated from all building areas. This should be accomplished by overexcavating the "shallow" fill portions of each building area and replacing the excavated materials as properly compacted fill. Generally, the depths of overexcavation should equal one-half the thickness of the maximum depth of fill underlying the building area to a maximum depth of 15 feet.

Over-Steepened Natural Slopes and Temporary Slopes

Following removal of unsuitable surficial soils, alluvium and weathered bedrock materials to competent native soils or bedrock during grading, over-steepened natural slopes and temporary excavated slopes (created during canyon cleanouts, etc.) will likely underlie some cut/fill transition areas and some fill areas within the subject site. To mitigate the detrimental effects of excessive differential settlement, over-steepened natural slopes or temporary excavated backcut slopes created in areas that will receive compacted fill should be laid back in accordance with the following criteria:

1. Natural and temporary excavated slope surfaces located within 25 vertical feet of finish grade should be laid back at a slope ratio no steeper than 2:1, horizontal to vertical.

2. Natural and temporary excavated slope surfaces located within 25 to 50 vertical feet of finish grade should be laid back at a slope ratio no steeper than 1.5:1, horizontal to vertical.

3. Natural and temporary excavated slope surfaces located greater than 50 vertical feet below finish grade do not need to be laid back at any specific slope ratio. However, temporary excavated slopes should be graded at inclinations that provide adequate temporary stability for worker safety, protection of existing offsite improvements, etc.

Volumetric Changes

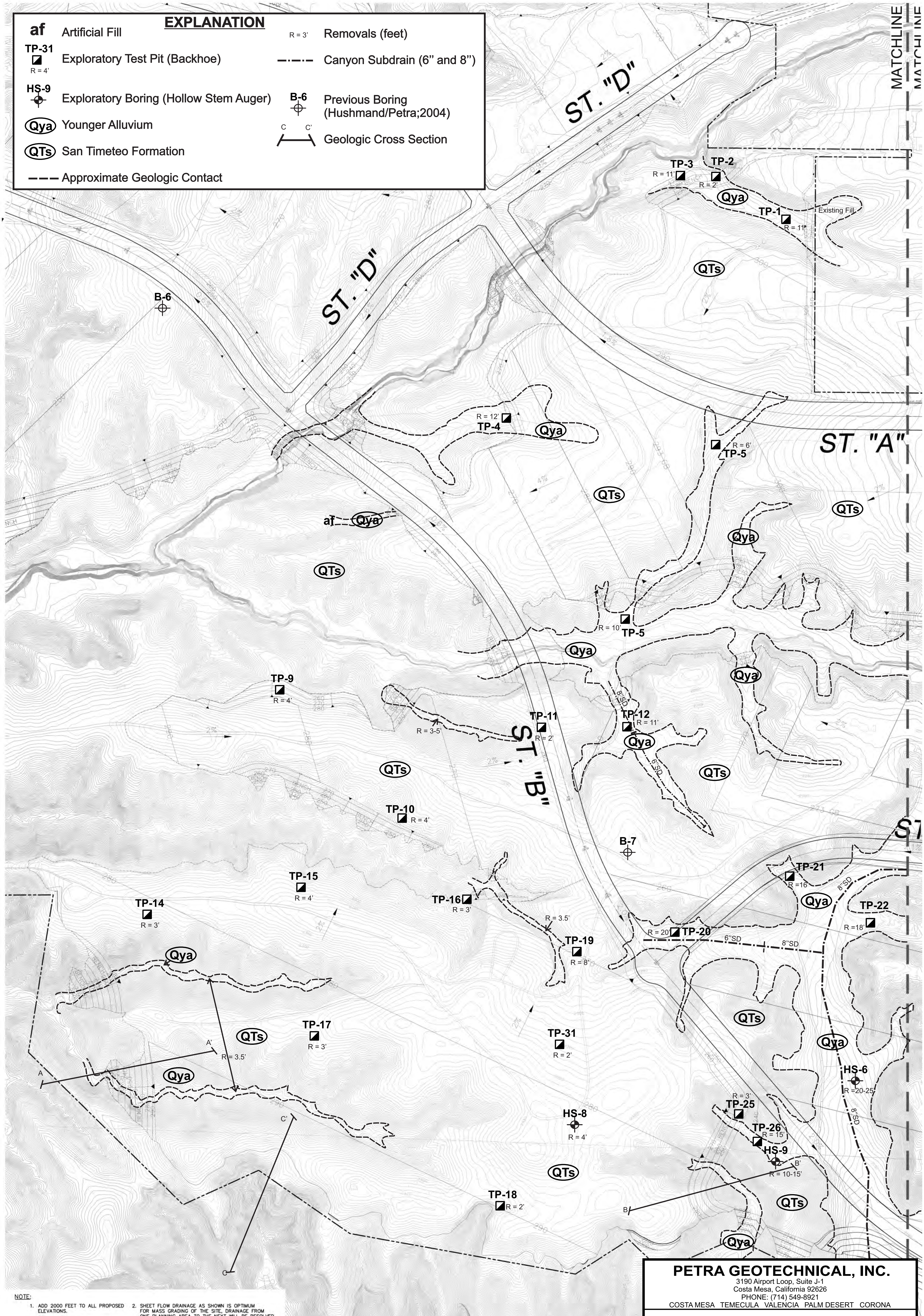
Volumetric changes in earth quantities will occur when excavated onsite soil and bedrock materials are replaced as properly compacted fill. Following is typical values of shrinkage and bulking factors anticipated for the various geologic units present on the site. These typical values are based on in-place densities of the various materials and on the estimated degree of relative compaction that will be achieved during grading.

Topsoil and artificial fill (af) ……………………... Shrinkage of 12% to 15%
Alluvium/Colluvium (Qya) ....Shrinkage of 12% to 15%
San Timoteo Formation (QTs) ....Bulking of 0% to 3%

The above estimated shrinkage and bulking factors are exclusive of oversize rock materials that are removed from the site if not placed properly within designated rock disposal areas. Furthermore, the actual shrinkage or bulking that will occur during grading will depend on the average degree of relative compaction achieved.

A subsidence estimated at 0.10 to 0.15 feet may be anticipated as a result of the scarification and recompaction of the exposed ground surfaces within alluvial areas and 0.05 to 0.10 feet within bedrock areas.

The above estimates of shrinkage, bulking and subsidence are intended for use by project planners in determining earthwork quantities and should not be considered absolute values. Contingencies should be made for balancing earthwork quantities based on actual shrinkage and subsidence that will occur during grading. Due to uncertainties in the anticipated amounts of shrinkage or bulking of the various earth materials within the site, and due to uncertainties that will occur due to the removal and disposal of oversize rock materials, it is recommended that several earthwork balance test plots be performed during the initial stages of grading. These test plots can be performed to determine the initial volume of soil excavated within the test plot area and the final volume of soil placed and compacted in the fill area in order to determine the actual as-graded shrinkage or bulking amounts of the onsite earth materials.



NOTE:

1. ADD 2000 FEET TO ALL PROPOSED ELEVATIONS.
2. SHEET FLOW DRAINAGE AS SHOWN IS OPTIMUM FOR MASS GRADING OF THE SITE, DRAINAGE FROM ONE PLANNING AREA TO THE NEXT WILL BE RESOLVED WITH ON SITE DRAINAGE PER "B" TENTATIVE MAPS FOR EACH PLANNING AREA.

0 100 200 400
1"=100'

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Costa Mesa, California 92626
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COSTA MESA TEMECULA VALENCIA PALM DESERT CORONA

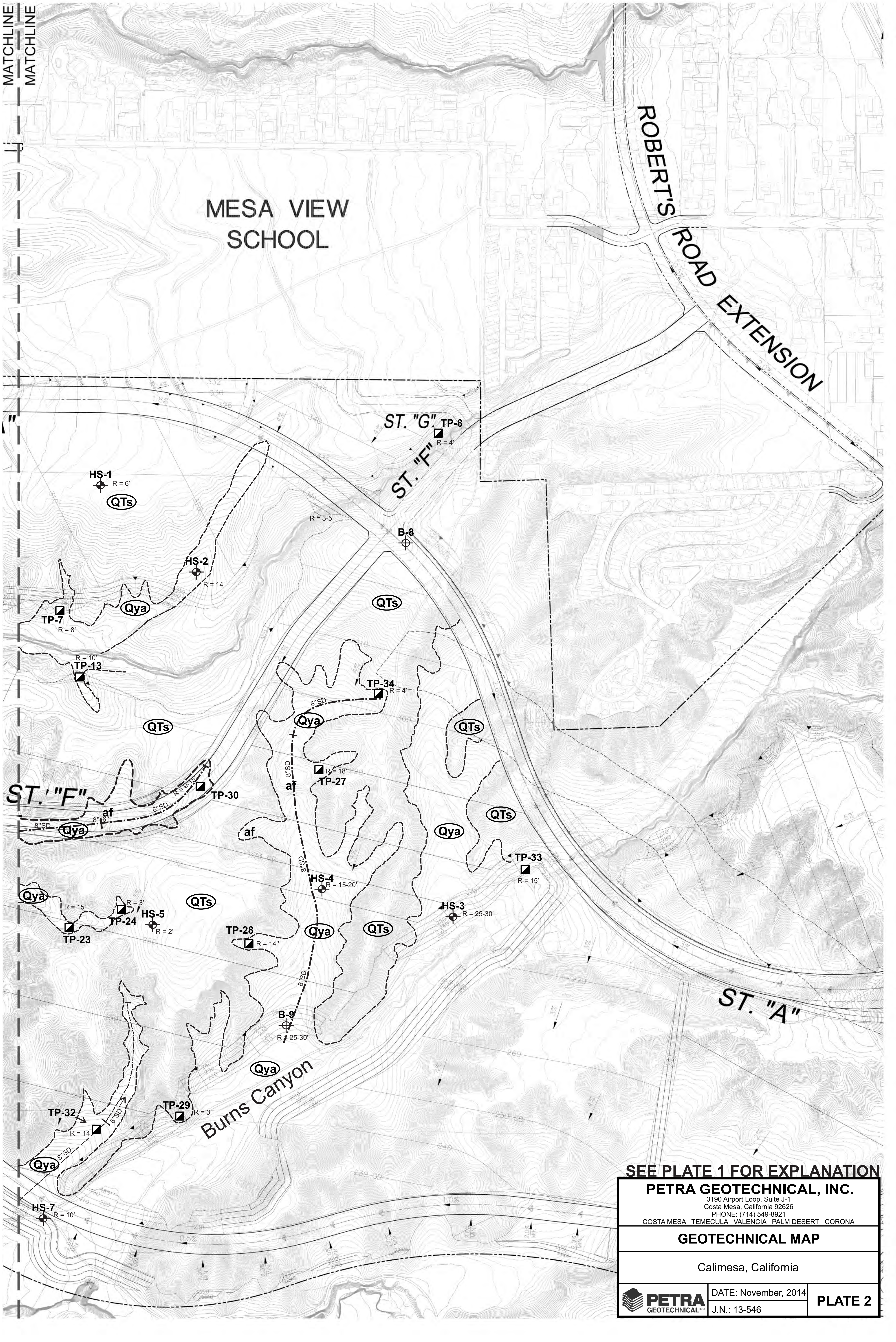
GEOTECHNICAL MAP

Calimesa, California

DATE: November, 2014

J.N.: 13-546

PLATE 1



SEE PLATE 1 FOR EXPLANATION

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GEOTECHNICAL MAP

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PLATE 2