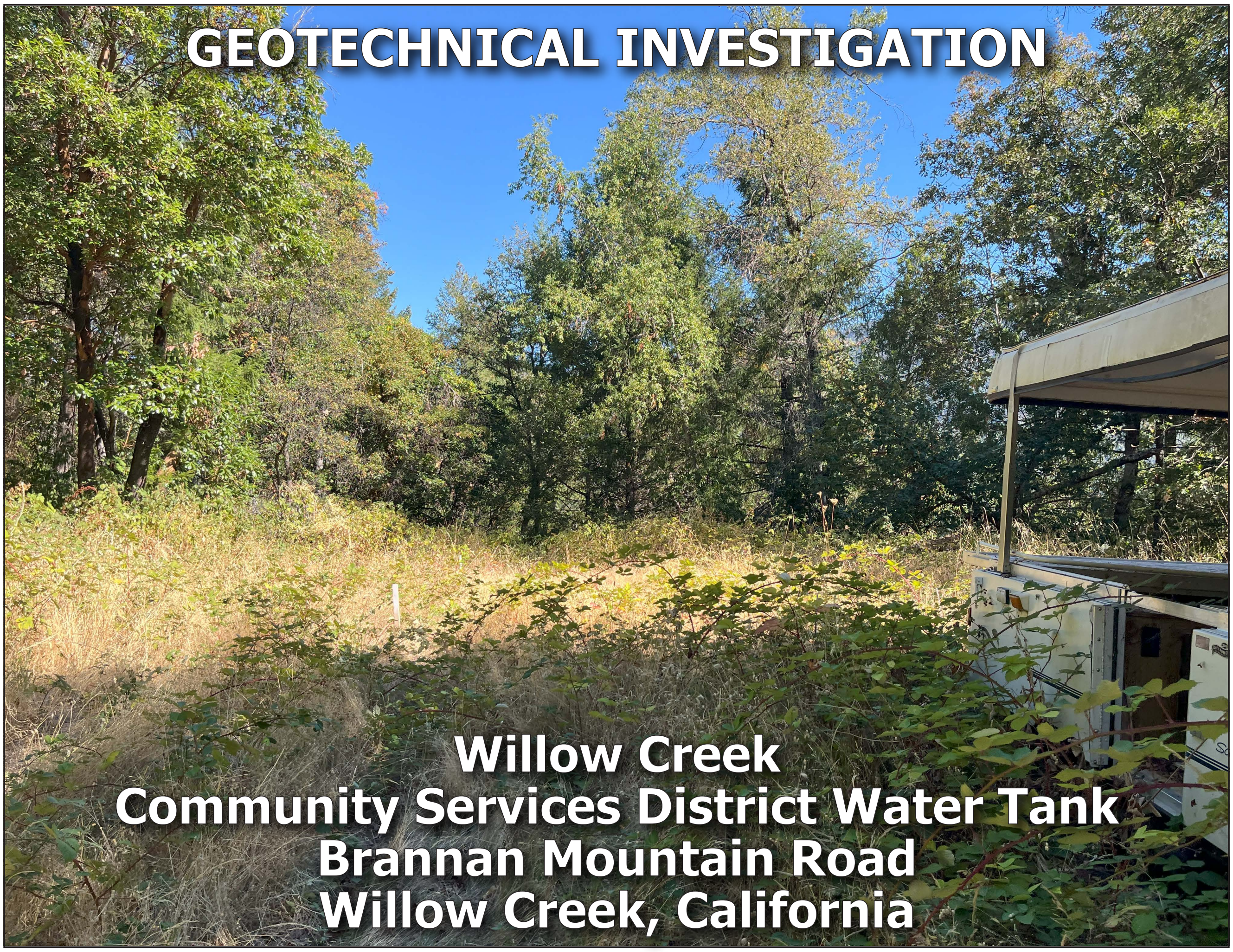

GEOTECHNICAL INVESTIGATION

Willow Creek
Community Services District Water Tank
Brannan Mountain Road
Willow Creek, California

PREPARED FOR:

TRINITY VALLEY CONSULTING ENGINEERS, INC.
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GEOCON

GEOCON PROJECT NO. S2904-05-01

MAY 2025

GEOCON
CONSULTANTS, INC.
GEOTECHNICAL ■ ENVIRONMENTAL ■ MATERIALS

Project No. S2904-05-01
May 15, 2025

VIA ELECTRONIC MAIL

Josh McKnight
Trinity Valley Consulting Engineers, Inc.
2200 Main Street
Weaverville, California 96093

Subject: GEOTECHNICAL INVESTIGATION
WILLOW CREEK COMMUNITY SERVICES DISTRICT WATER TANK
BRANNAN MOUNTAIN ROAD
WILLOW CREEK, CALIFORNIA

Mr. McKnight:

In accordance with your authorization of our proposal (Geocon Proposal No. SA-24-1620-P-GT, dated September 6, 2024), we have completed a geotechnical investigation for the proposed water storage tank located north of Brannan Mountain Road in Willow Creek, California.

The accompanying report presents our findings, conclusions, and recommendations for the project as presently proposed. In our opinion, no adverse geotechnical conditions were encountered that would preclude development at the site provided recommendations of this report are incorporated into the design and construction of the project.

Please contact us if you have any questions regarding this report or if we may be of further service.

Respectfully Submitted,

GEOCON CONSULTANTS, INC.

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GEOTECHNICAL INVESTIGATION

1.0 PURPOSE AND SCOPE

This report presents the results of our geotechnical investigation for the proposed water storage tank and associated improvements north of Brannan Mountain Road within the western portion of the community of Willow Creek, California. The approximate site location is depicted on the Vicinity Map, Figure 1.

The purpose of our investigation was to evaluate subsurface soil and geologic conditions at the site and provide conclusions and recommendations relative to the geotechnical aspects for the design and construction of the proposed project.

To prepare this report, we performed the following scope of services:

- Performed a limited geologic literature review to aid in evaluating the geologic conditions present at the site. A list of referenced material is included in Section 9.0 of this report.
- Notified subscribing utility companies via Underground Service Alert (USA) a minimum of 48 hours (as required by law) prior to performing exploratory excavations at the site.
- Performed seven exploratory test pits (T1 through T7) using a Deere 13L Backhoe. The test pits were excavated to depths ranging from approximately 4 to 13 feet below existing site grades.
- Paid required fees and obtained a subsurface exploration permit from the Humboldt County Environmental Health Division (HCEHD).
- Performed three exploratory borings (B1 through B3) with a truck-mounted drilling rig equipped with hollow-stem auger and mud rotary drilling capabilities. The borings were drilled to depths ranging from approximately 21½ to 26½ feet below existing site grades.
- Logged the exploratory excavations in accordance with American Society for Testing and Materials (ASTM) D2487 which is based on the Unified Soil Classification System (USCS).
- Performed sampling at periodic intervals and collected soil samples from the test pits and borings for subsequent laboratory testing.
- Upon completion, backfilled the test pits with soil cuttings and backfilled the borings with neat cement grout in accordance with HCEHD requirements.
- Performed laboratory tests to evaluate pertinent geotechnical parameters.
- Prepared this report summarizing our findings, conclusions and recommendations regarding the geotechnical aspects of developing the site as presently proposed.

Approximate locations of the exploratory test pits, borings, are shown on the Site Plan, Figure 2. Details of our field exploration program including exploratory test pit and boring logs are presented in Appendix A. Details of our laboratory testing program and test results are summarized in Appendix B. Results of our slope stability analysis are shown in Appendix C.

2.0 SITE AND PROJECT DESCRIPTION

The site consists of approximately 0.52 acres of land identified as Humboldt County Assessor Parcel Number 522-492-011-000. The site is bounded to the north and west by forested mountainous terrain, to the east by Willow Creek Cemetery and Trinity Valley Elementary School, and to the south by Brannan Mountain Road, beyond which are several single-family residences.

At the time of our field explorations, the site was undeveloped aside from an unpaved access road on the southern edge of the site. The surface of the site was covered in a heavy growth of annual grasses and berry shrubs. Vehicles, trailers and loose plastic and metal debris were present across the site. Numerous mature trees were present surrounding the site. Site conditions as of the dates of our field investigation are shown in Photographs 1 through 4.

Based on site-specific topography information presented in the Grading and Erosion Control Plan prepared by Trinity Valley Consulting Engineers, Inc., dated June 2018, the elevation of the site across the proposed tank area where development is targeted, is approximately 730 to 735 feet above mean sea level. The topography surrounding the landing area is steep, with grades ranging from approximately 30% to 60% to the west (uphill) side of the site, and from approximately 35% to 60% to the east (downhill) side of the site. Based on our review of historical imagery of the site (Historic Aerials, 2024) and published historic use of the site (Covina 2007), we understand that the site was undeveloped and forested prior to the 1960s. From approximately 1960 through the 1970s, the site and surrounding area was partially cleared by logging operations. By the time of the 1993 photograph, forest regrowth was underway, and the site appeared similar to the pre-logging condition by the 1998 photograph. The site has remained generally unchanged since the 1998 photograph.

We understand that the Willow Creek CSD needs additional water storage in the northwest quadrant of their water distribution system service area. The proposed water storage tank will likely be a 60- or 72-foot-diameter bolted steel tank with a storage capacity of 400,000- to 650,000-gallons. The proposed water storage tank will likely be supported on a shallow concrete perimeter ring foundation. We understand that a retaining wall may be necessary on the uphill side of the proposed water storage tank to create sufficient space for the tank. However, the retaining wall type, length, height, and loading conditions are currently unknown and will be evaluated during future design phases. Other planned improvements will include underground utility infrastructure, improvements to the existing access road, and landscaping. Based on the preliminary Grading and Erosion Control Plan prepared by Trinity Valley Consulting Engineers (TVCE 2018), site grading will include cuts and fills on the order of about 7.5 to 10 feet, with the northeast portion of the site requiring a fill slope inclination of 1.5 to 1 (horizontal to vertical) due to the relatively steep existing slopes. We anticipate that underground utility infrastructure may require deeper excavations. Pavement design was outside the scope of services for this report, and flexible pavements are not indicated on the conceptual project plans (TVCE 2018). If needed, we can provide recommendations for flexible pavements upon request. Detailed site topography is included on the Site Plan, Figure 2. Regional topography is depicted on Figure 3, Geologic Map.

3.0 SOIL AND GEOLOGIC CONDITIONS

We identified geologic and soil conditions by observing and sampling exploratory borings and test pits and reviewing the referenced geologic literature (Section 9.0). Soil descriptions below include the USCS symbol where applicable.

3.1 Site and Regional Geology

The site is located within the western edge of the Klamath Mountains Geomorphic Province of California. The Klamath Mountains are comprised of broad peaks and ridges and have been uplifted through tectonic activity. The Klamath Mountains are bounded to the west by the Coast Ranges and are considered to be a northern extension of the Sierra Nevada, which are dominated by granitic and metamorphic rocks.

Based on the California Geological Survey’s (CGS) map - Geology of the Willow Creek 15’ Quadrangle, Humboldt and Trinity Counties, California, (CGS, 1978), the site is underlain by the Jurassic-age Galice Formation (map symbol Jg). The Galice Formation is described as metamorphosed graywacke, slate, and phyllitic slate, often cut by meta-felsite intrusions. Contact metamorphism of the Galice Formation also results in the formation of greenschist facies. This formation is known to be subject to landslide failures in areas where the slates dip unfavorably. Published geologic mapping indicates that the orientation of bedding and foliation varies in the region, striking generally northwest-southeast, and dipping either northeast or southwest. We did not observe intact bedding structures within test pits or outcrops at the site.

In areas near the Trinity River, the Galice Formation is occasionally overlain by Quaternary Terrace Gravels (map symbol Qt), which have been deposited, cut, and exposed by the river's meander. The conditions encountered in our borings and test pits at the site were consistent with the mapped geology of the area. A Regional Geologic Map is included as Figure 3.

3.2 Undocumented Fill

We encountered fill material within all our test pits and borings, except for Test Pit TP7, extending to depths of approximately 6 inches up to 3 feet below existing grades. There are no records of compaction of the fill, therefore the fill is considered undocumented. The undocumented fill generally consisted of sandy lean clay (CL) and clayey sand with varying amounts of gravel (SC). Based on our understanding of the site's history and the composition of the fill material, the fill is likely derived from upslope material that was historically cut and reworked to create the flat landing space during past logging operations. Undocumented fill, where encountered, should be removed and replaced as engineered fill. Specific recommendations are provided herein.

3.3 Residual Soil

Beneath the undocumented fill, we encountered residual soil in each of our exploratory test pits and borings to depths ranging from 1 to 16 feet below existing site grades. The residual soil (soil that has weathered in-place from rock) consisted of very stiff to hard, moist sandy lean clay (CL) and dense to very dense, moist clayey sand (SC) with varying gravel and boulder content.

3.4 Galice Formation

We encountered the Jurassic-age Galice Formation, variably weathered greenschist and slate bedrock at depths ranging from 5 feet to the maximum explored depth of 26.5 feet below existing site grades. The Galice Formation includes metamorphosed slate, phyllitic slate, and greenschist with felsic intrusions. We encountered practical refusal on Galice Formation bedrock in Test Pits TP2, TP3, TP4, and TP7. The greenschist and slate bedrock generally excavates as poorly graded gravel with sand, silt, and clay. While competent enough to cause practical refusal with backhoe equipment, the bedrock is readily excavatable/friable using auger drilling methods and is unsuitable for rock coring. We did not observe intact bedding or other structural features within the bedrock.

Subsurface conditions described in the previous paragraphs are generalized. The exploratory boring and test pit logs detail soil type, color, moisture, consistency, and USCS classification of the materials encountered at specific locations and elevations.

4.0 GROUNDWATER

We did not encounter groundwater in our exploratory test pits excavated on October 8, 2024 (maximum depth of approximately 13 feet) and exploratory borings performed on October 23, 2024 (maximum depth of approximately 26.5 feet). The Trinity River is located approximately ½ mile east of the site at an elevation of approximately 400 feet MSL, approximately 300 feet lower than the elevation of the site. The Trinity River is fed from the west by downslope-flowing tributaries such as Brannan Creek, Boise Creek, and Willow Creek. Based on this site-specific information from our investigation, coupled with the topographic (mountainous) setting of the site, we anticipate that static groundwater beneath the site may be present at a seasonally variable depth on the order of 100 feet or greater. It should be noted that fluctuations in the level of groundwater may occur due to variations in precipitation, temperature, seasonal fluctuations, subsurface conditions, and other factors. Therefore, it is possible that future groundwater may be higher or lower than the conditions observed during our investigation.

Although the static groundwater is likely relatively deep based on site geology, it is our opinion that perched groundwater/seepage may develop at shallow depths near the contacts between fill/residual soil and formational material (bedrock), especially during winter and spring. Seepage can also occur within formational material based on the degree of weathering, fracturing, and jointing. The occurrence of seepage is dependent on seasonal precipitation, irrigation, and land use, among other factors, and varies as a result. Proper drainage provisions will be important to future performance of the project.

5.0 GEOLOGIC HAZARDS

5.1 Regional Active Faults

The site is not located within an Alquist-Priolo Earthquake Fault Zone as established by the State Geologist around known active faults. The nearest pre-Quaternary fault is an unnamed fault, which is located approximately one mile west of the site. This fault is not considered active by the CGS. Local field reconnaissance did not reveal overt indications of an active fault trace at the site. Review of available literature indicates there are no active fault traces within 1,000 feet of the project location. The USGS Quaternary Fault and Fold Database maps the nearest active (“Historical” and “Latest Quaternary”) fault as the Grogan Fault located 8.5 miles west of the site. Therefore, we consider the potential for ground rupture due to onsite active faulting to be low.

5.2 Seismicity

We used the United States Geological Survey (USGS) Unified Hazard Tool (https://earthquake.usgs.gov/hazards/interactive/) to determine the deaggregated seismic source parameters including controlling magnitude and fault distance. The USGS estimated modal magnitude is 9.1 and the estimated Peak Ground Acceleration (PGA) for the Maximum Considered Earthquake (MCE) is 1.06g with a 2,475-year return period.

5.3 Liquefaction

Liquefaction is a phenomenon in which loose, saturated, cohesionless soil deposits located beneath the groundwater table lose strength when subjected to intense and prolonged ground shaking. The seismic excitation increases pore water pressure creating a buoyant effect of the loose soil. When liquefaction occurs, building foundations may sink or tilt and differential ground settlement may occur. Other effects may include sand boils (ground loss) and lateral spreading if the liquefiable soil is located adjacent to a steep free face. The areas that have the greatest potential for liquefaction are those in which the water table is less than 50 feet below ground surface and the soils are predominately clean, poorly graded sand deposits of loose to medium-dense relative density.

The site is not located in a currently established State of California Seismic Hazard Zone for liquefaction. Based on the subsurface conditions encountered at the site, including shallow bedrock and a lack of groundwater in the top 50 feet, liquefaction is not a hazard for the site. Mitigation and specific design measures with respect to liquefaction are not necessary for the project.

5.4 Landslides and Slope Stability

We are not aware of any landslides which have directly impacted the site. However, the site is located within the Willow Creek Quadrangle, recognized by CGS broadly as a mapped geologic zone of landslide hazard. According to CGS *Map Sheet 58 – Deep-Seated Landslide Susceptibility* (CGS, 2010) the area is ranked as 9 out of 10, indicating a high susceptibility to landsliding. The landslides within the quadrangle have been mapped and discussed within the *Landslides in the Highway 299 Corridor Between Blue Lake and Willow Creek, Humboldt County* (CGS, 2006). Dormant-mature landslides were mapped in the vicinity approximately 0.45 miles south of the site, and the nearest active landslide was mapped approximately ½ mile west of the site. Additionally, no landslide data are available on the California Department of Conservation interactive Landslide Inventory map (https://maps.conservation.ca.gov/cgs/lsi/). The tank site is relatively flat and level from previous grading activities, however there are moderate slopes surrounding the graded area.

Based on conditions observed during site reconnaissance, the existing landing area appears to be stable, without overt indicators of instability. As part of our study, we performed a quantitative slope stability analysis using the using the computer program SLOPE/W, Version 23.1.2.11 (Geo Slope International, 2023) for static and seismic (i.e. pseudo-static) conditions using Spencer's method of limit-equilibrium analysis considering circular modes of failure.

Slope stability analyses evaluate the ratio of the resisting forces (predominantly soil shear strength) to the driving forces that would cause a slope failure (predominantly gravity, soil unit weight, slope/strata geometry). The ratio of the summation of driving forces divided by the summation of resisting forces is termed Factor of Safety (FS). A FS of 1.0 indicates that the driving and resisting forces are equal and the slope is a state of impending failure/movement. A FS greater than 1.0 indicates the presence of reserve strength; however, does not guarantee that failure will not occur. Rather, the probability of failure generally decreases as the FS increases. Typical minimum required FS for slope stability analyses is summarized in Table 5.4.

TABLE 5.4
MINIMUM REQUIRED FACTORS OF SAFETY – SLOPE STABILITY ANALYSES

Analysis Condition	Typical Minimum Factor of Safety (FS)
Static (Long-Term)	1.5[1]
Seismic / Earthquake	1.0 to 1.2[2]

1. *Typically accepted minimum FS by many regulatory agencies.*
2. *Typical minimum FOS range per commonly accepted engineering practice.*

For our analysis, we used the geometry shown in Cross-Section A-A' (Figure 4), which references the site-specific topography presented in the *Preliminary Grading and Drainage Plan* (TVCE 2018), and a second geometry of the same section assuming a 1.5H:1V slope following grading activities. We assigned relatively conservative shear strength values to the various soil layers based on the results of our laboratory testing program, published correlations, and our experience with similar soils. We analyzed dynamic (seismic) slope stability using a pseudo-static approach in which the earthquake load is simulated by an "equivalent" static horizontal acceleration acting on the mass of the slope. This methodology is generally considered to be conservative and is most often used in current practice. For our seismic analysis, we calculated the seismic coefficient using the procedures presented in Special Publication 117A, *Guidelines for Evaluating and Mitigating Seismic Hazards in California* (CGS 2008). In this procedure, the seismic coefficient is equal to a portion of the design-level PGA. Assuming a 15-cm displacement threshold, a design-level PGA of 1.06g, a modal distance of approximately 30 km, and a modal magnitude of 9.1, the calculated seismic coefficient (k_h) is 0.5.

The modeled conditions, geometry, and critical failure surfaces are shown graphically in Appendix C (Figures C1 through C4). The calculated minimum FS against failure for static and seismic conditions exceeds the generally accepted minimums, with FS of 7.3 and 2.2, respectively, for the current site topography, and with FS of 4.2 and 1.9, respectively, for the topography following proposed grading. Therefore, the proposed tank area appears to be stable under static and seismic shaking conditions. We note that our analysis was limited to the tank area and the adjacent slopes.

5.5 Expansive Soil

Laboratory Plasticity Index (PI) and Expansion Index (EI) tests on near surface soil samples indicate low plasticity and corresponding very low expansion potential (Appendix B). Mitigation and specific design measures with respect to expansive soil are not necessary.

5.6 Soil Corrosion Screening

We performed pH, resistivity, chloride, and sulfate tests on one sample to generally evaluate the corrosion potential of the soil with respect to proposed subsurface structures. These tests were performed in accordance with California Test Method (CTM) Nos. 643, 422, and 417. The results are presented in Table 5.6A and should be considered for design of underground structures.

TABLE 5.6A
SOIL CORROSION PARAMETER TEST RESULTS
(CALIFORNIA TEST METHODS 643, 417, AND 422)

Sample No.	Sample Depth (ft.)	pH	Minimum Resistivity (ohm-cm)	Chloride (ppm)	Sulfate (ppm)
TP3-Bulk	0-5	5.0	16,350	1.4	9.5

Note: ppm = parts per million

Soil with a low pH (higher acidity) is considered corrosive as it can react with lime in cement to leach out soluble reaction products and result in a more porous and weaker concrete. Per Caltrans *Corrosion Guidelines* (Caltrans, 2021), soil with a pH of 5.5 or lower may be corrosive to concrete or steel in contact with the ground.

Soil resistivity is the measure of the soil's ability to transmit electric current. Corrosion of buried ferrous metal is proportional to the resistivity of the soil. A lower resistivity indicates a higher propensity for transmitting electric currents that can cause corrosion of buried ferrous metal items. In general, the higher the resistivity, the lower the rate for corrosion. Per Caltrans *Corrosion Guidelines* (Caltrans, 2021), resistivity serves as an indicator parameter for the possible presence of soluble salts and it is not included as a parameter to define a corrosive area for structures. A minimum resistivity value for soil less than 1,500 ohm-cm may indicate the presence of high quantities of soluble salts and a higher propensity for corrosion. Based on the laboratory minimum resistivity test results and Caltrans criteria, soil at the location tested does not have higher propensity for corrosion.

Table 5.6B presents a summary of concrete requirements set forth by the California Building Code (CBC) Section 1904 and American Concrete Institute (ACI) 318 for possible chloride exposure. Chlorides can break down the protective oxide layer on steel surfaces resulting in corrosion. Sources of chloride include, but are not limited to, deicing chemicals, salt, brackish water, seawater, or spray from these sources.

TABLE 5.6B
REQUIREMENTS FOR CONCRETE EXPOSED TO CHLORIDE-CONTAINING SOLUTIONS
(AFTER ACI 318 TABLES 19.3.1.1 and 19.3.2.1)

Chloride Severity	Exposure Class	Condition	Maximum Water to Cement Ratio by Weight	Minimum Compressive Strength (psi)
Not Applicable	C0	Concrete dry or protected from moisture	N/A	2,500
Moderate	C1	Concrete exposed to moisture but not to external sources of chlorides	N/A	2,500
Severe	C2	Concrete exposed to moisture and an external source of chlorides	0.40	5,000

The appropriate Chloride Severity/Exposure Class should be determined by the project designer based on the specific conditions at the location of the proposed improvements. Further guidance is provided in ACI 318. Per Caltrans *Corrosion Guidelines*, soil with a chloride concentration of 500 ppm or higher may be corrosive to steel structures or steel reinforcement in concrete. Based on Caltrans criteria, soil at the locations tested is not corrosive with respect to chloride content.

Table 5.6C presents a summary of concrete requirements set forth by CBC Section 1904 and ACI 318 for sulfate exposure. Similar to chlorides, sulfates can break down the protective oxide layer on steel leading to corrosion. Sulfates can also react with lime in cement to soften and crack concrete.

TABLE 5.6C
REQUIREMENTS FOR CONCRETE EXPOSED TO SULFATE-CONTAINING SOLUTIONS
(AFTER ACI 318 TABLES 19.3.1.1 and 19.3.2.1)

Sulfate Severity	Exposure Class	Water-Soluble Sulfate (SO4) Content		Cement Type (ASTM C 150)	Maximum Water to Cement Ratio by Weight1	Minimum Compressive Strength (psi)
		Percent By Mass	Parts Per Million (ppm)			
Not Applicable	S0	$SO_4 < 0.10$	$SO_4 < 1,000$	No Type Restriction	N/A	2,500
Moderate	S1	$0.10 \leq SO_4 < 0.20$	$1,000 \leq SO_4 < 2,000$	II	0.50	4,000
Severe	S2	$0.20 \leq SO_4 \leq 2.00$	$2,000 \leq SO_4 \leq 20,000$	V	0.45	4,500
Very Severe	S3	$SO_4 > 2.00$	$SO_4 > 20,000$	V+Pozzolan or Slag	0.45	4,500

Notes:

1. Maximum water to cement ratio limits are different for lightweight concrete, see ACI 318 for details.

Based on the laboratory test results, the Sulfate Severity is classified as “Not Applicable” and the Exposure Class is S0. The concrete mix design(s) should be developed accordingly. The presence of water-soluble sulfates is not a visually discernible characteristic; therefore, other soil samples from the site could yield different concentrations. Additionally, over time landscaping activities (i.e., addition of fertilizers and other soil nutrients) may affect the concentration.

Geocon does not practice in the field of corrosion engineering and the above information is provided as screening criteria only. If corrosion sensitive improvements are planned, we recommend that further evaluations by a corrosion engineer be performed to incorporate the necessary precautions to avoid premature corrosion on buried metal pipes and metal or concrete structures in direct contact with the soils.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 General

6.1.1 No soil or geologic conditions were encountered during our investigation that would preclude development of the site as planned, provided the recommendations contained in this report are incorporated into the design and construction of the project.

6.1.2 Based on the results of our research and analyses, there are no significant geologic hazards that would prevent the proposed construction at the site as presently proposed. The primary geotechnical constraints identified in our investigation are:

- **Undocumented Fill:** Fill material is present in the landing area where the water tank location is proposed. Since we do not know the placement and compaction history of undocumented fill, if/where present, it is not suitable for support of proposed structures or additional fill. Therefore, undocumented fill material will need to be removed to expose undisturbed native soil. Specific recommendations are provided in this report.
- **Differential Fill/Soil Thickness:** Based on the variable thickness of residual soil and variable depth to intact bedrock, overexcavation and recompaction of near-surface soils will be required to create a uniform pad of engineered fill.
- **Shallow Bedrock:** The presence of Galice Formation bedrock is throughout the project area, which will present moderately difficult excavation conditions and the generation of oversize materials. Specific recommendations regarding grading, excavations, and backfilling are provided in this report.

6.1.3 Conclusions and recommendations provided in this report are based on our review of referenced literature, analysis of data obtained from our field exploration, laboratory testing program, and our understanding of the proposed development at this time. Geocon should be retained to review the project plans as they develop further, provide engineering consultation as needed, and perform geotechnical observation and testing services during construction.

6.2 Seismic Design Criteria

6.2.1 Seismic design of structures should be performed in accordance with the provisions of the 2022 California Building Code (CBC) which is based on the American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI) publication: *ASCE/SEI 7-16, Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (ASCE/SEI, 2017). We used the *Structural Engineers Association of California* (SEAOC) and *Office of Statewide*

Health Planning and Development (OSHPD) web application *Seismic Design Maps* (https://seismicmaps.org/) to evaluate site-specific seismic design parameters in accordance with ASCE 7-16.

For seismic design purposes, sites are classified as Site Class "A" through "F" as follows:

- Site Class A – Hard Rock;
- Site Class B – Rock;
- Site Class C – Very Dense Soil and Soft Rock;
- Site Class D – Stiff Soil;
- Site Class E – Soft Clay Soil; and
- Site Class F – Soils Requiring Site Response Analysis.

Based on the subsurface conditions at the site and measured penetration resistance in our borings, the Site Classification is Site Class "C – Very Dense Soil and Soft Rock" per Table 20.3-1 of ASCE/SEI 7-16. For the purpose of evaluating code-based seismic parameters for design, we assumed a seismic Risk Category II (per the CBC) for the project. Results are summarized in Table 6.2.1.

TABLE 6.2.1
ASCE 7-16 (CODE-BASED) SEISMIC DESIGN PARAMETERS
SITE CLASS "C" – VERY DENSE SOIL AND SOFT ROCK

Parameter	Value	ASCE 7-16 Reference
MCE_R Ground Motion Spectral Response Acceleration – Class B (short), S_S	1.874g	Figure 22-1
MCE_R Ground Motion Spectral Response Acceleration – Class B (1 sec), S_1	0.824g	Figure 22-2
Site Coefficient, F_A	1.200	Table 11.4-1
Site Coefficient, F_V	1.400	Table 11.4-2
Site Class Modified MCE_R Spectral Response Acceleration (short), S_{MS}	2.248g	Eq. 11.4-1
Site Class Modified MCE_R Spectral Response Acceleration (1 sec), S_{M1}	1.154g	Eq. 11.4-2
5% Damped Design Spectral Response Acceleration (short), S_{DS}	1.499g	Eq. 11.4-3
5% Damped Design Spectral Response Acceleration (1 sec), S_{D1}	0.769g	Eq. 11.4-4

6.2.2 Table 6.2.2 presents additional seismic design parameters for projects with Seismic Design Categories of D through F in accordance with ASCE 7-16 for the mapped maximum considered geometric mean (MCE_G).

TABLE 6.2.2
ASCE 7-16 SITE ACCELERATION DESIGN PARAMETERS

Parameter	Value	ASCE 7-16 Reference
Mapped MCE_G Peak Ground Acceleration, PGA	0.853g	Figure 22-7
Site Coefficient, F_{PGA}	1.200	Table 11.8-1
Site Class Modified MCE_G Peak Ground Acceleration, PGA_M	1.024g	Section 11.8.3 (Eq. 11.8-1)

6.2.3 Conformance to the criteria presented in Tables 6.2.1 and 6.2.2 for seismic design does not constitute any kind of guarantee or assurance that significant structural damage or ground failure will not occur if a maximum level earthquake occurs. The primary goal of seismic design is to protect life and not to avoid structural damage, since such design may be economically prohibitive.

6.3 Excavation Characteristics/Rippability

6.3.1 Excavation characteristics will vary at the site depending on location and excavation depths. Table 6.3 summarizes anticipated excavation characteristics in each geologic unit identified at the site.

TABLE 6.3.1
ANTICIPATED EXCAVATION CHARACTERISTICS

Geologic Unit	Excavation Characteristics
Fill	Existing fill generally consists of sandy lean clay/clayey sand with gravel, cobbles, and boulders. We anticipate moderate excavation effort with conventional, heavy-duty grading equipment. The fill was readily excavatable with a standard backhoe. However, the presence of oversize rock (greater than 12 inches in maximum dimension) should be anticipated and may increase excavation difficulty.
Residual Soil	Residual soil at the site generally consists of medium dense to very dense clays and clayey sands with gravel, cobbles and boulders. We anticipate moderate excavation effort with conventional, heavy-duty grading equipment, except where large boulders are encountered. The presence of oversize rock should be anticipated and may increase excavation difficulty.
Galice Formation	Galice Formation bedrock generally excavates as sandy gravel with silt, cobbles and boulders. The presence of oversize rock exceeding 24 inches in maximum dimension should be anticipated and may increase excavation difficulty. We encountered excavation refusal at depths ranging from 4 to 7 feet within the Galice Formation using a Deere 13L backhoe with a 12-inch bucket. Difficult excavation characteristics and the presence of cobbles should be anticipated. Pre-ripping with a large dozer (such as Caterpillar D8R or larger) will likely be required for grading, and large excavators (such as Caterpillar 245 or equal) or rock trenchers will likely be required for trenching.

6.3.2 Protruding rocks in excavation bottoms should be removed and resulting depressions filled in accordance with the recommendations in this report

6.3.3 Temporary excavation slopes must meet Cal/OSHA requirements as appropriate. We anticipate that the majority of excavations in fill and residual soil will be classified as Cal/OSHA “Type B” soil while excavations in Galice Formation bedrock may be classified as Cal/OSHA “Type A” soil if cementation is present. Trench/excavation wall sloping, benching, the use of trench shields, and the placement of excavation spoils should conform to the latest applicable Cal/OSHA standards. The contractor should have a Cal/OSHA-approved “competent person” onsite during excavation and pipe placement to evaluate excavation conditions and to make appropriate recommendations where necessary. It is the contractor’s responsibility to provide sufficient and safe excavation support as well as protecting nearby utilities, structures, and other improvements which may be damaged by earth movements.

6.4 Permanent Cut and Fill Slopes

6.4.1 Permanent cut slopes should be constructed no steeper than 1½H:1V and fill slopes should be constructed no steeper than 2H:1V. To mitigate potential erosion, slopes should be vegetated as soon as possible, and surface drainage should be directed away from the tops of slopes.

6.4.2 Fill slopes, if applicable, should be overbuilt a minimum of 2 feet and cut back to finished grade or track-walked with a D6 dozer (or similar equipment) such that the fill soils are uniformly compacted to at least 90% relative compaction and are moisture conditioned at or near optimum moisture content.

6.5 Water Tank Location

6.5.1 To reduce the potential for post-construction tank foundation differential settlement and potential slope instability (surficial slope creep or potential seismic slope deformation) below the tank, the proposed water tank should be located completely within engineered fill that extends at least 5 feet horizontally from the outside edge of the tank foundation. A cut-fill transition exceeding 5 feet below the tank should be avoided if possible. If a cut-fill transition cannot be avoided, remedial grading (undercut and backfill) will be necessary. Specific recommendations are provided herein.

6.6 Materials for Fill

6.6.1 Excavated soil and rock generated from cut operations at the site are suitable for use as engineered fill in structural areas provided they are selectively placed during grading in accordance with the following recommendations:

- Deleterious material, material with greater than 3 percent organics by weight, and debris should be exported from the site and not incorporated into structural fill.
- Fill material in areas with underground utilities, foundations, and areas within 5 feet of slope faces should consist of 6-inch-minus material with a sufficient amount of soil to provide adequate binder to reduce the potential for excavation caving.
- In other areas (general fill areas without utilities, foundations, and not within 5 feet of slope faces) rock or cementations up to 2 feet in maximum dimension may be used. However, this material should contain a sufficient amount of smaller rock and soil to fill void spaces between large rocks and avoid rock nesting (concentrations of rock with void space).
- If sufficient soil fill materials are not present at the site to mix with onsite rock material, import of soil fill material will be necessary.

6.6.2 Import fill material should be primarily granular with a “very low” expansion potential (Expansion Index less than 20), a Plasticity Index less than 15, be free of organic material and construction debris, and not contain rock/cementations larger than 6 inches in greatest dimension.

6.6.3 Environmental characteristics and corrosion potential of import soil materials should also be considered. Proposed import materials should be sampled, tested, and approved by Geocon prior to its transportation to the site.

6.7 Seepage, Groundwater, and Wet Weather Grading Considerations

6.7.2 Based on the conditions observed during our investigation, we do not anticipate groundwater to significantly affect foundation or underground utility construction if conducted during the summer and/or fall seasons. However, perched groundwater (seepage) may be present near residual soil/weathered bedrock or fill/native contacts (as shallow as 1 to 3 feet deep) year-round. If encountered, mitigation will likely consist of constructing French drains between seepage-prone areas (e.g., seasonal drainages, swales) and structures. We should provide specific recommendations at the time of construction based on actual conditions encountered.

6.7.3 If grading commences in winter or spring, or in periods of precipitation, excavated and in-place soils will likely be wet. Earthwork contractors should be aware of the moisture-sensitivity of site soils that may result in subgrade instability and/or potential compaction difficulties. Earthwork operations in these conditions will likely be difficult with low productivity. Often, a period of at least one month of warm and dry weather is necessary to allow the site to dry sufficiently so that heavy grading equipment can operate effectively. If the construction schedule allows, we recommend performing earthwork construction during the seasonal dry months.

6.8 Grading

6.8.1 Earthwork operations should be observed and fills tested for recommended compaction and moisture content by a representative of Geocon.

6.8.2 References to relative compaction and optimum moisture content in this report are based on the latest ASTM D1557 Test Procedure. Structural areas should be considered as areas extending a minimum of 5 feet horizontally beyond the outside dimensions of footings carrying structural loads.

6.8.3 Prior to commencing grading, a pre-construction conference with representatives of the client, grading contractor, and Geocon should be held at the site. Site preparation, soil handling and/or the grading plans should be discussed at the pre-construction conference.

6.8.4 Site preparation should begin with removal of existing surface/subsurface structures, if any, underground utilities (as required), any existing fill/backfill, and debris. Existing trees and similar large vegetation and associated roots larger than 1 inch in diameter should be completely removed. Smaller roots may be left in-place as conditions warrant as evaluated by our representative. Surface vegetation consisting of grasses and other similar vegetation (if present) should be removed by stripping to a sufficient depth to remove organic-rich topsoil. Material generated during stripping is not suitable for use within 5 feet of structures or within pavement areas but may be placed in landscaped or non-structural areas or exported from the site.

6.8.5 In order to provide uniform support of the new water tank, the tank pad should be over-excavated to remove all existing fill, and beyond to a depth of one foot below bottom of new footings or 2 feet below existing grade, whichever is deeper. The over-excavation should extend at least 5 feet beyond the structure perimeter. Existing fill may be reused as engineered fill provided it meets the requirements of Section 6.6 of this report. Oversize rock (larger than 6 inches in greatest dimension) should be screened and removed from the excavated fill prior to re-use in building areas. The over-excavation bottom should be proof-rolled in the presence of a Geocon representative with a loaded water truck (or similar equipment with high contact pressure) to evaluate the performance of exposed subgrade and to identify any loose or unstable conditions that could require additional excavation.

6.8.6 Excavations or depressions resulting from site clearing operations, or other existing excavations or depressions, should be restored with engineered fill in accordance with the recommendations of this report.

6.8.7 In general, where fill will be placed on slopes steeper than 5H:1V, we recommend that horizontal benches angled slightly into the slope be cut into competent formational material on the slopes prior to placing fill. Benches should roughly parallel slope contours and extend at least 2 feet into competent formational material. In addition, a keyway should be cut into the slope at the base of the fill. In general, keyways should be at least 15 feet wide and extend at least 2 feet into competent formational material. Subdrains may be required along the back edge of keyways and/or benches. Bench and keyway criteria may need revision during construction based on the actual materials encountered and grading performed in the field. A typical keying and benching detail is presented as Figure 6.

6.8.8 After site preparation, over-excavation bottoms, areas to receive fill or left at-grade should be scarified at least 12 inches, uniformly moisture-conditioned at or above optimum moisture content and compacted to at least 90 percent relative compaction. Scarification and recompaction operations should be performed in the presence of a Geocon representative to evaluate performance of the subgrade under compaction equipment loading.

6.8.9 Engineered fill consisting of onsite soil or approved import sources should be compacted in horizontal lifts not exceeding 8 inches (loose thickness) and brought to final subgrade elevations. Each lift should be moisture-conditioned at or above optimum and compacted to at least 90 percent relative compaction.

6.8.10 Fill slopes should be built such that soils are uniformly compacted to at least 90 percent relative compaction to the face of the completed slope.

6.8.11 Underground utility trenches within structural areas should be backfilled with properly compacted material. Pipe bedding, shading and backfill should conform to the requirements of the appropriate utility authority. Material excavated from trenches should be adequate for use as general backfill above shading provided it does not contain deleterious matter, vegetation or cementations larger than 6 inches in maximum dimension. Trench backfill should be placed in loose lifts not exceeding 8 inches. Lifts should be compacted to a minimum of 90 percent relative compaction at or above optimum moisture content. Compaction should be performed by mechanical means only; jetting of trench backfill is not recommended.

6.8.12 The upper 6 inches of roadway or pavement subgrade, whether completed at-grade, by excavation, or by filling, should be uniformly moisture-conditioned at or above optimum moisture content and compacted to at least 95 percent relative compaction. Final pavement subgrade should be finished to a smooth, unyielding surface. We further recommend proof-rolling the subgrade with a loaded water truck (or similar equipment with high contact pressure) to verify the stability of the subgrade prior to placing AB.

6.9 Foundations – Water Tank

6.9.1 Provided the tank pad is graded in accordance with the recommendations of this report, the water storage tank may be supported on a perimeter ring footing with an interior concrete slab-on-grade supported on a gravel cushion. As previously discussed, a minimum setback of 10 feet should be maintained between the outer edge of tank foundations to the hinge point of the tank pad and adjacent descending slope.

6.9.2 Ring footings should extend at least 12 inches below pad grade and may be designed using an allowable bearing capacity of 3,000 pounds per square foot (psf) for dead plus live loads with a one-third increase for short-term transient loading such as wind and seismic.

6.9.3 Allowable passive pressure used to resist lateral movement of footings may be assumed to be equal to a fluid weighing 350 pounds per cubic foot (pcf). The allowable coefficient of friction to resist sliding of footings is 0.35 for concrete against soil. Combined passive resistance and friction may be utilized for footing design provided that the frictional resistance is reduced by 50 percent.

6.9.4 Water tank foundations designed in accordance with the recommendations above should experience total settlement of less than one inch and differential settlement on the order of ½ inch from center to tank edge. The majority of settlement will be immediate and occur as the tank is filled to nominal capacity.

6.9.5 Concrete slabs-on grade (if used) for the tank should be underlain by a minimum of 6 inches of Class 2 AB uniformly compacted to at least 95 percent relative compaction at or above optimum moisture content.

6.10 Retaining Walls and Lateral Loads

6.10.1 Lateral earth pressures may be used in the design of retaining walls. Lateral earth pressures may be assumed to be equal to an equivalent fluid pressure (EFP). Table 6.10 summarizes our recommended EFP values for design.

TABLE 6.10
RECOMMENDED LATERAL EARTH PRESSURES

Condition	Equivalent Fluid Density
Active – level backfill	40 pcf
Active – sloping backfill (2H:1V)	60 pcf
At-Rest	60 pcf
Seismic Earth Pressure[1]	20 pcf

Note:

1. *Applicable for walls that support more than 6 feet of backfill in accordance with Section 1803.5.12 of the 2022 CBC. Conventional triangular distribution (zero at the top). Should be combined with ACTIVE lateral earth pressure for seismic case analysis.*

6.10.2 Unrestrained walls should be designed using the active case. Unrestrained walls are those that are allowed to rotate more than 0.001H (where H is the height of the wall). Walls restrained from movement (such as basement walls) should be designed using the at-rest case.

6.10.3 An allowable downward drag friction coefficient of 0.35 may be used for resistance to sliding between backfill soil and the concrete tank wall.

6.10.4 We anticipate that retaining wall foundations will be founded in cut, exposing Galice Formation bedrock at the bottom of footing. Retaining wall foundations with a minimum depth of 18 inches in intact Galice Formation or on at least 1 foot of engineered fill may be designed using the allowable bearing capacity provided in Paragraph 6.9.2 of this report.

Lateral resistance of footings will be provided by passive resistance of the soil in front and frictional resistance along the base of the footings. An allowable passive resistance of 350 pcf may be used where level ground extends at least 5 feet or three times the depth of the footing or shear key, whichever is greater, beyond the face of the retaining wall footing. Where sloping ground (up to 2H:1V) is present in front of footings, a reduced passive resistance of 175 pcf should be used. If this surface is not protected by floor slabs or pavement, the upper 12 inches of material should not be included in the design for lateral resistance. An allowable friction coefficient of 0.35 may be used for resistance to sliding between soil and concrete. Combined passive resistance and friction may be utilized for design provided that the frictional resistance is reduced by 50 percent.

6.10.5 Retaining walls should be provided with a drainage system adequate to prevent the buildup of hydrostatic forces and should be waterproofed as required by the project architect. Positive drainage for retaining walls should consist of a vertical layer of permeable material positioned between the retaining wall and the soil backfill. The permeable material may be composed of a composite drainage geosynthetic or a natural permeable material such as crushed gravel at least 12 inches thick and capped with at least 12 inches of native soil. A geosynthetic filter fabric should be placed between the gravel and the soil backfill. Provisions for removal of collected water should be provided for either system by installing a perforated drainage pipe along the bottom of the permeable material which leads to suitable drainage facilities.

6.11 Concrete Flatwork

6.11.1 Concrete flatwork not subjected to vehicular traffic should be underlain by at least 4 inches of Class 2 AB compacted to at least 90% relative compaction at or above optimum moisture content. Prior to placing the AB, the top 6 inches of soil subgrade soil should be uniformly moisture-conditioned above optimum moisture content and compacted to 90% relative compaction.

6.11.2 Concrete jointing and reinforcement (if used) should be detailed in accordance with ACI or PCA guidelines.

6.11.3 Exterior concrete flatwork should be structurally independent of building foundations except at doorways where dowels should be used to reduce vertical offset that could affect door operation.

6.12 Drainage

6.12.1 Proper site drainage is critical to reduce the potential for differential soil movement, soil expansion, erosion and subsurface seepage. Under no circumstances should water be allowed to pond adjacent to structure foundations. The site should be graded and maintained such that surface drainage is directed away from structures in accordance with the 2022 CBC or other applicable standards. Water should not be allowed to pond in relatively flat areas. In addition, surface drainage should be directed away from the top of slopes into swales or other controlled drainage devices.

6.12.2 Underground utilities should be leak free. Utility and irrigation lines should be checked periodically for leaks, and detected leaks should be repaired promptly. Detrimental soil movement could occur if water is allowed to infiltrate the soil for prolonged periods of time.

6.12.3 Landscaping planters adjacent to paved areas are not recommended due to the potential for surface or irrigation water to infiltrate the pavement’s subgrade and base course. We recommend that area drains to collect excess irrigation water and transmit it to drainage structures or impervious above-grade planter boxes be used. In addition, where landscaping is planned adjacent to the pavement, we recommend construction of a cutoff wall (deepened concrete curb, plastic root barrier, or similar cutoff) along the edge of the pavement that extends at least 4 inches into the soil subgrade below the bottom of the base material.

6.12.4 Roof drains should be connected to water-tight drainage piping connected to the storm drain system. Consideration should be given to draining roofs to lined planter boxes or placing liners below the proposed landscape areas to prevent infiltration of water. Geocon can be contacted for additional recommendations.

6.12.5 Experience has shown that even with these provisions, subsurface seepage may develop in areas where no such water conditions existed prior to site development. This is particularly true where a substantial increase in surface water infiltration has resulted from an increase in landscape irrigation.

7.0 FURTHER GEOTECHNICAL SERVICES

7.1 Plan and Specification Review

7.1.1 We should review the foundation and grading plans prior to final design submittal to assess whether our recommendations have been properly incorporated and evaluate if additional analysis and/or recommendations are required.

7.2 Testing and Observation Services

7.2.1 The recommendations provided in this report are based on the assumption that we will continue as Geotechnical Engineer of Record throughout the construction phase. It is important to maintain continuity of geotechnical interpretation and confirm that field conditions encountered during construction are similar to those anticipated during design. Testing and observation services by the Geotechnical Engineer of Record are necessary to verify that construction has been performed in accordance with this report, approved plans, and specifications. If we are not retained for these services, we cannot assume any responsibility for other’s interpretation of our recommendations or the future performance of the project.

8.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

The recommendations of this report pertain only to the site investigated and are based upon the assumption that the soil conditions do not deviate from those disclosed in the investigation. If any variations or undesirable conditions are encountered during construction, or if the proposed construction will differ from that anticipated herein, we should be notified so that supplemental recommendations can be given. The evaluation or identification of the potential presence of hazardous materials or environmental contamination was not part of our scope of services.

This report is issued with the understanding that it is the responsibility of the owner or their representative to ensure that the information and recommendations contained herein are brought to the attention of the design team for the project and incorporated into the plans and specifications and the necessary steps are taken to see that the contractor and subcontractors carry out such recommendations in the field.

The recommendations contained in this report are preliminary until verified during construction by representatives of our firm. Changes in the conditions of a property can occur with the passage of time, whether they are due to natural processes or the works of man on this or adjacent properties. Additionally, changes in applicable or appropriate standards may occur, whether they result from legislation or the broadening of knowledge. Accordingly, the findings of this report may be invalidated partially or wholly by changes outside our control. Therefore, this report is subject to review and should not be relied upon after a period of three years.

Our professional services were performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices used in the site area at this time. No warranty is provided, express or implied.

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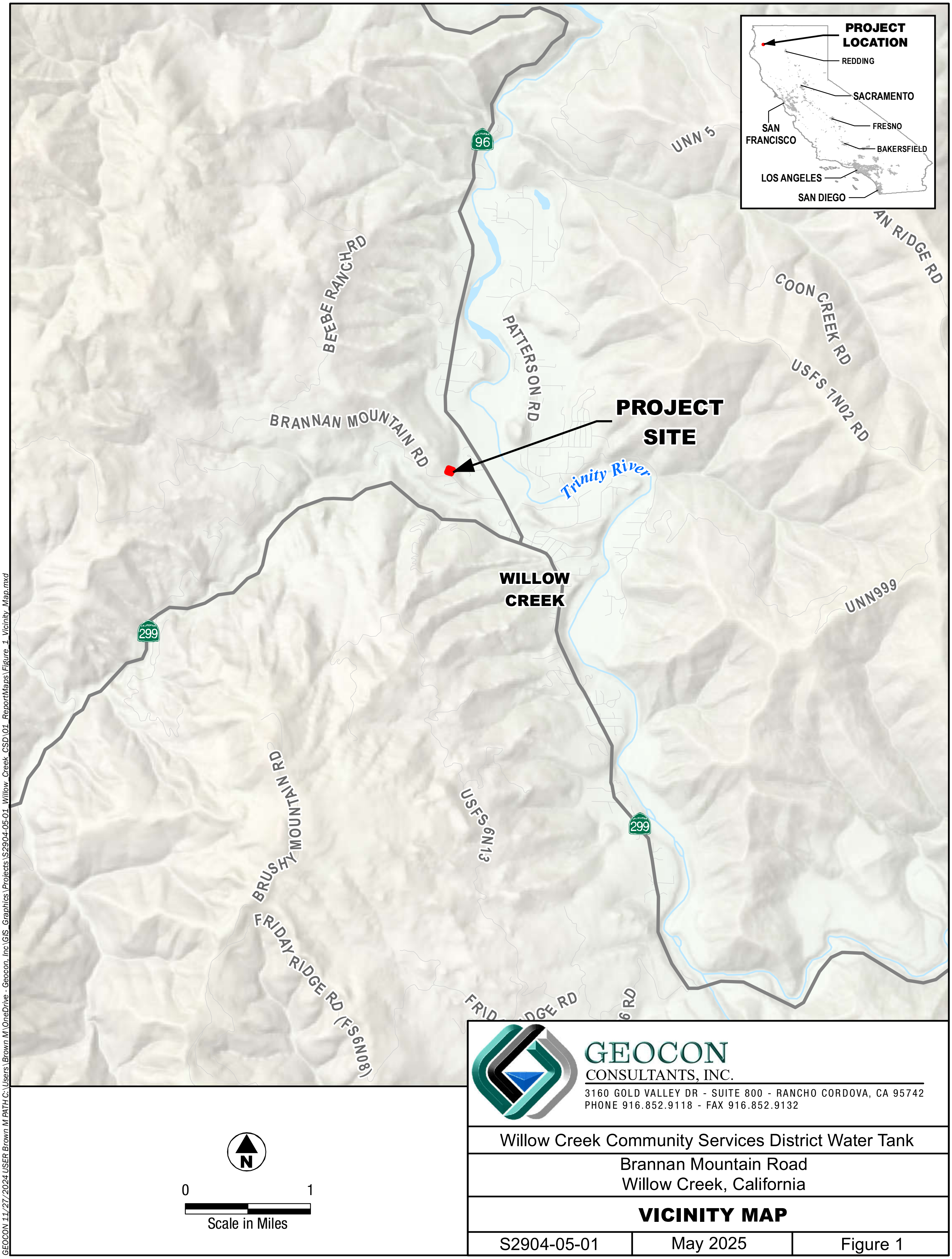

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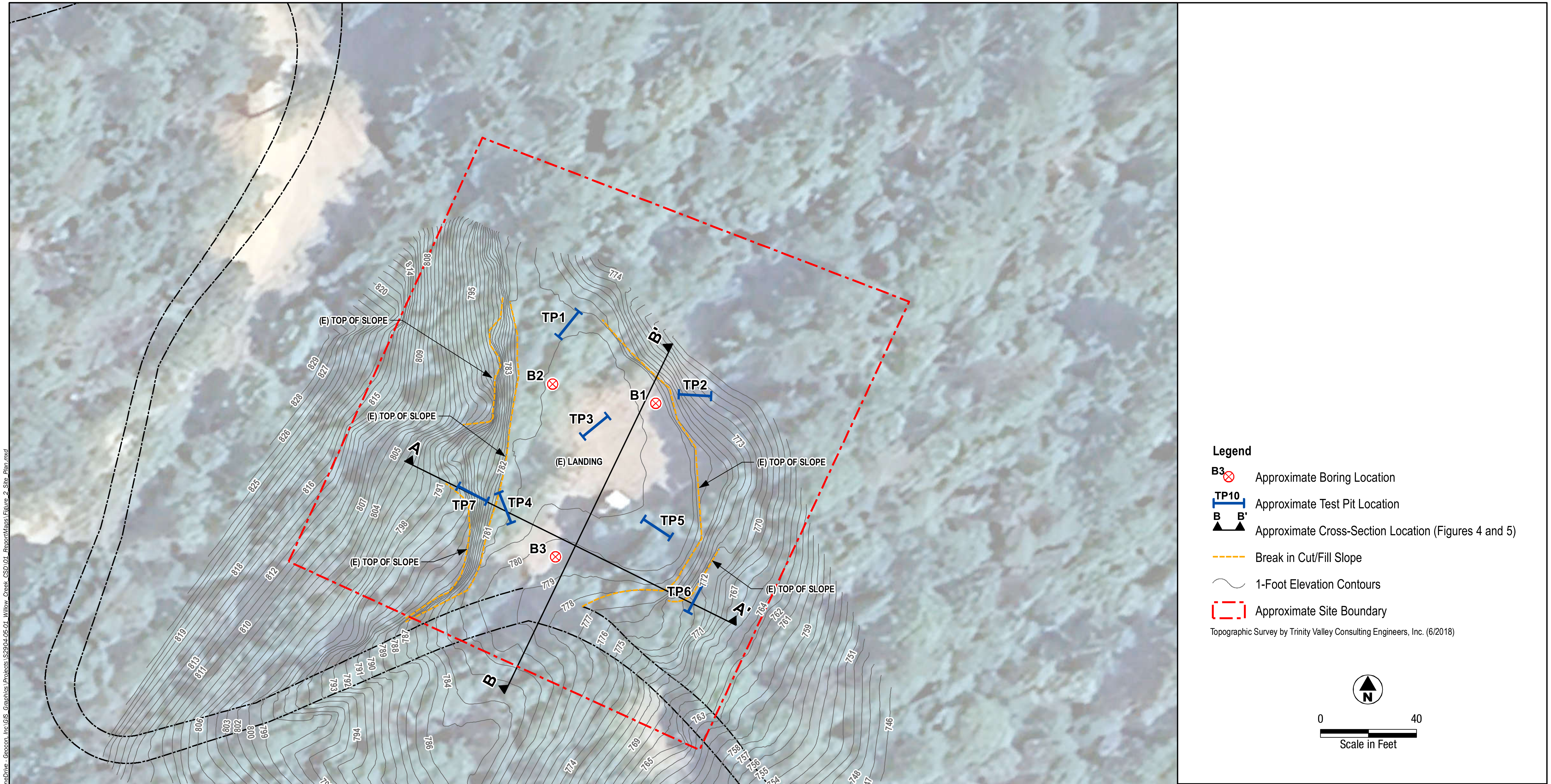
VICINITY MAP

S2904-05-01	May 2025	Figure 1



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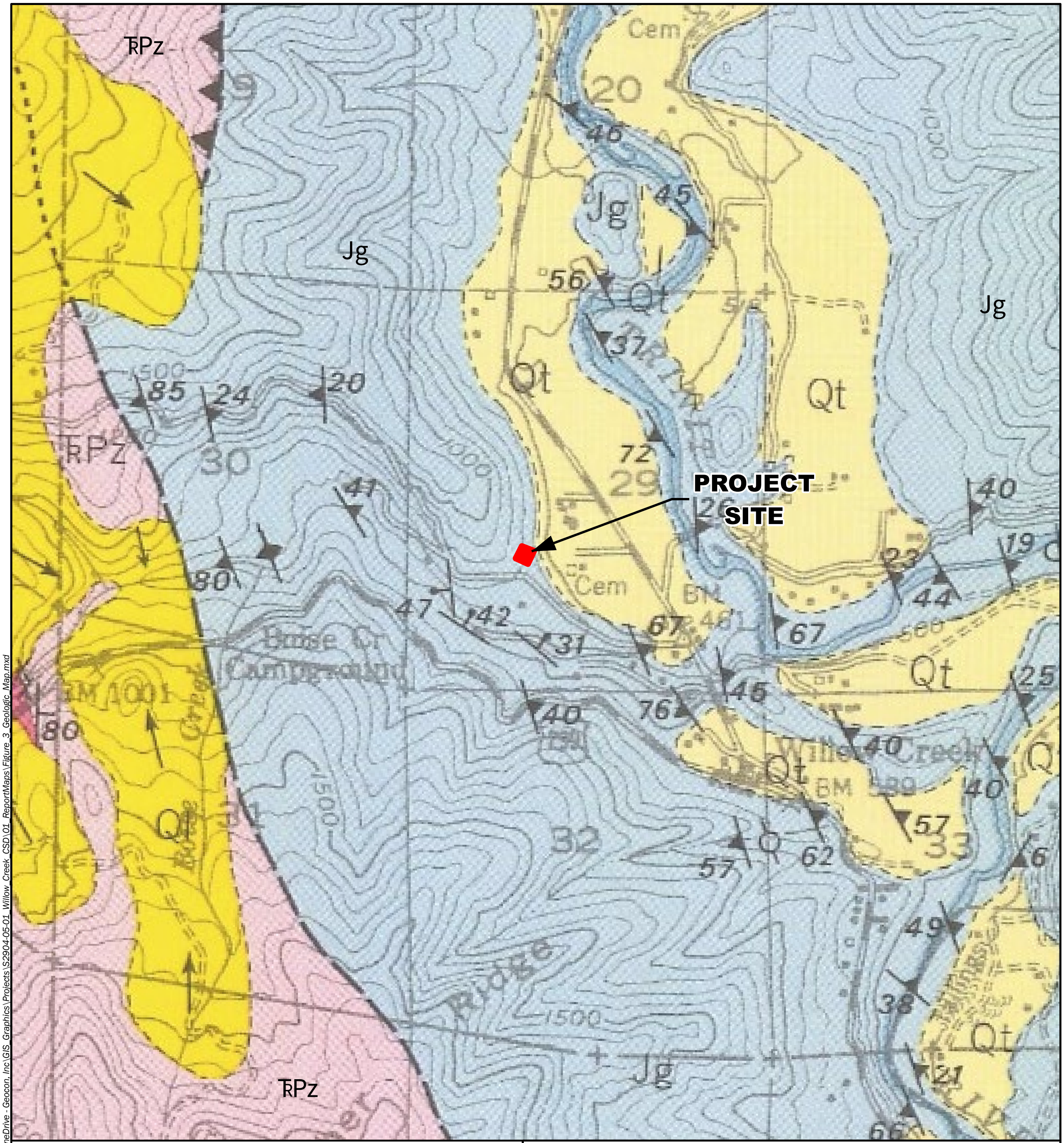
SITE PLAN

S2904-05-01	May 2025	Figure 2



Geologic and and Sections of the Willow Creek 15' Quadrangle, Humboldt and Trinity Counties, California; J.C. Young; 1978

Unit Explantion

Qt	Quaternary Terrace gravels
Ql	Landslide or Slump
Jg	Galice Formation
TRPz	Western Paleozoic and Triassic belt rocks (melange)
⤙30	Strike and Dip of Beds
⤙25	Strike and Dip of Foliation

N

0 2,000

Scale in Feet

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GEOLOGIC MAP

S2904-05-01	May 2025	Figure 3

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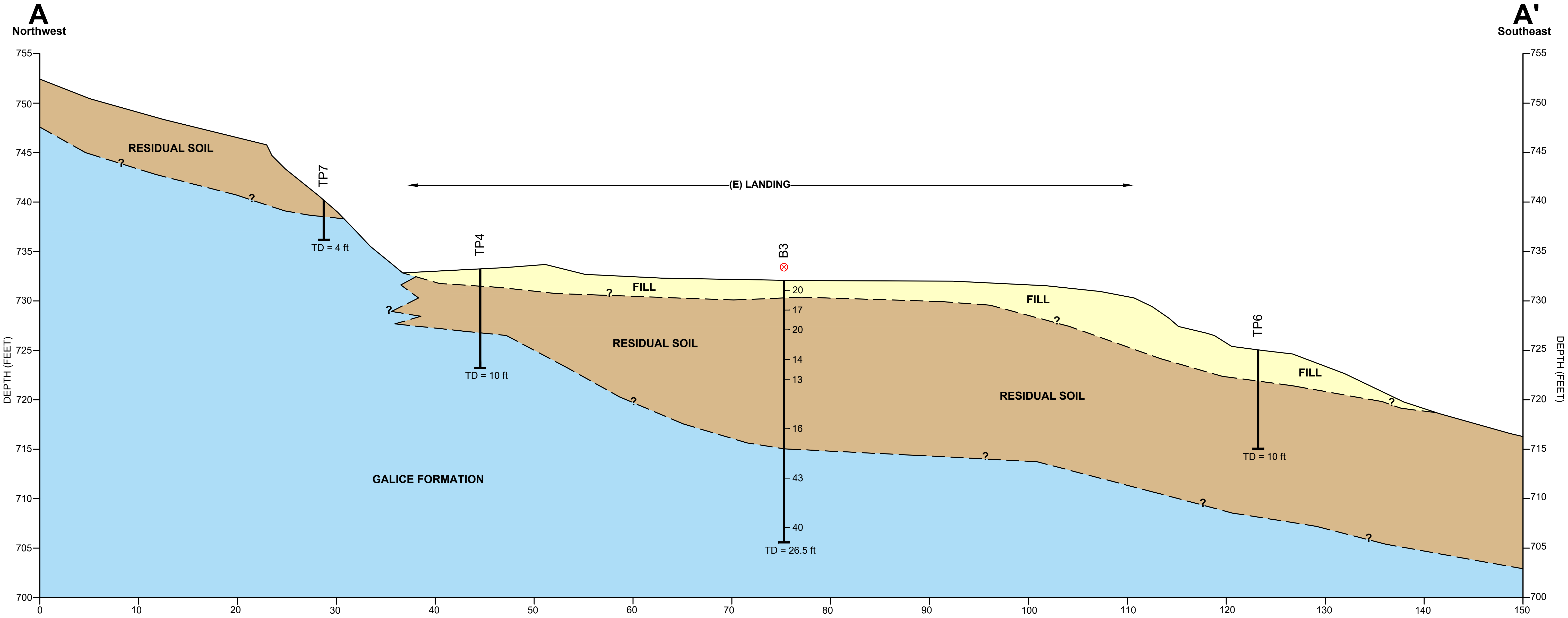


Legend

B3 ⊗ Exploration Location

-15 Blow Count (California Modified Sampler)

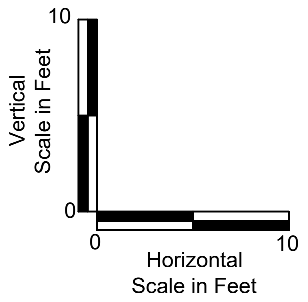
- - - - Lithology Contacts

🟨 Fill

🟫 Residual Soil

🟦 Galice Formation

Abbreviations:
ft = Feet



Notes:
1. This figure depicts generalized subsurface conditions inferred from our explorations and is intended for use as general geotechnical characterization and an aid for design. Actual subsurface conditions, including groundwater depths/elevations, may vary. Please refer to the Boring Logs (Appendix A) for detailed subsurface conditions encountered at each boring location.

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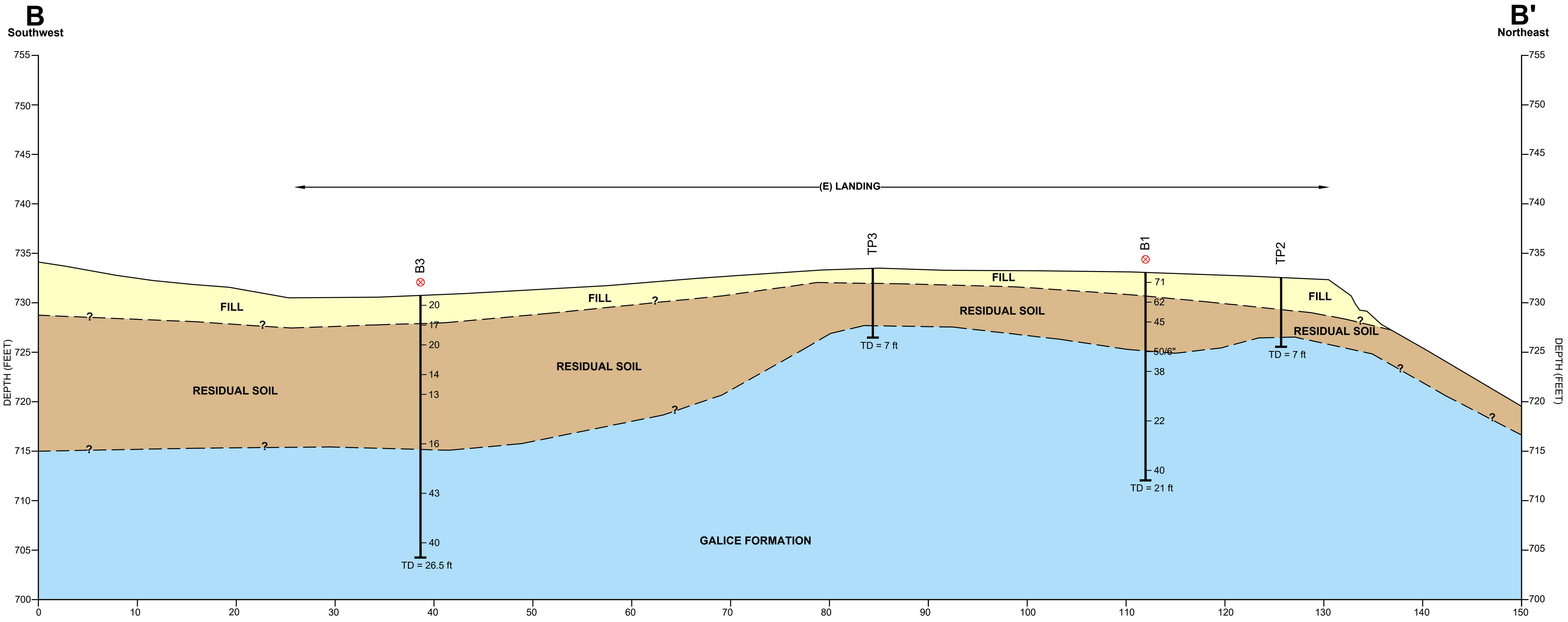
CROSS SECTION A-A'

S2904-05-01 | May 2025 | Figure 4



Legend

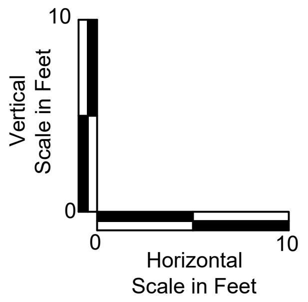
B3 ⊗ Exploration Location

-15 Blow Count (California Modified Sampler)

- - - - Lithology Contacts

🟨	Fill
🟫	Residual Soil
🟦	Galice Formation

Abbreviations:
ft = Feet



Notes:
1. This figure depicts generalized subsurface conditions inferred from our explorations and is intended for use as general geotechnical characterization and an aid for design. Actual subsurface conditions, including groundwater depths/elevations, may vary. Please refer to the Boring Logs (Appendix A) for detailed subsurface conditions encountered at each boring location.

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CROSS SECTION B-B'

S2904-05-01 | May 2025 | Figure 5

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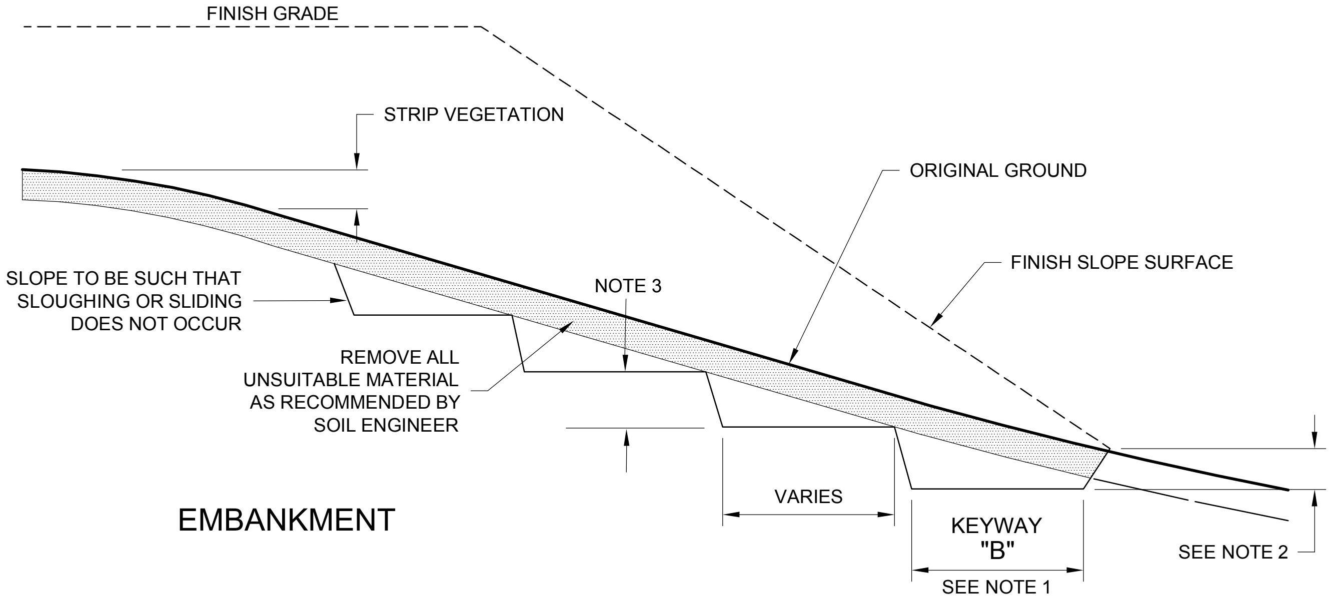

Notes:

1... The minimum width “B” of keyway shall be 2 feet wider than the compaction equipment and not less than 15 feet.

2... The outside edge of bottom key shall be below topsoil or loose surface material and at least 2 feet into competent formational material.

Keys are required where the existing slopes are steeper than 5 horizontal to 1 vertical.

The base of the key and each bench shall be inclined slightly into the slope.

3... Bench height not to exceed 3 feet.

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Willow Creek Community Services District Water Tank

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Typical Keying and Benching Detail

S2904-05-01 | May 2025 | Figure 6

APPENDIX A

APPENDIX A

FIELD EXPLORATION

Our geotechnical field exploration program was performed on October 8 and 23, 2024, and consisted of excavating seven exploratory test pits (TP1 through TP7) and drilling three exploratory borings (B1 through B3) at the approximate locations shown on the Site Plan, Figure 2.

The exploratory borings were performed using a truck-mounted CME 55 drill rig equipped with 6-inch outside diameter (OD) solid-flight augers and 7-inch OD hollow-stem augers. Soil sampling was performed using an automatic 140-pound hammer with a 30-inch drop. We obtained samples using a 3-inch OD split-spoon (California Modified) sampler. We recorded the number of blows required to drive the sampler the last 12 inches (or portion thereof) of the 18-inch sampling interval on the boring logs. Upon completion, the borings were backfilled with neat cement grout.

Test pits were performed using a Deere 310L backhoe equipped with an 18-inch-wide bucket. Soil samples were collected from the test pits at various locations and depths. Upon completion, the test pits were backfilled with the excavated material.

We visually examined, classified, and logged the subsurface conditions in the exploratory borings and test pits in general accordance with the American Society for Testing and Materials (ASTM) Practice for Description and Identification of Soils (Visual-Manual Procedure D2488-90). This system uses the Unified Soil Classification System (USCS) for soil designations. The logs depict soil and geologic conditions encountered and depths at which we obtained samples. The logs also include our interpretation of the conditions between sampling intervals. Therefore, the logs contain both observed and interpreted data. We determined the lines designating the interface between soil materials on the logs using visual observations, drill rig penetration rates, excavation characteristics, and other factors. The transition between materials may be abrupt or gradual. Where applicable, we revised the field logs based on subsequent laboratory testing. Logs of exploratory borings are presented herein.

UNIFIED SOIL CLASSIFICATION

MAJOR DIVISIONS			TYPICAL NAMES	
COARSE-GRAINED SOILS MORE THAN HALF IS COARSER THAN NO. 200 SIEVE	**GRAVELS** MORE THAN HALF COARSE FRACTION IS LARGER THAN NO.4 SIEVE SIZE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL GRADED GRAVELS WITH OR WITHOUT SAND, LITTLE OR NO FINES
			GP	POORLY GRADED GRAVELS WITH OR WITHOUT SAND, LITTLE OR NO FINES
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, SILTY GRAVELS WITH SAND
			GC	CLAYEY GRAVELS, CLAYEY GRAVELS WITH SAND
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO.4 SIEVE SIZE	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL GRADED SANDS WITH OR WITHOUT GRAVEL, LITTLE OR NO FINES
			SP	POORLY GRADED SANDS WITH OR WITHOUT GRAVEL, LITTLE OR NO FINES
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS WITH OR WITHOUT GRAVEL
			SC	CLAYEY SANDS WITH OR WITHOUT GRAVEL
FINE-GRAINED SOILS MORE THAN HALF IS FINER THAN NO. 200 SIEVE	**SILTS AND CLAYS** LIQUID LIMIT 50% OR LESS		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTS WITH SANDS AND GRAVELS
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, CLAYS WITH SANDS AND GRAVELS, LEAN CLAYS
			OL	ORGANIC SILTS OR CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50%		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OR CLAYS OF MEDIUM TO HIGH PLASTICITY
	HIGHLY ORGANIC SOILS		PT	PEAT AND OTHER HIGHLY ORGANIC SOILS

BORING/TRENCH LOG LEGEND

- ○ No Recovery (NOREC)
- ◩ Chunk Sample (CHK)
- ◫ Shelby Tube Sample (ST)
- ☒ Bulk Sample (B)
- ◧ Standard Penetration Test Sample (SPT)
- ■ Modified California Sample (MC)
- ◢ Continuous Push (CP)
- ▼ Groundwater Level (At Time of Drilling)
- ▽ Groundwater Level (After Drilling)
- ≡ Groundwater Level (Seepage Encountered)

PENETRATION RESISTANCE

SAND AND GRAVEL			SILT AND CLAY			
RELATIVE DENSITY	BLOWS PER FOOT (SPT)*	BLOWS PER FOOT (MOD-CAL)*	CONSISTENCY	BLOWS PER FOOT (SPT)*	BLOWS PER FOOT (MOD-CAL)*	COMPRESSIVE STRENGTH (tsf)
VERY LOOSE	0 - 4	0 - 6	VERY SOFT	0 - 2	0 - 3	0 - 0.25
LOOSE	5 - 10	7 - 16	SOFT	3 - 4	4 - 6	0.25 - 0.50
MEDIUM DENSE	11 - 30	17 - 48	FIRM	5 - 8	7 - 13	0.50 - 1.0
DENSE	31 - 50	49 - 79	STIFF	9 - 15	14 - 24	1.0 - 2.0
VERY DENSE	OVER 50	OVER 79	VERY STIFF	16 - 30	25 - 48	2.0 - 4.0
			HARD	OVER 30	OVER 48	OVER 4.0

*NUMBER OF BLOWS OF 140 LB HAMMER FALLING 30 INCHES TO DRIVE LAST 12 INCHES

MOISTURE DESCRIPTIONS

FIELD TEST	APPROX. DEGREE OF SATURATION, S (%)	DESCRIPTION
NO INDICATION OF MOISTURE; DRY TO THE TOUCH	S<25	DRY
SLIGHT INDICATION OF MOISTURE	25≤S<50	DAMP
INDICATION OF MOISTURE; NO VISIBLE WATER	50≤S<75	MOIST
MINOR VISIBLE FREE WATER	75≤S<100	WET
VISIBLE FREE WATER	100	SATURATED

QUANTITY DESCRIPTIONS

APPROX. ESTIMATED PERCENT	DESCRIPTION
<5%	TRACE
5 - 10%	FEW
11 - 25%	LITTLE
26 - 50%	SOME
>50%	MOSTLY

GRAVEL/COBBLE/BOULDER DESCRIPTIONS

CRITERIA	DESCRIPTION
PASS THROUGH A 3-INCH SIEVE AND BE RETAINED ON A NO. 4 SIEVE (#4 TO 3")	GRAVEL
PASS A 12-INCH SQUARE OPENING AND BE RETAINED ON A 3-INCH SIEVE (3"-12")	COBBLE
WILL NOT PASS A 12-INCH SQUARE OPENING (>12")	BOULDER

BEDDING SPACING DESCRIPTIONS

THICKNESS/SPACING	DESCRIPTOR
GREATER THAN 10 FEET	MASSIVE
3 TO 10 FEET	VERY THICKLY BEDDED
1 TO 3 FEET	THICKLY BEDDED
3 ⅝-INCH TO 1 FOOT	MODERATELY BEDDED
1 ¼-INCH TO 3 ⅝-INCH	THINLY BEDDED
⅜-INCH TO 1 ¼-INCH	VERY THINLY BEDDED
LESS THAN ⅜-INCH	LAMINATED

STRUCTURE DESCRIPTIONS

CRITERIA	DESCRIPTION
ALTERNATING LAYERS OF VARYING MATERIAL OR COLOR WITH LAYERS AT LEAST ¼-INCH THICK	STRATIFIED
ALTERNATING LAYERS OF VARYING MATERIAL OR COLOR WITH LAYERS LESS THAN ¼-INCH THICK	LAMINATED
BREAKS ALONG DEFINITE PLANES OF FRACTURE WITH LITTLE RESISTANCE TO FRACTURING	FISSURED
FRACTURE PLANES APPEAR POLISHED OR GLOSSY, SOMETIMES STRIATED	SLICKENSIDED
COHESIVE SOIL THAT CAN BE BROKEN DOWN INTO SMALLER ANGULAR LUMPS WHICH RESIST FURTHER BREAKDOWN	BLOCKY
INCLUSION OF SMALL POCKETS OF DIFFERENT SOIL, SUCH AS SMALL LENSES OF SAND SCATTERED THROUGH A MASS OF CLAY	LENSED
SAME COLOR AND MATERIAL THROUGHOUT	HOMOGENOUS

CEMENTATION/INDURATION DESCRIPTIONS

FIELD TEST	DESCRIPTION
CRUMBLES OR BREAKS WITH HANDLING OR LITTLE FINGER PRESSURE	WEAKLY CEMENTED/INDURATED
CRUMBLES OR BREAKS WITH CONSIDERABLE FINGER PRESSURE	MODERATELY CEMENTED/INDURATED
WILL NOT CRUMBLE OR BREAK WITH FINGER PRESSURE	STRONGLY CEMENTED/INDURATED

IGNEOUS/METAMORPHIC ROCK STRENGTH DESCRIPTIONS

FIELD TEST	DESCRIPTION
MATERIAL CRUMBLES WITH BARE HAND	WEAK
MATERIAL CRUMBLES UNDER BLOWS FROM GEOLOGY HAMMER	MODERATELY WEAK
⅛-INCH INDENTATIONS WITH SHARP END FROM GEOLOGY HAMMER	MODERATELY STRONG
HAND-HELD SPECIMEN CAN BE BROKEN WITH **ONE** BLOW FROM GEOLOGY HAMMER	STRONG
HAND-HELD SPECIMEN CAN BE BROKEN WITH **COUPLE** BLOWS FROM GEOLOGY HAMMER	VERY STRONG
HAND-HELD SPECIMEN CAN BE BROKEN WITH **MANY** BLOWS FROM GEOLOGY HAMMER	EXTREMELY STRONG

IGNEOUS/METAMORPHIC ROCK WEATHERING DESCRIPTIONS

DEGREE OF DECOMPOSITION	FIELD RECOGNITION	ENGINEERING PROPERTIES
SOIL	DISCOLORED, CHANGED TO SOIL, FABRIC DESTROYED	EASY TO DIG
COMPLETELY WEATHERED	DISCOLORED, CHANGED TO SOIL, FABRIC MAINLY PRESERVED	EXCAVATED BY HAND OR RIPPING (Saprolite)
HIGHLY WEATHERED	DISCOLORED, HIGHLY FRACTURED, FABRIC ALTERED AROUND FRACTURES	EXCAVATED BY HAND OR RIPPING, WITH SLIGHT DIFFICULTY
MODERATELY WEATHERED	DISCOLORED, FRACTURES, INTACT ROCK-NOTICEABLY WEAKER THAN FRESH ROCK	EXCAVATED WITH DIFFICULTY WITHOUT EXPLOSIVES
SLIGHTLY WEATHERED	MAY BE DISCOLORED, SOME FRACTURES, INTACT ROCK-NOT NOTICEABLY WEAKER THAN FRESH ROCK	REQUIRES EXPLOSIVES FOR EXCAVATION, WITH PERMEABLE JOINTS AND FRACTURES
FRESH	NO DISCOLORATION, OR LOSS OF STRENGTH	REQUIRES EXPLOSIVES

IGNEOUS/METAMORPHIC ROCK JOINT/FRACTURE DESCRIPTIONS

FIELD TEST	DESCRIPTION
NO OBSERVED FRACTURES	UNFRACTURED/UNJOINTED
MAJORITY OF JOINTS/FRACTURES SPACED AT 1 TO 3 FOOT INTERVALS	SLIGHTLY FRACTURED/JOINTED
MAJORITY OF JOINTS/FRACTURES SPACED AT 4-INCH TO 1 FOOT INTERVALS	MODERATELY FRACTURED/JOINTED
MAJORITY OF JOINTS/FRACTURES SPACED AT 1-INCH TO 4-INCH INTERVALS WITH SCATTERED FRAGMENTED INTERVALS	INTENSELY FRACTURED/JOINTED
MAJORITY OF JOINTS/FRACTURES SPACED AT LESS THAN 1-INCH INTERVALS; MOSTLY RECOVERED AS CHIPS AND FRAGMENTS	VERY INTENSELY FRACTURED/JOINTED

GEOCON

KEY TO LOGS

GEOCON

SOIL BORING NUMBER: B 1

Page 1 of 1

PROJECT NAME Willow Creek CSD Water Tank
LOGGED BY Lauren Herbert
PROJECT NUMBER S2904-05-01
LATITUDE / LONGITUDE 40.94773, -123.642291
DATE STARTED 10/23/2024 **COMPLETED** 10/23/2024
DEPTH 21.5' **SURFACE ELEVATION** ~733'
LOCATION Willow Creek, CA
DRILLING FIRM V&W Drilling
RIG TYPE CME-55
METHOD Auger **BORING DIAMETER** 7 in
HAMMER TYPE Auto
HAMMER WEIGHT / DROP 140 lb / 30 in

Depth (ft)	USCS	Water Levels	Material Description	Bulk	Driven	Sample Number	Blow Counts/6"	Penetration Resistance (blows/foot)
0	SC-SM		**FILL** Medium dense, moist, brown to yellowish brown, **Silty, Clayey SAND** with **Gravel**					
1.5	SC-SM		**RESIDUAL SOIL** Very dense, moist, yellowish brown, **Silty, Clayey**, fine to medium grained **SAND** with **Gravel**; up to 2" in diameter		■	B1-1.5 B1-2	12 21 50	71/12"
3.5					■	B1-3.5 B1-4	8 22 40	62
5.5			Dense; increasing gravel content and size		■	B1-5.5 B1-6	10 20 25	45
8			Very dense; increasing gravel size	■			50/6"	
9	GP		**GALICE FORMATION** Highly weathered Greenschist and Slate; excavates as Dense, moist, grayish brown, **Poorly graded GRAVEL** with **Sand and Clay**					
10.5					■	B1-10.5 B1-11	24 19 19	38
13			rig grinding on rocks					
15.5			Medium dense; highly variable rock weathering		■	B1-15.5 B1-16	9 11 11	22
20.5			Dense, grayish brown with iron oxide staining, some **Clay**		■	B1-20.5 B1-21	11 16 24	40

Boring terminated at 21.5 feet. Groundwater not encountered. Backfilled with neat cement grout.

Water Levels

∇ No free water encountered on 10/23

▼ -

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN APPLIES ONLY TO THE SPECIFIC BORING OR TRENCH LOCATION AT THE DATE INDICATED AND MIGHT NOT REPRESENT SUBSURFACE CONDITIONS AT OTHER LOCATIONS OR TIMES. THE STRATIGRAPHY PRESENTED REPRESENTS THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES; THESE TRANSITIONS COULD BE GRADUAL.

GEOCON

SOIL BORING NUMBER: B 2

Page 1 of 1

PROJECT NAME Willow Creek CSD Water Tank

PROJECT NUMBER S2904-05-01

DATE STARTED 10/23/2024 **COMPLETED** 10/23/2024

LOCATIO Willow Creek, CA

DRILLING FIRM V&W Drilling

METHOD Auge **BORING DIAMETER** 7 in

LOGGED BY Lauren Herbert

LATITUDE / LONGITUDE 40.947757, -123.642448

DEPTH 25.5' **SURFACE ELEVATION** ~733'

RIG TYPE CME-55

HAMMER TYPE Auto

HAMMER WEIGHT / DROP 140 lb / 30 in

Depth (ft)	Elevation (ft)	Graphic Log	USCS	Water Levels	Material Description	Bulk	Driven	Sample Number	Blow Counts/6"	Penetration Resistance (blows/foot)
	733		SC-SM		**FILL** Moist, yellowish brown, **Silty, Clayey SAND** with **Gravel**		■	B2-1.5 B2-2	13 31 36	67
	730				**RESIDUAL SOIL** Very dense, moist, yellowish brown to brown, **Silty, Clayey**, fine to medium grained **SAND** with **Gravel**		■	B2-3.5 B2-4	11 30 35	65
5					increasing gravel content		■	B2-5.5 B2-6	14 22 50	72/12"
	725				Brown; increasing clay content, gravel up to 1" in diameter Dense		■	B2-8 B2-8.5	13 15 21	36
10			GP		**GALICE FORMATION** Highly weathered Greenschist and Slate; excavates as Dense, moist, grayish brown, **Poorly graded GRAVEL** with **Sand and Clay**		■	B2-10.5 B2-11	13 17 24	41
	720									
15					gravel up to 2.5" in diameter in recovery		■	B2-15.5 B2-16	22 18 18	36
	715									
20					Very dense, brown to grayish brown; decreasing clay content		■	B2-21	30 50/6"	80/6"
	710									
25					material breaks down in auger but is hard to drive sample into sampling refusal		■	B2-25	50/6"	50/6"

Boring terminated at 25.5 feet.
Groundwater not encountered.
Backfilled with neat cement grout.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN APPLIES ONLY TO THE SPECIFIC BORING OR TRENCH LOCATION AT THE DATE INDICATED AND MIGHT NOT REPRESENT SUBSURFACE CONDITIONS AT OTHER LOCATIONS OR TIMES. THE STRATIGRAPHY PRESENTED REPRESENTS THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES; THESE TRANSITIONS COULD BE GRADUAL.

SOIL BORING NUMBER: B 3

Page 1 of 1

PROJECT NAME Willow Creek CSD Water Tank
LOGGED BY Lauren Herbert
PROJECT NUMBER S2904-05-01
LATITUDE / LONGITUDE 40.947559, -123.642439
DATE STARTED 10/23/2024 **COMPLETED** 10/23/2024
DEPTH 26.5' **SURFACE ELEVATION** ~732'
LOCATIO Willow Creek, CA
DRILLING FIRM V&W Drilling
RIG TYPE CME-55
METHOD Auge **BORING DIAMETER** 7 in
HAMMER TYPE Auto
HAMMER WEIGHT / DROP 140 lb / 30 in

Depth (ft)	Elevation (ft)	Graphic Log	USCS	Water Levels	Material Description	Bulk	Driven	Sample Number	Blow Counts/6"	Penetration Resistance (blows/foot)	Pocket Penetrometer (tsf)
	732		CL		**FILL** Moist, reddish brown, **Sandy LEAN CLAY** with **Gravel**						
	730						■	B3-1.5 B3-2	15 10 10	20	>4.5
					RESIDUAL SOIL Hard, moist, reddish brown, **Sandy**, fine to medium grained **LEAN CLAY** with **Gravel**; up to 1/2" in diameter		■	B3-3.5 B3-4	7 8 9	17	
5							■	B3-5.5 B3-6	6 8 12	20	4.0
	725				increasing gravel content and size, gravel up to 1" in diameter		■	B3-8 B3-8.5	5 7 7	14	3.75
10					Very stiff; increasing gravel content decreasing gravel size, gravel up to 1/2" in diameter		■	B3-10.5 B3-11	5 6 7	13	3.25
	720										
15					Hard; with gravel up to 2.5" in diameter in recovery, gradational contact with bedrock		■	B3-15.5 B3-16	5 6 10	16	4.0
	715		GP		**GALICE FORMATION** Highly weathered Greenschist and Slate; excavates as Medium dense, moist, grayish brown, **Poorly graded GRAVEL** with **Sand**						
20							■	B3-20.5 B3-21	8 21 22	43	
	710					■					
25					rock fragments up to 2.5" in diameter in recovery		■	B3-25.5 B3-26	10 15 25	40	
	705				Boring terminated at 26.5 feet. Groundwater not encountered. Backfilled with neat cement grout.						

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN APPLIES ONLY TO THE SPECIFIC BORING OR TRENCH LOCATION AT THE DATE INDICATED AND MIGHT NOT REPRESENT SUBSURFACE CONDITIONS AT OTHER LOCATIONS OR TIMES. THE STRATIGRAPHY PRESENTED REPRESENTS THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES; THESE TRANSITIONS COULD BE GRADUAL.

GEOCON

TEST PIT NUMBER: TP1

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PROJECT NAME Willow Creek CSD Water Tank

PROJECT NUMBER S2904-05-01

DATE STARTED 10/08/2024 **COMPLETED** 10/08/2024

LATITUDE / LONGITUDE 40.947826, -123.642426

CONTRACTOR Geocon

EQUIPMENT Deere 13L Backhoe

METHOD Backhoe

LOCATION Willow Creek, CA

LOGGED BY Lauren Herbert

DEPTH 13' **SURFACE ELEVATION** ~734'

Depth (ft)	Water Levels	Graphic Log	USCS	Material Description	Sample Graphic	Sample ID
1 2 3		▨	SM	**FILL** Dry, light brown to reddish brown, **Silty**, fine grained **SAND** with trace boulders up to 2' in diameter Moist	⏢ ■	TP1-BULK TP1-2
4 5 6 7 8		▨	SM	**RESIDUAL SOIL** Moist, brown to yellowish brown, **Silty SAND** with **Gravel**; with boulders Brown to grayish brown	⧗ ■ ⏢	TP1-5
9 10 11 12 13		▨	GP	**GALICE FORMATION** Highly weathered Greenschist and Slate; excavates as Medium dense, moist, gray to greenish gray, **Poorly graded GRAVEL** with **Sand and Silt**	■	TP1-8

Test pit terminated at 13 feet. Groundwater not encountered. Backfilled with soil cuttings.

Water Levels

▽ No free water encountered on 10/08

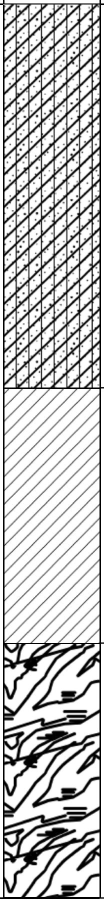
▼ -

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN APPLIES ONLY TO THE SPECIFIC BORING OR TRENCH LOCATION AT THE DATE INDICATED AND MIGHT NOT REPRESENT SUBSURFACE CONDITIONS AT OTHER LOCATIONS OR TIMES. THE STRATIGRAPHY PRESENTED REPRESENTS THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES; THESE TRANSITIONS COULD BE GRADUAL.

TEST PIT NUMBER: TP2

Page 1 of 1

PROJECT NAME Willow Creek CSD Water Tank
PROJECT NUMBER S2904-05-01
DATE STARTED 10/08/2024 **COMPLETED** 10/08/2024
LATITUDE / LONGITUDE 40.947747, -123.642233
CONTRACTOR Geocon
EQUIPMENT Deere 13L Backhoe
METHOD Backhoe
LOCATION Willow Creek, CA
LOGGED BY Lauren Herbert
DEPTH 7'
SURFACE ELEVATION ~732'



Depth (ft)	Elevation (ft)	Water Levels	Graphic Log	USCS	Material Description
	732				
2	730			SC-SM	**FILL** Dry, light brown to reddish brown, **Silty, Clayey**, fine grained **SAND** with **Gravel**; trace cobbles up to 10" in diameter, with rootlets Moist
4				CL	**RESIDUAL SOIL** Moist, brown to yellowish brown, **Sandy LEAN CLAY** with **Gravel**; with boulders
6	725			GP	**GALICE FORMATION** Highly weathered Greenschist and Slate; excavates as Medium dense, moist, gray to greenish gray, **Poorly graded GRAVEL** with **Sand and Silt**

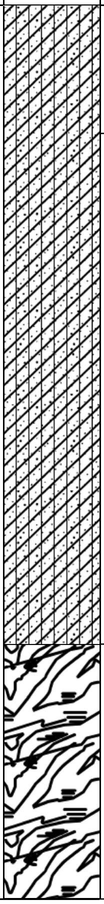
Test pit terminated upon practical refusal at 7 feet. Groundwater not encountered. Backfilled with soil cuttings.

GEOCON

TEST PIT NUMBER: TP3

Page 1 of 1

PROJECT NAME Willow Creek CSD Water Tank
PROJECT NUMBER S2904-05-01
DATE STARTED 10/08/2024 **COMPLETED** 10/08/2024
LATITUDE / LONGITUDE 40.947709, -123.642383
CONTRACTOR Geocon
EQUIPMENT Deere 13L Backhoe
METHOD Backhoe
LOCATION Willow Creek, CA
LOGGED BY Lauren Herbert
DEPTH 7'
SURFACE ELEVATION ~732'



Depth (ft)	Elevation (ft)	Water Levels	Graphic Log	USCS	Material Description
	732				
				SC-SM	**FILL** Moist, brown to reddish brown, **Silty, Clayey SAND** with **Gravel**; trace cobbles up to 10" in diameter
2 4	730			SC-SM	**RESIDUAL SOIL** Moist, brown, **Silty, Clayey SAND** with **Gravel**; with boulders
6	725			GP	**GALICE FORMATION** Highly weathered Greenschist and Slate; excavates as Medium dense, moist, gray to greenish gray, **Poorly graded GRAVEL** with **Sand and Silt**; with felsic inclusions

Test pit terminated upon practical refusal at 7 feet. Groundwater not encountered. Backfilled with soil cuttings.

TEST PIT NUMBER: TP4

Page 1 of 1

PROJECT NAME Willow Creek CSD Water Tank

PROJECT NUMBER S2904-05-01

DATE STARTED 10/08/2024 **COMPLETED** 10/08/2024

LATITUDE / LONGITUDE 40.947614, -123.642516

CONTRACTOR Geocon

EQUIPMENT Deere 13L Backhoe

METHOD Backhoe

LOCATION Willow Creek, CA

LOGGED BY Lauren Herbert

DEPTH 10'

SURFACE ELEVATION ~733'

Depth (ft)	Elevation (ft)	Water Levels	Graphic Log	USCS	Material Description
	733				
			▨	SC-SM	**FILL** Dry, light brown to reddish brown, **Silty, Clayey SAND** with **Gravel**; trace boulders up to 15" in diameter
2 4	730		▨	SC-SM	**RESIDUAL SOIL** Moist, brown to grayish brown, **Silty, Clayey SAND** with **Gravel**; with boulders Increase in boulder content
6 8 10	725		▨	GP	**GALICE FORMATION** Highly weathered Greenschist and Slate; excavates as Medium dense, moist, gray to greenish gray, **Poorly graded GRAVEL** with

Test pit terminated upon practical refusal at 10 feet. Groundwater not encountered. Backfilled with soil cuttings.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN APPLIES ONLY TO THE SPECIFIC BORING OR TRENCH LOCATION AT THE DATE INDICATED AND MIGHT NOT REPRESENT SUBSURFACE CONDITIONS AT OTHER LOCATIONS OR TIMES. THE STRATIGRAPHY PRESENTED REPRESENTS THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES; THESE TRANSITIONS COULD BE GRADUAL.

TEST PIT NUMBER: TP5

Page 1 of 1

PROJECT NAME Willow Creek CSD Water Tank

PROJECT NUMBER S2904-05-01

DATE STARTED 10/08/2024 **COMPLETED** 10/08/2024

LATITUDE / LONGITUDE 40.947594, -123.642287

CONTRACTOR Geocon

EQUIPMENT Deere 13L Backhoe

METHOD Backhoe

LOCATION Willow Creek, CA

LOGGED BY Lauren Herbert

DEPTH 11' **SURFACE ELEVATION** ~731'

Depth (ft)	Elevation (ft)	Water Levels	Graphic Log	USCS	Material Description
	731				
	730		▨	SC-SM	**FILL** Dry to moist, light brown to reddish brown, **Silty, Clayey SAND** with **Gravel**; trace boulders up to 1' in diameter
2			▨	SC-SM	**RESIDUAL SOIL** Moist, brown to grayish brown, **Silty, Clayey SAND** with **Gravel**; with boulders
4					
6	725				
					Increase in boulder content
8			▩	GP	**GALICE FORMATION** Highly weathered Greenschist and Slate; excavates as Medium dense, moist, gray to greenish gray, **Poorly graded GRAVEL** with **Sand and Silt**
10					
	720				

Test pit terminated at 11 feet. Groundwater not encountered. Backfilled with soil cuttings.

GEOCON

TEST PIT NUMBER: TP6

Page 1 of 1

PROJECT NAME Willow Creek CSD Water Tank
PROJECT NUMBER S2904-05-01
DATE STARTED 10/08/2024 **COMPLETED** 10/08/2024
LATITUDE / LONGITUDE 40.947515, -123.642227
CONTRACTOR Geocon
EQUIPMENT Deere 13L Backhoe
METHOD Backhoe
LOCATION Willow Creek, CA
LOGGED BY Lauren Herbert
DEPTH 10' **SURFACE ELEVATION** ~725'

Depth (ft)	Elevation (ft)	Water Levels	Graphic Log	USCS	Material Description
	725				
			▨	SC	**FILL** Moist, brown to reddish brown, **Clayey SAND** with **Gravel**; trace cobbles up to 10" in diameter
2			▨	SC	**RESIDUAL SOIL** Moist, brown to reddish brown, **Clayey**, fine grained **SAND** with **Gravel**; with cobbles
4			▨		Brown to grayish brown
	720		▨		
6			▨		
8			▨		
10	715				

Test pit terminated at 10 feet. Groundwater not encountered. Backfilled with soil cuttings.

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN APPLIES ONLY TO THE SPECIFIC BORING OR TRENCH LOCATION AT THE DATE INDICATED AND MIGHT NOT REPRESENT SUBSURFACE CONDITIONS AT OTHER LOCATIONS OR TIMES. THE STRATIGRAPHY PRESENTED REPRESENTS THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES; THESE TRANSITIONS COULD BE GRADUAL.

GEOCON

TEST PIT NUMBER: TP7

Page 1 of 1

PROJECT NAME Willow Creek CSD Water Tank
PROJECT NUMBER S2904-05-01
DATE STARTED 10/08/2024 **COMPLETED** 10/08/2024
LATITUDE / LONGITUDE 40.94763, -123.642566
CONTRACTOR Geocon
EQUIPMENT Deere 13L Backhoe
METHOD Backhoe
LOCATION Willow Creek, CA
LOGGED BY Lauren Herbert
DEPTH 4'
SURFACE ELEVATION ~740'

Depth (ft)	Elevation (ft)	Water Levels	Graphic Log	USCS	Material Description
	740				
			▨	SC-SM	**RESIDUAL SOIL** Moist, brown to grayish brown, **Silty, Clayey SAND** with **Gravel**
			▨	GP	**GALICE FORMATION** Highly weathered Greenschist and Slate; excavates as Medium dense, moist, gray to greenish gray, **Poorly graded GRAVEL** with **Sand and Silt**
2					
4					

Test pit terminated upon practical refusal at 4 feet. Groundwater not encountered. Backfilled with soil cuttings.

APPENDIX B

APPENDIX B

LABORATORY TESTING PROGRAM

Laboratory tests were performed in accordance with generally accepted test methods of the American Society for Testing and Materials (ASTM) or other suggested procedures. Selected soil samples were tested for their in-place dry density and moisture content, plasticity characteristics, grain size distribution, corrosion potential, expansion potential, unconfined compressive strength, and moisture-density relationship. The results of the laboratory tests are presented below and on the following pages.

TABLE B1
EXPANSION INDEX TEST RESULTS
ASTM D4829

Sample Number	Depth (feet)	Moisture Content (%)		Expansion Index	Classification*
		Before Test	After Test		
B3 – Bulk	0-5	9.6	18.0	8	Very Low

**Expansion Potential Classification per ASTM D4829.*

Sheet 1 of 1

Sample ID	Depth (feet)	Liquid Limit	Plastic Limit	Plasticity Index	Expansion Index	%<#200 Sieve	Water Content (%)	Dry Density (pcf)
B1-2	2						4.7	117.8
B1-6	6						9.3	84.9
B1-11	11						8.7	118.6
B1-16	16						10.4	94.2
B1-21	21						10.0	114.7
B2-2	2						9.0	120.1
B2-4	4						10.4	117.5
B2-8.5	8.5						10.9	112.6
B2-16	16						13.5	124.9
B3-Bulk	0-5	35	20	15	8			
B3-2	2						12.8	102.2
B3-4	4						12.6	110.7
B3-6	6						13.5	109.4
B3-8.5	8.5						13.1	105.8
B3-11	11	29	20	9			13.1	114.1
B3-16	16						12.3	104.9
B3-21	21						8.7	125.0
TP1-Bulk	1-8					19.2		
TP2-Bulk	1-7					39.1		
TP4-Bulk	1-6					38.3		
TP6-Bulk	2-7	34	19	15		47.2		

US LAB SUMMARY GEOTECH 2 WITH EI COLUMN S2904-05-01 WILLOW CREEK LOG FOR LAB.GPJ US LAB.GDT 1/2/25

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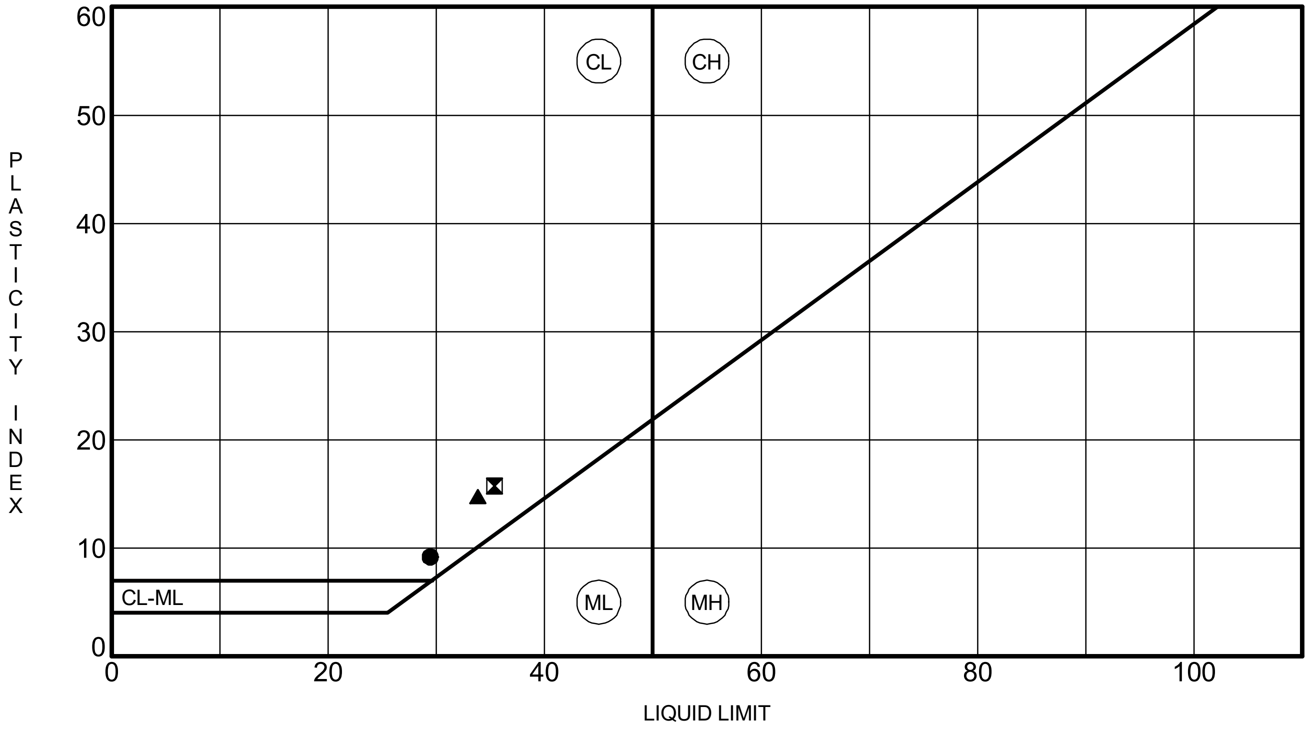
Summary of Laboratory Results

Project: Willow Creek CSD
Location: Willow Creek, California
Number: S2904-05-01
Figure: B1



	Sample No.	Liquid Limit	Plastic Limit	Plasticity Index	% Pass #200 Sieve	Unified Soil Classification Description	Preparation Method
●	**B3-11**	**29**	**20**	**9**		**SANDY LEAN CLAY (CL)**	**dry**
☒	**B3-Bulk**	**35**	**20**	**15**		**SANDY LEAN CLAY (CL)**	**dry**
▲	**TP6-Bulk**	**34**	**19**	**15**	**47.2**	**CLAYEY SAND(SC)**	**dry**

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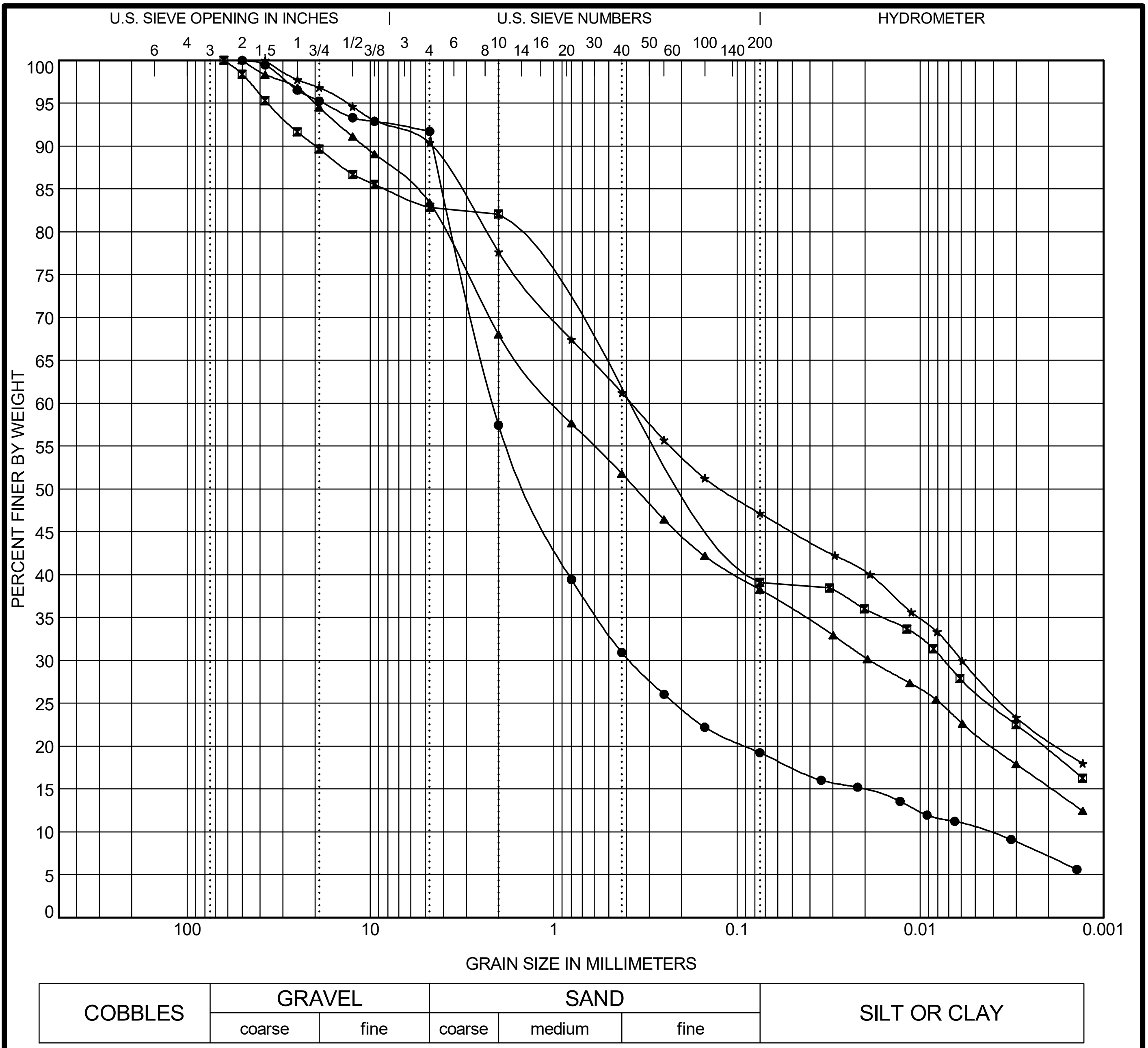
ATTERBERG LIMITS (ASTM D4318)

Project: Willow Creek CSD
Location: Willow Creek, California
Number: S2904-05-01
Figure: B2 Date:



	Sample No.	Classification	LL	PL	PI	Cc	Cu
●	**TP1-Bulk**	**SILTY SAND (SM)**				**16.03**	**495.1**
⊠	**TP2-Bulk**	**SILTY CLAYEY SAND WITH GRAVEL (SC-SM)**					
▲	**TP4-Bulk**	**SILTY CLAYEY SAND WITH GRAVEL (SC-SM)**					
★	**TP6-Bulk**	**CLAYEY SAND(SC)**	**34**	**19**	**15**		

	Sample No.	D100	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP1-Bulk**	**50**	**1.369**	**0.384**	**0.004**	**8.3**	**72.5**	**12.1**	**7.1**
⊠	**TP2-Bulk**	**63**	**0.172**	**0.007**		**17.1**	**43.8**	**19.6**	**19.5**
▲	**TP4-Bulk**	**50**	**0.355**	**0.019**		**16.6**	**45.1**	**23.0**	**15.3**
★	**TP6-Bulk**	**37.5**	**0.121**	**0.006**		**9.6**	**43.2**	**26.4**	**20.7**

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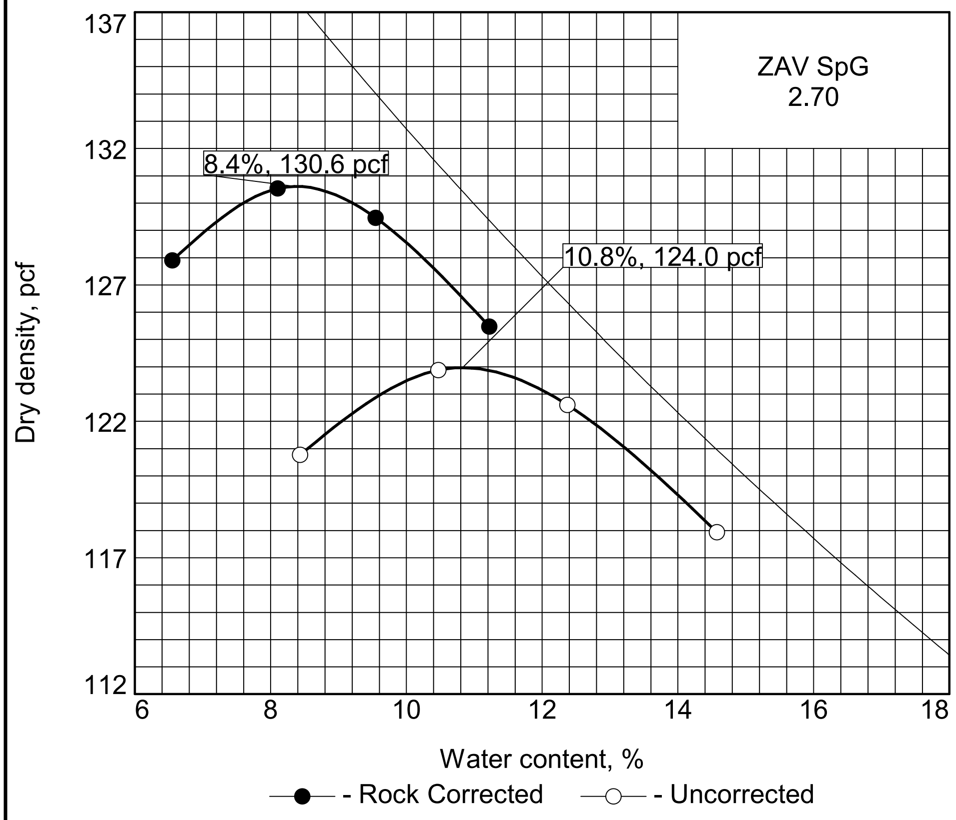
GRAIN SIZE DISTRIBUTION (ASTM D422, D6913)

Project: Willow Creek CSD
Location: Willow Creek, California
Number: S2904-05-01
Figure: B3

COMPACTION TEST REPORT



Curve No.
TP3 Bulk

Test Specification:
ASTM 1557 Method A 2024 Mold PM9
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Preparation Method ____________

Hammer Wt. 10

Hammer Drop 18

Number of Layers 5

Blows per Layer 25

Mold Size 0.0333 cu. ft.

Test Performed on Material Passing #4 **Sieve**

NM ________ **LL** ________ **PI** ________

Sp.G. (ASTM D 854) 2.7

%>#4 24.0 **%<No.200** ________

USCS ________ **AASHTO** ________

Date Sampled ____________

Date Tested 11/21/24

Tested By RS

TESTING DATA

	1	2	3	4	5	6
WM + WS	4105.0	4119.0	4016.0	4079.0		
WM	2038.0	2038.0	2038.0	2038.0		
WW + T #1	2522.0	2539.0	2422.0	2495.0		
WD + T #1	2326.5	2310.1	2269.3	2236.0		
TARE #1	459.0	460.0	458.0	459.0		
WW + T #2						
WD + T #2						
TARE #2						
MOISTURE	8.1	9.5	6.6	11.2		
DRY DENSITY	130.5	129.5	127.9	125.5		

ROCK CORRECTED TEST RESULTS	UNCORRECTED
Maximum dry density = 130.6 pcf	124.0 pcf
Optimum moisture = 8.4 %	10.8 %

Material Description

Brown sandy lean clay

Remarks:

Project No. S2904-05-01 **Client:**

Project: Willow Creek CSD Tank

○ **Sample Number:** TP3 Bulk

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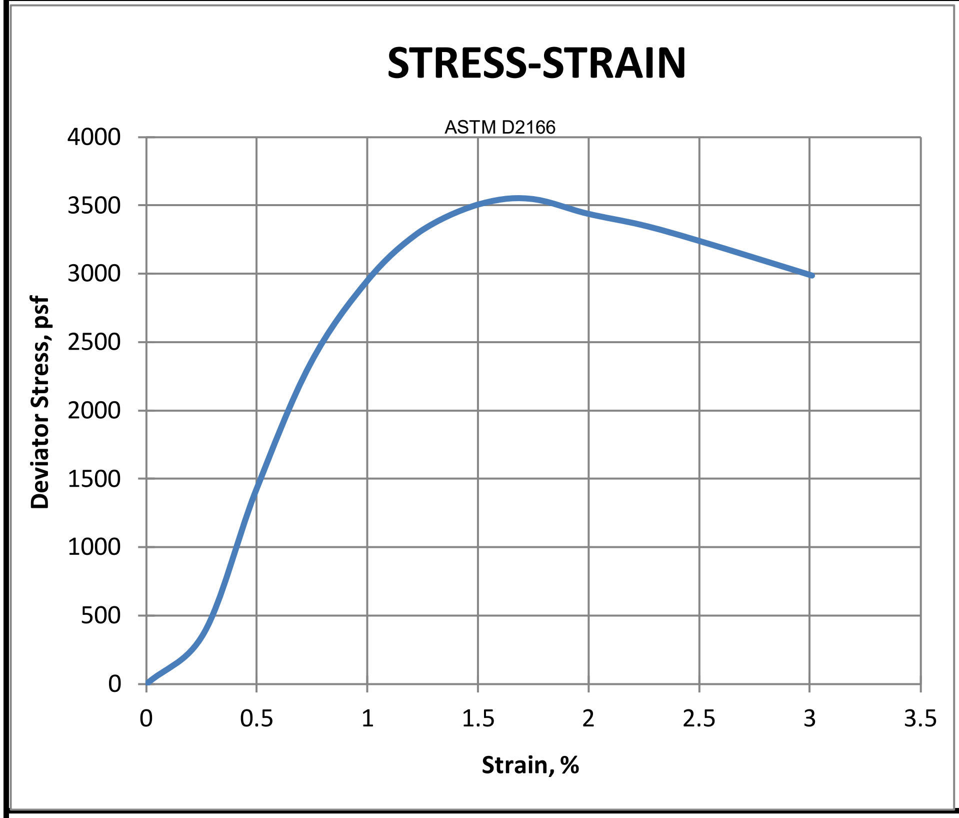
Checked by: AD

Title: LC

Figure B4



Failure Photo

No Photo, fell apart after test, material similar looking to B3-11

Sample Description	
Sample ID	B3-4
Sample Depth (feet)	4.00
Material Description	Strong Brown and Gray Lean CLAY with Gravel
Initial Conditions at Start of Test	
Height (inch) average of 3	4.92
Diameter (inch) average of 3	2.41
Moisture Content (%)	12.6
Dry Density (pcf)	110.7
Estimated Specific Gravity	2.7
Saturation (%)	65.4
Shear Test Conditions	
Strain Rate (%/min)	0.9949
Major Principal Stress at Failure (psf)	3550
Strain at Failure (%)	1.7
Test Results	
Unconfined Compressive Strength (tons/ft^2)	1.8
Unconfined Compressive Strength (lbs/ft^2)	3553
Unconfined Compressive Strength (psi)	25
Shear Strength (tons/ft^2)	0.9
Shear Strength (lbs/ft^2)	1777

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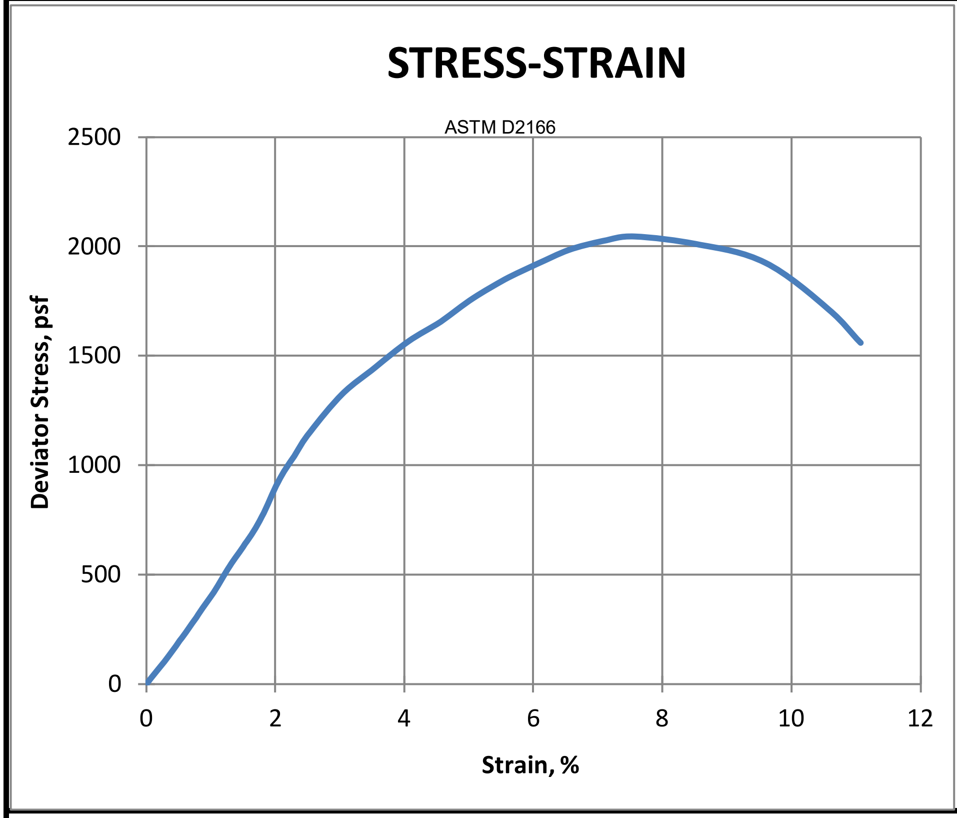
Unconfined Compressive Strength (ASTM D2166)

Project: Willow Creek CSD
Location: Willow Creek, CA
Number: S2904-05-01
Figure: B5



Failure Photo

Sample Description

Sample ID	B3-11
Sample Depth (feet)	11.00
Material Description	Strong Brown and Gray Lean CLAY with Gravel

Initial Conditions at Start of Test

Height (inch) average of 3	4.91
Diameter (inch) average of 3	2.34
Moisture Content (%)	13.1
Dry Density (pcf)	114.1
Estimated Specific Gravity	2.7
Saturation (%)	74.3

Shear Test Conditions

Strain Rate (%/min)	1.0008
Major Principal Stress at Failure (psf)	2050
Strain at Failure (%)	7.6

Test Results

Unconfined Compressive Strength (tons/ft^2)	1.0
Unconfined Compressive Strength (lbs/ft^2)	2046
Unconfined Compressive Strength (psi)	14
Shear Strength (tons/ft^2)	0.5
Shear Strength (lbs/ft^2)	1023

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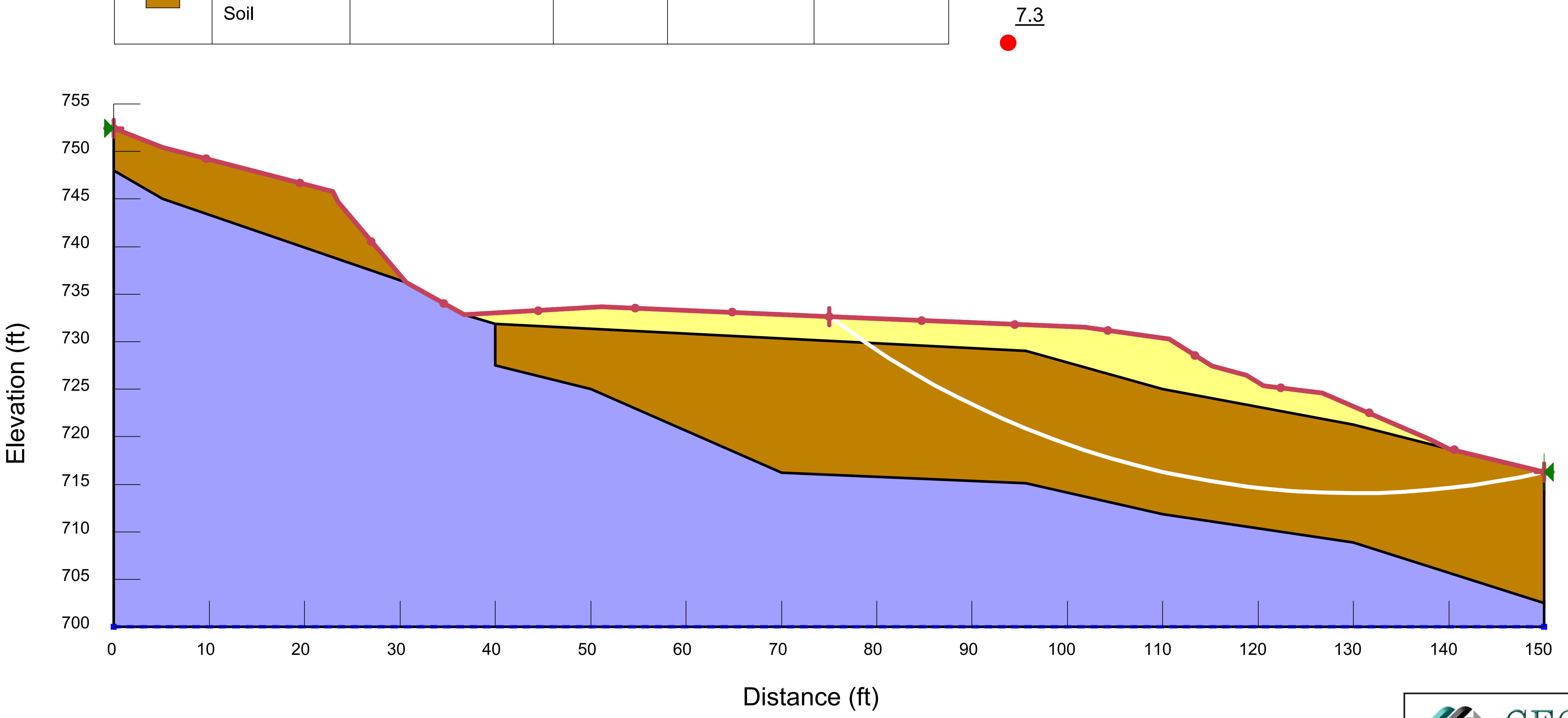
Unconfined Compressive Strength (ASTM D2166)

Project: Willow Creek CSD
Location: Willow Creek, CA
Number: S2904-05-01
Figure: B6

APPENDIX C

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
🟨	Fill	Mohr-Coulomb	125	50	35
🟦	Galice Formation	Mohr-Coulomb	130	2,000	35
🟫	Residual Soil	Mohr-Coulomb	120	1,000	30



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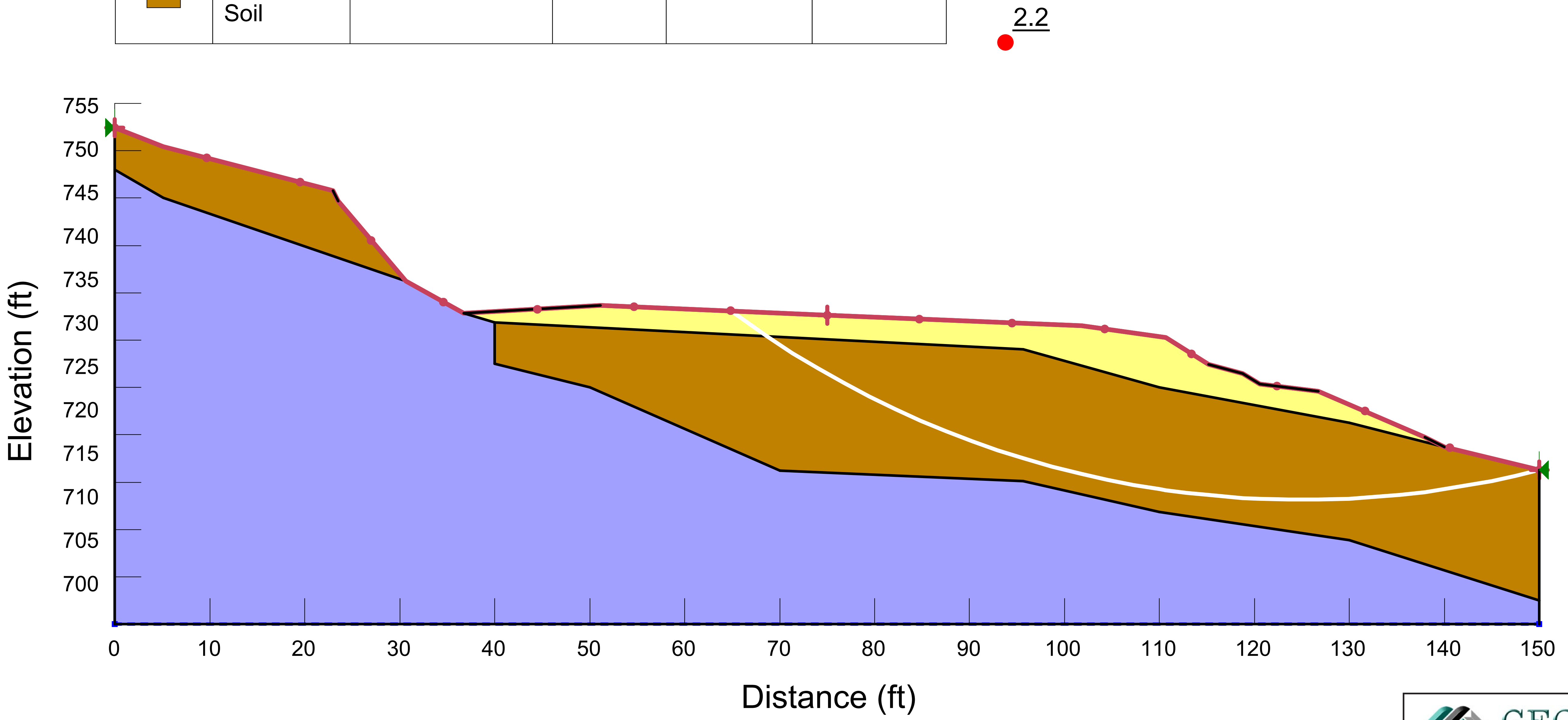
Willow Creek Community Services District Water Tank

Willow Creek,
California

SLOPE STABILITY ANALYSIS (STATIC)

S2904-05-01	May 2025	Figure C1

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
🟨	Fill	Mohr-Coulomb	125	50	35
🟪	Galice	Mohr-Coulomb	130	2,000	35
🟫	Residual Soil	Mohr-Coulomb	120	1,000	30



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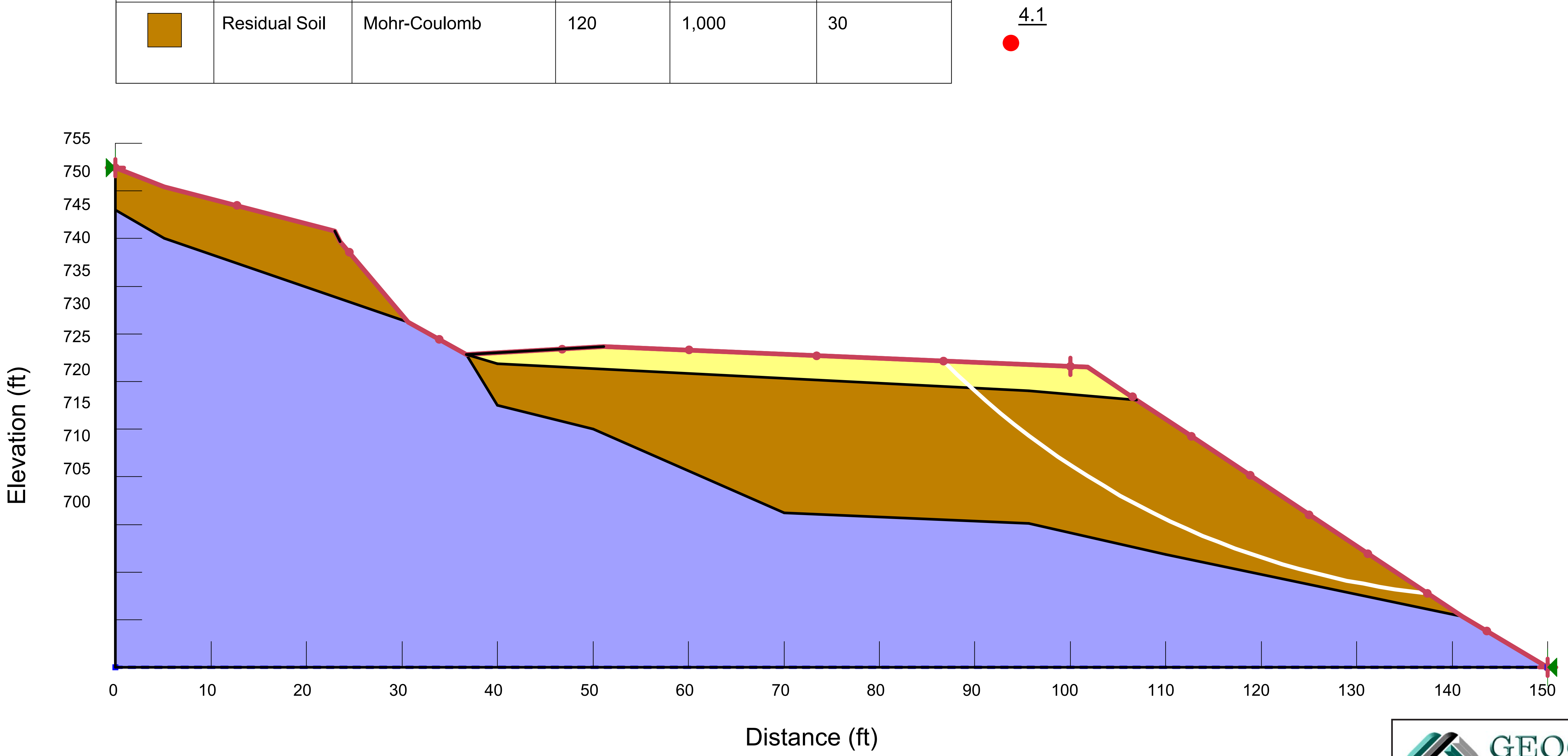
SLOPE STABILITY ANALYSIS (SEISMIC)

S2904-05-01	May 2025	Figure C2

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
🟨	Fill	Mohr-Coulomb	125	50	35
🟪	Galice Formation	Mohr-Coulomb	130	2,000	35
🟫	Residual Soil	Mohr-Coulomb	120	1,000	30



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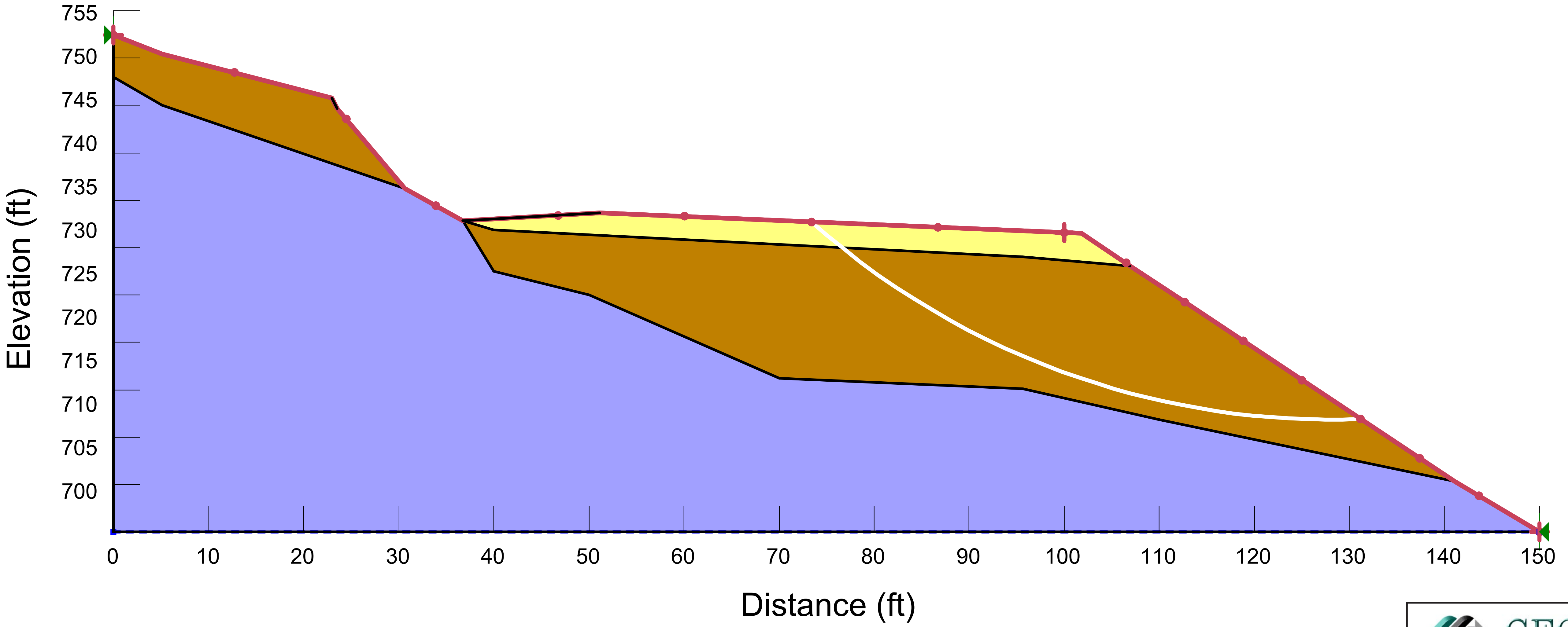
SLOPE STABILITY ANALYSIS 1.5:1 (STATIC)

S2904-05-01	May 2025	Figure C3

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
🟨	Fill	Mohr-Coulomb	125	50	35
🟦	Galice Formation	Mohr-Coulomb	130	2,000	35
🟫	Residual Soil	Mohr-Coulomb	120	1,000	30



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SLOPE STABILITY ANALYSIS 1.5:1 (SEISMIC)

S2904-05-01	May 2025	Figure C4