GEOTECHNICAL INVESTIGATION
PROPOSED SUBDIVISION
2565 GRANT STREET
CALISTOGA, CALIFORNIA

PREPARED FOR:

MHG BUILDER & CONSULTING, INC.
ATTENTION: MARK H. GARCIA
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PREPARED BY:

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JOB NO. 10187.01

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PJC & Associates, Inc.
Consulting Engineers & Geologists

June 30, 2021 Job No. 10187.01

MHG Builder & Consulting, Inc.
Attention: Mark H. Garcia
7033 Village Parkway, Suite 205
Dublin, CA. 94568
markg@mhgbuilder.com

Subject: Geotechnical Investigation
Proposed Subdivision
2565 Grant Street
Calistoga, California

Dear Mark:

PJC & Associates, Inc. (PJC) is pleased to submit this report presenting the results of our geotechnical investigation for the proposed subdivision located at 2565 Grant Street in Calistoga, California. The approximate location of the site is shown on the Site Location Map, Plate 1. The center of the site corresponds to the geographic latitudinal and longitudinal coordinates of 38.592° north and 122.586° west, according to GPS measurements performed at the site. Our services were completed in accordance with our proposal for geotechnical engineering services, dated January 29, 2021, and your authorization to proceed dated February 18, 2021. This report presents our opinions and recommendations regarding the geotechnical engineering aspects of the design and construction of the proposed project. Based on the results of this study, it is our opinion that the project site can be developed from a geotechnical engineering standpoint provided the recommendations and criteria presented in this report are incorporated in the design and carried out through construction.

We appreciate the opportunity to be of service. If you have any questions concerning the content of this report, please contact us.

Sincerely,

PJC & ASSOCIATES, INC.

Robert Di Jorio
Geotechnical Engineer
GE 3162, California

REGISTERED PROFESSIONAL ENGINEER
ROBERT B. DI JORIO
GE 3162
EXP. 12/31/22
GEOTECHNICAL
STATE OF CALIFORNIA

RD:mnm

GEOTECHNICAL INVESTIGATION
PROPOSED SUBDIVISION
2565 GRANT STREET
CALISTOGA, CALIFORNIA

1. PROJECT DESCRIPTION

Based on the information provided to us, the project will consist of constructing thirty-two single-family residential structures and constructing new asphalt paved roadways to provide access to the residences. The project will also include construction of new exterior flatwork, trails and installation of utilities. We anticipate that the residential buildings will consist of one or two-story, wood frame structures with concrete slab-on-grade floors.

Structural loading information was not available at the time of this report. For our analysis, we anticipate that structural loading will be light with dead plus live continuous wall loads less than two kips per lineal foot (plf) and dead plus live isolated column loads less than 50 kips. If these assumed loads vary significantly from the actual loads, we should be consulted to review the actual loading conditions and, if necessary, revise the recommendations of this report.

Grading and drainage plans and finished floor elevations were unavailable at the time of this report. The site is located on nearly level terrain. Based on the site topography, we assume that the structures will be constructed at or near the existing grades. Therefore, we assume that site grading will be minimal and will include cuts and fills up to three feet or less to achieve the desired building pad grades, upgrade the surface and near surface soils, construct the roadways and provide adequate gradients for site drainage. We assume that retaining walls will not be required for the project.

2. SCOPE OF SERVICES

The purpose of this study is to provide geotechnical criteria for the design and construction of the proposed project. Specifically, the scope of our services included the following:

a. Drilling six exploratory boreholes (BH-1 through BH-6) to depths between 10.0 and 50.5 feet below the existing ground surface to observe the soil and groundwater conditions underlying the site. Our project geologist was on site during the drilling to log the materials encountered in the boreholes and to obtain representative samples for visual classification and laboratory testing.

b. Laboratory observation and testing of representative samples obtained during the course of our field investigation to evaluate the index and engineering properties of the subsurface soils underlying the site.

c. Reviewing seismological and geologic literature on the site area, discuss site geology and seismicity, and evaluate potential geologic hazards and earthquake effects (i.e., liquefaction, ground rupture, settlement, lurching and lateral spreading, expansive soils, etc.).

d. Performing engineering analyses to develop geotechnical recommendations for site preparation and earthwork, foundation type(s) and design criteria, lateral earth pressures, settlement, concrete slab-on-grade recommendations, pavement design criteria, surface and subsurface drainage control, and construction considerations.

e. Preparation of this report summarizing our work on this project.

3. SITE CONDITIONS

a. General. The project site is located north of the City of Calistoga, approximately one-quarter of a mile northwest of the intersection of Grant Street and Mora Avenue. The property is currently being farmed as a vineyard with one structure located in the eastern corner and a reservoir in the southern corner of the property. The property is bounded by Grant Street to the northeast, residential properties to the northwest and Garnett Creek and the Napa River to the east and southwest, respectively.

b. Topography and Drainage. The nearly level site is located at the northern end of Napa Valley. According to the USGS Calistoga, California 7.5 Minute Quadrangle, the site is located near an elevation of 371 feet above mean sea level (MSL). The site is bordered by Garnett Creek along the eastern property line and the Napa River along the southwestern property line. Site drainage generally consists of sheet flow and surface infiltration.

c. Geology. According to the geologic map of the Calistoga 7.5 Minute Quadrangle prepared by the California Geological Survey (CGS), the site is underlain by Holocene alluvial soil deposits (Qha). These relatively young unconsolidated soil strata consist of poorly to moderately sorted sand, silt and gravel. The results of our exploration confirm the presence of alluvium underlying the site.

d. Faulting. Geologic structures in the region are primarily controlled by northwest trending faults. The site is not located in a State of California Alquist-Priolo Earthquake Fault Studies Zone. According the USGS National Seismic Hazard Map (2008), the three closest known active faults to the site are the Maacama, the Rodgers Creek, and the Collayomi. The Maacama fault is located 5.5 miles to the west, the Rodgers Creek fault is located 9.7 miles to the southwest and the Collayomi fault is located 14.0 miles north of the site. The maximum earthquake event expected to occur on the Maacama fault is estimated at 7.4 (moment magnitude).

4. SEISMICITY

The site is located within a zone of high seismic activity related to the active faults that traverse through the surrounding region. Future damaging earthquakes could occur on any of these fault systems during the lifetime of the proposed project. In general, the intensity of ground shaking at the site will depend upon the distance to the causative earthquake epicenter, the magnitude of the shock, the response characteristics of the underlying earth materials, and the quality of construction. Seismic considerations and hazards are discussed in the following subsections of this report.

5. SUBSURFACE CONDITIONS

a. Soils. The subsurface conditions at the site were investigated by drilling 6 exploratory boreholes (BH-1 through BH-6) near the proposed structures to depths between 10.0 and 50.5 feet below the existing ground surface. The approximate borehole locations are shown on the Borehole Location Plan, Plate 2. The boreholes were advanced to observe the underlying soil strata and to collect samples for visual examination and laboratory testing. The drilling and sampling procedures and descriptive borehole logs are included in Appendix A. Laboratory procedures are included in Appendix B.

   At the surface, BH-1 and BH-2 encountered one and four and one-half feet of moderately compacted, sandy clay fill. The fill appeared to exhibit medium to high plasticity characteristics. BH-3 through BH-5 encountered moderately to highly plastic, sandy clay surface soil that extended to depths between one and one-half and three feet below existing grade. This stratum was slightly moist to moist and soft to medium stiff. The surface soils in BH-6 consisted of loose, fine-grained, clayey sand that extended to a depth of one and one-half feet. Underlying the surface stratum, the boreholes encountered variable layers of sandy clays, clayey sands and clayey gravels that extended to the maximum depths explored. The granular soils were very moist to saturated and loose to dense. The sandy clay layers were soft to very stiff and judged to have medium to high plasticity characteristics.

b. Groundwater. Groundwater was encountered in BH-1, BH-2, BH-3 and BH-5 between the depths of 10.0 and 12.0 feet below grade during drilling and stabilized to depths between 8.5 and 14.5 feet at the end of exploration on March 17 and 19, and May 3, 2021. Groundwater levels in the area can fluctuate due to seasonal rainfall and other factors, and likely rises and falls by several feet throughout the year. Evaluation of these factors is beyond the scope of this report.

6. GEOLOGIC HAZARDS AND SEISMIC CONSIDERATIONS

The site is located within a region subject to a high level of seismic activity. Therefore, the site could experience strong seismic ground shaking during the lifetime of the project. The following discussion reflects the geologic hazards and possible earthquake effects which could result in damage to the proposed project.

a. <u>Fault Rupture</u>. Rupture of the ground surface is expected to occur along known active fault traces. According to the State of California, no active faults exist at or near the project site. Therefore, the likelihood of ground rupture at the site due to faulting is considered to be low.

b. <u>Ground Shaking</u>. Napa County has been subjected to strong ground shaking by earthquakes on the active fault systems that traverse the region. It is believed that a large earthquake with significant ground shaking may occur in the region within the next several decades. Therefore, it must be assumed that the site will be subjected to severe ground shaking during the design life of the proposed project.

c. <u>Liquefaction/Densification</u>. According to the USGS Liquefaction Susceptibility Map (2006) for Napa County, the site is located within an area considered to have a high susceptibility to liquefaction during or immediately following a significant seismic event. Liquefaction is a seismic hazard that occurs in saturated, loosely packed, predominantly granular soils found below the phreatic groundwater. In general, these loose materials experience a rapid, temporary loss in shear strength due to an increase in pore water pressure in response to strong earthquake ground shaking. Upon dissipation of pore water pressures following shaking, there is reduction in the void ratio of the impacted soils causing differential and erratic ground settlement. Loosely-packed, fine-grained sandy soils below the water level are most susceptible to liquefaction. However, case studies have shown that soft silts and loose gravels with limited drainage paths are also susceptible to liquefaction. Bedrock materials and plastic clayey soils with a liquid limit greater than 32 are generally not known to be prone to liquefaction.

The occurrence of this phenomenon is dependent on many complex factors including the intensity and duration of ground shaking, groundwater level at time of shaking, particle size distribution, consistency/relative density of the soil, overburden stress, age of deposit, and many other factors.

In order to evaluate liquefaction potential at the site BH-1 and BH-2 were drilled to depths of 50.5 and 50.0 feet below the existing ground surface, respectively. The boreholes encountered both granular and cohesive soils below the groundwater level at the site.

The potential for liquefaction and/or densification was analyzed according to the procedure presented in "Soil Liquefaction During Earthquakes" (Boulanger and Idriss, EERI, 2008). Based on the subsurface conditions and expected ground accelerations during a large seismic event, the results of our analysis indicate that the some of the site soils are prone to liquefaction. Our analyses indicate that up to one inch of additional settlement could occur at the surface due to seismically induced liquefaction.

Soil densification is a phenomenon where earthquake induced ground shaking causes soil particles to compress, thus causing ground settlement. Non-cemented, cohesionless soils, such as loose sands or gravels above the groundwater level, are susceptible to this type of settlement. Loose and dry, cohesionless soils were not encountered in the boreholes. Therefore, we judge the potential for seismically-induced densification at the site is low.

d. Lateral Spreading and Lurching. Lateral spreading is normally induced by vibration of near-horizontal alluvial soil layers adjacent to an exposed slope face. Lurching is an action which produces cracks or fissures parallel to an unsupported slope face, such as streams or banks, when the earthquake motion is at right angles to them. Based on a preliminary site plan provided by MHG, the proposed subdivision lots will be set back 35 feet from the banks of Garnett Creek and the Napa River. As such, the risk of lateral spreading or lurching during a seismic event impacting the proposed structures is considered low.

e. Artificial Fill and Disturbed Surface Soil. We encountered four and one-half feet of moderately compacted fill in BH-2, located in the eastern corner of the property. The extent of the fill is unknown. In addition, the surface soils throughout the vineyard are weak, compressible and locally disturbed by previous farming activities. The depth of weak and compressible native soils is approximately three to five feet.

f. Expansive Soils. Based on our observations and laboratory testing, the near surface sandy clay soils vary from medium to high in plasticity (PI=24 and 26) and the deeper sandy clay soils are high plasticity (PI=37). However, based on expansion index testing of samples from the upper three feet, the surface and near surface soils have medium expansion potential (EI=78 and 52). The presence of moderately to highly expansive soils should be considered during design and construction of the project.

g. Corrosive Soils. Based on corrosion potential testing performed on a composite sample obtained from the upper three feet of material encountered in BH-4, it appears that the native site soils are mildly acidic (5.49), and should not have a significant adverse impact on concrete, reinforcing steel, mortar, grout or cement. The soil contains low chlorides and has very low resistivity. Redox is mildly reduced, and the soils contain low sulfates. A detailed discussion and recommendations for extending the longevity of building materials and conduits buried in the site soils are presented on Plate 11.

h. Flooding. According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map Nos. 06055C0228E and 06055C0229E, the site is located in Zone X which is considered a minimal flood risk area.

7. CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our investigation, we judge that the project is feasible from a geotechnical engineering standpoint provided the recommendations of this report are incorporated in the design and carried out through construction. The primary geotechnical concerns in design and construction of the project are the presence of weak and compressible surface soils and the presence of moderately to potentially highly expansive surface and near surface soils.

With the exception of BH-2 which encountered four and one-half feet of moderately compacted fill, the boreholes encountered weak surface and near surface soils extending to depths up to approximately three feet below the existing ground surface. The soils were most likely disced or ripped to prepare the existing vineyard. These soils are weak and compressible and may appear hard and strong when dry. However, they could potentially collapse under the load of foundations, engineered fill, concrete slabs or pavements when their moisture content increases and approaches saturation. These soils can undergo considerable strength loss and increased compressibility, thus causing irregular and erratic ground settlement under loads. Therefore, these soils are not suitable in their existing condition for the support of foundations, engineered fill, slabs or asphaltic concrete pavements. In structural areas or where fills are planned these soils should be removed or removed and replaced as engineered fill. The engineered fill should extend laterally at least five feet beyond the perimeter of structures.

Based on laboratory testing and our field observations, the surface and near surface soils are moderately to potentially highly expansive. Shrinking and/or swelling of expansive soils due to loss and increase in moisture content can cause ground differential movement and distress and damage to concrete elements and architectural features of structures. This can also cause differential movement and severe cracking to exterior flatwork and asphaltic concrete. To reduce the effects of the expansive soils to within tolerable limits, we recommend that the structures be supported on post-tensioned slabs.

Exterior flatwork and asphaltic pavements should be underlain by at least 18 inches of low to non-expansive, engineered fill. The engineered fill should extend at least three feet beyond the edges of exterior flatwork and pavements.

The following section provides geotechnical recommendations and criteria for design and construction of the project.

8. SITE GRADING AND EARTHWORK

a. Stripping. We recommend that structural areas be stripped of all surface vegetation, roots, tree stumps and the upper few inches of soil containing organic matter. These materials should be moved off site; some of them, if suitable, could be stockpiled for later use in landscape areas. Where any underground utilities pass through the site, we recommend that these utilities or obstructions be removed in their entirety or rerouted where they exist outside an imaginary plane sloped two horizontal to one vertical (2H:1V) from the outside bottom edge of the nearest foundation element. Any existing wells or septic systems, or sewer lines should be abandoned in accordance with the requirements of the County of Napa Health Department. Voids left from the removal of utilities or other obstructions should be replaced with compacted engineered fill under the observation of the project geotechnical engineer.

b. Subexcavation and Compaction. Following site stripping, excavation should proceed to achieve finish grades and to remove weak and compressible soils in structural areas and areas to receive engineered fill. We anticipate this depth will be on the order of 24 to 36 inches. In areas where pavements and exterior flatwork will be constructed, we recommend that the upper 18 inches of soil be removed and replaced with 18 inches of low to non-expansive, engineered fill. The lateral extent of the engineered fill should be five feet beyond perimeter foundations and three feet beyond exterior flatwork and pavements. The exposed surface should be scarified to a depth of eight inches; moisture conditioned to three to five percent over optimum moisture content and compacted to a minimum of 88 percent of the material's maximum dry density, as determined by the ASTM D 1557-12 laboratory compaction test procedures. The native soils should generally be considered moderately to possibly highly expansive. Potentially expansive soils should not be placed within the upper 18 inches of exterior flatwork and pavements. The native or imported soils to be used as fill should be spread in eight-inch-thick loose lifts, moisture conditioned to within two percent of optimum and compacted to at least 90 percent of the material's maximum dry density, as determined by the ASTM D 1557-12 laboratory compaction test procedures. Imported fill should be evaluated and approved by the geotechnical engineer before importation. A sample of the low to non-expansive fill should be provided to PJC for laboratory testing and approval prior to importation to the site.

It is recommended that the import fill should be of a low to non-expansive nature and should meet the following criteria:

Plasticity Index	less than 12
Liquid Limit	less than 35
Percent Soil Passing #200 Sieve	between 15% and 35%
Maximum Aggregate Size	4 inches

All fills should be placed in lifts no greater than eight inches in loose thickness and compacted to the general recommendations provided below.

TABLE 1
SUMMARY OF COMPACTION RECOMMENDATIONS

Area	Compaction Recommendations*
General Engineered Fill (Native)	In lifts, a maximum of eight inches in loose thickness, compact to at least 90 percent relative compaction at two percent over the optimum moisture content.
General Engineered Fill (Low to Non-Expansive Import)	In lifts, a maximum of eight inches in loose thickness, compact to at least 90 percent relative compaction at or within two percent of the optimum moisture content.
Trenches**	Compact to at least 90 percent relative compaction at or within two percent of the optimum moisture content. Moisture condition to two percent over the optimum moisture content if on-site soils are used.
Driveways and Parking Areas	Compact the top eight inches of native clay subgrade to at least 92 percent relative compaction at two to four percent over the optimum moisture content. If the top 18 inches is lime-treated or import soils are used, the soils should be compacted to at least 95 percent relative compaction.

*All compaction requirements stated in this report refer to dry density and moisture content relationships obtained through the laboratory standard described by ASTM D-1557-12.
** Depths below finished subgrade elevations.

c. <u>Cut and Fill Slopes</u>. Cut and fill slopes should be graded to an inclination no steeper than two horizontal to one vertical (2H:1V). Steeper slopes should be retained. Graded slopes should be covered with erosion blankets to retard erosion and sediment transport.

All site preparation and fill placement should be observed by a representative of PJC. It is important that during the stripping, subexcavation and grading/scarifying processes, a representative of our firm be present to observe whether any undesirable material is encountered in the construction area.

Generally, grading is most economically performed during the summer months when on-site soils are usually dry of optimum moisture content. Delays should be anticipated in site grading performed during the rainy season or early spring due to excessive moisture in the on-site soils. Special and relatively expensive construction procedures should be anticipated if grading must be completed during the winter and early spring.

9. UTILITY TRENCHES

Shallow excavations for utility trenches can be readily made with either a backhoe or trencher; larger earth moving equipment should be used for deeper excavations. We expect the walls of trenches less than five feet deep, excavated into engineered fill or native soils, to remain in a near-vertical configuration during construction provided no equipment or excavated spoil surcharges are located near the top of the excavation. If the trench extends deeper than five feet, then the trench walls may become unstable and may require shoring. All trenches should conform to the current CAL-OSHA requirements for worker safety.

The trenches may be backfilled with on-site or imported soils and compacted to at least 90 percent of maximum dry density. The backfill soils should be moisture conditioned according to Table 1 of this report before compacting. Jetting should not be used.

Special care should be taken in the control of utility trench backfilling in structural areas. Substandard compaction may result in excessive settlements resulting in damage to structures or pavements.

10. FOUNDATIONS: POST-TENSIONED SLABS

If concrete slab-on-grade floors are desired in living areas, the structures should be supported on post-tensioned slabs due to the potential for differential settlement and heave of the near surface soils. The slabs should be designed in accordance with the following recommendations.

a. Vertical Loads. The proposed structures could be supported on post-tensioned slabs designed to be rigid and capable of resisting both positive and negative moments due to the shrink and swell cycles of expansive clay soils. For design purposes, we recommend that the slabs be designed to span areas of non-uniform support for full structural loading in both directions.

   The post tensioned slab may be preliminarily designed according to the following criteria, based on the method developed by the Post-Tensioning Institute (PTI), Third Edition and subsequent addendums. The following criteria are subject to revisions as the project progresses into working drawings:

   i. Edge Moisture Variation Distance (center lift) = 8.0 feet
   ii. Edge Moisture Variation Distance (edge lift) = 4.0 feet
   iii. Estimated Differential Shrink (center lift) = 1.34 inches
   iv. Estimated Differential Swell (edge lift) = 1.84 inches
   v. Allowable Bearing Capacity = 2,100 psf
   vi. Soil modulus of subgrade reaction (K_s) = 75 lb/in^3
   vii. Modulus of elasticity of the soil = 2,100 lb/in^2

We recommend a minimum slab thickness of 8 inches for uniform thickness slabs and 4 inches for a ribbed foundation with minimum rib depth of 11 inches and rib width of 6 inches. We recommend the perimeter of the slabs be provided with a 12-inch wide and 12-inch-deep thickened edge to reduce edge drying and reduce storm water intrusion under the slab. To minimize moisture propagation through the slab, the subgrade should be covered by a 15-mil thick impermeable membrane. The membranes should be taped at all utility connections through the slabs to reduce the risk of moisture migration.

Concentrated loads within the slab should be supported by thickened beams. The soils within the building pad should be thoroughly moisture conditioned to within two percent of optimum. The subgrade material should not be allowed to dry out prior to post-tensioned slab construction.

b. Settlement. The majority of elastic settlement is expected to be small and occur during construction and placement of dead loads. Total elastic settlement is expected to be less than one inch. A maximum differential elastic settlement of one-half inch is anticipated. Based on our analyses, an additional settlement of approximately one inch could occur during a seismic event due to liquefaction.

c. Lateral Loads. Resistance to lateral forces may be computed by using base friction or adhesion. A friction factor of 0.30 is considered appropriate between the bottom of the concrete structures and soil.

11. NON-STRUCTURAL SLABS-ON-GRADE

Non-structural concrete slabs-on-grade may be used for exterior flatwork provided the slabs are underlain by at least 18 inches of a low to non-expansive, engineered fill. The low to non-expansive fill should extend at least three feet beyond exterior slab edges.

All slab subgrades should be moisture conditioned and rolled to produce a firm and uniform subgrade. The slab subgrade should not be allowed to dry. Non-structural slabs should be at least five inches thick and underlain with a capillary moisture break consisting of at least four inches of clean, free-draining crushed rock or gravel. The rock should be graded so that 100 percent passes the one-inch sieve and no more than five percent passes the No. 4 sieve.

Special care should be taken to ensure that reinforcement is placed and maintained at least two inches below the top of the slab. Exterior slabs should be cast and maintained separate of foundations. Control joints should be provided to induce and control cracking.

Special precautions must be taken during the placement and curing of concrete slabs-on-grade. Excessive slump (high water-cement ratio) of the concrete and/or improper curing procedures and ad mixtures used during either hot or cold weather conditions will lead to excessive shrinkage, cracking or curling of the slabs. High water-cement ratios and/or improper curing also greatly increases water vapor transmission through the concrete.

Concrete placement and curing operations should be performed in accordance with the American Concrete Institute (ACI) manual.

12. ASPHALTIC CONCRETE PAVEMENTS

A Resistance Values (R-Value) of 12 was determined in the laboratory for the near surface soils at the site. As a result, we judge that the existing soils will have a low supporting capacity (after proper compaction) when used as a pavement subgrade. Furthermore, the soils are moderately to highly expansive. Pavement design sections are presented in Table 2. If low to non-expansive engineered fill is used for the top 18 inches of the pavement subgrade, pavement sections should be constructed according to Table 3. We highly recommend that 18 inches of low to non-expansive fill extending at least three feet beyond the pavement edges be used. If the import material is not utilized beneath the pavements, edge cracking could occur.

Pavement thicknesses were computed from Chapter 633 of the Caltrans Highway Design Manual and are based on a pavement life of 20 years. The Traffic Indices (TIs) used are judged representative of the anticipated traffic but are not based on actual vehicle counts. The actual traffic indices should be determined and provided by the project civil engineer.

Prior to placement of the aggregate base material, the top eight inches of the pavement subgrade should be scarified to at least eight inches deep, moisture conditioned as recommended by the geotechnical engineer, and compacted to a minimum of 92 percent relative compaction. If imported soils are used for subgrade they should be compacted to at least 95 percent relative compaction at or within two percent of optimum moisture content. Aggregate base material should be spread in thin layers and compacted to at least 95 percent relative compaction to form a firm and unyielding base. The subgrade and aggregate base section should visually pass an unyielding proof-roll inspection.

The material and methods used should conform to the requirements of the Caltrans Standard Specifications, except that compaction requirements for the soil subgrade and aggregate baserock should be based on ASTM D-1557-12. Aggregate used for the base coarse should comply with the minimum requirements specified in Caltrans Standard Specifications, Section 26, for Class 2 aggregate base.

In general, the pavements should be constructed during the dry season to avoid the saturation of the subgrade and base materials, which often occurs during the wet winter months. If pavements are constructed during the winter and early spring, a cost increase relative to drier weather construction should be anticipated. The geotechnical engineer should be consulted for recommendations at the time of construction.

Where pavements will abut landscaped areas, water can seep below the concrete curb and into the base rock within the pavement section. Continued saturation of the base rock leads to permanent wetness towards the lower elevation of the pavement where water ponds. Soft subgrade conditions and pavement damage can occur as a result.

Several precautionary measures can be taken to minimize the intrusion of water into the aggregate base; however, the cost to install the protective measures should be balanced against the cost of repairing damaged pavement sections. An alternative, which can be taken to extend the life of the pavement, would be to construct a cutoff wall along the perimeter edge of the pavement. The wall should consist of a lean concrete mix. The trench should be four inches wide and extend at least 36 inches deep.

Where trees are located adjacent to pavement areas, we recommend that a suitable impervious root barrier be included to minimize water migration into the pavement layer.

TABLE 2
PAVEMENT DESIGN FOR PAVEMENT AREAS
(Subgrade R-Value = 12)

Traffic Index	Asphaltic Concrete (in)	Class II Aggregate Base (in)
4.0	2.0	7.5
5.0	2.5	9.5
6.0	3.0	12.0
7.0	3.5	14.5

TABLE 3
PAVEMENT DESIGN FOR 18 INCHES OF LOW TO LOW TO NON-EXPANSIVE ENGINEERED FILL
(Subgrade R-Value = 50)

Traffic Index	Asphaltic Concrete (in)	Class II Aggregate Base (in)
4.0	2.0	6.0
5.0	2.5	6.0
6.0	3.0	6.0
7.0	3.5	6.0

13. DRAINAGE

Drainage control design should include provisions for positive surface gradients so that surface runoff is not permitted to pond, particularly adjacent to the building foundations or slabs. Surface runoff should be directed away from foundations. We recommend that the structures be provided with roof gutters and downspouts. The downspouts should be connected to closed conduits discharged into the storm drain system. If the drainage facilities discharge onto the natural ground, adequate means should be provided to control erosion and to create sheet flow. Care must be taken so that discharges from the roof gutter and downspout systems are not allowed to infiltrate the subsurface near the structures.

14. SEISMIC DESIGN

Based on criteria presented in the 2019 edition of the California Building Code (CBC) and ASCE (American Society of Civil Engineers) STANDARD ASCE/SEI 7-16, the following minimum criteria should be used in seismic design:

a.	Site Class:	D	
b.	Mapped Acceleration Parameters:	S_S =	1.818 g
		S_1 =	0.683 g
c.	Site Adjusted Spectral Response Acceleration Parameters:	S_{MS} =	1.818 g
		S_{M1} =	null
d.	Design Spectral Acceleration Parameters:	S_{DS} =	1.212 g
		S_{D1} =	null

According to section 11.4.8 of ASCE/SEI 7-16, Site-Specific Ground Motion Procedure, a ground motion hazard analysis shall be performed for structures located on sites classified as D or E with S_1 greater than or equal to 0.2. S_1 for the subject site falls into this category. An exemption from this analysis is provided in this section. We assume that the exemption will be implemented for the project.

15. LIMITATIONS

The data, information, interpretations and recommendations contained in this report are presented solely as bases and guides to the proposed subdivision located at 2565 Grant Street in Calistoga, California. The conclusions and professional opinions presented herein were developed by PJC in accordance with generally accepted geotechnical engineering principles and practices. No warranty, either expressed or implied, is intended.

This report has not been prepared for use by parties other than the designers of the project. It may not contain sufficient information for the purposes of other parties or other uses. If any changes are made in the project as described in this report, the conclusions and recommendations contained herein should not be considered valid, unless the changes are reviewed by PJC and the conclusions and recommendations are modified or approved in writing. This report and the figures contained herein are intended for design purposes only. They are not intended to act by themselves as construction drawings or specifications.

Soil deposits may vary in type, strength, and many other important properties between points of observation and exploration. Additionally, changes can occur in groundwater and soil moisture conditions due to seasonal variations or for other reasons. Therefore, it must be recognized that we do not and cannot have complete knowledge of the subsurface conditions underlying the subject site. The criteria presented are based on the findings at the points of exploration and on interpretative data, including interpolation and extrapolation of information obtained at points of observation.

16. ADDITIONAL SERVICES

Upon completion of the project plans, they should be reviewed by our firm to determine that the design is consistent with the recommendations of this report. During the course of this investigation, several assumptions were made regarding development concepts. Should our assumptions differ significantly from the final intent of the project designers, our office should be notified of the changes to assess any potential need for revised recommendations. Observation and testing services should also be provided by PJC to verify that the intent of the plans and specifications are carried out during construction; these services should include observing and testing grading and earthwork, approving the bottom of subexcavations, approving pier drilling and/or footing excavations, observing slab subgrades, and approving the construction of drainage facilities.

These services will be performed only if PJC is provided with sufficient notice to perform the work. PJC does not accept responsibility for items we are not notified to observe.

It has been a pleasure working with you on this project. Please call if you have any questions regarding this report or if we can be of further assistance.

APPENDIX A
FIELD INVESTIGATION

1. INTRODUCTION

The field program performed for this study consisted of advancing six boreholes (BH-1 through BH-6) at the project site. The exploration was completed on March 17 and 19, and May 3, 2021. The borehole locations are shown on the Borehole Location Plan, Plate 2. Descriptive logs of the boreholes are presented in this appendix as Plates 3 through 8.

2. BOREHOLES

BH-1 and BH-2 were advanced using a truck-mounted Mobile B-53 drill rig equipped with 8-inch hollow stem augers The remaining boreholes were advanced using a portable powered drill rig with 4-inch, solid flight augers. The drilling was performed by a project geologist and staff geologist of PJC who maintained a continuous log of the soil conditions and obtained samples suitable for laboratory testing. The soils were classified in accordance with the Unified Soil Classification System, as explained in Plate 9.

Relatively undisturbed and disturbed samples were obtained from the exploratory boreholes. A 2.43 inch inside diameter (I.D.) California Modified Sampler or a 1.5-inch interior diameter standard sampler was driven into the underlying soil using a 140-pound hammer falling 30 inches to obtain an indication in the field of the density of the soil and to allow visual examination of at least a portion of the soil column. The number of blows required to drive the sampler at six-inch increments was recorded on each borehole log. All samples collected were labeled and transported to PJC's office for examination and laboratory testing.

APPENDIX B
LABORATORY INVESTIGATION

1. INTRODUCTION

This appendix includes a discussion of test procedures and results of the laboratory investigation performed for the proposed project. The investigation program was carried out by employing currently accepted test procedures of the American Society of Testing and Materials (ASTM).

Undisturbed and disturbed samples used in the laboratory investigation were obtained during the course of the field investigation as described in Appendix A of this report. Identification of each sample is by borehole number and depth.

2. INDEX PROPERTY TESTING

In the field of soil mechanics and geotechnical engineering design, it is advantageous to have a standard method of identifying soils and classifying them into categories or groups that have similar distinct engineering properties. The most commonly used method of identifying and classifying soils according to their engineering properties is the Unified Soil Classification System described by ASTM D-2487-83. The USCS is based on recognition of the various types and significant distribution of soil characteristics and plasticity of materials.

The index properties tests discussed in this report include the determination of natural water content and dry density, grain-size distribution, Atterberg limits, expansion index, and corrosion testing.

a. Natural Water Content and Dry Density. Natural water content and dry density of the soils were determined, often in conjunction with other tests, on selected undisturbed samples. The samples were extruded and visually classified, trimmed to obtain a smooth flat face, and accurately measured to obtain volume and wet weight. The samples were then dried in accordance with the procedures of ASTM 2216-80 for a period of 24 hours in an oven, maintained at a temperature of 100 degrees C. After drying, the weight of each sample was determined and the moisture content and dry density calculated. The results are shown on the logs of boreholes, Plates 3 through 8.

b. Grain-Size Distribution. The gradation characteristics of a selected sample were determined in accordance with ASTM D422-63. The sample was soaked in water until individual soil particles were separated and then washed on the No. 200 mesh sieve. That portion of the material retained on the No. 200 mesh sieve was oven-dried and then mechanically sieved. The results are shown on Plates 12 through 14.

c. Atterberg Limits Determination. The liquid and plastic limits of selected fine-grained soil samples were determined by air drying and breaking down the sample. The results are shown on the logs of the boreholes, Plates 3 through 8.

d. Expansion Index. The soil samples were compacted into a metal ring so that the degree of saturation is between 40 and 60 percent and the sample and ring were placed in a consolidometer. A vertical pressure was applied and the specimen was inundated with water. The deformation of the sample is recorded in accordance with ASTM D 4829. The results are shown on the borehole logs, Plates 3 through 8.

e. Corrosion Testing. Corrosion testing was performed following the sources: Cal Test 417, 422 and 532/643 and/or ASTM Vol. 11.01, ASTM G 51, ASTM D 1125, ASTM G 57, ASTM D 516, ASTM D 512 and EPA 376.2. The results are shown on Plate 11.

3. ENGINEERING PROPERTIES

The engineering properties testing consisted of R-value and pocket penetrometer testing.

a. R-Value. An R-value test was performed on a representative sample of the near-surface soil to develop criteria for the design of pavement sections. The test was conducted in accordance with the California Division of Highways Test Method No. 310. The results are shown on Plate 10.

b. Pocket Penetrometer. Pocket Penetrometer tests were performed on all undisturbed cohesive samples. The test estimates the unconfined compressive strength of a cohesive material by measuring the materials resistance to penetration by a calibrated, spring-loaded cylinder. The maximum capacity of the cylinder is 4.5 tons per square foot (tsf). The results are shown on the logs of the boreholes, Pates 3 through 8.

APPENDIX C
REFERENCES

1. "Foundations and Earth Structures" Department of the Navy Design Manual 7.2 (NAVFAC DM-7.2), dated May 1982.

2. "Soil Dynamics, Deep Stabilization, and Special Geotechnical Construction" Department of the Navy Design Manual 7.3 (NAVFAC DM-7.3), dated April 1983.

3. Geologic Map of Calistoga California, 7.5 Minute quadrangle, prepared by the California Geological Survey, compiled by Marc P. Delattre and Carlos I. Gutierrez, dated 2013.

4. "Soil Mechanics" Department of the Navy Design Manual 7.1 (NAVFAC DM-7.1), dated May 1982. McCarthy, David.

5. Essential of Soil Mechanics and Foundations. 5th Edition, 1998.

6. Bowels, Joseph, Engineering Properties of Soils and Their Measurement. 4th Edition, 1992.

7. USGS Calistoga, California Quadrangle 7.5-Minute Topographic Map, updated 1998.

6\. U.S. Geological Survey National Seismic Hazard Maps, 2008.

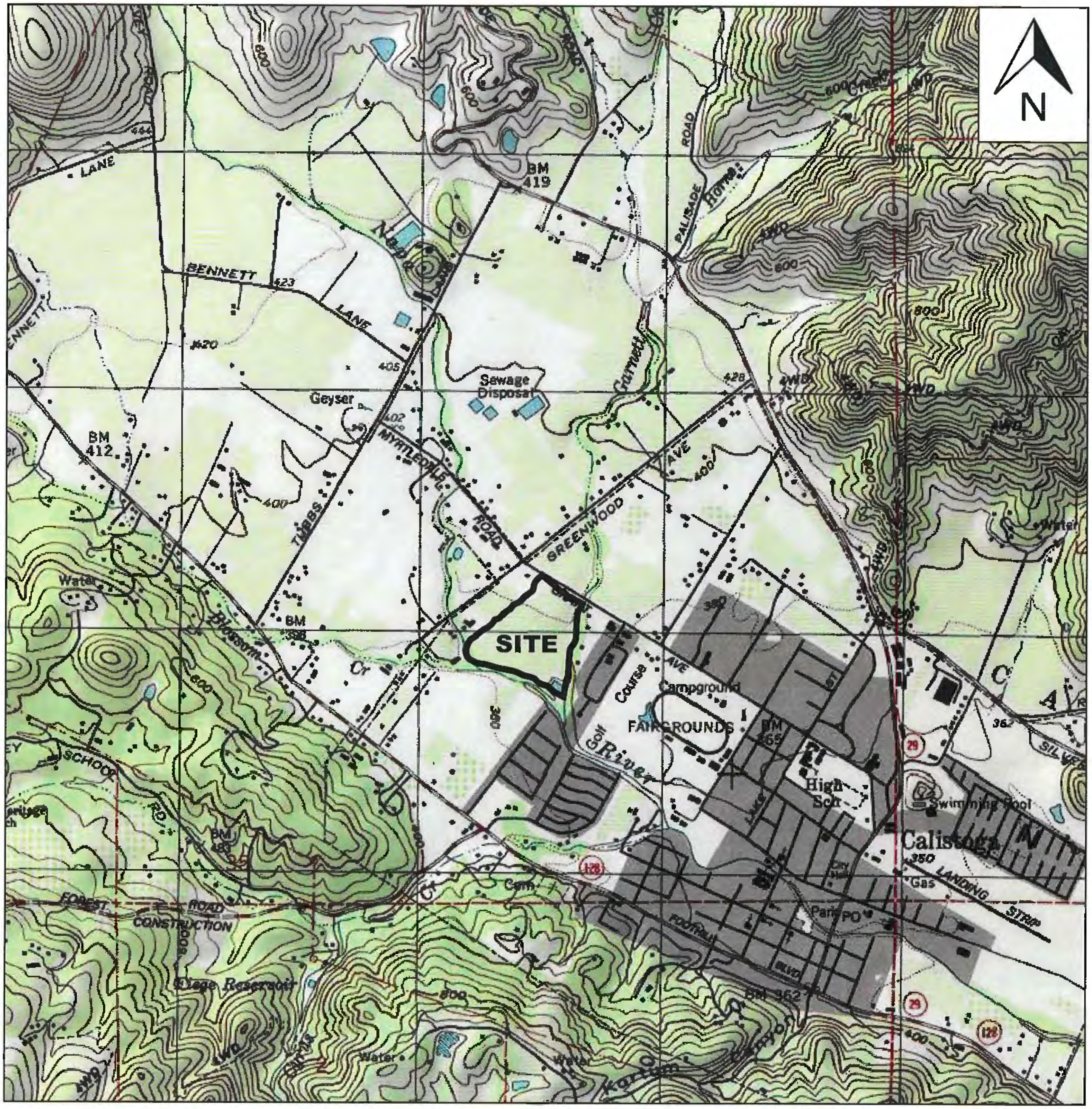
7\. California Building Code (CBC), 2019 edition.

8\. Association of Bay Area Governments, Interactive Liquefaction Susceptibility Map, dated June 2009.

9\. ASCE STANDARD ASCE/SEI 7-16, prepared by the American Society of Civil Engineers.

10\. Site Plan, untitled provided by Mark Garcia, dated September 26, 2019.

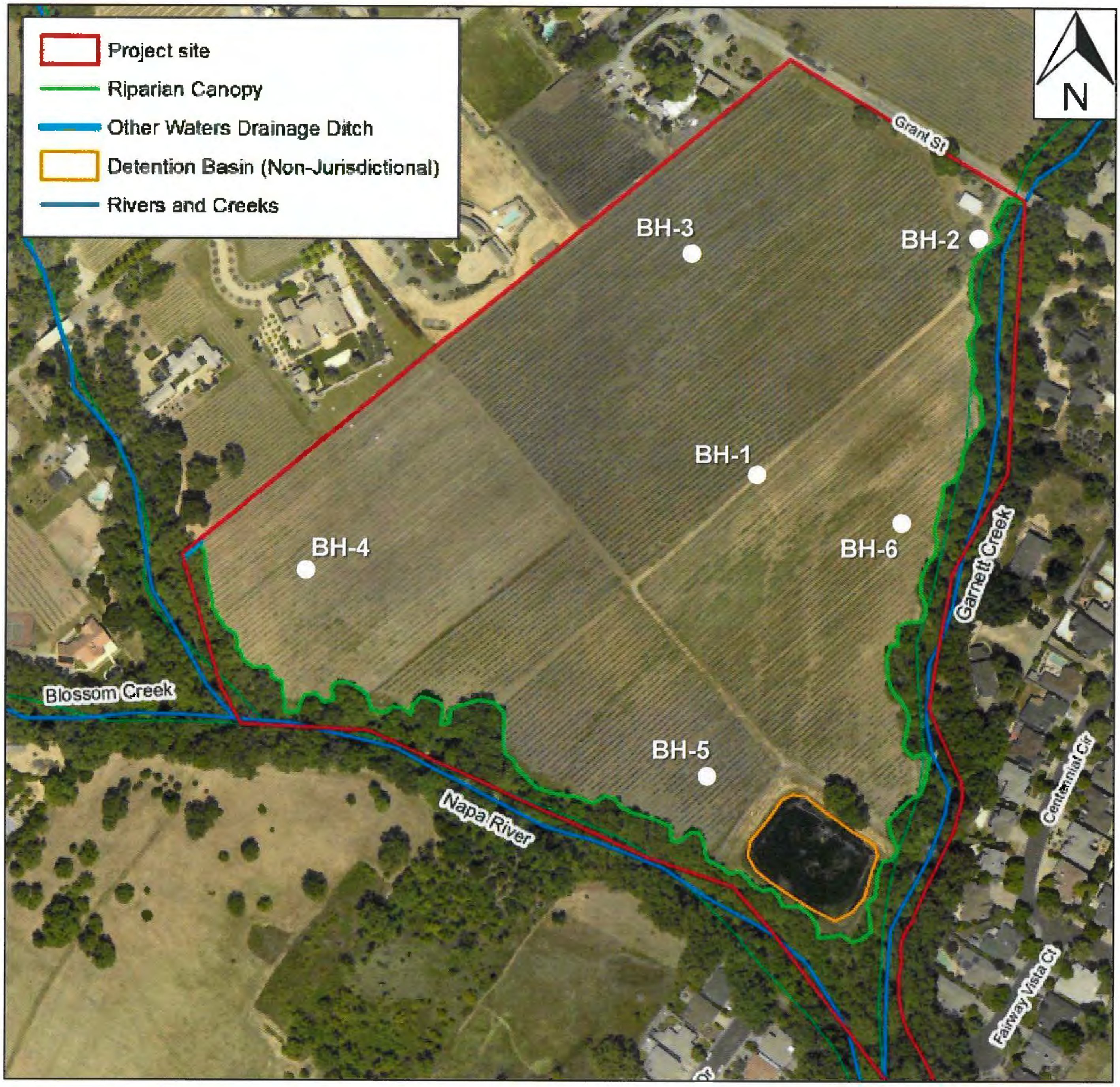
11\. Flood Insurance Rate Map, Federal Emergency Management Agency, County of Sonoma & Unincorporated Areas, County Panel Number 06055C0228E and 06055C0229E, Effective September 26, 2008.



SCALE: 1:24,000

REFERENCE: USGS CALISTOGA 7.5 MINUTE QUADRANGLE, UPDATED 1998.

PJC & Associates, Inc. Consulting Engineers & Geologists	SITE LOCATION MAP PROPOSED SUBDIVISION 2565 GRANT STREET CALISTOGA, CALIFORNIA	PLATE 1
	Proj. No: 10187.01 Date: 6/2021 App'd by: PJC	



EXPLANATION

APPROXIMATE SCALE: 1" = 740'

O BOREHOLE LOCATION AND DESIGNATION

REFERENCE: SITE PLAN TITLED "EXHIBIT A. JURISDICTIONAL CONSTRAINTS OF THE CALISTOGA PROJECT SITE, PREPARED BY MONK & ASSOCIATES, DATED AUGUST 19, 2019.

PJC & Associates, Inc. Consulting Engineers & Geologists	BOREHOLE LOCATION PLAN PROPOSED SUBDIVISION 2565 GRANT STREET CALISTOGA, CALIFORNIA	PLATE 2
	Proj. No: 10187.01 Date: 6/2021 App'd by: PJC	

PJC & Associates, Inc.

Consulting Engineers & Geologists

BORING NUMBER BH-1

CLIENT Grant Street Ranch, LLC **PROJECT NAME** Proposed Subdivision

JOB NUMBER 10187.01 **LOCATION** 2565 Grant Street, Calistoga, California

DATE STARTED 3/17/21 **COMPLETED** 3/17/21 **GROUND ELEVATION** **HOLE SIZE** 8"

DRILLING CONTRACTOR Pearson Exploration **GROUND WATER LEVELS:**

DRILLING METHOD B-53 Hollow Stem Auger with 140lb hammer ∇ **AT TIME OF DRILLING** 13.00 ft

LOGGED BY MNM **CHECKED BY** RD **AT END OF DRILLING** ---

NOTES ▼ **AFTER DRILLING** 12.00 ft

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0	0.0-1.0'; SANDY CLAY (CL); dark brown, moist, moderately compacted, with gravel, medium plasticity, (FILL).										
	1.0-3.0'; SANDY CLAY (CL); moderate brown, moist, hard, medium to high plasticity, (ALLUVIUM).	MC		6-7-8 (15)	4.5		19	47	21	26	
	3.0-5.0'; CLAYEY SAND (SC); orange-brown, very moist, loose, medium-grained, (ALLUVIUM).	MC		5-6-6 (12)		80	22				
5	5.0-8.5'; SANDY CLAY (CL); dark brown with orange-brown, very moist, very stiff, high sand content, medium to high plasticity, (ALLUVIUM).	MC		5-7-9 (16)	3.75	69	33				
	8.0-18.0'; GRAVEL with Clay and Sand (GW-GC); dark brown with orange-brown, moist to saturated, medium dense, fine to coarse, with minor clay, (ALLUVIUM).										
10		MC		6-9-11 (20)		85	16				9
		SPT		8-7-8 (15)							
	▼ loose, clean gravels and cobbles and cobbles to 5" diameter										
	∇										
15	dense, slow drilling	MC		10-18-25 (43)							
		SPT		14-16-16 (32)							
	18.0-22.5'; SANDY CLAY (CH); blue-gray, saturated, stiff, high plasticity, (ALLUVIUM).										
20		SPT		3-5-7				55	18	37	82

(Continued Next Page)

PJC & Associates, Inc.

Consulting Engineers & Geologists

CLIENT Grant Street Ranch, LLC **PROJECT NAME** Proposed Subdivision

JOB NUMBER 10187.01 **LOCATION** 2565 Grant Street, Calistoga, California

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
20		18.0-22.5'; SANDY CLAY (CH); blue-gray, saturated, stiff, high plasticity, (ALLUVIUM). *(continued)*			(12)							
		22.5-34.0'; INTERBEDDED CLAYEY GRAVEL AND CLAYEY SAND (GP-GC and SC), light orange-brown, saturated, medium dense, (ALLUVIUM).										
25			SPT		12-20-18 (38)							12
		drills like loose, large gravels and cobbles										
30			SPT		17-28-14 (42)							
		34.0-34.25'; SANDY CLAY (CH); blue-gray, saturated, stiff, high plasticity, (ALLUVIUM).										
35		34.25-35.25'; CLAYEY SAND (SC); gray-brown, saturated, dense, medium-grained, with occasional gravels, (ALLUVIUM).	SPT		8-11-29 (40)							
		35.25-50.5'; CLAYEY GRAVEL (GC); gray-brown, saturated, dense to medium dense, coarse-grained, (ALLUVIUM).										
40			SPT		10-13-18 (31)							

(Continued Next Page)

PJC & Associates, Inc.

Consulting Engineers & Geologists

BORING NUMBER BH-1

CLIENT Grant Street Ranch, LLC **PROJECT NAME** Proposed Subdivision

JOB NUMBER 10187.01 **LOCATION** 2565 Grant Street, Calistoga, California

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
		35.25-50.5'; CLAYEY GRAVEL (GC); gray-brown, saturated, dense to medium dense, coarse-grained, (ALLUVIUM). *(continued)*										
45			SPT		8-11-9 (20)							12
50			NR		12-17-10 (27)							

Bottom of borehole at 50.5 feet.

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PJC & Associates, Inc.

Consulting Engineers & Geologists

BORING NUMBER BH-2

CLIENT Grant Street Ranch, LLC **PROJECT NAME** Proposed Subdivision

JOB NUMBER 10187.01 **LOCATION** 2565 Grant Street, Calistoga, California

DATE STARTED 3/19/21 **COMPLETED** 3/19/21 **GROUND ELEVATION** **HOLE SIZE** 8"

DRILLING CONTRACTOR Pearson Exploration **GROUND WATER LEVELS:**

DRILLING METHOD B-53 Solid Stem Auger with 140lb Hammer ∇ **AT TIME OF DRILLING** 13.00 ft

LOGGED BY DN **CHECKED BY** RD **AT END OF DRILLING** ---

NOTES ▼ **AFTER DRILLING** 14.50 ft

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0		0.0-4.5'; SANDY CLAY (CH); dark brown, moist, moderately compacted, with gravel, high plasticity, (FILL).										
			MC		11-15-20 (35)	4.0 4.0	 99	15 12				
			MC		20-31-25 (56)							
5		4.5-13.25'; SANDY CLAY (CH); dark brown, very moist, very stiff, with trace gravels, high plasticity, (ALLUVIUM).	MC		10-10-15 (25)	4.0	87	22				
		color change to olive-brown	MC		8-14-20 (34)	4.0	88	24				
10												
	∇	13.25-15.0'; CLAYEY SAND (SC); moderate to dark brown, saturated, medium dense, (ALLUVIUM).	MC		3-7-5 (12)							
15	▼	15.0-18.0'; SANDY CLAY (CH); gray-brown, saturated, very soft, high plasticity, (ALLUVIUM)	SPT		1-1-1 (2)							
		16.0-18.0'; CLAYEY SAND (SC); gray-brown, saturated, loose, high clay content, fine to medium-grained, with occasional gravels, (ALLUVIUM). increasing sand with depth	SPT		2-2-2 (4)							37
		18.0-20.25'; CLAYEY SAND (SC); blue-gray, saturated, loose, (ALLUVIUM).										
20												

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PJC & Associates, Inc.

Consulting Engineers & Geologists

CLIENT Grant Street Ranch, LLC **PROJECT NAME** Proposed Subdivision

JOB NUMBER 10187.01 **LOCATION** 2565 Grant Street, Calistoga, California

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
20	20.25-23.5'; SANDY CLAY (CH); blue-gray with orange mottling, saturated, meduim stiff, high plasticity, (ALLUVIUM).	MC		2-3-5 (8)							
	23.5-29.0'; SAND with CLAY and GRAVEL (SW-SC); brown and gray, saturated, medium dense to dense, with subangular gravel below 29', well graded, (ALLUVIUM).										
25		MC		21-21-27 (48)							
		SPT		12-10-14 (24)							13
30		SPT		10-11-20 (31)							
35		SPT		6-11-13 (24)							
	38.0-50.0'; GRAVEL with CLAY and SAND (GP-GC); yellowish-orange, saturated, medium dense to dense, subangular gravel, poorly graded, (ALLUVIUM).										
40		SPT		19-16-11 (27)							14

(Continued Next Page)

CLIENT Grant Street Ranch, LLC **PROJECT NAME** Proposed Subdivision

JOB NUMBER 10187.01 **LOCATION** 2565 Grant Street, Calistoga, California

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
									LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
		38.0-50.0'; GRAVEL with CLAY and SAND (GP-GC); yellowish-orange, saturated, medium dense to dense, subangular gravel, poorly graded, (ALLUVIUM). *(continued)*										
45												
			SPT		13-21-15 (36)							
			SPT		19-17-21 (38)							
50												

Bottom of borehole at 50.0 feet.

PJC & Associates, Inc.

Consulting Engineers & Geologists

BORING NUMBER BH-3

CLIENT Grant Street Ranch, LLC

PROJECT NAME Proposed Subdivision

JOB NUMBER 10187.01

LOCATION 2565 Grant Street, Calistoga, California

DATE STARTED 5/3/21 COMPLETED 5/3/21

GROUND ELEVATION

HOLE SIZE 4"

DRILLING CONTRACTOR Lone Pine Drilling

GROUND WATER LEVELS:

DRILLING METHOD 6X6 with 140lb. Hammer

∇ AT TIME OF DRILLING 12.00 ft

LOGGED BY MNM CHECKED BY RD

▼ AT END OF DRILLING 9.00 ft

NOTES

AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		0.0-3.0'; SANDY CLAY (CL); dark brown to mottled dark brown and orange-brown, slightly moist to moist, very stiff, medium plasticity, (TOPSOIL).	GB									
		EI = 78 (medium)	MC		3-3-6 (9)	3.0	85	18	47	21	26	
		3.0-6.5'; SANDY CLAY (CH); olive-brown with white, very moist, stiff, with occasional small gravels, high plasticity, increasing sand with depth, (ALLUVIUM).	MC		4-5-10 (15)	2.5	72	30				
5			MC		7-12-14 (26)	4.0	81	18				
		6.5-14.0'; SANDY CLAY (CL); mottled olive-brown and orange-brown, moist, medium stiff, medium plasticity, high sand content, (ALLUVIUM).										
	▼											
10			MC		4-4-7 (11)							
	∇											
			MC		4-4-4 (8)							
15		14.0-16.0'; CLAYEY SAND (SC); olive-brown with orange-brown, saturated, loose, fine to coarse with depth, with small gravels at bottom, (ALLUVIUM).	SPT		5-12-12 (24)							

Bottom of borehole at 16.0 feet.

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PJC & Associates, Inc.

Consulting Engineers & Geologists

BORING NUMBER BH-4

CLIENT Grant Street Ranch, LLC

PROJECT NAME Proposed Subdivision

JOB NUMBER 10187.01

LOCATION 2565 Grant Street, Calistoga, California

DATE STARTED 5/3/21 COMPLETED 5/3/21

GROUND ELEVATION

HOLE SIZE 4"

DRILLING CONTRACTOR Lone Pine Drilling

GROUND WATER LEVELS:

DRILLING METHOD 6X6 with 140lb. Hammer

AT TIME OF DRILLING --- No free water encountered

LOGGED BY MNM CHECKED BY RD

AT END OF DRILLING ---

NOTES

AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		0.0-2.0'; SANDY CLAY (CL); dark brown, moist, soft, medium plasticity, (TOPSOIL).	MC		3-3-4 (7)							
		2.0-10.0'; SANDY CLAY (CH); dark olive-brown, very moist, stiff to very stiff, high plasticity, (ALLUVIUM).										
		color change to dark gray-brown	MC		3-4-7 (11)	2.0	76	25				
5			MC		4-6-12 (18)	3.8	77	25				
		with orange-brown and yellow-brown mottling, increasing sand content										
		high sand content										
10			MC		5-5-7 (12)							

Bottom of borehole at 10.0 feet.

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PJC & Associates, Inc.

Consulting Engineers & Geologists

BORING NUMBER BH-5

CLIENT Grant Street Ranch, LLC PROJECT NAME Proposed Subdivision

JOB NUMBER 10187.01 LOCATION 2565 Grant Street, Calistoga, California

DATE STARTED 5/3/21 COMPLETED 5/3/21 GROUND ELEVATION HOLE SIZE 4"

DRILLING CONTRACTOR Lone Pine Drilling GROUND WATER LEVELS:

DRILLING METHOD 6X6 with 140lb. Hammer ▽ AT TIME OF DRILLING 10.00 ft

LOGGED BY MNM CHECKED BY RD ▼ AT END OF DRILLING 8.50 ft

NOTES AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0		0.0-3.0'; SANDY CLAY (CL); dark brown, very moist, stiff, medium plasticity, with thin layers of olive-brown silt, (TOPSOIL).	GB						46	22	24	
		EI = 52 (medium)	MC		2-3-4 (7)	1.75	64	35				
		3.0-10.0'; SANDY CLAY (CH); mottled dark olive and orange-brown, very moist, very stiff, high plasticity, (ALLUVIUM).	MC		4-5-7 (12)	3.0	69	34				
5			MC		4-6-10 (16)	3.0	76	30				
	▼											
10	▽	10.0-11.25'; SANDY CLAY (CL); dark olive, saturated, stiff, medium plasticity, increasing sand content with depth, (ALLUVIUM).	MC		3-3-5 (8)	1.8	71	38				
		11.25-13.0'; CLAYEY SAND (SC); dark olive, saturated, loose, with silt layers, fine-grained, (ALLUVIUM).	SPT		3-4-4 (8)							

Bottom of borehole at 13.0 feet.

PJC & Associates, Inc.

Consulting Engineers & Geologists

BORING NUMBER BH-6

CLIENT Grant Street Ranch, LLC
PROJECT NAME Proposed Subdivision
JOB NUMBER 10187.01
LOCATION 2565 Grant Street, Calistoga, California
DATE STARTED 5/3/21
COMPLETED 5/3/21
GROUND ELEVATION
HOLE SIZE 4"
DRILLING CONTRACTOR Lone Pine Drilling
GROUND WATER LEVELS:
DRILLING METHOD 6X6 with 140lb. Hammer
AT TIME OF DRILLING --- No free water encountered
LOGGED BY MNM
CHECKED BY RD
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0		0.0-1.5'; CLAYEY SAND (SC); moderate brown, dry, loose, fine-grained, (ALLUVIUM).	MC		7-7-5 (12)							
		1.5-3.25'; SANDY CLAY (CL); dark olive-brown, moist, very stiff, medium plasticity, (ALLUVIUM).	MC		3-5-7 (12)	4.0	85	19				
		3.25-4.5'; CLAYEY SAND (SC); dark olive-brown, very moist, medium dense, fine-grained, (ALLUVIUM).										
5		4.5-7.25'; SANDY CLAY (CH); mottled dark olive and orange-brown, moist, stiff, high plasticity, (ALLUVIUM).	MC		5-6-9 (15)							
		7.25-10.5'; CLAYEY GRAVEL (GC); mottled brown, orange-brown and gray, moist, medium dense, with sand, gravels to 1" diameter increasing size with depth, (ALLUVIUM).	MC		7-9-11 (20)							
10			SPT		10-14-10-13 (24)							

Bottom of borehole at 10.5 feet.

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MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS More than half is larger than #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, GRAVEL-SAND MIXTURES
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND MIXTURES
			GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND MIXTURES
	SANDS more than half coarse fraction is smaller than no. 4 sieve size	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL GRADED SANDS, GRAVELLY SANDS
			SP	POORLY GRADED SANDS, GRAVEL-SAND MIXTURES
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES
			SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES
FINE GRAINED SOILS More than half is smaller than #200 sieve	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, SILTY OR CLAYEY FINE SANDS, VERY FINE SANDS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS OR LEAN CLAYS
			OL	ORGANIC CLAYS AND ORGANIC SILTY 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 OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS

KEY TO TEST DATA

LL — Liquid Limit (in %)
PL — Plastic Limit (in %)
G — Specific Gravity
SA — Sieve Analysis
Consol — Consolidation
■ "Undisturbed" Sample
☒ Bulk or Disturbed Sample
☐ No Sample Recovery

	Shear Strength, psf	Confining Pressure, psf	
*Tx	320	(2600)	Unconsolidated Undrained Triaxial
Tx CU	320	(2600)	Consolidated Undrained Triaxial
DS	2750	(2000)	Consolidated Drained Direct Shear
FVS	470		Field Vane Shear
*UC	2000		Unconfined Compression
LVS	700		Laboratory Vane Shear

Notes: (1) All strength tests on 2.8" or 2.4" diameter sample unless otherwise indicated
(2) * Indicates 1.4" diameter sample

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USCS SOIL CLASSIFICATION KEY
PROPOSED SUBDIVISION
2565 GRANT STREET
CALISTOGA, CALIFORNIA

PLATE 9

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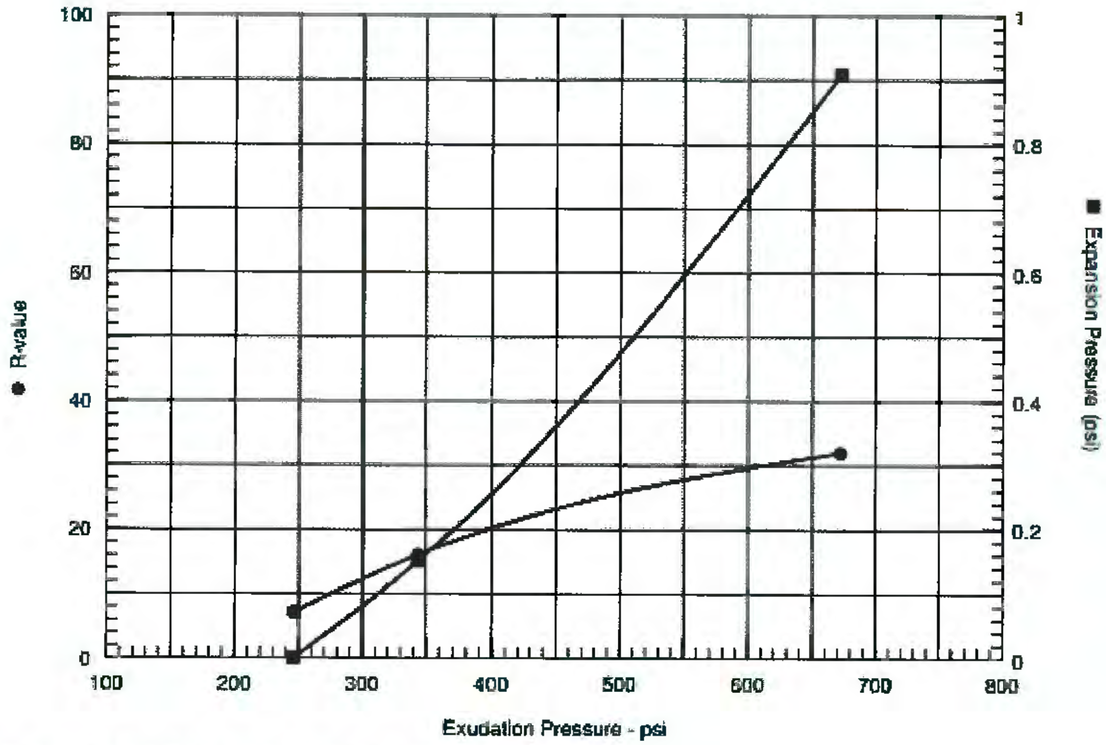
R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - ASTM D2844

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	150	106.1	20.6	0.91	97	2.47	672	32	32
2	75	100.4	23.5	0.15	124	2.46	344	16	16
3	35	92.9	26.0	0.00	139	2.56	246	7	7

Test Results	Material Description
R-value at 300 psi exudation pressure = 12 **Exp. pressure at 300 psi exudation pressure =** 0.08 psi	Brown Sandy Clay (CH)

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R-VALUE TEST
PROPOSED SUBDIVISION
2565 GRANT STREET
CALISTOGA, CALIFORNIA

PLATE
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Proj. No: 10187.01 Date: 6/2021 App'd by: PJC

LAB SAMPLE NUMBER	SAMPLE ID	DESCRIPTION of SOIL and/or SEDIMENT	SOIL pH -log[H+]	NOMINAL MIN RESISTIVITY ohm-cm	ELECTRICAL CONDUCTIVITY µmhos/cm	SULFATE SO4 ppm	CHLORIDE Cl ppm
08698-1	GS1/C	Native Soil BH-4 @ 1.5'-3.0'	5.49	637	[1570]	129	67.5
Method	Detection	Limits -->	---	1	0.1	1	1

LAB SAMPLE NUMBER	SAMPLE ID	DESCRIPTION of SOIL and/or SEDIMENT	SALINITY ECe mmhos/cm	SOLUBLE SULFIDES (S=) ppm	SOLUBLE CYANIDES (CN=) ppm	REDOX mV	PERCENT MOISTURE %
08698-1	GS1/C	Native Soil BH-4 @ 1.5'-3.0'				+290.8	
Method	Detection	Limits -->	---	0.1	0.1	1	0.1

COMMENTS

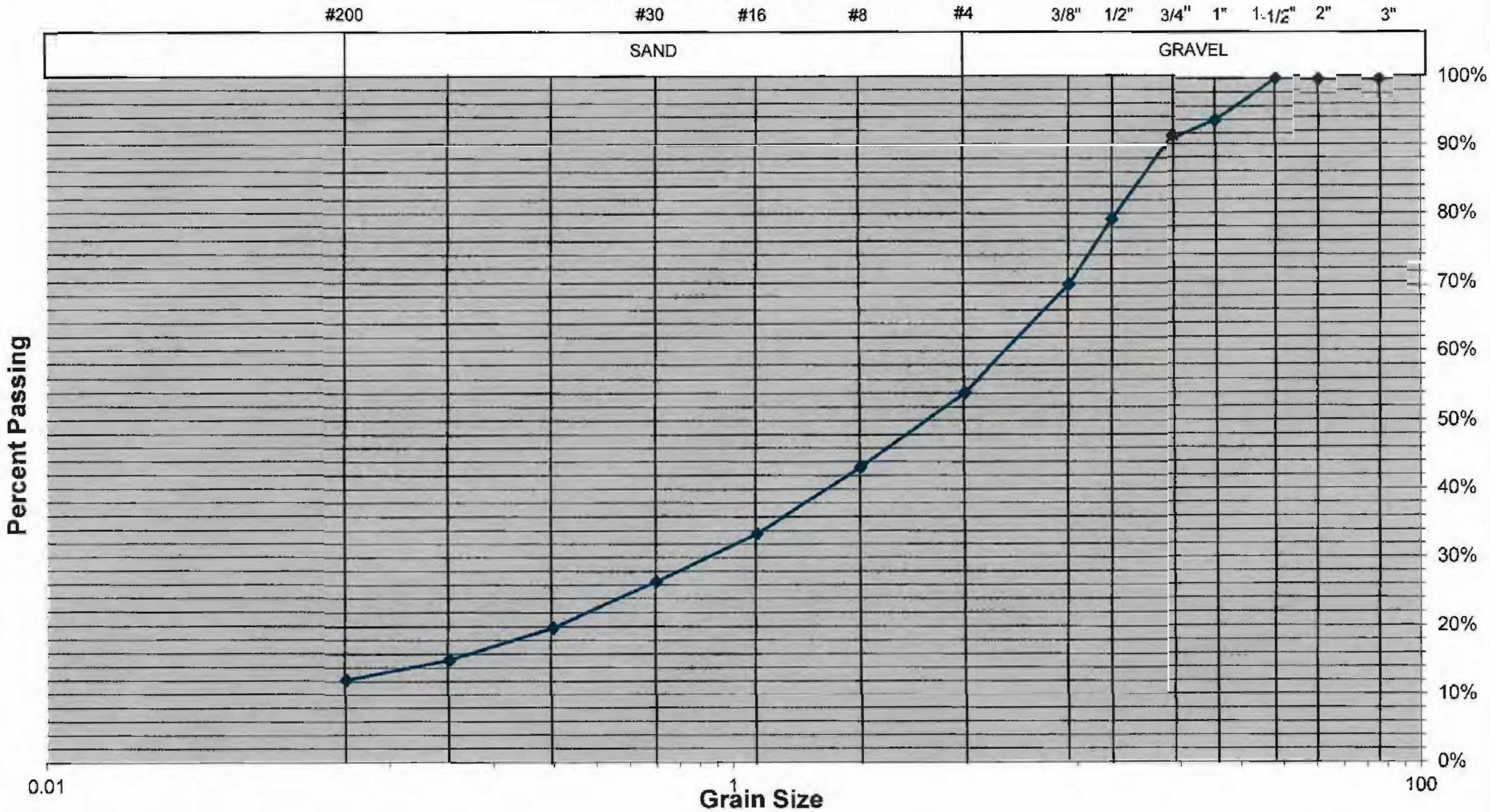
Resistivity is well under 1,000 ohm-cm, i.e., poor, and soil reaction (i.e., pH) is mildly acidic; sulfate is low enough (i.e., @ <200 ppm), and chloride is low (i.e., @ <100 ppm); the soil is mildly reduced (@ 200-300 mV); [see table below on right for assigned point values and ranges]. The CalTrans (CT) times to perforation of galvanized steel and full depth pitting times for unprotected steel (following Uhlig) in this soil are determined based on pertinent parameters [see able at left below]. Sulfate would not have any adverse impact on concrete, cement, mortar or grout; likewise, chloride should not have any adverse impact on rebar and buried steel over the long term. In principle, lime or mild cement treatment would be of potentially significant benefit in that raising soil pH to the 7.5-8.5 range would increase times to perforation as indicated below. Otherwise, to increase steel longevity in this soil would require upgrading and/or other actions. At times, structural strength considerations may require heavier gauge steel than is used in the presented examples such that perf and pitting to depth times can be beyond the specified life span. Where this is not the case, cathodic protection along with coating or wrapping steel assets is one potential solution. Other options can can include increased and/or specialized engineering fill, use of polymer coating, or use of plastic, fiberglass or concrete assets. Based on these results, due to poor resistivity (and mild redox) either upgrading (e.g. ASTM Type II, heavier rebar, etc.) and/or some remediation would be prudent in this case.

SAMPLE ID	CT 18 ga	CT 12 ga	2 mm (Uhlig)
GS1/C	~4 yrs	~9 yrs	~5 yrs
Treated	<21 yrs	>45 yrs	~10 yrs

PARAMETER/ID	GS1/C
pH	Ø
Rs	8-10
SO4	Ø
Cl	Ø
Redox	Ø-3.5
TOTALS	8-13.5

\\\NOTES: Methods are from following sources: extractions by Cal Trans protocols as per Cal Test 417 (SO4), 422 (Cl), and 532/643 (pH & resistivity); &/or by ASTM Vol. 4.08 & ASTM Vol. 11.01 (=EPA Methods of Chemical Analysis, or Standard Methods); pH - ASTM G 51; Spec. Cond. - ASTM D 1125; resistivity - ASTM G 57; redox - Pt probe/ISE; sulfate - extraction Title 22, detection ASTM D 516 (=EPA 375.4); chloride - extraction Title 22, detection ASTM D 512 (=EPA 325.3); sulfides - extraction by Title 22, and detection EPA 376.2 (= SMEWW 4500-S D); cyanides - extraction by Title 22, and detection by ASTM D 4374 (=EPA 335.2).

GRADATION CURVE



Sample: BH-1 @ 24.0' to 30.5': Light Orange-Brown Gravel with clay and sand (GP-GC)

SIEVE ANALYSIS
PROPOSED SUBDIVISION
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PLATE 12

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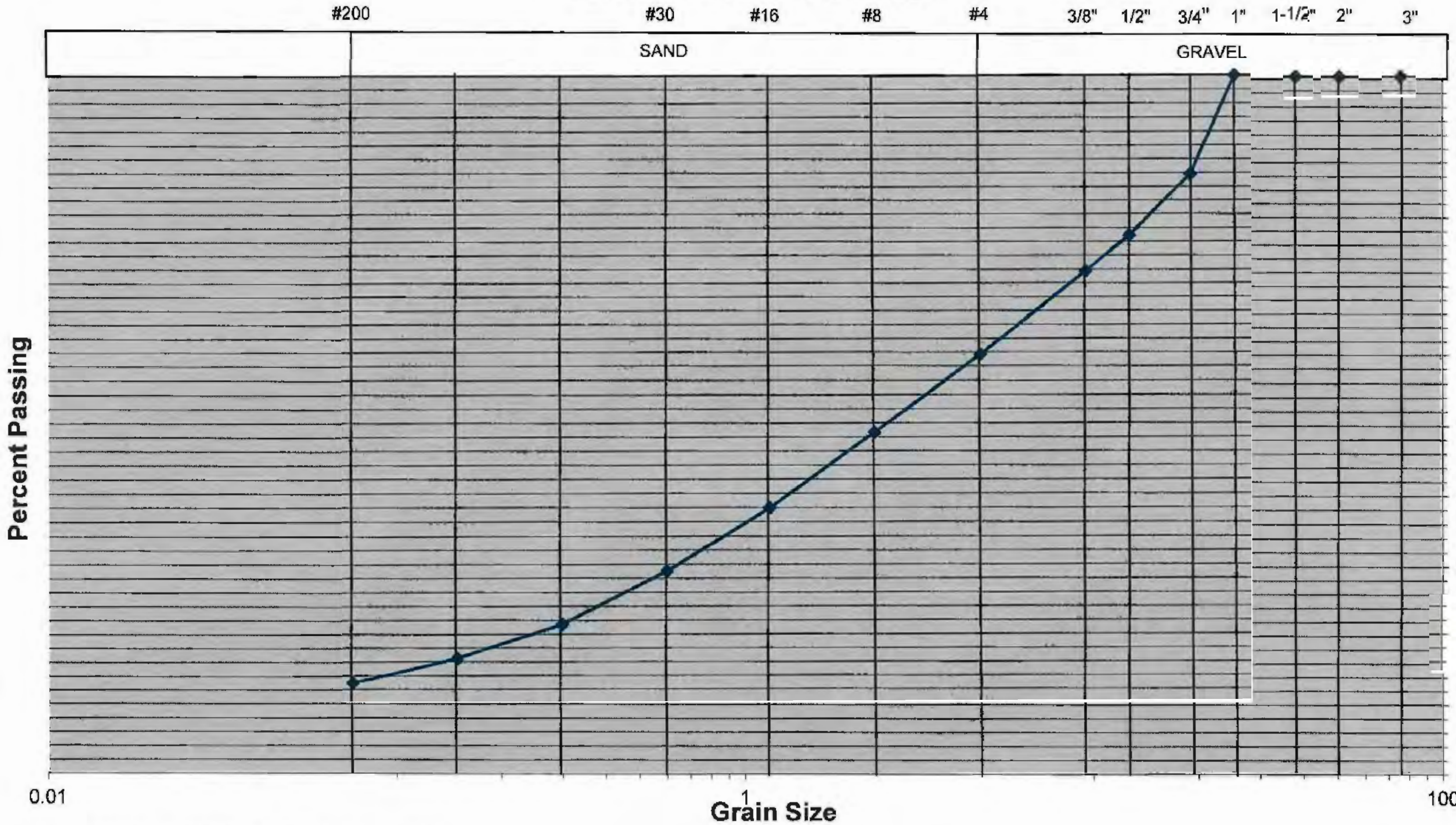
GRADATION CURVE



Sample: BH-2 at 27.0'-36.5': Brown and Gray Sand with Clay and Gravel (SW-SC).

SIEVE ANALYSIS
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PLATE 13

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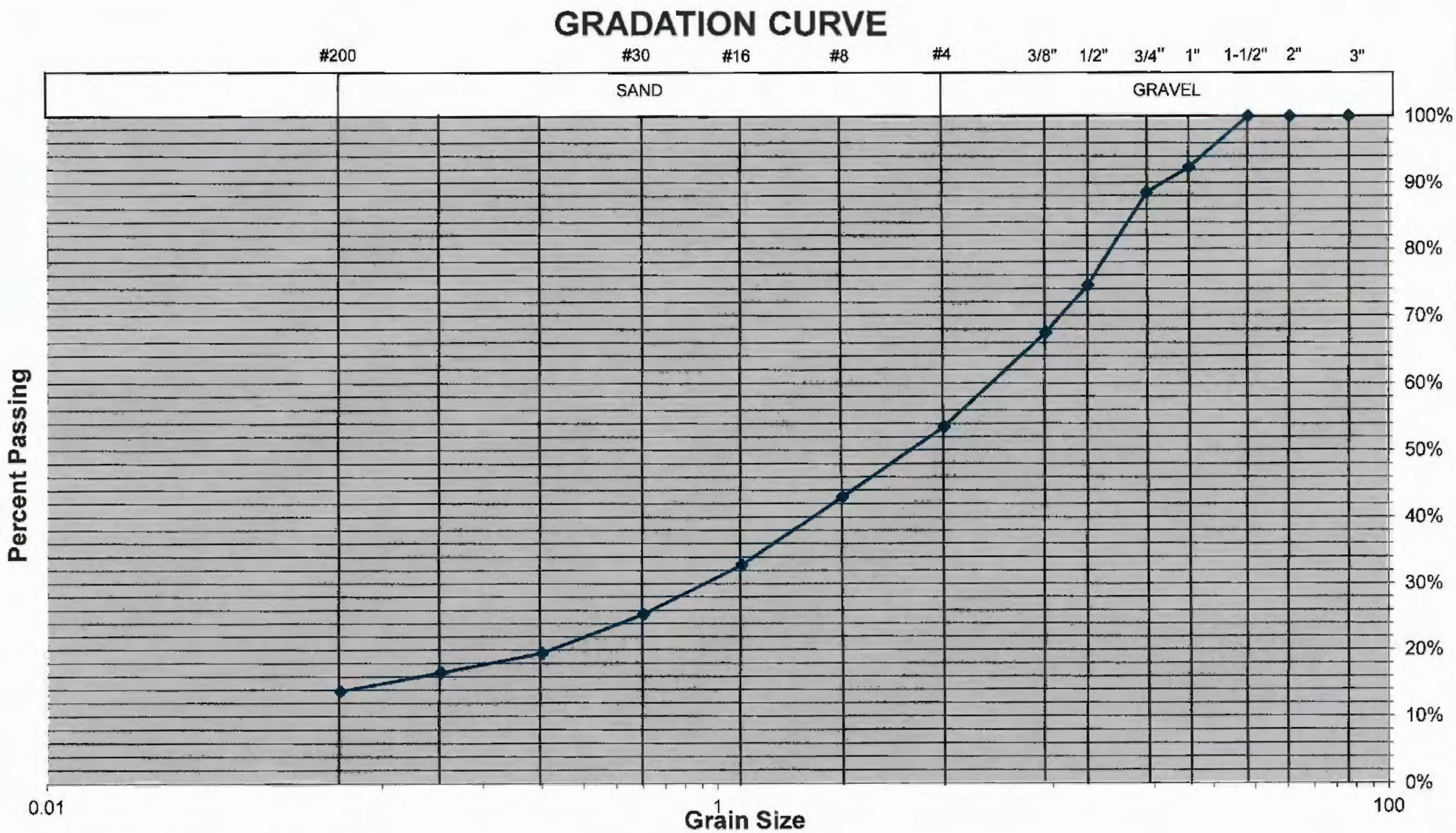

Sample: BH-2 @ 40.0'-50.0': Yellowish Orange Gravel with Clay and Sand (GP-GC).

SIEVE ANALYSIS
PROPOSED SUBDIVISION
2565 GRANT STREET
CALISTOGA, CALIFORNIA

PLATE 14

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