1501 LUCAS VALLEY ROAD
SAN RAFAEL, CALIFORNIA

PRELIMINARY GEOTECHNICAL EXPLORATION

SUBMITTED TO
Mr. Steve Reilly
Lucas Valley Road, LLC
6564 South State Street, Suite 400
Saline, MI 49727

PREPARED BY
ENGEO Incorporated

December 19, 2023

PROJECT NO.
24211.000.001

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Project No.
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December 19, 2023

Mr. Steve Reilly
Lucas Valley Road, LLC
6564 South State Street, Suite 400
Saline, MI 49727

Subject: 1501 Lucas Valley Road
San Rafael, California

PRELIMINARY GEOTECHNICAL EXPLORATION

Dear Mr. Reilly:

We are pleased to present this preliminary geotechnical report for the conceptual planning of your proposed 35 home residential development at 1501 Lucas Valley Road, California. This report presents our preliminary geotechnical findings, conclusions, and recommendations.

Based on our initial assessment, it is our opinion that development at the project site is feasible from a geotechnical standpoint. The primary geotechnical and geologic considerations for the project are the presence of expansive soils, undocumented fill, compressible colluvium, and relatively shallow hard rock. Design-level geotechnical exploration should be conducted prior to site development once information is available regarding the building layout, structural loads, and proposed grading.

We are pleased to have been of service on this project and are prepared to consult further with you and your design team as the project progresses. If you have any questions or comments regarding this.

Sincerely,

ENGEO Incorporated

Matthew S. Farrell

Todd Bradford, GE

Robert H. Boeche, CEG

msf/rhb/dt

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this geotechnical report is to provide preliminary geotechnical recommendations associated with the proposed residential development at the site as described in the Grading Aerial prepared by CSW/Stuber-Stroeh Engineering, dated August 21, 2023. We performed the following services.

- Reviewed available literature, aerial photographs, and geologic maps for the study area.
- Performed geotechnical explorations, collected samples, and analyzed laboratory test data.
- Prepared this report summarizing our preliminary conclusions and recommendations for the proposed development.

This report was prepared for the exclusive use of Lucas Valley Road, LLC and its consultants for project planning and preliminary design. In the event that any changes are made in the character, design, or layout of the development, we must be contacted to review the conclusions and recommendations contained in this report to determine whether modifications are necessary. This document may not be reproduced in whole or in part by any means whatsoever, nor may it be quoted or excerpted without our express written consent.

1.2 SITE LOCATION AND DESCRIPTION

As shown in Figures 1 and 2, the approximately 10-acre site, identified as Assessor's Parcel Number 164-280-35, is located west of Lucas Valley Road in San Rafael, California. The site is generally bounded by a small horse ranch to the south and open space to the north and west.

The site is currently occupied by a dilapidated barn structure and an abandoned residence atop the slope north of the site and open space consisting of native vegetation. Nunes Fire Road, which serves as an easement access road, is paved from the entrance of the site up to the abandoned residence.

1.3 PROPOSED DEVELOPMENT

Based on our conversations with you, and our review of the Tentative Parcel Map provided by CSW/Stuber-Stroeh Engineering, it is our understanding that the development will consist of 35 lots for single-family housing with associated improvements.

Grading for the site will roughly consist of cut slopes and fill areas, on the order of 10 feet thick, to create a drainable building pad. The lower lying portions of the site will be filled to create a fill slope up to the building pads. The small knob, where the dilapidated barn is, will likely be cut down to make level housing pads and roadways. Two large cut slopes will be formed on the upslope side of the building pads.

1.4 SITE HISTORY

We reviewed historical aerial photographs of the site available on Google Earth, UCSB Frame Finder, and www.historicaerials.com. Our review of the photographs indicates that the site was historically unoccupied until 1968. In 1968, the barn and residence are visible as well as a few smaller structures. The site remained relatively the same until 2016. Between 2016 to 2018, the smaller structures seem to have been removed and some additional cuts and fills were made near the barn area. No significant changes appear to have been made to the site between 2018 and the present.

2.0 GEOLOGY AND SEISMICITY

2.1 REGIONAL AND LOCAL GEOLOGY

The site is located within the Coast Ranges geomorphic province of California. The Coast Ranges province is typified by a system of northwest-trending, fault-bounded mountain ranges, and intervening alluvial valleys. Bedrock in the Coast Ranges consists of igneous, metamorphic, and sedimentary rocks that range in age from Jurassic to Pleistocene. The present physiography and geology of the Coast Ranges are the result of deformation and deposition along the tectonic boundary between the North American plate and the Pacific plate. Plate boundary fault movements are largely concentrated along the well-known fault zones, which in the area include the San Andreas, Hayward, and Calaveras faults, as well as other lesser-known faults.

According to a published geologic map by Rice et. al., 2002 (Figure 3), the bedrock at the site is consists of sandstone and shale blocks within the mélange that are large enough to be mapped. Bedding generally can vary throughout the mélange and is anticipated for this site. A southeast plunging synclinal fold is mapped west of the property. Wentworth (1975) mapped a small landslide within the central portion of the development area (Figure 4). Wentworths maps were developed using photo-interpretation techniques, and we did not encounter slide material in our exploratory test pits. Additionally, we did not observe surficial evidence of the mapped slide during our site visits; however, special attention to this area should be practiced during grading.

Based on our aerial photograph review and test pit explorations, the undocumented fill material present at various portions of the site appears to have supported the smaller former structures.

2.2 REGIONAL FAULTING AND SEISMICITY

The site is not located within a State of California Earthquake Fault Hazard Zone for active faults, and no known faults cross the site. Nearby active[1] or potentially active faults include the following.

TABLE 2.2-1: Approximate Fault Distances and Locations Relative to Project Site

FAULT	DISTANCE (MILES)	ESTIMATE OF MAXIMUM MAGNITUDE (ELLSWORTH)	DIRECTION FROM SITE
Hayward-Rogers Creek	9.0	7.3	East
San Andreas	4.5	7.9	West

Because of the presence of nearby active faults, the Bay Area Region is considered seismically active. Numerous small earthquakes occur every year in the region, and large (greater than moment magnitude) earthquakes have been recorded and can be expected to occur in the future. Figure 5 shows the approximate locations of these faults and significant historic earthquakes recorded within the Greater Bay Area Region.

[1] An active fault is defined by the State Mining and Geology Board as one that has had surface displacement within Holocene time (about the last 11,000 years) (Hart, 1997).

According to the California Geologic Survey, the site is not designated as an Alquist-Priolo Special Studies zone – the site has not been evaluated for earthquake-induced liquefaction.

3.0 FIELD EXPLORATION

During the week of November 1, 2023, we performed a preliminary geologic investigation that included the logging of excavated test pits and drilled borings. Figure 2 depicts the approximate location of our explorations. The boring and test pit logs depict subsurface conditions at the time the exploration was conducted; however, subsurface conditions may vary with time. Subsurface conditions at other locations may differ from conditions occurring at these locations. The boring and test pit logs are included in Appendix A and Appendix B, respectively.

3.1 BORINGS

On November 3, 2023, our field exploration consisted of two borings, which were drilled by a CME75 track-mounted drill rig with solid flight augers.

Boring 1-B1 was drilled on the southeast side of the site in the flatter alluvial area. We encountered roughly 3 feet of wood mulch and other organic material underlain by stiff clayey soil to a depth of 13 feet below the ground surface. At 13 feet deep, we encountered strong, moderately weathered, fine grained brown sandstone.

Boring 1-B2 was drilled on the southwest side of the proposed grading area. We encountered roughly 3½ feet of woody mulch and organics underlain by stiff clay to a depth of 13 feet below ground surface. At about 13 feet deep, we encountered strong, highly weathered, greywacke.

We retrieved soil samples at various intervals in the borings using a modified California sampler or standard penetration test sampler. The standard penetration test (SPT) blow counts were obtained using a 2-inch-diameter split-spoon sampler by dropping a 140-pound hammer through a 30-inch free fall. The 2-inch O.D. split-spoon sampler was driven 18 inches and the number of blows was recorded for each 6 inches of penetration. In addition, 2.5-inch I.D. samples were obtained using a Modified California sampler driven into the soil with the 140-pound hammer previously described. Unless otherwise indicated, the blows per foot recorded on the boring log represent the accumulated number of blows to drive the last 1 foot of penetration; the blow counts have not been converted using any correction factors.

3.2 TEST PITS

On November 1, 2021, we excavated eight test pits using a CASE 580 backhoe at various locations throughout the site. The test pits were dug with a two-foot-wide bucket to depths ranging from 4 to 10 feet below the ground surface.

3.3 SUBSURFACE CONDITIONS

In our test pits, we encountered colluvium, alluvial clays, undocumented artificial fill, sandstone, and greywacke. Based on our exploration data (Borings 1-B1 and 1-B2, and Test Pits 1-TP1 through 1-TP8) the site generally consists of 13 feet deep clayey soil overlying bedrock in the flatter alluvial area of the site. The surrounding hills have a thin mantle of colluvium draped over bedrock. We identified undocumented fill in Test Pits 1-TP3, 1-TP7, and 1-TP8. 1-TP7 is located at the end of the swale that trends west to east down the slope face and contains 6 feet of fill.

1-TP3 and 1-TP8 are located west of the dilapidated barn structure and contain up to 6½ and 4 feet of fill, respectively.

3.4 GROUNDWATER

We did not observe groundwater in the borings or test pits advanced throughout the site. Fluctuations in groundwater levels should be expected during seasonal changes or over a period of years because of precipitation changes, perched zones, and changes in irrigation and drainage patterns.

4.0 GEOLOGIC AND GEOTECHNICAL HAZARDS

We evaluated the site with respect to known geologic and other hazards common to the area. The primary hazards and the risks associated with these hazards with respect to the planned development are discussed in the following sections of this report.

4.1 SEISMIC HAZARDS

Potential seismic hazards resulting from a nearby moderate to major earthquake can generally be classified as primary and secondary. The primary effect is ground rupture, also called surface faulting. The common secondary seismic hazards include ground shaking, soil liquefaction, and lateral spreading. These hazards are discussed in the following sections.

4.1.1 Ground Rupture

The site is not located within a State of California Earthquake Fault Hazard Zone and no known faults cross the site (California Geologic Survey, 1982). Therefore, ground rupture is unlikely at the subject property.

4.1.2 Ground Shaking

An earthquake of moderate to high magnitude generated within the San Francisco Bay Region could cause considerable ground shaking at the property, similar to that which has occurred in the past. To mitigate the shaking effects, structures should be designed using sound engineering judgment and the current California Building Code (CBC) requirements, as a minimum. Seismic design provisions of current building codes generally prescribe minimum lateral forces, applied statically to the structure, combined with the gravity forces of dead-and-live loads. The code prescribed lateral forces are generally considered to be substantially smaller than the comparable forces that would be associated with a major earthquake. Therefore, structures should be able to: (1) resist minor earthquakes without damage, (2) resist moderate earthquakes without structural damage but with some nonstructural damage, and (3) resist major earthquakes without collapse but with some structural as well as nonstructural damage. Conformance to the current building code recommendations does not constitute any kind of guarantee that significant structural damage would not occur in the event of a maximum magnitude earthquake; however, it is reasonable to expect that a well-designed and well-constructed structure will not collapse or cause loss of life in a major earthquake (SEAOC, 1996).

4.1.3 Liquefaction

Soil liquefaction results from loss of strength during cyclic loading, such as imposed by earthquakes. Soil most susceptible to liquefaction is clean, loose, saturated, uniformly graded, fine-grained sand. According to our exploration data, the soil on site consists of lean sandy clay over shallow bedrock. In addition, we did not observe groundwater in the explorations throughout the site. Based on these conditions, the potential for liquefaction at the site is negligible during seismic shaking.

4.1.4 Lateral Spreading

Lateral spreading is a failure within a nearly horizontal soil zone (due to liquefaction) that causes the overlying soil mass to move toward a free-face or down a gentle slope. Generally, effects of lateral spreading are most significant at the free-face or the crest of a slope and diminish with distance from the slope. Because of the negligible potential for liquefaction at the site, the potential for lateral spreading at the site is also negligible.

4.2 UNDOCUMENTED FILL

As discussed previously, we observed artificial fill in three locations of the site, Test Pits 1-TP3, 1-TP7, and 1-TP8. The placement method of the fill is unknown; it is deemed unsuitable to be left in place.

4.3 EXPANSIVE SOIL

Based on the laboratory test results of soil at the site, the clayey deposits have a plasticity index in the low 20s, which is an indication of moderately expansive behavior when wetted.

Expansive soil can shrink and swell as a result of moisture changes. This can cause heaving and cracking of slabs-on-grade, pavements, and structures founded on shallow foundations. Therefore, construction of at-grade improvements will need to consider the potential impacts of expansive soil. Building damage due to volume changes associated with expansive soil can be reduced by: (1) using a rigid mat or slab foundation which is designed to resist the deflections associated with the soil expansion, (2) deepening the foundations to below the zone of moisture fluctuation, i.e. by using deep footings or drilled piers, and/or (3) using footings at normal shallow depths but bottomed on a layer of select fill having a low expansion potential.

Given the proposed development, post-tensioned mat foundations can be used for the residential construction at the site.

Successful construction on expansive soil requires special attention during grading. It is imperative to keep exposed soil moist with occasional sprinkling. If the soil is dry, it is extremely difficult to remoisturize without excavation, moisture conditioning, and recompaction.

Conventional grading operations, incorporating fill placement specifications tailored to the expansive characteristics of the soil, and use of a post-tensioned mat foundation are common, generally cost-effective measures to address the expansive potential of the near-surface soil.

4.4 COMPRESSIBLE SOIL

Compressible soil is subject to settlement when a new loading scenario is introduced by structures, earthworks, or equipment. The amount of settlement is dependent on the magnitude and duration of the applied load, the shape and size of the applied load area, depth, thickness, and stress history of the compressible soil. The time required for primary settlement to occur is highly dependent on the mode of settlement, moisture content, and/or stiffness of the deposit. Consequently, sandy soil will settle almost immediately, whereas clayey soil will settle much more slowly.

Based on review of the test pit logs, the subsurface consists of predominantly lean clay with sand mixture that are primarily stiff to very stiff. Based on our knowledge and experience, it is our opinion that a portion of settlement will occur during construction and that the remaining settlement can be accommodated by designing the structural foundation to withstand some differential settlement.

To minimize settlement of the softer colluvium due to building loads or engineered fill loads, corrective grading measures should include the removal of compressible materials down to a nonyielding material or bedrock. Laboratory testing and additional analysis should be performed in the design-level exploration to confirm the magnitude and extent of potentially compressible material and the potential settlement.

4.5 BEDROCK RIPPABILITY

Based on field observations during excavation of test pits and experience on projects in the immediate vicinity, the bedrock units at this site should be considered rippable with conventional heavy construction equipment (such as a D-6 bulldozer). Localized well-cemented beds and occasional well-cemented concretions may be encountered that will require more ripping effort. Trenching for utilities should be possible with conventional equipment. As noted above, localized well-cemented beds may be encountered that may necessitate the use of heavy equipment such as track-mounted excavators.

In general, all soil and bedrock materials observed on the site appear suitable for use as engineered fill, if properly processed. If rocks greater than 6 inches in diameter are encountered during grading, these should be placed in accordance with recommendations provided in Section 5.1.3 Selection of Materials.

5.0 PRELIMINARY RECOMMENDATIONS

In our opinion, from a geotechnical standpoint, the site is suitable for the proposed development provided the recommendations in this report are implemented during project planning, design, and construction. The main geologic and geotechnical concerns at the site include the presence of existing fill, expansive soil, compressible soil, and bedrock rippability. The following sections discuss differential fill lots, cut-and-fill lots, material selection, and various other recommendations to mitigate the geotechnical considerations. We recommend that additional borings and test pits be performed as part of a design-level study once conceptual plans are prepared.

5.1 GRADING

5.1.1 Demolition, Grading, and Stripping

The following preliminary recommendations are for initial land planning and preliminary estimating purposes. Final recommendations regarding site grading and foundation construction will be provided after design-level exploration has been undertaken. Underground structures, such as buried pipes, septic tanks, and leach fields, if any, should be removed from the project site entirely.

All existing artificial fill, vegetation, and soft or compressible soil should be removed, as necessary, for project requirements. The depth of removal of these materials should be determined by the geotechnical engineer's qualified representative in the field at the time of grading. Evaluation of unsuitable deposits should be performed during grading by sampling and laboratory analyses.

Areas to receive fill or structures and those areas that serve as borrow for fill should be stripped of existing vegetation. In general, topsoil is estimated to be from 3 to 6 inches in thickness depending on location. As previously noted, we encountered up to 3 feet of heavily organic laden soil and mulch in the low-lying area borings. This material should also be stripped. Tree roots should be removed to a depth of at least 3 feet below finished grade in cut areas and 3 feet below original grade in fill areas. Subject to approval by the landscape architect, strippings and organically contaminated soil that are not suitable for use as engineered fill may be used in landscape areas. Any topsoil that will be retained for future use in landscape areas should be stockpiled in areas where it will not interfere with the mass grading.

Within the development areas, excavations resulting from demolition and stripping that extend below final grades should be cleaned to firm undisturbed soil, as determined by the geotechnical engineer's representative. Following clearing and grubbing, all depressions in areas to be filled should be scarified, moisture conditioned, and backfilled with compacted engineered fill.

5.1.2 Corrective Grading

Based on the anticipated site grading and slopes, corrective grading, including the removal of compressible colluvium, excavation and construction of buttress keyways, cut and cut-fill lot excavation, differential fill excavation, and construction of subsurface drainage facilities, is anticipated. Keyway and subdrain configurations, corrective grading, and cross-sections should be prepared during design-level studies based on final development plans.

5.1.3 Selection of Materials

With the exception of construction debris (wood, brick, asphalt, concrete, metal, etc.), trees, organically contaminated materials (soil that contains more than 3 percent organic content by weight), and environmentally impacted soil, we anticipate the site soil is suitable for use as engineered fill. Unsuitable materials and debris, including trees with their roots, should be removed from the project site.

During grading, rock fragments up to 6 inches in diameter shall be placed in the deeper fill areas. No rock fragments larger than 6 inches in diameter shall be placed in the upper 10 feet of finished grade. If oversized rock fragments are encountered, these should not exceed 18 inches in any dimension if placed in selective landscape areas. Larger rocks should be broken mechanically, either by the heavy bulldozers rolling on them or by a pneumatic hammer. The rock should be spread and not allowed to nest.

5.1.4 Graded Sloped and Slope Stabilization

The following preliminary guidelines may be used when considering slope gradients, heights, and retaining walls.

In general, graded 2:1 (horizontal:vertical) slopes may be constructed up to 10 feet in vertical height. If higher vertical 2:1 slopes are planned, 2:1 slopes up to a maximum vertical height of 30 feet may be constructed using geogrid reinforcement. Slopes exceeding 30 feet in height should include benches and/or concrete ditches, as designed by the civil engineer.

Graded 3:1 slopes, or flatter, may exceed 10 feet and do not require benches and/or concrete ditches. Major slopes exceeding 50 feet in vertical height should include a minimum 20-foot-wide debris bench along the base of slope.

Graded cut and fill slopes exceeding 30 feet in height should include benches and/or concrete ditches, as designed by a civil engineer.

The above guidelines may be considered in combination with vertical retaining wall systems, such as MSE retaining walls; however, such walls upon shallow foundations with downslope conditions will require greater embedment than walls with level foreground at slope bottoms. As an alternative to the slope gradient recommendations described above, if steeper slope gradients exceeding the above-noted maximum vertical heights are desired, such slopes could be specially designed using appropriate geogrid reinforcement. Geogrid reinforced slopes should be designed and may include primary and secondary geogrid reinforcement layers. As a general design consideration for geogrid reinforced slopes, if selected, the primary horizontal reinforcement would extend on the order of 1.5 times the total vertical height of the slope, comprising the outer geogrid reinforced buttress zone of the slope; the typical vertical spacing of geogrid layers would be anticipated ranging from 1½- to 2½-foot spacing, depending on the total vertical slope height. Specific slope recommendations should be provided during design-level studies and once final plans are available.

All major cut slopes should be evaluated by an ENGEO Certified Engineering Geologist for slope conditions that might be detrimental to slope stability. If areas of instability are identified during grading, such as adverse bedrock orientation or structure or groundwater seepage conditions, these cut slopes may require over-excavation and reconstruction; if necessary, supplemental recommendations to mitigate cut slopes would be provided during construction.

5.1.5 Undocumented Fill

Existing artificial fill was observed in two areas of the site. Since the placement of this fill is unknown, the undocumented fill should be removed to expose competent native soil material and/or bedrock.

5.1.6 Differential Fill Lot and Cut-Fill Lot

The site transitions from a low lying fill area up to an area of cut higher up the slopes. The potential for differential fill lots may arise as a result of removal depths and fill heights. Building footprints may need to be over excavated to ensure maintain a differential fill thickness of not more than 10 feet if post-tensioned mat foundations are used.

For some lots, the subgrade material within the building area may be located over a cut-and-fill transition and should be made more uniform. This can be accomplished by subexcavating the natural soil cover and the native rock and replacing the subexcavated material with engineered fill. The subexcavation depth should be 3 feet below pad grade for cut-to-fill.

5.1.7 Fill Placement

After removal of soft soil and loose fill, the exposed non-yielding surface of all areas to receive minor fill, secondary slabs-on-grade, or pavements should be scarified to a depth of 12 inches, moisture conditioned, and recompacted to provide adequate bonding with the initial lift of fill. All fill should be placed in thin lifts. The lift thickness should not exceed 8 inches or the depth of penetration of the compaction equipment used, whichever is less. Test procedures should be determined in accordance with ASTM D1557. Additional samples will be collected during site grading and transported to our laboratory for compaction curve testing.

TABLE 5.1.7-1: Fill Placement Specifications

LOCATION	MINIMUM RELATIVE COMPACTION	MINIMUM MOISTURE CONTENT (percent above optimum)
Upper 5 feet of Building Pad	87 to 92	5
General Fill	90	4
Keyway	95	3

5.2 FOUNDATION DESIGN

In order to accommodate the potentially expansive soil, we recommend the residential buildings be supported on a post-tensioned mat, as discussed below.

5.2.1 Post-Tensioned Mat Foundation

We recommend that the proposed residential structures be supported on post-tensioned (PT) mat foundations bearing on engineered fill. On a preliminary basis, we recommend that PT mats be a minimum of 10 inches thick or greater and have a thickened edge at least 2 inches greater than the mat thickness. The structural engineer should determine the actual PT mat thickness using the geotechnical recommendations in the design-level report. We recommend that the thickened edge be at least 12 inches wide.

The building pad for the PT mat should have at least 3 feet of engineered fill. PT slab foundations should be setback from the top of slopes, as required by the California Building Code, 2022.

5.2.1.1 Building Pad Preparation

The building pads should be uniform. For planning purposes, we recommend the pad surface should be moisture conditioned to a moisture content of at least 3 percentage points above optimum immediately prior to foundation construction; this conditioning should be checked by our representative. The subgrade should not be allowed to dry prior to concrete placement.

A vapor retarding membrane should be installed below the mat foundations to reduce moisture condensation under floor coverings. The vapor retarder should meet ASTM E 1745 Class A requirements for water vapor permeance, tensile strength, and puncture resistance.

5.2.2 Building Slope Setback

The planned residences should be set back at a minimum of 1/3 of the height of the slope, or 40 feet from the top of any engineered slope, whichever is less. Where placement of the residences closer to the top of slope than the above criteria is desired, the proposed residences can be supported on drilled piers interconnected with grade beams. The drilled piers should be penetrated through fill material onto competent native soil materials. If some of the piers encountered bedrock, all piers should be drilled at least 3 feet into bedrock to reduce the potential for differential settlement.

5.2.3 2022 California Building Code (CBC) Seismic Parameters

The 2022 CBC utilizes seismic design criteria established in the ASCE/SEI Standard ”Minimum Design Loads and Associated Criteria for Buildings and Other Structures,” (ASCE 7-16). Based on the subsurface explorations data, soil at the two proposed building pads consists of stiff soil and relatively shallow bedrock; therefore, we can characterize the site as Site Class C. We provide the 2022 CBC seismic design parameters in Table 5.2.3-1 below, which include design spectral response acceleration parameters based on the mapped Risk-Targeted Maximum Considered Earthquake (MCER) spectral response acceleration parameters.

TABLE 5.2.3-1: 2022 CBC Seismic Information Latitude: 38.026376; Longitude: -122.476943

PARAMETER	DESIGN VALUE
Site Class	C
Mapped MCE_R spectral response accelerations for short periods, S_S (g)	1.5
Mapped MCE_R spectral response accelerations for 1-second periods, S_1 (g)	0.6
Site Coefficient, F_a	1.2
Site Coefficient, F_v	1.4
MCE spectral response accelerations for short periods, S_{MS} (g)	1.80
MCE spectral response accelerations for 1-second periods, S_{M1} (g)	0.84
Design spectral response acceleration at short periods, S_{DS} (g)	1.2
Design spectral response acceleration at 1-second periods, S_{D1} (g)	0.56
MCE Geometric Mean Peak Ground Acceleration, PGA_M (g)	0.62
Long period transition-period, T_L (sec)	12 sec

5.3 PRELIMINARY RETAINING WALL RECOMMENDATIONS

Unrestrained walls constructed on level and sloped foregrounds should be designed for active lateral fluid pressure as provided below.

TABLE 5.3-1: Active Earth Pressure

BACKFILL SLOPE CONDITION	ACTIVE PRESSURE (PCF)
Level	40
3:1	45
2:1	50

Passive pressures acting on foundations and shear keys may be assumed as 250 pounds per cubic foot (pcf) provided that the area in front of the retaining wall is level for a distance of at least 10 feet or three times the depth of foundation and keyway, whichever is greater. The upper 1 foot of soil should be excluded from passive pressure computations, unless it is confined by pavement or a concrete slab. The friction factor for sliding resistance may be assumed as 0.30. On a preliminary basis, the retaining wall footings may be planned using an allowable bearing pressure of 2,000 psf in firm native materials or fill. The footings should be at least 24 inches below lowest adjacent grades.

The above lateral earth pressures assume sufficient drainage behind the walls to prevent any build-up of hydrostatic pressures from surface water infiltration and/or a rise in the groundwater level. If adequate drainage is not provided, we recommend that an additional equivalent fluid pressure of 40 pcf be added to the values recommended above for both restrained and unrestrained walls. Damp-proofing of the walls should be included in areas where wall moisture would be problematic.

5.3.1 Retaining Wall Drainage

Either graded rock drains or geosynthetic drainage composites should be constructed behind the retaining walls to reduce hydrostatic lateral forces. For rock drain construction, we recommend two types of rock drain alternatives.

1. A minimum 12-inch-thick layer of Class 2 Permeable Filter Material (Caltrans Specification 68-2.02F) placed directly behind the wall, or
2. A minimum 12-inch-thick layer of washed, crushed rock with 100 percent passing the ¾-inch sieve and less than 5 percent passing the No. 4 sieve. Envelop rock in a minimum 6-ounce, nonwoven geotextile filter fabric.

For both types of rock drains:

1. The rock drain should be placed directly behind the walls of the structure.
2. The rock drains should extend from the wall base to within 12 inches of the top of the wall.
3. A minimum of 4-inch-diameter perforated pipe (glued joints and end caps) should be placed at the base of the wall, inside the rock drain and fabric, with perforations placed down.
4. The pipe should be placed at a gradient at least 1 percent to direct water away from the wall by gravity to a drainage facility.

We should review and approve geosynthetic composite drainage systems prior to use.

5.3.2 Backfill

Backfill behind the retaining walls should be placed and compacted in accordance with Section **Error! Reference source not found.**. Use light compaction equipment within 5 feet of the wall face. If heavy compaction equipment is used, the walls should be temporarily braced to avoid excessive wall movement.

5.4 PRELIMINARY PAVEMENT DESIGN

5.4.1 Flexible Pavement

For preliminary planning purposes, an R-value of 5 was selected. We developed the following recommended pavement sections using Topic 633 of the 2019 Caltrans Highway Design Manual Seventh Edition, implemented 2020 (including the asphalt factor of safety), and traffic indices varying from 5 to 9, presented in the table below.

TABLE 5.4.1-1: Preliminary Hot Mix Asphalt Concrete Pavement Sections

TRAFFIC INDEX	SECTION	
	HOT MIX ASPHALT (inches)	CLASS 2 AGGREGATE BASE (inches)
5	3	10
6	3 ½	13
7	4	16
8	5	18
9	5 ½	21

The civil engineer should determine the appropriate traffic indexes based on the estimated traffic loads and frequencies.

These sections are for estimating purposes only. Actual sections to be used should be based on R-value tests performed on samples of actual subgrade materials recovered at the time of grading. Pavement construction and all materials should comply with the requirements of the Standard Specifications of the State of California Department of Transportation, civil engineer, and appropriate public agency.

5.4.2 Pavement Subgrade Preparation

Finished subgrade and aggregate base should be compacted in accordance with Section **Error! Reference source not found.**. Aggregate base should meet the requirements for ¾-inch maximum Class 2 AB in accordance with Section 26-1.02B of the latest Caltrans Standard Specifications.

Subgrade soil and aggregate base materials should be in a stable, non-pumping condition at the time aggregate baserock materials and pavement are to be placed and compacted. Proof-rolling with a heavy wheel-loaded piece of construction equipment should be implemented. Yielding materials should be appropriately mitigated, with suitable mitigation measures developed in coordination with the client, contractor, and geotechnical engineer.

5.5 DRAINAGE

Perimeter grades should be positively sloped at all times to provide for rapid removal of surface water runoff away from the foundation systems and to prevent ponding of water under foundations or seepage toward the foundation systems at any time during or after construction. Ponded water may cause undesirable soil swell and loss of strength. As a minimum requirement, finished grades of pervious surfaces should have slopes of at least 5 percent within 10 feet from the exterior walls and at right angles to allow surface water to drain positively away from the structure. For paved areas, the slope gradient can be reduced to 2 percent.

All surface water should be collected and discharged into outlets approved by the civil engineer. Landscape mounds should not interfere with this requirement. All roof stormwater should be collected and directed to downspouts. Stormwater from roof downspouts should not be allowed to discharge directly onto the ground surface in close proximity to the foundation system, such as via splash blocks. Rather, stormwater from roof downspouts should be directed to a solid pipe that discharges into the street or to an outlet approved by the civil engineer. If this is not acceptable, we recommend downspouts discharge at least 5 feet away from foundations. Alternatively, engineered stormwater systems can be developed under our guidance.

6.0 DESIGN-LEVEL GEOTECHNICAL REPORT

This report presents findings, conclusions, and preliminary geotechnical recommendations intended for planning purposes only. Future design-level geotechnical explorations should be performed when development plans are finalized. We anticipate the design-level geotechnical report will include:

- Additional borings and test pits with soil sample collection to support design-level recommendations.
- Additional laboratory testing, but not limited to, moisture content, unit weight, plasticity index, gradation, strength, and corrosivity testing.
- Design-level assessment of slope stability for cut and fill slopes.
- Design recommendations for foundations.
- Design-level earthwork, improvement design, and construction recommendations.
- Development of corrective grading plans and cross-sections.

7.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

This report is issued with the understanding that it is the responsibility of the owner to transmit the information and recommendations of this report to developers, contractors, buyers, architects, engineers, and designers for the project so that the necessary steps can be taken by the contractors and subcontractors to carry out such recommendations in the field. The conclusions and recommendations contained in this report are solely professional opinions.

Our professional staff strives to perform its services in a proper and professional manner with reasonable care and competence but is not infallible. There are risks of earth movement and property damages inherent in land development. We are unable to eliminate all risks; therefore, we are unable to guarantee or warrant the results of our services.

This report is based upon field and other conditions discovered at the time of preparation of our documents of service. This document must not be subject to unauthorized reuse, that is, reuse without our written authorization. Such authorization is essential because it requires us to evaluate the document's applicability given new circumstances, not the least of which is passage of time. Actual field or other conditions will necessitate clarifications, adjustments, modifications or other changes to our documents. Therefore, we must be engaged to prepare the necessary clarifications, adjustments, modifications or other changes before construction activities commence or further activity proceeds. If our scope of services does not include on-site construction observation, or if other persons or entities are retained to provide such services, we cannot be held responsible for any or all claims, including, but not limited to claims arising from or resulting from the performance of such services by other persons or entities, and any or all claims arising from or resulting from clarifications, adjustments, modifications, discrepancies or other changes necessary to reflect changed field or other conditions.

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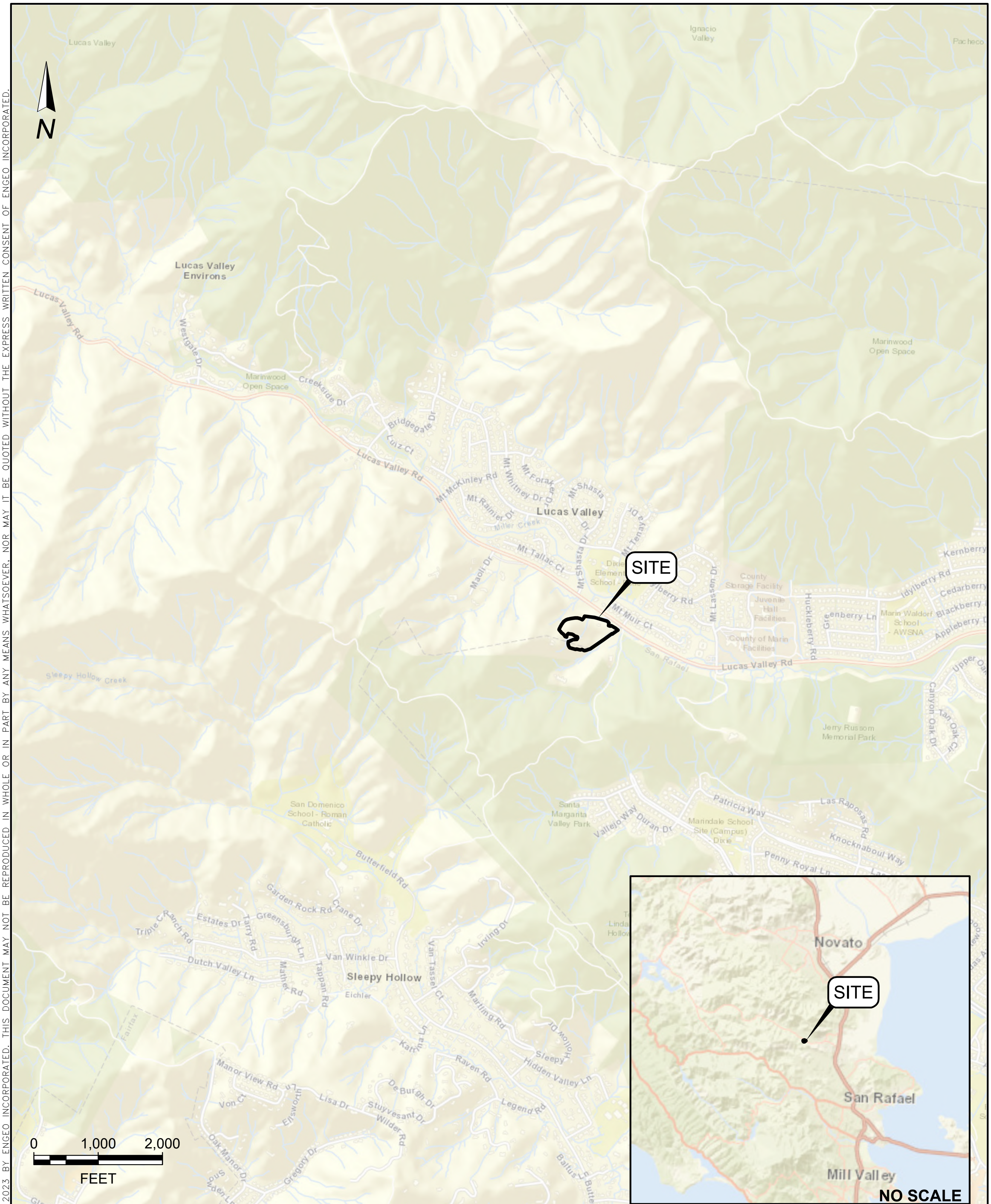
FIGURES



BASEMAP SOURCE: ESRI MAPPING SERVICE

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VICINITY MAP

1501 LUCAS VALLEY ROAD

SAN RAFAEL, CALIFORNIA

PROJECT NO. : 24211.000.001	FIGURE NO. 1
SCALE: AS SHOWN	
DRAWN BY: LL	CHECKED BY: BHB

PATH: G:\DRAFTING\PROJECTS_24000 TO 25999\24211\24211.000.001\GEOTECH\1501 LUCAS VALLEY ROAD GEX.APRX
LAYOUT: 01. VICINITY 8.5 X 11 PORTRAIT USER: LLEE

ORIGINAL FIGURE PRINTED IN COLOR

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BASE MAP SOURCE: CSW/Stuber-Stroeh Engineering Group, Inc.

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SITE PLAN
1501 LUCAS VALLEY ROAD
SAN RAFAEL, CALIFORNIA

PROJECT NO.: 24211.000.001
SCALE: AS SHOWN
DRAWN BY: MSF
CHECKED BY: RHB
FIGURE NO. 2

ORIGINAL FIGURE PRINTED IN COLOR

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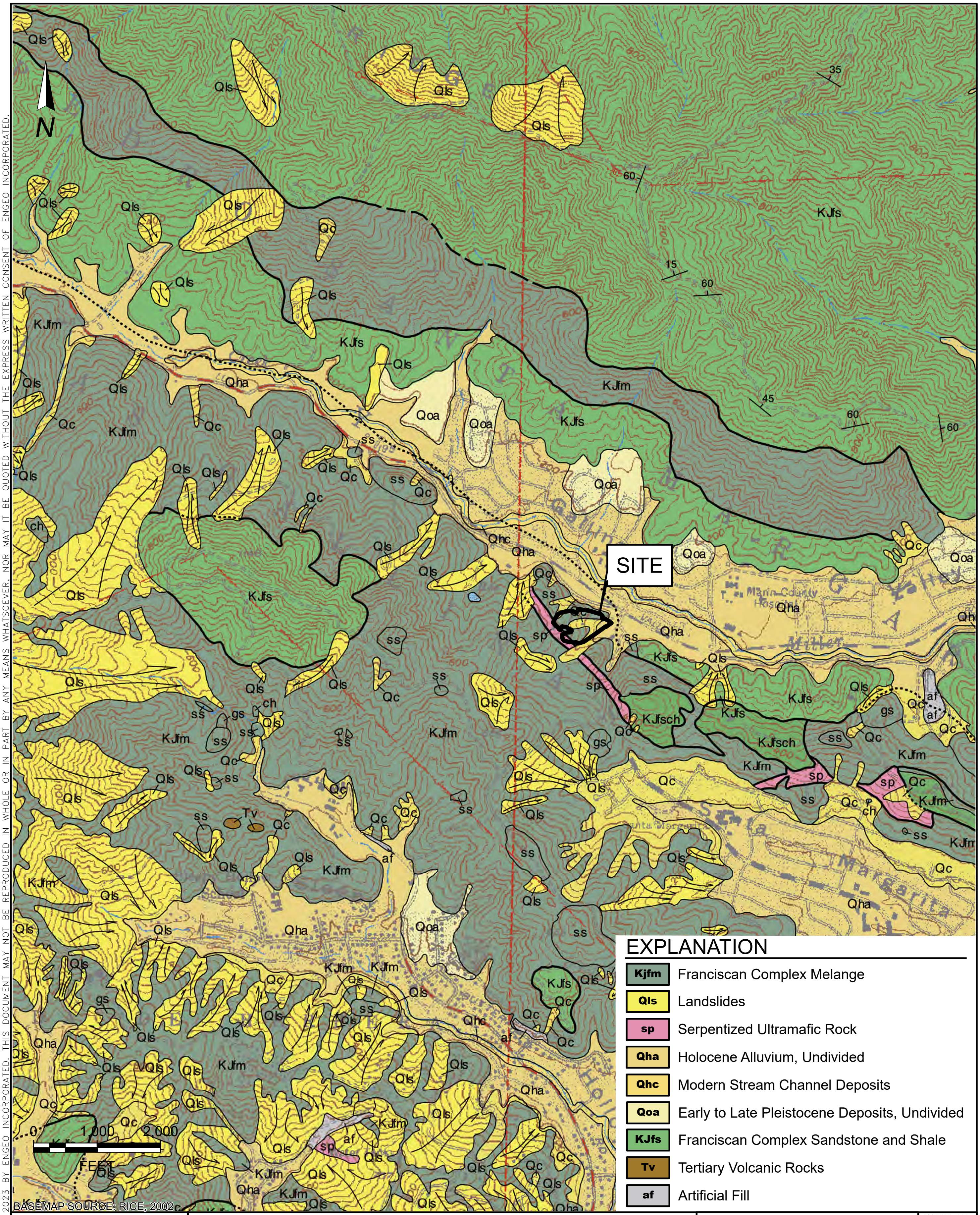

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REGIONAL GEOLOGIC MAP

1501 LUCAS VALLEY ROAD

SAN RAFAEL, CALIFORNIA

PROJECT NO.: 24211.000.001		FIGURE NO. 3
SCALE: AS SHOWN		
DRAWN BY: MMH	CHECKED BY: BHB	

PATH: G:\DRAFTING\PROJECTS_24000 TO 25999\24211\24211.000.001\GEOTECH\1501 LUCAS VALLEY ROAD GEX.APRX
LAYOUT: 03. GEOLOGIC 8.5 X 11 PORTRAIT USER: LLEE

ORIGINAL FIGURE PRINTED IN COLOR

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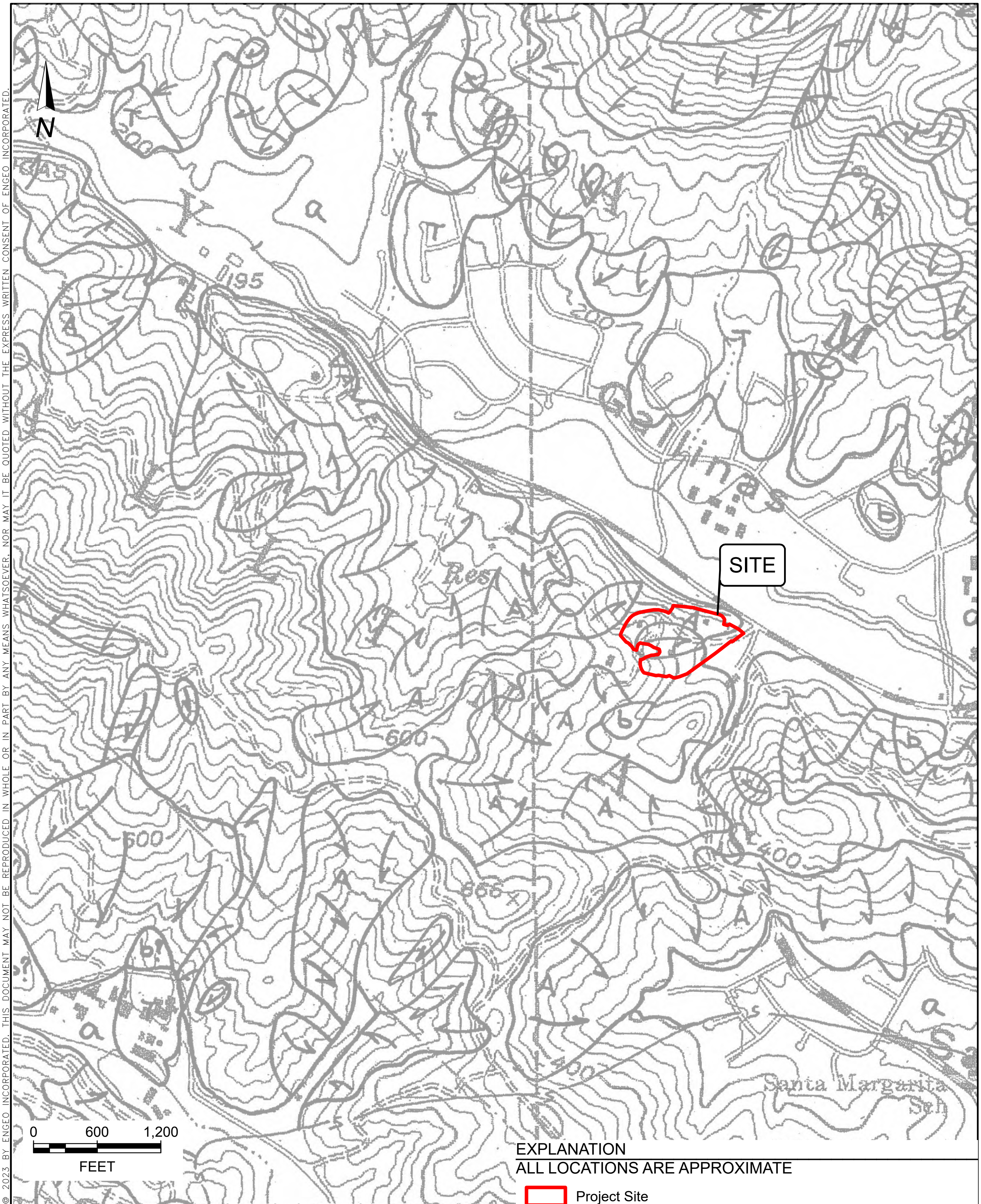

EXPLANATION

ALL LOCATIONS ARE APPROXIMATE

Project Site

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REGIONAL LANDSLIDE MAP

1501 LUCAS VALLEY ROAD

SAN RAFAEL, CALIFORNIA

PROJECT NO. : 24211.000.001	FIGURE NO. 4
SCALE: AS SHOWN	
DRAWN BY: LL	CHECKED BY: BHB

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LAYOUT: 05. LIQUEFACTION 8.5 X 11 PORTRAIT USER: LLEE

ORIGINAL FIGURE PRINTED IN COLOR

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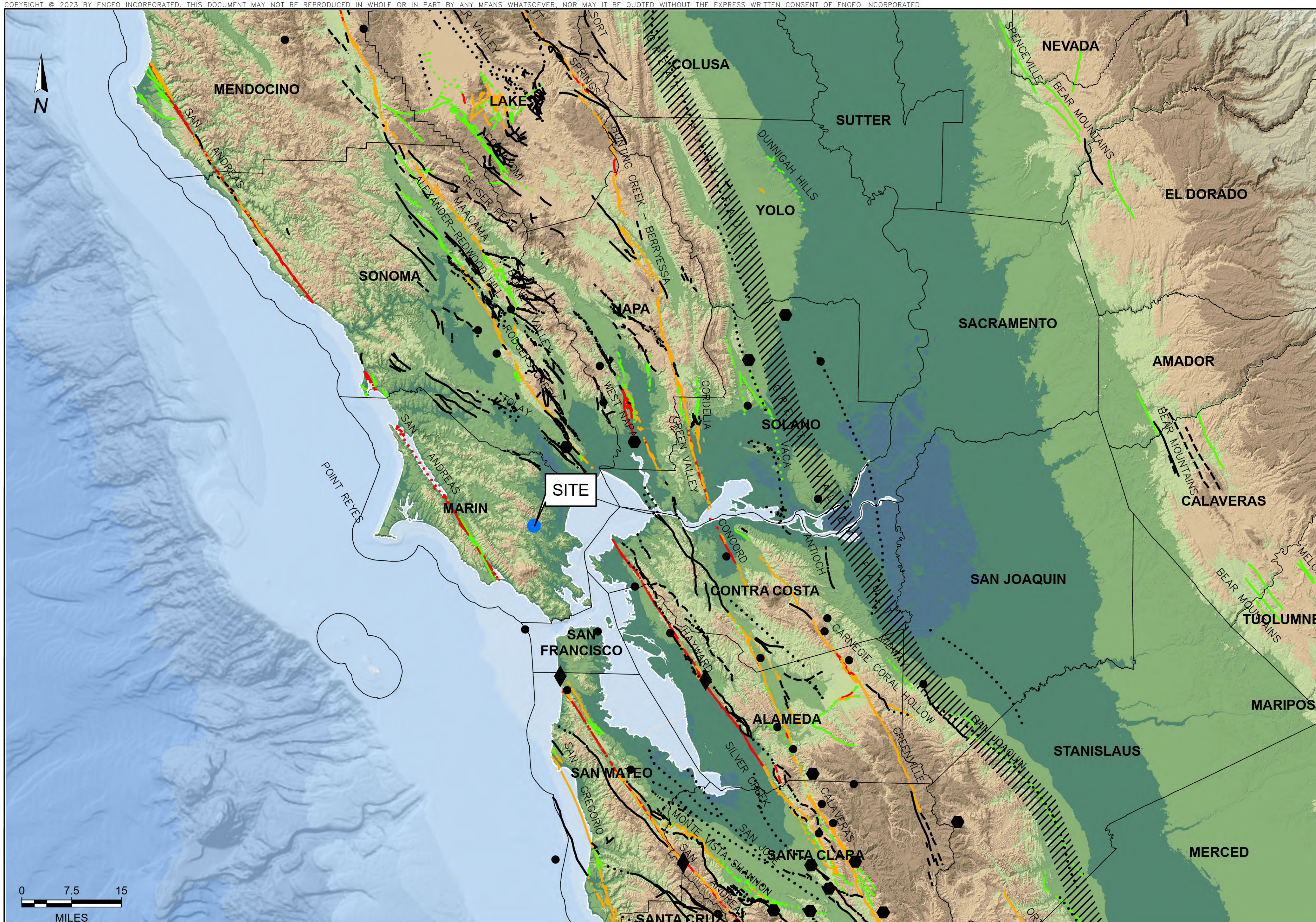

EXPLANATION

- Project Site

HISTORIC EARTHQUAKE EPICENTERS

- Magnitude 5-6
- Magnitude 6-7
- Magnitude 7+
- Historic Blind Thrust Fault Zone

QUATERNARY FAULTS 2020

Based on time of most recent surface deformation

- Historical (<150 Years), Well Constrained Location
- Historical (<150 Years), Moderately Constrained Location
- Historical (<150 Years), Inferred Location
- Latest Quaternary (<15,000 Years), Well Constrained Location
- Latest Quaternary (<15,000 Years), Moderately Constrained Location
- Latest Quaternary (<15,000 Years), Inferred Location
- Latest Quaternary (<15,000 Years), Inferred Location
- Late Quaternary (<130,000 Years), Moderately Constrained Location
- Late Quaternary (<130,000 Years), Inferred Location
- Middle And Late Quaternary (<750,000 Years), Well Constrained Location
- Middle And Late Quaternary (<750,000 Years), Moderately Constrained Location
- Middle And Late Quaternary (<750,000 Years), Inferred Location
- Undifferentiated Quaternary(<1.6 Million Years), Well Constrained Location
- Undifferentiated Quaternary(<1.6 Million Years), Moderately Constrained Location
- Undifferentiated Quaternary(<1.6 Million Years), Inferred Location
- Class B (Various Age), Well Constrained Location
- Class B (Various Age), Moderately Constrained Location
- Class B (Various Age), Inferred Location

BASE MAP SOURCE:
CSUMB, ESRI, GARMIN, NATURALVUE, ESRI, GEBCO, GARMIN, NATURALVUE
COLOR HILLSHADE IMAGE BASED ON THE NATIONAL ELEVATION DATA SET (NED) AT 30 METER RESOLUTION
U.S.G.S. QUATERNARY FAULT DATABASE, 2020
C.G.S. HISTORIC EARTHQUAKE DATABASE

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REGIONAL FAULTING AND SEISMICITY MAP 1501 LUCAS VALLEY ROAD SAN RAFAEL, CALIFORNIA	PROJECT NO.: 24211.000.001	FIGURE NO. 5
	SCALE: AS SHOWN	
	DRAWN BY: MMH	CHECKED BY: BHB

APPENDIX A

BORING LOGS

KEY TO BORING LOGS

MAJOR TYPES			DESCRIPTION
COARSE-GRAINED SOILS MORE THAN HALF OF MAT'L LARGER THAN #200 SIEVE	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS WITH LESS THAN 5% FINES	GW - Well graded gravels or gravel-sand mixtures
			GP - Poorly graded gravels or gravel-sand mixtures
		GRAVELS WITH OVER 12 % FINES	GM - Silty gravels, gravel-sand and silt mixtures
			GC - Clayey gravels, gravel-sand and clay mixtures
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS WITH LESS THAN 5% FINES	SW - Well graded sands, or gravelly sand mixtures
			SP - Poorly graded sands or gravelly sand mixtures
		SANDS WITH OVER 12 % FINES	SM - Silty sand, sand-silt mixtures
			SC - Clayey sand, sand-clay mixtures
FINE-GRAINED SOILS MORE THAN HALF OF MAT'L SMALLER THAN #200 SIEVE	SILTS AND CLAYS LIQUID LIMIT 50 % OR LESS		ML - Inorganic silt with low to medium plasticity
			CL - Inorganic clay with low to medium plasticity
			OL - Low plasticity organic silts and clays
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50 %		MH - Elastic silt with high plasticity
			CH - Fat clay with high plasticity
			OH - Highly plastic organic silts and clays
	HIGHLY ORGANIC SOILS		PT - Peat and other highly organic soils

For fine-grained soils with 15 to 29% retained on the #200 sieve, the words "with sand" or "with gravel" (whichever is predominant) are added to the group name.

For fine-grained soil with >30% retained on the #200 sieve, the words "sandy" or "gravelly" (whichever is predominant) are added to the group name.

GRAIN SIZES

U.S. STANDARD SERIES SIEVE SIZE: 200, 40, 10, 4 — CLEAR SQUARE SIEVE OPENINGS: 3/4", 3", 12"

SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		
	200–40	40–10	10–4	4–3/4"	3/4"–3"	3"–12"	>12"

RELATIVE DENSITY

SANDS AND GRAVELS	BLOWS/FOOT (S.P.T.)
VERY LOOSE	0-4
LOOSE	4-10
MEDIUM DENSE	10-30
DENSE	30-50
VERY DENSE	OVER 50

CONSISTENCY

SILTS AND CLAYS	STRENGTH*
VERY SOFT	0-1/4
SOFT	1/4-1/2
MEDIUM STIFF	1/2-1
STIFF	1-2
VERY STIFF	2-4
HARD	OVER 4

MOISTURE CONDITION

DRY	Dusty, dry to touch
MOIST	Damp but no visible water
WET	Visible freewater

SAMPLER SYMBOLS

- Modified California (3" O.D.) sampler
- California (2.5" O.D.) sampler
- S.P.T. - Split spoon sampler
- Shelby Tube
- Dames and Moore Piston
- Continuous Core
- Bag Samples
- Grab Samples
- NR No Recovery

LINE TYPES

- Solid - Layer Break
- Dashed - Gradational or approximate layer break

GROUNDWATER SYMBOLS

- ▽ Groundwater level during drilling
- ▼ Stabilized groundwater level

(S.P.T.) Number of blows of 140 lb. hammer falling 30" to drive a 2-inch O.D. (1-3/8 inch I.D.) sampler

* Unconfined compressive strength in tons/sq. ft., asterisk on log means determined by pocket penetrometer

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LOG OF BORING 1-B1

LATITUDE: 38.026365 LONGITUDE: -122.574903

Geotechnical Exploration
1501 Lucas Valley Road
San Rafael, CA
24211.000.001

DATE DRILLED: 11/3/2023
HOLE DEPTH: 17 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (WSG 84): Approx. 151 ft.

LOGGED / REVIEWED BY: M. Farrell / TTB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	DESCRIPTION	Blow Count/Foot	Atterberg Limits: Liquid Limit	Plastic Limit	Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
0	151	ORGANIC SOIL (OL), brown, dry, mulch and decomposing organics								
3	148	LEAN CLAY WITH SAND (CL), dark grayish brown, stiff, dry	23	42	20	22				
4.5	146.5	LEAN CLAY WITH SAND (CL), brown, very stiff, moist	15				66	15	96.7	4.5+*
		increasing plasticity	17				63	16.1		3.0*
10.5	140.5	LEAN CLAY WITH GRAVEL (CL), brown, very stiff, moist, angular fragments of weathered bedrock	16							2.0*
										4.0*
			50 for 4"							
13	138	GREYWACKE, gray to dark gray, strong (R4), highly weathered (WH)								
17	134	No Recovery	50 for 0"							

Bottom of boring at approximately 17 feet below ground surface.
Groundwater was not encountered at the time of drilling.

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LOG OF BORING 1-B2

LATITUDE: 38.026063 LONGITUDE: -122.575477

Geotechnical Exploration
1501 Lucas Valley Road
San Rafael, CA
24211.000.001

DATE DRILLED: 11/3/2023
HOLE DEPTH: 15.5 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (WSG 84): Approx. 164 ft.

LOGGED / REVIEWED BY: M. Farrell / TTB
DRILLING CONTRACTOR: Geo-Ex Subsurface
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	DESCRIPTION	Blow Count/Foot	Liquid Limit	Plastic Limit	Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Unconfined Strength (tsf) *field approx
0		ORGANIC SOIL (OL), brown to gray, medium stiff to soft, dry, mulch and woody debris with clays	11	42	22	20	58			
3.5	160	LEAN CLAY WITH SAND (CL), brown, very stiff, moist, rootlets						13.3	111	4.5*
5			15	39	19	20	57			4.5+*
	155		26					15.7		
10			31					11	106.5	
11		LEAN CLAY WITH GRAVEL (CL), brown, very stiff, moist, abundant angular bedrock fragments								4.5*
13	150	GREYWACKE, gray to dark gray, strong (R4), highly weathered (WH)								
15			50 for 6"							

Bottom of boring at approximately 15 1/2 feet below ground surface. Groundwater was not encountered at the time of drilling.

APPENDIX B

TEST PIT LOGS

ENGEO Expect Excellence	TEST PIT LOG	
Project Name: 1501 Lucas Valley Project Location: San Rafael Project number: 24211.000.001	Logged By: M. Farrell Logged Date: 11-1-2023 Equipment Used: Case 580 Backhoe	

Test Pit Number	Depth (Feet)	Description
1-TP1	0 – 2	Lean CLAY with sand (CL), light grayish brown, stiff, dry, low to moderate plasticity, 20-30% fine sands, grades to weathered bedrock
	2 – 5	GRAYWACKE, grayish brown, weak to moderate, thinly bedded, highly weathered and fractured BEDDING: 135/30S
1-TP2	0 – 2.5	Lean CLAY with sand (CL), light grayish brown, stiff, dry, low to moderate plasticity, 10-20% fine sands, some rootlets
	2.5 – 5	GRAYWACKE, strong, highly weathered and fractured, fine grained sand, MnO stained fracture surfaces

TEST PIT LOG

Project Name: 1501 Lucas Valley Project Location: San Rafael Project number: 24211.000.001		Logged By: M. Farrell Logged Date: 11/1/2023 Equipment Used: Case 580 Backhoe
Test Pit Number	Depth (Feet)	Description
1-TP3	0 – 6.5	Lean CLAY with gravel (CL), gray to brown, very stiff, dry to moist, some serpentinite clasts, occasional piece of brick [FILL]
	6.5 – 8	Lean CLAY with sand (CL) grayish brown, stiff, moist
	8 – 9	SANDSTONE, brown to brownish yellow, hard to strong, well jointed and fractured, moderately weathered, MnO stained fractures, dry, medium grained
1-TP4	0 – 0.5	Sandy lean CLAY (CL), stiff, dry
	0.5 – 4	SANDSTONE, brown to brownish yellow, hard to strong, well jointed and fractured, moderately weathered, MnO stained fractures, dry, medium grained BEDDING: 260/44N

TEST PIT LOG

Project Name: 1501 Lucas Valley Project Location: San Rafael Project number: 24211.000.001	Logged By: M. Farrell Logged Date: 11-1-2023 Equipment Used: Case 580 Backhoe

Test Pit Number	Depth (Feet)	Description
1-TP5	0 – 4.5	Lean CLAY with sand (CL), light grayish brown, stiff, dry, low to moderate plasticity, 10-20% fine sands, some rootlets
	4.5 – 5	SANDSTONE, brown to brownish yellow, weak to moderately strong, well jointed and fractured, moderately weathered, massive, MnO stained fractures, dry, medium grained
1-TP6	0 – 1	Organics including mulch
	1 - 2	Lean CLAY with organics (CL), gray, stiff to very stiff, dry to moist, some FeO stained pedogenic surfaces
	2 – 5	Lean CLAY with sand (CL), brown, very stiff, dry to moist, 20-30% fine grained sands, FeO stained pedogenic surfaces
	5 - 10	Sandy lean CLAY (CL), light grayish brown, very stiff to hard, moist, some rootlets, FeO stained pedogenic surfaces, some pebble sized angular rock fragments (graywacke) @ 9-feet increase in rock fragments

TEST PIT LOG

Project Name: 1501 Lucas Valley Project Location: San Rafael Project number: 24211.000.001	Logged By: M. Farrell Logged Date: 11-1-2023 Equipment Used: Case 580 Backhoe

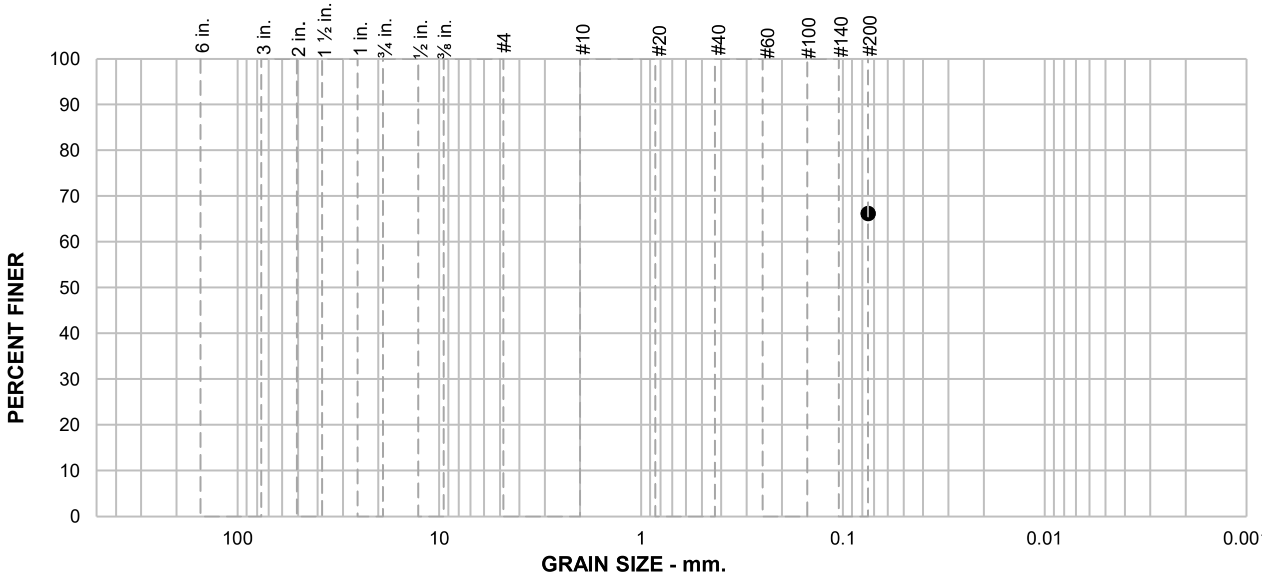
Test Pit Number	Depth (Feet)	Description
1-TP7	0 - 1	Gravels (GC), gray to reddish brown and green, loose piles of rock appear to have been spread and lightly compacted, 30% fines [FILL]
	1 – 6	Lean CLAY (CL), dark grayish brown, very stiff, dry to moist, occasional Franciscan clasts, uniform, non- stratified [FILL]
	6 – 7	Lean CLAY (CL), brown, stiff, dry to moist, FeO stained pedogenic surfaces, rootlets present
1-TP8	0 – 4	Lean CLAY with gravel (CL), gray to brown, very stiff, dry to moist, some serpentinite clasts, occasional piece of brick [FILL]
	4 – 5	SANDSTONE, brown to brownish yellow, weak to moderately strong, well jointed and fractured, moderately weathered, massive, MnO stained fractures, dry, medium grained

APPENDIX C

LABORATORY TESTING

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D1140, Method B



SAMPLE ID: 1-B1@5.5-6

DEPTH (ft): 5.5-6

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
						66	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	66		

SOIL DESCRIPTION

Sandy CLAY (per boring logs)

ATTERBERG LIMITS

PL = LL = PI =

COEFFICIENTS

D_{90} = D_{85} = D_{60} =
D_{50} = D_{30} = D_{15} =
D_{10} = C_u = C_c =

CLASSIFICATION

USCS =

REMARKS

Soak time = 360 min
Dry sample weight = 218.2 g
Largest particle size ≥ No. 4 Sieve

* (no specification provided)

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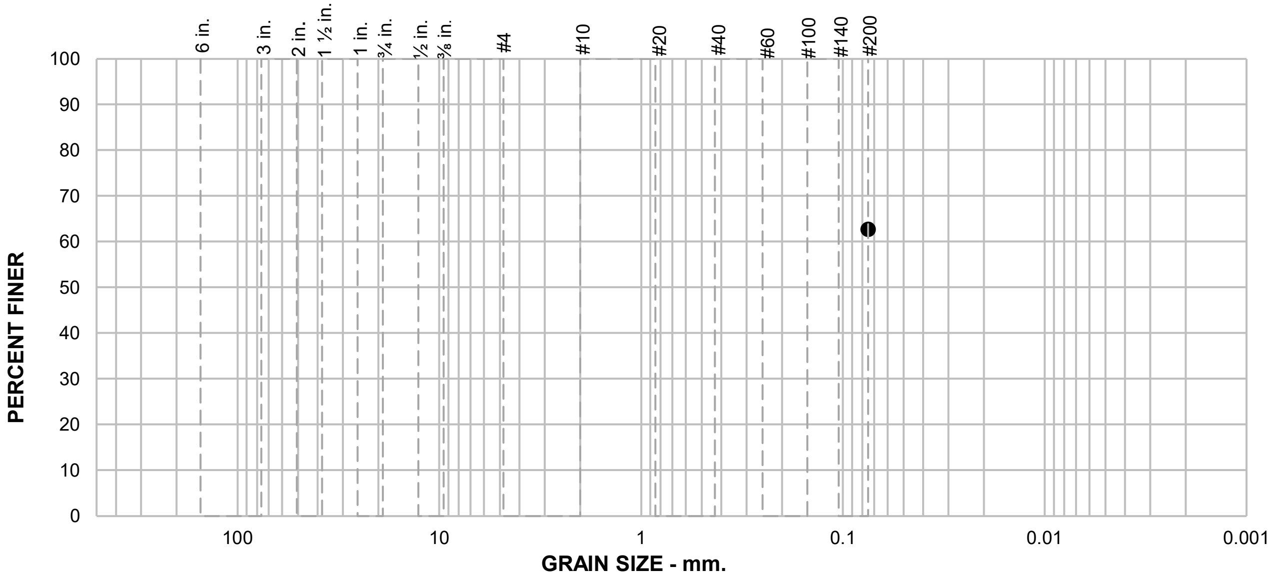
CLIENT: Lucas Valley Road, LLC
PROJECT NAME: 1501 Lucas Valley Road
PROJECT NO: 24211.000.001 PH001
PROJECT LOCATION: San Rafael, CA
REPORT DATE: 12/4/2023
TESTED BY: G. Criste
REVIEWED BY: D. Seibold

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D1140, Method B



SAMPLE ID: 1-B1@8.5-9

DEPTH (ft): 8.5-9

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
						63	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	63		

SOIL DESCRIPTION

Sandy CLAY (per boring logs)

ATTERBERG LIMITS

PL = LL = PI =

COEFFICIENTS

D_{90} =	D_{85} =	D_{60} =
D_{50} =	D_{30} =	D_{15} =
D_{10} =	C_u =	C_c =

CLASSIFICATION

USCS =

REMARKS

Soak time = 360 min
Dry sample weight = 166.2 g
Largest particle size ≥ No. 4 Sieve

* (no specification provided)

CLIENT: Lucas Valley Road, LLC

PROJECT NAME: 1501 Lucas Valley Road

PROJECT NO: 24211.000.001 PH001

PROJECT LOCATION: San Rafael, CA

REPORT DATE: 12/4/2023

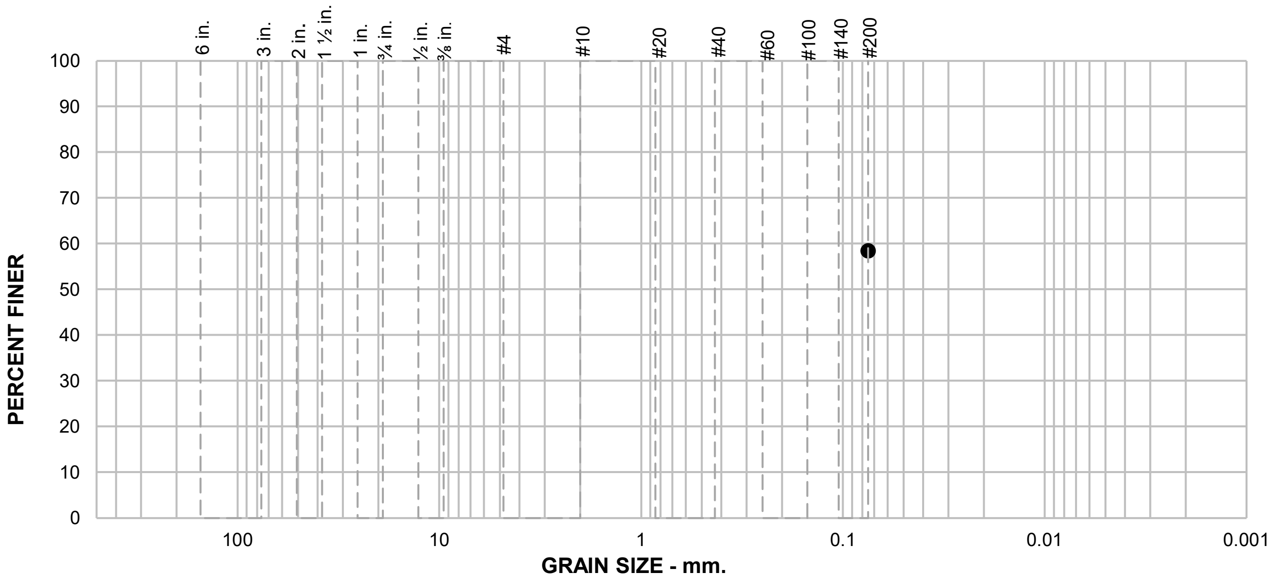
TESTED BY: G. Criste

REVIEWED BY: D. Seibold

ENGEO Expect Excellence

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D1140, Method B



SAMPLE ID: 1-B2@3-3.5

DEPTH (ft): 3-3.5

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
						58	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	58		

SOIL DESCRIPTION

Sandy lean CLAY (per boring logs)

ATTERBERG LIMITS

PL = 22	LL = 42	PI = 20

COEFFICIENTS

D_{90} =	D_{85} =	D_{60} =
D_{50} =	D_{30} =	D_{15} =
D_{10} =	C_u =	C_c =

CLASSIFICATION

USCS = CL

REMARKS

PI: ASTM D4318, Wet Method
USCS: ASTM D2487

Soak time = 360 min
Dry sample weight = 222.3 g
Largest particle size ≥ No. 4 Sieve

* (no specification provided)

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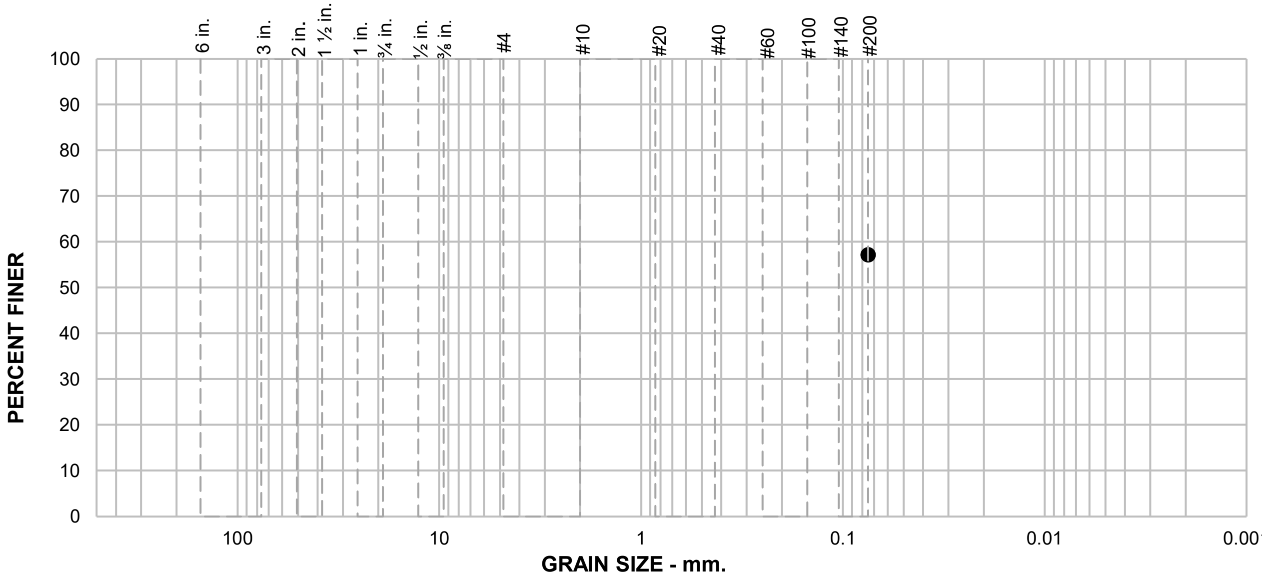
Expect Excellence

CLIENT: Lucas Valley Road, LLC
PROJECT NAME: 1501 Lucas Valley Road
PROJECT NO: 24211.000.001 PH001
PROJECT LOCATION: San Rafael, CA
REPORT DATE: 12/4/2023
TESTED BY: G. Criste
REVIEWED BY: D. Seibold

PARTICLE SIZE DISTRIBUTION REPORT
ASTM D1140, Method B



SAMPLE ID: 1-B2@5.5-6

DEPTH (ft): 5.5-6

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
						57	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	57		

SOIL DESCRIPTION

Sandy CLAY (per boring logs)

ATTERBERG LIMITS

PL =	LL =	PI =

COEFFICIENTS

D_{90} =	D_{85} =	D_{60} =
D_{50} =	D_{30} =	D_{15} =
D_{10} =	C_u =	C_c =

CLASSIFICATION

USCS =

REMARKS

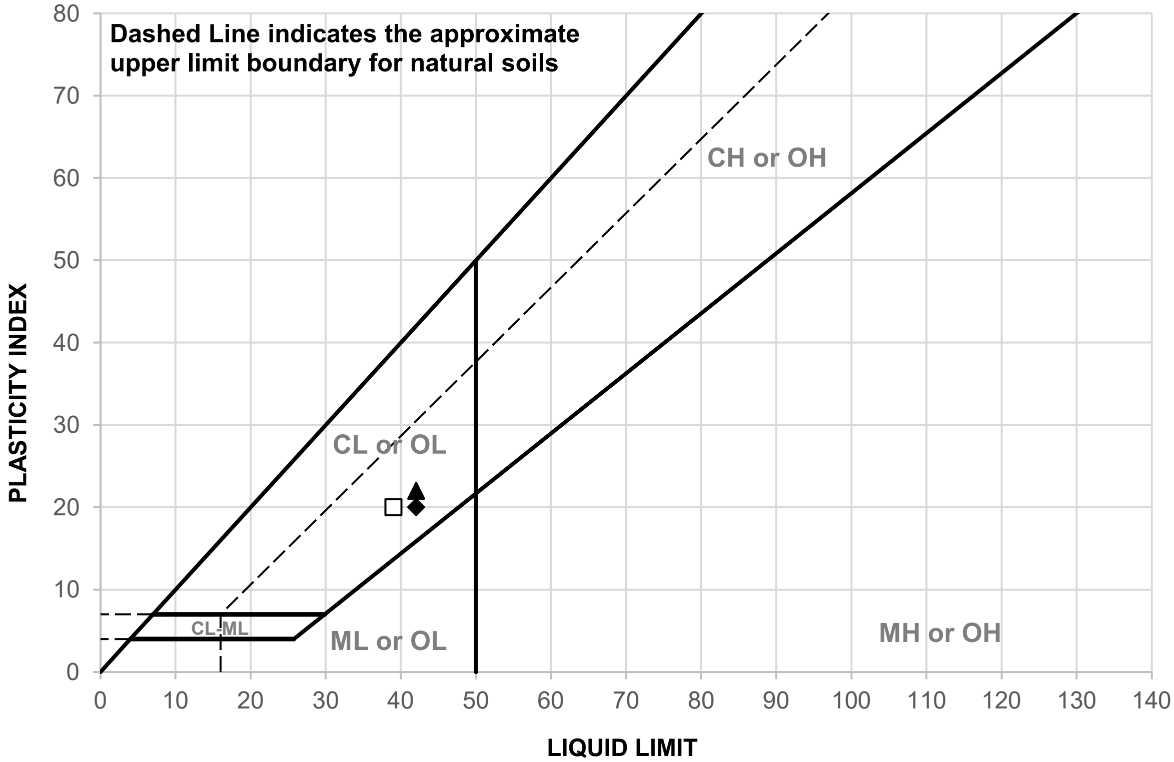
Soak time = 360 min
Dry sample weight = 205.8 g
Largest particle size ≥ No. 4 Sieve

* (no specification provided)

ENGEO
Expect Excellence

CLIENT: Lucas Valley Road, LLC
PROJECT NAME: 1501 Lucas Valley Road
PROJECT NO: 24211.000.001 PH001
PROJECT LOCATION: San Rafael, CA
REPORT DATE: 12/4/2023
TESTED BY: G. Criste
REVIEWED BY: D. Seibold

LIQUID AND PLASTIC LIMITS TEST REPORT
ASTM D4318



	SAMPLE ID	DEPTH (ft)	MATERIAL DESCRIPTION	LL	PL	PI
▲	1-B1@3.5-4	3.5-4	Sandy CLAY (per boring logs)	42	20	22
◆	1-B2@3-3.5	3-3.5	Sandy CLAY (per boring logs)	42	22	20
□	1-B2@6-6.5	6-6.5	Sandy CLAY (per boring logs)	39	19	20

	SAMPLE ID	TEST METHOD	REMARKS
▲	1-B1@3.5-4	PI: ASTM D4318, Wet Method	
◆	1-B2@3-3.5	PI: ASTM D4318, Wet Method	
□	1-B2@6-6.5	PI: ASTM D4318, Wet Method	

ENGEO
Expect Excellence

CLIENT: Lucas Valley Road, LLC
PROJECT NAME: 1501 Luca Valley Road, LLC
PROJECT NO: 24211.000.001 PH001
PROJECT LOCATION: San Rafael, CA
REPORT DATE: 12/4/2023
TESTED BY: K. Nguyen
REVIEWED BY: G. Criste

MOISTURE CONTENT REPORT
ASTM D2216

SAMPLE ID	1-B1@8-8.5	1-B2@8.5-9						
DEPTH (ft.)	8-8.5	8.5-9						
METHOD A OR B	B	B						
MOISTURE CONTENT (%)	16.1	15.7						

ENGEO
Expect Excellence

CLIENT: Lucas Valley Road, LLC
PROJECT NAME: 1501 Lucas Valley Road
PROJECT NO: 24211.000.001 PH001
PROJECT LOCATION: San Rafael, CA
REPORT DATE: 11/30/2023
TESTED BY: G. Criste
REVIEWED BY: D. Seibold

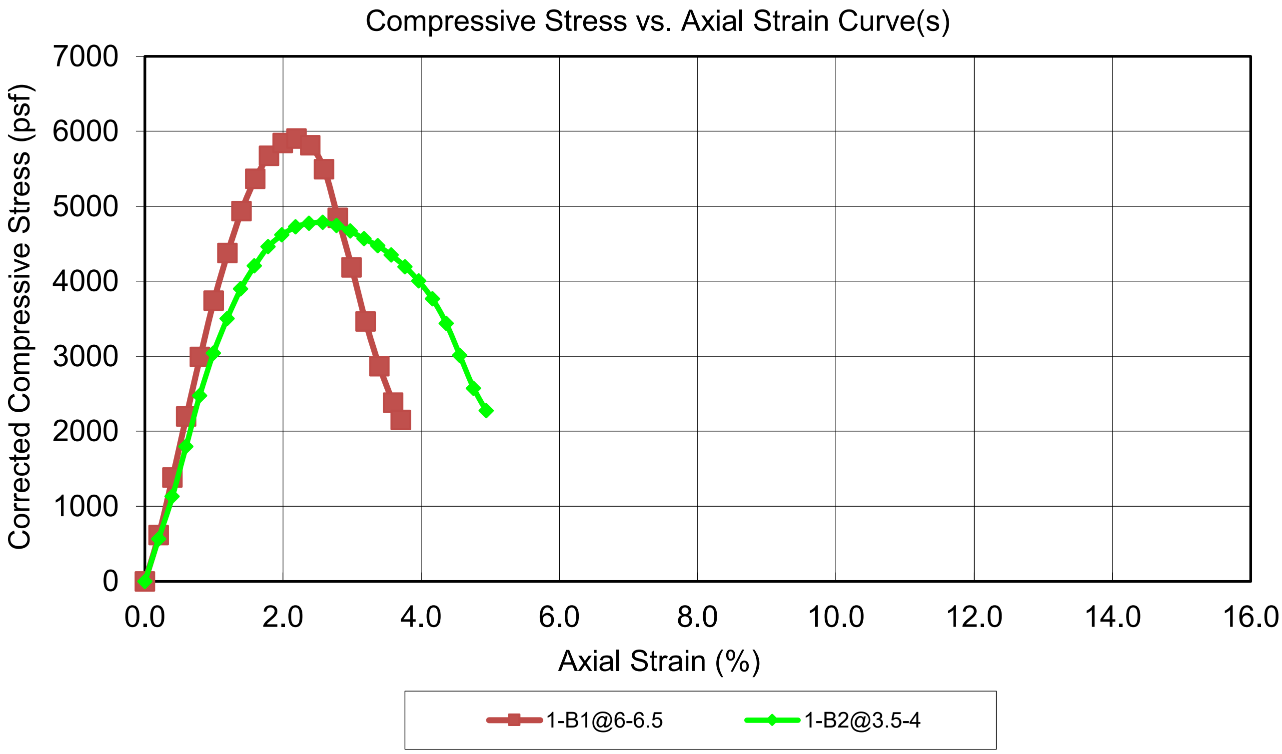
MOISTURE-DENSITY DETERMINATION REPORT
ASTM D7263

SAMPLE ID	1-B2@ 10.5-11							
DEPTH (ft.)	10.5-11							
METHOD A OR B	B							
MOISTURE CONTENT (%)	11.0							
DRY DENSITY (pcf)	106.5							

ENGEO
Expect Excellence

CLIENT: Lucas Valley Road, LLC
PROJECT NAME: 1501 Lucas Valley Road
PROJECT NO: 24211.000.001 PH001
PROJECT LOCATION: San Rafael, CA
REPORT DATE: 11/30/2023
TESTED BY: G. Criste
REVIEWED BY: D. Seibold

UNCONFINED COMPRESSION TEST REPORT
(ASTM D2166)



BEFORE TEST	SPECIMEN 1-B1@6-6.5	SPECIMEN 1-B2@3.5-4
Test Moisture Content (%)	14.97	13.29
Dry Density (pcf)	96.7	111.0
Saturation (%)	53.9	68.2
Void Ratio	0.76	0.53
Diameter (in)	2.379	2.395
Height (in)	5.012	5.047
Height-To-Diameter Ratio	2.11	2.11
TEST DATA		
Unconfined Compressive Strength (psf)	5904.63	4786.67
Undrained Shear Strength (psf)	2952.32	2393.34
Strain Rate (in/min)	0.050	0.050
Specific Gravity (ASSUMED)	2.720	2.720
Strain at Failure(%)	2.19	2.58
Test Remarks		

SPECIMEN	DESCRIPTION
1	Sandy lean CLAY (CL) per boring logs
2	Sandy lean CLAY (CL) per boring logs

PROJECT NAME: 1501 Lucas Valley Road
PROJECT NO: 24211.000.001 PH001
CLIENT: Lucas Valley Road, LLC
LOCATION: San Rafael, CA

Test Date: 11/28/2023
Tested By: G. Criste
Reviewed By: D. Seibold

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