Project No.
11403.001.000

October 10, 2017

Mr. Steven Ross
LSA Associates, Inc.
1 Park Plaza, Suite 100
Irvine, CA 92614

Subject: EBRPD Ridge Trail - Fremont
Fremont, California

GEOLOGIC CONSTRAINTS REPORT

Dear Mr. Ross:

We are pleased to submit this document that summarizes the geologic constraints for the proposed EBRPD Ridge Trail, located in Fremont, California.

The proposed trail alignment will be located between Vallejo Mill Park, 299 Niles Canyon Road in Fremont, and Garin Regional Park in Fremont, Alameda County, California. Access to the proposed trail from the north would be via an existing Emergency Vehicle and Maintenance Access (EVMA) road that extends from Garin Regional Park south toward Mission Boulevard.

The majority of the proposed trail development area has primarily remained undeveloped. The southern end of the trail, located within Vallejo Mill Park, has historically included undeveloped roads, open space, and small structures. Railroad tracks (formerly the Southern Pacific Railroad) that has operated since at least 1906 intersect a portion of the southern end of the trail, adjacent to Vallejo Mill Park.

BACKGROUND

The proposed project consists of a segment of the Bay Area Ridge Trail, a planned 550-mile multi-use trail along the ridgelines surrounding the San Francisco Bay. When complete, the trail will connect over 75 parks and open spaces and provide access for hikers, runners, mountain bicyclist and equestrians. The proposed project would provide a connection between existing segments of the Bay Area Ridge Trail in Garin Regional Park and the Vargas Plateau.

The proposed project is located near the entrance to Niles Canyon in the City of Fremont, Alameda County, California. The project area, which encompasses approximately 50 feet on either side of the proposed trail alignment, is located within Assessor's Parcel Numbers 85-5275-33-0, 85-5275-36-0, 85-5275-37-0, and 85-5275-42-0, and 85-5400-1-1 in Union City and 507-70-1-4, 507-70-1-10, 507-70-1-11, 507-70-1-12, 507-70-10-0, and 507-70-11-0; 507-150-5-1 and 507-480-14-2 along the Niles Canyon Railway, and 507-480-10-1 in the Vallejo Mill Historical Park.

GEOLOGY AND SEISMICITY

Regional Geology

The site is located within the Coast Ranges physiographic province of California. The Coast Ranges physiographic province is typified by a system of northwest-trending, fault-bounded mountain ranges and intervening alluvial valleys. More specifically, the site is located in the East Bay Hills on the slopes located above the northwestern portion of Niles Canyon. Niles Canyon is located along a stretch of Alameda Creek that has eroded a meandering canyon through the hills.

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-order faults.

Site Geology

The proposed trail traverses the northwest trending geologic structure of the area which includes geologic units that range from the Mid Miocene Tice Shale to the Late Cretaceous Oakland Conglomerate (Graymer et al 1994 and 1996). The geologic structure in the area is characterized by several northwest trending Quaternary age and older faults. These faults include the Dresser fault, The Chabot fault and other lesser order unnamed northwest trending faults (Graymer, 1994). In general, bedding along the southern alignment of the trail strikes northwest and dips from 50 to 80 degrees towards the northeast. Bedding along the northern trail alignment located north of the Chabot fault generally strikes northwest and dips from 30 to 70 degrees towards the southwest. Helley and Graymer (1997) map Holocene alluvial deposits along Alameda Creek. A geologic map of the study area is provided in the attached figures. A brief description of the geologic units exposed along the trail alignment is provided below.

Artificial Fill (Qaf)

Artificial fill is present along portions of the existing roadway and railway corridors. Artificial fill generally comprises man-made deposit of various materials and ages. In some instances the artificial fill is compacted and quite firm. Fill placed before 1965 is typically not compacted and consists simply of dumped materials (Helley and Graymer, 1997).

Landslides (Qls)

Previous landslide mapping by the California Geological Survey (2011 and 2014), and Geomatrix (2003) shows a number of landslides present on canyon slopes above Alameda Creek. The various mapped landslides include deep-seated bedrock landslides, debris flows, rock falls and shallow surficial earth flows.

1. Bedrock Landslides: A number of deep-seated bedrock landslides have been identified in the area (Figure 1). A “bedrock” landslide is a slope failure whose basal slip surface extends into the underlying bedrock. The geometry of the slip surface can be curved, as in a rotational slump, or planar, as in a translational landslide. In both cases, relatively intact and

undisturbed blocks of rock can be entrained within the transported landslide mass. These large deep-seated landslides do not show evidence of recent landslide activity and are likely activated by scour and down cutting along the creek or during earthquake related ground shaking.

2. Debris Flows: Debris flows are a type of landslide that can form during peak rainfall events when colluvium becomes saturated and fails, forming a fluid, mobile soil mass. Typically the formation and mobilization of debris flows is most likely on slopes that are inclined at 2:1 (horizontal:vertical) or steeper, and where the colluvium has a relatively low clay content. Under these conditions, debris flows have been known to travel relatively great distances from the source, sometimes entraining trees and boulders in their path.

3. Rock Fall: A rockfall is a fragment or small volume of rock detached by sliding, toppling, or falling, that falls along a steep slope or vertical cliff. The movement down slope is characterized by bouncing and flying along ballistic trajectories or by rolling on talus or debris slopes.

4. Earthflows: Earthflows are a type of landslide that is characterized by mobilization as a viscous, slow-moving mass. Earthflows commonly move by a combination of semi-fluid flow and sliding along weak clay slip planes. They commonly grade into rotational slumps or translation landslides (discussed above). Earthflows typically form when cohesive, clayey soils or weak bedrock become saturated and fail. Like debris flows, they commonly mobilize as a result of intense rain, but due to their high clay content they tend to move relatively slowly, and movements usually persist for some time following peak rainfall. Earthflows often accumulate as lobate masses of soil with complex internal shearing. A number of earth flows have been mapped in the area (Figure 1). In general, these features occupy drainage swales on the steep sided flanks of the ridges at the site.

Holocene Alluvial Fan and Fluvial Deposits (Qhaf)

These deposits are Holocene in age and occupy the narrow valley floor adjacent the active stream channel. These deposits are generally medium dense to dense and comprise gravely sand or sandy gravel that generally grades upward, to sandy or silty clay. According to the State of California Seismic Hazard Zone Map (CGS, 2004) covering the area, these deposits are susceptible to liquefaction and subject to permanent ground displacement during seismic ground shaking.

Middle Miocene Tice Shale (Tt)

Distinctly bedded, dark brown, gray and tan, marine mudstone, claystone and siliceous shale with numerous massive lenses of orange weathering dolomite. This bedrock unit outcrops near the southwest portion of the trail alignment.

Middle Miocene Claremont Formation (Tcs)

Thin bedded gray chert with very thin dark brown to gray siliceous shale interbeds. This bedrock unit outcrops as a fault bound panel of rock along the middle section of the trail. A large mapped deep-seated bedrock landslide obscures this geologic unit along the portion of the trail underlain by this unit.

Early Miocene Unnamed Shale, Sandstone, Chert and Dolomite (Tsh)

Massive orange weathering, medium-grained, quartz sandstone. Laminated gray chert interbedded with dolomite. Dark gray concretionary siltstone, mudstone and conglomerate. This bedrock unit outcrops along the southwest portion of the trail alignment.

Paleocene Unnamed Siltstone and Glauconite Sandstone (Tps)

Dark gray, siltstone, claystone and shale, indistinctly to distinctly bedded. Grades downward to coarse-grained, green, glauconite-rich, lithic sandstone. This bedrock unit outcrops at the base of the Cretaceous along the central portion of the trail alignment.

Late Cretaceous Oakland Sandstone (Ko)

Biotite and quartz rich, massive, medium- to coarse-grained wacke with interbedded lenses of pebble to cobble conglomerate. Large amount of clasts comprise silicic volcanic. This unit outcrops along the northernmost portion of the trail alignment.

Cretaceous Unnamed Sandstone and Shale (Ks)

Mica bearing, cross bedded, coarse- to fine-grained granitic sandstone, siltstone and shale. Biotite and quartz rich, massive, medium- to coarse-grained wacke with interbedded lenses of pebble to cobble conglomerate. Large amount of clasts comprise silicic volcanic. This is the most pervasive geologic unit exposed along the proposed trail alignment. This geologic unit outcrops along the central portion of the proposed trail alignment.

Several large landslide complexes occur in this geologic unit along the proposed trail alignment (Figure 1). Landslides within this unit vary from shallow earthflows to deep-seated bedrock landslides. Many of the larger mapped landslides are not considered historically active however many of them appear to be relatively young and susceptible to seismic induced landslide movement and capable of shedding smaller earth and debris flows especially where exposed in steep cuts along the alignment. Existing steep slopes along the trail alignment in this geologic unit should be considered highly susceptible to shallow landslides and debris flows.

Faulting and Seismicity

An active fault is defined by the California Geological Survey as one that has had surface displacement within the last 11,000 years (SP42 CGS, 2007). 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 7) earthquakes have been recorded and can be expected to occur in the future.

The proposed trail alignment does not pass through a State of California Earthquake Fault Zone. The proposed trail alignment however, does cross the Chabot fault. According to Jennings (2010), the Chabot fault shows evidence of Late Pleistocene activity; due to the age of the last measurable displacement, this fault is not considered active.

DISCUSSION

The primary hazards and the risks associated with these hazards with respect to the planned trail are discussed in the following sections of this report.

Existing Landslides and Slope Stability

As discussed, the proposed trail alignment traverses numerous mapped landslides. The presence of these landslides can result in unstable ground conditions at locations of planned cut and fill.

Existing Fill

As discussed, existing artificial fill is present at some locations along the proposed trail alignment. The existing artificial fill is typically located along the downslope edge of existing dirt ranch roads and within drainages at ranch road crossings.

We do not have documentation of fill placement. Without documentation regarding the manner of placement, type of material used, and degree of compaction, the existing fill should be considered non-engineered. Non-engineered fill can undergo consolidation that results in surface settlement under new surface loading that is difficult to predict.

Expansive Soil

Near-surface soil exposed at the site shows evidence of shrinkage cracking indicating that it likely has a moderate to high expansion potential. Expansive soil shrinks and swells as a result of moisture changes. This can cause heaving and cracking of slabs-on-grade, pavements, and structures founded on shallow foundations.

Successful construction on expansive soil requires special attention during grading. It is imperative to keep exposed soil moist by occasional sprinkling. If the soil dries, it is extremely difficult to remoisturize the soil (because of the clayey nature) without excavation, moisture conditioning, and recompaction.

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, ground lurching, and liquefaction. The following sections present a discussion of these hazards as they apply to the site.

Ground Rupture

The site is not located within a State of California Earthquake Fault Zone and no known active faults cross the site. The risk of surface fault rupture at the site is considered low.

Ground Shaking

An earthquake of moderate to high magnitude generated within the San Francisco Bay Region could cause considerable ground shaking at the site, similar to that which has occurred in the past. To mitigate the shaking effects, all structures should be designed using sound engineering judgment and the latest code requirements

Liquefaction

Liquefaction is a phenomenon in which saturated, loose or medium dense, cohesionless soil is subject to a temporary, but essentially total, loss of shear strength because of pore pressure build-up under the reversing cyclic shear stresses associated with earthquakes. As described in previously in the Site Geology section, the Holocene alluvial deposits located along the current drainage course are mapped as highly susceptible to liquefaction and should be considered subject to permanent ground displacement during seismic ground shaking.

Earthquake-Induced Landsliding

As described previously, deep-seated landslides have been mapped at several locations along the canyon slopes. According to the State of California Seismic Hazard Zone Map (CGS, 2004), the slopes along much of the trail alignment are mapped within an area that has a potential for permanent ground displacement as a result of landslides triggered by ground shaking.

CONCLUSIONS AND RECOMMENDATIONS

From a geologic and geotechnical standpoint, the study area is generally suitable for the proposed trail project. The preliminary recommendations in this report should be considered in the initial planning for the trail. Design-level exploration will be required to develop recommendations for proposed culvert repairs, ford crossings and bridge foundations.

Landslides and Slope Stability

Evidence of past landslide activity was observed within the proposed trail alignment. The adjacent cut and fill slopes along portions of the trail alignment that follow the existing ranch road are relatively steep and have experienced local sloughing and minor landslides. It should be noted that portions of the trail cross previously mapped deep-seated landslides. It is not feasible to repair and mitigate the large, deep-seated landslides for the proposed trail. The large deep-seated landslides do not show evidence of recent activity and likely mobilize during earthquakes or periods of scour and down cutting at the toes of the landslide along the creek. Care should be exercised when designing new cut and fill in areas of existing landslides to reduce the risk of mobilizing the slide. Likewise, where planned walls are planned coincident with a mapped landslide, the presence of the landslide should be considered in designing the retaining wall. We should review project grading plans when they become available to confirm that slope stability is adequately addressed in the design-level report.

Existing Fill

The existing fill depicted on the attached figures was placed for the existing ranch road. Existing fill placed along the downslope edge of the existing ranch road may be subject to downslope creep and localized sloughing. For the proposed trail the fill along the downslope portion of the existing ranch road may be left in place; however some maintenance along the downslope portion of the trail should be anticipated. Long-term, the fill at the edge of the road may be more susceptible to creep and erosion due to the non-engineered nature of its placement.

Existing fill was also mapped in areas of existing culvert crossings. At these locations fill was placed within existing drainages with buried pipes to convey runoff below the ranch road. It is our understanding that the existing culverts will either be replaced and upgraded or removed and replaced by ford crossings comprising articulated concrete blocks. At these locations we recommend that existing fill be removed down to competent soil or bedrock and replaced with engineered fill at the location of the proposed culvert repair or ford crossing.

Selection of Materials

With the exception of construction debris (wood, brick, asphalt, concrete, metal, etc.), organically contaminated materials (soil which contains more than 2 percent organic content by weight), and environmentally impacted soils (if any), we anticipate the site soil is suitable for use as engineered fill provided that any larger fragments derived from bedrock cuts are broken down to 6 inches or less in size.

Graded Slopes

For planning purposes, we recommend that graded slopes less than 20-feet-high should be planned at gradients no steeper than 2:1. Although not anticipated for this project slopes higher than 20 feet should be planned at gradients that are no steeper than 3:1 (horizontal:vertical).

Low-Water Ford Crossings

We understand that articulated concrete low-water ford crossings are planned where the trail will cross existing or daylighted creeks. Where these are used, they should be founded on firm subgrade and installed per manufacturer's recommendations. As a preliminary recommendation, we recommend that any loose creek sediment or soft existing fill be removed or compacted to form a firm subgrade, a filter fabric should be placed on subgrade within the area to receive the articulated concrete mat and the mat placed on top of the subgrade. If traffic loading is required, the crossing should include a layer of draining aggregate base between the filter fabric and the articulated concrete. The gradation of the aggregate base should be consistent with the opening sizes in the articulated concrete and the thickness will be dependent on the subgrade soil and traffic loading. Geogrid can be placed within the aggregate base section to reduce the total thickness of aggregate and earthwork in the creek.

Bridge Design

It is our understanding that one of the drainage crossings may require construction of a pedestrian bridge crossing. Depending on the location of the proposed crossing, the bridge abutments can be supported on either shallow foundations (spread footings) founded within bedrock or deeper foundations such as cast-in-drilled-hole (CIDH) piles. The type and depth of foundations should be determined based on subsurface borings or test pits once the precise location of the crossing is determined.

Design-Level Geotechnical Exploration

The final design of trail improvements should be based on a subsurface exploration that may include a combination of borings and exploratory test pits to identify the depth of bedrock or suitable foundation soil, as well as laboratory testing to measure the engineering characteristics of soil and bedrock. We can prepare a fee estimate and scope for a design-level exploration when more detailed project plans are prepared.

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 preliminary report to owners, 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 preliminary report are solely professional opinions

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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 or provide insurance; therefore, we are unable to guarantee or warrant the results of our services.

This preliminary report is based upon field and other conditions discovered at the time of preparation of our preliminary report. This document must not be subject to unauthorized reuse that is, reusing 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-study area construction observation, or if other persons or entities are retained to provide such services, we cannot be held responsible for any or all claims arising from or resulting from the performance of such services by other persons or entities, and from any or all claims arising from or resulting from clarifications, adjustments, modifications, discrepancies or other changes necessary to reflect changed field or other conditions.

If you have any questions regarding the contents of this report, we will gladly discuss with you.

Sincerely,

ENGEO Incorporated

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Attachments Selected References
Figures 1 through 6 – Geologic Constraints Map

SELECTED REFERENCES

Perez, F.G., McCrink, T.P., et al., 2014, Combined Landslide Hazards Mapping for State Highway 84, Alameda, California, California Geological Survey, AEG Poster #15,.

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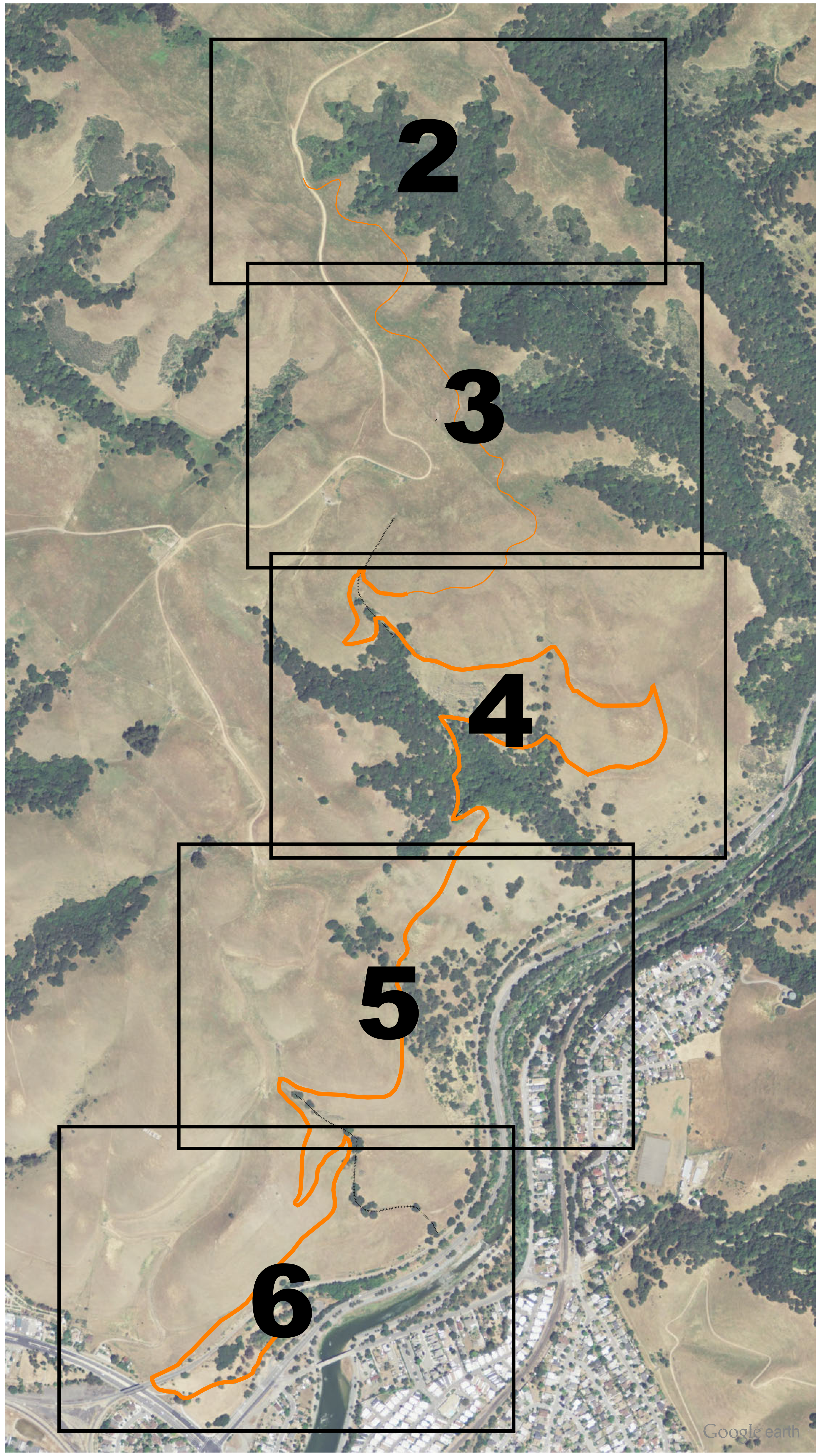

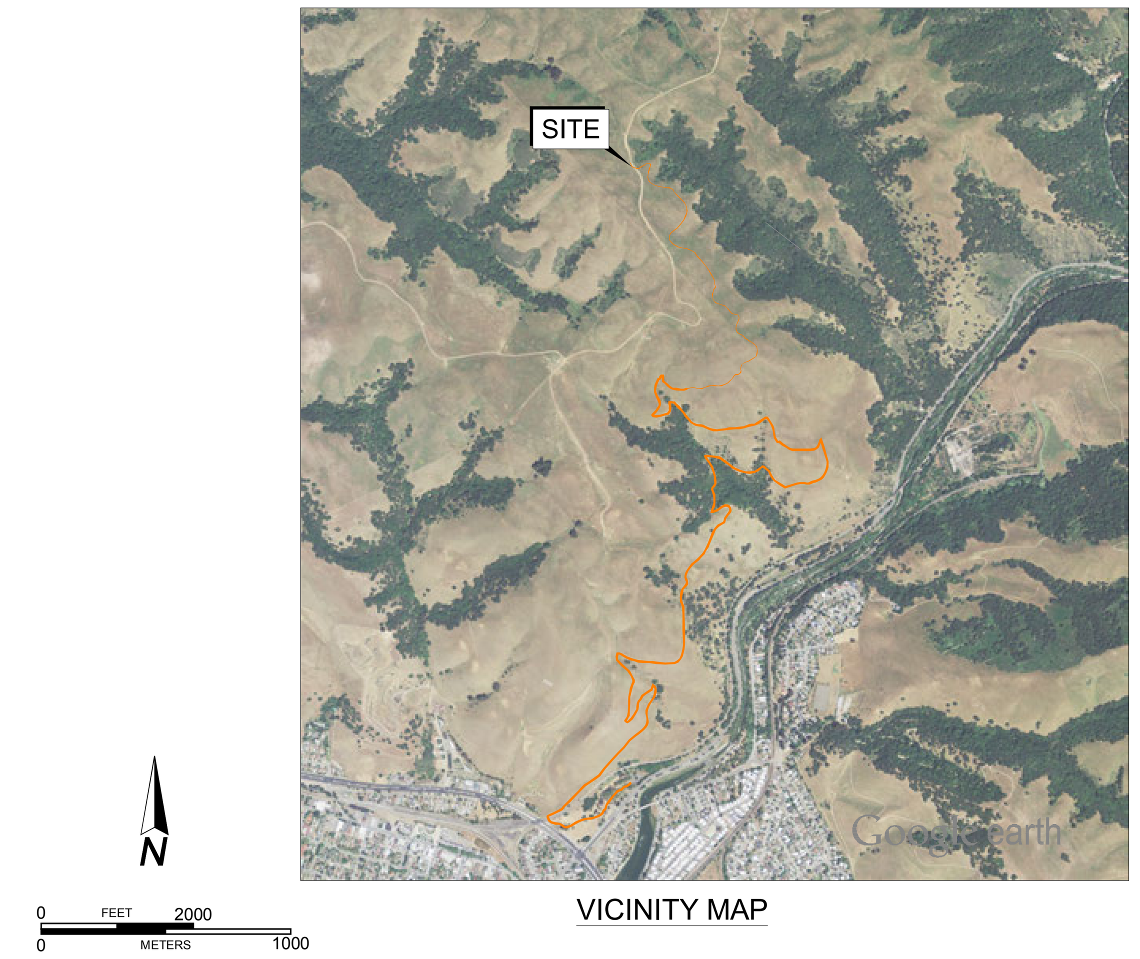

VICINITY MAP

EXPLANATION

ALL LOCATIONS ARE APPROXIMATE

Qaf	ARTIFICIAL FILLS ALONG TRAIL ALIGNMENT
Qhaf	ALLUVIAL FAN AND FLUVIAL DEPOSITS (HOLOCENE)
Qpaf	OLDER ALLUVIAL FAN AND FLUVIAL DEPOSITS (PLEISTOCENE)
Tt	TICE SHALE (EARLY MID-MIOCENE)
To	OURSAN SANDSTONE (EARLY MIOCENE)
Tcs	CLAREMONT FORMATION (EARLY MIOCENE)
Tsh	UNNAMED SHALE AND SANDSTONE (EARLY MIOCENE)
Tps	UNNAMED SHALE AND GLAUCONITE SANDSTONE (PALEOCENE)
Ku	UNNAMED SANDSTONE AND SHALE (LATE CRETACEOUS)
Kc	UNNAMED CONGLOMERATE (LATE CRETACEOUS)
Ks	UNNAMED SANDSTONE AND SHALE (CRETACEOUS)

- PROPOSED TRAIL ALIGNMENT
- GEOLOGIC CONTACT
- FAULT DOTTED WHERE CONCEALED, DASHED WHERE INFERRED
- DEEP-SEATED BEDROCK LANDSLIDE
- SHALLOW LANDSLIDE
- SHALLOW SLOUGHING
- EROSION GULLY
- SPRING
- 50 STRIKE AND DIP OF BEDDING
- 76 STRIKE AND DIP OF JOINT

COMPILATION MAP BASED ON PUBLISHED MAPPING AND REVIEW OF STEREO PAIRED HISTORIC AERIAL PHOTOGRAPHS (see references below).

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BASE MAP SOURCE: BASE MAP SOURCE: GOOGLE EARTH MAPPING SERVICE, USGS

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GEOLOGIC CONSTRAINTS MAP
EBRPD RIDGE TRAIL - FREMONT
FREMONT, CALIFORNIA

PROJECT NO.: 11403.001.000
SCALE: AS SHOWN
DRAWN BY: SRP
CHECKED BY: JBR
FIGURE NO. 1

ORIGINAL FIGURE PRINTED IN COLOR

BASE MAP SOURCE: BASE MAP SOURCE: GOOGLE EARTH MAPPING SERVICE, USGS

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GEOLOGIC CONSTRAINTS MAP
EBRPD RIDGE TRAIL - FREMONT
FREMONT, CALIFORNIA

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FIGURE NO. 2

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ENGEO Expect Excellence	GEOLOGIC CONSTRAINTS MAP EBRPD RIDGE TRAIL - FREMONT FREMONT, CALIFORNIA	PROJECT NO.: 11403.001.000 SCALE: AS SHOWN DRAWN BY: SRP CHECKED BY: JBR	FIGURE NO. 3

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GEOLOGIC CONSTRAINTS MAP
EBRPD RIDGE TRAIL - FREMONT
FREMONT, CALIFORNIA

PROJECT NO.: 11403.001.000	FIGURE NO. 5
SCALE: AS SHOWN	
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ENGEO Expect Excellence	GEOLOGIC CONSTRAINTS MAP EBRPD RIDGE TRAIL - FREMONT FREMONT, CALIFORNIA	PROJECT NO.: 11403.001.000 SCALE: AS SHOWN DRAWN BY: SRP CHECKED BY: JBR	FIGURE NO. 6

ORIGINAL FIGURE PRINTED IN COLOR