4.E GEOLOGY, SOILS, AND SEISMICITY

This chapter describes existing geological and soil conditions, the potential geologic and geotechnical hazards, and potential impacts and mitigation measures for the Project. In general, typical geologic hazards with potential impact to the Project include erosion, surface fault rupture, strong ground shaking, liquefaction, liquefaction-induced lateral spreading, differential compaction, expansive soils, differential settlement, and the potential for ground subsidence caused by groundwater withdrawal. Proper siting of the proposed project components with respect to site conditions, design-level geotechnical investigations, and appropriate engineering and construction measures will avoid, eliminate, or reduce potential impacts of geologic hazards to a less than significant level.

Geologic conditions at the Project Area were evaluated based on published and unpublished literature, and review of specific information from the Project Area. Applicant prepared geotechnical reports (ENGEO 2003, 2007) were reviewed by geologists contracted by the Town and EIR consultant (Cal Engineering and RMC Geoscience, Inc.) for use in the setting and environmental analysis. The potential impacts of the Project on geology and mineral resources were evaluated by considering both the initial construction activities as well as the long-term operation of the Project. When evaluating potential project impacts, it was assumed that the Project Applicant would comply with applicable federal, state, and local regulatory requirements.

4.E-1 ENVIRONMENTAL SETTING

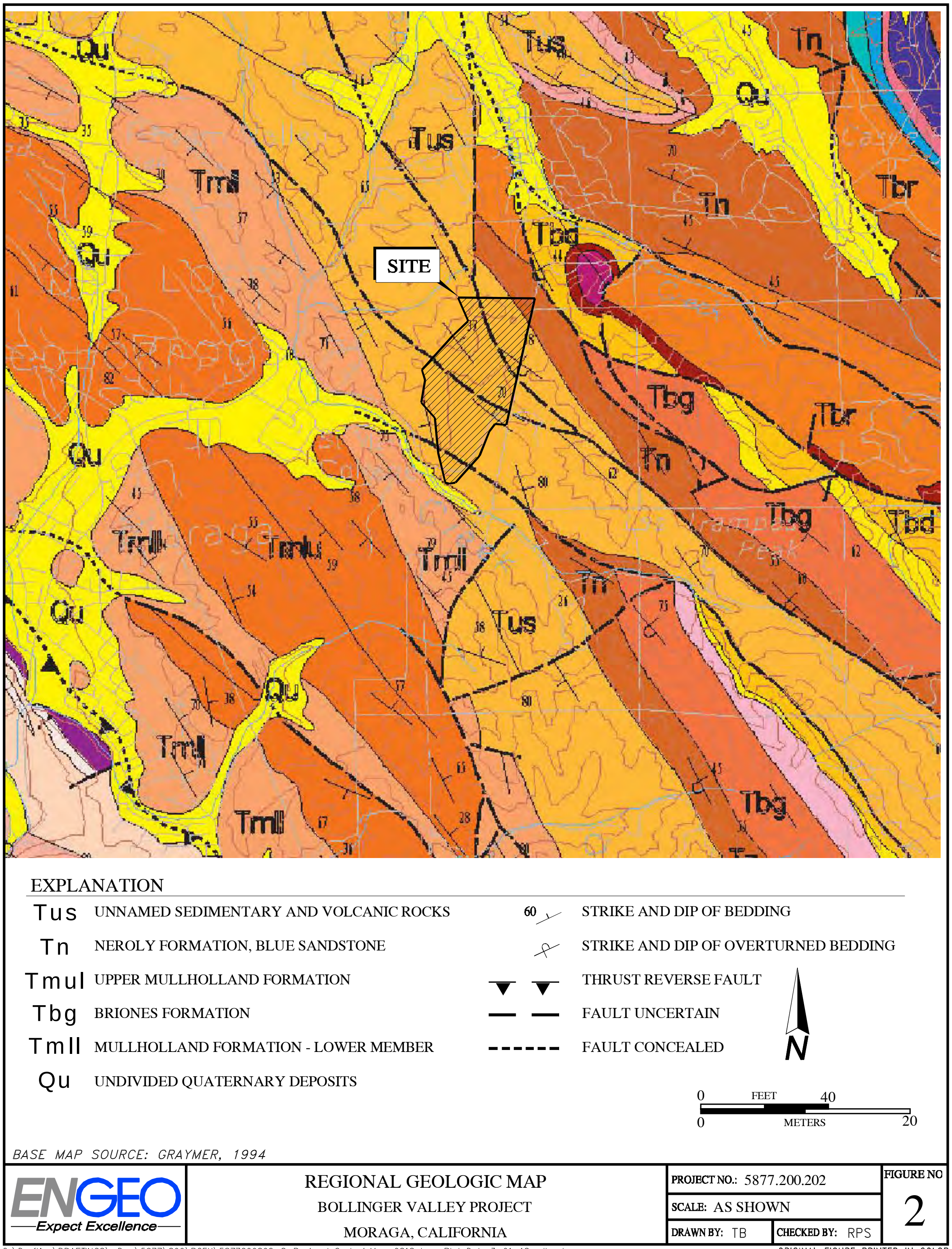
4.E-1.1 Regional Setting

Figure 4.E-1 presents the Regional Geology Map. The Project Area is located in the East Bay Hills west of the San Ramon Valley. The East Bay Hills lie within the region of coastal California referred to by geologists as the Coast Ranges geomorphic province. The Coast Ranges have experienced a complex geological history characterized by Late Tertiary folding and faulting that has resulted in a series of northwest-trending mountain ranges and intervening valleys. The Project Area is located within an uplifted range of hills (locally referred to as the East bay Hills block) that is bounded on the west by the active Hayward Fault and on the east by the active Calaveras Fault. Based on geologic mapping by Graymer (1994), the majority of the Project Area is underlain by Tertiary unnamed sedimentary and volcanic rocks. The northeast portion of the Project Area is underlain by Tertiary marine units of the Neroly and Briones Formations as well as the Rodeo and Hambro shale.

4.E-1.2 Site Topography

The Project Area is bordered by the Moraga Bluffs neighborhood to the west, the City of Lafayette to the north, and unincorporated portions of the County to the east and south. Low hills to the north, south, and west provide a physical separation from adjacent developed areas of Moraga and Lafayette. The total relief of the Project Area is about 585 feet (ft) and ranges from about 490 ft above mean sea level (msl) to 1,075 ft msl.

Figure 4.E-1. **Regional Geology Map**



4.E-1.3 Site Soils and Unconsolidated Deposits

USDA Soil Types

Soils are the byproduct of physical and chemical weathering of underlying rock and alluvial deposits and consist of mineral and organic matter. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) (formerly known as the Soil Conservation Service) prepares soil surveys that classify soil characteristics and their suitability for agriculture and development based on distinct combinations of soils known as associations. The NRCS map for Contra Costa County indicates the Project Area is underlain primarily by soils of the Sehorn Clay (15 to 30 percent slopes and 30 to 50 percent slopes), with lesser amounts of Cropley Clay (2 to 5 percent slopes), Los Osos Clay Loam (30 to 50 percent slopes), Los Osos-Los Gatos Complex, and Tierra Loam (9 to 15 percent slopes). The general properties of these soils are summarized in Table 4.E-1.

Alluvium

Low-lying areas in the southern portion of the Project Area are underlain by fine-grained alluvial terrace deposits (see Figure 4.E-1). Based on semi-continuous cored borings (ENGEO 2003, 2012), the alluvial soils typically consist of stiff to very stiff silty clay with minor amounts of interbedded sandy clay and clay with gravel. Occasional zones of very soft to soft clay and silty clay are also present in the alluvium. The alluvium is deeply incised (up to 70 feet deep) along the main south-trending channels on the property.

Residual Soil and Colluvium

The ground surface at the Project Area is mantled with 1 to 5 feet of residual soil formed from weathering and decomposition of the underlying bedrock and alluvium (ENGEO 2012). The composition of the residual soils varies based on the underlying parent material and is typically a silty clay with moderate to high shrink-swell potential. Deposits of colluvium, which are typically greater than 5 feet thick (ENGEO 2012), occur in swales and ravines at the base of many slopes on the property. The colluvium typically consists of silty clay with some sand and occasional rock fragments.

Existing Fill

The downstream side of the cattle pond in the eastern portion of the Project Area and the access road off of Valley Hill Drive include minor existing fill berms.

Table 4.E-1

Summary of Project Area Soil Types

Soil Name	Parent Material	Drainage Class	Typical Profile	Shrink-Swell Potential	Soil Classification
Cropley Clay, 2 to 5 Percent Slopes	Alluvium	Moderately well drained	0 to 24 inches: Clay 24 to 60 inches: Clay	High	CL, CH
Los Osos Clay Loam, 30 to 50 Percent Slopes	Residuum weathered from sandstone and shale	Well drained	0 to 10 inches: Clay loam 10 to 32 inches: Clay 32 to 36 inches: Weathered bedrock	High	CL
Los Osos-Los Gatos Complex	Residuum weathered from sandstone and shale	Well drained	0 to 8 inches: Loam 8 to 27 inches: Clay loam, Loam 27 to 30 inches: Unweathered bedrock	High	CL-ML, CL
Sehorn Clay, 15 to 30 percent slopes	Residuum weathered from shale	Well drained	0 to 25 inches: Clay 25 to 35 inches: Silty clay 35 to 38 inches: Unweathered bedrock	High	CL
Sehorn Clay, 30 to 50 percent slopes	Residuum weathered from shale	Well drained	0 to 25 inches: Clay 25 to 35 inches: Silty clay 35 to 38 inches: Unweathered bedrock	High	CL
Tierra Loam, 9 to 15 percent slopes	Alluvium derived from sedimentary rock	Moderately well drained	0 to 25 inches: Loam 25 to 59 inches: Clay, clay loam, sandy clay 59 to 71 inches: Silty clay loam	High	CL, CL-ML

NOTES:

1. Soil classification in accordance with the Unified Soil Classification System (USCS).

Reference: www.websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx; accessed 01/11/2012).

4.E-1.4 Site Landslides

A published regional scale landslide map of the Project Area (Nilsen, 1975) shows that more than 50 individual lineations, primarily landslides, are present in the Project Area. A project-specific map of landslides was originally prepared by ENGEO in 2003 using stereo-paired aerial photographs, site observations, and information from the Nilsen (1975) map. In the Preliminary Geotechnical Exploration of the Project Area, ENGEO (2003) recommended that the existence and extent of the landslide areas be evaluated by subsurface exploration prior to preparation of the final grading plans for the Project. A peer review by Cal Engineering and Geology also recommended additional evaluation of Project Area landslides. The Updated Preliminary Geotechnical Exploration prepared by ENGEO (2012) presents additional subsurface exploration and laboratory testing and further maps the extent of Project Area landslides. The subsurface exploration included the excavation and logging of 20 additional test pits in several of the critical slide areas at the Project Area. Four (4) cross sections were constructed through critical landslide areas at the Project Area.

The most recent project site plan and geology map (ENGEO 2012) is shown in Figure 4.E-2. Cross section and test pit locations are also illustrated in Figure 4.E-2. ENGEO confirmed the presence of the landslides shown by Nilsen (1975) and classified the landslides as:

- <u>Creek Bank Sloughing</u>: The steep walls of the creek channels incised into the terrace deposits are undergoing active shallow sloughing and some have developed into deeper landslides.
- <u>Earthflows</u>: Earthflows are a type of landslide that is characterized by mobilization as a viscous, slow-moving mass. These features commonly grade into rotational slumps or translational landslides. Earthflows typically form when cohesive, clayey soils or weak bedrock become saturated and fail. Like debris flows, they commonly mobile as a result of intense rains, but move relatively slowly due to high clay content. Earthflows mapped at the Project Area occupy drainage swales on the steep-sided flanks of the ridges at the Project Area.
- <u>Bedrock Landslides</u>: A number of deep-seated bedrock landslides have been identified at the Project Area (a bedrock landslide is a slope failure with a slide plane that extends into the underlying bedrock). The geometry of the slip surface can be arcuate (typically associated with rotational slumps) or planar (typically associated with translational sliding). Relatively intact and undisturbed blocks of rock can be entrained within the transported landslide mass, in both cases.

Subsurface data from the test pits was used to help constrain the landslide geometries and where no subsurface data was available reasonable geometries were inferred. The cross sections include potential remedial grading measures that could be employed to mitigate the landslides in the Project Area. ENGEO's supplemental work confirms the conclusions reached in the 2003 Preliminary Geotechnical Explorations and updates recommended measures to reflect the latest California Building Codes, as amended locally.

4.E-1.5 Site Bedrock Geology

Bedrock across most of the Project Area consists of unnamed Tertiary interbedded nonmarine sandstone, siltstone, claystone, and conglomerate (identified as "Tus" in Figures 4.E-1 and 4.E-2). In general, the sandstone is poorly to moderately cemented, friable to strong, massive to laminated, light brown where weathered, and gray to dark gray where fresh. The siltstone is generally dark gray-brown to dark gray, friable to moderately strong, and thinly-bedded. The claystone is typically dark gray to olive brown, thinly-bedded to massive and friable to weak. Testing performed by ENGEO (2003, 2012) shows that the siltstone and claystone contain a high percentage of expansive clay. The northernmost portion of the Project Area is underlain by marine Miocene siltstone (identified as "Tmsl" in Figure 4.E-2) and marine Miocene sandstone of the Neroly Formation (identified as "Tn" in Figures 4.E-1 and 4.E-2).

The ENGEO (2012) project site plan and geology map (Figure 4.E-2) indicates that the bedrock on the central and south-central portion of the Project Area trends in the northwesterly direction with an approximate 30 to 60 degree dip to the southwest. An anticline (In structural geology, an anticline is a fold that is convex up and has its oldest beds at its core) was mapped passing through the northeast portion of the Project Area; bedrock on the southwestern side of the anticline dips to the southwest and bedrock on the northeastern side of the anticline dips to the northeast. As shown in Figure 4.E-2, ENGEO (2012) also identified localized areas of overturned bedding.

E-1.5 Groundwater

ENGEO (2003) mapped two springs near the eastern limit of the proposed development in the central portion of the Project Area (Figure 4.E-1). One spring is located in Lafayette and not within the Project Area. The southernmost spring is located within a swale at the head of a landslide in an area that feeds southward into the steep-sided main drainage in the southern portion of the Project Area. ENGEO reevaluated in the mapped spring in 2012 and the spring was dry. Groundwater was encountered at depths of 16.5 and 17 ft below ground surface (bgs) in borings (B-2 and B-3) that were advanced as part of the ENGEO (2003) investigation. In 2012 explorations groundwater was encountered as shallow at 14 feet bgs. ENGEO noted that seasonal fluctuations in groundwater level should be expected due to variations in precipitation, temperature, irrigation, and other factors. Dewatering during construction should be anticipated.

4.E-1.6 Seismicity and Faulting

Historic Seismicity

The Project Area is located in the seismically active San Francisco Bay region and has experienced ground shaking associated with moderate to large earthquakes throughout the period where records are available. Earthquakes of magnitude 5 or greater that have occurred within about 25 miles of the Project Area are summarized in Table 4.E-2. As indicated in this table, the closest recorded earthquake occurred about 5.3 miles from the Project Area and was associated with a magnitude 5.6 earthquake that resulted in estimated Project Area peak horizontal ground acceleration (PHGA) of about 0.34g.[1] The largest historical earthquake to affect the Project Area occurred about 6.5 miles away and had a magnitude of 6.8 with an associated Project Area PHGA of about 0.64g.

Regional Faulting

The State of California considers a fault to be "active" if it has had identifiable movement within the last 11,000 years. The time period for a "potentially active" fault is 1.6 million years. Active and potentially active faults located within 62 miles (100 km) of the Project Area are summarized in Table 4.E-4 and shown in Figure 4.E-3. The most significant of these faults include the Calaveras, Hayward-Rodgers Creek, Mount Diablo Thrust, Green Valley, Greenville, Northern San Andreas and the discontinuous fault segments of the Great Valley fault system. Three of the faults (Calaveras, Hayward-Rodgers Creek, and Mount Diablo Thrust) are located within 10 km of the Project Area. The proximity of these faults to the Project Area means that a site-specific ground motion analysis will be required for design pursuant to Section 1614.1.2 of the California Building Code.

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[1] In an earthquake, sudden rupture or displacement along a fault releases energy in the form of seismic waves, which travel outward from the source. The amount of energy released by an earthquake is related to its magnitude. Seismic waves travel through the earth causing displacements or movements of the ground, similar to ripples on a pond. As waves travel away from the source, their energy is both absorbed and spread over an increasingly larger area through a process called attenuation. Through attenuation, amount of acceleration, velocity, and displacement caused by the passage of seismic waves decreases with distance from the source. Thus, both the distance from the seismic source and earthquake magnitude affect the amount of wave energy reaching a given location. A number of empirical attenuation relationships, which describe the relationship between the amplitude of ground motion, earthquake magnitude, and distance, have been developed based on analysis of past earthquake motions. The PHGA was calculated using the Abrahamson and Silva (1997) attenuation relationship assuming rock conditions.

Table 4.E-2

Summary of Historic Earthquakes Greater Than Magnitude 5 within 25 Miles of the Site

Date	Approximate distance (miles)	Magnitude	Site acceleration (g)[1]	Site intensity[2]
7/4/1861	5.3	5.6	0.335	IX
7/31/1889	6.5	5.2	0.182	VIII
6/10/1836	6.5	6.8	0.635	X
9/10/1935	8.9	5.0	0.105	VII
10/21/1868	9.2	6.8	0.468	X
10/24/1955	9.7	5.4	0.141	VIII
3/5/1864	10.3	5.7	0.191	VIII
4/2/1870	12.5	5.3	0.095	VII
1/24/1980	15.1	5.8	0.127	VIII
5/19/1889	15.4	6.0	0.136	VIII
5/21/1864	16.3	5.3	0.069	VI
1/24/1980	16.3	5.1	0.055	VI
10/5/1859	17.2	5.0	0.046	VI
5/15/1851	17.2	5.0	0.046	VI
1/27/1980	20.1	5.4	0.058	VI
6/11/1903	22.5	5.5	0.056	VI
6/21/1808	22.6	6.3	0.102	VII
2/26/1864	23.2	5.0	0.031	V
12/11/1855	23.2	5.0	0.031	V
10/22/1854	23.2	5.0	0.031	V
6/1/1838	23.4	7.0	0.138	VIII
3/22/1957	24.2	5.3	0.041	V
6/2/1899	24.3	5.4	0.045	VI
4/18/1906	24.3	8.3	0.242	IX
4/25/1906	24.3	5.3	0.040	V

Source: Blake, 2004a

[1]Site acceleration calculated based on Abrahamson and Silva (1997) attenuation relationship for rock sites.
[2]Estimated site intensity based on Modified Mercalli Scale – See Table 4.E-3.

Table 4.E-3

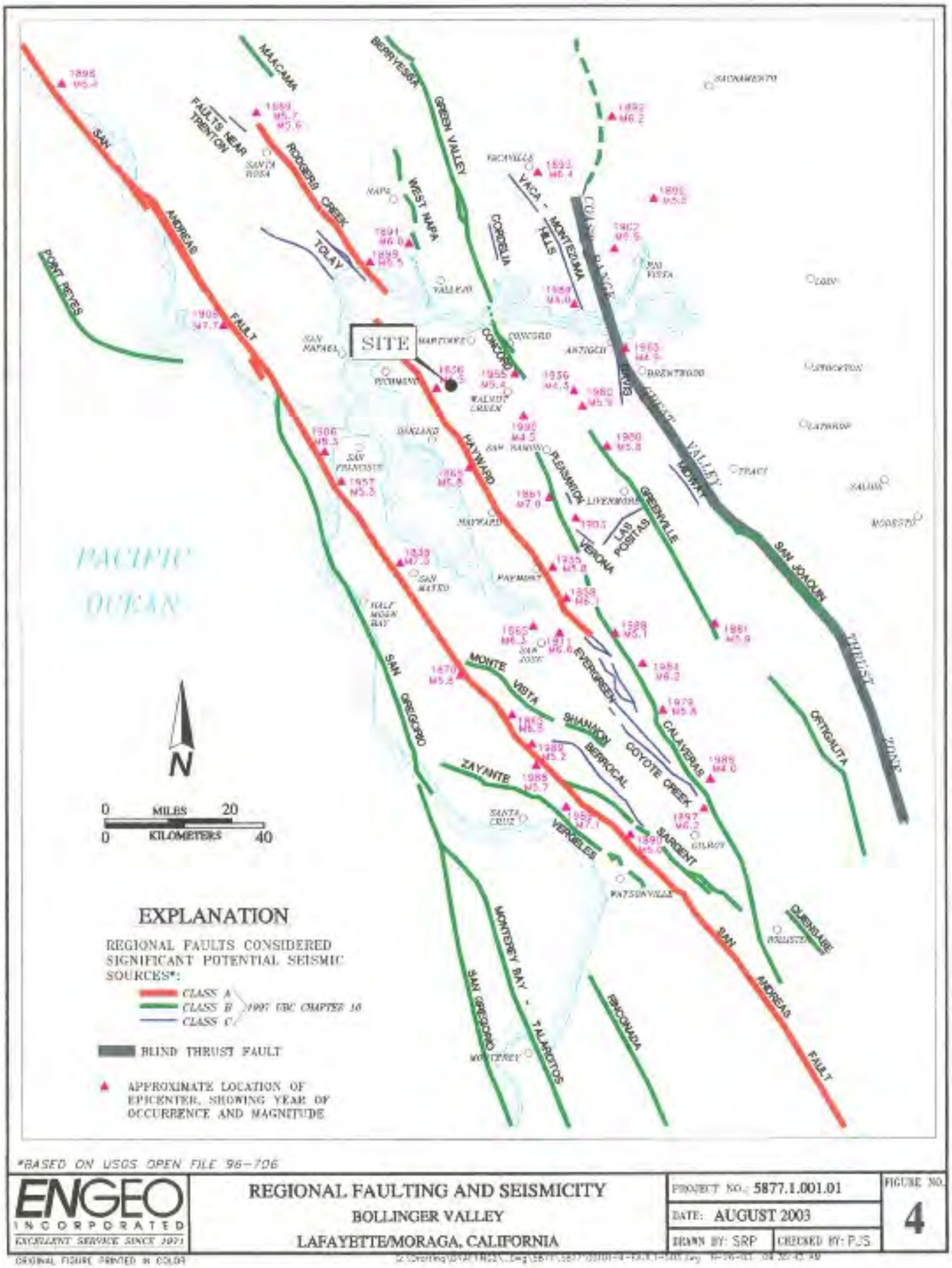
Modified Mercalli Intensity Scale

Intensity	Description	Average Peak Acceleration (g)[1]
I	Not felt except by a very few persons under especially favorable circumstances.	<0.0017
II	Felt only by a few persons at rest, especially on upper floors on buildings. Delicately suspended objects may swing.	<0.014
III	Felt noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly, vibration similar to a passing truck. Duration estimated.	<0.014
IV	During the day felt indoors by many, outdoors by few. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.	<0.014-0.04
V	Felt by nearly everyone, many awakened. Some dishes and windows broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles may be noticed. Pendulum clocks may stop.	0.04-0.09
VI	Felt by all, many frightened and run outdoors. Some heavy furniture moved; and fallen plaster or damaged chimneys. Damage slight.	0.09-0.18
VII	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.	0.18-0.034
V111	Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motor cars disturbed.	0.34-0.65
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.	0.65-1.24
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from riverbanks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.	>1.24
XI	Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.	>1.24
XII	Damage total. Practically all works of construction are damaged greatly or destroyed. Waves seen on ground surface. Lines of sight and level are distorted. Objects are thrown upward into the air.	>1.24

Source: Bolt, Bruce A., Earthquakes W.H. Freeman and Company, New York, 1988.

[1]g (gravity) = 980 centimeters per second squared. 1.0 g of acceleration is a rate of increase in speed equivalent to a car traveling 328 feet from rest in 4.5 seconds.

Figure 4.E-3. Regional Fault Map



Site Faulting

Structurally, the Project Area is north-northwest of a complex zone of convergence between the Bollinger Canyon fault, the Cull Canyon fault zone, and the Lafayette fault. Both Graymer (1994) and Crane (1995) also map an unnamed northwest-trending fault through the western portion of the Project Area. Based on mapping by Dibblee (1980), Crane (1988), and Graymer (1994), the southern end of the Lafayette fault traverses the northeastern portion of the Project Area (Figure E.4-2). An evaluation of the termination of the northern Calaveras fault by Unruh and Kelson (2002) suggests the Lafayette fault is considered to be a potentially active right-lateral strike-slip fault that is interpreted as one of a series of structures that may accommodate slip on the northern Calaveras fault.

Unruh and Kelson (2002) also identify a series of lineations (linear alignments of topographic features seen on aerial photographs) passing through the west-central portion of this project in the general vicinity of the Lafayette Fault. These lineations are classified by Unruh and Kelson (2002) as "weakly-pronounced," "distinct," and "strongly-pronounced." ENGEO (2003) indicated the lineations were most likely a combination of landslide offsets of slopes, differential weathering along fractures, and possible Late Quaternary displacement of fracture zones related to the tectonic deformation of the area. The Updated Preliminary Geotechnical Exploration (ENGEO 2012) confirms the presence of three landslide types within the Project Area, as described in Section 4.E-1.4 above.

ENGEO recently conducted subsurface exploration that included excavation and logging or two trenches across the mapped traces of the LaFayette fault. Figure 4.E-2 illustrates the trench locations. The Updated Preliminary Geotechnical Exploration (2012) details the findings in Section 3.1 of the report. In summary, the soil units exposed in the trench were laterally continuous and undisturbed and display approximately 24,000 years of soil development. No evidence of active faulting was observed and fault-related ground rupture is concluded to be unlikely.

4.E-1.7 Soil Erosion

Soil erosion is a widespread problem in many hilly portions of the Bay Area. It is a particular concern on steep slopes which have been disturbed during development grading and which are exposed to seasonal precipitation without adequate slope protection. Stream banks are especially prone to excessive erosion when changes in flow patterns and volume of water occur, such as during large storms. ENGEO (2003) noted that areas of moderate erosion in the forms of surface flow and gullying were observed at the Project Area and that erosion was particularly evident on the banks of the main drainage channel in the southern portion of the Project Area.

4.E-1.8 Mineral Resources

The Project Area is not identified as a Mineral Resource Zone (MRZ) by the California Division of Mines and Geology (CDMG, 1996). The Project Area is not located within or near a potential source of oil or valuable mineral resources (Bailey and Harden, 1975).

Table 4.E-4
Summary of Faults within 100 KM of Project Area

FAULT	DISTANCE (km)	MAGNITUDE (M_w)	MEAN PGA (g)					
			Weighted Mean	Abrahamson-Silva (2008)	Boore-Atkinson (2008)	Campbell-Bozorgnia (2008)	Chiou-Youngs (2007)	Idriss (2008)
Calaveras	7.4	7.0	0.39	0.40	0.33	0.36	0.45	0.41
Hayward-Rodgers Creek	9.5	7.3	0.36	0.34	0.32	0.32	0.41	0.38
Mount Diablo Thrust	10.4	6.7	0.40	0.47	0.31	0.41	0.48	0.34
Green Valley Connected	12.1	6.8	0.28	0.30	0.25	0.26	0.33	0.28
Greenville Connected	23.1	7.0	0.17	0.15	0.18	0.15	0.17	0.18
Great Valley 5	31.2	6.7	0.15	0.21	0.13	0.11	0.17	0.11
Northern San Andreas	38.5	8.0	0.17	0.17	0.20	0.14	0.19	0.17
West Napa	39.4	6.7	0.09	0.07	0.11	0.09	0.08	0.09
San Gregorio	46.1	7.5	0.12	0.12	0.14	0.10	0.12	0.12
Monte Vista-Shannon	46.2	6.5	0.07	0.05	0.08	0.07	0.06	0.07
Great Valley 4B	47.2	6.8	0.11	0.14	0.10	0.10	0.12	0.01
Great Valley 7	47.4	6.9	0.11	0.13	0.10	0.10	0.12	0.09
Point Reyes	66.5	6.9	0.06	0.05	0.07	0.57	0.05	0.06
Hunting Creek-Berryessa	69.7	7.1	0.06	0.06	0.07	0.06	0.06	0.06
Great Valley 4A	73.3	6.6	0.06	0.08	0.05	0.06	0.06	0.04
Zayante-Vergeles	83.3	7.0	0.05	0.04	0.06	0.05	0.04	0.04
Great Valley 8	87.8	6.8	0.05	0.07	0.05	0.06	0.05	0.04
Great Valley 3	91.5	7.1	0.07	0.10	0.05	0.06	0.07	0.05
Ortigalita	94.7	7.1	0.04	0.04	0.05	0.05	0.04	0.04
Maacama-Garberville	98.1	7.4	0.06	0.07	0.06	0.05	0.06	0.05

NOTES:
1. Fault magnitude and distance from Field et al. (2008).

4.E-2 REGULATORY SETTING

4.E-2.1 Alquist-Priolo Earthquake Fault Zoning Act

In California, the Alquist-Priolo Earthquake Fault Zoning Act of 1972 (formerly the Special Studies Zoning Act) regulates development and construction of buildings intended for human occupation to avoid the hazard of surface fault rupture. This Act and supplemental amendments group faults into the categories of active, potentially active, and inactive. Historic and Holocene age faults are considered active, Late Quaternary and Quaternary age faults are considered potentially active, and pre-Quaternary age faults are considered inactive. These classifications are qualified by the conditions that a fault must be shown to be “sufficiently active” and “well defined” by detailed site-specific geotechnical explorations in order to determine that building setbacks might be established.

4.E-2.2 Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act was developed to protect the public from the effects of strong ground shaking, liquefaction, landslides, or other ground failure, and from other hazards caused by earthquakes. This act requires the State Geologist to delineate various seismic hazard zones and requires cities, counties, and other local permitting agencies to regulate certain development projects within these zones. Before a development permit is granted for a Project Area within a Seismic Hazard Zone, a geotechnical investigation of the Project Area must be conducted and appropriate mitigation measures incorporated into the project design.

4.E-2.3 California Building Code

The California Building Code is another name for the body of regulations known as the California Code of Regulations (CCR), Title 24, Part 2, which is a portion of the California Building Standards Code (CBSC, 2007). Title 24 is assigned to the California Building Standards Commission, which, by law, is responsible for coordinating building standards.

Published by the International Conference of Building Officials (ICBO), the Uniform Building Code (UBC) is a widely adopted model building code in the United States. The California Building Code incorporates the UBC by reference and includes necessary California amendments. These amendments include criteria for seismic design. About one-third of the text within the California Building Code has been tailored for California earthquake conditions (ICBO, 1997). The 2007 UBC requires extensive geotechnical analysis and engineering for grading, foundations, retaining walls, and structures within zones. The Project Area is located within Zone 4, which, of the four seismic zones designated in the United States, is expected to experience the greatest effects from earthquake ground shaking and therefore has the most stringent requirements for seismic design.

4.E-2.4 Town of Moraga General Plan Policies and Grading Ordinance

General Plan Policies

The Town of Moraga 2002 General Plan has several policies related to geology, soils, and geologic risks. These policies are summarized in Table 4.E-5.

Grading Ordinance

The Town of Moraga Grading Ordinance (MMC 14) contains regulations applicable to the Project grading plans. In particular, MMC §14.04.033(D) restricts grading where the pre-development average slope gradient is steeper than 25 percent unless the grading is required for landslide repair, slope stabilization or other emergencies.

4.E-2.5 Evaluation Criteria

Potential seismic and soils-related effects associated with implementation of the Project include both geologic hazards to people or structures, and construction-related impacts. Implementation of the Project would be considered to result in a significant environmental impact if it were to:

- Increase the exposure of people or structures to potential hazards associated with a regional seismic event to levels generally considered unacceptable according to engineering standards for projects of this type in the seismically active San Francisco Bay region;
- Expose people or structures to potential substantial adverse effects involving rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area, or based on other substantial evidence of a known fault;
- Result in placement of structures or infrastructure in locations susceptible to landslides or slope instability;
- Result in substantial soil erosion or the loss of topsoil, either through construction activities or as a result of development; and/or
- Result in construction of buildings on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risk to life or property.

Geologic impacts are typically considered less than significant if, through engineering, geotechnical investigation, and construction techniques, the risk of damage to structures can be greatly reduced, although not eliminated completely.

Table 4.E-5 presents criteria for analysis of geologic, soil and seismic impacts.

Table 4.E-5

Impact Evaluation Criteria with Points of Significance

Impact Evaluation Criteria	As Measured by	Point of Significance	Justification
4.E-1. Will the Project or Alternatives expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking or seismic-related ground failure including liquefaction?	Location of facilities in an APFZ or area exposed to strong seismic shaking.	New facility without appropriate CBC seismic design features in an EFZ or other area exposed to strong seismic shaking.	CEQA Checklist VI(a-i, ii, iii); Alquist-Priolo Act; CDMG fault zone map SP-42; UBC with CBC amendments, Moraga General Plan Policies PS4.1 – PS4.3.
4.E-2. Will the Project or Alternatives expose people or structures to major geologic hazards, such as strong seismic groundshaking, or seismic related ground failure including rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault?	Location of facilities in an APFZ or area exposed to strong seismic shaking.	New facility without appropriate CBC seismic design features in an EFZ or other area exposed to strong seismic shaking.	CEQA Checklist VI(a-i, ii, iii); Alquist-Priolo Act; CDMG fault zone map SP-42; UBC with CBC amendments, Moraga General Plan Policies PS4.1 – PS4.3.
4.E-3. Will the Project or Alternatives result in placement of structures or infrastructure in locations susceptible to landslides or slope instability?	Facilities in an area of moderate to high landslide risk, including roads with slopes greater than 20%, buildings on slopes greater than 30%; landslide debris, soils with potential for erosion or liquefaction.	New facility in an area of moderate to high risk of slope or soil failure without appropriate CBC geotechnical stabilization measures.	Contra Costa County General Plan; CEQA Checklist VI(a-iv, c); Moraga General Plan Policies LU1.8, PS1.3 – PS1.4, PS4.1 – PS4.3.
4.E-4. Does the Project or Alternatives have the potential to result in damage to structures or infrastructure due to settlement of natural deposits or improperly constructed fills?	Facilities in an area of moderate to high landslide risk, including roads with slopes greater than 20%, buildings on slopes greater than 30%; landslide debris, soils with potential for erosion or liquefaction.	New facility in an area of moderate to high risk of slope or soil failure without appropriate CBC geotechnical stabilization measures.	Contra Costa County General Plan; CEQA Checklist VI(c); Moraga General Plan Policies LU1.8, PS1.3 – PS1.4, PS4.1 – PS4.3.

Table 4.E-5			
Impact Evaluation Criteria with Points of Significance			
Impact Evaluation Criteria	**As Measured by**	**Point of Significance**	**Justification**
4.E-5. Will the Project or Alternatives result in substantial soil erosion or loss of topsoil?	Facilities in an area of moderate to high landslide risk, including roads with slopes greater than 20%, buildings on slopes greater than 30%; landslide debris, soils with potential for erosion or liquefaction.	New facility in an area of moderate to high risk of slope or soil failure without appropriate CBC geotechnical stabilization measures.	Contra Costa County General Plan; CEQA Checklist VI(b); Moraga General Plan Policies LU1.8, PS1.4, PS4.2 – PS4.3.
4.E-6. Will the Project or Alternatives be located on expansive or corrosive soil, creating substantial risk to life or property?	Structures located in an area of expansive or corrosive soil.	A new structure on expansive or corrosive soil without appropriate CBC design features.	CEQA Checklist VI(d); 1994 UBC Table 18-1-B, Moraga General Plan Policy PS4.3.
4.E-7. Will the Project have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?	Hazards associated with septic tanks or alternative waste water systems located on incompatible soils.	A new septic or alternative waste system on incompatible soil.	CEQA Checklist VI(e); SFRWQCB Permit requirements; Moraga General Plan Policy OS3.1.

4.E-3 ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Table 4.E-6 presents potential geologic, soil and seismic impacts, outlines points of significance, level of impact, and type of impact and also ranks the level of significance for the Project and Alternatives.

Potential hazards are determined by the geologic properties and soil characteristics of the Project Area. Proximity to active earthquake faults, potential for strong ground shaking, expansive soil properties, landslides, slope instability and groundwater are the primary geotechnical hazards. Groundwater is discussed in more detail in Section 4.F – Hydrology and Water Quality.

Table 4.E-6

Geology, Soils and Seismicity Impacts – Project and Alternatives

Impact	Point of Significance	Type of Impact[1]	Level of Significance[2]
4.E-1. Will the Project or Alternatives expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking or seismic-related ground failure including liquefaction?	New facility without appropriate CBC seismic design features in an EFZ or other area exposed to strong seismic shaking.	C, P	Project (126 units) ⊙ Alternative 1 (No Project) == Alternative 2 (8 units) ⊙ Alternative 3 (37 units) ⊙ Alternative 4 (100 units) ⊙ Alternative 5 (121 units) ⊙
4.E-2. Will the Project or Alternatives expose people or structures to major geologic hazards, such as strong seismic groundshaking, or seismic related ground failure including rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault?	New facility without appropriate CBC seismic design features in an EFZ or other area exposed to strong seismic shaking.	C, P	Project (126 units) ⊙ Alternative 1 (No Project) == Alternative 2 (8 units) ⊙ Alternative 3 (37 units) ⊙ Alternative 4 (100 units) ⊙ Alternative 5 (121 units) ⊙
4.E-3. Will the Project or Alternatives result in placement of structures or infrastructure in locations susceptible to landslides or slope instability?	New facility in an area of moderate to high risk of slope or soil failure without appropriate CBC geotechnical stabilization measures.	C, P	Project (126 units) ⊙ Alternative 1 (No Project) == Alternative 2 (8 units) ⊙ Alternative 3 (37 units) ⊙ Alternative 4 (100 units) ⊙ Alternative 5 (121 units) ⊙
4.E-4. Does the Project or Alternatives have the potential to result in damage to structures or infrastructure due to settlement of natural deposits or improperly constructed fills?	New facility in an area of moderate to high risk of slope or soil failure without appropriate CBC geotechnical stabilization measures.	C, P	Project (126 units) ⊙ Alternative 1 (No Project) == Alternative 2 (8 units) ⊙ Alternative 3 (37 units) ⊙ Alternative 4 (100 units) ⊙ Alternative 5 (121 units) ⊙
4.E-5. Will the Project or Alternatives result in substantial soil erosion or loss of topsoil?	New facility in an area of moderate to high risk of slope or soil failure without appropriate CBC geotechnical stabilization measures.	C, P	Project (126 units) ⊙ Alternative 1 (No Project) ❍ Alternative 2 (8 units) ⊙ Alternative 3 (37 units) ⊙ Alternative 4 (100 units) ⊙ Alternative 5 (121 units) ⊙
4.E-6. Will the Project or Alternatives be located on expansive or corrosive soil, creating substantial risk to life or property?	A new structure on expansive or corrosive soil without appropriate CBC design features.	C, P	Project (126 units) ⊙ Alternative 1 (No Project) == Alternative 2 (8 units) ⊙ Alternative 3 (37 units) ⊙ Alternative 4 (100 units) ⊙ Alternative 5 (121 units) ⊙

Table 4.E-6			
Geology, Soils and Seismicity Impacts – Project and Alternatives			
Impact	**Point of Significance**	**Type of Impact[1]**	**Level of Significance[2]**
4.E-7. Will the Project or Alternatives have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?	A new septic or alternative waste system on incompatible soil.	C, P	Project (126 units) == Alternative 1 (No Project) == Alternative 2 (8 units) ⊙ Alternative 3 (37 units) == Alternative 4 (100 units) == Alternative 5 (121 units) ==

Notes:
1. Type of Impact:
C Construction/Temporary
P Permanent/Operation

2. Level of Significance:
● Significant impact before and after mitigation
⊙ Significant impact before mitigation; less than significant impact after mitigation
❍ Less than significant impact; no mitigation proposed
== No impact

Impact: **4.E-1. Will the Project or Alternatives expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking or seismic-related ground failure including liquefaction?**

Analysis: ***No Impact; Alternative 1 (No Project)***

Alternative 1 (No Project) involves no new development and would not expose people or structures to geologic hazards.

Mitigation: ***None required.***

Analysis: ***Significant Impact; Project (126 units), Alternative 2 (8 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units).***

In the event of a major earthquake in the region, seismic ground shaking potentially could injure persons at the Project Area due to damage to facility structures and infrastructure such as roadways and utilities. Ground shaking potentially could also expose persons and property to seismic-related hazards such as liquefaction and seismically-induced settlement. This would be a significant impact.

It is likely that the Project Area will experience periodic minor to moderate earthquakes and possibly a major earthquake of moment magnitude 7 or greater during the life of the Project. For example, the U.S. Geological Survey (USGS) Working Group on California Earthquake Probabilities evaluated the probability of one or more earthquakes of Richter magnitude 6.7 or higher occurring in the San Francisco Bay Area within the next 30 years. The result of the evaluation indicated a 62 percent likelihood that such an earthquake event will occur in the Bay Area between 2003 and 2032 (USGS, 2003).

The intensity of the earthquake ground motion at the Project Area will depend upon the characteristics of the generating fault, distance of the Project Area to the earthquake epicenter and rupture zone, magnitude and duration of the earthquake, and site-specific geologic conditions. The results of deterministic analyses (Table 4.E-4) indicate the maximum median PHGA at the Project Area could be on the order of 0.30g to 0.40g associated with moment magnitude earthquakes ranging from 6.7 to 7.3 on the nearby Calaveras, Hayward-Rodgers Creek, Mount Diablo Thrust, or Green Valley faults. This level of ground shaking potentially could injure persons at the Project Area due to damage to facility structures and infrastructure such as roadways and utilities.

Ground shaking potentially could also expose persons and property to seismic-related hazards such as liquefaction, seismically-induced settlement, and ground lurching. For example:

- Hazard maps produced by the Association of Bay Area Governments (ABAG 2005) indicate the Project Area is in an area expected to have a very low potential for liquefaction and ENGEO (2003) indicates the potential for liquefaction at the Project Area is low. However, the ABAG (2005) maps are not site-specific and the ENGEO (2003) evaluation was based on limited data. As a result, the potential for liquefaction of the unconsolidated alluvium at the Project Area is not well characterized.
- Settlement of the ground surface can be accelerated and accentuated by earthquakes. During an earthquake, settlement can occur as a result of the relatively rapid rearrangement, compaction, and settling of subsurface materials (particularly loose, non-compacted, and variable sandy sediments). Settlement can occur both uniformly and differentially (i.e., where adjoining areas settle at different rates). Areas are susceptible to differential settlement if underlain by compressible sediments, such as poorly engineered artificial fill or unconsolidated sediments.
- Lurch cracking and lateral spreading can occur in weaker soils on slopes and adjacent to open channels that are subjected to strong ground shaking during an earthquake. ENGEO (2003) notes this potential can be mitigated by conventional remedial grading methods and further indicates that lateral spreading is unlikely.
- The risk of slope instability is greater during earthquakes than during other periods of time. As summarized previously, an appreciable amount of Project Area is underlain by landslide deposits and is located in a seismically active area. As a result, the Project Area is judged to be susceptible to seismically-induced landsliding.
- Soil liquefaction results from loss of strength during cyclic loading, such as imposed by earthquakes. Soils most susceptible to liquefaction are clean, loose, saturated, uniformly graded to fine-grained sands. The alluvial deposits present at the Project Area are mapped as areas with a low potential susceptibility to liquefaction on the USGS Liquefaction Susceptibility map for the central San Francisco Bay Region (USGS 2006). Additionally, two continuous dry core borings (ENGEO 2012) within the alluvial terrace deposits indicate a low risk of liquefaction.

Foundation and structural designs that can withstand the level of ground shaking and its potential effects are in common use today. In accordance with the California Building Code (CBC), Project facilities would be designed, at minimum, to withstand a ground acceleration that has a 10 percent probability of being exceeded in 50 years. With foundation and structural design in accordance with the current CBC standards, seismic shaking should not result in significant structural damage to the planned structures. In the course of the final facility design, the project engineering geologist or geotechnical engineer would provide additional foundation design or ground improvement recommendations based on the ground conditions at the Project Area. These recommendations would become part of the Project specifications.

Mitigation: **<u>4.E-1: Design-Level Geotechnical and Geologic Investigation Report.</u>**

A design-level geotechnical and geologic investigation report shall be completed and submitted to the Town of Moraga for review prior to recording the final subdivision map for the approved Project, as required to obtain grading and construction permits. The investigation shall build upon the Updated Preliminary Geotechnical Exploration (ENGEO 2012) and include site-specific subsurface investigation (e.g. borings, test pits, geophysical methods, etc.) and laboratory testing sufficient to further characterize Project Area landslides and geologic materials and their anticipated response to seismic activity. The design-level geotechnical and geologic investigation report shall be signed and stamped by appropriately licensed professionals and shall be subject to peer review by the Town. Construction of Project improvements shall be in compliance with the design-level geotechnical and geologic investigation report approved by the Town.

<u>Seismic Hazards.</u> At a minimum, seismic evaluations shall be performed in general accordance with California Division of Mines and Geology Special Publication 117 (Guidelines for Evaluating and Mitigating Seismic Hazards in California) and expected ground motions determined by a registered geotechnical engineer shall be incorporated into the final structural design as part of the Project. The design-level investigations shall evaluate and report subsurface conditions with respect to secondary rupture of the lineations mapped at the Project Area as well as potential ground shaking hazards such as liquefaction, cyclic densification, and lateral spreading and shall provide recommendations to mitigate these hazards as necessary. Construction of project improvements shall be in accordance with all recommendations of the design-level geotechnical and geologic investigation report approved by the Town.

Structures and infrastructure for the Project shall be designed in accordance with the most recent version of the California Building Code, which requires structural design that incorporates ground accelerations expected from known active faults. Site grading and landslide mitigation measures shall conform to applicable codes, ordinances, and requirements, including the Title 14 of the Moraga Municipal Code. The stability of cuts and fills shall be supported by appropriate static and seismic stability analyses. Seismic stability analyses shall be based on an appropriate site-specific pseudostatic coefficient. Alternatively, or for cases where pseudostatic analyses indicate unacceptable safety factors, seismic stability may be demonstrated by an appropriate deformation analysis.

<u>Evaluation of and Measures to Address Lineations/Landslides.</u> The lineations and mapped landslides within the Project Area shall be specifically evaluated and reported as part of the design-level geologic and geotechnical investigations. Based on this evaluation, the potential for the lineations to act as groundwater barriers shall be addressed and the project geotechnical engineer shall specify set-backs or provide analyses and recommendations to accommodate possible deformation. The Project Applicant shall locate the project water system and sanitary pipelines to avoid crossing the lineations to the extent practicable. If a pipeline must cross a lineation, and if the design-level investigation indicates potential for seismic displacement, the system shall be designed in accordance with applicable methods identified in the American Lifeline Alliance (2005) design guidance or equal alternative methods. As part of this work, the Project Applicant shall confer with local fire agencies to define appropriate post-earthquake water supply design criteria and shall design pipeline crossing components to meet these criteria. If the design-level investigation indicates potential for seismic

displacement, the Project Applicant shall develop an emergency preparedness and response plan that incorporates methods to respond to and repair pipeline damage (by a HOA or applicable utility) following an earthquake.

Grading, Drainage and Slopes. The design-level geologic and geotechnical investigations shall determine and report final design parameters for the earthwork, foundations, foundation slabs, and any surrounding related improvements (e.g., the water tank, utilities, roadways, parking lots and sidewalks) and shall further define geologic and geotechnical criteria and standards for Project Area grading, drainage, foundation design, landslide mitigation, utilities, roadways, and other structures or facilities potentially affected by the Project. Slope stability assessments and site grading plans shall be prepared by a qualified California licensed engineering geologist or geotechnical engineer and approved by the Town Engineer. Consistent with Moraga 2002 General Plan Public Safety Policies PS4.3 and PS4.4, the Town implements the Geological Hazards Abatement Ordinance, the Hillside Zoning Overlay, and reviews geotechnical reports prior to issuing a Grading Permit. A slope stability assessment shall be required for new developments and slope stability design measures shall be implemented for slopes with gradients steeper than 20%.

Expansive, Compressible and Corrosive Soils. The design-level geologic and geotechnical investigations shall determine and report final design parameters and recommendations for prevention of moisture variation, potentially compressible colluvium and landslide deposits and corrosivity of Project Area soils.

Foundation and Pavement Design. The design-level geologic and geotechnical investigation report shall provide criteria and recommendations for foundation and pavement design to minimize the effects of settlement and address site-specific conditions (including soil corrosivity) developed from field exploration and laboratory testing. Criteria and recommendations shall be in accordance with California Building Code requirements. The design-level criteria and recommendations shall be subject to review by the Town.

After Mitigation: ***Less than Significant Impact; Project (126 units), Alternative 2 (8 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units).***

Implementation of Mitigation Measure 4.E-1 would reduce the impact to a less than significant level.

Impact: 4.E-2. Will the Project or Alternatives expose people or structures to major geologic hazards, such as strong seismic groundshaking, or seismic related ground failure including rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault?

Analysis: ***No Impact; Alternative 1 (No Project)***

Alternative 1 (No Project) involves no new development, and would not result in structures located in areas susceptible to geologic displacement.

Mitigation: ***None required.***

Analysis: ***Significant Impact; Project (126 units), Alternative 2 (8 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units).***

The Project Area is not located within an Alquist-Priolo fault zone and no active faults have been identified or mapped within the Project Area by Graymer (2000, 2006), Crane (1988), Dibblee (1980), or ENGEO (2003). Accordingly, the potential for significant surface rupture associated with active faulting is remote.

ENGEO conducted more recent subsurface explorations that included the excavation and logging of two trenches across the mapped traces of the LaFayette fault to conclude that soils displayed approximately 24,000 years of soil development in one trench and no evidence of active faulting in the second trench. ENGEO (2012) concludes that fault related ground rupture is unlikely at the Project Area.

However, several lineations of Late Quaternary age pass through the west-central portion of the Project Area, The lineations could be the result of a number of factors, possibly including Late Quaternary deformation. As a result, sympathetic ground movements due to an earthquake on one of the nearby active faults are possible. Although ENGEO (2003) indicates that this risk is very minor, they also recommend that any improvements across the mapped lineations should be evaluated on a case-by-case basis. Several lineations of Late Quaternary age pass through the west-central portion of the Project Area and sympathetic ground movements due to an earthquake on one of the nearby active faults are possible. Under the Project and Alternatives, these displacements potentially could damage facility structures and infrastructure such as pipes and underground utility lines depending and this would be a significant impact.

Mitigation: **4.E-1: Design-Level Geotechnical and Geologic Investigation Report.**

See impact analysis 4.E.1 for mitigation language.

After Mitigation: ***Less than Significant Impact; Project (126 units), Alternative 2 (8 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units).***

Implementation of Mitigation Measure 4.E-1 would reduce the impact to a less than significant level through determination of lineation geometry, specification of adequate setbacks, and properly designing and locating pipes and underground utilities.

Impact: 4.E-3. Will the Project or Alternatives result in placement of structures or infrastructure in locations susceptible to landslides or slope instability?

Analysis: ***No Impact; Alternative 1 (No Project)***

Alternative 1 (No Project) involves no new development, and would not result in structures located in areas susceptible to landslides.

Mitigation: ***None required.***

Analysis: ***Significant Impact; Project (126 units), Alternative 2 (8 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units).***

Landslides have the potential to cause significant damage to roads, utilities, and structures, and can be life-threatening. A published regional scale landslide map of the Project Area (Nilsen 1975) shows that more than 50 individual landslides are present in the Project Area. These landslides were confirmed by ENGEO (2003). A peer review for the Town by California Engineering and Geology CEG (2011) concluded that the Conceptual Development Plan (The Planning Team 2003) and Preliminary Geotechnical Exploration (ENGEO 2003) did not provide sufficient information and analysis to conclude that the Project is consistent with several Moraga 2002 General Plan policies related to geologic risks. In response, ENGEO provided response to peer review comments, and completed supplemental explorations on January 26 and February 6, 2012 that included two exploratory trenches, 20 additional test pits, and four cross sections in critical sliding areas. Table 4.E-7 summarizes consistency of the Project and Alternatives with Moraga 2002 General Plan policies related to geologic risk.

Table 4.E-7

Consistency with General Plan Policies Applicable to Soils and Geology

Applicable General Plan Policy	Project Consistency
LU1.8 Slope Restrictions. The soil characteristics in Moraga are prone to landslide conditions which can cause damage to property, injury to persons, public cost and inconvenience; therefore, development shall be avoided on slopes of 20 percent or steeper, but may be permitted if supported by site-specific analysis. No new residential structures may be placed on after-graded average slopes of 25 percent or steeper within the development area, except that this provision shall not apply to new residential structures on existing lots that were either legally created after March 1, 1951 or specifically approved by the Town Council after April 15, 2002. All new non-MOSO lots shall contain an appropriate development area with an average after-graded slope of less than 25%. Grading on any non-MOSO land with an average predevelopment slope of 25% or more within the proposed development area shall be prohibited unless formally approved by the Town Council where it can be supported by site-specific analysis and shown that a minimum amount of grading is proposed in the spirit of and not incompatible with all other policies of the General Plan. Under the terms of the Moraga Open Space Ordinance, development is prohibited on slopes greater than 20 percent in areas designated MOSO Open Space. The Zoning Ordinance, Chapter 8.52 (Open Space District) of the Moraga Municipal Code, defines the methodology for MOSO Open Space designation.	**Consistent: Project and Alternatives.** The average existing slope gradient in the grading and development footprint in Bollinger Valley is less than 20%. Building sites on after graded slopes would be less than 25%.
OS1.5 Development on Slopes and Ridgelines in Open Space Lands. In MOSO Open Space, development shall be prohibited on slopes with grades of twenty percent (20%) or greater and on the crests of minor	**Consistent: Project and Alternatives.** The ridgelines in Bollinger Valley are located in a "Study" General Plan land use designation, so the 'minor ridgeline' designation or MOSO guidelines do not apply to the

Table 4.E-7

Consistency with General Plan Policies Applicable to Soils and Geology

Applicable General Plan Policy	Project Consistency
ridgelines. The Town Council shall reduce the allowable densities on slopes of less than twenty percent (20%) through appropriate means such as requiring proportionally larger lot sizes or other appropriate siting limitations. For the purposes of this paragraph the term 'minor ridgeline' means any ridgeline, including lateral ridges, with an elevation greater than 800 feet above mean sea level, other than a major ridgeline.	Project.
PS1.3 High Risk Areas. Prohibit development in 'high risk' areas, which are defined as being (1) upon active or inactive slides, (2) within 100 feet of active slides, as defined in Figure 4 of the Safety Element Appendix, or (3) at the base of the centerline of a swale, as shown on the Town's Development Capability Map.	**Consistent: Alternative 1 (No Project)**. Alternative 1 (No Project) involves no development. **Consistent with Mitigation: Project (126 units), Alternative 2 (8 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units).** The Project Area has 'high risk' areas due to steep slopes and active and inactive landslides and slumps. The Project Applicant has conducted a preliminary geotechnical investigation and developed conceptual grading and slope stabilization plans (ENGEO 2003, 2012). The Project would remediate natural hazard risks associated with landslides, liquefaction, expansive soils, and inundation. Implementing **Mitigation Measure 4.E-1,** attains consistency with PS1.3 by requiring design-level geologic investigations and geotechnical stabilization plans to be prepared for Town approval prior to approving the vesting tentative map. The Town will issue a Grading Permit only after the Town Council has determined that the Project's development plan is geologically safe and the Project Area's 'high risk' classification can be removed, and the development area will have an acceptable level of risk as determined by the Town's engineer.
PS1.4 Moderate Risk Areas. Avoid building in 'moderate risk' areas, which are defined as being (1) those areas within 100 yards of an active or inactive landslide, as defined by the Town's Landslide Map, or (2) upon a body of colluvium, as shown in Figure 2 of the Public Safety Element background information. Where it is not possible to avoid building in such areas entirely, due to parcel size and configuration, limit development accordingly through density regulations, subdivision designs that cluster structures in the most stable portions of the subdivision, site designs that locate structures in the most stable portion of the parcel, and specific requirements for site engineering, road design, and drainage control.	**Consistent: Alternative 1 (No Project)**. Alternative 1 (No Project) involves no development. **Consistent with Mitigation: Project (126 units), Alternative 2 (8 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units).** The Project Area has 'moderate risk' areas due to steep slopes and active and inactive landslides and slumps. The Project Applicant has conducted a preliminary geotechnical investigation and developed conceptual grading and slope stabilization plans (ENGEO 2003, 2012). The Project would remediate natural hazard risks associated with landslides, liquefaction, expansive soils, and inundation. Implementing **Mitigation Measure 4.E-1** attains consistency with PS1.4 by requiring design-level geologic investigations and geotechnical stabilization

Table 4.E-7

Consistency with General Plan Policies Applicable to Soils and Geology

Applicable General Plan Policy	Project Consistency
	plans to be prepared for Town approval prior to approving the vesting tentative map. The Town will issue a Grading Permit only after the Town Council has determined that the Project's development plan is geologically safe and the Project Area's 'moderate risk' classification can be removed, and the development area will have an acceptable level of risk as determined by the Town's engineer.
<u>PS4.1 Development in Geologic Hazard Areas.</u> Prohibit development in geologically hazardous areas, such as slide areas or near known fault lines, until appropriate technical evaluation of qualified independent professional geologists, soils engineers and structural engineers is completed to the Town's satisfaction. Allow development only where and to the extent that the geologic hazards have been eliminated, corrected or mitigated to acceptable levels.	**Consistent: Alternative 1 (No Project)**. Alternative 1 (No Project) involves no development. **Consistent with Mitigation: Project (126 units), Alternative 2 (8 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units).** The Project Area has 'high risk' areas due to steep slopes and active and inactive landslides and slumps. The Project Applicant has conducted a preliminary geotechnical investigation and developed conceptual grading and slope stabilization plans (ENGEO, Inc. 2003). The Project would remediate natural hazard risks associated with landslides, liquefaction, expansive soils, and inundation. Implementing **Mitigation Measure 4.E-1** attains consistency with PS4.1 by requiring design-level geologic investigations and geotechnical stabilization plans to be prepared for Town approval prior to issuing a Grading Permit. The Town will issue a Grading Permit only after the Town Council has determined that geologic hazards have been eliminated, corrected, or mitigated to acceptable levels.
<u>PS4.2 Development Review for Geologic Hazards.</u> Require development proposals to address geologic hazards, including but not limited to landslide, surface instability, erosion, shrink-swell (expansiveness) and seismically active faults. Technical reports addressing the geologic hazards of the site shall be prepared by an independent licensed soil engineer, geologist and/or structural engineer, approved by the Town and at the expense of the developer. All technical reports shall be reviewed by the Town and found to be complete prior to approval of a development plan.	**Consistent: Alternative 1 (No Project)**. Alternative 1 (No Project) involves no development. **Consistent with Mitigation: Project (126 units), Alternative 2 (8 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units).** The Project Area includes geologic hazards areas due to steep slopes and evidence of active and inactive landslides and slumps. The Project Area is prone to strong seismic shaking. The Project Applicant has conducted a preliminary geotechnical investigation and developed conceptual grading and slope stabilization plans (ENGEO 2003, 2012). The Project requires additional geologic studies to identify appropriate geotechnical stabilization and soil engineering measures. Implementing **Mitigation Measure 4.E-1** attains consistency with PS4.2 by requiring design-level geologic investigations and geotechnical stabilization plans to be prepared for Town approval prior to approving the vesting tentative

Table 4.E-7

Consistency with General Plan Policies Applicable to Soils and Geology

Applicable General Plan Policy	Project Consistency
	map. The Town will issue a Grading Permit only after the Town Council has determined that the Project's development plan is geologically safe and the Project Area's geologic risk classification can be removed, and the development area will have an acceptable level of risk as determined by the Town's engineer.
PS4.3 Development Densities in Hazard Areas. Minimize the density of new development in areas prone to seismic and other geologic hazards.	**Consistent: Alternative 1 (No Project) and Alternative 2 (8 units)**. Alternative 1 (No Project) involves no development. Alternative 2 (8 units) provides minimal residential density of 0.05 DUA. With a 5-acre minimum parcel size, this analysis assumes that development and new structures and utilities can be located in geologically stable portions of the Project Area. **Consistent with Mitigation: Project (126 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units).** The Project Area includes geologic hazard areas due to steep slopes and evidence of active and inactive landslides and slumps. The Project Area is prone to strong seismic shaking. The Project Applicant has conducted a preliminary geotechnical investigation and developed conceptual grading and slope stabilization plans (ENGEO 2003, 2012). The Project requires additional geologic studies to identify appropriate geotechnical stabilization and soil engineering measures. Implementing **Mitigation Measure 4.E-1 attains** consistency with PS4.3 by requiring design-level geologic investigations and geotechnical stabilization plans to be prepared for Town approval prior to approving the vesting tentative map. The Town will issue a Grading Permit only after the Town Council has determined that the Project's development plan is geologically safe and the Project Area's geologic risk classification can be removed, and the development area will have an acceptable level of risk as determined by the Town's engineer.
PS4.5 Public Facilities and Utilities in Landslide Areas. Prohibit the financing and construction of public facilities or utilities in potential landslide areas.	**Consistent: Alternative 1 (No Project) and Alternative 2 (8 units)**. Alternative 1 (No Project) involves no development. Alternative 2 (8 units) provides minimal residential density of 0.05 DUA. With a 5-acre minimum parcel size, this analysis assumes that development and new structures and utilities can be located in geologically stable portions of the Project Area. **Consistent with Mitigation: Project (126 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units).** The Project Area has potential landslide areas. The Project Applicant has conducted a preliminary geotechnical investigation and

Table 4.E-7

Consistency with General Plan Policies Applicable to Soils and Geology

Applicable General Plan Policy	Project Consistency
	developed conceptual grading and slope stabilization plans (ENGEO 2003, 2012). The Project requires additional geologic studies to identify appropriate geotechnical stabilization and soil engineering measures. Implementing **Mitigation Measure 4.E-1** attains consistency with PS4.5 by requiring more detailed geologic investigations and geotechnical stabilization plans to be prepared for Town approval prior to approving the vesting tentative map. The Town will issue a Grading Permit only after the Town Council has determined that the Project's development plan is geologically safe and the Project Area's geologic risk classification can be removed, and the development area will have an acceptable level of risk as determined by the Town's engineer.
<u>PS4.6 Construction Standards.</u> Ensure that all new construction and applicable remodeling/ reconstruction projects are built to established standards with respect to seismic and geologic safety.	**Consistent: Project and Alternatives.** Project designs, plans, and construction methods are subject to review, approval, monitoring, and inspection by Town Engineers and Building Inspectors.
<u>PS4.7 Construction Oversight.</u> Adopt and follow procedures to ensure that the recommendations of the project engineer and the design and mitigating measures incorporated in approved plans are followed through the construction phase.	**Consistent: Project and Alternatives.** Project designs, plans, and construction methods are subject to review, approval, monitoring, and inspection by Town Engineers and Building Inspectors.
<u>PS4.9 Water Storage Reservoirs.</u> Permit properly designed storage reservoirs for domestic water supply only in those locations that will pose no hazard to neighboring development.	**Consistent: Project and Alternatives.** Alternative 1 (No Project) involves no development. The Project (126 units) and Alternative 2 (8 units) do not include water storage reservoirs. Under Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units), water storage reservoirs would be located behind earthen berms with a drainage system that would direct water from catastrophic breach away from home sites.
<u>PS4.10 Grading.</u> Grading for any purpose whatsoever may be permitted only in accordance with an approved development plan that is found to be geologically safe and aesthetically consistent with the Town's Design Guidelines. Land with a predevelopment average slope of 25% or greater within the development area shall not be graded except at the specific direction of the Town Council and only where it can be shown that a minimum amount of grading is proposed in the spirit of, and not incompatible with, the intention and purpose of all other policies of the General Plan. The Town shall develop an average slope limit beyond which grading shall be prohibited unless grading is required for landslide repair or slope stabilization.	**Consistent: Alternative 1 (No Project) and Alternative 2 (8 units)**. Alternative 1 (No Project) involves no development. Alternative 2 (8 units) requires no mass grading of hillslopes. **Consistent with Mitigation: Project (126 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units).** The development area in Bollinger Valley has an average existing slope gradient less than 25%. The Project Area has geologic hazards due to active and inactive landslides, and potential for inundation and seismic shaking. Implementing **Mitigation Measure 4.E-1** attains consistency with PS4.10 by requiring design-level geologic investigations and geotechnical stabilization plans to be prepared for Town approval prior to approving the vesting tentative map. The Town will issue a Grading Permit only after the Town Council has

Table 4.E-7

Consistency with General Plan Policies Applicable to Soils and Geology

Applicable General Plan Policy	Project Consistency
	determined that the Project's development plan is geologically safe, consistent with Moraga's 2010 Design Guidelines 2010, and the Project Area's geologic risk classification can be removed. The Town engineer is required to determine that the development area will have an acceptable level of risk.

Approval of a grading plan is required by the Town prior to issuance of a building permit. Prior to issuing a grading permit, the Project Applicant will be required to provide a grading plan and report for the approval by the Building Inspection Department (BID). The grading plan and report would need to comply with the recommendations of the design level geotechnical and geologic investigation report and conform to the requirements specified in Title 14 of the Moraga Municipal Code. This report would evaluate and address major graded slopes and open space hillsides whose short- and long-term performance could affect or be affected by the planned development. The grading plan would also identify proposed maintenance access roads to any landslide mitigation features such as catchment basins and drainage facilities to be maintained by the HOA or GHAD. The Town will issue a Grading Permit only after the Town Council has determined that the Project's development plan is geologically safe and the Project Area's 'high risk' classification can be removed, and the development area will have an acceptable level of risk as determined by the Town's engineer.

Although the grading plan would help to address this issue, additional mitigation such as design-level geologic and geotechnical investigations, deed disclosure and construction monitoring and reporting is necessary to ensure slope instability and risk of landsliding are fully addressed. This would be a significant impact.

Mitigation Measure 4.L-4 (see Section 4.L Traffic impact analysis 4.L-4) would require widening of Bollinger Canyon Road to address traffic impacts. Bollinger Canyon Road is not evaluated as part of the Project Area but implementation of Mitigation Measure 4-L-4 would potentially increase existing areas of slope instability and recent landsliding, as documented in the California Engineering and Geology Memorandum dated March 29, 2012. Widening of Bollinger Canyon Road to address traffic impact would be a significant impact requiring mitigation to reduce potential impacts from slope instability to a level of less than significant.

Mitigation: **4.E-1: Design-Level Geotechnical and Geologic Investigation Report.**

See impact analysis 4.E.1 for mitigation language.

Mitigation: **4.E-3a: Deed Disclosure.**

Prior to recording Final Subdivision Map(s), the Project Applicant shall provide a deed disclosure for each lot that references the design-level geotechnical and geologic investigation report and that summarizes the potential geologic hazards associated with the lot. The deed disclosure shall provide a thorough description of landslide mitigation measures associated with the lot and shall provide details of the maintenance responsibilities of the property owner. The disclosure shall advise the property owner if future Project Area improvements could trigger instability. The language of the deed disclosure shall be subject to review and approval of the Town.

Mitigation: **4.E-3b: Construction Monitoring, Testing, and Reporting.**

During Project Area grading and landslide remediation activities, the project engineering geologist or geotechnical engineer shall observe and approve keyway excavations, removal of fill and/or landslide materials down to stable bedrock or in-place material, and the installation of subdrains, including connections and outlet structures. Cut slopes shall be observed and mapped by the project engineering geologist or geotechnical engineer who shall provide recommendations for slope modifications (if any) based on the actual conditions encountered during grading. Written approval of modifications shall be obtained from the Town (or its representatives) prior to any modification to the approved grading plan. Placement of fill shall be observed and tested by the project engineer and the test results and final report shall be submitted to the Town.

Mitigation: **4.E-3c: Stabilize Areas of Slope Instability and Landsliding along Bollinger Canyon Road.**

Implementation of this mitigation measure shall be required in the context of implementation of Mitigation Measure 4.L-4 (see impact analysis 4.L.4 for mitigation language).

Prior to design of road improvements required under Mitigation Measure 4.L-4, a comprehensive evaluation of the Bollinger Canyon Road section between St. Mary's Road and Joseph Drive shall be completed and recommendations for stabilization of the road cut shall be developed for review and approval by the Town.

After Mitigation: ***Less than Significant Impact; Project (126 units), Alternative 2 (8 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units).***

Implementation of Mitigation Measures 4.E-1, 4.E-3a, 4.E-3b and 4.E-3c would reduce the impact from slope instability and landsliding to a less than significant level.

Impact: 4.E-4. Does the Project or Alternatives have the potential to result in damage to structures or infrastructure due to settlement of natural deposits or improperly constructed fills?

Analysis: ***No Impact; Alternative 1 (No Project)***

Alternative 1 (No Project) involves no new development, and would not have the potential to result in damage to structures or infrastructure due to settlement of natural deposits or improperly constructed fills.

Mitigation: ***None required.***

Analysis: ***Significant Impact; Project (126 units), Alternative 2 (8 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units).***

Settlement of natural deposits or improperly constructed fills could damage project structures and infrastructure. Loads such as that of a building or new fill material can cause the underlying soil to settle relative to the surrounding, unloaded areas. Soils tend to settle differentially and at different rates depending on a number of factors such as soil type, moisture content, and loading. In general, areas are susceptible to differential settlement if they are underlain by compressible sediments or poorly engineered artificial fill. The Project Area is predominately underlain by bedrock and soft, compressible sediments are largely absent. However, ENGEO (2003) noted that localized layers of potentially compressible silty and sandy clay were encountered with the terrace deposits ("Qt" in Figure 4.E-1) at depths up to about 47 feet below the existing ground surface. ENGEO (2003) also recommended that potential compressibility of the terrace deposits be further evaluated based on additional exploration and testing. This would be a potentially significant impact.

Mitigation: **4.E-1: Design-Level Geotechnical and Geologic Investigation Report.**

See impact analysis 4.E.1 for mitigation language.

After Mitigation: ***Less than Significant Impact; Project (126 units), Alternative 2 (8 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units).***

Implementation of Mitigation Measure 4.E-1 would reduce the impact to a less than significant level.

Impact: 4.E-5. Will the Project or Alternatives result in substantial soil erosion or loss of topsoil?

Analysis: ***Less than Significant; Alternative 1 (No Project)***

Alternative 1 (No Project) involves no new development; however the moderate level of soil erosion onsite would persist. ENGEO (2003) noted that areas of moderate erosion in the forms of surface flow and gullying were observed at the Project Area and that erosion was particularly evident on the banks of the main drainage channel in the southern portion of the Project Area.

Mitigation: ***None required.***

Analysis: ***Significant Impact; Project (126 units), Alternative 2 (8 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units).***

Site construction and development could result in substantial soil erosion or the loss of topsoil. Site grading activities would require excavation, scraping, grading, embankment construction, and stockpiling of rock and soil. As a result of these activities, erosion rates potentially could be accelerated because of surface disturbance and vegetation removal. Construction activities conducted when the ground is wet could also create potential for increased runoff, which in turn, could lead to increased erosion. Additionally topsoil would be stripped and removed from grading and excavation areas.

As required, a Notice of Intent (NOI), Stormwater Pollution Prevention Plan (SWPPP), and Stormwater Control Plan (SCP) would be prepared and submitted along with grading permit applications. The SWPPP provides for temporary measures to control sediment and other pollutants during construction at sites that disturb one acre or more and the SCP specifies permanent controls (such as drainage ditches) that should last for the life of the Project. The requisite plans would be prepared in accordance with the standards provided in the Manual of Erosion and Sedimentation Control Measures (ABAG, 1995). Implementation of the plan would help stabilize graded and stockpile areas and reduce erosion and sedimentation. The plans would designate Best Management Practices (BMPs) that would be adhered to during construction activities. Erosion minimizing efforts such as hay bales, water bars, covers, sediment fences, sensitive area access restrictions (for example, flagging), and/or retention/settlement areas would be implemented as necessary before the onset of inclement weather. Mulching, seeding, or other suitable stabilization measures would be used to protect exposed areas during construction activities. The plans would incorporate requirements of the Contra Costa County Clean Water Program, the Moraga Municipal Code, and other applicable federal, state, and local requirements. However, additional mitigations such as a restricted grading period and topsoil stockpiling are required to reduce potential impacts from soil erosion to a level of less than significant.

Mitigation: **4.E-5a: Grading Period.**

Grading activities shall be restricted to the summer construction season (April 15 through October 15). Any Project Area earthwork after October 15 shall be limited to activities related to erosion control unless authorized in writing by the Town. These restrictions shall be included in the construction specifications and grading plans.

Mitigation: **4.E-5b: Stockpile Topsoil.**

To the extent practicable, existing topsoil in areas to be graded shall be stockpiled and re-used in the Project Area for landscaping, erosion control, or other purposes. These restrictions shall be included in the construction specifications and grading plans submitted and approved by the Town.

After Mitigation: ***Less than Significant Impact; Project (126 units), Alternative 2 (8 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units).***

Implementation of Mitigation Measures 4.E-5a and 4.E-5b would reduce potential impacts of soil erosion to a less than significant level.

Impact: 4.E-6. Will the Project or Alternatives be located on expansive or corrosive soil, creating substantial risk to life or property?

Analysis: ***No Impact; Alternative 1 (No Project)***

Alternative 1 (No Project) involves no new development, and would not expose people or structures to geologic hazards.

Mitigation: ***None required.***

Analysis: ***Significant Impact; Project (126 units), Alternative 2 (8 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units).***

The Project Area is located on expansive soils that have the potential to cause damage to foundations, slabs, pavements, and structures. Expansive soils possess a “shrink-swell” characteristic. Shrink-swell is the cyclic change in volume (expansion and contraction) that occurs in fine-grained clay sediments from the process of wetting and drying. Structural damage may occur over a long period of time, usually the result of inadequate soil and foundation engineering or the placement of structures directly on expansive soils. Soils in the

Project Area are expansive (ENGEO, 2003; Radbruch, 1969). This would be a potentially significant impact. Damage due to volume changes associated with expansive soils can be reduced through proper grading and foundation preparation. Typical mitigation measures include over-excavating cut and cut/fill transition lots, moisture conditioning fills over the optimum moisture content, presoaking below slabs, and using thickened mat foundations or deepened footings.

Mitigation: **4.E-1: Design-level Geologic and Geotechnical Investigation Report.**

See impact analysis 4.E-1 for mitigation language.

After Mitigation: ***Less than Significant Impact; Project (126 units), Alternative 2 (8 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units).***

Implementing Mitigation Measure 4.E-1 applies standard engineering techniques to reduce potential risks associated with construction on expansive soils to less than significant.

Impact: 4.E-7. Will the Project or Alternatives have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?

Analysis: ***No Impact; Project (126 units), Alternative 1 (No Project), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units)***

Alternative 1 (No Project) involves no new development, and so would not pose potential risks to groundwater and surface water associated with septic systems on inappropriate soils. The Project (126 units), Alternative 3 (37 units), Alternative 4 (100 units), and Alternative 5 (121 units) would provide a connection to an existing CCCSD gravity flow trunk sewer on Bollinger Canyon Road and would not use septic tanks or alternative wastewater disposal systems. The connection would include an eight-inch diameter main line from the Project Area that would extend approximately 5,500 feet in Valley Hill Road and Bollinger Canyon Road. The existing service capacity of the CCCSD trunk line is adequate to accommodate the Project (Leavitt 2007). Consequently, there would be no impact associated with septic systems and no mitigation is required.

Mitigation: ***None required.***

Analysis: ***Significant Impact; Alternative 2 (8 units)***

Alternative 2 (8 units) would involve the development of up to eight residential lots with a minimum parcel size of five acres. Under this alternative, residences would have individual well and septic systems for water and wastewater disposal. While individual well and septic systems provide water and wastewater disposal for residences developed at a similar density in similar soils and geologic settings as the Project Area, site specific studies have not been conducted for Alternative 2 (8 units) to determine the suitability of soils and geology of the Project Area. Consequently, Project Area soils are considered potentially incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater. This is considered a significant impact and mitigation is required.

Mitigation: **4.E-7: Conduct Soils Investigations for Septic Systems.**

Prior to approving a vesting tentative map for Alternative 2 (8 units), the Town shall review and approve soils and geology studies that demonstrate that individual lots have appropriate soils for septic systems, and that the septic systems can be installed and operated without adversely affecting domestic water supply wells, groundwater, and surface water. The studies shall demonstrate that County water quality standards can be met with the use of septic systems on residential lots in Project Area in Bollinger Valley. If Project Area soils are determined incompatible with septic systems, Alternative 2 shall require redesign to avoid potential impacts.

After Mitigation: ***Less than Significant Impact; Alternative 2 (8 units)***

Implementing Mitigation Measure 4.E-7 would apply standard geologic and soil investigations to determine if the soils in Bollinger Valley are compatible with septic systems without potential impacts to domestic water supply wells, groundwater, or surface water. If Project Area soils are determined incompatible with septic systems, Alternative 2 would require redesign to avoid potential impacts to water quality.

4.E-4 CUMULATIVE IMPACTS

The impacts identified in this section are less than significant with implementation of recommended mitigation measures. The Project would construct facilities in a seismically active area, and thus contributes to the cumulative exposure to seismic hazards, such as ground shaking, in the region as a whole. However, this is the case for any project constructed in the State of California, and the actual level of risk is Project Area specific and would not be cumulatively increased at any particular site. The risk of damage from unstable slopes, on-site erosion, and expansive or corrosive soils is also site-specific. Measures proposed as part of the Project would reduce the impacts to less than significant, and because the risk is Project Area specific, it would not be cumulatively increased at any particular site.

4.E-5 PREPARERS

4.E-5.1 Preparers

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