3.2 GEOLOGY AND SOILS

This section describes the existing environmental conditions for the project site. Issues appearing in this section include geological setting, topography, soils and soil conditions, seismic conditions and mineral resources. The general and site-specific discussion of land resources contained herein provides the environmental baseline by which environmental impacts are identified and measured. Environmental impacts are discussed in **Section 4.0**.

3.2.1 REGULATORY SETTING

Agencies having potential jurisdiction over geological resources and project-related impacts pertaining to geology are identified under 40 CFR 1508.15. These agencies include U.S. Environmental Protection Agency (USEPA), the U.S. Army Corps of Engineers (USACE), the San Francisco Bay Conservation and Development Commission (BCDC), the Association of Bay Area Governments (ABAG), Contra Costa County (County), and the City of Richmond (City). The agencies identified above are either chartered by, or exercise jurisdiction over specific resources through a set of statutes or plans. The laws, ordinances, regulations, and standards are summarized in **Table 3.2-1**, enumerated below, and seriated according to their relation to federal, state, or local governments.

FEDERAL

The USEPA is the permitting authority through the Clean Water Act (CWA) National Pollution and Discharge Elimination System (NPDES). A NPDES Construction General Permit (General Permit) is generally required for construction and land disturbance greater than one acre. The General Permit requires a site-specific Stormwater Pollution Prevention Plan (SWPPP) that describes Best Management Practices (BMPs) that are implemented during construction, including procedures for dewatering of encountered groundwater. The goal of the SWPPP is to limit erosion during construction-related earth moving, mass grading, cut and fill activities, and to prevent sediment-laden stormwater and other potential pollutants from being transported off site. Refer to **Section 3.3** for a discussion of the water quality regulatory setting.

STATE

California Building Code

The California Building Code (CBC), (California Code of Regulations (CCRs), Title 24, Part 2), is a portion of the California Building Standards Code. Title 24 is assigned to the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. Under State law, all building standards must be centralized in Title 24 or they are not enforceable.

TABLE 3.2-1
LAWS, ORDINANCES, REGULATIONS, AND STANDARDS

Jurisdiction	Authority	Administrating Agency	Compliance
Federal/State/ Local	California Building Code (CBC), as amended by the City of Richmond	California Building Standards Commission, State of California, and City of Richmond	Acceptable design criteria for structures with respect to operating (dead plus live and wind) loads, seismic design loads, and load-bearing capacity.
State/Local	Alquist-Priolo Earthquake Fault Zoning Act (Public Resoruces Code (PRC), Chapter 7.5)	Title 14, Division 2, Chapter 8, Subchapter 1, Article 3, California Code of Regulations; city of Richmond and Contra Costa County	Identifies areas subject to surface rupture from active faults.
State/Local	Seismic Hazards Mapping Act (PRC Section 2695)	Contra Costa County	Identifies non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides.
State/Local	California Surface Mining and Reclamation Act (SMARA) (PRC Division 2, Chapter 9)	State Division of Mining/Contra Costa County/ City of Richmond	Requires identification and classification of Mineral Resource Zones (MRZs) to limit new development in areas with significant mineral deposits.
Local	Contra Costa County General Plan, Conservation and Safety Elements	Contra Costa County	The County shall require all new buildings to be constructed in accordance with the CBC for a Seismic Zone 4.
Local	City of Richmond General Plan (City), Public Safety Element	City of Richmond (City) planning department	The City shall require all new buildings to be constructed in accordance with the CBC for a Seismic Zone 4.
Local	City Grading Ordinance	City planning department	The ordinance requires that a registered civil engineer for projects within the City of Richmond prepare a preliminary and final erosion and sediment control plan
Local	City General Plan, Open Space and Conservation Element	City planning department	Requires local governments to regulate mineral resources at the planning level including identifying mineral resource zones (MRZs) and allowing those minerals to be mined and/or extracted prior to urban encroachment projects into the MRZs.

Source: AES, 2008.

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972; it prohibits the placement of structures intended for human occupancy from being built across active fault traces in California. The Act requires delineation of zones (Alquist-Priolo zones) along active faults in order to regulate development on or near active fault traces. The Act only addresses the hazards of surface fault rupture and is not intended to regulate activities relating to other earthquake hazards such as liquefaction, landslides, or tsunamis. Cities and counties are required to regulate development projects within Alquist-Priolo zones. While Alquist-Priolo zones are intended to identify active fault traces, regulation of surface fault ruptures and other seismic activities are not restricted to the Act.

Seismic Hazards Mapping Act

This Seismic Hazards Mapping Act requires cities, county, and local permitting agencies to regulate urbanization development and redevelopment projects within seismic hazard zones that have been delineated by the state geologist. Before a development permit can be granted to a proposed project located in a seismic hazard zone, a geotechnical investigation of the site must be conducted and appropriate mitigation measures incorporated into the project design.

Surface Mining and Reclamation Act of 1975

The California Surface Mining and Reclamation Act (SMARA) is part of the California PRC, Division 2, Chapter 9, sections 2710, *et seq*. SMARA requires classification of land into Mineral Resource Zones (MRZs) according to the mineral potential of that area.

Natural resources can include geologic deposits of valuable minerals used in various manufacturing processes and the production of construction materials. SMARA was enacted to limit new development in areas with significant mineral deposits and requires the state geologist to classify lands within California based on mineral resource availability. The classifications are categorized by MRZs, according to the presence or absence of significant mineral resources. The classification process disregards the existing land use or land ownership and is based solely on subsurface geology. The primary goal of classifying MRZs is to ensure local governments recognize the mineral potential of the land before making land use decisions that preclude mining of the geological resource.

LOCAL REGULATORY SETTING

City of Richmond

Grading Ordinance

Section 12.44.030 of the Richmond City Excavation, Grading, and Earthwork Construction Ordinance establishes minimum standards and requirements for grading, excavation, and filling activities, and identifies procedures by which the standards and requirements are enforced. The provisions of the ordinance are supplementary and in addition to the zoning and subdivision regulations of the City. These provisions and other City ordinances are applicable to projects that are constructed within the City of Richmond. The ordinance requires that a registered civil engineer for projects within the City prepare a preliminary and final erosion and sediment control plan. The preliminary plan defines locations of all cut and fill slopes, grading and earthwork limits of disturbance as well as the measures to control and minimize erosion, sedimentation, and fugitive dust during the construction of the project. The final plan includes details regarding operational control features put in place to minimize soil erosion, maximize sediment interception, and control runoff from the project site. The ordinance is implemented through the City's permitting process, which requires adherence to grading and seismic safety requirements within the CBC.

General Plan

Open Space and Conservation Element

The City's General Plan Open Space and Conservation Element includes the following policies for the regulation of Mineral Resources:

OSC-D.1 Encourage the state, or other appropriate agency, to conduct and maintain the following:

a. Protect the need for minerals based on future population growth.

b. Designate areas of critical importance as mineral resources.

OCS-D.2 Allow extraction of mineral resources (primarily from rock formations suitable for producing crushed rock for construction purposes) where it can be done without creating significant noise, dust, traffic, or visual impacts on surrounding areas.

OCS-D.3 Recognize the mineral resources that have been classified and/or designated by the State Mining and Geology board as having statewide or regional significance and conserve them to meet future needs of mineral resources within the region.

OCS-D.4 Protect the mineral resources, which have been classified and/or designated mineral resources from urban encroachment and development incompatible with mining.

OCS-D.5 Examine undeveloped lands that may be recognized in the future as possessing mineral resources of statewide or regional significance to determine the feasibility of conserving those lands for future mineral extraction.

OCS-D.6 Require buffers, vegetation, water treatment, dust control and other measures as deemed necessary to protect the physical and social environment where mineral extraction will be carried out.

OCS-D.7 Require revegetation of land used for mineral production and either restoration of the land to its original condition, or improvement for appropriate use after mineral extraction has been completed.

OCS-D.8 Limit construction in areas adjacent to designated mineral resource areas to those uses that will not be impacted by significant noise, dust, traffic, or visual impacts of mining operations.

OSC-A.3 Minimize removal of vegetation in all new developments. In particular, the cutting of mature native woodland trees, especially on unstable slopes and in creek beds, should be controlled.

Safety Element

<u>Geology</u>

SF-A Minimize the risks of injury, loss of life, and property damage from seismically induced and other known geologic hazards.

SF-A.2. Require all properties in private, public, or quasi-public ownership to be reviewed for structural integrity.

SF-A.7. Require a site investigation for any major or important structures to determine the degree of seismic and geologic hazards that can be expected for the particular structure (e.g., unreinforced masonry), and have the investigation reviewed by a technically qualified professional.

Existing and proposed programs and actions designed to meet the policies of Goal SF-A above include the following:

- The City will require a detailed structural investigation of municipal buildings by a structural engineer and make modifications to those buildings, as budget constraints permit.
- The City will require post-earthquake inspection of public and private buildings for structural integrity.
- The City will appraise individual development projects for the potential of significant geologic, seismic, soils, and hydrologic problems. Study and reporting will be made of seismic safety considerations in all Environmental Impact Reports (EIRs). Those sections of an EIR dealing with geology should be reviewed by an engineering geologist prior to being presented to a designated city board or commission.
- The City will incorporate the following measures into either already existing ordinances (e.g., subdivision ordinance) or proposed ordinances (e.g., hillside ordinance).
    - Minimize the removal of natural vegetative cover and re-vegetate quickly.
    - All major drainages should be kept clear of debris.
    - Where possible, direct drainage away from unstable slopes and at-capacity drainages.
    - Immediately inspect landslides to mitigate any flooding hazard that might result from blockage of drainages.
    - The project soils engineer should be notified at least four working days prior to any site clearing or grading operations on the property in order to observe grading and removal of vegetation.

- o A geologist or soil engineer should be present during site preparation and construction to evaluate the quality of work, verify compliance with geotechnical recommendations and suggest changes in procedures when necessary.
- o The City will require soil investigations by a geotechnical engineer or an engineering geologist registered in the State of California as part of the site-specific environmental review process for any proposed development on soils with moderate to high shrink-swell potential as defined by the Contra Costa County Soil Survey as mapped by the United States Department of Agriculture (USDA Soil Conservation Service, 1977). Review development on soils with moderate to high shrink-swell potential in terms of site grading, foundation design, and construction in order to avoid site and structural damage resulting from such soil conditions.

3.2.2 ENVIRONMENTAL SETTING

TOPOGRAPHY

Contra Costa County consists of four distinct topographical areas. These areas include: 1) the uplands in the Coast Ranges, 2) the terraces, consisting of the fans and floodplains in the Diablo Valley, 3) the river channel and delta overflow land, and 4) the tidal flats of the Bay (CCTA, 2003). The topography of the project site exhibits the characteristics of both the uplands in the coastal range and the tidal flats of the Bay. Elevations on the project site range from mean sea level (msl) along the western shoreline of the site to approximately 350 feet above msl along the eastern border of the site. The crest of the Potrero Ridge forms the eastern border of the site. The slopes on the project site range from relatively flat within the open shoreline areas to approximately 75 percent along the steep hillsides of the Potrero Ridge.

GEOLOGY

Information provided in this section is derived from a number of sources including United States Geological Survey (USGS) maps and publications, California Geological Survey (CGS), a site-specific geotechnical investigation performed in 2006, and a historic building structural assessment performed in 2007 for the Winehaven and associated existing on-site buildings. The project site is located in the Coast Ranges geomorphic province of California. The Coast Ranges province lies between the Pacific Ocean and the Great Valley of California and stretches from the Oregon border to the north and continues south to the Santa Ynez River near Santa Barbara. Much of the Coast Range province is characterized by discontinuous northwest trending mountain ranges, ridges, and intervening valleys composed of marine sedimentary and volcanic rocks of the Franciscan Assemblage. The Franciscan Assemblage consists primarily of greenstone (altered volcanic rock), basalt, chert (ancient silica rich ocean deposits), and sandstone that originated as ancient sea floor sediments. The site-specific geotechnical investigation was performed by Engeo Incorporated of Vallejo, CA (**Appendix I**). The scope of the investigation included field explorations to collect soil borings, excavation of soil test pits, and laboratory analysis of materials collected during the field activities. On December 23, 2005, five exploratory test borings were drilled within the southern residential area of the project site to depths ranging from 15.5 feet below ground surface (bgs) to 41.5 feet bgs. Soil samples from the borings were retained for laboratory analysis. The results of the investigation, including boring logs, are included in the geotechnical report. According to the laboratory results, on-site soils are composed of stiff to hard silty clays and clayey silts with variable amounts of gravel. The laboratory analysis determined the clayey soils to be moderately expansive. Fill materials were encountered in all five exploratory borings, as well as five of the ten exploratory test pits. The depth of undocumented fill ranged between 2.5 feet and 9 feet. The fill materials appear to have been placed primarily in the southwestern portion of the site (Engeo, 2006, **Appendix I**).

Three distinct geologic materials including undifferentiated Franciscan formation bedrock, Bay Mud deposits, and imported fill materials underlie the project site. The Franciscan Formation consists of a “mélange” of sedimentary and volcanic rocks. The mélange accumulated to a thickness of more than 50,000 feet in the deep part of the oceanic basin beyond the continental slope during Late Jurassic (205 to 140 million years ago) to Late Cretaceous time (140 to 65 million years ago). The Franciscan Formation is the oldest exposed geology in the region. Marine and non-marine sedimentary and volcanic rocks, which formed during the Miocene and Eocene time (24 to 5 million years ago), overlie the Franciscan Formation (Contra Costa, 2005). The imported fill materials are composed of a highly variable mix consisting of poorly sorted gravel, silt, sandy silt, sandy clay, and bedrock fragments. The fill materials have been placed over Bay Mud and marsh deposits along the southwest portions of the site. These fill materials are located primarily within the proposed areas of development for the Project (Engeo, 2006, **Appendix I**).

SOILS

The project site is overlain by unconsolidated sediments consisting of clays, silts, and sands, with a thickness ranging up to 1,000 feet or more. These sediments are semi-continuous throughout the Bay and are usually referred to as “Old Bay Mud.” Younger, fine-grained alluvial and estuarine deposits (Young Bay Mud) overlay the Old Bay Mud. The younger, fine grained alluvium is typically a mixture of inter-bedded stiff clays, silts, gravel, and sands derived from the hills or deposited during the formation of the Bay. Differential settlement (settlement that occurs to a greater extent in one area than settling that would be observed in another area) results from variations in thickness of the unconsolidated materials. Relatively speaking, the Bay Muds and fill materials are geologically young and relatively non-compacted, which may lead to consolidation and differential settlement. The shoreline areas at the project site are susceptible to this differential settlement because of variations in thickness of Bay Mud and historical tidal flat deposits.

Soils types within the general region of the project site are derived from the local Franciscan out-crops that are composed of sandstone, serpentine, chert, greenstone, and metamorphic rocks. Soil borings collected onsite consisted of sandstone, siltstone, and shale. There are two soil classifications on the site: Urban Land (Ub) and Millsholm Loam (MeG). Distribution of these soil types is shown in **Figure 3.2-1**.

MeG – Millsholm Loam

The MeG series of soil occurs along the upland areas of the project site. Millsholm Loam is classified as a well-drained soil that formed from interbedded shale and fine-grained sandstone located along slopes that range from 50 to 75 percent. Millsholm Loam complex is in hydrological group D, which includes soils that have a very slow water infiltration rate when thoroughly wet and slow rate of water transmission. Hydrologic group D soils consist chiefly of clays that have a high shrink-swell potential (classified as expansive), soils that have a high water table, soils that have a clay pan or clay layer at or near the surface, and soils that are shallow and located over nearly impervious material. Because of the clay content, these soils have a high rate of surface water runoff, which accounts for the classification as being well drained. These soils do not experience severe ponding or flooding and have a very low susceptibility to sheet and rill erosion (NRCS, 2007).

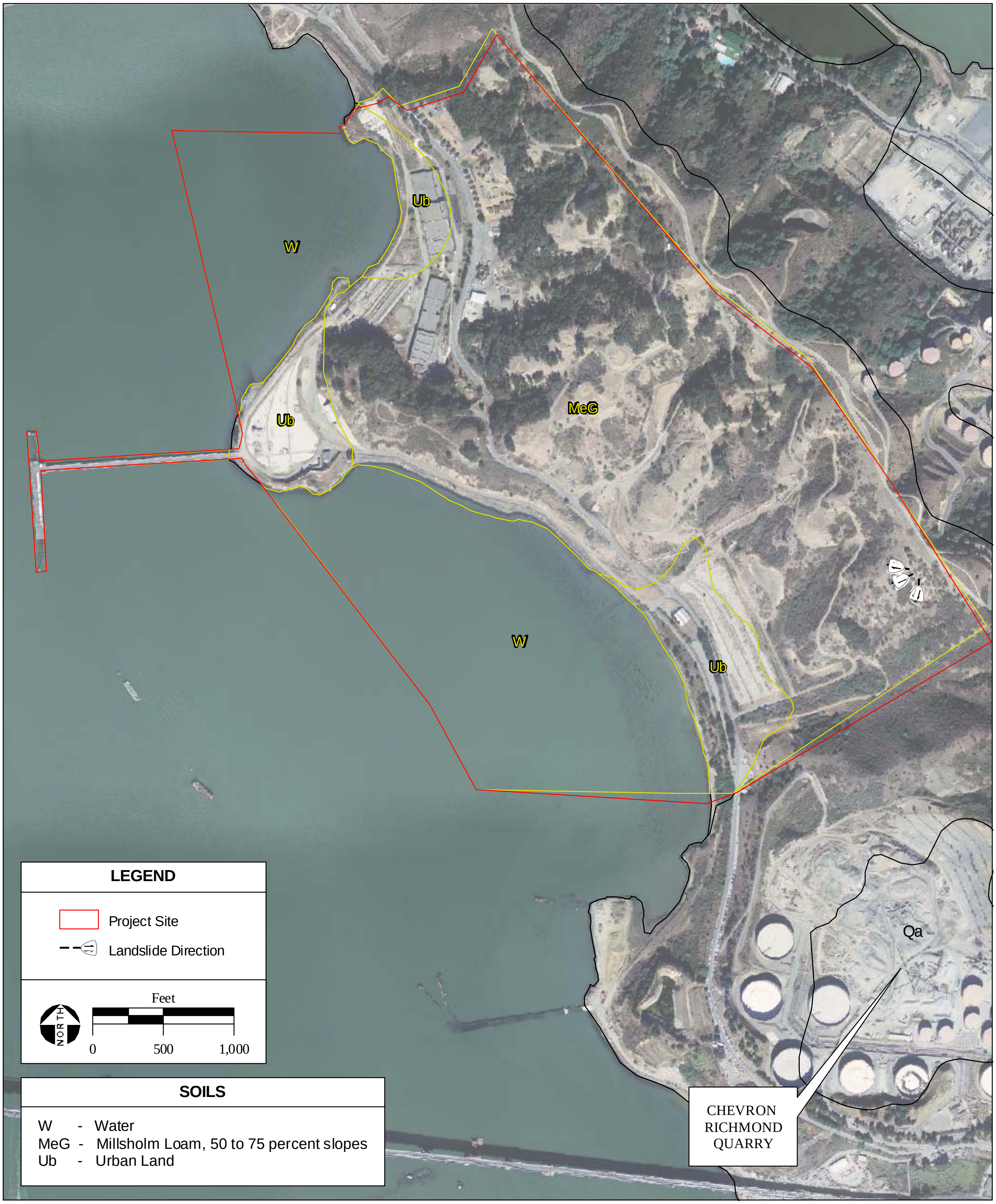
Ub - Urban Land

The Urban Land soil classification consists of areas that are filled with crushed rock or other material resistant to weathering. Such areas are usually adjacent to the Bay and are used for railroad yards and docks. Also included in the Urban classification are areas covered by blacktop material to reduce the hazard of fire after grading and shaping for industrial structures. Thickness of this fill material varies from 18 to 57 feet. The fill materials are highly variable, consisting of poorly sorted gravel, silt, sandy silt, sandy clay, and bedrock fragments. These fill materials have been placed over Bay Mud and marsh deposits in areas adjacent to the shoreline.

BAY AREA FAULTS

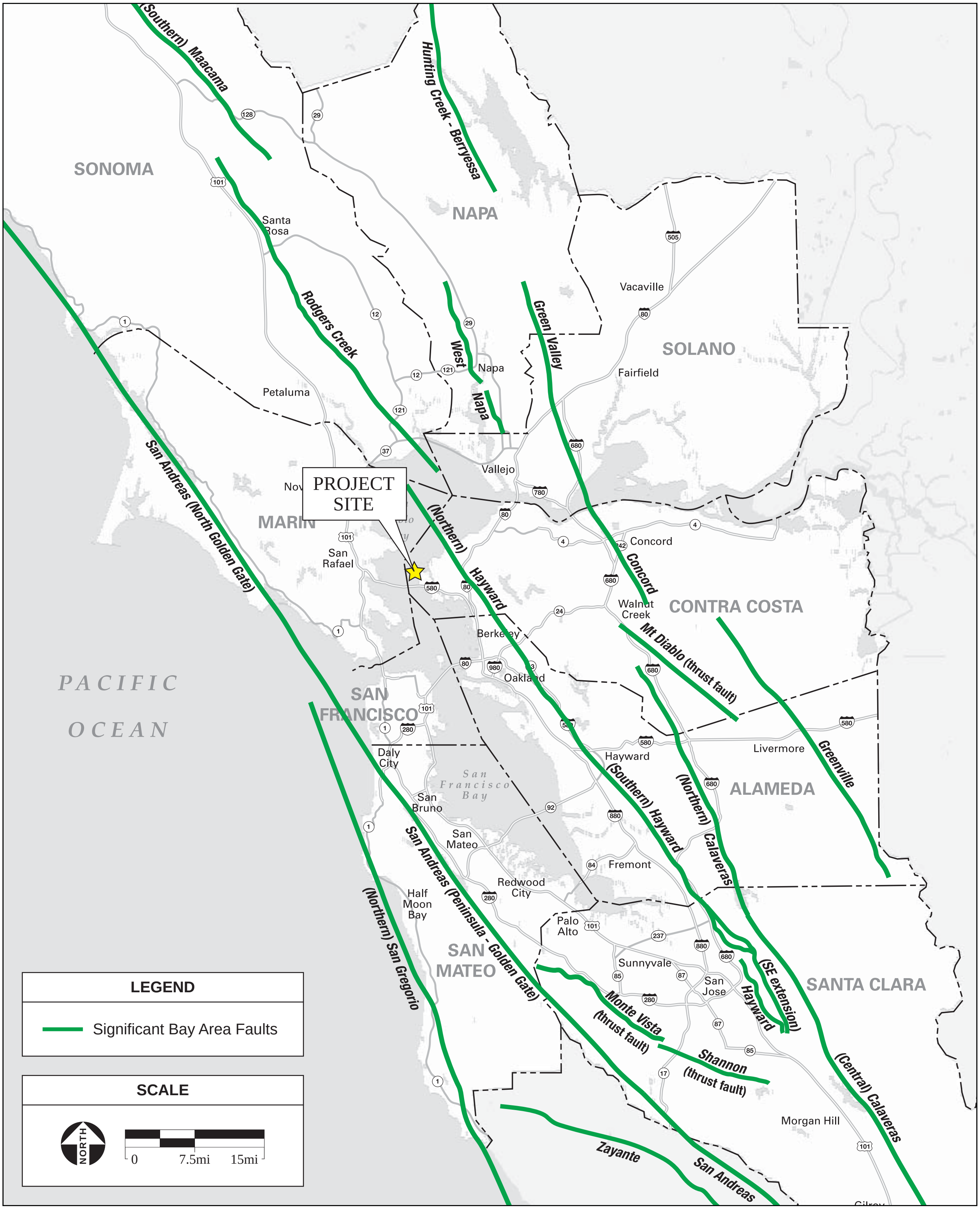
The majority of earthquake events in the Bay Area and throughout California result in dextral or right lateral displacement along faults. Dextral or right lateral movement indicates the horizontal movement of a fault from the perspective of one side of the fault looking across the fault to the other side; the relative displacement of the other side would move to the right. Two types of fault movement occur along faults; one type of movement is ground rupture that generates large earthquakes and the other type is a very slow movement of the fault called creep or slip that is quantified as a few millimeters (mm) or a fraction of an inch a year (slip rate) and that does not generate earthquakes (USGS, 1997).

There are six faults located in the region that could potentially cause a 6.7 or greater magnitude earthquake. The probabilities of such an earthquake to occur are presented in **Table 3.2-2**. Of these six faults, there are three major faults in the Bay Area that taken together are considered part of the San Andreas Fault complex (**Figure 3.2-2**). They include the San Andreas Fault, the Hayward Fault, and the Calaveras Fault (Engeo, 2006). The San Andreas Fault complex is a major dextral strike-slip (horizontal) fault zone that extends for approximately 800 miles along most of coastal California. The San Andreas



SOURCE: GlobeXplorer Aerial Photograph, 2/27/2004; NRCS, 2007; AES, 2008

Figure 3.2-1
Soils Map



SOURCE: Association of Bay Area Governments, 2003; AES, 2008

Point Molate Mixed-Use Tribal Destination Resort and Casino / 204536 ■

Figure 3.2-2
Regional Fault Map

Fault complex accommodates the relative north-south motion between the Pacific tectonic plate and the North American tectonic plate (USGS, 2004). One of the major faults of the San Andreas Fault complex is the Hayward fault, located 4.4 miles east of the project site.

The Hayward fault extends from San Jose for approximately 74 miles north, along the western region of the East Bay Hills, to the San Pablo Bay. South of the Bay Area, the Hayward Fault and the Calaveras Fault merge into the San Andreas Fault. The Hayward Fault is located within the Richmond Planning Area and is considered a Special Studies Zone, which is regulated through the Alquist-Priolo Earthquake Fault Zoning Act.

The Calaveras Fault is considered to be a historically active major dextral strike-slip fault and extends for approximately 93 miles from the San Ramon area southeast to approximately 19 miles south of Hollister.

The Concord-Green Valley Fault system is another component of the San Andreas Fault complex, located 16.3 miles northeast of the project site. The Concord fault is a dextral strike-slip fault that extends from Suisun Bay south to the northwestern slope of Mt. Diablo and crosses the City of Concord. The northern end of the fault connects with the Green Valley fault across Suisun Bay. The Greenville fault borders the eastern side of Livermore Valley and extends northwest towards Clayton Valley and southeastward into San Antonio Valley. Southeast of Livermore Valley, the fault is located within the uplifted Diablo Range and forms the topography of the linear drainage of the Arroyo Mocho, Colorado, and Sweetwater Creeks.

Other faults within the vicinity and part of the San Andreas Fault complex include the San Gregorio Fault and the Rodgers Creek Fault. The San Gregorio Fault is located 17.3 miles southwest of the project site. The fault is a dextral fault located predominantly offshore on the continental shelf of north-central California. The northern portion of the fault connects with the San Andreas Fault zone over an approximately nine-mile zone from the Golden Gate Bridge north to Bolinas Lagoon. The Rodgers Creek Fault is located 8.5 miles north of the project site. This fault is an active dextral fault, a branch of the larger San Andreas Fault system connecting the Hayward Fault to the south, and the Mayacama Fault to the north (USGS, 2004).

Seismicity

The project site is located within an area classified by the CBC as Seismic Zone 4, which indicates a geographic location with a high probability of significant seismic activity. It should be noted that most of the State of California is located within Seismic Zone 4. All buildings that are located within a seismic zone must be designed and constructed to meet CBC standards, including all of Division IV, which covers earthquake design. The CBC includes a number of standard practices to safeguard against major structural failures and loss of life during earthquakes.

Ground Shaking

The USGS has assessed earthquake probabilities throughout the Bay Area in an effort to increase planning capabilities and earthquake preparedness. The USGS has estimated that there is a 62 percent probability for the occurrence of one or more earthquakes with a magnitude 6.7 or greater in the Bay Region between the years of 2003 and 2032 (USGS, 2003). **Table 3.2-2** lists the probabilities of the six major faults in the Northern California Region to rupture. It can be expected that the project site would experience one or more episodes of strong ground shaking during the operational design life of the proposed on-site buildings (**Appendix I**).

TABLE 3.2-2
PROBABILITY OF MAGNITUDE 6.7 OR GREATER
EARTHQUAKE BEFORE 2032

Fault	Probability
Rogers Creek and Hayward Faults	27%
San Andreas Fault	21%
Calaveras Fault	11%
San Gregorio Fault	10%
Concord-Green Valley Fault	4%
Greenville Fault	3%

Source: USGS, 2004

The Richter Scale is the best known scale for measuring the magnitude of earthquakes. The scale has a logarithmic base, so an earthquake with a recording of Magnitude 7 signifies a disturbance with ground motion 10 times as large as an earthquake with a recording of Magnitude 6. However, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value. Richter's original methodology is no longer used because it does not give reliable results when applied to earthquakes with a magnitude greater than 7 and it was not designed for earthquakes recorded with epicenters 600 kilometers away or farther. A "moment magnitude" scale is currently used by seismologists to provide a measure that differentiates between the largest earthquakes and was designed to be consistent with the Richter scale. Consequently, the relative Richter scale is still used but more precise measurements such as the moment magnitude are now used to calculate the magnitude of an earth-shaking event (USGS, 2003).

The Modified Mercalli Intensity (MMI) Scale (**Table 3.2-3**) is a common measure of earthquake effects due to ground shaking intensity. The MMI values for intensity range from I (earthquake not felt) to XII (damage nearly total), and intensities ranging from IV to X could cause moderate to significant structural damage. The damage level represents the estimated overall level of damage that would occur for various

TABLE 3.2-3
MODIFIED MERCALLI INTENSITY SCALE

Intensity Value	Intensity Description	Average Peak Acceleration
I.	Not felt except by a very few persons under especially favorable circumstances.	< 0.0015 g
II.	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.	< 0.0015 g
III.	Felt quite noticeably indoors, especially on upper floors of buildings, but many persons do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration similar to the passing of a truck. Duration estimated.	< 0.0015 g
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 motorcars rocked noticeably.	0.015 g-0.02 g[a]
V.	Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.	0.03 g-0.04 g
VI.	Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.	0.06 g-0.07 g
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 motorcars.	0.10 g-0.15 g
VIII.	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 motorcars disturbed.	0.25 g-0.30 g
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.	0.50 g-0.55 g
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.	> 0.60 g
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.	> 0.60 g
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.	> 0.60 g

Source: Bolt, 1988.
USGS, 2003
Note: a) g is gravity = 980 centimeters per second squared.

MMI levels. The damage, however, would not be uniform. The age, material, type, method of construction, size, and shape of a building all affect the potential damage from ground shaking.

The ABAG Modeled Intensity Map (ABAG, 2008b), which is based on the 6.9 magnitude Loma Prieta earthquake identifies two MMI shaking intensity values for the proposed project site. Most of the project site has an intensity of V, which represents a light ground shaking intensity from an earthquake similar to the 6.9 magnitude Loma Prieta earthquake. Portions of the shoreline areas however have shaking intensities of VIII, which represent a very strong ground shaking intensity from a 6.9 magnitude earthquake. According to the ABAG map for this scenario, most of the ground shaking effects of this intensity include moderate structural damage to ordinary buildings, but negligible damage to buildings of good design and construction.

The USGS and ABAG have developed a model that estimates the impact to cities throughout the Bay Area in a variety of different earthquake scenarios. The estimated Bay Area earthquake effects for the occurrence of a magnitude 6.7 or greater earthquake for each of the faults located in the Bay Area is presented in **Table 3.2-4**. ABAG also provides liquefaction hazard levels using the same magnitude 6.7 or greater earthquake scenarios. The liquefaction hazard levels are present in **Table 3.2-4** for comparison. The Bay Area is a region of high seismicity with many nearby faults considered as "active."

TABLE 3.2-4
ESTIMATED BAY AREA EARTHQUAKE EFFECTS

Fault	Liquefaction		Modified Mercalli	
	Earthquake Magnitude	**Hazard Level**	**Earthquake Magnitude**	**MMI Intensity Value**
Hayward	7.1	High	6.9	X. Strong
North Hayward	6.6	High	6.5	IX. Violent
South Hayward	6.9	Moderate	6.7	VI. Moderate
San Andreas	7.9	Moderate to High	7.2	VI. Moderate
Calaveras	7.0	Moderate Low to Moderate	6.7	V. Light
Rogers Creek	7.1	Moderate Low to Moderate	7.0	VI. Moderate
Concord-Green Valley	6.8	Moderate Low to Moderate	6.7	V. Light
Greenville	7.2	Moderate Low to Moderate	6.9	V. Light
Mt. Diablo	6.7	Moderate Low to Moderate	6.7	VI. Moderate
San Gregorio	7.3	Moderate Low to Moderate	7.2	VI. Moderate

Source: ABAG, 2008a; AES, 2004.

Lurching

The energy released during an earthquake results in a rolling motion imparted to the ground surface. Also known as ground lurching, such rolling motion can cause ground cracks to occur. The potential of such cracks to occur is considered to be greater at contacts between deep alluvium deposits and bedrock. The potential for such cracks to occur is possible on the proposed project site. The risk of such an occurrence is similar to other Bay Area locations (**Appendix I**).

Liquefaction

Liquefaction occurs when loose, water saturated, granular material is transformed from a solid state to a liquefied state due to increased pore and water pressure, such that occurs during an earthquake. Although surrounding area such as the City of Richmond and areas northeast of the site have a high to moderate liquefaction potential, the ABAG liquefaction hazard map of the Bay area identifies the Point Molate peninsula as having a low liquefaction hazard. The 2002 Navy EIS/EIR (**Appendix U**) determined the fill and unconsolidated alluvial materials along the shoreline portions of the project site to be susceptible to liquefaction and lateral spreading. Although the Navy EIS/EIR determined the shoreline areas are susceptible, a more recent site-specific geotechnical report mapped the project site as being located within a Zone III (Engeo, 2006); meaning liquefaction potential is probably low or absent (**Appendix I**).

Lateral Spreading

Lateral spreading or land flow is a phenomenon that occurs during an earthquake, generally along a gentle slope (possible due to liquefaction) that causes the overlying soil mass to move towards a free face or down a gentle slope. Soils potentially susceptible to liquefaction are localized within the southwest portion (shoreline areas) of the project site. As documented within a site-specific geotechnical investigation, there are no free faces or bare slopes on the site that have a potential for lateral spreading. As a result, the geotechnical investigation determined the potential for lateral spreading is considered low (**Appendix I**). However, as stated previously, the Navy contradicts this finding and has determined the project site is susceptible to liquefaction and lateral spreading, specifically in areas within the shoreline areas of the site (**Appendix U**).

Landslides/Mudflows

Landslides and resulting mudflows if initiated by water saturated soils generally occur along slopes that are unstable as a result of several factors; called a slip surface, a landslide is triggered when cohesive properties of a soil are compromised. A slip surface is defined as the point (usually a sloped surface) where the loss of soil cohesion occurs, usually caused by excessive rainfall and/or saturated soils conditions. If the slip surface is relatively deep, the result could be loss of an entire hillside. The upland areas of the project site have the greatest potential for landslides. The Navy 2002 EIS/EIR identified three relatively small landslides at elevations greater than 300 feet above mean sea level (msl) in areas that are not planned for development. The affected landslide area is shown on the Soils Map (**Figure 3.2-1**). According to the Navy, these landslides were local in extent and were likely to have shallow slip surfaces.

MINERAL RESOURCES

Road base and bank stabilization materials (rip rap) are the most prevalent quarried materials in the county. The nearest quarry is the Richmond (Chevron) quarry located approximately 0.25 miles south of the project site. This quarry has been in production since 1907. Marketable materials from the Chevron quarry are primarily used for slope, stream bank, and bank stabilization. The project site contains the same marketable materials as the Chevron quarry with the exception of the southwestern shoreline areas. Geology within the shoreline areas of the site are primarily comprised of unconsolidated bay mud materials which are not considered marketable.