

D. GEOLOGY, SOILS AND SEISMICITY

This section describes the project site's geologic environment based on a 2005 site-specific Geotechnical Investigation¹ for a portion of the site, and a 2003 geotechnical peer review² of several previous geotechnical investigations for the remainder of the site. In addition, information sources include published and unpublished geologic reports and maps by the United States Geological Survey (USGS), California Geological Survey (CGS), and City, and a site reconnaissance. This section also assesses potential impacts from strong ground shaking, liquefaction, differential settlement, and unstable or expansive soils. Mitigation measures for the identified significant impacts are provided, where appropriate.

1. Setting

The project site's existing conditions related to geology and seismicity are described below.

a. Geologic Conditions. The following section describes existing geologic conditions at the project site.

(1) Geology. The proposed project would be located within the Coast Ranges Geomorphic Province, a relatively geologically young and seismically-active region on the western margin of the North American plate. In general, the Coast Ranges comprise a series of discontinuous north-west trending mountain ranges and ridges composed of sedimentary bedrock with layers of recent alluvium filling the intervening valleys.^{3,4} Based on USGS mapping, the project site is underlain by Quaternary Holocene-aged Bay Mud that is less than 9,600 years old and man-made artificial fills that have been placed at the site.^{5,6,7}

A geotechnical investigation was prepared for the southern portion of the Gilead Campus in preparation for a previous project consisting of the phased construction of new buildings designated as NLB-1 and NLB-2. The geotechnical investigation included two soil borings and four cone penetrometer tests. Testing indicated that the site subsurface consists of an upper layer of approximately 3.0 to 6.5 feet of fill material, underlain to a depth of 47 to 67 feet below ground surface (bgs) by Bay Mud⁸, further underlain to the maximum depth tested (120 feet bgs), by interbedded layers of dense to very dense clayey sands and stiff to very stiff clays (alluvial deposits).⁹ This recent geotechnical

¹ Lowney Associates, 2005. *Geotechnical Investigation Gilead Sciences Research Expansion: NRB1, NRB2, and Annex Buildings, Foster City*. Report No. 347-66A. November 8.

² Lowney Associates, 2003. *Geotechnical Peer Review, Vintage Park Campus, Foster City, California*. Doc # 347-66. May 28.

³ Norris, Robert M., Webb, Robert W., 1990. *Geology of California, 2nd Edition*, J. Wiley & Sons, Inc.

⁴ CGS, 2002. *California Geomorphic Provinces*; Note 36. December.

⁵ Brabb, E.E., Pampeyan, E.H., 1983. Geologic Map of San Mateo County, USGS Misc. Investigation I-1257-A.

⁶ USGS Scientific Investigations, 2006. *Geologic Map of San Francisco Bay Region, CA*, Map 2918.

⁷ Helley, E.J., Lajoie, K.R., 1979 (reprinted 1991). *Flatlands Deposits of the San Francisco Bay Region* with Maps, USGS Professional Paper 943. Jointly by DOI, HUD, USGS.

⁸ Bay Mud is an estuarine deposit composed of unconsolidated clay that is prone to settlement upon loading.

⁹ Lowney Associates, 2005. op. cit.

investigation included only a portion of the project site; however, due to the homogeneous nature of the area, the results of this geotechnical investigation provides insight into the likely existing conditions for the remainder of the project site. In addition, a geotechnical peer review was conducted by Lowney Associates of existing geotechnical reports and investigations, primarily authored by Berlogar Geotechnical Consultants during the 1980s.¹⁰ Specific findings and recommendations of these two reports are detailed below.

(2) Soils. The site and surrounding areas were originally part of tidal marshlands known as Brewer's Island. By 1897 an area of Brewer's Island (the precursor of Foster City) was partially diked and drained, with additional areas diked and added around 1901. The young Bay Mud dried over time and eventually about 2,220 acres became a dairy ranch while another 550 acres were used as salt ponds.¹¹ As part of the preparation for development as a planned community in the late 1950's, approximately 14 million cubic yards of sandy silt were pumped in from San Bruno Shoal (a sandbank in San Francisco Bay) to provide 4 to 5 feet of fill throughout the area currently occupied by Foster City.¹² Bay Mud, due to its high clay content and inclusion of organic materials, generally is rated high for shrink-swell potential, with a high risk of corrosion to concrete and uncoated steel, with slow permeability, and low erosion potential.¹³ The overlying sandy silt fill from San Bruno Shoal has compacted and formed an approximately 3-foot thick stiff to hard surface layer in the vicinity of the site. Regional mapping classifies the soils of the project site as: Urban land-Orthents, reclaimed complex, 0 to 2 percent slopes.¹⁴

The geotechnical investigation and geotechnical peer review identify the site as being covered by 3.0 to 6.5 feet of fill material consisting of very stiff to hard sandy lean clay with gravel, underlain by soft to medium stiff, highly compressible Bay Mud.¹⁵ In addition, based on the report of the geotechnical peer review, there may be areas where earlier surface features, such as levees and sloughs, may have been filled or incorporated as part of earlier development activities. The geotechnical peer review notes that the Berlogar reports detail a former levee along the western property line of the project site, near the current site of Building 322, that continues around the southern property line. Also, a slough was originally located approximately 15 feet north of the current foundations of building 324 and various lesser slough and drainage channels were reported throughout the property by Berlogar.¹⁶

(3) Topography. The irregularly shaped, approximately 40-acre project site is located within an urbanized portion of north Foster City near San Francisco Bay. The existing ground surface

¹⁰ Lowney Associates, 2003. *Geotechnical Peer Review, Vintage Park Campus, Foster City, California*. Doc # 347-66. May 28.

¹¹ City of Foster City, 2008. *Community Info, History of Foster City, Creating the Land*, accessed 6/8/07 at: http://www.fostercity.org/community_info/Creating-the-Land.cfm.

¹² City of Foster City, 2008. op. cit.

¹³ Natural Resources Conservation Service (NRCS), 2008. *Web Soil Survey*, USDA Mapping Website, accessed 08/6/08 at: websoilsurvey.nrcs.usda.gov.

¹⁴ NRCS, 2008. op. cit.

¹⁵ Lowney Associates, 2005. op. cit.

¹⁶ Lowney Associates, 2003. op. cit.

elevation is approximately 105 to 107 feet Foster City Datum,¹⁷ or 5 to 7 feet National Geodetic Vertical Datum of 1929 (NGVD).^{18,19} Based on observations during a site reconnaissance by a staff member of Baseline Environmental Consulting on July 2, 2008, and USGS topographic information, the entire site has approximately the same elevation.²⁰

b. Seismic Conditions. The following discussion describes existing seismic conditions within and in the vicinity of the project site.

(1) Regional Seismicity. The entire San Francisco Bay Area is located within the San Andreas Fault Zone (SAFZ), a complex of active faults forming the boundary between the North American and Pacific lithospheric plates. Movement of the plates relative to one another results in the accumulation of strain along the faults, which is released during earthquakes. Numerous moderate to strong historic earthquakes have been generated in northern California by the SAFZ. This level of active seismicity results in a relatively high seismic risk in the San Francisco Bay Area. The 2007 California Building Code, based on numerous inter-related factors, provides for increasingly stringent construction requirements for projects in areas of high seismic risk. The SAFZ includes numerous faults found by the California Geological Survey under the Alquist-Priolo Earthquake Fault Zoning Act (A-PEFZA) to be “active” (i.e., to have evidence of fault rupture in the past 11,000 years). Regional active faults are shown on Figure V.D-1.

The United States Geological Survey’s Working Group on California Earthquake Probabilities estimates that there is a 62 percent probability that one or more Moment Magnitude (M_w) 6.7 or greater earthquakes will occur in the San Francisco Bay Area between 2002 and 2031. The probability of a M_w 6.7 or greater earthquake occurring along individual faults was estimated to be 21 percent along the San Andreas Fault, 27 percent along the Hayward Fault, 11 percent along the Calaveras Fault, and 10 percent along the San Gregorio Fault. In addition, there is a cumulative 14 percent chance of a background (other earthquake source, either mapped or undiscovered) event occurring. When predictions are expanded to 100 years, it is estimated that about three M_w 6.7 or greater events could occur during that time. Thus the probability of at least one M_w 6.7 or greater earthquake rises to the near certainty of about 96 percent when calculated for a 100-year span.²¹

(2) Site-Specific Seismicity. The project site is not located within an Alquist-Priolo Earthquake Fault Zone (A-PEFZ). The nearest A-PEFZ is the peninsula segment of the San Andreas Fault, about 5.4 miles southwest of the project site.²² The San Andreas Fault is a right lateral

¹⁷ Lowney Associates, 2005. op. cit.

¹⁸ The Foster City Datum is equal to the National Geodetic Vertical Datum of 1929 plus 100 feet. Source: Towne, R., 2007, City of Foster City Public Works, personal communication with BASELINE.

¹⁹ For most purposes, NGVD is equivalent to mean sea level. Please see the Hydrology and Water Quality section for a discussion of climate change-induced sea level rise.

²⁰ USGS, 2008. Contiguous U.S. 1/3W arc second elevation data, *San Mateo Quadrangle, California*, the National Map, accessed 08/06/08 at <http://nationalmap.gov/index.html>.

²¹ Working Group On California Earthquake Probabilities (WGCEP), 2003. *Earthquake Probabilities in the San Francisco Bay Region: 2002-2031*. Open-File Report 03-214, USGS.

²² California Division of Mines and Geology (CDMG), 1974. *State of California Special Studies Zones, San Mateo Quadrangle Map*.

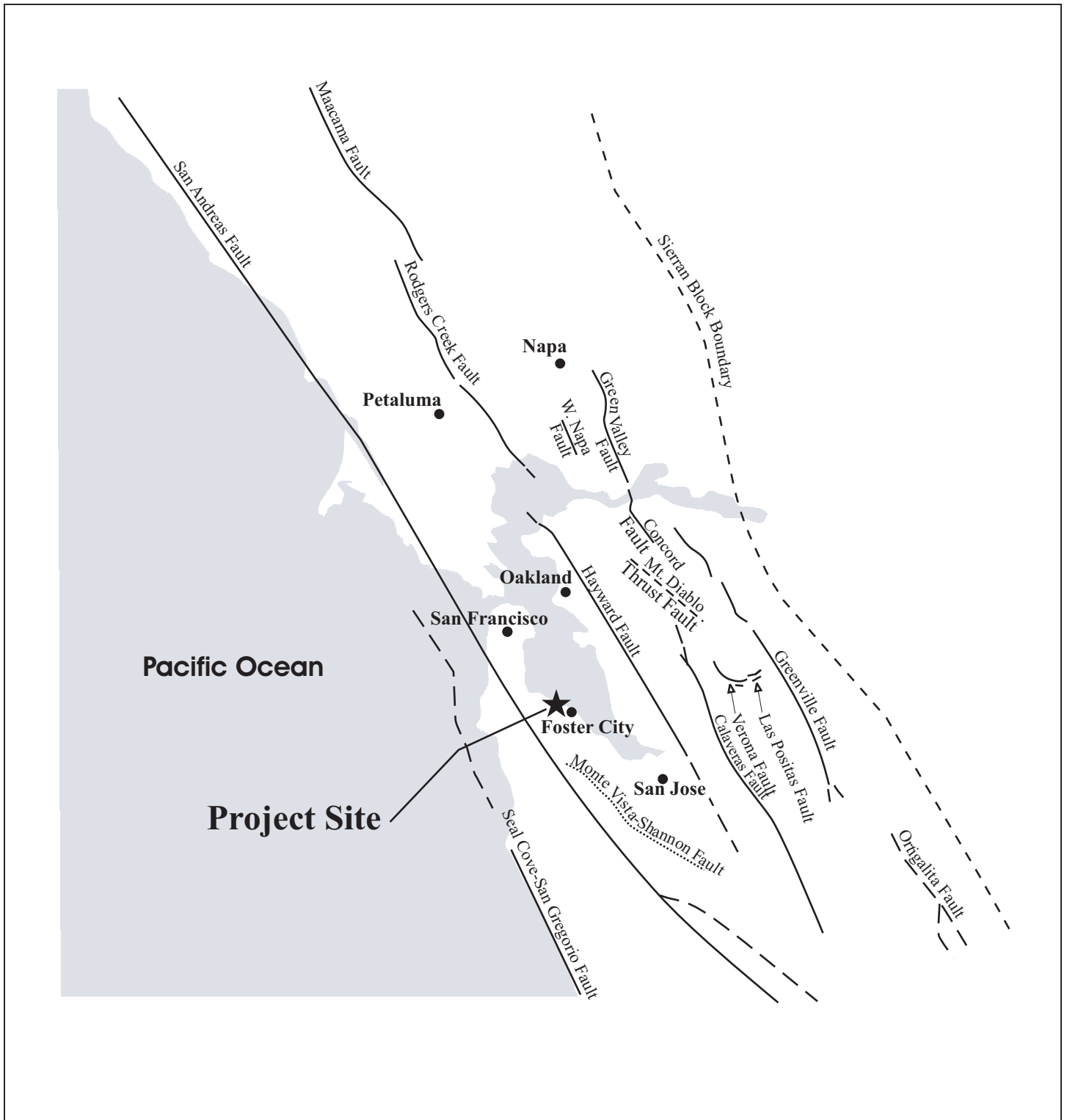
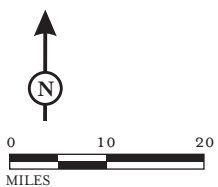


FIGURE V.D-1

LSA



LEGEND

- ACTIVE FAULT -
FAULT HAS EVIDENCE OF SURFACE
DISPLACEMENT WITHIN THE PAST
11,000 YEARS (DASHED WHERE INFERRED)
- POTENTIALLY ACTIVE FAULT -
FAULT HAS EVIDENCE OF SURFACE DISPLACEMENT
IN THE PAST 1.6 MILLION YEARS, BUT NOT WITHIN
THE PAST 11,000 YEARS
- - - - SEISMIC SOURCE WITHOUT SURFACE RUPTURE

Gilead Sciences Corporate Campus
Master Plan EIR
Regional Faults

SOURCE: BASELINE ENVIRONMENTAL, 2008.

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strike-slip fault with a northwest-southeast axis²³ and, as noted above, has a 21 percent chance of a M_w 6.7 earthquake occurring between 2002 and 2031. The Hayward Fault is approximately 12.8 miles northeast of the project site and has a 27 percent chance of a M_w 6.7 earthquake occurring for the same period.

c. Seismic and Geologic Hazards. The following section describes existing seismic and geologic hazards present at the project site.

(1) Surface Rupture. Surface rupture occurs when the ground surface is broken due to fault movement during an earthquake. Surface rupture generally can be assumed to occur along an active major fault trace. No active faults have been mapped at the project site; therefore, potential for fault rupture at the project site is negligible.²⁴

(2) Ground Shaking. Ground shaking is a general term referring to all aspects of motion of the earth's surface resulting from an earthquake, and is normally the major cause of damage in seismic events. The extent of ground shaking is controlled by the magnitude and intensity of the earthquake, distance from the epicenter, and local geologic conditions. The Modified Mercalli Intensity Scale (MMI) is the most commonly used scale for measurement of the effects of earthquake intensity (Table V.D-1). A related concept, acceleration, is measured as a fraction or percentage of the acceleration under gravity (g).²⁵

Estimates of the peak ground acceleration (PGA) have been made for the Bay Area based on probabilistic models that account for multiple seismic sources. Under these models, consideration of the probability of expected seismic events is incorporated into the determination of the level of ground shaking at a particular location. The expected PGA (with a 10 percent chance of being exceeded in the next 50 years) generated by any of the seismic sources potentially affecting the project area is estimated by the CGS as 0.52 (g).²⁶ The geotechnical investigation conducted a site-specific probabilistic seismic hazard analysis using computer modeling for the location which indicated a PGA of 0.55(g) for the site. These figures are generally in agreement, and this level of ground acceleration at the project site is a potentially significant hazard.

The closest active fault to the project site is the San Andreas Fault, located approximately 5.4 miles to the southwest. The San Andreas Fault is considered capable of generating a M_w 7.9 earthquake (similar to the 1906 San Francisco earthquake).²⁷ An earthquake of this magnitude on the San Andreas Fault would generate very strong (MMI VIII) to violent (MMI IX) seismic shaking at the

²³ Right-lateral: if the trace of the fault were viewed while standing on one side during a seismic event, it would appear that the ground on the other side of the fault moved to the right. Strike-slip: the sides are moving laterally relative to each other with little or no vertical movement.

²⁴ Lowney Associates, 2005. op. cit.

²⁵ The acceleration due to gravity, denoted g (also gee) is a unit of acceleration defined as approximately 32 ft/s², which is the acceleration due to gravity on the Earth's surface at sea level.

²⁶ California Geological Survey (CGS), 2008. *Probabilistic Seismic Hazards Mapping Ground Motion Page*, accessed 8/6/08 at: www.consrv.ca.gov/cgs/rghm/pshamap/pshamap.asp.

²⁷ WGCEP, 2003. op. cit.

Table V.D-1: Modified Mercalli Scale

I	Not felt except by a very few under especially favorable circumstances.
II	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III	Felt quite 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 like passing of truck. Duration estimated.
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.
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.
VI	Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.
VII	Everybody runs outdoors. Damage negligible in building 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.
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 motor cars disturbed.
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.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.
XI	Few, if any, (masonry) structures remain standing. Bridges destroyed. Board fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
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.

Source: California Geological Survey, 2002. *How Earthquakes and Their Effects are Measured*: Note 32

project site.²⁸ The potentially active concealed (one without surface expression) Palo Alto Fault is approximately 1.5 miles southwest of the site.²⁹ The Stanford (San Mateo) Fault, located approximately 8.9 miles south of the site, and the Monte Vista-Shannon Fault, located approximately 13.8 miles to the south, are considered potentially active faults.³⁰ Potentially active faults are defined as

²⁸ Association of Bay Area Governments (ABAG), 2003. *Shaking Maps*, accessed 8/6/2008 at: gis.abag.ca.gov/website/Shaking-Maps/viewer.htm.

²⁹ Jennings, Charles W., 1994. *Fault Activity Map of California and Adjacent Areas*. California Department of Conservation.

³⁰ Ibid.

those for which there is evidence of surface displacement within the Quaternary period (within about the past 1.6 million years) but no surface displacement within the past 11,000 years is shown.

(3) Liquefaction and Lateral Spreading. Liquefaction is the temporary transformation of loose, saturated granular sediments from a solid state to a liquefied state as a result of seismic ground shaking. In the process, the soil undergoes transient loss of strength, which commonly causes ground displacement or ground failure to occur. Since saturated soils are a necessary condition for liquefaction, soil layers in areas where the groundwater table is near the surface have higher liquefaction potential than those in which the water table is located at greater depths. Lateral spreading is a form of horizontal displacement of soil toward an open channel or other “free” face, such as an excavation boundary. Lateral spreading can result from either the slump of low-cohesion unconsolidated material, or more commonly, by liquefaction of either the soil layer or a subsurface layer underlying soil material on a slope.³¹ The lateral spreading hazard will tend to mirror the liquefaction hazard for a site. Regional studies by the USGS for the Bay Area provide information on Quaternary deposits and liquefaction susceptibility in the area. Based on these regional studies, the Association of Bay Area Governments (ABAG) mapping indicates that the site’s susceptibility to liquefaction is very high and the liquefaction hazard (susceptibility combined with likelihood) is high to very high.^{32,33} Regional studies can help provide guidance for general planning and hazard potential assessment; however, site-specific studies are needed to assess the design and engineering requirements for any particular site.

The site-specific geotechnical investigation for the southernmost portion of the project site included two soil borings and four cone penetration tests. The geotechnical investigation notes that groundwater in the area of the project site is generally reported at depths of 6 to 9 feet below ground surface (bgs); however, groundwater was reported as shallow as 3 feet bgs in the borings.³⁴ Based on data from the subsurface investigations, the subsurface materials of the site are primarily high clay-content alluvial deposits or dense- to very-dense fine-grained materials, with low potential for liquefaction or lateral spreading during a seismic event.³⁵

(4) Landslides and Slope Stability. Slope failure can occur as either rapid movement of large masses of soil (landslide) or slow, continuous movement (creep). The primary factors influencing the stability of a slope are: 1) the nature of the underlying soil or bedrock; 2) the geometry of the slope (height and steepness); 3) rainfall; and 4) the presence of previous landslide deposits. Regional mapping shows that the project area is mapped as Category 1a, unstable “[a]reas of zero to five percent slope that include tidelands, marshlands, and swamplands that are underlain by

³¹ Rauch, Alan F., 1997. EPOLLS: An Empirical Method for Predicting Surface Displacements Due to Liquefaction-Induced Lateral Spreading in Earthquakes, Ph. D. Dissertation, Virginia Tech, Blacksburg, VA.

³² ABAG, 2008. *Liquefaction Hazard Maps*, Accessed 8/6/2008 at: www.abag.ca.gov/bayarea/eqmaps/.

³³ The California Department of Conservation, Seismic Hazard Zone mapping program for liquefaction or landslide hazards has not published data for the San Mateo Quadrangle, hence, hazard determinations for the proposed project are not provided by the agency.

³⁴ Lowney Associates, 2005. op. cit.

³⁵ Ibid.

moist, unconsolidated muds.”³⁶ The site is generally flat and therefore not subject to typical landslide hazards; however, slope instability along the shore of Vintage Lake or banks of construction period excavations could potentially occur either due to static loads created by new fill and building loads or due to transient seismic loads resulting from shaking at the site.

(5) Unstable Soils, Settlement and Differential Settlement. Differential settlement or ground subsidence could occur if buildings or other improvements were built on low-strength foundation materials (including imported non-engineered fill) or if improvements straddle the boundary between different types of subsurface materials (e.g., a boundary between native material (Bay Mud), buried sloughs or levees, older un-engineered fill, and/or new engineered fill). The site-specific investigation notes that due to the proposed use of deep foundations, the potential impact on proposed structures from differential settlement is likely to be low; however, to ensure the stability of surface improvements, such as roads, walkways, and utilities, the investigation includes recommendations that improvements spanning locations subject to differential settlement minimize abrupt grading changes, over-steepen gravity-flow utilities, use flexible utility connections, hinge concrete flatwork to structures, and deepen foundation faces so as to prevent exposure of the bottom of structures due to long term effects of settlement.³⁷ Although differential settlement generally occurs slowly enough that its effects are not dangerous to inhabitants, it can cause significant building damage over time.

(6) Expansive Soils. Expansion and contraction of volume can occur when expansive soils undergo alternating cycles of wetting (swelling) and drying (shrinking). During these cycles, the volume of the soil changes markedly. As a consequence of such volume changes, structural damage to buildings and infrastructure may occur if the potentially expansive soils are not considered in project design and during construction.

The geotechnical investigation and geotechnical peer review note that approximately the upper 3.0 to 6.5 feet of materials at the site comprise man-made fill.³⁸ “Man-made” fill refers to any land-forming process where grades are increased by the placing of fill materials. Fill materials can generally be composed of varying amounts of natural soil materials, construction debris, dredging materials, municipal solid waste, and other materials.³⁹ However, as noted above, the history of Foster City indicates that the man-made fill for the general area was hydraulically pumped in from the San Bruno Shoal (a sandbank in San Francisco Bay), and consists primarily of sandy silts. The geotechnical investigation and geotechnical peer review do not include specific recommendations regarding potential expansive soil hazards.⁴⁰

³⁶ USGS, 1979, *Relative Slope Stability and Land-use Planning in the San Francisco Bay Region, CA*. Professional Paper 944.

³⁷ Lowney Associates, 2005. op. cit..

³⁸ Lowney Associates, 2003. op. cit.

³⁹ Scheyer, J.M., and K.W. Hipple, 2005. *Urban Soil Primer*. United States Department of Agriculture, Natural Resources Conservation Service, National Soil Survey Center, Lincoln, Nebraska (<http://soils.usda.gov/use>).

⁴⁰ Lowney Associates, 2005. op. cit.

d. Regulatory Setting. The following discussion includes a description of the regulatory context for geologic and seismic issues as they relate to development projects.

(1) **California Building Code.** The 2006 Uniform Building Code (UBC) is published by the International Conference of Building Officials (ICBO), and is the widely adopted model building code in the United States. The 2007 California Building Code (CBC) 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). The CBC incorporates by reference the UBC requirements, with necessary California amendments. 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. Compliance with the 2007 CBC requires that (with very limited exceptions) structures for human occupancy be designed and constructed to resist the effects of earthquake motions. The Seismic Design Category for a structure is determined in accordance with either CBC Section 1613 - *Earthquake Loads* or American Society of Civil Engineers (ASCE) Standard No. 7-05, *Minimum Design Loads for Buildings and Other Structures*. In brief, based on the engineering properties and type of soils at a development site, the site is assigned a Site Class ranging from A to F. The Site Class is then combined with Spectral Response (ground acceleration induced by earthquake) information for the location, resulting in the identification of a *Seismic Design Category* ranging from A to D, D representing the most severe conditions. The classification of the site and related calculations must be determined by a qualified person.

(2) **Alquist-Priolo Earthquake Fault Zoning Act (A-PEFZA).** Surface rupture is the most easily avoided seismic hazard. The A-PEFZA was passed in December 1972 to mitigate the hazard of surface faulting to structures used for human occupancy. The A-PEFZA's main purpose is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. The A-PEFZA only addresses the hazard of surface fault rupture and is not directed toward other earthquake hazards (the Seismic Hazards Mapping Act, passed in 1990, addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides). The law requires the State Geologist to establish regulatory zones, known as Earthquake Fault Zones, around the surface traces of active faults and to issue appropriate maps. The maps are distributed to all affected cities, counties, and State agencies for their use in planning and controlling new or renewed construction. Local agencies must regulate most development projects within the zones. Projects include all land divisions and most structures for human occupancy. Before a project can be permitted, cities and counties must require a geologic investigation to demonstrate that proposed buildings will not be constructed across active faults. The evaluation and written report of a specific site must be prepared by a licensed geologist. If an active fault is found, a structure for human occupancy cannot be placed over the trace of the fault and must be set back 50 feet from the fault trace.

(3) **Seismic Hazards Mapping Act (SHMA).** In 1990, following the Loma Prieta earthquake, the California Legislature enacted the SHMA to protect the public from the effects of strong ground shaking, liquefaction, landslides, and other seismic hazards. The SHMA established a State-wide mapping program to identify areas subject to violent shaking and ground failure; the program is intended to assist cities and counties in protecting public health and safety. The SHMA 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. As a result, the California Geologic Survey is mapping SHMA Zones and has completed seismic hazard mapping for the portions of California most susceptible to liquefaction, ground shaking, and

landslides: primarily the San Francisco Bay area and Los Angeles basin. Before a development permit is granted for a site within a seismic hazard zone, a geotechnical investigation of the site must be conducted and appropriate mitigation measures incorporated into the project design. At the time of the preparation of this EIR, the project site has not yet been mapped in conformance with the SHMA.

(4) City of Foster City. The Foster City Municipal Code and the Estero Municipal Improvement District (EMID) Code are a compilation of Foster City's and EMID's applicable ordinances (rules, regulations, or standards). They are the City and EMID's primary codes. Secondary codes include any other codes adopted by reference, such as building, fire safety, and electrical codes. Applicable geologic and seismic safety regulations in the City's General Plan, Municipal Code, and the amending Uniform Building Code (CBC, as adopted in California) are described below.

General Plan (1993). The following goals, policies and programs from the Foster City General Plan Safety Element relate to seismic and geologic hazards within the project site:

- *Safety Goal S-A. Protect From Seismic and Geologic Hazards.* Protect the community from unreasonable risk to life and property caused by seismic and geologic hazards.
 - *Policy S-1. Use Most Current Uniform Codes.* The City will use the most current uniform codes to review permits for new and modified structures.
 - *Program S-A. Geotechnical and Engineering Reports.* The City (Building Division) will require site specific geotechnical and engineering reports for new structures.

Municipal Code Ordinances: Title 15 - Buildings and Construction. Title 15 of the Foster City Municipal Code includes amendments to the 2006 Uniform Building Code (adopted in California as the 2007 California Building Code, or CBC) that may affect the proposed project. These changes are detailed under individual chapters beginning with 15.04.010 of the Foster City Municipal Code.

2. Impacts and Mitigation Measures

The analysis of the impacts related to geology, soils, and seismicity that could result from implementation of the proposed project is presented below. This section begins with criteria of significance, which establish the thresholds for determining whether a project impact is significant, and identify less-than-significant and the potentially significant geotechnical impacts/hazards associated with the proposed project. Mitigation measures are provided so as to reduce significant impacts to a less-than-significant level.

a. Criteria of Significance. The project would have a significant geology, soils, or seismicity impact if it would:

- Expose people or structures to substantial risk of loss, injury, or death involving:
 - Rupture of a known active or potentially active 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;
 - Strong seismic ground shaking;
 - Seismic-related ground failure, including liquefaction; or
 - Landslides;

- Result in substantial soil erosion or loss of topsoil;
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in an on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse;
- Be located on expansive soils (as defined in Table 18-1-B of the 1994 Uniform Building Code) or corrosive soils, which could cause substantial damage to building foundations, pavements, utilities, and/or other improvements;
- Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the State;
- Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan; or

A criterion regarding septic tanks and alternative wastewater disposal systems is not included since the project would be served by municipal wastewater lines.

b. Less-than-Significant Geology, Soils and Seismicity Impacts. The most recent A-PEFZ maps indicate that the nearest active fault to the project site is the San Andreas Fault peninsula segment, located approximately 5.4 miles to the southwest. Based on CGS fault maps, no potentially active faults underlie the site.⁴¹ The proposed project would therefore not be expected to be affected by rupture at the site of a known active or potentially active fault. The geotechnical investigation prepared for an earlier structure within the project area notes that subsurface materials at the site were either of high clay content and/or relatively fine-grained and stiff, and therefore had a relatively low risk of liquefaction. It is therefore unlikely that the project would result in geology, soils, or seismicity impacts related to fault rupture or liquefaction; these impacts are considered less than significant.

Potential impacts from loss of topsoil and soil erosion are discussed in Section V.E, Hydrology and Water Quality, of this EIR. The proposed project is within an area classified as MRZ-1, “[a]reas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence”.⁴² The project would therefore not result in the loss of availability of a known mineral resource of value locally or to the region or State. The project site is not identified in a planning document as being a locally-important mineral resource recovery site.

c. Significant Geology, Soils and Seismicity Impacts. Seismic hazards result from the primary and secondary effects of an earthquake, with the primary effect being ground rupture. Secondary effects include seismic shaking and seismically-induced ground failure, including liquefaction and landslides. As noted above, ground rupture is not likely at the project site. Secondary effects are more widespread and may result in more damage and injury. Development of the proposed project could result in three significant impacts related to seismic hazards and soil stability, as discussed below.

⁴¹ Jennings, Charles W., 1994. op. cit.

⁴² California Department of Mines and Geology, 1987 updated 1996. *Mineral Land Classification: Aggregate Minerals in the San Francisco-Monterey Bay Area*, California Department of Conservation.

Impact GEO-1: Project occupants would be subject to seismic shaking hazards. (S)

All structures in the Bay Area could be affected by ground shaking in the event of an earthquake on active regional faults. The amount of ground shaking depends on the magnitude of the earthquake, the distance from the epicenter, and the type of earth materials between the receptor and the epicenter. The 2007 CBC provides for increasingly stringent construction requirements on projects in areas of high seismic risk. Violent ground shaking is expected at the project site during predicted earthquakes on the San Andreas and other regional active faults. This level of seismic shaking could cause considerable damage in buildings at the site and could result in injuries to building occupants.

Mitigation Measure GEO-1: Prior to the issuance of any site-specific grading or building permits, a design-level geotechnical investigation, in compliance with Foster City guidelines, shall be prepared by a licensed professional and submitted to the City Building Inspection Division for review and approval, and a finding that the proposed development fully complies with the CBC, as amended by Foster City ordinances and Building Division guidance. The report shall determine the proposed project's geotechnical conditions and address potential seismic hazards. The report shall identify building techniques appropriate to minimize seismic damage. In addition, the following guidance for the design-level geotechnical investigation shall be addressed:

- Analysis presented in the geotechnical report shall conform to the California Division of Mines and Geology recommendations presented in the *Guidelines for Evaluating Seismic Hazards in California*.⁴³ Briefly, the guidelines recommend that the report include: a site screening evaluation; evaluation of on- and off-site geologic hazards; quantitative evaluation of hazard potential; detailed field investigation; estimation of ground-motion parameters; evaluation of landslide, liquefaction, lateral-spreading and ground-displacement hazards; and recommendations to reduce identified hazards.
- All recommendations, design criteria, and specifications set forth in the design-level geotechnical investigation shall be implemented as a condition of project approval. (LTS)

Impact GEO-2: Damage to structures or property related to man-made fill, unstable soils, or unstable subsurface materials resulting in settlement or differential settlement could occur. (S)

The site is underlain by approximately 40 to 60 feet of Bay Mud overlying alluvial deposits. Settlement of Bay Mud from consolidation under the weight of existing fill may be incomplete, and introduction of new loads, such as additional fill, foundations, and buildings, would be expected to result in additional settlement. Piles, which would be incorporated into the project, would minimize the effects of unstable soils because they would be driven into the stable layer underlying fill materials. However, differential settlement or rotational failure may occur across subsurface features such as buried sloughs, abandoned levees, and/or in areas underlain by non-engineered fill, engineered fill, and native soils over Bay Mud. If unstable soils are not properly addressed during

⁴³ CGS, 2008. *Guidelines for Evaluating and Mitigating Seismic Hazards in California*, Special Publication 117, 102 pp.

grading and foundation preparation, structural damage, warping, and cracking of roads, driveways, parking areas and sidewalks, and rupture of utility lines may occur.

Mitigation Measure GEO-2: In addition to the requirements of all other GEO mitigation measures in this section, the designers of the proposed project's building foundations and improvements (including sidewalks, roads, driveways, parking areas, and utilities) shall consider the site to be underlain by Bay Mud and/or non-engineered fill. The design-level geotechnical investigation shall include measures to ensure that potential damage related to compressible materials or soils and non-uniformly compacted fill is minimized. Mitigation options may range from removal of the problematic soils, and replacement, as needed, with properly conditioned and compacted fill to design and construction of improvements to withstand the forces exerted during the expected settlement. All mitigation measures, design criteria, and specifications set forth in the site-specific design-level geotechnical report, and the City of Foster City Building Division standards shall be followed to reduce impacts associated with problematic soils. (LTS)

Impact GEO-3: Damage to structures or property of the proposed project related to expansive (shrink-swell) and corrosive soils could occur. (S)

Expansive or corrosive soils could cause substantial damage to building foundations, piles, pavements, utilities, and/or other improvements. Structural damage, such as warping and cracking of roads, driveways, parking areas and sidewalks, and rupture of utility lines may occur if the potential expansive soils and the interface with imported fill are not considered during design and construction of improvements. The geotechnical investigation for the earlier project did not include testing of site soils for corrosivity; however, Bay Mud is known to have corrosive properties.⁴⁴

The following two-part measure shall be implemented:

Mitigation Measure GEO-3a: In addition to the requirements of all other GEO mitigation measures in this section, in locations underlain by soils of unknown character, the designers and engineers of proposed building foundations and improvements (including piles, sidewalks, roads, driveways, parking areas, and utilities) shall consider the site's potential to be underlain by soils with high shrink-swell potential. The site-specific design-level geotechnical investigation, prepared by a licensed professional, shall include measures to ensure potential damage related to expansive soils and non-uniformly compacted fill and engineered fill are minimized. Mitigation options may range from removal of the problematic soils, and replacement, as needed, with properly conditioned and compacted fill to design and construction of improvements to withstand the forces exerted during the expected shrink-swell cycles and settlements. All design criteria and specifications set forth in the design-level geotechnical investigation shall be implemented to reduce impacts associated with problematic soils.

Mitigation Measure GEO-3b: In addition to the requirements of all other GEO mitigation measures in this section, the design-level geotechnical investigation shall include an evaluation of the potential for corrosive soils on the site. If the results indicate corrosive soil conditions,

⁴⁴ Lowney Associates, 2003. op. cit.

appropriate measures to mitigate these conditions shall be incorporated into the design of project improvements that may come into contact with site soils. Wherever corrosive soils are found in sufficient concentrations, recommendations shall be made to protect steel and concrete (and any other material that may be placed in the subsurface) from long-term deterioration caused by contact with corrosive onsite soils. In general, these recommendations are expected to include, but not be limited to, the following provisions. All recommendations of the geotechnical investigations shall be implemented.

- Protect buried iron, steel, cast iron, ductile iron, galvanized steel, and dielectric coated steel or iron (including all buried metallic pressure piping) against corrosion from soil.
- Protect buried metal and cement structures in contact with earth surfaces from chloride ion concentrations.
- Use sulfate-resistant concrete mix for all concrete in contact with the ground.
- Consult a corrosion expert during the project's detailed design phase to design the most effective corrosion protection. (LTS)