3.6 GEOLOGY AND SOILS

This section describes the geology and soils setting and regulatory framework and addresses the potential effects of the EIS Alternatives related to geology and soils.

3.6.1 Affected Environment

Regional Physiographic and Geologic Setting

The sites studied in this EIS include the existing SFVAMC Fort Miley Campus, adjacent to the Richmond District, and the Mission Bay area. Both of these areas are located within the northern portion of the San Francisco peninsula in the San Francisco North U.S. Geological Survey (USGS) 7.5-Minute Quadrangle. San Francisco is located within the Coast Ranges geomorphic province, a relatively young geologically and seismically active region on the western margin of the North American plate. In general, the Coast Ranges comprise a series of discontinuous northwest-southeast trending mountain ranges, valleys, and ridges (CGS, 2002). San Francisco rests on a foundation of Franciscan formation bedrock in a northwest-trending band that cuts diagonally across the city. This geologic formation known as the Franciscan Formation is composed of many different types of rock—greywacke, shale, greenstone (altered volcanic rock), basalt, chert (ancient silica-rich ocean deposits), and sandstone that originated as ancient sea floor sediments (CGS, 2002).

Faulting and Seismicity

Existing SFVAMC Fort Miley Campus and Mission Bay Area

Because faults and seismic activity are regional in nature, the discussion below relates to both the existing SFVAMC Fort Miley Campus and the Mission Bay area.

The San Francisco Bay Area is located in a seismically active region near the boundary between two major tectonic plates, the Pacific Plate to the southwest and the North American Plate to the northeast. These two plates move relative to each other in a predominantly lateral manner, with the San Andreas Fault Zone at the junction. The Pacific Plate, on the west side of the fault zone, is moving north relative to the North American Plate on the east. Since approximately 23 million years ago, about 200 miles of right-lateral slip has occurred along the San Andreas Fault Zone to accommodate the relative movement between these two plates (USGS, 2002). The relative movement between the Pacific and the North American Plates generally occurs across a 50-mile zone extending from the San Gregorio Fault in the southwest to the Great Valley Thrust Belt to the northeast. In addition to the right-lateral slip movement between tectonic plates, a compressional component of relative movement has developed between the Pacific Plate and a smaller segment of the North American Plate at the latitude of the San Francisco Bay during the last 3.5 million years. Strain produced by the relative motions of these plates is relieved by right-lateral strike-slip faulting on the San Andreas and related faults, and by vertical reverse-slip displacement on the Great Valley and other thrust faults in the central California area.

The region's seismic faults can be classified as historically active, active, sufficiently active and well defined, or inactive, as defined below (CGS, 2007):

- *Historically active faults* are faults that have generated earthquakes accompanied by surface rupture during historic time (approximately the last 200 years) or that exhibit a seismic fault creep (slow incremental movement along a fault that does not entail earthquake activity).
- *Active faults* show geologic evidence of movement within Holocene time (approximately the last 11,000 years).
- *Sufficiently active and well-defined faults* show geologic evidence of movement during the Holocene along one or more of their segments or branches, and their trace may be identified by direct or indirect methods.
- *Inactive faults* show direct geologic evidence of inactivity (that is, no displacement) during all of Quaternary time or longer.

The existing SFVAMC Fort Miley Campus and the Mission Bay area both lie within a region of active faulting and high seismicity associated with the San Andreas Fault system. The San Andreas Fault system is a zone of major, northwest-trending active strike-slip faults consisting of, from east to west, the Calaveras, Hayward, San Andreas, and San Gregorio–Hosgri faults (Figure 3.6-1). The San Andreas Fault system has been the source of numerous moderate to large magnitude historical earthquakes that caused strong ground shaking in the project area, including the 1906 San Francisco and 1989 Loma Prieta earthquakes. Future strong ground shaking from nearby large-magnitude earthquakes is a virtual certainty and should be a consideration in the design of the new project facilities and components.

The San Andreas Fault lies approximately 5.6 kilometers (3.5 miles) southwest of the existing SFVAMC Fort Miley Campus at its closest point. Several other active and potentially active faults occur within the project limits: the San Gregorio, Hayward, Point Reyes, Rodgers Creek, Calaveras, and others. Table 3.6-1 lists the distances of these and other active or potentially active[1] faults in the region (within 100 kilometers) from the existing Campus and their estimated maximum moment magnitudes.[2,3]. The San Andreas Fault is approximately 9.6 kilometers (6.0 miles) from the center of the Mission Bay area. The existing Campus and the Mission Bay area are not located within an "Earthquake Fault Zone," as delineated by the California Geological Survey (CGS), and no active faults exist in either of these areas (Figure 3.6-1). (See "Alquist-Priolo Act," below.)

Ground Shaking

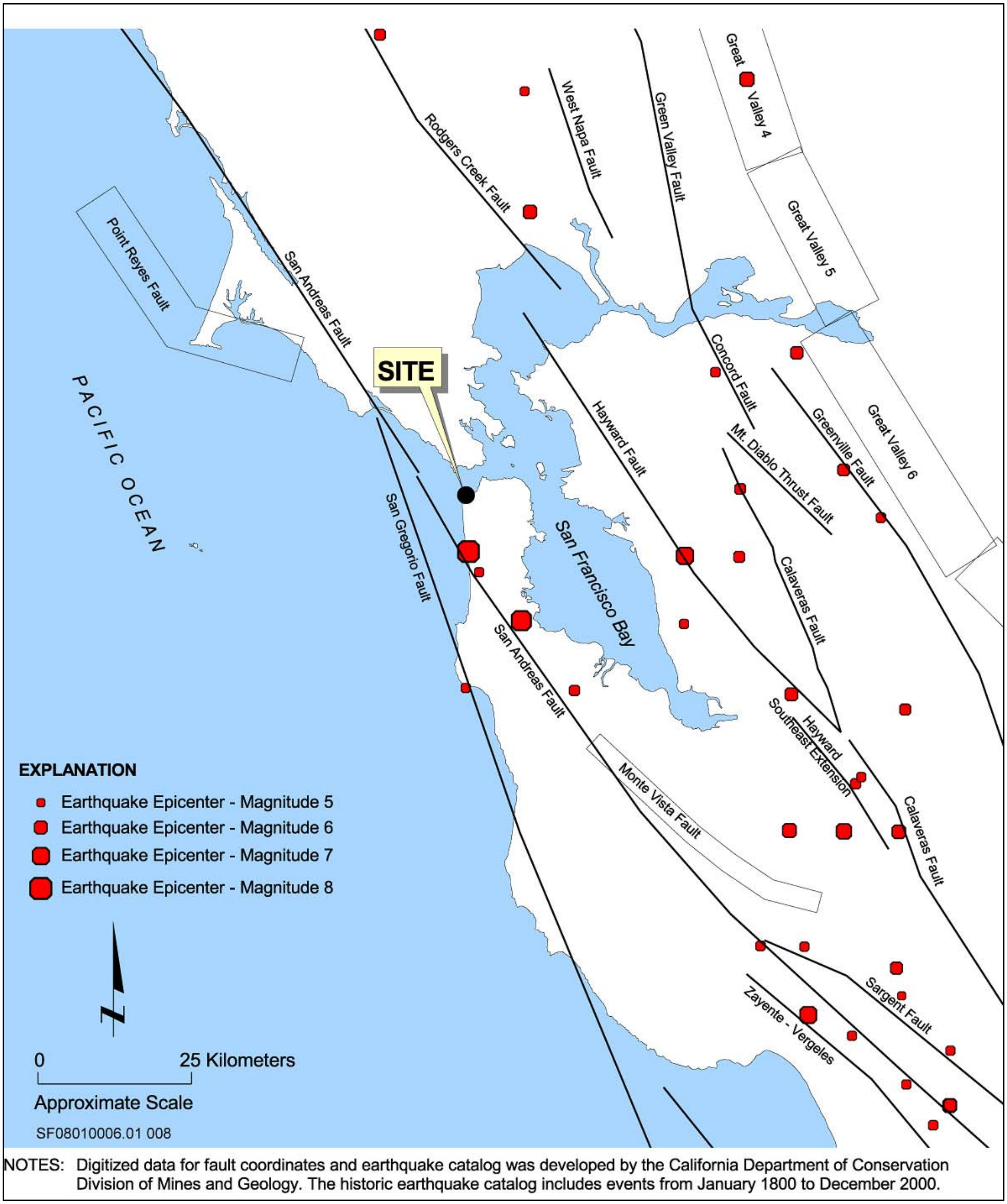
Existing SFVAMC Fort Miley Campus and Mission Bay Area

USGS has predicted that there is a 63 percent chance of a moment magnitude 6.7 earthquake or greater occurring in the San Francisco Bay Area over a period of 30 years, between 2003 and 2032 (USGS, 2007). The intensity of

1 Active faults are defined as those exhibiting either surface ruptures, topographic features created by faulting, surface displacements of geologically Recent (younger than about 11,000 years old) deposits, tectonic creep along fault lines, and/or close proximity to linear concentrations or trends of earthquake epicenters. Potentially active faults are those that have evidence of displacement of deposits of Quaternary age (the last 2 million years).

2 Maximum magnitude earthquakes (moment magnitude) are defined in *Probabilistic Seismic Hazard Assessment for the State of California* by the California Department of Conservation, Division of Mines and Geology, Open File Report 96-08.

3 Moment magnitude is an energy-based scale and provides a physically meaningful measure of the size of a faulting event. Moment magnitude is directly related to average slip and fault rupture area.



Source: Treadwell & Rollo, 2010

Figure 3.6-1: Major Faults and Earthquake Epicenters in the San Francisco Bay Area

Table 3.6-1: Regional Faults and Seismicity

Fault Name	Distance (km/mi) from SFVAMC Fort Miley Campus	Direction from SFVAMC Fort Miley Campus	Maximum Moment Magnitude
San Andreas—1906 Rupture	5.6/3.5	Southwest	7.9
San Andreas—Peninsula	5.6/3.6	Southwest	7.2
San Andreas—North Coast South	8.8/5.5	West	7.5
San Gregorio North	9.8/6.1	West	7.3
Hayward—Total	23.8/14.8	Northeast	7.1
Northern Hayward	23.8/14.8	Northeast	6.6
Southern Hayward	28.4/17.6	East	6.9
Point Reyes	34.0/21.1	Northwest	6.8
Rodgers Creek	36.8/22.9	Northeast	7.1
Mount Diablo Thrust	41.7/25.9	East	6.7
Northern Calaveras	42.0/26.1	East	7.0
Monte Vista	44.4/27.6	Southeast	6.8
Concord	46.2/28.7	Northeast	6.5
Southern Green Valley	47.4/29.5	Northeast	6.5
West Napa	48.0/29.8	Northeast	6.5
Northern Greenville	53.4/33.2	Northeast	6.6
Great Valley— Segment 6	59.4/36.9	Northeast	6.7
Central Greenville	61.5/38.2	East	6.7
Northern Green Valley	62.1/38.6	Northeast	6.3
Hayward—South East Extension	64.0/39.7	Southeast	6.4
Great Valley— Segment 5	64.1/39.8	Northeast	6.5
Great Valley— Segment 4	69.5/43.2	Northeast	6.6
Central Calaveras	71.9/44.7	Southeast	6.6
Southern Greenville	73.9/45.9	East	6.9
Hunting Creek—Berryessa	79.0/49.1	North	6.9
Great Valley— Segment 7	80.3/49.9	East	6.7
San Andreas—Santa Cruz Mts.	80.6/50.1	Southeast	7.2
Sargent	87.1/54.1	Southeast	6.8
Mayacama—South	89.5/55.6	North	6.9
Zayante—Vergeles	90.3/56.1	Southeast	6.8

Source: ENGEO, 2008
Notes: km = kilometers; mi = miles; SFVAMC = San Francisco Veterans Administration Medical Center

the seismic shaking during an earthquake depends on the distance and direction to the earthquake's epicenter, the magnitude of the earthquake, and the area's geologic conditions. The composition of underlying soils, even those relatively distant from faults, can intensify ground shaking. For this reason, earthquake intensities are also measured in terms of their observed effects at a given locality. Earthquakes occurring on faults closest to the existing SFVAMC Fort Miley Campus and other potential campus locations in the Mission Bay area would have the potential to generate the largest ground motions at those sites. A commonly used measure of earthquake intensity is the Modified Mercalli Intensity (MMI) scale, which is a subjective qualitative measure of the strength of an earthquake at a particular place as determined by its effects on objects and people at the Earth's surface. Table 3.6-2 describes the effects of earthquakes based on their level on the MMI scale. The MMI values for intensity range from I (earthquake not felt) to XII (damage nearly total), and an earthquake will vary over the region of a fault and generally decrease with distance from the epicenter of the earthquake.

Soils and Bedrock

Existing SFVAMC Fort Miley Campus

Information from previous subsurface investigations at the existing SFVAMC Fort Miley Campus indicates that the site is underlain by 1–6 feet of fill consisting of stiff to hard sand with varying amounts of clay and gravel, which is underlain by bedrock (ENGEO, 2008; Treadwell & Rollo, 2010). Native soil, consisting of very stiff clay with bedrock fragments, underlies some of the fill at the Campus. Tests performed on the fill indicate that it is nonexpansive; however, the native soil was found to be moderately to highly expansive (Treadwell & Rollo, 2010).

The existing SFVAMC Fort Miley Campus is underlain by intensely sheared rocks of the Franciscan Formation of Cretaceous Age, described as a chaotic mixture of fragmented rock (USGS, 2002), which is shown on the geologic map of the San Francisco North USGS 7.5-Minute Quadrangle. This mapped unit generally includes rock fragments rounded by shearing and embedded in a soft matrix. The Campus is also adjacent to deposits of Quaternary-age Dune Sand and weathered Franciscan bedrock. This formation generally consists of clean, well-sorted, fine- to medium-grained sand underlain by weathered Franciscan bedrock. The bedrock encountered locally at the site, from an elevation of 285–345 feet, consists of friable to moderately strong sandstone, claystone, and shale. Bedrock encountered at the site was closely fractured to crushed and highly to fully weathered. (ENGEO, 2008; Treadwell & Rollo, 2009, 2010).

Mission Bay Area

The Mission Bay area is located within the San Francisco North USGS 7.5-Minute Quadrangle. Based on a review of the *Geologic Map of the San Francisco–San Jose Quadrangle* (Wagner et al., 1991), the Mission Bay area is underlain by the following geologic formations, discussed below: Alluvium, Artificial Fill, Dune Sand, and the Franciscan Assemblage (sandstone, shale, conglomerate, and serpentinized ultramafic rock).

Alluvium under the Mission Bay area consists of unconsolidated stream and basin deposits ranging from very small to boulder size; it is of Holocene age. Artificial Fill is also of Holocene age, and consists of nonnative materials placed at the edge of the San Francisco Bay to raise the land surface above sea level. Dune Sand in the Mission Bay area is of Holocene age.

Table 3.6-2: Modified Mercalli Intensity Scale

Intensity	Effect
I	Not felt. Marginal and long period effects of large earthquakes.
II	Felt by persons at rest, on upper floors, or favorably placed.
III	Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.
IV	Hanging objects swing. Vibration like passing of heavy trucks; or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV, wooden walls and frame creak.
V	Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.
VI	Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks, books, etc., off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken (visibly, or heard to rustle).
VII	Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices (also unbraced parapets and architectural ornaments). Some cracks in masonry C. Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.
VIII	Steering of motor cars affected. Damage to masonry C; partial collapse. Some damage to masonry B; none to masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.
IX	General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. (General damage to foundations.) Frame structures, if not bolted, shifted off foundations. Frames racked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluvial areas sand and mud ejected, earthquake fountains, sand craters.
X	Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.
XI	Rails bent greatly. Underground pipelines completely out of service.
XII	Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.

Notes:
Masonry A: Good workmanship, mortar, and design; reinforced, especially laterally, and bound together by using steel, concrete, etc.; designed to resist lateral forces.
Masonry B: Good workmanship and mortar; reinforced, but not designed in detail to resist lateral forces.
Masonry C: Ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at corners, but neither reinforced nor designed against horizontal forces.
Masonry D: Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.
Source: ABAG, 2011

The Franciscan Assemblage outcrops at the surface in two areas of the Mission Bay area. Immediately adjacent to the San Francisco–Oakland Bay Bridge, it is composed primarily of sandstone, shale, and conglomerate of marine origin and is Cretaceous in age (i.e., approximately 144 to 65 million years Before Present [B.P.]).

Southwest of the Bay Bridge, between Interstate 80/U.S. Highway 101 and Interstate 280, this formation outcrops as serpentinized ultramafic rocks of Jurassic age (i.e., approximately 206–144 million years B.P.). In addition to these two surface outcrops, the Franciscan Assemblage underlies all of the other formations described above.

3.6.2 Regulatory Framework

Clean Water Act

The Clean Water Act (CWA) (33 U.S. Code [USC] 1251 et seq.) includes provisions for reducing soil erosion for the protection of water quality. The CWA makes the discharge of pollutants from a point source to navigable waters unlawful, unless a permit was obtained under the provisions of the CWA. Regulation of discharges under the CWA also pertains to construction sites where soil erosion and stormwater runoff and other pollutant discharges could affect downstream water quality. The CWA is described in greater detail in Section 3.8, "Hydrology and Water Quality."

Executive Order 12699

Executive Order 12699, "Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction," was signed by President George H. W. Bush on January 5, 1990, to further the goals of Public Law 95-124, the Earthquake Hazards Reduction Act of 1977, as amended. The executive order applies to new construction of buildings owned, leased, constructed, assisted, or regulated by the federal government. Guidelines and procedures for implementing the order were prepared in 1992 by the federal Interagency Committee on Seismic Safety in Construction. The guidelines establish minimum acceptable seismic safety standards, provide evaluation procedures for determining the adequacy of local building codes, and recommend implementation procedures. Each federal agency is independently responsible for ensuring that appropriate seismic design and construction standards are applied to new construction under its jurisdiction.

Under the original Executive Order 12699, the model code for the West Coast was the Uniform Building Code developed by the International Conference of Building Officials. In 1994, the International Conference of Building Officials joined with other similar organizations in the Southeast and on the East Coast to form the International Code Council (ICC). In 2000, the ICC published the first International Building Code (IBC) based on the reassessment of earlier codes and the combined updated experience of ICC member organizations. The current 2006 IBC is the result of nearly 100 years of building code improvement.

Executive Order 12941

Executive Order 12941, "Seismic Safety of Existing Federally Owned or Leased Buildings," was signed by President Bill Clinton on December 1, 1994, to mandate the seismic safety of existing federally owned or leased buildings by adopting RP4 Standards. The standards, developed by the Interagency Committee on Seismic Safety in Construction, were adopted as the minimum level acceptable for use by federal departments and agencies in assessing the seismic safety of their owned and leased buildings and in mitigating unacceptable seismic risk in those buildings. Executive Order 12941 mandates the seismic retrofitting of certain buildings at the existing SFVAMC Fort Miley Campus, which is described below in Section 3.6.3, "Environmental Consequences."

International Building Code

The IBC, which encompasses the former Uniform Building Code, is produced by the ICC to provide standard specifications for engineering and construction activities, including measures to address geologic and soil concerns (ICC, 2009). Specifically, these measures encompass issues such as seismic loading (e.g., classifying seismic zones and faults), ground motion, and engineered fill specifications (e.g., compaction and moisture content). The referenced guidelines, while not serving as formal regulatory requirements per se, are widely accepted by regulatory authorities and are routinely included in related standards such as grading codes. The IBC guidelines are updated regularly to reflect current industry standards and practices, including criteria from sources such as the American Society of Civil Engineers and ASTM International (formerly known as the American Society for Testing and Materials).

Earthquake Hazards Reduction Act

In October 1977, the U.S. Congress passed the Earthquake Hazards Reduction Act (42 USC 7701 et seq.) to "reduce the risks to life and property from future earthquakes in the United States through the establishment and maintenance of an effective earthquake hazards and reduction program" (42 USC 7702). To accomplish this, the act established the National Earthquake Hazards Reduction Program (NEHRP). The National Earthquake Hazards Reduction Program Act (NEHRPA) significantly amended this program in November 1990 by refining the description of agency responsibilities, program goals, and objectives. The NEHRPA designates the Federal Emergency Management Agency (FEMA) as the lead agency of the program and assigns FEMA several planning, coordinating, and reporting responsibilities. Other NEHRPA agencies include the National Institute of Standards and Technology, the National Science Foundation, and USGS.

Veterans Health Administration Directive 2005-019

The purpose of Veterans Health Administration (VHA) Directive 2005-019 is to establish a policy regarding the seismic safety of VHA buildings. Because facilities identified as essential must remain in operation after a seismic event, VHA Directive 2005-019 assists VA in providing adequate life-safety protection to Veterans, employees, and other building occupants. In compliance with Executive Order 12941, VA developed an inventory of its owned or leased buildings identifying their seismic risk. These data were reported to FEMA in January 1999. Under VHA Directive 2005-019, all new buildings must be structurally designed and constructed in compliance with VA Seismic Design Requirements H-18-8 and the IBC (VA, 2005). A major update of the VA Seismic Design Requirements H-18-8 (formerly known as H-08-8) was implemented in 1995. The current VA Seismic Design Requirements H-18-8 closely align with the IBC, and the VA Seismic Design Requirements would be applicable to proposed new SFVAMC buildings.

Alquist-Priolo Earthquake Fault Zoning Act

The California Alquist-Priolo Earthquake Fault Zoning Act (Alquist-Priolo Act) was passed in December 1972 to mitigate the hazard of surface faulting to structures for human occupancy. Surface rupture is the most easily avoided seismic hazard. The Alquist-Priolo Act's main purpose is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. The Alquist-Priolo Act addresses only the hazard of surface fault rupture and is not directed toward other earthquake hazards. The California Seismic Hazards Mapping Act, passed in 1990, addresses earthquake hazards caused by nonsurface fault rupture, 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. An 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.

Because no active fault zones are known to exist in San Francisco, no earthquake fault zones under the Alquist-Priolo Act are mapped in the City and County of San Francisco.

3.6.3 Environmental Consequences

Significance Criteria

A NEPA evaluation must consider the context and intensity of the environmental effects that would be caused by, or result from, the EIS Alternatives. There is currently no CEQ guidance related to the analysis of geology and soils impacts. Therefore, other environmental assessment documents were reviewed and the following criteria were selected for evaluation.

An alternative analyzed in this EIS is considered to result in an adverse impact related to geology and soils if it would:

- 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 or landslides;
- be located on a geologic unit or soil that is unstable, or would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse; or
- be located on expansive soil creating substantial risks to life or property.

Assessment Methods

Significance of impacts associated with faulting, ground acceleration, and ground shaking are evaluated based on distance to known fault zones as well as the seismic characteristics of fault zones. Effects of the proposed LRDP on soils that possess a moderate to severe potential for erosion and liquefaction could be adverse impacts. Soil erosion impacts are also discussed in Section 3.8, “Hydrology and Water Quality.” As noted above, San Francisco is not located within an “Earthquake Fault Zone” as delineated by CGS, and no active faults exist on either the existing SFVAMC Fort Miley Campus or in the Mission Bay area; thus, exposure of people or structures to surface fault rupture is not evaluated below.

Alternative 1: SFVAMC Fort Miley Campus Buildout Alternative

Near-Term Projects

Construction

Alternative 1 near-term projects include seismic retrofitting of existing buildings, which is mandated by Executive Order 12941. VA has identified Buildings 5, 7, 9, 10, and 13 (as part of Phase 1) as Critical or Essential Facilities for the existing SFVAMC Fort Miley Campus; therefore, those buildings would undergo retrofitting according to VA Seismic Design Requirements H-18-8. The seismic retrofitting of those buildings in Phase 1 under Alternative 1 would result in no impact related to geology and soils.

Erosion and Loss of Topsoil

Construction of the near-term project components (Phase 1) would involve site grading and preparation of approximately 1.34 acres, which would disturb exposed subsurface soils, including fill and underlying native soils. Despite previous development of the existing SFVAMC Fort Miley Campus, loose and compacted soil exists on-site in landscaped and open space areas and areas that would undergo construction or maintenance. Exposed fill materials would be susceptible to erosion during project construction excavation. Erosion resulting from stormwater runoff could occur during the project construction process, although most loosened and eroded soil would remain within the excavation pits. A National Pollutant Discharge Elimination System (NPDES) general permit for stormwater discharges associated with construction activities (Construction General Permit; SWRCB Order No. 99-08-DWQ) would be required for the implementation of near-term project components. For sites that disturb 1 acre or more and drain to the separate sewer system, compliance with the Construction General Permit and preparation and implementation of a storm water pollution prevention plan (SWPPP) that meets Construction General Permit conditions would be required. See the discussion of a SWPPP in Section 3.8, “Hydrology and Water Quality,” which evaluates erosion in further detail. With implementation of a SWPPP, the construction of Alternative 1 near-term projects would result in a minor impact related to erosion and loss of topsoil.

Alteration of Topography

Alternative 1 near-term projects would not result in any below-grade development. However, as a conservative estimate, excavation of 24 feet subgrade for each new structure is assumed in this EIS. Topography at the existing SFVAMC Fort Miley Campus would not be substantially altered and the proposed buildings would be constructed following applicable VA Seismic Design Requirements H-18-8 and the IBC; therefore, the construction of Alternative 1 near-term projects would result in a minor impact related to alteration of topography.

Operation

Alternative 1 near-term projects include seismic retrofitting of existing buildings, which is mandated by Executive Order 12941. After the seismic retrofitting of Buildings 5, 7, 9, 10, 11, and 13 (as part of Phase 1), this alternative would result in a beneficial operational impact, because the buildings would be built to current VA seismic standards.

Seismically Induced Ground Shaking and Ground Failure

Liquefaction typically occurs when near-surface (usually upper 50 feet) saturated, clean, fine-grained loose sands, coupled with a shallow groundwater table, are subject to intense ground shaking. One of the major types of liquefaction-induced ground failures is lateral spreading of mildly sloping ground. Lateral spreading is a failure within a nearly horizontal soil zone (possibly as a result of liquefaction) that causes the overlying soil mass to move toward a free face or down a gentle slope. The existing SFVAMC Fort Miley Campus is not located within an area that is mapped as a liquefaction hazard zone (CGS, 2000) and groundwater was not encountered during previous borings/geotechnical investigations (ENGEO, 2008; Treadwell & Rollo, 2010). Lateral spreading at the site is unlikely, because no liquefaction hazard is present at the Campus (Treadwell & Rollo, 2010). Subsidence, the sinking or settling of land, is caused by compaction of unconsolidated soils during a seismic event, compaction by heavy structures, erosion of peat soils, or groundwater depletion. Subsidence usually occurs over a broad area and therefore is not detectable at the ground surface. This normally occurs in areas underlain by alluvial soils, which are not expected to be present at the existing Campus.

An engineering geologic hazards (geotechnical investigation) and site-specific ground-response report would be required for the Critical and Essential Facilities proposed as part of Alternative 1 near-term projects (VA, 2011). Consequently, design and construction of the proposed facilities of Phase 1 would address seismically induced ground shaking and associated ground failure through engineering and design recommendations for the proposed facilities. Furthermore, a geotechnical contractor would review the project plans and specifications before construction to check their conformance with the recommendations of the geotechnical reports. Therefore, because the facilities would be designed and constructed to meet VA’s seismic design requirements, operation of the facilities constructed during Alternative 1 near-term projects would result in a minor impact related to seismically induced ground shaking and associated ground failure.

Seismically Induced Landslides or Slope Failures

Landslides and other slope failures are common occurrences during or soon after earthquakes. The existing SFVAMC Fort Miley Campus is not located within a designated landslide hazard zone (CGS, 2000), and no evidence of landslides was observed from a previous investigation (Treadwell & Rollo, 2010). However, there are two mapped landslide scarps to the north of the Campus and another previous landslide area on the northern slope of the Campus. The mapped landslides are outside the proposed development footprint and do not pose a risk to the development activities associated with Alternative 1 near-term projects (ENGEO, 2008; Treadwell & Rollo, 2010). Therefore, no impact related to seismically induced landslides or slope failures would result from the operation of Alternative 1 near-term projects.

Expansive or Corrosive Soils

Expansive soils generally result when specific clay minerals expand when saturated and shrink in volume when dry. Expansive soils can occur in any climate; however, arid and semiarid regions are subject to more extreme cycles of expansion and contraction than more consistently moist areas. As noted previously, native soil on the existing SFVAMC Fort Miley Campus was found to be moderately to highly expansive (Treadwell & Rollo, 2010). In addition, an engineering geologic hazards (geotechnical investigation) and site-specific ground-response report would be required for the Critical and Essential Facilities of Alternative 1 near-term projects (VA, 2011).

Consequently, design and construction of the proposed facilities would address any potential expansive or corrosive soils through engineering and design recommendations for the proposed facilities. Furthermore, a geotechnical contractor would review the project plans and specifications before construction to check their conformance with the recommendations of the geotechnical reports. Therefore, a minor impact related to expansive or corrosive soils would result from facility operation for Alternative 1 near-term projects.

Long-Term Projects

Alternative 1 long-term projects include seismic retrofitting of existing buildings, which is mandated by Executive Order 12941. VA has identified Buildings 1, 6, and 8 (as part of Phase 2) as Critical or Essential Facilities for the existing SFVAMC Fort Miley Campus; therefore, those buildings would undergo retrofitting according to VA Seismic Design Requirements H-18-8. The seismic retrofitting of those buildings under Alternative 1 long-term projects would result in no impact related to geology and soils.

Construction

Erosion and Loss of Topsoil

The erosion and topsoil effects of construction of the clinical and research buildings and administrative/mixed-use buildings under Alternative 1 long-term projects would be similar to those described for Alternative 1 near-term projects. The impact related to erosion and loss of topsoil would be minor.

Alteration of Topography

The topographical effects of construction of the clinical and research buildings and administrative/ mixed-use buildings under long-term projects of Alternative 1 would be similar to those described under near-term projects for Alternative 1. The impact related to alteration of topography would be minor.

Operation

Seismically Induced Ground Shaking and Ground Failure

The effects of operation of the clinical and research buildings and administrative/mixed-use buildings under Alternative 1 long-term projects would be similar to those described for Alternative 1 near-term projects. The impact related to seismically induced ground shaking and associated ground failure would be minor.

Seismically Induced Landslides or Slope Failures

The effects of operation of the clinical and research buildings and administrative/mixed-use buildings under Alternative 1 long-term projects would be similar to those described for Alternative 1 near-term projects. No impact related to seismically induced landslides or slope failures would result from the operation of facilities proposed under Alternative 1 long-term projects.

Expansive or Corrosive Soils

The effects of operation of the clinical and research buildings and administrative/mixed-use buildings under Alternative 1 long-term projects would be similar to those described for Alternative 1 near-term projects. A minor impact related to expansive or corrosive soils would result from the operation of the facilities proposed under Alternative 1 long-term projects.

Alternative 2: SFVAMC Fort Miley Campus Plus Mission Bay Campus Alternative

Near-Term Projects

Alternative 2 near-term projects (both construction and operation) would be the same as Alternative 1 near-term projects (see Tables 2-1 and 2-2 and Figures 2-1 and 2-2). Therefore, the impacts of Alternative 2 near-term projects would be the same as those described for Alternative 1 near-term projects. These impacts would range in significance from no impact to minor.

Long-Term Projects

Alternative 2 long-term projects (both construction and operation) located at the SFVAMC Fort Miley Campus would be the same as Alternative 1 long-term projects, except that the ambulatory care center would be located at the potential new SFVAMC Mission Bay Campus under Alternative 2 (see Tables 2-1 and 2-2 and Figures 2-1 and 2-2). Therefore, the impacts of Alternative 2 long-term projects at the SFVAMC Fort Miley Campus would be the same as or less than the impacts of Alternative 1 long-term projects.

Components of Alternative 2 long-term (Phase 2) projects would primarily involve development of 69,700 net new gross square feet (gsf) of medical, research, and support space at the existing SFVAMC Fort Miley Campus as well as 620,000 gsf of new construction, including an ambulatory care clinic, research space, and associated parking structures, at a potential new SFVAMC Mission Bay Campus. This alternative would involve constructing new facilities on approximately 0.25 acre at the existing Campus and on approximately 3.56 acres at the potential new Campus. The impact discussion below focuses on the impacts at the potential new SFVAMC Mission Bay Campus from construction and operation of the ambulatory care center, research building, and associated parking structures proposed as part of Alternative 2, Phase 2.

<u>Construction</u>

Under VHA Directive 2005-019, all new buildings would be structurally designed and constructed in compliance with VA Seismic Design Requirements H-18-8 and the IBC. Thus, at the time a specific site has been selected and before construction, a geotechnical report for development of the potential new SFVAMC Mission Bay Campus would be prepared with recommendations to protect against seismic impacts.

Erosion and Loss of Topsoil

The effects of construction of new buildings, medical facilities, and parking structures at the potential new SFVAMC Mission Bay Campus under Alternative 2 would be addressed at the time that a specific site is selected.

Similar to the measures that would be taken for Alternative 1, a NPDES general permit for stormwater discharges associated with construction activities (Construction General Permit; SWRCB Order No. 99-08-DWQ) would be required, and implementation of a SWPPP meeting Construction General Permit conditions would be required. See the discussion of a SWPPP in Section 3.8, “Hydrology and Water Quality,” which evaluates erosion in further detail. With implementation of a SWPPP, the construction of Alternative 2 at the potential new Campus would result in a minor impact.

Alteration of Topography

The effects of construction of new buildings, medical facilities, and parking structures at the potential new SFVAMC Mission Bay Campus under Alternative 2 would be addressed at the time that a specific site is selected. The new buildings would be constructed in accordance with applicable VA Seismic Design Requirements H-18-8 and the IBC. Therefore, the alteration of topography at the potential new Campus would result in a minor impact.

Operation

Seismically Induced Ground Shaking and Ground Failure

Seismic operational impacts of new buildings, medical facilities, and parking structures at the potential new SFVAMC Mission Bay Campus under Alternative 2 would be addressed at the time that a specific site is selected. An engineering geologic hazards (geotechnical investigation) and site-specific ground-response report would be required for the Critical and Essential Facilities (VA, 2011). The design and construction of the proposed facilities would address seismically induced ground shaking and associated ground failure through engineering and design recommendations for the proposed facilities. Furthermore, a geotechnical contractor would review the project plans and specifications before construction to check their conformance with the recommendations of the geotechnical reports. Therefore, because the facilities would be designed and constructed to meet VA’s seismic design requirements, operation of the facilities constructed under Alternative 2 would result in a minor impact related to seismically induced ground shaking and associated ground failure.

Seismically Induced Landslides or Slope Failures

Given the generally flat topography of the Mission Bay area, it is likely that a potential new SFVAMC Mission Bay Campus would be developed in a an area that is relatively flat with no slopes that are susceptible to landslides or other types of failure. Any new facilities built at a potential new Campus would be required to meet seismic code standards applicable to San Francisco. Thus, no operational impact related to seismically induced landslides or slope failures is anticipated with implementation of Alternative 2. The potential for such hazards would be addressed at the time that a specific site is selected.

Expansive or Corrosive Soils

As noted previously, expansive soils generally result when specific clay minerals expand when saturated and shrink in volume when dry. Expansive soils can occur in any climate; however, arid and semiarid regions are subject to more extreme cycles of expansion and contraction than more consistently moist areas. Depending on the soil characteristics of the site, a minor impact related to expansive or corrosive soils could result from implementation of Alternative 2. The potential for expansive or corrosive soils at the site of a potential new SFVAMC Mission Bay Campus would be addressed at the time that a specific site is selected. An engineering geologic hazards (geotechnical investigation) and site-specific ground-response report would be required for the Critical and Essential Facilities (VA, 2011). Any potential hazards related to expansive or corrosive soils would be addressed and mitigated through engineering and design recommendations for the potential new Campus's buildings and structures.

Alternative 3: No Action Alternative

Near-Term Projects

Construction

Under Alternative 3, there would be no construction or seismic retrofitting. Therefore, no construction-related impacts on geology and soils would occur.

Operation

Under Alternative 3, the LRDP would not be implemented, and the existing SFVAMC would continue to function at its current capacity. Existing Buildings 5, 7, 9, 10, 11, and 13 at the SFVAMC Fort Miley Campus (all of which are Critical or Essential Facilities) would not undergo seismic retrofitting. Because the buildings would continue to operate below current VA seismic standards, implementing Alternative 3 would result in adverse impacts related to seismically induced ground shaking and ground failure, seismically induced landslides, slope failures, and expansive or corrosive soils.

Long-Term Projects

Construction

Under Alternative 3, there would be no construction or seismic retrofitting. Therefore, no construction-related impacts on geology and soils would occur.

Operation

Under Alternative 3, the LRDP would not be implemented, and the existing SFVAMC would continue to function at its current capacity. Existing Buildings 1, 6, and 8 at the SFVAMC Fort Miley Campus (all of which are Critical or Essential Facilities) would not undergo seismic retrofitting. Because the buildings would continue to operate below current VA seismic standards, implementing Alternative 3 would result in adverse impacts related to seismically induced ground shaking and ground failure, seismically induced landslides, slope failures, and expansive or corrosive soils.

3.6.4 References

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