

F. Geology, Soils, and Seismicity

This section describes geologic and seismic conditions in the project vicinity and evaluates the potential for the Kaiser Permanente OMC Project to result in significant impacts related to exposing people or structures to unfavorable geologic hazards, soils, and/or seismic conditions. Potential impacts are discussed and evaluated, and appropriate standard conditions of approval are identified, as necessary.

Setting

Topographic

The city of Oakland includes the mountainous uplands of the Oakland-Berkeley Hills and an alluvial plain that slopes gently westward away from these hills to meet the flat marginal baylands of the San Francisco Bay. The project area is located on the alluvial plain, approximately 2 miles east of the bay shoreline, on a relatively flat area that has a southward slope less than 5 percent. The project area is situated at an elevation of about 80 feet above mean sea level (msl).

Geologic

The project area lies within the geologic region of California referred to as the Coast Ranges geomorphic province.¹ The natural region of the Coast Ranges is between the Pacific Ocean and the Great Valley and stretches from the Oregon border to the Santa Ynez River near Santa Barbara. Discontinuous northwest-trending mountain ranges, ridges, and intervening valleys characterize this province. Much of the Coast Range province is composed of marine sedimentary and volcanic rocks that form the Franciscan Assemblage. The Franciscan Assemblage in this region of California represents some of the oldest rocks in the region, and consists primarily of greenstone (altered volcanic rocks), basalt, chert (ancient silica-rich ocean deposits), and sandstone that originated as ancient sea floor sediments.

The San Francisco Bay is located in a broad depression in the Franciscan bedrock resulting from an east-west expansion between the San Andreas and the Hayward fault systems. The bedrock surface can be found at elevations of 200 to 2,000 feet below msl across the Bay Area. Sedimentary deposits overlie the Franciscan bedrock that originated from millions of years of erosion, deposition, and changes in sea level. Geologists categorize these sedimentary deposits into geologic formations based on the period of deposition and material type, as described below for the San Francisco Bay region.

- The Alameda Formation is the deepest and oldest of these sedimentary deposits and consists of a mixture of clay, silt, sand, gravel, and some shells with predominantly silt and clay sediments surrounding discontinuous layers of sand and gravel;

¹ A geomorphic province is an area that possesses similar bedrock, structure, history, and age. California has 11 geomorphic provinces.

- Overlying the Alameda Formation is the San Antonio Formation which consists of sandy clays, gravelly clays, clayey sands and gravels with interbedded silty clay deposits.
- Younger alluvial deposits once referred to as the Temescal Formation are deposited on top of the San Antonio and consist of sandy clays, clayey sands, sands and gravels. The source material for these alluvial deposits comes from the Berkeley Hills.

Bedrock, known as the Franciscan Formation or Complex, has reportedly been encountered at depths of approximately 150 to 175 feet below ground surface in the study area (URS, 2005). The bedrock surface becomes deeper towards the south-southeast and shallower towards the northeast.

Soils

The U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) (formerly known as the Soil Conservation Service) has identified soils at the project area as Urban Land-Danville complex and Urban Land-Tierra complex (USDA, 1981). Urban Land consists of soils that are covered by structures and other urban development. The native soils in these areas have been disturbed, reworked, and mixed.

The Danville complex consists of soils deposited on alluvial plains from sedimentary rock sources. These soils can extend up to 5 feet thick and have a low permeability rate, indicating surface water is slowly and poorly absorbed. The soils have a low erosion hazard potential. Danville complex soils have a very low strength and high shrink-swell characteristics. Shrink-swell is the cyclic change in volume (expansion and contraction) that occurs in fine-grained clay sediments from the process of wetting and drying (discussed below under “Expansive Soils”). The permeability, strength, and shrink-swell characteristics identified by the NRCS are for undisturbed soils, generally in the upper 5 feet. Urban development in the region may have reworked or removed most of the upper 5 feet of soil, reducing or eliminating the characteristics identified by the NRCS.

The Urban Land-Tierra complex has characteristics similar to the Urban Land-Danville complex described above. The Tierra loam is generally not as thick and is found at slightly higher elevations and slopes than the Danville complex. However, the permeability is also low and has a high shrink-swell potential. Similar to the Danville, the Tierra loam has a moderate potential for erosion hazard.

URS Corporation (URS) prepared a geotechnical investigation within the Phase 1 project area: the proposed West Broadway Medical Services Building (MSB)² and Center Care Center and West Broadway Parking Structure on Site 7, generally the eastern portion of the block bounded by West MacArthur Boulevard, Broadway, 38th Street and Manila Avenue. The investigation identified predominantly stiff clays with lesser amounts of sandy silts and clayey sands. With increasing depth, the materials encountered became higher in plasticity and greater in stiffness. In addition, a relatively thin layer of sand was observed in one of the borings between 19 and

² In the 2005 geotechnical investigation report prepared by URS, the Medical Services Building (MSB) is referred to as the “Medical Office Building”.

21.5 feet below ground surface (URS, 2005). However, this sand layer was not observed in any of the other borings and considered to be isolated in this area of the site.

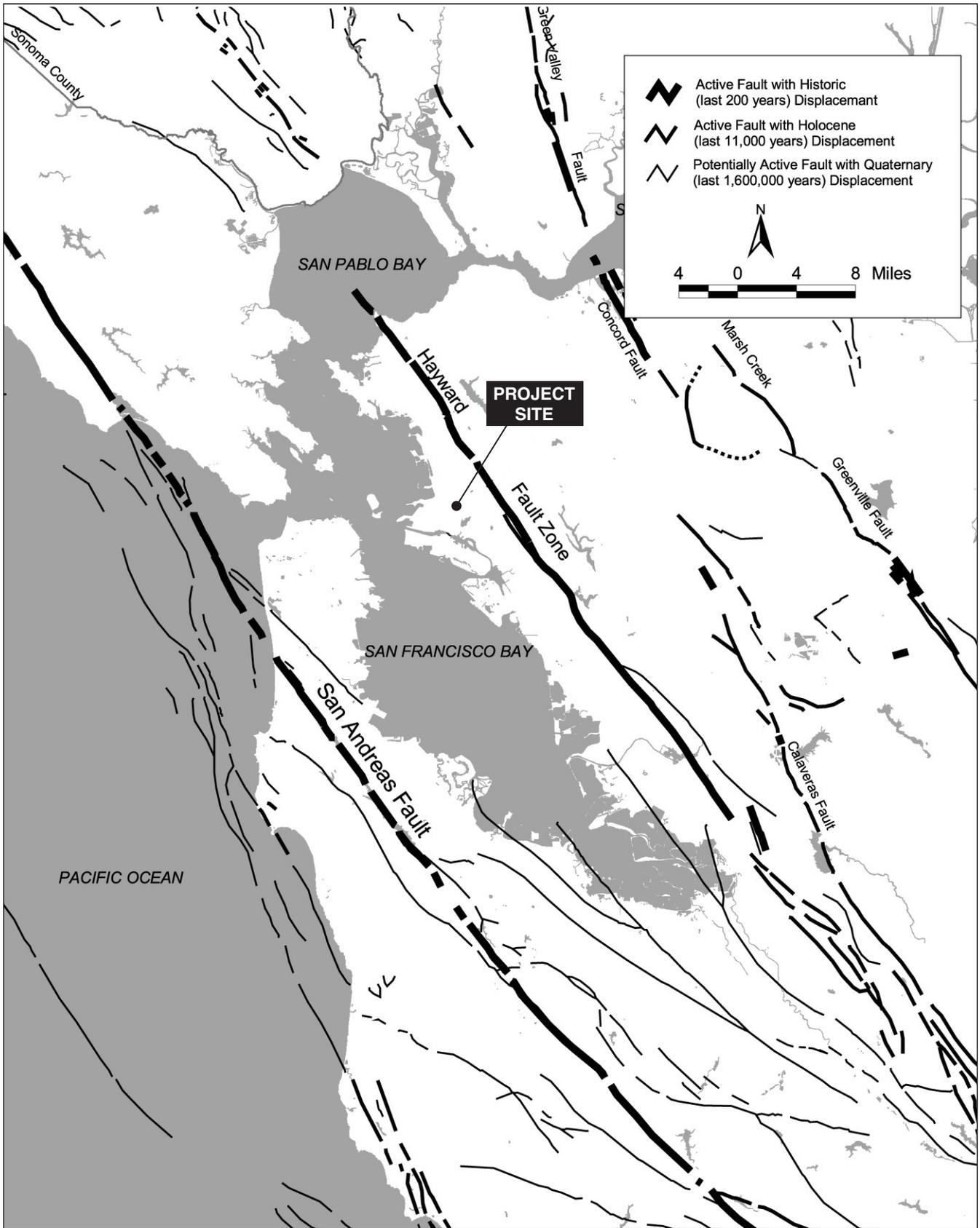
Seismicity

The San Francisco Bay Area region contains both active and potentially active faults and is considered a region of high seismic activity (**Figure IV.F-1**).³ The 1997 Uniform Building Code locates the entire Bay Area within Seismic Risk Zone 4. The U.S. Geological Survey (USGS) Working Group on California Earthquake Probabilities has evaluated the probability of one or more earthquakes of Richter magnitude 6.7 or higher occurring in the San Francisco Bay Area within the next 30 years. The result of the evaluation indicated a 62 percent likelihood that such an earthquake event will occur in the Bay Area between 2003 and 2032 (USGS, 2003). The magnitude (M) is a measure of the energy released in an earthquake. The estimated magnitudes, described as moment magnitudes (M_w) represent *characteristic* earthquakes on particular faults (**Table IV.F-1**).⁴ Intensity is a measure of the ground shaking effects at a particular location. However, ground movement during an earthquake can vary depending on the overall magnitude, distance to the fault, focus of earthquake energy, and type of geologic material. The composition of underlying soils, even those relatively distant from faults, can intensify ground shaking. The Modified Mercalli (MM) intensity scale (**Table IV.F-2**) is commonly used to measure earthquake effects due to ground shaking. The MM 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.⁵ For comparison, the 1906 San Francisco earthquake (M_w 7.9) produced strong (VII) shaking intensities, while the 1989 Loma Prieta earthquake, with an M_w of 6.9 produced moderate (VI) shaking intensities in the project area. (ABAG, 2005a,b).

³ An “active” fault is defined by the State of California as a fault that has had surface displacement within Holocene time (approximately the last 10,000 years). A “potentially active” fault is defined as a fault that has shown evidence of surface displacement during the Quaternary (last 1.6 million years), unless direct geologic evidence demonstrates inactivity for all of the Holocene or longer. This definition does not, of course, mean that faults lacking evidence of surface displacement are necessarily inactive. “Sufficiently active” is also used to describe a fault if there is some evidence that Holocene displacement occurred on one or more of its segments or branches (Hart, 1997).

⁴ Moment magnitude is related to the physical size of a fault rupture and movement across a fault. The Richter magnitude scale reflects the maximum amplitude of a particular type of seismic wave. Moment magnitude provides a physically meaningful measure of the size of a faulting event (CDMG, 1997b). The concept of “characteristic” earthquake means that we can anticipate, with reasonable certainty, the actual earthquake that can occur on a fault.

⁵ The damage level represents the estimated overall level of damage that will occur for various MM intensity levels. The damage, however, will not be uniform. Some buildings will experience substantially more damage than this overall level, and others will experience substantially less damage. Not all buildings perform identically in an earthquake. The age, material, type, method of construction, size, and shape of a building all affect its performance.



SOURCES: California Department of Conservation, Division of Mines and Geology (After Jennings, 1994)

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Figure IV.F-1
Regional Fault Map

**TABLE IV.F-1
 ACTIVE FAULTS IN THE PROJECT SITE VICINITY**

Fault	Distance and Direction from Project Area	Recency of Movement	Fault Classification^a	Historical Seismicity^b	Maximum Moment Magnitude Earthquake (Mw)^c
Hayward	3 miles east	Historic (1836; 1868 ruptures) Holocene	Active	M6.8, 1868 Many <M4.5	7.1
Calaveras	21 miles east	Historic (1861 rupture) Holocene	Active	M5.6–M6.4, 1861 M4–M4.5 swarms 1970, 1990	6.8
San Andreas	15 miles west	Historic (1906; 1989 ruptures) Holocene	Active	M7.1, 1989 M8.25, 1906 M7.0, 1838 Many <M6	7.9
Greenville	33 miles southeast	Historic (1980 rupture) Holocene	Active	M5.6 1980	6.9
Concord–Green Valley	18 miles east	Historic (1955) Holocene	Active	Historic active creep	6.9
Rodgers Creek	25 miles north	Historic Holocene	Active	M6.7, 1898 M5.6, 5.7, 1969	7.0

^a See Footnote 4.

^b Richter magnitude (M) and year for recent and/or large events. The Richter magnitude scale reflects the maximum amplitude of a particular type of seismic wave.

^c Moment magnitude (Mw) is related to the physical size of a fault rupture and movement across a fault. Moment magnitude provides a physically meaningful measure of the size of a faulting event (CDMG, 1997b). The Maximum Moment Magnitude Earthquake, derived from the joint CDMG/USGS Probabilistic Seismic Hazard Assessment for the State of California, 1996. (USGS, 1996).

SOURCES: Hart, 1997; Jennings, 1994; Peterson et al, 1996.

**TABLE IV.F-2
 MODIFIED MERCALLI INTENSITY SCALE**

Intensity Value	Intensity Description	Average Peak Acceleration
I	Not felt except by a very few persons under especially favorable circumstances.	< 0.0017 g ^a
II	Felt only by a few persons at rest, especially on upper floors on buildings. Delicately suspended objects may swing.	< 0.014 g
III	Felt noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly, vibration similar to a passing truck. Duration estimated.	< 0.014 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 motor cars rocked noticeably.	0.014–0.04 g
V	Felt by nearly everyone, many awakened. Some dishes and windows broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles may be noticed. Pendulum clocks may stop.	0.04–0.09 g
VI	Felt by all, many frightened and run outdoors. Some heavy furniture moved; and fallen plaster or damaged chimneys. Damage slight.	0.09–0.18 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 motor cars.	0.18–0.34 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 motor cars disturbed.	0.34–0.65 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.	0.65–1.24 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.	> 1.24 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.	> 1.24 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.	> 1.24 g

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

SOURCE: California Geological Survey, Note 32 (CDMG, 1997b), (CGS, 2003).

Regional Faults

The two main earthquake faults in the region are the San Andreas Fault Zone on the San Francisco Peninsula and the Hayward Fault Zone that extends along the east bay plain. These two faults are within the San Andreas Fault System, which marks the boundary between two continental plates – the Pacific Plate to the west and the North American Plate to the east. This fault system includes many active fault zones in northern and southern California. Other principal Bay Area faults capable of producing significant ground shaking in the project area are listed on **Table IV.F-2** and include the Calaveras, Concord–Green Valley, Marsh Creek–Greenville, and Rodgers Creek. These are also strike-slip faults that are part of the San Andreas Fault System. Most of these faults have produced historic earthquakes of varying magnitude, but the greatest threat to producing significant earthquakes is the San Andreas, the Hayward, and the Calaveras faults.

San Andreas Fault Zone

The San Andreas Fault Zone is the largest in the state, extending from the Salton Sea near the border with Mexico, to north of Point Arena where the fault trace extends into the Pacific Ocean. The main trace of the San Andreas fault through the Bay Area trends northwest through the Santa Cruz Mountains and the eastern side of the San Francisco Peninsula.

As the principle boundary between the Pacific plate and the North American plate, the San Andreas is often a highly visible topographic feature, such as the area between Pacifica and San Mateo, where Crystal Springs Reservoir and San Andreas Lake clearly mark the rupture zone.⁶

The San Andreas Fault Zone was the source of the two major seismic events in recent history that affected the San Francisco Bay region. The 1906 San Francisco earthquake was estimated at M 7.9 and resulted in approximately 170 miles of surface fault rupture. Horizontal displacement along the fault approached 17 feet near the epicenter. The more recent 1989 Loma Prieta earthquake, with a moment magnitude of M 7.1, resulted in widespread damage throughout the Bay Area. The USGS Working Group on California Earthquake Probabilities estimated there is a 21 percent chance of the San Andreas fault experiencing an earthquake of M 6.7 or greater in the next 30 years (USGS, 2003).

Hayward Fault Zone

The Hayward Fault Zone is part of the San Andreas Fault System and trends to the northwest along the eastern San Francisco Bay, extending from San Pablo Bay in Richmond, 60 miles south to San Jose. In San Jose, the Hayward fault converges with the Calaveras fault, a similar type fault that extends north to Suisun Bay. The Hayward Fault is the boundary between two distinctively different geologic formations of different age and origin. The hills to the east of the fault may be 10 million years old, while the flatlands to the west of the fault are probably less than 15,000 years old. The project area is approximately 3 miles west of the active Hayward Fault

⁶ Strike-Slip fault refers to the component of movement or slip on a fault that occurs laterally in the direction that the fault trends.

Zone and 15 miles east of the San Andreas Fault Zone (**Figure IV.F-1**). The Hayward fault is designated by the Alquist-Priolo Earthquake Fault Zoning Act as an active fault.

The Hayward fault exhibits strike-slip movement, which is the horizontal or lateral movement along fault. Expressions of fault movement along the Hayward fault can be seen in deformed curbs, cracks in pavement, offset walls and rails, and sag ponds.

Historically, the Hayward fault generated one sizable earthquake in 1868 and possibly another in 1836.⁷ The 1868, a Richter magnitude 7 earthquake on the southern segment of the Hayward Fault ruptured the ground for a distance of about 30 miles. Recent analysis of geodetic data indicates surface fault rupture may have extended as far north as the city of Berkeley. Lateral ground surface displacement during these events was at least 3 feet.

A characteristic feature of the Hayward fault is its well-expressed and relatively consistent fault creep. Although large earthquakes on the Hayward fault have been infrequent since 1868, slow fault creep has continued to occur and has caused measurable offset. Fault creep on the East Bay segment of the Hayward fault is estimated at 9 millimeters per year (mm/yr) (Peterson, et al., 1996). Although the fault creeps at a higher rate over time, the occurrence of large historical ruptures indicates that the fault is locked at depth and that energy accumulates steadily across the fault, which results in episodic earthquakes. A large earthquake could occur on the Hayward fault with an estimated magnitude of about Mw 7.1 (**Table IV.F-1**).

Geologic Hazards

Expansive Soils

Expansive soils possess a “shrink-swell” behavior. Shrink-swell is the cyclic change in volume (expansion and contraction) that occurs in fine-grained clay sediments from the process of wetting and drying. Structural damage may occur over a long period of time, usually the result of inadequate soil and foundation engineering or the placement of structures directly on expansive soils. On Site 7 (Phase 1), soils at depths of less than 50 feet were considered to have low to moderate potential for expansion. Soils below 50 feet ranged from marginal to highly expansive, but these depths are considered to be below the zone of influence for a mat or slab-on-grade foundation.

Soil Erosion

Erosion is the wearing away of soil and rock by processes such as mechanical or chemical weathering, mass wasting, and the action of waves, wind and underground water. Soils containing high amounts of silt or clay can erode easily, while sandy soils are less susceptible. Excessive soil erosion can eventually lead to damage of building foundations and roadways. At the project site, areas that are susceptible to erosion are those that are underlain by fine-grained material and areas

⁷ Prior to the early 1990s, it was thought that a Richter magnitude 7 earthquake occurred on the northern section of the Hayward Fault in 1836. However, a study of historical documents by the California Geological Survey concluded that the 1836 earthquake was not on the Hayward Fault (Topozada et al., 1998).

where the soil is exposed during the construction phase. Typically, the soil erosion potential is reduced once the soil is graded and covered with concrete, structures, or asphalt. The majority of the project would be constructed on existing developed areas that are not undergoing active erosion. However, construction of the new West Broadway MSB and parking structure on Site 7 (Phase 1) would be in immediate proximity to the daylighted portion of Glen Echo Creek. Construction would require special measures during the construction phase, as discussed in the “Impacts and Mitigation Measures” section below, and in Section IV.G, Hydrology and Water Quality, and Section IV.I, Biological Resources, in this EIR. Overall, construction involving exposed soil would occur in a single phase of work on each development site (Phase 1 on Site 7; Phase 2 on Site 4, and Phase 3 on Site 2). As a result, the amount of soil exposed at any construction period would be limited due to the phased approach of the project.

Differential Settlement

Settlement is the depression of the bearing soil when a load, such as that of a building or new fill material, is placed upon it. Soils tend to settle at different rates and by varying amounts depending on the load weight or change in properties over an area, which is referred to as differential settlement. Differential settlement of the loose soils generally occurs slowly, but over time can amount to more than most structures can tolerate. If not properly engineered, loose, soft, soils comprised of sand, silt, and clay have the potential to settle after a building or other load is placed on the surface. Differential settlement can damage buildings and their foundations, roads and rail lines, and result in breakage of underground pipes. The geotechnical investigation prepared for the proposed West Broadway MSB and parking structure on Site 7 (Phase 1) indicated that differential settlement was estimated to vary across the site from 0.5 inches to potentially as much as 3 inches. However, the report also indicated that the project would be structurally feasible on the project site and would be feasible with a shallow or deep foundation system (URS, 2005).

Seismic Hazards

Surface Fault Rupture

Seismically induced ground rupture is defined as the physical displacement of surface deposits in response to an earthquake’s seismic waves. The magnitude, sense, and nature of fault rupture can vary for different faults or even along different strands of the same fault. Ground rupture is considered more likely along active faults, which are referenced in **Table IV.F-2**.

The project area is not within an Alquist-Priolo Fault Rupture Hazard Zone, as designated through the Alquist-Priolo Earthquake Fault Zoning Act, and no mapped active faults are known to pass through the immediate project region (CGS, 2002). Therefore, there is low potential that fault rupture would occur within the project area.

Ground Shaking

Historic earthquakes have caused strong ground shaking and damage in the San Francisco Bay Area, the most recent being the M 6.9 Loma Prieta earthquake in October 1989. The epicenter was approximately 32 miles south of the project site, but this earthquake nevertheless caused strong ground shaking for about 20 seconds and resulted in varying degrees of structural damage throughout the Bay Area. Strong ground shaking from a major earthquake could affect Oakland during the next 30 years. Earthquakes on the active faults (listed in **Table IV.F-1**) are expected to produce a wide range of ground shaking intensities at the project site.

Ground shaking may affect areas hundreds of miles from the earthquake's epicenter. A way to describe ground motion during an earthquake is with the motion parameters of acceleration and velocity in addition to the duration of the shaking. A common measure of ground motion is the peak ground acceleration (PGA). The PGA for a given component of motion is the largest value of horizontal ground acceleration obtained from a seismograph. PGA is expressed as the percentage of the acceleration due to gravity (g), which is approximately 980 centimeters per second squared. In terms of automobile accelerations, one "g" of acceleration is a rate of increase in speed equivalent to a car traveling 328 feet from rest in 4.5 seconds. For comparison purposes, the maximum peak acceleration value recorded during the Loma Prieta earthquake was in the vicinity of the epicenter, near Santa Cruz, at 0.64 g. The highest value measured in the east bay during Loma Prieta was 0.29 g, recorded at the Oakland Wharf near the Naval Supply Center. The lowest values recorded were 0.06 g in the bedrock on Yerba Buena Island near the San Francisco Bay Bridge. However, an earthquake on the nearby Hayward fault could produce far more severe ground shaking at the project site than was observed during the Loma Prieta earthquake. Probabilistic seismic hazard maps indicate that peak ground acceleration in the Project area could reach or exceed 0.58 g (CGS, 2005).⁸ The presence of unconsolidated alluvium in the project area could intensify ground shaking effects in the event of an earthquake on one of the aforementioned faults in the vicinity of the project area. As a result, some site-specific calculations were also made within the project area that calculated peak ground acceleration that could be as high as 0.80g (URS, 2005).

Liquefaction

Liquefaction is a phenomenon whereby unconsolidated and/or near saturated soils lose cohesion and are converted to a fluid state as a result of severe vibratory motion. The relatively rapid loss of soil shear strength during strong earthquake shaking results in the temporary fluid-like behavior of the soil. Liquefaction often occurs in areas with shallow groundwater. The lenses and

⁸ A probabilistic seismic hazard map shows the predicted level of hazard from earthquakes that seismologists and geologists believe could occur. The map's analysis takes into consideration uncertainties in the size and location of earthquakes and the resulting ground motions that can affect a particular site. The maps are typically expressed in terms of probability of exceeding a certain ground motion. These maps depict a 10% probability of being exceeded in 50 years. There is a 90% chance that these ground motions will NOT be exceeded. This probability level allows engineers to design buildings for larger ground motions that seismologists think will occur during a 50-year interval, making buildings safer than if there were only designed for the ground motions that are expected to occur in the 50 years. Seismic shaking maps are prepared using consensus information on historical earthquakes and faults. These levels of ground shaking are used primarily for formulating building codes and for designing buildings.

layers of loose to dense sand, and gravel, which can be susceptible to liquefaction, were, in general, not identified from URS's exploratory borings during several previous geotechnical investigations (URS, 2005). The 2005 geotechnical investigation for Site 7 (Phase 1) identified a potential area of liquefaction based on a sand lense observed between 19 and 21.5 feet below ground surface in one of the borings drilled. The sand layer was not observed in any of the other borings and therefore is not considered continuous across the site, but rather localized in the area of that particular boring. If liquefaction did occur at this area of the site, calculations indicate that the maximum settlement at the top of this layer would be on the order of less than 0.5 inches (URS, 2005). This amount of settlement is considered low and within the range of tolerance for most buildings, including the seven-story MSB (Thornburg, 2005). In addition, the settlement would likely be reduced due to a bridging effect from the more stable overlying soils. Therefore, incorporation of current engineering design criteria and building code standards makes the potential impact from liquefaction less than significant and it is not discussed further in this section.

Earthquake-Induced Settlement

Settlement of the ground surface can be accelerated and accentuated by earthquakes. During an earthquake, settlement can occur as a result of the relatively rapid compaction and settling of subsurface materials (particularly loose, noncompacted, and variable sandy sediments) due to the rearrangement of soil particles during prolonged ground shaking. Settlement can occur both uniformly and differentially (i.e., where adjoining areas settle at different rates). Areas are susceptible to differential settlement if underlain by compressible sediments, such as poorly engineered artificial fill. Given the geologic setting of the region, the project area could be subjected to earthquake-induced settlement.

Regulatory Framework

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (formerly the Alquist-Priolo Special Studies Zone Act), signed into law December 1972, requires the delineation of zones along active faults in California. The Alquist-Priolo Act regulates development on or near active fault traces to reduce the hazard of fault rupture and to prohibit the location of most structures for human occupancy across these traces.⁹ Cities and counties must regulate certain development projects within the delineated zones, and regulations include withholding permits until geologic investigations demonstrate that development sites are not threatened by future surface displacement (Hart, 1997). Surface fault rupture, however, is not necessarily restricted to the area within an Alquist-Priolo Zone.

⁹ A "structure for human occupancy" is defined by the Alquist-Priolo Act as any structure used or intended for supporting or sheltering any use or occupancy that has an occupancy rate of more than 2,000 person-hours per year.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act was developed to protect the public from the effects of strong ground shaking, liquefaction, landslides, or other ground failure, and from other hazards caused by earthquakes. This act requires the State Geologist to delineate various seismic hazard zones and requires cities, counties, and other local permitting agencies to regulate certain development projects within these zones. Before a development permit is granted for a site within a Seismic Hazard Zone, a geotechnical investigation of the site must be conducted and appropriate mitigation measures incorporated into the project design. The project area containing sites for new construction are not located within a Seismic Hazard Zone for liquefaction or landslides, as designated by the California Geological Survey (CGS, 2005).

Senate Bill 1953 (SB 1953) and the Office of Statewide Health Planning and Development (OSHPD)

All acute care medical center properties fall under the jurisdiction of the 1983 Alfred E. Alquist Hospital Seismic Safety Act (Seismic Safety Act) and SB 1953, an amendment of the Alquist Act, passed in 1994. The Act and subsequent senate bill require medical facilities to comply with seismic safety building standards as defined by Office of Statewide Health Planning and Development (OSHPD).

OSHPD is a department of the California Health and Human Services Agency and is responsible for carrying out the provisions of SB 1953. OSHPD's primary goals include assessing California's healthcare infrastructure, managing the healthcare workforce, providing healthcare outcomes information to the public, insuring healthcare facilities development loans, and running the Hospital Seismic Safety Program, which enforces building seismic safety. The Hospital Building Safety Board (HBSB) further advises the director of OSHPD on the administration of SB 1953 and acts as a board of appeals for hospital seismic safety issues.

SB 1953 was adopted in part so that after a major earthquake or disaster, hospital facilities can continue to provide care to their current occupants as well as any new patients that might arrive after the event. During and after the 1994 Northridge earthquake, hospitals that were compliant with SB 1953 sustained minimal structural damage and continued to function. Hospitals that were not compliant sustained major damage and had to be abandoned (OSHPD, 2001).

SB 1953 Compliance

For a hospital building to remain classified as an acute care hospital facility, and thus be compliant with SB 1953, the owner of the building must do the following:

1. Complete seismic evaluations with procedures as defined by OSHPD,
2. Prepare a comprehensive plan and schedule for how each building will become compliant with SB 1953, within 3 years of the evaluation, and
3. Submit the report and a compliance plan to OSHPD for review and approval (California State Senate, 1994).

In the process of compliance, OSHPD and the hospital building owner evaluates both nonstructural (communications, medical gas, etc.) and structural (actual building structure) components of acute care hospital facilities that might sustain damage during a shaking event. Nonstructural components are put into a Nonstructural Performance Category (NPC), and structural components are put into a Structural Performance Category (SPC). Thus, each acute care facility is assigned an NPC rating and an SPC rating that is put into OSHPD's database for review. OSHPD evaluates SPC and NPC ratings separately. As part of the ratings evaluation process, OSHPD and affiliated engineers examined structural drawings and submitted reports of upgrades, if any, that have occurred to each hospital building. These evaluations may include an onsite visit by the Area Compliance Officer (ACO) and/or the District Structural Engineer (DSE) of OSHPD. After the evaluation process, the rating is either confirmed or changed according to OSHPD's review and determination, and OSHPD provides guidance to the hospital property owner further required upgrades.

Nonstructural Performance Category (NPC) and Structural Performance Category (SPC) Ratings

Each possible NPC and SPC rating is described below. In general, low ratings (e.g., SPC-1) mean a hospital building systems are not prepared for a disaster, and high ratings (e.g., SPC-4) mean hospital building systems are prepared for a disaster. If the building is determined to not be in compliance with SB 1953 based on the following NPC and SPC ratings, seismic retrofit regulations (Division III-R) shall be applied to guide the building's retrofit, thus increasing the NPC and SPC rating of the building (OSHPD, 2001).

Nonstructural Ratings

NPC-0: No rating was reported to OSHPD.

NPC-1: Basic systems used in life safety and care are not properly anchored, and will not survive an earthquake event. Communications, emergency power, medical gas, and fire alarm systems must be anchored by January 1, 2002.

NPC-2: Communications systems, emergency power supplies, bulk medical gas systems, fire alarm systems, and emergency lighting and exit signs are properly anchored.

NPC-3: Basic systems used in life safety and care are properly anchored in critical areas of the hospital. If there is not significant structural damage, basic emergency medical care should be able to continue.

NPC-4: All architectural, mechanical, electrical systems, components and equipment, and hospital equipment are properly anchored. If there is not significant structural damage and problems with water and sewer systems, basic emergency medical care should be able to continue.

NPC-5: All basic systems used in life safety and care are properly anchored. In addition, the building has water and wastewater holding tanks (integrated into the plumbing system)

and an on-site fuel supply that will last through 72 hours of acute care operations. Radiological service can also continue.

Structural Ratings

SPC-0: No rating was reported to OSHPD.

SPC-1: These buildings have a high risk of collapse in an earthquake, and are a significant safety hazard to the public. These buildings must be retrofitted, replaced, or removed from acute care classification by January 1, 2008.

SPC-2: These buildings are in compliance with pre-1973 California Building Code, but are not in compliance with the Alquist Hospital Facilities Seismic Safety Act. These buildings do not pose a significant safety hazard, but might not be functional after a strong earthquake. These buildings must be compliant with the Alquist Hospital Facilities Seismic Safety Act by January 1, 2030 or removed from acute care classification.

SPC-3: These buildings are compliant with the Alquist Hospital Facilities Seismic Safety Act. These buildings might sustain structural damage and might not be able to provide care after an event, but they have been constructed or reconstructed under OSHPD building permits. They can be used to January 1, 2030 and beyond.

SPC-4: These buildings are compliant with the Alquist Hospital Facilities Seismic Safety Act. These buildings may sustain structural damage and might not be able to provide care after an event, but they have been constructed or reconstructed under OSHPD building permits. They can be used to January 1, 2030 and beyond.

SPC-5: These buildings are compliant with the Alquist Hospital Facilities Seismic Safety Act. These buildings are reasonably capable of providing care after an event, and they have been constructed or reconstructed under OSHPD building permits. They can be used to January 1, 2030 and beyond.

Kaiser Permanente Oakland Compliance with SB 1953

The twelve existing medical buildings that comprise the hospital and low-rise medical services buildings on the Kaiser Permanente OMC are required to comply with SB 1953. Based on initial NPC and SPC ratings that Kaiser Permanente submitted to OSHPD regarding the Kaiser OMC buildings, the *Summary of Hospital Seismic Performance Ratings* report prepared by OSHPD in April 2001 reported that 11 buildings have an SPC-1 rating, and one building has an SPC-4 rating. All 12 buildings have a NPC-1 rating (OSHPD, 2001), which subjects these buildings to the 2008 deadline for full compliance with SB 1953. Therefore, the main purpose of the proposed Kaiser Permanente OMC project is to meet the provisions of SB 1953 by 2008, and Kaiser Permanente Oakland has applied for and been approved for an extension to this deadline (which they may reapply for on an annual basis), which if exercised would give a maximum deadline of 2013.. Construction of new buildings according to the most current seismic building code regulations, would meet the requirements of SB 1953 whereas the remaining buildings would require seismic retrofitting in order to comply.

California Building Code

The California Building Code is another name for the body of regulations known as the California Code of Regulations (CCR), Title 24, Part 2, which is a portion of the California Building Standards Code (CBSC, 1995). 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.

Published by the International Conference of Building Officials (ICBO), the Uniform Building Code is a widely adopted model building code in the United States. The California Building Code incorporates by reference the 1997 Uniform Building Code (UBC) with necessary California amendments. These amendments include significant building design criteria that have been tailored for California earthquake conditions (CBSC, 2001).

The project area is located within Zone 4, one of the four seismic zones designated in the United States. Zone 4 is expected to experience the greatest effects from earthquake ground shaking and therefore has the most stringent requirements for seismic design. Notwithstanding, the national model code standards adopted into Title 24 apply to all occupancies in California, except for modifications adopted by state agencies and local governing bodies. The CBSC is a standard that OSHPD uses when reviewing and evaluating building plans and specifications. The Seismic Safety Act and OSHPD enforces all building standards published in the CBSC relating to the regulation of hospital buildings and the enforcement of other regulations adopted pursuant to the Seismic Safety Act.

City of Oakland Regulations

Ordinances and Oakland Municipal Code

The City of Oakland implements the following regulations and ordinances aimed at reducing soil erosion and protecting water quality and water resources:

The City's Grading Ordinance (Ordinance No. 10312 is intended to reduce erosion during grading and construction activities. Pursuant to this ordinance, Chapter 13.16 of the Oakland Municipal Code requires that a project applicant obtain grading permits for earth moving activities under specified conditions of 1) volume of earth to be moved, 2) slope characteristics, 3) areas where "land disturbance" or 4) stability problems have been reported. To obtain a grading permit, the project applicant must prepare and submit to the Public Works Agency a soils report, a grading plan, and an erosion and sedimentation control plan for approval. (Oakland, 2004a)

The City also implements the Sedimentation and Erosion Control Ordinance (Ordinance No. 10446) also aimed at reducing erosion during construction and operations. Pursuant to this ordinance, Chapter 3304.2 of the Oakland Municipal Code requires any person who performs grading, clearing, and grubbing or other activities that disturb the existing soil to take appropriate preventative measures to 1) control erosion; 2) prevent sedimentation of eroded materials onto adjacent lands, public streets, or rights-of-way; and 3) prevent of the flow of eroded materials to any water course, by any route. (Oakland, 2004b)

Building Services Division

In addition to compliance with building standards set forth by the 1997 UBC, the project applicant will be required to submit to the Oakland Building Services Division an engineering analysis accompanied by detailed engineering drawings for review and approval prior to excavation, grading, or construction activities on the project site. Specifically, an engineering analysis report and drawings of relevant grading or construction activities on a project site would be required to address constraints and incorporate recommendations identified in geotechnical investigations. These required submittals and City reviews ensure that the buildings are designed and constructed in conformance with the seismic and other requirements of all applicable building code regulations, pursuant to standard City of Oakland procedures.

Impacts and Mitigation Measures

Significance Criteria

The project would have a significant geologic or seismic impact if it would:

- Expose people or structures to geologic hazards, soils, and/or seismic conditions so unfavorable that they could not be overcome by special design using reasonable construction and maintenance practices. Specifically,
 - Expose people or structures to substantial risk of loss, injury, or death involving:
 - Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map or Seismic Hazards Map issued by the State Geologist for the area or based on other substantial evidence of a known fault (refer to Division of Mines and Geology Special Publications 42 and 117 and PRC §2690 et. seq.);
 - Strong seismic ground shaking;

- Seismic-related ground failure, including liquefaction, lateral spreading, subsidence, collapse; or
 - Landslides;
- Result in substantial soil erosion or loss of topsoil, creating substantial risks to life, property, or creeks/waterways;
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994, as it may be revised), creating substantial risks to life or property;
- 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 on- or offsite landslide, lateral spreading, subsidence, liquefaction or collapse;
- Be located above a well, pit, swamp, mound, tank vault, or unmarked sewer line, creating substantial risks to life or property;
- Be located above landfills for which there is no approved closure and post-closure plan, or unknown fill soils, creating substantial risks to life or property; or
- Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.

Local Plans and Policies

Discussion of the project's overall consistency with the Oakland General Plan and the specific Oakland policies listed above is provided in Section IV.A, Land Use, Plans and Policies, of this EIR. The analysis below evaluates the project's consistency with General Plan policies that entail regulatory requirements with which the project must comply.

Geotechnical Investigation

The following analysis focuses on potential project impacts related to seismicity and erosion. The evaluation considered proposed project plans, current conditions at the project site, and applicable regulations and guidelines. A geotechnical investigation has been completed for Phase 1 Site 7 (West Broadway MSB and parking structure) (URS, 2005). Consistent with standard acceptable geotechnical practices and City of Oakland requirements, a subsequent investigation would be required for Phase 2 Site 4 (the new hospital, central utility plant, and parking structure) and for Phase 3 Site 2 (Central Administration Building Medical Services Building (MSB) and parking facilities. Given the proximity of these three sites where total new building construction will occur (within approx. 100 feet of each other, property line to property line), similar subsurface conditions would be encountered. and therefore the geotechnical investigation conducted by URS for Site 7 is considered sufficient to provide the range of geotechnical concerns that are likely to be encountered on the Phase 2 and Phase 3 sites, and is considered adequate to assess the project's potential impacts pursuant to the CEQA criteria identified above.

The following analysis is based on the findings of the geotechnical investigation prepared by URS (URS, 2005), as well as proposed project plans, current conditions at the project site and its

surroundings, and various maps, resources, and applicable regulations and guidelines cited throughout this section. As previously discussed in the *Setting* section, the URS report found that soils at depths that would be affected by the proposed building foundation systems were determined to have low to moderate potential for expansion, therefore the potential impact of expansive soils is less than significant and is not discussed further in this section. Also, the URS geotechnical investigation determined that the project would be structurally feasible on the project site given the range of differential settlement and the low amount of liquefaction settlement that could occur (URS, 2005). Therefore, potential impacts of differential settlement and liquefaction on the project site are considered less than significant and are not discussed further in this section.

Project Phasing

The project will be completed in three phases over a period of approximately 14 years: 2006 to 2020. While the OMC population load (i.e., patients, employees, providers, etc.) will increase incrementally, exposing additional people to seismic and geological hazards over a short term, the construction project will decrease the risk to people and property by upgrading or demolishing older buildings that are seismically unsafe. Older buildings will be seismically retrofitted and new buildings will be constructed to stricter building codes. The impact discussion below pertains to all construction phases of the project.

Geology, Soils and Seismicity Impacts

Operational Impacts on Exposing People and Structures to Seismic Hazards

Impact F.1: In the event of a major earthquake in the region, seismic ground shaking could potentially injure people and cause collapse or structural damage to existing and proposed hospital structures. (Potentially Significant)

The project site would likely experience at least one major earthquake (Richter magnitude 6.7 or higher) within the next 30 years. The intensity of such an event would depend on the causative fault and the distance to the epicenter, the moment magnitude, and the duration of shaking. A seismic event in the Bay Area could produce ground accelerations at the proposed project area that are moderate to very strong (MM-VI to MM-VIII) (ABAG, 2005c).

Based on the MMI scale, an earthquake of this intensity on the Hayward fault would cause considerable structural damage, even in well-designed structures. Ground shaking of this intensity could lead to an interruption in patient care due to structural building damage, movement or damage of internal building components (i.e., beds, shelves, and cabinets), or power failure. Substantial cracks could appear in the ground, and the shaking could cause other secondary damaging effects such as the failure of underground pipes. As a comparison, the great 1906 San Francisco earthquake, with an M 7.9, produced strong (MM-VII) shaking intensities in the project area (ABAG, 2005a). A characteristic earthquake on the Calaveras, San Andreas, Marsh Creek or Concord, Rodgers fault (listed in **Table IV.F-1**) could produce moderate (VI) shaking intensities

(ABAG, 2005a). Earthquakes of this intensity may move heavy furniture and cause slight damage.

In accordance with Section 129770 of the Seismic Safety Act, OSHPD is required to review the structural systems and related details of the construction or renovation of medical buildings with acute care facilities, as well as the recommendations of any site-specific geotechnical investigations prepared for those buildings, to ensure compliance with the Seismic Safety Act, the CBC and the UBC. OSHPD's comments and the recommendations from the geotechnical investigation would be submitted to the City of Oakland Building Department building permit application. The Oakland Building Department would not be able to issue a building permit until it has received approval from OSHPD. In addition to reviewing the proposed structural plans, OSHPD is responsible for overseeing construction of the proposed hospital building to ensure that construction complies with the California Building Code for hospital buildings.

In accordance with the 1997 UBC and the CBSC, the geotechnical investigation for the proposed MSB and parking structure on the northwest corner of West MacArthur and Broadway (Site 7) analyzed expected ground motion at the project site. This general finding would hold true for all the other existing and proposed buildings in the project area (Site 4 and Site 2). The geotechnical report includes recommendations applicable to foundation design, earthwork, and site preparation. These recommendations were prepared by a licensed geotechnical engineer and would be incorporated into the project designs upon approval by OSHPD. Prior to commencement of any other construction as part of the proposed project, a site specific geotechnical investigation would be prepared for the site of the proposed new hospital (Site 4) and the new Central Administration MSB (Site 2), the only other locations where new building construction would occur. In summary, oversight by OSHPD and implementation of accepted geotechnical evaluation techniques and appropriate engineering practices can reduce potential injury and damage, thereby exposing fewer people and less property to the effects of a major damaging earthquake. However, predicting seismic events is not possible, nor is it feasible to provide mitigation that can entirely reduce the potential for injury and damage that can occur during a seismic event. This would therefore result in a potentially significant impact.

As would be required for all development projects in Oakland, the project applicant will be required to implement and comply with the following uniformly-applied City conditions of approval, which would reduce Impact F.1 to a less-than-significant level:

Standard Condition F.1: A site-specific, design level geotechnical investigation for each construction site within the project area (which is typical for any large, phased development project) shall be required as part of this project. Specifically:

- Each investigation shall include an analysis of expected ground motions at the site from known active faults. The analyses shall be in accordance with applicable City ordinances and policies, OSHPD requirements, and consistent with the most recent version of the California Building Code, which requires structural design that can accommodate ground accelerations expected from known active faults.

- The investigations shall determine final design parameters for the walls, foundations, foundation slabs, and surrounding related improvements (utilities, roadways, parking lots and sidewalks).
- The investigations shall be reviewed and approved by a registered geotechnical engineer. All recommendations by the project engineer, geotechnical engineer, and OSHPD will be included in the final design.
- Recommendations that are applicable to foundation design, earthwork, and site preparation that were prepared prior to or during the project design phase, shall be incorporated in the project.
- For structures not subject to OSHPD permitting, the final seismic considerations for the site shall be submitted to and approved by the City of Oakland Building Services Division prior to the commencement of the project.

Significance after Implication of Standard Conditions: Less than Significant.

Construction Impacts on Soil Erosion

Impact F.2: Project construction, specifically in proximity to daylighted segments of Glen Echo Creek, would comply with all City and RWQCB requirements related to erosion control and water quality during construction, including compliance with the ACCQP NPDES permit; the City of Oakland Creek Protection, Stormwater Management, and Discharge Control Ordinance and Grading Ordinance; and compliance with requirements for preparation of a construction SWPPP. The project therefore would not result in substantial, long-term erosion or siltation that would increase the sediment load to Glen Echo Creek and Lake Merritt. (Less than Significant)

Construction activities such as backfilling, grading, and compaction can expose areas of loose soil that, if not properly stabilized, could be subjected to soil loss and erosion by wind and storm water runoff. Concentrated water-induced erosion, if not managed or controlled, can eventually result in significant soil loss.

Construction of the new West Broadway MSB and parking structure on Site 7 would be adjacent to the daylighted portion of Glen Echo Creek. The proposed construction activities in and around the daylighted portion of Glen Echo Creek could potentially result in erosion of creek banks and loss of topsoil. As discussed in detail in Section IV.G, Hydrology and Water Quality, and Section IV.I, Biological Resources, the project would involve work within the daylighted portion of the creek (i.e., removal of non-native vegetation and implementation of bank stabilization measures, such as regrading and revegetation), on its eastern bank (Standard Condition I.1b).

As discussed in Section IV.G, Hydrology and Water Quality, construction activities of the project would be required to comply with standard City practices and regulations and County regulations that address erosion and sediment control, and minimize the resulting effects of erosion on water quality. As required by Standard Condition G.1a, specifically, the project would be required to

- 1) Prepare a Grading Plan for the proposed project, pursuant to City of Oakland Municipal Code Section 15.04.780.
- 2) Comply with the Alameda Countywide Clean Water Program (ACCWP) National Pollutant Discharge Elimination System (NPDES) permit, and thus prepare a stormwater pollution prevention plan (SWPPP) in coordination with preparation of the grading plan; and
- 3) Obtain a Creek Protection Permit under Category 4 due to the project's proximity to Glen Echo Creek,¹⁰ pursuant to City of Oakland Municipal Code Section 13.16.¹¹

Each of these requirements and proposed implementation measures, including specific construction best management practices (BMPs) and creek protection measures. Adherence to these regulations, together with Alameda County and the City of Oakland's stormwater management requirements, would reduce erosion of disturbed soils during construction activities. Therefore, the project would not result in substantial soil erosion or loss of topsoil, creating substantial risks to life, property, Glen Echo Creek, or related waterways.

Cumulative Impacts

Cumulative Context

As discussed above, the project would result in significant project-level impacts related to potentially hazardous seismic conditions, which would be reduced to less than significant. Although the entire Bay Area is within a seismically-active region with a wide range of geologic and soil conditions, these conditions can vary widely across the city, making the cumulative context for potential impacts resulting from exposing people and structures to related risks one that is more localized or even site-specific.

Cumulative Impacts on Geology, Soils, and Seismic Conditions

Impact F.3: The development proposed as part of the project, when combined with other reasonably foreseeable development in the vicinity, could potentially injure people and cause collapse or structural damage to existing and proposed structures and result in significant cumulative impacts with respect to geology, soils, or seismic conditions. (Potentially Significant)

Development of the project, with implementation of the standard conditions of approval identified above, would have potentially significant impacts related to exposing persons or structures to geologic, soils, or seismic hazards. The number of people living and working in the area of the project, as a result of foreseeable development, in addition to the increased population

¹⁰ Category 4: Any exterior development or work that is conducted from the centerline of the creek to the 20-foot setback from the top of the creek bank that may or may not require any other development-related permits including without limitation: earthwork, landscape walls, fences, patios, decks, private drainage improvements, irrigation systems, or trenching work.

¹¹ The project would also require creek protection permits under Category 1 (interior construction and alterations/remodeling) or Category 2 (exterior work that does not include earthwork and is located more than 100 feet from the centerline of the creek), unrelated to work that would occur on Site 7 adjacent to Glen Echo Creek.

associated with the OMC, will increase incrementally, thus exposing additional people to seismic and geological hazards. However, all projects would be required to adhere to the City's Building Code and Grading Ordinance requirements, all other related and applicable City ordinances and policies, and all hospital project would be required to comply with all OSHPD requirements. The Kaiser Permanente OMC Project, in particular, would upgrade, retrofit, or demolish older buildings that are seismically unsafe, and would construct new buildings to stricter building codes, specifically those intended to heighten seismic safety of medical buildings. All construction phases of this project, and other foreseeable projects in the area, would be required to implement the uniformly applied City Standard Condition F.1 (geotechnical investigation) and adhere to all federal, state, and local programs, requirements and policies pertaining to building safety and construction permitting. Therefore, the project, combined with other foreseeable development in the area, would not result in a cumulatively significant impact by exposing people or structures to risk related to geologic hazards, soils, and/or seismic conditions.

Significance after Implication of Standard Conditions: Less than Significant.

References – Geology, Soils, and Seismicity

- Association of Bay Area Governments (ABAG), *Modeled Shaking Intensity Maps for North Oakland, 1906 San Francisco Earthquake*, <http://www.abag.ca.gov/bayarea/eqmaps/mapsba.html>, accessed April 25, 2005a.
- Association of Bay Area Governments (ABAG), *Earthquake Hazards Maps for North Oakland, Modeled Shaking Intensity for 1989 Loma Prieta Earthquake*, <http://www.abag.ca.gov/bayarea/eqmaps/mapsba.html>, accessed April 25, 2005b.
- Association of Bay Area Governments (ABAG), *Earthquake Hazards Maps for Oakland, Hayward Fault Earthquake*, <http://www.abag.ca.gov/bayarea/eqmaps/pickcity.html>, accessed April 25, 2005c.
- Association of Bay Area Governments (ABAG), *Liquefaction Susceptibility*, <http://www.gis.abag.ca.gov/website/liq/viewer.htm>, accessed April 25, 2005d.
- California Building Standards Commission (CBSC), *California Building Code, Title 24, Part 2*, 1995.
- California Division of Mines and Geology (CDMG), *How Earthquakes Are Measured*, CDMG Note 32, 1997b.
- California Geological Survey, *Background Information on Shake Maps*, <http://quake.wr.usgs.gov/research/strongmotion/effects/shake/about.html>, updated April 21, 2003.
- California Geological Survey, *Earthquake Fault Zones in California. Oakland West Quadrangle*, California Division of Mines and Geology, Revised Official Map, effective March 30, 2002.

- California Geological Survey, *Guidelines for Evaluating and Mitigating Seismic Hazards in California, Special Publication 117*. March 13, 1997.
- California Geological Survey, *Seismic Hazards Mapping Program*, http://gmw.consrv.ca.gov/shmp/download/pdf/ozn_oakw.pdf, Oakland West Quadrangle, accessed April 25, 2005.
- California Geological Survey, *Probabilistic Seismic Hazards Mapping Ground Motion Page*, <http://www.consrv.ca.gov/cgs/rghm/pshamap/pshamap.asp?Longitude=-122.275&Latitude=37.796>, accessed April 25, 2005.
- California Stormwater Quality Association, *California Storm Water Best Management Practice Handbook for New Development and Redevelopment*, 2003.
- California State Senate, *Text of Bill SB 1953*, 1994.
- City of Oakland General Plan Update, *Land Use and Transportation Element, Technical Report #6*, 1998.
- City of Oakland, General Plan Element, *Open Space, Conservation and Recreation*, October 1996.
- City of Oakland, Regulations, 2004a, available at http://www.oaklandnet.com/government/info/city_regs.html
- City of Oakland, Oakland Municipal Code, Title 15, Buildings and Construction, Chapter 15.04 Oakland Amendments to the California Model Building Codes, 2004b, available at http://www.bpcnet.com/cgi-bin/hilite.pl/codes/oakland/ DATA/TITLE15/Chapter_15_04_OAKLAND_AMENDMENTS /15_04_780_CBC_Appendix_Chapter.html
- Hart, E. W., *Fault-Rupture Hazard Zones in California: Alquist-Priolo Special Studies Zones Act of 1972 with Index to Special Studies Zones Maps*, California Division of Mines and Geology, Special Publication 42, 1990, revised and updated 1997.
- International Conference of Building Officials, *Uniform Building Code, ICBO*, Whittier, California, 1997.
- Jennings, C. W., *Fault Activity Map of California and Adjacent Areas*, California Division of Mines and Geologic Data Map No. 6, 1:750,000, 1994.
- Office of Statewide Health Planning and Development (OSHPD), *Summary of Hospital Seismic Performance Ratings* April 2001, OSHPD Public Affairs Office, 2001.
- Peterson, M.D., Bryant, W.A., Cramer, C.H., *Probabilistic Seismic Hazard Assessment for the State of California*, California Division of Mines and Geology Open-File Report issued jointly with U.S. Geological Survey, CDMG 96-08 and USGS 96-706, 1996.
- Thornburg, Jennifer CGS. Personal communication on October 24, 2005.

Topozada, T.R., and G. Borchardt, *Re-evaluation of the 1836 "Hayward fault" and the 1838 San Andreas fault earthquakes*, Bulletin Seismic Society of America, 88, 140-159, 1998.

United States Geological Survey (USGS) Working Group on Northern California Earthquake Potential, Database of Potential Sources for Earthquakes larger than Magnitude 6 in Northern California. Open File Report 96-705, 1996.

United States Geological Survey (USGS) Working Group on California Earthquake Probabilities (WG02), *Summary of Earthquake Probabilities in the San Francisco Bay Region: 2003-2032* .<http://quake.usgs.gov/research/seismology/wg02/>, 2003.

United States Department of Agriculture Natural Resource Conservation Service, formerly the Soil Conservation Service (SCS) (USDA NRCS), *Soil Survey Alameda Area*, Alameda County, California, 1981.

URS Corporation (URS), *Geotechnical Study Planned Medical Office Building and Parking Structure, Kaiser Permanente Oakland Medical Center*, January 4, 2005.