

G. GEOLOGY, SOILS AND SEISMICITY

This section describes the project site's geologic environment based on a site reconnaissance, published and unpublished regional geologic reports and maps, and a site-specific technical report. This section also assesses potential significant impacts from seismically-induced fault rupture, strong ground shaking, liquefaction, slope failure, lateral slope deformation, differential settlement, and unstable or expansive soils.

1. Setting

The following setting section describes the geologic and seismic conditions of the project site and describes applicable City policies.

a. Geologic Conditions. The geology, topography and soils of the project and vicinity are described below.

(1) Geology. The proposed project 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. The regional structure of the Coast Ranges consists of northwest trending folds and faults created by the tectonic processes of colliding plate boundaries and subsequent transitional shear along the San Andreas Fault Zone (SAFZ). As a result, the Coast Ranges comprise a series of discontinuous north-west trending mountain ranges and ridges composed primarily of sedimentary bedrock with layers of recent alluvium filling the intervening valleys.¹ The layer of near-surface deposits at the project site is mapped as Late Pleistocene alluvium. These poorly sorted stream deposits are between 10,000 and 70,000 years old, weakly consolidated, slightly weathered, with a maximum thickness of at least 150 feet, and a wedge shaped profile, thinning towards the East Bay Hills.² Overlaying this is a surface layer of Holocene alluvium.³

The site-specific preliminary geotechnical evaluation included reviewing subsurface boring information from available previous studies located near the project site as well as six cone penetration test (CPT) conducted within the project site. The nearest of the off-site borings, approximately located at the base of the State Route 24 embankment slope at the 40th Street undercrossing, was drilled to a depth of about 52 feet below ground surface (bgs). This boring encountered soft to stiff clays to approximately 20 feet bgs, a 5-foot layer of loose to very loose clayey sand/sandy silt with gravel, and below this, very dense to dense silty sandy gravel and hard sandy gravelly clay to the termination of drilling. The on-site CPT

¹ California Geographic Survey (CGS), 2002, *California Geomorphic Provinces, Note 36*.

² Helley, E. J., Lajoie, K. R., 1979 (reprinted 1991), *Flatlands deposits of the San Francisco Bay Region* (with maps), USGS Professional Paper 943, jointly by DOI, HUD, USGS.

³ USGS, 2006, *Geologic Map of Alameda County, CA*, USGS Scientific Investigations Map 2918.

borings were conducted to a depth of approximately 50 feet. The CPT data indicated that the site was generally underlain by interbedded soft to stiff silty to sandy clays and medium dense to very dense sandy silt to silt. Thin lenses of sand were encountered in four of the borings at a depth of 24 to 32 feet. The results of the CPT were noted to be similar to the results of the earlier off-site investigations.⁴

(2) Topography. The project site is 8.2 acres. In general, the area of the project is relatively flat and slopes gently to the south, with 40th Street having an elevation of approximately 78 feet above mean sea level (msl) and West MacArthur Boulevard at approximately 70 feet msl. Within the project site, the existing BART parking lot is nearly flat, with an elevation difference across the lot of 1-foot or less. The parking lot is set below the level of the adjacent streets, with an elevation of approximately 65 feet msl (except for a section of road that connects the lot with West MacArthur Boulevard). At 40th Street the lot is approximately 13 feet below the street grade at the south side of the lot. In places, slopes or retaining walls of 3 to 4 feet edge the parking lot, with adjacent properties at the elevation of the surrounding streets.

(3) Soils. Surface soils of the project site are mapped by the Natural Resource Conservation Service (NRCS) as Urban land – Danville complex, a mix of about 60 percent Urban land and 30 percent Danville with the remainder being Botella loam, Clear Lake clay and Tierra loam.⁵ The Urban Land category is a description for man-made materials and land, usually already developed and covered by paving and structures, and consisting of heterogeneous fills of (generally) unknown origin. Danville soil is a deep soil with slow permeability, high shrink-swell potential and low strength. The NRCS does not assign capability classification values for describing engineering constraints for the Urban land – Danville Complex type soils.

b. Seismic Conditions. Regional and site-specific seismicity are described in the following section.

(1) Regional Seismicity. The entire San Francisco Bay Area is located within the San Andreas Fault Zone (SAFZ), a complex of active faults forming the boundary between the North American and Pacific lithospheric plates. Movement of the plates relative to one another result in the accumulation of strain along the faults, which is released during earthquakes. Numerous moderate to strong historic earthquakes have been generated in northern California by the SAFZ. The level of active seismicity results in classification of the

⁴ Geomatrix, Inc., 2004, *Preliminary Geotechnical Evaluation, Proposed MacArthur BART Transit Village, Oakland, California*, Prepared for Aegis Realty Partners, Oakland, Ca., 18 November, Project No. 9923.000.

⁵ Natural Resources Conservation Services (NRCS), 2007, *Soil Survey Of Alameda County, California, Western Part*. Source of Map: Natural Resources Conservation Service Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>.

area as seismic risk Zone 4 (the highest risk category) in the California Building Code. The SAFZ includes numerous faults found by the California Geological Survey under the Alquist-Priolo Earthquake Fault Zoning Act (A-PEFZA) to be “active” (i.e., to have evidence of fault rupture in the past 11,000 years). Regional active faults are shown on Figure IV.G-1.

The U.S. Geological Survey’s Working Group on California Earthquake Probabilities estimates that there is a 62 percent probability that one or more Moment Magnitude (M_w) 6.7⁶ or greater earthquakes will occur in the San Francisco Bay Area between 2002 and 2031. The probability of a M_w 6.7 magnitude or greater earthquake occurring along individual faults was estimated to be 21 percent along the San Andreas Fault, 27 percent along the Hayward Fault, 11 percent along the Calaveras Fault, 4 percent along the Concord-Green Valley Fault, 10 percent along the San Gregorio Fault, 3 percent on the Greenville Fault, and 3 percent for the Mt. Diablo Thrust Fault. In addition, there is a cumulative 14 percent chance of a background (other earthquake source, either mapped or undiscovered) event occurring. When predictions are expanded to 100 years it was estimated that about three M_w 6.7 or greater events could occur during that time. Thus the probability of at least one M_w 6.7 or greater magnitude earthquake rises to the near certainty of about 96 percent when calculated for a 100-year span.⁷

(2) Site-Specific Seismicity. The project is not within an Alquist-Priolo Earthquake Fault Zone; the project site is about 2.4 miles southwest of the Hayward A-PEFZA fault zone.⁸ The Hayward fault is a right lateral strike-slip fault with a northwest-southeast axis,⁹ and, as noted above, has a 27 percent chance of an M_w 6.7 earthquake occurring between 2002 and 2031.

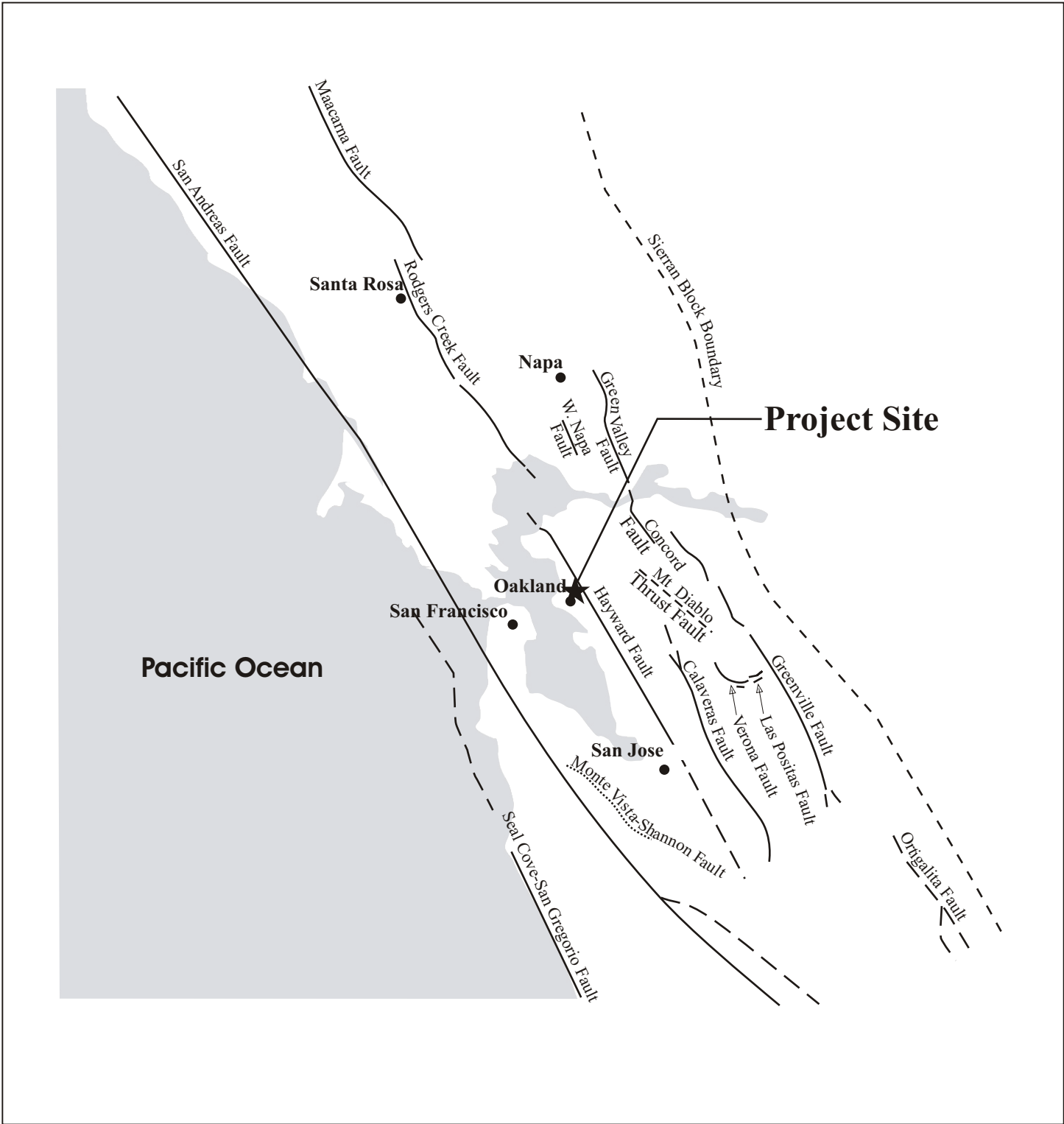
The project site is located within a California Department of Conservation Seismic Hazard Zone for liquefaction as defined by the Seismic Hazards Mapping Act. The site is not

⁶ Moment magnitude (M_w) is now commonly used to characterize seismic events as opposed to Richter Magnitude. Moment magnitude is determined from the physical size (area) of the rupture of the fault plane, the amount of horizontal and/or vertical displacement along the fault plane, and the resistance to rupture of the rock type along the fault.

⁷ USGS, 2003, *Earthquake Probabilities in the San Francisco Bay Region: 2002 to 2031 – A Summary of Findings*, Open File Report 03-214.

⁸ California Division of Mines and Geology (CDMG), 1982, *State of California Special Studies Zones, Oakland West Quadrangle Map*.

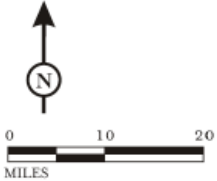
⁹ Right-lateral: if the trace of the fault were viewed while standing on one side during an event, it would appear that the ground on the other side of the fault moved to the right. Strike-slip: the sides are moving laterally relative to each other with little or no vertical movement.



Legend

- Active Fault-
Fault has evidence of surface displacement within the past 11,000 years (dashed where inferred)
- Potentially Active Fault-
Fault has evidence of surface displacement in the past 1.6 million years, but not within the past 11,000 years
- - - - Seismic Source Without Surface Rupture

**FIGURE IV.G-1
MacArthur Transit Village Project EIR
Regional Faults**



mapped as being at risk for seismically induced landslide.¹⁰ Hazard mapping by the Association of Bay Area Governments (ABAG) indicates the project site is in an area rated of moderate susceptibility and moderate hazard (susceptibility combined with likelihood) for liquefaction.¹¹

c. Seismic and Geologic Hazards. Topics related to seismic and geologic hazards are described below.

(1) Surface Rupture. Surface rupture occurs when the ground surface is broken due to fault movement during an earthquake. The location of surface rupture generally can be assumed to be along an active or potentially active major fault trace. No portion of the project site is located within an Alquist-Priolo Earthquake Fault Zone and no active faults have been mapped at the project site. Therefore, potential for fault rupture at the project site is negligible.

(2) Ground Shaking. Ground shaking is a general term referring to all aspects of motion of the earth's surface resulting from an earthquake, and is normally the major cause of damage in seismic events. The extent of ground shaking is controlled by the magnitude and intensity of the earthquake, distance from the epicenter, and local geologic conditions. The Modified Mercalli Intensity Scale (MMI) is the most commonly used scale for measurement of the subjective effects of earthquake intensity (Table IV.G-1). A related concept, peak ground acceleration, is measured as a fraction or percentage of gravity (g).¹²

The closest active fault to the project site is the Hayward fault zone. The north and south Hayward faults together are considered capable of generating about an M_w 6.9 earthquake. An earthquake of this magnitude would generate violent to very strong seismic shaking (MMI VIII) at the project site.¹³ This would constitute a potentially significant hazard.

Peak Acceleration. Estimates of the peak ground acceleration have been made for the Bay Area based on probabilistic models that account for multiple seismic sources. Under these models, consideration of the probability of expected seismic events is incorporated into the determination of the level of ground shaking at a particular location. The expected

¹⁰ California Geological Survey (CGS), 2003, *State of California Seismic Hazard Zones, Oakland West Quadrangle*.

¹¹ ABAG Earthquake Program, 2004a. *Liquefaction Hazard and Susceptibility Maps*, <http://quake.abag.ca.gov/>.

¹² The acceleration due to gravity, denoted g (also gee) is a unit of acceleration defined as approximately 32 ft/s², which is the acceleration due to gravity on the Earth's surface at sea level.

¹³ ABAG Earthquake Program, 2004b. *Earthquake Shaking Scenario Map*, <http://www.abag.ca.gov>.

Table IV.G-1 Modified Mercalli Scale

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

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

peak horizontal acceleration (with a 10 percent chance of being exceeded in the next 50 years) generated by any of the seismic sources potentially affecting the project area, including the project site, is estimated by the California Geological Survey as 0.681.¹⁴ This level of ground acceleration at the project site is a potentially significant hazard.

¹⁴ California Geological Survey (CGS), 2005, *Probabilistic Seismic Hazards Mapping Ground Motion Page*, accessed 7/06/07, www.consrv.ca.gov/cgs/rghm/pshamap/pshamain.html.

(3) Liquefaction and Lateral Spreading. Liquefaction is the temporary transformation of loose, saturated granular sediments from a solid state to a liquefied state as a result of seismic ground shaking. In the process, the soil undergoes transient loss of strength, which commonly causes ground displacement or ground failure to occur. Since saturated soils are a necessary condition for liquefaction, soil layers in areas where the groundwater table is near the surface have higher liquefaction potential than those in which the water table is located at greater depths.

As mentioned above, the project is rated as a moderate liquefaction hazard area by ABAG and mapped by the state as being in a liquefaction hazard area. According to site-specific preliminary geotechnical evaluation, the depth to groundwater in the vicinity of the project site is about one to seven feet bgs; in addition, the preliminary geotechnical evaluation notes that though the areas of sandy soil that may be prone to liquefaction are discontinuous, the site is underlain by weak soils, and liquefaction may occur in limited areas during a seismic event which could lead to settlement of shallow foundations, such as spread footings.¹⁵

Lateral spreading is a form of horizontal displacement of soil toward an open channel or other “free” face, such as an excavation boundary. Lateral spreading can result from either the slump of low-cohesion unconsolidated material or, more commonly, by liquefaction of either the soil layer or a subsurface layer underlying soil material on a slope.¹⁶ The lateral spreading hazard will tend to mirror the liquefaction hazard for a site, but needs an open channel or “free” face to expand into; this can include temporary excavations resulting from the construction process. Regional mapping provided by ABAG indicates the risk of liquefaction for the general area of the project to be moderate, therefore the risk of lateral spreading is considered to be moderate during construction/ excavation unless site-specific investigations would determine otherwise.¹⁷ The site-specific preliminary geotechnical evaluation indicates that there are lenses of sandy and silty material below the level of local groundwater. These could be prone to liquefaction, and as such, may provide potential for lateral spreading into excavations, particularly utility trenches or deep foundation excavations.¹⁸

(4) Expansive Soils. Expansion and contraction of volume can occur when expansive soils undergo alternating cycles of wetting (swelling) and drying (shrinking). During these

¹⁵ Geomatrix, Inc., 2004, op. cit.

¹⁶ Rauch, Alan F., 1997, EPOLLS: An Empirical Method for Predicting Surface Displacements due to Liquefaction-Induced Lateral Spreading in Earthquakes, Ph. D. Dissertation, Virginia Tech, Blacksburg, VA.

¹⁷ ABAG, 2004a, op. cit.

¹⁸ Geomatrix, Inc., 2004, op. cit.

cycles, the volume of the soil changes markedly. As a consequence of such volume changes, structural damage to building and infrastructure may occur if the potentially expansive soils were not considered in project design and during construction.

The site is mapped as Urban land – Danville complex. Danville soils are rated as moderate to highly expansive.¹⁹ Urban land (man-made fill) can be composed of varying amounts of natural soil materials, construction debris, dredging materials, municipal solid waste and other fill.²⁰ The NRCS does not assign engineering properties to soils of the Urban Land classification, as they are variable in content and characteristics.

(5) Slope Stability. Slope failure can occur as either rapid movement of large masses of soil (“landslide”) or slow, continuous movement (“creep”). The primary factors influencing the stability of a slope are: (1) the nature of the underlying soil or bedrock; (2) the geometry of the slope (height and steepness); (3) rainfall; and (4) the presence of previous landslide deposits. Regional mapping shows that the project area is mapped as Category 1, “areas of zero to 5 percent slope that are not underlain by landslide deposits.”²¹

(6) Settlement and Differential Settlement. Differential settlement or subsidence could occur if buildings or other improvements were built on low-strength foundation materials (including imported non-engineered fill) or if improvements straddle the boundary between different types of subsurface materials (e.g., a boundary between native material and fill). Although differential settlement generally occurs slowly enough that its effects are not dangerous to inhabitants, it can cause significant building damage over time. Portions of the project site that may contain loose or uncontrolled (non-engineered) fill may be susceptible to differential settlement.

The preliminary geotechnical evaluation notes the project site is blanketed by approximately 20 feet of relative weak compressible soils with zones of sandy soils, as well as the potential for urban fill to be present, and that building settlement is a potential issue at the site.²²

¹⁹ NRCS, 2007, op. cit.

²⁰ Scheyer, J.M., and K.W. Hipple. 2005. Urban Soil Primer. United States Department of Agriculture, Natural Resources Conservation Service, National Soil Survey Center, Lincoln, Nebraska (<http://soils.usda.gov/use>).

²¹ Nilson, Tor H., and Wright, Robert H., 1979. *Relative Slope Stability and Land-use Planning In The San Francisco Bay Region, California*, USGS Professional Paper 944, USGS & HUD, Washington D.C.

²² Geomatrix, Inc., 2004, op. cit.

d. City of Oakland General Plan Policies. The following policies from the Safety Element²³ and the Open Space, Conservation, and Recreation (OSCAR) Element²⁴ of the City of Oakland General Plan specifically address soils, geology and/or seismic hazards and are applicable to the proposed project.

- Policy GE-1: Develop and continue to enforce and carry out regulations and programs to reduce seismic hazards and hazards from seismically triggered phenomena.
- Policy GE-2: Continue to enforce ordinances and implement programs that seek specifically to reduce the landslide and erosion hazards.
- Policy GE-3: Continue, enhance or develop regulations and programs designed to minimize seismically related structural hazards from new and existing buildings.
- Policy GE-4: Work to reduce potential damage from earthquakes to “lifeline” utility and transportation systems.
- Policy CO-1.1: Soil loss in new development. Regulate development in a manner which protects soil from degradation and misuse or other activities which significantly reduce its ability to support plant and animal life. Design all construction to ensure that soil is well secured so that unnecessary erosion, siltation of streams, and sedimentation of water bodies does not occur.
- Policy CO-1.2: Soil contamination hazards. Minimize hazards associated with soil contamination through the appropriate storage and disposal of toxic substances, monitoring of dredging activities, and clean up of contaminates sites. In this regard, require soil testing for development of any site (or dedication of any parkland or community garden) where contamination is suspected due to prior activities on the site.
- Policy CO-2.2: Unstable geologic features. Retain geologic features known to be unstable, including serpentine rock, areas of known landsliding, and fault lines, as open space. Where feasible, allow such lands to be used for low-intensity recreational activities.
- Policy CO-2.3: Development on filled soils. Require development on filled soils to make special provisions to safeguard against subsidence and seismic hazards.

e. City of Oakland Municipal Code. The City of Oakland Municipal Code implements ordinances designed to protect against seismic and geologic hazards, reduce soil erosion and protect water quality. These ordinances, detailed below and in the following discussions of the City of Oakland Standard Conditions of Approval, are designed to reduce erosion during grading and construction activities (grading ordinance); ensure that building plans, engineering and design are prepared by qualified individuals, fully compliant with latest

²³ City of Oakland, Adopted November 2004, *General Plan Safety Element*, accessed 7/6/07 at: www.oaklandnet.com/government/SE/Chapter3.pdf.

²⁴ City of Oakland, Adopted June 1996, *Open Space, Conservation, and Recreation Element*, accessed 7/6/07 at: www.oaklandnet.com/government/ceda/revised/planningzoning/StrategicPlanningSection/openspace.html.

requirements and approved by appropriate agencies (amendments to the building code) and that necessary geologic conditions analysis of hazards, and appropriate mitigations are designed and implemented in compliance with state and local requirements (geologic reports). Applicable chapters regarding geology include:

- **Chapter 15.04, Oakland Amendments to the California Model Building Codes.** This chapter of the Oakland Municipal Code shall be known as the “Oakland Amendments of the 2001 edition of the California Building Standards Code, Part 2 (California Building Code), Part 4 (California Mechanical Code), and Part 5 (California Plumbing Code), and the 2004 edition of the California Building Standards Code, Part 3 (California Electrical Code).” These amendments expand on or supersede the requirements of the California Model Building Code and will be applicable to the proposed project. Buildings and structures regulated by this Code shall be so arranged, assembled, installed, maintained and of sufficient size and so protected as to reduce and minimize all egress, fire, safety, and health hazards. Amendments to the City of Oakland Municipal and Planning Codes extend or supersede existing codes to further ensure the future health, safety, and general welfare of the public.
 - **Chapter 15.04.780, Section 3304 – Grading, Excavation and Fills.** The Grading Ordinance requires a permit for projects that exceed certain criteria. Subsection 3304.2 defines the terms under which a grading permit will be required. A partial list of criteria under which a permit would be required includes:
 - The volume of excavation or fill will exceed 50 cubic yards provided the vertical distance between the top and bottom of excavation or fill will exceed 5 feet at any location.
 - An excavation or fill exceeding 5 cubic yards within 15 horizontal feet of any property line if the bottom of such excavation is below a line descending at a rate of slope of two to one from the existing ground surface at such property line.
 - The volume of excavation or fill will exceed 500 cubic yards on a parcel or contiguous parcels.
 - Grading, clearing or grubbing, or land disturbance activity that involves an area of one (1) acre or more.
 - The project, as proposed, includes ten parcels totaling approximately 8.4 acres. The majority of the site is occupied by a sub-grade parking lot, but also includes several buildings to be demolished. Construction of five new buildings is proposed along with development of internal streets and other improvements. The buildings would be up to 85 feet in height with a single sublevel of parking garages. Therefore, a grading permit would be required for the proposed project.
- f. City of Oakland’s Standard Conditions of Approval.** The City of Oakland’s Standard Conditions of Approval (COAs) would apply to the proposed project. The Conditions of

Approval will be adopted as requirements of the proposed project if the project is approved by the City to help ensure no significant impacts (for the applicable topic) occur, as a result they are not listed as mitigation measures.

COA GEO-1 (same as COA HYDRO-1): Erosion and Sedimentation Control Plan. *Prior to any grading activities.*

- a) The project applicant shall obtain a grading permit if required by the Oakland Grading Regulations pursuant to Section 15.04.780 of the Oakland Municipal Code. The grading permit application shall include an erosion and sedimentation control plan. The erosion and sedimentation control plan shall include all necessary measures to be taken to prevent excessive stormwater runoff or carrying by stormwater runoff of solid materials on to lands of adjacent property owners, public streets, or to creeks as a result of conditions created by grading operations. The plan shall include, but not be limited to, such measures as short-term erosion control planting, waterproof slope covering, check dams, interceptor ditches, benches, storm drains, dissipation structures, diversion dikes, retarding berms and barriers, devices to trap, store and filter out sediment, and stormwater retention basins. Off-site work by the project applicant may be necessary. The project applicant shall obtain permission or easements necessary for off-site work. There shall be a clear notation that the plan is subject to changes as changing conditions occur. Calculations of anticipated stormwater runoff and sediment volumes shall be included, if required by the Director of Development or designee. The plan shall specify that, after construction is complete, the project applicant shall ensure that the storm drain system shall be inspected and that the project applicant shall clear the system of any debris or sediment.

Ongoing throughout grading and construction activities.

- b) The project applicant shall implement the approved erosion and sedimentation plan. No grading shall occur during the wet weather season (October 15 through April 15) unless specifically authorized in writing by the Building Services Division.

COA GEO-2: Soils Report. *Required as part of the submittal of a Tentative Tract or Tentative Parcel Map.* A preliminary soils report for each construction site within the project area shall be required as part of this project. The soils reports shall be based, at least in part, on information obtained from on-site testing. Specifically the minimum contents of the report should include:

A. Logs of borings and/or profiles of test pits and trenches:

- a) The minimum number of borings acceptable, when not used in combination with test pits or trenches, shall be two (2), when in the opinion of the Soils Engineer such borings shall be sufficient to establish a soils profile suitable for the design of all the footings, foundations, and retaining structures.
- b) The depth of each boring shall be sufficient to provide adequate design criteria for all proposed structures.
- c) All boring logs shall be included in the soils report.

B. Test pits and trenches:

- a) Test pits and trenches shall be of sufficient length and depth to establish a suitable soils profile for the design of all proposed structures.
- b) Soils profiles of all test pits and trenches shall be included in the soils report.

- C. *A plat shall be included which shows the relationship of all the borings, test pits, and trenches to the exterior boundary of the site. The plat shall also show the location of all proposed site improvements. All proposed improvements shall be labeled.*
- D. *Copies of all data generated by the field and/or laboratory testing to determine allowable soil bearing pressures, shear strength, active and passive pressures, maximum allowable slopes where applicable and any other information which may be required for the proper design of foundations, retaining walls, and other structures to be erected subsequent to or concurrent with work done under the grading permit.*
- E. *Soils Report.* A written report shall be submitted which shall but is not limited to the following:
- a) Site description
 - b) Local and site geology.
 - c) Review of previous field and laboratory investigations for the site.
 - d) Review of information on or in the vicinity of the site on file at the Information Counter, City of Oakland, Office of Planning and Building.
 - e) Site stability shall be addressed with particular attention to existing conditions and proposed corrective attention to existing conditions and proposed corrective actions at locations where land stability problems exist.
 - f) Conclusions and recommendations for foundations and retaining structures, resistance to lateral loading, slopes, and specifications, for fills, and pavement design as required.
 - g) Conclusions and recommendations for temporary and permanent erosion control and drainage. If not provided in a separate report they shall be appended to the required soils report.
 - h) All other items which a Soils Engineer deems necessary.
 - i) The signature and registration number of the Civil Engineer preparing the report.
- F. *The Director of Planning and Building may reject a report that she/he believes is not sufficient. The Director of Planning and Building may refuse to accept a soils report if the certification date of the responsible soils engineer on said document is more than three years old. In this instance, the Director may be require that the old soils report be recertified, that an addendum to the soils report be submitted, or that a new soils report be provided.*

COA GEO-3: Geotechnical Report. *Required as part of the submittal of a tentative Tract Map or tentative Parcel Map.*

- a) A site-specific, design level, Landslide or Liquefaction geotechnical investigation for each construction site within the project area shall be required as part if this project. Specifically:
- Each investigation shall include an analysis of expected ground motions at the site from identified faults. The analyses shall be accordance with applicable City ordinances and polices, and consistent with the most recent version of the California Building Code, which requires structural design that can accommodate ground accelerations expected from identified faults.
- The investigations shall determine final design parameters for the walls, foundations, foundation slabs, surrounding related improvements, and infrastructure (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, shall be included in the final

design, as approved by the City of Oakland.

The geotechnical report shall include a map prepared by a land surveyor or civil engineer that shows all field work and location of the "No Build" zone. The map shall include a statement that the locations and limitations of the geologic features are accurate representations of said features as they exist on the ground, were placed on this map by the surveyor, the civil engineer or under their supervision, and are accurate to the best of their knowledge.

Recommendations that are applicable to foundation design, earthwork, and site preparation that were prepared prior to or during the projects design phase, shall be incorporated in the project.

A peer review is required for the Geotechnical Report. Personnel reviewing the geologic report shall approve the report, reject it, or withhold approval pending the submission by the applicant or subdivider of further geologic and engineering studies to more adequately define active fault traces.

Final seismic considerations for the site shall be submitted to and approved by the City of Oakland Building Services Division prior to commencement of the project.

- b) Tentative Tract or Parcel Map approvals shall require, but not be limited to approval of the Geotechnical Report.

2. Impacts and Mitigation Measures

This section analyzes the impacts related to geology, soils and seismicity that could result from the proposed project. This section begins with criteria of significance, which establishes the thresholds for determining whether a project impact is significant. The latter part of this section presents the potential geologic, soils and seismicity impacts associated with the proposed project. Mitigation Measures are provided, as appropriate.

a. **Criteria of Significance.** The proposed project would have a significant impact on the environment if it would:

- 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 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.

b. Less-than-Significant Impacts. The following section describes the less-than-significant geology, soils, and seismicity impacts.

(1) Fault Rupture and Landslides. The proposed project would not be expected to expose people or structures to substantial risk of loss, injury or death from rupture of a known earthquake fault as delineated by the State Geologist, as the site is not located within an active or potentially active fault zone as defined by the Alquist-Priolo Earthquake Fault Zoning Act. The proposed project would not be subject to substantial risk from landslides, as the site is relatively flat, and is not underlain by, or adjacent to, an area subject to slope hazards.

(2) Seismic Ground Shaking, Ground Failure, and Liquefaction. All structures in the Bay Area could potentially be affected by ground shaking in the event of an earthquake along any of the regional active faults. The amount of ground shaking depends on the magnitude of the earthquake, the distance from the epicenter, and the type of earth materials in between. Very strong (MMI VIII) ground shaking is expected at the project site during expected earthquakes on the Hayward and other regional faults. This level of seismic shaking could potentially cause structural damage in buildings at the site. Some masonry and frame structures would likely be destroyed, window glass broken, underground pipes broken, and conspicuous cracks may appear in the ground, curbs and pavement. Nonstructural effects during and following the event may include difficulty or inability to stand, general panic, unsecured furniture and appliances being overturned, panels walls thrown down, contents of cupboards and closets spilling, and temporary loss of utilities service. The level of active seismicity and potential damage results in classification of the area as seismic risk Zone 4 (the highest risk category) in the California Building Code.

The possible presence of fill and the required mitigations for project design must be included as part of the discussion of settlement and differential settlement in the required soils investigation and design-level geotechnical investigation, in accordance with the requirements of the City's Soils Report and Geotechnical Report Standard Conditions of Approval (see COAs GEO-2 and GEO-3, respectively on pages 339 to 340). Under the

proposed project, surface soils at the site may be removed as part of the foundation excavation for the proposed multi-story structures. Outside the perimeter of the major area of excavation, the native soils underlying portions of the project site may exhibit high shrink/swell characteristics.²⁵ These materials could experience expansion and contraction in response to the amount of moisture present. Structural damage, warping, and cracking of pavements and other infrastructure, and rupture of utility lines may occur; however, these conditions and recommended geotechnical precautionary measures must be incorporated into the design-level geotechnical investigation in accordance with the requirements of the City's Geotechnical Report Standard Conditions of Approval (see COA GEO-3 on page 339) requiring that the investigation determine final design parameters for the walls, foundations, foundation slabs, surrounding related improvements, and infrastructure (utilities, roadways, parking lots, and sidewalks).

Regional mapping by ABAG and the State of California indicates moderate susceptibility to liquefaction within the project site. In addition, the preliminary geotechnical evaluation notes that the site subsurface has lenses of sandy soil that may be subject to liquefaction. Adverse effects of liquefaction can take many forms including flow failures, lateral spreads, ground oscillation, loss of bearing strength, settlement, and increased lateral pressure on retaining walls.²⁶ These conditions must be addressed and adequate geotechnical solutions incorporated in the site-specific design-level geotechnical investigation as required under the City's Geotechnical Report Standard Condition (see COA GEO-3 on page 340) requiring that the investigation include a site-specific, design level, landslide or liquefaction geotechnical investigation for each construction site. Final seismic considerations for the site shall be submitted to and approved by the City of Oakland Building Services Division prior to commencement of the project.

Compliance with the City of Oakland Standard and Uniformly Applied Conditions of Approval as described above reduces the potential hazards associated with seismic activity to a less-than-significant level. Seismic hazards cannot be completely eliminated even with site-specific geotechnical investigation and advanced building practices (as required above); however, the level of exposure to seismic hazards is not anticipated to be so great as to pose people or structures to substantial risk of loss, injury, or death as a result it is not considered significant.

(3) Underground Voids, Pits, Wells, Tanks, Sewer Lines, or Buried Landfills.

Review of the California Department of Toxic Substances Control Envirostor Website does not indicate any landfill sites under closure proceedings, or ongoing remediation projects involving tanks within the project site or vicinity. As part of the soils investigation and

²⁵ NRCS, 2006, op. cit.

²⁶ Earthquake Engineering Research Institute (EERI), 1994, *Earthquake Basics: Liquefaction – What is it and what to do about it.*

design-level geotechnical investigation and plans required for the grading permit, as required by the City of Oakland under the terms of the Standard Conditions of Approval, plan checks, and utility service searches will verify the location or absence of these features. The proposed project is located within the City of Oakland and would use city services for potable water delivery and wastewater disposal; septic systems are not proposed. Potential impacts related to these issues are therefore less than significant.

(4) Erosion or Loss of Topsoil, and Mineral Deposits. Potential impacts associated with erosion and loss of topsoil is discussed in Section IV.F, Hydrology and Water Quality, of this DEIR. The implementation of the proposed project would not result in the loss of a known mineral resource; the project site is classified MRZ-1, "Areas where available geologic information indicates that little likelihood exists for the presence of significant mineral resources."^{27,28} The proposed project would not hinder energy reserve development, as the project site is not located over a known gas, oil or geothermal field.²⁹

c. Significant Impacts. The City's Standard Conditions of Approval require that all mitigation measures, design criteria, and specifications set forth in the design-level geotechnical investigation are required by to be implemented for the proposed project. Adherence to these guidelines will result in no significant impacts related to geology, soils or seismicity from the proposed project.

d. Cumulative Geology, Soils and Seismicity Impacts. Potential cumulative geology and seismic impacts do not extend far beyond a project's boundaries, since such geological impacts are typically confined to discrete spatial locations and do not combine to create an extensive cumulative impact. The exception to this generalization would occur where a large geologic feature (e.g., fault zone, massive landslide) might affect an extensive area, or where the development effects from the project could affect the geology of an off-site location. These circumstances are not present on the project site, and do not apply to the proposed project.

During the early part of the 1900s, nonprofit organizations developed model building codes used throughout the United States. Although these regional code developments were effective and responsive to regulatory needs, the time came for a single set of codes. The International Code Council (ICC) was established as a nonprofit organization dedicated to developing a single set of comprehensive and coordinated national model construction

²⁷ California Department of Conservation (CDC), 1987, *Mineral Land Classification: Aggregate Materials in the San Francisco-Monterey Bay Area*, Division of Mines and Geology (DMG) Special Report 146 Part II.

²⁸ CDC, 1996, *Update of Mineral Land Classification, Plate 1*. DMG Open-File Report 96-03.

²⁹ CDC, 2000, *Energy Map of California, Third Edition*, Division of Oil, Gas or Geothermal Resources.

codes, now known as the Uniform Building Code (UBC). Within California, additional state requirements were added to the UBC to form the California Model Building Codes (CBC). Localities, such as the City of Oakland, may adopt additional amendments to the CBC through local ordinance. The trend in building codes has been increased rigor in the design and implementation requirements for geotechnical and seismic safety. These requirements, as specified by state and local regulation with the adoption of the CBC and amendments, have progressively become more rigorous in requirements mandating a greater reduction of risk to life, health, and safety, and minimized seismic risk. Many existing buildings (i.e., past projects) in the surrounding area have been built in accordance with building code requirements for geotechnical and seismic safety in effect at the time of building construction. Present and future projects within the project's geographic area are subject to these enhanced requirements and result in reduced geologic and seismic hazards. As present and future projects replace aging infrastructure and older structures with new, more rigorously regulated projects, the potential for cumulative seismic risks is incrementally reduced over time.

The Standard Conditions of Approval discussed above, including appropriate grading requirements, and compliance with the Uniform Building Code as locally amended would reduce the potential for cumulative geologic and seismic effects from the proposed project site and surrounding area. Therefore, implementation of the project together with the impact of past, present, existing, pending and reasonably foreseeable future development would not result in any significant cumulative geologic and seismic impacts. Moreover, given that the project will remove older structures and replace them with new structures that must comply with current and future building code requirements for geologic and seismic safety, the project would not make any considerable contribution to any potential cumulative impact, because it will improve geologic and seismic safety on the project site.

