4.7 GEOLOGY, SOILS, AND SEISMICITY

This section describes current conditions at the project site relative to geology, soils, and seismicity; analyzes potential environmental impacts; and recommends mitigation measures to reduce significant or potentially significant impacts to less-than-significant levels. The project site is not located in an area of known mineral resources, nor are any expected to be encountered during project development. As such, no impacts related to mineral resources are anticipated, and this issue is not evaluated further in the Draft EIR. Paleontological resources impacts are addressed in Section 4.12, "Cultural Resources."

4.7.1 ENVIRONMENTAL SETTING

PHYSIOGRAPHIC SETTING

The project area is located at the northern end of the San Joaquin Valley. Together, the San Joaquin Valley and the Sacramento Valley constitute the Great Valley of California. The Great Valley is a broad structural trough bounded by the tilted block of the Sierra Nevada on the east and the complexly folded and faulted Coast Ranges on the west.

The Great Valley is composed of thousands of feet of sedimentary deposits that have undergone periods of subsidence and uplift over millions of years. During the Jurassic (approximately 206 million years Before Present [B.P.]) and Cretaceous (approximately 144 million years B.P.) periods of the Mesozoic era, the Great Valley existed in the form of an ancient ocean. By the end of the Mesozoic era, the northern portion of the Great Valley began to fill with sediment as tectonic forces caused uplift of the basin. Geologic evidence suggests that the Sacramento Valley and San Joaquin Valley gradually separated into two separate water bodies as uplift and sedimentation continued. By the time of the Miocene epoch (approximately 24 million years ago), sediments deposited in the Sacramento Valley were mostly of terrestrial origin. In contrast, the San Joaquin Valley continued to be inundated with water for another 20 million years, as indicated by marine sediments dated to the late Pliocene epoch (approximately 5 million years ago). Most of the surface of the Great Valley is covered with Holocene (less than 10,000 years ago) and Pleistocene (10,000 to 1.5 million years old) alluvium. This alluvium is composed of sediments from mountains of the Sierra Nevada to the east and the Coast Ranges to the west that were carried by water and deposited on the valley floor. Siltstone, claystone, and sandstone are the primary types of sedimentary deposits.

LOCAL GEOLOGY

The project site is located in the U.S. Geological Survey (USGS) Manteca 7.5-Minute Quadrangle and is approximately 16 acres in size. The topography of the site is relatively flat and the elevation is approximately 30 feet above mean sea level.

Much of the area surrounding the City of Manteca (City) is covered by Holocene-age dune sand deposits (Wagner et al. 1991). Inland dunes usually exist in the form of ridges, small hills, and knolls found on ancestral lake beds and outwash plains. Dune sand at the project site originated on the broad coastal plain of the ancestral Sacramento/San Joaquin River system.

RECREATIONAL GEOLOGIC FEATURES

Recreational geologic resources typically include rock or mineral collecting, volcanoes, surface hydrothermal features, or surface expression of geologic features unique enough to generate recreational interests of the general public (e.g., natural bridges, caves, features associated with glaciation, and geomorphic features such as waterfalls, cliffs, canyons, and badlands). Based on a review of available geological literature, topographic maps, and a field visit to the site, there are no known recreational geologic resources associated with the project area.

REGIONAL SEISMICITY AND FAULT ZONES

The northern San Joaquin Valley has generally not been seismically active in the last 10,000 years. Most faults in the project region with known or estimated activity during the Holocene epoch are generally located in the Bay Area, approximately 40 miles to the west, and lie within the Coast Ranges geomorphic province, as shown in Table 4.7-1.

Table 4.7-1
Regional Fault Activity During the Holocene Epoch

Faults Active in Holocene Time in the Vicinity of the Project Site	Distance from Project Area	Probable Maximum Magnitude[1]	Location
Great Valley	23 miles	6.7	Coast Ranges, western margin of San Joaquin Valley
Greenville/Marsh Creek	38 miles	6.9	Coast Ranges, Bay Area
Ortigalita	40 miles	6.9	Coast Ranges, Bay Area
Calaveras	60 miles	6.8	Coast Ranges, Bay Area
Hayward	63 miles	7.1	Coast Ranges, Bay Area
Concord	63 miles	6.9	Coast Ranges, Bay Area
Green Valley	65 miles	6.9	Coast Ranges, Bay Area
San Andreas (1838 Event)	65 miles	7.9	Coast Ranges, Bay Area

[1] A measure of earthquake size calculated on the basis of seismic moment called Moment Magnitude (M_w).

Source: Jennings 1994, Helley and Harwood 1987, Kleinfelder 2005

The fault closest to the project site that has been active during the Holocene epoch is the Great Valley Fault System, a series of blind-thrust faults located along the western edge of the San Joaquin Valley. A number of earthquakes have been attributed to this fault system during the last 100 years, including the 1892 Vacaville –Winters earthquake (although some researchers dispute the Great Valley fault as the source for this earthquake), the 1881 West San Joaquin Valley earthquakes, the 1983 Coalinga earthquake, and the 1985 Kettlemen Hills earthquake (Toppozada 1987, Kleinfelder 2005). Only the 1983 Coalinga earthquake resulted in surface ground rupture.

Potential seismic hazards resulting from a nearby moderate to major earthquake can generally be classified as primary and secondary. The primary effect is fault ground rupture, also called surface faulting. Surface ground rupture along faults is generally limited to a linear zone a few meters wide. Common secondary seismic hazards include ground shaking, ground failure/liquefaction, subsidence and lateral spreading, and tidal waves and seiches, which are discussed below.

Seismic Ground Shaking

The most important geologic hazard that could affect the project area is the risk to life and property from an earthquake generated by active and potentially active faults in the Bay Area and along the western margin of the San Joaquin Valley.

Seismic ground shaking is the most likely seismic hazard to affect the site. Ground motions can be estimated by the probability of occurrence at specified hazard levels. The intensity of ground shaking depends on the distance from the earthquake epicenter to the site, the magnitude of the earthquake, site soil conditions, and the characteristic of the source. The Probabilistic Seismic Hazard Assessment for the State of California (Petersen et al. 1996), published by the USGS and the California Geological Survey (formerly the California Department of Conservation, Division of

Mines and Geology), identifies the seismic hazard based on a review of these characteristics and historical seismicity throughout California. The results of these studies suggest there is a 10 percent probability that the peak horizontal acceleration experienced at the site would exceed 0.2 g in 50 years. Damage to a single-family dwelling typically begins at 0.2 g (where “g” is the acceleration of gravity) (Rogers et al. 1996).

According to the California Building Standards Code (CBC), 1998 edition, the site is located in Seismic Zone 3. This location implies a minimum horizontal acceleration of 0.3 g for use in earthquake resistant design. The CBC specifies more stringent design guidelines where a project would be located adjacent to Class “A” or “B” faults as designated by the California Probabilistic Seismic Hazard Maps (Cao et al. 2003). Faults with an “A” classification are capable of producing large-magnitude (M) events (M greater than 7.0), have a high rate of seismic activity (e.g., having slip rates greater than 5 millimeters per year), and have well constrained paleoseismic data (e.g., evidence of displacement within the last 700,000 years). Class “B” faults are those that lack paleoseismic data necessary to constrain the recurrence intervals of large-scale events. Faults with a “B” classification are capable of producing an event of magnitude 6.5 or greater. Table 4.7-2 shows the seismic source description, magnitude, and slip rate for the various classes of faults. A review of the available data indicates that no Class A or B faults are located within 20 miles of the project site.

Table 4.7-2
1998 California Building Code – Seismic Source Type

Seismic Source Type	Seismic Source Description	Seismic Source Definition	
		Maximum Moment Magnitude, M	Slip Rate, SR (mm/year)
A	Faults that are capable of producing large-magnitude events that have a high rate of seismic activity	M > 7.0	SR > 5
B	All faults other than Types A and C	M > 7.0 M < 7.0 M > 6.5	SR < 5 SR > 2 SR < 2
C	Faults that are not capable of producing large-magnitude earthquakes and that have a relatively low rate of seismic activity	M < 6.5	SR < 2

Source: 1998 California Building Code

The Alquist-Priolo Earthquake Fault Zoning Act is intended to prevent the construction of buildings used for human occupancy on the surface trace of active faults. There are no Earthquake Fault Zones subject to the Alquist-Priolo Act in Manteca. In addition, no Seismic Hazard Zones have been identified in Manteca (California Geological Survey 2005).

The Modified Mercalli Scale, presented in Table 4.7-3, is a scale used to illustrate the effects of earthquake intensity. Table 4.7-4 shows the approximate relationships between earthquake magnitude (Richter scale) and intensity (Modified Mercalli Scale). The California Geological Survey indicates that the project site is located in a region of moderate maximum earthquake intensity, that is, a zone of VII to VIII on the Modified Mercalli Scale; an earthquake of maximum intensity in this region would cause general alarm and moderate damage (California Office of Emergency Services 2005).

Table 4.7-3
Modified Mercalli Scale of Earthquake Intensity

Scale	Effects
I.	Not felt except by a very few under especially favorable conditions.
II.	Felt only by a few persons at rest, especially on upper floors of buildings.
III.	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV.	Felt indoors by many, outdoors by few during the day. 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 broken. Unstable objects overturned. Pendulum clocks may stop.
VI.	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII.	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII.	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX.	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X.	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI.	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
XII.	Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Source: U.S. Geological Survey 2005

Table 4.7-4
Approximate Relationships between Earthquake Magnitude and Intensity

Richter Scale Magnitude	Maximum Expected Intensity (Modified Mercalli Intensity Scale)	Distance Felt (Approx. Miles)
3.0 – 3.9	I – III	15
4.0 – 4.9	IV – V	30
5.0 – 5.9	VI – VIII	70
6.0 – 6.9	VII – VIII	125
7.0 – 7.9	IX – X	250

Source: California Office of Emergency Services 2005

Ground Failure/Liquefaction

Soil liquefaction occurs when ground shaking from an earthquake causes a sediment layer saturated with groundwater to lose strength and take on the characteristics of a fluid, thus becoming similar to quicksand. There are four types of ground failure or collapse of soil structures that commonly result from liquefaction: lateral spread, flow failure, ground oscillation, and loss of bearing strength. Age also is a factor in the potential of soils to liquefy, with Holocene deposits (from approximately the last 11,000 years) being the most sensitive to liquefaction.

One consequence that may result from the occurrence of liquefaction is an associated surface expression. If the seismic event occurs over an extended duration, the liquefied soils may migrate toward the surface, resulting in ejection and subsequent sand boiling at the surface.

Liquefaction poses a hazard to engineered structures. The loss of soil strength can result in bearing capacity insufficient to support foundation loads, increased lateral pressure on retaining or basement walls, and slope instability. Factors determining the liquefaction potential of a given site are soil type, the level and duration of possible seismic ground motions, the type and consistency of soils, and the depth to groundwater. Loose sands and peat deposits are susceptible to liquefaction. Its occurrence is particularly likely where land has been reclaimed from inundated areas by filling with loose sand. Clayey silts, silty clays, and clays deposited in freshwater environments are generally stable under the influence of seismic ground shaking.

The geotechnical engineering report for the project site was prepared by Kleinfelder (2005). Subsurface conditions were explored at the site by drilling test borings ranging from 6 to 26.5 feet below existing grade. The test borings indicate groundwater was encountered at a depth of approximately 15 feet beneath the existing site grade. The geotechnical engineering report further indicates that the majority of subsurface soils consist predominantly of medium-dense, fine-grained silty sand to depths from approximately 6.5 to 16 feet below the existing ground surface. However, an isolated stratum of loose sand was encountered at a depth of approximately 5 feet, underlain by interbedded and discontinuous layers of very-stiff, low-plastic sandy silt; medium-dense to dense, fine-grained, relatively “clean” sand, sand with silt, and silty to clayey sand; and moderately-plastic silty to sandy clay to the maximum depths explored (Kleinfelder 2005).

Subsidence and Lateral Spreading

Land surface subsidence can be induced by both natural and human phenomena. Natural phenomena include: subsidence resulting from tectonic deformations and seismically induced settlements; soil subsidence from consolidation, hydrocompaction, or rapid sedimentation; subsidence from oxidation or dewatering of organic-rich soils; and subsidence related to subsurface cavities. Subsidence related to human activity includes subsurface fluid or sediment withdrawal. Pumping of water for residential, commercial, and agricultural uses from subsurface water tables causes more than 80% of the identified subsidence in the United States. (Galloway et al. 1999).

Lateral spreading is the horizontal movement or spreading of soil toward an open face, such as a streambank, the open side of fill embankments, or the sides of levees. The potential for failure from lateral spreading is highest in areas where there is a high groundwater table, where there are relatively soft and recent alluvial deposits, and where creek banks are relatively high.

By 1970, subsidence in excess of 1 foot had affected one-half of the San Joaquin Valley (more than 5,200 square miles of farmland). The maximum subsidence, over 28 feet, was recorded near Mendota. Land subsidence in the San Joaquin Valley since the 1970s has generally slowed from reductions in groundwater pumping and the subsequent recovery of groundwater levels as a result of a greater emphasis on surface water irrigation. In the late 1980s, pumping of groundwater during a period of extended drought resulted in rapid decline in groundwater levels and renewed subsidence (Galloway et al. 1999).

Tidal Waves and Seismic Seiches

Earthquakes may affect open bodies of water in two ways: by creating seismic sea waves and by creating seiches. Seismic sea waves (often called “tidal waves”) are caused by abrupt ground movements (usually vertical) on the ocean floor in connection with a major earthquake. Because of the distance of the project site from the ocean (i.e., greater than 20 miles), seismic sea waves would not to be a factor. A seiche is a sloshing of water in an enclosed or restricted water body such as a basin, river, or lake. It is caused by earthquake motion; the sloshing can occur for a few minutes or several hours. In 1868, for example, an earthquake along the Hayward fault in the San Francisco Bay area is known to have generated a seiche along the San Joaquin River.

The project site is approximately 2 ½ miles from the San Joaquin River, and is located in an area of flat topography. Although a high percentage of Delta levees are subject to overtopping and subsequent failure, the risk of damage to the project site from a levee break is minimal due to the site's distance from the San Joaquin River. In addition, the potential for damaging seiches is considered very low to negligible because of the absence of a deep, large open body of water adjacent to or in the immediate project area. Therefore, the risk of seiche is considered low.

SOIL RESOURCES

Soil properties can affect the construction and maintenance of roads, building foundations, and infrastructure. Among these properties are permeability, shrink-swell potential, water retention capacity, and corrosion potential.

Subsurface data from Kleinfelder (2005) indicate that the majority of the project site is underlain by medium-dense, fine-grained silty sand to depths from approximately 6.5 to 16 feet below the existing ground surface. An isolated stratum of loose sand was encountered at a depth of approximately 5 feet, underlain by interbedded and discontinuous layers of very-stiff, low-plastic sandy silt; medium-dense to dense, fine-grained, relatively "clean" sand, sand with silt, and silty to clayey sand; and moderately-plastic silty to sandy clay to the maximum depths bored (Kleinfelder 2005).

Identification of soil types and their distribution was accomplished primarily through a review of maps provided by the U.S. Soil Conservation Service (now called the Natural Resources Conservation Service [NRCS]). Exhibit 4.7-1 provides a detailed map of the surficial soils in the project area. Table 4.7-5 provides a detailed summary of the physical and chemical characteristics of each soil type identified on the project site. A discussion of soil characteristics is presented below.

Table 4.7-5
Soil Mapping Unit Descriptions

Map[1]	Soil Series Name	Depth (inches)	USDA texture	Shrink-Swell Potential	Permeability (in/hr)	Erosion Factors[2]		Wind Erodibility Group[3]	pH	Plasticity Index[4]
						K	T			
143	Delhi	0–16	Loamy sand	Low	6.0–13	0.24	5	2	6.1–7.8	NP
		16–26	Loamy fine sand, loamy sand	Low	6.0–13	0.24			6.1–7.8	NP
		26–60	Fine sand, loamy sand, sand	Low	6.0–13	0.20			6.1–7.8	NP
255	Tinnin	0–28	Loamy coarse sand	Low	6.0–20	0.17	5	2	6.1–7.8	NP
		28–53	Loamy coarse sand, loamy sand	Low	6.0–20	0.17			6.1–7.8	NP
		53–75	Loamy coarse sand, loamy sand, sand	Low	6.0–20	0.17			6.6–8.4	NP
		54–70	Cemented	---	---	---			---	---

[1] Soil map numbers refer to numbers shown on Exhibit 4.7-1 (Soils Map of Project Site).

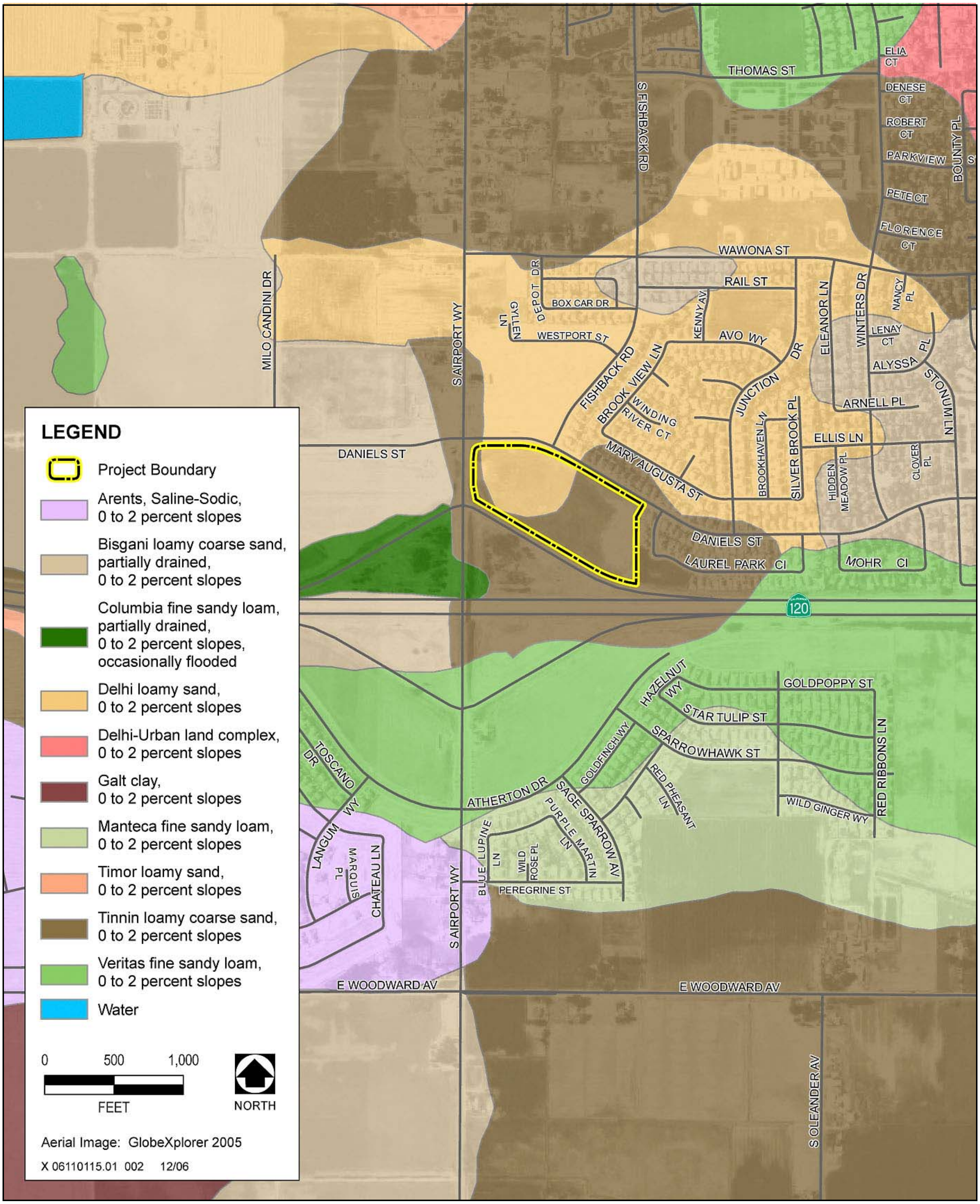
[2] K is a measurement of relative susceptibility to sheet and rill erosion by water. It ranges from 0.10 to 0.64, with lower values representing a lower susceptibility to erosion.
T represents soil loss tolerance, which is defined as the maximum rate of soil erosion (wind and water) without reducing crop production or environmental quality. Values ranges from 1 to 5 tons of soil loss per acre per year, with 5 representing soils less sensitive to erosion.

[3] A measure of the susceptibility of soil to movement by wind. Groups are 1 through 8, with 8 being soil types not subject to soil blowing because of coarse fragments on the surface or surface wetness.

[4] Soils with a high plasticity index have a wide range of moisture content in which the soil performs as a plastic material. Larger PI values (e.g. 20-40) indicate highly plastic soils. NP=Not plastic

--- Either not measured or not applicable.

Source: NRCS 1992.



Source: City of Manteca 2006, SSURGO 2005

Soils Map **Exhibit 4.7-1**

142 Delhi Loamy Sand, 0 to 2% slopes - This soil is found on floodplains, alluvial fans, and terraces, and formed in wind modified alluvium derived from granitic rock sources. Delhi loamy sand is a very deep, somewhat excessively drained that grades downward from a brown sand, fine sand, loamy fine sand, or loamy sand to a light yellowish-brown sand or loamy sand at depths of 70 inches. Runoff is negligible to slow, permeability is rapid, and there is only a slight hazard of water erosion. However, the wind erosion hazard is severe. This soil type has a low shrink-swell potential. In San Joaquin County, the primary use for Delhi loamy sand is orchards, vineyards, and alfalfa.

255 Tinnin Loamy Coarse Sand, 0 to 2% slopes - Tinnin loamy coarse sand is a deep, well-drained soil found on alluvial fans, and is derived from granitic rock sources. The soil grades downward from a grayish brown loamy coarse sand to a pale brown mottled loamy coarse sand at depths of 75 inches. Runoff is slow and there is only a slight hazard of water erosion. However, the wind erosion hazard is severe. This soil type has a low shrink-swell potential. The extremely rapid permeability rate makes this soil unsuitable for septic systems. The primary use of this soil type in San Joaquin County is irrigated crops, orchards, or vineyards.

Shrink-Swell Potential

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture; soils swell when wet and shrink when dry. If the shrink-swell potential is rated moderate to high, volume changes can result in damage over time to building foundations, underground utilities, and other subsurface facilities if they are not designed and constructed appropriately to resist the changing soil conditions. Soils with high clay content tend to be most affected by shrink and swell. The potential for soil to undergo shrink and swell is greatly enhanced by the presence of a fluctuating, shallow groundwater table. Volume changes of expansive soils can result in the consolidation of soft clays following the lowering of the water table or the placement of fill. Mapped soil types at the project site (see Exhibit 4.7-1) are not considered to be expansive because of their low clay content and low plasticity index (NRCS 1992).

Seepage and Soil Moisture

As described above, groundwater at the project site is an average of approximately 15 feet below ground surface in the lowest areas of the site. In general, groundwater levels are relatively high throughout the project area (City of Manteca 2003a). Soil permeability is moderate to rapid, but surface runoff is very slow, combining with high groundwater levels during the winter and spring months, which could create saturated surface soil conditions and high soil moisture content.

Corrosion Potential

Corrosion is the gradual degradation of materials through electrochemical processes resulting from the interaction between chemical properties of the soil (e.g., pH, resistivity, and sulfate and chloride concentrations) and metal, concrete, or stone. Kleinfelder (2005) did not conduct soil testing to evaluate the potential for corrosion. In addition, no lab testing by a corrosion engineer has been completed, so no definitive conclusion can be reached regarding the soil corrosion potential in the project area.

4.7.2 REGULATORY SETTING

FEDERAL PLANS, POLICIES, REGULATIONS, AND LAWS

Federal Earthquake Hazards Reduction Act

In October 1997, the U.S. Congress passed the Earthquake Hazards Reduction Act to “reduce the risks to life and property from future earthquakes in the United States through the establishment and maintenance of an effective earthquake hazards and reduction program.” To accomplish this, the Act established the National Earthquake

Hazards Reduction Program (NEHRP). This program was significantly amended in November 1990 by the National Earthquake Hazards Reduction Program Act (NEHRPA), by refining program goals, objectives, and agency responsibilities.

NEHRP's mission includes improved understanding, characterization, and prediction of hazards and vulnerabilities; improved building codes and land use practices; risk reduction through post-earthquake investigations and education; development and improvement of design and construction techniques; improved mitigation capacity; and accelerated application of research results. The NEHRPA designates the Federal Emergency Management Agency (FEMA) as the lead agency of the program and assigns it several planning, coordinating, and reporting responsibilities. Other NEHRPA agencies include the National Institute of Standards and Technology, National Science Foundation, and U.S. Geological Survey.

STATE PLANS, POLICIES, REGULATIONS, AND LAWS

California Building Standards Code

The State of California provides a minimum standard for building design through the California Building Standards Code (California Code of Regulations, Title 24). Where no other building codes apply, Chapter 29 regulates excavation, foundations, and retaining walls. The CBC also applies to building design and construction in the state and is based on the federal Uniform Building Code (UBC) used widely throughout the country (generally adopted on a state-by-state or district-by-district basis). The CBC has been modified for California conditions with numerous more detailed and/or more stringent regulations.

The State earthquake protection law (California Health and Safety Code 19100 et seq.) requires that structures be designed to resist stresses produced by lateral forces caused by wind and earthquakes. Specific minimum seismic safety and structural design requirements are set forth in Chapter 16 of the CBC. The CBC identifies seismic factors that must be considered in structural design.

Chapter 18 of the CBC regulates the excavation of foundations and retaining walls, and Appendix Chapter A33 regulates grading activities, including drainage and erosion control, and construction on unstable soils, such as expansive soils and liquefaction areas.

California Seismic Hazards Mapping Act

The California Seismic Hazards Mapping Act of 1990 (California Public Resources Code Section 2690-2699.6) addresses seismic hazards other than surface rupture, such as liquefaction and induced landslides. The Seismic Hazards Mapping Act specifies that the lead agency for a project may withhold development permits until geologic or soils investigations are conducted for specific sites and mitigation measures are incorporated into plans to reduce hazards associated with seismicity and unstable soils.

Alquist-Priolo Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was passed by the California Legislature to mitigate the hazard of surface faulting to structures. The main purpose of the act is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. The act addresses only the hazard of surface fault rupture and is not directed toward other earthquake hazards. Local agencies must regulate most development in fault zones established by the State Geologist. Before a project can be permitted in a designated Alquist-Priolo Fault Study Zone, cities and counties must require a geologic investigation to demonstrate that proposed buildings would not be constructed across active faults.

National Pollutant Discharge Elimination System Permit

In California, the State Water Resources Control Board (State Water Board) administers the federal Environmental Protection Agency promulgated regulations (55 CFR 47990) requiring the permitting of stormwater-generated pollution under the National Pollutant Discharge Eliminations System (NPDES). In turn, the Board's jurisdiction is administered through Regional Water Quality Control Boards. Pursuant to these federal regulations, an operator must obtain a General Permit under the NPDES Stormwater Program for all construction activities with ground disturbance of 1 acre or greater. The General Permit requires the implementation of best management practices (BMPs) to reduce pollutant loads into the waters of the State and measures to reduce sediment and erosion control. In addition, a Storm Water Pollution Protection Plan (SWPPP) must be prepared. The SWPPP addresses water pollution control during construction. SWPPPs require that all storm water discharges associated with construction activity (where clearing, grading and excavating results in soil disturbances) must, by law, be free of site pollutants.

REGIONAL AND LOCAL PLANS, POLICIES, REGULATIONS, AND ORDINANCES

City of Manteca General Plan

Geologic and Seismic Safety

The Safety Element of the City of Manteca General Plan (City general plan) outlines goals and policies associated with geology and soils. The following policies relate to the project:

- **Policy S-P-1:** The City shall require preparation of geological reports and/or geological engineering reports for proposed new development located in areas of potentially significant geological hazards, including potential subsidence (collapsible surface soils) because of groundwater extraction.

- **Policy S-P-2:** The City shall require new development to mitigate the potential impacts of geologic hazards through Building Plan review.

- **Policy S-P-3:** The City shall require new development to mitigate the potential impacts of seismic induced settlement of uncompacted fill and liquefaction (water-saturated soil) because of the presence of a high water table.

- **Policy S-P-5:** The City shall ensure that all public facilities, such as buildings, water tanks, and reservoirs, are structurally sound and able to withstand seismic shaking and the effects of seismically induced ground failure.

The Safety Element of the City general plan further states that all new development shall comply with the current CBC requirements and with California Health and Safety Code Section 19100 et seq. (Earthquake Protection Law).

Soils and Erosion Control

The Resource Conservation Element of the City general plan contains the following policies related to the project:

- **Policy RC-P-10:** Minimize soil erosion and loss of topsoil from land development activities, wind, and water flow.

The Resource Conservation Element of the City general plan further states that all new development shall comply with the current CBC requirements for construction standards for specific soil types, and with CBC Chapter 70 regulating grading activities including drainage and erosion control. The City requires site-specific land management and development practices for proposed development projects, including appropriate mitigation measures to avoid or reduce erosion.

Grading Permits

In the City of Manteca, grading and construction are regulated through grading permits in compliance with the requirements of the most current version of the California Building Standards Code.

4.7.3 ENVIRONMENTAL IMPACTS

ANALYSIS METHODOLOGY

Evaluation of potential geologic and soil impacts was based on a review of documents pertaining to the project site, including the *San Joaquin County General Plan 2010* (San Joaquin County 1992), the *City of Manteca General Plan* (2003), the geotechnical report prepared by Kleinfelder (2005), field review of the proposed project site, geologic maps, and published and unpublished geologic literature. Project-related geotechnical reports and the San Joaquin County and City of Manteca general plans are available for review at the City of Manteca Community Development Department. Impacts related to geology and soils that would result from implementation of the proposed project were identified by comparing existing data and environmental documents.

THRESHOLDS OF SIGNIFICANCE

For the purpose of this analysis, the following applicable thresholds of significance have been used to determine whether implementing the proposed project would result in a significant impact. These thresholds of significance are based on the State CEQA Guidelines. A geology and soils impact is considered significant if implementation of the proposed project would do any of the following:

- expose people or structures to potential substantial adverse effects, including the 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 issued by the State Geologist for the area or based on other substantial evidence of a known fault;
    - strong seismic ground shaking;
    - seismic-related ground failure, including liquefaction; or
    - landslides;
- result in substantial soil erosion or the loss of topsoil;
- be located on a geologic unit or soil that is unstable, or that would become unstable as a result of a project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, or liquefaction or collapse;
- be located on expansive soil, as defined in Table 18-1-B of the UBC (1997), 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 waste water.

IMPACT ANALYSIS

The proposed project would have no impact associated with the following issues, and these issues will not be analyzed further in this Draft EIR:

- **Fault Ground Rupture:** There are no known active faults crossing the project site and the site is not located in an Alquist-Priolo Special Study Zone; therefore, fault ground rupture is unlikely.
- **Landslide:** Landsliding may result from strong ground shaking. Based on topographic and soil data, the risk of landslides is considered negligible for the project site.
- **Tsunamis:** The potential for tsunamis at the proposed project site is considered negligible because of the distance from the San Francisco Bay and the Pacific Ocean.
- **Seiche:** Seiche is an oscillation within an enclosed or restricted body of water caused by moderate ground motion, such as from an earthquake. The potential for damaging seiches is considered very low to negligible because of the absence of a deep, large open body of water adjacent to or in the project site.
- **Septic systems:** The proposed project would remove any septic systems currently on-site and would be served by the City's existing wastewater collection and treatment system. The proposed project does not include and would not use septic tanks or alternative wastewater disposal systems.
- **Mineral Resources:** The project site is not located in an area of known mineral resources, nor are any expected to be encountered during project development (City of Manteca 2003a).

IMPACT 4.7-1 Geology, Soils, and Seismicity — Risks to People and Structures Caused by Strong Seismic Ground Shaking. *The project site is approximately 23 miles from the nearest potentially active fault and is located in CBC Seismic Zone 3. Project facilities would be designed in accordance with CBC seismic standards for structures located within Zone 3. However, in the event of a moderate to major seismic event along the Great Valley fault, ground shaking could result in lateral forces exceeding the capabilities of structures built to minimum CBC design standards. Severe structural and nonstructural damage and associated hazards resulting from such a seismic event would be a* ***potentially significant*** *impact.*

According to the *California Geological Survey's Maps of Known Active Fault Near-Source Zones in California and Adjacent Portions of Nevada*, there are no type "A" or "B" faults located within 20 miles of the project site. According to the CBC, 1998 edition, the site is located in Seismic Zone 3; for this reason, the level of anticipated seismic ground shaking is lower at the site than in many areas within the state of California. The nearest potentially active fault is the Great Valley fault system, approximately 23 miles from the project site, which is estimated to have a maximum credible earthquake of 6.7 on the Richter scale.

Seismic activity in the nine-county San Francisco Bay Area (San Andreas, Hayward, and Calaveras faults) and the Great Valley fault system could generate strong ground shaking on the project site. Because of this potential fault activity, ground shaking is a hazard for facilities in the San Joaquin Valley. Intensity of the ground shaking would depend on the magnitude of the earthquake, the distance from the epicenter, and the duration of shaking. The damage sustained and the degree of hazard depends on the seismic hazards of each specific site, the type of structure and its building materials, and construction quality. The project involves the development of large retail, restaurant, and other retail space, as well as associated utility improvements. The proposed development would be anticipated to experience at least one major earthquake during the operational lifetime of the project. Although the project area would not likely experience a fault rupture, ground shaking could cause structural damage to buildings, pipelines, and other permanent improvements proposed as part of the project.

The project developers would be required to comply with the provisions of the CBC. Seismic design provisions of current building codes generally prescribe minimum lateral forces, applied statically to the structure and combined with the gravity forces of dead-and-live loads. The CBC-prescribed lateral forces generally are substantially smaller than the expected peak forces that would be associated with a major earthquake. Therefore, when built according to CBC standards, structures are anticipated to:

- resist minor earthquakes without damage,
- resist moderate earthquakes without structural damage but with some nonstructural damage, and
- resist major earthquakes without collapse but with some structural as well as nonstructural damage.

Conformance to the current building code standards does not constitute any kind of guarantee that significant structural damage would not occur in the event of a maximum magnitude earthquake; however, it is reasonable to expect that a well-designed and well-constructed structure would not collapse or cause loss of life in a major earthquake.

At this time, the CBC requirements (based on the probabilistic seismic event) are considered the design minimum. Because of the relatively close presence of the Great Valley fault, it is conceivable that the site may experience ground shaking more severe than the CBC-specified ground shaking (produced by the more distant Greenville/March Creek fault), but the probability of occurrence is lower. In the event of a moderate to major seismic event along the Great Valley fault, ground shaking could result in lateral forces exceeding the capabilities of structures built to minimum CBC design standards. Severe structural and nonstructural damage and associated hazards resulting from such a seismic event would be a **potentially significant** impact.

IMPACT 4.7-2	Geology, Soils, and Seismicity — Risks to People and Structures Caused by Seismic-Related Ground Failure. *The project site is susceptible to seismic events. Based on the underlying soil conditions in the project area and the depth of the groundwater table, construction of the proposed project has the potential to expose people or structures to seismic-related ground failure, including liquefaction and differential settlement. Therefore, this impact is considered* ***potentially significant****.*

Because the project area is located in the CBC's Seismic Zone 3, the level of anticipated seismic ground shaking is lower than for many other areas in California. However, strong ground shaking (corresponding with a zone of VII to VIII on the Modified Mercalli Scale) may still occur as a result of large, distant earthquakes, causing general alarm and moderate damage. In addition, Seismic Zone 3 implies a minimum horizontal acceleration of 0.3 g for use in earthquake resistant design (where damage to a single-family dwelling typically begins at 0.2 g).

Liquefaction occurs when saturated soil loses shear strength and deforms as a result of increased pore water pressure induced by strong ground shaking during an earthquake. As the excess pore pressure dissipates, volume changes are produced within the liquefied soil layer, which can manifest at the ground surface as settlement of structures, floating of buried structures, and failure of retaining walls. Soil types most susceptible to liquefaction are saturated, loose, sandy soils. According to data generated by Kleinfelder (2005), the majority of the subsurface soils on the project site consist of medium dense to dense, fine-grained sand and is therefore not susceptible to liquefaction. However, according to the geotechnical analysis, discontinuous or localized relatively thin strata of loose to medium-dense silty sands were encountered at depths of 19 and 25 feet below existing site grade. These sand strata may have the potential for liquefaction in the event of a large magnitude earthquake along the nearest segments of the Great Valley fault; however, this potential for liquefaction would not be expected to be widespread because of the discontinuous and localized nature of these sand layers (Kleinfelder 2005). The project site contains dry, loose sands and non-plastic silts which could experience settlement or subsidence when subjected to cyclic application of loads such as ground shaking from nearby seismic events (Kleinfelder 2005). In addition, groundwater levels are relatively high throughout the project area (City of Manteca 2003a).

Given these conditions, if project structures and facilities are not designed or constructed appropriately, a large seismic event could expose commercial shopping center workers and visitors to a substantial risk of loss, injury, or death. Because seismic events are a hazard in the project area as a result of distant earthquakes, subsurface soils consist of loose to medium-dense silty sands, and project area groundwater levels are relatively high, a large seismic event could expose people or structures to seismic-related ground failure, including liquefaction and differential settlement. This would be a **potentially significant** impact.

IMPACT 4.7-3 Geology, Soils, and Seismicity — Construction-Related Erosion Hazards. *Based on soil types and topography, excavation and grading of soil could result in erosion during project construction, particularly during periods of strong winds. This impact is considered* ***potentially significant****.*

Soils at the project site consist of Delhi loamy sand and Tinnin loamy coarse sand which have been characterized as having only slight erosion hazards; moreover, the flat topography of the site would minimize the potential for wind erosion during grading activities or water erosion during a storm event. However, according to the NRCS (Table 4.7-5), soil types at the project site are subject to a severe hazard from wind erosion, which could result in a loss of topsoil during the spring and summer months.

Project construction activities would involve excavation and grading of soil which could result in localized erosion during construction activities. Because construction activities would remove vegetative cover and would expose disturbed areas to wind and storm events, this would be a **potentially significant** impact.

IMPACT 4.7-4 Geology, Soils, and Seismicity — Risks to People and Structures Resulting from Unstable Soil Conditions. *Soils on the project site have a very low clay content and are rated by the NRCS as non-plastic (no shrink-swell potential). Based on this information, there is a low potential for shrink-swell soils at the project site to cause damage to project structures. Therefore, this impact is considered* ***less than significant****.*

Expansive soils shrink and swell as a result of moisture change. These volume changes can result in damage over time to building foundations, underground utilities, and other subsurface facilities if they are not designed and constructed appropriately to resist the changing soil conditions. Volume changes of expansive soils also can result in the consolidation of soft clays following the lowering of the water table or the placement of fill.

The project site is underlain by soils in the Delhi and Tinnin series which have a very low clay content and are rated by the NRCS (Table 4.7-5) as non-plastic (i.e., no shrink-swell potential). Based on this information, there is a low potential for shrink-swell soils at the project site to cause damage to project structures. This impact is considered **less than significant**.

IMPACT 4.7-5 Geology, Soils, and Seismicity — Risk of Structural Damage Caused by Corrosive Soils. *The corrosiveness of on-site soils was not tested to determine whether the soils could cause damage to buried concrete slabs, concrete foundations and buried metal pipes during the operation of the proposed project. Therefore, without additional information, the potential exists for on-site structures to be corroded or otherwise damaged by the presence of corrosive soils. This impact is considered* ***potentially significant****.*

The consulting engineers did not conduct soil testing to evaluate the potential for corrosion. Consequently, no lab testing by a corrosion engineer has been completed, so no definitive conclusion can be reached regarding the soil corrosion potential. The consulting engineers recommend that additional analysis be conducted by a corrosion engineer to further define the soil corrosion potential or to design a cathodic protection system. Because corrosive soils could cause failures to underground structures over the long-term, potentially causing substantial risk to life and property, and because the consulting engineers recommend additional testing, this impact is considered **potentially significant**.

4.7.4 MITIGATION MEASURES

No mitigation measures are required for the following less-than-significant impacts:

Impact 4.7-4: Risks to People and Structures Resulting from Unstable Soil Conditions.

The following mitigation measures are provided for the potentially significant impacts:

Mitigation Measure 4.7-1: Risks to People and Structures Caused by Strong Seismic Ground Shaking.

a. Before contract bidding for project construction, the approved project design plans and specifications, including grading and foundation plans, shall be reviewed by a soils engineer approved by the City. This review shall be completed to assess whether the recommendations in the geotechnical report (prepared by Kleinfelder 2005) are sufficient for construction of the buildings described in the final project design plans. If these measures are deemed insufficient, the geotechnical engineer shall prepare a supplemental site-specific geotechnical report with appropriate recommendations sufficient to ensure the safety of project structures and site occupants. These measures could include, but are not limited to, the construction of deep foundations, installation of driven piles (if needed), and extra reinforcement of foundation slabs. At a minimum, these measures shall demonstrate that the proposed project design would meet CBC and City design standards.

b. During project design and construction, all measures outlined in the geotechnical report for the proposed project (Kleinfelder 2005) and, if necessary, measures included in supplemental site-specific geotechnical report(s), shall be implemented to ensure that project structures and site occupants would be safe during seismic events. These measures could include, but are not limited to, the construction of deep foundations, installation of driven piles (if needed, but not currently proposed), and extra reinforcement of foundation slabs. At a minimum, these measures shall demonstrate that the proposed design would meet CBC and City design standards.

c. The on-site soils will likely be saturated by rainfall in the winter and early spring months. If the construction schedule requires continued work during the wet months, the City shall require the applicant to consult with a qualified civil engineer and implement any additional recommendations provided, as conditions warrant. These measures could include, but are not limited to, the construction of deep foundations, installation of driven piles (if needed), and extra reinforcement of foundation slabs. At a minimum, these measures shall demonstrate that the proposed design would meet CBC and City design standards.

Mitigation Measure 4.7-2: Risks to People and Structures Caused by Seismic-Related Ground Failure. The applicant shall implement Mitigation Measure 4.7-1, described above, to reduce the seismic-related ground failure risks to people and structures at the proposed project site.

Mitigation Measure 4.7-3: Construction-Related Erosion Hazards.

a. A grading and erosion control plan shall be prepared by a California Registered Civil Engineer and submitted to the Manteca Department of Public Works prior to issuance of any grading permits. The plan shall be consistent with CBC grading requirements and shall include the site-specific grading proposed for the new development. The project applicant shall ensure that the construction contractor is responsible for securing a source of transportation and deposition of excavated materials.

b. BMPs for erosion and siltation prevention, as further described in Section 4.9, “Hydrology and Water Quality” of this document, shall be implemented at the project site during all construction activities. The project applicant shall consult with the Central Valley Regional Water Quality Control Board to acquire the appropriate regulatory approvals that may be necessary to obtain Section 401 water quality certification, State Water Board statewide NPDES stormwater permit for general construction activity, and any other necessary site-specific waste discharge requirements (WDRs) or waivers. As required under the NPDES stormwater permit for general construction activity, the project applicant shall prepare and submit the appropriate Notice of Intent (NOI) and prepare the SWPPP and any other necessary engineering plans and specifications for pollution prevention and control. The SWPPP and other appropriate plans shall identify and specify the use of erosion and sediment control BMPs, means of waste disposal, implementation of approved local plans, nonstormwater management controls, permanent postconstruction BMPs, and inspection and maintenance responsibilities. The SWPPP would also specify the pollutants that are likely to be used during construction that could be present in stormwater drainage and nonstormwater discharges. A sampling and monitoring program would be included in the SWPPP that meets the requirements of State Water Board Order 99-08-DWQ to ensure that the BMPs are effective.

c. Prior to issuance of grading permits, construction techniques shall be identified that would reduce the potential for runoff, and the grading and erosion control plan shall identify the erosion and sedimentation control measures to be implemented. The SWPPP shall also specify spill prevention and contingency measures, identify the types of materials used for equipment operation, and identify measures to prevent or clean up spills of hazardous materials used for equipment operation and hazardous waste. Emergency procedures for responding to spills shall also be identified. BMPs identified in the SWPPP shall be used in all subsequent site development activities. The SWPPP shall identify personnel training requirements and procedures that would be used to ensure that workers are aware of permit requirements and proper installation and performance inspection methods for BMPs specified in the SWPPP. The SWPPP shall also identify the appropriate personnel responsible for supervisory duties related to implementation of the SWPPP. All construction contractors shall retain a copy of the approved SWPPP on the construction site.

Mitigation Measure 4.7-5: Risk of Structural Damage Caused by Corrosive Soils. A design recommendation study for the proposed project site shall be completed by a qualified corrosion engineer before any grading permit is issued. The study shall specifically address corrosive soils where damage to underground facilities may occur and shall provide recommendations, if needed, that the project applicant shall implement. Potential methods to address corrosive soils include the use of cathodic protection or sacrificial anodes for buried metals, use of concrete with a lower water-to-cement ratio and/or sulfate-resistant concrete, and the use of Type II or Type II modified cement. Appropriate measures identified in the design-level study and approved by the City shall be implemented during project construction.

4.7.5 LEVEL OF SIGNIFICANCE AFTER MITIGATION

With implementation of the mitigation measures identified above, the project’s geology, soils, and seismicity impacts would be reduced to a less-than-significant level because of required completion of site-specific technical studies and implementation of construction and design measures developed in response to the studies. Implementation of these mitigation measures would also make the project consistent with the City’s general plan policies related to geology and soils (including policies S-P-1, S-P-2, S-P-3, S-P-5, and RC-P-10).