4.5 GEOLOGY AND SOILS

This section discusses the geology and soils of the project area and the potential risks associated with known geologic hazards, including seismic activity. The purpose of this section is to provide a general understanding of how project activities and future development may be affected by geologic hazards. This section assesses the potential impacts to geology and soils as a result of project implementation and includes mitigation measures to reduce potentially significant impacts. Cumulative impacts to geology and soils are also evaluated, as well as the project's contribution to such cumulative impacts. A discussion of policies and regulations related to geology and soils is provided. Information in this section is based on the *Geology, Soils, and Seismicity Technical Memorandum* prepared by Baseline Environmental Consulting (February 2008), included as **Appendix D**.

4.5.1 ENVIRONMENTAL SETTING

Regional Setting

The project area is located in California's Coast Range Geomorphic Province, a geologically young and seismically active region. The region includes ranges of low mountains and intervening valleys. The region is bisected by the active San Andreas Fault. The project area is located approximately 30 miles west of the fault on terraced coastline (see **Figure 4.5-1**).

Project Area Geology

The project area is located on the northwest side of a gently sloping valley formed by Canyon Del Rey. The project area is underlain by Quaternary marine coastal terrace deposits, which are semi-consolidated, moderately well-sorted marine sands containing thin, discontinuous gravel-rich layers. These deposits are covered by eolian wind-driven sand deposits. A stream flows through the floor of the valley into Laguna Grande and Roberts Lake, located southwest of the project area. Elevations of the project area range from approximately 20 feet in the southwest, closest to the ocean, to approximately 40 feet in the northeast. The soils in the project area are mapped as Baywood Sands; in general, soils in the City are characterized as medium-grained sand of low to moderate organic matter content, and excessively well drained.

Seismic and Geological Hazards

Seismicity

The broader region surrounding the project area is seismically active. The tectonic plate boundary between the North American and Pacific plates generates seismic activity in the region; this boundary is known locally as the San Andreas Fault Zone, which includes several active faults.

Surrounding faults in the local region include the western branches of the San Andreas, including the Chupines and Navy Faults, the San Gregorio Palo Colorado Fault Zone, the King City-Reliz-Riconada Fault, and the Zayante-Vergeles Fault (see **Figure 4.5-1**). All of these are considered 'active' (fault rupture in the last 11,000 years) or 'potentially active' (fault rupture in the past 1.6 million years). The closest faults to the Specific Plan Area are the Chupines Fault, located at the southwest edge of the project area northeast of Roberts Lake, and the Seaside Fault, located about 500 feet northeast of the project area (see **Figure 4.5-2**). The project area does not include any faults identified as Alquist-Priolo Earthquake Fault Zones.[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 major fault trace. The two nearest faults to the project area are considered "potentially active" (no activity in the last 11,000 years), therefore, there is a low potential for fault rupture in the project area.

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. Magnitude is a measure of the energy released by an earthquake; it is assessed by seismographs that measure the amplitude of seismic waves.

Intensity is a subjective measure of the perceptible effects of seismic energy at a given point and varies with distance from the epicenter and local geologic conditions. Intensity can be quantitatively measured using accelerometers (strong motion seismographs) that record ground acceleration at a specific location, a measure of force applied to a structure under seismic shaking. Acceleration is measured as a fraction or percentage of the acceleration under gravity (g).

Estimates of the peak ground acceleration have been made for the project area based on 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 peak horizontal acceleration (with a ten percent chance of being exceeded in the next 50 years) generated by any of the seismic sources potentially affecting the project area is estimated by the California Geological Survey at about 0.30g to 0.40g. The Seaside Local Hazard Mitigation Plan estimates this acceleration for the City of

[1] The Alquist-Priolo Act designates fault zones and prohibits the development of habitable structures on the surface of 'active' faults.

Seaside at 0.61 to 0.70g. These levels of estimated ground acceleration (between 0.35g and 0.7g) have the potential to cause serious damage to buildings, building collapse, damage to building foundations, and obvious cracks in the ground. Geologists consider there to be a high potential for this level of ground shaking in the project area.

Liquefaction

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 temporary 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.

The Monterey County 2004 General Plan indicates that the project area has a low potential for liquefaction, and indicates the potential is moderate just beyond the western project area boundary. The water table is expected to be within five feet of the ground surface (about the elevation of Laguna Grande) in the southwest portion of the project area, and about 15 feet below ground surface northeast of the project area.

Lateral Spreading

Lateral spreading is a form of horizontal displacement of soil toward an open channel or 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, resulting in gravitationally driven movement. Earthquake shaking leading to liquefaction of saturated soil can result in lateral spreading where the soil undergoes a temporary loss of strength.

The project area has a gently sloping topography, with Laguna Grande near the southwest boundary of the area. Portions of the project area with a higher water table may be susceptible to liquefaction hazards. Baywood Sand soils below the project area are susceptible to creating subsurface tunnels, known as piping, indicating that lateral movement and lateral spreading is a concern.

Expansive Soils

Expansion and contraction of volume can occur when expansive soils undergo alternating cycles of wetting (swelling) and drying (shrinking). During these cycles, the volume of the soil changes markedly. As a consequence of such volume changes, structural damage to buildings and infrastructure may occur if the potentially expansive soils were not considered in project design and during construction. The Baywood Sand soils below the project area are generally not expansive, so risks associated with expansive soils are anticipated to be low.

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: the nature of the underlying soil or bedrock; the geometry of the slope (height and steepness); rainfall; and the presence of previous landslide deposits. The project area is flat to very gently sloping with slopes of less than five percent. Therefore, landslide hazards are not expected.

Differential Settlement

Differential settlement, or subsidence, occurs if buildings or other improvements are built on low-strength foundation materials (including imported 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. The project area contains loose native sands and may be susceptible to differential settlement.

Subsidence and Collapse

Subsidence can occur in areas where the subsurface materials, such as limestone rock or salt deposits, are dissolved by fluid flow, creating subsurface voids that can collapse. Subsidence also occurs where natural resources are extracted, and soil grains compact. Decomposition of highly organic soils and seasonal drying of expansive clay soils can result in subsidence, which could damage buildings. Sandy soil in the project area is subject to piping; given a concentrated flow of water, low-strength conditions and collapse of the ground surface may follow.

Soil Erosion

Soil erosion is a natural process that can be caused by wind or water. Sand mining and loss of vegetation west of the project area has caused accelerated erosion along the coast. The Baywood Sand soils located beneath the project area are susceptible to wind erosion. Erosion of these soils could also be accelerated by loss of vegetation or an increase in channelized water runoff.

Runoff water quality is regulated by the National Pollutant Discharge Elimination System (NPDES) program (established through the Federal Clean Water Act); the NPDES program objective is to control and reduce pollutant discharges to surface water bodies. In California, the NPDES program is administered by the State Water Resources Control Board (State Board), with local oversight provided by the Regional Water Quality Control Boards (Water Boards).

Tsunami and Seiche

Large earthquakes can generate seismic sea waves, or tsunamis, which can cause damage along the coastline. Water waves called seiches can be generated on lakes and other inland bodies of water by seismic ground shaking.

According to the Seaside General Plan EIR (adopted in 2004), "much of the City of Seaside lies approximately 2,000 feet inland from the coastline, which should provide sufficient distance and protection from tsunamis." However, a July 2007 report by the Monterey Office of Emergency Services (OES) identified areas of potential risk in the event of a minor or major tsunami. This report identified several lower-lying portions of the City to be areas of concern in the event of a minor tsunami (less than 5 meters in height). These areas include Roberts Lake, Canyon Del Rey Boulevard, and associated lower-lying areas, including the site of the City Hall and the Seaside Police Department. The western edge of the project area is adjacent to this higher risk zone (i.e. the area is at risk even in the event of a relatively minor tsunami); Canyon Del Rey Boulevard roughly divides the area of higher risk (to the west) from the project area (to the east). Refer to **Section 4.7, Hydrology and Water Quality**, for further discussion of the impacts of tsunami and seiche in the project area.

4.5.2 Regulatory Setting

Seaside General Plan

The following goals, policies, and implementation plans from the 2004 Seaside General Plan are relevant to geology, soils, and seismicity issues:

Goal S-1: *Reduce the risks to people and property from hazards related to seismic activity, flooding, geologic conditions, and wildfires.*

Policy S-1.1: *Reduce the risks of impacts from seismic and geologic hazards.*

Implementation Plan S-1.1.1: CEQA

Assess development proposals for potential seismic and geologic hazards pursuant to the California Environmental Quality Act (CEQA). Require studies of soil and geologic conditions by state-licensed Engineering Geologists and Civil Engineers where appropriate. When potential geologic impacts are identified, require project applicants to mitigate the impacts per the recommendations contained within the soil and geologic studies. If substantial geologic/seismic hazards cannot be mitigated, require the development to be relocated or redesigned to avoid the significant hazards.

Implementation Plan S-1.1.2: Building Codes

As new versions of building and construction codes are released, adopt and enforce the most recent codes. Specifically, to minimize damage from earthquakes and other geologic activity, implement the most recent State and seismic requirements for structural design of new development and redevelopment.

Project Consistency

As identified in Mitigation Measure 4.5-1a in Section 4.5.3 below, the project will require proponents of future development projects within the project area to provide project-specific assessments performed by state-licensed geologists and specialists to identify potential seismic and geologic hazards and incorporate recommended mitigation measures into proposed projects. Additionally, all developments within the project area will be designed based on the most recent state seismic requirements and building codes, as stated in Mitigation Measure 4.5-2. These measures will ensure the reduction of potential risks to people and property resulting from seismic and geologic hazards. The project would therefore be consistent with the Seaside General Plan policies relevant to geology, soils, and seismicity.

4.5.3 Environmental Impacts and Mitigation Measures

Methodology

The analysis in this section is based on the *Geology, Soils and Seismicity Technical Memorandum*, included as **Appendix D**. The memo describes the geologic environment of the project area based on site reconnaissance and published and unpublished regional geologic reports and maps. The report also assesses the potential impacts related to geological hazards and identified appropriate mitigation measures for impacts.

Significance Criteria

Under Appendix G of the *CEQA Guidelines*, the project would have a significant impact on geology and soils if it would:

a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

i) 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;

ii) Strong seismic ground shaking;

iii) Seismic-related ground failure, including liquefaction; and/or

iv) Landslides;

b) Result in substantial soil erosion or the loss of topsoil;

c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse;

d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property; or

e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water.

Issues Not Discussed Further

Alquist-Priolo Earthquake Fault Zones

As discussed previously, the project area does not include any faults identified as Alquist-Priolo Earthquake Fault Zones. Therefore, the project would not expose people or structures to potential substantial adverse effects from these types of earthquake fault zones.

Expansive Soils

Expansive soils, as their name implies, are soils that swell when subjected to moisture. These soils typically contain clay minerals that attract and absorb water. The soils in the project area are mapped as Baywood Sands, which are generally not expansive because of their inability to absorb water. Development upon Baywood Sands would be subject to a less than significant risk with regard to expansive soils. Therefore, this issue is not discussed further.

Soils Incapable of Supporting Alternative Waste Water Systems

The project area would be served by the Seaside County Sanitation System. Future developments would not rely on septic tanks or other alternative waste water disposal systems, as the urbanized nature of the proposed development necessitates the use of municipal wastewater collection and treatment systems (see **Section 4.14, Utilities**). Therefore the issue of whether soils could or could not support septic system is moot; this issue is not discussed further in this EIR.

Landslides

The project area is flat to very gently sloping, with slopes of less than five percent. There is no history of landslides in the City of Seaside. As such, there is considered to be a negligible level of risk related to landslides. Therefore, this issue is not discussed further.

Project Impacts

Impact 4.5-1: Development envisioned by the project could expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death related to strong seismic shaking and liquefaction resulting in lateral spreading. (Significant)

It is likely that the project area will experience at least one major earthquake in the next 30 years. The intensity of the event would depend on the location of the ruptured fault and epicenter, the magnitude, duration of shaking and surrounding soil qualities. In the project area, such an event could potentially result in soil liquefaction, lateral spreading, and piping, or

soil erosion, due to saturated Baywood Sands soils beneath the project area, which would be a significant impact.

Mitigation Measure 4.5-1a: Prior to the issuance of any building permits for construction within the project area, applicants of future development projects shall perform an assessment for potential seismic and geologic hazards. The assessment shall include a geotechnical report prepared by state-licensed Engineering Geologist and/or Civil Engineer. The recommendations contained in such geotechnical reports shall be reviewed and approved by the City of Seaside, Building Official and incorporated into grading and/or building plans for proposed development within the project area.

Mitigation Measure 4.5-1b: All developments within the project area shall be constructed in accordance with the most recent building codes and the most recent state seismic requirements for structural design of new development and redevelopment. Some general construction type options with good seismic energy absorbing properties include, but are not limited to:

- Wood or timber frame;
- Reinforced masonry walls;
- Reinforced concrete walls; and
- Steel frame with masonry fill-in walls.

Significance After Mitigation: Less than Significant.

Impact 4.5-2: Development envisioned by the project could generate substantial soil erosion or the loss of topsoil due to the demolition of existing buildings and land clearance activities. (Significant)

Development associated with the project is likely to entail demolition and land clearance activities. These construction related activities have the potential to adversely effect the quality of stormwater, should the eroded soils and other materials get carried into the nearby waterways via stormwater run-off. The mitigation measures below would minimize the potential erosion of soils during the construction of the project. Other potential project-related impacts to water quality are further discussed in **Section 4.7, Hydrology and Water Quality**.

Mitigation Measure 4.5-2: Future development in the project area would be subject to water quality control measures associated with the required NPDES program elements, as enforced by the State Water Resources Control Board (Water Board) and the City Resource Management Services Department, during both construction and operation activities. As development under the Specific Plan begins, implementation of a Storm Water Pollution Prevention Plan (SWPPP), Best Management Practices (BMPs), and on-going maintenance and monitoring activities associated with the NPDES sub-program would reduce impacts from erosion to a less than significant level, as described below.

Projects disturbing more than one acre of land during construction are required to file a Notice of Intent (NOI) with the Water Board to be covered under the state NPDES General

Construction Permit for Discharges of Storm Water associated with Construction Activity (NPDES General Permit No. CAS000002). Proponent of such projects must develop a SWPPP to be implemented at each site covered under the State General Permit. The SWPPP must included BMPs that propose erosion control measures consistent with the State General Permit, which are designed to reduce potential impacts to surface water quality through the construction period. These erosion control BMPs may include a combination of bale or rock ditch checks, silt fence barriers, temporary seeding, erosion-control blankets, etc. The Construction Program is largely "self-implemented" (i.e., typically no direct oversight is provided by the Water Board). Additional measures, that may include document reviews and site inspections during construction, are required under the Municipal Program.

Significance After Mitigation: Less than Significant.

Impact 4.5-3: The project area is located on a geologic unit or soil that could become unstable as a result of potential future construction activities, and potentially result in subsidence, collapse, or differential settlement. (Significant)

Future development activities in the project area could be located on soils that could become unstable. A concentrated flow of water to sandy soils in the project area could result in piping and probable collapse of the ground surface.

Future projects are likely to require grading activities, and may involve new or redevelopment projects that span old building footprints and combined parcels with historically different uses. Fills of different thickness and fills adjacent to cut areas could create the potential for differential settlement. Construction on uncompacted and loose fill, if present, would be subject to varying rates of settlement. If the settlement is not uniform, structural damage could occur. Buried utilities may also experience differential settlement along their alignments. Structures built over discontinuous materials of varying densities and compactness may be subject to stress or damage due to differential settlement.

Mitigation Measure 4.5-3: The City Resource Management Services Department shall require that applicants for future development in the project area perform an assessment of the potential for differential settlement. A site-specific geologic conditions report shall be prepared for future projects in the project area. Recommendations from a licensed engineering geologist or civil engineer contained in the geologic report shall be incorporated as conditions of project approval. Geologic recommendations may cover one or more of the following topics, depending on the nature of the site:

- foundation strength characteristics of soil and rock;
- excavations and earthwork;
- slopes and slope stability;
- suitability of materials for use;
- surface and subsurface drainage;

- management of vegetation;
- temporary sediment control; and
- relevant regulatory issues.

The California Building Code (CBC) recommends that geologic reports include evaluations of conditions that could lead to differential settlement and provide for project-level mitigations in the report.

Significance After Mitigation: Less than Significant.

Cumulative Impacts

The cumulative area for geology and soils impacts is the project area and the remainder of the City of Seaside. The methodology used for evaluating cumulative impacts related to geology and soils utilizes the 2004 Seaside General Plan and General Plan EIR. The General Plan EIR concluded that increased development in the City would increase the number of people exposed to the area's known seismic hazards. However, conformance with the Uniform Building Code and related measures intended to maintain building safety during a seismic event would reduce this cumulative impact to a less than significant level. Impacts to geology and soils associated with the project would also be fully mitigated and not result in significant impacts. All impacts would therefore be reduced to less than significant levels and there would be no cumulative impact to geology and soils.