4.5 GEOLOGY AND SOILS

This EIR section analyzes the potential for adverse impacts on existing geologic and soil conditions resulting from implementation of the proposed project. The Initial Study (Appendix A) identified the potential for impacts associated with hazards that would result from strong seismic groundshaking; seismic-related ground failure, including liquefaction; potential erosion from project construction activities; development on an unstable geologic unit; and development on expansive soil.

Issues scoped out from detailed analysis in the EIR include: rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map[1]; exposure of people or structures to hazards related to landslides; and development on soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems.

Data used to prepare this section were taken from the City's General Plan Environmental Hazards Element, a Preliminary Soils Report for the proposed project prepared by Lawson & Associates Geotechnical Consulting, Inc. (LGC; included as Appendix G to this EIR), and a Feasibility Geotechnical Assessment Report prepared for the proposed project by PETRA Geotechnical, Inc. (Petra; included as Appendix F to this EIR).

4.5.1 Existing Conditions

The project site is located in the southeastern portion of the City of Huntington Beach, California. It rests on relatively level land and is essentially void of significant improvements with the exception of perimeter fencing. In addition, the northeast corner of the project site is currently occupied by an asphalt concrete paved RV/Boat Storage area.

Geologic Setting

The Huntington Beach area, including the project site, lies within the northern/northwestern portion of the Peninsular Ranges Geomorphic Province of Southern California, which is characterized by northwest-southeast trending faults, folds, and mountain ranges. During the time from the late Pliocene to the Pleistocene epochs (3.4 to 1.6 million years ago), activities along the Newport-Inglewood fault zone, combined with regional tectonic effects (such as uplift), climatic forces, and changes in sea level, have resulted in the formation of the underlying basement materials and structure that underlay and support the project site. The forces that have created the geomorphology of the project site and vicinity are still active today.

Much of the regional area of the project site is underlain by terrace deposits, which are unconsolidated sediments (i.e., loose soil materials, such as sand, silt, etc.) left by streams on shore benches cut by the ocean. These deposits were laid in a shallow marine to near-shore terrestrial environment in the Pleistocene time frame (about 2 million to about 10 thousand years ago). In late Pleistocene time, the

1

action of coastal plain rivers/streams dissected the terrace materials and subsequently formed "gaps." As sea levels subsequently rose with the melting of continental ice sheets, sediments filled these gaps. Geomorphically, the site is situated in the coastal plain of Orange County within the Talbert Gap (also known as the Santa Ana Gap) between Huntington Beach Mesa on the northwest and the Costa Mesa on the southeast.

Soil and Groundwater Conditions

Generally, the project site and surrounding areas are underlain by Holocene-age alluvial materials derived from sediments deposited along the Santa Ana River across the Orange County coastal plain from Alamitos Bay to Newport Bay. The site is underlain by alluvial deposits consisting generally of interlayered silts, sandy silts, clays, silty clays and high-plasticity organic clays, with occasional layers and/or lenses of sand and silty sand. In addition, within the paved portion of the site (the RV/Boat Storage area), the native soils are overlain by approximately four inches of asphalt concrete (Petra 2005).

Previous environmental remediation operations have resulted in the placement of artificial fill (approximately 11,000 cubic yards) within various portions of the project site, particularly in areas that were previously occupied by aboveground and underground storage tanks. The 11,000 cubic yards of imported fill have not yet been formally compacted (City of Huntington Beach 2005).

During previous subsurface investigations, groundwater at the project site was generally encountered approximately three to nine feet below ground surface level. However, groundwater levels in the project area typically fluctuate based on seasonal rainfall patterns and tidal conditions, and may differ considerably at the time of construction of the proposed development. According to information provided in the published Seismic Hazard Zone Report for the Newport Beach 7.5-minute quadrangle, a historical high groundwater elevation of three feet below ground surface may be assumed for the area of the project site (Petra 2005). Cross sections in the 2002 Remedial Action Plan for the site (completed due to former petroleum-related uses onsite) indicate that the direction of groundwater flow near the coast tends to be towards inland (Targhee 2002).

Faulting

The project site is in a seismically active area of Southern California. Major regional faults are shown in Figure 4.5-1, and local faults are shown in Figure 4.5-2. Faults may be categorized as active, potentially active, or inactive. Active faults are those that show evidence of displacement within the last 11,000 years; potentially active faults are those that show evidence of displacement during the last 1.6 million years. Faults showing no evidence of displacement within the last 1.6 million years are considered inactive for most purposes.

Surface displacement can be recognized by the existence of cliffs in alluvium, terraces, offset stream courses, fault troughs and saddles, the alignment of depressions, sag ponds, and the existence of steep mountain fronts. Earthquake fault zones have been delineated along the traces of active faults within California. Where developments for human occupation are proposed within these zones, the state requires detailed fault investigations be performed so that engineering geologists can mitigate the hazards

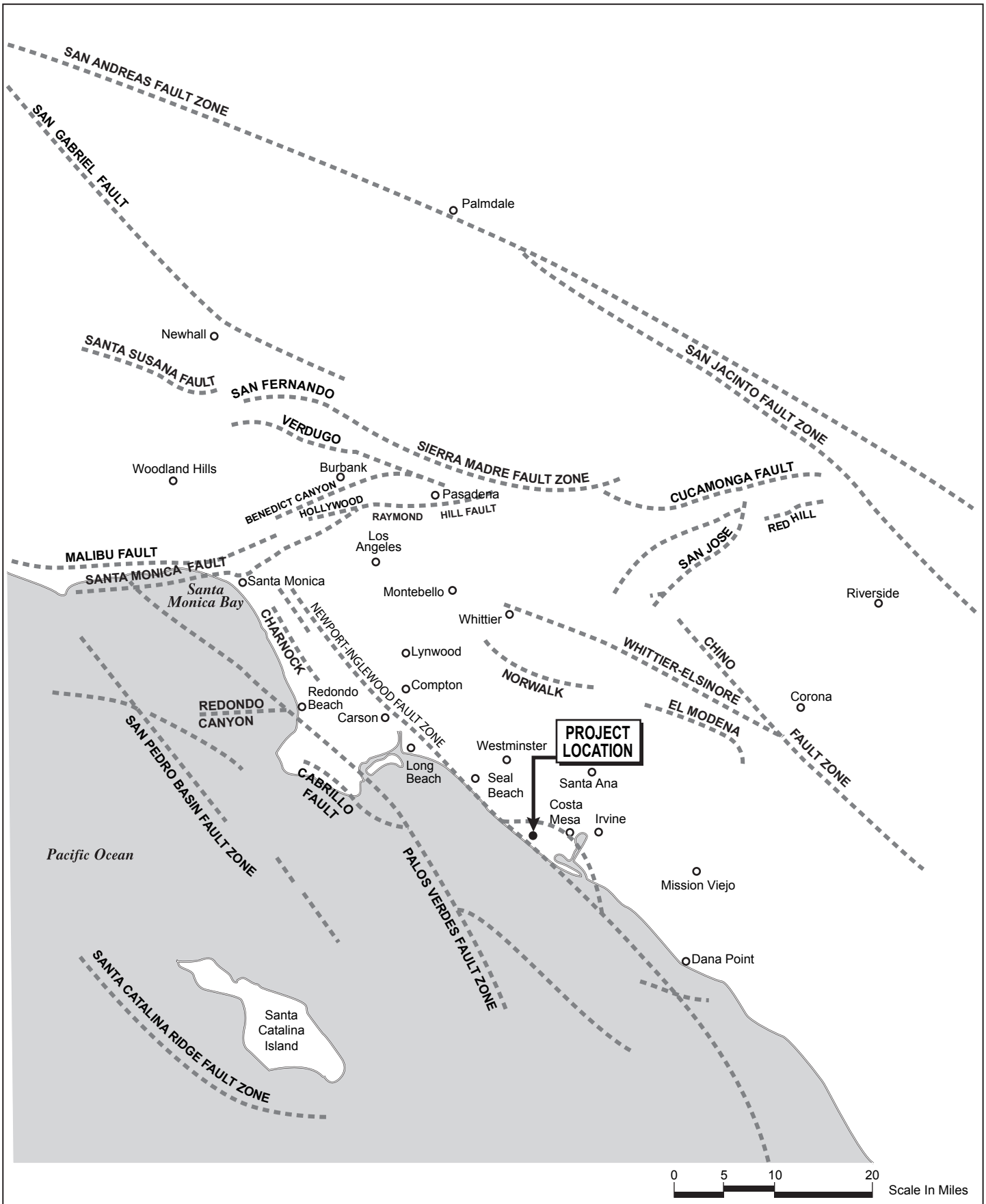

FIGURE **4.5-1**

Major Regional Faults

Source: EIP Associates, 2006

City of Huntington Beach

11034-00

EIP ASSOCIATES

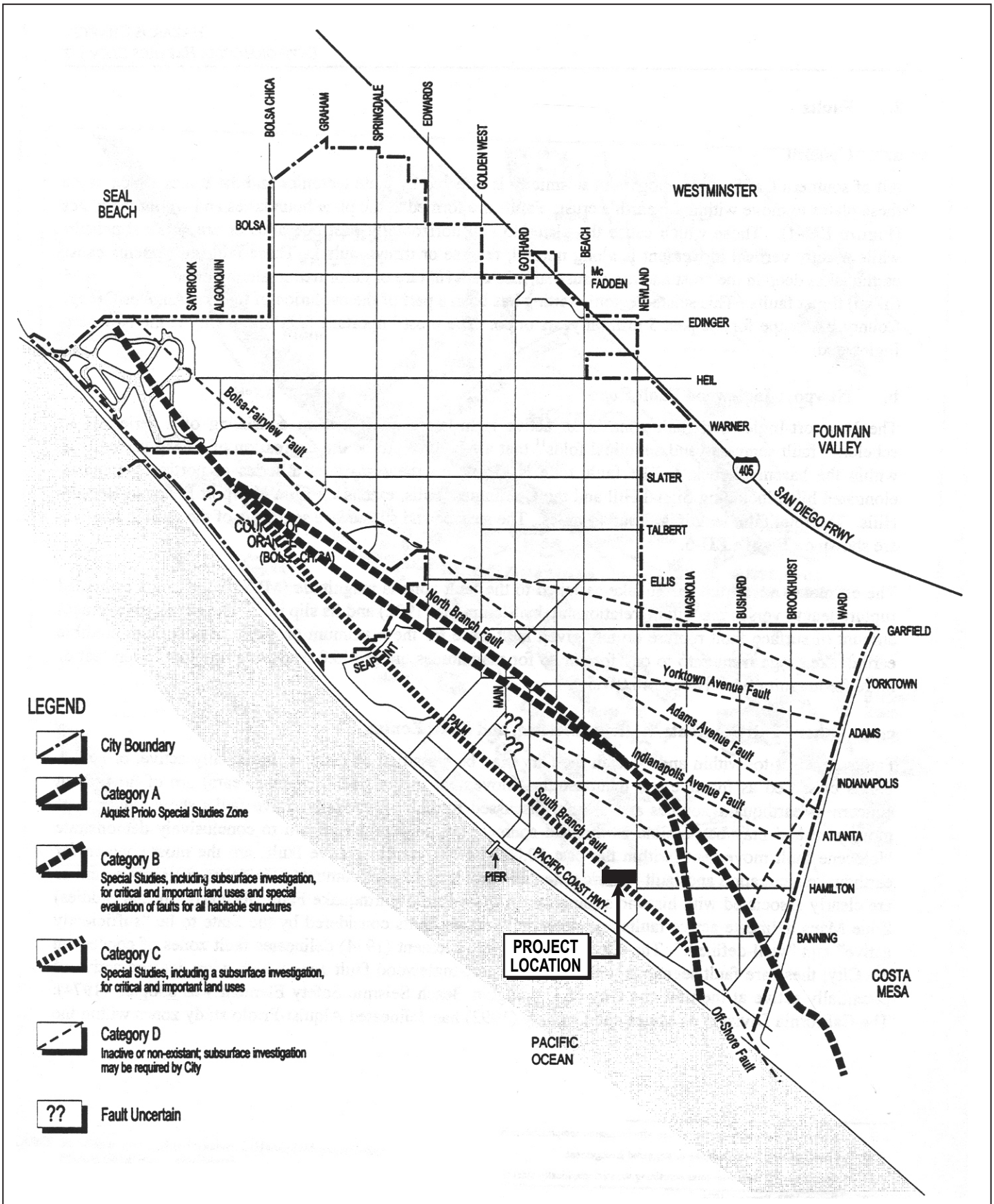

FIGURE **4.5-2**

Local Faults

Not to Scale

11034-00

Source: City of Huntington Beach General Plan

City of Huntington Beach

EIP ASSOCIATES

associated with active faulting by identifying the location of active faults and allowing for a setback from the zone of previous ground rupture.

The project site is in the Newport-Inglewood structural zone. This zone has also been described as a fault zone[2] of sub-parallel fault segments and folds extending about 40 miles from the Santa Monica Mountains to Newport Beach where it continues offshore, more or less parallel to the coastline, for at least another 30 miles. The fault zone is about two miles wide in Huntington Beach. The Alquist-Priolo Earthquake Fault Zoning Act designates some of the segments of this structural zone as earthquake fault zones, but not the segment projected to pass beneath the project site.

The City of Huntington Beach General Plan indicates that a concealed southeast-trending projection of the southern branch of the Newport-Inglewood fault traverses the central portion of the site. According to the Petra (2005) review of Fault Evaluation Reports (FERs 172 and 173) for the Newport-Inglewood structural zone published by the California Geological Survey (CGS) in 1986 and 1985 (then known as the California Division of Mines and Geology), it appears the location of the fault shown transecting the project site was based primarily on oil drilling data. Those data indicate this feature occurs at depth and does not reach the upper 1,000 feet of sediments beneath the project site. More recent fault trenching studies performed on fault traces in the vicinity of the project site indicate that the south branch of the Newport-Inglewood structural zone (containing the segment projected to pass beneath the project site) may not be a fault at all and that if it is a fault, it does not appear to offset late Pleistocene deposits. Consequently, it is not considered active and it is not included in an Alquist-Priolo Earthquake Fault Zone. Petra's report also notes that the Newport-Inglewood structural zone has not been identified clearly in the region of the property, specifically across the Santa Ana River drainage, and that the southern branch of the fault zone in this area may in fact represent a number of relatively short, laterally discontinuous faults that have not yet been positively identified. Thus, unknown associated faults may exist in this region.

Historic Seismicity

A listing of historical earthquakes published by the National Earthquake Information Center indicates that the largest earthquake occurring within a radius of approximately 100 miles (160 kilometers) of the site was the Magnitude 7.3 Landers earthquake in 1992, approximately 155 kilometers to the northeast of the subject property. On the same day in 1992, the Magnitude 6.4 Big Bear earthquake occurred approximately 122 kilometers north of the project site. The maximum historic site acceleration in the project region was estimated to be 0.4 g in 1933, caused by an earthquake of $6.3M_w$ on the Newport Inglewood Fault.

[2] The terms "structural zone" and "fault zone" are used interchangeably for the Newport-Inglewood fault zone by the California Geological Survey, the US Geological Survey, and several county and city agencies in southern California. However, there are additional geologic structures (folds, lineaments, etc.) in the zone other than faults.

Seismic Hazards

Groundshaking

The major cause of structural damage from earthquakes is groundshaking. The intensity of ground motion expected at a particular site depends upon the magnitude of the earthquake, the distance to the epicenter, and the geology of the area between the epicenter and the property. Greater movement can be expected at sites located on poorly consolidated material, such as alluvium, within close proximity to the causative fault, or in response to an event of great magnitude. Because the southern branch of the Newport-Inglewood structural zone may traverse the central portion of the project site, the project site could experience substantial groundshaking if a seismic event occurred along the fault. Although the probability of primary surface rupture is considered low, groundshaking hazards caused by earthquakes along regional active faults do exist and should be taken into account in the design and construction of the proposed project within the project site. The maximum magnitude earthquake expected to be produced on the Newport-Inglewood Fault is 6.9 (Petra 2005). Damage from an earthquake of this range in intensity could include general damage to foundations, shifting of frame structures if not bolted, and breaking of underground pipes.

Liquefaction

Liquefaction is a seismic phenomenon in which loose, saturated, granular soils behave similarly to a fluid when subject to high-intensity groundshaking. Liquefaction occurs when three general conditions exist: (1) shallow groundwater; (2) low density non-cohesive (granular) soils; and (3) high-intensity ground motion. In general, saturated, loose to medium dense, near surface granular soils exhibit the highest liquefaction potential, while dry, dense soils exhibit low to negligible liquefaction potential. Effects of liquefaction on level ground include: settlement, sand boils, and bearing capacity failures below structures. Dynamic settlement of dry sands can occur as the sand particles tend to settle and densify as a result of a seismic event.

The site is underlain by alluvial deposits consisting generally of interlayered silts, sandy silts, clays, silty clays and high-plasticity organic clays, with occasional layers and/or lenses of sand and silty sand. The presence of granular soil layers, together with a shallow historic high groundwater level (approximately 3 feet below the ground surface) and nearby fault systems that are considered capable of causing strong ground motion, render the site susceptible to a relatively high degree of liquefaction and dynamic settlement (Petra 2005). In addition, the project site is located within a Liquefaction Hazard Zone, as designated by the California Division of Mines and Geology (Petra 2005). The City's Environmental Hazards Chapter of the General Plan also identifies the site as having a very high liquefaction potential. It is anticipated that seismically induced settlements on the order of two inches may occur as a result of liquefaction (LCG 2005).

Seismically Induced Settlement

Settlement is defined as areas that are prone to different rates of surface settling and densification (differential compaction), and are underlain by sediments that differ laterally in composition or degree of

existing compaction. Differential settlement can damage structures, pipelines, and other subsurface entities. Strong groundshaking can cause soil settlement by vibrating sediment particles into more tightly compacted configurations, thereby reducing pore space. Unconsolidated, loosely packed alluvial deposits and sand are especially susceptible to this phenomenon. Poorly compacted artificial fills also may experience seismically induced settlement.

In addition to seismically induced settlement potential, the project site would experience settlement of existing clay soils due to the weight of buildings and the proposed fill (to raise building pads out of the floodplain).

Lateral Spreading

Lateral spreading is the horizontal movement of loose, unconfined sedimentary and fill deposits during seismic activity, often directly resulting from liquefaction events. Lateral spreading typically occurs as a form of horizontal displacement of relatively flat-lying alluvial material toward an open or "free" face, such as an open body of water or channel. This movement may often be associated with liquefaction.

The project site is adjacent to the Huntington Beach Channel. Based on the characteristics of the onsite soils, groundwater levels, and potential for seismically induced ground acceleration, there is a potential for lateral spreading in the southwest corner of the site, the area closest to the Huntington Beach Channel. The effects of lateral spreading may extend up to a distance of 100 feet from the channel wall, according to soil samples analyzed by LGC.

Subsidence

Land subsidence is the condition where the elevation of a land surface decreases due to the withdrawal of fluid. The location of major oil drilling areas and state-designated oil fields are areas with subsidence potential in the City of Huntington Beach. However, according to the City's General Plan, the site is not within an area that has been impacted by long-term subsidence due to local oil extraction.

Expansive and Collapsible Soils

Expansive soils have a significant amount of clay particles that can give up water (shrink) or take on water (swell). The change in volume exerts stress on buildings and other loads placed on these soils. The occurrence of these soils is often associated with geologic units having marginal stability. Expansive soils can be widely dispersed, found in hillside areas as well as low-lying areas in alluvial basins. Soils testing to identify expansive characteristics and appropriate mitigation measures are now routinely required by grading and building codes. As determined by LGC, onsite soils exhibit high expansion potential. In addition, the City's General Plan identifies the project site as having a moderate to high (20 to 42 percent) potential for expansive soils.

Collapsible soils undergo a rearrangement of their grains, and a loss of cementation, resulting in substantial and rapid settlement under relatively low loads. Soils prone to collapse are commonly associated with man-made fill, wind-lain sands and silts, and alluvial fan and mudflow sediments

deposited during flash floods. Examples of common problems associated with collapsible soils include tilting floors, cracking or separation in structures, sagging floors, and nonfunctional windows and doors. However, it was determined by LGC that the collapse potential of underlying soils at the project site is negligible.

Soil Erosion

Soil erosion is the process by which soil particles are removed from a land surface by wind, water, or gravity. Topsoil is the uppermost layer of soil, usually the top six to eight inches. Topsoil has the highest concentration of organic matter and microorganisms, and is where most biological soil activity occurs. Plants generally concentrate their roots in, and obtain most of their nutrients from, this layer. Topsoil erosion is of concern when the topsoil layer, which supports plant life, is blown or washed away. Most natural erosion occurs at slow rates; however, the rate of erosion increases when land is cleared or altered and left in a disturbed condition. The majority of the project site is currently vacant, graded soil. The project site was previously graded as part of a soil remediation program. As a result of the previous industrial uses and extensive soil disturbance, the graded soil portion of the site supports minimal vegetation.

Methane

The project site is located within a Methane Overlay District identified in the City's General Plan. As such, the Huntington Beach Fire Department requires the developer to implement a site soils testing plan at the project site (City Specification 429), after the plan has been reviewed by the Fire Department, to determine the presence of methane gas and/or soil contamination. Potential impacts related to methane gas are discussed in Section 4.6 (Hazards and Hazardous Materials).

4.5.2 Regulatory Framework

State

Alquist Priolo Earthquake Fault Zoning Act

The state legislation protecting the population of California from the effects of fault-line ground-surface rupture is the Alquist-Priolo Earthquake Fault Zoning Act. In 1972, California began delineating Earthquake Fault Zones (called Special Studies Zones prior to 1994) around active and potentially active faults to reduce fault-rupture risks to structures for human occupancy. This Act has resulted in the preparation of maps delineating Earthquake Fault Zones to include, among others, recently active segments of the Newport-Inglewood structural zone. The Act provides for special seismic design considerations if developments are planned in areas adjacent to active or potentially active faults. The project site is not crossed by the Alquist-Priolo Earthquake Fault Zones delineated along traces of the Newport-Inglewood structural zone. The closest active trace is approximately 2,300 feet north of the project site.

California Building Code

California Code of Regulations (CCR), Title 24, Part 2, the California Building Code (CBC), provides minimum standards for building design in the state. The CBC is based on the current Uniform Building Code, but contains Additions, Amendments and Repeals that are specific to building conditions and structural requirements in the State of California. Local codes are permitted to be more restrictive than Title 24, but are required to be no less restrictive. Chapter 16 of the CBC deals with General Design Requirements, including (but not limited to) regulations governing seismically resistant construction (Chapter 16, Division IV) and construction to protect people and property from hazards associated with excavation cave-ins and falling debris or construction materials. Chapters 18 and A33 deal with site demolition, excavations, foundations, retaining walls, and grading, including (but not limited to) requirements for seismically resistant design, foundation investigations, stable cut and fill slopes, and drainage and erosion control. Construction activities are subject to occupational safety standards for excavation, shoring, and trenching as specified in Cal-OSHA regulations (CCR, Title 8). The City of Huntington Beach has adopted the 2001 CBC as the Huntington Beach Building Code (Title 17, Chapter 17.04 of the Huntington Beach Municipal Code). Additional requirements have been adopted in the City of Huntington Beach Grading and Excavation Code (Title 17, Chapter 17.05 of the Huntington Beach Municipal Code).

Among other things, the CBC defines different building regions in the state and ranks them according to their seismic hazard potential. There are four types of these regions: Seismic Zones 1 through 4, with Zone 1 having the least seismic potential and Zone 4 having the highest seismic potential. The project site is in Seismic Zone 4, as is about 45 percent of California. Accordingly, any future development would be required to comply with all design standards applicable to Seismic Zone 4, the most stringent in the state.

NPDES Phase I (General Construction Activity Stormwater Permit)

As discussed in further detail in Section 4.7 (Hydrology and Water Quality), a Stormwater Pollution Prevention Plan (SWPPP) prepared in compliance with an National Pollutant Discharge Elimination System (NPDES) Phase I Permit describes the project site, erosion and sediment controls, runoff water quality monitoring, means of waste disposal, implementation of approved local plans, control of sediment and erosion control measures and maintenance responsibilities, and non-stormwater management controls. Dischargers are also required to inspect construction sites before and after storms to identify stormwater discharge from construction activity, and to identify and implement controls where necessary.

Seismic Hazards Mapping Act

The CGS provides guidance with regard to seismic hazards. Under CGS *Seismic Hazards Mapping Act*, seismic hazard zones are identified and mapped to assist local governments in land use planning. The intent of this Act is to protect the public from the effects of strong groundshaking, liquefaction, landslides, ground failure, or other hazards caused by earthquakes. In addition, CGS Special Publication 117, Guidelines for Evaluating and Mitigating Seismic Hazards in California, provides

guidance for the evaluation and mitigation of earthquake-related hazards for projects within designated zones of required investigations. The project site is in a CGS Liquefaction Hazards Investigation Zone.

Regional

Southern California Association of Governments

SCAG's Regional Comprehensive Plan and Guide (RCPG) and RHNA are tools for coordinating regional planning and development strategies in southern California. Policies contained in the RCPG that could be relevant to the proposed project are identified below with an assessment of the proposed project's consistency with these policies.

Policy 3.22 Discourage development, or encourage the use of special design requirements, in areas with steep slopes, high fire, flood, and seismic hazards.

Policy 3.23 Encourage mitigation measures that reduce noise in certain locations, measures aimed at preservation of biological and ecological resources, measures that would reduce exposure to seismic hazards, minimize earthquake damage, and to develop emergency response and recovery plans.

Consistency Analysis

The proposed project site is considered to have a high to very high potential for liquefaction; however, development on the project site would be subject to the requirements of Chapter 16 of the UBC (as amended) and Chapter 23 of the CBC (as amended), which includes specific design requirements for seismic hazards. Additionally, as described further in Impact 4.5-1, CR 4.5-1(a) and MMs 4.5-1(a) and (b), require the incorporation of site preparation and structural design recommendations from the geotechnical report into the project to ensure that impacts to project structures would be less than significant.

The proposed project includes city requirements and mitigation measures, where necessary, to reduce potentially significant environmental impacts including, but not limited to, noise, biological resources, and geology and soils to less-than-significant levels. Consequently, implementation of the proposed project would not conflict with these policies.

Local

The City of Huntington Beach advances public safety and welfare in the City through its General Plan and compliance with applicable local regulations in the Huntington Beach Municipal Code. General Plan policies specific to geologic, soil, and seismic hazards are listed in the Environmental Hazards Element. In addition, site development work in the City is required to comply with the Huntington Beach Building Code and all State requirements pertaining to geologic, soil, and seismic hazards.

General Plan Environmental Hazards Element

The Environmental Hazards Element identifies various policies addressing natural and human-related hazards and the potential methods to reduce risks associated with those hazards. The discussion below identifies goals and objectives presented in the Environmental Hazards Element of the General Plan related to geologic resources that are potentially relevant to the proposed project.

Goal EH 1 Ensure that the number of deaths and injuries, levels of property damage, levels of economic and social disruption, and interruption of vital services resulting from seismic activity and geologic hazards shall be within acceptable levels of risk.

Objective EH 1.1 Ensure that land use planning in the City accounts for seismic and geologic risk, including groundshaking, liquefaction, subsidence, soil and slope stability, and water table levels.

Policy EH 1.1.4 Evaluate the levels of risk based on the nature of the hazards and assess acceptable risk based on the human, property, and social structure damage compared to the cost of corrective measures to mitigate or prevent damage.

Objective EH 1.2 Ensure that new structures are designed to minimize damage resulting from seismic hazards, ensure that existing unsafe structures are retrofitted to reduce hazards and mitigate other existing unsafe conditions.

Policy EH 1.2.1 Require appropriate engineering and building practices for all new structures to withstand groundshaking and liquefaction such as stated in the Uniform Building Code.

Goal EH 4 Eliminate, to the greatest degree possible, the risk from flood hazards to life, property, public investment and social order in the City of Huntington Beach.

Objective EH 4.1 Ensure that the City's flood prevention standards and practices provide satisfactory safeguards for public and private development.

Policy EH 4.1.1 During major redevelopment or initial construction, require specific measures to be taken by developers, builders, or property owners in flood prone areas, to prevent or reduce damage from flood hazards and the risks upon human safety.

Consistency Analysis

The structures proposed by the project would be constructed in accordance with applicable provisions of the Huntington Beach Building Code regarding seismic hazards and structural design. The project would incorporate the required site preparation and structural design recommendations included in the geotechnical report prepared for the project site. The report would be required to address all potential geotechnical issues at the site, including groundshaking and liquefaction. The incorporated measures

would ensure that earthquake survivability is a primary concern in the design and construction of the proposed project. The project site is in an existing floodplain and implementation of the proposed residential development would require an increase of the project site elevation, by approximately three to five feet above existing grade via import of fill soil, to comply with FEMA regulations. Therefore, implementation of the proposed project would not conflict with these applicable policies.

City of Huntington Beach Municipal Code

Building Code and Grading and Excavation Code

Site development in the City of Huntington Beach is required to comply with the Huntington Beach Building Code and all State requirements pertaining to geologic, soil, and seismic hazards. The California Building Code (CBC) has been incorporated and adopted into the Huntington Beach Building Code. The CBC, discussed previously under State regulations, is adopted by the City as Chapter 17.04, Building Code, of the Municipal Code. The Building Code, as adopted, includes minor variations to the CBC related to minimum slab thickness, fire-extinguishing systems, building security, and methane district regulations. The Grading and Excavation Code (adopted by the City as Chapter 17.05, Grading and Excavation Code, of the Municipal Code) sets forth rules and regulations to control excavation, grading, earthwork and site improvement construction and establishes administrative requirements for issuance of permits and approvals of plans and inspection of grading construction. Specifically, the Grading and Excavation Code identifies, defines, and regulates hazardous conditions, plans and specifications, soils and geology reports, fills, setbacks, drainage and terracing, asphalt concrete pavement, and erosion control systems.

4.5.3 Project Impacts and Mitigation

Analytic Method

Widely available industry sources were examined to document regional and local geology. Information regarding regional geology and seismically induced hazards was taken from various sources of the CGS and the USGS. Project-specific geologic information, soil characteristics, and liquefaction potential were obtained from LGC's Preliminary Soils Report and Petra's Feasibility Geotechnical Assessment Report prepared for the project site. Estimated maximum earthquake magnitudes resulting from potential seismic activity on various active faults in the area were obtained from previous environmental documentation prepared for projects in the general vicinity. Where potential geological hazards are identified on the project site, such hazards are expected to affect the proposed project and any potential development. The following analysis considers the potential effects of components of the proposed project described in Chapter 3 (Project Description).

Thresholds of Significance

Implementation of the proposed project could result in potentially significant impacts if the project would do the following:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving
  - Strong seismic groundshaking
  - Seismic-related ground failure, including liquefaction
- 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
- Be located on expansive soil, as defined in Table 18-1-A of the California Building Code (2001), creating substantial risks to life or property
- Result in substantial soil erosion or the loss of topsoil

Impacts and Mitigation Measures

Threshold	Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving: ■ Strong seismic groundshaking? ■ Seismic-related ground failure, including liquefaction?

Impact 4.5-1 **Project implementation could expose people or structures on-site to strong seismic groundshaking and seismic-related ground failure, including liquefaction.**

The project site is susceptible to strong seismic groundshaking in the event of an earthquake. The maximum magnitude earthquake that could be generated by the nearby Newport-Inglewood Fault is estimated to be approximately Moment Magnitude[3] (M_W) 6.9. Damage from an earthquake of this range in intensity could include general damage to foundations, shifting of frame structures if not bolted, and breaking of underground pipes. In addition, active and potentially active regional faults are capable of producing seismic shaking at the project site, and it is anticipated that the project site would periodically experience ground acceleration as a result of exposure to small and moderate magnitude earthquakes occurring on active distant and blind thrust faults.

In order to reduce the risks associated with seismically induced groundshaking, the design of foundations and structures must consider the location and type of subsurface materials on the project site. Because the project site is in Seismic Zone 4, structures are required to be designed in accordance with applicable parameters of the current CBC. Specific engineering design and construction measures required by the CBC for the construction of new buildings and/or structures would be implemented to anticipate and avoid the potential for adverse impacts to human life and property caused by seismically induced groundshaking.

Because the Project Site is less than one mile from the ground surface projection of the Newport Inglewood structural zone, CBC Section 1629, *Criteria Selection*, requires Near-Source Factors for Seismic

[3] Moment Magnitude is a logarithmic scale is to measure the total amount of energy released by an earthquake. For the purposes of describing this energy release, the moment magnitude (M_W) of the characteristic earthquake for that segment has replaced the concept of a maximum credible earthquake of a particular Richter magnitude.

Source Type B[4] to be applied to the design of structures at the Project Site. Near-Source Factors represent additional safety factors to be incorporated in structural design equations for building sites within 15 kilometers (9.3 miles) of the ground surface projection of a known active fault plane. The Near-Source Factors and, therefore, the standards for seismic-resistant design, increase as the distance from a construction site to the fault trace decreases.

As discussed in Section 4.5.1, soil characteristics render the site susceptible to a relatively high degree of liquefaction. Seismically induced settlement on the order of two inches may occur as a result of liquefaction. The project proposes the use of a post-tensioned foundation system in order to minimize the effects of liquefaction. Post-tensioning is a method of reinforcing concrete, masonry, and other structural elements by pre-stressing the concrete or masonry. For example, after the concrete has hardened, embedded steel tendons are stressed (thus the term "post-tensioned"), generally with the use of hydraulic jacks. The internal forces that are generated improve the response of the structure to loading and load changes (Terracon Consulting Engineers and Scientists 2005). The actual design of the post-tensioned foundation would be based on the expansion potential of the near surface soils (i.e., fill) and the potential effects of liquefaction. Post-tensioned foundations would address liquefaction, in part. However, additional design parameters must be identified in order to ensure that structures can withstand the effects of liquefaction, should it occur. Implementation of CR 4.5-1 and MM 4.5-1(a) and (b) would address the potentially significant effects related to seismically induced groundshaking and liquefaction potential.

CR 4.5-1 *Prior to recordation of the final map, a qualified, Licensed Engineer shall prepare a detailed soils and geotechnical analysis. This analysis shall include results of soil sampling and laboratory testing of materials to provide detailed recommendations for grading, chemical and fill properties, liquefaction, foundations, concrete piles, landscaping, dewatering, ground water, retaining walls, pavement sections and utilities.*

MM 4.5-1(a) *A liquefaction assessment study shall be performed in order to quantify the amount of liquefaction and associated lateral spreading that could occur due to a seismic event. The liquefaction assessment shall be completed in compliance with CGS's Special Publications 117, "Guidelines for Evaluating and Mitigating Seismic Hazards in California" and the referenced companion publication prepared by the Southern California Earthquake Center. The assessment shall include engineering specifications for building designs that would allow structures to withstand the effects of seismically induced liquefaction and lateral spreading.*

MM 4.5-1(b) *The rough/mass grading plan prepared for the proposed project shall contain the recommendations of the geotechnical analysis and final liquefaction soils assessment prepared pursuant to CR 4.5-1 and MM 4.5-1(a), as approved by the City. These recommendations shall be implemented in the design of the project, including but not limited to measures associated with site preparation, surcharge, fill placement and compaction, seismic design features, excavation stability and shoring requirements, dewatering, establishment of post-tension foundations, corrosion measures, surface drainage, erosion control, ground improvements, and plan review. All geotechnical recommendations provided in the soils and geotechnical analysis shall be implemented during site preparation and construction activities.*

[4] Seismic Source Type B in CBC Table 16-U is defined by moment magnitudes between M_W 6.5 and 7.0.

As with nearly all structures located in liquefaction hazard zones, some risk of damage from liquefaction would remain, such that repair and remedial work may be required after a liquefaction event. Adherence to CR 4.5-1 and MM 4.5-1(a) and (b) in addition to local regulations and building standards would ensure that the proposed project provides an acceptable level of protection against seismic-related hazards, according to current geotechnical engineering. Impacts associated with seismic groundshaking and liquefaction would be ***less than significant***.

Threshold	Would the project 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?

Impact 4.5-2 **Development of the proposed project would be located on potentially unstable soils and subject to subsidence, lateral spreading, and corrosive soils.**

The proposed project would locate structures on soils that are considered potentially unstable due to the liquefaction, settlement, and lateral spreading potential of the site, as well as the corrosive onsite soils. As discussed in the Initial Study, because the project site and surrounding area are relatively flat, there is no potential for landslides to occur on the site or nearby. In addition, as discussed in Section 4.5.1 (Existing Conditions), subsidence and collapse of underlying soils at the project site are also considered to have a negligible potential of occurrence. Liquefaction and seismically induced settlement are addressed under Impact 4.5-1, above.

Settlement

As described in Chapter 3 (Project Description), portions of the project site were graded and excavated as part of a soil remediation program due to the historic industrial use of the site. Approximately 11,000 cubic yards of soil were imported onsite to backfill excavated areas, although no compaction of this soil occurred. The project proposes excavation to competent bottom and recompaction with certification by a geotechnical consultant prior to the onset of any construction activity. If recompaction is not completed, soils onsite would remain unstable, and impacts would be potentially significant.

Soil samples indicated that the upper approximately ten to 15 feet of native alluvial soils would be moderately to highly compressible under proposed project conditions. These soil characteristics could contribute significantly to foundation settlement. The project proposes use of surcharge fill in order to address settlement potential. This process would accelerate the consolidation of compressible materials through temporary placement of approximately 6 feet of soil over the site, and would induce up to approximately three inches of settlement. In order to expedite the consolidation of compressible soil layers, the proposed project would also include the installation of a subsurface drainage system consisting of a network of vertical wick drains interconnected by horizontal strip drains. It is anticipated that a period of approximately four to six months would be required to complete the settlement process to reach 90 percent consolidation (LGC 2005). This procedure is intended to reduce the amount of post-construction settlement to a level that could be withstood by proposed building foundations. A detailed

surcharge plan has not been proposed by the applicant at this time. MM 4.5-2(a) would be required to ensure effective treatment of existing onsite and proposed import soils.

MM 4.5-2(a) *Recommendations for site grading, including treatment of existing artificial fill within the site, details regarding wick drain installation (including depths and horizontal spacings), thickness of required fill surcharge, installation of settlement monitoring equipment and requirements for settlement monitoring shall be developed and included with project plans.*

With the implementation of MM 4.5-2(a), impacts associated with settlement would be ***less than significant***.

Lateral Spreading

The southwestern portion of the project site is located adjacent to the Huntington Beach Channel, a tributary channel of the local storm water conveyance system. Sampling results indicate that soils in the southeast corner of the site located within 100 feet of the Huntington Beach Channel are susceptible to lateral spread. There are four structures proposed in this area, with the closest approximately 51 feet from the nearby channel. Construction of a deep foundation system that uses concrete piles would provide soil stability and structural integrity of the buildings constructed in areas susceptible to lateral spread. It is estimated that up to 40 pre-cast concrete piles driven to a depth of 30 feet would be necessary. Requirements for piles would be refined upon completion of the final geotechnical report.

MM 4.5-1(a), described above, would ensure that structures are designed to withstand the effects of lateral spreading. Impacts would be ***less than significant.***

Corrosive Soils

On-site soils contain elevated concentrations of soluble sulfates and are thus considered to be severely corrosive to concrete and steel. This could affect buried utility lines and other support structures for the proposed project. In addition, near surface soils beneath the project site are likely to be corrosive to metallic building materials and plumbing. If not properly addressed, proposed structures and support facilities could become damaged and unstable due to soil corrosion. Mitigation Measure MM 4.5-2(b) would ensure that the proposed project is constructed of material resistant to corrosion from on-site soil.

MM 4.5-2(b) *Samples of on-site soils shall be obtained at or near the completion of all site grading and submitted to a qualified corrosion engineer by the developer for further assessment. Based on this assessment by the corrosion engineer, appropriate recommendations shall be provided for concrete design mix, as well as for protection of buried metallic building materials (including steel reinforcement bars and/or post-tensioning tendons), plumbing, and all public utility facilities.*

Incorporation of MM 4.5-2(b) into the proposed project would reduce the potential impact of corrosive soils to a ***less-than-significant*** level.

Threshold	Would the project be located on expansive soil, as defined in Table 18-1-A of the Uniform Building Code (2001), creating substantial risks to life or property?

Impact 4.5-3 The proposed project would be located on expansive soil.

As discussed in Section 4.5.1 (Existing Conditions), the on-site soils generally exhibit a high expansion potential. Expansive soils have a significant amount of clay particles that can give up water (shrink) or take on water (swell). The change in volume exerts stress on buildings and other loads placed on these soils. The occurrence of these soils is often associated with geologic units of marginal stability. The expansion characteristics of fill that will be used at the project site is currently unknown. It is anticipated that the actual design of the post-tensioned foundation would be based on the expansion potential of the near surface soils (i.e., fill). Implementation of mitigation measure MM 4.5-3 would ensure implementation of this design parameter.

MM 4.5-3 *Import fill at the project site shall be approved by the City Fire Department (prior to import). Structural foundations shall be designed based on the expansion potential of the near surface soils at building pad locations.*

Incorporation of MM 4.5-3 into the proposed project would ensure that impacts associated with expansive soil are reduced to a ***less-than-significant*** level.

Threshold	Would the project result in substantial soil erosion or the loss of topsoil?

Impact 4.5-4 Project implementation could result in soil erosion and the loss of topsoil.

For the purposes of this analysis, erosional effects consider whether or not the effects of project activities would accelerate the natural erosional processes.

Because the project site is now generally undeveloped, it is already exposed to erosional processes. Since the project site does not contain steep slopes, the potential for erosion by water through surface drainage is not extensive.

Proposed development would include removal of the existing RV/Boat Storage area, followed by the import of fill and surcharge activities; grading and excavation; construction of utility infrastructure and curbs, streets, gutters, walls, etc.; and construction of residential buildings and the installation of landscaping. Proposed surcharge activities would involve import of soil to provide an additional six feet of temporary fill on the site in order to compress underlying soils, as discussed above under Impact 4.5-2. Surcharge would occur over the site in three phases, with the total process occurring over a period of four to six months. Exposed fill dirt would be exposed to erosional processes during this phase of project construction. Surcharge and other construction activities could result in the loss of topsoil or expose areas of soil to erosion by wind or water. Operational activities such as the addition of paved and landscaped areas would, over the long term, decrease the potential for erosion because less exposed soil would exist on the project site.

The import of fill to raise building pads out of the floodplain would result in a permanent alteration of the existing topographic features of the project site. While the site would remain flat, its elevation would be increased by approximately three to five feet. This increase in site elevation would be necessary to comply with FEMA regulations in order to elevate the residential units out of the floodplain.

Earth-disturbing activities associated with soil import and surcharge would be temporary. Specific erosion impacts would depend largely on the areas affected and the length of time soils are subject to conditions that would be affected by erosion processes. The proposed site is greater than five acres in size, and is subject to the provisions of the General Construction Activity Stormwater Permit adopted by the State Water Resources Control Board (SWRCB). The Applicant for the proposed project must submit a Notice of Intent (NOI) to the SWRCB for coverage under the Statewide General Construction Activity Stormwater Permit and must comply with all applicable requirements, including the preparation of a Stormwater Pollution Prevention Plan (SWPPP), applicable NDPES Regulations, and best management practices (BMP). The SWPPP must describe the site, the facility, erosion and sediment controls, runoff water quality monitoring, means of waste disposal, implementation of approved local plans, control of sediment and erosion control measures, maintenance responsibilities, and non-stormwater management controls. Inspection of construction sites before and after storms is required to identify stormwater discharge from the construction activity and to identify and implement controls where necessary.

In addition, all construction activities would comply with Chapter 33 of the CBC, which regulates excavation activities and the construction of foundations and retaining walls: Appendix Chapter 33 of the CBC, which regulates grading activities, including drainage and erosion control; and the City of Hunting Beach Grading and Excavation Code, which identifies and enforces requirements specific to earthwork conditions in the City. Compliance with the NPDES permit process, the CBC requirements, and the City Codes would minimize the effects from erosion. Therefore, such compliance would ensure that that erosion and other soil instability impacts resulting from project construction would be ***less than significant***.

4.5.4 Cumulative Impacts

The geographic context for the analysis of impacts resulting from geologic hazards generally is site-specific, rather than cumulative in nature, because each project site has unique geologic considerations that would be subject to uniform site development and construction standards. As such, the potential for cumulative impacts to occur is limited.

Impacts associated with potential geologic hazards related to soil or other conditions occur at individual building sites. These effects are site-specific, and impacts would not be compounded by additional development. Buildings and facilities in the City of Huntington Beach would be sited and designed in accordance with appropriate geotechnical and seismic guidelines and recommendations consistent with the Building Code. Adherence to all relevant plans, codes, and regulations with respect to project design and construction would provide adequate levels of safety, and the cumulative impact would be less than significant. Adherence by the project to all relevant plans, codes, and regulations would ensure that the proposed project would not result in a cumulatively considerable contribution to cumulative impacts

regarding geologic hazards, and the cumulative impact of the project would, therefore, be less than significant.

Impacts from erosion and loss of topsoil from site development and operation can be cumulative in effect within a watershed. The Talbert Watershed District forms the geographic context of cumulative erosion impacts. Development throughout Orange County and the City of Huntington Beach is subject to state and local runoff and erosion prevention requirements, including the applicable provisions of the general construction permit, BMPs, and Phases I and II of NPDES permit process, as well as implementation of fugitive dust control measures in accordance with SCAQMD Rule 403 (see Section 4.2 (Air Quality) of this EIR). These measures are implemented as conditions of approval of project development and subject to continuing enforcement. As a result, it is anticipated that cumulative impacts on the Talbert Watershed District due to runoff and erosion from cumulative development activity would be less than significant. The project's contribution to cumulative impacts would not be cumulatively considerable and would, therefore, also be less than significant.

Implementation of the proposed project would result in the modification of site conditions to accommodate residential development and to provide a stable and safe development. During construction, areas of soil could be exposed to erosion by wind or water. Development of other cumulative projects in the vicinity of the proposed project could expose soil surfaces, and further alter soil conditions, subjecting soils to erosional processes during construction. To minimize the potential for cumulative impacts that could cause erosion, the proposed project and cumulative projects in the adjacent area are required to be developed in conformance with the provisions of applicable federal, state, County, and City laws and ordinances. Adequate mitigation must be incorporated into individual projects to address current legal requirements for control of erosion caused by stormwater discharges. Project sites of more than one acre in size would be required to comply with the provisions of the NPDES permitting process and local implementation strategies, which would minimize the potential for erosion during construction and operation of the facilities. Compliance with this permit process, in addition to the legal requirements related to erosion control practices, would minimize cumulative effects from erosion. Therefore, cumulative impacts on erosion would be less than significant. The project would not result in a cumulatively considerable contribution to this impact and would, therefore, be less than significant.

4.5.5 References

Alquist-Priolo Earthquake Fault Zoning Act, California Public Resources Code, Division 2, "Geology, Mines, and Mining," Chapter 7.5 "Earthquake Fault Zones," Sections 2621 through 2630; signed into law 22 December 1972, most recently amended 07 October 1997.

Hart, E.W., and Bryant, W.A., *Fault-Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with index to Earthquake Fault Zones Maps*, California Geological Survey, Special Publication 42, revised 1997, Supplements 1 and 2, 1999, Supplement 3, 2003.

Huntington Beach, City of. 1996. *The City of Huntington Beach General Plan*.

International Conference of Building Officials, *Uniform Building Code*, Volumes 1, 2 & 3; Chapter 16, Structural Forces (earthquake provisions); Chapter 18, Foundations and Retaining Walls; appendix Chapter A33, Evacuation and Grading, Whittier, CA, 1994.

James, Jane. 2005. Email communication with City of Huntington Beach, 23 September.

LGC, 2005. *Preliminary Soils Report for the Proposed Residential Development on the 'Mills Land Property'*, Revised 6 May.

Petra. 2005. *Feasibility Geotechnical Assessment for Proposed Residential Development*, 19 August.

Targhee, Inc. 2002. *Remedial Action Plan, Mills Land & Water Company—Huntington Beach Property, Golden West Refining Company—Huntington Beach Pipeline Terminal*, 3 September.

Terracon Consulting Engineers and Scientists. 2005. *Post-Tensioned Slab Construction*, Website: http://www.terracon.com/np_newsyou_posttensionedslab.htm. Accessed 6 November.