4.5 GEOLOGY AND SOILS

This EIR section analyzes the potential for adverse impacts on existing geologic and soil conditions within the project site resulting from implementation of the proposed Specific Plan. Data used to prepare this section were taken from the Environmental Hazards Element of the City of Huntington Beach (General Plan 1996), reports published by the California Geological Survey (CGS) and the United States Geological Survey (USGS); and other geotechnical or environmental investigations pertinent to the conditions within the Specific Plan Area. Because of the technical nature of this section, a glossary is provided in Section 4.5.5 to define geologic terms that may not be familiar to the reader. Additionally, full bibliographic entries for all reference materials are provided in Section 4.5.6 (References) at the end of this section.

All comments received in response to the Initial Study/Notice of Preparation (IS/NOP) circulated for the proposed project were taken into consideration during preparation of the EIR, and if relevant, have been addressed in this section or others within this document.

4.5.1 Environmental Setting

The Specific Plan area (also referred to as the project site) extends along Beach Boulevard from the boundary of the Coastal Zone in the south, specifically the southeast corner of Atlanta Avenue, and through and including Beach Boulevard's intersection with Edinger Avenue. The Specific Plan area then extends westward along Edinger Avenue to Goldenwest Street in the northern portion of the City of Huntington Beach (refer to Figure 3-1 [Project Vicinity and Regional Location Map] in Chapter 3 [Project Description]). The total acreage of the project site is approximately 459 acres. The area is relatively flat, with localized variations in surface grade.

Regional and Local Geology and Seismic Setting

The City of Huntington Beach is on a coastal plain underlain by relatively recent sediments ranging in age from Quaternary deposits of the Pleistocene epoch (11,000 to 1,600,000 years) through the Holocene epoch (less than 11,000 years). The older sediments typically are shallow marine terrace deposits that have been uplifted by ongoing seismic movement and eroded to form the Bolsa Chica and Huntington Beach mesas. The mesas are bordered by younger (unconsolidated) alluvial soils that fill the gaps near Seal Beach, Bolsa Chica, and the Santa Ana River. The alluvial sediments are many hundreds of feet thick throughout the City. The Newport-Inglewood Fault Zone is visible on the ground surface as a series of northwest-trending elongated hills, including Signal Hill and the Dominguez Hills, extending from Newport Beach to Beverly Hills.

Local Soil and Groundwater Conditions

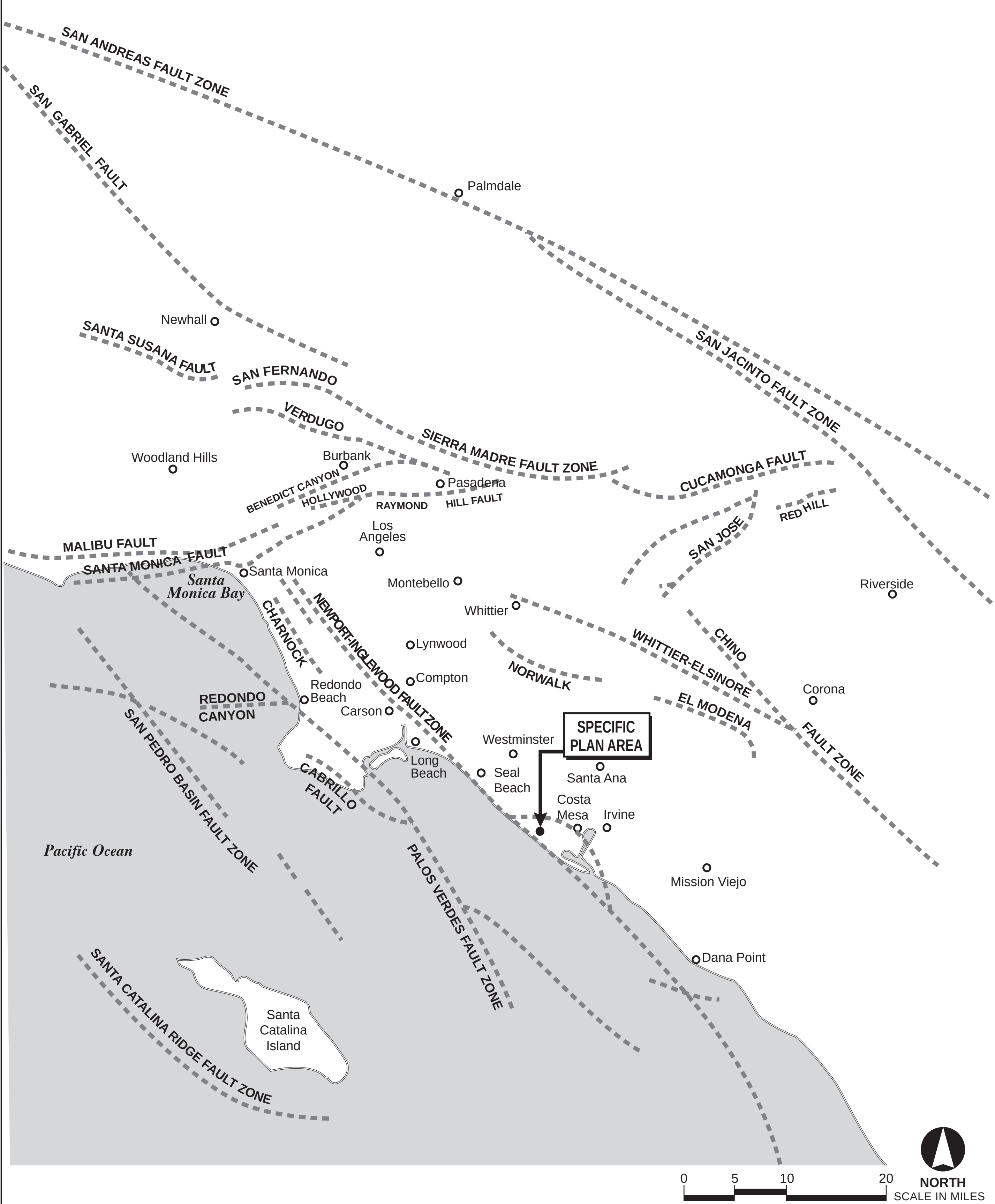
According to the Environmental Hazards Element of the City's General Plan, the entire project site is underlain by alluvial materials: mostly older alluvium (interbedded silty clay and clay, overlain by interlayered sandy gravel and silty clay) south of Warner Avenue; and mostly younger alluvium (floodplain sand, gravel, and silt) north of Warner. The older alluvium is more consolidated (denser), less expansive, and more erodible than the younger alluvium and has fair to good engineering properties for foundation support. The younger alluvium contains layers of peat that are subject to settlement, expansion, and liquefaction.

Regional and Local Faults

All of Southern California is seismically active. The region is crossed by a network of major regional faults and minor local faults. This faulting and seismicity is dominated by the San Andreas Fault System, which separates two of the major tectonic plates that represent part of Earth's continental and oceanic crust: the Pacific plate is west of the San Andreas Fault System; the North American plate is to the east. Refer to Figure 4.5-1 (Major Regional Faults) and Figure 4.5-2 (Newport-Inglewood Fault Zone) for regional and local faults, respectively.

There are numerous faults in Southern California that are categorized as active, potentially active, and inactive by the California Geological Survey (CGS). A fault is classified as active if it has either moved during the Holocene epoch (during the last 11,000 years) or is included in an Alquist-Priolo Earthquake Fault Zone (as established by CGS). A fault is classified as potentially active if it has experienced movement within the Quaternary period (during the last 1.6 million years). Faults that have not moved in the last 1.6 million years generally are considered inactive. 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.

As identified in Figure 4.5-2, The Newport-Inglewood Fault Zone, crosses the City. The Newport-Inglewood Fault Zone is an active right-lateral fault system consisting of a series of fault segments located mostly parallel to the coastline throughout the City. Branches of the fault have been categorized by the City as A, B, C, or D. Each category determines the level of investigation considered appropriate for each category of fault examined by the City's consultants for preparation of the 1974 Seismic Safety Element. This element was superseded by the 1996 General Plan update, which also considered the 1992 Alquist-Priolo Study Zones delineated by the CA Division of Mines and Geology. The North Branch and Seal Beach fault traces of the Newport-Inglewood Fault Zone are the only fault traces in the Alquist-Priolo Earthquake Fault Zones in the City and classified as Category A faults. Portions of the North Branch and Seal Beach fault traces that are not in Alquist-Priolo Earthquake Fault Zones are classified by the City as Category B faults, which require special studies, including subsurface investigation for critical and important land uses and special evaluation of faults for all habitable structures. The South Branch fault trace is classified by the City as a Category C fault, which requires special studies, including a subsurface investigation for critical and important land uses. The Bolsa-Fairview, Yorktown Avenue, Adams Avenue, Indianapolis Avenue, Off-Shore, and several unnamed or uncertain faults are classified by the City as Category D faults: these are considered inactive or non-existent (i.e., without ground surface expression), but subsurface investigation may be required by the City.



Source: PBS&J, 2008.

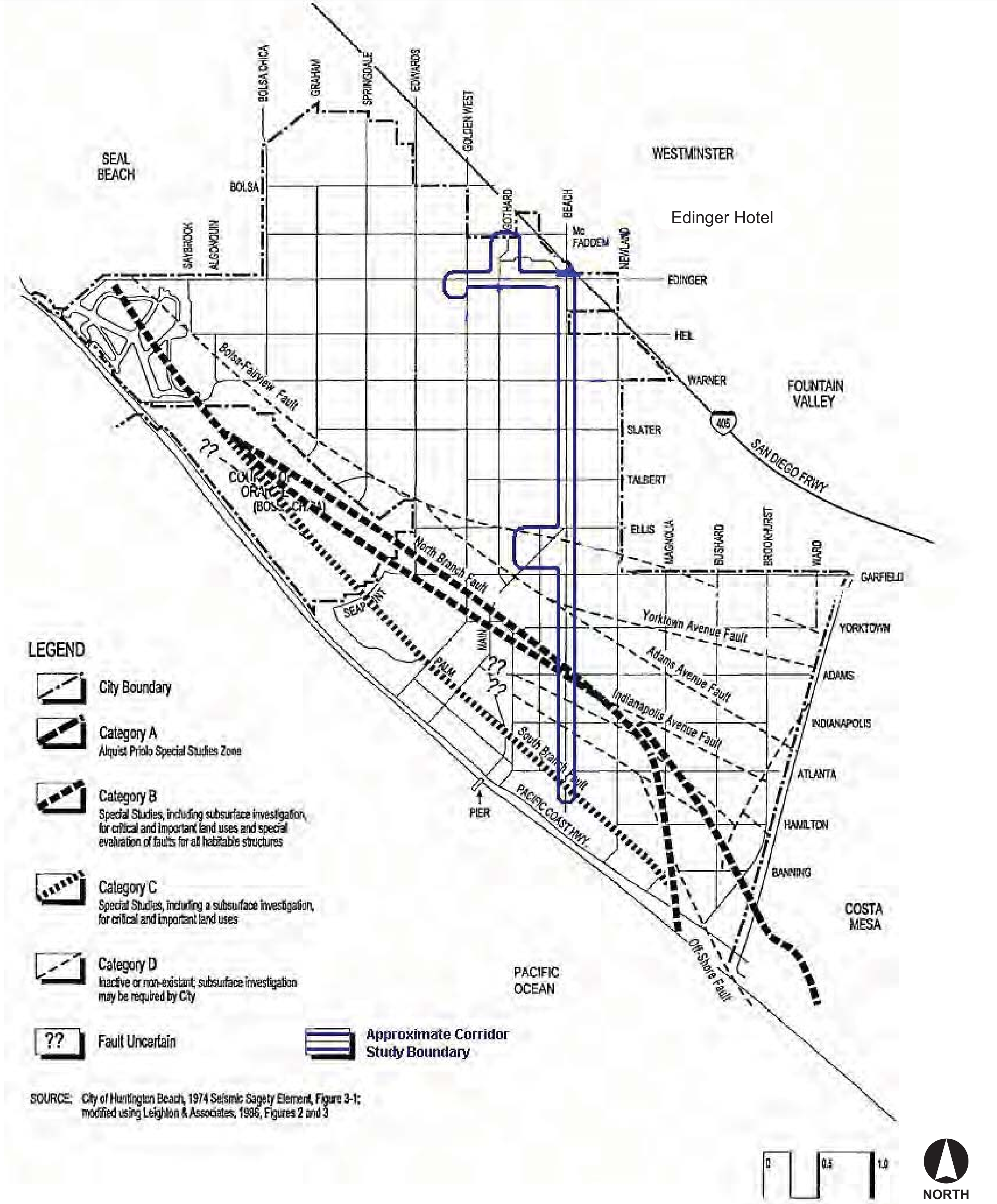
FIGURE **4.5-1**

Major Regional Faults

100000407

Beach-Edinger Corridors Specific Plan EIR

10176 | JCS | 08



***Source*:** The City of Huntington Beach General Plan.

FIGURE **4.5-2**

Newport-Inglewood Fault Zone

100000407

Beach-Edinger Corridors Specific Plan EIR

04092 | JCS | 09

A buried segment of the North Branch fault of the Newport-Inglewood Fault Zone is in an 800-foot-wide Alquist-Priolo Earthquake Fault Zone which crosses the project site at the intersection of Adams Avenue and Beach Boulevard. Consequently, the potential for surface fault rupture there is high and investigation is required for proposed structures for human occupancy. The remainder of the project site is not in any Alquist-Priolo Earthquake Fault Zone, although the City Category C South Branch fault trace crosses the southern end of the corridor south of Atlanta Avenue. Any proposed critical or important land uses in this area would be required to complete subsurface investigations as part of the building design process.

Other regional faults in Alquist-Priolo Earthquake Fault Zones include the West Coyote Hills fault about 15 miles north of the City; the Whittier Fault Zone, about 20 miles north-northeast; and the Elsinore fault, about 28 miles northeast. The San Jacinto and San Andreas Earthquake Fault Zones are about 51 and 54 miles northeast, respectively. Additionally, there are several potentially active faults in the vicinity of the City; Table 4.5-1 (Summary of Fault Data for the City of Huntington Beach) provides a summary of information about known faults in the vicinity of Huntington Beach.

Table 4.5-1 Summary of Fault Data for the City of Huntington Beach

Fault Name	*Distance from City Center (miles)*	*Orientation (Compass Direction)*	*Maximum Probable Magnitude (Richter [M]/Moment [M_W])*	*Peak Acceleration (expressed as a portion of the force of gravity [g])*
Faults with Mapped Surface Traces				
Elsinore	28	NW-SE	6.75/6.7	0.11–0.18
Newport-Inglewood	Less than 2	NW-SE	5.75/7.1	0.55–1.0
Palos Verdes Coronado Bank	10	NW-SE	6.75/7.3	0.34–0.53
Raymond	30	E-W	4.0/6.5	0.02–0.21
San Andreas	51	NW-SE	8.0/7.5	0.11–0.14 (long period motions important)
Sierra Madre–San Fernando	32	E-W	6.0/7.2	0.07–0.20
Whittier-North Elsinore	19	NW-SE.	6.0/6.8	0.11–0.30
Blind of Buried Thrust Faults				
Elysian Park	25	EW-WNW-ESE	5.75/6.4	Whittier = M 5.9
Compton-Los Alamitos	Less than 10	NW-SE	5-6?/7.8	Little known; possible association with NIFZ
Torrance Wilmington	Less than 10	NW-SE	5-6?/?	Little known; apparent association with PVFZ

SOURCES: City of Huntington Beach General Plan, Environmental Hazards Element. May 13, 1996.
Southern California Earthquake Center, Uniform California Earthquake Rupture Forecast 2. 2007

Historic and Future Seismicity

According to the City's General Plan Environmental Hazards Element, the estimated maximum earthquake assigned to the Newport-Inglewood Fault Zone is Richter magnitude (M) 7.0. The expected (average) amount of surface fault rupture on any given fault trace would range from zero to about one foot for earthquakes with magnitudes under M6.0, and from one foot to about 10 feet for earthquakes with magnitudes between M6.0–7.5. Large earthquakes occurred in the area of the City in 1769 (fault unknown), 1812 (possible the Newport-Inglewood fault), 1855 (Newport-Inglewood fault or an unnamed concealed fault), and in 1920, 1933, and 1941 (all Newport-Inglewood fault).

Earthquakes greater than Moment Magnitude (M_W) 7.0 (refer to Section 4.5.5 [Glossary]) may occur on the Newport-Inglewood Fault once in 200 to 2,000 years. According to the Uniform California Earthquake Rupture Forecast, the probability of a M_W 7.0 earthquake occurring in the Los Angeles area (although more probably on the San Andreas Fault than on the Newport-Inglewood Fault) during the next 30 years is 82 percent (WGCEP 2007).

Geologic Hazards

The potential seismic hazards in the project site include fault rupture, groundshaking, liquefaction, and settlement. Potential soil hazards include subsidence and expansion.

Fault Rupture

A buried segment of the North Branch fault of the Newport-Inglewood Fault Zone is in an 800-foot-wide Alquist-Priolo Earthquake Fault Zone, which crosses the project site at the intersection of Adams Avenue and Beach Boulevard. The potential for surface fault rupture in this Fault Zone is considered high. The remainder of the project site is not in an Alquist-Priolo Fault Zone. As such the potential for damage in the majority of the project site from direct rupture is remote. Figure 4.5-2 identifies traces of the Newport-Inglewood Fault, which cross the project site.

The *Alquist-Priolo Earthquake Fault Zoning Act* prohibits the construction of buildings for human occupancy across the trace of a known active fault. The Act does not address power lines, water lines, or roads unless there are associated structures in which human occupancy would exceed 2,000 person hours per year. Proposed construction within an Earthquake Fault Zone is permitted only following the completion of a fault location evaluation and written report prepared for the specific site by a California-registered Professional Geologist. If an active fault is found, a structure for human occupancy must be set back from the fault trace (usually at least 10 feet, but generally 50 feet or more). It is not feasible to design and build structures that can accommodate the rapid ground displacement caused by surface fault rupture. Avoidance of the active trace is the only available treatment and is the one required by the *Alquist-Priolo Earthquake Fault Zoning Act* for sites within State of California Earthquake Fault Zones.

Groundshaking

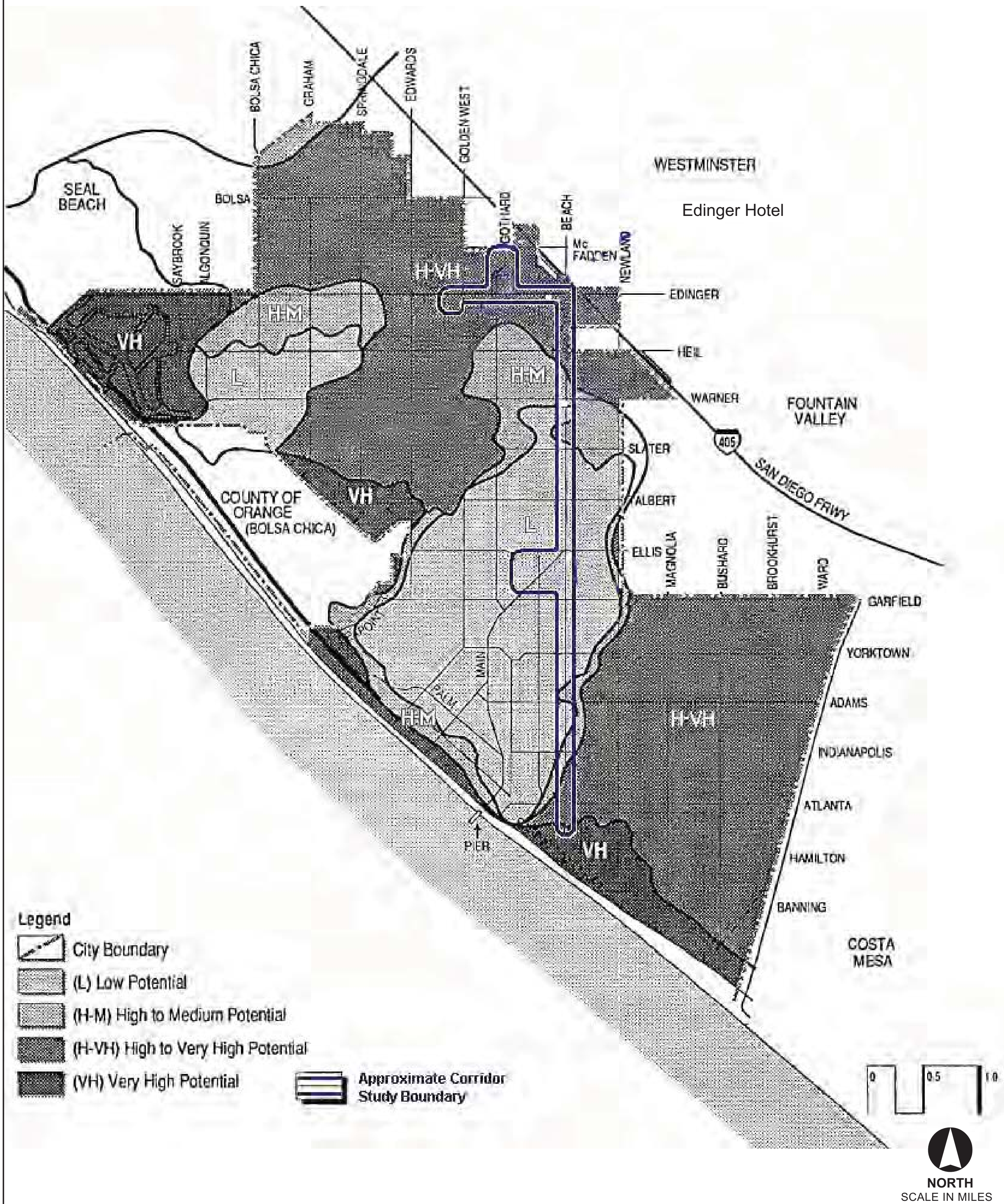
The major cause of structural damage from earthquakes is groundshaking. The intensity of ground motion expected at a particular site depends on the magnitude of the earthquake, the distance and direction to the epicenter, and the geology of the area between the epicenter and the property. Greater movement can be expected at sites on poorly consolidated material, such as loose alluvium, in proximity to the causative fault, or in response to an earthquake of great magnitude.

The CGS Probabilistic Seismic Hazards Assessment Program estimates peak ground accelerations in the alluvium along the corridor would be 0.408 g (g = the force of gravity). The 2007 CBC incorporates attenuation relationships developed by the CGS's Probabilistic Seismic Hazard Program, which consider vibration contributions from multiple seismic sources, including those generated by the Newport-Inglewood fault crossing the corridor and those of the more distant, but potentially as damaging, San Andreas and San Jacinto faults. The resultant map (Figure 1613.5(3) of the 2007 CBC) of short-term (0.2-second) ground response indicates the site would be subjected to average peak ground accelerations as high as 1.67 g for the largest earthquakes in the Los Angeles area. The 2007 CBC requires the design earthquake (i.e., the maximum considered earthquake acceleration response for a given site) to be calculated using 2/3 of the mapped acceleration value—in this case, 1.1g, which accords reasonably well with the CGS calculated probabilistic short term ground response of 0.973 g for alluvium at the site.

Liquefaction

Liquefaction is the phenomenon in which uniformly sized, loosely deposited, saturated, granular soils with low clay contents undergo rapid loss of shear strength through the development of excess pore pressure during strong earthquake induced groundshaking of sufficient duration to cause the soil to behave as a fluid for a short period of time. Liquefaction generally occurs in saturated or near-saturated cohesionless soils at depths shallower than 50 feet below the ground surface. If the liquefying layer is near the surface, the effect for any structure supported on it is much like that of quicksand, resulting in sinking or tilting. If the layer is deeper in the subsurface, it can provide a sliding surface for materials above it, resulting in lateral motion (spreading or lurching) toward any nearby 'free face' (shore bluff, river embankment, excavation wall). Most of the corridor north of Warner Avenue, in the vicinity of Beach Boulevard and Slater Avenue, and south of Adams Avenue is in a Liquefaction Investigation Zone on the State of California Seismic Hazard Zone Map for the Newport Beach and Seal Beach Quadrangles (CGS 1998b, 1999). As shown on in Figure 4.5-3 (Liquefaction Potential in Specific Plan Area) the Beach Boulevard corridor north of Heil Avenue and south of Indianapolis Avenue is in "High to Very High" Liquefaction Potential areas; Slater Avenue to Heil Avenue and Yorktown Avenue to Indianapolis Avenue along the Beach Boulevard Corridor are mostly "High to Medium" Liquefaction Potential areas; the remainder of the corridor has "Low" Liquefaction Potential.

The City has a shallow (possibly perched) water table with depths throughout most of the City less than 30 feet below the ground surface (bgs). Along Beach Boulevard, the depth is at least 30 feet bgs from just north of Slater Avenue to just south of Yorktown Avenue where the alignment is underlain by older alluvial deposits. From Slater Avenue north to McFadden Avenue, the water table rises to within 5 feet bgs. From Yorktown Avenue south toward the Pacific Coast Highway (PCH), the water table rises to less than 3 feet bgs. The presence of shallow groundwater raises concerns about liquefaction potential, settlement rates, and the possible need for construction dewatering. A close relationship exists between liquefaction potential and the depth of the water table in the City.



Source**:** The City of Huntington Beach General Plan.

FIGURE **4.5-3**

Liquefaction Potential in Specific Plan Area

PBS&J

100000407

Seismically Induced Settlement

Settlement can occur in areas that are prone to rates of ground surface collapse and densification (soil particle compaction) that are greater than those of the surrounding area. Such areas often are underlain by sediments that differ laterally in composition or degree of compaction. Differential settlement refers to adjacent areas that have more than one rate of settlement. 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 between the particles. Settlement is caused by the reduction of soil volume. It can result from the decomposition of organic material, the compression of weak material, the rearrangement of soils particles to a higher density from the withdrawal of fluid or the application of vibration, or any combination thereof. The change in volume exerts stress on building foundations and other loads placed on these soils. Soils testing to identify settlement characteristics and appropriate remediation measures are required routinely by the City's Building Code and Grading Ordinance (Section 1802.2.1 Questionable Soils, of the 2007 CBC). Specific treatments to eliminate settlement of soils include, but are not limited to, recompaction (watering and compressing the soils) and replacement with a non- compressible material (excavation of unsuitable soil followed by filling with suitable material), all of which are commonly used in the City.

Shrinkage and Subsidence

Shrinkage is the loss of soil volume caused by compaction of fills to a higher density than before grading. Subsidence is the settlement of in-place subgrade soils caused by loads generated by the weight of large earthmoving equipment or overlying fill or structures. Shrinkage and subsidence would depend on the types of earthmoving equipment used and the final fill and structural loads.

Most of the project site north of Heil Avenue and south of Adams Avenue is in areas containing a layer of peat or organic soils at least 5 feet deep; the remainder of the project site contains layers less than half a foot deep. Given the presence of organic material in the soil, the area could be subject to subsidence associated with hydrocompaction (the settling and hardening of land caused by application of large amounts of water), and/or peat oxidation (the decomposition of organic materials in the soil).

According to the Subsidence Areas Map in the Environmental Hazards Element of the General Plan, the project site south of Talbert Avenue is in an area identified to be susceptible to subsidence. Consequently, there is a potential risk of subsidence occurring.

Landslides

Landslides are the downhill movement of masses of earth and rock caused by gravity acting on over-steepened slopes; vibrations from earthquakes, machinery, blasting, etc., or other lateral or horizontal loading. As shown in Figure 4.5-4 (Potentially Unstable Slope Areas in Specific Plan Area) most of the City is relatively flat with only the Coastal Bluffs as pronounced slopes with a High Potential for instability. The edges of the mesas have a Low Potential for slope instability with the remainder of the City having Very Low or No Potential. Ellis Avenue west of Beach Boulevard and about 60 percent of the project site between Yorktown and Atlanta are in areas of Low Potential for slope instability: the remainder of the corridor has No Potential. The surrounding area is relatively flat with no pronounced slopes, and there are no known landslides near the project site, nor is the project site in the path of any known or potential landslides.

Expansive Soils

Expansive soils contain types of clays (principally montmorillonite, illite, and kaolinite) that can give up water (shrink) or take on water (swell) during changes in soil moisture content. The change in volume exerts stress on building foundations and other loads placed on these soils. The occurrence of these clays often is associated with geologic units of marginal stability. Expansive soils can be widely dispersed and are found in hillside areas as well as low-lying areas in alluvial basins. Soils testing to identify expansive characteristics and appropriate remediation measures are required routinely by grading and building codes.

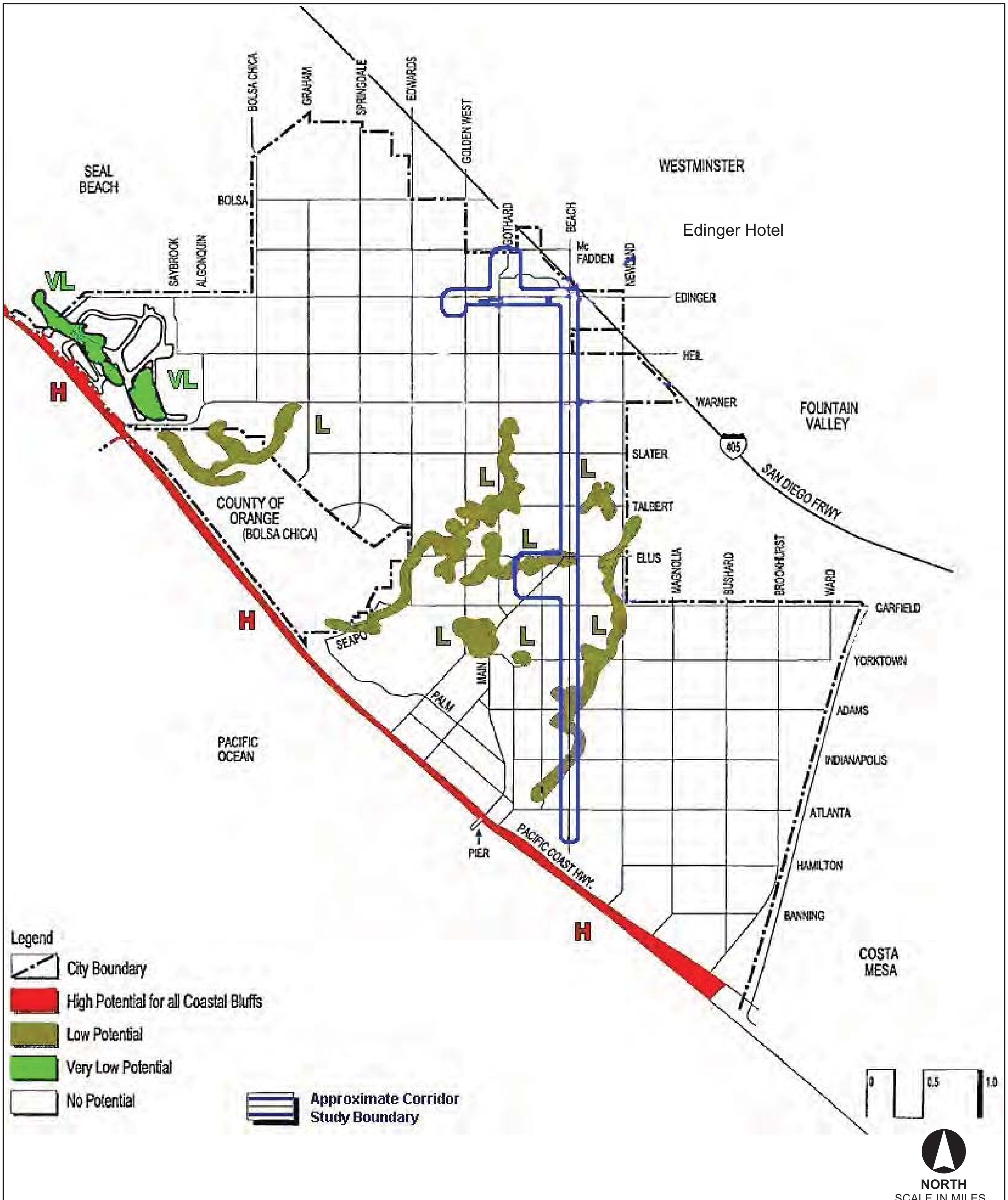
As shown in Figure 4.5-5 (Expansive Soils in Specific Plan Area), most of the project site north of Slater Avenue, in the vicinity of Beach Boulevard and Ellis Avenue, and south of Adams Avenue are in areas of "Moderate to High" soil Expansion Potential. The remainder of the corridor has "Low to Moderate" soil Expansion Potential.

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. Soils of this type are required by Section 1802.2.1 Questionable Soils, of the 2007 CBC to be tested for load-bearing value and, if unacceptable, treated to reduce the hazards they pose. Examples of common problems associated with collapsible soils include tilting floors, cracking or separation in structures, sagging floors, and nonfunctional windows and doors. The City's Building Code requires construction sites containing organic and other collapsible soils to be investigated and treated. Because collapsible soils are unsuitable for foundation support, the simplest approach for light structures with shallow foundations usually is to remove the soils and replace them with suitable material: for heavier structures, deep foundation support (piles, piers) often is recommended.

4.5.2 Regulatory Framework

Federal

There are no federal regulations directly applicable to the geotechnical conditions at the project site. Nonetheless, installation of any underground utility lines are required to comply with industry standards specific to the type of utility (e.g., National Clay Pipe Institute for sewers; American Water Works Association for water lines, etc.) and the discharge of contaminants is required to be controlled through



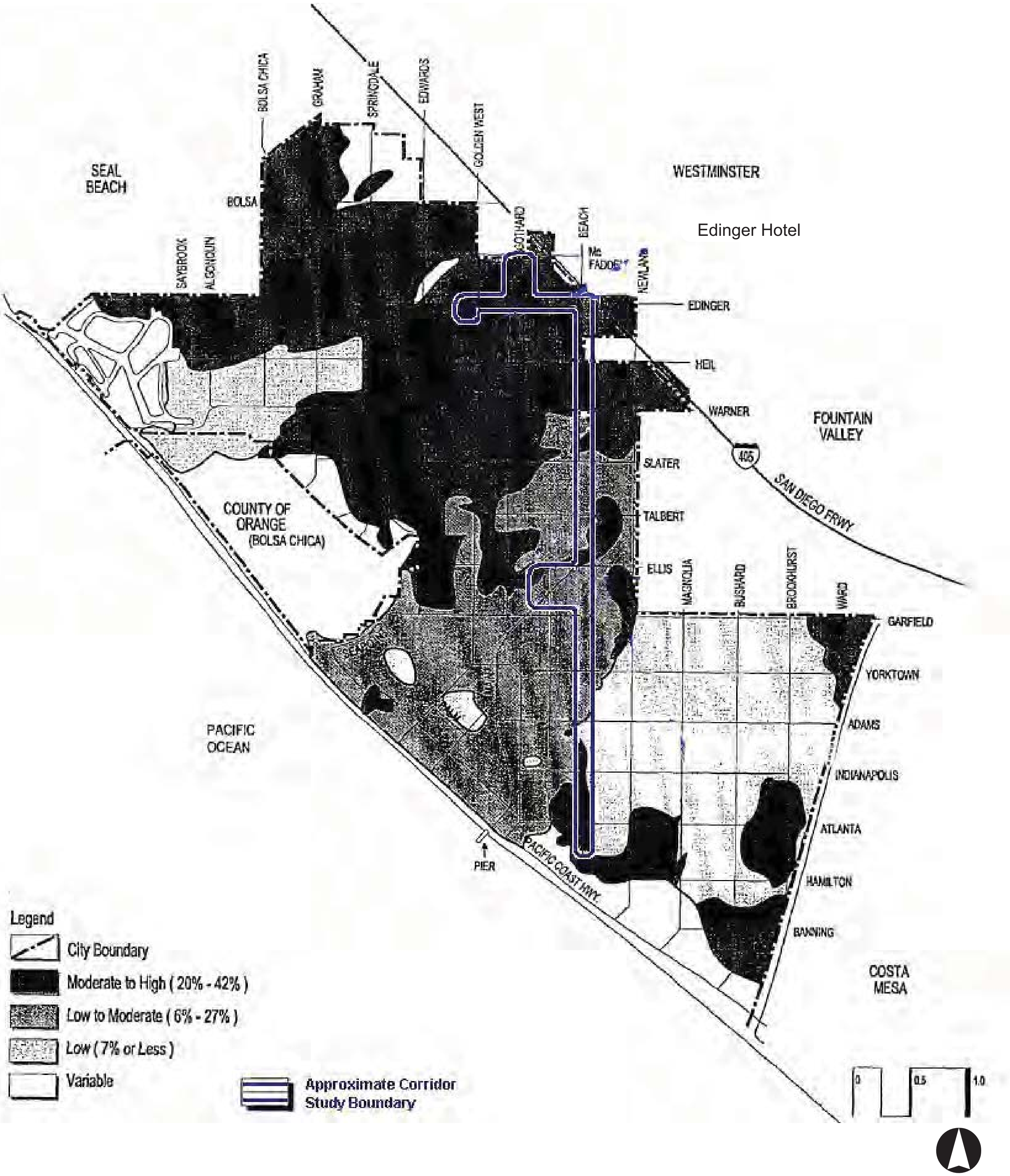
***Source*:** The City of Huntington Beach General Plan.

FIGURE **4.5-4**

Potentially Unstable Slopes in Specific Plan Area

100000407 Beach-Edinger Corridors Specific Plan EIR

04092 | JCS | 09



***Source*:** The City of Huntington Beach General Plan.

PBS&J

FIGURE **4.5-5**

Expansive Soils in Specific Plan Area

100000407

Beach-Edinger Corridors Specific Plan EIR

04092 | JCS | 09

the National Pollutant Discharge Elimination System (NPDES) permitting program for management of construction and municipal stormwater runoff, as described in Section 4.7 (Hydrology and Water Quality) of this EIR. These standards contain specifications for installation, design, and maintenance to reflect site-specific geotechnical conditions.

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* (California *Public Resources Code* [PRC] 1972, 1997). The Act provides for special seismic design considerations if developments are planned in areas adjacent to active or potentially active faults. The Act was passed in response to the 1971 Sylmar Earthquake (also known as the San Fernando Earthquake), which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures. At the direction of the Act, in 1972 the State Geologist became responsible for delineating Earthquake Fault Zones (called Special Studies Zones prior to 1994) around active and potentially active fault traces to reduce fault-rupture risks to structures for human occupancy. The zones are revised periodically, and extend 200 to 500 feet on either side of identified active fault traces. The California Geological Survey (CGS) has prepared nearly 600 maps delineating Earthquake Fault Zones to include, among others, recently active fault traces in the Newport-Inglewood Fault Zone (CGS 2007). The North Branch fault of the Newport-Inglewood Fault Zone is in an Alquist-Priolo Earthquake Fault Zone which crosses the Specific Plan Area at the intersection of Adams Avenue and Beach Boulevard.

No structures for human occupancy may be built across an identified active fault trace. An area of 50 feet on either side of an active fault trace is assumed to be underlain by the fault, unless proven otherwise. Proposed structures for human occupancy within an Alquist-Priolo Earthquake Fault Zone are permitted only following the completion of a fault location report prepared by a California-registered Professional Geologist, usually in cooperation with a Geotechnical Engineer, and reviewed by the City's California-registered Professional Geologist. These reports conform to the guidelines set forth by CGS Note 49, Guidelines for Evaluating the Hazard of Surface Fault Rupture, 1997a, and Special Publication 117, Guidelines for Evaluating and Mitigating Seismic Hazards in California, 1997b. The investigations encompass the most recent information obtainable from the United States Geological Survey (USGS), the CGS, and other published sources, as well as data recovered onsite from trenches, borings, test pits, and by geophysical methods. The location and structural design recommendations resulting from the investigation must be incorporated in the planning for, and structural design of, the proposed development (CGS, 2007).

Fault Evaluation Report for the Southern Newport-Inglewood Fault

The Southern Newport-Inglewood fault was investigated by CGS in the early phases of fault evaluation under the *Alquist-Priolo Earthquake Fault Zoning Act*. The Fault Evaluation Report (CGS 1985) and its Supplement (CGS 1986a), were prepared to decide which of the numerous segments of the Southern

Newport Inglewood fault were to be designated under the Act and "zoned" for special studies in the event structures for human occupancy were proposed that could be underlain by active traces of these faults. Only the North Branch and Seal Beach faults were considered to meet the criteria of sufficient activity and definition to be zoned under the Act. Based on field investigations, aerial photo interpretation, reviewing previous geological and fault studies, as well as articles appearing in publications by CGS, USGS, the California Department of Water Resources (DWR), or in peer-reviewed journals, CGS concluded that both faults probably had been active as recently as very latest Pleistocene time, i.e., between 15,000 and 20,000 years ago, but that there was sufficient evidence only for the North Branch fault to indicate it had undergone Holocene displacement, i.e., during the last 11,000 years. Consequently, although the City recognizes eight faults of different activity levels crossing the Specific Plan Area south of Ellis Avenue, only the trace of the North Branch fault at Adams and Beach was delineated by the State as an Earthquake Fault Zone.

CGS has an ongoing program to update earthquake fault zoning decisions. Updates occurred in the vicinity of the City in 1990, 1991, 2003, and 2007, but the North Branch fault remained the only zoned source of possible surface faulting in the Specific Plan Area. This does not mean there is no threat of surface rupture along the other fault traces: only that the current state of our knowledge about them does not indicate whether a threat is present. Knowing that moderate to large earthquakes continue to occur throughout the region, it is prudent to consider the possibility of surface rupture in the design and construction of development in the Specific Plan Area south of Ellis Avenue.

Seismic Hazards Mapping Act

One of the State legislations protecting the public from geo-seismic hazards, other than surface faulting, is the *Seismic Hazards Mapping Act* (California 1991). The Act's regulations apply to public buildings intended for human occupancy and a large percentage of private buildings intended for human occupancy. The Act became effective in 1991 with the purpose of identifying and mapping seismically hazardous areas to assist cities and counties in preparing the safety elements of their general plans and to encourage land use management policies and regulations that reduce seismic hazards. Under the terms of the Act, cities and counties must require a geotechnical report defining and delineating any seismic hazard prior to the approval of a project in a state-identified seismic hazard zone. The local jurisdiction is required to submit one copy of the approved geotechnical report to the State Geologist within 30 days of approval of the report.

Seismic Hazard Zone Reports

The hazards recognized in the Act include strong groundshaking, liquefaction, landslides, and other ground failure. These effects account for approximately 95 percent of economic losses caused by earthquakes. At the direction of the Act, the State Geologist became responsible for preparing maps delineating Liquefaction Zones of Required Investigation and Earthquake-Induced Landslide Zones of Required Investigation in the Los Angeles Basin and San Francisco Bay areas. Evaluation and mapping have been completed for the Newport Beach and Seal beach quadrangles (CGS 1997c, 1998a), which encompass the Specific Plan Area, and the official maps were issued in April 1998 and March 1999, respectively. The approximate portions of the Specific Plan Area that are in the State identified zone of potential liquefaction are north of Warner Avenue; in the vicinity of the intersection of Beach Boulevard and Slater Avenue; in the vicinity of the intersection of Beach Boulevard and Adams Avenue; and in the vicinity of the intersection of Beach Boulevard and Indianapolis Avenue. A geotechnical report defining and delineating the seismic hazard is required by the state for development proposed in these areas. This information is reflected in the City's 1996 Environmental Hazards Element of the General Plan.

California Building Code

Another State regulation protecting the public from geo-seismic hazards, other than surface faulting, is the *California Building Code* (CBC) (State of California 2007). The requirements apply to public buildings intended for human occupancy and a large percentage of private buildings intended for human occupancy.

Until January 1, 2008, the CBC was based on the then-current Uniform Building Code and contained Additions, Amendments, and Repeals specific to building conditions and structural requirements in the State of California. The 2007 CBC, effective January 1, 2008, is based on the current (2006) International Building Code. The more precise requirements for fire safety, equal access for disabled persons, and environmentally friendly construction are among the most obvious differences from the previous CBC based on the Uniform Building Code. Seismic-resistant construction design is also required to meet more stringent technical standards than those set by previous versions of the CBC. Each jurisdiction may adopt its own building code based on the 2007 CBC. Local codes are permitted to be more stringent than the 2007 CBC, but, at a minimum, are required to meet all State standards and enforce the regulations of the 2007 CBC beginning January 1, 2008.

Chapters 16 and 16A of the 2007 CBC deal with Structural Design requirements governing seismically resistant construction, including (but not limited to) factors and coefficients used to establish seismic site class and seismic occupancy category for the soil/rock at the building location and the proposed building design. Chapters 18 and 18A of the 2007 CBC include (but are not limited to) the requirements for foundation and soil investigations (Sections 1802 & 1802A); excavation, grading, and fill (Sections 1803 & 1803A); allowable load-bearing values of soils (Sections 1804 & 1804A); and the design of footings, foundations, and slope clearances (Sections 1805 & 1805A), retaining walls (Sections 1806 & 1806A), and pier, pile, driven, and cast-in-place foundation support systems (Sections 1808, 1808A, 1809, 1809A, 1810 & 1810A). Chapter 33 of the 2007 CBC includes (but is not limited to) requirements for safeguards at work sites to ensure stable excavations and cut or fill slopes (Section 3304). Appendix J of the 2007 CBC includes (but is not limited to) grading requirements for the design of excavations and fills (Sections J106 & J107) and for erosion control (Section J110).

California Geological Survey Special Publications

The California Geological Survey produces a variety of on-line and hard-copy publications that provide guidance for individuals and municipalities addressing issues related to geology and geologic hazards including fault rupture, seismic groundshaking, liquefaction, landsliding, settlement, etc. With the exception of Official Maps, such as Earthquake Fault Zones and Seismic Hazard Zones, these publications represent compendia of State legislation, professional judgment, and Best Management

Practices recognized by the State of California as appropriate methods for investigating and mitigating geologic hazards. Although many of the guidelines have been adopted by the State for advisory purposes, none has the force of law in itself unless adopted specifically by a municipality as its "official" procedure. Most municipalities have not adopted any of these documents as official procedures, but expect their consultants to use them as intended – as the most practical and widely accepted guides for addressing issues arising from geologic conditions within the municipality's jurisdiction. The City has not codified any of these guidelines in its Municipal Code.

General Waste Discharge Requirements for Discharges to Surface Waters That Pose an Insignificant (De Minimus) Threat to Water Quality (De Minimus Threat General Permit)

Low threat discharges are regulated under Order No. R8-2006-0004 Amending Order No. R8-2003-0061, NPDES No. CAG998001 As amended by Order No. R8-2005-0041, General Waste Discharge Requirements for Discharges to Surface Waters That Pose An Insignificant (De Minimus) Threat to Water Quality. De minimus threat discharges are not expected to cause toxicity; therefore, no toxicity limits are specified in this general permit. Construction dewatering wastes (except stormwater) are regulated as de minimus threat discharges to surface waters that are subject to the terms and conditions of this Order and all dischargers must comply with the effluent limitations specified in the Revised Discharge Specifications A.1.a and A.1.b and monitoring and reporting program of this Order. Because each future project would have site-specific geotechnical considerations, it is possible that future development under the proposed Specific Plan could require groundwater dewatering during construction and/or operation, which would be subject to the requirements of this De Minimus Threat General Permit.

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. 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.

Huntington Beach Municipal Code and Grading Ordinance

The City adopted the 2007 CBC as the basis for its own Building Code (Municipal Code Title 17, Chapter 17.04) through Ordinance No. 3789 on December 3, 2007. The Building Code, as adopted, includes acceptable 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 on November 3, 2003 through Ordinance No. 3621 as Municipal Code Title 17) 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. These two code chapters stipulate the requirements for proposed new development in the City to address geotechnical issues, including all aspects of geologic and engineering site investigation, seismic-resistance foundation and building design, and slope and soil stability including erosion and sediment control. Development is required to comply with the Huntington Beach Building Code, Grading and Excavation Code, and all State requirements pertaining to geologic, soil, and seismic hazards. With this regulatory framework in place, the City has the authority to enforce the General Plan policies protecting the public from geotechnical hazards associated with proposed development.

Huntington Beach General Plan, Environmental Hazards Element

The 1996 Environmental Hazards Element contains concise descriptions of regional and local geologic, soils, and seismic conditions; 13 graphics indicating areas of the City subject to various geotechnical conditions; and a set of Goal, Objective, and Policy Statements, together with specific Implementation Programs, directed toward the reduction, elimination, or avoidance of risks to public safety arising from those conditions. With the adoption of this Element, the City has established its intent and basis of authority to require investigation and, if necessary, mitigation of geotechnical hazards that could threaten proposed developments. Research and education are emphasized in the policies and programs, but the critical components for ensuring the safety of new development are contained in Policy EH 1.2.1 and Implementation Program I-EH 5. It is the Applicant's responsibility to provide the City with appropriate geological and/or geotechnical information for the City to determine whether the proposed project meets the General Plan goals and objectives.

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 (UBC). (I-EH 5)

Implementation Program I-EH 5 Ordinances a. Enforce the most current Uniform Building code adopted by the State of California.

Consistency Analysis

Future development would be required to be constructed in accordance with *Huntington Beach Municipal Code* design requirements for structures for human occupancy. Minimum requirements for protection from seismic hazards, including foundation support and structural design, are specified in the *Building Code* (see above). Minimum grading requirements, including erosion control, excavation stability, and fill material acceptability are specified in the *Grading and Excavation Code* (see above). Future development would incorporate the required site preparation and structural design recommendations included in the geotechnical reports prepared for individual project sites. The incorporated measures would ensure that earthquake survivability is a primary concern in the design and construction of future development. Implementation of the proposed Specific Plan would not conflict with these policies.

Although peat layers are known to be present in the Specific Plan area, hazards associated with the subsidence or collapse of these organic soils would be avoided through the use of a pile foundation or through other foundation recommendations per a project-specific final soils report and geotechnical analysis that would not depend on the peat for its support (see above). Implementation of the proposed project would not conflict with this policy.

4.5.3 Project Impacts and Mitigation

Analytic Method

Information regarding regional geology and seismically induced hazards was researched in various sources of the CGS and the USGS. Estimated earthquake magnitudes resulting from potential seismic activity on various active faults in the area were obtained from various analyses included with the Geological Investigation and the General Plan Environmental Hazards Element. Where potential geological hazards are identified, such hazards would be expected to affect any proposed development in the hazard area.

The following analysis considers the potential effects of the proposed project described in Chapter 3 (Project Description) of this EIR. Construction-related impacts are considered for the project as a whole. Operational-related impacts of the project site are considered in the context of seismic and/or other geological hazards to residents, employees, and visitors.

Thresholds of Significance

The following thresholds of significance are based on Appendix G of the 2009 CEQA Guidelines and have been updated to meet the State requirement that the 2007 *California Building Code* be enforced by each jurisdiction in California after January 1, 2008. For purposes of this EIR, implementation of the proposed project would have a significant adverse impact if it would create any of the following conditions:

- 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 known fault
  - Strong seismic groundshaking
  - Seismic-related ground failure, including liquefaction
  - Landslides
- Result in substantial soil erosion, loss of topsoil, or changes in topography or unstable soil conditions from excavation, grading, or fill
- 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 Section 1802.3.2 of the *California Building Code* (2007), creating substantial risks to life or property

- 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

Adverse impacts in any of the above categories would be considered unavoidable significant effects of the proposed project, if they could not be *(a)* reduced to a level of risk consistent with the standards established by the *Huntington Beach Building Code*, *(b)* eliminated, or *(c)* avoided by using generally accepted geotechnical methods applied in California.

Adherence to design and construction standards, as required by state and City regulations and codes described previously, would ensure maximum practicable protection for users of the buildings and associated infrastructure. All aspects of seismic-related hazards, other geotechnical hazards, and erosion and sedimentation issues are regulated by City of Huntington Beach and/or the State of California. All potential geotechnical impacts are required by these codes and regulations to be rendered less-than-significant as part of proposed project designs.

Effects Not Found to Be Significant

Threshold	Would the project have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?

The Specific Plan Area is currently provided sanitary sewer service by the City of Huntington Beach. The City would continue to provide these services to development in the Specific Plan area. No septic tanks or alternative wastewater systems are proposed. Therefore, no impact would occur and no further analysis of this issue is required.

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: ■ Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Fault Zone Map as issued by the State Geologist for the area or based on other substantial evidence of known fault? ■ Strong seismic groundshaking? ■ Seismic-related ground failure, including liquefaction?

Impact 4.5-1 **Future development under the proposed project could expose people and/or structures to potentially substantial adverse effects, including the risk of loss, injury, or death, involving fault rupture, strong seismic groundshaking and/or seismic-related ground failure, including liquefaction. Although seismic groundshaking would occur during major earthquakes, with compliance with applicable State and City regulations and implementation of mitigation measures, this impact is considered *less than significant*.**

A buried segment of the North Branch Fault underlies an intersection of the Specific Plan area. An 800-foot-wide Alquist-Priolo Fault Zone crosses the Beach Boulevard Corridor at Adams Avenue. All corners of the intersection at Beach Boulevard and Adams Avenue are currently developed with low-scale commercial uses, and no residential uses. Immediately to the east of Beach Boulevard, and north of Adams Avenue is a large undeveloped sloping area (i.e., Bartlett Park); it is likely that the hillside resulted from previous fault rupture. The *Alquist-Priolo Fault Zoning Act* prohibits the construction of buildings for human occupancy across the trace of a known fault. Proposed construction within an Earthquake Fault zone is permitted only following the completion of a fault location evaluation and written report prepared for the specific site by a California-registered professional geologist. Avoidance of the active trace is the only available treatment and is required by the Act for sites within the State of California Earthquake fault zone.

The proposed Specific Plan is a navigational tool to guide development of the Beach Boulevard and Edinger Avenue Corridors; no specific development plans have been submitted for parcels located within the fault zone. All future development would be required to perform a site specific Geotechnical Report which includes design and foundation recommendations and adhere to the City's Municipal Code. No structures intended for human occupancy have been proposed under the Specific Plan in areas subject to potential fault rupture.

The Specific Plan is located in a seismically active Region. During the design life of existing and future development, strong seismic groundshaking will occur throughout the project site. Review of regional and local geo-seismic conditions indicates the Specific Plan area would probably be subjected to at least one major earthquake during the next 30 years. A characteristic earthquake (see Glossary in Section 4.5.5) on the San Andreas fault (M_W 7.5), 51 miles to the northeast of the City Center, probably is the largest that would affect the Specific Plan area, but a characteristic earthquake of the Newport-Inglewood fault (M_W 7.1) could be more destructive because the fault crosses Beach Boulevard at Adams Avenue in the southern portion of the project site (refer to Figure 4.5-2). Section 1613 Earthquake Loads, of the 2007 CBC requires the seismic-resistant design for the project buildings to factor in a design earthquake that would create average peak ground accelerations of at least 1.0g. Damage resulting from a design earthquake could include general damage to foundations, shifting of frame structures if not bolted in place, and breaking of underground pipes. In addition, active and potentially active regional faults are capable of producing seismic groundshaking throughout the project site. It is anticipated that existing and future development in the Specific Plan area would experience ground acceleration periodically as a result of small and moderate magnitude earthquakes occurring on active nearby and distant faults. Future development and improvements could be adversely affected by seismic groundshaking if required design measures were not implemented.

Most of the Beach Boulevard corridor, north of Warner Avenue in the vicinity of Beach Boulevard and Slater Avenue, and south of Adams Avenue is in a liquefaction investigation zone on the State of California State Hazard Zone Map for the Newport Beach and Seal Beach Quadrangles. Figure 4.5-4 shows that the Beach Boulevard corridor, north of Heil Avenue and south of Indianapolis Avenue is located mostly in "High to Very High" liquefaction areas. Slater Avenue to Heil Avenue and Yorktown Avenue to Indianapolis Avenue along the Beach Boulevard Corridor is mostly "High to Medium" liquefaction potential. The Edinger Avenue Corridor and the remainder of the project site have "Low" Liquefaction Potential.

Adherence to the City's *Municipal Code* would ensure the maximum practicable protection available for all future development throughout the Specific Plan area. Design of all future development under the Specific Plan would be required to include the application of CBC seismic standards as the minimum seismic resistance. The applicable code requirements include seismic-resistant earthwork and construction design criteria, based on site-specific recommendations of the project's California-registered geotechnical and structural engineers; engineering analyses that demonstrate satisfactory performance of any unsupported cut or fill slopes, and of alluvium and/or fill where they form part or all of the support for structures, foundations and underground utilities; and analyses of soil expansion, collapse, and subsidence potential and appropriate remediation (compaction, removal-and-replacement, etc.) prior to using any soils for foundation support, as explained below.

Adherence to the seismic design and construction parameters of the CBC, as required by State law, would ensure protection of occupants and visitors within the project site. Compliance with the CBC includes the following procedures to ensure protection of structures and occupants from geo-seismic hazards:

- The 2007 design criteria for protection of structures and earthworks at the project site from groundshaking and ground failure would be review and updated, as necessary, by a California Certified Engineering Geologist, or California-licensed Civil Engineer (Geotechnical) to ensure compliance with the 2007 CBC standards of performance.
- During site preparation, a registered geotechnical professional must be on the site to supervise implementation of the recommended criteria.
- A California Certified Engineering Geologist, or California-licensed Civil Engineer (Geotechnical) for the Applicant must prepare an "as built" map/report to be filed with the City showing details of the site geology, the location and type of seismic-restraint facilities, and documenting the following requirements, as appropriate.
  - > Engineering analyses demonstrating satisfactory performance of compacted fill or natural unconsolidated sediments where either forms part or all of the support for any structures, especially where the possible occurrence of liquefiable, compressible, or expansive soils exists.
  - > Engineering analyses demonstrating accommodation of settlement or compaction estimates by the site-specific Geotechnical Report for access roads, foundations, and underground utilities in fill or alluvium.

Additionally, CR4.5-1 and MM4.5-1 would be required.

CR4.5-1 *A California-licensed Civil Engineer (Geotechnical) shall prepare and submit to the City a detailed soils and geotechnical analysis with the first submittal of a grading plan for future development. This analysis shall include Phase II Environmental soil sampling and laboratory testing of materials to provide detailed recommendations for grading, chemical and fill properties, liquefaction, and landscaping.*

MM4.5-1 *Future development in the Beach Boulevard and Edinger Avenue Corridors Specific Plan area shall prepare a grading plan to contain the recommendations of the final soils and geotechnical report. These recommendations shall be implemented in the design of the project, including but not limited to measures associated with site preparation, fill placement, temporary shoring and permanent dewatering, groundwater seismic design features, excavation stability, foundations, soil stabilization, establishment of deep foundations, concrete slabs and pavements, surface drainage, cement type and corrosion measures, erosion control, shoring and internal bracing, and plan review.*

Implementation of the Specific Plan would not result in specific projects along the Corridor, rather the Specific Plan is a planning document which would guide future development and provide policy framework for development throughout the Corridor. In view of the requirements to comply with the seismic safety requirements of the City's Municipal Code, including adherence to CR4.5-1, as well as adherence to mitigation measure MM4.5-1 and the design recommendations of the Geotechnical Investigation to be included in all future project design, the proposed Specific Plan's impact on exposure to seismically induced groundshaking and seismic-related ground failure would be ***less than significant***.

Threshold	Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving landslides?

Impact 4.5-2 **Future development under the proposed project could expose people or structures to risk of loss, injury, or death involving landslides. However, with compliance with soil stability standards required by the City of Huntington Beach General Plan, Building Code, and Grading and Excavation Code, and implementation of code requirements and mitigation measures, this impact is considered *less-than-significant*.**

The Specific Plan area is a relatively flat area with no pronounced slopes. As shown in Figure 4.5-4, only a small portion of the Beach Boulevard corridor is in an area identified to have "Low" potential for slope instability. The remainder of the project site has no potential for slope instability. Slope stability issues related to the sides of excavation during construction of the Specific Plan are regulated by the City's *Municipal Code*. Adherence to the City's *Municipal Code*, CR4.5-1, mitigation measure MM4.5-1 and the design recommendations of the Geotechnical Investigation to be prepared for all future development would ensure that a ***less-than-significant*** impact from landslide would result and no further analysis is required.

Threshold	Would the project result in substantial soil erosion, loss of topsoil, or changes in topography or unstable soil conditions from excavation, grading, or fill?

Impact 4.5-3 **Construction and operation of future development under the proposed project could result in substantial soil erosion, loss of top soil, changes in topography or unstable soil conditions. However, with compliance with slope stability, soil stability, and seismic-resistant design standards for structures proposed for human occupancy required by the City of Huntington Beach General Plan, Building Code, and Grading and Excavation Code and implementation of code requirements and mitigation measures, this impact is considered *less than significant*.**

For the purposes of this analysis, erosional effects consider whether project activities would accelerate natural erosional processes. Because the Specific Plan area is currently developed, natural erosion processes have not occurred in the recent past.

Future development under the proposed Specific Plan would result in ground-disrupting activities such as excavation and trenching for foundations and utilities; soil compaction and site grading; and the erection of new structures, all of which would temporarily disturb soils. The exposure of previously covered soils during these activities could lead to increased on-site erosion and off-site sediment transport because disturbed soils are susceptible to higher rates of erosion from wind, rain, and runoff of dewatering discharge or dust control water than undisturbed soils. The State Water Resources Control Board and the City's *Municipal Code* require erosion and sediment controls for construction projects with land disturbance. The City's *Grading and Excavation Code* (*Municipal Code* Title 17, Chapter 17.05), which implements the requirements of CBC Appendix Section J110, Erosion Control, for construction periods, addresses the issue of soil loss. The requirements include preparation and implementation of a Storm Water Pollution Prevention Plan (SWPPP), with both construction-period and permanent erosion and sediment controls; preparation and implementation of an erosion and sediment control plan, describing both construction-period and permanent erosion and sediment controls; and construction site inspection by the City. Future development under the Specific Plan would be required to comply with these existing regulations. Adherence to these requirements would prevent substantial on-site erosion and would reduce impacts to a less-than-significant level from the perspective of soil loss at the construction site.

Off-site erosion and sedimentation could occur if increased stormwater runoff were conveyed over unstable off-site soil surfaces or to a susceptible creek or channel where the higher erosive forces associated with increased flow rates could contribute to off-site erosion, including streambed and bank erosion. Because all stormwater from the Specific Plan area would continue to be conveyed through the City storm drainage system, stormwater runoff would not flow over unstable off-site soil surfaces, and there would be a low probability of erosion or sedimentation involving them.

Earth-disturbing activities associated with construction 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. Any project sites 1 acre in size or larger are subject to the provisions of the General Construction Activity Stormwater Permit adopted by the State Water Resources Control Board (SWRCB). Applicants for specific development projects 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 SWPPP, applicable NPDES 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. Such compliance, in addition to implementation of CR4.5-1 and mitigation measure MM4.5-1, would ensure that erosion and other soil instability impacts resulting from future construction within the project site 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 4.5-4 **A portion of the Specific Plan area would be located on subsidence-prone and potentially liquefiable soils. However, with compliance with slope and soil stability standards required by the City of Huntington Beach General Plan, Building Code, and Grading and Excavation Code, and implementation of code requirements and mitigation measures, this impact is considered *less than significant*.**

The potential for landslides are addressed under Impact 4.5-2 and liquefaction is addressed under Impact 4.5-1. As explained in Section 4.5.1 (Environmental Setting), subsidence could be caused by the weight of large earthmoving equipment used during the construction phases of future development. In addition, the shallow groundwater table through the City may affect the stability of the soils during construction and operation of the proposed project.

Settlement

Most of the Specific Plan area north of Heil Avenue and south of Adams Avenue is located in areas containing a layer of peat or organic soils at least five feet deep. The remainder of the project site contains layers less than half a foot deep. Given the presence of organic materials, areas identified above could be subject to subsidence associated with hydrocompaction (the settling or hardening of land caused by application of large amounts of water), and/or peat oxidation (the decomposition of organic materials in the soil). Future development would be designed, constructed, and operated in conformance with Section 1802.2.1 Questionable Soils, of the City's *Municipal Code* and Title 17 *Excavation and Grading Code*. Therefore, potential risks to life and property from unstable soil conditions caused by settlement would be ***less than significant***.

Subsidence

Subsidence could result in the settlement of in-place subgrade soils caused by loads generated by large earthmoving equipment. Subsidence that could potentially occur would depend on the types of earthmoving equipment used. Due to the timeframe of the proposed Specific Plan with buildout estimated in 2030, the potential extent of settlement that could occur during this time is currently unknown. However, future development would be designed, constructed, and operated in conformance with Section 1802.2.1 Questionable Soils, of the City's *Municipal Code* and Title 17 *Excavation and Grading Code*. Therefore, potential risks to life and property from unstable soil conditions caused by subsidence would be ***less than significant***.

Shallow Groundwater

Depth of groundwater throughout most of the City is less than 30 feet bgs. Along Beach Boulevard the depth is at least 30 feet bgs from just north of Slater Avenue to just south of Yorktown Avenue. From Yorktown Avenue south toward the PCH, the water table rises to less than 3 feet bgs. Because of the shallow depth of groundwater, dewatering activities in the Specific Plan area could be needed during construction of any subterranean levels, such as for parking. The removal of groundwater to create a dry construction pit could cause porous soils to collapse when the support provided by the water was withdrawn. Temporary shoring, dewatering wells, storage tanks, filters, and erosion control measures would be required to comply with the City's Grading Manual (Chapter 17.05.030 of the *Huntington Beach Municipal Code*). Dewatering activities would be required to comply with the NPDES Permit for Groundwater Discharge from the Santa Ana Regional Water Quality Control Board. Impacts associated with dewatering as a result of construction and operation activities are addressed further in Impact 4.7-2.

Because future structures would be designed, constructed and operated in conformance with Section 1802.2.1 Questionable Soils, of the City's *Municipal Code* and Title 17 *Excavation and Grading Code*, and because the project would be required to comply with CR4.5-1, mitigation measure MM4.5-1, and CR4.7-1, potential risks to life and property from unstable soils caused by groundwater saturation or withdrawal would be ***less than significant***.

Threshold	Would the project be located on expansive soil, as defined in Section 802.3.2 of the California Building Code (2007), creating substantial risks to life or property?

Impact 4.5-5 **A portion of the Specific Plan area would be located on expansive soil. However, with compliance with soil stability standards required by the City of Huntington Beach General Plan, Building Code, and Grading and Excavation Code, and implementation of code requirements and mitigation measures, this impact is considered *less than significant*.**

As shown in Figure 4.5-5, most of the Beach Boulevard corridor north of Slater Avenue, in the vicinity of Ellis Avenue, and south of Adams Avenue are in areas of "Moderate to High" soil Expansion Potential. The remainder of the project site has "Low to Moderate" soil Expansion Potential. The existence of expansive soils makes it necessary to ensure the materials used for foundation support are sound to avoid future problems of foundation settlement and utility line disruption. An acceptable degree of soil stability could be achieved by treatment programs to eliminate expansion of soils which could include, but are not limited to, grouting (cementing the soil particles together), recompaction (watering and compressing the soils), and replacement with a non-expansive material (excavation of unsuitable soil followed by filling with suitable material). If future development occurs on sites with underlying expansive soils, development would be subject to the above-mentioned treatments as required by the City's *Municipal Code*.

Because future structures would be designed, constructed and operated in conformance with Section 1802.2.2 Expansive Soils, of the City's *Municipal Code* and Title 17 *Excavation and Grading Code*, and because the project would be required to comply with CR4.5-1 and mitigation measure MM4.5-1, potential risks to life and property associated with expansive soil would be reduced to a ***less-than-significant*** level.

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. Each project site has unique geologic considerations that would be subject to uniform site-development policies and construction standards imposed by the City of Huntington Beach. Restrictions on development would be applied in the event that geologic or soil conditions posed a risk to public safety. A regional context must be considered for the analysis of the cumulative effects of exposure of people or structures to seismic hazards other than surface rupture of a fault because the hazard generators (earthquakes) and the direct effects (groundshaking, ground failure) tend to be region-wide in nature. Additionally, a watershed-wide context must be considered for the analysis of the cumulative effects of potential erosion and siltation because the direct effects (turbidity, reduction of water quality, channel-bed sedimentation) can affect all downstream reaches of a waterway system. Nonetheless, 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 the geotechnical and seismic guidelines and recommendations of the City's *Municipal 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 therefore, the cumulative impact of the project would 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 Santa Ana River Watershed 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 control requirements, including applicable provisions of the general construction permit, BMPs, and Phases I and II of the NPDES permit process, as well as implementation of fugitive dust control measures in accordance with SCAQMD Rule 403 (refer to 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 Santa Ana River Watershed District caused by 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, therefore, also would be ***less than significant***.

Implementation of the proposed project would result in the modification of site conditions to accommodate future 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. The City's *Grading and Excavation Code* (*Municipal Code* Title 17, Chapter 17.05), implements the requirements of CBC Appendix Section J110, Erosion Control, for construction periods. Adequate protection in the form of BMPs and erosion and sediment control plans must be incorporated into individual projects to address current legal requirements for control of erosion caused by stormwater discharges. Project sites of more than 1 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, therefore, would be ***less than significant***.

4.5.5 Glossary

- **Alquist-Priolo Earthquake Fault Zone**—In 1972 the state of California began delineating special studies zones (called Earthquake Fault Zones since January 1994) around active and potentially active faults in the state. The zones are revised periodically, and extend 200 to 500 feet on either side of identified fault traces. No structures for human occupancy may be built across an identified active fault trace. An area of 50 feet on either side of an active fault trace is assumed to be underlain by the fault, unless proven otherwise. Proposed construction within the Earthquake Fault Zone is permitted only following the completion of a fault location report prepared by a California Registered Geologist.
- **Blind Thrust Fault**—A seismic rupture plane that is not visible at the ground surface and is at a low to moderate angle.
- **Characteristic Earthquake**—Characteristic earthquakes are repeat earthquakes that have the same faulting mechanism, magnitude, rupture length, location, and, in some cases, the same epicenter and direction of rupture propagation as earlier shocks. As used in this report, the M_W of the "characteristic earthquake" indicates the scale of the seismic event considered representative of a particular fault segment, based on seismologic observations and statistical analysis of the probability that a larger earthquake would not be generated during a given time frame (often 50 or 100 years). The term "characteristic earthquake" replaces the term "maximum credible earthquake" as a more reliable descriptor of future fault activity.
- **Design Earthquake Ground Motion**—The seismically induced acceleration that buildings and structures are specifically proportioned to resist in Section 1613 of the 2007 *California Building Code*.
- **Geomorphic Provinces**—California's geomorphic provinces are naturally defined geologic regions that display a distinct landscape or landform. Earth scientists recognize eleven provinces in California. Each region displays unique, defining features based on geology, faults, topographic relief, and climate. These geomorphic provinces are remarkably diverse. They provide spectacular vistas and unique opportunities to learn about earth's geologic processes and history.
- **Horizontal Ground Acceleration**—The speed at which soil or rock materials are displaced by seismic waves. It is measured as a percentage of the acceleration of gravity (0.5 g = 50 percent of 32 feet per second squared, expressed as a horizontal force). Peak horizontal ground acceleration is the maximum acceleration expected from the characteristic earthquake predicted to affect a given area. Repeatable acceleration refers to the acceleration resulting from multiple seismic shocks.

Sustained acceleration refers to the acceleration produced by continuous seismic shaking from a single, long duration event.

- **Maximum Credible Earthquake**—The largest Richter magnitude (M) seismic event that appears to be reasonably capable of occurring under the conditions of the presently known geological framework. This term has been replaced by "characteristic earthquake," which is considered a better indicator of probable seismic activity on a given fault segment within a specific time frame.
- **Maximum Considered Earthquake Ground Motion**—The most severe seismically induced acceleration effects considered by the 2007 *California Building Code*.
- **Moment Magnitude (M_W)**—A logarithmic scale introduced by Hiroo Kanamori in 1977 that is used by modern seismologists to measure the total amount of energy released by an earthquake. For the purposes of describing this energy release (i.e., the "size" of an earthquake on a particular fault segment for which seismic-resistant construction must be designed) the M_W of the characteristic earthquake for that segment has replaced the concept of a maximum credible earthquake of a particular Richter M. This has become necessary because the Richter scale "saturates" at the higher magnitudes; that is, the Richter scale has difficulty differentiating among the sizes of earthquakes above M 7.5. To correct for this effect, the formula used for the M_W scale incorporates parameters associated with the rock types at the seismic source and the area of the fault surface involved in the earthquake. Thus, the M_W is related to the length and width of the fault rupture. It reflects the amount of "work" (in the sense of classical physics) done by the earthquake. The relationship between M and M_W is not linear (i.e., M_W is not a set percentage of M): the two values are derived using different formulae. The four well-known earthquakes listed below exemplify this relationship.

Location	Date	Richter Magnitude	Moment Magnitude
New Madrid MO	1812	8.7	8.1
San Francisco CA	1906	8.3	7.7
Anchorage AK	1964	8.4	9.2
Northridge CA	1994	6.4	6.7

Although some of the values shown on the moment magnitude scale (M_W) appear lower than those of the Richter magnitude scale (M), they convey more precise (and more useable) information to geologic and structural engineers.

- **Richter Magnitude Scale (M)**—A logarithmic scale developed in 1935 and 1936 by Dr. Charles F. Richter and Dr. Beno Gutenberg to measure earthquake magnitude (M) by the amount of energy released, as opposed to earthquake intensity as determined by local effects on people, structures, and earth materials (for which, see Modified Mercalli Intensity Scale, above). Each whole number on the Richter scale represents a 10-fold increase in amplitude of the waves recorded on a seismogram and about a 32-fold increase in the amount of energy released by the earthquake. Because the Richter scale tends to saturate above about M 7.5, it is being replaced in modern seismologic investigations by the M_W scale (see above).

4.5.6 References

California. 1972 (amended 1997). *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.

California Building Standards Commission. 2007. *2007 California Building Code*, *California Code of Regulations*, Title 24, Part 2, Volumes 1 and 2, effective January 1, 2008.

California Geological Survey. 1997. CGS Special Publication 117, *Guidelines for Evaluating and Mitigating Seismic Hazards in California*.

California Geological Survey. 2003. CGS Special Publication 42, *Fault-Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with index to Earthquake Fault Zones Maps*.

Huntington Beach, City of. 1996. *The City of Huntington Beach General Plan*. "Environmental Hazards Element."

Southern California Earthquake Data Center (SCEDC). 2007. *Alphabetical Fault Index*. 2006. Website: http://www.data.scec.org /fault_index/alphadex.html (accessed October 17).

Working Group on California Earthquake Probabilities (WGCEP). 2007. Forecasting California's Earthquakes—What Can We Expect in the Next 30 Years? http://pubs.usgs.gov/fs/2008/3027/fs2008-3027.pdf (accessed February 25, 2009).