IV. ENVIRONMENTAL IMPACT ANALYSIS
K. GEOLOGIC AND SEISMIC HAZARDS

1. ENVIRONMENTAL SETTING

This section provides an analysis of seismic hazards such as fault rupture, ground shaking, land sliding, and liquefaction. The implications of former local oil fields and potential subsidence are also analyzed, although they are not seismic-related hazards.

For planning purposes, the City of Los Angeles was divided into eleven subregions for many of the issues addressed in the *General Plan Framework Draft EIR*,[109] including the issues of geologic and seismic impacts. The South Park area of the Central Business District in which the Project site is located is within the *Central City Community Plan* area (Central City area) of downtown Los Angeles. Therefore, much of this analysis is based on information regarding the Central City area provided in the *General Plan Framework* documentation.

a. Topography and Geologic Conditions

The Project site is located in the northern portion of the Central Block of the Los Angeles Structural Basin. The Central Block is a fault-bounded basin characterized by an alluviated lowland plain that is bounded on the west by the Santa Monica Mountains and associated Santa Monica Fault, on the north by the Elysian and Repetto Hills and Elysian Park Fault, on the northeast by the Puente Hills and Whittier Fault, on the east by the Santa Ana Mountains, on the southeast by the San Joaquin Hills, and on the southwest by the Newport-Inglewood Fault zone.

The Project site is located in a relatively level area. Soil beneath the site consists primarily of Quarternary alluvial sediments that includes clay, silt, sand, and gravel, which in turn is underlain by marine and non-marine sedimentary deposits that extend to considerable depths. Holocene age alluvial deposits consisting of interlayered sand, silt, and clay with some gravel underlie the STAPLES Center site. These alluvial deposits extend to a depth of approximately 65 feet beneath the project site and are underlain by Pleistocene age alluvial deposits consisting of clay, silt, sandy silt, sand and gravel. The Pleistocene age alluvial deposits are approximately 80 feet thick and are underlain by approximately 12,000 feet of Tertiary age sedimentary rocks. The Tertiary age rocks

[109] *Los Angeles Citywide General Plan Framework Draft EIR, January 1995*

are underlain by igneous and metamorphic basement rocks (Yerkes et al., 1965).[110] It is likely that similar deposits and rocks underlie the Project site.

Regarding groundwater, the closest groundwater monitoring well is Los Angeles County Well No. 2735A, located about 400 feet south-southeast of the STAPLES Center. Water level measurements for this well indicate the depth to groundwater was 137.2 feet in April 1994. This depth corresponds to a water surface elevation of approximately 97.8 feet above mean sea level. Groundwater was not encountered during borings drilled for the STAPLES Center project in May and June 1997. These borings were drilled to a maximum depth of 51 feet.[111]

b. Seismic Hazards

(1) Seismicity

The seismicity of the region surrounding the site was determined from research of a computer catalog of seismic data. This catalog includes earthquake data compiled by the California Institute of Technology (CalTech) for 1932 to 1997 and data for 1812 to 1931 compiled by Richter and the U.S. National Oceanic Atmospheric Administration (NOAA). The search for earthquakes that occurred within 100 kilometers (62 miles) of the STAPLES Center site indicates that 393 earthquakes of Richter magnitude 4.0 and greater occurred between 1932 and 1997, two earthquakes of magnitude 6.0 or greater occurred between 1906 and 1931; and one earthquake of magnitude 7.0 or greater occurred between 1812 and 1905. Several earthquakes of moderate to large magnitude have occurred in the Southern California area within the last 60 years. A list of these earthquakes is included in Table 56 on page 422.[112]

(2) Fault Rupture Potential

Numerous active and potentially active faults with surface expressions, also known as fault traces, have been mapped adjacent to, within, and beneath the City of Los Angeles. Potentially active faults include those faults that may be possible earthquake sources but for which there is no known data that conclusively demonstrate fault movement since the Holocene era, that is, within the past 10,000 to 12,000 years. Active faults are of the most relevance for analyzing earthquake generation and fault rupture potential because there is either documented evidence of movement on these faults since the Holocene era or they are clearly associated with historic seismicity.

[110] *Law/Crandall, Report of Geotechnical Investigation, Proposed Los Angeles Sports and Entertainment Center, July 1997.*

[111] *Ibid.*

[112] *Ibid.*

Table 56

LIST OF HISTORIC EARTHQUAKES

Earthquake (Oldest to Youngest)	Date of Earthquake	Magnitude	Distance to Epicenter (Kilometers)	Direction to Epicenter
Long Beach	1933	6.4	34	SSE
San Fernando	1971	6.6	27	NNW
Whittier Narrows	1987	5.9	11	E
Sierra Madre	1991	5.8	22	NE
Landers	1992	7.3	100	E
Big Bear	1992	6.4	81	ENE
Northridge	1994	6.7	19	NW

Source: PCR Services Corporation, December 2000.

The active and potentially active faults in the City which are deemed capable of producing fault rupture due to seismic activity are found on Figure 50 on page 423, and include in decreasing order of concern for City planning purposes: Newport-Inglewood, Hollywood, Elysian Park, Santa Monica, San Fernando, Raymond, Sierra Madre, Verdugo, Northridge, and Palos Verdes.[113] These faults have ground rupture potential and may be expected to generate movement at the surface ranging from a few inches to about six feet. The maximum credible and probable earthquake from each of these faults is shown on Table 57 on page 424.

The State provides maps to city and county agencies designating Alquist-Priolo Earthquake Fault Zones for purposes of planning, zoning, and building regulation functions.[114] The *City of Los Angeles General Plan Seismic Safety Plan Element* also identifies Fault Rupture Study Zones (referred to as Alquist-Priolo Earthquake Fault Zones) based on known or assumed active or potentially active faults.[115] Regulations for Alquist-Priolo Earthquake Fault Zones include requirements designed to minimize potential impacts during seismic events including prohibiting the location of most structures for human occupancy across the traces of active faults. None of the City-designated Fault Rupture Study Zones[116] or State-designated Alquist-Priolo Earthquake Fault Zones crosses the Project site. Two Fault Zones are located with a five-mile radius of the site, also shown

[113] *City of Los Angeles, Los Angeles Citywide General Plan Framework Draft EIR, January 1995.*

[114] *In compliance with the Alquist-Priolo Special Study Zones Act, PR 26622(a), the State Geologist has mapped special study zones adjacent to "faults considered to have been active during Holocene time (within 11,000 years to the present) and to have a relatively high potential for surface rupture."*

[115] *Approximately one-eighth mile zones on each side of potentially active and active faults to establish hazard potential.*

[116] *City of Los Angeles Planning Department, Los Angeles Citywide General Plan Framework, GIS Maps, March 1994.*

Figure 50 Regional Major Faults

Table 57

ESTIMATED PROBABLE EARTHQUAKE MAGNITUDES

Fault Name	Maximum Credible Event [a]	Maximum Probable Event [b]
Elysian Park	7.00+	6.00
Newport-Inglewood	7.50	6.00
Palos Verdes	7.50	6.75
San Gabriel	7.00	5.75
Santa Monica-Hollywood	7.50	5.50
Santa Susana	7.00	6.00
San Fernando-Sierra Madre	7.50	6.00
Raymond	7.00	5.00
Sierra Madre	7.50	6.00
Northridge Hills	6.50	5.00
Verdugo	6.75	5.00

[a] *The maximum credible event is defined as the theoretical maximum event which could occur along a fault.*

[b] *The maximum probable event is defined as the maximum earthquake that may reasonably be expected within a 100-year period.*

Source: Los Angeles General Plan Framework Draft EIR, January 1995.

on Figure 50. These two fault zones include the Malibu-Santa Monica-Raymond Fault Zone and Newport-Inglewood Fault Zone and are both City-designated Fault Rupture Zones and Alquist-Priolo Earthquake Fault Zones. The nearest known fault to the site is the Elysian Park-Wilshire Thrust Zone, located approximately 3.5 miles northeast of the Project site. A segment of this Zone, the Elysian Park Fault, has not been designated as a Fault Rupture Zone or an Alquist-Priolo Earthquake Fault Zone.

A second type of fault that is not exposed at the surface, known as “blind or buried thrust,” has been the focus of study since the 1987 Whittier Narrows earthquake. These faults typically do not offset surface deposits; however, they do generate coseismic uplift and very likely cause coseismic movement on fault traces that may be linked to the blind thrust at substantial depth. Few published maps exist which attempt to delineate the precise subsurface boundaries of these blind thrusts; however, it seems probable that nearly all of the City is underlain by some form of near horizontal or shallow dipping blind thrust.[117]

[117] *Ibid.*

An example of a major earthquake that occurred on a blind thrust fault was the Northridge earthquake that occurred on January 17, 1994. The surface magnitude of the earthquake measured magnitude 6.7 on the Richter scale as determined by Caltech. The earthquake's epicenter was located approximately 30 kilometers (km) west-northwest of downtown Los Angeles. This event was the largest to have occurred in the Los Angeles region during the 20^{th} Century. Damages resulting from the earthquake were widespread and included the collapse of six sections of highway structures, thousands of damaged or destroyed residential and commercial structures, widespread disruption of utilities and other lifeline facilities in the epicentral region, and a number of soil embankment failures and numerous landslides.[118] The blind or buried thrust faults located beneath the City which are deemed capable of seismic activity include the Elysian Park-Wilshire (the Elysian Park Fault discussed above is one segment of this thrust zone), Santa Susana, Compton-Los Alamitos, Torrance-Wilmington, and San Fernando Ramp Thrusts. Of these, the Elysian Park-Wilshire Thrust Zone has the greatest potential to impact the Project site, as the entire Central City area of the City is believed to be underlain by this Zone. This Thrust Zone was responsible for the 1987 Whittier Narrows earthquake that had a Richter Magnitude of 5.9, and has the potential capability of producing a maximum probable earthquake between magnitude 5.5 and 6.0 and a maximum credible earthquake of greater than magnitude 7.0.[119]

(3) Ground Shaking

The most widespread, damaging effects of earthquakes are caused by strong ground shaking. The intensity of ground shaking at a given location depends on several factors, but primarily on the earthquake magnitude, the distance of the site from the earthquake's epicenter, and the response characteristics of the soil or bedrock units underlying the area. Strong ground shaking can catastrophically damage structures.

The two most consistent databases that assess the City's ground shaking hazard potential are the California Division of Mines and Geology (CDMG) (1988) planning scenario study for a major earthquake (i.e., magnitude greater than 7.0) on the Newport-Inglewood Fault Zone (NIFZ) and the Caltrans (1992) estimates of peak horizontal acceleration from maximum credible earthquakes for rock and stiff-soil sites.[120] The CDMG scenario utilizes the Modified Mercelli Intensity (MMI) scale standard, a modeled seismic intensity distribution. The MMI intensity values are presented as VII, VIII, and IX, where IX is considered a high hazard, VIII is moderate, and VII is low. However, an episode of VII intensity could severely damage an unreinforced structure, cause parapets and building fronts to fall on to sidewalks, and tumble chimneys through roofs. According to the *General Plan Framework Draft EIR*, the Central City area could reach an intensity of VIII

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[118] *Preliminary Report on the Principal Geotechnical Aspects of the January 17, 1994 Northridge Earthquake, University of California at Berkeley, College of Engineering, June 1994.*

[119] *Los Angeles Citywide General Plan Framework Draft EIR, January 1995.*

[120] *Ibid.*

(moderate) from the Newport Inglewood Fault Zone (NIFZ) scenario earthquake. Furthermore, according to the Caltrans scenario, the Central City area could experience peak ground acceleration (PGA) of greater than 0.5 to 0.6g from a large earthquake on any of the nearby faults. The term "g" is the force of acceleration that is due to gravity. A PGA of greater than 0.5 to 0.6g is considered a high hazard, since it is greater than minimum levels upon which building code standards are based.

The City of Los Angeles, in the *Citywide General Plan Framework Draft EIR*, evaluated the ground shaking hazard for parts of the City that are expected to accommodate the majority of future growth. The entire Project site is located in Targeted Growth Area (TGA)[121], Central City-2 (CC-2), which encompasses part of the Central City Subregion. The City's analysis concluded that this area has a moderate potential impact from ground shaking.

(4) Land sliding

Land sliding can occur from static slope instability of soil or bedrock or from earthquake-induced ground shaking. Land sliding is perhaps the leading cause of property damage and personal danger related to earthquakes. Usually associated with steep canyons and hillsides, earthquake-induced land sliding can originate on or move down slopes as gentle as one degree in areas underlain by saturated, sandy materials. There are no designated hillside areas (greater than 15 percent slope) or areas of landslide potential located in or around the Project site.[122]

(5) Liquefaction

Liquefaction is essentially the transformation of soil to a liquid state, resulting in lateral spreading, ground settlement, sand boils, and soil falls. In areas of low slopes and low topographic relief, seismically induced ground failure is commonly related to the liquefaction of sediments, particularly saturated cohesionless soils. Flatly bedded strata of poor cohesion may also slip relative to adjacent strata. Earthquake-induced liquefaction does not affect bedrock; however, it does affect certain types of alluvium under conditions of water saturation. Water-saturated, cohesionless, granular sediment situated at depths of less than 30 feet below the surface constitutes the ideal condition for the liquefaction process. Water levels encountered at depths of 30 to 50 feet present a low susceptibility to failure from liquefaction. Water levels below 50 feet indicate a very low risk of

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[121] *Targeted growth areas are those districts, centers, and boulevards identified within the General Plan Framework where new development is encouraged and within which incentives are provided by the policies of the specific Framework Element.*

[122] Los Angeles County General Plan, Safety Element *(Landslide Inventory - Plate 5), December 1990.*

failure.[123] As discussed above, groundwater level measurements and borings in the area indicate the depth to groundwater exceeds 50 feet.

Municipal/building codes, grading codes, and engineering investigation report requirements generally provide the means to identify and mitigate against unsafe conditions and construction practices regarding seismic risks prior to approval of building permits.

c. Oil Fields

Subsidence is the downward settling of the earth's surface with little or no horizontal motion. One cause of land subsidence is the withdrawal of fluids such as oil, gas, or water from deep geologic formations leaving void spaces at depths. Unless these voids, between the ground surface and the pumped geologic units, are refilled with fluids by re-pressurization techniques, they may collapse or settle, causing subsidence in the shallower earth layers. Land subsidence can result in varying degrees of distress to foundations and other engineered structures built above or within these subsiding earth layers caused by settling of the earth.

The southerly portion of the Project site (Figueroa South and Figueroa Central) is located within the boundary of the State-designated Los Angeles Downtown Oil Field. Currently, only a portion of the oil field is active, with many historic wells that are inactive and abandoned. No active oil, gas, or geothermal wells are located in the Project site area. In addition, no previously plugged or abandoned oil, gas, or geothermal wells are located in the Project site area. The closest previously plugged or abandoned oil, gas, or geothermal wells are the "Standard-Occidental Albany Core Hole 1," located under the Los Angeles Convention and Exhibition Center's West Hall Parking Garage, and the Chevron USA Inc., "Salvation Army Core Hole 1," located at the corner of Francisco Street and 9th Street.[124]

2. PROJECT IMPACT

a. Significance Thresholds and Methodology

A geotechnical impact assessment evaluates the effect of the geotechnical environment on proposed land use changes, rather than how land use changes will impact the environment. For purposes of this EIR, a significant geologic or seismic impact would occur if the Project posed an unacceptable threat to public safety or property through exposure of people, property, or

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[123] *Fault-Rupture Hazard Zones in California, Department of Conservation, Division of Mines and Geology Special Publication 42, 1988.*

[124] *Community Redevelopment Agency of the City of Los Angeles, Los Angeles Sports and Entertainment Complex Draft EIR, March 26, 1997.*

infrastructure to seismically-induced or oil field-induced hazards or oil field-related conditions by failure to comply with geotechnical engineering design criteria specified for and required of the Project through the building permit process.

Measurement of risk for geologic hazards is based on knowledge and geologic principles. Acceptability of risk is based on subjective criteria (public policy) and is a function of social, political, and economic factors. Evaluation of a geologic hazard impact is accomplished using engineering data (risk measurement) and by determination of the degree of acceptable risk (subjective criteria, including public policy, professional judgment and experience). Some level of risk is inherent on nearly every project and is typically evaluated on a site-specific basis. The level of risk is controlled by implementing project-specified engineering design and is a function of the potential hazard occurrence and magnitude.

b. Analysis of Project Impact

(1) Construction

Minor grading will be required for paved and hardscaped areas on the project site. Excavation of existing fill and unsuitable natural soils and replacement with properly compacted fill will be required to provide good support for paving and hardscape. In addition, excavation will be required for Project areas where subterranean parking will be required and for building foundations.

No exceptional difficulties are anticipated in excavating materials at the site. Groundwater is not anticipated to affect proposed construction activities. No significant impacts to geology and soils are anticipated during construction of the proposed project.

(2) Operation

In determining the overall impacts associated with seismic activity, the following topics are evaluated: fault rupture potential, ground shaking (e.g., peak horizontal ground acceleration in “g” and Modified Mercelli Intensity [MMI]), land sliding, and liquefaction. In addition, the potential risk of subsidence on the Project site is also evaluated.

c. Seismic Hazards

(1) Fault Rupture Potential

For those faults with surface expressions, ground rupture potential may be expected to generate movements at the surface ranging from a few inches to about six feet. This surface rupture would be concentrated along the mapped trace of the fault; however, collateral ground breakage with several inches of displacement may occur in proximity to these ruptures. A few inches of surface slip along a fault plane can severely damage structures built across a fault. Although blind thrusts are a much lower risk for fault rupture, they may generate localized uplift. Based on the data presently available, no faults with surface expressions are located on the Project site. The Elysian Park-Wilshire Thrust Zone is located potentially below the entire Central City Subregion. A mitigation measure has been included to reduce this potentially significant impact to a level of less than significant.

(2) Ground Shaking

The City of Los Angeles, in the *Citywide General Plan Framework Draft EIR*, evaluated the ground shaking hazard for all targeted growth areas (TGA) within the City. The Project is located within TGA CC-2, which has a moderate potential impact from ground shaking according to the City's analysis. Therefore, the introduction of employees, visitors, and residents onto the proposed Project site would increase the potential for on-site exposure to possible hazards associated with ground shaking. However, the location of the Project site in relation to known active faults indicates that it is not expected to be exposed to any greater seismic risk from ground shaking than found in other locations within the majority of the City and, in particular, downtown Los Angeles.

The potential hazards associated with ground shaking are addressed in the City's *Seismic Safety Plan* and by the Grading Standards that are incorporated within the *City of Los Angeles Building Code, Engineering Investigation Reports Standard,* and policies/programs contained in the City's Geologic Evaluation, Existing Development, New Development, and Critical Facilities publications. These documents establish standards for earthquake design features in Project buildings. The Project would increase the potential for on-site exposure to possible hazards associated with ground shaking. However, the Project site would not be exposed to any greater risk from ground shaking than any other site in the Central City area. The Project shall be designed to withstand ground shaking associated with a major earthquake event occurring on the Malibu-Santa Monica-Raymond Fault Zone, Newport-Inglewood Fault Zone, or the Elysian Park-Wilshire Thrust Zone. As ground shaking has the potential to affect all structures within the City of Los Angeles, this hazard would pose a potentially significant, but mitigable, impact associated with the Project site. A mitigation measure has been included to reduce this potentially significant impact to a less than significant level.

(3) Landsliding

No portions of the Project site are located in a designated hillside area. There are no known areas of landslide potential located on the Project site. Therefore, the potential for this hazard does not exist.

(4) Liquefaction

A 1993 City of Los Angeles Department of Public Works subsurface investigation conducted adjacent to the Project site did not encounter groundwater above 40 feet below ground surface.[125,] Therefore, the risk of liquefaction is very low in the area. No portions of the Project site are located in areas susceptible to liquefaction. Therefore, the potential for this hazard would not be significant.

d. Oil Fields (Subsidence)

A portion of the Project site is located inside the boundary of the State-designated Los Angeles Downtown Oil Field. Although not well-defined, the portion of the Project site located north of Pico Boulevard and east of South Figueroa Street (Figueroa South/Figueroa Central development areas) is located within what was the major oil drilling area for this former oil field. This area would be considered a potential hazard for subsidence. However, no active or inactive oil, gas, or geothermal wells are located within the Project site, therefore indicating a reduced potential for subsidence. State and federal regulations are in place to prevent significant long-term subsidence due to historical oil and gas extraction. Subsidence would be controlled through proper engineering design for Project buildings and structures and adherence to the *City Seismic Safety Plan, City Building Code*, and Department of Building and Safety standards. The hazard associated with subsidence would pose a potentially significant, but mitigable, impact associated with the Project site. A mitigation measure has been included to reduce this potentially significant impact to a less than significant level.

3. MITIGATION MEASURES

The proposed Project must comply with all applicable City of Los Angeles Building Code regulations with regard to seismic safety requirements and shall be approved by the City Department of Building and Safety prior to the issuance of building permits. Geotechnical investigations shall be performed by a registered geotechnical engineer. In addition, the following mitigation measures have been established for potential seismic and subsidence hazards potentially impacting future development on the Project site.

a. Construction

1. A State-certified geologist shall review all excavations for evidence indicative of faulting, or seismically-induced ground deformation. If during grading, an active

[125] *Phase I Environmental Site Assessment, Sports Arena and Entertainment Complex Support Site, Los Angeles, California. Prepared by Bryan A. Stirrat & Associates, Inc., October 1996.*

fault is determined to extend through the area, appropriate building setbacks from the fault line shall be established.

b. Operation

2. An assessment of the potential for subsidence at the Project site shall be conducted as part of the geotechnical evaluation.

3. To assist in response to a seismic event, an emergency response and building-specific evacuation plan for Project structures shall be developed in coordination with the Los Angeles Fire Department prior to the Certificate of Occupancy being granted by the City of Los Angeles. Such information shall be disseminated to employees to reduce the potential for human injury.

4. To assist in response to a seismic event, an emergency response and building-specific evacuation diagram for Project structures shall be posted in each on-site building. Such signage shall be posted in appropriate locations to reduce the potential for injury to visitors and employees.

4. ADVERSE EFFECTS

The proposed Project would potentially expose both employees and visitors to on-site seismic hazards. However, the proposed Project would be designed so that there would be no increased threat of exposing people, property, or infrastructure to geotechnical or seismic hazards. In addition, the Project is not subject to any greater seismic risk than any other site within the Central City subregion of the City of Los Angeles. Therefore, with implementation of the recommended mitigation measures, any potential geologic or seismic impacts would be reduced to less than significant levels.

5. CUMULATIVE IMPACTS

Project impacts related to geologic and seismic issues are localized on-site and do not affect any off-site areas associated with the related projects or the ambient growth. Cumulative development in the area would, however, increase the overall potential for exposure to seismic hazards by bringing more people into the area, thus increasing the number of people potentially exposed. Nevertheless, with adherence to applicable State and federal regulations, Building Codes and good engineering practices, these impacts would be less than significant. No cumulative impacts would therefore be associated with the proposed Project and related projects with respect to geologic and seismic issues.