TABLE OF CONTENTS

Section 5 Environmental Information 5.3-1

5.3 Geologic Hazards and Resources 5.3-1
5.3.1 Affected Environment 5.3-1
5.3.1.1 Tectonic Framework 5.3-2
5.3.1.2 Seismic Setting 5.3-2
5.3.1.3 Regional Stratigraphy 5.3-2
5.3.1.4 Local Geology 5.3-3
5.3.1.5 Geologic Hazards 5.3-3
5.3.2 Environmental Consequences 5.3-8
5.3.2.1 Construction-Related Effects 5.3-9
5.3.2.2 Operation-Related Effects 5.3-9
5.3.3 Cumulative Effects 5.3-9
5.3.4 Mitigation Measures 5.3-9
5.3.4.1 Seismic Ground Shaking 5.3-9
5.3.4.2 Liquefaction 5.3-9
5.3.4.3 Expansive Soils 5.3-9
5.3.5 Laws, Ordinances, Regulations, and Standards 5.3-10
5.3.5.1 Federal 5.3-10
5.3.5.2 State 5.3-10
5.3.5.3 Local 5.3-11
5.3.5.4 Agencies and Agency Contacts 5.3-11
5.3.5.5 Applicable Permits 5.3-12
5.3.6 References 5.3-12

Tables

Table 5.3-1 Significant Seismic Events in Southern California

Table 5.3-2 Faults Within the Greater Los Angeles Area

Table 5.3-3 Summary of LORS – Geologic Hazards and Resources

Table 5.3-4 Agency Contacts

Figures

Figure 5.3-1 Regional Geologic Map

Figure 5.3-2 Site Geologic Map

Figure 5.3-3 Regional Fault and Epicenter Map

TABLE OF CONTENTS

5.3 GEOLOGIC HAZARDS AND RESOURCES

This section presents information on the general geology of the region of the Watson Cogeneration Steam and Electric Reliability Project (Project), the subsurface conditions at the Project Site, the geologic hazards affecting the Project, and potential effects of the Project on the geologic resources in the area.

Identification of geologic hazards is based on published literature and a previous site investigation performed by LeRoy Crandall and Associates (Crandall 1986). Regarding geologic resources, evaluations of effect significance are based on the type and the proximity of the resource to the Project. Recommendations are provided for mitigation of geologic hazards and geotechnical issues at the Project.

The information provided in this section is based on a review of published geologic and mineral resource references.

5.3.1 Affected Environment

The Project Site is a 2.5-acre brown field site located within the boundary of the existing Watson Cogeneration Facility, which is a 21.7-acre area within the 428-acre parcel further described as Assessors Parcel Number (APN) 7315-006-003, 1801 Sepulveda Boulevard, Carson, California, 90745 and is integral to BP's existing Carson Refinery (BP Refinery). The street address of the Project Site is located within the boundary of the existing Watson Cogeneration Facility at 22850 South Wilmington Avenue, Carson, California. Figure 3-1, Regional Geologic Map, depicts the Project Site and surrounding area. An existing warehouse/maintenance shop on a portion of the site will be removed as part of the Project. The Project Site is located approximately 0.7 mile south of the 405 Freeway, roughly bounded by Wilmington Avenue to the west, East Sepulveda Boulevard to the south, and South Alameda Street to the east.

The Project Site elevation is approximately 32 feet above mean sea level (MSL). Because the site is located within the existing refinery property boundary, the Project Site and surrounding areas are highly developed, and have been subject to disturbance for many years.

The Project's primary objective is to provide additional process steam in response to the refinery's process steam demand. The Project complements the existing cogeneration facility located within the confines of the refinery. The existing facility has four GE 7EA combustion turbine generators (CTGs), four heat recovery steam generators (HRSGs), and two steam turbine generators (STG). The Project consists of adding a fifth CTG/HRSG to the existing configuration and is referred to as the "fifth train."

The Construction Laydown and Parking Area is a paved 25-acre parcel located approximately 1 mile southeast of the Project Site, at the northeast corner of East Sepulveda Boulevard and South Alameda Street. The area is owned by BP and is currently used as a truck parking and staging area.

No off-site improvements associated with the Project, such as water supply, natural gas or wastewater pipelines, are currently planned for the Project. The Project will connect to the existing supply pipelines currently located at the facility.

5.3.1.1 Tectonic Framework

According to the California Geological Survey (CGS 2002) [previously known as the California Division of Mines and Geology], the Project Area are located in the Peninsular Ranges Geomorphic Province of California, which consists of a series of ranges separated by northwest-trending valleys that are subparallel to faults branching from the San Andreas Fault. More specifically, the Project is located on the southwest edge of the Los Angeles (LA) Basin, an alluvial plain created by tectonic subsidence and the subsequent filling by sediments eroded from surrounding mountains. The LA Basin is bounded to the north by the Santa Monica Mountains; to the east by the Santa Ana Mountains and San Joaquin Hills; and to the south and west by the Pacific Ocean. The basin is a coastal plain of low relief that slopes gradually seaward.

The LA Basin is situated within the active boundary zone between the North American and Pacific tectonic plates. In the Project Area, the width of the boundary zone extends more than 220 miles, from the offshore San Clemente fault zone to the eastern California shear zone in the Mojave Desert. Deformation along the boundary zone is predominantly right-lateral strike-slip, but is complicated in the Los Angeles area by compressional deformation along the “Big Bend” in the San Andreas fault zone, about 50 miles northeast of the Project, and by changes in regional tectonics over the last 4 to 5 million years. Deformation in the area is now accommodated by the northwest-trending right-lateral strike-slip faulting of the San Andreas system and other parallel faults, the east- to northeast-trending left-lateral strike-slip and reverse oblique–slip faulting, and the west- to northwest-trending thrust and reverse faulting (Walls et al. 1998).

5.3.1.2 Seismic Setting

Because of its location in Southern California, the Project Site is within a seismically active region. However, the geologic literature does not identify any known active or potentially active faults at the Project Site (see Figure 5.3-1, Regional Geologic Map, and Figure 5.3-2, Site Geologic Map).

The closest known seismic sources designated by the CGS are the Newport-Inglewood and Palos Verdes faults, which are located approximately 3 miles to the northeast and 4 miles to the southwest of the Project Site, respectively (Blake 1998). These faults, together with other faults and historical earthquake epicenters, are shown on Figure 5.3-3, Regional Fault and Epicenter Map.

5.3.1.3 Regional Stratigraphy

The LA Basin is underlain by a major structural depression that has been the site of subsidence and deposition since the Miocene epoch (5 to 23 million years ago). The Project is located near the northwest-to-southeast trending Wilmington Anticline. The Project Area is underlain by fill materials, alluvial and marine sediments, sedimentary rocks, and metamorphic basement rocks. Quaternary (1.8 million years ago to present) sand, silt, and clay deposits are estimated to be approximately 5,000 feet thick in the Project Area and as much as 15,000 feet thick near the depositional center of the LA Basin, which is located several miles to the north (Davis and Namson 1998).

The Quaternary deposits in the Project Area are underlain by approximately 10,000 feet of Tertiary (65 to 1.8 million years ago) sedimentary rocks that are underlain by Mesozoic (245 to

65 million years ago) metamorphic basement rocks (Davis and Namson 1998). The Tertiary sedimentary rocks expand toward the north, attaining a thickness of at least 25,000 feet near the center of the LA Basin. Tertiary and Quaternary units also thicken to the southwest, off the southwest flank of the Wilmington Anticline.

5.3.1.4 Local Geology

As shown on Figure 5.3-2, Site Geologic Map, the Project Area surficial deposits are identified as late to middle Pleistocene alluvial floodplain deposits, undivided. These alluvial deposits are described as fluvial sediments deposited on canyon floors consisting of moderately well consolidated, poorly sorted, permeable, commonly slightly dissected gravel, sand, silt, and clay (USGS 2003). According to regional mapping (Dibblee 1999), these surficial deposits are underlain by Pleistocene-age San Pedro sand and pebble gravel; Pliocene-age Fernando Formation consisting of sandy shale, sandy siltstones, and claystones; and Mesozoic Catalina schist.

The topographic elevations in the Project Area range from approximately 20 feet to 35 feet above MSL. The historical high groundwater level contours indicate groundwater at a depth of approximately 20 feet below the existing ground surface (CGS 1998).

5.3.1.5 Geologic Hazards

This section discusses the general geologic hazards at the Project Site. The primary geologic hazard at the Project Site is strong ground motion from a seismic event centered on one of several nearby active faults.

Seismic Shaking

The Project Site is in one of the most seismically active areas in the United States and California. At least two-thirds of the relative motion between the North American plate and the Pacific plate in California occurs in the San Andreas Fault system (Hutton et al. 1991; Sieh and Jahns 1984).

Historical Seismic Events

The major historical seismic events in the Project Area in terms of their magnitude and the extent of the damage caused are summarized in Table 5.3-1, Significant Seismic Events in Southern California.

Table 5.3-1
Significant Seismic Events in Southern California

Date	Location/Event	Moment Magnitude (M_w)	Latitude (degrees)	Longitude (degrees)
09 January 1857	Fort Tejon	7.9	36.20	-120.80
21 July 1952	Kern County	7.3	35.00	-119.02
28 June 1992	Landers	7.3	34.20	-116.44
16 October 1999	Hector Mine	7.1	34.59	-116.27
19 May 1940	Imperial County	7.0	32.73	-115.50
17 January 1994	Northridge	6.7	34.21	-118.54
09 February 1971	San Fernando	6.6	34.41	-118.40

Source: CGS 2007.
Note:
M_w = moment magnitude

The largest-magnitude earthquake recorded in the Project vicinity has been a moment magnitude [M_w] 7.9 along the San Andreas Fault at Fort Tejon on 9 January 1857. The most damaging earthquakes in Southern California have been the San Fernando event on 9 February 1971 (M_w = 6.6) and the Northridge event on 17 January 1994 (M_w = 6.7). Figure 5.3-3, Regional Fault and Epicenter Map, presents the location of the epicenters of the major recorded seismic events since 1769.

Seismic Sources

The State of California is located on the edge of the North American plate, which is moving south relative to the Pacific Plate, which is moving north. This contact zone has given rise to prevalent faulting across the region. The result has been the high levels of seismic activity described above. These seismic events give rise to significant ground motions and displacements across the region.

Details of the seismic sources located in the Los Angeles area are provided in Table 5.3-2, Faults Within the Greater Los Angeles Area.

Table 5.3-2
Faults Within the Greater Los Angeles Area

Fault Name	Length (kilometers)	Fault Type	Slip Rate (mm/yr)	MCE (M_w)	MPE (M_w)
Anacapa-Dume	75	r-ll-o 45N	3	7.50	
Big Pine	41	ll-ss	0.8	6.90	5.40
Channel Islands Thrust	63	r 17N	1.5	7.50	6.00
Chino–Central Avenue	28	rl-r-o 65SW	1	6.70	5.50
Clamshell-Sawpit	16	r 45NW	0.5	6.50	5.00
Cleghorn	25	ll-ss	3	6.50	6.00
Compton Thrust	39	r 20 NE	1.5	6.80	5.80
Cucamonga	28	r 45N	5	7.00	6.10
Elsinore–Glen Ivy	36	rl-ss	5	7.50	6.30
Elysian Park Thrust	34	r 20 NE	1.5	7.00	5.80
Garlock (West)	98	ll-ss	6	7.30	6.50
Hollywood	17	ll-r-o 70N	1	7.30	5.30
Holser	20	r 65S	0.4	6.50	4.90
Malibu Coast	37	ll-r-o 75N	0.3	7.30	4.90
Mission Ridge–Arroyo Parida–Santa Ana	69	r 60N	0.4	7.20	5.40
Montalvo–Oak Ridge Trend	37	r 28N	1	6.60	5.50
Newport-Inglewood (LA Basin)	66	rl-ss	1	7.10	5.60
Newport-Inglewood (Offshore)	66	rl-ss	1.5	7.10	5.80
North Frontal Fault Zone (West)	51	r 45S	1	7.20	
Northridge (Oakridge)	31	r 42S	1.6	7.00	5.80
Oak Ridge (Onshore)	49	r 65S	4	6.90	6.20
Oak Ridge (Blind Thrust-Offshore)	37	r 30S	3	7.10	6.10
Palos Verdes (Cabrillo)	96	rl-ss	3	7.30	6.20
Pleito Thrust	44	r 65S	2	7.20	6.10
Raymond	26	ll-r-o 75N	1.5	6.50	5.00
Red Mountain	23	r 60 N	2	6.80	5.90
San Andreas–San Bernardino	103	rl-ss	24	7.50	7.30
San Andreas–Southern		rl-ss		7.40	7.30
San Andreas–Mojave	103	rl-ss	34	7.50	7.10
San Andreas–Carrizo	146	rl-ss	35	8.00	7.20
San Andreas–1857 Rupture				7.80	7.50
San Cayetano	42	r 60N	6	7.00	6.40
San Clemente		ss	1.5	7.90	
San Fernando (Sierra Madre)	18	r 45N	5	7.50	5.60
San Gabriel	140	rl-ss	5	7.50	5.60
San Jacinto–San Bernardino	36	rl-ss	12	6.70	6.70
San Jose	20	ll-r-o 75NW	0.5	6.50	5.00
Santa Monica	28	ll-r-o 75N	1–4	7.30	5.50
Santa Susana	38	r 55N	7	7.30	6.30
Santa Ynez (East)	68	ll-ss	2	7.10	5.90
Sierra Madre	57	r 45N	2	7.20	6.20

Table 5.3-2
Faults Within the Greater Los Angeles Area

Fault Name	Length (kilometers)	Fault Type	Slip Rate (mm/yr)	MCE (M_w)	MPE (M_w)
Simi–Santa Rosa	40	ll-r-o 60N	1	7.50	5.50
Ventura–Pitas Point	40	ll-r-o 75N	1	6.80	5.50
Verdugo	29	r 45NE	2.5	6.75	5.20
Whittier	38	rl-r-o	2.5	7.50	5.90

Source: Cao et al. 2003.
Notes:
Fault types: ss = strike slip; r = reverse; rl = right lateral; ll = left lateral; o = oblique.
MCE = Maximum Credible Event (10 percent probability of exceedance in 250 years; 2,475-year return period)
mm/yr = millimeters per year
MPE = Maximum Probable Event (50 percent probability of exceedance in 50 years; 100-year return period)
M_w = moment magnitude

Surface Rupture

Primary ground rupture is defined as the surface displacement that occurs along the surface trace of the causative fault during an earthquake. Ground rupture can occur along known pre-existing faults, unknown pre-existing faults, or new faults that develop as a result of a seismic event. The State of California categorizes known faults in three ways.

- Active: Faults where there is evidence of rupture in the last 11,000 years. These faults are considered capable of future movement.
- Potentially Active: Faults where there is evidence that movement occurred in the past 1.6 million years.
- Inactive: Faults that are older than 1.6 million years.

According to the CGS, the Project Site is not currently located within an Alquist-Priolo Earthquake Fault Zone (CGS 1986). A review of available geologic data indicates that no surface traces of active faults pass through the Project Site; therefore, the potential for primary ground rupture within the Project Site during a seismic event is low, and the effects of surface rupture will be less than significant.

Seismic Ground Shaking

The Project Site is susceptible to strong ground shaking generated during earthquakes on nearby faults. The intensity of ground shaking, or strong ground motion, depends on the distance from the fault to the Project Site, the magnitude of the earthquake, and the underlying soil conditions. This hazard is mitigated by designing and constructing Project Site improvements and buildings in conformance with current building codes and engineering practices. With the implementation of mitigation measure GEO-1, as discussed in Section 5.3.4, Mitigation Measures, the effects of seismic ground shaking will be less than significant.

Liquefaction

Liquefaction is a process in which soil grains in a saturated sandy deposit lose contact because of earthquakes or other sources of ground shaking. During liquefaction, the soil deposit temporarily behaves as a viscous fluid; as a result, pore pressures rise, and the strength of the deposit is greatly diminished. Liquefaction is often accompanied by sand boils, lateral spreading, and post-liquefaction settlement as the pore pressures dissipate. Liquefiable soils typically consist of cohesionless sands and silts that are of a loose to medium density and saturated.

The CGS (CGS 1999) has developed seismic hazard maps for Northern and Southern California that delineate areas of potential liquefaction hazard. The Project Site is located outside of the designated liquefaction hazard zone for the Long Beach Quadrangle. Thus, the likelihood of liquefaction at the Project Site is low; however, a liquefaction analysis will be performed within the scope of a future geotechnical investigation for the Project. If liquefaction potential is found to exist at the Project Site, foundation design and/or ground improvement can reduce the hazard to a less-than-significant effect.

Subsidence

Subsidence ground failure can be aggravated by several causes, including ground shaking, withdrawal of large volumes of fluids from underground reservoirs, and the addition of surface water to certain types of soils (hydro-compaction). Subsidence from any of these causes accelerates maintenance problems on roads, lined and unlined canals, and underground utilities. According to the City of Carson General Plan (2006), subsidence at oil fields has been mitigated and has not occurred since the early 1980s. As a result, the effects of subsidence on the Project will be less than significant.

Flooding

According to the Federal Emergency Management Agency (FEMA) flood insurance rate map for the Project Site, the Project is not located within an area identified as having flood hazards (FEMA 1998). Therefore, the effects of flooding on the Project will be less than significant.

Tsunamis

A tsunami is a great sea wave (commonly called a tidal wave) produced by a significant undersea disturbance, such as the tectonic displacement of the sea floor associated with large, shallow earthquakes. Due to the distance of the city of Carson from the Pacific Ocean, the potential for tsunami effects is negligible (City of Carson 2006); therefore, the potential for a tsunami to have a significant effect at the Project Site is also negligible.

Seiches

A wave created by an earthquake shaking in an enclosed body of water is called a seiche. The potential for a seiche to occur is related to the natural frequency of vibration of the body of water and the predominant frequencies of vibration in the seismic event. The potential for seiches at the Project Site is low to nil due to the absence of oceans, lakes, or large bodies of water in the

immediate area of the Project Site. Therefore, the potential for a seiche to have a significant effect at the Project Site is also low to nil.

Landslides and Lateral Spreading

Landsliding and lateral spreading usually occur in areas of relief, weak soil strength, and high groundwater. They are often triggered by earthquakes. The Project Site is in an area of low relief. Therefore, the potential for localized landsliding or lateral spreading to occur within the Project Site is very low, as is the potential for this hazard to have a significant effect on the Project.

Volcanic Hazards

No centers of potential volcanic activity occur within hundreds of miles of the Project Site. Therefore, volcanic hazards, such as lava flows and ash falls, are not anticipated to present a hazard to the Project and are not expected to have a significant effect on the Project.

Expansive Soils

A previous subsurface investigation in the area of the Project Site (Crandall 1986) concluded that the site soils range from non-plastic to plasticity indices of 38, which indicate a low to high expansion potential. With the implementation of mitigation measure GEO-2, as discussed in Section 5.3.4, Mitigation Measures, the effects of expansive soils on the Project will be less than significant.

Erosion

Unconsolidated alluvial deposits and semi-consolidated sandy deposits, such as those in the subsurface at the Project Site, generally have moderate to high erosion potentials; however, the Project Site is covered by structures or pavement. Erosion is unlikely to occur at the site, and therefore the effect of erosion on the Project will be less than significant.

Geologic Resources

The Project Site is located in an area of known oil production. Geologic resources of recreational, commercial, or scientific value that are located in the area of the Project Site include oil and gas reserves. Construction of the Project would not prevent the recovery of oil and gas reserves in the Project Area; therefore, the Project does not represent a significant effect to the geologic resources of the region.

5.3.2 Environmental Consequences

The potential effects of the Project on geologic or mineral resources and the potential effects of geologic hazards on the Project can be divided into those related to Project construction and those related to Project operation.

5.3.2.1 Construction-Related Effects

Construction-related effects to geologic resources primarily involve grading operations and operations for foundation support. The Project slopes and the temporary construction slopes and excavations should be properly designed to be stable. Project construction is not anticipated to result in significant adverse effects to geologic resources.

5.3.2.2 Operation-Related Effects

No significant adverse effects to geologic resources were identified as a result of Project operation. The potential effects of geologic hazards on Project operation include seismic shaking. With the implementation of the measures outlined in Section 5.3.4, Mitigation Measures, the effects of geologic hazards on Project operation will be reduced to a less-than-significant level.

5.3.3 Cumulative Effects

As discussed above in Section 5.3.2 Environmental Consequences, there are limited effects by the Project on geologic or mineral resources; therefore, cumulative effects to the geologic resources at the Project Site are considered to be negligible.

5.3.4 Mitigation Measures

5.3.4.1 Seismic Ground Shaking

The potential exists for strong ground shaking at the Project Site from a variety of nearby sources. Therefore, the following mitigation measure will be implemented.

GEO-1: Seismic Design Criteria

Project facilities will be designed in accordance with the seismic design criteria of applicable building codes or a design-level geotechnical investigation.

5.3.4.2 Liquefaction

Liquefaction potential at the Project Site will be determined during a future geotechnical investigation. In general, mitigation of liquefaction at the Project Site, if necessary, will be accomplished through ground improvement or the design of the specific structures.

5.3.4.3 Expansive Soils

Expansive soils exist at the Project Site. Therefore, the following mitigation measure will be implemented.

GEO-2: Effects of Expansive Soils

Project improvements will be designed to withstand the effects of expansive soils; or the expansive soils will be removed or graded to mitigate the effects of expansive soils. Recommendations for mitigation of expansive soils will be provided as part of a design-level geotechnical investigation.

5.3.5 Laws, Ordinances, Regulations, and Standards

The Project will be constructed and operated in accordance with all the laws, ordinances, regulations, and standards (LORS) applicable to geologic hazards and resources discussed below and summarized in Table 5.3-3, Summary of LORS – Geologic Hazards and Resources.

Table 5.3-3
Summary of LORS – Geologic Hazards and Resources

LORS	Applicability	Conformance (AFC Section)
Federal		
No federal LORS are applicable.		
State		
California PRC Section 25523(a), Alquist-Priolo Earthquake Fault Zoning Act of 1994	Act addresses the seismic hazard of surface rupture. Not applicable because Project Site is not located in an earthquake fault zone.	5.3.1
California Building Code, Chapters 16, 18, and 33	Codes address excavation, grading, and earthwork construction, including construction applicable to earthquake safety and seismic activity hazards.	5.3.1
Local		
City of Carson General Plan/Safety Element	Minimize the risk of injury, loss of life, and property damage caused by earthquake hazards.	5.3.1

Notes:
LORS = laws, ordinances, regulations, and standards
PRC = Public Resources Code

5.3.5.1 Federal

No federal LORS apply to the Project for geological hazards and resources or grading and erosion control.

5.3.5.2 State

California Public Resources Code Section 25523(a); 20 California Code of Regulations Section 1252(b,) (c)

None of the Project components are located within or across from an Alquist–Priolo earthquake zone. Therefore, the Project will not be subject to the requirements for construction within an earthquake fault zone.

California Building Code

The 2007 edition of the California Building Code is based on the 2006 edition of the International Building Code, with revisions specifically tailored to geologic hazards in California.

Chapter 16: Structural Design Requirements, Division IV, Earthquake Design. This section requires structural designs to be based on geologic information for seismic parameters, soil characteristics, and site geology.

Chapter 18: Foundations and Retaining Walls, Division I. This section sets requirements for excavations and fills, foundations, and retaining structures with regard to expansive soils, subgrade bearing capacity, and seismic parameters. This section also addresses the waterproofing and damp-proofing of foundations.

Chapter 33: Site Work, Demolition and Construction, and Appendix Chapter 33. These sections establish rules and regulations for construction of cut-and-fill slopes, fill placement for structural support, and slope setbacks for foundations.

California Environmental Quality Act of 1970

The California Energy Commission will be the lead agency for rules and regulations to implement the California Environmental Quality Act. Appendix G, Section VI of the guidelines concerns the geologic hazards and resources related to the Project.

5.3.5.3 Local

City of Carson General Plan, Chapter 6, Safety Element

The Safety Element of the City of Carson General Plan provides an implementation program to reduce the threat of seismic and public safety hazards within the City of Carson.

The Project will comply with all of the Seismic/Geologic Hazard Safety Elements of the City of Carson General Plan. The City of Carson will review the geologic information and geotechnical recommendations presented in design-level geotechnical reports.

5.3.5.4 Agencies and Agency Contacts

The agencies with jurisdiction to enforce LORS related to geologic hazards and resources and the appropriate contact person are summarized in Table 5.3-4, Agency Contacts.

Table 5.3-4
Agency Contacts

Number	Agency	Contact/Title	Telephone
1	California Energy Commission Facilities Siting Division Siting Office	Eileen Allen/ Facilities Siting Program Manager	916-654-4082
2	California Energy Commission Facilities Siting Division Engineering Office	Rick Tyler/ Senior Mechanical Engineer	916-653-1646
3	City of Carson, Building & Safety	Building and Safety Officer	310-952-1766

5.3.5.5 Applicable Permits

The City of Carson may issue a grading permit before the start of Project construction based on a review of the grading plan and the Geotechnical Investigation Report.

Compliance with California Building Code standards will be addressed in the engineering and construction permits to be issued for the Project. No other permit requirements that specifically address geologic resources and hazards have been identified.

5.3.6 References

Blake, T.F. 1998. EQFAULT, EQSEARCH, and FRISKSP. Computer Programs for the Estimation of Peak Horizontal Acceleration from Southern California Earthquakes.

Cao, Tianqing, William A. Bryant, Badie Rowshandel, David Branum, and Christopher J. Wills. 2003. The Revised 2002 California Probabilistic Seismic Hazard Maps, Appendix A, California Department of Conservation. June 2003.

CGS (California Geological Survey), formerly known as the CDMG (California Department of Conservation, Division of Mines and Geology). 1986. State of California Special Studies Zones, Long Beach Quadrangle.

CGS (California Geological Survey). 1998. Seismic Hazard Evaluation of the Long Beach 7.5-minute quadrangle, Los Angeles County, California, Open-File Report 98-19.

CGS (California Geological Survey). 1999. State of California Seismic Hazard Zones, Long Beach Quadrangle.

CGS (California Geological Survey). 2002. Note 36, California Geomorphic Provinces.

CGS (California Geological Survey). 2007. Significant California Earthquakes (M> 6.5 or that caused loss of life or more than $200,000 in damage), http://www.conservation.ca.gov/cgs/rghm/quakes/Pages/eq_chron.aspx.

City of Carson. 2006. General Plan, Chapter 6, Safety Element.

Crandall (LeRoy Crandall and Associates). 1986. Report of Final Geotechnical Investigation, Proposed Cogeneration Unit and Proposed Transmission Line, Watson Refinery, Carson, California, 14 March 1986.

Davis, J., and J. Namson. 1998. Southern California Cross Section Study.

Dibblee, T.W. 1999. Geologic Map of the Palos Verdes Peninsula and Vicinity, Redondo Beach, Torrance, and San Pedro Quadrangles, Los Angeles County, California.

FEMA (Federal Emergency Management Agency). 1998. Flood insurance rate map, City of Carson, California, Los Angeles County, Community-Panel Number 060107 0005 A, Effective Date: 6 July 1998.

Hart, E.W., and W.A. Bryant. 1997. Fault-Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps. California Department of Conservation Division of Mines and Geology Special Publication 42, 38 p.

Hutton, L.K., L.M. Jones, E. Hauksson, and D.D. Given. 1991. Seismotectonics of southern California. In: *Neotectonics of North America*. Boulder, Colorado: Geological Society of America, Decade Map. Vol. 1. D.B. Slemmons, E.R. Engdahl, M.D. Zoback, and D.D. Blackwell, eds. 133–151.

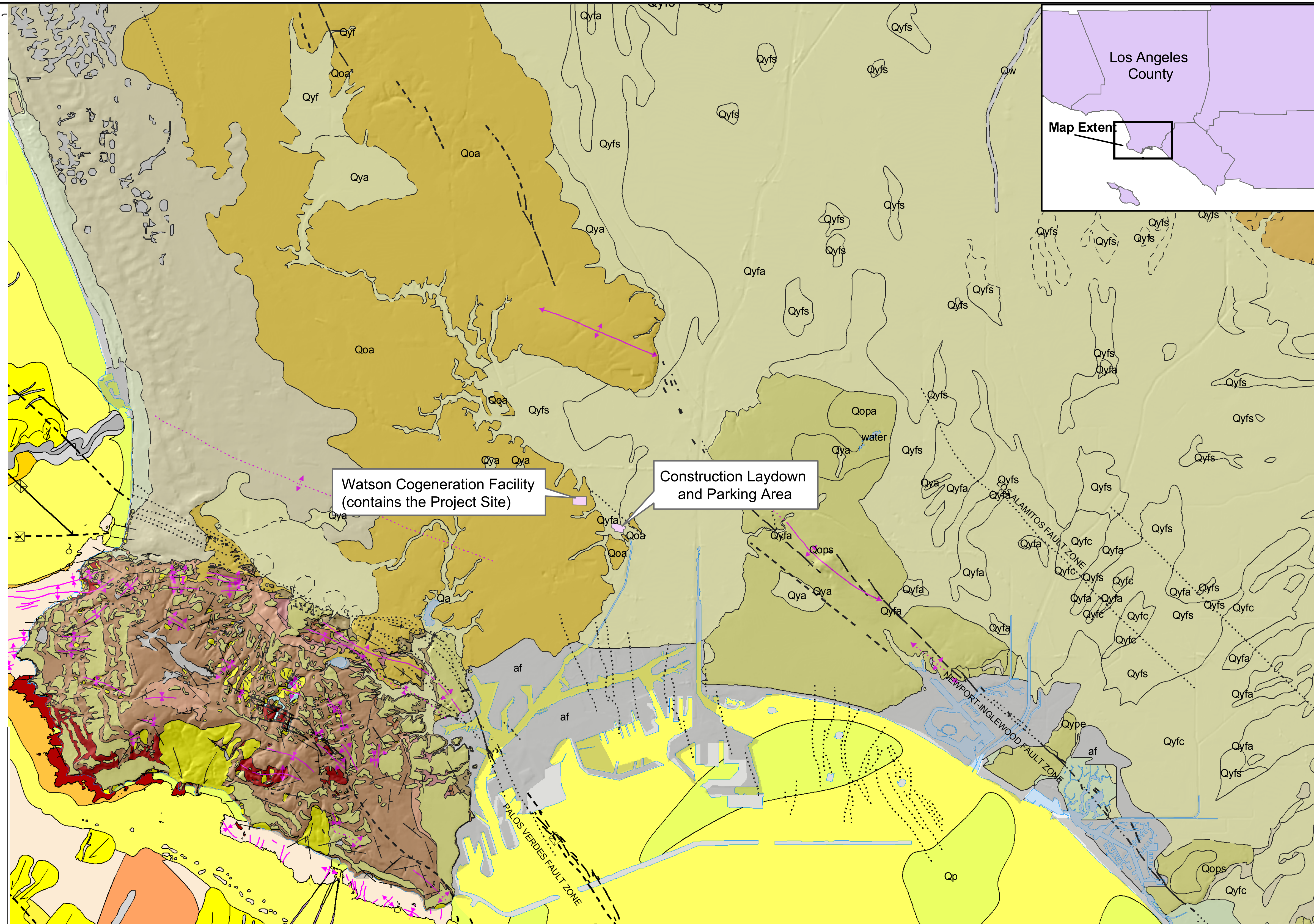
Sadigh, K., C.Y. Chang, J.A. Egan, F. Makdisi, and R.R. Youngs. 1997. Attenuation relationships for shallow crustal earthquakes based on California strong ground motion data. *Seismological Research Letters* 68:180–189.

Sieh, K.E., and R.H. Jahns. 1984. Holocene Activity of the San Andreas Fault at Wallace Creek, California. *Geological Society of America Bulletin*, Vol. 95, p. 883-896.

USGS (United States Geological Survey). 2003. United States Geological Survey, Geologic Map of the Long Beach 30’ X 60’ Quadrangle, California, Version 1.0. Compiled by G.J. Saucedo, H.G. Greene, M.P. Kennedy, and S.P. Bezore. Scale 1:100,000.

Walls, C., T.K. Rockwell, K. Mueller, Y. Back, S. Williams, J. Pfanner, J. Dolan, and P. Fang. 1998. Escape tectonics in the Los Angeles metropolitan region and implications for seismic risk: Nature, v. 394, p. 356-360.

Wesnousky, S.G. 1986. Earthquakes, quaternary faults, and seismic hazard in California. *Journal of Geophysical Research* 91(B12) 12587–12631.



			Symbol	Description
CENOZOIC	QUATERNARY	HOLOCENE	af	Artificial fill
			Qw	Active channel and wash deposits
			Qa	Alluvial flood plain deposits
			Qls	Landslide deposits
			Qb	Beach deposits
			Qe	Eolian deposits
			Qpe	Paralic estuarine deposits
			Qyf	Young alluvial fan and valley deposits, undivided a = sand, s = silt, c = clay
			Qyf2	Young alluvial fan deposits, unit 2
			Qyf1	Young alluvial fan deposits, unit 1
			Qya	Young alluvial flood plain deposits, unit 1
			Qye	Young eolian deposits
			Qype	Young paralic estuarine deposits
			Qof	Old alluvial fan and valley deposits, undivided a = sand, s = silt, c = clay
			Qoa	Old alluvial flood plain deposits, undivided
		PLEISTOCENE	Qoe	Old eolian deposits
			Qom	Old marine deposits, undivided
			Qop	Old paralic deposits, undivided, a = sand, s = silt, c = clay
			Qlh	La Habra Formation
				San Pedro Formation
			Qsp	San Pedro Formation, undivided
			Qspt	Timms Point Silt Member
			Qspl	Lomita Marl Member
			Qi	Inglewood Formation
	TERTIARY	PLIOCENE		Fernando Formation
			Tfu	Upper Member
			Tfl	Lower Member, Tflc = conglomerate
				Puente Formation
		MIOCENE	Tpsc	Sycamore Canyon Member, Tpscc = conglomerate
			Tpy	Yorba Member
			Tps	Soquel Member
			Tplv	La Vida Member
				Monterey Formation
			Tmm	Malaga Mudstone Member
			Tmvd	Valmonte Diatomite Member
			Tmv	Volcanic rocks within the Monterey Formation
			Tma	Altamira Shale Member
MESOZOIC	CRETACEOUS JURASSIC		mcs	Catalina Schist

MAP SYMBOLS

Contact - accuracy of location ranges from well located to inferred. All offshore contacts are considered approximately located.

Fault - solid where well located; dashed where approximately located or inferred; dotted where concealed; queried where continuation or existence is uncertain. Where age was determined in offshore area, age symbol is shown astride fault and relative offset is shown by U, upthrown side; D, downthrown side (relative or apparent). Age of faults are indicated as follows:

cuts strata of Holocene age; cuts strata of Pleistocene age; cuts strata of Quaternary age; cuts strata of Pliocene age; cuts Miocene or older strata

Anticlinal fold - solid where well located; dashed where approximately located or inferred; dotted where concealed. Plunge direction indicated by arrowhead on fold axis.

Synclinal fold - solid where well located; dashed where approximately located or inferred; dotted where concealed. Plunge direction indicated by arrowhead on fold axis.

Strike and dip of stratified rocks. Number indicates dip angle in degrees when known.

25 Inclined beds

80 Overturned beds

Horizontal beds

Strike and dip of metamorphic and igneous foliation.

Vertical foliation

Arrows on landslides indicate direction of movement. Hachured where headscarp is mappable.

Notes:
Basemap derived from 1:100,000 scale USGS maps.

URS

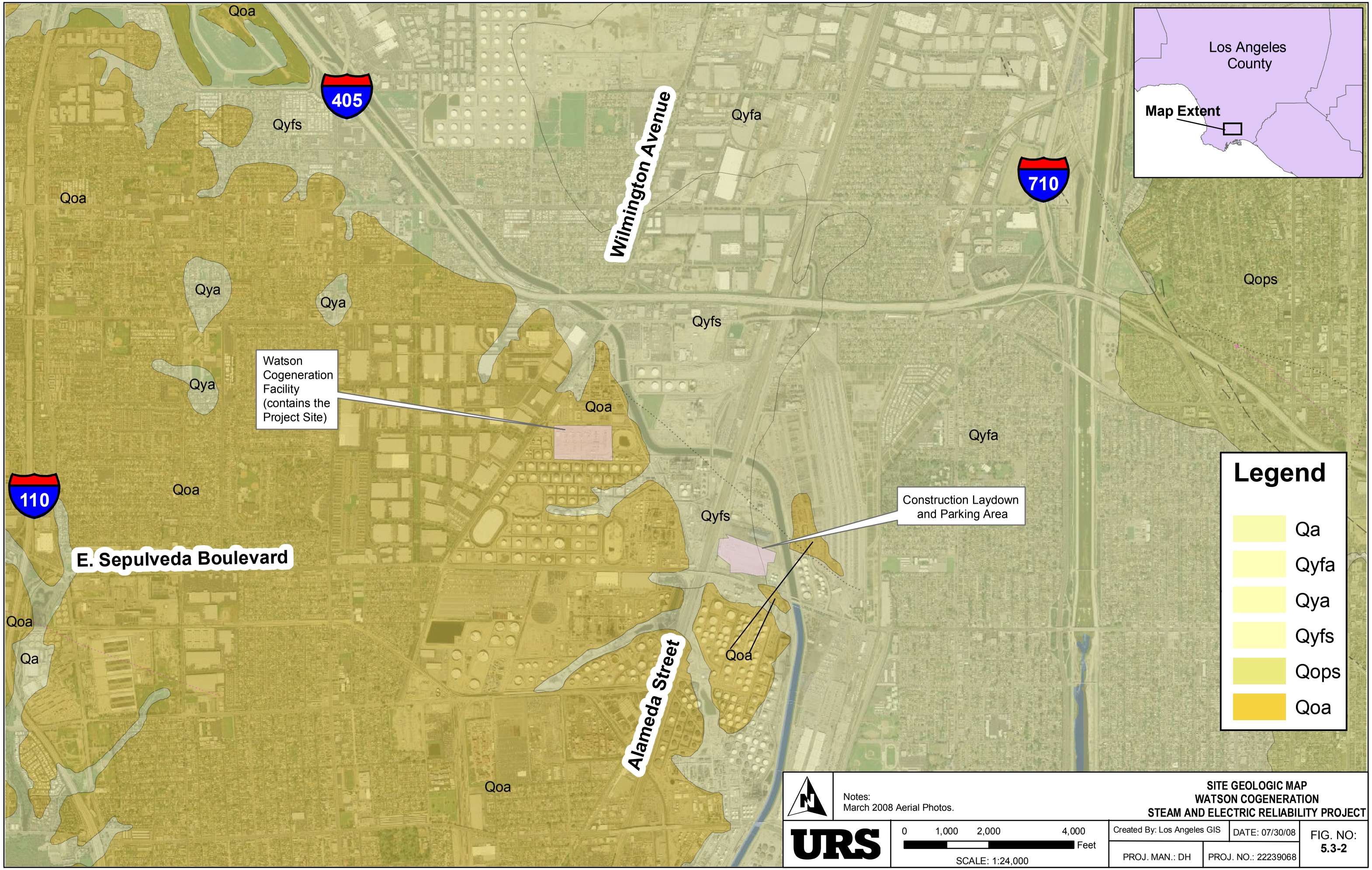
1 0.5 0 1 Miles

SCALE: 1:100,000

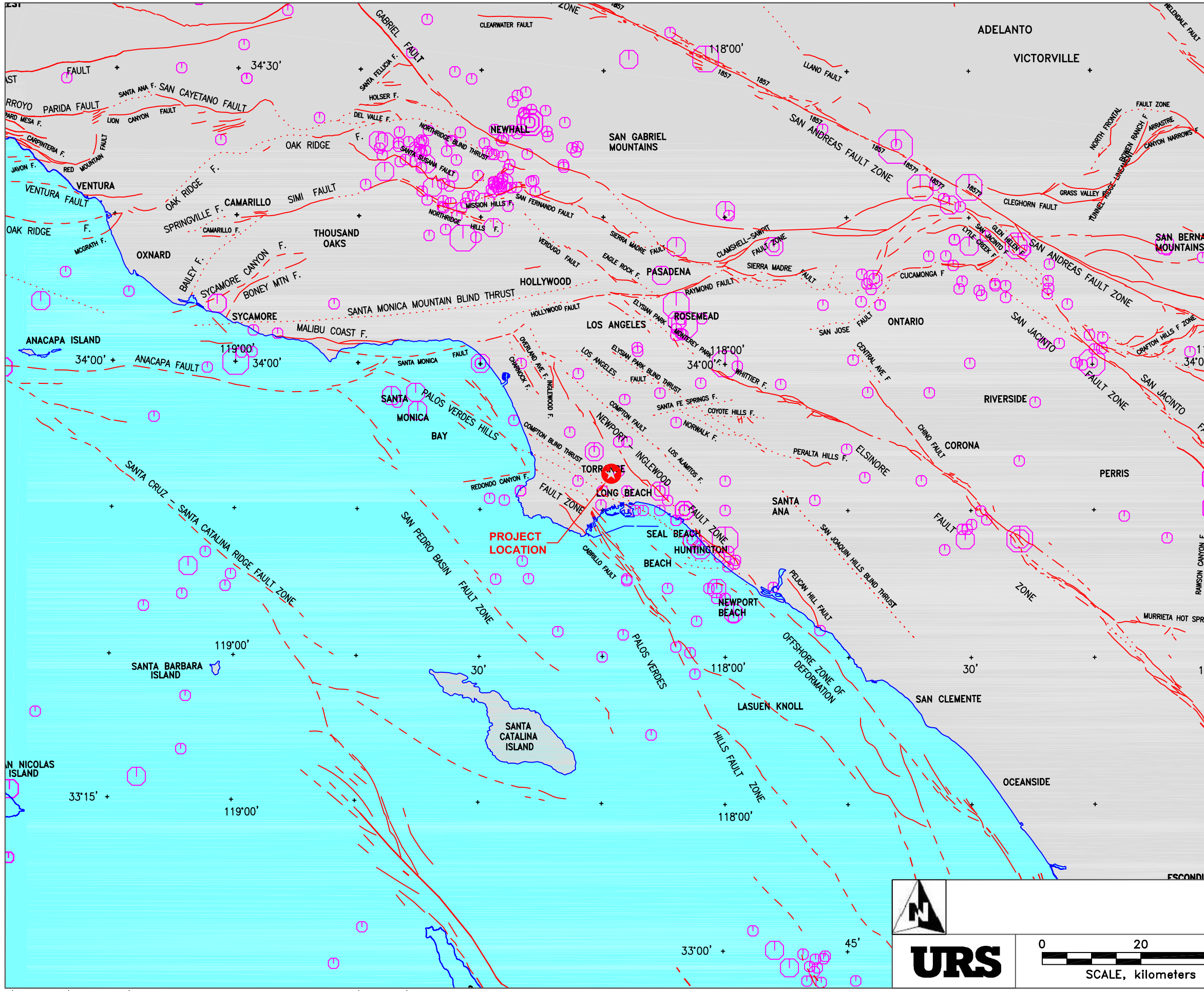
REGIONAL GEOLOGIC MAP
WATSON COGENERATION
STEAM AND ELECTRIC RELIABILITY PROJECT

CREATED BY: LA GIS	DATE: 08/07/08	FIG. NO: 5.3-1
PROJ. MAN.: DH	PROJ. NO.: 22239068	

Path: Y:\GIS\Projects\BP_Carson_Cogen\mxds\template.mxd



Path: O:\GIS\Mxds\Carson\Carson_BP.mxd



LEGEND

REPORTED EARTHQUAKE MAGNITUDES.

- 4.0 TO 4.9
- 5.0 TO 5.9
- 6.0 TO 6.9
- 7.0 AND GREATER

SOUTH OF LATITUDE 35°N, EPICENTER AND MAGNITUDE DATA ARE FROM THE CALIFORNIA GEOLOGICAL SURVEY (2001) EARTHQUAKE CATALOG FOR THE PERIOD FROM 1769 TO 2000. ONLY EARTHQUAKES OF MAGNITUDE 4.0 AND LARGER ARE SHOWN. AFTERSHOCKS ARE NOT INCLUDED.

? ? ?

APPROXIMATE LOCATION OF HOLOCENE AND PLEISTOCENE FAULTS, DOTTED WHERE CONCEALED, QUERIED WHERE CONJECTURAL. FAULT LOCATIONS BASED ON: ZIONY AND JONES, 1989; CDMG GEOLOGIC MAP SERIES OF CALIFORNIA, 1977-1986 (1:250,000 SCALE); CDMG GEOLOGIC MAP SERIES, CALIFORNIA CONTINENTAL MARGIN, 1987 (1:250,000 SCALE); HAUKSSON, 1990; SHAW AND SHEARER, 1999; WRIGHT, 1991; GRANT ET AL. 1999.

REGIONAL FAULT AND EPICENTER MAP
WATSON COGENERATION
STEAM AND ELECTRIC RELIABILITY PROJECT

URS

0 20 40
SCALE, kilometers

CREATED BY: LA GEOTECH	DATE: 08/25/08	FIG. NO: 5.3-3
PROJ. MAN.: DH	PROJ. NO.:22239068	

L:\Casey_Jensen\Active_Projects\22239068.04004_RR_Carson_Cogen_Expansion_Project_AFC\Figure_Files\Regional_Fault_and_Epicenter_Map1.dwg, Oct 21, 2008 - 9:19am

Adequacy Issue: Adequate ____ Inadequate ____

DATA ADEQUACY WORKSHEET

Revision No. 0 Date ____

Technical Area: **Geologic Hazards and Resources**

Project: Watson Cogeneration Steam and Electric Reliability Project

Technical Staff: ____

Project Manager: ____

Docket: ____

Technical Senior: ____

SITING REGULATIONS	INFORMATION	AFC PAGE NUMBER AND SECTION NUMBER	ADEQUATE YES OR NO	INFORMATION REQUIRED TO MAKE AFC CONFORM WITH REGULATIONS
Appendix B (g) (1)	...provide a discussion of the existing site conditions, the expected direct, indirect and cumulative impacts due to the construction, operation and maintenance of the project, the measures proposed to mitigate adverse environmental impacts of the project, the effectiveness of the proposed measures, and any monitoring plans proposed to verify the effectiveness of the mitigation.	Section 5.3.1; pages 5.3-1 through 5.3-8 Section 5.3.2; pages 5.3-8 through 5.3-9 Section 5.3.3; page 5.3-9		
Appendix B (g) (17) (A)	A summary of the geology, seismicity, and geologic resources of the Project Site and related facilities, including linear facilities.	Section 5.3.1; pages 5.3-1 through 5.3-8		
Appendix B (g) (17) (B)	A map at a scale of 1:24,000 and description of all recognized stratigraphic units, geologic structures, and geomorphic features within two (2) miles of the Project Site and along proposed facilities. Include an analysis of the likelihood of ground rupture, seismic shaking, mass wasting and slope stability, liquefaction, subsidence, tsunami runup, and expansion or collapse of soil structures at the plant site. Describe known geologic hazards along or crossing linear facilities.	Figure 5.3-2 Section 5.3.1; pages 5.3-1 through 5.3-8		
Appendix B (g) (17) (C)	A map and description of geologic resources of recreational, commercial, or scientific value which may be affected by the project. Include a discussion of the techniques used to identify and evaluate these resources.	Figure 5.3-1 Section 5.3.1; pages 5.3-1 through 5.3-8		

Adequacy Issue: Adequate ____ Inadequate ____

DATA ADEQUACY WORKSHEET

Revision No. 0 Date ____

Technical Area: **Geologic Hazards and Resources**

Project: Watson Cogeneration Steam and Electric Reliability Project

Technical Staff: ____

Project Manager: ____

Docket: ____

Technical Senior: ____

SITING REGULATIONS	INFORMATION	AFC PAGE NUMBER AND SECTION NUMBER	ADEQUATE YES OR NO	INFORMATION REQUIRED TO MAKE AFC CONFORM WITH REGULATIONS
Appendix B (i) (1) (A)	Tables which identify laws, regulations, ordinances, standards, adopted local, regional, state, and federal land use plans, leases, and permits applicable to the proposed project, and a discussion of the applicability of, and conformance with each. The table or matrix shall explicitly reference pages in the application wherein conformance, with each law or standard during both construction and operation of the facility is discussed; and	Section 5.3.5, Table 5.3-3; page 5.3-10		
Appendix B (i) (1) (B)	Tables which identify each agency with jurisdiction to issue applicable permits, leases, and approvals or to enforce identified laws, regulations, standards, and adopted local, regional, state and federal land use plans, and agencies which would have permit approval or enforcement authority, but for the exclusive authority of the commission to certify sites and related facilities.	Section 5.3.5, Table 5.3-3; page 5.3-10		
Appendix B (i) (2)	The name, title, phone number, address (required), and email address (if known), of an official who was contacted within each agency, and also provide the name of the official who will serve as a contact person for Commission staff.	Section 5.3.5.4, Table 5.3-4; page 5.3-12		
Appendix B (i) (3)	A schedule indicating when permits outside the authority of the commission will be obtained and the steps the applicant has taken or plans to take to obtain such permits.	Section 5.3.5.5; page 5.3-12		