

APPENDIX D SITE SPECIFIC SEISMIC RESPONSE ANALYSIS

In this appendix, we present our seismic response analysis for the project for a seismic event that has a 10 percent chance of exceedance in 50 years. The response presented assumes 5 percent structural damping. The discussion below includes a description of the site seismic setting, basis of analysis, and recommended response spectrum.

Regional Seismicity

The San Francisco Bay Area is one of the most seismically active regions in the United States. The significant earthquakes that occur in the Bay Area are generally associated with crustal movement along well-defined, active fault zones of the San Andreas Fault system, which regionally trend in a northwesterly direction. The Hayward Fault is located approximately 4 kilometers to the east of the project site. The San Andreas fault is located approximately 23 kilometers to the east of the project site. Both the Hayward and San Andreas faults are known to be active and capable of producing very large earthquakes with magnitudes greater than 7 Mw.

Ground Shaking

Maps published by the California Geological Survey indicate that a peak horizontal ground acceleration of 0.56 g has a 10 percent chance of exceedance in 50 years for soft rock outcrop conditions. Rock outcrop motions are used as input to estimate the response of soil overlying the site bedrock.

Response Analysis

We evaluated the estimated seismic response based on actual earthquake records collected on rock outcrops, from five earthquakes with magnitudes of 6.9 to 7.6Mw, at distances of less than 1 kilometer to about 17 kilometers from the fault rupture of the earthquakes. Using the earthquake records, we estimated the ground response, based on the lithology and shearwave velocity measurements observed in our borings and CPTs at the site. Ground response was performed using the SHAKE91 computer routine which performs a non-linear equivalent linear response analysis using dynamic modulus and damping functions in an iterative procedure. The earthquake records were chosen as representative earthquakes to model the subject site, which is located about 4 kilometers from the Hayward Site and approximately 23 kilometers from the San Andreas Fault. The magnitudes of earthquakes used in our evaluation were similar to the estimated controlling seismic events for the site. The table below summarizes the earthquake records used for our analysis.

Table D-1. Earthquake Records Used for Seismic Response Evaluation

Earthquake	Moment Magnitude	Approximate Distance to Rupture (km)	Record Source
Kocaeli, Turkey, 1999	7.4	17	PEER Strong Motion Data Base
Landers, California, 1992	7.3	1	PEER Strong Motion Data Base
Kobe, Japan, 1995	6.9	<1	PEER Strong Motion Data Base
Loma Prieta, California, 1989	6.9	11	PEER Strong Motion Data Base
Northridge, California, 1994	6.7	7	PEER Strong Motion Data Base

Each of the earthquake records above was scaled to match the anticipated peak ground acceleration for an imaginary rock outcrop at the site. These scaled motions were used as input into a 1-dimensional soil column for response analysis. The soil column model was based on our understanding of the site lithology, CPT shearwave velocity measurements and published correlations for dynamic modulus and damping properties. Spectral acceleration was calculated (for both x and y horizontal earthquake components) for an imaginary massless element with a damping ratio of 5 percent for structural periods up to 4 seconds.

Horizontal Design Response Spectra

The response spectra presented in the table below represent smoothed response spectra curves for a seismic event having 10 percent chance of exceedance in 50 years. The results are also presented graphically in Figure C-1. For some structural periods the site specific response may exceed 2001 CBC Code spectra due to the near source effects of the Hayward Fault.

Table D-2. Horizontal Response Spectra

Period (seconds)	Horizontal Spectral Acceleration (g) 5 Percent Damping
	10% chance of exceedance in 50 years
0	0.53
0.15	1.33
0.20	1.42
0.25	1.48
0.3	1.52
0.4	1.58
0.5	1.60
0.6	1.56
0.7	1.52
0.8	1.44
0.9	1.35
1.0	1.20
1.2	1.00
1.4	0.80
1.6	0.68
1.8	0.61
2.0	0.55
2.4	0.45
2.8	0.39
3.3	0.33
3.8	0.28
4.2	0.26

**RCEC Site Response (5% Damping)
10% Exceedance in 50 years**

