Section 2.18 – Protection from Natural Hazards

WAC 463-60-265
Proposal – Protection from natural hazards.

The application shall describe the means to be employed for protection of the facility from earthquakes, volcanic eruption, flood, tsunami, storms, avalanche or landslides, and other major natural disruptive occurrences.

(Statutory Authority: RCW 80.50.040 (1) and (12). 04-21-013, amended and recodified as § 463-60-265, filed 10/11/04, effective 11/11/04. Statutory Authority: RCW 80.50.040(1). 92-09-013, § 463-42-265, filed 4/2/92, effective 5/3/92. Statutory Authority: RCW 80.50.040(1) and Chapter 80.50 RCW. 81-21-006 (Order 81-5), § 463-42-265, filed 10/8/81. Formerly WAC 463-42-290.)

Section 2.18 Protection from Natural Hazards

The following sections address the means to be employed to protect the facility natural hazards that could occur on or surrounding the Facility. Existing conditions, potential impacts, and mitigation measures, where appropriate, are discussed below.

2.18.1 Earthquake Hazard

Earthquake-related damage could occur from surface fault rupture, ground motion, and liquefaction and lateral spreading. The project site is located in a region where geologic evidence indicates that significant earthquakes can occur from three sources of seismic energy (Cascadia Subduction Zone [CSZ], intraplate, and crustal earthquakes). Additional details regarding earthquakes and seismicity are provided in section 3.1.3.

2.18.1.1 Surface Fault Rupture

Geologic mapping completed in the vicinity of the project site has not identified evidence of historical or geologically recent surface rupture crossing the site. Potentially active faults have not been mapped or inferred within the site boundaries (Personius et al. 2003). Surface rupture is unlikely to occur at the site.

2.18.1.2 Ground Motion

Ground motion is shaking that occurs during an earthquake set in motion from a passing seismic wave. The project is located in an area that has the potential for strong earthquake ground motion. The potential ground motion during an earthquake event is generally represented by horizontal peak ground motion acceleration (PGA) and is expressed in gravity units (g). The expected earthquake return interval is generally expressed as a probability of exceedance during a given time period or design life. The U.S. Geological Survey (USGS) publishes probabilistic seismic hazard data for the relative contribution of different magnitude-distance combinations for a given location. For an estimated seismic shear wave velocity of 760 meters per second, a PGA of 0.2 g was estimated for a 475-year return period earthquake (10 percent chance of not being exceeded in 50 years), and a PGA of 0.42 g was estimated for a 2,475-year return period earthquake (2 percent probability of exceedance in 50 years), except where subject to deterministic limitations (Leyendecker et al. 2000).

2.18.1.3 Liquefaction and Lateral Spreading

Liquefaction occurs when saturated, loose to medium dense sand, or soft to medium stiff, low-plasticity silt are subject to ground shaking during an earthquake. The ground shaking can result in the rearrangement of the soil particles, which leads to a rise in the pore water pressure within the susceptible soils. If the pore water pressure rises to a level that approaches the total weight of the overlying soil column, the soils begin to behave and deform as a viscous liquid. As soil strength is reduced in the liquefiable layers, there is an increased risk of settlement and the loss of some bearing capacity for both shallow and deep foundations. Unsaturated soils do not liquefy, but may settle during an earthquake (Mabey et al. 1993). Structures can be adversely affected by liquefaction-induced settlement and reduced bearing capacity. The site has been identified as having moderate to high liquefaction susceptible soils (Palmer et al. 2004).

Lateral spreading occurs as blocks of soil moves horizontally toward unsupported banks such as a river or stream channels in response to earthquake ground motion and liquefaction in a subsurface layer. Ground displacement generally occurs on slopes of less than 3 degrees (Bartlett and Youd 1992). Lateral spreading can have adverse impacts on building foundations, roadways, pipelines, and other utilities built on or across the failure (Youd 1993). Lateral spreading could potentially occur along the banks of the Columbia River. Lateral spreading of the riverbank at the dock during a seismic event would induce large lateral forces on the in-water piles for the trestles and/or dock.

2.18.1.4 Mitigation Measures for Earthquake Hazards

All structures and pipelines constructed for the Facility will be designed and built in accordance with the applicable design provisions and seismic requirements of the 2012 International Building Code, the American Society of Civil Engineers 7-10 standard (Minimum Design Loads for Buildings and Other Structures), America Concrete Institute 318-11 standard (Building Code Requirements for Structural Concrete), American Institute of Steel Construction Manual section 360-10 (Specifications for Structural Steel Buildings) and Seismic Design Manual 2nd Ed., and the American Forest & Paper Association 2008 Special Design Provisions for Wind and Seismic.

Tables 2.18-1 and 2.18-2 list the seismic design criteria for the Facility.

Table 2.18-1. 2012 IBC Seismic Design Criteria Storage (Area 300)

Parameter	Value	2012 IBC/ASCE 7-10 Reference
0.2 Second Spectral Acceleration, S_s	0.94	ASCE 7-10 Figure 22-1
1.0 Second Spectral Acceleration, S_1	0.41	ASCE 7-10 Figure 22-2
MCE_G Peak Ground Acceleration, PGA (Site Class B)	0.41	ASCE 7-10 Figure 22-7
Soil Profile Site Class	N/A*	ASCE 7-10 Section 20.3.1 and 21.3*
0.2 Second MCE_R Spectral Acceleration, S_{Ms}	1.04	Site Specific Ground Motion, ASCE 7-10 Ch. 21 *
1.0 Second MCE_R Spectral Acceleration, S_{M1}	0.8	Site Specific Ground Motion, ASCE 7-10 Ch. 21 *
MCE_G Peak Ground Acceleration, PGA	0.37	Site Specific Ground Motion, ASCE 7-10 Ch. 21 *
0.2 Second Design Spectral Acceleration, S_{Ds}	0.69	2012 IBC Equation 16-39
1.0 Second Design Spectral Acceleration, S_{D1}	0.53	2012 IBC Equation 16-40
Seismic Design Category	D	2012 IBC Table 11.6-1 (& -2)

* A liquefaction hazard was identified for the Storage area (Area 300). In accordance with ASCE 7-10 Section 11.4.7 and 20.3, a site-specific ground motion analysis was completed for seismic design at the Storage area to develop the criteria listed above.

**Table 2.18-2. 2012 IBC Seismic Design Criteria
Unloading and Office (Areas 200 and 600)**

Parameter	Value	2012 IBC / ASCE 7-10 Reference
0.2-Second Spectral Acceleration, S_s	0.94	ASCE 7-10 Figure 22-1
1.0-Second Spectral Acceleration, S_1	0.41	ASCE 7-10 Figure 22-2
MCE_G Peak Ground Acceleration, PGA (Site Class B)	0.41	ASCE 7-10 Figure 22-7
Soil Profile Site Class	E*	ASCE 7-10 Section 20.3.1*
Site Coefficient, F_a	0.97	2012 IBC Table 1613.3.3(1)
Site Coefficient, F_v	2.40	2012 IBC Table 1613.3.3(2)
Site Coefficient, F_{PGA}	0.9	ASCE 7-10 Table 11.8-1
0.2 Second MCE_R Spectral Acceleration, S_{Ms}	0.91	2012 IBC Equation 11.4-1
1.0 Second MCE_R Spectral Acceleration, S_{M1}	0.98	2012 IBC Equation 11.4-2
MCE_G Peak Ground Acceleration, PGA	0.37	2012 IBC Equation 11.8-1
0.2 Second Design Spectral Acceleration, S_{Ds}	0.61	2012 IBC Equation 11.4-3
1.0 Second Design Spectral Acceleration, S_{D1}	0.66	2012 IBC Equation 11.4-4
Seismic Design Category	D	2012 IBC Table 11.6-1 (& -2)

* A liquefaction hazard was identified for the Unloading and Office area (Areas 200 and 600). Based on ASCE 7-10 Section 20.3.1, Site Class E was used to develop seismic design criteria for the structures in Areas 200 and 600 assuming the fundamental period of the structures in Areas 200 and 600 is less than 0.5 second.

Final analysis of the seismic conditions and determination of the building foundation designs will be completed to address seismic conditions found at the site prior to construction. Ground improvement methods and foundations designs will be selected to meet the criteria identified in Tables 2.18-1 and 2.18-2. Ground motion mitigation includes adhering to local building codes and standard foundation design for the proposed facility and associated buildings and pipelines. The proposed facility would comply with the state building code provisions for seismic hazards applicable to the proposed location and the site conditions disclosed by the geotechnical investigation.

Liquefaction mitigation solutions for the risk of liquefaction may include improving the condition of soils beneath the site to reduce the risk of liquefaction during an earthquake or the use of deep foundations to provide foundation support below the liquefiable soils. Ground improvement methods, such as stone columns, jet grouting, or deep soils mixing, could be designed to reduce the seismic lateral load on the dock foundations and improve seismic slope stability. Ground improvement methods and/or the use of deep foundations, such as driven piles or drilled shafts, could be designed to reduce the risk of seismic settlement impacting the proposed structures. Specific mitigation measures will be identified based on the results of the project-specific geotechnical investigation.

2.18.2 Volcanic Eruption

Volcanoes in the region pose a variety of eruptive hazards. Volcanoes of the Cascade Mountains are found from northern California to British Columbia. Mount St. Helens and Mount Hood are located within 50 miles of the project, located to the northeast and southeast of the project site, respectively. The Boring Lava Field volcanoes resulted from a smaller series of eruptions and are within approximately 25 miles southeast of the project. The Boring Lava Field volcanoes are low, broad lava shield volcanoes and all are considered extinct.

Mount St. Helens is capable of producing eruptions of ash, lava flows, pyroclastic flows, and lahars (Wolfe and Pierson 1995). However, the Facility is upstream of drainages that extend from the flank of Mount St. Helens and would not be subject to pyroclastic flows or lahars. The USGS estimates that there is between a 0.01 and 0.02 percent annual probability that there would 4 inches or more of ash will be deposited at the site from eruptions throughout the Cascade Range, with the highest probability resulting from. Most Cascade Range contribution in the analysis is from Mount St. Helens (Wolfe and Pierson 1995).

Mount Hood has produced lava and pyroclastic flows, lahars, and debris avalanches (Scott et al. 1997). A future Mount Hood eruption could generate a lahar that would enter the Columbia River 15 miles upstream from the project area at the mouth of the Sandy River. A large lahar entering the Columbia River could produce localized flooding and sediment deposition at the mouth of the Sandy River.

Based on the distance and activity level of nearby volcanoes to the project site, there is a low potential for damaging volcanic processes to reach the project, and these events would be considered extremely rare.

2.18.2.1 Mitigation of Volcanic Eruption

Volcanic events can typically be anticipated through monitoring of earthquakes and other data from the USGS volcano monitoring network. Should an eruption occur and pose a risk to the Facility the operations will be shut down until conditions allow for safe operation.

2.18.3 Flooding

The 100-year floodplain and floodway of the Columbia River are located at 30 feet (NAVD 88) and extend generally to the top of the bank along berths 13 and 14 (FEMA Map 53011C0363D). In addition, there is an isolated floodplain located on Parcel 1A as shown on FEMA Map 53011C0364D. The port filled this area as authorized by City permit GRD2012-00025.

The 100-year floodplain represents the area subject to flooding by a flood with a 1 percent chance of being equaled or exceeded in any given year. Hazards from flooding include an increase in river elevation and current and the amount of debris in the river. During a flood the river levels will rise and can inundate, damage or sweep away buildings or equipment, result in debris accumulation, and present hazards to river navigation.

Facility elements that are located in the Floodplain include berths 13 and 14 and the control room, e-house and motor control center buildings in Area 400.

It is not anticipated that any fill will be placed in the flood fringe or floodway.

2.18.3.1 Mitigation for Flooding

The Facility will be designed to comply with the City's Frequently Flooded Areas provisions of the Shoreline Management Program. These provisions require that buildings and structures located in the floodplain be elevated to at least one foot above the flood elevation or be floodproofed, be anchored to prevent floatation, collapse or lateral movement and incorporate other design elements to insure safety during a flood event. Compliance with these provisions will be determined during the issuance of construction permits anticipated by EFSEC.

Dock operations will comply with the USCG- and Ecology-approved Terminal Operating Limits as published in the Terminal Operations Manual.

2.18.4 Tsunami

Tsunamis are large damaging waves generated in oceanic areas due to earthquakes. The project site is approximately 95 miles up the Columbia River from the Pacific Coast and is at an elevation of approximately 25 to 35 feet (North American Vertical Datum [NGVD]). Based on the distance from the coast to the site and the elevation of the project site, tsunamis are not considered a potential hazard, and tsunami inundation is not a concern for the project. No mitigation measures are considered necessary for tsunami hazards.

Seiches are earthquake-generated waves that can occur in inland bodies of water, including rivers. The site is adjacent to the Columbia River. After the 1964 Alaska earthquake, a very minor (less than 1 foot) seiche was reported in the upper (non-free flowing) section of the Columbia River system from McNary Reservoir (McNary Dam) to Franklin D. Roosevelt Lake (Grand Coulee Dam) (McGarr and Vorhis 1965). No historic seiches are known from the lower, free-flowing Columbia River. The likelihood that seiches could affect the project is very low. No mitigation measures are considered necessary for seiche hazards.

2.18.5 Storms

Washington State is vulnerable to severe weather events, primarily from storm systems moving into the State from the Pacific Ocean. Severe storms are generally considered to be an atmospheric disturbance with sustained winds of over 40 mile per hours and or significant precipitation events. The County has been subject to infrequent but severe weather events including the Columbus Day Windstorm in October 1962, with recorded wind speeds of up to 92 miles per hour in Vancouver. Tornadoes occur very infrequently but have occurred in Vancouver including a Category F-3 event in April 1972 and an EF-1 event in January of 2008 that touched down NE of the project site near Vancouver Lake. Other severe weather events include ice storms resulting from strong easterly winds through the Columbia Gorge and lightning strikes. Strong winds and tornadoes can damage buildings and equipment. Lighting could strike buildings affecting power and electrical equipment. Ice storms can coat roads, equipment and buildings resulting in unsafe travel and working conditions and increase load on roofs. Heavy rainfall events can result in localized standing water.

2.18.5.1 Mitigation for Storms

The Facility will be designed to comply with the International Building Code requirements to reduce the risk of damage to structures from storm events. Buildings will be designed for a snow load of 25 pounds per square foot and a 135 mph wind speed (exposure c, strength level per ASCE 7-10). Protection against lightning will be provided by proper grounding and use of intrinsically safe electrical installations. All buildings are required to be designed by a structural engineer. Compliance with the code provisions will be determined during the building permits administered by EFSEC.

During severe weather events, the Facility operator will monitor the conditions at the site and if conditions result in risks to employees or facilities, will cease operations until safe to resume.

2.18.6 Avalanche and Landslides

Landslide hazard areas are typically defined as areas that, due to a combination of slope inclination, soil type, geologic structure, and the presence of water, are susceptible to failure and subsequent downhill movement. No landslides have been mapped on the site or in the vicinity of the project area (Fiksdal 1975). With the exception of along the banks of the Columbia River, the project site is relatively flat. The banks of the river near the area of the dock and a small depression in the area of the storage area have portions where slope inclinations are greater than 25 percent. Avalanche is typically associated with the rapid flow of snow downhill. The project site is well below the snow line elevation and climatic conditions generally do not allow the buildup of snow at the site. Avalanches are not a concern for the project and no mitigation measures are considered necessary.

Based on the lack of landslide deposits mapped in the vicinity of the site, its low topographic relief, and the absence of geologic structures that may increase landslide susceptibility, the impact of landslides to the project is negligible. No mitigation for landslide hazard is anticipated.