4.11 EARTH RESOURCES

This section provides project-level discussion and analysis of potential risks and impacts related to earth resources, specifically in regard to the potential for seismic activity to affect the project. Soils and geology were analyzed in the Phase 1 Draft EIS because seismic and geotechnical hazards (including ground shaking, liquefaction, landslides, coal mines, and other hazards) are present throughout the area. In the Phase 1 Draft EIS, impacts under all alternatives were determined to be less-than-significant, assuming regulatory compliance and implementation of industry standards, geotechnical recommendations, and BMPs. Therefore, Earth was not further analyzed in the Phase 2 Draft EIS.

In response to comments received during the Phase 2 Draft EIS comment period, the Partner Cities determined that additional discussion of the risk of seismic activity at a project level should be provided. While seismic risks, including both the general seismic risks in the region as well as risks related to liquefaction-prone soils were discussed in the Phase 1 Draft EIS, the project alternatives pass through specific locations with varying types of geotechnical hazards. In addition, information on the regulations that apply to development in areas of seismic and liquefaction risk is further described in this section.

Information on erosion-prone soils, landslide areas, and steep slopes is provided in the Phase 1 Draft EIS, Chapter 3 (Section 3.3). This section describes seismic risks in the study area, which includes all areas within 1 mile of PSE's Proposed Alignment (Figure 4.11-1). Geology and soils information was obtained from U.S. Geological Survey (USGS) data (including GEOMapNW)[1], and *critical areas* mapping was obtained from study area communities. In addition to the USGS data, the following sources were reviewed to obtain the data presented in this chapter:

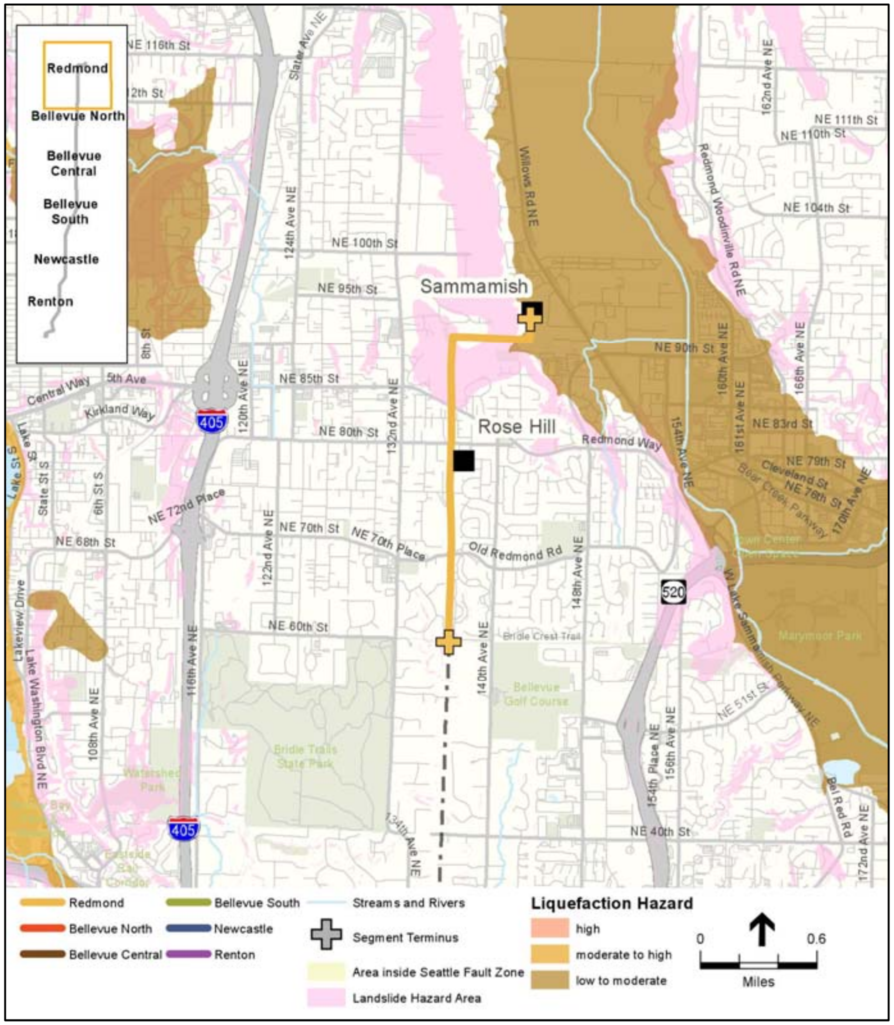
- GeoEngineers, Geotechnical Engineering Services Report for Energize Eastside Project, June 8, 2016.
- Department of Natural Resources, Modeling a Magnitude 7.2 Earthquake on the Seattle Fault Zone in Central Puget Sound, 2012–2013.
- King County geographic information systems (GIS) web portal (King County, 2015).
- Information from the Cascadia Region Earthquake Workgroup (City of Seattle, 2017; CREW, 2013).

Key Changes from the Phase 2 Draft EIS

The Phase 2 Draft EIS did not discuss impacts related to earth resources because the Phase 1 Draft EIS found that significant impacts are not anticipated. In response to the number of comments on the Phase 2 Draft EIS asking for additional information on seismic risks, the Final EIS includes this expanded discussion of the specific seismic risks present in the study area for PSE's Proposed Alignment. While seismic risks are present in the study area and throughout the region, the project would not substantially affect those risks.

Key Findings – Earth Resources

Seismic and geotechnical hazards including fault rupture, ground shaking, liquefaction, landslides, and other hazards are present throughout the area. Impacts would be minor with implementation of NESC standards, geotechnical recommendations, and regulatory requirements.

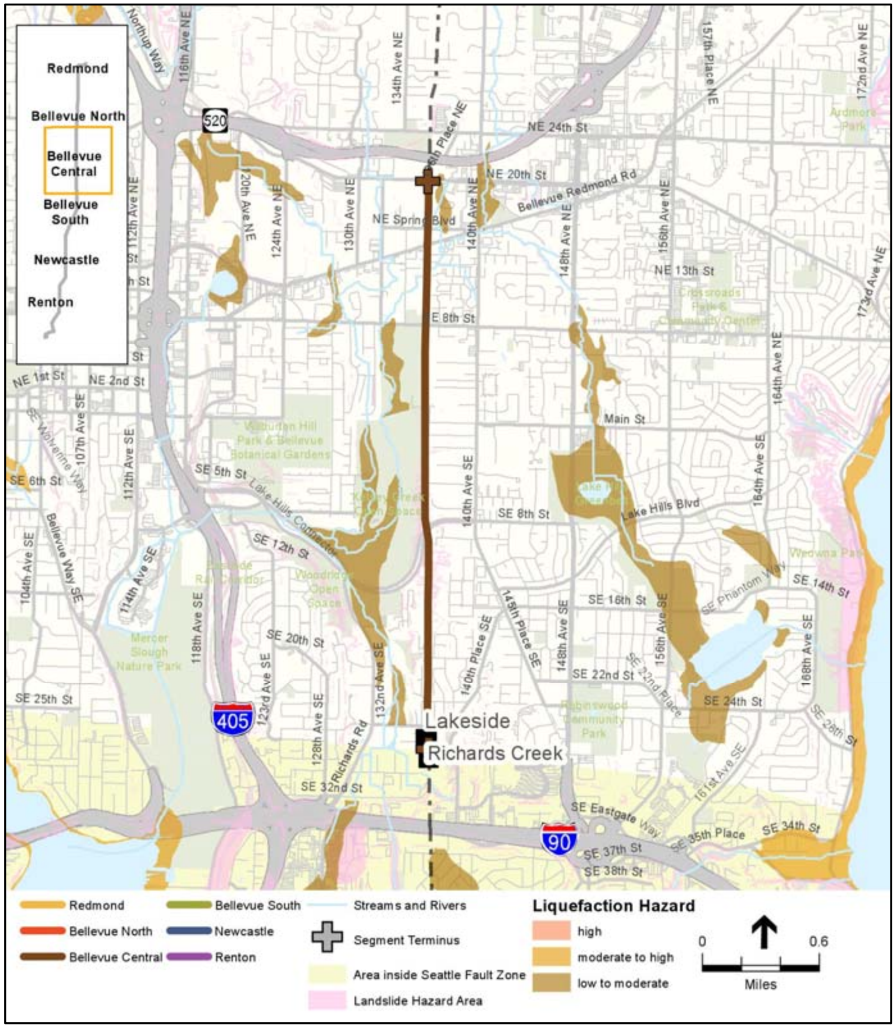


Redmond Segment

Bellevue North Segment

Sources: King County, 2015; Ecology, 2014

Figure 4.11-1. Seismic Hazards in the Earth Resources Study Area

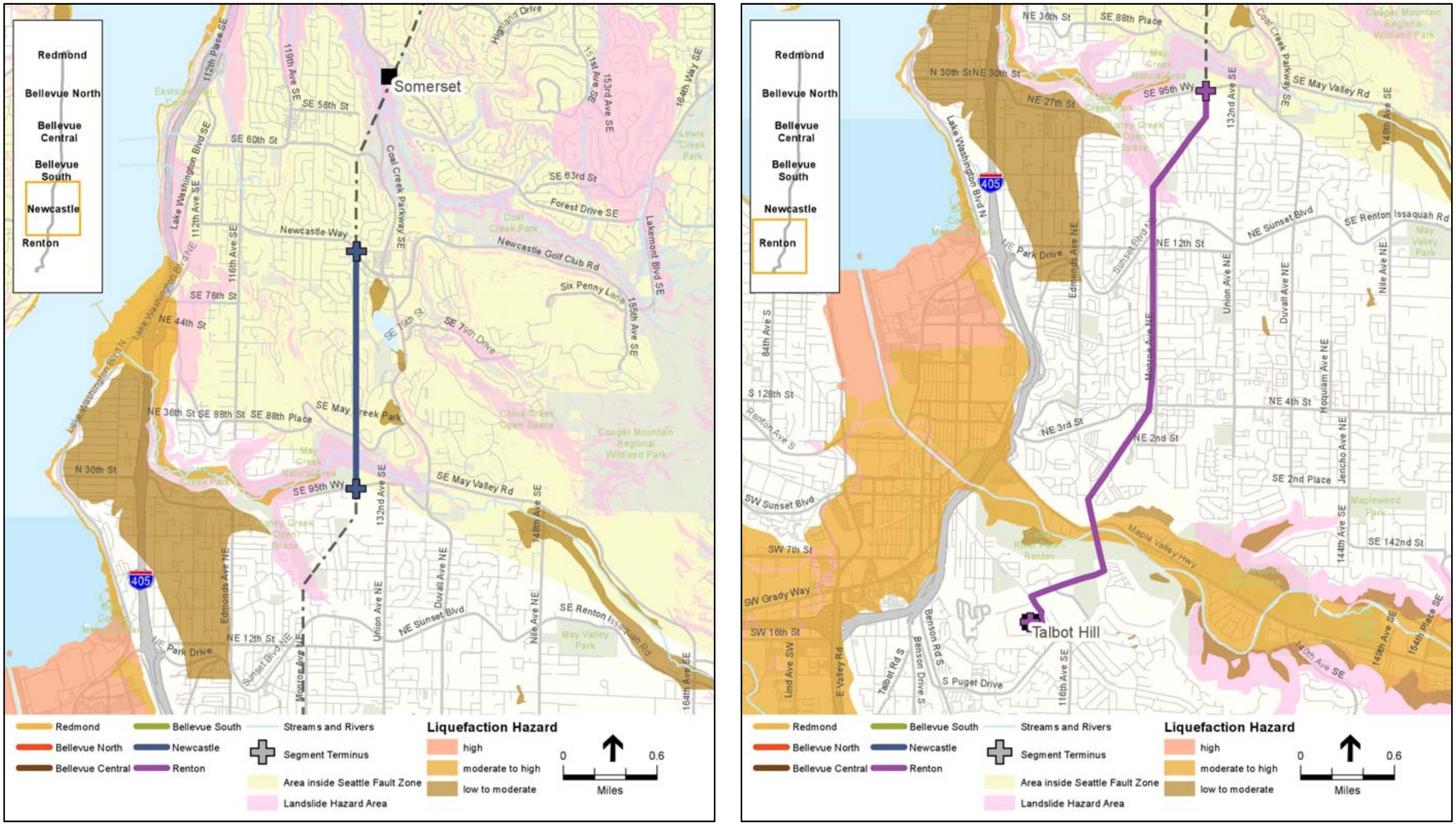


Bellevue Central Segment (Revised Existing Corridor Option)

Bellevue South Segment (Revised Willow 1 Option)

Sources: King County, 2015; Ecology, 2014

Figure 4.11-1. Seismic Hazards in the Earth Resources Study Area (continued)



Newcastle Segment, Options 1 and 2

Renton Segment

Sources: King County, 2015; Ecology, 2014

Figure 4.11-1. Seismic Hazards in the Earth Resources Study Area (continued)

4.11.1 Relevant Plans, Policies, and Regulations

This section describes the relevant regulatory framework including plans, policies, and regulations related to geology and soil resources that would apply to the alternatives. The Phase 1 Draft EIS provides a full description of the relevant plans, policies, and regulations that apply to earth resources. Following is a brief listing of those plans, policies, and regulations.

The National Electric Safety Code (NESC) establishes basic provisions for safeguarding of persons from hazards arising from the installation, operation, or maintenance of: (1) conductors and equipment in electric substations, and (2) overhead and underground electric supply and communication lines (IEEE, 2017). The NESC is adopted by the state public utility commission (in Washington, the Utilities and Transportation Commission or UTC) and is updated every 5 years.

Washington State's Growth Management Act (GMA) requires all cities and counties to identify *geologic hazard areas*, which are areas susceptible to erosion, sliding, earthquake, or other geologic events, as part of the designation of critical areas (Chapter 36.70A.060(2) and 36.70A.172 RCW).

As required by the GMA, each jurisdiction in the study area has adopted codes regulating development in or near geologic hazard areas (including building codes). Protecting structures from *liquefaction*[2] and ground shaking are generally addressed through implementation of building code standards that include seismic design measures. Typically, for new construction, an applicant is required to provide a site-specific geotechnical investigation that identifies underlying soil and bedrock properties, and geotechnical hazards, as well as demonstrate that identified hazards can be overcome through the application of geotechnical engineering recommendations. The Washington State Building Code is modeled on the 2015 International Building Code, combined with Washington State amendments. However, the International Building Code, which applies in all jurisdictions, specifically exempts utility structures in a right-of-way controlled by the utility, as is the case with the Energize Eastside project. Therefore, with regard to structural stability, electric utility structures for the project are governed by NESC standards only. Nonetheless, PSE has provided geotechnical studies that incorporate the methodology used in the International Building Code to determine seismic requirements, and provide recommendations in accord with those findings.

Final structural design for electrical utility structures must comply with NESC 2017 as adopted by the UTC. For transmission lines, NESC 2017 states that the structural requirements necessary for wind/ice loadings are more stringent than seismic requirements and sufficient to resist anticipated earthquake ground motions. In addition, according to ASCE Manual No. 74, "transmission structures need not be designed for ground-induced vibrations caused by earthquake motion because historically, transmission structures have performed well under earthquake events, and transmission structure loadings caused by wind/ice combinations and broken wire forces exceed earthquake loads" (ASCE, 2009).

[2] Liquefaction occurs where saturated, loose granular soils are subjected to ground shaking such that the soil loses strength and begins to behave more like a liquid than a solid. Saturated loose soils within 50 feet of the ground surface are considered at most risk of liquefaction.

4.11.2 Seismic Hazards in the Study Area

Seismic hazards include the primary effects of earthquakes, such as ground displacement from fault rupture and ground shaking and secondary effects such as liquefaction and landslides. While tsunamis and seiche waves can be also triggered by earthquakes, no portion of the study area is close enough to major water bodies to be affected. *Settlement*[3], fires, and hazardous materials releases are also likely secondary effects from a major earthquake in an urban region such as the study area for the Energize Eastside project.

4.11.2.1 Primary Effects: Earthquake-induced Ground Rupture and Groundshaking

Earthquake-induced ground rupture and groundshaking are defined as the physical displacement of surface deposits in response to an earthquake's seismic waves. The magnitude, characteristics, and nature of fault rupture can vary for different faults or even along different strands of the same fault.

The Puget Sound basin is a seismically active area dominated by the Cascadia *subduction* zone, which forms the boundary between two tectonic plates: the North American plate and the Juan de Fuca plate. The project vicinity has been subject to earthquakes in the historic past and will undoubtedly undergo shaking again in the future. Damage from earthquakes depends on many factors including distance to epicenter, soil and bedrock properties, and duration of shaking.

Earthquakes in the Puget Sound region result from one of three sources:

1. **Crustal or Shallow Earthquakes** from faults found in the North American tectonic plate that are near the crust's surface. Intense shaking occurs near the epicenter but usually diminishes quickly with distance relative to the other earthquake types. The closest active crustal fault to the study area is the Seattle Fault Zone, which runs roughly east-west in south Bellevue and roughly parallel to I-90 (see Figure 4.11-1). The Seattle Fault Zone is the primary but not only source for shallow earthquakes in Seattle. A Seattle Fault earthquake could be as large as magnitude 7.5, but a magnitude less than 7.0 is more probable (Seattle, 2015). This type of earthquake could have the highest intensity in the study area compared to the other earthquake sources described below, but the degree of accompanying regional damage would likely be smaller than the megathrust earthquakes described below. Geologic evidence suggests displacement on the Seattle fault in West Seattle (Alki Point) from an earthquake about 1,100 years ago. Investigation of an 8,000-year history of activity on the Seattle fault found evidence for possibly one additional earthquake on the Seattle fault about 6,900 years ago, suggesting a recurrence interval of thousands of years for large earthquakes (Seattle, 2015).

2. **Intraplate or Deep Earthquakes** that occur at depths of approximately 20 to 40 miles where dense oceanic crust dives under lighter continental crust. Because of the depth, even buildings right above the epicenter are generally far enough away that ground motions are attenuated and damage is limited. Deep earthquakes are the most common large earthquakes that occur in the Puget Sound region. Deep earthquakes with magnitude greater than 6.0

[3] Ground shaking can cause shifting and rearrangement of unconsolidated materials that result in settlement of the ground surface, both uniformly and differentially (i.e., where adjoining areas settle at differing amounts due to different characteristics).

(Richter scale) have occurred six times between 1909 and 2001 in the Puget Sound region, and the highest recorded event was magnitude 7.3 in 1946. The 2001 Nisqually Earthquake was a deep earthquake with a magnitude of 6.8 (Seattle, 2015).

3. **Subduction Zone or Megathrust Earthquakes** occur on the Cascadia Subduction Zone, Megathrust earthquakes are the largest type of earthquakes in the world, and the greatest risk to the region as a whole. A megathrust earthquake could reach magnitude 9.0+ at its epicenter, and affect an area from Canada to northern California. Shaking in Seattle would be violent and prolonged, but not as intense as a Seattle Fault quake. The last known megathrust earthquake in the northwest was in 1700. Geologic evidence suggests that seven megathrust earthquakes have occurred over the last 3,500 years indicating a return interval of 400 to 600 years (PNSN, 2017).

Strong ground shaking from a major earthquake can produce a range of intensities experienced at any one location. Ground shaking may affect areas hundreds of miles distant from the earthquake's epicenter. The ground shaking can result in slope failure, settlement, soil liquefaction, tsunamis, or seiches, all of which pose a risk to the public. Areas considered to be of high seismic risk are depicted in Figure 4.11-1. These include Seattle Fault Zone, liquefaction prone soils, and landslide prone areas.

4.11.2.2 Secondary Effects

Liquefaction

Liquefaction is often the cause of damage to structures during earthquakes. Liquefaction occurs where soils are primarily loose and granular in consistency and located below the water table. Saturated loose soils within 50 feet of the ground surface are considered at most risk of liquefaction. The consequences of liquefaction include loss in the strength and settlement of the soil. The loss of strength can result in lateral spreading, bearing failures, or flotation of buried utility vaults and pipes.

Liquefaction hazard areas identified in Figure 4.11-1 are those areas where the foundation soils are subject to liquefaction or lateral spreading during an earthquake (but could also be susceptible to seismically induced settlement). Typically, these soils are in low-lying areas near bodies of water, such as along the larger streams and around lakes where there is a high probability of loose, saturated, alluvial soils. In the study area, areas such as lowland lakeside areas within the Redmond Segment north of Lake Sammamish, as well as the floodplains of the Cedar River, contain areas that have low to moderate susceptibility to liquefaction. Other areas are generally not considered susceptible. However, site-specific geotechnical investigation identified two areas with soil conditions considered susceptible to liquefaction (GeoEngineers, 2016), which are described below.

Landslides

Landslides have often occurred during past earthquakes in the Puget Sound region, due to the region's geologic and soil formations. Factors affecting the likelihood of landslides during an earthquake include the types of materials involved (e.g., the geologic composition of materials), precipitation, topography, slope geometry, and human activity that has altered slope support. Earthquake motions can induce significant horizontal and vertical dynamic stresses in slopes that can trigger failure that might otherwise be stable under static conditions.

4.11.3 Long-term (Operation) Impacts Considered

4.11.3.1 Magnitude of Impact

The magnitude of the potential impacts from the Energize Eastside project due to seismic activity is classified as less-than-significant or significant, defined as follows:

- **Less-than-Significant** – Impacts due to seismic activity would be considered less than significant if, assuming compliance with current practices and regulations pertaining to structural safety, the project would not substantially increase the risk of damage to natural resources or adjacent land uses.
- **Significant** – Impacts due to seismic activity would be considered significant if, even with compliance with current regulations, the project could substantially increase the risk of damage, injury, death, or widespread or long-term interruption of power supply as a result of an expected seismic event. Impacts could be considered significant even if the overall probability is remote.

Methods and Approach for Studying the Long-term (Operation) Impacts

Potential impacts were determined by identifying the geologic hazard areas present within the study area and the geotechnical approaches to minimize the hazards.

Geology and soil considerations important to the Energize Eastside project include general topography, underlying geological characteristics and properties, and soil characteristics, as well as seismic and other related geologic hazards. Regional geology and seismicity would not change as a result of the project, but the way the project is designed and constructed will determine its structural stability in the event of a large earthquake. If the poles or other structures in the project were to fail, it would directly affect the electrical supply. Falling poles or failing foundations in the substation could result in secondary damage to people, adjacent structures, and infrastructure.

4.11.4 Long-term Impacts: No Action Alternative

Under the No Action Alternative, PSE would continue to operate the existing 115 kV transmission lines, as described in Chapter 2.

Under the No Action Alternative, existing risks of seismic activity would remain. Seismic activity is likely to occur during the life of the existing transmission lines, and could result in ground rupture, ground shaking, liquefaction, and landslides, any of which could cause the transmission line poles to fall. This in turn could cause substantial power outages, damage to adjacent structures, injuries, or death. However, even in severe earthquakes, it is not common for transmission line poles to fall because the poles are designed to be flexible to resist considerable lateral movement due to wind loads, which create forces that exceed earthquake loads (IEEE, 2017).

Ground rupture from a surface fault rupture on the Seattle Fault zone could cause the Olympic Pipeline system that runs underground through much of the corridor to burst and release flammable petroleum products. In the event of a release from the pipelines, the risk of a fire near the transmission lines would be high, and the wood poles could burn. Because it is unlikely for a pole to fall in an earthquake, it is also unlikely that a falling pole would in some way cause a rupture on the pipeline.

An arc from a broken transmission line could provide an ignition source for a fire in the event of a release from the pipeline. However, the likelihood of an arc starting a fire in this manner is limited by the following factors: (1) if a transmission line breaks or there is some other electrical fault on the transmission line, a circuit breaker would shut down the power to the transmission line in a fraction of a second; (2) because of the slack in transmission lines, it is not common for them to break during an earthquake; and (3) transmission lines are designed so that the individual wires or conductors can swing, either due to wind or earth shaking, without striking each other and causing an arc. While these factors make the likelihood of an arc on the transmission line starting a fire very low, it is not impossible that a severe earthquake could cause a simultaneous release from the pipelines and a break in the transmission lines, resulting in a fire. Section 4.9, *Pipeline Safety*, addresses the potential effects if a transmission line were to ignite fuel that had been released from the Olympic Pipeline system.

Ground shaking could also cause damage at substations from a seismic event on the Seattle Fault Zone or from other sources along the Cascadia Subduction Zone. Equipment such as transformers, switches, and buswork could be damaged structurally. Catastrophic failures of circuit breakers, transformer bushings, and disconnect switches at substations can result in widespread power outages. Due to potential for oil used as insulation in this equipment to be released if the equipment is damaged, fires are also possible.

These existing risks of adverse impacts to the environment would not change under the No Action Alternative because the transmission lines and substations would remain in place, as would existing infrastructure surrounding the transmission lines, including the Olympic Pipeline system.

4.11.5 Long-term Impacts: PSE's Proposed Alignment

4.11.5.1 Impacts Common to all Components

The Energize Eastside project under any alternative or option would cross the same seismic and other geologic hazard areas as crossed by the existing transmission lines. As such, the project would be subject to the probability of future seismic activity. Seismic activity will likely occur during the life of the proposed transmission lines, and could result in ground rupture, ground shaking, liquefaction, and landslides, any of which could cause transmission line poles to fall or other equipment to fail as described in the No Action Alternative, if not designed appropriately. However, according to the geotechnical investigation conducted by a Washington State licensed geotechnical engineer during the design stage of the project, the recurrence interval of the Seattle Fault is on the order of 1,000 years and considered to have a low risk of causing fault rupture over the design life of the project (GeoEngineers, 2016). This is not to suggest that ground shaking is not a hazard present throughout the alignment, as discussed below.

There would be no wood poles, so fires resulting from a seismic event would not cause the poles to burn, although other damage to wires and connectors could be similar, and fires could weaken steel poles if they are hot enough. Pole heights would be substantially taller than the existing poles in most segments of the project and could reduce the possibility of fire damage to the lines in those areas. If a pole were to fall, the taller poles would be both heavier and have greater force should one strike a person, property, or structure.

The final structural design for poles and other electrical equipment at the substations would comply with NESC 2017 as adopted by the UTC (IEEE, 2017). In addition, PSE provided calculations showing that the design of the project facilities could withstand probable seismically induced ground shaking as would be required if the project were subject to the International Building Code. Modeled potential seismic impacts were determined for the area to determine what the peak ground acceleration (PGA) value, a measure of maximum groundshaking, would be for the study area. Using the estimated PGA value of 0.606 according to methods consistent with the International Building Code, the loadings or forces that would be produced would be 82 to 87 percent of the NESC requirements for wind and ice load on transmission poles. Therefore, as noted above, designing for weather is sufficient to ensure that the appropriate structural design would be able to withstand both of these conditions. Therefore, the NESC requirements for transmission poles are more stringent that the current International Building Code. Wind load is not as great a factor for substation facilities, however.

The liquefaction potential of the study area corridor was reviewed by a Washington State licensed geotechnical engineer during the design stage as part of the geotechnical review for seismic stability. Areas of potential liquefaction were identified and the amount of ground settlement that could occur as a result of liquefaction was estimated to range up to a maximum of 4 to 8 inches. Design of structures to resist seismic forces and secondary effects such as liquefaction was informed by geotechnical engineering methods by a Washington-licensed geotechnical engineer that was consistent with current regulatory standards.

Under the Energize Eastside project, a minimum of 16 miles of new overhead transmission lines would be constructed. As noted above, the transmission lines would be constructed in accordance with the standards outlined by NESC, FERC, NERC, and ASCE Manual No. 74 (ASCE, 2009). In areas of common utility corridors, coordination with other utility providers would be conducted as appropriate. Site-specific geotechnical investigations have been used to define the underlying engineering properties and identify geotechnical hazards that may be present. Geotechnical engineering methods, such as the use of engineered fill or foundation design, would be used to ensure that the effects of any identified hazards are minimized and impacts during operation would be minor.

4.11.5.2 Richards Creek Substation

The Richards Creek substation site is on the edge of the Seattle Fault Zone. Areas within the fault zone are at a potential risk of ground surface displacement and groundshaking hazards. As noted above, improvements would be designed in accordance with NESC standards, which may or may not meet the same standard as the International Building Code. Because earthquakes in other regions have resulted in damage to substations, it is reasonable to assume that substation equipment could be damaged unless designed to withstand earthquakes typical of the region.

Seismic hazards at the site, including fault rupture and liquefaction, were considered in development of seismic design recommendations presented in the project geotechnical report (GeoEngineers, 2016). PSE has indicated that recommendations included in the geotechnical report are consistent with the International Building Code (IBC) requirements for designing structures to resist seismic hazards known to be present on a site, and that the Richards Creek substation will be designed in accordance with the design recommendations presented in the project geotechnical report.

- **Seattle Fault Zone/Fault Rupture Hazards:** The substation site is on the fault zone. As noted above, the recurrence interval of the Seattle Fault Zone represents a low risk of fault rupture.
- **Liquefaction Hazard Areas:** The substation site does not intersect a mapped liquefaction hazard area with a moderate or high hazard rating. However, a geotechnical evaluation conducted by a Washington State licensed geotechnical engineer provided an analysis of the

liquefaction potential and estimated the potential for ground settlement due to liquefaction in the small area between the Lakeside substation and the south side of the existing pole yard, which was not shown on the general area map cited above. Consideration of this area was incorporated into the design criteria (GeoEngineers, 2016).

- **Landslide Hazard Areas:** The substation site does not intersect an identified landslide hazard area.

4.11.5.3 Redmond Segment

Relative to the No Action Alternative, this segment would include new, taller poles that intersect landslide and seismic hazard areas. However, impacts would be less-than-significant with implementation of NESC standards and geotechnical recommendations based on the geotechnical evaluations that have been conducted by a Washington-licensed geotechnical engineer.

- **Seattle Fault Zone/Fault Rupture Hazards:** This segment is outside of the fault zone.
- **Liquefaction Hazard Areas:** The north portion of this segment (in the vicinity of the Sammamish substation) intersects the edge of an identified liquefaction hazard area with a moderate or high hazard rating. A geotechnical evaluation conducted by a Washington State licensed geotechnical engineer provided an analysis of the liquefaction potential and estimated the potential for ground settlement due to liquefaction in the wetland area near the Sammamish substation, which was more specific than the general area maps. Consideration of this area was incorporated into the design criteria (GeoEngineers, 2016).
- **Landslide Hazard Areas:** The north portion of the segment intersects an identified landslide hazard area that has received geotechnical evaluation and appropriate design measures by a Washington State licensed geotechnical engineer.

4.11.5.4 Bellevue North Segment

Relative to the No Action Alternative, this segment would include new, taller poles that would not intersect any identified landslide and seismic hazard areas. Implementation of NESC standards overseen by a Washington-licensed geotechnical engineer would ensure that the new poles would have less-than-significant impacts related to seismic (primarily groundshaking) hazards.

- **Seattle Fault Zone/Fault Rupture Hazards:** This segment is outside the fault zone.

  Liquefaction Hazard Areas: This segment does not intersect any identified liquefaction hazard areas.
- **Landslide Hazard Areas:** The segment is outside of any identified landslide hazard areas.

4.11.5.5 Bellevue Central Segment (Revised Existing Corridor Option)

PSE's Proposed Alignment for the Bellevue Central Segment follows the route of the Existing Corridor Option as described in the Phase 2 Draft EIS (see Section 2.1.2.3), with refined design details for pole types and placement. Relative to the No Action Alternative, potential impacts would be similar as the new poles, even though taller, would be better designed to withstand seismic hazards; therefore, impacts would be less-than-significant.

- **Seattle Fault Zone/Fault Rupture Hazards:** This segment is largely outside of the fault hazard zone. However, the south end of the segment abuts the north edge of the fault zone area, as described above for the Richards Creek substation site. As noted above, the recurrence interval of the Seattle Fault Zone represents a low risk of fault rupture (GeoEngineers, 2016).
- **Liquefaction Hazard Areas:** This segment does not intersect any identified liquefaction hazard areas.
- **Landslide Hazard Areas:** The segment is outside of any identified landslide hazard areas.

4.11.5.6 Bellevue South Segment (Revised Willow 1 Option)

PSE's Proposed Alignment for the Bellevue South Segment follows the route of the Willow 1 Option as described in the Phase 2 Draft EIS, with refined design details for pole types and placement. In this segment, poles would be placed within the Seattle Fault Zone where potential ground surface displacement could occur along any of the fault strands within this zone. The thrust fault strands within this zone are complex, not well defined because of surface concealment, but thought to include three main strands. Incorporating seismic design measures as guided by geotechnical evaluations from a Washington State licensed geotechnical engineer would make the potential for catastrophic failure unlikely. As a result, the potential impacts would be less-than-significant. Making this more closely reflect the conclusion of the geotech report.

- **Seattle Fault Zone/Fault Rupture Hazards:** This segment is located entirely in the fault hazard zone. Final design was reviewed by a geotechnical evaluation by a Washington State licensed geotechnical engineer, which provided appropriate design criteria. As noted above, the recurrence interval of the Seattle Fault Zone represents a low risk of fault rupture.
- **Liquefaction Hazard Area:** This segment does not intersect any identified liquefaction hazard areas.
- **Landslide Hazard Area:** The segment is outside of any identified landslide hazard areas.

4.11.5.7 Newcastle Segment – Option 1 and 2

This segment includes two options that represent different approaches in pole design and placement but would follow the same route; thus, both would be exposed to similar hazards. Relative to the No Action Alternative, this segment would place poles of either design within the Seattle Fault Zone where potential ground surface displacement could occur along any of the fault strands. The thrust fault strands within this zone are complex and not well defined because of surface concealment, but thought to include three main strands. Incorporating seismic design measures as guided by geotechnical evaluations from a Washington State licensed geotechnical engineer would make the potential for catastrophic failure unlikely. As a result, the potential impacts would be less-than-significant.

- **Seattle Fault Zone/Fault Rupture Hazards:** This segment is largely located within the fault zone. However, as noted above, the recurrence interval of the fault represents a low risk of fault rupture.
- **Liquefaction Hazard Areas:** This segment does not intersect any identified liquefaction hazard areas.

- **Landslide Hazard Areas:** The segment is outside of any identified landslide hazard areas.

4.11.5.8 Renton Segment

This segment is outside of the Seattle Fault zone but still at risk of groundshaking hazards. In addition, the alignment intersects a landslide hazard area (near the Honey Creek Open Space) that could be triggered by a seismic event. Implementation of NESC standards overseen by a Washington-licensed geotechnical engineer would ensure that the geotechnical design of the new poles minimizes the seismic and landslide hazards present; therefore, impacts would be less-than-significant.

- **Seattle Fault Zone/Fault Rupture Hazards:** This segment is outside the fault hazard zone. However, the north end of the segment abuts the south edge of the fault zone. However, as noted above, the recurrence interval of the fault represents a low risk of fault rupture.
- **Liquefaction Hazard Areas:** This segment would intersect an identified liquefaction hazard area with a moderate to high rating (see Figure 4.11-1). However, no poles or other structures would be constructed in the liquefaction hazard area; therefore, the project would not be affected by this hazard.
- **Landslide Hazard Areas:** The segment intersects an identified landslide hazard area that has received geotechnical evaluation and appropriate design measures by a Washington State licensed geotechnical engineer.

4.11.6 Mitigation Measures

This section describes mitigation measures that would be used during operation of the project and recommends additional measures to avoid, minimize, and mitigate impacts related to seismic risks. Federal, state, and local regulations would minimize the potential for impacts dues to seismic activity resulting from the Energize Eastside project. The design features and BMPs that PSE proposes to use to avoid or minimize impacts during design and operation and those required by agency standards are assumed to be part of the project and have been considered in assessing the environmental impacts that could result from seismic activity.

All mitigation measures would be determined during the permitting process. Measures may be required prior to construction, at project start-up, or during operation of the project. For instance, mitigation measures related to the design of poles and substation equipment would be incorporated into the project design prior to construction. Other mitigation measures, such as monitoring foundations, would need to be implemented after the project is constructed.

4.11.6.1 Regulatory Requirements

PSE Responsibilities and Requirements

PSE is responsible for the Energize Eastside project's design, construction, and operational parameters within the shared corridor with the Olympic Pipeline systems. For general responsibilities of the Olympic Pipe Line Company regarding pipeline safety, see Section 4.9. For geotechnical recommendations for construction activities near the Olympic Pipeline system, see Section 5.9.

For PSE, national and state standards, codes, and regulations, and industry guidelines govern the design, installation, and operation of transmission lines and associated equipment. The National

Electrical Safety Code (NESC) 2017, as adopted by the UTC, provides the safety guidelines that PSE follows. The NESC contains the basic provisions necessary for worker and public safety under specific conditions, including electrical grounding, protection from lightning strikes, extreme weather, and seismic hazards. PSE would use these in developing final design.

The final design of the project has not been completed; therefore, the final specifications and standards that would be incorporated into the project have not been identified.

4.11.6.2 Potential Mitigation Measures

Potential mitigation measures are summarized below based on results and recommendations of the GeoEngineers, Geotechnical Engineering Services Report for Energize Eastside Project, June 8, 2016, measures PSE has indicated they will use, and measures the EIS Consultant Team has proposed to provide additional safety assurances. The applicable measures are organized based on the stage at which they would be applied (i.e., before construction, at project start-up, and during operation).

Prior to Construction

- Confirm that a Washington State licensed geotechnical engineer has conducted geotechnical hazard evaluations for all proposed elements addressing groundshaking, fault rupture, liquefaction, and landslides, and that all geotechnical recommendations have be incorporated into project design.
- Design the Richards Creek substation in accordance with the design recommendations presented in the project geotechnical report (GeoEngineers, 2016). This will ensure that substation structures are designed to IBC seismic standards even though the IBC exempts this project from its requirements.
- Use the 2012 IBC parameters for short-period spectral response acceleration (S_S), 1-second period spectral response acceleration (S_1), and Seismic Coefficients F_A and F_V presented in Table 2 of the geotechnical report (GeoEngineers, 2016).
- Use site-specific soil input parameters for lateral load design that consider the effects of liquefaction through the application of p-multipliers for LPILE parameters.
- For the area north of the proposed Richards Creek substation, reevaluate the lateral spreading risk to the proposed poles in this area once their final locations have been determined, to determine appropriate foundation dimensions.
- Where liquefiable deposits are present, extend foundations below the loose to medium density liquefiable deposits into underlying dense, non-liquefiable soils.
- Reevaluate the axial capacity of the pole foundations and potential downdrag loads for poles in liquefiable deposits once final locations are selected, and consider these in the structural design.
- For the one location where soil test results indicated a moderate to high potential for corrosion, consider involving a corrosion engineer.

- Where bedrock is near the surface, additional options such as rock anchors or micropiles might be appropriate as an alternative to drilled shafts. If micropiles are used, the contractor should submit a detailed micropile plan describing methods and demonstrating consistency with specifications.
- The contractor should submit a detailed drilled shaft installation plan describing casing and drilled shaft construction methods for review and comment by the engineer before construction. The submittal should include a narrative describing the contractor's understanding of the anticipated subsurface conditions, the overall construction sequence, access to the pole locations, and the proposed pole foundation installation equipment.
- The contractor should submit a detailed direct embedment pole installation plan describing both uncased and temporary casing methods.

During Constrution

Implementation of the following measures during construction would ensure proper installation and prevent damage to adjacent structures for all of the proposed segments:

- If drilled shafts are used where groundwater is present, the concrete for drilled shafts should be placed using the "tremie" method (as described in the geotechnical report).
- Monitor the installation of the drilled shafts to confirm that soil conditions are as anticipated and that the shafts are installed in accordance with project plans and specifications, document variations in the field if necessary, and provide consultation as required should conditions vary from those anticipated.
- Where sensitive structures may be present within about 100 feet of the work area, vibration should be monitored.

During Operation

Implementation of the following measures during operation would reduce or minimize the potential for damage due to seismic activity for all of the proposed segments:

- Develop a monitoring and maintenance program that includes inspection and reporting on structural stability.
- As part of PSE's regular inspection of the transmission line, monitor all improvements for changes in conditions such as cracking foundations or slumping slopes that could reduce the ability of structures to resist seismic disturbances. This could include regular reporting to permitting agencies to ensure compliance.
- If changes are identified during inspection and monitoring of conditions, implement additional measures to reduce or minimize those impacts.