3.1 GEOLOGY AND SOILS

3.1.1 INTRODUCTION

This section describes the affected environment by summarizing the topography, geology, seismicity, and geologic hazards within the Study Area. Information was collected from available City of Bellevue, Washington State Department of Natural Resources, and Natural Resources Conservation Service data. The impacts of the identified geologic hazards are discussed for all alternatives for both the short-term and long-term. Significant impacts are based on the following thresholds:

- Erosion that could not be contained on future development sites
- Contamination of soils that require removal and disposal
- Exposure of people to risk of injury or substantial damage to structures and infrastructure due to the creation or acceleration of a geologic hazard
- Erosion that could not be contained on future development sites

There are no performance measures related to Geology and Soils.

Mitigation measures to address potential geologic hazards within the Study Area for each alternative are included.

3.1.2 AFFECTED ENVIRONMENT

REGULATORY ENVIRONMENT

The development and property use should be planned in accordance with the environmental regulations and procedures by Bellevue City Code, State, and Federal laws considering the "critical areas" such as wetlands, stream areas, geologic hazard areas, flood hazard areas, and shorelines. Presence of critical areas might affect the development and land use. At other areas, structures should be designed to resist location-specific seismic forces, as required by applicable building codes.

TOPOGRAPHY

The Study Area is located in the central portion of the Puget Sound Basin, an elongated, north-south trending depression situated in western Washington between the Olympic Mountain Range to the west and the Cascade Mountain Range to the east. The regional topography was shaped mainly by glaciations that moved across the region over 10,000 years ago, creating a series of north-south trending ridges separated by deep troughs. The troughs are now occupied by streams, lakes, and waterways, including Puget Sound, Elliott Bay, Lake Washington, and Lake Sammamish. More recently, erosional processes and landform changes made by human development of the area have modified the local topography.

Topography within the Study Area is generally flat-lying with rolling hills and localized areas of steep slopes. Ground surface elevations in the Study Area generally range from about 50 feet in the south and west portions of the Study Area to about 220 feet in the north and east along NE 8th Street—per North American Vertical Datum of 1988 (NAVD 88) (see Exhibit 3.1–1).

Steep slopes (> 40%) are mostly observed along the future Eastside Rail Corridor to the south of NE 8th Street and SE 1st Streets and east of the NE 4th Street/116th Avenue NE intersection within the Study Area. The Study Area is also bordered by isolated steep slopes located east of 120th Avenue NE, directly adjacent to the Wilburton Hill neighborhood. Most of the steep slopes observed within the Study Area were artificially created by construction.

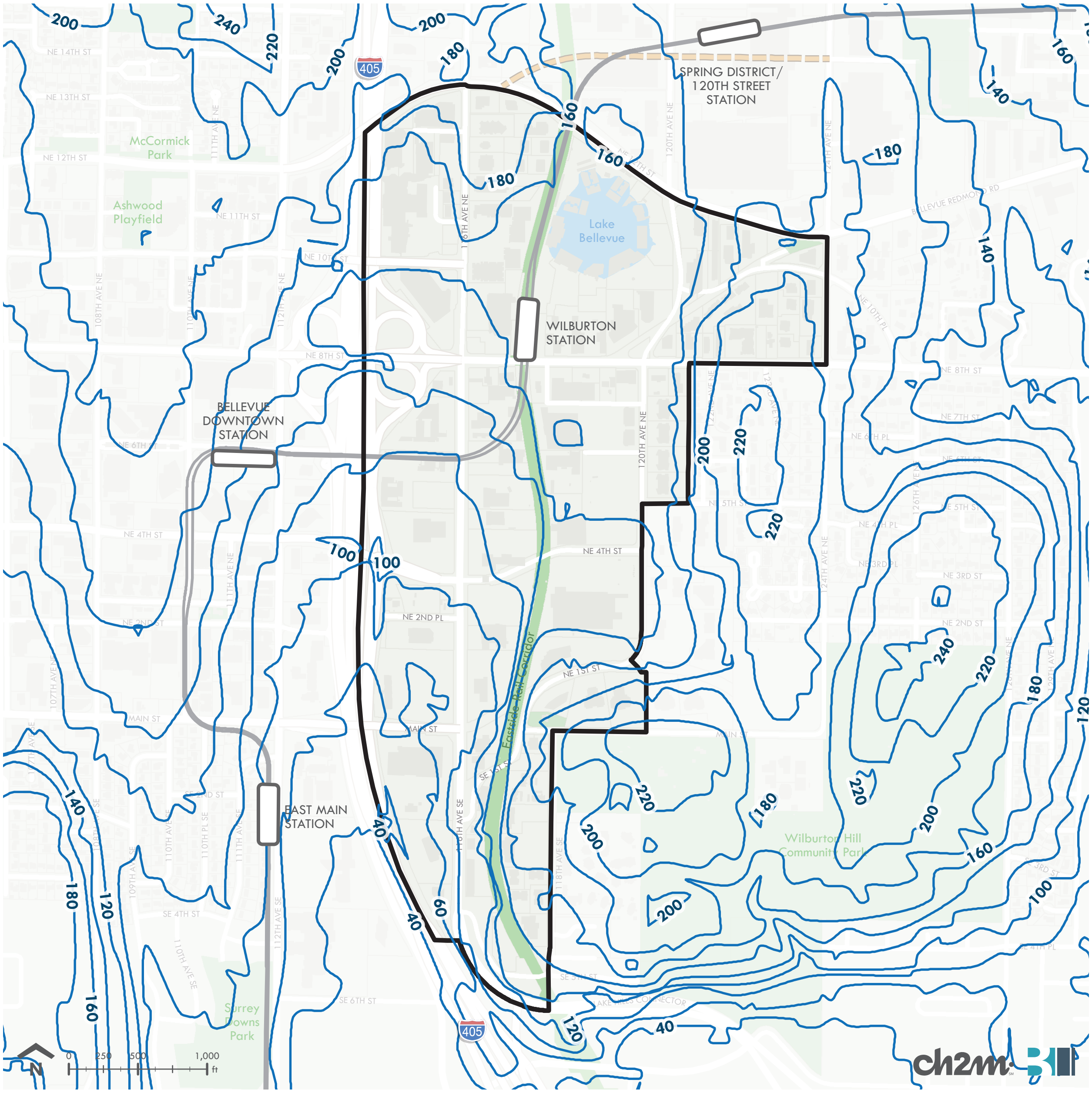

Exhibit 3.1–1 Ground Surface Elevation Map

Source: United State Geological Survey National Map retrieved via Esri, 2017; CH2M, 2017

Wilburton Study Area Boundary
East Link Light Rail Stations
East Link Light Rail Route
Spring Blvd–Under Construction
Parks & Open Space
Buildings
20ft Contours

GEOLOGY

Repeated glaciations within the Puget Sound Basin over the last 1.2 million years have left a thick deposit of unconsolidated soil in the region, which includes the Study Area. Between periods of glaciations, the valleys and low-lying areas filled with river and lake sediments. The near-surface soils in the Study Area were deposited during the most recent glacial episode, the Vashon Period of the Fraser Glaciation. During the last glaciation, between 15,000 and 13,000 years ago, a 3,000-foot-thick glacier advanced over the Puget Sound area. Deposits associated with this geologic process include the hard or very dense till, which was deposited and compacted at the base of the glacier, and outwash deposits, which were produced by the meltwater streams from the glacier. The very hard and dense consistency of the glacially overridden deposits is the result of consolidation from the weight of the glacial ice. Typically, these deposits exhibit very good bearing characteristics and performance during seismic loading. Per the geologic map of King County and Washington State Department of Natural Resources, the Study Area is mainly composed of continental glacial till of Fraser-age (Qgt), except around Lake Bellevue where continental glacial outwash of Fraser-age (Qgo) are present.

Soils are mapped in the project area by the Natural Resources Conservation Service (NRCS). Exhibit 3.1–2. illustrates the soil units mapped in the Study Area. Alderwood soils are the most common and abundant soils in the Study Area. Exhibit 3.1–2. shows presence of Urban land (Ur), Tukwila muck (Tu), Bellingham silt loam (Bh), and Norma sandy loam (No).

Alderwood gravelly sandy loams (AgC and AgD) are moderately well drained soils that have a substratum of consolidated till at a depth of approximately 24 to 40 inches. Arents-Alderwood (AmC) materials are Alderwood soils that have been substantially disturbed by urban development, but still have many features of undisturbed Alderwood soils. In both soils, surface horizons have moderately rapid permeability, but the till substratum is very slowly permeable, creating a high-water table in winter. Tukwila muck is poorly drained organic soil formed in depressions on till plains and in river and stream valleys. In the project area, Tukwila mucks are found around Lake Bellevue. Bellingham silt loams and Norma sandy loams are poorly drained soils formed in alluvium. Norma soils occur in basins on glacial uplands. Norma Sandy Loam (No) are found between NE 4th Street and Main Street to the west of 116th Street.

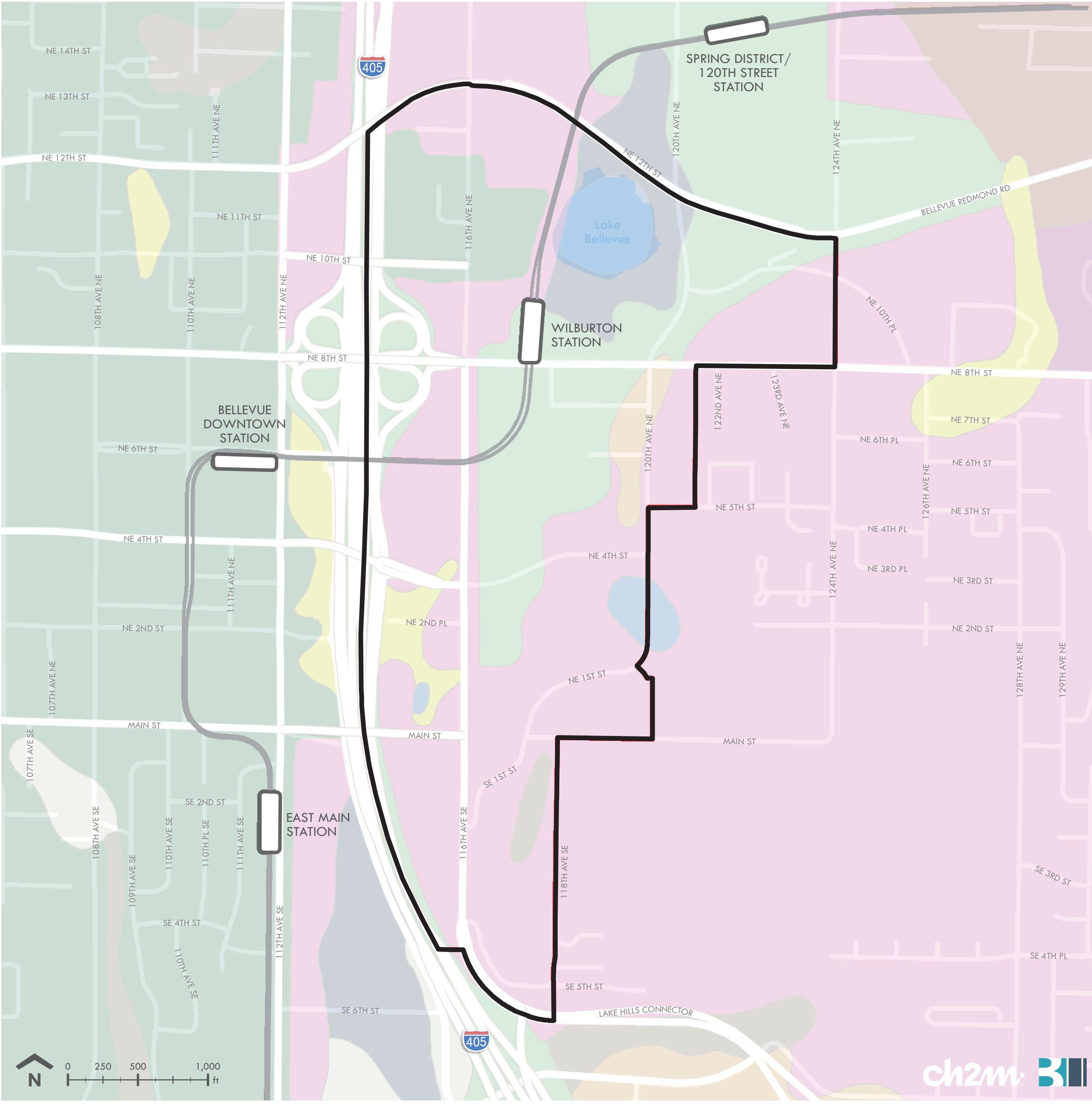

Exhibit 3.1–2 Soils Map

Source: City of Bellevue GIS Data Portal

- Wilburton Study Area Boundary
- East Link Light Rail Stations
- East Link Light Rail Route

Soil Classifications

- Alderwood Gravelly Sandy Loam, 15–30% slopes
- Alderwood Gravelly Sandy Loam, 8–15% slopes
- Arents, Alderwood Material, 6–15% slopes
- Bellingham Silt Loam
- Everett Gravelly Sandy Loam, 0–5% slopes
- Everett Gravelly Sandy Loam, 5–15% slopes
- Norma Sandy Loam
- Tukwila Muck
- Urban Land
- Water

Erosion and deposition created by the glaciers altered slopes and ground surfaces in the region, resulting in deposits of river and lake sediments that range from a few tens of feet or less to hundreds of feet in thickness in some regions. In most cases these deposits are normally consolidated, meaning that they have not been overridden by glaciers or subject to significant removal of overburden soils from erosion. These soils are often softer or looser in consistency (and, therefore, provide less bearing support), are often prone to settlement, and when saturated and cohesionless, are subject to liquefaction during seismic events. Erosion hazard is slight on slopes of 0 to 6 percent, slight to moderate on slopes of 6 to 15 percent and severe on slopes greater than 15 percent. Slippage potential along till contact is moderate to severe on slopes greater than 15 percent. Alderwood soils with slopes greater than 15 percent are mapped in a small area between SE 1st Street and 118th Ave SE.

SEISMICITY

The Study Area lies within an region of moderately high seismicity. Since 1900, there have been seven earthquakes of magnitude 5 or greater with epicenters near the Study Area (USGS Earthquake Catalog, 2017). Seismic activity in the region is a function of tectonic events and processes that occur as a result of ongoing collision between the Juan de Fuca and North America plates, which produces earthquakes in three seismic source zones: interface, benioff, and crustal (see Exhibit 3.1–3).

- An interface zone event is expected to create ground motions with accelerations up to 1 g at rock surfaces along the Pacific Coast and up to 0.2 g (g = ground acceleration = 32.2 ft./sec2) at rock surfaces in the greater Seattle area with a shaking duration of greater than several minutes.
- Benioff (deep) zone earthquakes previously occurred in the region in 1949 near Olympia, in 1965 near Sea-Tac Airport, and in 2001 near Nisqually. These deep-seated events occur at depths 40 kilometers or more in to the ground and can create up to 0.3 g accelerations at rock surfaces.

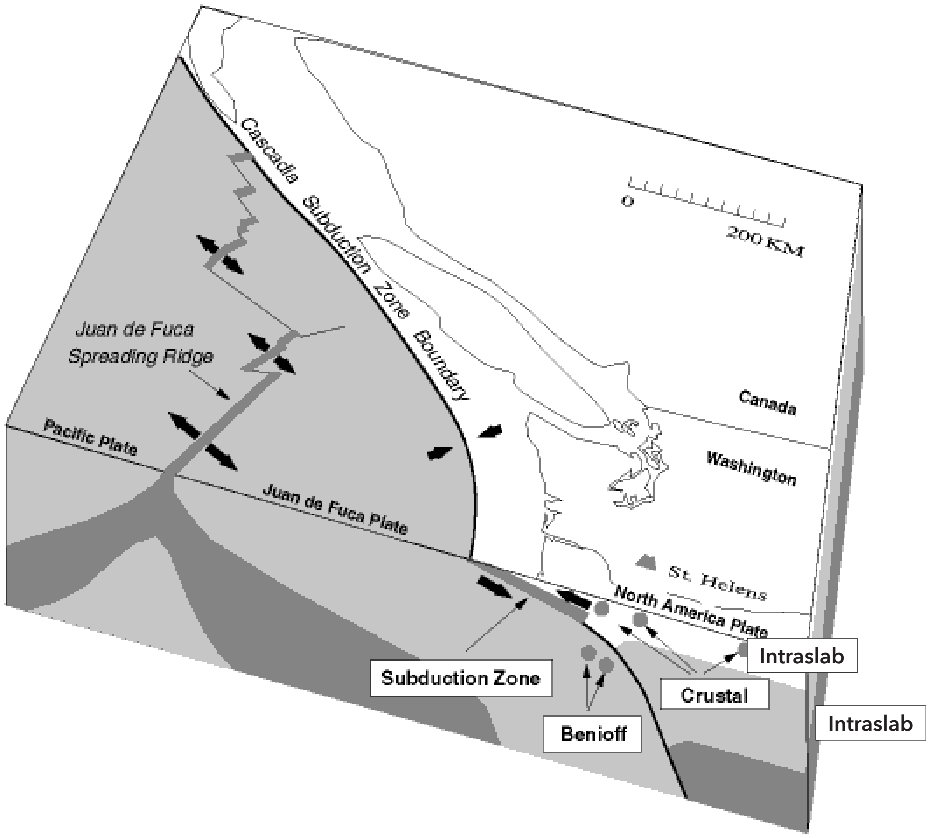

Exhibit 3.1–3 Seismic Source Zones Affecting the Study Area

Source: Haugerud et al., 2016

- Crustal zone earthquakes are sourced from the crust of the North American Plate and occur at shallow depths of 5 to 30 km below the ground surface with a potential to cause great damage. The closest active faults to the Study Area are the Seattle fault zone and Southern Whidbey Island fault zone located approximately two miles to the south and 18 miles to the northwest of the Study Area, respectively. No active faults are mapped across the Study Area based on Open File Report 2014-05 of Washington Division of Geology and Earth Resources (see Exhibit 3.1–4).

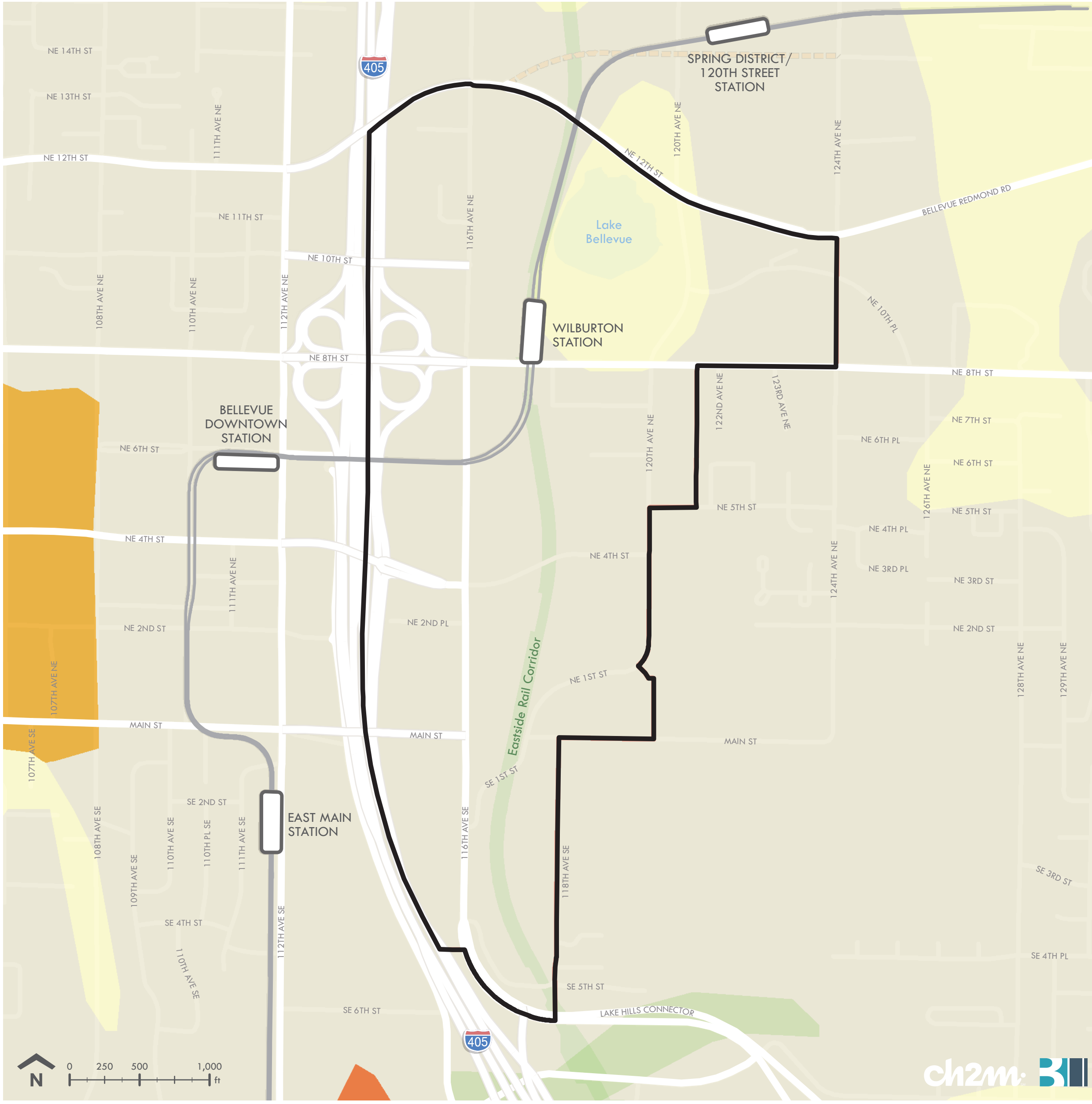

Exhibit 3.1-4 Seismic Site Class Map

Source: USGS Quaternary Fault and Fold Database

Wilburton Study Area Boundary
East Link Light Rail Stations
East Link Light Rail Route
Eastside Rail Corridor

NEHRP Seismic Site Class

B
B-C
C
C-D
D
D-E
E
F
Ice
Water

CITY OF BELLEVUE GEOLOGIC HAZARDS

The Study Area is located within a seismic zone that represents an area susceptible to moderately high seismic activity. Seismic hazard areas are defined as areas subject to severe risk of earthquake damage as a result of seismically induced ground shaking, liquefaction, and lateral spreading.

- Seismic hazards for strong ground shaking will occur throughout the Study Area. Levels of ground shaking in terms of peak ground acceleration (PGA) could exceed 0.5 g for firm-ground conditions (Site Class C) based on methodologies described in ASCE 7-10 design guidance documents for defining levels of ground shaking. Exhibit 3.1–5 illustrates King County and Washington State Department of Natural Resources interactive map which indicates firm-ground conditions (Site Class C) across the Study Area except for the area around Lake Bellevue, where dense to stiff soil conditions were mapped (Site Class C-D). The softer soil deposits potentially exist at wetlands within the Study Area, and might experience higher ground shaking due to site-specific amplification of ground motions.
- Seismic hazard areas for liquefaction identified within the Study Area are shown in Exhibit 3.1–6 as mapped by City of Bellevue. Most of the Study Area lies within the zone with very low liquefaction susceptibility, except for the wetlands around Lake Bellevue where the liquefaction susceptibility is mapped low to moderate.

Exhibit 3.1–7 illustrates that there are minimal steep slopes in the Study Area. Steep slopes are mostly artificial and located along the future Eastside Rail Corridor to the south of NE 8th Street and SE 1st Streets and east of the 116th Avenue NE/NE 4th Street intersection. There are few other isolated areas of steep slopes within the Study Area, as well as some that border the eastern portion of the Study Area as part of the Wilburton Hill neighborhood. Given their location and extent, steep slopes would not significantly influence the proposed developments in the project area.

- The Wilburton Existing Conditions Report (City of Bellevue, 2016c) states that some soils in the Study Area may be contaminated with petroleum products and volatile organic compounds due to the long-lasting presence of the auto sale industry.

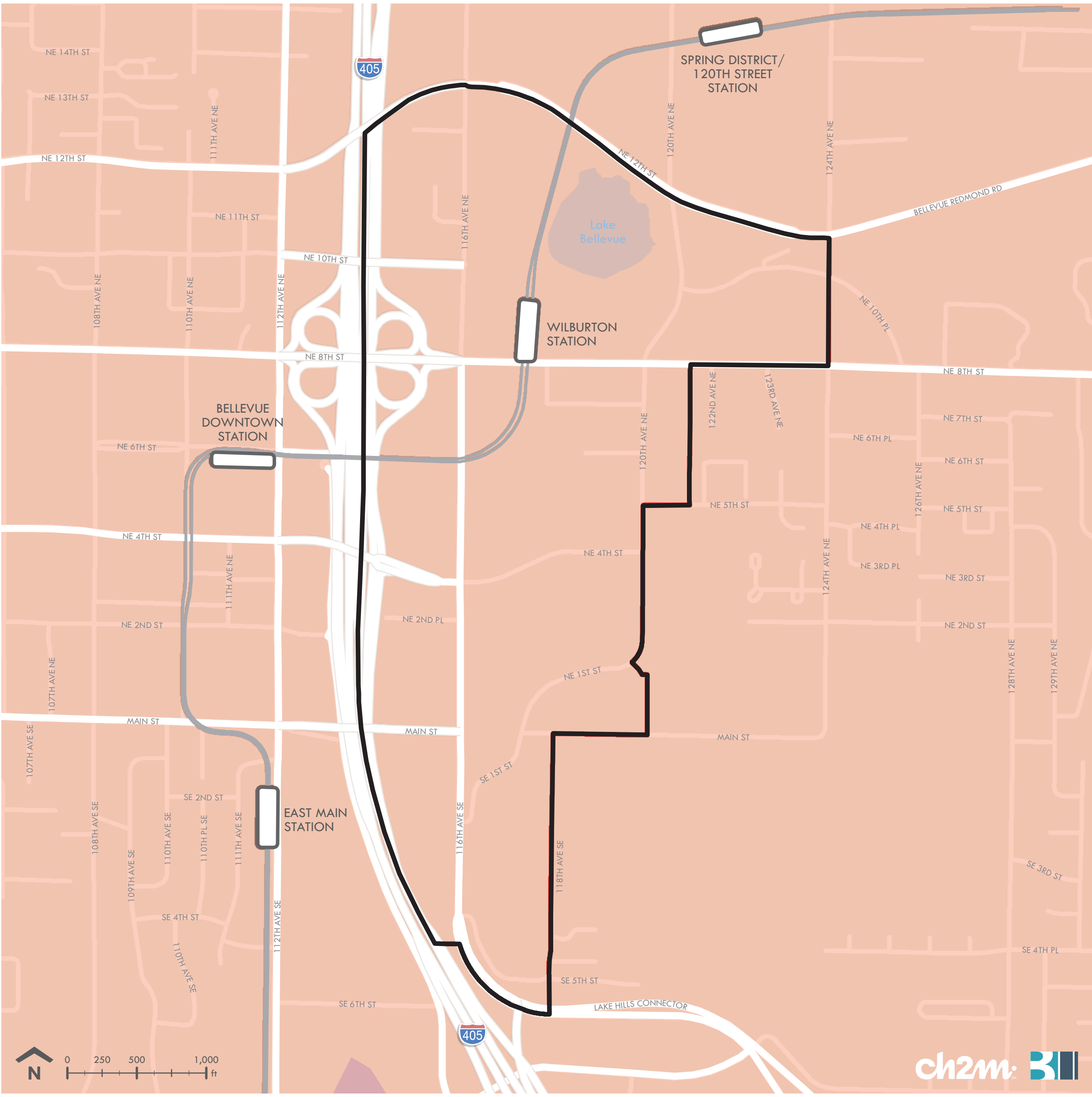

Exhibit 3.1–5 Seismic Source Zones Affecting the Study Area

Source: Washington State Department of Natural Resources Interactive Geologic Map

Wilburton Study Area Boundary

East Link Light Rail Stations

East Link Light Rail Route

Seismic Design Categories (Assuming Site Class D)

D2

F

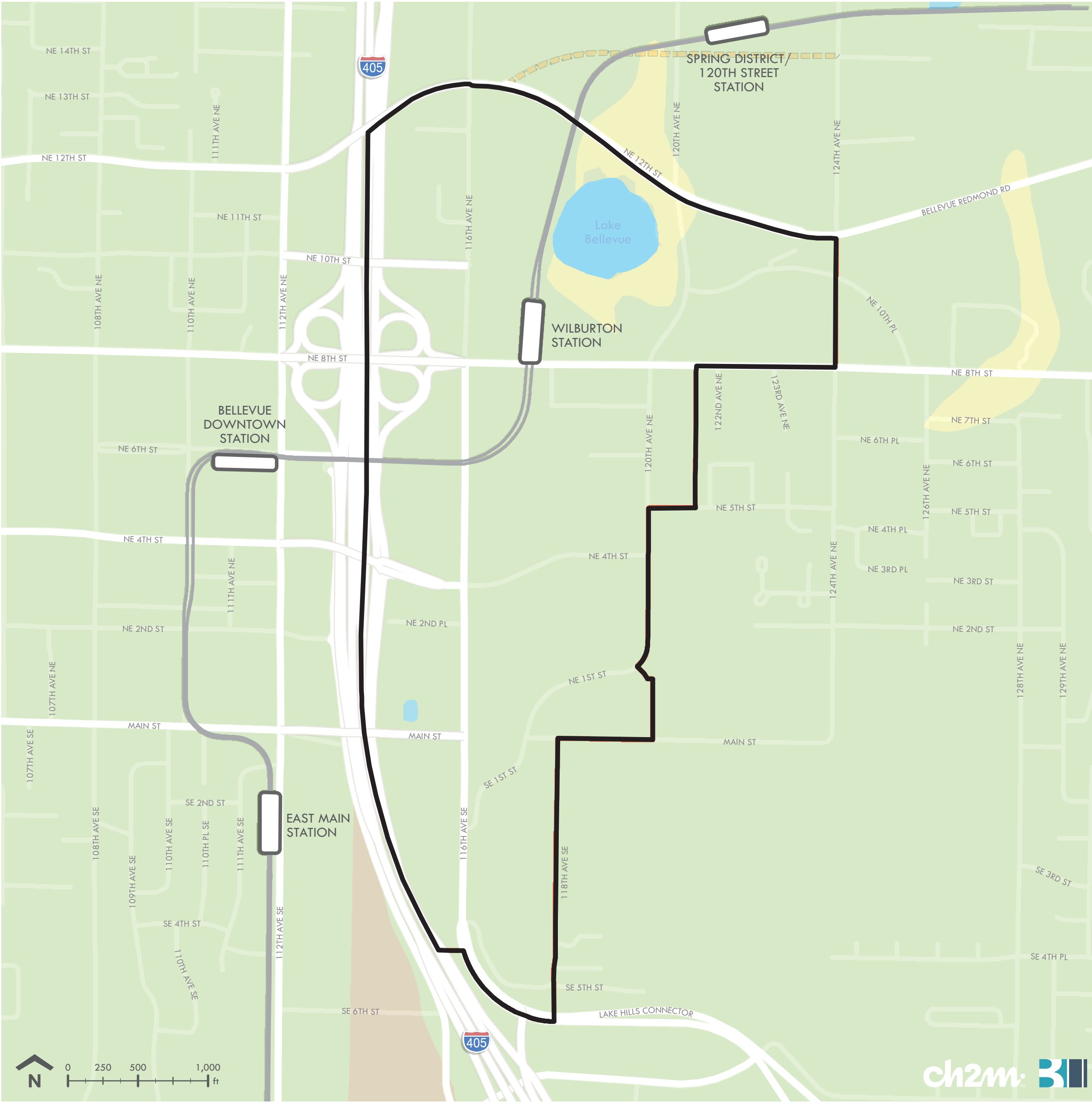

Exhibit 3.1-6 Liquefaction Susceptibility Map

Source: City of Bellevue GIS Data Portal, CH2M, 2017

Wilburton Study Area Boundary
East Link Light Rail Stations
East Link Light Rail Route

Liquefication Susceptibility

Low to Moderate
Very Low
Peat
Water

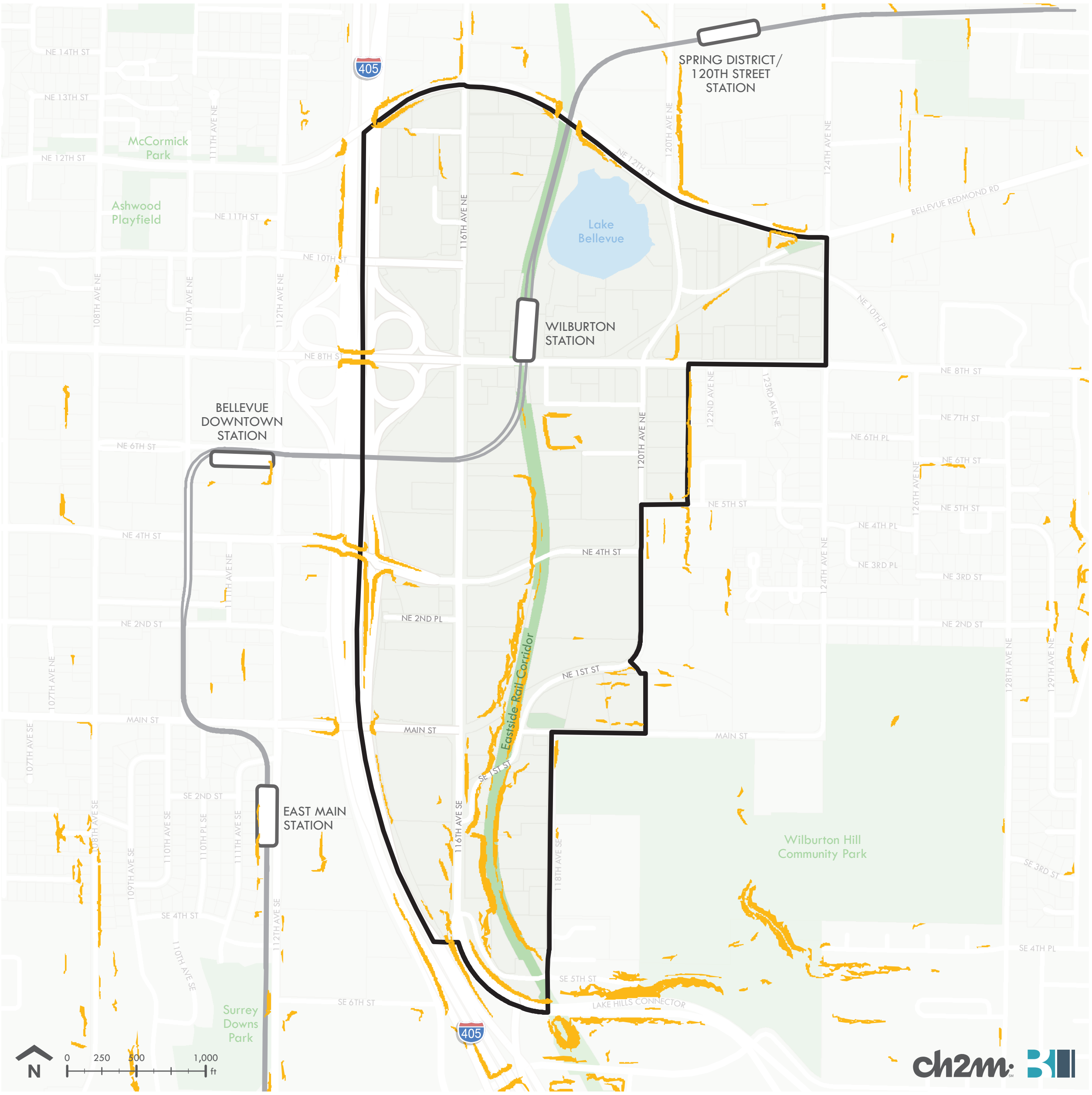

Exhibit 3.1–7 Steep Slopes Map

Source: City of Bellevue GIS Data Portal, CH2M, 2017

- Wilburton Study Area Boundary
- East Link Light Rail Stations
- East Link Light Rail Route
- Eastside Rail Corridor
- Steep Slope

3.1.3 IMPACTS

IMPACTS COMMON TO ALL ALTERNATIVES

SHORT-TERM IMPACTS

For the purposes of this EIS, short-term geologic and soils impacts would be considered significant based on the following threshold:

- Contamination of soils that require removal and disposal.

The soils with in the Study Area may be contaminated, and contaminated soils excavated during construction activities might require special handling, transport, storage, and off-site disposal. A soil and groundwater management plan might be necessary for the construction activities in contaminated areas. If the soils are not contaminated, excavations would require off-site hauling. If there is concurrent construction requiring earth fill in close proximity, excavated materials could be transported to the nearby site as long as the excavated material is protected from precipitation and surface water runoff.

LONG-TERM IMPACTS

For the purposes of this EIS, long-term geologic and soils impacts would be considered significant based on the following thresholds:

- Exposure of people to risk of injury or substantial damage to structures and infrastructure due to the creation or acceleration of a geologic hazard.
- Erosion that could not be contained on future development sites.

Alternatives would not accelerate or create geologic hazards; future development would need to be designed to respond to potential hazards consistent with adopted building codes to reduce risk of damage or injury. The Study Area is located within the Puget Sound Region, an area susceptible to moderately high seismic activity. During a seismic event, the Study Area might be subjected to high-level ground motions. Areas with steep slopes might experience seismic slope stability problems. Areas with moderate liquefaction susceptibility are common for all alternatives around Lake Bellevue. During an earthquake, vertical and lateral displacements of structures, embankments, and paved areas might occur due to seismic liquefaction hazard. The liquefaction potential of mapped liquefaction hazard areas would be confirmed during the design stage of proposed development, regardless of the alternative.

All alternatives would allow the possibility of development and maintenance of existing structures immediately south of Lake Bellevue which are underlain by a potentially compressible Tukwila muck. At areas where Tukwila muck is encountered, compressible soils might need to be excavated and replaced, or planned structures, embankments, and pathways might need to be supported on deep foundations. All alternatives would allow development that could disturb soils, but would be subject to erosion control measures per suggested best practices, which would minimize the potential for erosion impacts associated with development for all alternatives. Due to the least amount of planned development, the No Action Alternative would result in least amount of soil disturbance.

Grand Connection Options

Impacts are similar to those described under Impacts Common to All Alternatives.

Public Space

Where public spaces would involve site disturbance or structures, such as Grand Connection Lid or Civic Center, impacts would be similar to those described under Impacts Common to All Alternatives.

Some public space options set aside or reduce site alterations in areas of steep slopes or liquefaction potential such as:

- **Neighborhood Green:** illustrating potential neighborhood parks around a wetland and the west side of Lake Bellevue.
- **ERC Linear Park:** which illustrates some park space along the ERC and Lake Bellevue.
- **Natural Network:** showing restoration of natural systems including Lake Bellevue and wetlands.

PERFORMANCE MEASURES EVALUATION

There are no performance measures related to Geology and Soils.

Summary Comparison Of Alternatives

The No Action Alternative would result in the least increase in density in the Study Area compared to Alternatives 1 and 2, and as a result the overall potential risk of damage or injury and soil disturbance would be lower. Because Alternative 2 has the greatest increases in densities for both residential and employment, potential risk of damage or injury and soil disturbance would increase because there would be more people living and working in the area and there would be more development; however, future development could be designed to minimize risks consistent with building and construction standards.

Grand Connection

No Action Alternative: Not Applicable

The Grand Connection is not included under the No Action Alternative and would not result in constructability issues.

Alternatives 1 and 2: Moderate

Under Alternatives 1 and 2, all options for the overcrossing would need to be designed to avoid or minimize geotechnical issues, with geotechnical investigations to guide the design process.

IMPACTS OF THE NO ACTION ALTERNATIVE

The No Action Alternative Future Baseline estimates 4.2 million total square feet based on the City's current comprehensive plan and zoning; this is less than one million square feet of growth by 2035. The No Action Alternative could retain similar building forms as found today, with potential increase in intensity east of 116th Avenue NE and north of NE 8th Street. This area was subject of a rezone as part of the prior BelRed planning initiative. The future development will be mostly of commercial loading. Due to the least amount of planned growth, there would be less potential risk of damage or injury, and the least amount of soil disturbance of the studied alternatives.

The risk of damage or injury would be less in new buildings developed to international building code standards; new development under all alternatives will meet such standards and mitigate the potential for damage or injury. The No Action Alternative would have less persons exposed to seismic hazards but also fewer buildings constructed to the latest standards compared with Alternatives 1 and 2.

IMPACTS OF ALTERNATIVE 1

Alternative 1 would create a mixed-use urban neighborhood that would result in higher total development and added space by 2035, mostly in office and housing uses compared to the No Action Alternative. Refer to Chapter 2 for information on estimated growth. The ultimate buildout would equal 16.3 million square feet of building space during and after the 2035 planning period, with building heights ranging from 35 to 250 feet. The most common building height would be between 120 and 160 feet. More development would be subject to geologic hazards than the No Action Alternative, but would be designed to minimize risks consistent with building and construction standards.

Compared to the No Action Alternative, Alternative 1 could create more cut material to be hauled due to taller buildings that might require deeper foundations and potential increase in underground parking needs due to larger buildings. Cut materials in the area are potentially contaminated which would require special handling, storage, transportation, and off-site hauling. The cut materials in the region are known to be moisture sensitive (meaning difficult to compact if they are allowed by become wet) and therefore if not contaminated, cut material should be kept covered to facilitate reuse.

IMPACTS OF ALTERNATIVE 2

Alternative 2 proposes the most significant change in future urban form compared to other alternatives, with the highest estimate of total development and net increase of added development by 2035 compared to the No Action Alternative and Alternative 1. Refer to Chapter 2 for information on estimated growth.

The greatest level of development could be subject to geologic hazards, compared to the No Action Alternative and Alternative 1, but could be designed to minimize risks consistent with building and construction standards.

Alternative 2 could potentially create the greatest volume of cut material to be hauled associated with the greater total building space. Similar issues regarding the contamination potential and moisture sensitive nature of the cut materials holds for Alternative 2.

3.1.4 MITIGATION MEASURES

INCORPORATED PLAN FEATURES

There are no incorporated plan features related to geology and soils.

REGULATIONS AND COMMITMENTS

- Title 23, Chapter 23.10 of the Bellevue City Code contains construction code standards, including the International Building Code, that ensure buildings are designed to meet seismic safety standards.
- Title 23, Chapter 23.76 of the Bellevue City Code also contains a clearing and grading code, including erosion control standards.

OTHER PROPOSED MITIGATION MEASURES

Geotechnical investigations are required as part of the design phase for new development, especially for those buildings with greater heights or in close proximity to artificially created slopes. Specific recommendations for liquefaction mitigation, subgrade preparation, roadway embankment, cut and fill, slope stability, foundation design, retaining structures, and dewatering measures would be prepared prior to construction. Appropriate waste sites for unsuitable excavated soils would be identified prior to construction.

Potential impacts of soil liquefaction could be mitigated by removing and replacing the loose materials with compacted fill materials, by densifying or reinforcing the in-situ soils, or by supporting the proposed facilities on deep foundations. The need for liquefaction mitigation would be evaluated on a case-by-case basis for the individual structural elements potentially impacted.

3.1.5 SIGNIFICANT UNAVOIDABLE ADVERSE IMPACTS

Development in the Study Area, as with most locations in Central Puget Sound, would expose population and structures to geologic hazards, and would disturb soils. These impacts can be mitigated to a less than significant level by designing development to the City's adopted construction codes and applying any site-specific conditions required by the City during permit review.