

## 4.1. Earth

Earth resources consist of geologic features, as well as processes such as soil and slope stability during erosion, landslides, and seismic events. Geologic conditions limit development in some areas. Soil disturbance and concentrated runoff caused by development can exacerbate geologic hazards; accordingly, development activities in or near geologically hazardous conditions may require measures to prevent the loss of soils or damage to property and structures.

This section provides a brief overview of the existing geologic conditions and geologically hazardous areas that exist within Whatcom County (County). It also presents the potential impacts associated with the alternatives being considered and the avoidance and minimization measures that have been identified to mitigate these potential impacts.

### 4.1.1. Existing Conditions

The topography of the County has been influenced by glacial scour, erosion, and deposition. The northwest portion of the County is relatively flat and includes the Nooksack River floodplain. In the south and east portions, the Cascade foothills provide topography more characteristic of the rest of the County.

Areas susceptible to erosion, landslides, earthquakes, volcanic activity, and/or other geological processes are considered geologically hazardous areas and they pose a significant risk to people and property. See Figure 4.1-1 for a map of geologic hazards.

### Geologically Hazardous Areas

Several geologically hazardous areas are present in the County, including landslide hazard areas, seismic hazard areas, alluvial fan hazard areas, volcanic hazard areas, erosion hazard areas, tsunami and seiche hazard areas, and mine hazard areas.

### Landslide Hazard Areas

Landslide hazard areas include those regions that are susceptible to landslides because of any combination of bedrock, soil, slope (gradient), slope aspect, structure, hydrology, or other physical factors. Landslide hazard areas are further classified by certain geologic characteristics defined in the Whatcom County Critical Areas Ordinance (CAO) (WCC Title 16, Chapter 16.16, Article 3). Landslide hazard areas primarily occur in the southern and eastern portion of the County and are associated with the Cascade foothills. Marine landslide areas are present in the Birch Bay urban growth area (UGA), including most of Birch Point and from Point Whitehorn south, past Cherry Point to the Lummi Reservation boundary.

Much of this marine shoreline is characterized as unstable slope, with several locations where both recent and old slides have occurred. Two areas with significantly modified marine shorelines include the northwest portion of Birch Bay (Birch Bay Village) and the Cherry Point area (oil refineries).

## Seismic Hazard Areas

Seismic hazard areas are defined as areas subject to a severe risk of earthquake damage as a result of seismically induced ground shaking, differential settlement, slope failure, settlement, lateral spreading, mass wasting, surface faulting or soil liquefaction (WCC Title 16, Chapter 16.16, Article 3). Areas associated with streams, primarily the Nooksack River and its floodplain, are most susceptible to liquefaction. Areas of peat are also susceptible to differential settlement, even when filled. Peat areas are mapped near Everson, Sumas, and Birch Bay.

Much of the northwest portion of the County is susceptible to liquefaction and enhanced ground shaking. The Vedder Mountain Fault near Sumas and the Boulder Creek Fault across Sumas Mountain have been mapped with some certainty. The recently discovered Kendall Fault, 1 mile east of Kendall, is a small fault that occurred since the glaciers left this area approximately 12,000 years ago.

## Alluvial Fan Hazard Areas

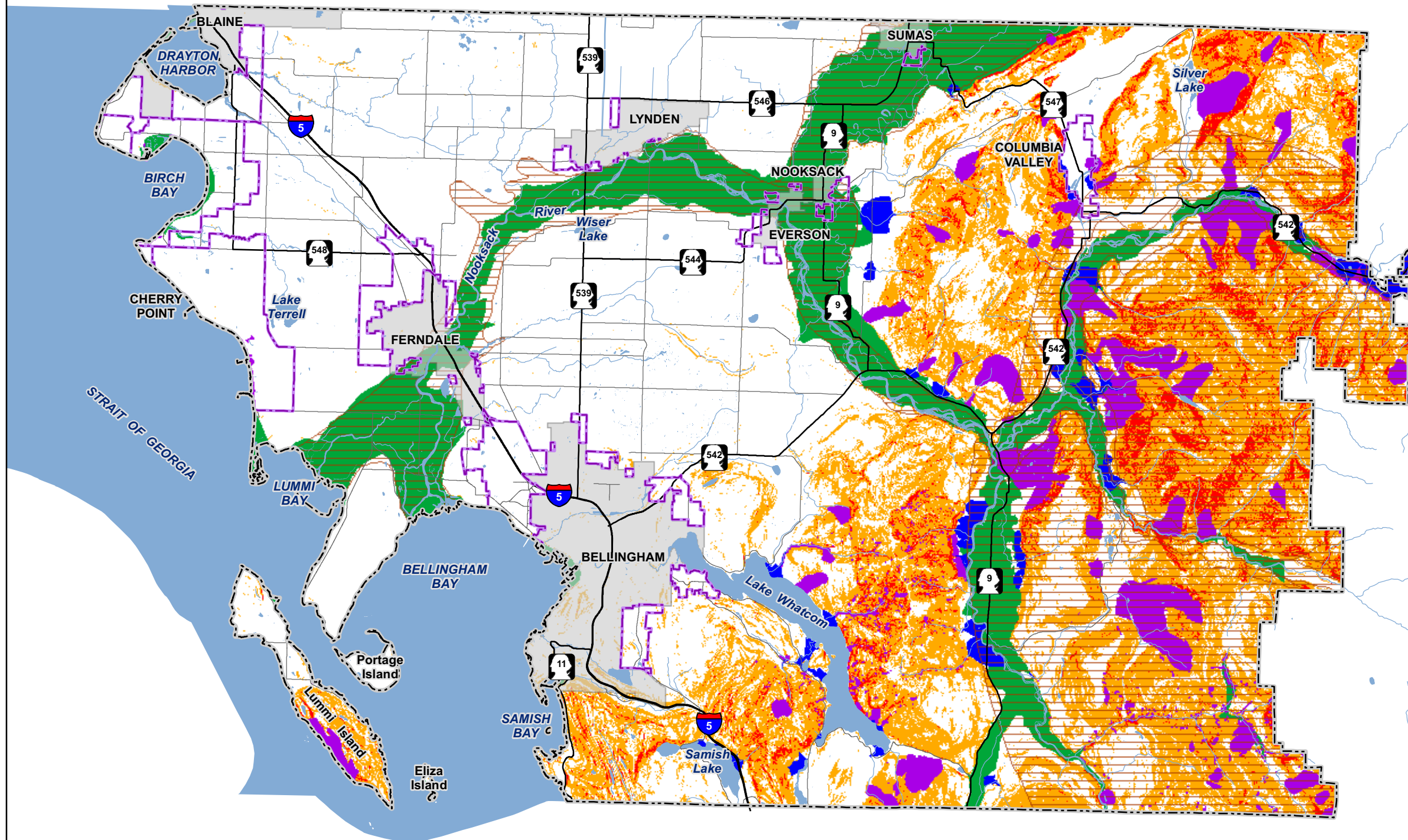
Alluvial fan hazard areas include areas on alluvial fans where debris flows, debris floods, or clear water floods have the potential to significantly damage or harm the health or welfare of the community. These hazard areas include the region generally corresponding to the path of potential flooding, channel changes, sediment and debris deposition, or debris flow paths as determined by analysis of watershed hydrology and slope conditions, topography, valley bottom and channel conditions, potential for channel changes, and surface and subsurface geology (WCC Title 16, Chapter 16.16, Article 3). Alluvial fan hazard areas are located primarily in the southern and eastern portions of the County and are generally associated within the Cascade foothills. The large Swift Creek alluvial fan, known more for its asbestos health risks, is located approximately 1 mile east of the current Everson and Nooksack UGA boundary. Alluvial fan hazards are also present in the Columbia Valley UGA and vicinity.

## Volcanic Hazard Areas

Volcanic hazard areas include areas subject to lava flows, pyroclastic flows, pyroclastic surges, mud flows, lahars, debris flows, debris avalanche, ash (tephra) clouds or ash (tephra) fall, lateral blast, ballistic debris, or flooding resulting from volcanic activity (WCC Title 16, Chapter 16.16, Article 3). Mount Baker is an active volcano located approximately 30 miles east of Bellingham in the south-central portion of the County. Mount Baker stands at 10,778 feet in elevation and drains to both the Nooksack River and the Skagit River subbasins. Mount Baker last erupted in the mid-1800s. The greatest hazard to people and property in the County

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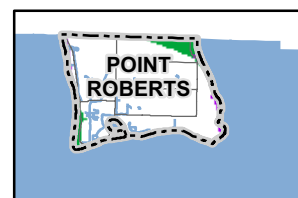
Figure 4.1-1  
Critical Areas - Land



- County Planning Area
- Highway
- Arterial/Collector
- Water Feature
- City Limits
- Existing UGA
- Volcanic Hazard Area
- Alluvial Fan
- Landslide Hazard Area
- Seismic Hazard Area
- Steep Slope Area**
  - 15 - 35% Slope
  - 35%+ Slope

Sources: Whatcom County (2008)

Map Revised: April 2009





associated with an eruption of Mount Baker includes the release of a lahar. Areas that could be affected by a large-scale lahar associated with a major eruption of Mount Baker include the regions of Everson, Lynden, Sumas, and Ferndale that run along the north and middle forks of the Nooksack River.

## Erosion Hazard Areas

Erosion hazard areas include surface, erosion coastal, and riverine erosion areas. Surface erosion areas include areas with slopes greater than 15% with soils identified by the Natural Resources Conservation Service as having a severe or very severe rill and inter-rill erosion hazard because of natural characteristics. Coastal and riverine erosion areas include areas subject to lateral erosion related to moving water such as river channel migration zones and shoreline retreat.

Surface erosion areas typically occur in the eastern and southern portion of the County and are associated with the Cascade foothills. Coastal and riverine erosion areas are generally associated with larger rivers, such as the Nooksack River, which historically migrate extensively within the active floodplain. Locations susceptible to erosion may include frequently flooded areas, including portions of Everson, Lynden, and Ferndale along the Nooksack River and portions of Sumas along the Sumas River. Dikes and levees have been constructed along these rivers to protect agricultural land and residential and business development. These dikes have disconnected floodplain habitat and eliminated potential migration of the channel within the floodplain, thus reducing the potential for erosion hazards associated with historic channel migration zones.

## Tsunami and Seiche Hazard Areas

Tsunami and seiche hazard areas include coastal areas and lake shoreline areas susceptible to flooding, inundation, debris impact, and/or mass wasting as the result of coastal or inland wave action generated by seismic events (WCC Title 16, Chapter 16.16, Article 3). Tsunami and seiche hazard areas occur in Bellingham Bay and Lummi Bay. Other areas may also be susceptible to tsunami and seiche hazards; however, modeling for such events has only been completed for Bellingham Bay and Lummi Bay. Tsunami hazard areas are located to the south of the Ferndale UGA, with the potential for a tsunami to cause waters to back-up both the Nooksack River and the Lummi River, inundating areas to the south of Ferndale. Other coastal areas of the County may also be susceptible to inundation as a result of tsunamis; however, the modeling has not been completed to accurately identify these areas. The larger lakes in the County may be also susceptible to seiches (i.e., Lake Whatcom and Lake Samish), but no modeling has been completed to identify the areas susceptible to inundation from a seiche (Parametrix 2005).

The County has a history of coal mining going back to 1853. Many areas of the County still have historic remnants of the extraction of this resource, including

abandoned coal mines, which are most prevalent in the foothills of the County and are susceptible to ground subsidence.

## 4.1.2. Impacts

This Draft Environmental Impact Statement (Draft EIS) analyzes the environmental impacts of four alternatives:

- **No Action Current Comprehensive Plan Alternative.** This alternative is a continuation of the current Whatcom County Comprehensive Plan and subarea plans.
- **No Action Trends Alternative.** This alternative assumes past growth continues forward.
- **Action Alternative X.** This alternative shifts growth from rural areas to UGAs, focusing on Bellingham.
- **Action Alternative Y.** This alternative shifts growth from rural areas to UGAs other than Bellingham.

## Impacts Common to All Alternatives

All four alternatives would allocate population and employment growth in cities and unincorporated areas. Each alternative would apply the Whatcom County CAO policies and other applicable regulations.

The programmatic growth allocations would not generate impacts on earth resources in themselves. Earth-related impacts would occur from development that caused any of the following disturbance mechanisms: clearing; grading; erosion and sedimentation; other site disturbance; expanded impervious area; and increased chemical contamination.

Nearly all development would result in the removal or modification of vegetative cover, particularly tree and forest cover, except in some cases where redevelopment or changes in development occurs within the footprint of existing development. All four alternatives would result in the eventual reduction of vegetative cover in concert with the construction of approved development projects. Additionally, increases in development could also increase the need for wood and other forest products and lead to additional modification of vegetative cover. Vegetative disturbance would initiate multiple opportunities for soil disturbance through erosion, compaction, and contamination.

Erosion risk would increase with the reduction in soil organic matter. Water that might otherwise be held by organic material would be available to erode mineral soil, a process that is accelerated when grading directly exposes soil to precipitation and surface water. When eroded particles move off site or into streams, sediment impacts on water quality, channel conditions, and aquatic habitat would be likely.

Additionally, the primary benefit of organic soil in reducing erosion is that it reduces the mechanical and physical erosive force of water.

Soils in developed areas would be subject to compaction and disruption of the soil structure necessary to maintain natural drainage processes and to support native vegetation communities. Soils would also be prone to contamination by petroleum spills, fertilizers, pesticides, and industrial wastes. Expanded impervious surfaces seal the soil surface, altering soil drainage and precluding any other uses for the soil. Long-term loss of soil productivity (relative to undisturbed conditions) would be a subsequent effect of any of these impacts. In particular, compacted soil, or soil covered by impervious surfaces, would allow for less infiltration of stormwater into the ground, creating additional surface water runoff that could result in increased downstream flooding, erosion, water quality problems, and aquatic habitat degradation. However, much of the mineral soil (below the organic soil layer) is glaciomarine drift, a glacially deposited, clay-rich, and impervious dense soil often having been compacted by overriding ice sheets. On slopes, these types of soils can become unstable when saturated by infiltration and impervious surfaces associated with development can sometimes improve this condition.

All four alternatives would permit development that is at risk of some degree of catastrophic geologic hazards, including landslides, earthquakes, and volcanic eruptions. These geologic hazards have generally been mapped based on past research and site investigations, and may be avoided or minimized by siting development outside of geologic hazard zones. Some developments may occur within these hazard areas because actual risks are unknown or perceived to be at an acceptably low level. In fact, much of the vacant, developable lands within the existing city and UGA boundaries exclude geologically hazardous areas since these areas are not suitable for development. Geologic hazard regulations are described in greater detail above in Section 4.1.1.

## No Action Current Comprehensive Plan Alternative

The Current Comprehensive Plan Alternative would result in the lowest population growth, with densities increasing within existing UGAs. As described in Impacts Common to All Alternatives above, densification would result in the loss of soil productivity through the expansion of impervious surfaces, modification of soil structure, and site contamination. While densification may reduce opportunities for soil erosion, it would increase the erosion potential on remaining pervious soils by modifying vegetation as well as runoff patterns from developed lands. Densification would also decrease the amount of open space and could diminish the size and/or function of stream and wetland buffer areas.

Despite stormwater controls intended to maintain stream flows in ranges consistent with native vegetation cover, stormwater runoff from impervious areas in highly urbanized watersheds would require large stormwater facilities that further diminish

the area of remaining pervious soil in most instances. The focus on increasing the density within the existing UGAs would potentially increase development within geologic hazard areas, such as volcanic, seismic, and marine landslide hazard areas. Erosion hazard areas and landslide hazard areas are not uncommon to most areas subject to growth under the No Action Current Comprehensive Plan Alternative. Developments are expected to be adequately protected from these geologic hazards by adhering to existing Whatcom County CAO regulations to manage development that may occur in geologic hazard areas.

All the UGAs contain areas of potential moderate to high geologic hazard, areas of potential moderate geologic hazard, and areas of hydric soils that could be subject to liquefaction during seismic events.

Additional development in low coastal areas could also expose a greater number of people to an increased risk from tsunamis, should development southwest of Ferndale occur. The tsunami risk in areas outside of Bellingham and Lummi Bays has not been modeled, thus the level of risk has not been determined for specific areas outside of Bellingham Bay and Lummi Bay.

## No Action Trends Alternative

The No Action Trends Alternative would have greater population growth countywide, with more development occurring in rural areas and Bellingham. Impacts due to expansion of impervious surfaces, modification of soil structure and site contamination would be as described under Impacts Common to All Alternatives.

This alternative maintains existing UGA boundaries, but the focus on increasing the density within the existing UGAs would potentially increase development within geologic hazard areas, such as volcanic, seismic, and marine landslide hazard areas. This alternative also allows for greater development within rural areas, the locations of which cannot be precisely identified, but where there is a greater distribution of landslide hazard areas, seismic hazard areas, volcanic hazard areas, and alluvial fan hazard areas. The potential for impacts due to geologic hazards and the applicability of current regulations is similar to that described for the No Action Current Comprehensive Plan Alternative.

## Action Alternative X

Action Alternative X would result in increased densities within existing Cities and UGAs, similar to the No Action Current Comprehensive Plan Alternative, but with population growth that matches the No Action Trends Alternative. Action Alternative X also assumes that Bellingham would continue to be the primary population center with the greatest growth rate, while the growth in rural areas would remain relatively low. Action Alternative X would not result in any expansion of existing UGA boundaries.

Soils impacts resulting from increased densification under Action Alternative X would be similar to the No Action Trends Alternative. Densification would occur with a greater intensity under Action Alternative X, resulting in more urban, high-density residential areas. However, many of the areas where this would occur are already compacted or paved and generally impervious. Remaining pervious areas within existing UGA boundaries, such as greenbelts, would be at a greater risk of erosion than under the No Action Current Comprehensive Plan Alternative and No Action Trends Alternative scenarios for all of the UGAs, with the exception of the Columbia Valley UGA, which will see the lowest growth rate under Action Alternative X. The potential for impacts from densification would be directly proportional to the degree of infilling and would be greatest in Bellingham, Blaine, Ferndale, and Lynden.

The geologic hazards described for the No Action Current Comprehensive Plan Alternative and the No Action Trends Alternative would be similar for Action Alternative X; however, increased densities within existing UGAs could increase the exposure to such hazards, with areas of increased population exposed to large regional earthquakes and the risk of damage greatest in areas prone to liquefaction.

## Action Alternative Y

Under this alternative, population growth would be focused away from Bellingham and to the small urban areas (e.g., Ferndale and Lynden), while growth in rural areas would also continue, similar to the No Action Trends Alternative. Action Alternative Y would result in increased land consumption within existing UGAs where achieved densities are lower than planned densities, and potentially in parts of the Suitability Analysis Area for UGAs that are undersized for either population or employment. Greater land consumption would be possible compared to the other alternatives in Birch Bay, Everson, Ferndale, Lynden, Nooksack, and Sumas UGAs (see Table 2.6 in Chapter 2). UGAs undersized for population or employment include Lynden and Bellingham, respectively.

Soil impacts resulting from densification under Action Alternative Y would be similar to those described earlier for the No Action Trends Alternative, but with greater emphasis on growth in the small urban areas of the County such as Birch Bay, Ferndale, and Lynden. Densification would occur in the small urban areas with a greater intensity under Action Alternative Y. For example, this would include the development of more urban high-density residential areas and commercial and industrial areas to provide employment, although with the focus on the small urban areas as opposed to Bellingham. Bellingham would grow only slightly more than the No Action Current Comprehensive Plan Alternative under Action Alternative Y, and rural areas would continue to see increased growth at 14.6% share of the growth, but less than the No Action Trends Alternative at 22.8% share of the growth.

However, as with Action Alternative X, many of the areas where growth would occur are already compacted or paved and generally impervious, at least within the existing UGAs. Remaining pervious areas would be at greater risk of erosion. The potential for impacts from densification would be directly proportional to the degree of infilling, which would be greatest in the small urban areas.

Action Alternative Y could result in an increase in land used for urban purposes, and the potential for soil impacts would be greater in UGAs that may be expanded compared to those existing areas where densification may occur. Expansion could occur in areas that currently have low density developments, including rural areas, where soils are less compacted and soil particles, when disturbed, may be more easily detached under the forces of erosion. Soil permeability is generally greater in these areas, and contamination that could occur early in development would be less easily contained.

Landslide areas and areas particularly susceptible to erosion would be protected under Action Alternative Y per the existing Whatcom County CAO to manage development within, on, or near geologic hazard areas. Nevertheless, the expansion of UGA “footprints” in the vicinity of these features could increase the risk of damage that could occur to people and property from failures subsequent to severe storms, seismic events, or volcanic activity.

In addition to those areas within the UGAs, parts of the Suitability Analysis Area with identified geologic risks include unstable slopes along marine shorelines and potential hazard of a marine landslide located at Point Whitehorn, within the Cherry Point UGA. Generally, the geologic hazards associated with Action Alternative Y would not be significantly greater than the other alternatives, because expanding UGA boundaries will not encroach significantly into geologic hazard areas.

Seismic hazards under Action Alternative Y would be similar to the other alternatives in that all areas would be subject to larger regional earthquakes, and the risk of damage would be greatest in areas prone to liquefaction. Boundary expansion for most UGAs under Action Alternative Y would occur in areas with predominately low or low-to-moderate liquefaction susceptibility.

### 4.1.3. Mitigation Measures

This section describes existing regulations that would, or measures that could be employed to mitigate potential impacts associated with the alternatives described above.

## Incorporated Alternative Features

The current Whatcom County Comprehensive Plan (Whatcom County 2007) provides goals and policies related to natural resources, including potential

destruction to property that may occur based on a lack of public understanding of the subtlety of the hazardous conditions that may exist. Potential hazards include geologic hazards. The goals related to the protection of property and people include the following:

- **Goal 11A.** Protect natural resources and systems, life and property from potential hazards.
- **Goal 11D.** Minimize potential loss of life, damage to property, the expenditure of public funds and degradation of natural systems resulting from development in hazardous areas such as floodplains, landslide-prone areas, seismic hazard areas, volcanic impact areas, abandoned mine locations, potentially dangerous alluvial fans and other known natural hazards by advocating the use of land acquisition, open space taxation, conservation easements, growth planning, and other options to discourage development in such areas.

To achieve each goal, the current comprehensive plan defines several policies intended to address a specific issue and achieve the stated goal. These policies are provided in the current comprehensive plan (Whatcom County 2007). Refer to Section 4.6, Plans and Policies for further information on the current comprehensive plan and other relevant policies.

## Applicable Regulations and Commitments

Existing county policies regulate land use activities in the vicinity of and within geologically hazardous areas. Whatcom County CAO 16.16.300 addresses the geologic hazards that occur in the County and provides parameters for development in and near geologically hazardous areas through regulatory, review, and permitting processes. It also provides the designation and classification of geologically hazardous areas, as well as general standards (16.16.320) and hazard-specific standards (16.16.325 through 16.16.370) for activities that occur in or near geologically hazardous areas.

## Other Potential Mitigation Measures

Other potential mitigation measures include avoid expanding UGAs in parts of the Suitability Analysis Area having moderate to high liquefaction hazard areas (e.g., parts of Lynden and Sumas) or volcanic hazard area (e.g., parts of Lynden and Sumas).

### 4.1.4. Significant Unavoidable Adverse Impacts

All alternatives would result in increased urbanization in the County. An unavoidable consequence will include a corresponding increase in erosion and sedimentation. A greater population could also be at risk from the adverse impacts of damage to buildings and infrastructure should an earthquake, volcanic eruption, or landslides occur. The No Action Current Comprehensive Plan Alternative would

have the least potential for these impacts as it has the least growth and maintains present UGA boundaries. The No Action Trends Alternative would have the greatest potential impact in rural areas as it allocates the most growth to the rural areas, though its overall population is similar to the Action Alternative X and Action Alternative Y. Action Alternative Y would allocate growth with a more extensive urban pattern because of use of achieved densities and the potential that growth in undersized UGAs could extend into the Suitability Analysis Area.