3.15 GEOTECHNICAL

3.15.1 Affected Environment

Before beginning construction of a transportation project, it is important to understand the geology of the project area. This section describes the general geology of the soils, geologic hazards, slope stability, and geologic field observations for the area encompassed by the Preferred Alternative. Project geologists collected geotechnical data from agencies such as United States Geological Survey (USGS), the Department of Geology and Mineral Industries (DOGAMI), and ODOT.

3.15.1.1 Soils

Geologic mapping from the USGS indicates that Willamette Silts, which could be up to 325 feet deep in places, underlie the project area. Bedrock beneath these soils is Columbia River Basalt. This basalt also makes up the bedrock of the Rex Hill and Parrett Mountain areas and local hills in Newberg and Dundee.

Soil borings in the project area encountered materials that range from medium stiff silt, generally located throughout the project area, to fine sandy silt soil with little to no cohesion, near Oregon 219. The soil borings generally produce materials that are wet clayey to sandy silt to silty clay with varying sand (Willamette Silt) content.

Groundwater table depths in the project area vary seasonally, from near ground surface in wetter months to over 30 feet below ground surface during the drier months.

3.15.1.2 Earthquake Hazard

There are two known faults in the project area: the Newberg Fault, which runs northwest to southeast, and the Sherwood Fault, which runs west to east. There is no evidence of recent movement on either fault, indicating little to no activity within the past 1.8 million years.

The overall relative seismic hazard ratings are designated A through D, with Hazard Zone D being the least hazardous and Hazard Zone A being the most hazardous and likely to experience greater damage. The Hazard Zone designation is a relative aggregate rating based on three categories of earthquake-related effects: liquefaction, ground amplification, and earthquake-induced landslides.

The liquefaction susceptibility varies throughout the project area with generally low potential in the flat lowlands, which increases towards the Willamette River and various streams. The combination of cohesionless soils and steeper slopes results in higher liquefaction potential. Liquefaction susceptibility is ranked 0 to 3, with level 3 areas potentially experiencing greater damage.

The ground amplification hazard is relatively similar across the project area and will be determined during design on a site-specific basis. The consideration of earthquake-induced landslides is combined in the subsequent evaluation of slope instability susceptibility.

Earthquake hazards range from Hazard Zone A locally around Chehalem Creek, to Hazard Zones B and C in several locations, and a small area in Hazard Zone D (lowest hazard) near Fernwood Road in East Newberg. Figure PA 3.15-1 shows the details of

44 Medium stiff silt is exposed soil into which you can press your thumb several inches deep using moderate pressure.
slope instability hazard and suspected landslide areas for the Chehalem Creek area. Figure PA 3.15-2 shows the details of slope instability hazard and suspected landslide areas near Hess Creek North. Hazard ratings for potential damage due to liquefaction during an earthquake range from low to moderate. The west end of the project area is more prone to liquefaction.

3.15.1.3 Site Reconnaissance

During a slope stability reconnaissance survey of the area surrounding Chehalem Creek, geologists identified nine landslides. In addition, they identified several other areas with evidence of previous surface creep.

A site reconnaissance was performed during wet weather in January 2006, with followup during the summer and fall months of 2006. In January 2006, geologists observed high groundwater levels throughout the project area. They also observed low cohesion, soft silt stream sediments, recent and old landslides, slope creep, and steep slopes prone to instability, particularly when impacted by high groundwater levels. These geologic conditions are often seen in and around incised stream valleys or where former streams deposited sediments in calm, low-energy environments.

3.15.2 Environmental Consequences

This section addresses direct, indirect and construction impacts of the No Build and Preferred Alternatives on geologic resources and the potential impacts of geotechnical characteristics on the Preferred Alternative and Phase 1 of the Preferred Alternative (Phase 1) after it is constructed.

The degree of geotechnical impacts is generally proportional to the following:

- Size of the construction area.
- Depth of excavations below groundwater level.
- Heights of embankments and retaining walls.
- Steepness of cut and fill slopes.
- Slope of the ground surface.

3.15.2.1 Best Management Practices

The evaluation of environmental consequences associated with the No Build Alternative, Preferred Alternative and Phase 1 is based on a level of geotechnical information appropriate for preparation of an environmental document, but insufficient to address the full range of geotechnical design issues that currently exist in the project area. As design engineering proceeds, ODOT will undertake additional drilling, testing, analysis, surveying, and other necessary reconnaissance tasks to increase geotechnical knowledge in support of this engineering effort. Both the identification of hazards to avoid and the approach to future design will be more detailed. This final design effort will allow the project to more precisely address how impacts will be avoided or minimized.

Best Management Practices (BMPs) identified to address geotechnical issues during design engineering include the following actions.
Figure PA 3.15-1  Slope Instability Hazard and Suspected Landslide Areas Near Chehalem Creek

- Segment 4 Right-of-Way
- Segment 5 Right-of-Way
- Urban Growth Boundary (UGB)
- City Limits
- Bypass Approved Corridor
- Railroad
- Bridges or Overcrossings
- Slope Instability Hazard Area
- Suspected Landslide Area
- Elevation Contours: 5 foot Interval (brown), 1 foot Interval (yellow)

Legend:

- Columbia Empire Farms
- Newberg-Dundee Bypass Project
- Dundee
- Dayton
- Newberg
- Day of year: 12/7/2011
- Path: P:\GIS\Projects\NewbergDundee\EIS\SlopeHazard\ND_SlopeHazard_ChehalemCreek.mxd
Figure PA 3.15-2 Slope Instability Hazard and Suspected Landslide Areas Near Hess Creek North

- Segment 5 Right-of-Way
- Segment 6 Right-of-Way
- Urban Growth Boundary (UGB)
- City Limits
- Bypass Approved Corridor
- Railroad
- Bridges or Overcrossings

Slope Instability Hazard Area
Suspected Landslide Area
Elevation Contours
5 foot Interval
1 foot Interval

Date: 12/7/2011   Path: P:\GIS\Projects\NewbergDundee\FEIS\SlopeHazard\ND_SlopeHazard_HessCreek.mxd
Geologic Hazard

BMPs for avoiding geologic hazards will be based on detailed engineering design analysis and could include the following, as appropriate:

- Improve ground stability in loose and saturated soils. For example, bridge piers could require ground improvement to provide sufficient stability in loose and saturated soils.

- Avoid landslide areas if possible. In general, embankment fills should be avoided near slopes suspected to contain landslides and slope creep. Measures to improve stability and to protect roads from possible landslide activity could include the construction of rock buttresses, shear keys, riprap, toe berms, drainage trenches, horizontal drains, bioengineering, and regrading slopes to more gentle inclinations. Where insufficient room exists at the toe of slopes that end at streams, proposed measures may need to be restricted to the upper part of the slope, such as the use of tieback retaining walls or slope unloading. Lightweight fills and/or subsurface drainage systems might improve slope stability. Impact avoidance measures could require additional cost for structures currently not included in project cost estimates.

- Lower the Bypass grade from the East Dundee Interchange over Chehalem Creek and into the east side of the creek to reduce landslide hazards of the project. The lowered grade will also create valuable setback distances from several slides.

Earthwork

BMPs related to earthwork will be based on detailed engineering design analysis and could include the following, as appropriate:

- Avoid placing fill on or near steep slopes.

- Provide a setback distance for bridge abutments away from slopes. It may be necessary to use stabilizing toe berms, buttresses, and/or shear keys in non-wetland/stream areas. In some locations, avoidance measures may need to be restricted to the upper part of the slope.

- Improve foundation soils as needed, including possible preloading with surcharge fill.

- Stabilize large fill embankments with counterbalance fills, rock shear keys, stone columns, embankment reinforcement, and subdrainage to lower the groundwater. Other methods to reduce embankment settlement and stability concerns could include using lightweight fills and extending bridge length to reduce embankments.

- Use staged fill construction as needed to allow for incremental improvement of foundation soils before adding additional fill loads.

- Use embankment retaining structures as needed to reduce impacts to adjacent developed properties.

- At-grade and below-grade road construction will likely need subdrainage in anticipation of wintertime shallow groundwater levels to prevent water levels from impacting the pavement section. Subsurface water will be collected in gravity pipe systems and discharged to natural surface drainage areas.

- Use drainage systems to control and remove groundwater in semi-depressed roadway sections of the Bypass (less than 15 feet deep).

- Remove or replace unsuitable fill soils as needed to prevent long-term settling or voids below roadways. If too costly, use deep foundations, preloading, dynamic compaction, or lengthening bridge structures to span over the unsuitable soils.
Avoid earthwork or aerate silt soils during wet winter and spring months due to the difficulty of handling and construction. Use chemical stabilization as needed to extend the construction season in moderately wet months.

**Material Disposal**

BMPs for material disposal will be based on detailed engineering design analysis and could include the following, as appropriate:

- Raise road grades of the Preferred Alternative to reduce excavation quantities and to increase embankment fill needs.
- Avoid or minimize use of depressed road sections that could create excavation and excess material.
- Use design options with moderately sized embankments to use available soils on site.
- Allow longer aeration of wet soils and/or use chemical stabilization to utilize wet soils within the project limits.
- Use waste material in landscape berms and wider/flatter fill slopes alongside the Bypass and within interchange footprints.
- Manage the routing and frequency of haul trucks used for disposal (see Section 3.1.5 for a discussion of construction traffic management).

As ODOT will build the Preferred Alternative in phases, a study could be considered to determine how to balance earthwork quantities and best manage earthwork construction. Phased construction could allow better coordination of excavations and fill needs. The contractor will be responsible for finding and environmentally clearing off-project disposal sites.

**Structures**

BMPs regarding the use of structures will be based on detailed engineering design analysis and could include the following, as appropriate:

- Evaluation of the use of retaining walls instead of cut slopes where cut slopes could adversely impact adjacent facilities.
- Evaluation of the use of deep foundations rather than shallow footings for bridge piers over floodplains and adjacent lowlands. Foundations for bridge structures will be deep driven piles or drilled shafts. Bridge piers could require improving the ground stability in loose and saturated soils.

**3.15.2.2 No Build Alternative**

**Direct and Indirect Impacts**

There will be very few geotechnical direct and indirect impacts resulting from the No Build Alternative. Roadway structures designed more than 20 years ago could be damaged or destroyed by very strong earthquakes.

Landslides near Hess Creek, Chehalem Creek and its tributaries, and tributaries to the Yamhill River would continue to creep occasionally and could affect the project area, adjacent properties, and streams. Erosion from streams and flooding could undermine steep slopes, and landslides could cause increased ground damage. Placing waste materials and fills near the heads of slides could make the landslide conditions worse.
Groundwater springs will continue to cause erosion and slope failures. During winter storms, groundwater levels will rise to near the ground surface in many locations and could cause unstable soil conditions.

### 3.15.2.3 Preferred Alternative

**Direct and Indirect Impacts**

Table PA 3.15-1 summarizes affected acreage for the Preferred Alternative in relation to several factors that measure potential exposure to geological hazard. Essentially, the larger the number in Table PA 3.15-1, the greater the area that is considered geologically hazardous. See the Newberg Dundee Bypass Tier 2 Final Geotechnical Technical Memorandum, ODOT 2012, for additional information on the evaluation categories.

To avoid direct impacts associated with the Preferred Alternative, BMPs discussed above will be implemented, as appropriate, during design engineering and construction. In summary, these BMPs are intended to:

- Minimize construction in higher earthquake and liquefaction hazard areas.
- Avoid deep excavations and tall embankments.
- Approach a balance between excavation quantities and fill requirements.
- Reduce excess excavation quantities that will need to be wasted.
- Maximize construction seasons when working with wet soils.
- Avoid where possible fill heights exceeding 25 feet, which are unprecedented in the Willamette Valley.
- Minimize construction in areas of questionable slope stability.

**Geologic Hazards**

Geologic hazards are present in varying degrees throughout the project area. The Preferred Alternative will be designed to avoid impacts to geologic hazards and to withstand the hazardous conditions.

Landslides will most likely occur in steep-sloped areas of silt soils that have been eroded by channelized surface water and springs. These types of slopes and soils are located near Chehalem Creek and Hess Creek North. The degree of instability in these areas is unknown.

Landslides could impact adjacent ground and streams and cause damage to the Bypass and local circulation structures and roadways. The Preferred Alternative will include landslide stabilization measures to avoid impacts to slope stability. However, these stabilization measures could result in impacts on other resources. For example, stabilization measures could result in lowering of groundwater levels, discharging collected groundwater into nearby streams, changing scenery and habitat, and removing vegetation and trees. In addition, slopes could become unstable and slope failures might occur if embankments are placed too close to the stream banks. The design process will provide more detailed information to consider stabilization options that avoid geological impacts and best fit the project, are cost effective, and minimize impacts to trees and adjacent properties. The ODOT project development process provides a means for resolving potential conflicts and environmental issues.
Table PA 3.15-1. Summary of Geotechnical Factors for the Preferred Alternative by Segment

<table>
<thead>
<tr>
<th>Segments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<tr>
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<tr>
<td><strong>Grading Area in Earthquake Hazard Zones (acres)</strong>&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Zone A (Highest)</td>
</tr>
<tr>
<td>Zone B (Intermediate-High)</td>
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<tr>
<td>Zone C (Low-Intermediate)</td>
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<tr>
<td>Zone D (Lowest)</td>
</tr>
<tr>
<td><strong>Grading Area in Earthquake Liquefaction Zones (acres)</strong>&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Zone 3 (High)</td>
</tr>
<tr>
<td>Zone 2 (Moderate)</td>
</tr>
<tr>
<td>Zone 1 (Low)</td>
</tr>
<tr>
<td>Zone 0 (None)</td>
</tr>
<tr>
<td><strong>Grading Area in Steep Slopes and Landslide Zones (acres)</strong></td>
</tr>
<tr>
<td>Slopes generally &gt;22</td>
</tr>
<tr>
<td>Landslide Areas Observed</td>
</tr>
<tr>
<td><strong>Grading Area in Various Cut/Fill Categories (acres)</strong></td>
</tr>
<tr>
<td>Tall Embankments (Height &gt; 25 ft)</td>
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<tr>
<td>Moderate Embankments (Height &lt;25 ft)</td>
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<tr>
<td>Near Grade (Cuts &amp; Fills &lt;5 ft)</td>
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<tr>
<td>Moderate Excavated Grades (Cuts &lt;15 ft)</td>
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<tr>
<td>Excavated Grades (Cuts &gt;15 ft)</td>
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<tr>
<td><strong>Approximate Quantities and Costs (preliminary)</strong></td>
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<tr>
<td>Clearing and Grubbing (acres)</td>
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<td>Excavation (1,000 cy)</td>
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<tr>
<td>Embankment (1,000 cy)</td>
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<tr>
<td>Embankment Foundation and Mitigation (in $Millions)</td>
</tr>
<tr>
<td>Disposal (1,000 cy)</td>
</tr>
<tr>
<td>Subsurface Dewatering (in $Millions)</td>
</tr>
</tbody>
</table>

Source: Newberg Dundee Bypass Tier 2 Final Geotechnical Technical Memorandum, ODOT 2012.

Notes: cy = cubic yards; costs in this table represent 2011 dollars.

<sup>a</sup> Zone A has the highest hazard for damage and Zone D the least.

<sup>b</sup> Zone 3 has the highest liquefaction potential and Zone 0 the least.
Slopes and Soil Stabilization

The Preferred Alternative will include embankment fills that could cause impacts such as erosion, slumping or settlement. Wet fills steeper than about 22 degrees could be susceptible to becoming unstable. Dry fill slopes appear to be stable up to about 27 degrees. Special construction measures may be necessary to achieve satisfactory performance. These construction measures could include installation of subdrainage systems for slope stability. Soft foundation soils might need to be improved with structural material to support fill and mitigate any settling. The Preferred Alternative will have moderate embankment heights (less than 25 feet high) with slopes of 27 degrees or less and should perform satisfactorily.

Structures

The Preferred Alternative will include retaining walls where cut slopes could adversely impact adjacent facilities. Top-down wall construction is typically used for these types of walls. This construction uses tieback systems for excavation depths more than 10 feet and requires permanent subsurface easements. When drilling for the installation of tieback anchors, there is a possibility that obstructions, buried utilities, underground storage tanks, and similar items may be encountered.

Design of crossings over streams will need to consider springs, shallow groundwater, and potential slope instability. Slopes could become unstable if fill and/or embankments associated with culverts are placed too close to the stream banks resulting in potential impacts to streams, wetlands and/or riparian areas. Bridge structures over streams and floodplains will have minimal or no impact in comparison.

Groundwater

Groundwater tends to be shallow throughout the project area with the depth to groundwater in monitoring wells ranging from 0 feet to more than 15 feet. In some well-drained locations, the groundwater level could be deeper. Shallow groundwater in the project area tends to be highly responsive to rainfall, such as a 10-foot increase in water depth within days of a heavy rainfall. The precise effects of groundwater drawdown are not yet known due to the site-specific nature of hydrogeologic soil characteristics. To determine effects, detailed investigations, such as pumping tests, will be required.

Semi-depressed sections of the Bypass (shallower than about 15 feet deep) will need subdrainage systems to control and remove groundwater. Subdrainage measures will lower groundwater levels up to 100 yards from the right-of-way. Private wells, which obtain water from the same hydrologic unit being dewatered (hand-dug or drilled), could be affected, and a few very shallow wells could become dry. Most residences in the cities of Newberg and Dundee are served by city water and do not rely on private wells. One potential well could be affected by project dewatering in Dundee and a few in Newberg. Shallow hand-dug wells are frequently not in the Oregon Water Resources Department database.

If water collected in drainage systems for the Preferred Alternative becomes contaminated (such as from nearby oil or chemical spills or leaks), mitigation measures and treatment could be required.

In general, the groundwater levels north of the Bypass will be impacted less than those south of the Bypass, due to the general flow of groundwater downhill towards the Yamhill or Willamette Rivers.

Construction Impacts

Construction impacts are short-term effects to resources that could occur while building the Preferred Alternative, whether these effects are experienced on site (within the project corridor) or off site (at project staging areas). As discussed further in Sections
3.12 and 3.16 (Water Quality and Hazardous Materials, respectively), construction of the Preferred Alternative will include excavation, fill, drilling, and grading activities. The implementation of geologic BMPs (as outlined in Section 3.15.2.1) will avoid temporary soil erosion, sedimentation, and impacts to stormwater, surface water, and groundwater quality within the main project area. Implementation of geologic BMPs will also be implemented at off-site staging facilities to avoid impacts to stormwater, surface water and groundwater.

**Resources**

Generally, the short-term use of geologic resources will be limited to the disturbance of existing topography affected by construction activities. These activities will include both construction of the Preferred Alternative and construction of temporary access and haul roads needed to accommodate traffic during construction.

**Blasting**

Grading and excavation for the Preferred Alternative could result in encountering bedrock or basalt, which may require blasting to remove. Geologic information from some monitoring wells and excavations indicates that basalt bedrock could be encountered at various depths throughout the project area. If ODOT uses blasting, impacts could include vibrations, noise, and possible damage to nearby structures. This may be a concern for construction of the Preferred Alternative in the vicinity of the Providence Newberg Medical Center and areas within the Newberg city limits.

In general, the at-grade earthwork, berms, and moderately sized embankments proposed for the Preferred Alternative should not adversely affect geologic resources, if landslide terrain and steep slopes are avoided or impacts to these are mitigated.

**Excavation and Disposal**

Unsuitable fill soils are located in the project area at the landfill on the south side of Waterfront Street in the west portion of Newberg and at a woody debris fill on the west bank of Hess Creek North near Wynooski Street (see Figure PA 3.15-3). These fill soils might need to be removed or treated to develop foundations with adequate strength for roadways and structures. Fills generating methane gases could also be a concern.

Excavations throughout the project area will encounter moisture-sensitive silt soils. Earthwork using on-site silt soil is typically not recommended during wet winter/spring months due to difficulty in handling and constructing with these soils. If construction takes place during wet conditions, all-weather materials (i.e., rock fill) will be needed, which could increase project costs and the amount of soil that needs to be disposed.

Construction of the Preferred Alternative will result in a large amount of excavated material. About 600,000 cubic yards (cy) will require off-site disposal. The disposal of 600,000 cy of soil will require about 60,000 truck trips on local roads and arterials. Additionally, disposal will require suitable large disposal sites and construction time and expense to treat moisture-sensitive soil. Treatment of wet soils, if used, will consist of aeration for slightly wet soils and Portland cement stabilization for wetter soils.

Locating disposal sites to accommodate large volumes of material could be difficult. Mitigation measures should be considered to reduce disposal of excess material, which could include minimizing cut and fill requirements, using moderately sized embankments to use excavated material on site, using waste material in landscape berms or other landscaping, etc. Earth berms are proposed for visual screening. Each berm requires an additional 40-foot width to accommodate side slopes, which are included in the Bypass footprint.

During final engineering, studies will be performed to balance earthwork quantities and to determine how to best manage earthwork construction for separate phases of the
Preferred Alternative. The earthwork usage will be considered in order to optimize excavations with embankment needs for each contract phase. Moving excavated material from one construction phase of the project to a future phase area might require driving haul trucks on public roads.

Availability of Subsurface Resource Materials

Construction of the Preferred Alternative will require large quantities of sand and gravel. Suppliers may need advance notice to supply the amount needed. Four large commercial aggregate sources and one undeveloped ODOT source are located within 10 miles of the project area. The availability of aggregate for construction should not be a problem.

Temporary Access and Haul Roads

Temporary access and haul roads will require the use of quarried aggregate and rock for placement on the roadbed.

Geologic Hazards

No temporary effects from potential geologic hazards are expected to occur on site or off site because of the Preferred Alternative because appropriately engineered designs and applicable construction practices will be employed by ODOT and its contractors.

3.15.2.4 Phase 1

Phase 1 will extend from Oregon 219 in Newberg and connect to Oregon 99W just south of Dundee, and will have geotechnical impacts within Segments 2, 3, 4, 5, and 6. Phase 1 includes geotechnical impacts not identified in the Tier 2 DEIS for project areas along Springbrook Road in East Newberg and just south of Dundee.

Direct and Indirect Impacts

Phase 1 will include fewer acres of grading impacts to all earthquake hazard zones, liquefaction hazard areas, and areas with steep slopes (greater than 25 degrees) than the full build out of the Preferred Alternative. Reductions will also be seen related to clearing and grubbing, excavation, embankments, disposal and costs associated with embankment foundations and mitigation, and subsurface dewatering. This reduction is attributed to the reduced acreage covered by Phase 1 in comparison to the full build out of the Preferred Alternative. Acreage of most types of cut and fill activities will be reduced, with the exception of deeply excavated grades (cuts greater than 15 feet). Segment 6 includes 3.5 acres of deep excavations west of Oregon 219 approaching Hess Creek.
Figure PA 3.15-3  Location of Unsuitable Soils

Legend:
- Segment 5 Right-of-Way
- Segment 6 Right-of-Way
- Urban Growth Boundary (UGB)
- Woody Debris Fill

*Indicates Approximate Boundaries

City Limits
Bypass Approved Corridor
Railroad

Date: 2/26/2012  Path: P:\GIS\Projects\NewbergDundee\FEIS\Chapter3\ND_UnsuitableFillSoils.mxd
### Table PA 3.15-2. Summary of Geotechnical Factors for Phase 1 by Segment

<table>
<thead>
<tr>
<th></th>
<th>Seg 2</th>
<th>Seg 3</th>
<th>Seg 4</th>
<th>Seg 5</th>
<th>Seg 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grading Area in Earthquake Hazard Zones (acres)</strong>&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Zone A (Highest)</td>
<td>-</td>
<td>-</td>
<td>&lt;7.2</td>
<td>0.3</td>
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<td>Zone B (Intermediate-High)</td>
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<td>-</td>
<td>&lt;17.6</td>
<td>21.2</td>
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<tr>
<td>Zone C (Low-Intermediate)</td>
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<td>21.0</td>
<td>&lt;8</td>
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<td>Zone D (Lowest)</td>
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<td>&lt;9.2</td>
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<td>-</td>
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<tr>
<td><strong>Grading Area in Earthquake Liquefaction Zones (acres)</strong>&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
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<td>Zone 3 (High)</td>
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<td>-</td>
<td>-</td>
</tr>
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<td>Zone 2 (Moderate)</td>
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<td>-</td>
<td>&lt;0.8</td>
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<td>Zone 0 (None)</td>
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<td>&lt;6.3</td>
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<td>-</td>
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<tr>
<td><strong>Grading Area in Steep Slopes and Landslide Zones (acres)</strong></td>
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<td></td>
<td></td>
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<td>Slopes generally &gt;22°</td>
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<td>0.6</td>
<td>&lt;9.7</td>
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<td>Landslide Areas Observed</td>
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<td>&lt;4.6</td>
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<td><strong>Grading Area in Various Cut/Fill Categories (acres)</strong></td>
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</tr>
<tr>
<td>Tall Embankment (Height &gt; 25 ft)</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Moderate Embankments (Height &lt;25 ft)</td>
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<td>5.5</td>
<td>&lt;15.0</td>
<td>11.9</td>
<td>-</td>
</tr>
<tr>
<td>Near Grade (Cuts &amp; Fills &lt;5 ft)</td>
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<td>15.5</td>
<td>&lt;22.5</td>
<td>11.9</td>
<td>6.9</td>
</tr>
<tr>
<td>Moderate Excavated Grades (Cuts &lt;15 ft)</td>
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<td>-</td>
<td>&lt;2.7</td>
<td>5.2</td>
<td>1.2</td>
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<tr>
<td>Deep Excavated Grades (Cuts &gt;15 ft)</td>
<td>-</td>
<td>-</td>
<td>&lt;1.8</td>
<td>-</td>
<td>3.5</td>
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<tr>
<td><strong>Approximate Quantities and Costs (preliminary)</strong></td>
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<tr>
<td>Clearing and Grubbing (acres)</td>
<td>23</td>
<td>21</td>
<td>&lt;42</td>
<td>29</td>
<td>12</td>
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<tr>
<td>Excavation (1,000 cy)</td>
<td>4</td>
<td>30</td>
<td>&lt;255</td>
<td>100</td>
<td>49</td>
</tr>
<tr>
<td>Embankment (1,000 cy)</td>
<td>296</td>
<td>60</td>
<td>&lt;230</td>
<td>80</td>
<td>11</td>
</tr>
<tr>
<td>Embankment Foundation and Mitigation (in $Millions)</td>
<td>$0.4</td>
<td>-</td>
<td>&lt;$0.4</td>
<td>$0.2</td>
<td>$0.1</td>
</tr>
<tr>
<td>Disposal (1,000 cy)</td>
<td>2</td>
<td>10</td>
<td>&lt;90</td>
<td>60</td>
<td>18</td>
</tr>
<tr>
<td>Subsurface Dewatering (in $Millions)</td>
<td>-</td>
<td>N/A</td>
<td>&lt;$0.3</td>
<td>$0.4</td>
<td>$1.6</td>
</tr>
</tbody>
</table>

Source: Newberg Dundee Bypass Tier 2 Final Geotechnical Technical Memorandum, ODOT 2012.

Notes: Data in the table that includes a "<" symbol refers to a value that is less than the units calculated for the Preferred Alternative. This is a result of the reduced physical area encompassed by Phase 1 in comparison with the Preferred Alternative. The actual values for Phase 1 have not been calculated.

- cy = cubic yards; costs in this table represent 2011 dollars.
- a Zone A has the highest hazard for damage and Zone D the least.
- b Zone 3 has the highest liquefaction potential and Zone 0 the least.
Construction Impacts

Construction impacts for Phase 1 are similar to those listed under the Preferred Alternative, with the exception of excavation and disposal. Construction of Phase 1 will result in less than 250,000 cy of soil that will require off-site disposal. The disposal of less than 250,000 cy of soil will require fewer than 25,000 truck trips on local roads and arterials.

3.15.3 Cumulative Impacts for the Preferred Alternative

The geotechnical cumulative impacts analysis starts at the baseline year of 1970 for past actions and extends to 2035 for reasonably foreseeable future actions. For this analysis, the area of potential cumulative impacts for Preferred Alternative includes both the project area and the area within about 1 mile of Oregon 99W. The Preferred Alternative, in combination with other future roadway and land development projects within the project area, could potentially have cumulative impacts.

Large-scale construction projects, like the Preferred Alternative, have the potential to substantially change the topography of the area. This is most often due to construction of such project elements as new grade-separated interchanges and sound berms. It may also be due to necessary disposal of excess and/or unsuitable material.

Construction of the Preferred Alternative will probably have a direct impact on groundwater levels and/or flow due to the size of the project. There are no known or reasonably foreseeable future projects bordering the project area that would cause groundwater cumulative impacts. If the Preferred Alternative is constructed with excavations that are shallower than 15 feet deep, cumulative groundwater impacts could be avoided because all impacts will be localized and likely difficult to measure over the long term. The few local areas with side-hill cuts deeper than 15 feet should be readily stabilized with gravity drains.

Construction of the Preferred Alternative will require the use of large quantities of sand and gravel. As previously discussed, there appear to be more than sufficient sand and gravel sources available in the project area to supply the Preferred Alternative and other reasonably foreseeable future projects.

3.15.4 Mitigation

3.15.4.1 Preferred Alternative

Design engineering following BMPs will avoid most geotechnical hazards associated with the Preferred Alternative. Accordingly, no mitigation will be required.

3.15.4.2 Phase 1

There are no additional mitigation measures for Phase 1 that are not described for the Preferred Alternative.
3.15.5 Tier 2 DEIS Build Alternative

The following is an exact copy of the Tier 2 DEIS Build Alternative section for geotechnical. In-text references cite information in the Tier 2 DEIS.

The Tier 2 DEIS Build Alternative, which includes all of the design and local circulation options no longer under consideration, is included here as a comparison to the Tier 2 FEIS Preferred Alternative and for informational purposes only.

Copies of the complete Tier 2 DEIS are available from:

  Kelly Amador, Senior Project Leader, Region 2
  Oregon Department of Transportation
  Mid-Willamette Valley Area
  885 Airport Road SE, Building P
  Salem, OR 97301-4788
  kelly.l.amador@odot.state.or.us

3.15.2.2 Build Alternative

Direct and Indirect impacts

This section provides a summary of the potential impacts of the Build Alternative on geologic resources and the potential impacts of geotechnical characteristics on the Build Alternative after it is constructed.

Table 3.15-1 summarizes affected acreage for the Build Alternative in relation to several factors that measure potential exposure to geological hazard. Comparative factors for the geologically preferred design options are shown in bold in this table and include such features as: earthquake hazard zones, earthquake liquefaction zones, grading in areas of steep slopes (e.g., greater than 22 degrees where soil is wet) and grading associated with various other cut and fill categories. Essentially, the larger a number is in Table 3.15-1, the more area there is that is considered geologically hazardous. See the Newberg Dundee Bypass Geotechnical Technical Memorandum (ODOT 2009) for additional information on the evaluation categories.

Where there are design options, other factors being equal, the design option selected should:

- Minimize construction in higher earthquake and liquefaction hazard areas.
- Limit the need for extensive and costly dewatering efforts; avoid deep excavations and tall embankments.
- Approach a balance between excavation quantities and fill requirements.
- Reduce excess excavation quantities that would need to be wasted.
- Maximize construction seasons when working with wet soils.
- Avoid where possible fill heights exceeding 25 feet, which are unprecedented in the Willamette Valley.
- Minimize construction in areas of questionable slope stability.
Geologic Hazards

Geologic hazards are present in varying degrees throughout the project area. Some of these hazards can be avoided depending upon the design option selected; others cannot be avoided. The primary hazards are associated with the potential for earthquakes or landslides, and with steep slopes.

Landslides would most likely occur in steep-sloped areas of silt soils that have been eroded by channelized surface water and springs. In the project area, these types of slopes and soils are located near Chehalem Creek and Hess Creek North. The degree of instability in these areas is unknown.

Landslides in the project area could impact adjacent ground and streams and cause damage to Bypass and local circulation structures and roadways. Bypass construction could make landslide conditions worse and cause further damage. The likelihood of landslides could be reduced by using landslide stabilization measures in the Bypass design. However, these stabilization measures could result in impacts on other resources. For example, stabilization measures could result in lowering of groundwater levels, discharging collected groundwater into nearby streams, changing scenery and habitat, and removing vegetation and trees. In addition, slopes could become unstable and slope failures might occur if embankments are placed too close to the stream banks.
Table 3.15-1. Summary of Geotechnical Factors for the Build Alternative by Segment and Design Option

<table>
<thead>
<tr>
<th>Segment</th>
<th>Seg. 1</th>
<th>Seg. 2</th>
<th>Seg. 3</th>
<th>Seg. 4</th>
<th>Seg. 5</th>
<th>Seg. 6</th>
<th>Seg. 7</th>
<th>Seg. 8.1</th>
<th>Seg. 8.1A</th>
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<tr>
<td></td>
<td>3.5</td>
<td>56.8</td>
<td>23.0</td>
<td>25.7</td>
<td>18.0</td>
<td>21.0</td>
<td>9.8</td>
<td>9.2</td>
<td>8.6</td>
</tr>
<tr>
<td></td>
<td>Zone B (Intermediate-High)</td>
<td>31.5</td>
<td>9.2</td>
<td>9.2</td>
<td>0.3</td>
<td>18.9</td>
<td>17.6</td>
<td>20.2</td>
<td>18.9</td>
</tr>
<tr>
<td></td>
<td>Zone C (Low-Intermediate)</td>
<td>3.5</td>
<td>56.8</td>
<td>56.8</td>
<td>23.0</td>
<td>25.7</td>
<td>18.0</td>
<td>21.0</td>
<td>8.6</td>
</tr>
<tr>
<td></td>
<td>Zone D (Lowest)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Grading Area in Earthquake Hazard Zones (acres)a</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Zone A (Highest)</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Zone B (Intermediate-Low)</td>
<td>35.0</td>
<td>9.2</td>
<td>9.2</td>
<td>0.3</td>
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<td>8.0</td>
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<td>18.6</td>
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<tr>
<td>Zone C (Low-Intermediate)</td>
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<td>56.8</td>
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<td>26.0</td>
<td>18.0</td>
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<td>37.4</td>
<td>34.9</td>
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<td>Zone D (Lowest)</td>
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<tr>
<td>Grading Area in Earthquake Liquefaction Zones (acres)b</td>
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<tr>
<td>Zone 3 (High)</td>
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<td>-</td>
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<td>9.0</td>
<td>9.0</td>
<td>18.6</td>
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<td>56.8</td>
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<td>18.0</td>
<td>21.0</td>
<td>37.4</td>
<td>34.9</td>
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<td>-</td>
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<td>Grading Area in Steep Slopes and Landslide Zones (acres)</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>Slopes generally &gt;22°</td>
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<td>1.3</td>
<td>1.3</td>
<td>0.6</td>
<td>0.6</td>
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<td>0.6</td>
<td>10.4</td>
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<td>-</td>
<td>-</td>
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<td>Grading Area in Various Cut/Fill Categories (acres)</td>
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<td></td>
</tr>
<tr>
<td>Tall Embankments (Height &gt; 25 ft)</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Moderate Embankments (Height &lt; 25 ft)</td>
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<td>10.6</td>
<td>10.6</td>
<td>2.5</td>
<td>5.5</td>
<td>2.5</td>
<td>5.5</td>
<td>14.0</td>
<td>15.0</td>
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</table>
Table 3.15-1. Summary of Geotechnical Factors for the Build Alternative by Segment and Design Option

<table>
<thead>
<tr>
<th>Seg.</th>
<th>Segment 2 (w/3. A &amp; B &amp; 3.A2)</th>
<th>Semi-Depressed</th>
<th>At-Grade</th>
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<tr>
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<td>Segment 2</td>
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<td>3.A2</td>
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<td>4.1 (w/3. A &amp; B &amp; 3.A2)</td>
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<td>6</td>
<td>5.1C. under RR</td>
<td>5.1D. over RR</td>
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</tr>
<tr>
<td>7</td>
<td>5.2D. over RR</td>
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</tr>
<tr>
<td>8.1</td>
<td>Segment 8.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Near Grade (Cuts & Fills <5 ft)

|       | 26.5 | 55.4 | 55.4 | 2.5 | 2.5 | 15.5 | 15.5 | 17.5 | 22.5 | 21.0 | 25.0 | 14.7 | 11.9 | 11.9 | 9.9 | 10.2 | 10.5 | 14.4 | 5.5 |

Moderate Excavated Grades (Cuts <15 ft)

|       | 1.1  | -    | -    | 18.0 | 18.0 | -    | -    | 11.7 | 2.7  | 10.5 | 2.5  | 3.8  | 5.2  | 5.2  | 12.5 | 8.5  | 8.5  | -    | 0.5 |

Deep Excavated Grades (Cuts >15 ft)

|       | -    | -    | -    | -    | -    | -    | 1.8  | 1.8  | 1.5  | 1.5  | 9.6  | -    | -    | -    | -    | -    | -    | -    | -    |

Approximate Quantities and Costs (preliminary)

<table>
<thead>
<tr>
<th></th>
<th>Clearing and Grubbing (acres)</th>
<th>Excavation (1,000 CY)</th>
<th>Embankment (1,000 CY)</th>
<th>Embankment Foundation and Mitigation (in Millions)</th>
<th>Disposal (1,000 CY)</th>
<th>Subsurface Dewatering (in Millions)</th>
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<tr>
<td></td>
<td>35</td>
<td>100</td>
<td>260</td>
<td>$0.1</td>
<td>70</td>
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</tr>
<tr>
<td></td>
<td>66</td>
<td>200</td>
<td>380</td>
<td>$0.5</td>
<td>130</td>
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<tr>
<td></td>
<td>23</td>
<td>360</td>
<td>40</td>
<td>$0.5</td>
<td>210</td>
<td>$1.8</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>360</td>
<td>50</td>
<td>$0.5</td>
<td>200</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>30</td>
<td>60</td>
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<td></td>
<td>21</td>
<td>30</td>
<td>60</td>
<td>$0.4</td>
<td>10</td>
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<tr>
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<td>45</td>
<td>515</td>
<td>210</td>
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<td>240</td>
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<td>220</td>
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<tr>
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<td>46</td>
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<td></td>
<td>29</td>
<td>840</td>
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<tr>
<td></td>
<td>34</td>
<td>360</td>
<td>55</td>
<td>$0.1</td>
<td>250</td>
<td>$0.1</td>
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<tr>
<td></td>
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<td>110</td>
<td>250</td>
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<td></td>
<td>8</td>
<td>45</td>
<td>20</td>
<td>$0.4</td>
<td>25</td>
<td>$0.4</td>
</tr>
</tbody>
</table>


Note: Comparative values of factors for the geotechnical preferred design options are in bold.

a Zone A has the highest hazard for damage and Zone D the least.
b Zone 3 has the highest liquefaction potential and Zone 0 the least.
Blasting

Grading and excavation for the Bypass could result in encountering bedrock or basalt, which may require blasting to remove. Geologic information from some monitoring wells and excavations indicates that basalt bedrock could be encountered at various depths throughout the project area. Should blasting be used, impacts could include vibrations, noise, and possible damage to nearby structures. This may be a concern for construction of the Bypass in the vicinity of the Newberg Providence Hospital and areas within the Newberg city limits.

In general, the at-grade earthwork, berms, and moderately sized embankments proposed for the Bypass should not adversely affect the geologic resources, if landslide terrain and steep slopes are avoided or impacts to these are mitigated.

Slopes and Soil Stabilization

Construction of embankment fills could cause impacts such as erosion, slumping or settlement. Wet fills steeper than about 22 degrees would be susceptible to becoming unstable. Dry fill slopes appear to be stable up to about 27 degrees. Soft foundation soils might need to be improved with structural material to support fill and mitigate any settling. The Bypass design options being considered have moderate embankment heights (less than 25 feet high) and should perform satisfactorily.

Excavation and Disposal

Unsuitable fill soils are located in the project area at the landfill on the south side of Waterfront Street in the west portion of Newberg and at a woody debris fill on the west bank of Hess Creek North near Wynooski Street. These fill soils might need to be removed or treated to develop foundations with adequate strength for roadways and structures. Fills generating methane gases could also be a concern.

Excavations throughout the proposed project area would encounter moisture-sensitive silt soils. Earthwork using on-site silt soil is typically not recommended during wet winter/spring months due to difficulty handling and constructing with these soils. If construction takes place during wet conditions, all-weather materials (i.e., rock fill) would be needed, which could increase project costs and the amount of soil that needs to be disposed.

Construction of the Bypass would result in a large amount of excavated material. About 900,000 to 1,900,000 cubic yards (CY) would require off-site disposal. The disposal of 1,900,000 CY of soil would require about 200,000 truck trips on local roads and arterials. Additionally, disposal would require suitable large disposal sites, and construction time and expense to treat moisture-sensitive soil. Treatment of wet soils, if used, would consist of aeration for slightly wet soils and Portland cement stabilization for wetter soils.

Locating disposal sites to accommodate large volumes of material would be difficult. Mitigation measures should be considered to reduce disposal of excess material, which could include minimizing cut and fill requirements, using moderately sized embankments to use excavated material onsite, using waste material in landscape berms or other landscaping, etc. Earth berms are proposed in Design Options 3.A2 and 3.B2 for visual screening. Each berm requires an additional 40 foot width to accommodate side slopes. This additional width is included in the Bypass footprint for these design options.

Studies could be performed to balance earthwork quantities and to determine how to best manage earthwork construction of the proposed project if it is built in phases. The earthwork usage should be considered in order to optimize excavations with embankment needs for each contract phase. Moving excavated material from one construction phase of the project to a future phase might require driving haul trucks on public roads.
Structures

Retaining walls might be necessary where cut slopes could adversely impact adjacent facilities. Top-down wall construction is typically used for these walls. This construction uses tieback systems for excavation depths more than 10 feet and requires permanent subsurface easements. When drilling for the installation of tieback anchors, there is a possibility that obstructions, buried utilities, underground storage tanks, and similar items may be encountered.

Construction plans for bridge crossings over streams would need to consider springs, shallow groundwater, and potential slope instability. Slopes could become unstable if embankments are placed too close to the stream banks. Bridge structures over streams and floodplains would create less impact than culverts and/or fill.

Groundwater

Groundwater tends to be shallow throughout the project area with the depth to groundwater in monitoring wells ranging from 0 feet to more than 15 feet deep. Shallow groundwater in the project area tends to be highly responsive to rainfall, such as a 10-foot increase in water depth within days of a heavy rainfall. The precise effects of groundwater drawdown are not yet known due to the site-specific nature of hydrogeologic soil characteristics. To determine effects, detailed investigations, such as pumping tests would be required.

Semi-depressed sections of the Bypass (shallower than about 15 feet deep) would need subdrainage systems to control and remove groundwater. Subdrainage measures would lower groundwater levels up to 100 yards from the right-of-way. Private wells, which obtain water from the same hydrologic unit being dewatered (hand-dug or drilled) could be affected, and a few very shallow wells could become dry. Most residences in the cities of Newberg and Dundee are served by city water and do not rely on private wells. One potential well could be affected by project dewatering in Dundee and a few in Newberg. Shallow hand-dug wells are frequently not in the OWRD database.

Bypass sections depressed more than about 15 feet would likely require more substantial pumped dewatering systems. The removal and discharge of collected groundwater would be necessary during construction and for long-term maintenance. Deep dewatering could lower the groundwater levels within an area about 200 yards from the right-of-way beyond which the anticipated groundwater drawdown would be relatively minor (i.e., less than 3 feet of lowering). Potential impacts from using deep dewatering wells could include:

- Lower groundwater levels beneath nearby facilities, possibly causing decreased flows into shallow domestic wells.
- Settlement under structures (due to lowered groundwater levels), possibly causing damage from increased foundation soil stresses.
- Discharge of collected groundwater into drainage systems and streams.

If deep dewatering systems or heavy embankments cause settlement of utilities or structures outside the right-of-way, repairs might be necessary. Dewatering could also cause the need for more irrigation on properties adjacent to the Bypass.

An indirect impact of deep dewatering excavations would be the long-term power required to operate the pumps for dewatering wells. During power outages or when pumps fail, groundwater could seep into the pavement and slopes.

If water collected in drainage systems becomes contaminated (such as from nearby oil or chemical spills or leaks), mitigation measures and treatment could be required. Construction of depressed Bypass sections near hazardous material sites or areas with
groundwater contamination is not recommended because of the substantial risks to water quality in the proposed project's subdrainage systems. Locating dewatering systems adjacent to contaminated groundwater could cause contaminants to move into the dewatering system, requiring groundwater treatment before it is discharged.

In general, the groundwater levels north of the Bypass would be impacted less than those south of the Bypass, due to the general flow of groundwater downhill towards the Yamhill or Willamette Rivers.

Availability of Subsurface Resource Materials

Construction of the Build Alternative would require large quantities of sand and gravel. Suppliers may need advance notice to supply the amount needed. Four large commercial aggregate sources and one undeveloped ODOT source are located within 10 miles of the project area. The availability of aggregate for construction should not be a problem.

Impacts Related to Specific Design Options

Segment 3


- Design Options 3.B and 3.B2 would result in less excavated soil and soil waste, and would allow a longer construction season.

- Design Options 3.A2 and 3.B2 berm construction would provide a possible disposal area for excavated soils that would otherwise require off-site disposal.

Segment 4

The major difference between Design Options 4.1 and 4.2 is that the partial cloverleaf East Dundee Interchange in Design Option 4.2 would lessen the impacts over landslide terrain and marginally stable slopes, requiring fewer mitigation measures.

Based on geotechnical considerations (in addition to the one stated above), Design Option 4.2 in combination with Design Option 3.B2 (at-grade) would be preferred over Design Option 4.1 for the following factors:

- At-grade construction would not require expensive permanent subsurface drainage.

- At-grade construction would reduce excavation quantities and reduce soil waste.

Segment 5

The major differences between the design options in Segment 5 are the various above-and below-grade options. The landslide hazards near Chehalem and Hess Creeks and the landfill impacts would be similar for each option. However, the differences in above-or below-grade construction would result in some differences in potential geotechnical impacts:

- Design Option 5.1C.2 (fully depressed roadway) would require excavation greater than 15 feet. This would require permanent deep dewatering systems which could lower groundwater levels within an area approximately 200 yards from the right-of-way. Groundwater settlement associated with groundwater drawdown might be substantial adjacent to the pumping system, and could impact existing wells.
- Design Options 5.1D.2 and 5.2D (fully above-grade on fill) would avoid the complex and costly construction and permanent deep dewatering wells, and would avoid potential impacts to nearby wells, groundwater, and buildings near the Bypass.

- Design Options 5.1D.2 and 5.2D could potentially use excavated soil materials from other portions of the proposed project, minimizing soil waste and off-site disposal needs and expenses. Conversely, Design Option 5.1C.2 would generate more excess soil.

- Shifting the Bypass south in Design Option 5.2D would mean less encroachment of the realigned Wyonooki Road on the banks of Hess Creek North.

**Segment 7**

The following are the major differences in impacts for Design Options 7.4C and 7.5C:

- With Design Option 7.5C, the depressed section of the Bypass undercrossing would be located farther from homes along Brutscher Street than with Design Option 7.4C, resulting in smaller embankments at the Fernwood/Brutscher intersection.

- With Design Option 7.5C, there would also be less likelihood of damage due to groundwater drawdown effects than with Design Option 7.4C (although the probability for damage to buildings with either design option would be very low).

- In Design Option 7.4C, a site-specific soil survey in the vicinity of the Newberg Providence Hospital should be considered for more detailed analysis of vibration impacts to the hospital. See the Noise and Vibration section in this chapter for additional detail on vibration impacts.