3.1 EARTH

The topography, geologic setting and subsurface conditions at the Wood Trails and Montevallo sites have been characterized in separate geotechnical reports prepared for each proposed project and submitted with the project applications. For each site, review of the original technical studies indicated a need for additional information, resulting in the preparation of addendum reports. These four geotechnical reports were provided as Appendices A, B, C and D to the Draft EIS. In response to public comments on the Draft EIS, the City's geotechnical consultant conducted supplemental investigation of selected earth resource topics for the Final EIS. The documentation prepared by the City's consultant is provided in Appendix M to the Final EIS.

Due to the presence of critical areas related to geologic and soil conditions on the site and nearby, greater emphasis has been placed on characterization of earth resources for the Wood Trails site. Subsurface exploration, review of geologic maps, and review of geotechnical reports for adjacent properties were utilized for purposes of characterizing the geologic setting. Slope stability and erosion hazards are the primary geotechnical considerations for the Wood Trails site. The Montevallo site does not contain steep slopes or erosion hazard areas, and soil stability is not a primary geotechnical consideration for the property.

3.1.1 Existing Conditions

This subsection summarizes the existing surface and subsurface conditions at the Wood Trails and Montevallo sites. The technical reports included in the appendices provide additional discussion and detailed subsurface data related to the existing site conditions. The existing conditions were characterized through on-site field investigations, including observation of surface conditions and subsurface testing, and review of applicable published and unpublished information.

The following references were reviewed to aid in the overall characterization of site subsurface conditions and geologic setting:

- Geologic Map of the Bothell Quadrangle, Minard 1985;
- Composite geologic map of the Sno-King Area, Booth, D.B., Cox, B.F., Troost, K.G. and Shinel, S.A., University of Washington, Seattle Area Geologic Mapping Project, 2004;
- Woodinville Comprehensive Plan, Chapter 12, Figures A13-1 and A13-3, Critical Areas and Sensitive Geologic Areas in Woodinville;
- City of Woodinville Municipal Code, Chapter 21.24;
- King County Sensitive Areas Map Folio, 1990;
- Soil Survey of King County Area, Washington, Soil Conservation Service (SCS), 1973;
- Glacial Geology of the Puget Lowland, Cole, 1967 (unpublished); and
- Seattle Landslide Study, Seattle Department of Planning and Development.

Due to the complex nature of the glacial and post-glacial processes combined with local variations in terrain and drainage paths, the soils and geology within the limits of a relatively small area can be highly varied. Conversely, relatively widespread areas are found to possess very little variation with respect to the predictable sequence of geologic deposits. To better understand the sites, soil and geologic investigations were conducted on the sites. These investigations were conducted at a level adequate enough for the decision-maker to determine whether or not the rezones and preliminary plats, with regards to earth impacts, can be approved, approved with conditions or denied. The investigations also

provide enough information for determining general mitigation requirements. Further geotechnical studies, if determined necessary, will accompany site development engineering plans, provided the preliminary plats are approved.

Regional Geologic Setting

The Puget Sound lowland, within which the Wood Trails site is located, is a region that has been subjected to multiple periods of glaciation. The most recent glaciation of the Puget Sound lowland is known as the Fraser glaciation. The final retreat of glacial ice from the Puget Sound lowland is estimated to have occurred approximately 13,500 years ago. The soil or glacial debris deposits associated with the recent glaciation largely dominate the geologic setting throughout the Puget Sound lowland. Within the period of glaciation, minor changes in climate are thought to have caused a series of retreats and advances of the terminus of the glacier. These periods of fluctuations are known as stades. Much of the depositional environment throughout the Puget Sound lowland resulted from the Vashon stade of the Fraser glaciation, in which the glacial ice is thought to have reached a maximum thickness, and the terminus of the glacial ice reached as far south as Olympia, Washington.

Relatively rapid changes in the depositional environment during the advance and retreat of the glacial ice sheet resulted in a variety of soil textural characteristics and topographic features throughout the Puget Sound lowland. As the glacial ice sheet advanced into the Puget Sound lowland, lake deposits (proglacial lacustrine deposits) formed as natural drainage pathways became blocked by the advancing glacier. These proglacial lacustrine deposits are characterized primarily by silt and clay particles. Streams originating from the advancing glacier deposited coarser sand and gravel sized particles that generally overlie much of the finer grained silt and clay proglacial lacustrine deposits. Within the advancing ice sheet, silt, sand, and gravel particles referred to as till were transported by the ice and subsequently deposited. The till was deposited over much of the fine- and coarse-grained deposits that originated in advance of the glacial ice sheet. The weight of the advancing ice sheet, which is estimated to have been on the order of 3,000 feet thick at some locations, produced a highly compact condition within the underlying sequences of glacial deposits, often called glacial till.

During the final retreat of the glacial ice, relatively rapid melting of the ice produced large amounts of water that transported fine- and coarse-grained material, depositing these materials in steam deltas and lakes. The retreating ice continued to block the primary drainage path to the north, resulting in the formation of large lakes throughout areas previously occupied by the glacial ice. Following the retreat of the glacial ice, post-glacial processes including stream erosion, stream delta deposits, beach erosion, landslide activity, and other processes served to expose or cover the sequences of glacial and pre-glacial deposits. Deeply incised stream channels often expose the sequence of glacial deposits. This is also the case along the margins of Puget Sound where beach erosion and the resulting steep bluff areas expose the sequence of glacial deposits.

3.1.1.1 Wood Trails

Topography

The Wood Trails site topography is varied, with the overall slopes descending to the west. Elevations on the site range from approximately 250 feet in places along the western edge of the property to 430 feet at the eastern boundary. The most distinguishing site features include a series of east-west trending ravines with relatively moderate to steep side slopes. The ravine areas of the site generally contain slopes of 40 percent or steeper. Some relatively gentle-sloping areas are located along the margins of the ravines, and throughout the easterly portions of the site. Moderately sloping areas with grades of less than 40 percent are located along the westerly margins of the property. Figure 3.1-1 is a slope map for the Wood Trails site.

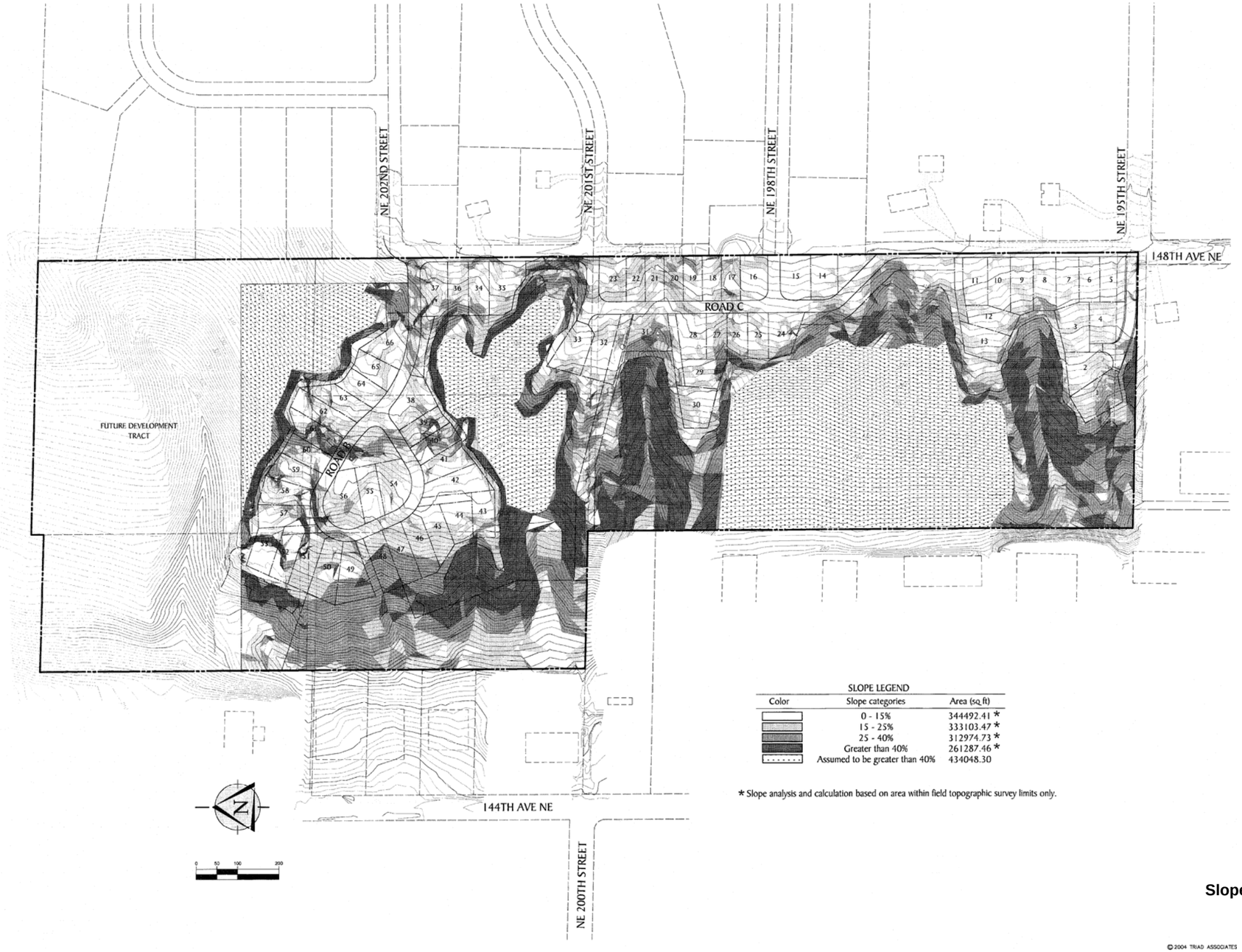

Figure 3.1-1
Slope Map, Wood Trails Site

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On-Site Geologic and Soil Characterization

Test excavations and drilled borings were completed, soil samples collected, photographs taken at test excavation sites, a series of aerial photographs interpreted, and the above referenced geologic maps, soil survey, critical area maps, and literature were reviewed to supplement the subsurface investigation. The data collected from the test sites, photographs, and laboratory test data are provided in the technical reports included as Appendices C and D of the Draft EIS and M of the Final EIS.

Published Map Information.

Geologic maps of the Bothell area identify Advance Outwash (Qva) deposits throughout much of the site and surrounding area. These deposits are generally described as relatively well-graded sand and gravel deposits that were deposited in streams originating from the advancing glacier. Silt lenses are common throughout the upper regions of the deposit, and localized deposits of Glacial Till (Qvt) may be present in areas mapped as Advance Outwash. Glacial Till (Qvt) deposits are identified on published maps immediately to the east of the property, and to the west of the property, west of 144th Avenue NE. The published maps do not identify landslide deposits (Qls) on the site or on surrounding properties.

The Soil Survey (Map) of King County Area, Washington (Soil Conservation Service, 1973; now the National Resource Conservation Service) characterizes the site soils as Alderwood Gravelly Sandy Loam (6 to 15 percent slopes) and Alderwood Gravelly Sandy Loam (15 to 30 Percent slopes). Alderwood series soils formed in glacial deposits throughout upland areas. The typical soil profile is described as dark-brown to brown, gravelly, sandy loam to a depth of approximately 2 feet. Underlying the upper statum, grayish brown to gray, weakly- to strongly-consolidated (or cemented) glacial till is described to depths extending to 5 feet or deeper.

With respect to the Alderwood Gravelly Sandy Loam (6 to 15 percent slopes) that is mapped throughout much of the east upland areas of the site, runoff is described as slow to medium, and the erosion hazard is described as moderate. With respect to the Alderwood Gravelly Sandy Loam (15 to 30 percent slopes) that is mapped throughout much of the west sloping areas of the site, runoff is described as medium, and the erosion hazard is characterized as severe. The slippage potential is described as moderate. For drainage and runoff analyses, the King County (1998) Surface Water Design Manual assigns Hydrologic Soil Group C to the Alderwood Series soils.

Site Investigation Data

Forty-five test excavations and two drilled borings were completed and soil samples collected at the test sites. Grain size (sieve) analyses were performed for purposes of classifying the soils in accordance with the Unified Soil Classification System (USCS). Photographs were acquired at several of the test excavation sites to supplement the overall subsurface exploration.

Review and interpretation of the test pit and boring logs for the Wood Trails site indicates four types of geologic deposits are present underneath the surface soils. The deposits and their characteristics are summarized as follows (see Appendix M for additional discussion):

- Recessional Outwash: These granular deposits are derived from meltwaters of the Vashon Age glaciation, and are known to exist within the general area over dense glacial and Transitional Bed deposits.
- Glacial Till: The till is generally dense to very dense, and is composed of a mixture of silt, sand, and gravel derived from deposition by the Vashon Age glaciers. The till deposits typically "blanket" upland areas in the Puget Sound region, and are found to exhibit this condition at the site area.

- Advance Outwash: These deposits are derived from meltwaters of the advancing Vashon Age glaciers, which were subsequently compacted by the weight of the glacial ice, like the Glacial Till. Advance Outwash deposits are more granular than the till, due to the effects of "flushing" of fines from the fluvial-type deposition. Typically, these deposits exhibit bedding or layering, with local interbeds of sand, gravel, and silt.
- Transitional Beds: Fine-grained Transitional Bed deposits are interglacial, lacustrian deposits deposited prior to the latest glaciation of Vashon Age. These deposits typically consist of silt, with varying amounts of clay and fine sand, and are generally well to massive bedded. They tend to be very stiff to hard, due to compaction by glacial ice.

Upland Area Soils. In accordance with the Unified Soil Classification System (USCS), the majority of the soils encountered throughout the upland areas of the site are classified as silty sand with gravel (SM). These silty sand with gravel (SM) soils are generally consistent with Glacial Till (Qvt) deposits. This same subsurface data, combined with sieve analysis data and observed soil profile, strongly support the conclusion that Alderwood series soils (hard pan/till soils) dominate the upland areas of the site and that outwash soils do not dominate.

Advance Outwash Sands (Qva), however, may be overlain by the Glacial Till (Qvt) deposits within the mapped area, and may be found to grade upward into Glacial Till (Qvt) deposits. The upland soil deposits may be representative of the lower margins of the Glacial Till (Qvt) deposits mapped immediately to the east of the site. The transitions between the Glacial Till (Qvt) and Advance Outwash Sand (Qva) glacial sequences, however, are not necessarily abrupt. Therefore, the upland soil deposits may be associated with the transition between the two glacial sequences, or possibly associated with the upper limits of the Advance Outwash Sand (Qva) deposit. In general, it appears that Glacial Till blankets the upslope easterly and downslope northwesterly portions of the site and can overlie both or either the advance outwash or transitional bed deposits

Lower Elevation Area Soils. Throughout the lower-elevation portions of the Wood Trails site, in the vicinity of the proposed storm water detention pond, loose to medium-dense, silty sand with gravel mantling and dense to very dense, sandy silt and sandy silt with gravel was predominantly encountered at the test sites (USCS Designations SM and ML, respectively). These deposits typically extend to a depth of 6 to 8 feet before transitioning into the underlying dense to very dense sandy silt and sandy silt with gravel. The sandy silt was generally massive and contained varying amounts of gravel and occasional cobbles. At one of the test sites, a 2-foot by 4-foot boulder (erratic) was encountered at a depth of approximately 8 feet.

The referenced geologic maps identify Advance Outwash Sand (Qva) deposits throughout the lower portions of the Wood Trails site and a relatively narrow band of the Lawton Clay (Qvlc) deposit to the north and west of the proposed detention pond area. The dense to very dense and massive sandy silt deposit encountered at the test sites may be associated with the Lawton Clay (Qvlc) deposit mapped near the site. The sandy silt may also be associated with the lower regions of the Advance Outwash Sand (Qva) deposit, where transition between the upper Advance Outwash Sand (Qva) and the lower Lawton Clay (Qvlc) sequences occurs. The area of the proposed detention pond is mapped as Alderwood Gravelly Sandy Loam (15 to 30 percent slopes) in the Soil Survey of King County. The upper deposits of brown to light-brown, silty sand with gravel mantling the lower, dense to very dense sandy silt are consistent with Alderwood soils. The Soil Survey of King County defines Alderwood soils as consisting of a moderately well drained soil over a weakly to strongly consolidated substratum. The silty sand with gravel soil found throughout the detention pond area meets this definition.

Groundwater. Using water well data, it appears that two different groundwater levels exist within the project area. An aquifer over 100 feet deep exists but does not surface at the site, nor is it connected with

the surface recharge. Groundwater seepage was observed at some of the test sites. In addition, seepage areas were observed at elevations approximating 290 to 360 feet, shown in Figure 3.1-1a. In general, heavy groundwater seepage conditions were not encountered at the site.

Where a relatively deep excavation is planned for the proposed storm water detention pond along the westerly margins of the property, a 20-foot test pit (TP-201) was excavated for purposes of assessing groundwater seepage conditions. Due to very dense soil conditions encountered in the vicinity of the proposed storm water detention pond, specialized "tiger teeth" were fitted to the excavator bucket to aid in the productivity of the excavation. Groundwater seepage was encountered in the excavation at a depth of approximately 20 feet. Groundwater seepage was also observed at a depth of 4 to 6 feet, and was associated with a seasonal perched groundwater seepage condition (see Appendix D of the Draft EIS). Refer to Section 3.2.1 for a more complete discussion of regional and local groundwater conditions.

Following the initial site excavations, three additional test pits were excavated in the detention pond area to supplement the previously acquired data. These test pits were also excavated to depths of 20 feet, and were advanced below the proposed bottom-of-pond elevation. Consistent with prior excavations, dense to very dense sandy silt and sandy silt with gravel soils were encountered below a relatively shallow deposit of silty sand with gravel. Perched groundwater seepage was encountered at a depth of approximately 6 to 8 feet, at or near the contact between the upper silty sand and underlying silt deposits. Throughout the remainder of the excavation within the sandy silt deposit, persistent or chronic groundwater seepage conditions were not encountered.

As stated above, heavy groundwater seepage conditions were not encountered. However, where groundwater seepage was encountered, the rate of seepage is expected to be light to moderate, depending on the time of year the excavation is completed. Additionally, groundwater seepage is anticipated to be associated with relatively shallow perched zones.

What are commonly referred to as "clean" sand deposits were not predominantly encountered at the test sites. Sieve analysis data included in the geotechnical report indicate the sand deposits encountered at the test sites contain fines of 16 percent or greater, with the majority of the samples tested containing greater than 20 percent fines (see Appendix D). Localized sand deposits likely exist throughout the site and surrounding areas. However, based on the subsurface exploration and review, the Wood Trails site is not immediately underlain by an extensive and widespread deposit of "clean" sand that is susceptible to large-scale movements.

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Figure 3.1-1a Ground Water Seepage Location Map

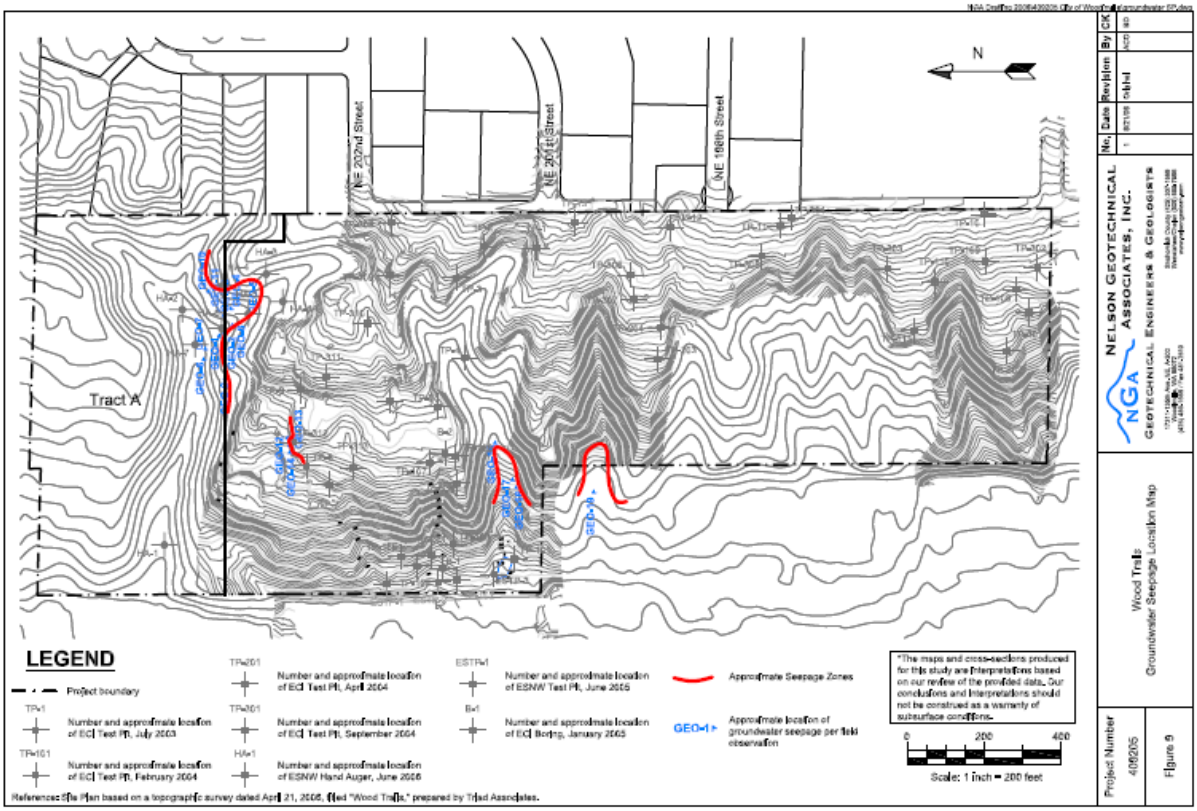

Figure 3.1-2 is a geologic map of the Wood Trails site developed from interpretation of the boring and test pit logs in comparison with the published geologic information. The map indicates that the eastern and northwestern portions of the site predominantly have Glacial Till materials at or near the surface. Advance Outwash deposits dominate the slopes in the southwestern portion of the site and part of the upland area in the northeastern quadrant. Silt Transitional deposits are present in a few small areas in the northwestern quadrant of the site, and there is one small area nearby where Recessional Outwash materials were encountered. Appendix M includes a series of cross-sections indicating the relative positions of these deposits along various transects through the site.

Site Stability

The critical areas portion of the Woodinville Municipal Code (WMC) addresses several types of geologic hazards that must be accounted for in development plans if they are present on a site. The specific types of geologic hazards defined in the code include erosion, seismic hazards, landslide and other geologic events including mass wasting debris flows, rock falls and differential settlement (WMC 21.24.290). Section 3.4.2 summarizes the provisions of the WMC with respect to these geologic hazards and discusses the consistency of the project with the Code requirements.

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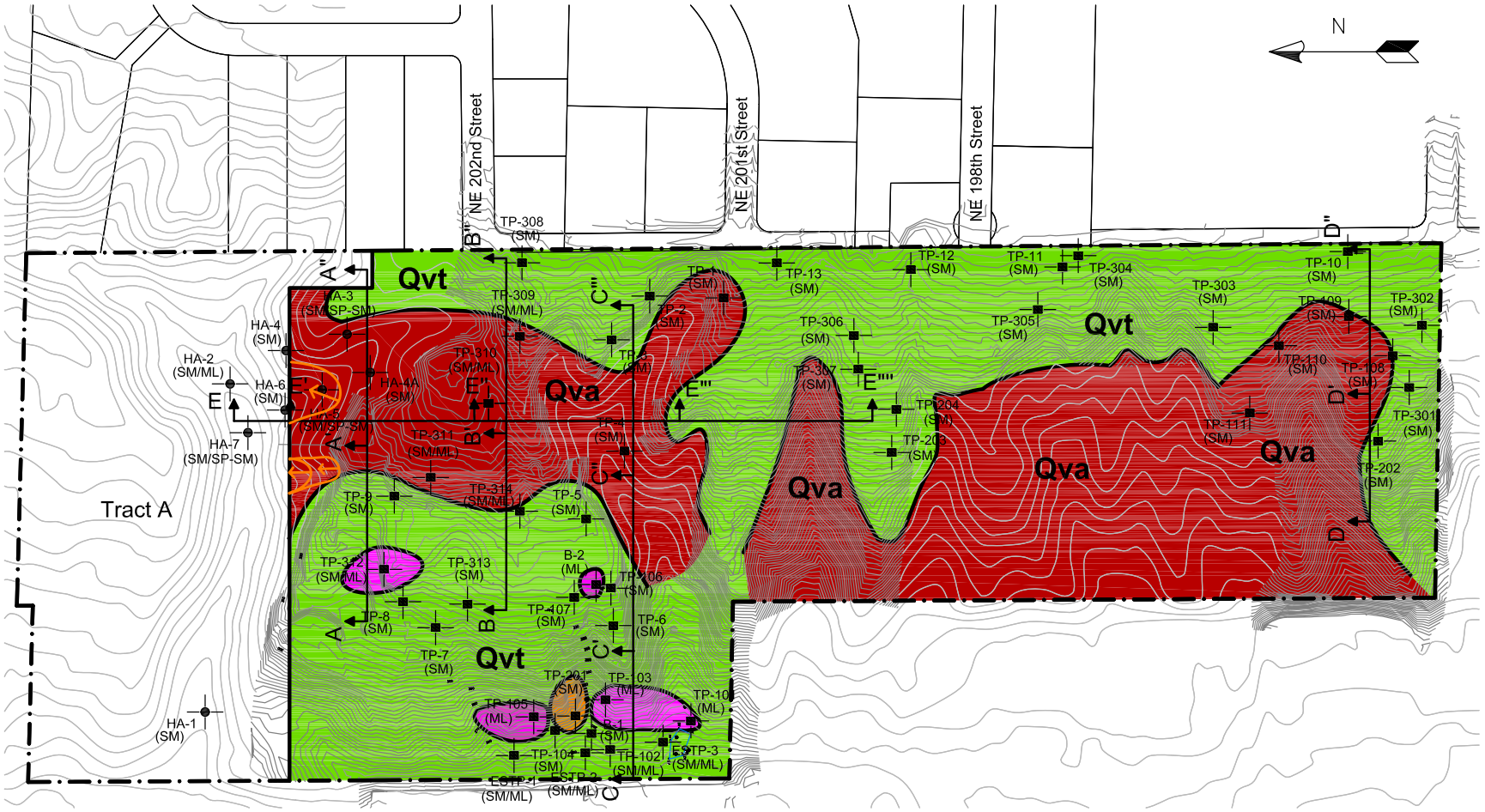

LEGEND

- Project boundary
- TP-1 — Number and approximate location of ECI Test Pit, July 2003
- TP-101 — Number and approximate location of ECI Test Pit, February 2004
- TP-201 — Number and approximate location of ECI Test Pit, April 2004
- TP-301 — Number and approximate location of ECI Test Pit, September 2004
- HA-1 — Number and approximate location of ESNW Hand Auger, June 2006
- Approximate location of landslide scarp
- ESTP-1 — Number and approximate location of ESNW Test Pit, June 2005
- B-1 — Number and approximate location of ECI Boring, January 2005
- A A' — Approximate location of cross-section
- Approximate geologic contact
- Approximate area of Sand - Recessional Outwash (Qvr)
- Approximate area of Silty Sand - Till (Qvt)
- Approximate area of Silty Sand - Advance Outwash - Local TIll Cover (Qva)
- Approximate area of Silt - Transitional (Qtu)

*The maps and cross-sections produced for this study are interpretations based on our review of the provided data. Our conclusions and interpretations should not be construed as a warranty of subsurface conditions.

0 200 400

Scale: 1 inch = 200 feet

Reference: Site Plan based on a topographic survey dated April 21, 2006, titled "Wood Trails," prepared by Triad Associates.

No.	Date	Revision	By	CK
1	8/16/06	Original	ACO	BD

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Wood Trails
Geologic Site Map

Project Number 409205

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Erosion Potential. The King County (1990) Sensitive Areas Map Folio identified a relatively large area, including the majority of the Wood Trails site and surrounding land as an Erosion Hazard Area, but did not identify the site as a Landslide Hazard Area. Likewise, Figure A13-3 in the City of Woodinville (2002) Comprehensive Plan shows an Erosion Hazard Area in the same location, which appears to be based on the earlier King County mapping. The area mapped by King County as an Erosion Hazard Area appears to be geographically consistent with the local extent of Alderwood soils. As discussed previously, the King County Soil Survey indicates that only the Alderwood Gravelly Sandy Loam soils on 15 to 30 percent slopes have an erosion hazard characterized as severe; Alderwood Gravelly Sandy Loam soils on 6 to 15 percent slopes, which occur in much of the upland portion of the Wood Trails site, have a moderate erosion hazard.

Seismic Potential. The City's map of identified critical areas (Figure A13-3, again) identifies a relatively extensive seismic area covering essentially the entire valley floor along the Sammamish River. The valley floor along Little Bear Creek is also identified as a seismic area, although this feature is much narrower. The WMC (21.24.290) defines seismic hazards as those areas subject to severe risk of damage as a result of earthquake-induced ground shaking, slope failure, settlement, surface rupture or soil liquefaction; it does not specify the physical site conditions that result in such a hazard. As is generally the case throughout the Puget Sound region, areas delineated as seismic hazards tend to be areas of fill and alluvial deposits on valley floors. The Wood Trails site does not have these characteristics and is not likely to have areas that would be considered seismic hazards.

Landslide Potential. The City's critical area map shows the locations of known landslide hazard areas, all of which are on steep slopes on the eastern and western sides of the Sammamish River Valley. The map does not identify any landslide hazard areas on or in the vicinity of the Wood Trails site; although a note on the map indicates it is a work in progress and does not include all critical areas in the City. As discussed in Section 3.4.2, the WMC identifies several types of conditions relating to slope, groundwater seepage and other physical characteristics that can constitute a landslide hazard condition. Under the WMC, all slopes of 40 percent or more are considered to be landslide hazards. As shown previously in Figure 3.1-1, multiple localized areas on the Wood Trails site have slopes exceeding 40 percent and meet the WMC criteria for identification of a landslide hazard. These areas are also indicated on the City's current (2006a) environmental impact map. The geologic map of the Bothell Quadrangle (Minard 1985) does not identify landslide deposits on the Wood Trails site or surrounding properties.

On-site investigations do not indicate a history or likelihood of substantial slope-instability on the Wood Trails site. The subsurface data obtained from the test sites and reconnaissance of the steep-slope areas indicates the overall stability of the site appears good. Only limited evidence of past slope instability exists. Two distinct areas within the site near the northern edge of the Wood Trails display evidence of historic landslides and should be considered marginally stable to unstable (indicated in Figure 3.1-2. The areas include a slump/earth flow which is a mass movement consisting of a single or multiple rotational slump and an ongoing surface slump, with local tension cracks and slump blocks, that appears related to the upper seepage zone shown in Figure 3.1-1a. From the approximate age of the vegetation noted within the area, the former slump appears at least 15 to 20 years old.

Historic Disturbance. Review of aerial photographs dating to 1936 (included in Appendix C to the Draft EIS) also did not reveal any evidence of significant past instability on the site, although they indicate there has been historical ground disturbance of the type that can initiate erosion and slope instability. Figure 2 in Appendix M shows the approximate areas of disturbance from grading on the site. Based on the photos, it appears that approximately 25 percent of the site was logged prior to 1936, including most of the southwestern quadrant and a rectangular-shaped area along the northwestern edge of the site. The 1936 photo also shows a previous dwelling and outbuildings in the latter cleared area. By 1968 those structures had been removed, although clearing and access road locations are still evident on the 1968 photo. A 1980 aerial photo indicates additional road development in the northeastern quadrant of the

property. On-site reconnaissance in 2006 confirmed evidence of past logging, including several old logging and/or access roads and paths that exhibit both cuts and fills.

Based on review of existing site conditions, the City's geotechnical consultant concluded that the effects of the past on-site disturbance have, in general, been relatively minor. Old access and logging roads were constructed across slopes and across the northerly drainage swales on the site. The historic disturbances are evidenced by road fills that have been washed away in places, concrete culverts that remain from an inadequately designed fill crossing of the stream in Tract A north of the Wood Trails site, and local cut/fill areas that show signs of backwasting. Fills and cuts for these roadways may have contributed to the scarp feature noted within the northeasterly portion of the property and off-site within Tract A. Cuts created within the former residence site appear to have intersected a seepage zone of the Advance Outwash above the Transitional Bed deposits. While these movements of surface materials are not severe or extensive, it may be appropriate to treat them through common stabilization techniques such as backsloping and erosion control within cut slopes, and removal and/or stabilization of fill slopes.

Because steeply-sloping ravines occur throughout much of the Wood Trails site, the risk for erosion and shallow debris flow activity is elevated compared to areas without these slope conditions. With the exception of localized areas along the lower portions of the ravines, however, areas of erosion or debris flow activity throughout the Wood Trails site were not observed. Any future seismically-induced slope failures on the site would likely be associated with shallow debris flow activity along the steep side slopes of the ravine areas. Due to the very dense glacial deposits underlying the site, as demonstrated by the subsurface conditions encountered at the test sites, there is a low susceptibility to large-scale, deep-seated slope movements at the site. This conclusion is supported by the current on-site observations and the evidence of historic ground disturbance. While disturbance from timber harvest and construction of roads and buildings is rather extensive on the site, evidence of erosion or slope failures associated with those disturbances is rather limited. If the slopes on the site were inherently unstable, it is reasonable to conclude that erosion and landslide activity from the historic disturbance would be much more extensive.

3.1.1.2 Montevallo

Topography

The topography of the Montevallo site slopes gently from east to west at gradients in the range of 5 to 10 percent. Elevations on the site range from approximately 430 feet in the western part of the property to 490 feet at the eastern edge, near 156th Avenue NE. Slope grades also decrease from the eastern part of the site to the western part, and the wetland at the western end of the property is a topographic low point. Steep slope areas are not present on the site.

Subsurface Conditions

Subsurface conditions at the Montevallo property were explored by excavating 13 test pits. The test pit logs for the Montevallo site are included in Appendices A and B of the Draft EIS. To a large degree, the geologic setting and soil characterization conditions for the Montevallo site are quite similar to those described previously for the Wood Trails site. Consequently, the EIS presents a highly abbreviated summary of the existing subsurface conditions for this site.

The referenced geologic maps of the Bothell area indicate the site is underlain by glacial till (Qvt) deposits. The native soils encountered at test pit locations are generally consistent with glacial till deposits. The Soil Survey of King County indicates the site is underlain by Alderwood gravelly sandy loam, with 6 to 15 percent slopes (AgC). As noted previously, the erosion hazard for these soils is described as moderate. Groundwater seepage is associated with relatively shallow perched zones. A relatively deep test excavation completed in the vicinity of the proposed storm water vault did not

encounter persistent or chronic groundwater seepage conditions. Soil conditions at depth are characterized as very dense.

Site Stability

The soils present on the Montevallo site have a moderate erosion hazard and no areas of the site would be classified as severe erosion hazard areas. Steep slope areas do not exist on the Montevallo site and none of the site would be classified as a landslide hazard area. The site does not contain valley-floor alluvial deposits that would indicate the possible existence of a seismic hazard. The overall stability of the site can be characterized as good from a geotechnical standpoint, and there are no impact or constructability issues associated with geologic hazards.

3.1.2 Impacts of the Proposed Action

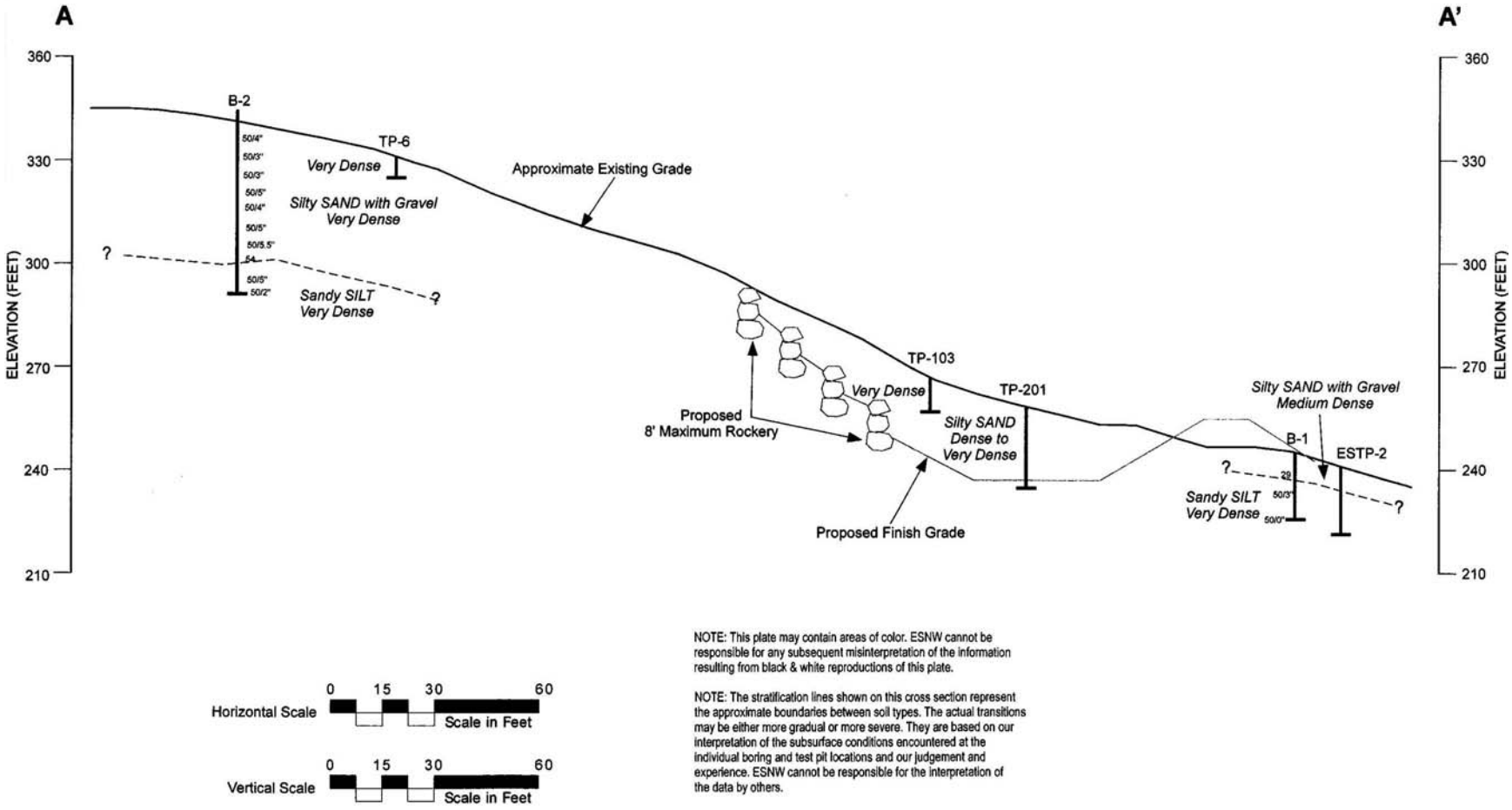
3.1.2.1 Wood Trails

Issues involving potential impacts to earth resources primarily include the risk of erosion resulting from surface disturbance during construction and the prospect that the proposed development could increase the long-term risk of slope instability. Slope stability issues relate both to modification of local terrain to accommodate the project and the effect that project drainage systems could have on local drainage patterns, given the soil and geologic characteristics that are present.

The 66 building lots and associated roadway areas would be established in three distinct clusters or pods, with the majority of the development along the relatively level and stable easterly portions of the property. The steep slope and ravine areas of the site would not be developed, and instead would be preserved as a Native Growth Protection Easement (NGPE). A stormwater detention pond would be established near the westerly margin of the property. Existing vegetation would be removed throughout the building lot, roadway, and detention pond areas of the site. Existing vegetation throughout the remainder of the site would be retained. Grade modifications would include cuts and fills throughout the roadway, building lot, and storm water detention pond areas. Engineered fills and retaining walls will be utilized, as appropriate, to achieve the grading objectives. Construction activity for the proposal would also include the extension of a sanitary sewer line from the industrial area along 144th Avenue NE to the developed portion of the Wood Trails site. This facility would require excavation of a trench, placement of an underground sewer pipe, backfilling around the pipe and restoration of the disturbed area, as described in Section 2.1.

Detention Pond Proposal. Excavation of the stormwater detention pond would require cuts on the order of 15 to 30 feet at some locations. The subsurface exploration performed throughout the detention pond area revealed very dense silty sand and silt soil conditions. The soils encountered at the test sites exhibited a high degree of soil strength, as evidenced by the Standard Penetration Test blow count data and by the observed resistance of the soils to excavation with a track-hoe. Earth impacts related to the stormwater detention pond excavation would primarily be associated with an increased potential for surface erosion along the face of the permanent cut slopes.

Permanent slopes for the proposed detention pond would be established at a 2H:1V (Horizontal:Vertical) ratio. The dense to very dense soil conditions encountered at the test pit and boring locations (see Figure 3.1-3, a cross-section through this area) support a conclusion that the permanent slopes may have good stability. Erosion susceptibility along the graded slopes would be elevated. Measures to limit erosion along the slopes above the pond include installation of erosion control mats, hydroseeding, or other appropriate permanent vegetation. With respect to long-term stability of the pond slopes, and in particular the wetted surfaces of the pond, stability and soil strength is expected to be good, provided appropriate methods for establishing vegetation and other appropriate erosion control measures are utilized.



NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

NOTE: The stratification lines shown on this cross section represent the approximate boundaries between soil types. The actual transitions may be either more gradual or more severe. They are based on our interpretation of the subsurface conditions encountered at the individual boring and test pit locations and our judgement and experience. ESNW cannot be responsible for the interpretation of the data by others.

Figure 3.1-3
Cross-Section, Wood Trails Site

Dispersion Trenches Proposal. Stormwater runoff from individual building lots throughout the southerly pod of the development would be accommodated with the use of dispersion trenches. Dispersion trenches are intended to accommodate a portion of the stormwater runoff through infiltration during rain events of limited duration. During extended periods of rainfall, runoff would be discharged from the dispersion trenches over a level spreader, which uniformly distributes the flow into a vegetated flow path and prevents a concentrated discharge of the flow. Stormwater discharged over the level spreader would infiltrate into the upper zones of the Alderwood soil deposits along the vegetated flow path. Provided the existing native vegetation is preserved along the proposed flow path, use of dispersion trenches is not expected to increase the erosion hazard, significantly change groundwater flow paths, or decrease the stability of the adjacent slope. Based on existing topography, the general trend of surface water runoff and groundwater flow is to the west and into the ravine areas. The dispersion systems would effectively reintroduce surface water along a path similar to the flow path that currently exists.

Limitations to Proposed Facilities. Although construction of utilities, storm drainage discharge systems and excavation of a detention pond on the steep slope and/or erosion hazard areas has been proposed by the applicant, the following select performance standards from WMC 21.24.310 are anticipated to be limitations to these construction activities in the erosion and possible landslide hazard areas. There are exceptions allowed for many of the standards (see complete standards in WMC 21.24.310), however, the data from the soils and geotechnical reports submitted for this EIS tend to support a more conservative approach to construction on the erosion hazard and steep slopes, with much less impact to the slopes. Without including the following, significant adverse impact could occur. The applicable WMC standards that would promote less impact are:

a. A minimum buffer of 50’ from the edge of the hazard area. Although this buffer could be reduced with acceptance of the City, the soil reports submitted would support maintaining these buffers at their required distance. Buffers also can be increased to prevent risk of damage. This will be considered at the time of site review, if the proposal is approved.
b. The development will not decrease slope stability on adjacent properties.
c. Structures and improvements shall minimize alterations to the natural contour of the slope
d. Structures and improvements shall be located to preserve the most critical portion of the site and its natural landforms and vegetation.
e. Removal of vegetation from an erosion hazard area or related buffer is prohibited.
f. Utilities lines and pipes shall be permitted in these hazard areas only when the applicant demonstrates that no other practical alternative exists. The line shall be located above ground and properly anchored and/or designed so that it will continue to function in the event of an underlying slide. Storm water conveyance shall only be allowed through a high-density polyethylene pipe with fuse welded joints or similar product approved by the Director.
g. Dispersed discharge upslope of the steep slope onto a low gradient undisturbed buffer only where it can be demonstrated that such discharge will not increase saturation of the slope.

In summary, storm water dispersion trenches, excavation of a detention pond and unnecessary utility construction are not anticipated to be approved. Possible alternatives include:

a. A narrow, long detention vault (possible above ground to act as a retaining wall) in place of the pond,
b. All stormwater conveyance via HDPE pipe (or equivalent), including piping in place of dispersion trenches,

c. Narrow trenches, construction during the dry season with special erosion and slide prevention techniques for utilities. Disturbed areas outside of the building and roadway footprint, including the easement area for the sanitary sewer extension, would be re-vegetated following construction.

In addition, as part mitigation proposed as part of the proposal, the applicant is required to prepare a Stormwater Pollution Prevention Plan (SWPPP) as a condition of obtaining a construction stormwater permit for the project. Because erosion issues primarily relate to the potential for pollution of surface waters with sediment and other contaminants, these issues are discussed in more detail in Section 3.2.2). A temporary erosion and sedimentation control plan (TESP), designed in accordance with City of Woodinville and Ecology standards, would be a key component of the SWPPP and would be employed during construction. This plan would be prepared in conjunction with the recommendations of the geotechnical reports, so that issues identified in the geotechnical investigation are addressed in the construction plans. Based on the applicable regulatory requirements, the SWPPP will include standard best management practices (BMPs) for minimization of erosion and control of runoff on construction sites.

Because BMPs are required during site development, short-term impacts to soils and the overall stability of the site should be negligible. Development of the building sites would not occur on the steep-slope areas of the site, and vegetation in these areas would be preserved. The relatively gentle slopes in most of the development area would naturally limit the potential for soil erosion on that portion of the site. In addition, the erosion hazard for the Alderwood soils that are predominant in the development area of the site is characterized as moderate. BMPs would be used to cover and stabilize soils exposed during construction, and to manage runoff and thereby minimize sediment transport.

3.1.2.2 Montevallo

Because surface gradients on the site are gentle, extensive cutting and filling to accommodate development would not be needed. As discussed previously for the Wood Trails site, standard BMPs would be identified in a project-specific erosion and sedimentation control plan, designed in accordance with City of Woodinville standards and required as a permit condition. These BMPs would be utilized during construction to control erosion from surface disturbance, and erosion impacts should be minimal.

The on-site wetland and required buffers would be protected as an NGPE. There are no steep-slope, erosion, landslide or seismic hazard areas located on the site, or in the area between the Wood Trails and Montevallo sites that would be crossed by the sanitary sewer extension. Subsurface conditions encountered on site and along the sewer line route would be managed through standard construction techniques. Areas disturbed during construction and not occupied by developed facilities would be re-vegetated to stabilize the surface. Based on the lack of geologic hazards or unusual subsurface conditions, the short-term and long-term impacts to earth resources associated with the proposed 66-lot Montevallo site are anticipated to be negligible.

3.1.3 Impacts of the Alternatives

3.1.3.1 R-1 Zoning Alternative

Wood Trails

Under the R-1 Zoning Alternative, the Wood Trails site would be developed with 23 residential building lots, compared to 66 lots for the Proposed Action. Consistent with the existing adjacent residential development, these building lots would utilize septic systems. WMC requires developments on lots less than one acre per unit must hook up to a sewer that is within 330 feet. Construction activities (vegetative

clearing, grading, site preparation, etc.) and their impacts would be essentially the same as described for the Proposed Action (except for the elimination of the sanitary sewer extension).

Concerns about construction on the steep and/or erosion hazard areas with regards to location and type of detention facility, placement of dispersion trenches, and installation of utilities would be the same as mentioned in the Proposed Action Section, "Limitations to the Proposed Facilities." In summary, proposed storm water dispersion trenches, excavation of a detention pond and unnecessary utility construction are not anticipated to be approved. Possible alternatives include:

a. A narrow, long detention vault (possible above ground to act as a retaining wall) in place of the pond,
b. All stormwater conveyance via HDPE pipe (or equivalent), including piping in place of dispersion trenches,
c. Narrow trenches, construction during the dry season with special erosion and slide prevention techniques for utilities. Disturbed areas outside of the building and roadway footprint, including the easement area for the sanitary sewer extension, would be re-vegetated following construction.

Because BMPs would be observed during the project development, surface erosion and impacts to the overall site stability are anticipated to be negligible, if a, b and c above are followed. Development of the building sites would not occur on the steep-slope areas of the site, and vegetation in these areas would be preserved. As discussed in Section 3.1.2.1, plans for site development would need to demonstrate compliance with the building setbacks and performance standards identified in the WMC. Based on this requirement, it is assumed that erosion and landslide hazards on the site would be avoided or sufficiently mitigated, and long-term impacts related to erosion and slope stability would be insignificant, again provided that a, b and c are followed.

The feasibility of utilizing septic systems on this site, and the potential long-term impacts from the septic systems, would need to be further evaluated if this alternative were implemented. The Alderwood soils throughout the planned development area consist primarily of medium dense to very dense silty sand deposits that exhibit varying degrees of cementing. In this respect, permeability of the soils would be considered low, and generally not conducive to the use of septic systems. Soil survey ratings classify the Alderwood soils found on the site as "very limited" for use in septic tank absorption fields, identifying slow water movement, depth to saturated zone and slope as limiting factors (Natural Resources Conservation Service [NRCS] 2006).

Montevallo

The R-1 Zoning Alternative at the Montevallo site would include development of 14 building lots. Impacts to earth resources on the Montevallo site are expected to be negligible under the R-1 Zoning Alternative. Because BMPs would be observed during the project development, surface erosion and impacts to the overall site stability are anticipated to be negligible. Similar to the Wood Trails site, the Alderwood soils throughout the planned development area consist primarily of medium dense to very dense silty sand deposits that exhibit varying degrees of cementing. In this respect, permeability of the soils would be considered low, and generally not conducive to development of drainfield systems. Again, the NRCS classifies these soils as "very limited" for septic system development. Seepage was observed at an elevation of approximately 434 and on the slope adjacent to the proposed detention vault. This seepage conveys necessary water to the wetland. Sections 3.2 and 3.3 address possible impacts to the wetland from removal of subsurface and surface water conveyed away from the wetland. Providing only some of the roof drain and lawn water from a number of the housing units is not practical and without control over these systems could ultimately dry-up the wetland.

3.1.3.2 Attached Housing Alternative

Wood Trails

The Attached Housing Alternative would include an 85-unit multi-family development consisting of several buildings and associated roadway areas on the Wood Trails site. Impacts would include the necessary removal of vegetative cover throughout the building sites, roadway areas and the sewer alignment, as described for the Proposed Action. The existing topography throughout the development areas would be modified, as necessary, to achieve the building design and roadway grades. Underground utilities and drainage facilities would be installed, as necessary, to support the development.

Overall, the extent of construction disturbance and developed facilities on the site would be less than for the Proposed Action and the R-1 Zoning Alternative. However, concerns still exist about construction on the steep and/or erosion hazard areas with regards to location and type of detention facility, placement of dispersion trenches, and installation of utilities. The same discussion provided in the Proposed Action and the R-1 Alternatives related to "limitations to the Proposed Facilities" also applies to this Alternative. In summary, proposed storm water dispersion trenches, excavation of a detention pond and unnecessary utility construction are not anticipated to be approved as proposed. See possible alternatives in the Proposed Action discussion.

Montevallo

With the Attached Housing Alternative at R-4 zoning, the Montevallo property would be developed with 47 single-family residential units. Impacts to earth resources at the Montevallo site under the Attached Housing Alternative would be slightly less than for the Proposed Action; however, the concerns for protection of the wetland still apply (See the Proposed Alternative discussion and Sections 3.2 and 3.3). Because BMPs would be constructed or observed during the project development, surface erosion and short-term impacts to the overall site stability are anticipated to be negligible. There are no geologic hazards present on the site, and no long-term impacts associated with erosion or slope stability are expected.

3.1.3.3 No Action Alternative

Under this alternative the applicant would not be permitted to undertake development action on the subject properties. There would be no alteration to the existing topography, vegetative cover, drainage patterns, or structural loading on the Wood Trails and Montevallo sites for the foreseeable future. Existing conditions with respect to soil and geologic characteristics would be expected to continue.

3.1.4 Secondary and Cumulative Impacts

Given the discussion in the impact sections above and the use of a detention vault rather than a pond, conveying stormwater via HDPE fuse-welded pipe down the slope rather than through dispersion trenches, and minimizing construction of utilities on the slopes would greatly reduce the potential for secondary and cumulative impacts; however, if the proposal develops as proposed there is a basis to expect that development activity on the Wood Trails site would result in indirect/secondary and potentially cumulative impacts to earth resources on adjacent or nearby sites. These possible impacts could include a slide or erosion event that would affect the properties below Wood Trails and potentially sediments flowing into Little Bear Creek.

Past and current development activity in the vicinity of the project sites has created modifications to the local topographic, slope stability and drainage conditions over a period of several decades. Notable recent developments in the vicinity have included construction of a large commercial retail facility on the west

side of the Woodinville-Snohomish Road near the SR 9/SR 522 interchange, and another development project on the east side of the Woodinville-Snohomish Road in that location has created noticeable modification of the slopes above the road. With respect to foreseeable future developments, planned widening of SR 9 north of SR 522 and construction of the Brightwater regional wastewater treatment plant in the same general area are the largest development actions that have been formally proposed. These planned projects are located some distance north of the Wood Trails and Montevallo project area and would not have wide-ranging impacts on earth resources.

Some type of development activity could be proposed for the vacant 11.8-acre parcel adjacent to the Wood Trails site on the north. Conditions on that parcel are similar to those in the northern part of the Wood Trails site, although the topography reflects more prominent drainages. Steep slopes on the parcel suggest the existence of possible landslide and erosion hazard areas that would need to be addressed through critical area review for any development proposal. There is also a small stream on the site and wetland habitat within part of the riparian corridor. Based on the constraints present, it is uncertain whether the site would be developed in the foreseeable future or what form that development might take. Given the size of the parcel and extensive area of steep slopes, any development on the parcel would clearly have a much smaller footprint than either subdivision included in the Proposed Action. If some form of development were to occur on the site, potential effects from the Wood Trails subdivision could create cumulative impacts in the area of the landslides.

Snohomish County (2005) recently proposed designation of a UGA (Urban Growth Area) Expansion Area with an Urban Industrial designation for the Wellington Hills Golf Course location, as part of its periodic update of the County's Comprehensive Plan. The Snohomish County Council subsequently voted to leave the current rural designation for the area in place, although this decision is subject to appeal. If Snohomish County did adopt a UGA designation in the future, it is conceivable that substantial development activity could occur in that location over the next 10 to 20 years. While intensive development on the golf course site would require road improvements and utility extensions, current development regulations would prevent such development from having major impacts on topography, erosion, slope stability and drainage conditions.

As indicated previously, earth resource impacts from the Wood Trails and Montevallo subdivisions would be minor and would be confined to the project sites. Considered within the context of earth resource impacts from other past, present and foreseeable future activities in the surrounding area, there is no basis to conclude that the proposed projects would contribute measurably to significant cumulative impacts to earth resources on a localized or regional basis.

3.1.5 Mitigation Measures

The primary potential impact to earth resources associated with all of the development alternatives is the potential for erosion resulting from surface disturbance. Controlling surface water runoff and maintaining existing vegetation outside the development areas and outside the steep/erosion prone slopes would help mitigate the erosion hazard during the construction period.

- Best Management Practices (BMPs) for erosion control would be implemented during the development of the sites, as they would be required as conditions of the construction stormwater permit for the project. Because these BMPs are oriented toward preventing pollution of surface waters, they are described in Section 3.2.5. The King County (1998) Surface Water Design Manual and similar guidance documents provide detailed descriptions of the many BMPs included in the menus of control measures and available for use on the sites. In summary, the key types of BMPs for erosion control include visibly defined clearing limits; cover measures, such as mulching to protect exposed earth surfaces; traffic area stabilization; and runoff and dust control.

- Permanent erosion control measures consisting of landscaping and drainage control facilities are incorporated into the development plans, as described in Section 2.1. The applicant will develop detailed plans for these measures during final design for the site development. These mitigation measures apply to the Proposed Action, the R-1 Zoning Alternative and the Attached Housing Alternative.
- It is unlikely that the construction of the detention pond, dispersion trenches and utility installation would be approved as proposed. Mitigation could not completely mitigate for the potential impacts, the following are required if the facilities are allowed:
    - A geotechnical engineer will be present on site at all when construction or activity is occurring on the slope.
    - Excavation for the stormwater detention pond would require cuts on the order of 15 to 30 feet at some locations. A series of tiered rockeries could serve to stabilize these slopes and prevent erosion along the face of the slopes;
    - Detailed site plans will need to demonstrate compliance with setback requirements and performance standards for these critical areas, as prescribed in the WMC. In response to the potential for slope instability in certain locations on the site, standard engineering measures for stabilization may need to be considered in those plans. Monitoring of erosion, slope stability and drainage conditions on the site, both during and after construction, may also be appropriate to ensure that geotechnical concerns are adequately addressed in site development.
- Complying with "limitations to proposed facilities" requirements listed in the impact section, would reduce the level of mitigation mentioned above. There would continue to be the need for a geologist during the utility installation and the construction of the detention vault. Stormwater conveyance is expected to be above ground with approved piping.

3.1.6 Significant Unavoidable Adverse Impacts

The primary significant unavoidable adverse impact to earth resources from any of the development alternatives would be related to the surface disturbance on erosion hazard areas and/or steep slopes. From a soil stability standpoint the following create significant adverse impacts:

- Installation of the proposed pond with horizontal encroachment into the hillside of more than 150' and a difference between the bottom of the proposed detention pond and the top of the sequence of rockeries of approximately 60'.
- Construction of the dispersion trenches
- Construction of utility trenches.

3.1.7 Compliance with policy, codes and regulations

A discussion of those areas of the development where the proposed action and the alternatives do not meet policy, codes and regulations can be found in Section 3.4.