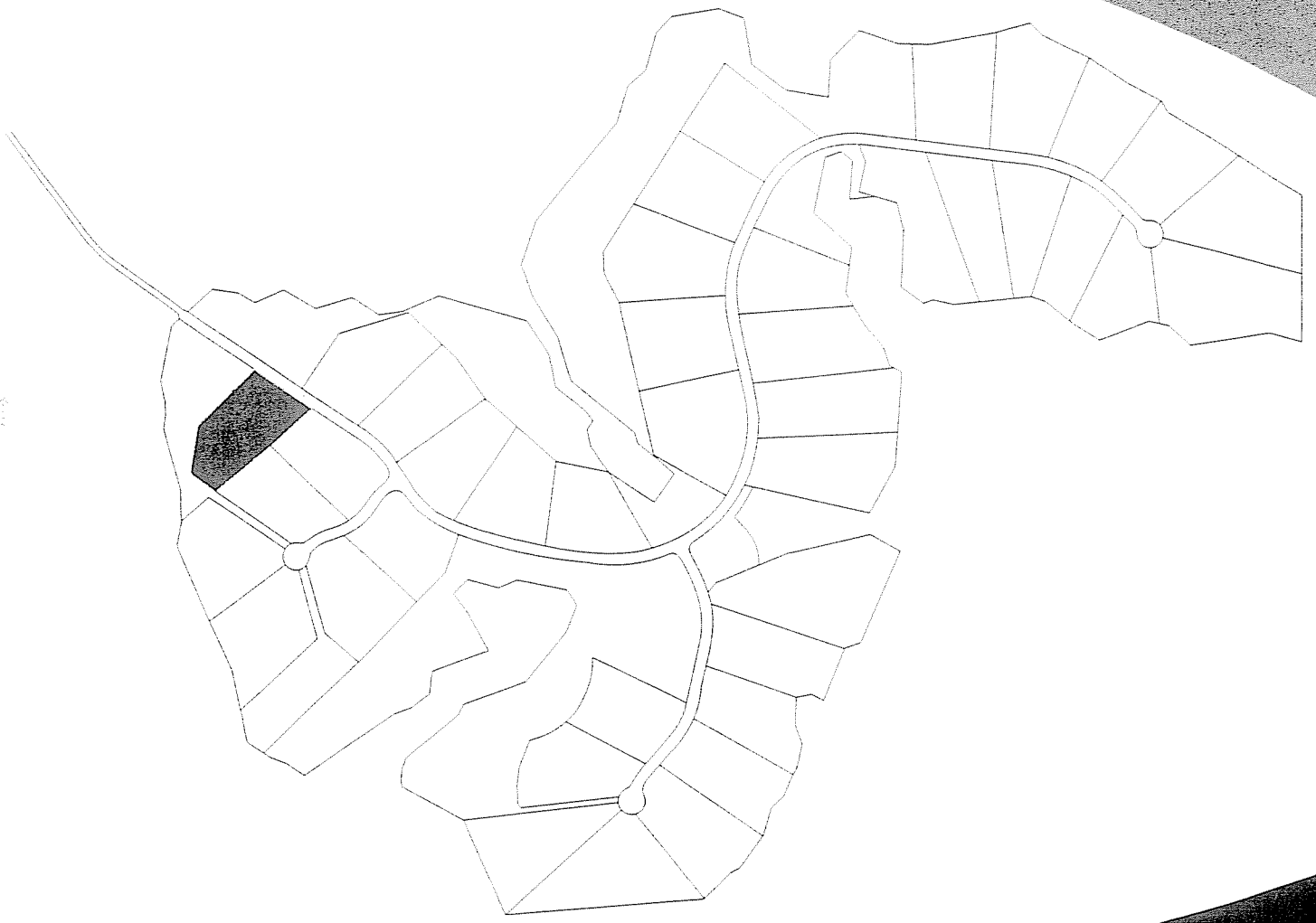
Preliminary Geotechnical Evaluation

The Grand Ridge Drive Neighborhood, Lot 1

ISSAQUAH HIGHLANDS



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August 15, 2005

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Report
Preliminary Geotechnical Evaluation
The Grand Ridge Drive Neighborhood,
Lot 1
Issaquah Highlands Project
Issaquah (King County), Washington
File No. 0125-011

INTRODUCTION

Icicle Creek Engineers, Inc. (ICE) is pleased to submit this report regarding our preliminary geotechnical evaluation for Lot 1 in The Grand Ridge Drive Neighborhood within the Issaquah Highlands project near Issaquah in King County, Washington. The purpose of our services was to provide a preliminary evaluation of the geologic and hydrogeologic site conditions as a basis for developing preliminary geotechnical recommendations for design and construction of a single family residence (SFR) on Lot 1. The location of The Grand Ridge Drive Neighborhood, including Lot 1, is shown relative to the Issaquah Highlands project site on the Vicinity Map, Figure 1.

PROJECT DESCRIPTION

Issaquah Highlands is a master-planned community under construction in Issaquah, Washington. The Grand Ridge Drive Neighborhood, which is in unincorporated King County, occupies the uppermost portion of Issaquah Highlands on the southeastern corner of the site. The Grand Ridge Drive Neighborhood is an irregularly-shaped parcel that measures approximately 3,500 feet by 4,500 feet overall and encompasses roughly 360 acres that is currently subdivided into 40 SFR lots. The Grand Ridge Drive Neighborhood is accessed off of NE Harrison Street South by a two-lane paved road currently referred to as "Road A." Two paved secondary roads currently referred to as "Road B" and "Road C" intersect with Road A to access other areas within The Grand Ridge Drive Neighborhood. The topographic plan and lot layout for this project is referenced as "Grand Ridge Drive Development Plan" by Concept Engineering, Inc. (Concept) dated August 20, 2004 (revised January 14, 2005).

Port Blakely Communities provided ICE with a layout for Lot 1 that included the property boundary, topography and the proposed building site as shown on the Site Plan, Figure 2. No specific building footprint or driveway alignment was known at the time that this report was prepared.

Although specific development plans have not been completed for the site, we understand that Lot 1 will be developed as a SFR. The SFR will likely be a two-story, wood-frame house with an attached garage and a concrete- or asphalt-surfaced driveway. The SFR may also include a daylight basement. The remainder of the lot will be open space. We expect that conventional spread footings will

be used to support the SFR. The bottom level of the SFR will be a joist-supported floor with a crawlspace below and/or a soil-supported concrete slab-on-grade floor.

SCOPE OF SERVICES

The purpose of our services was to explore subsurface conditions within the proposed building site area of Lot 1 in The Grand Ridge Drive Neighborhood as a basis for developing preliminary geotechnical recommendations associated with lot development. Specifically, our services included the following:

- Review available geologic information regarding the project site area.
- Conduct a geologic reconnaissance of the lot and adjacent areas.
- Explore subsurface soil and ground water conditions in the area of the proposed house by excavating one test pit using a track-mounted excavator.
- Evaluate King County Department of Development & Environmental Services (DDES) Critical Areas including Landslide, Coal Mine, Seismic, Steep Slope and Erosion Hazards, as appropriate.
- Provide preliminary recommendations for building setback and buffer width from Steep Slope Hazard areas, if appropriate.
- Provide seismic design criteria in general accordance with the 2003 International Building Code.
- Provide preliminary recommendations for foundation support including allowable soil bearing capacity and settlement estimates for shallow spread footings.
- Provide preliminary recommendations for floor slabs.
- Provide preliminary recommendations for general earthwork including overexcavation, subgrade preparation and evaluation, structural fill criteria, excavations and temporary cut slopes, subgrade protection and excavation dewatering.
- Provide lateral earth pressures and drainage recommendations for subgrade walls, as appropriate.
- Provide preliminary recommendations for reuse of on-site soils and bedrock as structural fill.
- Provide preliminary recommendations for site drainage and erosion control.
- Provide guidance for geotechnical plan review and construction observation, if needed.

REGULATORY CONSIDERATIONS

GENERAL

Based on our review of the King County Zoning Code Title 21A (March 2005) and the King County DDES regional mapping of Critical Areas (IMAP, www.metrokc.gov/gis/mapportal, 2005), the following Critical Areas are identified within portions of Lots 1 through 20 of The Grand Ridge Drive Neighborhood.

- Steep Slope Hazards (Lots 1 and 16 only)
- Erosion Hazards

According to the King County DDES regional mapping of Critical Areas, review of topographic information and site observations, Landslide, Coal Mine and Seismic Hazards do not exist within Lots 1 through 20 of The Grand Ridge Drive Neighborhood. Steep Slope and Erosion Hazards, along with buffers and setbacks, are described as follows:

STEEP SLOPE HAZARDS

King County Zoning Code Chapter 21A.06.1230 defines "Steep Slope Hazards" as follows: *"Those areas in King County on slopes 40 percent or steeper with a vertical elevation change of at least 10 feet. A slope is delineated by establishing its toe and top and is measured by averaging the inclination over at least 10 feet of vertical relief."*

Currently, King County Zoning Code Chapter 21A.24.310 requires a minimum buffer of 50 feet from the top, toe and along all sides of any slope 40 percent or steeper. The buffer may be reduced to 10 feet, if based on special study King County DDES determines that the reduction will adequately protect the proposed development and the Critical Area. The buffer may only be reduced to 25 feet in the case of Erosion Hazards. In addition to the buffer, a building setback of 15 feet is required from the edge of the steep slope buffer. Landscaping, uncovered decks, building overhangs (provided the overhang does not extend more than 18 inches into the buffer), driveways and patios are allowed within the building setback area.

The buffer and building setback requirement may not be required if *"slopes which are 40% or steeper with a vertical change of up to 20 feet if no adverse impact will result from the exemption based on King County's review of an concurrence with a soils report prepared by a geologist or geotechnical engineer."*

EROSION HAZARDS

King County Zoning Code Chapter 21A.06.415 defines "Erosion Hazards" as follows: *"Those areas in King County underlain by soils which are subject to severe erosion when disturbed. Such soils include, but are not limited to, those classified as having a severe to very severe erosion hazard according to the USDA Soil Conservation Service, the 1990 Snoqualmie Pass Area Soil Survey, the 1973 King County Soils Survey or any subsequent revisions or addition by or to these sources."*

Based on our review of King County Zoning Code Chapter 21A.24.220, Erosion Hazards may be developed. However, development within Erosion Hazards carries limitations or additional requirements with regard to seasonal grading restrictions, size of graded area, special erosion and sediment control measures, site restoration, and others. As previously described, if an Erosion Hazard (where the building is planned) exists adjacent to a Steep Slope Hazard, then the buffer from steep slopes may be reduced to a minimum of only 25 feet rather than 10 feet.

BUFFER

King County Zoning Code Chapter 21A.06.122 defines a "Buffer" as follows: *"A designated area contiguous to a steep slope or landslide hazard area intended to protect slope stability, attenuation of surface water flows and landslide hazards."*

SETBACK

King County Zoning Code Chapter 21A.06.1070 defines a "Setback" as follows: *"The minimum required distance between a structure and a specified line such as a lot, easement or buffer line that is required to remain free of structures."*

SITE CONDITIONS

GENERAL

Our geologic reconnaissance of Lot 1 was completed on June 1, 2005. Subsurface conditions at Lot 1 were explored by excavating one test pit (Test Pit TP-7) to depth of 6.5 feet on June 1, 2005. The test pit was excavated by KLB Construction, Inc. using a track-mounted CAT 315 excavator. The approximate test pit location is shown on Figure 2. The test pit was logged by an engineering geologist from ICE, who described the soils in general accordance with the classification system presented on Figure 3. The test pit log is presented on Figure 4.

In addition, ICE reviewed the following documents containing pertinent surface and subsurface information in The Grand Ridge Drive Neighborhood area:

- Associated Earth Sciences, Inc. (AESI), August 1998, "Issaquah Highlands Development (SE Rural Roadway), Issaquah, Washington," prepared for Port Blakely Communities, 23 pages.
- Icicle Creek Engineers, Inc. June 20, 2002, "Report, Geological Engineering Services, Bedrock Excavation, Issaquah Highlands SE Rural Area, Access Roads and Detention Ponds, Issaquah, Washington," prepared for Port Blakely Communities, 3 pages.

GEOLOGIC SETTING

The near-surface geologic units in the site area were identified based on published geologic information, field reconnaissance and a test pit completed as part of this study. The most recent regional geologic mapping in the site area was conducted by the U.S. Geological Survey (Booth, D.B. and Minard, J.P., 1992, "Geologic Map of the Issaquah 7.5' Quadrangle, King County, Washington," Miscellaneous Field Studies, Map MF-2206, scale 1 inch = 2,000 feet). Based on our review of the regional geologic mapping, the near-surface deposits at The Grand Ridge Drive Neighborhood consist of glacial till and Tukwila formation bedrock.

Glacial till is generally a dense to very dense mixture of silt, sand, gravel and cobbles that was deposited directly by an ice sheet that covered the area approximately 10,000 to 13,000 years ago. The silt (or fines) content is typically 15 to 40 percent by weight. The permeability of glacial till is usually very low, typically less than 0.000001 centimeters per second (cm/sec), but may be higher depending on the silt content.

Tukwila formation bedrock includes several different types of volcanic rock including andesitic lava flows, pyroclastic flows, lithified lahars, and volcanic tuff, all of which were likely formed about 25 million years ago during the Tertiary period. The most prevalent bedrock type appears to be massive andesitic basalt that exhibits varying degrees of weathering, from fresh (a hard, rock-like texture) to highly weathered (a soft, soil-like texture). Claystone and siltstone layers and localized pockets of volcanic ash have also been encountered within the bedrock at scattered locations. The Tukwila formation bedrock has been further classified by ICE based on the degree of weathering as follows:

- Tv1 - Highly weathered; primarily soil-like texture, with some rock texture; highly fractured and jointed; easy to excavate.
- Tv2 - Moderately weathered; blocky texture; can be fractured and jointed; some slickensides present; moderately difficult to excavate.
- Tv3 - Fresh; massive texture; minor fracturing and jointing; some slickensides present; very difficult, or impossible, to excavate. May require blasting or mechanical splitting to loosen.

Post-glacial weathering of the native soils has resulted in a zone of weathered soils that overlie the glacial till or bedrock. The weathered soils typically consist of loose to medium dense silty sand with variable amounts of gravel, cobbles and rock fragments. The permeability of weathered soil is usually moderate, typically more than 0.001 cm/sec, but may be higher or lower depending on the silt content and the degree of weathering.

SURFACE CONDITIONS

Lot 1 is located in the west portion of The Grand Ridge Drive Neighborhood along the south side of Road A as shown on Figures 1 and 2. Lot 1 is bordered to the northwest and west by a wetland and forest land, to the northeast by Road A and to the southeast by undeveloped Lots 2 and 3.

The ground surface on Lot 1 slopes moderately steeply down at about a 15 to 30 percent grade from about Elevation 1,110 at the east property corner to about Elevation 1,030 feet along the west property line. The proposed building site slopes at about a 20 percent grade down to the west. A road cut occurs along the east portion of the north property line that is inclined about a 40 to 50 percent grade and is up to 16 feet high.

Lot 1 is forested with mature, second-growth coniferous and deciduous trees with a moderately dense understory of brush. Recent modifications to the lot include removal of trees and brush in the building site area. The exposed ground surface in the building site area has been revegetated with grass.

No surface water, including springs and seepage, was observed on Lot 1 at the time of our site reconnaissance.

Based on the King County DDES regional mapping of Critical Areas, review of topographic information and observations, Lot 1 is entirely within an Erosion Hazard area, and a Steep Slope Hazard area occurs along the east portion of the north property line as shown on Figure 2. The building site on Lot 1 is located within an Erosion Hazard area.

SUBSURFACE CONDITIONS

Test Pit TP-7 encountered about 1 foot of topsoil consisting of soft silt with abundant organic matter and roots underlain by weathered glacial till consisting of loose to medium dense silty sand with gravel, cobbles and rock fragments to a depth of about 2.5 feet. Underlying the weathered glacial till, Test Pit TP-7 encountered unweathered glacial till consisting of dense silty sand with gravel, cobbles and rock fragments to a depth of about 4.5 feet underlain by Tukwila formation bedrock to the completion depth of the test pit at about 6.5 feet where digging refusal was encountered. The Tukwila formation bedrock observed in the test pit consisted of slightly weathered volcanic breccia (Tv3).

GROUND WATER CONDITIONS

At the time of our test pit excavation on June 1, 2005, Test Pit TP-7 did not encounter ground water. However, we expect that some ground water seepage could occur seasonally within the near-surface weathered soils and/or in topographic low areas in response to season, precipitation and other factors.

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

In our opinion, based on available information regarding site conditions, the proposed development of Lot 1 in The Grand Ridge Drive Neighborhood appears feasible from a geotechnical standpoint, provided that the geotechnical design and construction recommendations presented in this report are incorporated into the project.

CRITICAL AREAS

General

As previously mentioned, no Landslide, Coal Mine or Seismic Hazards exist within Lot 1. Steep Slope and Erosion Hazards occur within Lot 1 as shown on Figure 2.

Steep Slope Hazards

A Steep Slope Hazard area occurs in the northeast portion of Lot 1 as shown on Figure 2. In our opinion, no buffer or building setback is required from this Steep Slope Hazard area that is less than 20

feet high. However, foundations should extend to an elevation below a 1H:1V (horizontal to vertical) line projected up from the base of the steep slope (road cut).

Erosion Hazards

The building site is located within an Erosion Hazard area. Erosion and sedimentation potential during construction and operation of the project can be reduced to an insignificant environmental impact if an erosion and sediment control plan is done as would normally be required. The principal factors of effective erosion and sediment control are the prevention of concentrated surface runoff and the protection of the disturbed or exposed ground surface by reestablishing vegetation. Erosion and sediment control practices and methods appropriate for this project include the following:

- Coordination of clearing, excavation and revegetation to reduce the exposure time and area.
- Control of surface water originating on site or flowing through the construction area.
- Covering exposed soil or soil stockpiles.
- Use of silt fences, straw bale filters, and temporary sedimentation ponds.
- Topsoil preservation.
- Hydroseeding - revegetation.
- Rock or grass-lined ditches.
- Water diversions on slopes.
- Rerouting existing drainage in pipes around the construction area.

SEISMIC CONSIDERATIONS

Based on our review of subsurface exploration data and our understanding of near-surface geology at Issaquah Highlands and The Grand Ridge Drive Neighborhood, we interpret the native soil and bedrock conditions to correspond with a seismic Site Class C, as defined by the 2003 *International Building Code* (IBC). This classification pertains to any combination of dense soil and soft rock.

SITE PREPARATION

Temporary Erosion and Sedimentation Control Measures

Near-surface soils in the building site area and other areas of the site have a high potential for erosion, especially when disturbed by construction activities. Temporary erosion control measures should be installed prior to construction to control surface water runoff and manage sedimentation such as silt fences, straw bales, and other measures as required by King County.

Clearing, Stripping and Grubbing

We recommend that the areas where the house, driveway and other improvements will be built be stripped of vegetation and topsoil and that these materials be removed from the site. Tree stumps, and roots over 1 inch in diameter should be grubbed and removed from these areas.

Subgrade Evaluation

After clearing, stripping and grubbing are complete, the exposed surface should be proofrolled or probed. Proofrolling should be done using a heavily-loaded rubber-tired vehicle such as a fully-loaded dump truck. Proofrolling should only be done in dry weather. If site preparation is done during wet weather small track-mounted equipment should be used to complete the stripping, clearing and grubbing and the exposed soils should be probed. Soft areas identified during proofrolling or probing on the

ground surface should be overexcavated and replaced with compacted structural fill as described in the following section.

EARTHWORK

Structural Fill

Fill placed in the house and driveway areas and other areas where improvements require structural support should be placed as compacted structural fill. Structural fill should be free of debris, organic matter and rock fragments larger than about one-half the loose lift thickness or about 4 to 5 inches. The suitability of soil for use as structural fill will depend on the gradation and moisture content. As the amount of fines increases, the soil becomes more sensitive to small changes in moisture content and adequate compaction becomes more difficult to achieve.

Structural fill should be placed in horizontal lifts and compacted to a uniform density. Fill placed in the area of the house and other supported structures and within 2 feet below driveway subgrade elevation should be compacted to at least 95 percent of the maximum dry density (MDD) obtained in general accordance with ASTM Test Method D 1557. Fill placed more than 2 feet below the driveway subgrade should be compacted to at least 90 percent of MDD. The lift thickness will depend on the soil type and gradation, the type of compaction equipment used and other factors. We anticipate that lift thicknesses will be on the order of 8 to 10 inches in loose thickness. Each lift should be conditioned to the proper moisture content and compacted to the required density.

Structural fill placed to raise site grades in areas where the ground surface is sloped more steeply than 4H:1V should be benched and keyed into the existing slope. The faces of newly constructed slopes should be compacted by running compaction equipment directly on the face of the slope or by overbuilding the slope by several feet and cutting back the face.

Use of On-Site Soil and Rock

General. According to our site surface and subsurface observations and published geologic information, the majority of the soils and weathered bedrock underlying Lot 1 and The Grand Ridge Drive Neighborhood in general are highly moisture-sensitive and susceptible to disturbance when wet. In order to use on-site soils and weathered bedrock as structural fill, earthwork must occur in periods of dry weather. We offer the following evaluation of these on-site soil and rock materials in relation to potential use as structural fill.

Glacial Till. The native glacial till soils mantling the lot have a high silt content and are, therefore, moisture sensitive. Based on visual estimates of moisture content, the glacial till will only be suitable if it is moisture conditioned prior to compaction. This is usually done by aerating the soils in sunny, warm weather conditions. The glacial till will be difficult to impossible to use as structural fill during wet weather.

Tukwila Formation Bedrock. Tukwila formation bedrock underlying Lot 1 may partially disintegrate when exposed to air, water and mechanical action from earthwork activities. Therefore, we recommend that bedrock not be used as structural fill where the fill would be less than 2 feet below foundations, on-grade slabs or other elements requiring firm support. Bedrock used as structural fill should be crushed so that the particles are less than one-half of the loose lift thickness for structural fill. We estimate that the maximum particle size will be on the order of 4 to 5 inches.

Volcanic Ash (if encountered). Volcanic ash was not observed in Test Pit TP-7. However, it is possible that localized layers of volcanic ash may be encountered in on-site excavations. We recommend that spoils consisting of volcanic ash be placed in landscape areas or removed from the site.

Imported Soils

Based on our evaluation, the on-site soils will not be suitable for use as structural fill unless the prevailing weather is warm and dry. Imported soils for use as structural fill should consist of granular soils with a maximum of 15 percent of fines (particles passing the U.S. Standard No. 200 sieve) by weight of the ¾-inch diameter minus material. In wet weather, imported soils should consist of sand and gravel with a maximum of 5 percent fines by weight of the minus ¾-inch diameter material in order to achieve the required compaction criteria.

EXCAVATIONS AND TEMPORARY CUT SLOPES

We recommend that the inclination of temporary cut slopes be selected to reduce the potential for sloughing, raveling, and/or collapse. Soil and/or bedrock may be exposed in on-site cuts and excavations. We recommend using the following maximum cut slope inclinations.

Exposed Material	Maximum Inclination
Weathered Glacial Till and Highly Weathered Bedrock (Tv1)	1.5H:1V
Unweathered Glacial Till and Moderately Weathered Bedrock (Tv2)	1H:1V
Slightly Weathered Bedrock (Tv3)	0.5H:1V

However, appropriate inclinations will ultimately depend on the actual soil and water conditions exposed during earthwork. Temporary excavations, including temporary shoring should be the responsibility of the contractor who is on site continuously to monitor the conditions. Temporary slopes and shoring should conform to applicable local, state and federal safety standards.

The near-surface bedrock may be in a slightly weathered state. It will be difficult to impossible to excavate slightly weathered Tukwila formation bedrock using conventional excavation equipment. It may be necessary to use blasting or mechanical splitting to remove the bedrock in some excavations.

SUBGRADE PROTECTION AND EXCAVATION DEWATERING

The contractor should be prepared to install temporary drainage measures to reduce the potential for flowing and/or ponding water in earthwork areas if wet weather is anticipated. In addition, foot traffic and vehicular traffic on prepared subgrades should be minimized to reduce the potential for disturbance to the exposed moisture-sensitive soils.

Test Pit TP-7 did not encounter ground water. However, we anticipate that a perched ground water condition could develop along the weathered/unweathered glacial till contact; the glacial till/bedrock contact; or in localized zones within these units. If ground water seepage is encountered in site excavations (such as for footings or underground utilities), we anticipate that an internal system of ditches, sump holes, and pumps will be adequate to temporarily dewater the excavations.

FOUNDATION SUPPORT

Allowable Bearing Capacity

The SFR may be supported using conventional reinforced concrete spread footings. We recommend that footings be founded on native glacial till in a medium dense or denser condition or on