bedrock. Alternatively, the footings may be supported on a pad of structural fill compacted to at least 95 percent of MDD that extends down to native glacial till that is in a medium dense or denser condition or to bedrock. Structural fill placed below foundation subgrades should extend laterally beyond the footing edges a horizontal distance at least equal to the thickness of the structural fill in all directions.

We recommend using the allowable bearing capacities presented in the following table for footing design. These values apply to the total of all dead plus long-term live loads, exclusive of the weight of the footing and overlying backfill and include a factor of safety of at least 2.0. These values may be increased by one-third when considering transient loads such as wind or seismic loads.

Footing Subgrade Material	Allowable Soil Bearing Capacity (psf)*
Weathered Glacial Till or Highly Weathered Bedrock (Tv1) (medium dense or denser)	2,000
Unweathered Glacial Till, Moderately Weathered Bedrock (Tv2) or Structural Fill	2,500
Slightly Weathered Bedrock (Tv3)	6,000

* psf = pounds per square foot

We suggest using 2,500 psf for preliminary design purposes. We recommend against using the weathered glacial till or highly weathered bedrock for foundation support.

Footing Size and Embedment Requirements

Exterior and interior footings should be embedded at least 18 and 12 inches deep, respectively. We recommend minimum footing widths of 15 inches for continuous wall footings and 18 inches for isolated column footings.

Overexcavation Depths

In the event that any localized zones of volcanic ash or loose highly weathered bedrock are encountered below structures, the affected subgrade areas should be overexcavated and replaced with structural fill. We specifically recommend the following overexcavation depths for various types of structures that will or might be built on site:

Structure Type	Overexcavation Depth (for ash or loose highly weathered bedrock - inches)
House Footing	36
Slab-on-Grade Floor	24
Landscape Wall	24
Driveway	18
Deck Support	18
Sidewalk	18
Patio Slab	12

Construction Considerations

The native soils are moisture-sensitive and although relatively strong in an undisturbed state, they should be expected to soften easily when exposed to moisture and foot or equipment traffic. During wet weather it may be necessary to protect footing excavations from disturbance by placing a thin layer of crushed rock or lean mix concrete.

Settlement

Settlements of footings, total and differential, supported on medium dense or denser native soil in a relatively undisturbed state, structural fill placed and compacted according to our recommendations or bedrock are expected to be ½ inch or less. Settlements will occur rapidly as loads are applied.

FLOOR SLABS

Floor Slab Support and Settlement

Floor slabs can be supported on-grade provided that slab subgrade areas are prepared as recommended in the **SITE PREPARATION** and **EARTHWORK** sections of this report. We estimate that settlement of floor slabs will be on the order of ½ inch or less. Settlements are expected to occur rapidly as loads are applied.

Capillary Break and Vapor Control

A layer of gravel at least 4 inches thick containing less than 3 percent fines by weight should be placed on the slab subgrade to provide uniform support and a capillary break beneath the slab. A vapor retarder is also recommended where moisture control in the slab is critical where floor finishes such as vinyl, tile and/or carpeting may be applied to the slab. The vapor retarder should consist of polyethylene sheeting directly under the slab. A layer of clean fine to medium sand, not more than 2-inches thick, may be placed over the polyethylene sheeting to protect it from damage during slab construction.

SUBGRADE WALLS

Lateral Pressures on Subgrade Walls

Retaining walls will likely be required for design and construction of an SFR on this site. Lateral pressures on retaining walls depend on the type, density and configuration of soil behind the wall and the amount of lateral movement that can occur as backfill is placed. Walls that are restrained from rotation (such as by floor/ceiling joists) during the backfilling operation should be designed to resist at-rest earth pressures. Retaining walls that are free to move laterally at the top of the wall at least a distance equal to one-one-thousandth of the height of the wall during backfilling may be designed for active earth pressure conditions. Design lateral earth pressures expressed as equivalent fluid densities in pounds per cubic foot (pcf) for at-rest and active earth pressure conditions are provided in the following table for three different ground surface conditions behind the wall; level ground, a 4H:1V (horizontal to vertical) slope and a 2H:1V slope behind the wall.

Wall Restraint Condition During Backfilling	Ground Surface Slope Behind the Wall	Design Lateral Pressure (pcf)
Wall is free to move at the top (active earth pressure)	Level	35
	4H:1V	55
	2H:1V	75
Wall is restrained at the top (at-rest earth pressure)	Level	55
	4H:1V	65
	2H:1V	80

The design lateral pressures presented are appropriate when the backfill behind the wall is drained. Drainage behind the wall should be provided by placing a zone of well-graded free-draining sand, or sand and gravel against the wall. The backfill should contain no more than 5 percent fines by weight of the material passing the ¾-inch sieve. Clean drainage material such as pea gravel may be placed against the wall provided that a nonwoven geotextile fabric such as Mirafi 140N or other nonwoven geotextile fabric with similar drainage properties is placed between the clean drainage material and structural fill or native soils. The nonwoven geotextile fabric should extend the full height of the clean drainage material and cover the top of the drainage material.

The drainage zone should be at least 18 inches wide. A perforated drainpipe with a diameter of at least 4 inches should be embedded within the drainage material at the base of the wall along its full length. The drainpipe should be sloped to drain to tightlines leading to an appropriate collection and disposal system.

Backfill behind retaining walls should be compacted to meet the appropriate compaction criterion for support of adjacent structures or driveways where appropriate. In other locations, the backfill should be compacted to between 90 and 92 percent of the MDD. Measures should be taken to avoid buildup of excess lateral soil pressures due to overcompaction of backfill behind the wall.

Lateral Resistance

Lateral pressures acting on below-grade retaining walls can be resisted by friction on the base of footings and passive resistance on the face of footings and embedded portions of the retaining wall neglecting the top 2 feet of embedment. We recommend using the following allowable values for base friction and passive resistance in the following table to resist lateral loads acting on retaining walls.

Source of Resistance	Ground Surface Slope in Front of the Wall	Resistance (pcf)
Passive Earth Pressure	Level	300
	4H:1V	175
	2H:1V	100
Base Friction	All cases	0.4

The values for passive resistance and the coefficient of base friction include a factor of safety of about 1.5. These values may be increased by one-third when considering transient loads such as wind loads and seismic loads.

PERMANENT DRAINAGE RECOMMENDATIONS

Footing drains should be provided around the perimeter of the SFR. These drains should consist of a minimum 4-inch diameter, rigid, perforated drainpipe located outside of the perimeter footings at or near the bottom elevation of the footings. The perforated drainpipe should be embedded in a zone of coarse sand and gravel containing less than 3 percent fines and sloped to drain to a tightline system. The drainpipe should be connected to a tightline system at appropriate intervals so that water backup does not occur.

We recommend that the ground surface be sloped away from the SFR to promote drainage away from the foundations. We recommend that roof drains be discharged using splash blocks or dispersion systems design in accordance with the 1998 King County Surface Water Design Manual. Downspout drains must be independent from the footing drains.

Appropriate surface swales, drainage ditches and other facilities should be installed to collect and manage surface runoff.

PLANS REVIEW AND CONSTRUCTION OBSERVATION

Review of the geotechnical aspects of the project plans and requirements for geotechnical construction observation should meet all of the requirements of King County that are applicable to this development. If earthwork and foundation construction are undertaken during wet weather, we recommend that ICE be contacted to provide recommendations regarding appropriate levels of construction observation.

USE OF THIS REPORT

We have prepared this report for use by Port Blakely Communities to provide preliminary geotechnical recommendations for design and construction of a single family residence on Lot 1 within The Grand Ridge Drive Neighborhood at Issaquah Highlands. Observations, conclusions and recommendations contained in this report are not applicable to other sites or projects. The data and report should be provided to prospective buyers or contractors for planning, bidding, or estimating purposes. However, our reported conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

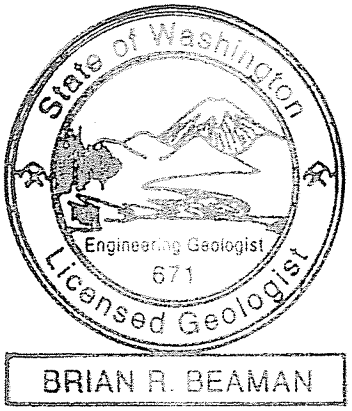
Subsurface conditions can vary significantly between our explorations and can also vary with time. For this reason, a contingency for unexpected conditions should be included in the construction budget and schedule. Sufficient monitoring, testing and consultation by our firm should be provided during construction to evaluate whether the conditions encountered are consistent with those indicated by our explorations, to provide recommendations for design changes should the conditions revealed during construction differ from those anticipated, and to evaluate whether or not earthwork and foundation installation activities comply with contract plans and specifications.

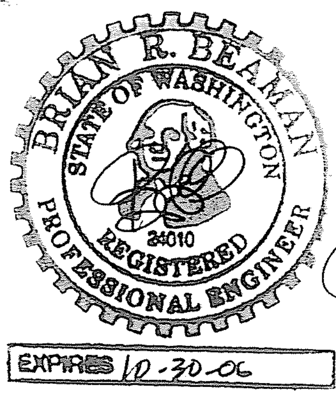
Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in this area at the time the report was prepared. No warranty or other conditions, either express or implied, should be inferred.

****

We appreciate the opportunity to be of service on this project. If you have questions regarding this report or any aspects of the project, please contact us.

Yours very truly,
Icicle Creek Engineers, Inc.





Gary D. Beckham, L.E.G.
Senior Engineering Geologist

Brian R. Beaman, P.E., L.G.
Principal Engineer

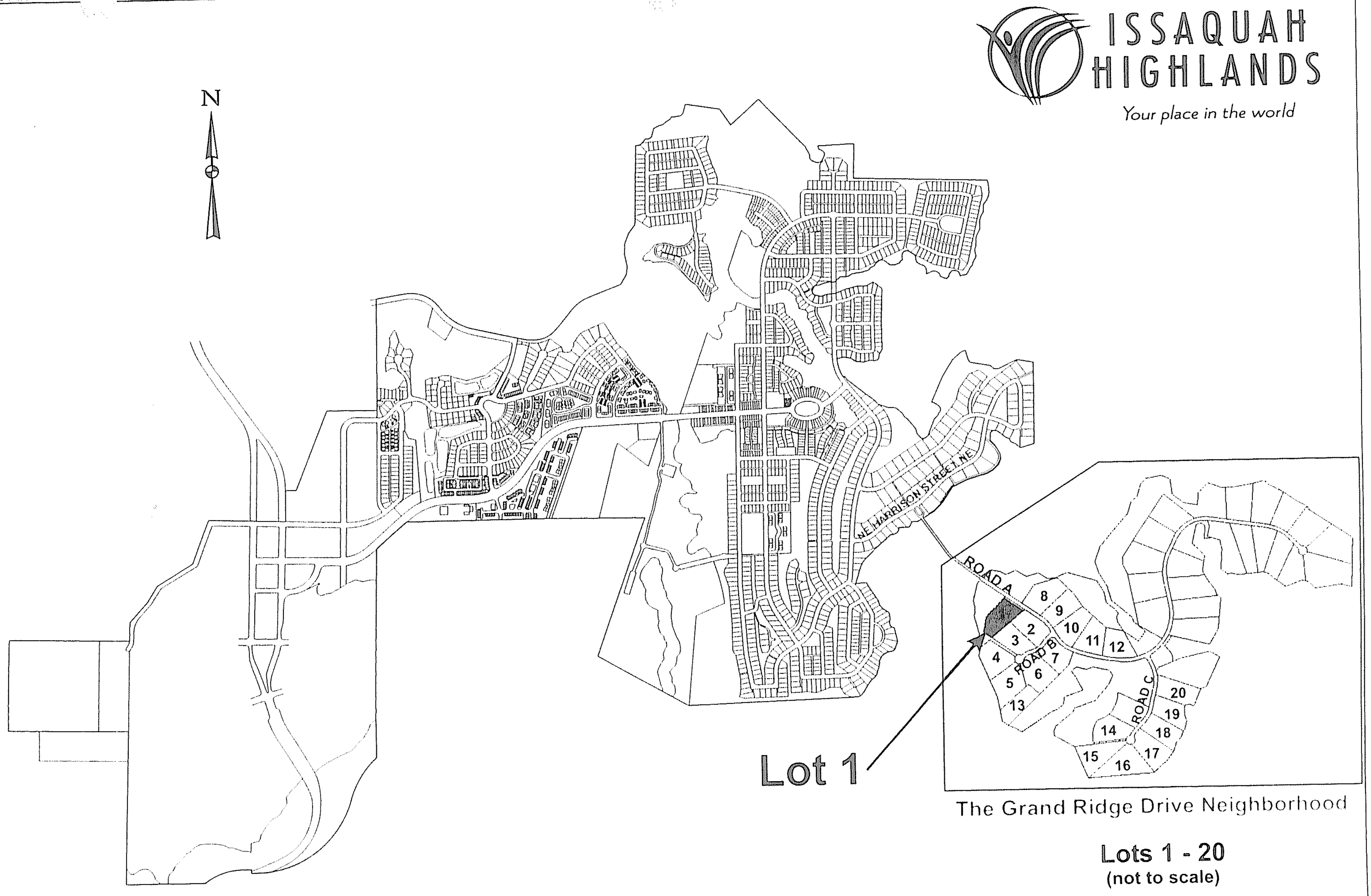
Document ID: 0125011.GrandRidgeDrive.Lot01report.doc

Four copies submitted

Attachments: Figure 1 – Vicinity Map
Figure 2 – Site Plan
Figure 3 – Explanation for Test Pit Log
Figure 4 – Test Pit Log

ICE File No. 012- -1

BRB:06/15/05



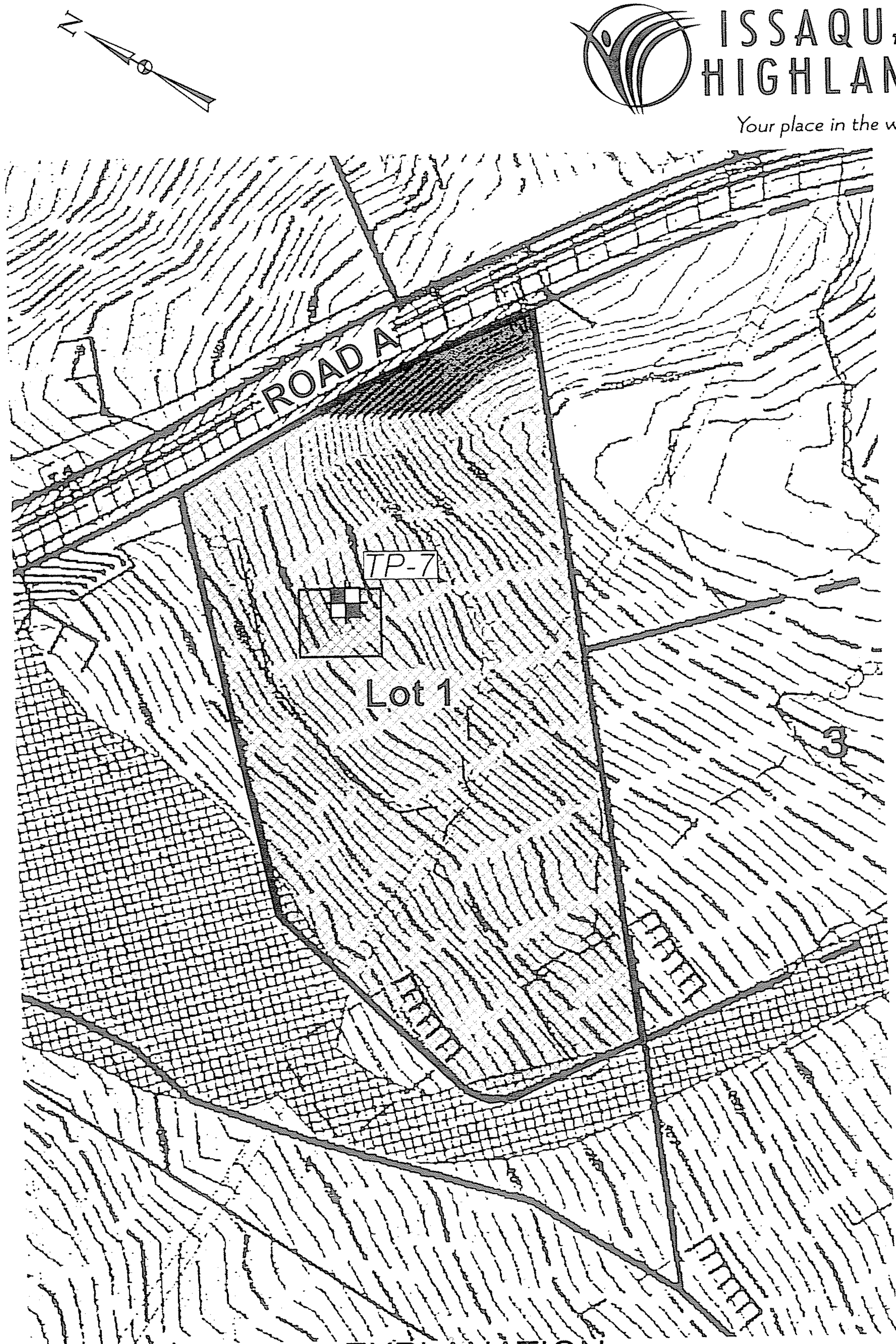
Vicinity Map - Figure 1

Icicle Creek Engineers

BRB:06/15/05

ISSAQUAH HIGHLANDS

Your place in the world



EXPLANATION

Notes: 1) Base map titled "Grand Ridge Drive Development Plan" by Concept Engineering, Inc. dated August 20, 2004 (revised January 14, 2005).
2) Erosion Hazards based on regional mapping by King County Department of Development and Environmental Services; modified by Icicle Creek Engineers based on updated topographic data.

TP-7 Test Pit Location

Building Site

Erosion Hazard

Steep Slope Hazard

0 100 200

Scale in Feet

ICE File No. 012

Icicle Creek Engineers

Site Plan - Figure 2

CLIENT Port Blakely Communities
PROJECT NUMBER 0125-011
PROJECT NAME The Grand Ridge Drive Neighborhood
PROJECT LOCATION Issaquah Highlands

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			SYMBOLS	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
			GP	POORLY GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	MORE THAN 50% OF COARSE FRACTION PASSING NO 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL-GRADED SANDS, LITTLE OR NO FINES
			SP	POORLY GRADED SANDS, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	SILTY SANDS, SAND - SILT MIXTURES
			SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTES:
1) Dual symbols are used to indicate gravels or sand with 5-12% fines and soils with fines classifying as CL-ML.
2) Symbols separated by a dash indicate borderline soil classifications.
3) The lines separating soil types on the logs represents approximate boundaries only. The actual boundaries may vary or be gradual.
4) Soil Classification based on visual classification of soil is based on ASTM D2488-90.
5) Soil Classification using laboratory tests is based on ASTM D2487-90.
6) Description of soil density or consistency is based on interpretation of blow count data and/or test data.

Soil Particle Size Definitions

Component	Size Range
Boulders	Coarser than 12 inch
Cobbles	3 inch to 12 inch
Gravel	3 inch to No. 4 (4.78 mm)
Coarse	3 inch to 3/4 inch
Fine	3/4 inch to No. 4 (4.78 mm)
Sand	No. 4 (4.78 mm) to No. 200 (0.074mm)
Coarse	No. 4 (4.78 mm) to No. 10 (2.0 mm)
Medium	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine	No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt and Clay	Finer than No. 200 (0.074 mm)

Moisture Content

Dry	Absence of moisture
Moist	Damp but no visible water
Wet	Visible water

Sampler and Other Symbol Descriptions

☒ Location of Grab Sample

▽ Approximate depth of perched water or ground water

Asphalt

Relative Consistency

Fine-Grained Soils	
Very Soft	Easily penetrated several inches by fist
Soft	Easily penetrated several inches by thumb
Medium Stiff	Penetrated by thumb with effort
Stiff	Indented by thumb with effort
Very Stiff	Indented by thumbnail
Hard	Indented with difficulty with thumbnail

NOTE: The depths on the test pit logs are shown in 0.1 foot increments, however these depths are based on approximate measurements across the length of the test pit and should be considered accurate to 0.5 foot. The depths are relative to the adjacent ground surface.

Test Pit TP-7

CLIENT Port Blakely Communities
PROJECT NAME The Grand Ridge Drive Neighborhood
PROJECT NUMBER 0125-011
PROJECT LOCATION Issaquah Highlands

DATE EXCAVATED 6/1/05
GROUND ELEVATION 1,067 ft (approx.)
LOGGED BY GDB
EXCAVATION CONTRACTOR KLB Construction
GROUND WATER None observed
CHECKED BY BRB
EXCAVATION EQUIPMENT Caterpillar 315 track-mounted excavator
NOTES Lot 1

DEPTH (ft)	MATERIAL DESCRIPTION	ELEVATION (ft)	GRAPHIC LOG	GROUP SYMBOL	SAMPLE TYPE NUMBER	LAB TESTS	REMARKS
0 – 1.0	Dark brown SILT with abundant decayed organic matter and roots (soft, moist) (topsoil)	1066.0		ML			
1.0 – 2.5	Brown and mottled orange silty fine to medium SAND with gravel, cobbles and rock fragments (loose to medium dense, moist) (weathered glacial till)	1064.5		SM			
2.5 – 4.5	Brown and gray silty fine to medium SAND with gravel, cobbles and rock fragments (dense, moist) (glacial till)	1062.5		SM	1		
4.5 – 6.5	Green and gray VOLCANIC BRECCIA (slightly weathered bedrock) (Tukwila formation - Tv3)	1060.5		Rock			

Test pit completed at 6.5 feet on 6/1/05 due to digging refusal

No ground water seepage observed