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December 8, 2010

City of Seattle
c/o SvR Design Company
1205 Second Avenue, Suite 200
Seattle, Washington 98101

Attention: Dave Rodgers, PE, LEED

Subject: Preliminary Geotechnical Evaluation
Burke Gilman Trail Extension
Shilshole Avenue NW between 17th Avenue NW and NW Vernon Place
Seattle, Washington
File No. 0129-128-00, Task 1100

INTRODUCTION

The Seattle Department of Transportation (SDOT) Burke-Gilman Trail Extension Project (the project) seeks to complete the missing link between two existing portions of the Burke-Gilman Trail between 11th Avenue NW and 30th Avenue NW (at the Hiram M. Chittenden Locks) in Seattle. SDOT issued a Determination of Nonsignificance for the project under the State Environmental Policy Act (SEPA) on November 26, 2008, which was appealed.

Now, upon remand by the King County Superior Court, SDOT has revised its description of the project to include Shilshole Avenue NW between 17th Avenue NW and NW Vernon Place in Seattle.

This letter presents a summary of our preliminary geotechnical engineering evaluation of subsurface information for the section of the Burke Gilman Trail Extension Project along Shilshole Avenue NW between 17th Avenue NW and NW Vernon Place (hereafter referred to as the Shilshole segment). Our services have been provided in accordance with our Change Order No. 008, dated May 20, 2010.

Project construction along the Shilshole segment would take place within the existing street right-of-way and would involve the same type of work and improvements involved in project construction for the other portions of the project route. Specifically, all construction along the Shilshole segment would involve removal of existing concrete, asphalt, and compact gravel to be replaced with a 10- to 12-foot-wide multi-use pathway. Additional improvements may include railway crossings, stormwater drainage controls, relocation of underground utilities, reconstruction of existing driveways, and installation of traffic controls, warning signs, and signals to direct motor-vehicle, bicycle, and pedestrian traffic.

This letter presents geotechnical conclusions and recommendations specific to construction of the Burke Gilman Trail Extension along the Shilshole segment. The methods used to research and develop this report are similar to those used for development of the original 2008 geotechnical report.

SITE CONDITIONS

Surface Conditions

The Shilshole segment alignment is located along the north shoreline of Salmon Bay, which connects Lake Union to the Puget Sound via the Hiram M. Chittenden Locks, as shown on Figure 1. The Shilshole segment is located in a relatively flat area and the ground surface slopes gently downward to the south-southwest, toward Salmon Bay. The ground surface along the Shilshole segment ranges between about Elevation 26 feet and Elevation 28 feet above mean sea level.

The area surrounding the Shilshole segment alignment is occupied by restaurants, residential buildings, and small shops. Also, many industries such as sand and gravel facilities and boat yards are located along the north shore of Salmon Bay and along the planned Shilshole segment.

Surface water south of Shilshole Avenue NW generally flows to the south-southwest where there is no formal storm drainage system.

Review of Geologic Map

Published geologic information for the Shilshole segment vicinity includes the "Geologic Map of Seattle – A Progress Report" by the United States Geological Survey dated 2005. The soils mapped in the Shilshole segment consist of glacial till associated with the Vashon glaciation (about 15,000 years ago). Glacial till typically includes dense to very dense silty sand and gravel with occasional cobbles and boulders that were deposited below the advancing glaciers. There are also areas of artificial fill identified on the geologic map. These areas are associated with road building activities and site development along the north side of Salmon Bay and are also shown in Figure 1.

Environmentally Critical Areas mapping

We also reviewed Environmentally Critical Area (ECA) maps available from the City of Seattle web site. There are two mapped ECA's located near the planned Shilshole segment. An ECA for an abandoned landfill is mapped between Shilshole Avenue NW and Salmon Bay, north of 20th Avenue NW. An ECA for shoreline habitat is also mapped along the shore of Salmon Bay. These features are shown on the Site Plan, Figure 1.

Review of Existing Exploration Data

We collected and reviewed exploration data available from the GeoMap NW (The Pacific Northwest Center for Geologic Mapping Studies at the University of Washington) website and from projects completed by GeoEngineers in the vicinity of the Shilshole segment alignment. The approximate locations of these nearby explorations are shown in Figure 1.

The explorations we reviewed included six boring logs for other projects completed previously by others near the proposed Shilshole segment alignment (exploration locations are shown on the Site Plan, Figure 1). The presence of fill and native soils is indicated by each of these exploration logs. Fill thicknesses range from about 6 feet to 10 feet and generally consist of soft silt and sandy silt, and loose silty sand with variable gravel content. Glacially consolidated native soils were encountered below the fill. The native soils typically consist of medium dense to very dense sand with variable silt content.

Groundwater, where noted in the other reviewed studies, was encountered in the Shilshole segment at depths ranging from about 2 to 8 feet below the ground surface. The direction of groundwater flow in the area of the Shilshole segment alignment is expected to be from the north-northeast towards Salmon Bay to the south-southwest based on the topography of the area.

Subsurface Explorations Completed by GeoEngineers, Inc.

Boring GEI-1 was completed as part of this project in the southeast quadrant of the intersection of NW 17th Street and Shilshole Avenue NW as shown in Figure 1. The soil conditions encountered at this boring location generally consist of approximately 17 feet of interbedded loose to medium dense sand with varying amounts of silt and gravel, and soft to medium stiff silt and clay, overlying very dense silty sand with gravel and occasional cobbles (glacial deposits). The upper 2 to 3 feet appeared to be fill likely placed during past grading activities; however, the fill thickness could be as much as 8 feet based on the soils encountered. The very dense glacial deposits were encountered from a depth of about 17 feet to the bottom of the boring at a depth of about 26½ feet. Groundwater was encountered at a depth of about 10 feet during drilling.

Boring GEI-2 was completed as part of this project in the southeast quadrant of the intersection of NW Vernon Place and Shilshole Avenue NW as shown in Figure 1. The soil conditions encountered at this boring location generally consist of approximately 7 feet of loose to very dense silty sand with varying amounts of gravel and cobbles (fill) overlying dense to very dense silty sand with varying amounts of gravel and cobbles (glacial deposits). The dense to very dense glacial deposits were encountered from a depth of about 7 feet to the bottom of the boring at a depth of about 21½ feet. We also noted that wood debris was encountered within the fill zone during drilling. Groundwater was encountered at a depth of about 11½ feet during drilling.

CONCLUSIONS AND RECOMMENDATIONS

It is our opinion that the proposed trail improvements in the Shilshole segment may be satisfactorily completed from a geotechnical standpoint. Based on our review of geologic mapping, available exploration data, and conditions observed in our subsurface explorations, we anticipate that the subsurface soils along the Shilshole segment alignment will consist of fill overlying native glacial deposits. The surficial fill is expected to be encountered to depths of up to about 8 feet below grade and may contain foundation elements/utilities from previous site development, debris, rubble, and/or cobbles and boulders. Also, based on explorations completed previously by others in the area of the Shilshole segment alignment (exploration locations are shown on Figure 1), the groundwater level is relatively shallow and is likely to be encountered in deeper excavations expected for utility improvements and signal pole foundations.

Subgrade Preparation

We recommend that all new fill under planned pavement areas and below concrete cast-in-place barriers be compacted to at least 95 percent of the maximum dry density (MDD) per ASDTM D 1557 in the upper 12 inches. Subgrade soils that will support pavement and barriers should be evaluated prior to placing the base course materials by proofrolling and/or probing with a ½-inch diameter steel probe rod and all loose or otherwise disturbed soil should be recompacted to at least 95 percent of the MDD per ASTM D 1557. If the subgrade soils are excessively loose or soft, or too wet to compact, it may be necessary to overexcavate localized areas and replace the unsuitable soils with structural fill or gravel base course material.

Pavement Recommendations

Flexible asphalt pavement sections for the Shilshole segment should be designed in accordance with applicable sections of the Washington State Department of Transportation and the Seattle Department of Transportation design manuals. We recommend asphalt pavement sections consist of 2 inches of hot mix asphalt overlying 6 inches of crushed surfacing base course. Hot mix asphalt should conform to WSDOT Standard Specification 5-04 and crushed surfacing base course should conform to WSDOT Standard Specification 9-03.9(3). These recommendations assume very limited vehicular traffic will travel on the proposed trail.

We recommend rigid concrete pavement sections used to replace driveways and repair railway crossings where heavily loaded trucks will cross the alignment, consist of 12 inches of Portland cement concrete, conforming to WSDOT Standard Specification 5-05, overlying 6 inches of crushed surfacing base course, conforming to WSDOT Standard Specification 9-03.9(3).

Signalization Foundation Recommendations

We understand that as part of planned trail improvements, signal improvements are planned to be installed at the intersections of Shilshole Avenue NW and 17th Avenue NW and/or Shilshole Avenue NW and NW Vernon Place. We recommend that these improvements be designed based on explorations completed by GeoEngineers for this project at the following locations. If improvements are planned away from these locations, it may be necessary to complete additional explorations to develop specific recommendations during final design. We understand that signal improvements may also occur at the intersection of Shilshole Avenue NW and 20th Avenue NW. If this is included in the final design, we recommend completing an additional exploration at this location to obtain site specific subsurface information.

Shilshole Avenue NW and 17th Avenue NW

The area around this intersection includes about 17 feet of fill (generally loose to medium dense silty sand and gravel, sand with silt and gravel, and layers of soft to medium stiff silt and clay) overlying glacially consolidated soil (generally dense to very dense silty sand and gravel) as indicated in our exploration GEI-1. We encountered groundwater approximately 10 feet below the ground surface during drilling; however, shallower groundwater levels may be present during wetter portions of the year. The contractor should therefore be prepared to case the foundation excavations.

Mast arm pole foundations designed in accordance with City of Seattle Department of Transportation standards (Standard Plan No. 562a and 562b) should be designed based on a Lateral Bearing of 150 pounds per square foot per foot (lbs/sf/ft). Per Note 6 on Standard Plan No. 562b the Lateral Bearing value is based on the soil classification Type 4 defined in Table 18-1-A of the 1997 Uniform Building Code.

For non standard designs, we recommend that analyses be based on the following:

- Soil internal friction angle: 29 degrees
- Moist unit weight of soil: 118 pounds per cubic foot
- Shear strength of soil: NA
- Passive lateral soil pressure: 300 pounds per cubic foot (pcf), includes a safety factor of 1.5

Shilshole Avenue NW and NW Vernon Place

The area around this intersection includes about 7 feet of fill (generally loose silty sand and gravel) overlying glacially consolidated soil (generally dense to very dense silty sand and gravel) as indicated in our exploration GEI-2.

We encountered groundwater approximately 11½ feet below the ground surface during drilling; however, shallower groundwater levels may be present during wetter portions of the year. The contractor should therefore be prepared to case the foundation excavations.

Mast arm pole foundations designed in accordance with City of Seattle Department of Transportation standards (Standard Plan No. 562a and 562b) should be designed based on a Lateral Bearing of 150 pounds per square foot per foot (lbs/sf/ft). Per Note 6 on Standard Plan No. 562b the Lateral Bearing value is based on the soil classification Type 4 defined in Table 18-1-A of the 1997 Uniform Building Code.

For non standard designs, we recommend that analyses be based on the following:

- Soil internal friction angle: 30 degrees
- Moist unit weight of soil: 118 pounds per cubic foot
- Shear strength of soil: NA
- Passive lateral soil pressure: 320 pounds per cubic foot (pcf), includes a safety factor of 1.5

LIMITATIONS

We have prepared this letter for the exclusive use City of Seattle and their consultants, including SvR Design Company, for the evaluation of preliminary geotechnical considerations for development of a portion of the Burke Gilman Trail Extension located along Shilshole Avenue NW between 17th Avenue NW and NW Vernon Place in Seattle, Washington.

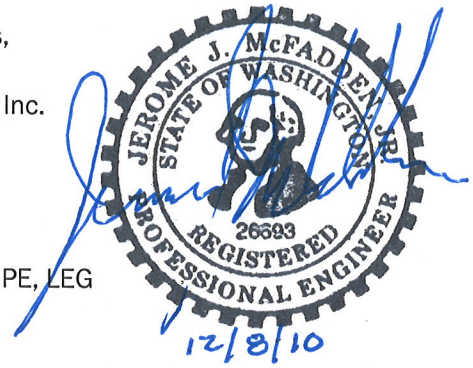
Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area

at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

Please call if you have any questions.

Sincerely yours,

GeoEngineers, Inc.



Bo McFadden, PE, LEG
Principal

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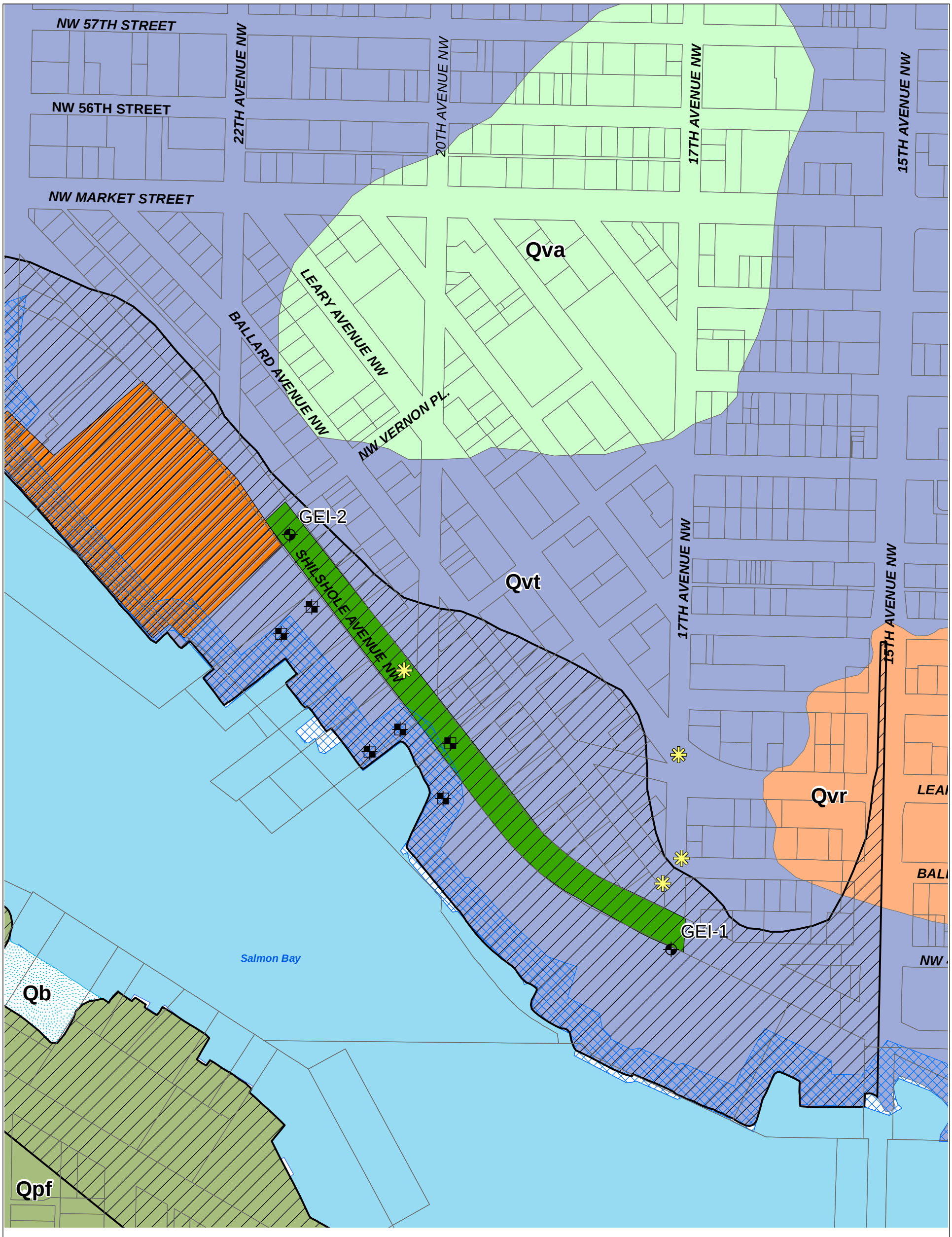
Figure 1 - Site Plan

Appendix A - Field Explorations and Laboratory Testing

One copy submitted via email

Seattle Path:W:\Seattle\Projects\0\0129128\GIS\012912800_F1_Siteplan.mxd Map Revised: September 22, 2010 EL



Projects Completed Previously by GeoEngineers
Boring Completed by GeoEngineers
Boring Completed Previously by Others
Route
Abandoned Landfill
Shoreline Habitat
Artificial Fill
Qva - Vashon advance outwash deposits
Qvr - Vashon recessional outwash deposits
Qvt
Qpf
Qb
Waterbody

300 0 300
Feet

N W E S

Reference: "The Geologic Map of Seattle - A Progress Report" by USGS dated 2005.
Parcels provided by King County GIS data center.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Site Plan

Burke Gilman Trail Extension
King County, Washington

GeoEngineers

Figure 1

APPENDIX A
Field Explorations and Laboratory Testing

APPENDIX A
FIELD EXPLORATIONS AND LABORATORY TESTING

General

Subsurface soil and groundwater conditions were explored along portions of the alignment by completing two borings (GEI-1 and GEI-2). The borings were completed to depths of 21½ to 26½ feet below the existing ground surface. The drilling was performed by Boretec Drilling on December 8, 2009.

Locations of the explorations were determined in the field by measuring distances from site features through taping/pacing in the field. The approximate exploration locations are shown on the Site Plan, Figure 1.

Borings

Borings were completed using track-mounted, continuous-flight, hollow-stem auger drilling equipment. The borings were continuously monitored by a geotechnical engineer from our firm who examined and classified the soils encountered, obtained representative soil samples, observed groundwater conditions and prepared a detailed log of each exploration.

The soils encountered in the borings were generally sampled at 2½- or 5-foot vertical intervals using a split-barrel standard penetration test (SPT) sampler with an outside diameter of 2 inches. The samples were obtained by driving the sampler 18 inches into the soil with a 140-pound hammer free-falling 30 inches. The number of blows required for each 6 inches of penetration was recorded. The blow count ("N-value") of the soil was calculated as the number of blows required for the final 12 inches of penetration. This resistance, or N-value, provides a measure of the relative density of granular soils and the relative consistency of cohesive soils. Where very dense soil conditions precluded driving the full 18 inches, the penetration resistance for the partial penetration was entered on the logs. The blow counts are shown on the boring logs at the respective sample depths.

Soils encountered in the borings were visually classified in general accordance with the classification system described in Figure A-1. A key to the boring log symbols is also presented in Figure A-1. The logs of the borings are presented in Figures A-2 and A-3. The boring logs are based on our interpretation of the field and laboratory data and indicate the various types of soils and groundwater conditions encountered. The logs also indicate the depths at which these soils or their characteristics change, although the change may actually be gradual. If the change occurred between samples, it was interpreted. The densities noted on the boring logs are based on the blow count data obtained in the borings and judgment based on the conditions encountered.

Observations of groundwater conditions were made during drilling. The groundwater conditions encountered during drilling are presented on the boring logs. Groundwater conditions observed during drilling represent a short-term condition and may or may not be representative of the long-term groundwater conditions at the site. Groundwater conditions observed during drilling should be considered approximate.

LABORATORY TESTING

Moisture Content Testing

Moisture content tests were completed in general accordance with ASTM D 2216 for representative samples obtained from the explorations. The results of these tests are presented on the exploration logs in Appendix A at the depths at which the samples were obtained.

Percent Passing U.S. No. 200 Sieve

Selected samples were "washed" through the U.S. No. 200 mesh sieve to determine the relative percentages of coarse- and fine-grained particles in the soil. The percent passing value (%F) represents the percentage by weight of the sample finer than the U.S. No. 200 sieve. These tests were conducted to verify field descriptions and to determine the fines content for analysis purposes. The tests were conducted in general accordance with ASTM D 1140, and the results are shown on the exploration logs in Appendix A at the respective sample depths.

SOIL CLASSIFICATION CHART

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

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	CC	Cement Concrete
	AC	Asphalt Concrete
	CR	Crushed Rock/ Quarry Spalls
	TS	Topsoil/ Forest Duff/Sod

Measured groundwater level in exploration, well, or piezometer

Groundwater observed at time of exploration

Perched water observed at time of exploration

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata or geologic units

Approximate location of soil strata change within a geologic soil unit

Material Description Contact

Distinct contact between soil strata or geologic units

Approximate location of soil strata change within a geologic soil unit

Sampler Symbol Descriptions

2.4-inch I.D. split barrel

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

A "P" indicates sampler pushed using the weight of the drill rig.

Laboratory / Field Tests

%F	Percent fines
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
OC	Organic content
PM	Permeability or hydraulic conductivity
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen
NT	Not Tested

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

KEY TO EXPLORATION LOGS

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FIGURE A-1

Drilled	Start 12/8/2009	End 12/8/2009	Total Depth (ft) 26.5	Logged By RBM / Checked By DPC	Driller Geologic Drill	Drilling Method Hollow-stem Auger
Surface Elevation (ft) / Vertical Datum	Undetermined		Hammer Data	Rope and Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment	Bobcat MT-52
Easting (X) / Northing (Y)			System Datum		Groundwater: Date Measured 12/8/2009	Depth to Water (ft) 10.0

Notes: Auger Data: 2¼ inches I.D.; 6 inches O.D.

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	Blows/foot	Collected Sample: Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0						AC	6 inches asphalt			
							SM	Brown silty fine to coarse sand with gravel and occasional cobbles (moist) (fill)			Concrete chunk
		12	12	1			SP-SM	Brownish gray fine to medium sand with silt and occasional gravel and orange staining (medium dense, moist)			
	5	15	9	2					16		%F=5
		18	7	3a & 3b			SM	Gray silty fine to medium sand with occasional gravel (loose, moist)			
							ML/OL	Dark brown silt with sand and organic matter (soft, moist to wet)	112		
	10	16	6	4	▽		SM	Gray silty fine to medium sand with occasional gravel (loose, wet)			
							ML/CL	Gray silt/clay with sand and trace organic matter (soft to medium stiff, moist)			
	15	18	4	5	▽		SM	Gray silty fine to medium sand with gravel (very dense, wet) (glacially consolidated)			
	20	10	50/4"	6							Fractured gravel in shoe
							SM	Gray silty fine to medium sand with gravel and occasional cobbles (very dense, moist) (till-like)			
	25	10	50/5"	7							

Note: See Figure A-1 for explanation of symbols.

Log of Boring GEI-1

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Project: City of Seattle/Burke-Gilman Trail Extension
Project Location: Seattle, Washington
Project Number: 0129-128-00

Figure A-2
Sheet 1 of 1

Drilled: Start 12/8/2009 End 12/8/2009	Total Depth (ft): 21.5	Logged By: RBM Checked By: DPC	Driller: Geologic Drill	Drilling Method: Hollow-stem Auger	
Surface Elevation (ft) Vertical Datum: Undetermined		Hammer Data: Rope and Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment: Bobcat MT-52	
Easting (X) Northing (Y)		System Datum		Groundwater: Date Measured 12/8/2009; Depth to Water (ft) 11.5; Elevation (ft)	

Notes: Auger Data: 2¼ inches I.D.; 6 inches O.D.

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	Blows/foot	Collected Sample: Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0						GP	Gray crushed rock			
							SM	Brownish gray silty fine to medium sand with gravel and occasional cobbles (loose, moist) (fill)			
		3	52	1							Driller comment bouncing on rock
	5	6	9	2							Wood chips in cuttings
							SM	Gray silty fine sand with gravel and occasional cobbles (dense to very dense, moist to wet) (glacially consolidated)	9		%F=30
		18	98	3							
	10	16	63	4	▽			Grades to fine to medium	11		
	15	15	41	5				Grades to brown			
							SM	Gray silty fine to medium sand with gravel and occasional cobbles (very dense, moist) (till like)			
	20	11	68	6							

Note: See Figure A-1 for explanation of symbols.

Log of Boring GEI-2

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Project: City of Seattle/Burke-Gilman Trail Extension
Project Location: Seattle, Washington
Project Number: 0129-128-00

Figure A-3
Sheet 1 of 1