June 2, 2021

City of Puyallup
Attention: Ryan Rutkosky, PE
333 S. Meridian
Puyallup, WA 98371

Re: Groundwater Level Monitoring and Preliminary Infiltration Feasibility Evaluation
City of Puyallup AOB Parking Lot
330 3rd Street NW
Puyallup, Washington
Project No. 200589

Dear Ryan:

This report summarizes Aspect Consulting, LLC's (Aspect) groundwater level monitoring and preliminary infiltration feasibility evaluation for the City of Puyallup AOB Parking Lot located at 330 3rd Street NW in Puyallup, Washington (Site).

Executive Summary

The pertinent conclusions of our study are summarized below.

- Seasonal high groundwater was recorded on January 13, 2021, at approximately 4.5 feet below the ground/pavement surface in B-1 and 3.5 feet below the ground/pavement surface in B-2. Based on precipitation data, the seasonal high groundwater is a peak, short-term response to the precipitation that occurred in the preceding days. Ignoring this peak response, a more representative seasonal high groundwater level is approximately 5 feet below the ground/pavement surface in B-1 and 4 feet below the ground/pavement surface in B-2.

- Due to the shallow depth to groundwater, infiltration would need to occur within the near-surface fill soil. Based on grain-size correlations on three samples within the fill, the estimated saturated hydraulic conductivity of the fill soil ranges between 0.5 and 21 inches per hour. Based on the fine-grained nature of the fill soil and the relatively low estimated saturated hydraulic conductivity, we conclude that the Site soils have low infiltration potential. The shallow depth to groundwater is an additional constraint on infiltration facilities that further limits the potential for infiltration at the Site.

Project Understanding

We understand the City of Puyallup (City) is seeking to determine the seasonal high groundwater and a preliminary evaluation of infiltration feasibility at the Site, which is currently occupied by an asphalt surface parking lot.

Scope of Work

Our authorized scope of work including the following:

1. **Document and code review.** This consisted of review of an existing geotechnical engineering report for the Site and current stormwater code/regulations adopted by the City.

2. **Groundwater Level Monitoring.** This consisted of deploying a submersible water level data logger in each of the two existing monitoring wells at the Site to record groundwater levels between December 2020 and May 2021, and intermittent site visits to download data from the data loggers.

3. **Infiltration Feasibility Evaluation and Technical Memo.** This consisted of summarizing the results of groundwater level monitoring and infiltration feasibility evaluation (including a preliminary infiltration rate) in a technical report.

Document and Code Review

We have reviewed data and information contained in the following documents:

- **Geotechnical Engineering Services, AOB Site Development, Puyallup, Washington (GeoEngineers, 2011).** This geotechnical engineering study was completed for the City to inform possible future development at the Site. Of relevance to our study, the report includes the logs of three geotechnical borings (designated B-1 through B-3; B-1 and B-2 were completed as monitoring wells and are the wells we used to monitor groundwater levels) and the results of laboratory testing (grain-size analyses) on three samples from the borings. The locations of the monitoring wells are shown in Attachment 1. The logs of the borings and the results of laboratory testing are presented in Attachments 2 and 3, respectively, of this report.

- ***2012 Stormwater Management Manual for Western Washington* (SWMMWW), as Amended in December 2014 (Ecology, 2014).** We understand this version of the SWMMWW is currently adopted by the City.

Subsurface Conditions

Our understanding of the Site subsurface conditions is based on the information presented on the boring logs in the GeoEngineers report (2011). Based on the GeoEngineers report, the Site is immediately underlain by 2 to 5 feet of fill. The fill consists of loose, moist, silty sand (SM)[1] and sandy silt (ML). The fill is underlain by alluvium consisting of interbedded very soft to medium stiff silt with sand (ML) and loose to sand with varying amount of silt (SP and SP-SM) within the upper 20 feet before becoming predominantly medium dense to dense sand with varying amount of silt (SP, SP-SM, and SM) that extends to the maximum depths explored in the borings (approximately 80 feet below the ground/pavement surface).

Groundwater Level Monitoring

We monitored groundwater levels at the Site over a 5-month period between December 8, 2020, and May 11, 2021, using submersible data loggers deployed in the monitoring wells in B-1 and B-2. The data loggers were programmed to record groundwater levels every 60 minutes. The seasonal high groundwater level was recorded on January 13 in both wells, at approximately 4.5 feet below the ground surface in B-1 and 3.5 feet below the ground surface in B-2. The seasonal high appears as a distinct spike on the plot of recorded groundwater levels, which indicates it is in response to the precipitation that occurred in the preceding days.

[1] Soils classified in accordance with the Unified Soil Classification System (USCS)

The plots of recorded groundwater levels over the 5-month monitoring period are presented on Figure 1. Precipitation data is included on the plot.

Infiltration Feasibility Evaluation

Infiltration feasibility depends on several factors, such as hydraulic conductivity of the receptor soils, depth to ground water, and depth/size of the infiltration facility. Each of these factors is discussed below.

Hydraulic Conductivity of Receptor Soils

Based on the shallow depth to groundwater, infiltration will need to occur within the fill soil and/or the fine-grained alluvium. We used the results of grain-size analyses on three soil samples within the fill and presented in the GeoEngineers report (2011) and the Soil Grain Size Analysis Method outlined in the SWMMWW to estimate the saturated hydraulic conductivity (K_{sat}) of the fill soil. The estimated K_{sat} using the Soil Analysis Method is presented in Table 1, below.

Table 1. Estimated K_{sat} using the Soil Analysis Method

Exploration	Sample Depth (feet)	Soil Unit and Classification	K_{sat} (in/hr)
B-1	0	Fill; silty sand (SM)	21.0
B-2	2.5	Fill; silt with sand (ML)	0.7
B-3	2.5	Fill; sandy silt (ML)	2.5

The Soil Grain Size Analysis Method uses the grain size for which 10, 60, and 90 percent of the sample is finer, as well as the fines fraction. It should be noted that the samples for which particle-size analyses were conducted had fines fractions ranging between 0.16 and 0.84 (fines content between 16 and 84 percent). Where fines content of a sample exceeds 10 percent, the grain size for which 10 percent of the sampler is finer (D_{10}) should be determined using a hydrometer analysis. A hydrometer analysis was not conducted on the samples; therefore, we extrapolated the grain-size curves using our best estimate. It should also be noted that fill soil is typically heterogeneous, which is evidenced by the variable estimated infiltration rates. Considering this, the fill soil at the Site may contain layers or zones that exhibit a higher or lower saturated hydraulic conductivity than the estimates presented above.

The estimated saturated hydraulic conductivities presented above are preliminary and are based solely on correlations to soil grain size. Actual saturated hydraulic activities will need to be verified in the field through infiltration testing on a project-specific basis. Design infiltration rates typically include a factor of safety/reduction factor applied to the field-measured hydraulic conductivity based on Site variability, uncertainty in the test method used, and the potential for siltation of the infiltration facility: therefore, design infiltration rates would be lower than those presented above.

Depth to Groundwater and Minimum Separation from Infiltration Facilities

The SWMMWW provides the following minimum vertical separation requirements between the bottom of the infiltration facility and seasonal high groundwater for infiltration facilities:

- 1 foot for rain gardens

- 1 to 3 feet (varies depending on area of impervious surface) for bioretention facilities, swales, and planter boxes
- 1 foot below the bottom of base course for permeable pavement

Considering the depth to seasonal high groundwater ranges between 3.5 to 4.5 feet below the ground/pavement surface, the bottom of infiltration facilities cannot be deeper than about 2.5 to 3.5 feet below the existing ground/pavement surface to maintain the minimum separation.

Infiltration Infeasibility Criteria

The SWMMWW provides a list of infiltration infeasibility criteria, any of which can be cited to exclude infiltration from consideration. Included in the list of criteria are the following:

- The minimum vertical separation between groundwater and the bottom of the infiltration facility cannot be achieved.

- Field testing indicates potential infiltration sites have a measured saturated hydraulic conductivity less than 0.3 inches per hour.

These criteria will need to be evaluated by others in the future on a project-specific basis. Based on the combination of 1) the fine-grained nature of the near-surface fill soil in which infiltration would need to occur and 2) the relatively low estimates of saturated hydraulic conductivity of the fill soil based on grain size, the Site soils appear to have relatively low infiltration potential.

References

GeoEngineers, 2011, AOB Site Redevelopment, September 30, 2011.

Washington State Department of Ecology (Ecology), 2014, 2012 Stormwater Management Manual for Western Washington, 2014 Revision.

Limitations

Work for this project was performed for the City of Puyallup (Client), and this report was prepared consistent with recognized standards of professionals in the same locality and involving similar conditions, at the time the work was performed. No other warranty, expressed or implied, is made by Aspect Consulting, LLC (Aspect).

Recommendations presented herein are based on our interpretation of site conditions, geotechnical engineering calculations, and judgment in accordance with our mutually agreed-upon scope of work. Our recommendations are unique and specific to the project, site, and Client. Application of this report for any purpose other than the project should be done only after consultation with Aspect.

Variations may exist between the soil and groundwater conditions reported and those actually underlying the site. The nature and extent of such soil variations may change over time and may not be evident before construction begins. If any soil conditions are encountered at the site that are different from those described in this report, Aspect should be notified immediately to review the applicability of our recommendations.

It is the Client's responsibility to see that all parties to this project, including the designer, contractor, subcontractors, and agents, are made aware of this report in its entirety. At the time of this report, design plans and construction methods have not been finalized, and the recommendations presented herein are based on preliminary project information. If project developments result in changes from the preliminary project information, Aspect should be contacted to determine if our recommendations contained in this report should be revised and/or expanded upon.

The scope of work does not include services related to construction safety precautions. Site safety is typically the responsibility of the contractor, and our recommendations are not intended to direct the contractor's site safety methods, techniques, sequences, or procedures. The scope of our work also does not include the assessment of environmental characteristics, particularly those involving potentially hazardous substances in soil or groundwater.

All reports prepared by Aspect for the Client apply only to the services described in the Agreement(s) with the Client. Any use or reuse by any party other than the Client is at the sole risk of that party, and without liability to Aspect. Aspect's original files/reports shall govern in the event of any dispute regarding the content of electronic documents furnished to others.

Please refer to Attachment 4 titled "Report Limitations and Guidelines for Use" for additional information governing the use of this report.

We appreciate the opportunity to perform these services.

Sincerely,

Aspect consulting, LLC

6/2/2021

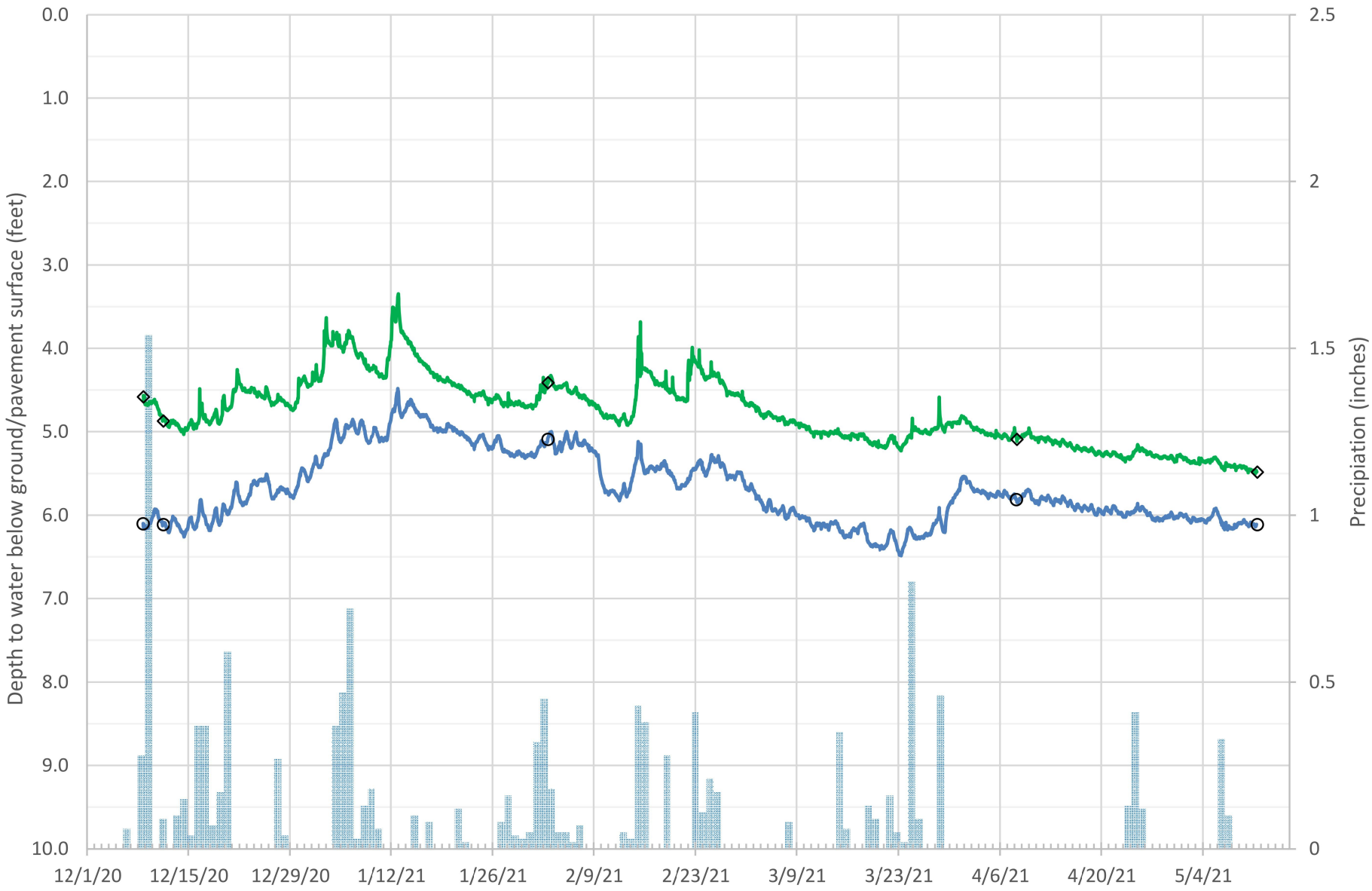
Henry H. Haselton, PE, PMP
Principal Geotechnical Engineer
hhaselton@aspectconsulting.com

Eric Schellenger, PE
Project Engineer
eschellenger@aspectconsulting.com

Attachments: Figure 1 –Recorded Groundwater Levels
Attachment 1 – Site Plan (by others)
Attachment 2 – Boring Logs (by others)
Attachment 3 – Results of Geotechnical Laboratory Testing (by others)
Appendix 4 – Report Limitations and Guidelines for Use

V:\200589 City of Puyallup AOB Parking Lot\Deliverables\Infiltration Feasibility Study\Final\AOB Parking Lot Infiltration Feasibility Study_Final_2021.06.02.docx

FIGURE



Legend

- Precipitation
- B-1
- B-2

Note:
bgs = feet below ground surface. Ground surface taken at top of existing monument cover.

Precipitation Date Source:
National Oceanic and Atmospheric Administration (NOAA)

Recorded Groundwater Levels

Groundwater Level Monitoring and
Preliminary Infiltration Feasibility Study
City of Puyallup AOB Parking Lot
330 3rd St NW, Puyallup, Washington

Aspect Consulting	May-2021	BY: ECS/CMV	FIGURE NO. 1
	PROJECT NO. 200589	REVISED BY: -	

ATTACHMENT 1

Site Plan (by others)

TACO;JAR : SCY

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Legend

B-1 Geotechnical boring number and approximate location

Approximate location of project boundary

Approximate footprint, former building

W E S N

40 0 40

Feet

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.

Reference: Aerial photo provided by ESRI I3 imagery aerial.

Site Plan

City of Puyallup - AOB Site
Puyallup, Washington

GeoEngineers

Figure 2

ATTACHMENT 2

Boring Logs (by others)

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

Sonic Core

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

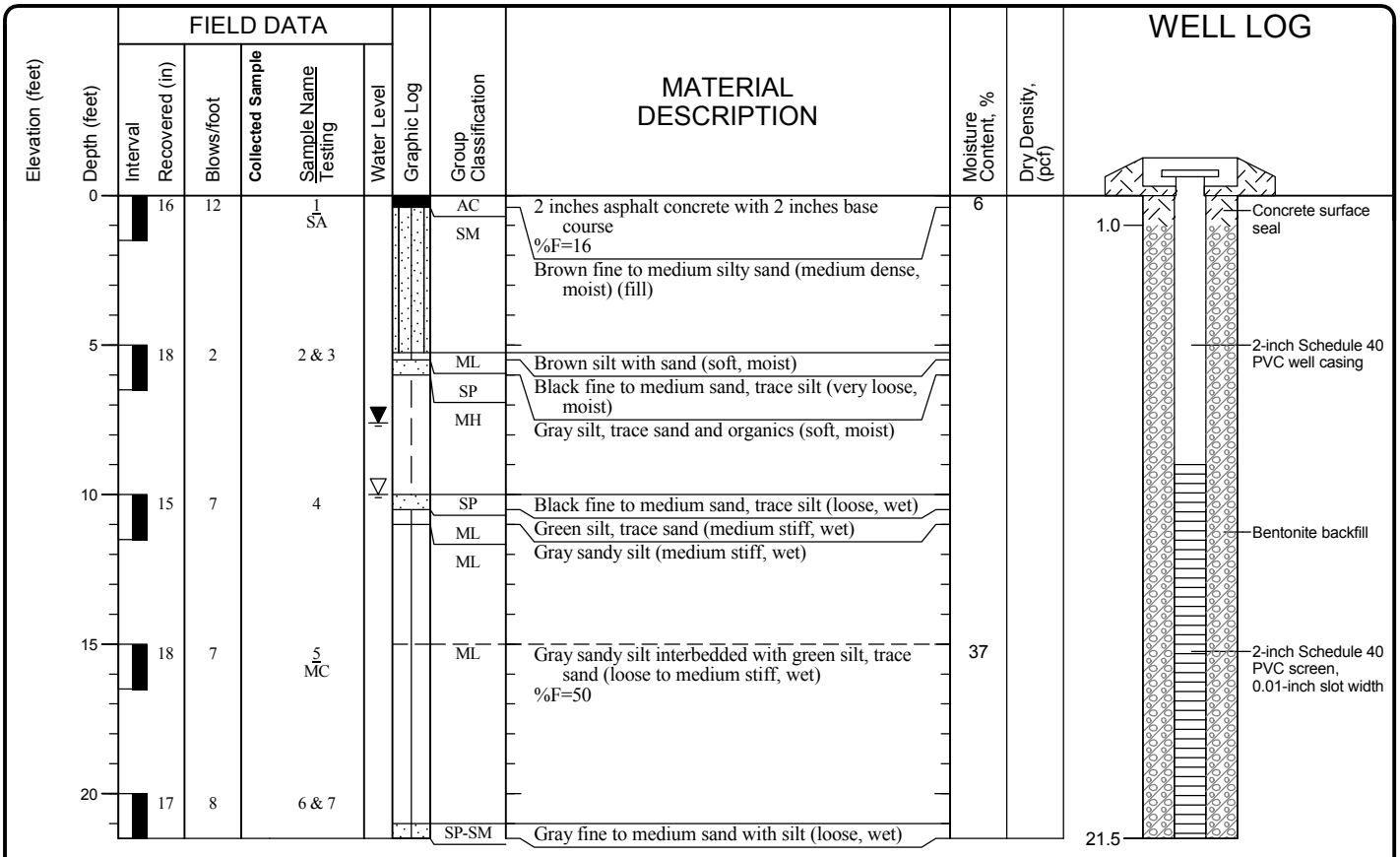
GeoEngineers

FIGURE A-1

Drilled Start 8/15/2011	End 8/15/2011	Total Depth (ft) 21.5	Logged By MJH / Checked By MJH	Driller Holocene	Drilling Method HSA

Hammer Data: Autohammer 140 (lbs) / 30 (in) Drop		Drilling Equipment: BK-81	Licensing agency well number: **940** A 2 (in) well was installed on to a depth of (ft).
Surface Elevation (ft) Vertical Datum: Undetermined		Top of Casing Elevation (ft)	Groundwater: Date Measured 9/15/2011; Depth to Water (ft) 7.6; Elevation (ft)
Easting (X) Northing (Y)		Horizontal Datum	

Notes: Well No. 940



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

Log of Boring B-1

GeoEngineers

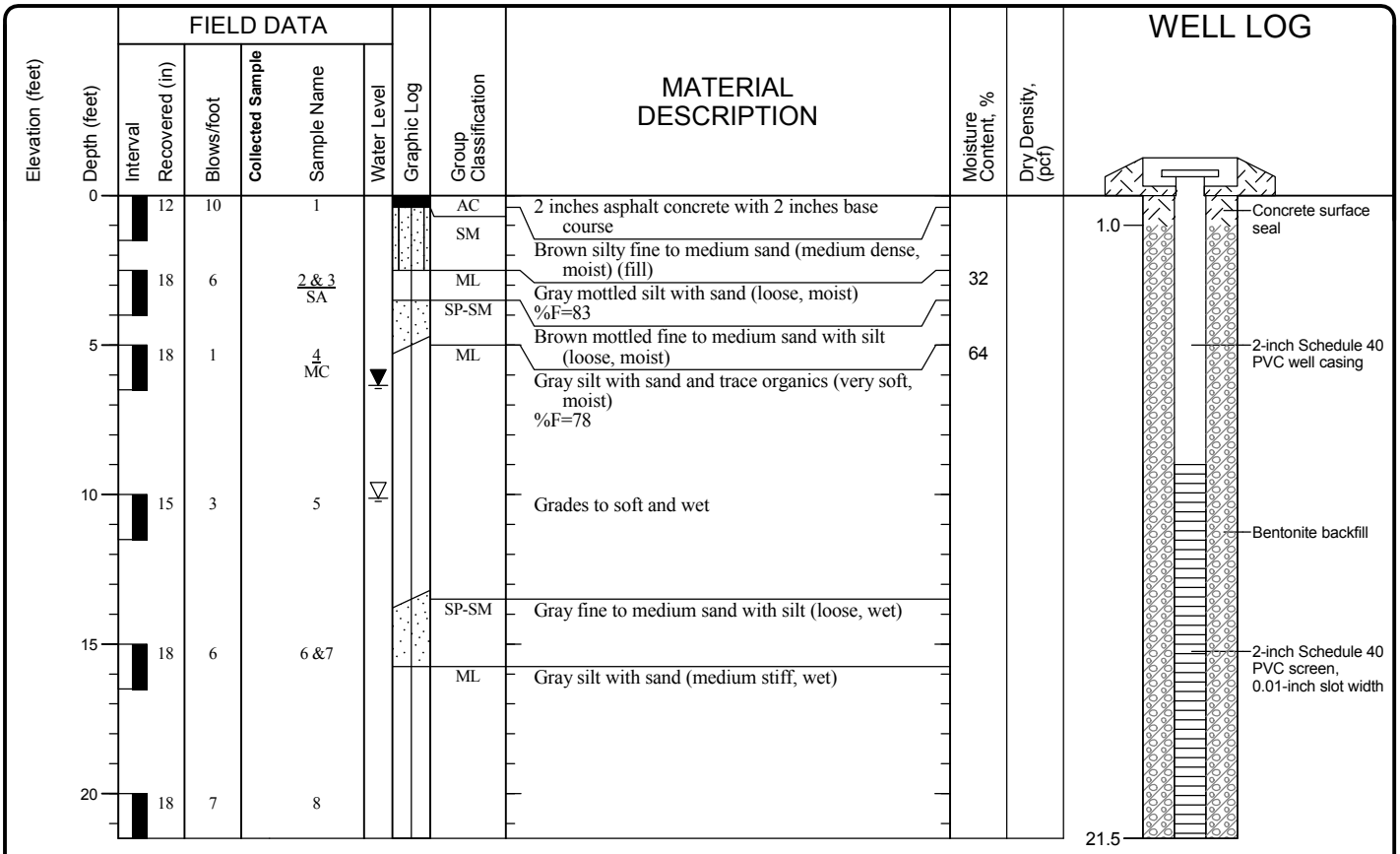
Project: City of Puyallup - AOB Site
Project Location: Puyallup, Washington
Project Number: 0402-030-00

Figure A-2
Sheet 1 of 1

Drilled Start	End	Total Depth (ft)	Logged By / Checked By	Driller	Drilling Method
8/15/2011	8/15/2011	21.5	MJH / MJH	Holocene	HSA

Hammer Data	Drilling Equipment	Licensing agency well number: **941**
Autohammer 140 (lbs) / 30 (in) Drop	BK-81	A 2 (in) well was installed on to a depth of (ft).
Surface Elevation (ft) Vertical Datum: Undetermined	Top of Casing Elevation (ft)	Groundwater: Date Measured 8/15/2011; Depth to Water (ft) 6.4; Elevation (ft)
Easting (X) Northing (Y)	Horizontal Datum	

Notes: Well No. 941



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

Log of Boring B-2

GeoEngineers

Project: City of Puyallup - AOB Site
Project Location: Puyallup, Washington
Project Number: 0402-030-00

Figure A-3
Sheet 1 of 1

Drilled Start 8/15/2011 End 8/15/2011	Total Depth (ft) 80	Logged By MJH Checked By MJH	Driller Holocene	Drilling Method HSA
Surface Elevation (ft) Vertical Datum Undetermined		Hammer Data Autohammer 140 (lbs) / 30 (in) Drop		Drilling Equipment BK-81
Easting (X) Northing (Y)		System Datum		Groundwater Date Measured / Depth to Water (ft) / Elevation (ft)
Notes:				

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						ML	Brown sandy silt (loose, moist) (fill)			
	12	4	1 SA					29		%F=57
5						ML/SP	Gray silt with sand interbedded with black sand, trace silt (loose to medium stiff, moist)			
	13	4	2							
10						ML	Gray silt with sand and organics (1 inch thick wood) (soft, wet)			
	18	3	3 MC					42		%F=93
15						ML/SP	Gray silt, trace sand interbedded with black sand, trace silt (soft to very loose, wet)			
	14	3	4							
20						ML	Gray silt with sand (medium stiff, wet)			
	14	6	5 & 6 MC					33		%F=80
25						SP-SM	Black fine to medium sand with silt (loose, wet)			
	14	12	7				Grades to medium dense			
30										
	15	28	8 MC				Grades to with occasional fine gravel, dense	23		%F=6
35										
	15	32	9							
40										

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

Log of Boring B-3

GeoEngineers

Project: City of Puyallup - AOB Site
Project Location: Puyallup, Washington
Project Number: 0402-030-00

Figure A-4
Sheet 1 of 2

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
40										
	10	35	10				Grades to with gravel			
45										Driller indicates intermittent hard drilling from 45 to 50 feet
	6	3	11			SM	Gray silty fine to coarse sand with gravel (very loose, wet)			Rock in shoe tip
50						GP-GM	Gray fine to coarse gravel with silt and sand (medium dense, wet)			
	2	16	12							
55						SM	Gray silty fine to coarse sand, occasional gravel (loose wet)			
	15	6	13 / MC					19		%F=27
60						SP	Black fine to medium sand, trace silt, occasional gravel (dense, wet)			
	10	35	14							
65						SM	Gray silty fine to medium sand with gravel (dense, wet)			
	10	42	15 / MC					19		%F=33
70						ML	Gray silt with sand (very stiff, wet)			
	16	16	16 / MC					37		%F=64
75										
	15	42	17 & 18			SP	Gray fine sand, trace silt (dense, wet)			
80										

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

Log of Boring B-3 (continued)

GeoEngineers

Project: City of Puyallup - AOB Site
Project Location: Puyallup, Washington
Project Number: 0402-030-00

Figure A-4
Sheet 2 of 2

ATTACHMENT 3

Results of Geotechnical Laboratory Testing (by others)

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	MOISTURE (%)	SOIL CLASSIFICATION
◆	B-1	0	6	Silty sand (SM)
■	B-2	2.5	32	Silt with sand (ML)
●	B-3	2.5	29	Sandy silt (ML)

GeoEngineers

Figure A-5

City of Puyallup – AOB Site
Puyallup, Washington

Sieve Analysis Results