PBS | Engineering + Environmental

October 20, 2015

Clark County Department of Environmental Services
Attn: Mr. Mike Davis, Leichner Landfill Project Manager
1300 Franklin Street
Vancouver, Washington 98660-9810

Re: HDPE Liner Investigation – Phase 2
Leichner Campus Development – Koski Property
8713 Northeast 94th Avenue, Vancouver, Washington
PBS Project No. 72971.006

INTRODUCTION AND BACKGROUND

PBS Engineering and Environmental Inc. (PBS) is pleased to provide this letter report for geotechnical engineering services in support of a feasibility/due diligence review for the approximately 25-acre Leichner Campus Development–Koski Property (project site) located along Northeast 88th Street in Clark County, Washington. PBS understands Clark County (County) is currently planning to develop the approximately 25-acre project site that may be split into six 3- to 6-acre lots for commercial and/or light industrial development. The project site is part of the larger and adjacent, closed Leichner Landfill located at 9411 94th Avenue. A majority of the Leichner Landfill property, including the project site, was purchased by the County in December 2012, and the County has begun the master planning process to guide decisions about the future use of the site. The Leichner Campus Development–Koski Property is planned to be sold or developed by the County separately from other portions of the Leichner Landfill property.

Phase 1 of our geotechnical engineering services was completed and provided in our June 17, 2015 report that included a detailed data review and walking site reconnaissance. During the site reconnaissance, concrete debris was observed at the surface in the northern portion of the property that was previously identified as the former burn areas. The burn materials were reportedly excavated, relocated to the Leichner Landfill, and a High-Density Polyethylene (HDPE) liner placed over the base of the excavation to prevent leaching of any residual contamination into the groundwater. Four progress reports by Emcon (1992a, 1992b, 1992c, and 1992d) detailed the investigation, findings, and site alterations. At some point, undocumented fill was placed in this area and currently forms mounds approximately 3 to 6 feet topographically above the majority of the property to the south. The fill source was unknown at the time of our reconnaissance, but we were later informed that it came from off-site and was placed by Clark County. We recommended test pit explorations be completed to document the content of the fill mounds, determine its potential re-use as structural fill or whether it should be removed, and the depth and presence of the HDPE liner.

SUBSURFACE CONDITIONS

A geotechnical engineer from PBS documented subsurface conditions at the site by observing excavation of 15 test pits (designated TP-1 through TP-15) to depths up to approximately 9 feet below the existing ground surface (bgs), Figure 1, Field Exploration Map. The test pits were completed on September 2, 2015, by SCS Engineers, Inc., of Portland, Oregon, using a Deere 50G excavator equipped with a toothed-bucket. The terminology used to describe the soils is provided in Table A-1 in Attachment A.

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The soil conditions observed during the subsurface exploration in each test pit are summarized in Table 1 below.

Table 1: Summary of Test Pit Soil Conditions

Test Pit	Soil Type (ft. bgs)	Debris
TP-1 TD = 7	FILL: 0 to 2.5 feet: Brown SILT (ML) with sand; non-plastic; fine to coarse sand; fine to coarse, angular gravel; dry	Bricks, glass, concrete
	NATIVE 2.5 to 4.5 feet: Brown silty GRAVEL (GM) with sand and cobbles; non-plastic; fine to coarse sand, fine to coarse, rounded gravel, round cobbles, moist	Debris not observed
	4.5 to 7 feet: Brown poorly graded GRAVEL (GP-GM) with silt, sand, and cobbles; non-plastic; fine to coarse sand, fine to coarse, rounded gravel, round cobbles, moist	Debris not observed
TP-2 TD = 6.5	FILL: 0 to 2 feet: Brown SILT (ML) with sand; non-plastic; fine to coarse sand; fine, angular gravel; dry	Debris not observed
	NATIVE 2 to 4.5 feet: Dark brown SILT (ML) with sand; non-plastic; fine to coarse sand; fine, angular gravel; moist	
	4.5 to 6.5 feet: Brown poorly graded GRAVEL (GP-GM) with silt, sand, and cobbles; non-plastic; fine to coarse sand, fine to coarse, rounded gravel, round cobbles, moist	
TP-3 TD = 8	FILL: 0 to 2.5 feet: Light brown SILT (ML) with sand; non-plastic; fine to coarse sand; fine, angular gravel; dry	Concrete
	NATIVE 2.5 to 4.5 feet: Dark brown SILT (ML) with sand; non-plastic; fine to coarse sand; fine, angular gravel; moist	Debris not observed
	4.5 to 8feet: Brown silty GRAVEL (GM) with sand and cobbles; non-plastic; fine to coarse sand, fine to coarse, rounded gravel, round cobbles, moist	Debris not observed
TP-4 TD = 8	FILL: 0 to 2.5 feet: Light brown SILT (ML); non-plastic; dry	Bricks and concrete (approx. 15%)
	2.5 to 8 feet: Black SILT (ML); non-plastic; fine, rounded gravel; organics; moist	Wood (approx. 25%)

Test Pit	Soil Type (ft. bgs)	Debris
TP-5 TD = 8.5	FILL: 0 to 4.5 feet: Brown SILT (ML) with sand; non-plastic; fine to coarse sand; dry	Bricks, glass, concrete
	4.5 to 8.5 feet: Black ORGANIC SILT (OL); medium plasticity; fine, rounded gravel; organics; moist	Wood (approx. 25%)
TP-6 TD = 9	FILL: 0 to 2.5 feet: Light brown SILT (ML) with sand; non-plastic; fine to coarse sand; fine, angular gravel; dry	Debris not observed
	2.5 to 4.5 feet: Gray SILT (ML) with sand; non-plastic; fine to coarse sand; fine to coarse, angular gravel; moist	Concrete (3.5-foot diameter)
	4.5 to 9 feet: Black ORGANIC SILT (OL); medium plasticity; fine, rounded gravel; organics; moist	Wood (approx. 25%)
TP-7 TD = 7	FILL: 0 to 3.5 feet: Light brown SILT (ML); non-plastic; dry	Bricks, glass, concrete
	3.5 to 7 feet: Gray ORGANIC SILT (OL); medium plasticity; fine, rounded gravel; organics; moist	Concrete (3.5-foot diameter)
TP-8 TD = 9	FILL: 0 to 5 feet: Brown SILT (ML) with sand; non-plastic; fine to coarse sand; dry	Bricks, glass, concrete, metal
	5 to 9 feet: Dark brown ORGANIC SILT (OL); medium plasticity; fine, rounded gravel; organics; moist	Wood
TP-9 TD = 8	FILL: 0 to 2.5 feet: Brown SILT (ML) with sand; non-plastic; fine to coarse sand; dry	Bricks, glass, concrete, asphalt (approx. 10%)
	2.5 to 8 feet: Brown silty SAND (SM) with gravel; non-plastic; fine to coarse sand; fine to coarse, rounded gravel; moist	Debris not observed
TP-10 TD = 7	FILL: 0 to 2 feet: Brown SILT (ML) with sand; non-plastic; fine to coarse sand; dry	Glass and metal (approx. 10%)
	2 to 7 feet: Brown silty SAND (SM) with gravel and cobbles; non-plastic; fine to coarse sand; fine to coarse, rounded gravel; rounded cobbles; moist	Debris not observed
TP-11 TD = 7	FILL: 0 to 7 feet: Brown silty SAND (SM) with gravel and cobbles; non-plastic; fine to coarse sand; fine to coarse, rounded gravel; rounded cobbles; dry to moist	Debris not observed

Test Pit	Soil Type (ft. bgs)	Debris
TP-12 TD = 6	FILL: 0 to 6 feet: Brown silty GRAVEL (GM) with sand and cobbles; non-plastic; fine to coarse sand; fine to coarse, rounded gravel; rounded cobbles; dry to moist	Debris not observed
TP-13 TD = 8	FILL: 0 to 7.5 feet: Brown sandy SILT (ML) with gravel; non-plastic; fine to coarse sand; fine to coarse, rounded gravel; dry	Plastic, metal, carpet
	7.5 to 8 feet: Brown silty GRAVEL (GM) with sand and cobbles; non-plastic; fine to coarse sand; fine to coarse, rounded gravel; rounded cobbles; dry to moist	Debris not observed
TP-14 TD = 6	FILL: 0 to 6 feet: Brown silty GRAVEL (GM) with sand and cobbles; non-plastic; fine to coarse sand; fine to coarse, rounded gravel; rounded cobbles; dry to moist	Debris not observed
TP-15 TD = 7	FILL: 0 to 6 feet: Brown silty GRAVEL (GM) with sand and cobbles; non-plastic; fine to coarse sand; fine to coarse, rounded gravel; rounded cobbles; dry to moist	Concrete, asphalt, metal

Groundwater

Groundwater was not encountered in any of our explorations except for a possible perched zone at 7.5 feet bgs in TP-9. We expect seasonal fluctuations in groundwater could occur during extended periods of rainfall or during wet conditions.

The hydrostratigraphy at the site consists of an approximately 35-foot-thick unsaturated zone of sand and gravel, an unconfined to semi-confined zone about 35 to 55 feet thick, and a semi-confined to confined aquifer in the Troutdale Formation. However, historical groundwater data collected as part of the Leichner Landfill post-closure monitoring program indicate groundwater occurs beneath the property between depths ranging from 12 to 19 feet bgs in the eastern portion and 17 to 37 feet bgs in the western portion with flow generally toward the west-southwest (SCS, 2014).

PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

Based on field explorations and observations of 15 test pits excavated in the northern portion of the property, the mounds contain a variety of deleterious material. The observations included:

- Debris that included concrete, bricks, plastic, glass, mostly burned wood, carpet, and metal was encountered in the majority of the test pits and within both the areas previously delineated as burn areas. The debris types observed in the test pits excavated on September 2, 2015 are similar to those described in the April 21, 1992 report.
- The debris depth is in excess of 9 feet bgs in the western area. Concrete blocks were up to 3.5-feet in the longest dimension, and the debris may also be mixed in with the on-site gravelly soil similar to that stripped and/or exposed at the ground surface south of the mounds.
- The debris was generally observed in the upper 2.5 feet or not at all in the eastern area and consisted of bricks, glass, concrete, and asphalt.

- The burned wood debris was encountered in the western burn area and comprises up to 25 percent of the soil matrix mixed with black silt or organic silt soil.
- The HDPE liner was not observed in any of the test pits.
- The burned wood materials may be related to the past work activities. Environmental testing and characterization may be necessary prior to removal from the site.

The materials observed in the western area in test pits (TP-1 through TP-8 and TP-13) are not suitable for re-use as structural fill due to the variability in constituent size and content. The fill would require the removal of materials larger than 4-inches in nominal diameter and the deleterious materials including plastic, glass, carpet, and metal, and the burned wood and organics/organic soil for it to be considered suitable for re-use. The materials observed in the eastern area in test pits TP 9, -10, and -11 are likely suitable for re-use as structural fill elsewhere on the property provided the upper approximately 2.5 feet that contain debris are stripped and set aside.

RESEARCH SOURCES

The primary data sources used for this letter-report were prepared by other consultants who have completed work at the Leichner Landfill site and included:

- EMCON Northwest, Inc., 1992a, Letter (Re: Burn Area Study, Leichner Landfill), prepared for Washington State Department of Ecology, Olympia, Washington, and Southwest Washington Health District, Vancouver, Washington, April 21, 1992.
- EMCON Northwest, Inc., 1992b, Memorandum (Re: Leichner Landfill, Burn Area Excavation/Remediation), prepared Leichner Brothers Landfill Reclamation Corporation, Vancouver, Washington, June 8.
- EMCON Northwest, Inc., 1992c, Letter (Re: June 1992 Progress Report for the Leichner Landfill Project), prepared for Washington State Department of Ecology, Olympia Washington, July 8.
- EMCON Northwest, Inc., 1992d, Letter (Re: August 1992 Progress Report for the Leichner Landfill Project), prepared for Washington State Department of Ecology, Olympia Washington, September 14.
- SCS Engineers, September 29, 2014, Phase I Environmental Site Assessment, Koski Property, 8713 NE 94th Avenue, Vancouver, Washington 98662.
- PBS Engineering & Environmental, June 17, 2015, Geotechnical Data Review and Geologic Site Reconnaissance – Phase 1_Updated, Leichner Campus Development – Koski Property, 8713 Northeast 94th Avenue, Vancouver, Washington, PBS Project No. 72971.006

LIMITATIONS

This report has been prepared for the exclusive use of the addressee, and their architects and engineers, for aiding in the design and construction of the proposed development and is not to be relied upon by other parties. It is not to be photographed, photocopied, or similarly reproduced, in total or in part, without express written consent of the Client and PBS. It is the addressee's responsibility to provide this report to the appropriate design professionals, building officials, and contractors to ensure correct implementation of the recommendations.

The opinions, comments, and conclusions presented in this report are based upon information derived from our literature review and field explorations. Conditions between, or beyond, our explorations may vary from those encountered. It is possible that soil, rock, or groundwater conditions could vary between or beyond the points explored. If soil, rock, or groundwater conditions are encountered during

construction that differ from those described herein, the Client is responsible for ensuring that PBS is notified immediately so that we may reevaluate the recommendations of this report.

The scope of services for this subsurface exploration and geotechnical report did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous substances in the soil, surface water, or groundwater at this site.

If there is a substantial lapse of time between the submission of this report and the start of work at the site, if conditions have changed due to natural causes or construction operations at or adjacent to the site, or if the basic project scheme is significantly modified from that assumed, this report should be reviewed to determine the applicability of the conclusions and recommendations presented herein. Land use, site conditions (both on- and off-site), or other factors may change over time and could materially affect our findings. Therefore, this report should not be relied upon after three years from its issue, or in the event that the site conditions change.

CLOSING

We trust this report meets your current needs. If you have any questions or wish to further discuss our observations, conclusions, and recommendations, please contact Mark Swank at 503.417.7738 or Ryan White at 503.417.7608.

Sincerely,
PBS Engineering and Environmental Inc.

State of Washington
04/21/2016
Engineering Geologist
2960
Licensed Geologist
Mark Swank

Mark Swank, LG, LEG
Senior Engineering Geologist

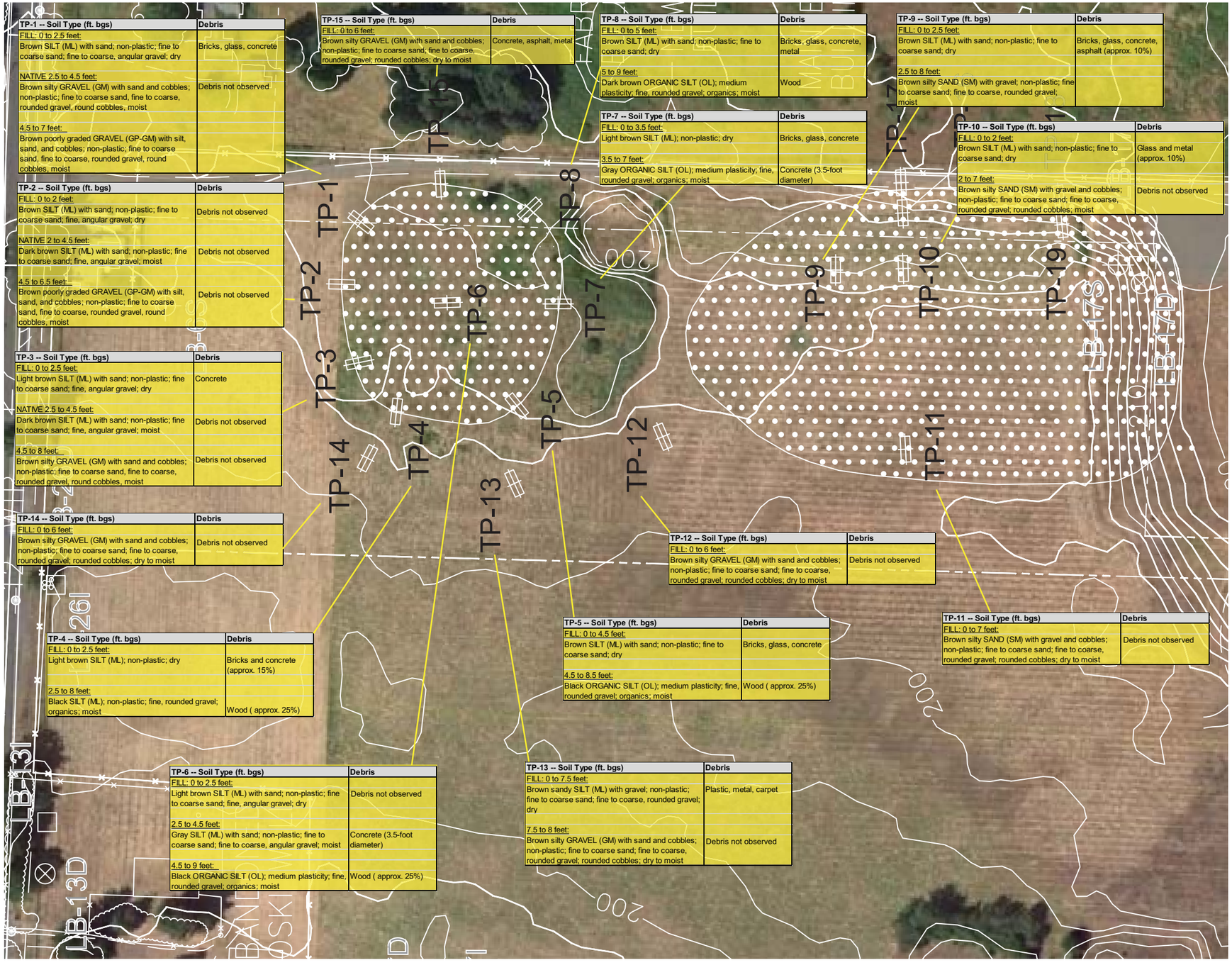
Ryan White, PE, GE
Geotechnical Discipline Lead

MS/RW

Figures: Figure 1 – Field Exploration Map

Attachment: Table A-1, Terminology Used to Describe Soil

FIGURES



TP-1 -- Soil Type (ft. bgs)	Debris
FILL: 0 to 2.5 feet:	
Brown SILT (ML) with sand; non-plastic; fine to coarse sand; fine to coarse, angular gravel; dry	Bricks, glass, concrete
NATIVE 2.5 to 4.5 feet:	
Brown silty GRAVEL (GM) with sand and cobbles; non-plastic; fine to coarse sand, fine to coarse, rounded gravel, round cobbles, moist	Debris not observed
4.5 to 7 feet:	
Brown poorly graded GRAVEL (GP-GM) with silt, sand, and cobbles; non-plastic; fine to coarse sand, fine to coarse, rounded gravel, round cobbles, moist	

TP-2 -- Soil Type (ft. bgs)	Debris
FILL: 0 to 2 feet:	
Brown SILT (ML) with sand; non-plastic; fine to coarse sand; fine, angular gravel; dry	Debris not observed
NATIVE 2 to 4.5 feet:	
Dark brown SILT (ML) with sand; non-plastic; fine to coarse sand; fine, angular gravel; moist	Debris not observed
4.5 to 6.5 feet:	
Brown poorly graded GRAVEL (GP-GM) with silt, sand, and cobbles; non-plastic; fine to coarse sand, fine to coarse, rounded gravel, round cobbles, moist	Debris not observed

TP-3 -- Soil Type (ft. bgs)	Debris
FILL: 0 to 2.5 feet:	
Light brown SILT (ML) with sand; non-plastic; fine to coarse sand; fine, angular gravel; dry	Concrete
NATIVE 2.5 to 4.5 feet:	
Dark brown SILT (ML) with sand; non-plastic; fine to coarse sand; fine, angular gravel; moist	Debris not observed
4.5 to 8 feet:	
Brown silty GRAVEL (GM) with sand and cobbles; non-plastic; fine to coarse sand, fine to coarse, rounded gravel, round cobbles, moist	Debris not observed

TP-14 -- Soil Type (ft. bgs)	Debris
FILL: 0 to 6 feet:	
Brown silty GRAVEL (GM) with sand and cobbles; non-plastic; fine to coarse sand; fine to coarse, rounded gravel; rounded cobbles; dry to moist	Debris not observed

TP-15 -- Soil Type (ft. bgs)	Debris
FILL: 0 to 6 feet:	
Brown silty GRAVEL (GM) with sand and cobbles; non-plastic; fine to coarse sand; fine to coarse, rounded gravel; rounded cobbles; dry to moist	Concrete, asphalt, metal

TP-8 -- Soil Type (ft. bgs)	Debris
FILL: 0 to 5 feet:	
Brown SILT (ML) with sand; non-plastic; fine to coarse sand; dry	Bricks, glass, concrete, metal
5 to 9 feet:	
Dark brown ORGANIC SILT (OL); medium plasticity; fine, rounded gravel; organics; moist	Wood

TP-7 -- Soil Type (ft. bgs)	Debris
FILL: 0 to 3.5 feet:	
Light brown SILT (ML); non-plastic; dry	Bricks, glass, concrete
3.5 to 7 feet:	
Gray ORGANIC SILT (OL); medium plasticity; fine, rounded gravel; organics; moist	Concrete (3.5-foot diameter)

TP-9 -- Soil Type (ft. bgs)	Debris
FILL: 0 to 2.5 feet:	
Brown SILT (ML) with sand; non-plastic; fine to coarse sand; dry	Bricks, glass, concrete, asphalt (approx. 10%)
2.5 to 8 feet:	
Brown silty SAND (SM) with gravel; non-plastic; fine to coarse sand; fine to coarse, rounded gravel; moist	Wood

TP-10 -- Soil Type (ft. bgs)	Debris
FILL: 0 to 2 feet:	
Brown SILT (ML) with sand; non-plastic; fine to coarse sand; dry	Glass and metal (approx. 10%)
2 to 7 feet:	
Brown silty SAND (SM) with gravel and cobbles; non-plastic; fine to coarse sand; fine to coarse, rounded gravel; rounded cobbles; moist	Debris not observed

TP-12 -- Soil Type (ft. bgs)	Debris
FILL: 0 to 6 feet:	
Brown silty GRAVEL (GM) with sand and cobbles; non-plastic; fine to coarse sand; fine to coarse, rounded gravel; rounded cobbles; dry to moist	Debris not observed

TP-4 -- Soil Type (ft. bgs)	Debris
FILL: 0 to 2.5 feet:	
Light brown SILT (ML); non-plastic; dry	Bricks and concrete (approx. 15%)
2.5 to 8 feet:	
Black SILT (ML); non-plastic; fine, rounded gravel; organics; moist	Wood (approx. 25%)

TP-5 -- Soil Type (ft. bgs)	Debris
FILL: 0 to 4.5 feet:	
Brown SILT (ML) with sand; non-plastic; fine to coarse sand; dry	Bricks, glass, concrete
4.5 to 8.5 feet:	
Black ORGANIC SILT (OL); medium plasticity; fine, rounded gravel; organics; moist	Wood (approx. 25%)

TP-11 -- Soil Type (ft. bgs)	Debris
FILL: 0 to 7 feet:	
Brown silty SAND (SM) with gravel and cobbles; non-plastic; fine to coarse sand; fine to coarse, rounded gravel; rounded cobbles; dry to moist	Debris not observed

TP-6 -- Soil Type (ft. bgs)	Debris
FILL: 0 to 2.5 feet:	
Light brown SILT (ML) with sand; non-plastic; fine to coarse sand; fine, angular gravel; dry	Debris not observed
2.5 to 4.5 feet:	
Gray SILT (ML) with sand; non-plastic; fine to coarse sand; fine to coarse, angular gravel; moist	Concrete (3.5-foot diameter)
4.5 to 9 feet:	
Black ORGANIC SILT (OL); medium plasticity; fine, rounded gravel; organics; moist	Wood (approx. 25%)

TP-13 -- Soil Type (ft. bgs)	Debris
FILL: 0 to 7.5 feet:	
Brown sandy SILT (ML) with gravel; non-plastic; fine to coarse sand; fine to coarse, rounded gravel; dry	Plastic, metal, carpet
7.5 to 8 feet:	
Brown silty GRAVEL (GM) with sand and cobbles; non-plastic; fine to coarse sand; fine to coarse, rounded gravel; rounded cobbles; dry to moist	Debris not observed

LEGEND:

- LB-5S ⊕ Monitoring Well Location, Alluvial Water–Bearing Zone
- LB-5D ⊗ Monitoring Well Location, Troutdale Aquifer
- LB-17I □ Monitoring Well Location, Middle of Alluvial Water–Bearing Zone
- Property Boundary
- Limit of Landfill Cover and Approximate Edge of Waste
- TP-19 Test Pit
- Approximate Extent of Area Burn Waste was Excavated.

SOURCE:

SCS ENGINEERS
Environmental Consultants and Contractors
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Portland, Oregon 97224
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NOTES:

1. Topography taken from Clark County GIS, December 2008.

0' 50' 100' 200'

SCALE: 1" = 100'

PREPARED FOR: CLARK COUNTY

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LEICHNER CAMPUS DEVELOPMENT
KOSKI PROPERTY

8713 NORTHEAST 94TH AVENUE
VANCOUVER, WASHINGTON

FIELD EXPLORATION MAP

PROJECT: 72971.006 PH 2

DATE: OCTOBER 2015

FIGURE: 1

ATTACHMENT A

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Table A-1
Terminology Used to Describe Soil

Soil Descriptions

Soils exist in mixtures with varying proportions of components. The predominant soil, i.e., greater than 50 percent based upon total dry weight, is the primary soil type and is capitalized in our log descriptions, e.g., SAND, GRAVEL, SILT or CLAY. Lesser percentages of other constituents in the soil mixture are indicated by use of modifier words in general accordance with the Visual-Manual Procedure (ASTM D2488-06). "General Accordance" means that certain local and common descriptive practices have been followed. In accordance with ASTM D2488-06, group symbols (such as GP or CH) are applied on that portion of the soil passing the 3-inch (75mm) sieve based upon visual examination. The following describes the use of soil names and modifying terms used to describe fine- and coarse-grained soils.

Fine - Grained Soils (More than 50% fines passing 0.075 mm, #200 sieve)
The primary soil type, i.e. SILT or CLAY is designated through visual – manual procedures to evaluate soil toughness, dilatency, dry strength, and plasticity. The following describes the terminology used to describe fine - grained soils, and varies from ASTM 2488 terminology in the use of some common terms.

Primary soil NAME, adjective and symbols			Plasticity Description	Plasticity Index (PI)
SILT ML & MH	**CLAY** CL & CH	**ORGANIC SILT & CLAY** OL & OH		
SILT		Organic SILT	Non-plastic	0 - 3
SILT		Organic SILT	Low plasticity	4 - 10
SILT / Elastic SILT	Lean CLAY	Organic clayey SILT	Medium Plasticity	10 – 20
Elastic SILT	Lean/Fat CLAY	Organic silty CLAY	High Plasticity	20 – 40
Elastic SILT	Fat CLAY	Organic CLAY	Very Plastic	>40

Modifying terms describing secondary constituents, estimated to 5 percent increments, are applied as follows:

Description	% Composition
With sand; with gravel (combined total greater than 15% but less than 30%, modifier is whichever is greater)	15% to 30%
Sandy; or gravelly (combined total greater than 30% but less than 50%, modifier is whichever is greater)	30% to 50%

Borderline Symbols, for example CH/MH, are used where soils are not distinctly in one category or where variable soil units contain more than one soil type. **Dual Symbols,** for example CL-ML, are used where two symbols are required in accordance with ASTM D2488.

Soil Consistency. Consistency terms are applied to fine-grained, plastic soils (i.e., PI $\geq$ 7). Descriptive terms are based on direct measure or correlation to the Standard Penetration Test N-value as determined by ASTM D1586-84, as follows. Note, SILT soils with low to non-plastic behavior (i.e. PI < 7) are classified using relative density.

Consistency Term	SPT N-value	Unconfined Compressive Strength tsf	Unconfined Compressive Strength kPa
Very soft	Less than 2	Less than 0.25	Less than 24
Soft	2 – 4	0.25 - 0.5	24 - 48
Medium stiff	5 – 8	0.5 - 1.0	48 – 96
Stiff	9 – 15	1.0 - 2.0	96 – 192
Very stiff	16 – 30	2.0 - 4.0	192 – 383
Hard	Over 30	Over 4.0	Over 383

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Table A-1
Terminology Used to Describe Soil

Soil Descriptions

Coarse - Grained Soils (less than 50% fines)
Coarse-grained soil descriptions, i.e., SAND or GRAVEL, are based on that portion of materials passing a 3-inch (75mm) sieve. Coarse-grained soil group symbols are applied in accordance with ASTM D2488-06 based upon the degree of grading, or distribution of grain sizes of the soil. For example, well graded sand containing a wide range of grain sizes is designated SW; poorly graded gravel, GP, contains high percentages of only certain grain sizes. Terms applied to grain sizes follow.

Material	Particle Diameter	
	Inches	Millimeters
Sand (S)	0.003 - 0.19	0.075 - 4.8
Gravel (G)	0.19 - 3.0	4.8 - 75
	Additional Constituents	
Cobble	3.0 - 12	75 - 300
Boulder	12 - 120	300 - 3050

The primary soil type is capitalized, and the amount of fines in the soil are described as indicated by the following examples. Other soil mixtures will provide similar descriptive names.

Example: Coarse-Grained Soil Descriptions with Fines

5% to less than 15% fines (Dual Symbols)	15% to less than 50% fines
GRAVEL with silt, GW-GM	Silty GRAVEL: GM
SAND with clay, SP-SC	Silty SAND: SM

Additional descriptive terminology applied to coarse-grained soils follow.

Example: Coarse-Grained Soil Descriptions with Other Coarse-Grained Constituents

Coarse-Grained Soil Containing Secondary Constituents	
With sand or with gravel	> 15% sand or gravel
With cobbles; with boulders	Any amount of cobbles or boulders.

Cobble and boulder deposits may include a description of the matrix soils, as defined above.

Relative Density terms are applied to granular, non-plastic soils based on direct measure or correlation to the Standard Penetration Test N-value as determined by ASTM D1586-84.

Relative Density Term	SPT N-value
Very loose	0 - 4
Loose	5 - 10
Medium dense	11 - 30
Dense	31 - 50
Very dense	> 50