Geotechnical Engineering Report

Proposed West Sound Utility District Well #22 Pump House
Port Orchard, Washington

July 29, 2016
Terracon Project No. 81155055

Prepared for:
BHC Consultants, Inc.
Seattle, Washington

Prepared by:
Terracon Consultants, Inc.
Seattle, Washington

July 29, 2016

BHC Consultants, Inc.
1604 Fifth Avenue, Suite 500
Seattle, Washington 98101

Attn: Mr. Jim Lutz, P.E., S.E.
P: [206] 505-3400
F: [573] 555-2323

Re: Geotechnical Engineering Report
Proposed West Sound Utility District Well #22 Pump House
Port Orchard, Washington
Terracon Project Number: 81155055

Dear Mr. Lutz:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above referenced project. This study was performed in general accordance with our proposal number P81150295 dated September 11, 2015. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs for the proposed project at 3550 Lund Avenue SE.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Tori Hesedahl

Tori Hesedahl, E.I.T.
Geotechnical Engineer

DAVID A. BASKA
STATE OF WASHINGTON
26027
REGISTERED
PROFESSIONAL ENGINEER
7/29/16

David Baska, Ph.D., P.E.
Principal

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EXECUTIVE SUMMARY

Terracon has completed a geotechnical engineering evaluation for the proposed construction of a new pump house. Our scope of services included geotechnical analysis and preparation of this report.

Based on the information obtained from our subsurface exploration, the site can be developed for the proposed project. The following geotechnical considerations were identified:

- ***Surface Conditions:*** The subject site is in a clearing atop a small hill.
- ***Soil Conditions:*** Subsurface soil consisted of medium dense to dense recessional outwash.
- ***Groundwater Conditions:*** Groundwater was not encountered in our boring at the time of exploration.
- ***Pump House Foundations:*** The pump house can be supported on shallow foundations bearing on prepared subgrade. We predict less than one inch of settlement, most of which will occur during construction.
- ***Construction:*** Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support. We therefore recommend that Terracon be retained to monitor this portion of the work.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

GEOTECHNICAL ENGINEERING REPORT
PROPOSED WEST SOUND UTILITY DISTRICT
WELL #22 PUMP HOUSE
PORT ORCHARD, WASHINGTON

Terracon Project No. 81155055
July 29, 2016

1.0 INTRODUCTION

Terracon Consultants, Inc. (Terracon) is pleased to present the results of our geotechnical engineering services for the proposed West Sound Utility District Pump Station. The site is located at 3550 Lund Avenue SE, Port Orchard, Washington. A log of the site exploration along with a site location map and exploration plan are included in Appendix A of this report.

Our services included a review of existing geologic and geotechnical information, subsurface exploration, geotechnical engineering analyses, and preparation of this report. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- seismic considerations
- shallow foundation design and construction
- groundwater conditions
- earthwork
- slab design and construction

2.0 PROJECT INFORMATION

2.1 Project Description

Item	Description
Site layout	See Appendix A, Exhibit A-2: Exploration Plan
Structure	Estimated 20 foot by 20 foot Concrete Masonry Unit block (CMU) structure housing a pump station
Building Construction	Estimated 20 foot by 20 foot Concrete Masonry Unit block (CMU) structure
Finished floor elevation	Approximately 360 feet
Assumed Maximum loads	Perimeter Strip Footing: 1.5 klf Slabs: 125 psf max
Grading	Minimal site grading is anticipated

2.2 Site Location and Description

Item	Description
Location	3550 Lund Avenue SE, Port Orchard, Washington
Existing improvements	Well #22 and Well #9R Power box
Current ground cover	Sparsely vegetated clearing surrounded by trees
Existing topography	Gently sloping down to the west in the clearing. Drive way slopes down from clearing to Lund Avenue SE at approximately 2H : 1V.

3.0 SUBSURFACE CONDITIONS

3.1 Geology

The Geologic Map of Kitsap County, Washington (Upson and Sceva 1957) shows the surficial geology for the site is mapped as Qvt – Continental Glacial Till of the Vashon Stade and Fraser-age. Pleistocene glacial till consists of clay, silt, sand, gravel, cobbles and boulders that were deposited by continental glaciers.

Surficial geology is mapped nearby as Qvo – Recessional Outwash of the Vashon Stade and Fraser-age. Pleistocene recessional outwash consists of sand, gravel, cobbles, and boulders that were deposited by receeding glaciers. The soils observed in our exploration are consistent with the Qvo deposits mapped nearby.

3.2 Typical Profile

Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
1	Deeper than 16.5 feet	silty sand	Medium Dense to Dense

Conditions encountered at the boring location are indicated on the boring log. Stratification boundaries on the boring log represent the approximate location of changes in soil types; in situ, the transition between materials may be gradual. Details for the boring can be found on the boring log in Appendix A of this report.

3.3 Groundwater

Groundwater seepage was not observed in our exploration. Groundwater levels can be expected to vary seasonally and from year to year depending on precipitation, site utilization, and other on- and off-site factors.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

Based on the results of the subsurface exploration, laboratory testing, and our analyses, it is our opinion that the proposed pump station can be supported on shallow foundations that bear on undisturbed native recessional outwash soil or newly placed compacted structural fill following removal of loose surficial soils.

ASTM and Washington State Department of Transportation (WSDOT) specification codes cited herein respectively refer to the current manual published by the American Society for Testing & Materials and the 2014 edition of the WSDOT *Standard Specifications for Road, Bridge, and Municipal Construction* (Publication M41-10).

4.1 Earthwork

Based on the subsurface conditions encountered in our exploration, we expect that all of the on-site soils within the limits of construction can be removed with conventional excavation equipment. Cobbles and boulders were not observed in our exploration but are often found in recessional outwash. The contractor should be prepared to deal with cobbles and boulders. Recommendations for site preparation, structural fill, and permanent slopes are presented below.

4.1.1 Site Preparation

Prior to equipment arriving onsite, clearing and grading limits should be established and marked. Silt fences should be constructed along the downslope side of all areas planned for clearing and grading. Preparation for site grading and construction should begin with procedures intended to control surface water runoff. The sandy site soils are moderately susceptible to erosion by flowing water. We anticipate that the use of shallow ditches, with sumps and pumps as needed, will be adequate for surface water control during wet weather and wet site conditions.

Stripping efforts should include removal of vegetation, organic materials, and any deleterious debris from the pump station area. It appears that up to about 0.5 feet of stripping will be necessary in areas with light vegetation. Greater depths of stripping and grubbing may be necessary in areas with thick vegetation and tree roots. These materials are not suitable for reuse as structural fill. Site disturbance beyond the work area should be limited to reduce the potential for erosion and off-site sediment transport. Disturbance of existing vegetation and soil structure on and above the approximately 2H:1V slope up from Lund Avenue should be avoided if at all practical; if disturbance is necessary the area should be restored with landscaping, or paving with stormwater diversion as soon as possible.

Areas that are stripped or excavated to the design subgrade elevation, or that are to receive structural fill, should be proofrolled with heavy rubber-tired construction equipment (e.g. loaded dump truck). Any soft, loose, or otherwise unsuitable areas identified during proofrolling should be recompacted if practical or removed and replaced with structural fill. We recommend that proofrolling of the subgrade be observed by a representative of our firm to assess the adequacy of the subgrade conditions and identify areas needing remedial work. We recommend that this procedure not be performed during wet weather. During wet conditions, systematic probing should be used to evaluate the subgrade.

4.1.2 Temporary Cut Slopes

We anticipate that temporary open cuts and/or trenches will be utilized during construction of the project. Temporary slope stability is a function of many factors, including the following:

- The presence and abundance of groundwater
- The type and density of the various soil strata
- The depth of cut
- Surcharge loading adjacent to the excavation
- The length of time the excavation remains open

It is exceedingly difficult under the variable circumstances to pre-establish a safe and “maintenance-free” temporary cut slope angle. Therefore, it should be the responsibility of the contractor to maintain safe slope configurations since the contractor is continuously at the job site, able to observe the nature and condition of the cut slopes, and able to monitor the subsurface materials and groundwater conditions encountered. It may be necessary to drape temporary slopes with plastic or to otherwise protect the slopes from the elements and minimize sloughing and erosion. We do not recommend vertical slopes or cuts deeper than 4 feet if worker access is necessary. The cuts should be adequately sloped or supported to prevent injury to personnel from local sloughing and spalling. The excavations should conform to applicable Federal, State, and local regulations.

4.1.3 Material Requirements

Compacted structural fill should meet the following material property requirements:

Fill Type	WSDOT Standard Specification	Acceptable Location for Placement
Structural Fill	9-03.12(1)A *Gravel Backfill for Foundations Class A* 9-03.9(1) *Ballast* 9-03.9(3) *Crushed Surfacing Base Course* Native gravelly sand[1]	Beneath and adjacent to pump station slab and foundation
Trench Backfill	Native silty sand[1]	Utility Trenches

1. Fines content of near surface native silty sand make this material moisture sensitive and therefore unsuitable for use during periods of wet weather.

4.1.4 Compaction Requirements

Item	Description
Fill Lift Thickness	8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used
Minimum Compaction Requirements	Minimum 95% of the material's maximum modified Proctor dry density (ASTM D 1557)
Moisture Content – Granular Material	Workable moisture levels [1]

1. Typically within 2% of optimum

4.1.5 Utility Trench Backfill

Native soils excavated from utility trenches may be used as backfill. The placement and compaction requirements of Section 4.1.4 should be followed, except that in landscape areas minimum compaction should be 90% of maximum modified Proctor dry density.

4.1.6 Earthwork Construction Considerations

Fill placed on existing slopes that are steeper than 4H:1V should be keyed and benched into the slope. These areas should be completely stripped of topsoil and very loose to loose, weathered recessional outwash, exposing the medium dense to dense recessional outwash. The benches should be excavated flat for minimum bench widths of 5 feet, vertical steps no taller than 3 feet in height, and expose the competent soil in the entire bench width. The key should be excavated at least 1 foot into the medium dense recessional outwash. We recommend a Terracon representative observe the base of the prepared surface to verify that these recommendations are followed. The purpose of these recommendations is to prevent construction of an unstable slope. Loose soil zones left beneath fill slopes can be a potential slip zone especially during wet weather when the fill could potentially become saturated.

4.1.7 Wet Weather Earthwork

The near surface, native, recessional outwash soil has appreciable fines content based on our visual observations and lab testing and is considered to be moisture sensitive. The soil has a low to moderate erosion potential in-place and may be transported by running water. Therefore, silt fences and other measures will be necessary to control erosion and sediment transport during construction. The forest duff sod and topsoil act as protective layers to surface erosion and should be removed only where and when necessary.

The suitability of soils used for structural fill depends primarily on their grain-size distribution and moisture content when they are placed. As the fines content (that soil fraction passing the U.S. No. 200 Sieve) increases, soils become more sensitive to small changes in moisture content. Soils containing more than about 5 percent fines (by weight) cannot be consistently compacted to a firm, unyielding condition when the moisture content is more than 2 percentage points above or below optimum. Optimum moisture content is the moisture content at which the maximum dry density for the material is achieved in the laboratory following ASTM procedures.

If inclement weather or in situ soil moisture content prevents the use of on-site material as structural fill, we recommend the use of import granular fill containing less than 5 percent by weight passing the U.S. No. 200 sieve, based on the fraction passing the U.S. No. 4 sieve.

We recommend that all stockpiled soils for use as structural fill be protected with polyethylene sheeting anchored to withstand local wind conditions.

4.2 Foundations

Our understanding of the project is that the pump station will be founded on a perimeter strip footing with about 3 feet of embedment below finish grade around the structure.

DESCRIPTION	
Net allowable bearing pressure [1]	3,000 psf
Minimum dimensions	16 inches
Minimum embedment below finished exterior grade for perimeter footing [2]	18 inches
Approximate total settlement [3]	<1 inch
Estimated differential settlement [3]	<½ inch
Ultimate coefficient of sliding friction	0.50

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Assumes any unsuitable fill or soft soils, if encountered, will be removed and replaced with structural fill.
2. For frost protection and to reduce the effects of seasonal moisture variations in the subgrade soils.
3. The foundation settlement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of compacted fill, and the quality of the earthwork operations.

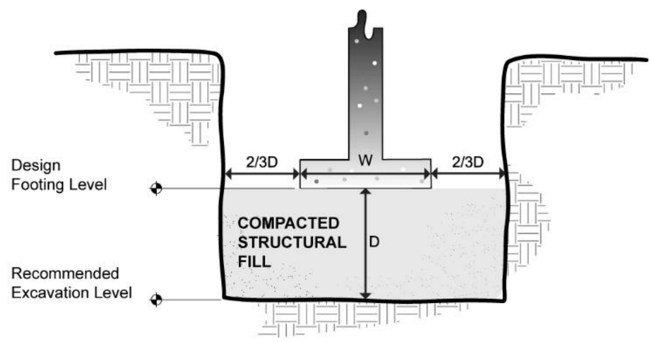
The allowable foundation bearing pressures apply to dead loads plus design live load conditions. The design bearing pressure may be increased by one-third when considering total loads that include wind or seismic conditions. The weight of the foundation concrete below grade may be neglected in dead load computations.

Footings and masonry walls should be reinforced as necessary to reduce the potential for distress caused by differential foundation movement. The use of joints at openings or other discontinuities in masonry walls is recommended.

4.2.1 Foundation Construction Considerations

Foundation preparation for the pump station on the site should include removal of all topsoil and roots. The exposed soil should either be compacted in place to achieve a compacted density of at least 95 percent of the modified Proctor maximum dry density (ASTM D 1557), or the loose soil removed and replaced with compacted structural fill in accordance with the recommendations of Section 4.1 of this report.

If unsuitable bearing soils are encountered in footing excavations, the footings could bear on properly compacted structural backfill extending down to the suitable soils. Overexcavation for compacted structural fill placement below footings should extend laterally beyond all edges of the footings at least 8 inches per foot of overexcavation depth below footing base elevation. The overexcavation should then be backfilled up to the footing base elevation with well graded granular material placed in lifts of 8 inches or less in loose thickness (4 inches or less if using hand-guided compaction equipment) and compacted to at least 95 percent of the material's modified effort maximum dry density (ASTM D 1557). The overexcavation and backfill procedure is described in the following figure.



Overexcavation / Backfill

Note: Excavation in sketch shown vertical for convenience. Excavations should be sloped as necessary for safety.

Foundation excavations should be observed by a Terracon representative. If the soil conditions encountered differ from those presented in this report, supplemental recommendations will be required.

4.3 Floor Slabs

We recommend complete removal of topsoil or loose surficial soil encountered below the proposed pump station as described above for the foundation subgrades. If necessary to raise grade, removed soils should be replaced with structural fill placed and compacted in accordance with the Earthwork section of this report. A subgrade prepared and tested as recommended in this report should provide adequate support for lightly loaded floor slabs.

DESCRIPTION	RECOMMENDATION
Interior floor system	Slab-on-grade concrete.
Floor slab support [1]	Structural fill placed and compacted in accordance with the Section 4.1 of this report or undisturbed native recessional outwash soil.
Base course [2]	4-inch compacted layer of free draining, uniform gravel

DESCRIPTION	RECOMMENDATION
Modulus of subgrade reaction	300 pounds per square inch per inch (psi/in) for point loading conditions

1. Floor slabs should be structurally independent of any building footings or walls to reduce floor slab cracking caused by differential movements between the slab and foundation. Narrower, turned-down slab-on-grade foundations may be utilized at the approval of the structural engineer. The slabs should be appropriately reinforced to support the proposed loads.
2. The base course serves as a capillary break, drainage layer, a leveling layer, and a bearing layer.

We recommend subgrades be maintained at the proper moisture condition until floor slabs are constructed. If the subgrade should become desiccated prior to construction of floor slabs, the affected material should be removed or the materials scarified, moistened, and recompacted. Upon completion of grading operations in the building areas, care should be taken to maintain the recommended subgrade moisture content and density prior to construction of the building floor slabs.

Where appropriate, saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations refer to the ACI Design Manual.

4.4 Seismic Considerations

IBC seismic design parameters were determined for the site using the USGS Interactive Design Map tool available online at (http://earthquake.usgs.gov/designmaps/us/application.php) accessed on November 3, 2015. Values are summarized in the table below.

Code Used	Site Classification
2012 International Building Code (IBC) and 2010 ASCE 7 [1]	D [2]
Site Latitude	47.52286°N
Site Longitude	122.60228°W
S_s – Short Period Spectral Acceleration for Site Class B	1.576 g
S_1 – 1-Second Period Spectral Acceleration for Site Class B	0.602 g
F_a – Short Period Site Coefficient	1.0
F_v – 1-Second Period Site Coefficient	1.5

1. The 2012 International Building Code and 2010 ASCE 7 document indicates that the seismic site classification is based on the average soil and bedrock properties in the top 100 feet. The current

scope does not include a 100-foot soil profile determination. This seismic site class definition considers that soils encountered at depth in our boring continue below the termination depth. Additional exploration to deeper depths would be required to confirm the conditions below the current depth of exploration.

2. Site Class D applies to an average soil profile within the top 100 feet consisting predominantly of stiff soil. These soils are characterized by Standard Penetration Test blow counts of between 15 and 50, a shear wave velocity of between 600 and 1,200 feet per second, and an undrained shear strength of between 1,000 and 2,000 pounds per square foot.

Risk of damage from onsite fault rupture appears to be low based on review of the Washington State Department of Natural Resources Geologic Hazards interactive map accessed on November 3, 2015. The closest mapped fault is the Seattle fault zone. The closest estimation of the trace of this fault lies approximately 2 miles to the north.

The term liquefaction refers to a phenomenon by which saturated soils develop high pore water pressures during seismic shaking and, as a result, lose their strength characteristics. This phenomenon generally occurs in areas of high seismicity, where groundwater is relatively shallow and where loose granular soils (mainly sands) or non-plastic fine-grained soils (mainly silts) are present. Ground water was not encountered in our exploratory boring. The well log indicates that depth to groundwater is at least 50 feet below ground surface. Considering depth to groundwater and assuming that the soil below our exploration is at least as dense as the soil encountered in our boring, our opinion is that risk from liquefaction is low.

5.0 GENERAL COMMENTS

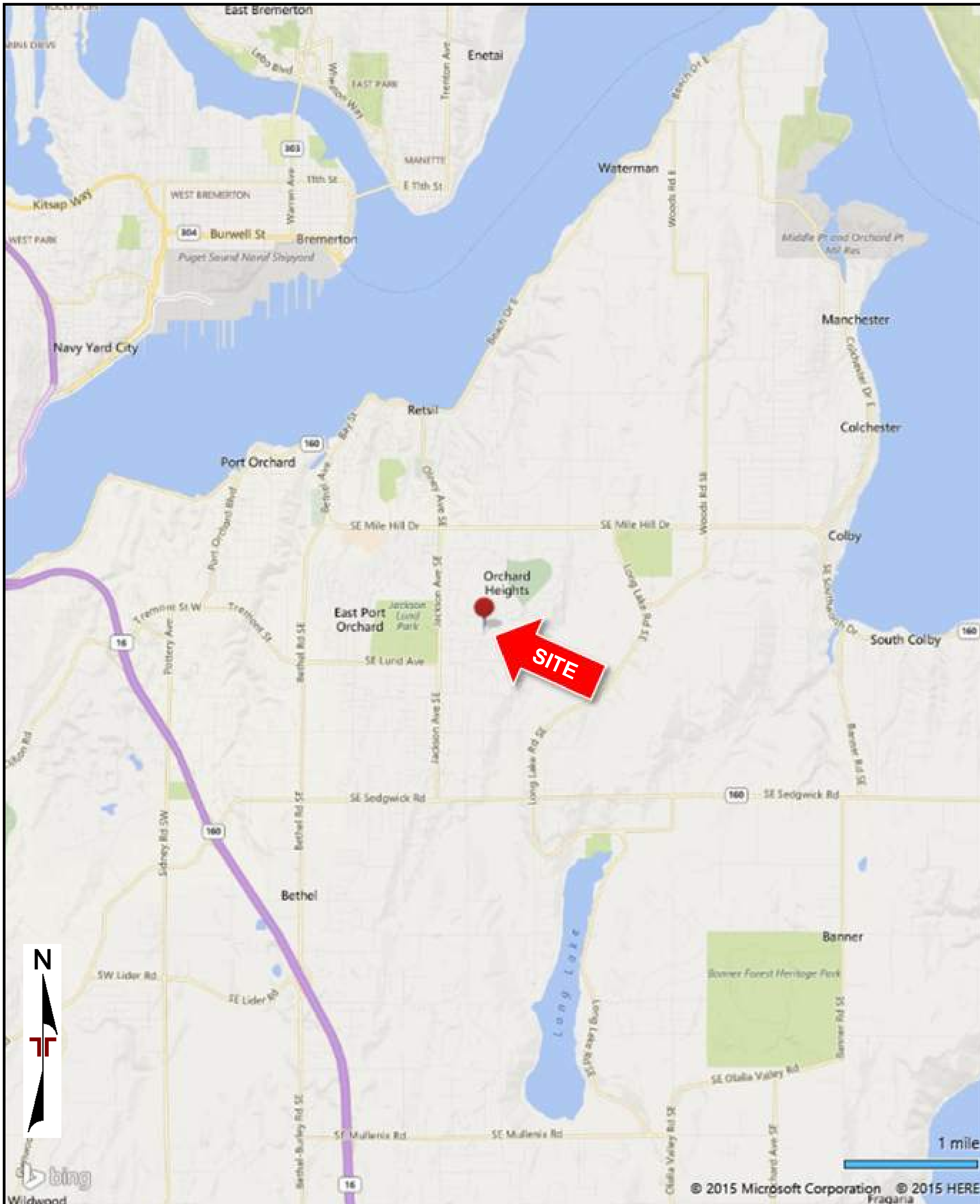
Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the boring performed at the indicated location and from other information discussed in this report. This report does not reflect variations that may occur across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, and bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
QUADRANGLES INCLUDE: BREMERTON WEST, WA (1/1/1981) and BREMERTON EAST, WA (1/1/1981).

Project Manager: D. Baska	Project No. 81155055	Terracon	SITE LOCATION	Exhibit
Drawn by: T. Hesedahl	Scale: AS SHOWN	21905 64th Ave W Suite 100	Proposed West Sound Utility District Pump Station	A-1
Checked by: D. Baska	File Name: Exh 1.docx	Mountlake Terrace, WA 98043	**3550 Lund Ave SE**	
Approved by: D. Baska	Date: 11/2015		**Port Orchard, WA**	

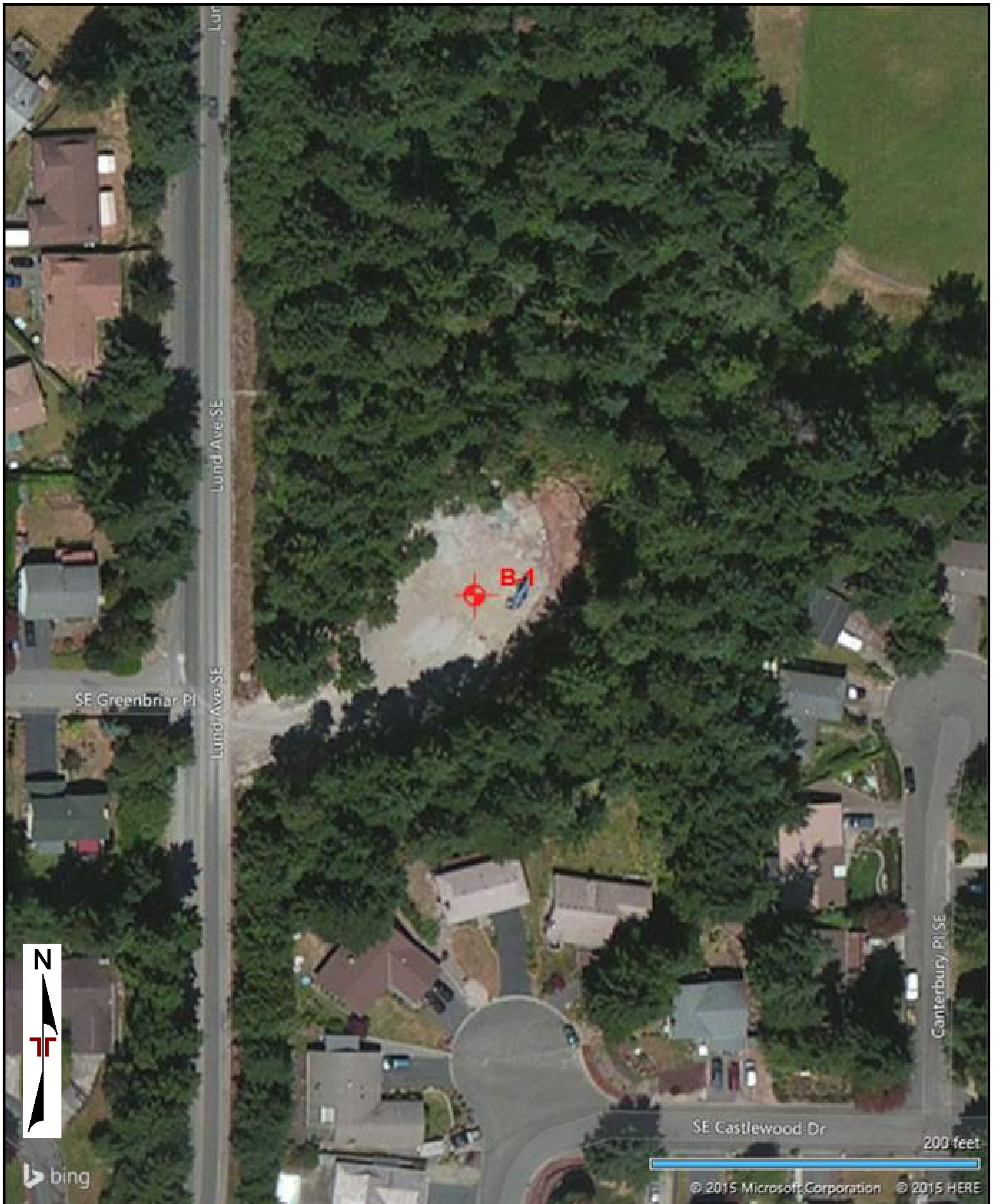


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

Project Manager: D. Baska	Project No. 81155055	Terracon	EXPLORATION PLAN	Exhibit
Drawn by: T. Hesedahl	Scale: AS SHOWN	21905 64th Ave W Suite 100	Proposed West Sound Utility District Pump Station	A-2
Checked by: D. Baska	File Name: Exh 2.docx	Mountlake Terrace, WA 98043	3550 Lund Ave SE	
Approved by: D. Baska	Date: 11/2015		Port Orchard, WA	

Field Exploration Description

The proposed boring location was laid out in the field by a Terracon representative using a scaled site plan provided by the client and utilizing hand-held GPS equipment. Ground surface elevation indicated on the boring log was measured in the field using a surveyor's level and grade rod. The elevation is referenced to the ground surface elevation indicated on the Well #22 well log, and is rounded to the nearest ½ foot. The locations and elevations of the borings should be considered accurate only to the degree implied by the means and methods used to define them.

The boring was drilled with a track-mounted rotary drill rig using continuous flight hollow-stem augers to advance the borehole. Samples of the soil encountered in the boring were obtained using the split-barrel sampling procedures.

In the split-barrel sampling procedure, the number of blows required to advance a standard 2-inch O.D. split-barrel sampler the last 12 inches of the typical total 18-inch penetration by means of a 140-pound hammer with a free fall of 30 inches, is the standard penetration resistance value (SPT-N). This value is used to estimate the in situ relative density of cohesionless soils and consistency of cohesive soils.

An automatic SPT hammer was used to advance the split-barrel sampler in the borings performed on this site. A significantly greater efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. This higher efficiency has an appreciable effect on the SPT-N value. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Information provided on the boring log attached to this report includes soil descriptions, consistency evaluations, boring depth, sampling intervals, and groundwater conditions. The boring was backfilled with bentonite chips prior to the drill crew leaving the site.

A field log of the boring was prepared by a geotechnical engineer. The log included visual classifications of the materials encountered during drilling as well as the driller's interpretation of the subsurface conditions between samples. The final boring log included with this report represent the engineer's interpretation of the field log and include modifications based on laboratory observation and tests of the samples.

BORING LOG NO. B-1

PROJECT: Proposed West Sound Utility District Pump Station

CLIENT: BHC Consultants
Seattle, Washington

SITE: 3550 Lund Avenue SE
Port Orchard, Washington

LOCATION See Exhibit A-2

Latitude: 47.522859° Longitude: -122.602283°

Approximate Surface Elev: 362 (Ft.) +/-

DEPTH / DESCRIPTION / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE ID	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
SILTY SAND (SM), trace gravel, fine to medium, light yellow brown, medium dense to dense, moist										
gravelly cuttings										
			X	18	8-12-12 N=24	S-1	8			18
	5		X	18	8-13-20 N=33	S-2				
with gravel			X	18	10-16-11 N=27	S-3	8			17
10.0 — 352+/-	10									
POORLY GRADED SAND (SP), trace silt and gravel, fine to medium, light olive gray, medium dense to dense, moist			X	18	6-12-16 N=28	S-4				
			X	14	10-16-17 N=33	S-5				
	15		X	14	9-11-13 N=24	S-6	3			4
16.5 — 345.5+/-										
Boring Terminated at 16.5 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
HSA 3 1/4" ID

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Exhibit A-3 for description of field procedures

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater seepage not observed

Terracon
21905 64th Ave. W, Suite 100
Mountlake Terrace, Washington

Boring Started: 10/29/2015	Boring Completed: 10/29/2015
Drill Rig: D-50 track	Driller: Holocene
Project No.: 81155055	Exhibit: A-4

APPENDIX B
LABORATORY TESTING

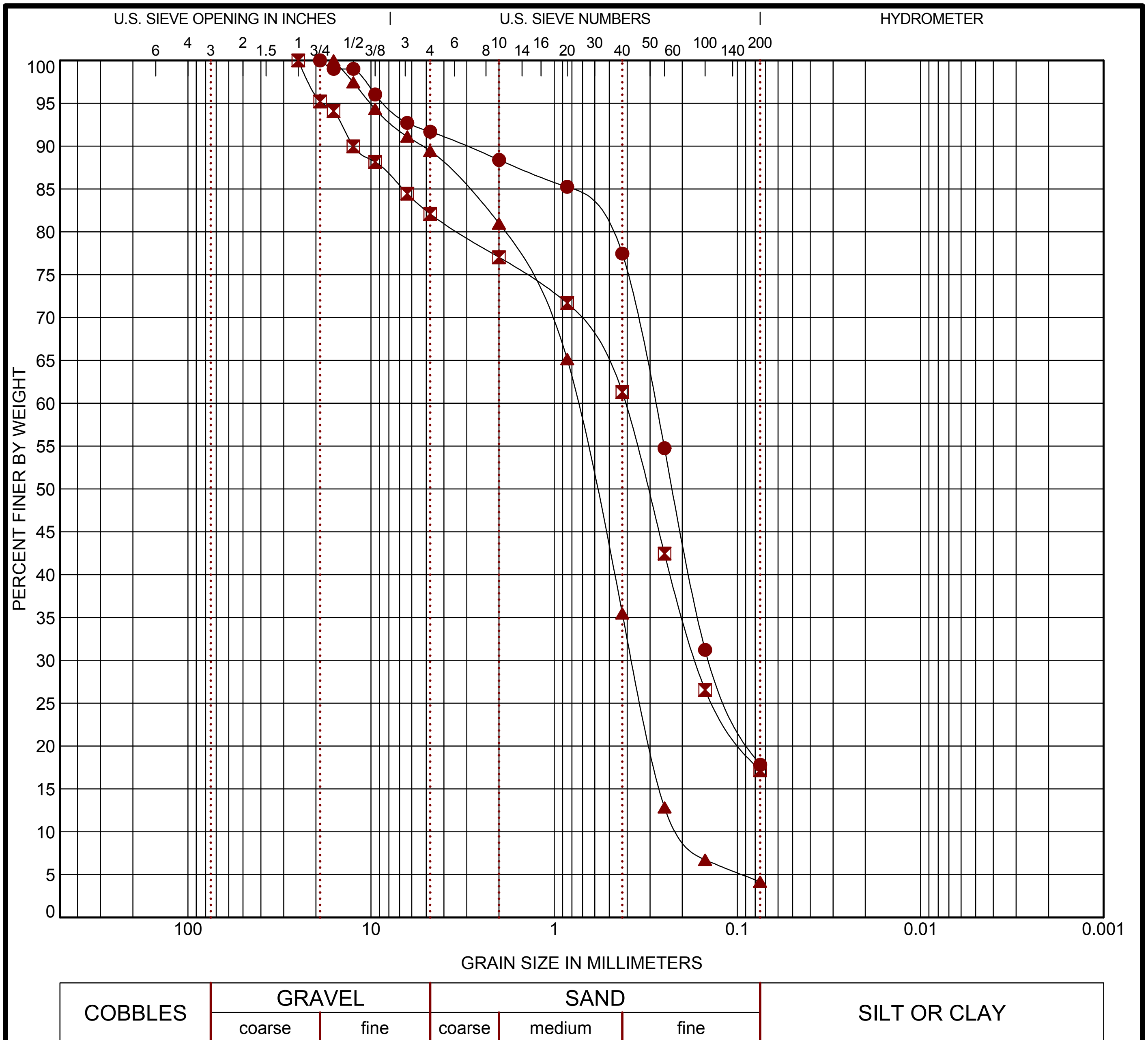
Laboratory Testing

Soil samples were tested in the laboratory to measure their natural water content. The test results are provided on the boring log included in Appendix A.

Descriptive classifications of the soils indicated on the boring log are in accordance with the enclosed General Notes and the Unified Soil Classification System. Also shown are estimated Unified Soil Classification Symbols. A brief description of this classification system is attached to this report. All classification was by visual manual procedures. Selected samples were further classified using the results of grain size distribution testing. The percent finer than the U.S. Standard No. 200 sieve results are provided on the boring log. Grain size distribution plots are included in this appendix.

GRAIN SIZE DISTRIBUTION

ASTM D422



Boring ID	Depth	USCS Classification	LL	PL	PI	Cc	Cu
● B-1	2.5 - 4	SILTY SAND(SM)					
⊠ B-1	7.5 - 9	SILTY SAND(SM)					
▲ B-1	15 - 16.5	POORLY GRADED SAND(SP)				0.94	3.82

Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Fines
● B-1	2.5 - 4	19	0.283	0.141		8.3	73.9	17.8
⊠ B-1	7.5 - 9	25	0.41	0.168		17.9	64.9	17.2
▲ B-1	15 - 16.5	16	0.754	0.374	0.197	10.6	85.3	4.2

PROJECT: Proposed West Sound Utility District Pump Station

SITE: 3550 Lund Avenue SE
Port Orchard, Washington

Terracon
21905 64th Ave. W, Suite 100
Mountlake Terrace, Washington

PROJECT NUMBER: 81155055

CLIENT: BHC Consultants
Seattle, Washington

EXHIBIT: B-2

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING		WATER LEVEL			FIELD TESTS		
	Standard Penetration Test		▽	**Water Initially Encountered**		**N**	**Standard Penetration Test Resistance (Blows/Ft.)**
			▽	**Water Level After a Specified Period of Time**		**(HP)**	**Hand Penetrometer**
			▼	**Water Level After a Specified Period of Time**		**(T)**	**Torvane**
				Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.		**(DCP)**	**Dynamic Cone Penetrometer**
						(PID)	**Photo-Ionization Detector**
						(OVA)	**Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		**CONSISTENCY OF FINE-GRAINED SOILS** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (psf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 500	0 - 1
Loose	4 - 9	Soft	500 to 1,000	2 - 4
Medium Dense	10 - 29	Medium Stiff	1,000 to 2,000	4 - 8
Dense	30 - 50	Stiff	2,000 to 4,000	8 - 15
Very Dense	> 50	Very Stiff	4,000 to 8,000	15 - 30
		Hard	> 8,000	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

Terracon

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification: Group Symbol	Soil Classification: Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	$PI > 7$ and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			$PI < 4$ or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10} \qquad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains $\geq$ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains $\geq$ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains $\geq$ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains $\geq$ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] $PI \geq 4$ and plots on or above "A" line.
[O] $PI < 4$ or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.