



HYDROGEOLOGIC STUDY  
SCOPE OF WORK  
Pulver Road Vegetable Cooling Facility  
Permit No. ST0501320  
June 5, 2025

### **3.4. Hydrogeologic Characterization (Standardized HG Report)**

#### **3.4.1. Previous HG Reports and Investigations**

1. Please review the original HG Report issued Dec 23, 2020. All work performed was and is in accordance with the original application declaration. All samples and lab test results have been documented in the Wastewater Secure Access portal per the scope of work outlined in permit ST0501320.
2. Please review the attached lab QA and QC methods for sample quality and reliability.
3. Data results are available in Wastewater Secure Access portal.

#### **3.4.2 Regional Geology and Hydrogeology**

##### **1. Site description**

The site is located in the Lower Skagit Valley approximately 1 mile west-northwest of Burlington and 0.65 miles west of Interstate 5. The land application area covers approximately 1.7 acres in the north-central portion of the site (Figure 3), and is divided into a main land application area of roughly 1.5 acres, and a smaller supplemental area of 0.2 acres (Figure 3). The western half of the site is occupied by the Facility. A stormwater infiltration pond occupies the south-central portion of the site, directly south of the land application area. The land application area is bordered by agricultural fields to the north and east. Another agricultural field is present to the west across Pulver Road. A single-family residence with active agricultural fields borders the site to the south. Land surface is relatively flat across the site and the land application area with elevations ranging from approximately 22 to 27 feet above the North American Vertical Datum.

##### **2. Geology**

The site is located within the wide, relatively flat Lower Skagit Valley. Geologic mapping completed by the United States Geological Survey (Dethier and Whetten, 1981. Pessl et al., 1989) and the Washington State Department of Natural Resources (Dragovich et al., 2000) indicates that the site is primarily underlain by Holocene alluvium (Qal). The alluvium is described as fluvial and deltaic silt, clay, and fine sand associated with the present and ancient Skagit River. The Vashon recessional outwash (Qvr) likely underlies the Qal. Identifying the outwash in well logs is challenging because of its similarity to the Qal. Combined, the Qal and Qvr are over 100 feet thick near the site (Savoca et al., 2009). Well logs for nearby wells (Figure 4), accessed through Ecology's Well Report Viewer (Ecology, 2018), support this conclusion. GTS encountered the alluvium within all explorations below the agricultural soil/topsoil and native fill. Exploration logs (available in Appendix A) describe the alluvium as varying from soft to stiff, slightly sandy to very sandy silt to very loose to medium dense, silty to very silty sand. Occasional wood debris is noted in several logs 20 to 40 feet below ground surface.

##### **3. Regional Groundwater Flow**

Regional groundwater flow studies by Savoca et al. (2009), and Savoca, Johnson, and Fasser (2009) indicate a westward gradient toward Padilla Bay within the Qago. Groundwater levels near the Facility appear to be approximately 8 feet below ground surface (bgs) on average. Water levels within the Qago vary seasonally, mainly in response to changes in precipitation. Water levels rise in the autumn and winter (during

the wet season) and fall during the spring and summer (the dry season). Wells near the site exhibited seasonal variations of up to 10 feet during the study period.

### **3.4.3 Site Hydrogeologic Conditions**

Please review Wastewater Secure Access portal for all well water testing results. Field investigation did not identify issues with wastewater discharge area. Wells were installed by a certified third party contractor and appear in excellent condition  
Discharge area appears consistent with its original appearance.

#### **3.4.3.1 Site characterization**

No natural surface water occurs on the site. A network of nearby drainage ditches, the nearest of which runs along Pulver Road at the western edge of the site, conveys runs off approximately 3 miles to Joe Leary Slough. Joe Leary Slough eventually empties into Padilla Bay

#### **3.4.3.2 Location and construction of existing wells**

N/A. No existing wells existed within the discharge area.

#### **3.4.3.3 3.4.3.3 Location and construction of new wells**

Well location and construction were constructed per original scope of work submitted as part of the original Wastewater discharge permit.

Original Hydrogeological Study:

3.1 Task 1.

A third party licensed contractor performed the installation. Soil composition reports are available upon request.

Well GPS locations are attached

### **3.4.4 Groundwater Flow System**

Groundwater depth is measured and reported per the original discharge permit requirements. All recordings are entered in the Wastewater Secure Access portal.

### **3.4.5 Hydrogeologic Parameters**

Parameters are part of the original scope of work and can be referenced. Flow direction and rates are addressed within the original scope of the report.

### **3.4.6 Conceptual Site Model**

This requirement is addressed as part of the original Hydrogeological report.

Page 23, 25, 26 and 27.

### **3.4.7 Background Groundwater Quality**

Groundwater samples are pulled and tested per the original Wastewater Discharge Permit.

All lab testing and validation statements are attached for review. Third party laboratory performed all parameter testing.

#### **3.4.8 Surface and Groundwater Connectivity**

See the site plan identifying all surface water locations and proximity to the wastewater discharge site.

Pages 25,26 and 27

#### **3.5 Topography**

See the site plan identifying all surface water locations and proximity to the wastewater discharge site.

Pages 25,26 and 27

#### **3.6 Zoning and Human Infrastructure Considerations**

See the original Hydrogeological Report. All physical characteristics are addressed in the original report.

##### **3.6.1 Site Buffers**

Site plan with surrounding characteristics are part of the original scope of work.

##### **3.6.2 Well Head and Critical Aquifer Recharge Areas**

All impacted areas were identified in the original scope of the Hydrogeological report.

##### **3.6.3 Area Impacted**

Impact areas were identified in the original Hydrogeological assessment.

##### **3.6.4 Beneficial Uses**

The wastewater discharge site consists of a grass covered area of ground. The wastewater irrigates the grass and is mechanically maintained and not for the purpose of growing agriculture commodities or provide sustenance for livestock.



# HYDROGEOLOGIC STUDY SCOPE OF WORK

Pulver Road Vegetable Cooling Facility  
Prepared for: Skagit Valley Farm Cooling

Permit No. ST0501320 • December 23, 2020 FINAL  
Project No. 170466



e a r t h + w a t e r



# HYDROGEOLOGIC STUDY SCOPE OF WORK

## Pulver Road Vegetable Cooling Facility

Prepared for: Skagit Valley Farm Cooling

Permit No. ST0501320 • December 23, 2020 FINAL  
Project No. 170466

Aspect Consulting, LLC

**Owen G. Reese, PE**  
Sr. Associate Water Resources Engineer  
oreese@aspectconsulting.com

**James Bush, LHG**  
Project Hydrogeologist  
jbush@aspectconsulting.com

V:\170466 Confidential Vegetable Storage Facility\Deliverables\HG Study Scope of Work\Final\HG Study Scope of Work\_Final\_12232020.docx



# Contents

<b>1</b>	<b>Introduction .....</b>	<b>1</b>
<b>2</b>	<b>Site Conditions .....</b>	<b>2</b>
2.1	Facility Description .....	2
	History.....	2
	Industrial Process and Wastewater Quantities.....	2
	Wastewater Treatment and Discharge .....	3
	Wastewater Characterization .....	3
2.2	Site Description .....	4
	Surface Conditions .....	4
	Soils.....	5
	Geology.....	5
	Climate.....	6
	Surface Water .....	6
2.3	Site Hydrogeology.....	6
	Hydrogeologic Units .....	6
	Regional Groundwater Flow.....	6
	Site-Specific Groundwater Data .....	6
	Groundwater Use .....	7
<b>3</b>	<b>Scope of Work .....</b>	<b>8</b>
3.1	Task 1 – Drilling and Monitoring Well Installation .....	8
	Well Siting.....	8
	Well Drilling, Construction, and Development .....	9
	Locational Survey.....	9
3.2	Task 2 – Groundwater Monitoring.....	9
3.3	Task 3 – Groundwater Quality Evaluation Report.....	10
3.4	Schedule .....	10
	<b>References .....</b>	<b>12</b>
	<b>Limitations.....</b>	<b>14</b>

## List of Tables

---

1	Wastewater Generation and Land Application Calculations – Initial Scenario	
2	Wastewater Generation and Land Application Calculations – Future Growth Scenario	
3	Wastewater Characterization.....	4
4	Groundwater Sampling Purge Stabilization Criteria.....	10
5	Implementation Schedule .....	11

## List of Figures

---

1	Vicinity Map
2	Process Flow Diagram
3	Site Map
4	Water Well Inventory
5	Surface Water Drainage

## List of Appendices

---

A	Geotechnical Engineering Report (GTS, 2018)
---	---

# 1 Introduction

This Scope of Work (Scope) presents a plan for completing a groundwater quality study of the wastewater land application site at Skagit Valley Farm Cooling, LLC's (SVFC) new vegetable cooling facility located at 11263 Pulver Road in Burlington, Washington (Facility). A map of the Facility and vicinity is provided in Figure 1. The Washington State Department of Ecology (Ecology) recently issued State Waste Discharge Permit ST0501320 (Permit), allowing SVFC to land apply wastewater at the Facility effective July 1, 2020.

Condition S9 of the Permit requires that SVFC conduct a hydrogeologic study to "evaluate the impacts of its activities on groundwater quality" and outlines a three-step process of:

1. *By **January 1, 2021**, the Permittee must submit a scope of work to Ecology for a groundwater quality evaluation study at the wastewater application site, in general accordance with WAC 173-200-080. The scope of work must conform to Guidelines for Preparation of Engineering Reports for Industrial Wastewater Land Application Systems, Ecology 1993.*
2. *Upon approval of the scope of work by Ecology, the Permittee must conduct a study to determine site-specific hydrogeologic conditions, well siting, quality control protocols, and a sampling plan and sampling protocols. The Permittee must submit a report of the results within 180 days of approval of the scope of work.*
3. *Within one-hundred twenty days (120) after review and approval of the final report by Ecology, the Permittee must begin construction of the groundwater monitoring network. The Permittee must construct wells in accordance with Chapter 173-160 WAC. After completion of the installation of the groundwater monitoring network, the Permittee must notify Ecology and begin monitoring according to S2. Notification can be by electronic mail and also reported in the Annual Irrigation Report for the year the work is completed."*

This Scope addresses Step 1 of Condition S9 and should be submitted to Ecology no later than January 1, 2021. We recommend that installation of the groundwater monitoring network occur soon after Ecology approves the Scope to provide the information necessary to complete the groundwater quality evaluation. Upon completion of the hydrogeologic study, Aspect will produce a Groundwater Quality Evaluation Report that documents the study and assesses the need for continued monitoring under Permit Condition S10 for submission to Ecology.

## 2 Site Conditions

### 2.1 Facility Description

---

#### ***History***

Skagit Valley Farm Cooling is a subsidiary of Skagit Valley Farm, an agricultural company that grows, handles, and ships vegetable products at multiple locations in Skagit County. Skagit Valley Farm acquired the property in 2013 and has operated it since as a vegetable storage and handling facility. Skagit Valley Farm transferred the property to Skagit Valley Farm Cooling in 2018. Records from the Skagit County Assessor indicate the existing buildings were constructed in 1991.

#### ***Industrial Process and Wastewater Quantities***

The new Facility receives, cools, handles, stores, packages, and ships agricultural products. The primary agricultural products handled at the Facility include Brussels sprouts, broccoli, cauliflower, baby leaf and other lettuces, green beans, and cucumbers. The Facility operates from May through February, with limited activities and minimal wastewater generation in March and April.

The Facility discharges water from three sources: wash down, ice melt, and vegetable washing. The water supply for the Facility is the municipal water supply system. The water flow through the Facility is included as a line diagram in Figure 2.

Portions of the interior of the Facility are washed down daily, generating an estimated 5,000 gallons per day (gpd) of production water to be discharged. This water is used to clean up the plant floors and is not applied directly to the vegetable products. Wash down typically occurs daily for about 2 hours in the morning at the beginning of a shift. An organic surfactant (Bio-Foamer™) is added to the wash water to enhance cleaning. In addition, an intensive whole facility wash down occurs each April in preparation for resuming operations for the season. This wash down can last for 1 to 3 days and could generate up to 18,000 gpd of wastewater on those days.

The Facility uses approximately 15,000 gpd of water to make ice for cooling vegetables, the majority of which are shipped out with the product. Some ice melts inside the Facility; the quantity of ice melt is estimated at 1,500 gpd, or 10 percent of the ice produced. In addition, the 1,200-gallon reservoir of the ice injector system is changed out 4 times per day, generating 4,800 gpd of wastewater. Peroxyacetic acid is added to the water used to make ice as a food-safe disinfectant.

The vegetable washing process involves a recirculating bath of wash water (approximately 400 gallons) that the vegetables flow through. Periodically (about 4 to 5 times per day), the wash water is discharged and replaced, resulting in an additional daily average discharge of 1,600 to 2,000 gpd per product line. Up to 3 product lines operate in the peak season generating up to 5,200 gpd of wastewater. During other times of the year, one or two product lines operate, generating 1,600 to 3,200 gpd. Peroxyacetic acid is added to the wash water as a food-safe disinfectant at a concentration of 80 to 100 parts per million (ppm).

The volume of water generated by each process varies seasonally. Ice melt occurs only in May through mid-October, as ice is not used for cooling vegetables during the colder seasons. Wash down occurs throughout the year, with the exception of March, when Facility operations are limited, and during the annual intensive wash down in April. Vegetable washing occurs from April to February but varies in the number of products washed and intensity of activity.

A summary of the seasonal variation in estimated average daily wastewater generation by process is shown in Table 1. The daily volume of discharge is expected to vary from 6,600 gpd from December to February up to 16,500 gpd in the peak season of June to September, with no discharge in March. The intensive wash down in April could result in maximum daily discharges of 19,600 gpd, but these would only occur for 1 to 3 days.

Wastewater is managed through land application. Typically, upwards of 85 percent of the land-applied water infiltrates (as shown in Table 1), with the remainder evaporating or being transpired by the pasture grass crop. Management of the water generated under the initially planned scenario through land application requires up to 0.74 acres.

SVFC anticipates the potential for rapid expansion in both the quantities and types of products handled within the next 5 years. As a result, estimates have been prepared for both the initial planned wastewater generation (Table 1) and potential growth anticipated within 5 years (Table 2). The growth scenario was calculated by applying a 100 percent contingency factor to the initial estimate (with the exception of the annual plant washdown in April, which was not increased).

Within 5 years, SVFC anticipates generating up to 33,000 gpd of wastewater in the peak months of June through September (Table 2). The average wastewater generation was estimated at 20,500 gpd, and the minimum was estimated at 13,200 gpd from December to February, with no wastewater generated in March. Management of this quantity of water by land application would require up to 1.47 acres in June. Typically, upwards of 85 percent of the water would infiltrate with the remainder lost to evapotranspiration.

### ***Wastewater Treatment and Discharge***

Wastewater is collected by trench drains inside the Facility, then conveyed to an approximately 800-gallon sump. A pump lifts the water from the sump to a hydrosieve, which would screen out particulate matter with a 0.02-inch stainless steel screen. The water then discharges by gravity to a 3,500-gallon pump station wet well. The pump station lifts the water to an irrigation system in the land application area located east of the facility buildings (Figure 3). The land application area is approximately 75,000 square feet (about 1.7 acres). Water is applied to the land surface through a sprinkler system or perforated pipe network. An irrigation controller is used to irrigate different zones of the land application area on a rotating, timed schedule.

### ***Wastewater Characterization***

Table 3 summarizes all process wastewater flow data from the three monthly discharge monitoring reports submitted to Ecology since July 2020.

**Table 3. Wastewater Characterization**

Parameter	Units	Average Value	Daily Maximum Value
<b>Effluent Limits</b>			
Flow	gpd	19,927	21,105
Biological Oxygen Demand (BOD)	lb/ac/day	2.27	4.2
Total Dissolved Solids (TDS)	mg/L	154	200
Total Coliform Bacteria	CFU/ 100 mL	5,925 (a)	16,000 (a)
pH	std. units	7.2	7.2
<b>Early Warning Values<sup>1</sup></b>			
Arsenic	µg/L	0.25 U (b)	0.66 (b)
Manganese	mg/L	0.077	0.108
<b>Additional Monitoring</b>			
Total Suspended Solids (TSS)	mg/L	68.5	118
Biological Oxygen Demand (BOD)	mg/L	85	196
Ammonia	mg/L	0.86	1.41
Chloride	mg/L	37.6	50.8
Iron	mg/L	1.85	2.58
Nitrate-Nitrite as N	mg/L	0.03	0.04
Total Phosphorus (TP)	mg/L	0.84	1.5

**Notes:**

1) Early warning values apply to downgradient monitoring wells only, which are not yet installed. Results presented are from monitoring of wastewater.

- a) SVFC disinfected the pump station wet well in fall 2020 and total coliform concentrations have decreased substantially.
- b) Arsenic results appear to have been incorrectly entered in facility DMRs as mg/L instead of µg/L. The values presented in this table have been corrected.

gpd = gallons per day

mg/L = milligrams per liter

Average pH calculated as the logarithm of the average hydrogen ion concentration.

## 2.2 Site Description

### **Surface Conditions**

The site is located in the Lower Skagit Valley approximately 1 mile west-northwest of Burlington and 0.65 miles west of Interstate 5. The land application area covers approximately 1.7 acres in the north-central portion of the site (Figure 3), and is divided into a main land application area of roughly 1.5 acres, and a smaller supplemental area of 0.2 acres (Figure 3). The western half of the site is occupied by the Facility. A stormwater infiltration pond occupies the south-central portion of the site, directly south of the land application area. The land application area is bordered by agricultural fields to the north and east. Another agricultural field is present to the west across Pulver Road. A single-family residence with active agricultural fields borders the site to the south. Land surface is relatively flat across the site and the land application area with elevations ranging from approximately 22 to 27 feet above the North American Vertical Datum of 1988 (NAVD88).



## Soils

GeoTest Services, Inc. (GTS) conducted a soil geotechnical engineering evaluation at the site in support of the Facility's construction during 2017 and 2018. As part of the evaluation, GTS completed soil borings and soil test pits on July 25, 2017, and January 26, 2018, and documented their findings in a report dated April 10, 2018 (GTS, 2018). GTS's report is provided in Appendix A.

GTS found that subsurface soils at the site generally consist of approximately 12 to 16 inches of soft to medium stiff, sandy, silt with organics and interpreted the soil as tilled agricultural soil/topsoil overlying the native alluvium. Approximately 3 feet of stiff, slightly sandy silt was encountered in the sole exploration at the land application field (boring B-5), but nowhere else onsite. GTS interpreted this soil to be native fill, which we understand to be reworked native soils used to fill portions of the Facility.

GTS's findings are consistent with mapping completed by the United States Department of Agriculture Soil Conservation Service (SCS). Figure 3 displays the SCS-mapped soils present at the site (SCS, 2020). Most of the site, including the western third of the land application field, is mapped as Skagit silt loam with a 0 to 1 percent slope. Skagit silt loam is poorly drained with moderately high to high hydraulic conductivity (0.57 to 1.98 in/hr). Skagit silt loam has a high available water capacity of about 12.0 inches per 60 inches of soil depth.

The eastern portion of the site, including the eastern two-thirds of the land application field, is covered by Field silt loam with a 0 to 3 percent slope. Field silt loam is moderately well drained with moderately high to high hydraulic conductivity (0.57 to 1.98 in/hr). Field silt loam has a high available water capacity of about 10.2 inches per 60 inches of soil depth.

## Geology

The site is located within the wide, relatively flat Lower Skagit Valley. Geologic mapping completed by the United States Geological Survey (Dethier and Whetten, 1981; Pessl et al., 1989) and the Washington State Department of Natural Resources (Dragovich et al., 2000) indicates that the site is primarily underlain by Holocene alluvium (Qal). The alluvium is described as fluvial and deltaic silt, clay, and fine sand associated with the present and ancient Skagit River. The Vashon recessional outwash (Qvr) likely underlies the Qal. Identifying the outwash in well logs is challenging because of its similarity to the Qal. Combined, the Qal and Qvr are over 100 feet thick near the site (Savoca et al., 2009). Well logs for nearby wells (Figure 4), accessed through Ecology's Well Report Viewer (Ecology, 2018), support this conclusion.

GTS encountered the alluvium within all explorations below the agricultural soil/topsoil and native fill. Exploration logs (available in Appendix A) describe the alluvium as varying from soft to stiff, slightly sandy to very sandy silt to very loose to medium dense, silty to very silty sand. Occasional wood debris is noted in several logs 20 to 40 feet below ground surface.

## **Climate**

The site experiences warm, dry summers and cool, wet winters. Average monthly temperatures range from approximately 41 degrees Fahrenheit (°F) in January to approximately 63 °F in August, as measured at the Mount Vernon 3 WNW weather station (Coop ID 455678; Western Regional Climate Center, 2020). During the summer months (June through August), the area averages about 4.7 inches of precipitation. Winters (December through February) are substantially wetter, averaging about 10.1 inches of precipitation. Between 1981 and 2010, the area received an average annual precipitation total of approximately 33.2 inches.

## **Surface Water**

No natural surface water occurs on the site. A network of nearby drainage ditches (Figure 4), the nearest of which runs along Pulver Road at the western edge of the site, conveys runoff approximately 3 miles to Joe Leary Slough. Joe Leary Slough eventually empties into Padilla Bay (Figure 5).

## **2.3 Site Hydrogeology**

---

### **Hydrogeologic Units**

The combined Qal and Qvr present in the Lower Skagit Valley form the regional Alluvial and Recessional Outwash Aquifer (Qago; Savoca et al., 2009). This aquifer is present throughout the lower Skagit Valley, and forms the shallow groundwater system. In the site vicinity, the Qago is 100 to 450 feet thick. Groundwater is unconfined throughout most of the aquifer, though occasional clay interlayers are known to form locally confined zones. No confined zones are apparent in nearby well logs (Figure 4).

### **Regional Groundwater Flow**

Regional groundwater flow studies by Savoca et al. (2009), and Savoca, Johnson, and Fasser (2009) indicate a westward gradient toward Padilla Bay within the Qago. Groundwater levels near the Facility appear to be approximately 8 feet below ground surface (bgs) on average. Water levels within the Qago vary seasonally, mainly in response to changes in precipitation. Water levels rise in the autumn and winter (during the wet season) and fall during the spring and summer (the dry season). Wells near the site exhibited seasonal variations of up to 10 feet during the study period.

### **Site-Specific Groundwater Data**

Water levels recorded in soil borings at the time of drilling (July 2017) indicate a generally westward groundwater gradient (GTS, 2018). Relatively shallow depths-to-water noted in B-3 and B-4 indicate that water may be seeping from the ditch that runs along Pulver Road into the groundwater system. However, it is important to note that water level measurements made in temporary borings are subject to significant error. Additionally, these water levels may only reflect flow directions during the dry season.

Groundwater appears to fluctuate between approximately 2.7 feet bgs during the winter wet season and 9 feet bgs during the summer dry season (GTS, 2018). A mottled soil horizon was observed in borings B-2 and B-3 at depths of approximately 7.5 and 6 feet bgs, respectively. Mottling is typically indicative of soils that experience fluctuating moisture conditions, generally due to seasonal wetting and drying.

Gleyed soils were encountered in all borings, generally beginning near 10 feet bgs. Gleyed soils are typically gray or bluish-gray in color and are the result of a reduced soil state caused by significant periods of saturation. Gleyed soils are often associated with soils that are restrictive of groundwater flow.

### ***Groundwater Use***

Several water supply wells tap the Qago in the vicinity of the site (Figure 4). According to well logs, most of these wells draw water for agricultural and single-family domestic purposes. Near the site, wells appear to target a coarser (more permeable) interval within the Qago approximately 70 to 90 feet bgs. The nearest public water system source is located approximately 2 miles due west of the site (Jensen Water System), according to locations provided in Washington State Department of Health's Well Head Protection Area geodataset (Health, 2020). No wells currently exist at the site.

### 3 Scope of Work

Skagit Valley Farm Cooling proposes the following three tasks to evaluate site-specific hydrogeologic conditions and address Special Condition S9 of the Permit. Objectives of this study include:

- Characterizing ambient groundwater quality
- Assessing groundwater depth and flow direction
- Assessing the impacts of land application activities on groundwater quality
- Determining the need for additional groundwater monitoring

At the conclusion of the hydrogeologic study, SVFC will produce a Groundwater Quality Evaluation Report for submission to Ecology. If the final report recommends additional groundwater monitoring, any additional monitoring points should be installed and sampling should commence no later than January 1, 2023.

This scope of work includes installation of monitoring wells ahead of the schedule outlined in Condition S9. Given the lack of existing onsite wells, limited wells in the site vicinity, and challenges in the accuracy of water levels measured at time of drilling in geotechnical borings, it is important to install wells to understand the localized groundwater flow directions at the land application site in order to conduct an effective groundwater quality evaluation.

SVFC will contract with a hydrogeologic consulting firm to implement the Scope.

#### 3.1 Task 1 – Drilling and Monitoring Well Installation

---

This task covers installing, equipping, and surveying at least 4 groundwater monitoring wells in accordance with Special Conditions S9 and S10. These wells will be used to monitor groundwater levels and to extract groundwater samples for water quality testing.

##### **Well Siting**

Figure 3 shows proposed locations for 4 monitoring wells (labeled “AMW”). Three alternate locations are also provided in case the preferred locations prove not feasible. Locations were chosen to provide upgradient and downgradient monitoring points consistent with guidance provided in Section 5.3 of *Implementation Guidance for the Ground Water Quality Standards* (Ecology, 2005). Proposed wells AMW-1 and AMW-2 are likely to provide adequate characterization of upgradient groundwater quality based on regional groundwater flow directions. Proposed wells AMW-3 and AMW-4 are positioned at likely downgradient locations as closely as practicable to the land application field to capture potential impacts due to land application.

SVFC’s hydrogeologic consultant will conduct a site visit prior to the start of drilling to confirm well locations. A private utility location firm will be contracted to evaluate the proposed drilling locations for conflicts with underground utilities. No utilities are known to exist in the vicinity of the proposed well locations.

## **Well Drilling, Construction, and Development**

Drilling and installation of the monitoring wells will be completed by a licensed driller in accordance with Washington Administrative Code (WAC) Chapter 173-160 *Minimum Construction and Maintenance of Wells* using direct-push, 4-inch hollow stem auger, or sonic drilling methods. The driller will collect near-continuous soil cores as the boring is advanced. Each boring will be advanced to at least the depth that saturated, gleyed soils are encountered; or 15 feet bgs (whichever is deeper) to identify the likely seasonally low water level.

Field staff from SVFC's consultant will observe the drilling and log the boring under the direction of a Washington Licensed Hydrogeologist (LHG). Borings will be logged in general accordance with ASTM International (ASTM) Method D2488, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*.

Upon reaching total depth, all borings will be completed as 2-inch diameter PVC monitoring wells. Each well screen (the portion of the well into which water enters from the aquifer) will be constructed at a depth and with an appropriate length so that there is a high likelihood the screen continuously intersects the water table as it fluctuates throughout the year and allows sufficient quantities of water to enter the borehole for water quality sampling.

Following construction, each well will be developed to remove fine materials from inside the well casing and surrounding aquifer using any combination of bailing, mechanical surging, overpumping, and backwashing methods until the well produces non-turbid water. Newly developed wells will be allowed to rest for at least 72 hours prior to sampling.

## **Locational Survey**

Once the monitoring wells have been constructed, a Professional Land Surveyor licensed in Washington will complete a survey of the new wells. The surveyor will measure each well's latitude and longitude using the NAD83/WGS84 datum. The surveyor will measure the measuring point (top-of-casing) elevation on the northern edge of the PVC inner casing in feet above the North American Vertical Datum of 1988 (NAVD88) and mark the measuring point with a permanent mark. The surveyor will also measure ground surface elevation immediately adjacent to the well in feet above NAVD88.

## **3.2 Task 2 – Groundwater Monitoring**

---

After the post-development resting period, groundwater monitoring will begin for the parameters specified in Table 4 of the Permit. Depth-to-water will be measured from the surveyed measuring point in feet (to the nearest 0.01 feet) on a monthly basis using an electronic water level tape. If a groundwater sample will be taken during the same event, the depth-to-water will be measured prior to the initiation of purging and sampling.

Groundwater samples will be collected at least twice during the 180-day period identified in the permit for completing the groundwater quality evaluation. Groundwater samples will be collected from the monitoring wells using a peristaltic pump. New sample tubing made of inert materials will be used for every sample and discarded immediately following collection. Groundwater will be purged using the peristaltic pump at a rate that

minimizes drawdown (about 0.2 to 0.3 liters per minute). Field parameters (pH, conductivity, dissolved oxygen, oxidation-reduction potential, turbidity, and temperature) will be continuously measured using a water quality meter during the purge. Water quality will be considered representative of the formation and the sample will be collected once field parameters have stabilized according to the stabilization criteria provided in Table 4, which is excerpted from *Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers* (Yeskis and Zavala, 2002). Stabilized values of field parameters will be recorded.

**Table 4. Groundwater Sampling Purge Stabilization Criteria**

Parameter	Stabilization Criteria
pH	± 0.1
Specific Conductance (SC)	± 3%
Oxidation-Reduction Potential (ORP)	± 10 mV
Turbidity	± 10% (when turbidity > 10 NTUs)
Dissolved Oxygen	± 3 mg/L

**Notes:**

mg/L is milligrams per liter

mV is millivolts

NTU is nephelometric turbidity unit

Groundwater samples will be collected directly from the sample tubing into containers provided by the laboratory. Sample labels will be marked with the well identifier, the date and time collected, the name of the sampling personnel, and the proposed analyses. Samples will then be placed in an ice-filled cooler and chilled to 4 degrees Celsius pending delivery to an accredited laboratory. Samples will be analyzed using the recommended analytical protocol in Appendix A of the Permit. At least one duplicate groundwater sample will be collected during the 180-day study period for quality control purposes.

### 3.3 Task 3 – Groundwater Quality Evaluation Report

SVFC's consultant will develop a Groundwater Quality Evaluation Report for submission to Ecology within 180 days of approval of this Scope. The report will document the installation of the monitoring network and the site-specific hydrogeologic conditions identified during the installation and monitoring period. The groundwater quality dataset will be used to assess potential impacts of land application on groundwater quality. The report will assess the need for continued groundwater monitoring with respect to the likelihood of potential impacts to groundwater from land application activities at the Facility. It will also identify which, if any, wells should be included in an ongoing groundwater monitoring program for permit compliance or if additional wells are necessary.

### 3.4 Schedule

The Scope will be implemented according to the following schedule, based on the requirements of Permit Condition S9.

**Table 5. Implementation Schedule**

<b>Action</b>	<b>Duration</b>	<b>Approximate Timeline</b>
Submit Scope of Work		<b>January 1, 2021</b>
Ecology review and approval of Scope	<i>Estimated at 2 to 3 months</i>	March to April, 2021
Complete Scope (including installation of four wells) and Submit Groundwater Quality Evaluation Report	<b>180 days from Ecology approval</b>	September to October, 2021
Ecology review and approval of Evaluation Report	<i>Estimated at 2 to 3 months</i>	November 2021 to January 2022
Install additional wells if recommended by Evaluation Report (unlikely)	<b>Begin construction within 120 days of Ecology approval of Evaluation Report</b>	February to April 2022
Complete well installation and begin groundwater sampling		<b>By January 1, 2023</b>

**Notes:**

Regulatory deadlines are shown in **Bold**. Approximate durations are shown in *italics*.

## References

- ASTM International (ASTM), 2018, 2018 Annual Book of ASTM Standards, West Conshohocken, Pennsylvania.
- Dethier, D. P., and J. T. Whetten, 1981, Preliminary Geologic Map of the Mount Vernon 7.5-minute Quadrangle, Skagit County, Washington, Open-File Report 81-105.
- Dragovich, J. D., M. L. Troost, D. K. Norman, G. Anderson, J. Cass, L. A. Gilbertson, D.T. McKay, and K. G. Ikerd, 2000, Geologic Map of the Anacortes South and La Conner 7.5-minute Quadrangles, Skagit and Island Counties, Washington, Division of Geology and Earth Resources, Open File Report 2000-6, 2000.
- GeoTest Services, Inc. (GTS), 2018, Geotechnical Engineering Evaluation, Raw Product Cooling Facility, 11261 Pulver Road, Burlington, WA, April 10, 2018.
- Pessl, F., D. P. Dethier, D. B. Booth, and J. P. Minard, 1989, Geologic Map of the Port Townsend 30- by 60-minute Quadrangle, Puget Sound Region, Washington, Miscellaneous Investigations Series, Map I-1198-F.
- Savoca M. E., K. H. Johnson, S. S. Sumioka, T. D. Olsen, E. T. Fasser, and R. L. Huffman, 2009, Hydrogeologic Framework, Groundwater Movement, and Water Budget in Tributary Subbasins and Vicinity, Lower Skagit River Basin, Skagit and Snohomish Counties, Washington: U.S. Geological Survey Scientific Investigations Report 2009-5270, 45 pp.
- Savoca, M.E., Johnson, K.H., and Fasser, E.T., 2009, Shallow groundwater movement in the Skagit River Delta Area, Skagit County, Washington: U.S. Geological Survey Scientific Investigations Report 2009-5208, 22 p.
- United States Department of Agriculture Soil Conservation Service (SCS), 2020, Web Soil Survey, accessed December 2020, available at <https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>.
- Washington State Department of Ecology (Ecology), 1993, Guidelines for Preparation of Engineering Reports for Industrial Wastewater Land Application Systems. Publication # 93-36. May 1993.
- Washington State Department of Ecology (Ecology), 2005, Implementation Guidelines for the Ground Water Quality Standards, Publication # 96-02, Revised October 2005.
- Washington State Department of Ecology (Ecology), 2018, Washington State Well Report Viewer, accessed September 2018, available at: <https://apps.wr.ecology.wa.gov/wellconstruction/map/WCLSWebMap>.
- Washington State Department of Health, 2020, Wellhead Protection Areas, Geographic Information Systems dataset, Office of Drinking Water, accessed December 2020, available at: <https://geo.wa.gov/datasets/WADOH::wellhead-protection-areas>.



Western Regional Climate Center, 2020. Mt. Vernon 3 WNW, Washington, 1981-2020 Normals, <https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?wa5678>. Accessed December 11, 2020.

Yeskis, D. and B. Zavala, 2002, Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, Ground Water Forum Issue Paper, EPA Document 542-S-02-001, May 2002.

## Limitations

Work for this project was performed for Skagit Valley Farm Cooling (Client), and this report was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This report does not represent a legal opinion. No other warranty, expressed or implied, is made.

All reports prepared by Aspect Consulting 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 Consulting. Aspect Consulting's original files/reports shall govern in the event of any dispute regarding the content of electronic documents furnished to others.

# TABLES

Table 1 - Wastewater Generation and Land Application Calculations - Initial Scenario

Project No. 170466, Burlington, Washington

Wastewater Generation

Process	Units	January	February	March	April	May	June	July	August	September	October	November	December
Wash down	gpd	5,000	5,000	0	18,000 a	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Ice melt and ice water changes	gpd	0	0	0	0	0	6,300	6,300	6,300	6,300	0	0	0
Vegetable washing	gpd	1,600	1,600	0	1,600	3,200	5,200	5,200	5,200	5,200	5,200	3,200	1,600
Total Wastewater Generated	gpd	6,600	6,600	0	19,600	8,200	16,500	16,500	16,500	16,500	10,200	8,200	6,600

Land Application Area Needed

Hydrologic Process	Units	January	February	March	April	May	June	July	August	September	October	November	December
Evapotranspiration <sup>1</sup>	inch/day	0.00	0.02	0.03	0.06	0.09	0.11	0.12	0.11	0.07	0.03	0.01	0.00
Infiltration <sup>2</sup>	inch/day	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
Maximum Application Rate (ET + Infiltration)	inch/day	0.72	0.74	--	0.78	0.81	0.83	0.84	0.83	0.79	0.75	0.73	0.72
Minimum Area of Land Application <sup>3</sup>	acres	0.34	0.33	0.00	0.93	0.37	0.74	0.72	0.73	0.77	0.50	0.41	0.34

Fate of Land Applied Water

Evapotranspired	gpd	0	155	0	1,416	889	2,110	2,421	2,181	1,397	385	155	0
Infiltrated	gpd	6,600	6,445	0	18,184	7,311	14,390	14,079	14,319	15,103	9,815	8,045	6,600
Percent Infiltrated	%	100%	98%	--	93%	89%	87%	85%	87%	92%	96%	98%	100%
Total Wastewater Managed	gpd	6,600	6,600	0	19,600	8,200	16,500	16,500	16,500	16,500	10,200	8,200	6,600

Notes:

a) Wash down in April represents a single deep cleaning event lasting 1-3 days. Wash down would not occur at this rate throughout the month.

1) Crop evaporation calculated from Puyallup 2 W Experimental Station, 1931-1995 by converting to daily evaporation rate, then applying pan coefficient of 0.76 (WVHM) and crop coefficient of 0.9, corresponding with grasses (RH<30%, wind 0-5 m/s; Table 4.4.5 in Maidment, 1993).

2) Infiltration of 0.03 inches per hour based on site specific geotechnical engineering evaluation (See Attachment G.4&G.5; Geotest, 2018)

3) Minimum area of land application is calculated as the total wastewater generated divided by the maximum infiltration rate.

Table 2 - Wastewater Generation and Land Application Calculations - Future Growth Scenario

Project No. 170466, Burlington, Washington

Wastewater Generation

Process	Units	January	February	March	April	May	June	July	August	September	October	November	December
Wash down	gpd	10,000	10,000	0	18,000 a	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Ice melt and ice water changes	gpd	0	0	0	0	0	12,600	12,600	12,600	12,600	0	0	0
Vegetable washing	gpd	3,200	3,200	0	3,200	6,400	10,400	10,400	10,400	10,400	10,400	6,400	3,200
Total Wastewater Generated	gpd	13,200	13,200	0	21,200	16,400	33,000	33,000	33,000	33,000	20,400	16,400	13,200

Land Application Area Needed

Hydrologic Process	Units	January	February	March	April	May	June	July	August	September	October	November	December
Evapotranspiration <sup>1</sup>	inch/day	0.00	0.02	0.03	0.06	0.09	0.11	0.12	0.11	0.07	0.03	0.01	0.00
Infiltration <sup>2</sup>	inch/day	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
Maximum Application Rate (ET + Infiltration)	inch/day	0.72	0.74	--	0.78	0.81	0.83	0.84	0.83	0.79	0.75	0.73	0.72
Minimum Area of Land Application <sup>3</sup>	acres	0.68	0.66	0.00	1.01	0.75	1.47	1.44	1.46	1.55	1.00	0.82	0.68

Fate of Land Applied Water

Evapotranspired	gpd	0	310	0	1,532	1,779	4,220	4,841	4,362	2,793	770	311	0
Infiltrated	gpd	13,200	12,890	0	19,668	14,621	28,780	28,159	28,638	30,207	19,630	16,089	13,200
Percent Infiltrated	%	100%	98%	--	93%	89%	87%	85%	87%	92%	96%	98%	100%
Total Wastewater Managed	gpd	13,200	13,200	0	21,200	16,400	33,000	33,000	33,000	33,000	20,400	16,400	13,200

10

Notes:

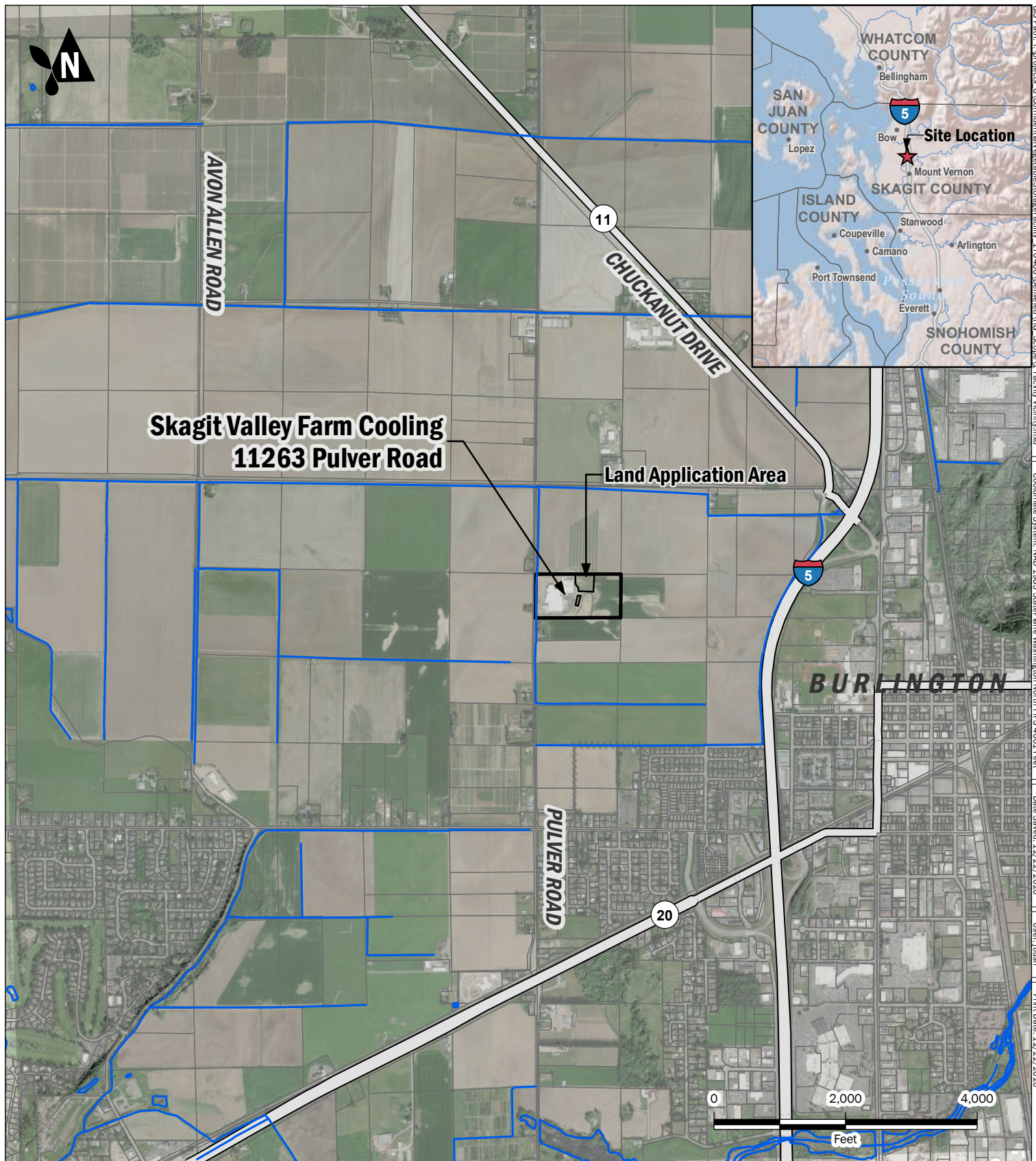
a) Wash down in April represents a single deep cleaning event lasting 1-3 days. Wash down would not occur at this rate throughout the month.

1) Crop evaporation calculated from Puyallup 2 W Experimental Station, 1931-1995 by converting to daily evaporation rate, then applying pan coefficient of 0.76 (WVHM) and crop coefficient of 0.9, corresponding with grasses (RH<30%, wind 0-5 m/s; Table 4.4.5 in Maidment, 1993).

2) Infiltration of 0.03 inches per hour based on site specific geotechnical engineering evaluation (See Attachment G.4&G.5; Geotest, 2018)

3) Minimum area of land application is calculated as the total wastewater generated divided by the maximum infiltration rate.

# FIGURES



Site Parcel



Parcels



Surface Water Drainage

## Vicinity Map

Hydrogeologic Study Scope of Work  
Skagit Valley Farm Cooling, LLC  
11263 Pulver Road  
Burlington, Washington



DEC-2020

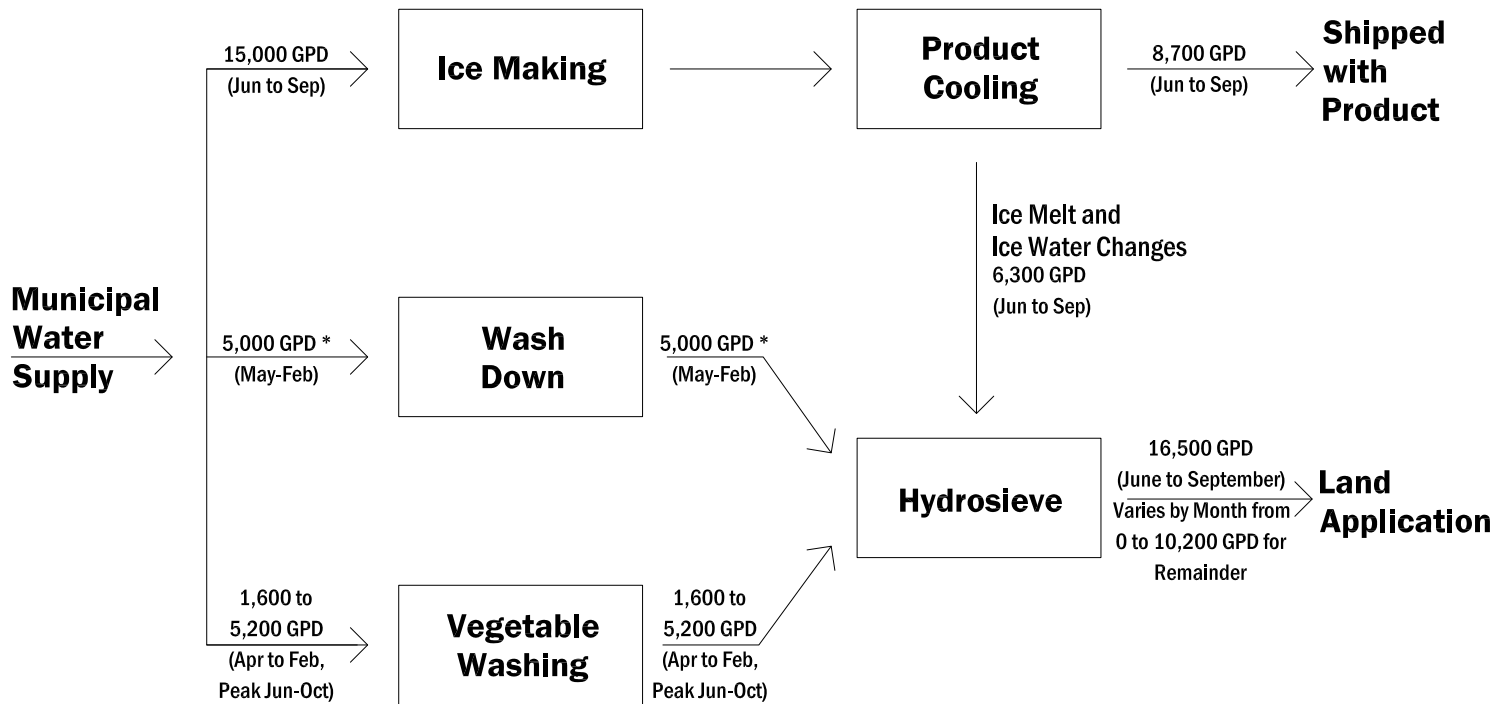
PROJECT NO.  
170466

BY:  
JCB

REVISED BY:  
---

FIGURE NO.

**1**



**Notes:**

- 1) Flows reflect initially planned scenario. Future scenario would be 100% higher.
- 2) No wastewater discharge anticipated in March.
- \* Wash down estimated at 18,000 GPD for annual intensive cleaning for 1 to 3 days in April.

**Process Flow Diagram**  
Wastewater Generating Processes  
Skagit Valley Farm Cooling  
Burlington, Washington

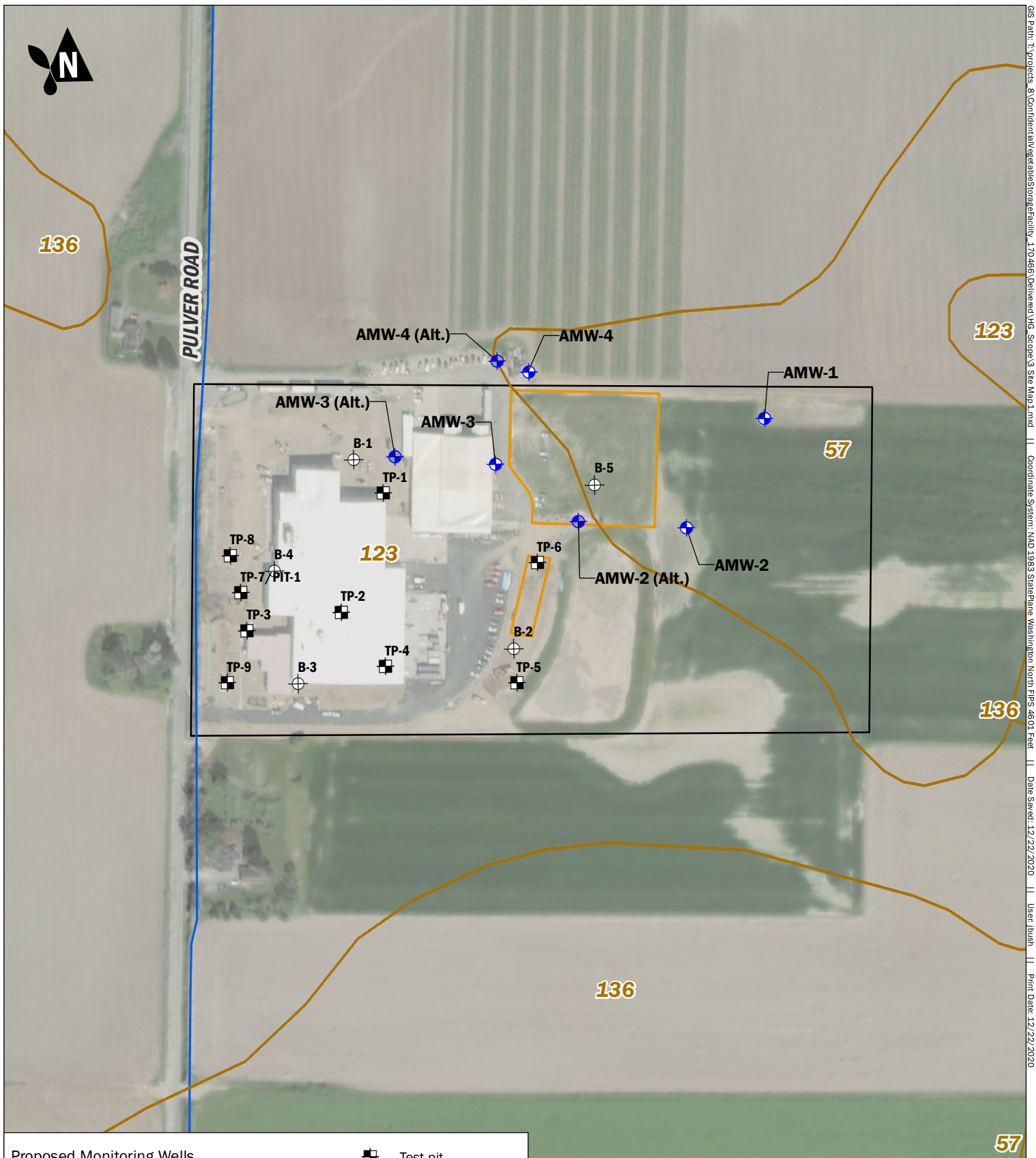


December 2020  
PROJECT NO.  
170466

BY:  
OGR/SCC  
REVISED BY:  
-

FIGURE NO.  
**2**





#### Proposed Monitoring Wells

- Primary Location
- Alternate Location

Site Parcel

Land Application Area

Surface Water Drainage

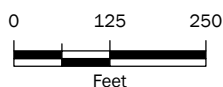
Explorations (Geotest Services, Inc., 2018)

Boring

Test pit

#### Surficial Soils

- 57 Field silt loam
- 123 Skagit silt loam
- 136 Sumas silt loam



## Site Map

Hydrogeologic Study Scope of Work  
Skagit Valley Farm Cooling, LLC  
11263 Pulver Road  
Burlington, Washington



DEC-2020

PROJECT NO.  
170466

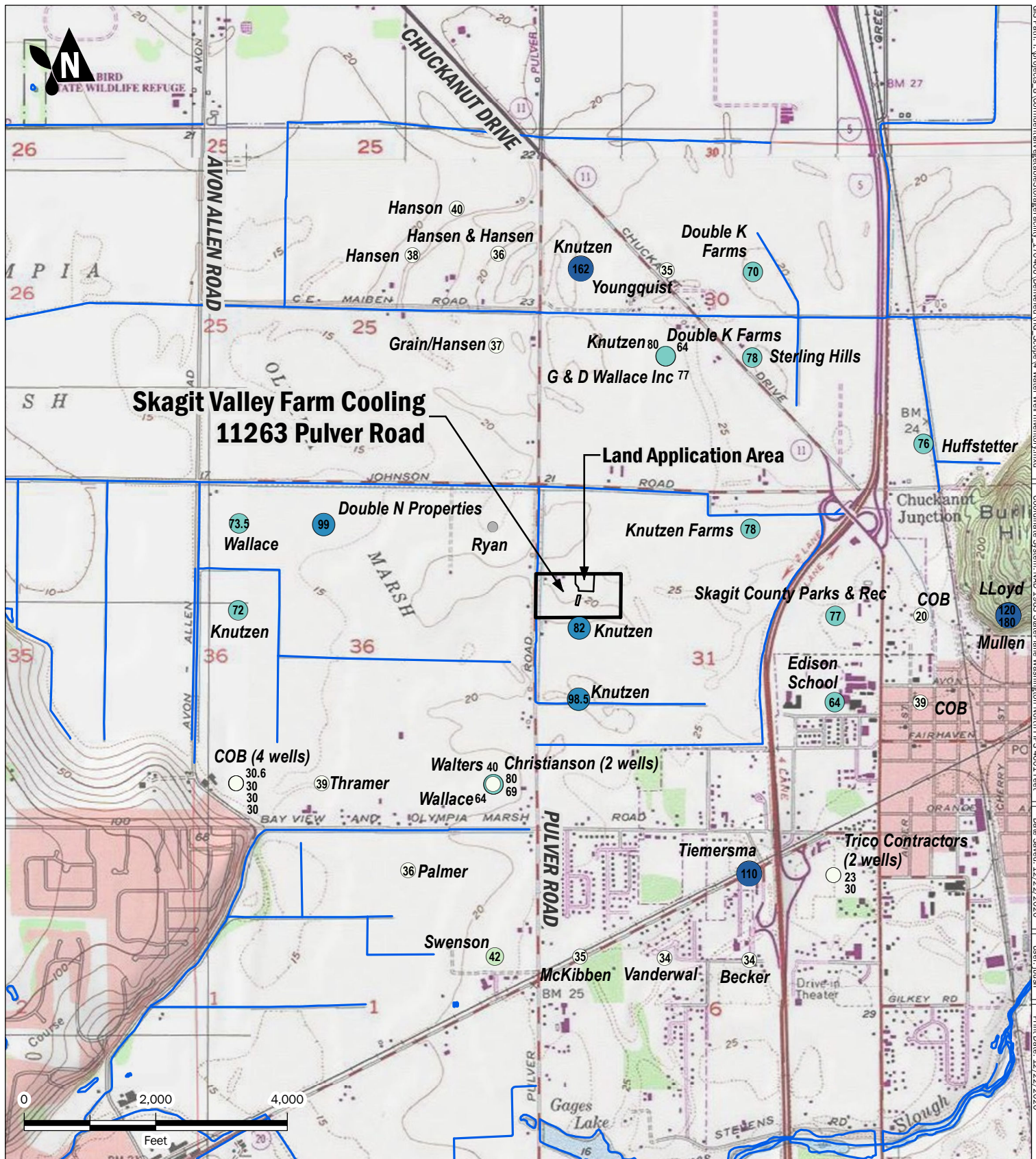
BY:  
JCB

REVISED BY:  
---

FIGURE NO.

**3**





## Water Well Inventory

Hydrogeologic Study Scope of Work  
Skagit Valley Farm Cooling, LLC  
11263 Pulver Road  
Burlington, Washington



DEC-2020

PROJECT NO.  
170466

BY:  
OGR / EAC

REVISED BY:  
---

FIGURE NO.

**4**







## **APPENDIX A**

### **Geotechnical Engineering Report (GTS, 2018)**



**GEOTEST**

741 Marine Drive  
Bellingham, WA 98225

20611-67<sup>th</sup> Avenue NE  
Arlington, WA 98223

PHONE  
360 733\_7318

TOLL FREE  
888 251\_5276

FAX  
360 733\_7418

April 10, 2018  
Job No. 17-0452

**Trico Companies**

15066 Josh Wilson Road  
Burlington, WA 98233

Attn: **Bruce Berglin**

**Re: Geotechnical Engineering Evaluation**

Raw Product Cooling Facility  
11261 Pulver Road  
Burlington, WA 98233

Dear Mr. Berglin:

As requested, GeoTest Services, Inc. (GTS) is pleased to submit this geotechnical engineering evaluation for the proposed raw product cooling facility that will be located at 11261 Pulver Road in Burlington, WA. The purpose of this evaluation was to obtain information regarding the subsurface conditions below the proposed improvements for use in project design. Specifically, our scope of services included the following tasks:

- Exploration of soil and groundwater conditions underlying the site by advancing 5 soil boring explorations and excavating 6 exploratory test pits within the subject property. An additional Pilot Infiltration Test and potholes were performed during the wet season to support our data.
- Laboratory testing on representative samples in order to classify and evaluate the engineering characteristics of the soils encountered.
- Provide this written report containing a description of the general geologic conditions, subsurface soils and groundwater conditions. Also presented in this report are our findings and recommendations pertaining to site preparation and earthwork, fill and compaction, wet weather construction and seismic design considerations. Included in these recommendations are foundation support and settlement, surcharge program, slab-on-grade construction, foundation and site drainage, utilities, stormwater infiltration and geotechnical consultation and construction monitoring.

**PROJECT DESCRIPTION**

We understand that there are plans to construct a new, approximately 75,000 square foot building that includes a cold storage facility and processing area. It is our understanding that the proposed building will consist of concrete tilt-up walls, steel joist roof with steel decking and a clear height of approximately 20 feet. The total height of the building is expected to be 30 to 40 feet tall. It is our understanding that site grades will be raised approximately 3 to 4 feet at the proposed building footprint. We anticipate

that the proposed building will be supported by shallow conventional foundations and that the structural loads will be light to moderate.

### **Surface Conditions**

The site currently contains an existing agricultural facility with associated buildings and gravel drives on the northern portion of the site. The southern half of the site consists of an active agricultural field at the time of our investigations. The subject property is bordered by active agricultural fields to the north and east, Pulver Road to the west and a single-family residence with active agricultural fields to the south. The subject property is relatively flat, with less than a few feet of elevation difference across the site. No surface water was observed at the time of subsurface investigations.

### **Subsurface Soil Conditions**

Subsurface conditions within the areas of interest on site were explored by excavating 6 exploratory test pits (TP-1 through TP-6) on July 14, 2017 and advancing 5 boring explorations (B-1 through B-5) on July 25, 2017. Exploratory test pits were excavated to depths ranging from 9 to 10 feet below ground surface (BGS) and the boring explorations were advanced to depths ranging from 21.5 to 46.5 BGS. A Pilot Infiltration Test was performed on January 26, 2018. Subsequent shallow potholes were advanced on March 30, 2018 at the location of the proposed infiltration facility. The approximate locations of the explorations are shown on the Site and Exploration Plan, Figure 2.

Representative samples were obtained during drilling by using the Standard Penetration Test (SPT) procedure in accordance with American Society for Testing and Materials ASTM D1586 during the explorations. This test and sampling method consists of driving a standard 2-inch, outside-diameter, split-barrel sampler a distance of 18 inches into the soil with a 140-pound hammer free-falling a distance of 30 inches. The number of blows for each 6-inch interval is recorded and the number of blows required to drive the sampler the final 12 inches is known as the Standard Penetration Resistance ("N") or blow count. If a total of 50 is recorded within one 6-inch interval, the blow count is recorded as the number of blows for the corresponding number of inches of penetration. The resistance, or N-value, provides a measure of the relative density of granular soils or the relative consistency of cohesive soils; these values are reported on the attached boring logs.

Subsurface soils generally consisted of approximately 12 to 16 inches of soft to medium stiff, sandy, silt with organics interpreted as tilled agricultural soil/topsoil overlying the native alluvium which extended to the full depth of the explorations. The native alluvium varied from a soft to stiff, slightly sandy to very sandy, silt to a very loose to medium dense, silty to very silty, sand throughout all of the subsurface explorations. Approximately 3 feet of stiff, slightly sandy, silt interpreted as native fill soils was encountered overlying the alluvium at boring B-5. No tilled agricultural soil/topsoil was encountered within boring B-5.

More detailed logs of the subsurface conditions encountered at the exploration locations are presented in the attached Soil Boring Logs and Test Pit Logs at the end of this report.

## **General Geologic Conditions**

Geologic information for the project site was obtained from the interactive *Geologic Map of Washington State*, published by the Washington State Department of Natural Resources (DNR). According to the referenced map, subsurface soils mapped on the project area consist of Quaternary Alluvium. Soils defined as Alluvium typically consist of irregularly layered sands and gravels deposited in river and stream channels, with silts, clays and peats deposited in the surrounding floodplain.

The subsurface soils encountered in our explorations underlying the tilled agricultural soil/topsoil and fill soils were interpreted to be representative of Quaternary Alluvial deposits.

## **Groundwater Seepage and Seasonal Groundwater**

For the purposes of this report, observed groundwater seepage represents either the existing surface of a groundwater table or the surface of perched seepage. The groundwater table is referred to as the atmospheric pressure surface that coincides with the top of the zone of saturation and is the surface that dictates the development design recommendations in this report. Perched seepage is referred to as a saturated zone that develops where a restrictive surface (i.e. dense, fine grained soils or bedrock) limits the vertical, downward migration of near-surface water. This surface should be considered when determining methods of earthwork construction but is not used to dictate development design. However, if perched seepage at the subject property is ponded above a restrictive surface (i.e. bedrock) and no groundwater table exists, then the perched seepage dictates development design recommendations herein.

### *Groundwater Observations*

At the time of our visits on July 14, 2017 and July 25, 2017, groundwater seepage was observed within test pits TP-2, TP-3, TP-6 and all of the subsurface borings (B-1 to B-5). Depth to groundwater was observed to be approximately 9 to 9.25 feet BGS within the test pits and approximately 8.5 to 13 feet BGS within the boring explorations. We interpret seepage encountered at depths of approximately 9 to 9.25 feet BGS to be indicative of a regionally extensive groundwater table at the time of the “dry season” explorations.

During our subsurface potholing (in the proposed pond location) and Pilot Infiltration Test (discussed later in this report) performed during the wet season, GTS observed exhibited what appeared to be a regional groundwater table at approximately 28 inches BGS. Based on the observed standing water in the surrounding area, and the amount of water in the pot holes, this appears to be indicative of a regional groundwater condition.

### *Seasonal Groundwater Fluctuation Observations*

A distinct mottled horizon or “rust line,” was observed within borings B-2 and B-3 at depths of approximately 7.5 and 6 feet BGS, respectively, during our subsurface explorations. Mottling (reddish-brown, orange, or yellow splotches or mottles) is typically indicative of soils that experience fluctuating moisture conditions, generally due to seasonal wetting and drying.

Gleyed soils, indicative of poorly drained and potentially restrictive soils, were encountered within borings B-1 through B-5 generally beginning at a depth of approximately 10 feet BGS. Gleyed soils are typically gray or bluish-gray in color and the result of a reduced (non-oxidative) soil state caused by significant periods of saturation. Gleyed soils are often associated with soils that are restrictive of groundwater flow.

Please note that changes to soil color and morphology may take significant periods of time to develop and may not be reliable indicators of groundwater conditions in areas that have experienced significant recent changes in hydrology. Additionally, in areas of fill, sufficient time may not have passed since fill placement for these indicators to develop. Not all hydric soils exhibit mottled and /or gleyed horizons. Their presence or absence alone should not dictate the interpretation of site groundwater conditions.

#### *Sources of groundwater table fluctuations*

As groundwater table levels and/or seepage rates are typically not static, it is anticipated that groundwater conditions will vary depending on local subsurface conditions, season, precipitation, changes in land use both on and off site and other factors. Markedly, we anticipate that groundwater conditions on site are largely influenced by seasonal variations of precipitation.

#### *Considerations*

GTS considers the depth at which groundwater seepage stabilizes and ponds to be the groundwater table. Perched seepage may not represent the groundwater table. However, in addition to the groundwater table, perched seepage may influence infiltration rates and should be considered during the design process.

The groundwater conditions reported on the boring and test pit logs are for the specific locations and dates indicated, and therefore may not necessarily be indicative of other locations and/or times. Please consider that groundwater table levels are generally higher (at shallower depths) during the wetter months (October through May).

Our construction recommendations consider the groundwater conditions encountered at the time of our field investigation, in association with the project design provided at the time of this report. Unless specifically requested, GTS is not responsible to provide monitoring of groundwater conditions beyond the time of our site investigations. Please keep in mind that groundwater conditions may be different if there is a substantial lapse of time between submission of this report and the start of construction. If this is the situation, GTS recommends we be contacted to evaluate groundwater conditions in order to determine whether our report conclusions and recommendations remain applicable.

### **Geologic Hazards and Recommended Mitigation**

The site is generally flat and, in our opinion, does not meet the criteria established in the Skagit County Municipal Code as a slope or erosion hazard and no specific mitigations for these hazards is required for this project.

Site development is anticipated to include a Washington State Department of Ecology Stormwater Pollution Prevention Plan to mitigate the erosion potential of soils exposed during construction or site grading activities. In order to meet the criteria established by



the Department of Ecology, an erosion control plan consistent with the governing municipal standards, 2012 DOE Stormwater Management Manual for Western Washington, and best management practices will be required for this project. The contractor shall be responsible for implementing the erosion control plan as established in the plans and specifications approved by the governing municipality for the project.

### *Liquefaction Hazard Potential*

The online interactive *Geologic Map of Washington State*, published by the Washington State Department of Natural Resources, references the subject site and surrounding area as a moderate to high liquefaction susceptibility area. However, this map only provides an estimate of the likelihood that soil will liquefy as a result of earthquake shaking and is meant as a general guide to delineate areas prone to liquefaction. Based on our field explorations, the encountered subsurface conditions within the subject site would tend to confirm the mapped classification of a moderate to high liquefaction susceptibility during an earthquake. The proposed site development will most likely include either a pre-load surcharge and/or other ground improvement methodologies; accordingly, we anticipate that the planned development will somewhat reduce the liquefaction potential of the native site soils.

The geotechnical data collected during our subsurface exploration and laboratory testing program was analyzed to estimate the factor of safety against liquefaction and settlement induced by earthquakes occurring at the site. The method of analyses was a simplified procedure originally proposed by Seed and Idriss (1971) that has been modified as discussed by Youd and Idriss (2001). Liquefaction potential was evaluated for a large design-level earthquake having a 10 percent probability of exceedance in a 50-year period, which corresponds to a mean recurrence interval of about 475 years. The liquefaction analyses assumed a peak horizontal ground acceleration of 0.18g and an earthquake magnitude of 7.0.

Our liquefaction analysis modeling was based on encountered soil conditions with respect to grain size, soil type, and relative density within borings B-1 and B-5. The analysis indicates the highest potential for liquefaction occurring between the depths of approximately 10 to 35 feet BGS. Typically, depths of 35 to 40 feet BGS is considered the limit of liquefaction potential in the Pacific Northwest. The actual magnitude and extent of liquefaction will depend on many factors, including the duration and intensity of the ground shaking during the seismic event, and local soil and groundwater conditions. Therefore, the extent of liquefaction may vary from that estimated above.

The amount of post-liquefaction ground subsidence was estimated using an empirical method developed by Tokimatsu and Seed (Tokimatsu and Seed 1987) based on field studies of areas that had undergone liquefaction. The magnitude of post-liquefaction ground subsidence was estimated to be up to 7 inches under existing site conditions for our analysis of up to 45 feet BGS. This settlement is expected to be non-uniform with potential differential settlements of up to 3.5 inches. The amount of anticipated settlements under developed conditions are expected to be less than the values listed above due to some post construction consolidation of the site following project completion. Post construction consolidation of the site is expected as a result of the application of new loads exerted on the underlying soils. These loads consist of the planned placement of structural fill below the proposed structure as well as building and floor slab loads that will influence the underlying site soils.

Based on the results of the liquefaction analysis, and within the limitations of the accuracy of the analyses and limiting assumptions, it is GeoTest's opinion that there is a moderate to high probability of liquefaction occurring beneath the subject site under the design level earthquake. It is assumed that mitigation of liquefaction through deep foundations or ground improvement is recommended/warranted due to the relatively high estimated total and differential settlements.

## **CONCLUSIONS AND RECOMMENDATIONS**

Based upon an evaluation of the data collected during this investigation, it is our opinion that subsurface conditions at the site are suitable for the support of the proposed pre-engineered steel frame building with concrete tilt-up walls provided the recommendations contained herein are incorporated into the project design. GTS anticipates that the planned construction will utilize shallow conventional foundations and slab-on-grade floors.

### *Site Preparation and Earthwork*

The portions of the site to be occupied by proposed foundations, floor slabs, gravel surfaced access drives and/or sidewalks should be prepared by removing any existing deleterious material, tilled agricultural soil/topsoil, fill soils and/or significant accumulations of organics from the area to be developed. **On average**, the stripping depth is 1 foot across the site. Prior to the placement of any structural elements, the exposed subgrade under all areas to be occupied by soil-supported floor slabs and spread or continuous foundations should be recompacted to a firm and unyielding condition. After the exposed subgrade has been recompacted, it should be proof rolled with a loaded dump truck, large self-propelled vibrating roller, or similar piece of equipment applicable to the size of the excavation. The purpose of this effort is to identify possible loose or soft soil deposits and recompact, if feasible, the soil disturbed during site excavation activities.

Proof rolling should be carefully observed by qualified geotechnical personnel. Areas exhibiting significant deflection, pumping, or over-saturation that cannot be readily compacted should be overexcavated to firm soil. Overexcavated areas should be backfilled with compacted granular material placed in accordance with subsequent recommendations for structural fill. During periods of wet weather, proof rolling could damage the exposed subgrade. Under these conditions, qualified geotechnical personnel should observe subgrade conditions to determine if proof rolling is feasible.

### *Structural Fill and Compaction*

Structural fill used to obtain final elevations must be properly placed and compacted. Structural fill materials obtained from an off-site source must consist of non-organic, granular, free-draining material that is approved for use in the plans and specifications prepared for this project. Structural fill must be properly moisture conditioned prior to placement and compacted to the specified degree referenced within this report and per the project plans and specifications. Excavated site material will not be suitable for reuse as structural fill and should be properly disposed offsite or placed in nonstructural areas.

### *Reuse of Onsite Soil*

Soils containing more than approximately 5 percent fines are considered moisture sensitive, and are very difficult to compact to a firm and unyielding condition when over the optimum moisture content by more than approximately 2 percent. The optimum moisture content is that which allows the greatest dry density to be achieved at a given level of compactive effort. The native silty/sandy alluvium is not recommended for re-use as structural fill due to their elevated moisture and “fines” content (that which passes the U.S. No. 200 sieve) and anticipated moisture sensitivity. However, the sandy medium dense material found at depth may be acceptable for reuse.

We recommend that any re-use of the native clayey, silty alluvium be limited to non-structural areas.

### *Imported Structural Fill*

We recommend that imported structural fill consist of clean, well-graded sandy gravel, gravelly sand, or other approved naturally occurring granular material (pit run) with at least 30 percent retained on the No. 4 sieve, or a well-graded crushed rock. Structural fill for dry weather construction may contain on the order of 10 percent fines (that portion passing the U.S. No. 200 sieve) based on the portion passing the U.S. No. 4 sieve. Soil containing more than about 5 percent fines cannot consistently be compacted to a dense, non-yielding condition when the water content is greater than optimum. Accordingly, we recommend that imported structural fill with less than 5 percent fines be used during wet weather conditions. Due to wet weather or wet site conditions, soil moisture contents could be high enough that it may be very difficult to compact even “clean” imported select granular fill to a firm and unyielding condition. Soils with over-optimum moisture contents should be either scarified or dried back to more suitable moisture contents during periods of dry weather or removed and replaced with fill soils at a more suitable range of moisture contents.

### *Backfill and Compaction*

Structural fill should be placed in horizontal lifts 8 to 10 inches in loose thickness and thoroughly compacted. All structural fill placed under load bearing areas should be compacted to at least 95 percent of the maximum dry density, as determined using test method ASTM D1557. The top of the compacted structural fill should extend outside all foundations and other structural improvements a minimum distance equal 1.5 times the thickness of the fill. We recommend that compaction be tested periodically throughout the fill placement.

### **Wet Weather Earthwork**

It is our experience that soils with high fines content like the near-surface silty/sandy alluvium will be highly susceptible to degradation during wet weather. If the native alluvium is exposed during the wet season, it may be difficult to control the moisture content of the site soils. If construction is accomplished during wet weather, we recommend that structural fill consist of imported, clean, well-graded sand or sand and gravel as described above. If fill is to be placed or earthwork is to be performed in wet weather or under wet conditions, the contractor may reduce soil disturbance by:

- Limiting the size of areas that are stripped of tilled agricultural soil/topsoil and existing fill and left exposed
- Accomplishing earthwork in small sections
- Limiting construction traffic over unprotected soil
- Sloping excavated surfaces to promote runoff
- Limiting the size and type of construction equipment used
- Providing gravel "working mats" over areas of prepared subgrade
- Removing wet surficial soil prior to commencing fill placement each day
- Sealing the exposed ground surface by rolling with a smooth drum compactor or rubber-tired roller at the end of each working day
- Providing up gradient perimeter ditches or low earthen berms and using temporary sumps to collect runoff and prevent water from ponding and damaging exposed subgrades.

### **Seismic Design Considerations**

The Pacific Northwest is seismically active and the site could be subject to ground shaking from a moderate to major earthquake. Consequently, moderate levels of earthquake shaking should be anticipated during the design life of the project, and the proposed structure should be designed to resist earthquake loading using appropriate design methodology.

#### *Site Class Definition*

For structures designed using the seismic design provisions of the 2015 International Building Code, the underlying Alluvial deposits interpreted to underlie the site within the upper 100 feet classifies as Site Class E according to 2010 ASCE -7 Standard – Table 20.3-1, Site Class Definitions. The corresponding values for calculating a design response spectrum for the assumed soil profile type is considered appropriate for the site.

Please use the following values for seismic structural design purposes:

Conterminous 48 States – 2015 International Building Code

Zip Code 98233

Central Latitude = 48.48165°, Central Longitude = -122.35428°

#### Short Period (0.2 sec) Spectral Acceleration

Maximum Considered Earthquake (MCE) Value of  $S_s = 1.042$  (g)

Site Response Coefficient,  $F_a = 0.900$  (Site Class E)

Adjusted spectral response acceleration for Site Class E,  $S_{MS} = S_s \times F_a = 0.938$  (g)

Design spectral response acceleration for Site Class E,  $S_{DS} = 2/3 \times S_{MS} = 0.625$  (g)

#### One Second Period (1 sec) Spectral Acceleration

Maximum Considered Earthquake (MCE) Value of  $S_1 = 0.407$  (g)

Site Response Coefficient,  $F_v = 2.400$  (Site Class E)

Adjusted spectral response acceleration for Site Class E,  $S_{M1} = S_1 \times F_v = 0.978$  (g)

Design spectral response acceleration for Site Class E,  $S_{D1} = 2/3 \times S_{M1} = 0.652$  (g)

## **Post-Construction Settlement Potential and Mitigation**

The subsurface soils generally consist of soft to stiff silt and very loose to medium dense sand that is expected to be moderately compressible. Based on our experience, these soils are compressible and are anticipated to produce post construction settlements greater than the generally accepted 1 inch. GTS recommends including a pre-load program prior to the start of construction to mitigate post-construction settlements due to new structural fill and building loads. There is, however, still a risk of excessive settlement during a seismic event. If the risk of settlement due to a seismic event is unacceptable, then a deep foundation system or a surcharge program or other means of ground improvement will be required. The following surcharge program is typical for this area. However, once final building loads are known, GTS should be provided with this information to confirm pre-load fill quantities and heights are correct.

It is our understanding that there are plans, at the time of this report, to raise site grades as much as 4 feet. Therefore, GTS recommends pre-loading of the site to help mitigate the potential for post-construction settlements. Pre-loading the building site typically consists of importing several feet of fill material to compress the near-surface soil so that the settlement due to new fill under the building and structural loads occur prior to the start of construction. Surcharge programs include monitoring the amount and rate of settlement occurring below the pre-load. The surcharge should extend outside the building perimeter a distance of at least five horizontal feet before transitioning to a slope extending down to subgrade soil. GTS also recommends that pre-load areas be centralized in the area of development to reduce or eliminate potential off-site impacts due to the pre-load. GTS recommends that side slopes of the surcharge be inclined no steeper than 1.5H:1V (Horizontal: Vertical).

GTS anticipates that approximately 5 to 6 feet of imported structural fill surcharge will be placed above the proposed finish floor elevation with unit weights between 125 to 135 pounds per cubic foot (pcf). This fill thickness will be required to achieve the anticipated loading conditions for this type of building. The application of thicker amounts of fill will result in an additional surcharge that is expected to shorten the amount of time to consolidate the underlying soil and will increase total settlements such that the majority of settlement will have occurred when the surcharge load is removed. GTS anticipates that 2 to 3 months of pre-loading the building footprint will be required. However, a settlement monitoring program should be in place to document and record the amount of total settlement over time.

### *Settlement Monitoring Program*

Because the purpose of a pre-load is to induce settlement prior to the start of construction, it is necessary to monitor the magnitude and rate of consolidation below the surcharged area. In order to accomplish this task, settlement markers should be placed within pre-load areas. GTS recommends that between 5 and 8 settlement markers, depending on final building layout, be placed across the site prior to importing fill material to surcharge the site. Settlement markers are an imperative part of documenting and recording the amount of settlement over time. With respect to settlement markers and recording the amount of settlement using these markers, GTS recommends the following items be addressed as part of construction and survey activities:

- Settlement markers should be placed on properly prepared subgrades prior to the placement of structural fill. It is assumed that settlement markers will be placed on stripped and compacted subgrade soils at or slightly below existing site grades.
- If a settlement marker is damaged during pre-load placement it should be immediately replaced and surveyed.
- A baseline reading should be obtained at the base and top of each marker and referenced to a benchmark that will not be affected by the induced settlements.
- During the placement of the surcharge, GTS recommends that settlement readings be taken at relatively short intervals. Settlement readings should be taken between 1 and 3 days apart during the first two weeks of fill placement due to the pre-load typically having rapid, initial settlements.
- Once the entirety of the surcharge material has been imported to the site, readings are obtained periodically. GTS recommends that readings be performed at least once a week until the settlement ceases or until measured settlements are within acceptable levels. Construction of new facilities should only begin after the settlement has ceased or the Owner has received input from the geotechnical engineer that indicates that acceptable amounts of settlement have been achieved.
- Each settlement reading should be plotted graphically against time to determine magnitude and rate of settlement. The plot of magnitude and rate of settlement is expected to be steeper during initial placement and shallower nearing the end of the pre-load period. The steeper plot is representative of rapid initial settlements and the shallower plot is representative of a slower settlement rate due to the pre-load. Soils should not be assumed to be uniform and the project team should expect variations in settlement magnitudes and rates between individual settlement markers.
- Settlement readings should include both the ground surface and top of rod elevation readings each time the marker is surveyed.

We recommend that a licensed surveyor be retained to acquire the settlement readings. It is anticipated that surveyed results of the marker readings will be provided to GTS on a regular basis no later than 48 hours from the survey reading. GTS has included a typical detail showing a cross section of a settlement marker at the end of this report (Figure 4).

GTS recommends that we be allowed to participate in the selection and placement of settlement markers. The settlement markers must be kept intact during and after the earthwork operations. In our experience, earthwork equipment often destroys or damages markers. Damage to the markers adds to the project costs in that they need to be replaced and the information obtained is less reliable. We recommend that the earthwork contractor be briefed on the location of the settlement markers and the importance of keeping the markers intact. Where feasible, individual settlement markers

should be flagged and/or coned off to reduce the risk of the markers being damaged by construction equipment.

Post-construction settlement of constructed building foundations and concrete slabs after pre-loading is expected to be less than 1 inch. This does not include liquefaction induced settlements.

### **Surcharge Alternative**

We have outlined the conventional option of pre-loading/surcharging the site to induce initial settlements during the construction phase of the project. We believe this to be the most economical option at this time. However, other options are feasible and depending on various construction considerations, the project team may choose to proceed with a different site development option. We are available to further assist the project team with evaluation of other ground improvement options, upon request.

### **Foundation Support and Settlement**

Settlement of shallow foundations depends on foundation size and bearing pressure, as well as the strength and compressibility characteristics of the underlying soil. Based on our experience with similar projects in the area and assuming that a pre-load occurs prior to the start of construction, construction is accomplished as previously recommended, and foundations don't exceed the maximum allowable soil bearing pressure recommended above, we estimate the total settlement of building foundations under static conditions should be less than about one inch and differential settlement between two adjacent load-bearing components supported on competent soil should be less than about one half the total settlement.

The design team should be aware that heavier building loads will induce settlements greater than what is reported above. GTS should be provided with building loads once the project is more fully developed to confirm that the proposed building and associated loads do not induce settlements that are greater than what is anticipated.

At the time of this report, GTS has been provided preliminary loading conditions for the structure. The client provided loads consist of 700 pounds per square foot (psf) slab-on-grade with an assumed 2,000 psf perimeter (strip) footing loads. When GTS receives the final loading conditions, the settlement estimate should be revised. The computer software program Settle 3D (V4.0) by ROCSCIENCE calculated between 3 and 3.5 inches of post-construction settlement with no subsurface soil improvements. After applying a pre-load (outlined above) under the building footprint for a minimum of 60 days, the total estimated settlement is less than one inch. It is assumed that the calculated estimates of settlement will exceed the "acceptable" amounts for the building design without ground improvements. It is assumed that an "acceptable" limit is defined as 1 inch of total settlement or less.

Foundation support for the proposed improvements may be provided by continuous or isolated spread footings founded on at least 2 feet of compacted structural fill placed directly over firm and unyielding native soil. Where firm and unyielding native soil does not exist, GTS anticipates that either an 18 inch lift of quarry spall base or a woven geotextile fabric such as Mirafi 500X (or equivalent) will be used to limit pumping of

subgrade soils. Only after firm subgrades have been established should structural fill be placed below foundation areas.

Where structural fill exists due to pre-loading or site grading activities, this fill depth below foundations may be included as part of the recommended structural fills thickness. The structural fill should extend laterally beyond the edge of each side of the footing a distance equal to the depth of the excavation below the base of the footing. We recommend that foundation elements for the proposed structure bear entirely on similar soil conditions (i.e., imported structural fill) to help prevent differential settlement from occurring. We recommend that qualified geotechnical personnel confirm that suitable bearing conditions have been reached prior to placement of structural fill or foundation formwork.

Continuous and isolated spread footings should be founded a minimum of 18 inches below the lowest adjacent final grade for freeze/thaw protection. The footings should be sized in accordance with the structural engineer's prescribed design criteria and seismic considerations.

#### *Allowable Bearing Capacity*

GTS recommends that new foundations be supported by at least 2 feet of imported structural fill placed in general accordance with the recommendations presented within this report. Assuming the above foundation support criteria are satisfied, continuous or isolated spread footings founded directly on compacted imported structural fill placed directly over undisturbed native soils may be proportioned using a net allowable soil bearing pressure of 2,000 pounds per square foot (psf).

The term "net allowable bearing pressure" refers to the pressure that can be imposed on the soil at foundation level resulting from the total of all dead plus live loads, exclusive of the weight of the footing or any backfill placed above the footing. The net allowable bearing pressure may be increased by one-third for transient wind or seismic loads.

#### *Foundation Support for Miscellaneous (Non-Critical) Structures*

To provide proper support for structures other than the planned building, we recommend that existing loose portions of the on-site soils be removed from beneath the foundation areas and be replaced with properly compacted structural fill as described elsewhere in this report. We recommend that foundation elements for the proposed structure bear entirely on similar soil conditions (i.e., structural fill) to help reduce the amount of differential settlement that can occur.

Continuous and isolated spread footings should be founded a minimum of 18 inches below the lowest adjacent final grade for freeze/thaw protection. The footings should be sized in accordance with the structural engineer's prescribed design criteria and seismic considerations.

#### *Allowable Bearing Capacity (Structures Outside the Preload Area)*

Assuming the above foundation support criteria are satisfied, continuous or isolated spread footings founded directly on 24 inches of compacted imported structural fill



placed directly over firm and unyielding subgrades may be proportioned using a net allowable soil bearing pressure of 1,500 pounds per square foot (psf).

The term "net allowable bearing pressure" refers to the pressure that can be imposed on the soil at foundation level resulting from the total of all dead plus live loads, exclusive of the weight of the footing or any backfill placed above the footing. The net allowable bearing pressure may be increased by one-third for transient wind or seismic loads.

### **Concrete Slabs-on-Grade**

Conventional slab-on-grade floor construction is considered feasible for the site. Floor slabs may be supported on properly placed and compacted imported structural fill placed over properly prepared native soil. New floor slabs should not be founded on tilled agricultural soil/topsoil, fill, or loose native soils. Prior to placement of imported structural fill, the native soil should be proof-rolled as recommended in the *Site Preparation and Earthwork* section of this report.

A capillary break section should consist of compacted, clean, free-draining gravel (clear crushed rock) with less than 3 percent passing the U.S. Standard No. 200 sieve (based on a wet sieve analysis of that portion passing the U.S. Standard No. 4 sieve). The purpose of capillary break layer is to provide uniform support for the slab, provide a capillary break, and act as a drainage layer.

To help reduce the potential for water vapor migration through floor slabs, a continuous 10-mil minimum thickness vapor retarder/barrier with tape-sealed joints should be installed below the slab section. The vapor retarder/barrier should be installed and sealed in accordance with the manufacturer's instructions.

GTS recommends a minimum of 2 feet of compacted imported structural fill overlying the silty/sandy native alluvium with high moisture contents at depth. A modulus of subgrade reaction of 180 pounds per cubic inch (pci) should be appropriate for use in design of foundation elements placed on a minimum of 2 feet of imported structural fill for this site. If placed directly on native alluvium structural fill a subgrade reaction of 80 pci may be used.

The American Concrete Institute (ACI) guidelines suggest that the slab may either be poured directly on the vapor retarding membrane or on a granular curing layer placed over the vapor retarding membrane depending on conditions anticipated during construction. We recommend that the architect or structural engineer specify if a curing layer should be used. Use of a curing layer is generally only recommended during drier months of the year and/or when limited rain is expected during the slab-on-grade construction process. If the slab will be constructed during the wet season, exposed to rain after construction or the site may be potentially wet, we do not recommend the use of curing layer as excessive moisture emissions through the slab may occur.

Exterior concrete slabs-on-grade, such as sidewalks, may be supported directly on properly placed and compacted structural fill overlying undisturbed native soils.

## **Foundation and Site Drainage**

To reduce the potential for groundwater and surface water to seep into interior spaces we recommend that an exterior footing drain system be constructed around the perimeter of new building foundations as shown in the Typical Footing and Wall Drain Section, Figure 3. The drain should consist of a minimum 4-inch diameter perforated pipe, surrounded by a minimum 12 inches of filtering media with the discharge sloped to carry water to a suitable collection system. The filtering media may consist of open-graded drain rock wrapped by a nonwoven geotextile fabric (such as Mirafi 140N or equivalent) or a graded sand and gravel filter. The drainage backfill should be carried up the back of the wall to within approximately 1 foot of the ground surface and contain less than 3 percent by weight passing the U.S. Standard No. 200 sieve (based on a wet sieve analysis of that portion passing the U.S. Standard No. 4 sieve). The invert of the footing drain pipe should be placed at approximately the same elevation as the bottom of the footing or 12 inches below the adjacent floor slab grade, whichever is deeper, so that water will not seep through walls or floor slabs. The footing drain should discharge to an approved drain system and include cleanouts to allow periodic maintenance and inspection.

Positive surface gradients should be provided adjacent to the proposed building to direct surface water away from the foundation and toward suitable discharge facilities. Roof drainage should not be introduced into the perimeter footing drains, but should be separately discharged directly to the stormwater collection system or other appropriate outlet at a suitable distance away from the structure. Pavement and sidewalk areas should be sloped and drainage gradients should be maintained to carry all surface water away from the building towards the local stormwater collection system. Surface water should not be allowed to pond and soak into the ground surface near buildings or paved areas during or after construction. Construction excavations should be sloped to drain to sumps where water from seepage, rainfall, and runoff can be collected and pumped to a suitable discharge facility.

## **Temporary and Permanent Slopes**

Actual construction slope configurations and maintenance of safe working conditions, including temporary excavation stability, should be the responsibility of the contractor, who is able to monitor the construction activities and has direct control over the means and methods of construction. All applicable local, state, and federal safety codes should be followed. All open cuts should be monitored during and after excavation for any evidence of instability. If instability is detected, the contractor should flatten the side slopes or install temporary shoring.

Temporary excavations in excess of 4 feet should be shored or sloped in accordance with Safety Standards for Construction Work Part N, WAC 296-155-66403.

Temporary unsupported excavations in the native silty/sandy alluvium encountered onsite should be classified as a Type C soil according to WAC 296-155-66403 and may be sloped as steep as 1.5H:1V (Horizontal: Vertical). All soils encountered are classified as Type C soil in the presence of groundwater seepage. Flatter slopes or temporary shoring may be required in areas where groundwater flow is present and unstable conditions develop.

Temporary slopes and excavations should be protected as soon as possible using appropriate methods to prevent erosion from occurring during periods of wet weather.

We recommend that permanent cut or fill slopes be designed for inclinations of 2H:1V or flatter. Permanent cuts or fills used in detention ponds, retention ponds, or earth slopes intended to hold water should be 3H:1V or flatter. All permanent slopes should be vegetated or otherwise protected to limit the potential for erosion as soon as practical after construction.

## **Utilities**

It is important that utility trenches be properly backfilled and compacted to reduce the likelihood of cracking or localized loss of support. It is anticipated that excavations for new underground utilities may be in the native alluvium.

Trench backfill in improved areas should consist of structural fill as defined earlier in this report. Outside of improved areas, trench backfill may consist of native soils provided that their use is allowed in the plans and specifications. Trench backfill should be placed and compacted in accordance with the report section *Fill and Compaction*.

Surcharge loads on trench support systems due to construction equipment, stockpiled material, and vehicle traffic should be included in the design of any anticipated shoring system. The contractor should implement measures to prevent surface water runoff from entering trenches and excavations. In addition, vibration as a result of construction activities and traffic may cause caving of the trench walls.

Actual trench configurations should be the responsibility of the contractor. All applicable local, state, and federal safety codes should be followed. All open cuts should be monitored by the contractor during excavation for any evidence of instability. If instability is detected, the contractor should flatten the side slopes or install temporary shoring. If groundwater or groundwater seepage is present, and the trench is not properly dewatered, the soil within the trench zone may be prone to caving, channeling, and running. Trench widths may be substantially wider than under dewatered conditions.

### *Utility Trench Base Support*

There is a potential that utility trenches excavated below the groundwater table could experience a “quick” condition. A quick condition develops when the seepage pressure exceeds the resisting pressure. In this case, it would be the upwards vertical flow of water exceeding the unit weight of the soils at the bottom of the trench. The potential for a quick condition to develop is based on the hydraulic head difference between the water table level and the trench bottom and the unit weight of the surrounding soils. Our subsurface explorations indicate that the depth to water is unlikely to cause quick conditions in shallow utility areas, but may be present for deeper utility excavations.

If a quick condition does develop within utility trenches, it may become necessary to add quarry spall rock to the bottom of the trench during the excavation process. The quarry spall rock will add weight to the saturated sands and provide resistance against hydrostatic forces. If quick conditions develop in a lateral direction (i.e., running sand), mitigating the differential forces will be more difficult and will likely require that the water table be lowered to below the depth of the excavation.

GTS assumes that dewatering efforts will be required for deeper utility connections for this project. Temporary excavation dewatering using appropriate sump pumps is anticipated to be required for shallow utility excavations on this site. A more elaborate dewatering system may be required for deeper excavations, but it is the contractor's responsibility to develop a dewatering plan based on the expected elevation of utility excavations. GTS recommends that the design team have an opportunity to review the contractor's dewatering plan prior to the start of construction.

### Stormwater Infiltration Discussion

From the subsurface explorations in the areas of interest, 20 representative soil samples were selected from those soils in the upper 15 feet and mechanically tested for grain size distribution and interpretation according to the ASTM soil size distribution test procedure (ASTM D422) using the simplified approach as outlined in the 2012 Washington State Department of Ecology *Stormwater Management Manual for Western Washington (amended December 2014)*, Section 3.3.4. Preliminary infiltration rates are shown in Table 1 below.

<b>TABLE 1</b> <b>Soil Sample Infiltration Rates</b> <b>Based On The 2012 DOE Stormwater Management Manual Section 3.3.4</b>					
Exploration Number	Sample Depth (ft)	Classification USCS	K <sub>sat</sub> Uncorrected Rate (Inches/Hour)	Design Infiltration Rate Per ASTM D422 Detailed Approach (Inches/Hour)*	Fines Content (%)
B-1	2.5	ML	N/A	N/A**	96.9
B-1	7.5	SM	8.67	1.87	30.9
B-2	5.0	ML	1.14	0.25	73.2
B-2	15.0	ML	2.08	0.45	60.7
B-3	2.5	ML	0.51	0.11	89.9
B-3	10.0	ML	1.02	0.22	75.6
B-4	15.0	SM	9.77	2.11	28.4
B-5	5.0	ML	N/A	N/A**	96.6
B-5	15.0	SM	5.05	1.09	42.2
TP-1	2.5	ML	N/A	N/A**	97.8
TP-2	3.5	ML	2.06	0.45	60.9
TP-2	8.5	SM	4.08	0.88	46.7
TP-2	9.25	ML	0.44	0.09	93.2
TP-3	2.5	ML	N/A	N/A**	93.9
TP-4	6.5	ML	1.18	0.25	72.6

TP-5	2.5	ML	N/A	N/A**	99.3
TP-5	5.5	ML	N/A	N/A**	94.6
TP-6	9.0	ML	N/A	N/A**	96.7

Notes:

- \* Per ASTM D422 Simplified Approach, Does not Include Mounding Analysis
- \*\* Due to high fines content unable able to estimate infiltration rate
- Ksat = Initial Saturated Hydraulic Conductivity
- Correction Factors Used: CFv = 0.6, CFt = 0.4, CFm = 0.9

In the simplified approach (Section 3.3.4), the infiltration rate is derived by applying appropriate correction factors to the measured saturated hydraulic conductivity ( $K_{sat}$ ) from the ASTM 422 grain size analysis.

Saturated hydraulic conductivity is a quantitative measure of a saturated soil's ability to transmit water when subjected to a hydraulic gradient. It can be thought of as the ease with which pores of a saturated soil permit water movement.

Saturated Hydraulic Conductivity is expressed as follows:

$$\text{Log}_{10}(K_{sat}) = -1.57 + 1.90D_{10} + 0.015D_{60} - 0.013D_{90} - 2.08f_{fines}$$

Where  $D_{10}$ ,  $D_{60}$ , and  $D_{90}$  are the grain sizes in mm for which 10 percent, 60 percent, and 90 percent is more fine and  $f_{fines}$  is the fraction of the soil (by weight) that passes the U.S. No. 200 sieve.  $K_{sat}$  is measured in cm/sec.

With this equation, we can determine the saturated hydraulic conductivity for our representative samples. See example below:

Boring B-1 at 7.5 feet BGS:  $K_{sat} = 0.0061$  cm/sec or approximately 8.67 inches/hour

Applying correction factors for site variability (0.6), test method (0.4) and degree of influent control to prevent siltation and bio-buildup (0.9), for an overall correction factor of 0.216, gives a corrected calculated design rate of 1.78 inches/hour for the example above.

As displayed in Table 1, the native alluvium has design infiltration rates between 0.09 and 2.11 inches/hour, based on the simplified approach. Rates for 7 of the 18 samples were unable to be determined by the simplified approach due to their elevated fines content.

After the location and elevation of the stormwater facilities were determined, GTS performed a Pilot Infiltration Test (PIT), as outlined in the 2012 DOE Manual for long term design infiltration rates at the proposed location of the stormwater facilities. The PIT exploration was conducted on January 26, 2018, along the western perimeter of the site at an approximate location selected by Sound Development Group (See figure 2, site and exploration plan). The infiltration test used a method in general accordance with the procedure described in the 2014 Washington State Department of Ecology *Stormwater Management Manual for Western Washington*. The purpose of this test was to confirm infiltration suitability of stormwater in the vicinity of proposed facilities. Two additional

test pits were excavated to verify consistency of soil types and groundwater elevation along the western site perimeter.

The base of the infiltration test pit was located approximately 2 feet below existing site grades and contained a flat bottom with a surface area of 50 square feet (7.5 feet by 6.5 feet). Water was discharged into the test pit through a diffuser to reduce turbulence and scouring in the bottom of the excavation for a 6-hour "soaking period". Water for the infiltration test was obtained from a water truck provided by the contractor.

The purpose of the 6-hour pre-soak was to allow the soils in the immediate vicinity of the test area to exhibit "saturated" conditions. Water was discharged in to the excavation at a metered rate while keeping the water level within the testing area approximately fixed. Once the desired water level was reached, the water flow was shut off, following which no infiltration was observed or measured for the remainder of the test. After the 6-hour "soaking period", GTS attempted to conduct a falling-head infiltration test for 1 hour.

During the falling head test, water levels appeared to remain static. It is our opinion that the static water levels are a result of the stiff, high fines content of the soils at the invert elevation of the test. The standard PIT methods calculates a design infiltration rate based on an average of instantaneous readings of water flowing through a meter for a one hour time period. Since the in situ test performed was a falling head test, GTS attempted to measure the amount of drop in water elevation over a given time period. The equipment used to measure the falling head did not have the precision to obtain an elevation change within the test pit.

Subsurface conditions on January 26, 2018, consisted of 1 foot of tilled agricultural topsoil, over approximately 3-4 feet of medium stiff, tan, low plasticity silt, overlying a medium dense, silty, sand that extended to the full depth of the explorations. After 6 hours, the test pits were backfilled with the excavated spoils. Subsurface soil conditions were consistent between each exploration on this date, and well as nearby explorations from our site visits on July 14, 2017 and July 25, 2017. Groundwater elevations, however, were noticeably different. Based on this information, the design rate is most representative of soils belonging to NRCS Hydrologic Soil Group D.

However, past observations show site drainage after long periods of rain events. Based on the attached hydrometer laboratory test reports, the soils found at 12 inches to 30 inches BGS have a United States Department of Agriculture (USDA) Texture classification of Clay (C) and silty clay (SIC). These soil types are considered to have a low permeability rate. Based on previously published documents, these soils have an uncorrected laboratory permeability rate between 0.06 to 0.2 inches per hour.

Based on discussions with Sound Development, if we assume 1 inch of standing surface water over the entire site (during a rain event), their software back calculates that the in situ soils have an average infiltration rate of 0.03 inches per hour. From this information, a long term design rate of 0.03 inches per hour appears acceptable. However, it should be understood that this rate is considered to be unmeasurable with standard equipment and is based on previously published infiltration reports and the existing on-site back calculated results.

GeoTest Services was also requested to determine if this same soil column discussed above would qualify as berm material. From the above referenced hydrometer results,

the overall silt content is higher than the allowable limit. Therefore, the native materials would have to be blended with sand to reduce the silt content to be within the limits for berm material.

The following factors should be considered for the design of on-site infiltration facilities:

- The near surface native soils are not favorable for infiltration.
- Groundwater was found at approximately 28 inches BGS.
- Design of infiltration facilities is based on a back calculated rate of 0.03 inches per hour.
- The calculated rates do not account for mounding.
- The rates provided are representative of undisturbed loose soils. Compaction of the soil will change the calculated rates.

### Cation Exchange Capacity and Other Testing

Two samples were collected during our subsurface explorations for pollutant treatment purposes. Cation exchange capacity (CEC) and organic content, and pH tests were performed by Northwest Agricultural Consultants. Laboratory test results are presented in Table 2.

TABLE 2 CEC Laboratory Test Results					
Test Pit Number	Sample Depth (ft)	Geologic Classification	Cation Exchange Capacity (meq/100 grams)	Organic Content (%)	pH
TP-2	0.5	Topsoil/Tilled Agricultural Soils	17.4	7.78	6.3
TP-2	5.5	Alluvium	6.0	2.14	6.4

Based on the results listed in Table 2, the tilled agricultural soil/topsoil and native alluvium encountered in the upper approximately 6 feet of the test pits appear to be suitable for on-site pollutant purposes based on SSC-6 of the 2012 Washington State Department of Ecology *Stormwater Management Manual for Western Washington*. Criteria SSC-6 states that cation exchange capacity must be equal to or greater than 5.0 meq/100 grams for treatment purposes.

### Geotechnical Consultation and Construction Monitoring

GeoTest Services recommends that geotechnical construction monitoring services be provided. These services should include observation by geotechnical personnel during fill placement/compaction activities and subgrade preparation operations to verify that design subgrade conditions are obtained beneath the proposed improvement areas. We also recommend that periodic field density testing be performed to verify that the appropriate degree of compaction is obtained. The purpose of these services would be to observe compliance with the design concepts, specifications, and recommendations of this report, and in the event subsurface conditions differ from those anticipated before the start of construction, provide revised recommendations appropriate to the conditions

revealed during construction. GeoTest Services would be pleased to provide these services for you.

GeoTest Services is also available to provide a full range of materials testing and special inspection during construction as required by the local building department and the International Building Code. This may include specific construction inspections on materials such as reinforced concrete, structural steel, masonry, fireproofing, wood framing, adhesive anchors, etc. These services are supported by our fully accredited materials testing laboratory.

## **USE OF THIS REPORT**

GeoTest Services has prepared this report for the exclusive use of Trico Companies and their design consultants for specific application to the design of the Skagit Valley Farm Raw Product Cooling Facility Project located at 11261 Pulver Road in Burlington, Washington. Use of this report by others or for another project is at the user's sole risk. Within the limitations of scope, schedule, and budget, our services have been conducted in accordance with generally accepted practices of the geotechnical engineering profession; no other warranty, either expressed or implied, is made as to the professional advice included in this report.

Our site explorations indicate subsurface conditions at the dates and locations indicated. It is not warranted that they are representative of subsurface conditions at other locations and times. The analyses, conclusions, and recommendations contained in this report are based on site conditions to the limited depth of our explorations at the time of our exploration program, a brief geological reconnaissance of the area, and review of published geological information for the site. We assume that the explorations are representative of the subsurface conditions throughout the site during the preparation of our recommendations. If variations in subsurface conditions are encountered during construction, we should be notified for review of the recommendations of this report, and revision of such if necessary. If there is a substantial lapse of time between submission of this report and the start of construction, or if conditions change due to construction operations at or adjacent to the project site, we recommend that we review this report to determine the applicability of the conclusions and recommendations contained herein.

The earthwork contractor is responsible to perform all work in conformance with all applicable WISHA/OSHA regulations. GeoTest Services, Inc. should not be assumed to be responsible for job site safety on this project, and this responsibility is specifically disclaimed.



We appreciate the opportunity to provide geotechnical services on this project and look forward to assisting you during the construction phase. If you have any questions or comments regarding the information contained in this report, or if we may be of further service, please contact the undersigned.

Respectfully Submitted,  
**GeoTest Services, Inc.**



Joe Schmidt, E.I.T.  
Staff Engineer



4-10-2018

Dave Rauch, P.E.  
Engineering Project Manager

Attachments:	Plate 1	Liquefaction Analysis
	Figure 1	Vicinity Map
	Figure 2	Site and Exploration Plan
	Figure 3	Typical Footing and Wall Drain Section
	Figure 4	Typical Settlement Monitoring Plate Section
	Figure 5	Soil Classification System and Key
	Figures 6 – 10	Boring Logs
	Figures 11 –15	Test Pit Logs
	Figures 16 – 21	Grain Size Distribution
	Figure 22	Atterberg Limits
	Attached	Hydrometer Results (2 pages)
	Attached	CEC, pH and Organic Content Test Results (1 Page)
	Attached	Report Limitations and Guidelines (3 pages)

## REFERENCES

Washington State Department of Natural Resources. "Washington State Geologic Information Portal." Accessed August 17, 2017. <https://fortress.wa.gov/dnr/geology/?Theme=wigm>.

Washington State Department of Ecology Water Quality Program. August 2012. *Stormwater Management Manual for Western Washington, amended December 2014*. Publication Number 14-10-050.



MAP REFERENCED FROM GOOGLE MAPS



2000 Feet

# **GEOTEST SERVICES, INC.**

741 Marine Drive  
Bellingham, WA 98225  
phone: (360) 733-7318  
fax: (360) 733-7418

Date: 8-17-17

By: JS

Scale: As Shown

Project

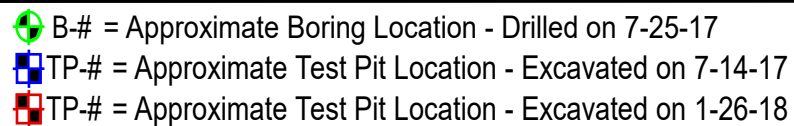
**17-0452**

**VICINITY MAP**  
**SVF PRODUCT COOLING FACILITY**  
**11261 PULVER ROAD**  
**BURLINGTON, WASHINGTON**

Figure

**1**



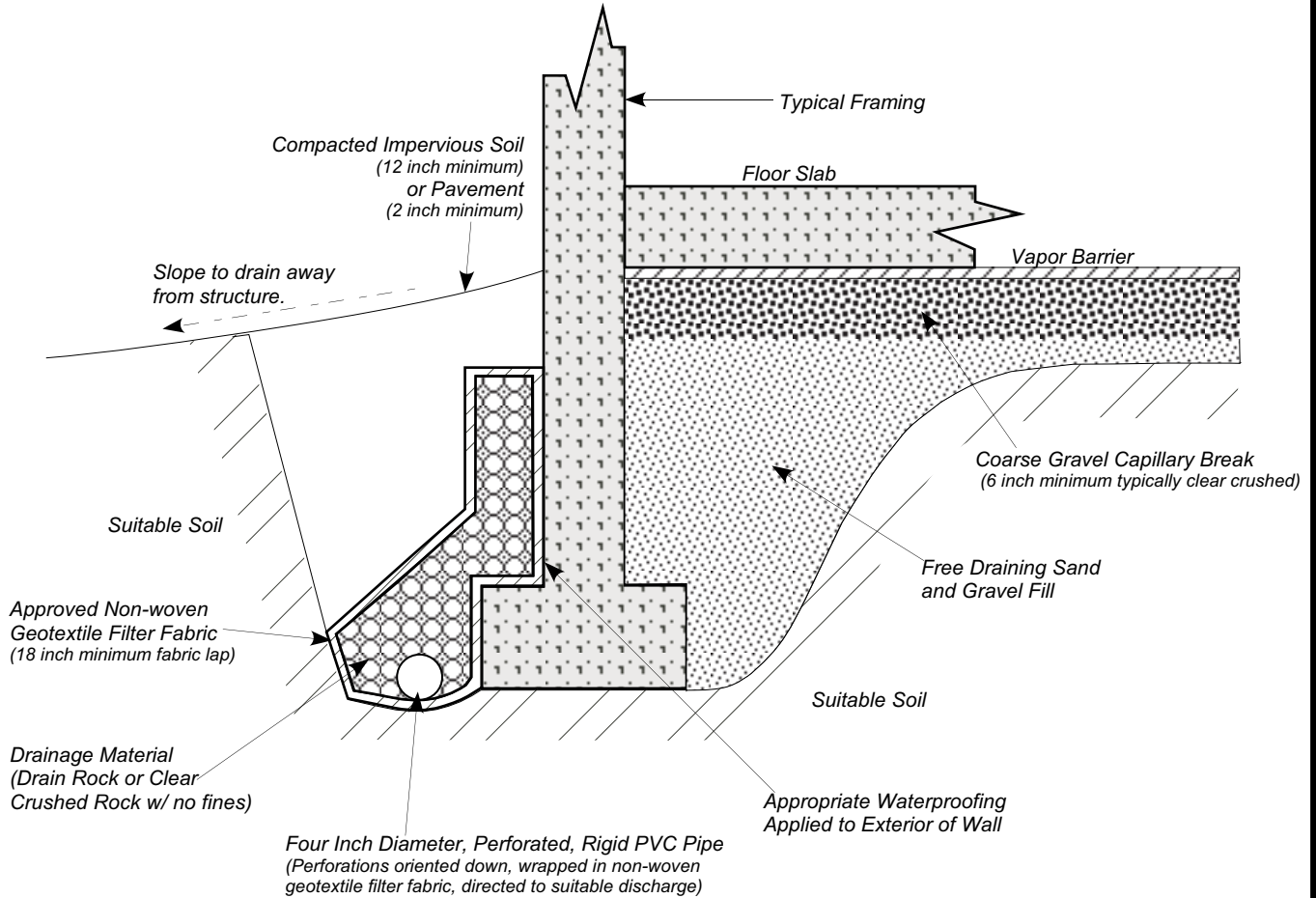


741 Marine Drive  
Bellingham, WA 98225  
phone: (360) 733-7318  
fax: (360) 733-7418

**SITE AND EXPLORATION PLAN  
SVF PRODUCT COOLING FACILITY  
11261 PULVER ROAD  
BURLINGTON, WASHINGTON**

2

## SHALLOW FOOTINGS WITH INTERIOR SLAB-ON-GRADE



### Notes:

Footings Should be properly buried for frost protection in accordance with International Building Code or local building codes  
(Typically 18 inches below exterior finished grades)

The footing drain will need to be modified from this typical drawing to fit the dimensions of the planned monolithic footing and slab configuration

### GEOTEST SERVICES, INC.

741 Marine Drive  
Bellingham, WA 98225

phone: (360) 733-7318  
fax: (360) 733-7418

Date: 8-17-17

By: JS

Scale: None

Project

**TYPICAL FOOTING & WALL DRAIN SECTION**

**17-0452**

**SVF PRODUCT COOLING FACILITY**

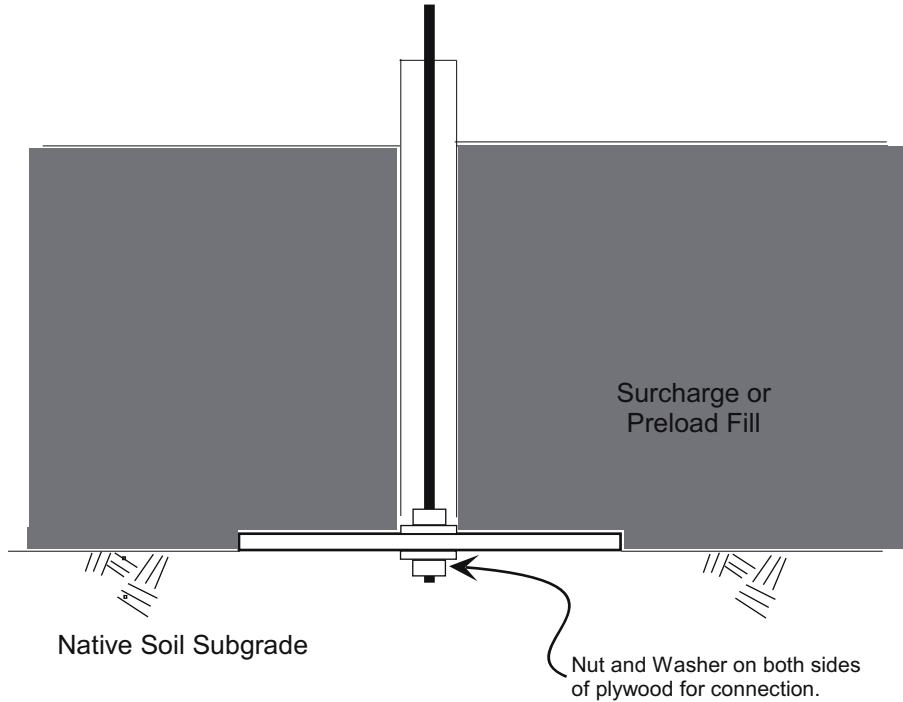
Figure

**11261 PULVER ROAD**

**3**

**BURLINGTON, WASHINGTON**

**SCHEMATIC ONLY- NO SCALE  
NOT A CONSTRUCTION DRAWING**



**NOTES**

- 1) Base is a 2 foot by 2 foot by 3/4 inch sheet of plywood. (Do not use OSB)
- 2) A small amount of Sand may be used as leveling material for base. (If applicable)
- 3) Marker Rod is 3/4 inch diameter all-threaded steel rod.
- 4) Protective PVC sleeve surrounding marker rod is NOT attached to base.
- 5) Additional marker rods may be attached by using a threaded coupler.
- 6) Marker rod should extend at least 12 inches above the adjacent grade.

**GEOTEST SERVICES, INC.**

741 Marine Drive  
Bellingham, WA 98225

phone: (360) 733-7318  
fax: (360) 733-7418

Date: 8-17-17

By: JS

Scale: NONE

Project  
**17-0452**

**TYPICAL SETTLEMENT MARKER**

**SVF PRODUCT COOLING FACILITY  
11261 PULVER ROAD  
BURLINGTON, WASHINGTON**

FIGURE

**4**

## Soil Classification System

	MAJOR DIVISIONS		GRAPHIC SYMBOL	USCS LETTER SYMBOL	TYPICAL DESCRIPTIONS <sup>(1)(2)</sup>
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL	CLEAN GRAVEL (Little or no fines)		<b>GW</b>	Well-graded gravel; gravel/sand mixture(s); little or no fines
				<b>GP</b>	Poorly graded gravel; gravel/sand mixture(s); little or no fines
	(More than 50% of coarse fraction retained on No. 4 sieve)	GRAVEL WITH FINES (Appreciable amount of fines)		<b>GM</b>	Silty gravel; gravel/sand/silt mixture(s)
				<b>GC</b>	Clayey gravel; gravel/sand/clay mixture(s)
	SAND AND SANDY SOIL	CLEAN SAND (Little or no fines)		<b>SW</b>	Well-graded sand; gravelly sand; little or no fines
				<b>SP</b>	Poorly graded sand; gravelly sand; little or no fines
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY (Liquid limit less than 50)			<b>SM</b>	Silty sand; sand/silt mixture(s)
				<b>SC</b>	Clayey sand; sand/clay mixture(s)
				<b>ML</b>	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity
	SILT AND CLAY (Liquid limit greater than 50)			<b>CL</b>	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay
				<b>OL</b>	Organic silt; organic, silty clay of low plasticity
				<b>MH</b>	Inorganic silt; micaceous or diatomaceous fine sand
	HIGHLY ORGANIC SOIL			<b>CH</b>	Inorganic clay of high plasticity; fat clay
				<b>OH</b>	Organic clay of medium to high plasticity; organic silt
				<b>PT</b>	Peat; humus; swamp soil with high organic content

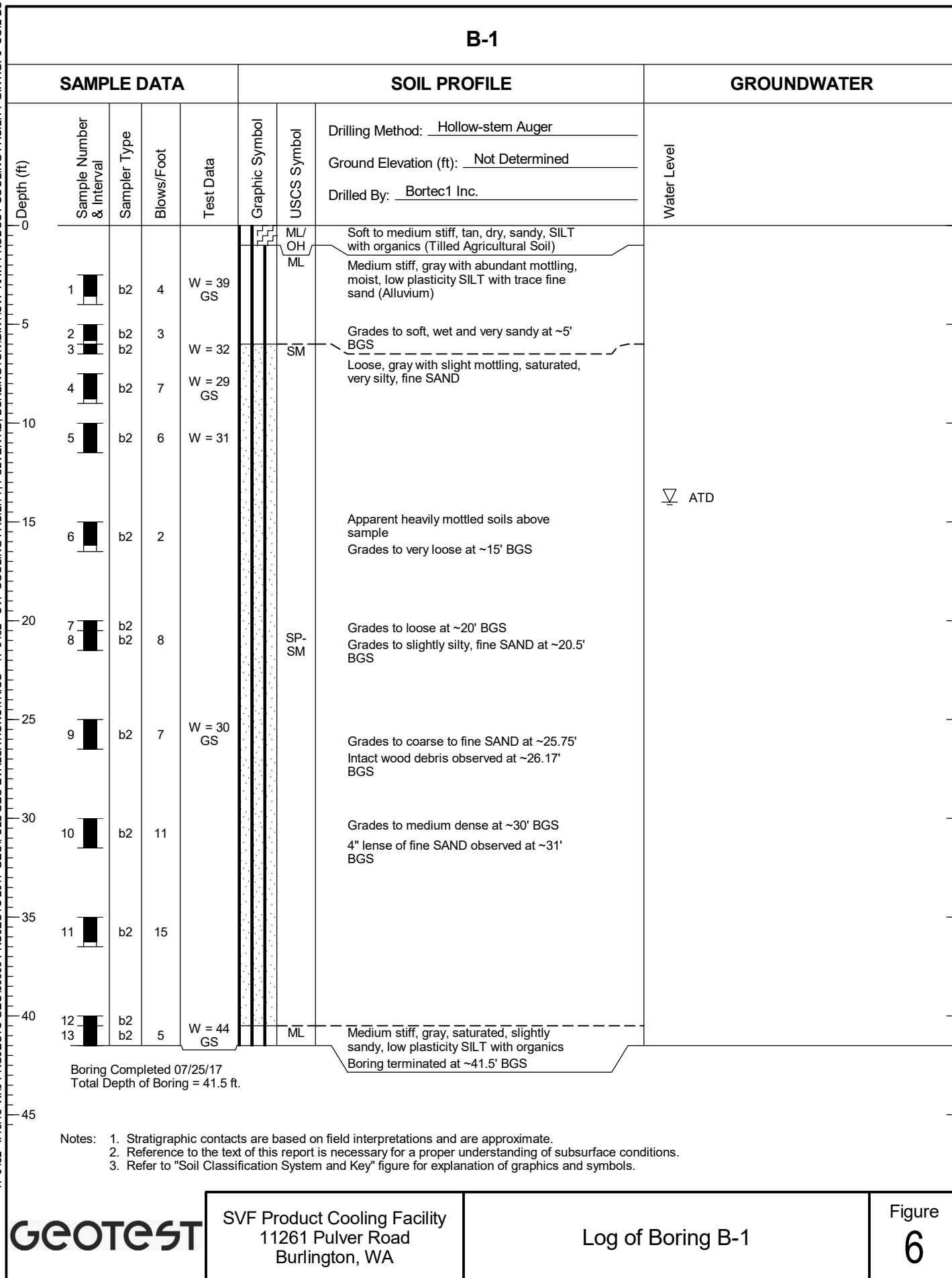
OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT		<b>AC or PC</b>	Asphalt concrete pavement or Portland cement pavement
ROCK		<b>RK</b>	Rock (See Rock Classification)
WOOD		<b>WD</b>	Wood, lumber, wood chips
DEBRIS		<b>DB</b>	Construction debris, garbage

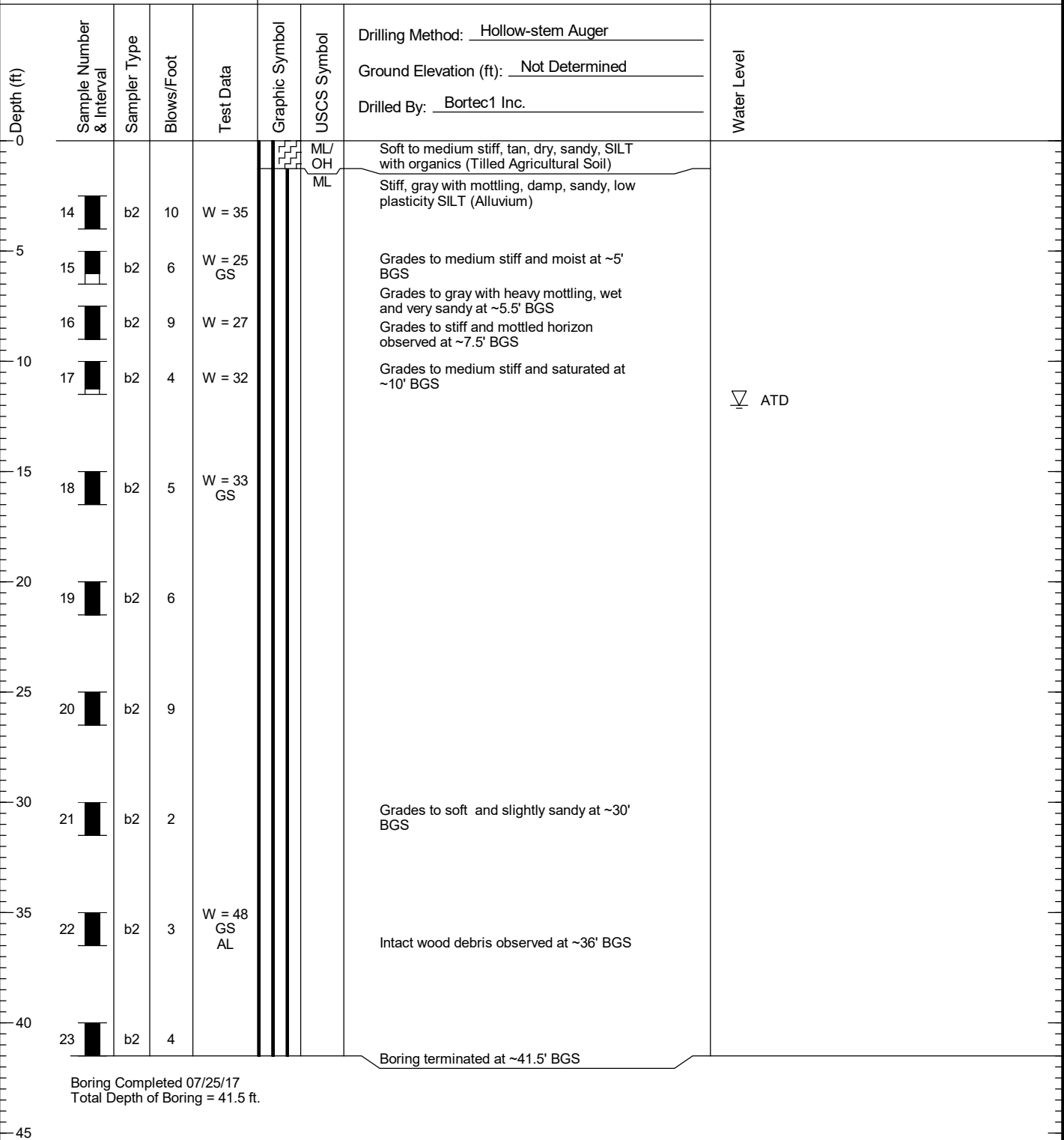
Notes: 1. Soil descriptions are based on the general approach presented in the *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*, as outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the *Standard Test Method for Classification of Soils for Engineering Purposes*, as outlined in ASTM D 2487.

2. Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:

Primary Constituent: > 50% - "GRAVEL," "SAND," "SILT," "CLAY," etc.  
 Secondary Constituents: > 30% and ≤ 50% - "very gravelly," "very sandy," "very silty," etc.  
 > 12% and ≤ 30% - "gravelly," "sandy," "silty," etc.  
 Additional Constituents: > 5% and ≤ 12% - "slightly gravelly," "slightly sandy," "slightly silty," etc.  
 ≤ 5% - "trace gravel," "trace sand," "trace silt," etc., or not noted.

Drilling and Sampling Key			Field and Lab Test Data	
SAMPLE NUMBER & INTERVAL	SAMPLER TYPE		Code	Description
	Code	Description		
	a	3.25-inch O.D., 2.42-inch I.D. Split Spoon	PP = 1.0	Pocket Penetrometer, tsf
	b	2.00-inch O.D., 1.50-inch I.D. Split Spoon	TV = 0.5	Torvane, tsf
	c	Shelby Tube	PID = 100	Photoionization Detector VOC screening, ppm
	d	Grab Sample	W = 10	Moisture Content, %
	e	Other - See text if applicable	D = 120	Dry Density, pcf
	1	300-lb Hammer, 30-inch Drop	-200 = 60	Material smaller than No. 200 sieve, %
	2	140-lb Hammer, 30-inch Drop	GS	Grain Size - See separate figure for data
	3	Pushed	AL	Atterberg Limits - See separate figure for data
	4	Other - See text if applicable	GT	Other Geotechnical Testing
			CA	Chemical Analysis
Groundwater				
Approximate water elevation at time of drilling (ATD) or on date noted. Groundwater levels can fluctuate due to precipitation, seasonal conditions, and other factors.				



**B-2****SAMPLE DATA****SOIL PROFILE****GROUNDWATER**

- Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
  2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
  3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

**GEOTEST**

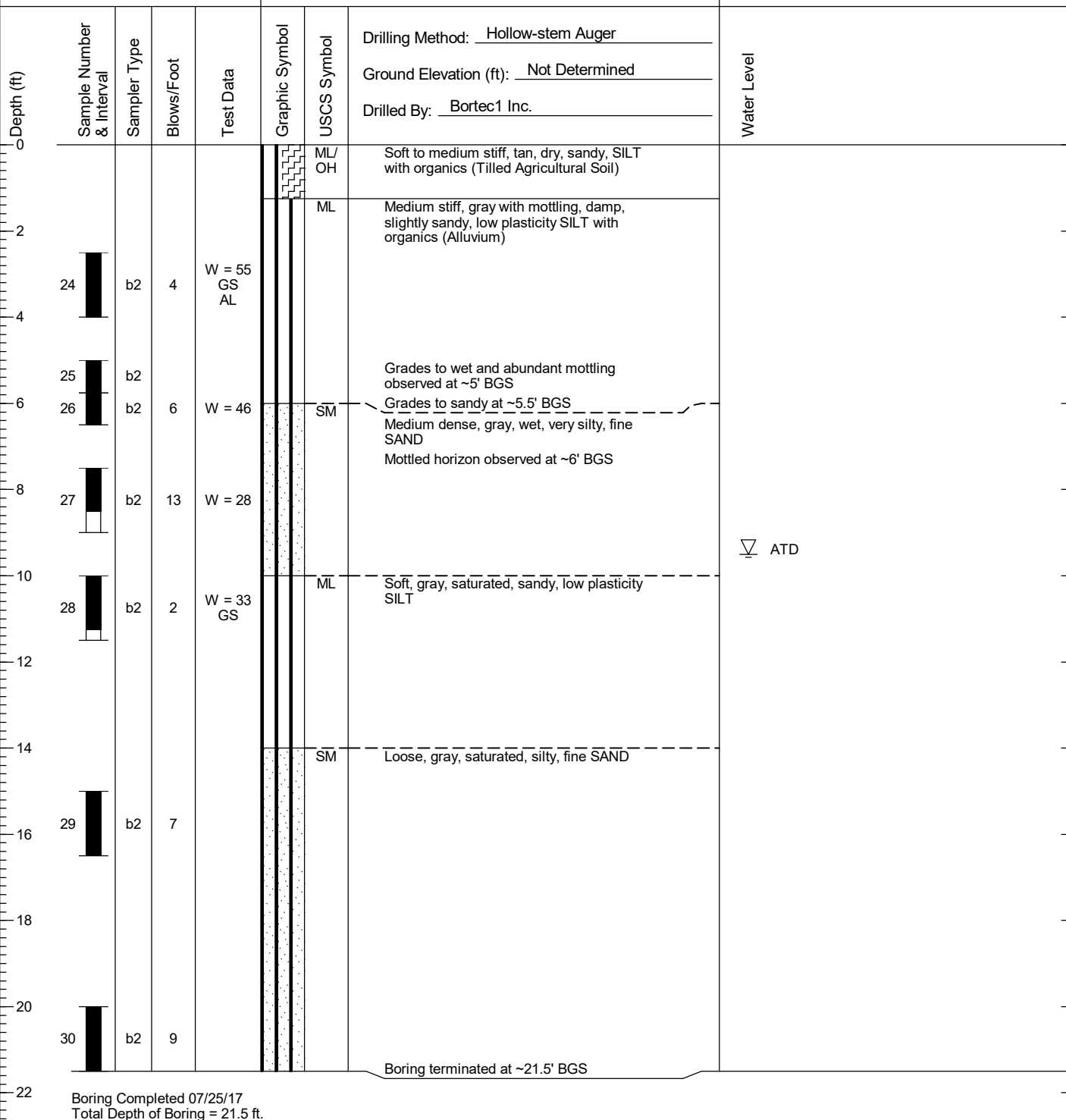
SVF Product Cooling Facility  
11261 Pulver Road  
Burlington, WA

Log of Boring B-2

Figure

**7**



**B-3****SAMPLE DATA****SOIL PROFILE****GROUNDWATER**

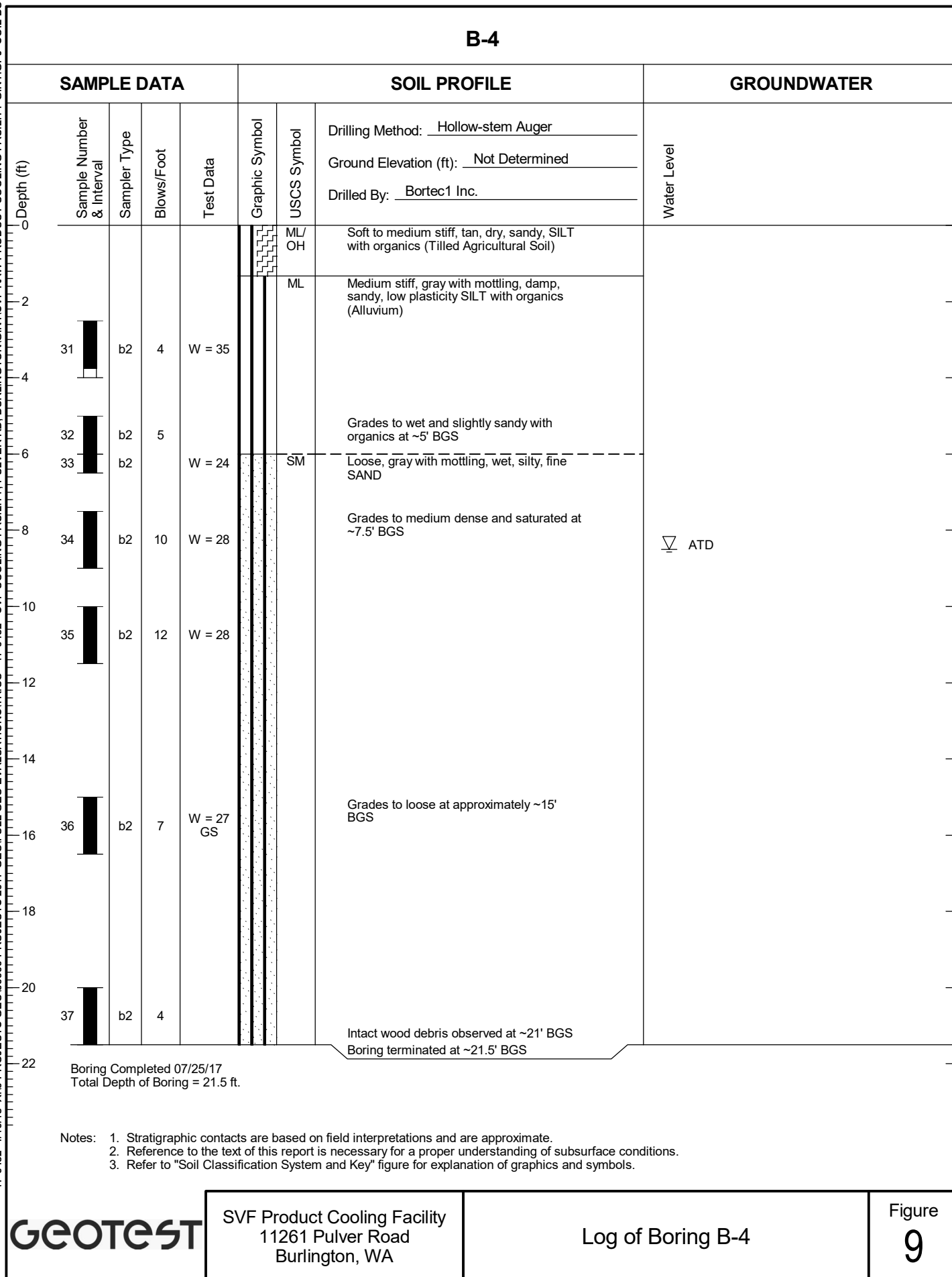
- Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
  2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
  3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

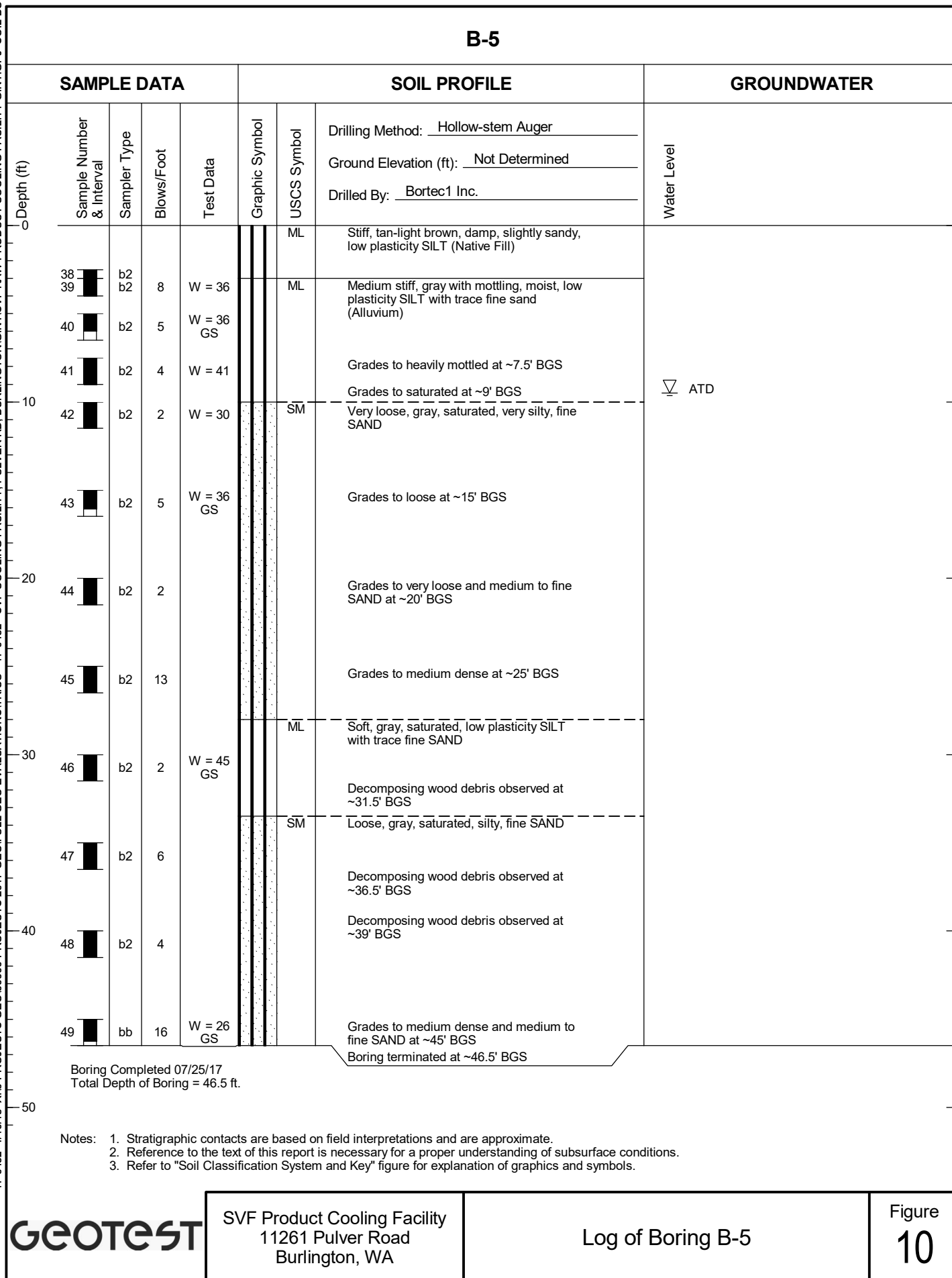
**GEOTEST**

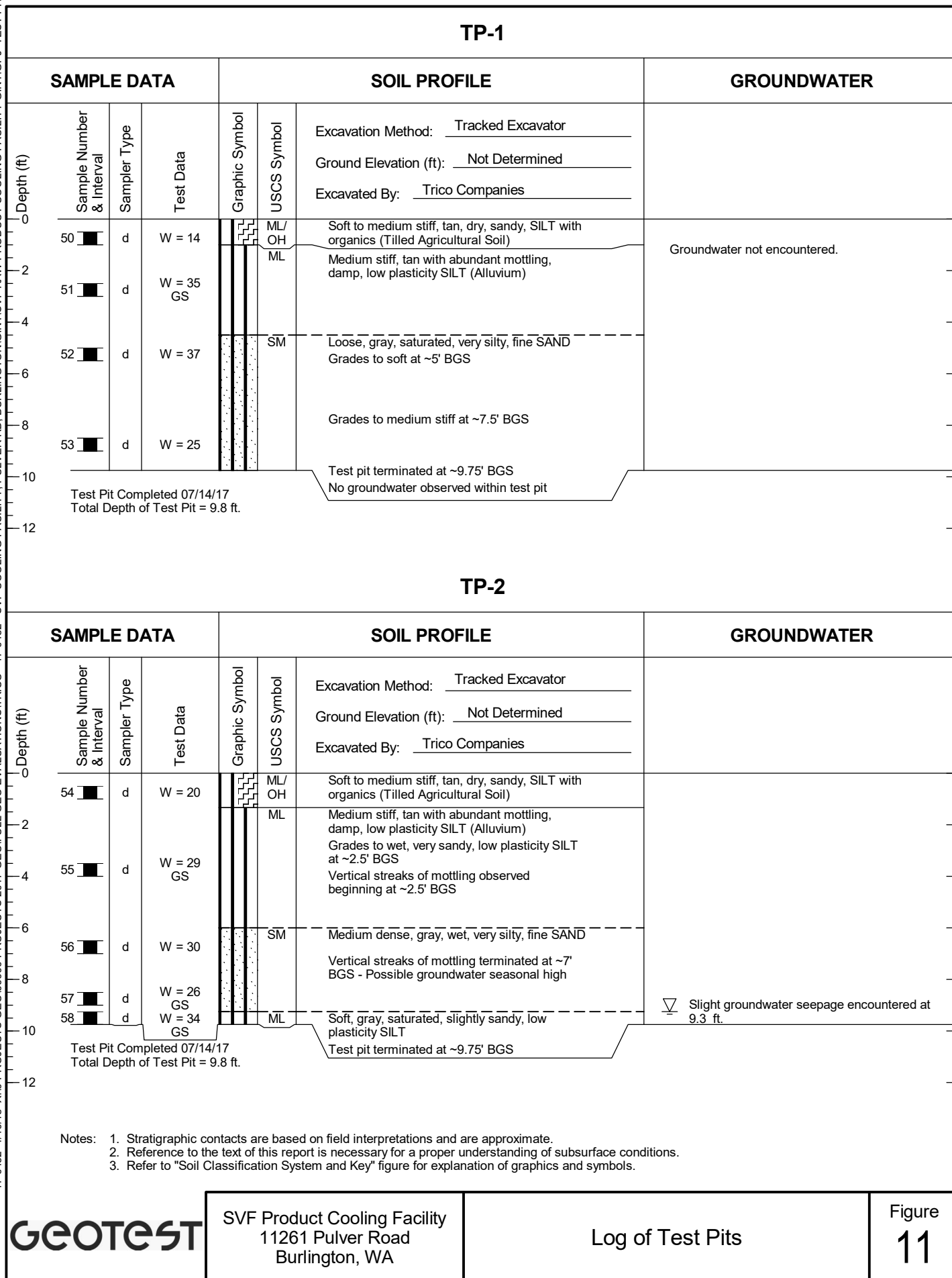
SVF Product Cooling Facility  
11261 Pulver Road  
Burlington, WA

Log of Boring B-3

Figure  
**8**







## TP-3

## SAMPLE DATA

## SOIL PROFILE

## GROUNDWATER

Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: <u>Tracked Excavator</u>	Ground Elevation (ft): <u>Not Determined</u>	Excavated By: <u>Trico Companies</u>	
0									
59	59-60	d	W = 20		ML/OH	Soft to medium stiff, tan, dry, sandy, SILT with organics (Tilled Agricultural Soil)			
60	60-61	d	W = 29		ML	Medium stiff, tan with abundant mottling, damp, slightly sandy, low plasticity SILT (Alluvium)			
61	61-62	d	W = 35 GS						
62	62-63	d	W = 35			Grades to grey with mottling, saturated, sandy, low plasticity SILT at ~4' BGS Caving observed beginning at ~4' BGS			
63	63-64	d	W = 38			Grades to soft, gray-blue, saturated, slightly sandy, low plasticity SILT at ~9' BGS			▽ Slight groundwater seepage encountered at 9.0 ft.
10						Test pit terminated at ~9.75' BGS			
12									

Test Pit Completed 07/14/17  
Total Depth of Test Pit = 9.8 ft.

## TP-4

## SAMPLE DATA

## SOIL PROFILE

## GROUNDWATER

Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: <u>Tracked Excavator</u>	Ground Elevation (ft): <u>Not Determined</u>	Excavated By: <u>Trico Companies</u>	
0									
64	64-65	d	W = 18		ML/OH	Soft to medium stiff, tan, dry, sandy, SILT with organics (Tilled Agricultural Soil)			
65	65-66	d	W = 35		ML	Medium stiff, tan with abundant mottling, damp, slightly sandy, low plasticity SILT (Alluvium)			
66	66-67	d	W = 42			Grades to gray and moist at ~4.75' BGS			
67	67-68	d	W = 25 GS			Grades to gray-blue with mottling, moist to wet, sandy, low plasticity SILT at ~6' BGS No mottling observed after ~7' BGS			
10						Test pit terminated at ~9.0' BGS No groundwater observed within test pit			
12									

Test Pit Completed 07/14/17  
Total Depth of Test Pit = 9.0 ft.

- Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
  2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
  3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

## TP-5

## SAMPLE DATA

## SOIL PROFILE

## GROUNDWATER

Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: <u>Tracked Excavator</u>	Ground Elevation (ft): <u>Not Determined</u>	Excavated By: <u>Trico Companies</u>	
0									
68	68	d	W = 22		ML/OH	Soft to medium stiff, tan, dry, sandy, SILT with organics (Tilled Agricultural Soil)			Groundwater not encountered.
69	69	d	W = 24 GS		ML	Medium stiff, tan with abundant mottling, damp, low plasticity SILT (Alluvium)			
70	70	d	W = 54 GS			Grades to gray, wet, slightly sandy, low plasticity SILT at ~3.67' BGS Wood debris (Flood Event Deposit) observed at ~4' BGS Grades to very sandy at ~6' BGS			
71	71	d	W = 31			Test pit terminated at ~9.0' BGS No groundwater observed within test pit			
10									
12									

Test Pit Completed 07/14/17  
Total Depth of Test Pit = 9.8 ft.

## TP-6

## SAMPLE DATA

## SOIL PROFILE

## GROUNDWATER

Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: <u>Tracked Excavator</u>	Ground Elevation (ft): <u>Not Determined</u>	Excavated By: <u>Trico Companies</u>	
0									
72	72	d	W = 25		ML/OH	Soft to medium stiff, tan, dry, sandy, SILT with organics (Tilled Agricultural Soil)			Moderate groundwater seepage encountered at 9.0 ft.
73	73	d	W = 32		ML	Medium stiff, grey with mottling, damp, sandy, low plasticity SILT (Alluvium)			
74	74	d	W = 46			Grades to soft with trace sand at ~4' BGS			
75	75	d	W = 34			Grades to grey-blue and very sandy at ~7' BGS			
76	76	d	W = 37 GS			Grades to gray-blue, saturated, low plasticity SILT with trace fine SAND at ~9' BGS Test pit terminated at ~10.0' BGS			
10									
12									

Test Pit Completed 07/14/17  
Total Depth of Test Pit = 10.0 ft.

- Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
  2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
  3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

GEOTEST

SVF Product Cooling Facility  
11261 Pulver Road  
Burlington, WA

Log of Test Pits

Figure  
13

## TP-7/PIT 1

## SAMPLE DATA

## SOIL PROFILE

## GROUNDWATER

Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: <u>Tracked Excavator</u> Ground Elevation (ft): <u>Not Determined</u> Excavated By: <u>Trico Companies</u>	
0					ML/ OL	Soft to medium stiff, tan, moist, sandy, SILT with organics (Tilled Agricultural Soil)	
2					ML	Medium stiff, tan with abundant mottling, damp, low plasticity SILT (Alluvium - Flood Plain Deposits) Base of Pit at ~2' BGS	▽ Moderate groundwater seepage encountered at 2.5 ft.
4					SM	Medium dense, blue, wet, silty, fine SAND (Alluvium - Flood Plain Deposits)	
6							
8	Test Pit Completed 01/26/18 Total Depth of Test Pit = 7.0 ft.						
10							

## TP-8

## SAMPLE DATA

## SOIL PROFILE

## GROUNDWATER

Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: <u>Tracked Excavator</u> Ground Elevation (ft): <u>Not Determined</u> Excavated By: <u>Trico Companies</u>		
0					ML/ OL	Soft to medium stiff, tan, moist, sandy, SILT with organics (Tilled Agricultural Soil)		
2	1	d	W = 40 GS		SM	Medium stiff, tan with abundant mottling, damp, low plasticity SILT (Alluvium - Flood Plain Deposits)  Wood debris (Flood Event Deposit) observed at ~3' BGS	Moderate groundwater seepage encountered at 2.5 ft.	
4	2	d						
6					ML	Medium dense, blue, wet, silty, fine SAND (Alluvium - Flood Plain Deposits)		
Test Pit Completed 01/26/18 Total Depth of Test Pit = 7.0 ft.								
8								
10								

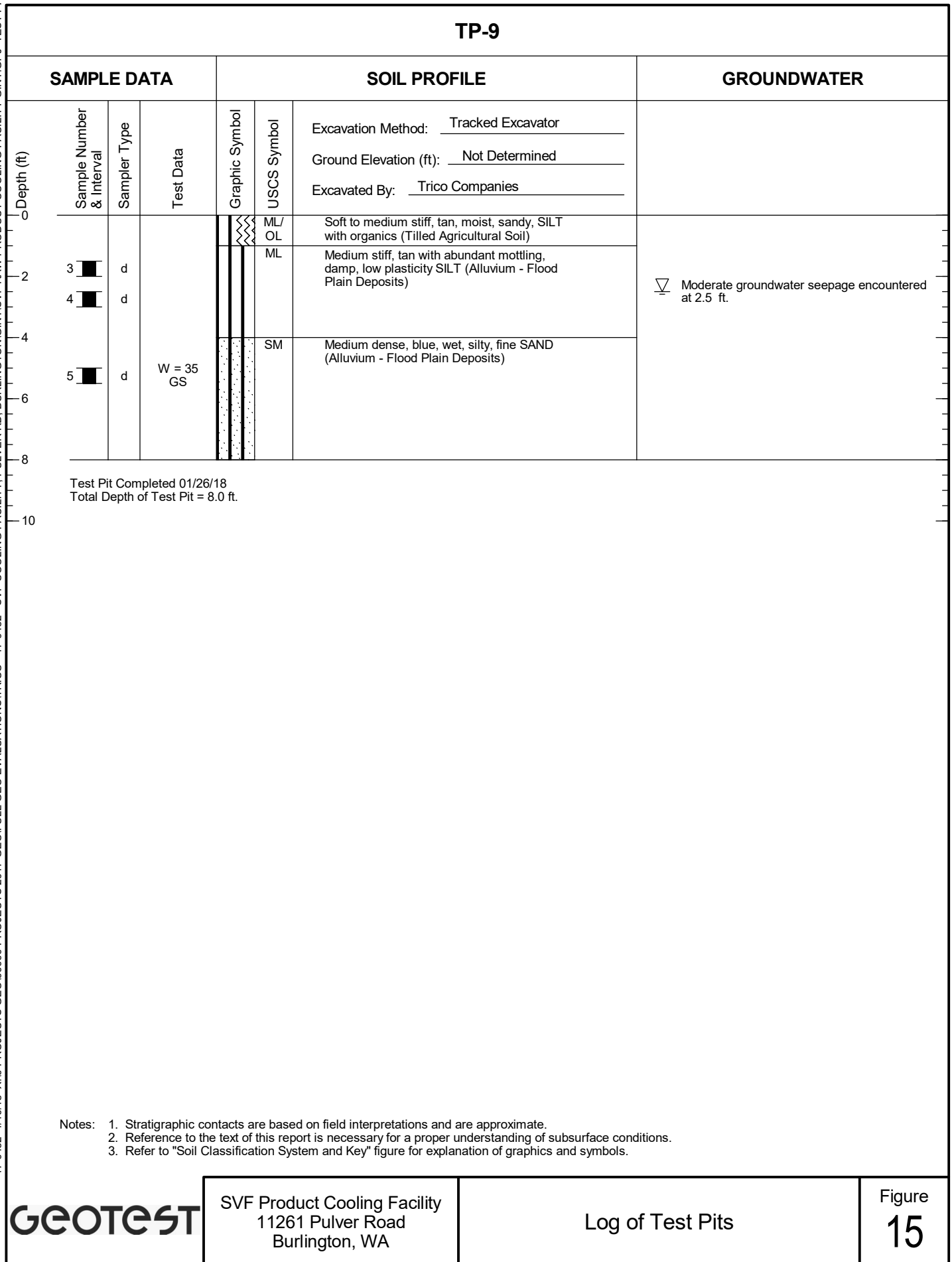
- Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
  2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
  3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

GEOTEST

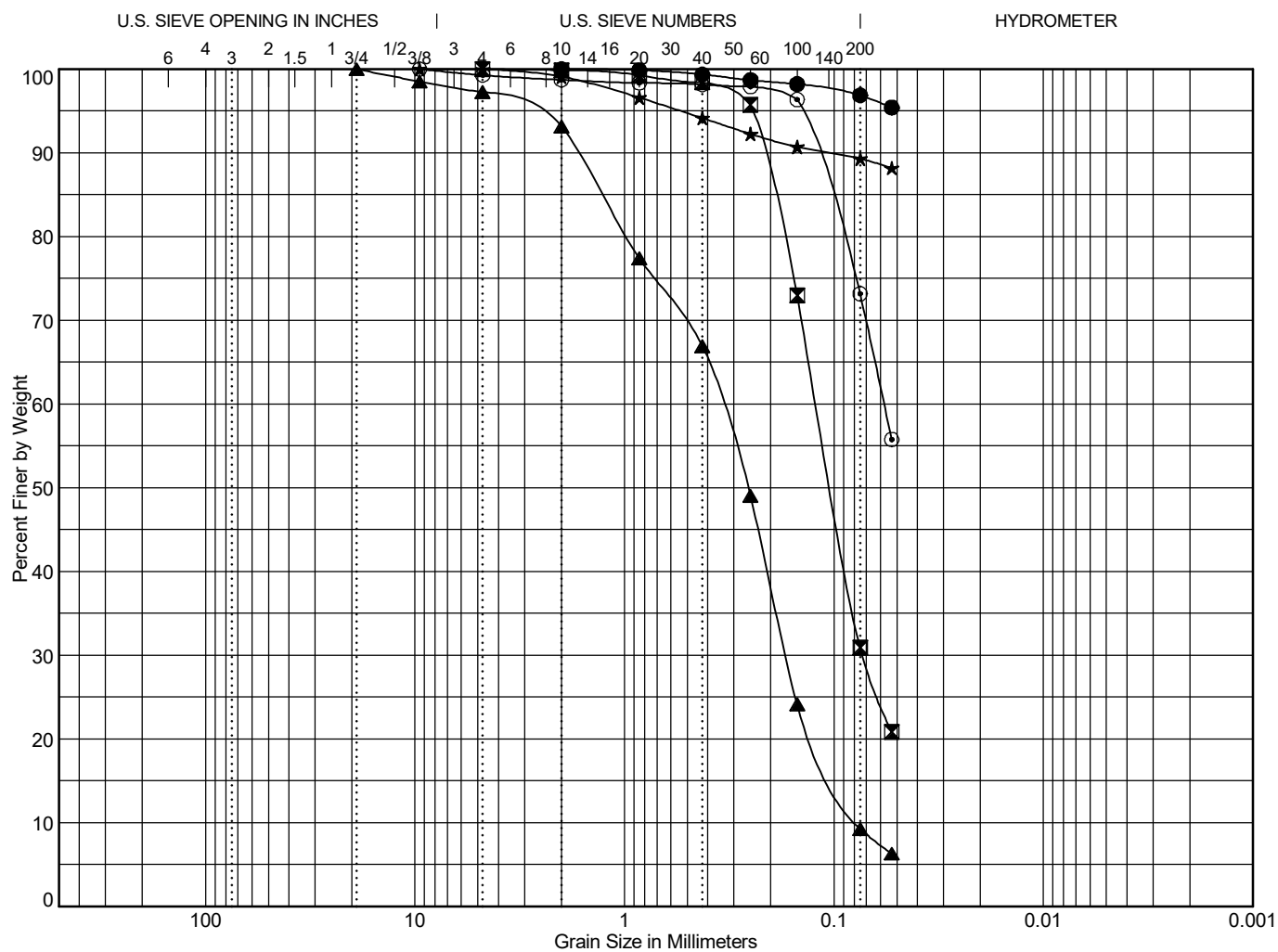
SVF Product Cooling Facility  
11261 Pulver Road  
Burlington, WA

Log of Test Pits

Figure  
14







Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Point	Depth	Classification								LL	PL	PI	C <sub>c</sub>	C <sub>u</sub>	
●	B-1	2.5	LOW PLASTICITY SILT WITH TRACE FINE SAND (ML)												
☒	B-1	7.5	VERY SILTY, FINE SAND (SM)												
▲	B-1	25.0	SLIGHTLY SILTY, MEDIUM TO FINE SAND WITH TRACE FINE GRAVEL (SP-SM)											1.07	4.46
★	B-1	40.5	SLIGHTLY SANDY, LOW PLASTICITY SILT (ML)												
◎	B-2	5.0	SANDY, LOW PLASTICITY SILT (ML)												
Point	Depth	D <sub>100</sub>	D <sub>60</sub>	D <sub>50</sub>	D <sub>30</sub>	D <sub>10</sub>	%Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines			
●	B-1	2.5	2				0.0	0.0	0.0	0.6	2.5	96.9			
☒	B-1	7.5	4.75	0.121	0.103	0.073		0.0	0.0	0.1	1.5	67.5	30.9		
▲	B-1	25.0	19	0.346	0.257	0.169	0.078	0.0	2.7	4.1	26.2	57.7	9.3		
★	B-1	40.5	9.5					0.0	0.0	0.9	4.9	4.9	89.3		
◎	B-2	5.0	9.5	0.058				0.0	0.7	0.6	0.6	25.0	73.2		

$$C_c = D_{30}^2 / (D_{60} * D_{10})$$

$$C_u = D_{60} / D_{10}$$

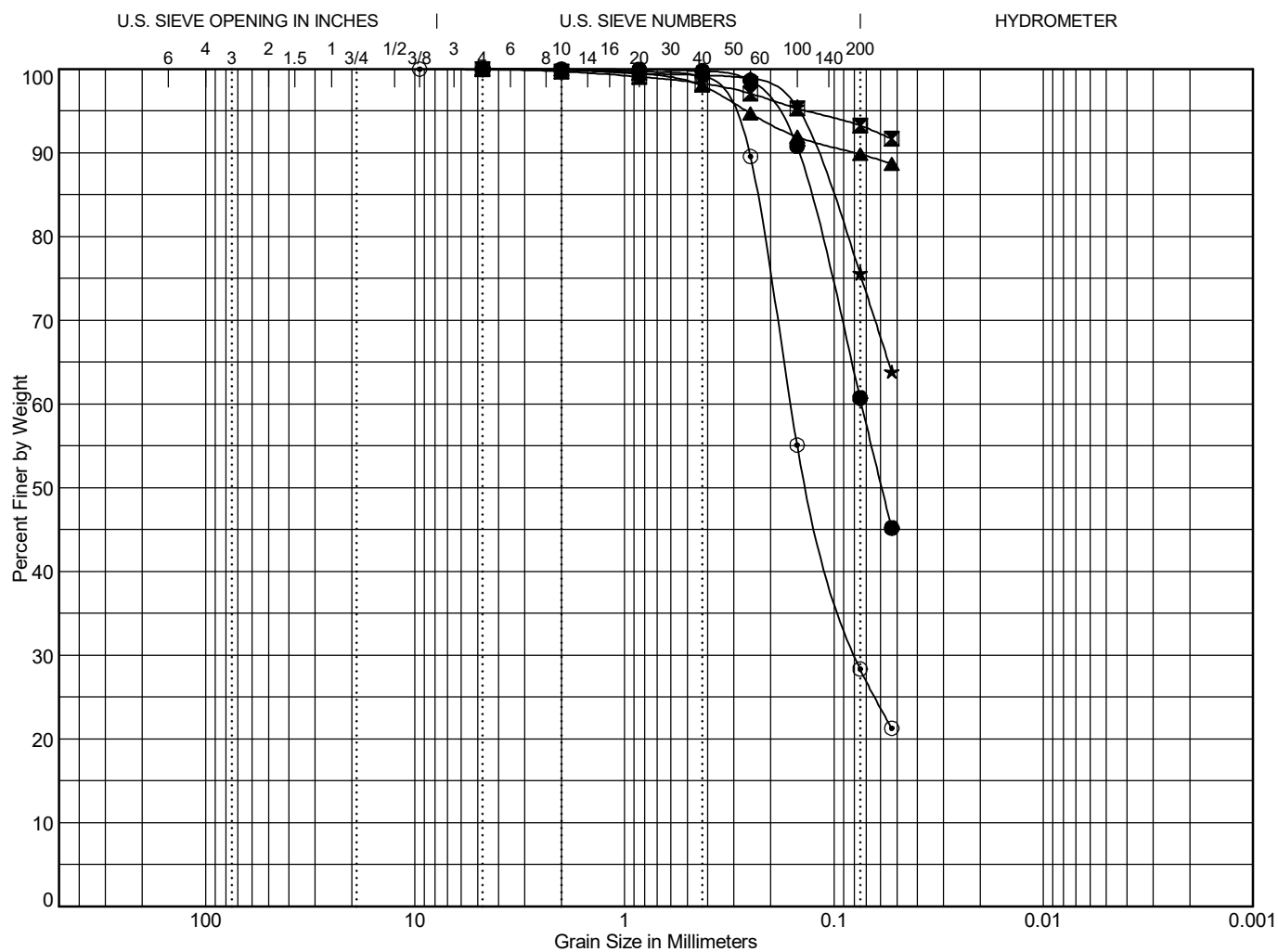
To be well graded:  $1 < C_c < 3$  and  $C_u > 4$  for GW or  $C_u > 6$  for SW

**GEOTEST**

SVF Product Cooling Facility  
11261 Pulver Road  
Burlington, WA

Grain Size Test Data

Figure  
**16**



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Point	Depth	Classification								LL	PL	PI	C <sub>c</sub>	C <sub>u</sub>	
●	B-2	15.0	VERY SANDY, LOW PLASTICITY SILT (ML)												
☒	B-2	35.0	SLIGHTLY SANDY, LOW PLASTICITY SILT (ML)								35	29	6		
▲	B-3	2.5	SLIGHTLY SANDY, LOW PLASTICITY SILT (ML)								42	31	11		
★	B-3	10.0	SANDY, LOW PLASTICITY SILT (ML)												
◎	B-4	15.0	SILTY, FINE SAND (SM)												
Point	Depth	D <sub>100</sub>	D <sub>60</sub>	D <sub>50</sub>	D <sub>30</sub>	D <sub>10</sub>	%Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines			
●	B-2	15.0	4.75	0.074	0.059			0.0	0.0	0.0	0.2	39.0	60.7		
☒	B-2	35.0	4.75					0.0	0.0	0.3	1.4	5.0	93.3		
▲	B-3	2.5	4.75					0.0	0.0	0.0	1.9	8.2	89.9		
★	B-3	10.0	4.75					0.0	0.0	0.1	0.6	23.7	75.6		
◎	B-4	15.0	9.5	0.161	0.131	0.078		0.0	0.0	0.0	0.8	70.8	28.4		

$$C_c = D_{30}^2 / (D_{60} * D_{10})$$

$$C_u = D_{60} / D_{10}$$

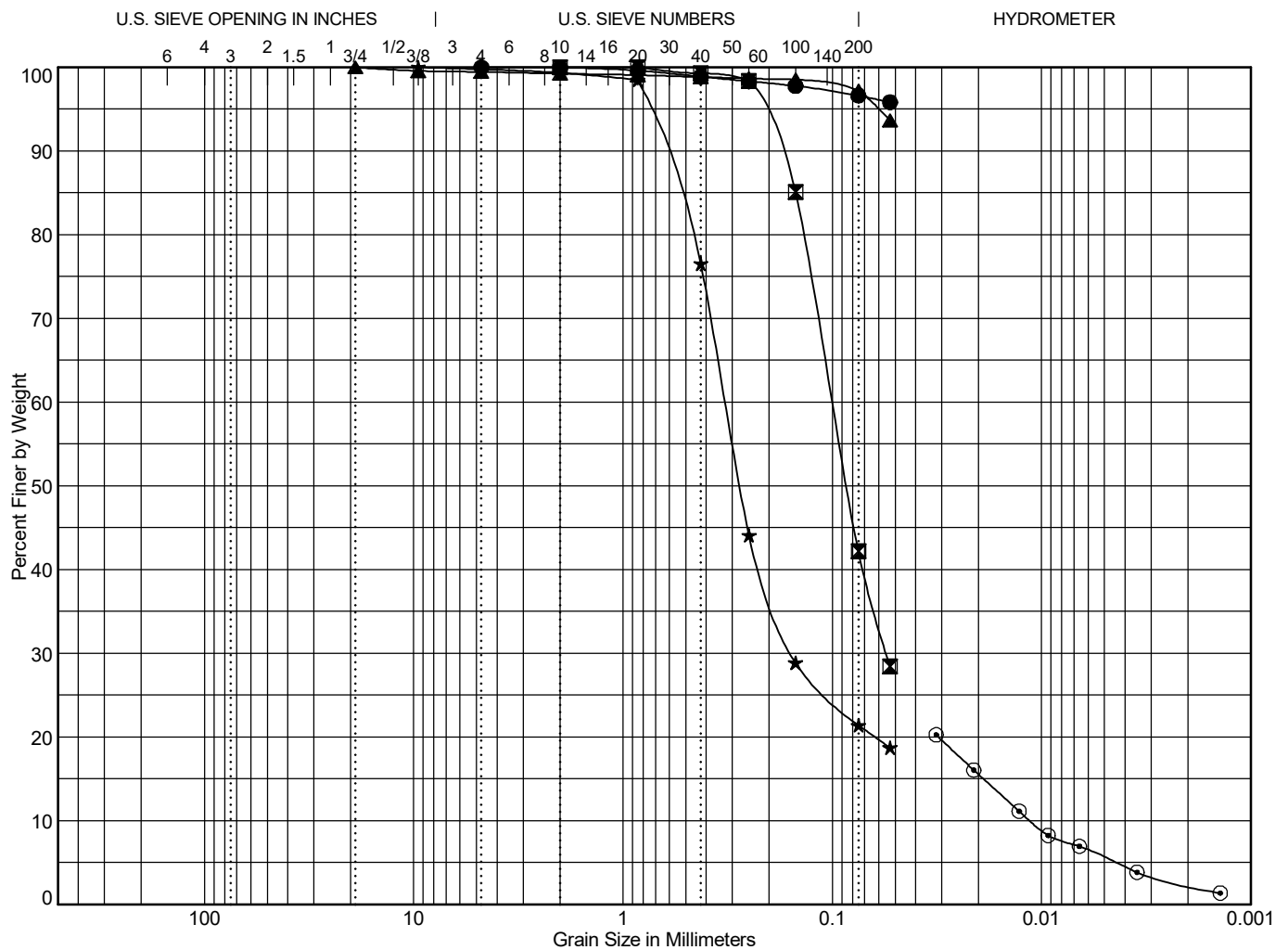
To be well graded:  $1 < C_c < 3$  and  $C_u > 4$  for GW or  $C_u > 6$  for SW

**GEOTEST**

SVF Product Cooling Facility  
11261 Pulver Road  
Burlington, WA

Grain Size Test Data

Figure  
**17**



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Point	Depth	Classification							LL	PL	PI	C <sub>c</sub>	C <sub>u</sub>	
●	B-5	5.0	LOW PLASTICITY SILT WITH TRACE FINE SAND (ML)											
☒	B-5	15.0	VERY SILTY, FINE SAND (SM)											
▲	B-5	30.0	LOW PLASTICITY SILT WITH TRACE FINE SAND (ML)											
★	B-5	45.0	SILTY, MEDIUM TO FINE SAND (SM)											
◎	HA-1	3.0	()											
Point	Depth	D <sub>100</sub>	D <sub>60</sub>	D <sub>50</sub>	D <sub>30</sub>	D <sub>10</sub>	%Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines		
●	B-5	5.0	4.75				0.0	0.0	0.0	1.1	2.3	96.6		
☒	B-5	15.0	2	0.1	0.085	0.055		0.0	0.0	0.0	0.7	57.1	42.2	
▲	B-5	30.0	19					0.0	0.6	0.2	0.4	1.7	97.2	
★	B-5	45.0	9.5	0.324	0.275	0.156		0.0	0.2	0.4	22.8	55.1	21.4	
◎	HA-1	3.0					0.011							

$$C_c = D_{30}^2 / (D_{60} * D_{10})$$

$$C_u = D_{60} / D_{10}$$

To be well graded:  $1 < C_c < 3$  and

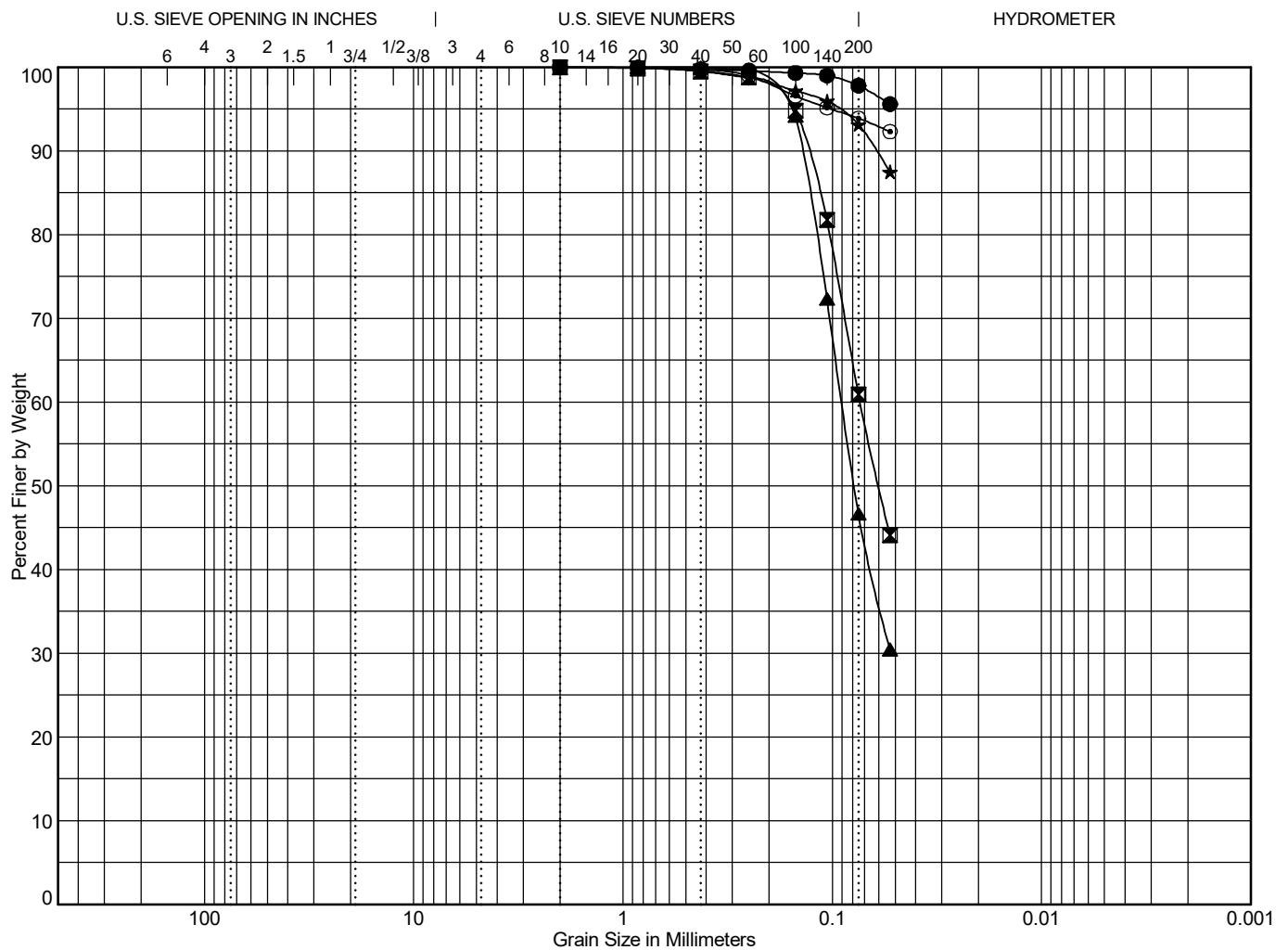
$C_u > 4$  for GW or  $C_u > 6$  for SW

**GEOTEST**

SVF Product Cooling Facility  
11261 Pulver Road  
Burlington, WA

Grain Size Test Data

Figure  
**18**



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Point	Depth	Classification							LL	PL	PI	C <sub>c</sub>	C <sub>u</sub>	
●	TP-1	2.5	LOW PLASTICITY SILT (ML)											
☒	TP-2	3.5	VERY SANDY, LOW PLASTICITY SILT (ML)											
▲	TP-2	8.5	VERY SILTY, FINE SAND (SM)											
★	TP-2	9.3	SLIGHTLY SANDY, LOW PLASTICITY SILT (ML)											
⊙	TP-3	2.5	SLIGHTLY SANDY, LOW PLASTICITY SILT (ML)											
Point	Depth	D <sub>100</sub>	D <sub>60</sub>	D <sub>50</sub>	D <sub>30</sub>	D <sub>10</sub>	%Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines		
●	TP-1	2.5	2				0.0	0.0	0.0	0.2	1.9	97.8		
☒	TP-2	3.5	2	0.074	0.06		0.0	0.0	0.0	0.5	38.6	60.9		
▲	TP-2	8.5	0.85	0.09	0.078		0.0	0.0	0.0	0.0	53.3	46.7		
★	TP-2	9.3	0.85				0.0	0.0	0.0	0.5	6.4	93.2		
⊙	TP-3	2.5	0.85				0.0	0.0	0.0	0.3	5.8	93.9		

$$C_c = D_{30}^2 / (D_{60} * D_{10})$$

$$C_u = D_{60} / D_{10}$$

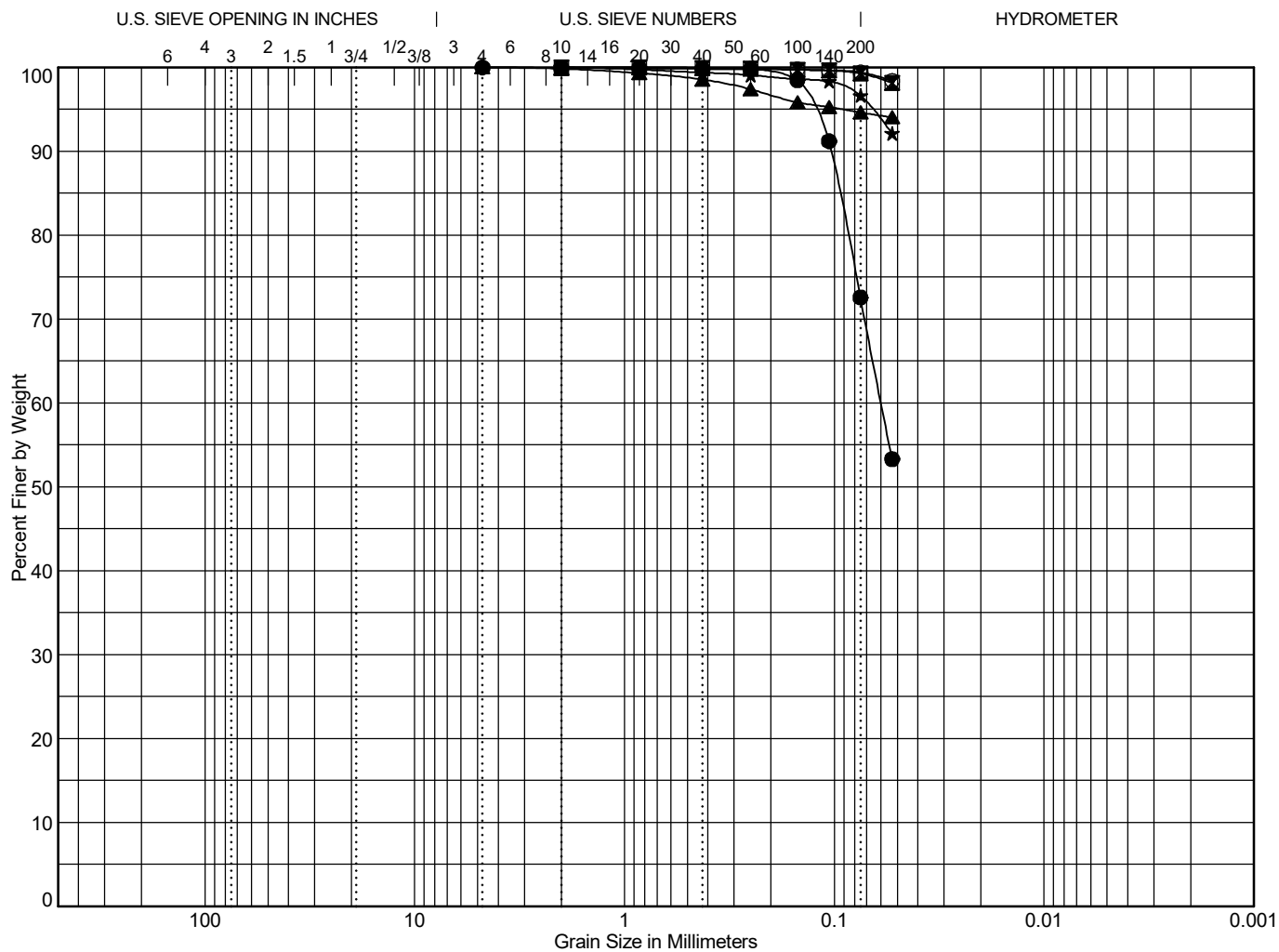
To be well graded:  $1 < C_c < 3$  and  $C_u > 4$  for GW or  $C_u > 6$  for SW

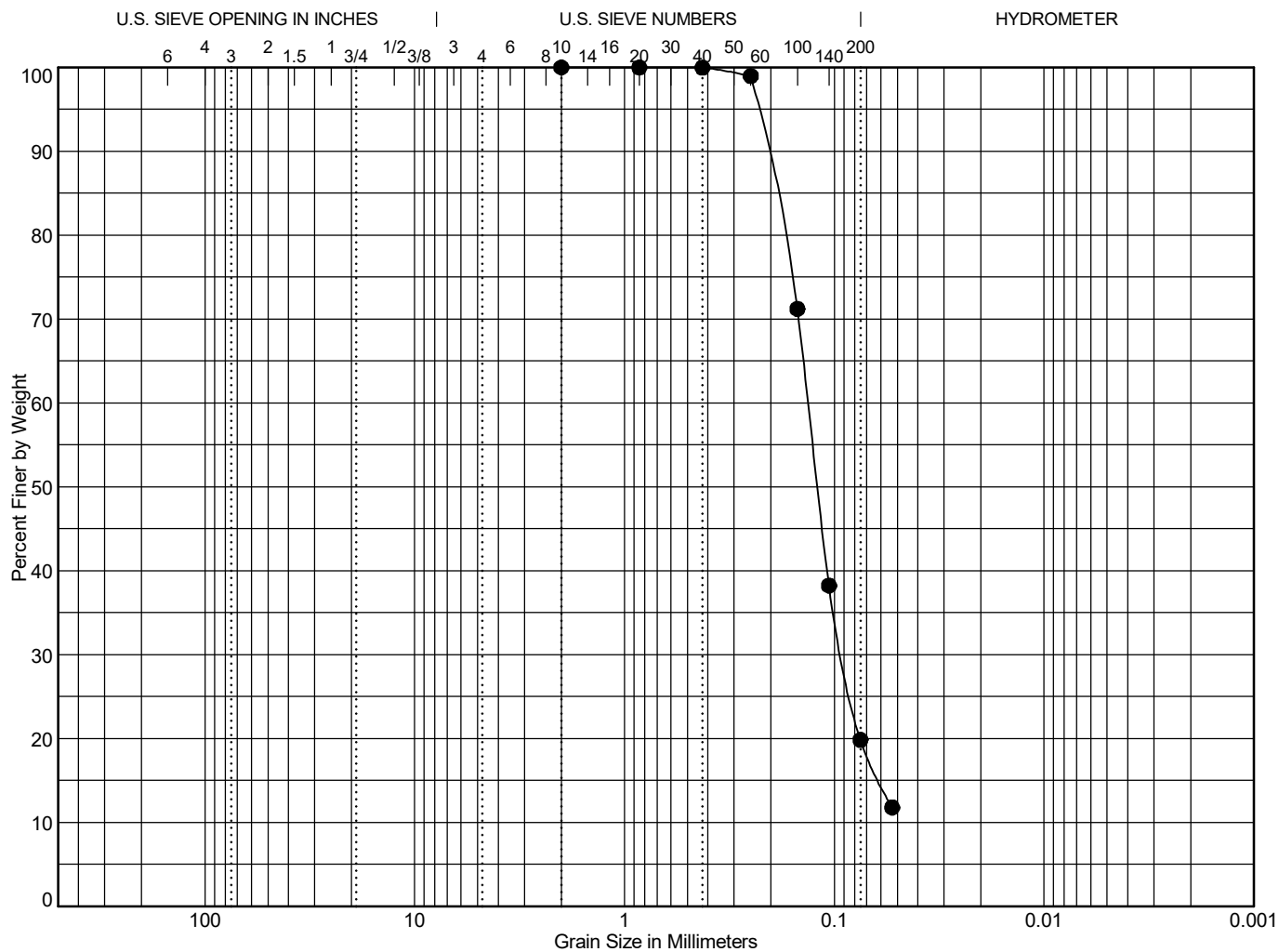
**GEOTEST**

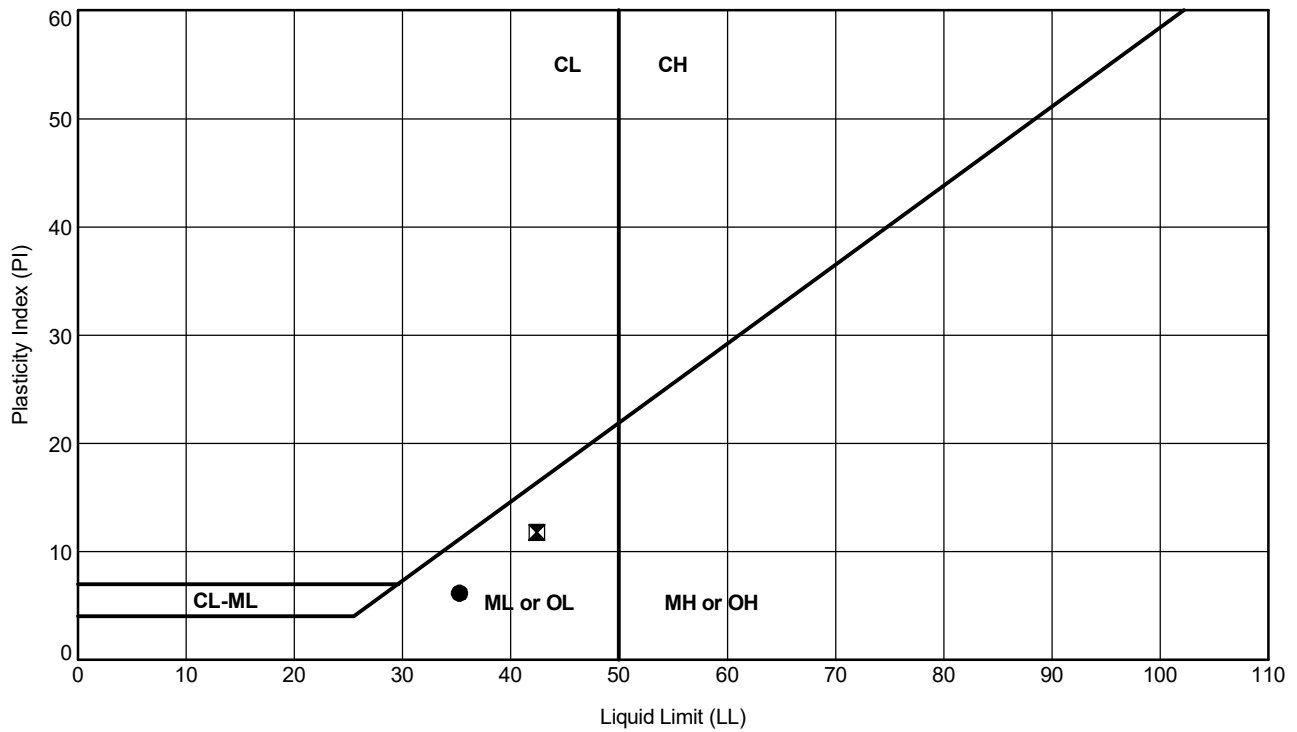
SVF Product Cooling Facility  
11261 Pulver Road  
Burlington, WA

Grain Size Test Data

Figure  
**19**







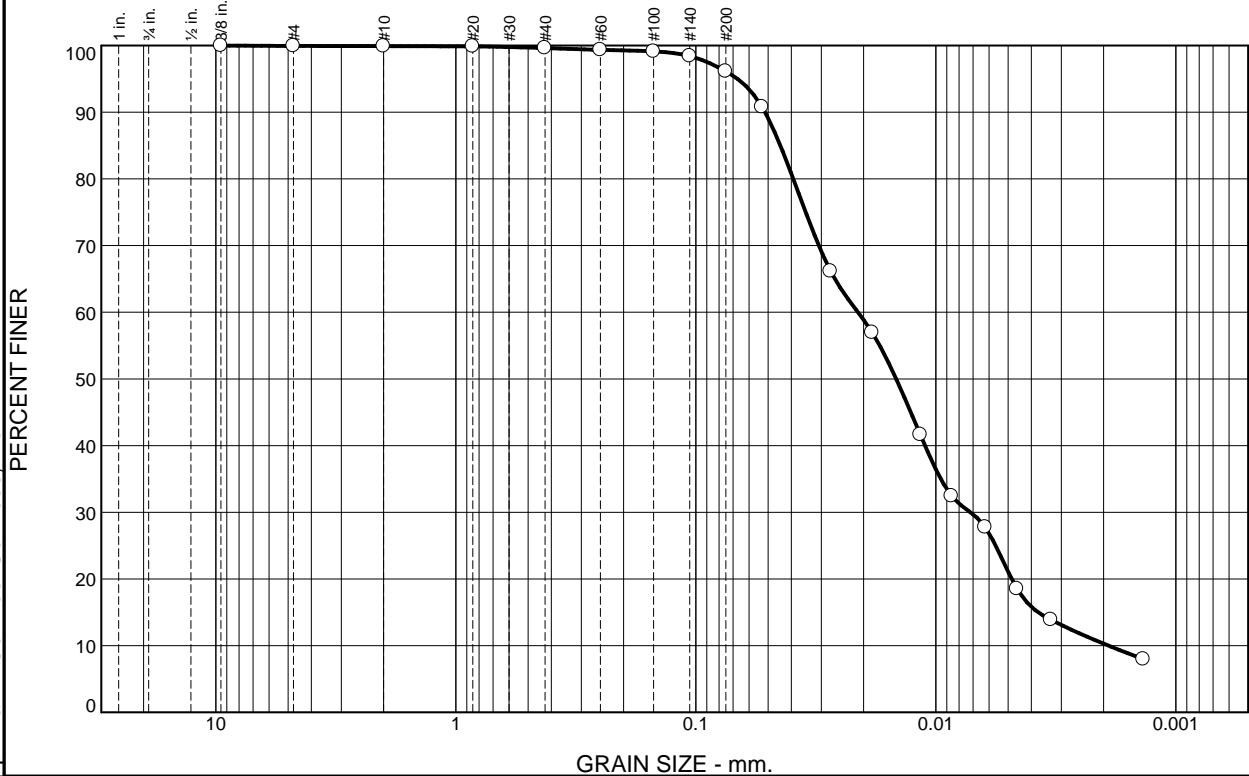
## ATTERBERG LIMIT TEST RESULTS

Symbol	Exploration Number	Sample Number	Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-2	22	35.0	35	29	6	48	SLIGHTLY SANDY, LOW PLASTICITY SILT	ML
⊠	B-3	24	2.5	42	31	11	55	SLIGHTLY SANDY, LOW PLASTICITY SILT	ML

ASTM D 4318 Test Method

# Sieve Analysis w/Hydrometer Test Report - D422/D1140

This report may not be reproduced, except in full, without the prior written approval of GeoTest Services, Inc.



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	0	4	75	21

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100		
#4	100		
#10	100		
#20	100		
#40	100		
#60	99		
#100	99		
#140	98		
#200	96		
#270	91		
0.0274 mm.	66		
0.0184 mm.	57		
0.0116 mm.	42		
0.0086 mm.	32		
0.0062 mm.	28		
0.0046 mm.	19		
0.0033 mm.	14		
0.0014 mm.	8.0		

\* (no specification provided)

## Soil Description

Berm at 1.5' silt

## Atterberg Limits

PL= 34 LL= 38 PI= 4

## Coefficients

D<sub>90</sub>= 0.0515 D<sub>85</sub>= 0.0445 D<sub>60</sub>= 0.0211  
D<sub>50</sub>= 0.0146 D<sub>30</sub>= 0.0072 D<sub>15</sub>= 0.0037  
D<sub>10</sub>= 0.0019 C<sub>u</sub>= 11.07 C<sub>c</sub>= 1.28

## Classification

USCS= ML AASHTO= A-4(7)

## Remarks

Moisture content: 23.6%  
Organic Matter: 3.21%

**Location:** Sampled in-situ at Berm - 2 @ 1.5'  
**Sample Number:** Berm - 2 @ 1.5'

**Date:**



**GEOTEST**

741 Marine Drive  
Bellingham, WA 98225  
www.GeoTest-Inc.com

**Client:** Trico Company

**Project:** SVF Raw Product Cooling Facility

Josh Wilson and Pulver Roads, Burlington, WA 98233

**Project No:** 17-0452

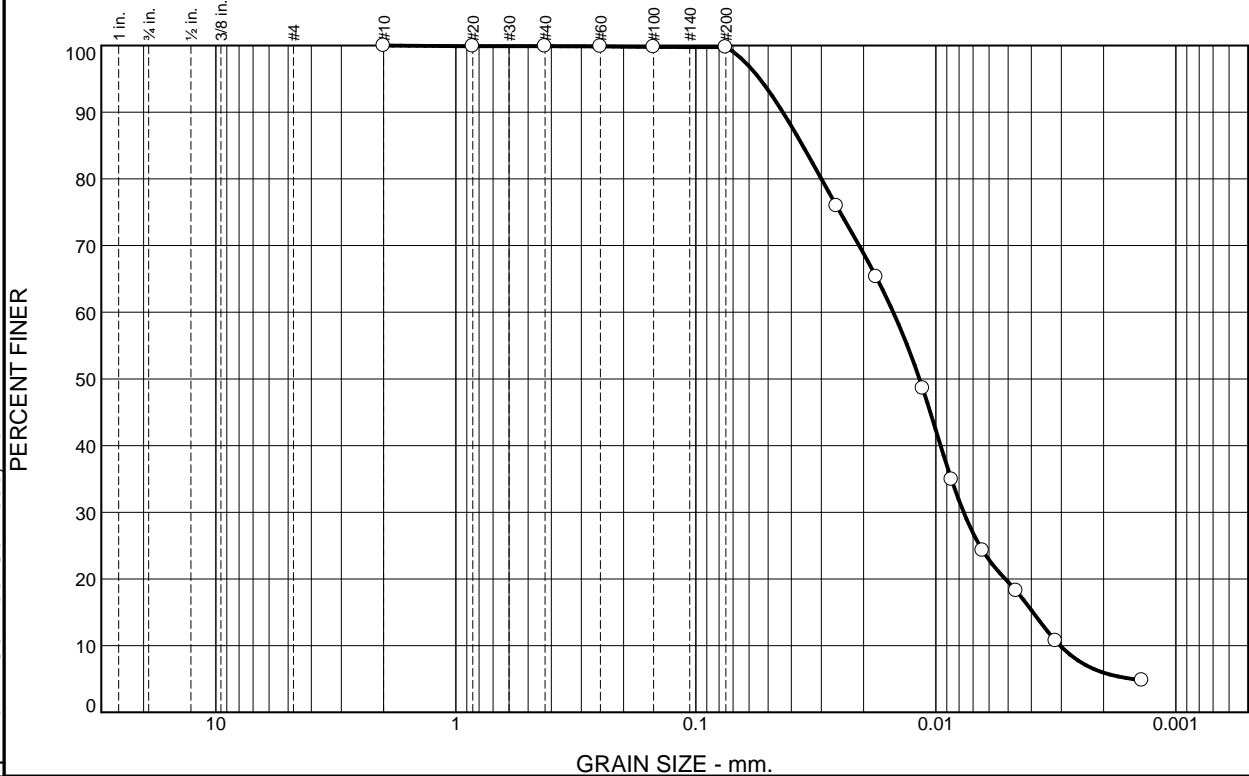
**Figure** Berm - 1.5'

**Tested By:** \_\_\_\_\_ **Checked By:** \_\_\_\_\_



# Sieve Analysis w/Hydrometer Test Report - D422/D1140

This report may not be reproduced, except in full, without the prior written approval of GeoTest Services, Inc.



% Gravel		% Sand			% Fines	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	0	0	80	20

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100		
#20	100		
#40	100		
#60	100		
#100	100		
#200	100		
0.025 mm.	76		
0.0177 mm.	65		
0.0113 mm.	49		
0.0086 mm.	35		
0.0064 mm.	24		
0.0046 mm.	18		
0.0032 mm.	11		
0.0014 mm.	4.8		

\* (no specification provided)

## Soil Description

Berm at 2'  
silt

## Atterberg Limits

PL=

LL= NV

PI=

## Coefficients

D<sub>90</sub>= 0.0434

D<sub>85</sub>= 0.0359

D<sub>60</sub>= 0.0150

D<sub>50</sub>= 0.0117

D<sub>30</sub>= 0.0077

D<sub>15</sub>= 0.0039

D<sub>10</sub>= 0.0030

C<sub>u</sub>= 4.96

C<sub>c</sub>= 1.29

## Classification

USCS=

AASHTO=

## Remarks

Moisture Content: 14.6%

Organic Content: 2.38%

**Location:** Sampled in-situ at Berm - 1 @ 2'  
**Sample Number:** Berm - 2 @ 2'

**Date:** 3-29-18



**GEOTEST**

741 Marine Drive  
Bellingham, WA 98225  
www.GeoTest-Inc.com

**Client:** Trico Company

**Project:** SVF Raw Product Cooling Facility

Josh Wilson and Pulver Roads, Burlington, WA 98233

**Project No:** 17-0452

**Figure** berm - 2 @ 2'

**Tested By:** KM

**Checked By:** DB



**Northwest Agricultural  
Consultants**

2545 W Falls Avenue  
Kennewick, WA 99336  
509.783.7450  
www.nwag.com  
lab@nwag.com

PAP-Accredited



GeoTest Services Inc.  
741 Marine Drive  
Bellingham, WA 98225

**Report:** 41873-1

**Date:** July 19, 2017

**Project No:** 17-0452

**Project Name:** SVF Raw Product Cooling  
Facility

Sample ID	pH	Organic Matter	Cation Exchange Capacity
TP-2, 5 @ 0.5'	6.3	7.78%	17.4 meq/100g
TP-2, 6 @ 5.5'	6.4	2.14%	6.0 meq/100g
Method	SM 4500-H <sup>+</sup> B	ASTM D2974	EPA 9081

## REPORT LIMITATIONS AND GUIDELINES FOR ITS USE<sup>1</sup>

Subsurface issues may cause construction delays, cost overruns, claims, and disputes. While you cannot eliminate all such risks, you can manage them. The following information is provided to help:

### **Geotechnical Services are Performed for Specific Purposes, Persons, and Projects**

At GeoTest our geotechnical engineers and geologists structure their services to meet specific needs of our clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of an owner, a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared solely for the client. No one except you should rely on your geotechnical engineer who prepared it. And no one – not even you – should apply the report for any purpose or project except the one originally contemplated.

### **Read the Full Report**

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

### **A Geotechnical Engineering Report is Based on a Unique Set of Project-Specific Factors**

GeoTest's geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the clients goals, objectives, and risk management preferences; the general nature of the structure involved its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless GeoTest, who conducted the study specifically states otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed, for example, from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed construction,
- alterations in drainage designs; or
- composition of the design team; the passage of time; man-made alterations and construction whether on or adjacent to the site; or by natural alterations and events, such as floods, earthquakes or groundwater fluctuations; or project ownership.

Always inform GeoTest's geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

<sup>1</sup>Information in this document is based upon material developed by ASFE, Professional Firms Practicing in the Geosciences(asfe.org)

## **Subsurface Conditions Can Change**

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. Do not rely on the findings and conclusions of this report, whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. Always contact GeoTest before applying the report to determine if it is still relevant. A minor amount of additional testing or analysis will help determine if the report remains applicable.

## **Most Geotechnical and Geologic Findings are Professional Opinions**

Our site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoTest's engineers and geologists review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ – sometimes significantly – from those indicated in your report. Retaining GeoTest who developed this report to provide construction observation is the most effective method of managing the risks associated with anticipated or unanticipated conditions.

## **A Report's Recommendations are *Not* Final**

Do not over-rely on the construction recommendations included in this report. Those recommendations are not final, because geotechnical engineers or geologists develop them principally from judgment and opinion. GeoTest's geotechnical engineers or geologists can finalize their recommendations only by observing actual subsurface conditions revealed during construction. GeoTest cannot assume responsibility or liability for the report's recommendations if our firm does not perform the construction observation.

## **A Geotechnical Engineering or Geologic Report may be Subject to Misinterpretation**

Misinterpretation of this report by other design team members can result in costly problems. Lower that risk by having GeoTest confer with appropriate members of the design team after submitting the report. Also, we suggest retaining GeoTest to review pertinent elements of the design teams plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having GeoTest participate in pre-bid and preconstruction conferences, and by providing construction observation.

## **Do not Redraw the Exploration Logs**

Our geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors of omissions, the logs included in this report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable; but recognizes that separating logs from the report can elevate risk.

## **Give Contractors a Complete Report and Guidance**

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, but preface it with a clearly written letter of transmittal. In that letter, consider advising the contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the GeoTest and/or to conduct

<sup>1</sup>Information in this document is based upon material developed by ASFE, Professional Firms Practicing in the Geosciences([asfe.org](http://asfe.org))

additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might you be in a position to give contractors the best information available, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. In addition, it is recommended that a contingency for unanticipated conditions be included in your project budget and schedule.

### **Read Responsibility Provisions Closely**

Some clients, design professionals, and contractors do not recognize that geotechnical engineering or geology is far less exact than other engineering disciplines. This lack of understanding can create unrealistic expectations that can lead to disappointments, claims, and disputes. To help reduce risk, GeoTest includes an explanatory limitations section in our reports. Read these provisions closely. Ask questions and we encourage our clients or their representative to contact our office if you are unclear as to how these provisions apply to your project.

### **Environmental Concerns Are Not Covered in this Geotechnical or Geologic Report**

The equipment, techniques, and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated containments, etc. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk management guidance. Do not rely on environmental report prepared for some one else.

### **Obtain Professional Assistance to Deal with Biological Pollutants**

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts biological pollutants from growing on indoor surfaces. Biological pollutants includes but is not limited to molds, fungi, spores, bacteria and viruses. To be effective, all such strategies should be devised for the express purpose of prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional biological pollutant prevention consultant. Because just a small amount of water or moisture can lead to the development of severe biological infestations, a number of prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of this study, the geotechnical engineer or geologist in charge of this project is not a biological pollutant prevention consultant; none of the services preformed in connection with this geotechnical engineering or geological study were designed or conducted for the purpose of preventing biological infestations.

<sup>1</sup>Information in this document is based upon material developed by ASFE, Professional Firms Practicing in the Geosciences([asfe.org](http://asfe.org))





## Ground Water Test Wells

#1	48.481972,- 122.354226
#2	48.482448,- 122.354351
#3	48.482476,- 122.353483
#4	48.481981,- 122.353070



January 23, 2025

Page 1 of 1

Rick Garlock  
Skagit Valley Farm  
PO BOX 870  
Burlington, WA 98233

RE: 25-00571 - Monthly Wastewater Monitoring

Dear Rick Garlock,

Your project: Monthly Wastewater Monitoring, was received on Wednesday January 08, 2025.

All samples were analyzed within the accepted holding times and were appropriately preserved and analyzed according to approved analytical protocols, unless noted in the data or QC reports. The quality control data was within laboratory acceptance limits, unless specified in the data or QC reports.

If you have questions phone us at 800 755-9295.

Respectfully



Lawrence J Henderson, PhD  
Director of Laboratories, Vice President

Enclosures: Data Report  
QC Reports  
Chain of Custody





## SAMPLE INDEPENDENT QUALITY CONTROL REPORT

Reference Number: **25-00571**

Report Date: 01/23/25

Batch	Analyte	Result	True Value	Units	Method	% Recovery	Limits*	QC Qualifier	QC Type	Comment
<b>Calibration Check</b>										
200.7_250113F5	2 IRON	1.04	1	mg/L	200.7	104	90-110	CAL		
	2 MANGANESE	1.05	1	mg/L	200.7	105	90-110	CAL		
200.8_250120A5	0 ARSENIC	0.00108	0.001	mg/L	200.8	108	80-120	CAL		
350.1_250122D	0 AMMONIA-N	2.5	2.5	mg/L	350.1	100	90-110	CAL		
351.2_250123A	0 TOTAL KJELDAHL NITROGEN as N	2.53	2.5	mg/L	351.2	101	90-110	CAL		
IC06_250108A	0 CHLORIDE	1	1	mg/L	300.0	100	90-110	CAL		
NO3NO2_250108A	0 TOTAL NITRATE+NITRITE as N	1.02	1.00	mg/L	SM4500-NO3 F	102	90-110	CAL		
OPHOS_250108	0 ORTHO-PHOSPHATE	0.995	1.00	mg/L	SM4500-P F	100	85-115	CAL		
pH_250108	0 HYDROGEN ION (pH)	7.98	8	pH Units	SM4500-H+ B	100	80-120	CAL		
	0 HYDROGEN ION (pH)	8.07	8	pH Units	SM4500-H+ B	101	80-120	CAL		
	1 HYDROGEN ION (pH)	7.97	8	pH Units	SM4500-H+ B	100	80-120	CAL		
	1 HYDROGEN ION (pH)	8.08	8	pH Units	SM4500-H+ B	101	80-120	CAL		
TPHOS_250123	0 TOTAL PHOSPHORUS-P	0.101	0.100	mg/L	SM4500-P F	101	85-115	CAL		
<b>Laboratory Fortified Blank</b>										
1664_250121	0 OIL AND GREASE	40.2	40	mg/L	1664	101	78-114	LFB		
200.7_250113F5	2 IRON	0.261	0.25	mg/L	200.7	104	85-115	LFB		
	2 MANGANESE	0.251	0.25	mg/L	200.7	100	85-115	LFB		
200.8_250120A5	0 ARSENIC	0.012	0.0125	mg/L	200.8	96	85-115	LFB		
350.1_250122D	0 AMMONIA-N	0.91	1	mg/L	350.1	91	85-115	LFB		
351.2_250123A	0 TOTAL KJELDAHL NITROGEN as N	3.15	3	mg/L	351.2	105	90-110	LFB		
DXW_250113	0 DIESEL (C12 - C24)	4.13	5	mg/L	NWTPH-Dx	83	70-130	LFB		
<b>Laboratory Reagent Blank</b>										
200.7_250113F5	0 IRON	ND		mg/L	200.7		0-0	LRB		
	0 MANGANESE	ND		mg/L	200.7		0-0	LRB		
200.8_250120A5	0 ARSENIC	ND		mg/L	200.8		0-0	LRB		
351.2_250123A	0 TOTAL KJELDAHL NITROGEN as N	ND		mg/L	351.2		0-0	LRB		
IC06_250108A	0 CHLORIDE	ND		mg/L	300.0		0-0	LRB		
NO3NO2_250108A	0 TOTAL NITRATE+NITRITE as N	ND		mg/L	SM4500-NO3 F		0-0	LRB		
OPHOS_250108	0 ORTHO-PHOSPHATE	ND		mg/L	SM4500-P F		0-0	LRB		
TPHOS_250123	0 TOTAL PHOSPHORUS-P	ND		mg/L	SM4500-P F		0-0	LRB		

\*Notation:

% Recovery = (Result of Analysis)/(True Value) \* 100

NA = Indicates % Recovery could not be calculated.

Limits are intended for water matrices only. These criteria are for guidance only when reported with soils/solids.

FORM: QCIndependent4.rpt



## SAMPLE INDEPENDENT QUALITY CONTROL REPORT

Reference Number: **25-00571**

Report Date: 01/23/25

Batch	Analyte	Result	True Value	Units	Method	% Recovery	Limits*	QC Qualifier	QC Type	Comment
<b>Method Blank</b>										
1664_250121	0 OIL AND GREASE	ND		mg/L	1664		0-1		MB	
200.7_250113F5	0 IRON	ND		mg/L	200.7		0-0		MB	
	0 MANGANESE	ND		mg/L	200.7		0-0		MB	
200.8_250120A5	0 ARSENIC	ND		mg/L	200.8		0-0		MB	
350.1_250122D	0 AMMONIA-N	ND		mg/L	350.1		0-0		MB	
351.2_250123A	0 TOTAL KJELDAHL NITROGEN as N	ND		mg/L	351.2		0-0		MB	
BOD_250108	0 5-Day BOD Test	0.4		mg/L	SM5210 B		0-0	K5	MB	
DXW_250113	0 DIESEL (C12 - C24)	ND		mg/L	NWTPH-Dx		0-0		MB	
	0 HEAVIER OILS (>C24)	ND		mg/L	NWTPH-Dx		0-0		MB	
NO3NO2_250108	0 TOTAL NITRATE+NITRITE as N	ND		mg/L	SM4500-NO3 F		0-0		MB	
OPHOS_250108	0 ORTHO-PHOSPHATE	ND		mg/L	SM4500-P F		0-0		MB	
tds_250110	0 TOTAL DISSOLVED SOLIDS (TDS)	ND		mg/L	SM2540 C		0-3		MB	
TPHOS_250123	0 TOTAL PHOSPHORUS-P	ND		mg/L	SM4500-P F		0-0		MB	
tss_250109	0 TOTAL SUSPENDED SOLIDS	ND		mg/L	I-3765-85		0-2		MB	
	1 TOTAL SUSPENDED SOLIDS	ND		mg/L	I-3765-85		0-2		MB	
<b>Quality Control Sample</b>										
200.7_250113F5	0 IRON	2.06	2	mg/L	200.7	103	95-105		QCS	
	0 MANGANESE	2.04	2	mg/L	200.7	102	95-105		QCS	
200.8_250120A5	0 ARSENIC	0.019	0.02	mg/L	200.8	95	90-110		QCS	
350.1_250122D	0 AMMONIA-N	2.47	2.5	mg/L	350.1	99	85-115		QCS	
351.2_250123A	0 TOTAL KJELDAHL NITROGEN as N	2.16	2.16	mg/L	351.2	100	85-115		QCS	
BOD_250108	0 5-Day BOD Test	183	198	mg/L	SM5210 B	92	85-115		QCS	
IC06_250108A	0 CHLORIDE	6.2	6	mg/L	300.0	103	90-110		QCS	
NO3NO2_250108	0 TOTAL NITRATE+NITRITE as N	2.01	2.00	mg/L	SM4500-NO3 F	101	90-110		QCS	
OPHOS_250108	0 ORTHO-PHOSPHATE	2.01	2.00	mg/L	SM4500-P F	101	90-110		QCS	
tds_250110	0 TOTAL DISSOLVED SOLIDS (TDS)	494	500	mg/L	SM2540 C	99	80-120		QCS	
TPHOS_250123	0 TOTAL PHOSPHORUS-P	0.194	0.207	mg/L	SM4500-P F	94	90-110		QCS	
tss_250109	0 TOTAL SUSPENDED SOLIDS	500	500	mg/L	I-3765-85	100	80-120		QCS	
	0 TOTAL SUSPENDED SOLIDS	500	500	mg/L	I-3765-85	100	80-120		QCS	

\*Notation:

% Recovery = (Result of Analysis)/(True Value) \* 100

NA = Indicates % Recovery could not be calculated.

Limits are intended for water matrices only. These criteria are for guidance only when reported with soils/solids.

FORM: QCIndependent4.rpt



## SAMPLE DEPENDENT QUALITY CONTROL REPORT

### Duplicate, Matrix Spike/Matrix Spike Duplicate and Confirmation Result Report

Reference Number: **25-00571**

Report Date: 1/23/2025

## Duplicate

Batch/CAS	Sample	Analyte	Result	Duplicate Result	Units	%RPD	Limits	QC Qualifier	Comments
<b>200.7_250113F5</b>									
7439-89-6	932	IRON	0.13	0.12	mg/L	<b>8.0</b>	0-20		
7439-96-5	932	MANGANESE	0.0246	0.0238	mg/L	<b>3.3</b>	0-20		
<b>350.1_250122D</b>									
7664-41-7	2529	AMMONIA-N	0.05	0.05	mg/L	<b>0.0</b>	0-20		
7664-41-7	2580	AMMONIA-N	0.12	0.32	mg/L	<b>90.9</b>	0-20	INH	
<b>351.2_250123A</b>									
E-10264	3067	TOTAL KJELDAHL NITROGEN as N	4.45	4.61	mg/L	<b>3.5</b>	0-20		
E-10264	3069	TOTAL KJELDAHL NITROGEN as N	5.14	5.96	mg/L	<b>14.8</b>	0-20		
<b>BOD_250108</b>									
E-10106	618	5-Day BOD Test	29	35	mg/L	<b>18.8</b>	0-20		
E-10106	817	5-Day BOD Test	510	514	mg/L	<b>0.8</b>	0-20		
E-10106	1078	5-Day BOD Test	787	797	mg/L	<b>1.3</b>	0-20		
<b>DXW_250113</b>									
NA	1859	DIESEL (C12 - C24)	ND	ND	mg/L	<b>NA</b>	0-30		
NA	1859	HEAVIER OILS (>C24)	ND	ND	mg/L	<b>NA</b>	0-30		
<b>IC06_250108A</b>									
16887-00-6	540	CHLORIDE	4.5	4.6	mg/L	<b>2.2</b>	0-20		
16887-00-6	897	CHLORIDE	13.2	13.3	mg/L	<b>0.8</b>	0-20		
16887-00-6	975	CHLORIDE	122	122	mg/L	<b>0.0</b>	0-20		
<b>OPHOS_250108</b>									
14265-44-2	932	ORTHO-PHOSPHATE	0.016	0.016	mg/L	<b>0.0</b>	0-20		
<b>pH_250108</b>									
E-10139	911	HYDROGEN ION (pH)	4.61	4.65	pH Units	<b>0.9</b>	0-45		
<b>tds_250110</b>									
E-10173	1725	TOTAL DISSOLVED SOLIDS (TDS)	336	335	mg/L	<b>0.3</b>	0-5		
<b>TPHOS_250123</b>									
7723-14-0	2263	TOTAL PHOSPHORUS-P	0.229	0.239	mg/L	<b>4.3</b>	0-20		
7723-14-0	3058	TOTAL PHOSPHORUS-P	31.7	31.6	mg/L	<b>0.3</b>	0-20		
7723-14-0	3069	TOTAL PHOSPHORUS-P	0.742	0.638	mg/L	<b>15.1</b>	0-20		
<b>tss_250109</b>									
E-10162	247	TOTAL SUSPENDED SOLIDS	3	4	mg/L	<b>28.6</b>	0-5	INH	
E-10162	817	TOTAL SUSPENDED SOLIDS	102	102	mg/L	<b>0.0</b>	0-5		

%RPD = Relative Percent Difference

NA = Indicates %RPD could not be calculated

Matrix Spike (MS)/Matrix Spike Duplicate (MSD) analyses are used to determine the accuracy (MS) and precision (MSD) of an analytical method in a given sample matrix. Therefore, the usefulness of this report is limited to samples of similar matrices analyzed in the same analytical batch.

Only Duplicate sample with detections are listed in this report

Limits are intended for water matrices only. These criteria are for guidance only when reported with soils/solids.

FORM: QC Dependent\_Port.rpt



## SAMPLE DEPENDENT QUALITY CONTROL REPORT

Duplicate, Matrix Spike/Matrix Spike Duplicate  
and Confirmation Result Report

Reference Number: **25-00571**

Report Date: 1/23/2025

### Laboratory Fortified Matrix (MS)

Batch/CAS	Sample	Analyte	Result	Spike Result	Duplicate Spike Result	Conc	Units	Percent Recovery			%RPD	Limits*	QC	
								MS	MSD	Limits*			Qualifier	Comments
1664_250121														
E-10140	2738	OIL AND GREASE	ND	38.9		40	mg/L	97			70-130	NA	0-20	
200.7_250113F5														
7439-89-6	932	IRON	0.13	0.39		0.25	mg/L	104			70-130	NA	0-20	
7439-96-5	932	MANGANESE	0.0246	0.280		0.250	mg/L	102			70-130	NA	0-20	
350.1_250122D														
7664-41-7	2529	AMMONIA-N	0.05	1.08	1.10	1	mg/L	103	105		70-130	1.9	0-20	
7664-41-7	2580	AMMONIA-N	0.12	1.13	1.06	1	mg/L	101	94		70-130	7.2	0-20	
351.2_250123A														
E-10264	3067	TOTAL KJELDAHL NITROGEN as N	4.45	6.21		3	mg/L	59			70-130	NA	0-20	IM
E-10264	3069	TOTAL KJELDAHL NITROGEN as N	5.14	8.38		3	mg/L	108			70-130	NA	0-20	
IC06_250108A														
16887-00-6	540	CHLORIDE	4.625	5.680		1	mg/L	106			90-110	NA	0-20	
16887-00-6	897	CHLORIDE	13.2	14.0		1	mg/L	80			90-110	NA	0-20	IS
16887-00-6	975	CHLORIDE	122	120		1	mg/L	-200			90-110	NA	0-20	IS
OPHOS_250108														
14265-44-2	932	ORTHO-PHOSPHATE	0.016	1.01	1.01	1.00	mg/L	99	99		70-130	0.0	0-20	
TPHOS_250123														
7723-14-0	2263	TOTAL PHOSPHORUS-P	0.229	0.282	0.280	0.050	mg/L	106	102		70-130	3.8	0-20	
7723-14-0	3058	TOTAL PHOSPHORUS-P	31.7	31.0	31.4	0.050	mg/L	-1,400	-600		70-130	80.0	0-20	IS
7723-14-0	3069	TOTAL PHOSPHORUS-P	0.742	0.640	0.705	0.050	mg/L	-204	-74		70-130	93.5	0-20	IS

%RPD = Relative Percent Difference

NA = Indicates %RPD could not be calculated

Matrix Spike (MS)/Matrix Spike Duplicate (MSD) analyses are used to determine the accuracy (MS) and precision (MSD) of an analytical method in a given sample matrix. Therefore, the usefulness of this report is limited to samples of similar matrices analyzed in the same analytical batch.

Only Duplicate sample with detections are listed in this report

Limits are intended for water matrices only. These criteria are for guidance only when reported with soils/solids.

FORM: QC Dependent\_Port.rpt