Geotechnical Engineering Services Report

Firgrove Elementary School
Puyallup, Washington

for
Puyallup School District

November 17, 2016

GeoEngineers
Earth Science + Technology

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File No. 2017-006-00

November 17, 2016

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INTRODUCTION AND PROJECT UNDERSTANDING

This report presents the results of our geotechnical investigation performed for the Firgrove Elementary School project located at 13918 Meridian Avenue East in Puyallup, Washington. The approximate project boundaries are shown on the Vicinity Map, Figure 1. Our understanding of the project is based on our discussions with you, members of the project team and information provided including a preliminary Site Plan dated October 28, 2016 and a site survey.

We understand that the existing Firgrove Elementary School is to be demolished and new school building and associated facilities will be constructed to the west of the existing building location. The proposed building location is shown on the Site Plan, Figure 2. We understand that the new school building will be a one- or two-story structure supported on shallow foundations and slab-on-grade. School bus access to the new school will be provided via 136th Street East. An additional access route to the school along with parking will be provided via Meridian Avenue. We understand that the existing track located to the north of the current Firgrove Elementary School building will be relocated toward the east. Other planned improvements at the site include stormwater storage and/or infiltration facilities and play areas.

SCOPE OF SERVICES

The purpose of our services is to evaluate subsurface conditions and provide geotechnical and earthwork recommendations to support planning and design of the proposed improvements. Our specific scope of services outlined in our August 31, 2016 signed agreement is provided below:

1. Reviewing readily available published geologic data, critical area maps and our relevant in-house files for existing information on subsurface conditions in the project vicinity.
2. Visiting the project site to mark out preliminary locations for explorations and contacting the "One-Call" Utility Notification Center, as required by Washington State law.
3. Exploring subsurface conditions within the project area by advancing 12 borings using subcontracted equipment and operators. Borings depths ranged from 7.5 to 21.5 feet below ground surface (bgs).
4. Conducting geotechnical laboratory testing on selected soil samples. Laboratory testing included particle size gradation analyses, moisture content determinations, cation exchange capacity (CEC) and organic content (OC).
5. Providing a discussion of soil and groundwater conditions encountered in our explorations.
6. Providing geotechnical seismic design information in accordance with the 2012 International Building Code (IBC) criteria and discuss our opinion on the potential for liquefaction and lateral spreading at the site.
7. Providing recommendations for site preparation and earthwork. We discuss temporary erosion and sedimentation controls, temporary and permanent slopes, estimated stripping and clearing depths, fill placement and compaction requirements, suitability of on-site material for use as structural fill, import fill requirements, wet weather considerations, groundwater handling and site drainage.

8. Providing design recommendations for shallow foundations. We include bearing surface preparation recommendations, minimum recommended size, allowable bearing pressures, estimates of settlement and allowable passive soil pressures and friction for resisting lateral loads.
9. Providing design considerations for building slab design, including subgrade preparation, modulus of subgrade reaction and capillary break thickness and materials.
10. Providing recommended active, passive and at-rest lateral earth pressures for retaining walls and below-grade structures. We have also included recommendations for seismic surcharge pressures and drainage criteria.
11. Providing a discussion of suitability of site soils for stormwater infiltration, including preliminary estimated infiltration rates based on laboratory sieve analysis results and the criteria described in the 2014 Washington State Department of Ecology (Ecology) Stormwater Management Manual for Western Washington (SWMMWW). We have also provided recommendations for further infiltration studies that may be necessary at the site.
12. Providing layer thickness recommendations for conventional asphalt concrete pavement (ACP) design sections, including subgrade preparation. We include typical pavement sections for heavy and light traffic areas based on our experience and subsurface conditions.
13. Providing layer thickness recommendations for pervious cement concrete pavement, based on our experience and information provided in the Low Impact Development (LID) Technical Guidance Manual for Puget Sound.
14. Preparing this written geotechnical report presenting our findings, conclusions and recommendations.

SITE CONDITIONS

Surface Conditions

The project site is "L-shaped" and generally bounded by Meridian Avenue to the east, a residential housing development to the south, a wooded area to the west and 136th Street East to the north. The existing Firgrove Elementary School building is located in the southeast quarter of the site, a grass field is located in the southwest quarter, the Ballou Junior High School facilities are located northwest of the site and an unpaved running track is located in the northeast quarter of the site.

The existing school is a single-story structure. We understand that the southern portion of the school building is the original historic schoolhouse. Paved parking areas are located to the south and east of the building. A baseball field, paved and unpaved play areas and portable structures used as classrooms are located to the west and north of the existing building. Vegetation around the site generally consists of grass and trees and small shrubs planted in hardscaped areas. Large coniferous trees are located along the southern and western site boundaries and sporadically within some of the field areas.

The proposed building footprint will encompass areas of the site that are currently undeveloped and are used as grass playfields. In general the site is relatively flat. Based on the survey provided, it appears that the difference in the existing ground surface elevation between the west and east sides of the proposed building area is around 4 feet.

Published Geology

We reviewed relevant in-house files and the *Geologic Map of the Puyallup Quadrangle, Washington* (Troost, *In Review*). The geologic map indicates soils in the project vicinity generally consist of gravel outwash deposits (Qvs) and ice-contact deposits (Qvi). The gravel outwash deposits are described in the literature as poorly to well sorted sands and gravels that were deposits during glacial lake outburst floods. Ice-contact deposits are described as interbedded outwash (sand and gravel), lacustrine beds (fine-grained sands and silts) and glacial till. Ice-contact soils were deposited within meltwater at the margins of glaciers.

SUBSURFACE CONDITIONS

Subsurface Explorations

We explored subsurface conditions at the site by advancing 12 borings (designated B-1 through B-12) at the approximate locations shown on Figure 2. The borings were advanced to depths ranging from about 8 feet bgs to about 20.5 feet bgs. Details regarding our subsurface exploration program are provided in Appendix A. A key to our boring logs is presented as Figure A-1 and the exploration logs are presented as Figure A-2 through Figure A-13.

Selected samples from our borings were tested in order to evaluate engineering properties and to confirm or modify field classifications. A description of our laboratory testing program and testing results including the results of the CEC and OC tests are included in Appendix B.

Subsurface Conditions

Soil Conditions

We observed what we interpret to be three general geologic units in our explorations, fill or reworked soils (fill), lacustrine ice-contact deposits (lacustrine soils), and glacial till like soils (glacial till). While mapped in the project vicinity, we did not encounter what we typically interpret to be gravel outwash deposits.

All of our explorations with the exception of B-12 were advanced within areas covered with sod. The sod thickness observed in our explorations was on the order of 1 to 2 inches. B-12 was advanced in an asphalt paved area; observed asphalt thickness was 2.5 inches. Below the sod in borings B-1 through B-6 and B-8 we encountered what we interpret to be fill to a depth ranging from about 2 to 4 feet bgs. The fill generally consisted of very loose to medium dense silty sand with occasional organic material (roots) and variable gravel content and gravel with silt and sand. Below the fill material in B-1, B-2, B-3, B-5 and B-6 we encountered what we interpret to be glacial till. Encountered glacial till typically consisted of silty gravel with sand, gravel with silt and sand, silty sand with variable gravel content and sandy silt with gravel. Relative consistency of the glacial till ranged from medium dense to very dense or hard. The glacial till appeared to be weathered within the upper 1.5 to 5 feet of the deposit in borings B-1, B-2, B-3 and B-6. Borings B-1, B-2, B-3, B-5 and B-6 were terminated within the glacial till like ice-contact deposits at depths ranging from 8 to 16 feet bgs.

Below the fill in borings B-4 and B-8 we encountered what we interpret to be lacustrine soils. The lacustrine soils typically consisted of stiff sandy silt and silt with sand and medium dense sand. The lacustrine deposits extended to the full depth explored in B-4 (11.5 feet bgs) and to around 9 feet bgs in

B-8. The lacustrine soils were underlain by glacial till soils in B-8. The glacial till encountered in B-8 generally consisted of dense to very dense silty sand with gravel.

Directly below the sod in B-7 we encountered what we interpret to be glacial till which extended to the full depth explored (20.5 feet). Starting below the sod and extending to about 7.5 feet bgs the glacial till was observed to be medium dense to dense silty sand with gravel, which we interpreted to be a weathered zone. Below about 7.5 feet bgs the glacial till consisted of very dense gravel with silt and sand.

Directly below the sod in B-9, B-10, B-11 and B-12 we encountered what we interpret to be lacustrine soils typically consisting of loose to medium dense silty sand and medium stiff sandy silt. The lacustrine soils extended to between about 6.5 feet bgs and 11.5 feet bgs in these boings. B-10 was terminated within the lacustrine soils at 11.5 feet bgs. The lacustrine soils were underlain by glacial till in B-9, B-11 and B-12. The glacial till was observed to be weathered in B-11 between about 10 feet and 11 feet bgs and in B-12 between about 6.5 feet bgs and 9 feet bgs. Encountered glacial till typically consisted of medium dense to very dense silty sand with variable gravel content. B-9, B-11 and B-12 were terminated within the glacial till at depths ranging from 9 to 20.5 feet bgs.

Groundwater Conditions

We observed what we interpret to be perched groundwater at the time of drilling at approximately 2.5 feet and 6 feet bgs in B-2, around 2.5 feet bgs in B-4, around 7.5 feet in B-10, and 10 feet bgs in B-11. We did not encounter what we interpret to be the regional groundwater table in our explorations. We anticipate that perched groundwater could be encountered at other areas of the site and is most likely to occur at contacts between soils with relatively different permeability's such as the contact between fill soils and glacial till deposits or within different layers of the ice-contact deposits. The amount of perched groundwater encountered will vary depending on a variety of conditions including season, irrigation activities and rainfall events. We anticipate that the likelihood for encountering perched groundwater will be lowest during the dryer months of the year, typically between June and September in this region.

CONCLUSIONS AND RECOMMENDATIONS

General

Based on our understanding of the project, the explorations performed for this study and our experience, it is our opinion that the proposed improvements can be constructed generally as envisioned with regard to geotechnical considerations. A summary of the primary geotechnical considerations for the project is provided below and is followed by our detailed recommendations.

- Structures at the site can be adequately supported on conventional shallow foundations.
- The depth to dense to very dense glacial till soils varies across the site but generally appears to be deeper around the west half of the proposed structure. In areas where glacial till is located near the ground surface, foundations can likely be supported directly on the glacial till. Because of the variability in density of the fill and lacustrine deposits, areas where glacial till soils are located at depth, foundations will need to be supported on structural fill. Overexcavation and replacement of foundation bearing soils is recommended for the approximate west half of the proposed structure. Foundation bearing surface preparation and structural fill recommendations are described further in this report.

- Infiltrating stormwater into the site soils appears to be feasible, however, additional field explorations will likely be required in order to establish the final design infiltration rate for infiltration facilities. Overall, preliminary infiltration rates appear to be low, which is expected given the glacial soil types encountered.
- A majority of soils encountered in our borings have a relatively high fines (silt and clay-sized particles passing the U.S. Standard No. 200 sieve) content. Soil with a high fines content is more sensitive to small changes in moisture content and may be difficult to work with and is susceptible to disturbance when wet.

Seismic Design Considerations

International Building Code Seismic Design Parameters

We evaluated seismic site response using map-based methods described in the 2012 IBC. The parameters provided below should be used for design.

TABLE 1: SEISMIC DESIGN CRITERIA

2012 IBC Seismic Design Parameters	
Spectral Response Acceleration at Short Periods (S_S)	1.243g
Spectral Response Acceleration at 1-Second Periods (S_1)	0.477g
Site Class	C
Design Peak Ground Acceleration (PGA_M)	0.50g
Design Spectral Response Acceleration at Short Periods (S_{DS})	0.828g
Design Spectral Response Acceleration at 1-Second Periods (S_{D1})	0.421g

Liquefaction, Lateral Spreading, and Surface Rupture

Liquefaction

Liquefaction refers to a condition where vibration or shaking of the ground, usually from earthquake forces, results in development of excess pore pressures in loose, saturated soils and subsequent loss of strength in the deposit of soil so affected. In general, soils that are susceptible to liquefaction include loose to medium dense sands to silty sands that are below the water table. Based on the soil type, relative density of the soils encountered, and the absence of near-surface groundwater levels observed in our explorations it is our opinion that the risk of liquefaction at the site is low.

Lateral Spreading Potential

Lateral spreading related to seismic activity typically involves lateral displacement of large, surficial blocks of non-liquefied soil when a layer of underlying soil loses strength during seismic shaking. Lateral spreading usually develops in areas where sloping ground or large grade changes (including retaining walls) are present. Based on our understanding of the proposed improvements and current site topography, it is our opinion that the risk of lateral spreading is low.

Surface Rupture Potential

According to the Washington State Department of Natural Resources Interactive Natural Hazards Map (accessed November 7, 2016), no surface faults are mapped near the project site. Because no surface faults are mapped in the project vicinity, it is our opinion that the risk for seismic surface rupture at the site is low.

Site Development and Earthwork

General

We anticipate that site development and earthwork will include clearing and stripping vegetated areas, demolition of existing hardscaping, site grading, establishing subgrades for roadways, parking areas, building foundations, and placing and compacting fill and backfill materials. We expect that the majority of site grading and earthwork can be accomplished with conventional earthmoving equipment.

The following sections provide recommendations for stripping, erosion and sedimentation control, excavation, temporary and permanent cut slopes, wet weather considerations, fill materials and fill placement and compaction requirements.

Clearing and Stripping

Based on conditions observed in out explorations minimum stripping depths at the site will likely be on the order of 2 to 4 inches. However, greater stripping depths could be required to remove localized zones of loose or organic-rich soil, especially in areas of the site currently planted with trees. During clearing and stripping, stumps and primary root systems of shrubs and trees should be completely removed. Voids caused by removal of stumps and/or root systems should be backfilled with compacted structural fill. Stripped material should be transported off site or processed and used as fill in landscaping areas.

Based on our explorations, we anticipate that soils exposed will have a high fines content and thus be susceptible to disturbance when wet. Care should be taken to avoid allowing these soils to become saturated and disturbed. We provide recommendations for subgrade protection in the "Subgrade Protection and Wet Weather Considerations" section below.

Cobbles and boulders were not encountered in our explorations, however, in our experience they can be present in the glacial deposits in the area. The contractor should be prepared for the presence of cobbles or boulders in areas to be excavated or re-graded. Additionally, the contractor should be prepared to separate cobbles and boulders from soils generated during excavation if excavated soils are to be reused as fill or backfill. Boulders may be removed from the site or used in landscape areas. Voids caused by boulder removal should be backfilled with structural fill.

Erosion and Sedimentation Control

Erosion and sedimentation rates and quantities can be influenced by construction methods, slope length and gradient, amount of soil exposed and/or disturbed, soil type, construction sequencing and weather. Implementing an erosion and sedimentation control plan will reduce the project impact on erosion-prone areas. The plan should be designed in accordance with applicable city, county and/or state standards. The plan should incorporate basic planning principles, including:

- Scheduling grading and construction to reduce soil exposure.
- Re-vegetating or mulching denuded areas.
- Directing runoff away from exposed soils.

- Reducing the length and steepness of slopes with exposed soils.
- Decreasing runoff velocities.
- Preparing drainage ways and outlets to handle concentrated or increased runoff.
- Confining sediment to the project site.
- Inspecting and maintaining control measures frequently.

Some sloughing and raveling of exposed or disturbed soil on slopes should be expected. We recommend that disturbed soil be restored promptly so that surface runoff does not become channeled.

Temporary erosion protection should be used and maintained in areas with exposed or disturbed soils to help reduce erosion and reduce transport of sediment to adjacent areas and receiving waters. Permanent erosion protection should be provided by paving, structure construction or landscape planting.

Until the permanent erosion protection is established and the site is stabilized, site monitoring may be required by qualified personnel to evaluate the effectiveness of the erosion control measures and to repair and/or modify them as appropriate. Provision for modifications to the erosion control system based on monitoring observations should be included in the erosion and sedimentation control plan.

Temporary Excavations, Support and Dewatering

Excavations deeper than 4 feet should be shored or laid back at a stable slope if workers are required to enter. Shoring and temporary slope inclinations must conform to the provisions of Title 296 Washington Administrative Code (WAC), Part N, "Excavation, Trenching and Shoring." Regardless of the soil type encountered in the excavation, shoring, trench boxes or sloped sidewalls will be required under Washington Industrial Safety and Health Act (WISHA). The contract documents should specify that the contractor is responsible for selecting excavation and dewatering methods, monitoring the excavations for safety and providing shoring, as required, to protect personnel and structures.

In general, temporary cut slopes should be inclined no steeper than about 1-1/2H:1V (horizontal to vertical) in the fill, recessional outwash and weathered glacial till soils. For cuts in dense glacial till, temporary cut slopes as steep as of 3/4H:1V may be feasible. These conditions should be verified prior to planning for slopes cut this steep. These guidelines assume that all surface loads are kept at a minimum distance of at least one-half the depth of the cut away from the top of the slope and that seepage is not present on the slope face. Flatter cut slopes will be necessary where seepage occurs or if surcharge loads are anticipated. Temporary covering with heavy plastic sheeting should be used to protect these slopes during periods of wet weather.

Based on our explorations, we do not expect groundwater to be a significant factor during shallow excavations and earthwork. However, some perched groundwater could be present depending on the time of year of construction. Based on our interpretation of the soil conditions and our experience, the interface between the fill material and the native soils and contacts between weathered and unweathered glacial till are likely locations for accumulation of perched groundwater. Groundwater handling needs are typically lower during the late summer and early fall months. We anticipate that shallow perched groundwater can typically be handled adequately with sumps, pumps, and/or diversion ditches, as necessary. Ultimately, we recommend that the contractor performing the work be made responsible for controlling and collecting groundwater encountered.

Permanent Cut and Fill Slopes

If permanent slopes are necessary we recommend they be constructed at a maximum inclination of 2H:1V. Where 2H:1V permanent slopes are not feasible, protective facings and/or retaining structures should be considered.

To achieve uniform compaction, we recommend that fill slopes be overbuilt slightly and subsequently cut back to expose well-compacted fill. Fill placement on slopes steeper than 5H:1V should be benched into the slope face. The configuration of benches depends on the equipment being used. Bench excavations should be level and extend into the slope face.

Exposed areas should be re-vegetated as soon as practical to reduce the surface erosion and sloughing. Temporary protection should be used until permanent protection is established.

Subgrade Preparation and Evaluation

Subgrades that will support slabs-on-grade, parking areas and driveways should be thoroughly compacted to a uniformly firm and unyielding condition on completion of stripping and before placing structural fill. We recommend that subgrades be evaluated to identify areas of yielding or soft soil. Evaluation methods such as probing with a steel probe rod or proof-rolling with a heavy piece of wheeled construction equipment are appropriate methods of evaluation.

If soft or otherwise unsuitable subgrade areas are revealed during evaluation that cannot be compacted to a stable and uniformly firm condition, we recommend that: (1) the unsuitable soils be scarified (e.g., with a ripper or farmer’s disc), aerated and recompacted, if practical; or (2) the unsuitable soils be removed and replaced with compacted structural fill, as needed.

Subgrade Protection and Wet Weather Considerations

The wet weather season generally begins in October and continues through May in western Washington; however, periods of wet weather can occur during any month of the year. The soils encountered in our explorations contain a significant amount of fines. Soil with high fines content is very sensitive to small changes in moisture and is susceptible to disturbance from construction traffic when wet or if earthwork is performed during wet weather. If wet weather earthwork is unavoidable, we recommend that the following steps be taken.

- The ground surface in and around the work area should be sloped so that surface water is directed away from the work area. The ground surface should be graded so that areas of ponded water do not develop. Measures should be taken by the contractor to prevent surface water from collecting in excavations and trenches. Measures should be implemented to remove surface water from the work area.
- Earthwork activities should not take place during periods of heavy precipitation.
- Slopes with exposed soils should be covered with plastic sheeting.
- The contractor should take necessary measures to prevent on-site soils and other soils to be used as fill from becoming wet or unstable. These measures may include the use of plastic sheeting, sumps with pumps and grading. The site soils should not be left uncompacted and exposed to moisture.

Sealing the exposed soils by rolling with a smooth-drum roller prior to periods of precipitation will help reduce the extent to which these soils become wet or unstable.

- Construction traffic should be restricted to specific areas of the site, preferably areas that are surfaced with working pad materials not susceptible to wet weather disturbance.
- Construction activities should be scheduled so that the length of time that soils are left exposed to moisture is reduced to the extent practical.
- Protective surfacing such as placing asphalt-treated base (ATB) or haul roads made of quarry spalls or a layer of free-draining material such as well-graded pit-run sand and gravel may be necessary to protect completed areas. Typically, minimum gravel thicknesses on the order of 24 inches are necessary to provide adequate subgrade protection.
- Foundation bearing surface preparation should also be considered. We provide additional recommendations in the "Shallow Foundations" section of this report.

Fill Materials

Structural Fill

Material used for structural fill should be free of debris, organic contaminants and rock fragments larger than 6 inches. We recommend that structural fill material consist of material similar to "Select Borrow" or "Gravel Borrow" as described in Section 9-03.14 of the Washington State Department of Transportation (WSDOT) Standard Specifications.

The workability of material for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines increases, soil becomes increasingly sensitive to small changes in moisture content. We recommend that washed crushed rock or select granular fill, as described below, be used for structural fill during the rainy season. If prolonged dry weather prevails during the earthwork phase of construction, materials with a somewhat higher fines content may be acceptable.

Select Granular Fill

Select granular fill should consist of well-graded sand and gravel or crushed rock with a maximum particle size of 6 inches and less than 5 percent fines by weight based on the minus 3/4-inch fraction. Organic matter, debris or other deleterious material should not be present. In our opinion, material with gradation characteristics similar to WSDOT Specification 9-03.9 (Aggregates for Ballast and Crushed Surfacing), or 9-03.14 (Borrow) is suitable for use as select granular fill, provided that the fines content is less than 5 percent (based on the minus 3/4-inch fraction) and the maximum particle size is 6 inches.

Pipe Bedding

Trench backfill for the bedding and pipe zone should consist of well-graded granular material similar to "gravel backfill for pipe zone bedding" described in Section 9-03.12(3) of the WSDOT Standard Specifications. The material must be free of roots, debris, organic matter and other deleterious material. Other materials may be required depending on manufacturer specifications and/or jurisdictional requirements.

Trench Backfill

The use of on-site soil is discussed below. Imported trench backfill material may be required if material generated from the trench excavation is above optimum moisture content and cannot be dried out. We recommend that imported trench backfill material consist of material similar to “Select Borrow” or “Gravel Borrow” as described in Section 9-03.14 of the WSDOT Standard Specifications. During wet weather, select granular fill may be required as a trench backfill. Deeper excavations close to or below groundwater seepage may require other backfill materials and base stabilization materials such as a clean ballast and/or quarry spalls, which are relatively self compacting. Pipe manufactures and jurisdictional requirements should also be considered when choosing trench backfill materials.

Quarry Spalls

We recommend that quarry spalls consist of 2- to 4-inch washed, crushed stone similar to that described in Section 9-13 of the WSDOT Standard Specifications. Alternative stone size ranges may be considered, depending on the application.

On-Site Soil

Existing fill soils and native soil at the site may be considered for use as structural fill and trench backfill provided that the material:

- Is used during extended periods of dry weather,
- Can be adequately moisture conditioned and placed and compacted as recommended,
- Does not contain organic or other deleterious material, and
- Meets any special requirements related to its end use.

The fill, lacustrine and till-like soils encountered in our explorations are very moisture sensitive and will be very difficult or impossible to properly compact when wet. In addition, the soil could be at moisture content above optimum when excavated. If earthwork occurs during a typical wet season, or if the soils are persistently wet and cannot be dried back due to prevailing wet weather conditions we recommend the use of imported structural fill or select granular fill, as described above. Budgets should include provisions for import granular fill, especially if construction is planned during the wet weather season.

Fill Placement and Compaction

General

To obtain proper compaction, fill soil should be compacted near optimum moisture content and in uniform horizontal lifts. Lift thickness and compaction procedures will depend on the moisture content and gradation characteristics of the soil and the type of equipment used. The maximum allowable moisture content varies with the soil gradation and should be evaluated during construction. Generally, 12-inch loose lifts are appropriate for steel-drum vibratory roller compaction equipment. Compaction should be achieved by mechanical means. During fill and backfill placement, sufficient testing of in-place density should be conducted to check that adequate compaction is being achieved.

Area Fills and Pavement Bases

Fill placed to raise site grades and materials under pavements and structural areas should be placed on subgrades prepared as previously recommended. Fill material placed below structures and footings should be compacted to at least 95 percent of the theoretical maximum dry density (MDD) per ASTM International (ASTM) D 1557. Fill material placed less than 2 feet below pavement sections should be compacted to at least 95 percent of the MDD. Fill placed deeper than 2 feet below pavement sections should be compacted to at least 90 percent of the MDD. Fill material placed in landscaping areas should be compacted to a firm condition that will support construction equipment, as necessary, typically around 85 to 90 percent of the MDD.

Backfill Behind Retaining Walls

Backfill behind retaining walls should be compacted to between 90 and 92 percent of the MDD. Overcompaction of fill placed directly behind retaining walls should be avoided. We recommend use of hand-operated compaction equipment and maximum 6-inch loose lift thickness when compacting fill within about 5 feet behind retaining walls.

Trench Backfill

For utility excavations, we recommend that the initial lift of fill over the pipe be thick enough to reduce the potential for damage during compaction but generally should not be greater than about 18 inches. In addition, rock fragments greater than about 1 inch in maximum dimension should be excluded from this lift.

Trench backfill material placed below structures and footings should be compacted to at least 95 percent of the MDD. In paved areas, trench backfill should be uniformly compacted in horizontal lifts to at least 95 percent of the MDD in the upper 2 feet below subgrade. Fill placed below a depth of 2 feet from subgrade in paved areas must be compacted to at least 90 percent of the MDD. In non-structural areas, trench backfill should be compacted to a firm condition that will support construction equipment as necessary.

Shallow Foundations

General

Proposed structures can be founded on continuous wall and isolated column footings. Based on the materials observed in our borings, the site topography, and the conceptual site layout we anticipate that footings will likely be founded on one of three typical soils profiles: glacial till, structural fill extending to glacial till, and structural fill overlying existing fill or lacustrine soils. The existing fill and lacustrine deposits encountered in our explorations are typically loose or medium stiff and variable. Due to the potential for excessive differential settlement, we recommend that foundations not bear directly on existing fill or lacustrine soils. Overexcavation and replacement of existing fill or lacustrine soils below foundations will be required. Based on our explorations we estimate that modification to the bearing surfaces will be required over about half of the building footprint. Exterior footings should be established at least 18 inches below the lowest adjacent grade. Interior footings can be founded a minimum of 12 inches below the top of the floor slab. Isolated column and continuous wall footings should have minimum widths of 24 and 18 inches, respectively.

Footing Bearing Surface Preparation

Our specific bearing surface preparation recommendations for the three typical soils profile described above are as follows:

- Bearing surfaces for footings bearing directly on glacial till should be proof-compacted as necessary to a uniformly firm and unyielding condition.
- Structural fill overlying glacial till should extend laterally beyond the edge of the footings a distance equal to the thickness of the fill or 2 feet, whichever is less.
- Existing fill or lacustrine soils should be overexcavated at least 2 feet below footings and replaced with compacted structural fill if more than 2 feet of existing fill or lacustrine soils are present. Structural fill should extend 2 feet laterally beyond the edges of the footings.

The base of all footing excavations should be evaluated by a representative from our firm prior to placement of structural fill or formwork and reinforcement. Loose or disturbed materials present at the base of footing excavations should be removed or compacted. If soft or otherwise unsuitable areas are revealed during evaluation that cannot be compacted to a stable and uniformly firm condition the following options may be considered: (1) the exposed soils be moisture conditioned and recompacted; or (2) the unsuitable soils be overexcavated and replaced with compacted structural fill, as needed; or (3) it may be possible to push, seat, and compact quarry spalls into the soft soils to stabilize the surface.

During periods of wet weather, concrete should be placed as soon as practical after preparation of the footing excavations. Foundation bearing surfaces should not be exposed to standing water. If water pools in the base of the excavation, it should be removed before placing structural fill or reinforcing steel. If footing excavations are exposed to extended wet weather conditions a lean concrete mat can be considered for subgrade protection.

Allowable Soil Bearing Pressure

For footings prepared as described above bearing directly on firm, unyielding glacial till or structural fill extending to glacial till we recommend that shallow foundations be designed using an allowable downward soil bearing pressure of 5,000 pounds per square foot (psf).

We recommend an allowable soil bearing pressure of 3,500 psf for foundations bearing on 2 feet of compacted structural fill overlying existing fill material or lacustrine soils. An allowable soil bearing pressure of 5,000 psf can be used for structural fill overlying existing fill or lacustrine soils if the overexcavation depth is increased to 3 feet and imported select granular fill is used as the overexcavation backfill.

These bearing pressures apply to the total of dead and long-term live loads and may be increased by one-third when considering total loads, including earthquake or wind loads. These are net bearing pressures. The weight of the footing and overlying backfill can be ignored in calculating footing sizes.

Foundation Settlement

We estimate that settlement of footings designed and constructed as recommended will be less than 1 inch, with differential settlements of less than 1/2 inch between comparably loaded isolated column footings or along 50 feet of continuous footing. Settlement of footings founded on the very dense glacial till will likely be negligible. Settlement is expected to occur rapidly as loads are applied. Settlements could be greater than estimated if loose or disturbed soil is present beneath footings.

Lateral Resistance

The ability of the soil to resist lateral loads is a function of frictional resistance, which can develop on the base of footings and slabs and the passive resistance, which can develop on the face of below-grade elements of the structure as these elements tend to move into the soil. For footings founded in accordance with the recommendations presented above, the allowable frictional resistance on the base of the footing may be computed using a coefficient of friction of 0.40 applied to the vertical dead-load forces. The allowable passive resistance on the face of the footing or other embedded foundation elements may be computed using an equivalent fluid density of 330 pounds per cubic foot (pcf) for undisturbed site soils or structural fill extending out from the face of the foundation element a distance at least equal to two and one-half times the depth of the element. These values include a factor of safety of about 1.5.

The passive earth pressure and friction components may be combined provided that the passive component does not exceed two-thirds of the total. The passive earth pressure value is based on the assumptions that the adjacent grade is level and that groundwater remains below the base of the footing throughout the year. The top foot of soil should be neglected when calculating passive lateral earth pressure unless the area adjacent to the foundation is covered with pavement or a slab-on-grade.

Foundation Drains

We recommend that perimeter foundation footing drains be installed at the base of exterior footings. The perimeter drains should be provided with cleanouts and should consist of at least 4-inch-diameter perforated pipe surrounded on all sides by 6 inches of drain material enclosed in a non-woven geotextile fabric for underground drainage to prevent fine soil from migrating into the drain material. We recommend that the drainpipe consist of either heavy-wall solid pipe or rigid corrugated smooth interior polyethylene pipe. We do not recommend using flexible tubing for footing drainpipes. The drain material should consist of pea gravel or material similar to “Gravel Backfill for Drains” per WSDOT Standard Specifications Section 9-03.12(4). The perimeter drains should be sloped to drain by gravity, if practical, to a suitable discharge point. Water collected in roof downspout lines must not be routed to the perimeter footing drains

Slab-on-Grade Floor

The exposed subgrade should be evaluated after site grading is complete. The slab subgrades could be variable and range from fill, lacustrine soil, weathered or unweathered glacial till. We recommend the slab subgrades be approved by a member of our firm during construction. Disturbed areas should be compacted, if possible, or removed and replaced with compacted structural fill. In all cases, the exposed soil should be firm and unyielding. It may be appropriate to compact the exposed subgrade with a smooth drum vibratory roller to a dense and unyielding condition. Ideally, the subgrade should be compacted to at least 95 percent of the MDD in accordance with ASTM D 1557, or as determined by the field geotechnical engineer.

We recommend the slab-on-grade floors be underlain by a minimum 8-inch-thick capillary break consisting of clean sand and gravel, crushed or washed rock with less than 3 percent fines. Provided that loose soil is removed and the subgrade is prepared as recommended, we recommend slabs-on-grade be designed using a modulus of subgrade reaction of 300 pounds per cubic inch (pci).

We estimate that settlement for slabs-on-grade constructed as recommended will be less than 3/4 inch for a floor load of 500 psf.

For on-grade construction at or within 2 feet of existing grades it is our opinion that an underslab drain system is not necessary. Based on the conditions observed, isolated areas of perched groundwater could occur where slab subgrades transition from unweathered to weathered glacial till. Interceptor drains may be required and should be included as a contingency. We can provide additional recommendations for underslab drains as requested during design.

Conventional Retaining Walls

Drainage

Positive drainage is imperative behind retaining walls, unless they are designed to resist hydrostatic forces. We recommend a zone of free-draining material behind the retaining structure with perforated pipes to collect water. The drainage material should consist of material similar to "gravel backfill for drains" described in Section 9-03.12(4) of the WSDOT Standard Specifications. The drainage zone should extend horizontally at least 18 inches from the back of the retaining structure. Waffle boards or drainage mats may also be considered. We recommend we review drainage mat submittals and plan details if drainage mats are to be used.

A perforated, smooth-walled, rigid PVC pipe with a minimum diameter of 4 inches should be placed at the bottom of the drainage zone along the entire length of the retaining structure with the pipe invert at or below the elevation of the base of the footing. The drainpipes should collect water and direct it to a tightline leading to an appropriate disposal system. Cleanouts should be incorporated into the design of the drains in order to provide access for regular maintenance. Roof downspouts, perimeter drains or other types of drainage systems should not be connected to drain systems for retaining walls or below-grade structures.

Design Parameters

Footings for retaining structures should be designed in accordance with the "Shallow Foundations" recommendations above. We recommend retaining structures that are free to deflect at least 0.001H, where H is the height of the retaining structures, be designed for active earth pressures using an equivalent fluid unit weight of 35 pcf for the level backfill condition and 50 pcf for structures with backfill sloping upward behind the wall at 2H:1V. If the retaining structures are restrained against deflection, we recommend they be designed for an at-rest equivalent fluid unit weight of 55 pcf for the level backfill condition. These values do not include hydrostatic forces.

Surcharge loads applied closer than one-half of the retaining structure height may be considered as uniformly distributed horizontal pressures equal to one-third of the distributed vertical surcharge pressure.

A uniform seismic pressure of 10H psf, where H is the height of the retaining structure, should be included when designing permanent retaining structures for seismic loads.

Stormwater Infiltration

General

We understand that stormwater infiltration facilities may be incorporated into improvements at the project site. We understand that the City of Puyallup has recently adopted or will soon be adopting the 2014 Department of Ecology SWMMWW. Accordingly, our preliminary stormwater infiltration recommendations follow the guidance outlined 2014 SWMMWW.

The sections below provide our interpretation of the suitability of the site soil for infiltration, an estimate of soil infiltration rates that may be possible based on empirical correlations, and a discussion about further studies that may be needed to facilitate design of infiltration facilities.

Infiltration Suitability

It is our opinion that infiltration is feasible at the site, however, due to the relatively high fines content of the site soils encountered the infiltration capacity could be limited. The till-like soils encountered in some explorations are highly consolidated, which will limit their infiltration potential. Based on our explorations, it is our opinion that the glacial till soils at the site could be considered a low permeability layer when designing infiltration facilities. According to the 2014 SWMMWW, a minimum separation of 3 to 5 feet between the bottom of concentrated infiltration facilities, such as infiltration galleries or infiltration ponds, and low permeability layers must be maintained. Separation of 1 foot is acceptable for permeable pavements and roof downspout facilities. Once the team begins planning of stormwater facility depth and location, we can assist in determining if a low permeability layer provision should be considered. We did not encounter what we interpret to be the regional groundwater table in our explorations and, therefore, maintaining specified separation between facilities and the groundwater table is not anticipated to be a design constraint.

Preliminary Infiltration Rates

To provide an estimate of what range of infiltration values could be achieved for the different soil types at the site, we established a range of preliminary infiltration rates based on the Soil Grain Size Analysis Method presented in the 2014 SWMMWW. Table 2 below summarizes our results.

TABLE 2: SOIL INFILTRATION RATE ANALYSIS[1]

Boring	Soil Sample Depth (feet)	Soil Unit	Approximate Percent Fines[2]	USCS Soil Classification[3]	Preliminary Long-term Design Infiltration Rate[4] (Inches per Hour)
B-2	2.5	Weathered Glacial Till	38	SM	≤0.25
B-4	2.5	Lacustrine Soils	52	ML	≤0.75
B-5	5	Glacial Till	30	GM	≤0.25
B-8	2.5	Lacustrine Soils	84	ML	≤0.2

Notes:

[1] For selected soil samples.

[2] Fines = Silt and clay-sized particles passing U.S. No. 200 sieve.

[3] Unified Soil Classification System (USCS). See Figure A-1 for additional descriptions.

[4] Based on the procedures outlined in the 2012 SWMMWW and our experience.

Because the estimated infiltration rates are variable it may be appropriate to assume values on the lower end of the range presented for preliminary design. If more than one soil type is present below the base of an infiltration facility, the infiltration rate associated with the less permeable soil should be used. The values presented above are for the samples obtained in a particular area at a particular depth and represent an estimate of soil infiltration rates as indicated by gradation characteristics. These values should not be used for final design of infiltration facilities.

Recommendations for Additional Field Testing

If infiltration facilities are included at this site, additional testing, analysis, and reporting will be required to establish the design infiltration rate. The SWMMWW recommends that long-term design infiltration rates be determined via a pilot infiltration test (PIT). Based on our experience, PITs could provide a more accurate (and less conservative) estimate of soil infiltration rates than soil gradation-based infiltration rate estimates. Due to the variability of soil conditions and the limited infiltration potential of the site soils we recommend that at least two PITs be performed at the site if infiltration facilities are incorporated in the design. The locations of the PITs should be near (ideally within) the footprint of the proposed infiltration facilities. The PITs could be performed over the course of one to two days. We can assist with determining preliminary infiltration pond locations, performing PITs, and performing associated analysis and reporting, if requested.

Asphalt Concrete Pavement Recommendations

On Site Pavements

Pavements constructed on school grounds will likely include parking areas, access roads, and school bus and car drop off areas. Based on our experience, we provide recommended conventional ACP sections below. These pavement sections may not be adequate for heavy construction traffic loads such as those imposed by concrete transit mixers, dump trucks or cranes. Additional pavement thickness may be necessary to prevent pavement damage during construction. The recommended sections assume that final improvements surrounding the conventional ACP will be designed and constructed such that stormwater or excess irrigation water from landscape areas does not accumulate below the pavement section or pond on pavement surfaces.

Pavement subgrade should be prepared, placed and observed as previously described. Crushed surfacing base course and subbase should be moisture conditioned to near optimum moisture content and compacted to at least 95 percent of MDD (ASTM D 1577).

Crushed surfacing base course should conform to applicable sections of 4-04 and 9-03.9(3) of the WSDOT Standard Specifications. Hot mix asphalt should conform to applicable sections of 5-04, 9-02 and 9-03 of the WSDOT Standard Specifications.

Standard-Duty ACP – Automobile Driveways and Parking Areas

- 2 inches of hot mix asphalt, class ½ inch, PG 58-22
- 4 inches of crushed surfacing base course
- 6 inches of subbase consisting of select granular fill to provide uniform grading and pavement support, to maintain drainage, and to provide separation from fine-grained subgrade soil

- Native subgrade or structural fill prepared in accordance with the "Subgrade Preparation and Evaluation" section of this report

Heavy-Duty ACP – Areas Subject to Heavy-Duty Traffic

- 4 inches of hot mix asphalt, class ½ inch, PG 58-22
- 6 inches of crushed surfacing base course
- 6 inches of subbase consisting of select granular fill to provide a uniform grading surface and pavement support, to maintain drainage, and to provide separation from fine-grained subgrade soil
- Native soil or structural fill on subgrades prepared in accordance with the "Subgrade Preparation and Evaluation" section of this report

Pervious Pavements

General

Our recommendations for pervious pavement design sections are based on information provided in the technical guidance manual for LID (Puget Sound LID manual), completed by the Puget Sound Partnership (December 2012) and our experience designing permeable pavements in the region. The pavement sections presented below are suitable for use in driveway and parking areas and may not be suitable for use on surface streets or in areas with heavy traffic loads such as the bus travel and parking areas. The design of pervious pavements for stormwater management should consider storage capacity of the pervious pavement system and infiltration rate of the subgrade soils. Our general recommendations are provided in the following sections; however, we recommend that final pervious pavement design should be in accordance with the complete recommendations provided in the Puget Sound LID manual.

Sections for pervious concrete pavement and porous asphalt pavement are presented below followed by specific recommendations for each section.

Pervious Cement Concrete Section

- 6 inches of pervious cement concrete
- 6 inches (minimum) of permeable ballast, more permeable ballast may be required to provide adequate storage capacity for the section
- 6 inches treatment layer (if necessary)
- Geotextile separation liner (if necessary)
- Subgrade prepared as recommended below

Porous Asphalt Concrete Section

- 4 inches of porous hot mix asphalt concrete
- 6 inches (minimum) of permeable ballast, more permeable ballast may be required to provide adequate storage capacity for the section
- 6 inches treatment layer (if necessary)
- Geotextile separation liner (if necessary)
- Subgrade prepared as recommended below

Pavement

Permeable pavements should be open graded and should have a minimum infiltration rate of at least 8 inches per hour when newly installed. Field infiltration tests should be performed on newly placed permeable pavements to verify the infiltration rate.

Permeable Ballast

We recommend a minimum 6-inch thick permeable ballast layer that meets the specification for American Public Works Association (APWA) General Special Provision (GSP) 9-03.9(2) Option 1 (shown in table below). A thicker permeable ballast layer may be necessary to provided sufficient storage capacity for the design infiltration rate. In general, the permeable ballast can be considered to have a porosity of 30 percent.

TABLE 3: GRADATION SPECIFICATION FOR PERMEABLE BALLAST

Sieve Size	Percent Passing
2½-inch	99-100
2 inch	65-100
¾ inch	40-80
No. 4	0-5
No. 100	0-2
% Fracture	95

Permeable ballast layers between 6 and 12 inches thick should be placed as a single lift. The ballast should be lightly compacted to a firm unyielding condition. Overcompaction of the ballast can result in reduced permeability. The prepared ballast layer should be observed by an engineer to ensure that the ballast has been adequately compacted prior to placement of the permeable pavement. If the permeable ballast layer is thicker than 12 inches, it should be placed and compacted in multiple lifts not exceeding 12 inches in thickness.

Treatment Layer

If treatment of the collected stormwater is necessary before infiltration, a minimum 6-inch thick layer of sand or permeable treatment media could be included in the pavement section and located below the permeable ballast. A geotextile liner is required between the ballast layer and the treatment layer to prevent the treatment media from migrating into the ballast layer. The permeability of the treatment layer should match or exceed that of the permeability ballast layer. The treatment layer should be placed and compacted following the recommendations in the “Permeable Ballast” section above.

Subgrade Preparation and Geotextile Liner

Subgrades below permeable pavement sections should be lightly compacted to a firm and unyielding condition before constructing the permeable pavement section; however, overcompaction of the subgrade should be avoided. Prepared subgrades should be protected from construction traffic standing water or other disturbance. If portions of the subgrade become disturbed or are overcompacted, the subgrade should be scarified to a minimum depth of 8 inches and recompacted. The subgrade should be recompacted to between 90 and 92 percent of the MDD.

A layer of non-woven geotextile filter fabric should be placed between the prepared subgrade soils and permeable pavement section if the subgrade soils contain more than 7 percent fines by weight based on the minus 3/4-inch fraction. This is likely the case, based on conditions observed in our explorations. Filter fabric should meet the requirements of WSDOT Standard Specifications Section 9-33.1 for separation.

Protection, Maintenance and Safety

It is imperative that soils are not tracked onto pervious pavement surfaced areas during construction. Periodic visual inspections should be performed throughout the pavement life to determine if pervious pavement surfaces are clogged with fine soil or vegetation. Surfaces should be swept with a high-efficiency or vacuum sweeper regularly (typically at least 2 to 4 times per year) and washed with a high-pressure hose at least once per year.

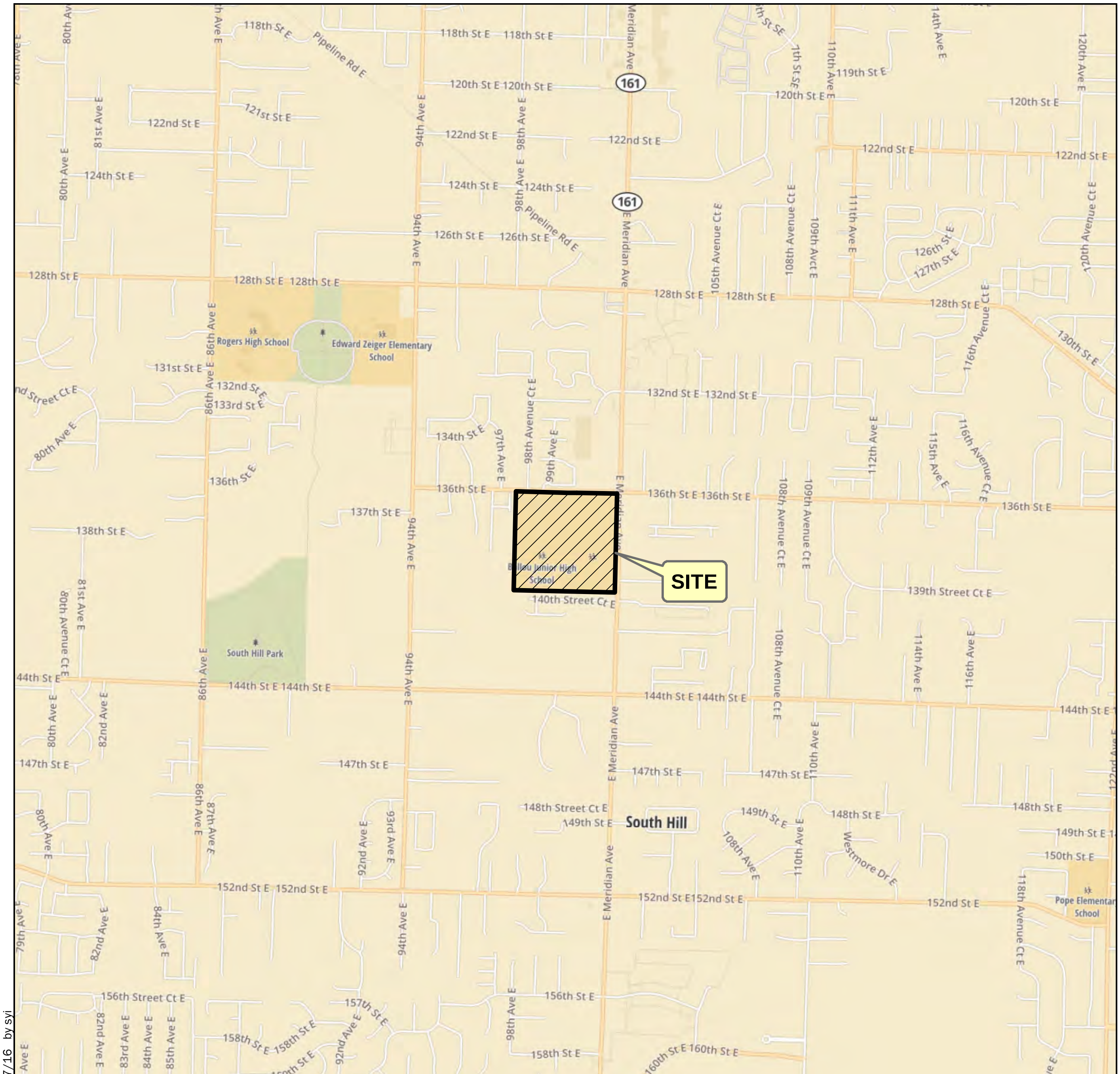
Because the relatively porous base and subbase layers allow some air movement below the pavement, pervious pavement surfaces may become icy more easily than surrounding conventional pavement surfaces. This problem is similar to differential icing of bridges and elevated road structures. Users should be made aware of the possibility of differential icing if pervious pavements are used.

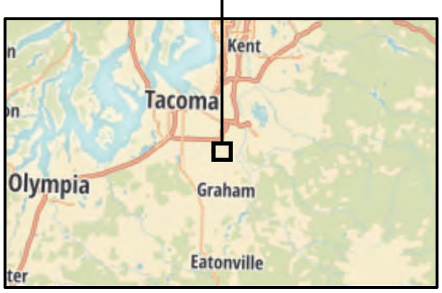
LIMITATIONS

We have prepared this report for the Puyallup School District, for Firgrove Elementary School. Puyallup School District may distribute copies of this report to owner's authorized agents and regulatory agencies as may be required for the Project.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices for geotechnical engineering services in this area at the time this report was prepared. The conclusions, recommendations, and opinions presented in this report are based on our professional knowledge, judgment and experience. No warranty, express or implied, applies to the services or this report.

Please refer to Appendix C titled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.





N
W E
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2,000 0 2,000
Feet

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

Data Source: Mapbox Open Street Map, 2015

Projection: NAD 1983 StatePlane Washington South FIPS 4602 Feet

Vicinity Map

Firgrove Elementary School
Puyallup, Washington

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Figure 1

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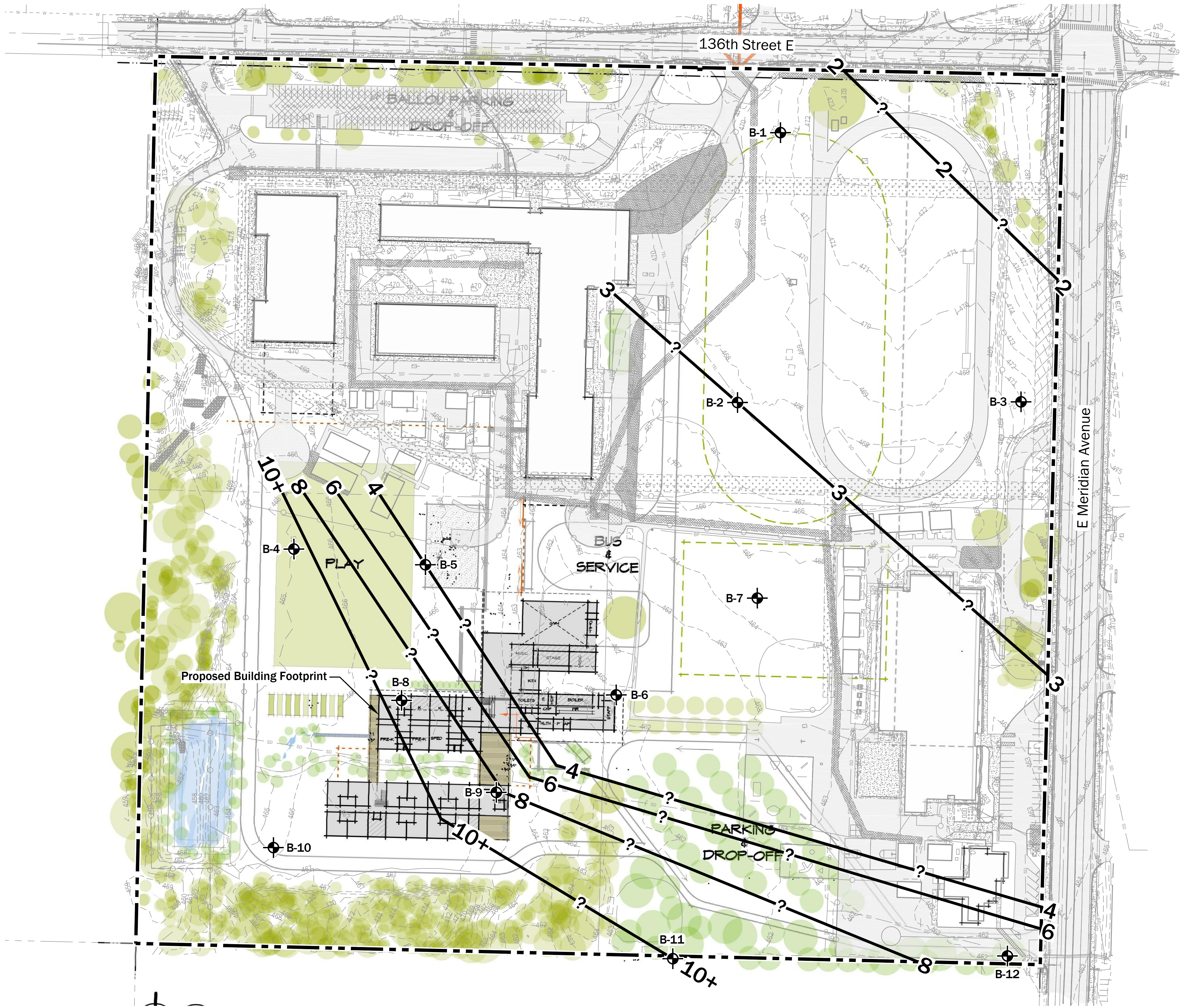

Legend

- Site Boundary
- B-1 Boring by GeoEngineers, 2016
- Existing Ground Surface Contour
- ?—4—? Approximate Depth to Dense Glacial Till-Like Soils

N S E W

150 0 150
Feet

Notes:

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

Vertical Datum: NGVD 29.

Projection: NAD83 Washington State Planes, South Zone, US Foot.

Data Source:
Base drawing provided by Mahlum Architects, Inc. dated 11/16/16.

Site Plan

Firgrove Elementary School
Puyallup, Washington

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Figure 2

P:\2\2017006\CAD\00\Geotech\2017006000_F02_Site Plan.dwg TAB:F2 Date Exported: 11/17/16 - 14:23 by cvanslyke

APPENDIX A
Subsurface Explorations

APPENDIX A
SUBSURFACE EXPLORATIONS

General

Soil conditions at the project site were explored on October 19 and 20, 2016 by advancing 12 borings at the approximate locations shown on the Site Plan (Figure 2). The explorations were located in the field using a GPS device. The locations of the explorations shown on the Site Plan should be considered approximate.

Soil Borings

Soil borings were advanced to between 8 feet and 20.5 feet below ground surface (bgs) using a track-mounted hollow-stem auger drill rig. The explorations were continuously monitored by a representative from our firm who examined and classified the soil encountered, obtained representative soil samples, and maintained a detailed log of the explorations. Soil encountered in the borings was classified in general accordance with ASTM International (ASTM) D 2488 and the classification chart listed in Key to Exploration Logs, Figure A-1. Logs of the borings are presented in Figures A-2 through A-13. The logs are based on interpretation of the field and laboratory data, and indicate the depth at which we interpret subsurface materials or their characteristics to change, although these changes might actually be gradual.

Soil samples were obtained from the borings at approximate 2.5 to 5-foot-depth intervals using either a 2-inch, outside-diameter, standard split-spoon sampler (Standard Penetration Test [SPT]) in general accordance with ASTM D 1586 or using a larger 3-inch diameter sampler. The samplers were driven into the soil using a 140-pound automatic hammer, free-falling 30 inches. The number of blows required to drive the samplers each of three, 6-inch increments of penetration were recorded in the field. The sum of the blow counts for the final 12 inches of penetration, unless otherwise noted, is reported on the boring logs.

Borings were drilled and backfilled by Holocene Drilling, Inc. subcontracted to GeoEngineers.

SOIL CLASSIFICATION CHART

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

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

ADDITIONAL MATERIAL SYMBOLS

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

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata

Approximate contact between soil strata

Material Description Contact

Contact between geologic units

Contact between soil of the same geologic unit

Sampler Symbol Descriptions

2.4-inch I.D. split barrel

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Continuous Coring

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

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

A "WOH" indicates sampler pushed using the weight of the hammer.

Laboratory / Field Tests

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

Sheen Classification

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

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

KEY TO EXPLORATION LOGS

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FIGURE A-1

Rev. 02/16

Drilled	Start 10/20/2016	End 10/20/2016	Total Depth (ft) 8	Logged By EAW / Checked By BEL	Driller Holocene Drilling, Inc.	Drilling Method Hollow Stem Auger

Surface Elevation (ft) 470 Vertical Datum NAVD88	Hammer Data 140 (lbs) / 30 (in) Drop	Drilling Equipment Diedrich D-50	
Easting (X) 1193727 Northing (Y) 661240	System Datum WA State Plane South NAD83 (feet)	Groundwater	Date Measured / Depth to Water (ft) / Elevation (ft): Not Observed
Notes:			

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0								TS	1 inch sod			
			8	7		1			SM	Dark brown silty fine to coarse sand with occasional gravel and organic matter (roots) (loose, moist) (fill)			
			18	39		2 %F			SM	Gray-brown with orange staining silty fine to medium sand with gravel (dense, moist) (weathered till)	16	40	Drill chatter from 3 to 7.5 feet
465	5					3							Drilling refusal at 6.5 feet, location adjusted ~3 feet north and boring redrilled
			2	50/2"		4			ML	Gray-brown sandy silt with gravel (hard, moist) (glacial till)			

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

Log of Boring B-1

GEOENGINEERS

Project: Firgrove Elementary School
Project Location: Puyallup, Washington
Project Number: 2017-006-00

Figure A-2
Sheet 1 of 1

Drilled	Start 10/19/2016	End 10/19/2016	Total Depth (ft)	10.25	Logged By EAW / Checked By BEL	Driller	Holocene Drilling, Inc.	Drilling Method	Hollow Stem Auger

Surface Elevation (ft) / Vertical Datum	468 / NAVD88	Hammer Data	140 (lbs) / 30 (in) Drop
Easting (X) / Northing (Y)	1193664 / 660844	System Datum	WA State Plane South NAD83 (feet)
Drilling Equipment	Diedrich D-50	Groundwater: Date Measured / Depth to Water (ft) / Elevation (ft)	See Remarks
Notes:			

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0								TS	2 inches sod			
			18	4		1			SM	Dark brown silty fine to medium sand with occasional gravel and organic matter (roots) (loose, moist) (fill)			
465			18	10		2 / SA			SM	Brown with orange staining silty fine to medium sand with gravel (medium dense, wet) (weathered till)	20	38	Perched groundwater observed at 2.5 feet during drilling
										Grades to moist			
	5												
									GM	Gray silty fine to coarse gravel with sand (very dense, wet) (glacial till)			Drill chatter from 6 to 10 feet Perched groundwater observed at 6 feet during drilling
460			4	80/8"		3				Grades to moist			
	10		0	50/4"									

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

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Log of Boring B-2

GEOENGINEERS

Project: Firgrove Elementary School
Project Location: Puyallup, Washington
Project Number: 2017-006-00

Figure A-3
Sheet 1 of 1

Drilled	Start 10/19/2016	End 10/19/2016	Total Depth (ft) 9	Logged By EAW / Checked By BEL	Driller Holocene Drilling, Inc.	Drilling Method Hollow Stem Auger

Surface Elevation (ft) / Vertical Datum: 471 / NAVD88	Hammer Data: 140 (lbs) / 30 (in) Drop	Drilling Equipment: Diedrich D-50	
Easting (X) / Northing (Y): 1194080 / 660845	System Datum: WA State Plane South / NAD83 (feet)	Groundwater: Date Measured / Depth to Water (ft) / Elevation (ft)	
Notes:		Not Observed	

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0								TS	2 inches sod			
470			18	10		1 / MC			SM	Dark brown silty fine to coarse sand with occasional gravel and organic matter (roots) (medium dense, moist) (fill)	16		
			18	35		2, 3			SM	Light brown to gray silty fine to coarse sand with gravel (dense, moist) (weathered till)			
									SM	Gray silty fine to coarse gravel with sand (very dense, moist) (glacial till)			Drill chatter 4 to 7.5 feet
	5												
465													
			16	50/4"		4							

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

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Log of Boring B-3

GeoEngineers

Project: Firgrove Elementary School
Project Location: Puyallup, Washington
Project Number: 2017-006-00

Figure A-4
Sheet 1 of 1

Drilled	Start 10/20/2016	End 10/20/2016	Total Depth (ft) 11.5	Logged By EAW / Checked By BEL	Driller Holocene Drilling, Inc.	Drilling Method Hollow Stem Auger

Surface Elevation (ft) / Vertical Datum	465 / NAVD88	Hammer Data	140 (lbs) / 30 (in) Drop
Easting (X) / Northing (Y)	1193013 / 660629	System Datum	WA State Plane South / NAD83 (feet)
Drilling Equipment	Diedrich D-50		

Groundwater

Date Measured	Depth to Water (ft)	Elevation (ft)
	See Remarks	

Notes:

FIELD DATA

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0								TS	~2 inches sod			
									GP-GM	Brown fine gravel with silt and sand (medium dense, wet) (fill)			
			1	19		1				Grades to moist			Perched groundwater observed at 2.5 feet during drilling Driller indicated change in conditions at 3 feet
									ML	Brown to gray sandy silt (stiff, moist) (lacustrine soils)			
460	5		18	11		2 / SA					21	52	
455	10		18	11		3							

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

Tacoma: Date:11/17/16 Path:P:\2\2017006\GINT\201700600.GPJ DBTemplate/LibTemplate:GEOENGINEERS_DF_STD_US.GDT/GEI8_GEOTECH_STANDARD_%F

Log of Boring B-4

GeoEngineers

Project: Firgrove Elementary School
Project Location: Puyallup, Washington
Project Number: 2017-006-00

Drilled	Start	End	Total Depth (ft)	Logged By / Checked By	Driller	Drilling Method
	10/20/2016	10/20/2016	11.5	EAW / BEL	Holocene Drilling, Inc.	Hollow Stem Auger

Surface Elevation (ft) / Vertical Datum	466 / NAVD88	Hammer Data	140 (lbs) / 30 (in) Drop
Easting (X) / Northing (Y)	1193206 / 660606	System Datum	WA State Plane South NAD83 (feet)
Drilling Equipment	Diedrich D-50		
Notes:			

Groundwater

Date Measured	Depth to Water (ft)	Elevation (ft)
Not Observed		

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
466	0								TS	~2 inches sod			
465									SM	Gray-brown silty fine to medium sand with occasional organic matter (roots) (very loose, moist) (fill)			
			6	3		1							
									GM	Gray silty fine to coarse gravel with sand (very dense, moist) (glacial till)			Driller indicates change in conditions at 4 feet
	5		12	54		2 / SA					7	30	Samples 2 and 3 combined for lab testing
460													
													Drill chatter from 7 to 10 feet
	10		18	47		3							
455													

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

Log of Boring B-5

GEOENGINEERS

Project: Firgrove Elementary School
Project Location: Puyallup, Washington
Project Number: 2017-006-00

Drilled	Start 10/20/2016	End 10/20/2016	Total Depth (ft) 16	Logged By EAW Checked By BEL	Driller Holocene Drilling, Inc.	Drilling Method Hollow Stem Auger

Surface Elevation (ft) / Vertical Datum	462 / NAVD88	Hammer Data	140 (lbs) / 30 (in) Drop	Drilling Equipment	Diedrich D-50
Easting (X) / Northing (Y)	1193486 / 660415	System Datum	WA State Plane South NAD83 (feet)	Groundwater	Date Measured / Depth to Water (ft) / Elevation (ft): Not Observed
Notes:					

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
462	0								TS	~2 inches sod			
									SM	Brown silty fine to coarse sand with occasional gravel and organic matter (roots) (loose, moist) (fill)			
460													
			18	11		1 / %F			ML	Brown and gray sandy silt (stiff, moist) (weathered till)	26	68	
	5		18	77		2 / CA, ORG							ORG=0.3% Drill chatter from 5.5 to 15 feet
									SM	Gray silty fine to coarse sand with gravel (very dense, moist) (glacial till)			
455													
	10		12	69		3							
450													
									GP-GM	Gray fine to coarse gravel with silt and sand (very dense, moist)			
	15		8	50/6"		4							
													Drilling refusal at 16 feet

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

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Log of Boring B-6

GeoEngineers

Project: Firgrove Elementary School
Project Location: Puyallup, Washington
Project Number: 2017-006-00

Figure A-7
Sheet 1 of 1

Drilled	Start 10/19/2016	End 10/19/2016	Total Depth (ft)	20.5	Logged By EAW / Checked By BEL	Driller	Holocene Drilling, Inc.	Drilling Method	Hollow Stem Auger

Surface Elevation (ft) / Vertical Datum	464 / NAVD88	Hammer Data	140 (lbs) / 30 (in) Drop
Drilling Equipment	Diedrich D-50		
Easting (X) / Northing (Y)	1193693 / 660557	System Datum	WA State Plane South NAD83 (feet)
Notes:			

Groundwater Date Measured	Depth to Water (ft)	Elevation (ft)
	Not Observed	

Elevation (feet)	Depth (feet)	Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
464	0							TS	~2 inches sod			
								SM	Gray-brown with orange staining silty fine to coarse sand with gravel (medium dense, moist) (weathered till)			
		12	24		1 MC					20		
460												
	5	12	38		2							
								GP-GM	Gray fine to coarse gravel with silt and sand (very dense, moist) (glacial till)			
455												
	10	12	50/5"		3							Very hard drilling below 10 feet
450												
	15	0	50/4"									
445												
	20	5	50/3"		4							

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

Log of Boring B-7

GeoEngineers

Project: Firgrove Elementary School
Project Location: Puyallup, Washington
Project Number: 2017-006-00

Drilled	Start 10/19/2016	End 10/19/2016	Total Depth (ft)	19	Logged By EAW / Checked By BEL	Driller	Holocene Drilling, Inc.	Drilling Method	Hollow Stem Auger

Surface Elevation (ft) / Vertical Datum	466 / NAVD88	Hammer Data	140 (lbs) / 30 (in) Drop	Drilling Equipment	Diedrich D-50
Easting (X) / Northing (Y)	1193171 / 660407	System Datum	WA State Plane South / NAD83 (feet)	Groundwater: Date Measured / Depth to Water (ft) / Elevation (ft)	Not Observed
Notes:					

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
466	0								TS	2 inches sod			
465				8		1			SM	Dark brown silty fine to medium sand with occasional organic matter (roots) (loose, moist) (fill)			
			18	6		2 / SA			ML	Light brown silt with sand (medium stiff, moist) (lacustrine soils)	24	84	
460	5												
			18	13		3				Grades to stiff			
						4			SP	Gray fine to coarse sand, trace silt (medium dense, moist)			Drill chatter 9 to 19 feet
									SM	Gray silty fine to coarse sand with gravel (dense, moist) (glacial till)			
455	10												
			12	39		5							
450	15												
			3	54		6				Grades to very dense			

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

Log of Boring B-8

GEOENGINEERS

Project: Firgrove Elementary School
Project Location: Puyallup, Washington
Project Number: 2017-006-00

Figure A-9
Sheet 1 of 1

Drilled	Start 10/19/2016	End 10/19/2016	Total Depth (ft)	20.5	Logged By EAW / Checked By BEL	Driller	Holocene Drilling, Inc.	Drilling Method	Hollow Stem Auger

Surface Elevation (ft) / Vertical Datum	465 / NAVD88	Hammer Data	140 (lbs) / 30 (in) Drop
Drilling Equipment	Diedrich D-50		
Easting (X) / Northing (Y)	1193310 / 660272	System Datum	WA State Plane South / NAD83 (feet)
Notes:			

Groundwater: Date Measured	Depth to Water (ft)	Elevation (ft)
	Not Observed	

FIELD DATA

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0								TS	~2 inches sod			
									ML	Light brown sandy silt (medium stiff, moist) (lacustrine soils)			
			18	5		1							
460	5		18	7		2 / MC					29		
									SM	Gray silty fine to coarse sand with gravel (very dense, moist) (glacial till)			Drill chatter 8 to 20 feet
455	10		12	60		3							
450	15		0	50/3"		4							
			18										
445	20		4	50/1"		5							

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

Log of Boring B-9

GeoEngineers

Project: Firgrove Elementary School
Project Location: Puyallup, Washington
Project Number: 2017-006-00

Drilled	Start 10/19/2016	End 10/19/2016	Total Depth (ft) 11.5	Logged By EAW Checked By BEL	Driller Holocene Drilling, Inc.	Drilling Method Hollow Stem Auger

Surface Elevation (ft) Vertical Datum	466 NAVD88	Hammer Data	140 (lbs) / 30 (in) Drop	Drilling Equipment	Diedrich D-50
Easting (X) Northing (Y)	1192983 660191	System Datum	WA State Plane South NAD83 (feet)	Groundwater	
Notes:				Date Measured / Depth to Water (ft) / Elevation (ft)	Not Observed

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0								TS	2 inches sod			
465			18	10		1 / CA, ORG			SM	Gray-brown silty fine to medium sand (medium dense, moist) (lacustrine soils)			ORG=0.8%
			18	9		2 / %F				Grades to loose	10	43	
	5		18	6		3							
460													
			18	4		4 / MC			ML	Brown-gray sandy silt (medium stiff, wet)	35		Perched groundwater observed at 7 feet during drilling
										Grades to moist			
	10		18	4		5							
455													

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

Log of Boring B-10

GeoEngineers

Project: Firgrove Elementary School
Project Location: Puyallup, Washington
Project Number: 2017-006-00

Drilled	Start 10/19/2016	End 10/19/2016	Total Depth (ft) 14	Logged By EAW Checked By BEL	Driller Holocene Drilling, Inc.	Drilling Method Hollow Stem Auger

Surface Elevation (ft) 463 Vertical Datum NAVD88	Hammer Data 140 (lbs) / 30 (in) Drop	Drilling Equipment Diedrich D-50	
Easting (X) 1193569 Northing (Y) 660028	System Datum WA State Plane South NAD83 (feet)	Groundwater: Date Measured / Depth to Water (ft) / Elevation (ft)	See Remarks
Notes:			

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0								TS	~2 inches sod			
									SM	Gray-brown silty fine to medium sand, occasional gravel (loose, moist) (lacustrine soils)			
460			6	7		1							
	5		18	5		2 / MC					31		
										Grades to without gravel			
455													
	10		12	30		3			SM	Gray silty fine to medium sand with occasional gravel (dense, wet) (weathered till)			Perched groundwater observed at 10 feet during drilling
										Grades to moist			
450			18	63		4							
									SM	Gray silty fine to coarse sand with gravel (very dense, moist) (glacial till)			

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

Log of Boring B-11

GeoEngineers

Project: Firgrove Elementary School
Project Location: Puyallup, Washington
Project Number: 2017-006-00

Drilled	Start 10/19/2016	End 10/19/2016	Total Depth (ft) 9	Logged By EAW Checked By BEL	Driller Holocene Drilling, Inc.	Drilling Method Hollow Stem Auger

Surface Elevation (ft) 462 Vertical Datum NAVD88	Hammer Data 140 (lbs) / 30 (in) Drop	Drilling Equipment Diedrich D-50	
Easting (X) 1194060 Northing (Y) 660032	System Datum WA State Plane South NAD83 (feet)	Groundwater	Date Measured / Depth to Water (ft) / Elevation (ft): Not Observed
Notes:			

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0								AC	2.5 inches asphalt concrete			
									SM	Gray silty fine to medium sand (loose, moist) (lacustrine soils)			
460			12	4		1 / MC					12		
			18	9		2							
	5												
455									SM	Gray silty fine to coarse sand with gravel (medium dense, moist) (weathered till)			
			18	19		3							

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

Log of Boring B-12

GeoEngineers

Project: Firgrove Elementary School
Project Location: Puyallup, Washington
Project Number: 2017-006-00

APPENDIX B
Laboratory Testing

APPENDIX B
LABORATORY TESTING

General

Soil samples obtained from the borings were returned to our laboratory for further examination and testing. Our laboratory testing program consisted of: six moisture content determinations, four grain-size distribution analyses, and three percent fines determinations. We also sent selected samples to an off-site laboratory for cation exchange capacity (CEC) and organic content (OC) tests. Details of the tests performed are provided in the sections below.

Moisture Content

The moisture content of selected samples was determined in general accordance with ASTM International (ASTM) D 2216. The test results are used to aid in determining the moisture content of the soil, soil classification and correlation with other pertinent engineering soil properties. The test results are presented on the exploration logs in Appendix A at the respective sample depths.

Grain-Size Analysis

Grain-size analyses were performed on selected soil samples in general accordance with ASTM Test Method D 442-63. This test provides a quantitative determination of the distribution of particle sizes in soils. Figures B-1 and B-2 present the results of the grain-size analyses.

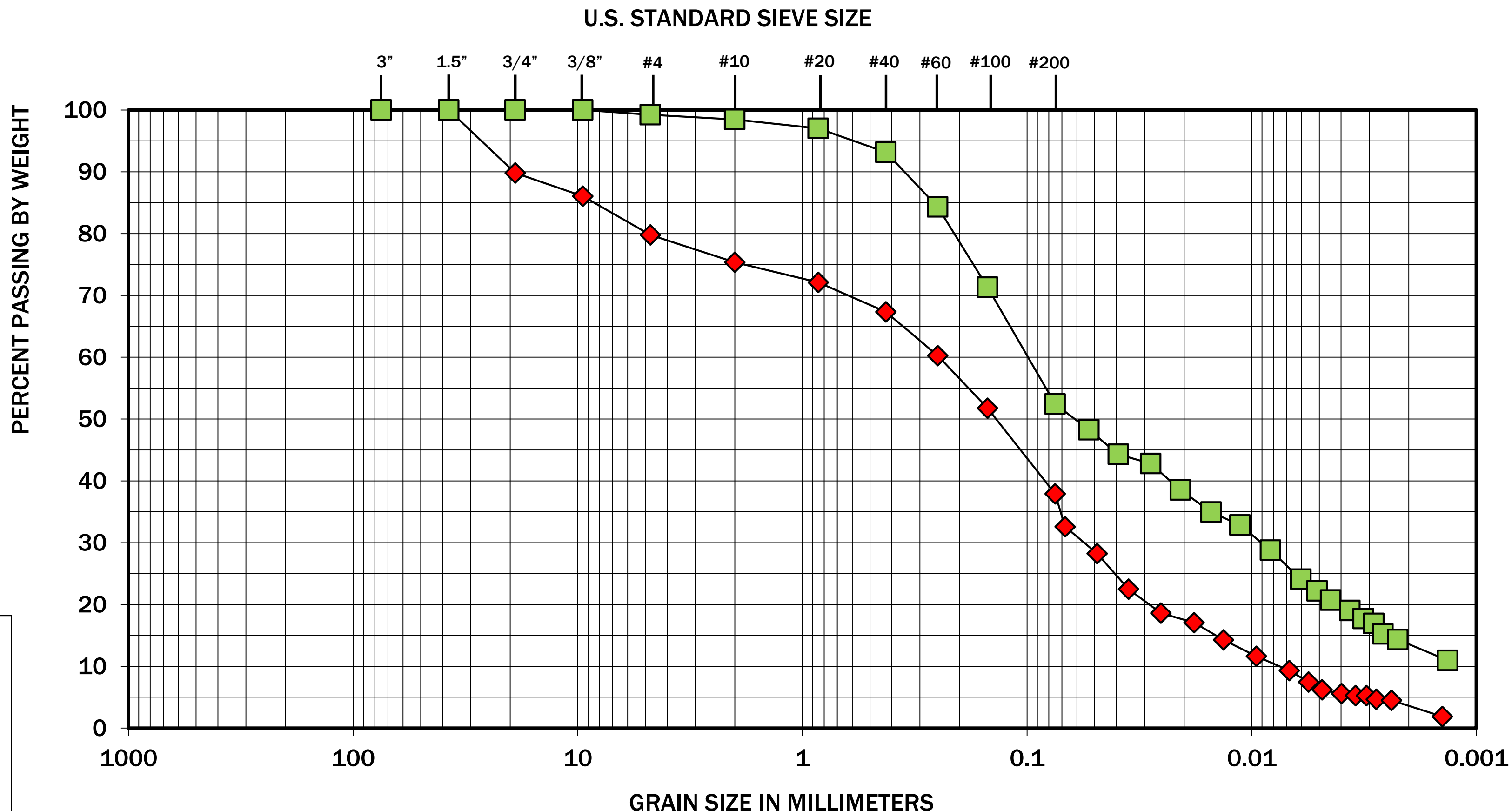
Percent Passing the U.S. No. 200 Sieve

Selected samples were "washed" through the U.S. No. 200 sieve to estimate the relative percentages of coarse- and fine-grained particles in the soil. The percent passing value represents the percentage by weight of the sample finer than the U.S. No. 200 sieve (fines). The tests were conducted in general accordance with ASTM D 1140. The test results are presented on the exploration logs in Appendix A at the respective sample depths.

Cation Exchange Capacity and Organic Content Tests

CEC and OC tests were performed on selected samples at a subcontracted laboratory (SoilTest Farm Consultants located in Moses Lake, Washington.) Test results are presented in the table below.

Exploration	Sample Depth (feet)	Soil Unit	Cation Exchange Capacity (meq/100g)	Organic Content (%)
B-6	5	Glacial Till	10.0	0.3
B-10	0.5	Lacustrine Soils	6.6	0.8



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Boring Number	Depth (feet)	Moisture (%)	Laboratory Soil Description
◆ (red diamond)	B-2	2.5	20	Silty sand with gravel (SM)
■ (green square)	B-4	5	21	Sandy silt (ML)

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The grain size analysis results were obtained in general accordance with ASTM D 6913.

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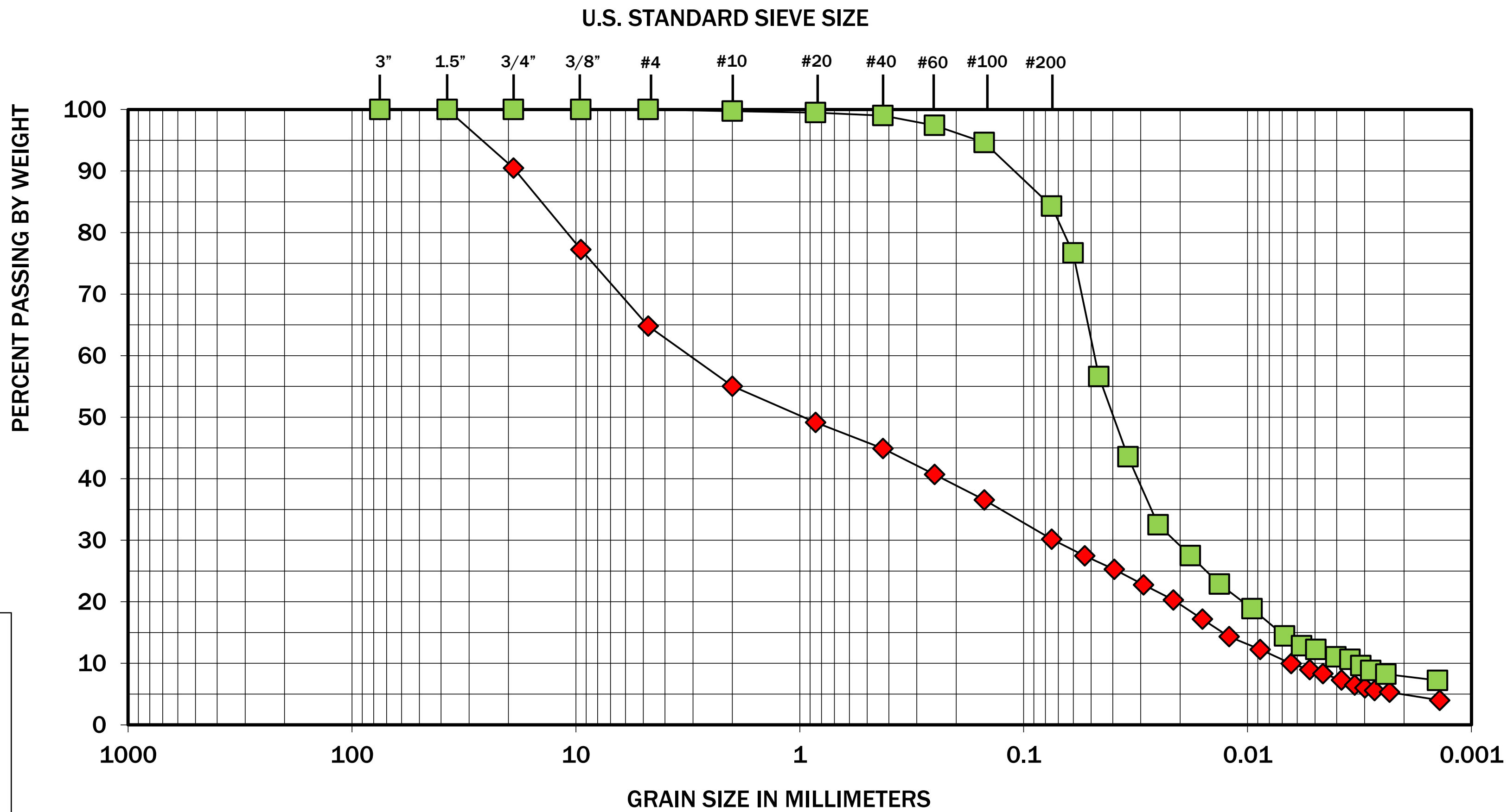
Sieve Analysis Results

Firgrove Elementary School
Puyallup, Washington

Figure B-1



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Boring Number	Depth (feet)	Moisture (%)	Laboratory Soil Description
◆	B-5	5	7	Silty gravel with sand (GM)
■	B-8	2.5	24	Silt with sand (ML)

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The grain size analysis results were obtained in general accordance with ASTM D 6913.

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Firgrove Elementary School
Puyallup, Washington

Sieve Analysis Results

Figure B-2

APPENDIX C
Report Limitations and Guidelines for Use

APPENDIX C
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

Read These Provisions Closely

It is important to recognize that the geoscience practices (geotechnical engineering, geology and environmental science) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers includes the following explanatory "limitations" provisions in its reports. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

Geotechnical Services are Performed for Specific Purposes, Persons and Projects

This report has been prepared for the Puyallup School District and for the Project(s) specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project, and its schedule and budget, our services have been executed in accordance with our Agreement with the Puyallup School District dated October 7, 2016 and generally accepted geotechnical practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A Geotechnical Engineering or Geologic Report is based on a Unique Set of Project-Specific Factors

This report has been prepared for Firgrove Elementary School in Puyallup, Washington. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it 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.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

- composition of the design team; or
- project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

Environmental Concerns are Not Covered

Unless environmental services were specifically included in our scope of services, this report does not provide any environmental findings, conclusions, or recommendations, including but not limited to, the likelihood of encountering underground storage tanks or regulated contaminants.

Information Provided by Others

GeoEngineers has relied upon certain data or information provided or compiled by others in the performance of our services. Although we use sources that we reasonably believe to be trustworthy, GeoEngineers cannot warrant or guarantee the accuracy or completeness of information provided or compiled by others.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Geotechnical and Geologic Findings are Professional Opinions

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied its professional judgment to render an informed opinion about subsurface conditions at other locations. Actual subsurface conditions may differ, sometimes significantly, from the opinions presented in this report. Our report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

Geotechnical Engineering Report Recommendations are Not Final

We have developed the following recommendations based on data gathered from subsurface investigation(s). These investigations sample just a small percentage of a site to create a snapshot of the subsurface conditions elsewhere on the site. Such sampling on its own cannot provide a complete and accurate view of subsurface conditions for the entire site. Therefore, the recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for the recommendations in this report if we do not perform construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective means of managing the risks associated with unanticipated conditions. If another party performs field observation and confirms our expectations, the other party must take full responsibility for both the observations and recommendations. Please note, however, that another party would lack our project-specific knowledge and resources.

A Geotechnical Engineering or Geologic Report Could Be Subject to Misinterpretation

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

Do Not Redraw the Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable, but separating logs from the report can create a risk of misinterpretation.

Give Contractors a Complete Report and Guidance

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving contractors the complete geotechnical engineering or geologic report, including these "Report Limitations and Guidelines for Use." When providing the report, you should preface it with a clearly written letter of transmittal that:

- advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- encourages contractors to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer.

Contractors are Responsible for Site Safety on Their Own Construction Projects

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

Biological Pollutants

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.