associated earth sciences incorporated

Subsurface Exploration, Geologic Hazard, Infiltration Feasibility, and Preliminary Geotechnical Engineering Report

TYEE HIGH SCHOOL REPLACEMENT

SeaTac, Washington

Prepared For:

HIGHLINE SCHOOL DISTRICT NO. 401

Project No. 20200075E001
May 29, 2020

Associated Earth Sciences, Inc.
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May 29, 2020
Project No. 20200075E001

Highline School District No. 401
Capital Projects
17810 8th Avenue South, Building A
Burien, Washington 98148

Attention: Ms. Ellie Daneshnia

Subject: Subsurface Exploration, Geologic Hazard, Infiltration Feasibility, and Preliminary Geotechnical Engineering Report
Tyee High School Replacement
4424 South 188th Street
SeaTac, Washington

Dear Ms. Daneshnia:

We are pleased to present the referenced report. This report summarizes the results of tasks including subsurface exploration, geologic hazard analysis, stormwater infiltration feasibility assessment, and preliminary geotechnical engineering.

We have enjoyed working with you on this study and are confident that the preliminary recommendations presented in this report will aid in the successful completion of your project. Please contact me if you have any questions or if we can be of additional help to you.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

Kurt D. Merriman, P.E.
Senior Principal Engineer

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SUBSURFACE EXPLORATION, GEOLOGIC HAZARD, INFILTRATION FEASIBILITY, AND PRELIMINARY GEOTECHNICAL ENGINEERING REPORT

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I. PROJECT AND SITE CONDITIONS

1.0 INTRODUCTION

This report presents the results of Associated Earth Sciences, Inc.'s (AESI's) subsurface exploration, geologic hazard analysis, infiltration feasibility, and preliminary geotechnical engineering study for the proposed Tyee High School Replacement project in SeaTac, Washington. Our understanding of the project is based on discussions with the Highline School District No. 401 (District) and members of the design team. Our recommendations are preliminary in that the project is in preliminary design. The site location is shown on the "Vicinity Map," Figure 1. The approximate locations of explorations completed for this study are shown on the "Site and Exploration Plan," Figure 2. Interpretive exploration logs of subsurface explorations completed for this study, and laboratory test data are included in Appendix A.

1.1 Purpose and Scope

The purpose of this study was to provide subsurface soil and groundwater data to be utilized in a 50% Schematic Design for the Tyee High School Replacement project. The preliminary design will be used for cost estimating and planning. Final design is expected to be completed at a later time. Our study included reviewing selected available geologic literature, advancing twelve exploration borings, installing one groundwater observation well, completing laboratory testing of soil grain-size distribution, and performing a geologic study to assess the type, thickness, distribution, and physical properties of the subsurface sediments and shallow groundwater. Geotechnical engineering studies were completed to determine the type of suitable foundations, allowable foundation soil bearing pressures, anticipated foundation settlements, erosion considerations, drainage considerations, and to provide stormwater infiltration feasibility recommendations. This report summarizes our current fieldwork and offers preliminary design recommendations based on our present understanding of the project.

1.2 Authorization

Our study was accomplished in general accordance with our proposal, dated March 2, 2020. We were authorized to proceed by means of a District professional services agreement. This report has been prepared for the exclusive use of Highline School District and their agents, for specific application to this project. Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering and engineering geology practices in effect in this area at the time our report was prepared. No other warranty, express or implied, is made.

2.0 PROJECT AND SITE DESCRIPTION

The project site is that of the existing Tyee High School. The existing school was constructed in 1962 and has been remodeled and added to several times since its construction. Several existing buildings are clustered on the northeast portion of the parcel. Chinook Middle School is located on the same parcel immediately to the west of the high school. A running track, natural turf athletic field, and tennis courts are located north of the existing high school on a District-owned parcel, and additional athletic fields used by the school are located adjacent to the north and east at a City-owned park. Site topography across the project area for the high school replacement is relatively flat, with overall vertical relief across the high school campus of approximately 10 feet. The middle school adjacent to the west is approximately 10 to 20 feet higher, with a moderate slope creating the grade change between campuses. Historically the site appears to have been mined for aggregate borrow and the 10- to 20-foot-tall slope is a remnant cut slope from past mining activity.

The proposed project will include construction of a new high school. Most of the existing buildings will be demolished and replaced. The project may include retention, renovation, and seismic upgrades to the existing gymnasium. The new school will be constructed while the northern portion of the existing high school remains in service. We anticipate that new school buildings will be constructed south of the existing main high school building close to existing grades. After the new building is commissioned, remaining existing buildings would be demolished and replaced with parking areas and other site improvements. If stormwater infiltration is feasible, SeaTac will require stormwater infiltration as part of the project design.

At this time the project team has been asked to proceed to 50% Schematic Design, and the resulting preliminary design will be used for bond measure planning. Project final design and construction will proceed after bond approval. The work included in this proposal would guide the preliminary design and cost planning. We anticipate that additional work will be required of all members of the design team to advance the preliminary design to completed construction documents.

3.0 SITE EXPLORATION

Our field studies were conducted for this project in May 2020 and included advancing twelve exploration borings, and installing one groundwater observation well. The existing site conditions and the approximate locations of subsurface explorations referenced in this study are presented on the “Site and Exploration Plan” (Figure 2). The various types of sediments, as well as the depths where the characteristics of the sediments changed, are indicated on the exploration logs presented in Appendix A. The depths indicated on the logs where conditions changed may represent gradational variations between sediment types. If changes occurred between sample

intervals in our exploration borings, they were interpreted. Our explorations were approximately located in the field by measuring from known site features.

The conclusions and recommendations presented in this report are based, in part, on the explorations completed for this study. The number, locations, and depths of the explorations were completed within site and budgetary constraints. Because of the nature of exploratory work below ground, extrapolation of subsurface conditions between field explorations is necessary. It should be noted that differing subsurface conditions may be present due to the random nature of deposition and the alteration of topography by past grading and/or filling. The nature and extent of variations between the field explorations may not become fully evident until construction. If variations are observed at that time, it may be necessary to re-evaluate specific recommendations in this report and make appropriate changes.

3.1 Exploration Borings

For this study, twelve exploration borings were completed by a track-mounted drill rig advancing a hollow-stem auger. During the drilling process, samples were generally obtained at 2½- to 5-foot-depth intervals. The borings were continuously observed and logged by a geologist from our firm. The exploration logs presented in Appendix A are based on the field logs, drilling action, and observation of the samples collected.

Disturbed, but representative samples were obtained by using the Standard Penetration Test (SPT) procedure in accordance with *ASTM International* (ASTM) D-1586. This test and sampling method consists of driving a standard 2-inch, outside-diameter, split-barrel sampler a distance of 18 inches into the soil with a 140-pound hammer free-falling a distance of 30 inches. The number of blows for each 6-inch interval is recorded, and the number of blows required to drive the sampler the final 12 inches is known as the Standard Penetration Resistance ("N") or blow count. If a total of 50 is recorded within one 6-inch interval, the blow count is recorded as the number of blows for the corresponding number of inches of penetration. The resistance, or N-value, provides a measure of the relative density of granular soils or the relative consistency of cohesive soils; these values are plotted on the attached exploration boring logs.

The samples obtained from the split-barrel sampler were classified in the field and representative portions placed in watertight containers. The samples were then transported to our laboratory for further visual classification and laboratory testing, as necessary.

3.2 Exploration Borings Completed as Observation Wells

One exploration boring was completed as a 2-inch-diameter observation well designated as EB-2W to allow monitoring of groundwater levels over time. Well EB-2W was constructed with 10 feet of machine-slotted Schedule 40 polyvinyl chloride (PVC) well screen placed 39 to 49 feet below ground surface, 40 feet of solid, non-slotted, Schedule 40 PVC casing, and a flush

monument. The well screen interval and 4 feet of the boring above the well screen was backfilled with filter sand. The well was completed with bentonite and concrete surface seals, a flush mount monument, and a locking well cap. Well construction details are presented on the geologic and well construction logs in Appendix A. Site hydrology is discussed in further detail in Section 4.3 of this report.

On May 12, 2020, a representative from AESI developed the well. EB-2W was developed by surging a 12-volt, 2-inch-diameter submersible pump along each foot of well screen for approximately 2 to 3 minutes while removing water from the well. Depth to groundwater was 21.23 feet below ground surface after well development.

To continuously monitor groundwater levels, a water level data logger and a logging barometer were installed in EB-2W. Data from water level and barometric loggers will be periodically downloaded for up to one year.

4.0 SUBSURFACE CONDITIONS

4.1 Regional Geologic Map

Published geologic mapping for the site and immediate vicinity were reviewed on the *Lidar-Revised Geologic Map of the Des Moines 7.5' Quadrangle, King County, Washington*, by Rowland W. Tabor and Derek B. Booth, United States Geological Survey (USGS) Scientific Investigations Map SIM-3384, 2017. This map depicts near-surface geology at the site consisting of Vashon advance outwash deposits with ice contact and lodgement till deposits nearby.

4.2 Site Stratigraphy

Subsurface conditions at the project site were inferred from the field explorations accomplished for this study, visual reconnaissance of the site, and review of selected applicable geologic literature. As shown on the exploration logs, the overall stratigraphic sequence observed in our explorations included existing man-made fill underlain by advance outwash sediments that are interpreted to be laterally continuous across the project site. The following section presents more detailed subsurface information on the sediment types encountered at the site.

Asphalt Paving

In exploration borings EB-1, EB-2W, EB-3, EB-4, and EB-7, located in the existing student and staff parking areas, a typical pavement section of approximately 2 to 3 inches of asphalt over 3 inches of crushed rock pavement base course was encountered.

Topsoil

Organic-rich brown topsoil and grass was encountered at exploration borings EB-5, EB-6, EB-8, EB-9, E-10, and EB-12 in the existing landscaping areas. Topsoil was typically approximately 6 to 8 inches thick at the boring locations. Organic topsoil is not suitable for foundation support or for use in a structural fill.

Existing Fill

Fill soils (those not naturally placed), were encountered in all twelve explorations. Fill depths observed at the boring locations ranged from 9 to greater than 21.5 feet below the existing ground surface. All but one boring fully penetrated the existing fill and encountered native soils. Exploration boring EB-8 was terminated at a depth of 21.5 feet and encountered only existing fill. Fill generally consisted of loose to dense (blow counts may be overstated), moist, brown to grayish brown, silty, sandy, gravel.

The existing fill was observed to be well compacted in seven of the twelve exploration borings, moderately well compacted in three of the borings, and less well compacted at two borings. In the area where new buildings will be constructed south of the existing main building the fill was typically observed to be well compacted. This report provides recommendations for supporting the new high school on existing fill. Relying on existing fill for structural support carries some risks. If the existing fill contains undiscovered adverse conditions, structural settlement could occur. Where observed, the existing fill was typically adequately compacted to support lightly-loaded foundations. Foundation design, settlement risks, and alternatives to using existing fill for structural support are discussed in further detail later in this report.

Where existing fill is present below planned new paving, utilities, and other site improvements, the “Site Preparation” section of this report recommends assessment and situation-specific remedial preparation of existing fill prior to constructing new site improvements. Excavated existing fill material is suitable for reuse in structural fill applications if such reuse is specifically allowed by project plans and specifications, if excessively organic and any other deleterious materials are removed, and if moisture content is adjusted to allow compaction to the specified level and to a firm and unyielding condition. Existing fill is not suitable for infiltration of stormwater. One boring, EB-6, encountered a thin layer of black soil with hydrocarbon odors within existing fill approximately 2.5 feet below the ground surface. The District assigned follow-up of odorous soils to the project environmental consultant, PBS Engineering and Environmental.

Vashon Advance Outwash

Stratigraphically underlying the fill, our explorations encountered brown, dense to very dense, fine to medium sand with some silt ranging to silty fine sand interpreted as Vashon advance

outwash. The advance outwash observed in our explorations included areas that were texturally massive, and other areas that were stratified. The observed depth from the existing ground surface to the upper surface of advance outwash sediments varied across the site and ranged from approximately 17 to greater than 21.5 feet below the existing ground surface. One boring, EB-8, did not reach native soils within the total depth drilled of 21.5 feet.

The Vashon advance outwash was deposited by meltwater streams that emanated from the advancing glacial ice during Vashon Stade of the Fraser Glaciation. The high relative density characteristic of the advance outwash is due to consolidation by the massive weight of the glacial ice that overran these sediments after deposition. Advance outwash is suitable for support of structural loads when prepared as recommended in this report. Advance outwash may contain a significant fine-grained fraction, and may be sensitive to excess moisture during placement in structural fill applications. Reuse of advance outwash in structural fill applications is feasible if allowed by project specifications, and will require drying to achieve moisture content within 1 to 2 percent of optimum for compaction purposes. Advance outwash can serve as a stormwater infiltration receptor when unsaturated, permeable, and present in sufficient vertical and lateral extent. Infiltration feasibility is discussed in detail later in this report.

4.3 Hydrology

Groundwater was encountered in all exploration borings at depths of 14 to 25 feet at the time of drilling (May 4 and 5, 2020), except explorations EB-3 and EB-5. Groundwater observations are summarized in Table 1. We interpret the groundwater observed to represent a groundwater table within the lower portion of the fill and within the Vashon advance outwash sediments underlying the site. The depth to water, duration and quantity of groundwater seepage will largely depend on the soil grain-size distribution, topography, seasonal precipitation, on- and off-site land usage, and other factors. Our exploration was conducted in early May, when groundwater levels are elevated. Groundwater elevations were slightly higher in the northern and western portions of the site, indicating the groundwater flows to the south and east.

An electronic data logger was installed in monitoring well EB-2W to monitor for fluctuations in the groundwater level as part of a stormwater infiltration feasibility study. Groundwater level monitoring is ongoing in this well.

Table 1
Summary of Groundwater Observations

Exploration	Depth to Groundwater at the time of drilling* (feet below ground surface)	Geologic Unit
EB-1	18	Vashon advance outwash
EB-2W	25 (post-well development, groundwater measured at 21.2 feet)	Vashon advance outwash
EB-3	Not encountered to 21.5 feet	--
EB-4	19	Vashon advance outwash
EB-5	Not encountered to 21 feet	--
EB-6	15	Fill
EB-7	19	Vashon advance outwash
EB-8	14	Fill
EB-9	20	Vashon advance outwash
EB-10	14	Fill
EB-11	14	Fill
EB-12	18	Vashon advance outwash

*Groundwater observations at the time of drilling are not considered static water levels, and are typically somewhat lower than static groundwater levels.

4.4 Laboratory Testing

Grain-Size Analysis

AESI performed grain-size analyses (sieves) on representative samples of fill and Vashon advance outwash sediments. The grain-size analyses test results are included in Appendix A and are summarized below in Table 2 with soil descriptions based on the ASTM D-2487 Unified Soil Classification System (USCS).

Table 2
Summary of Grain-Size Analyses

Exploration Number	Depth (feet)	Geologic Unit	USCS Soil Description	Fines Content (%)
EB-5	15	Fill	Silty SAND with gravel (SM)	17.7
EB-7	15	Vashon Advance Outwash	Silty SAND (SM)	20.8

USCS = Unified Soil Classification System.
% = percent of total weight passing the U.S. No. 200 Sieve.

II. GEOLOGIC HAZARDS AND MITIGATIONS

The following discussion of potential geologic hazards is based on the geologic, slope, and ground and surface water conditions, as observed and discussed herein.

5.0 STEEP SLOPE HAZARDS AND MITIGATIONS

The *SeaTac Municipal Code* (SMC 15.700.015) defines Steep Slope Hazard Areas as the following:

Those areas in the City on slopes of forty percent (40%) or greater within a vertical elevation change of at least twenty (20) feet. A slope is delineated by establishing its toe and top, and is measured by averaging the inclination over at least ten (10) feet of vertical relief.

Based on our visual reconnaissance of the site and review of published Light Detection and Ranging (LIDAR) topographic data, the site is generally flat with a moderate slope between the high school site and Chinook Middle School to the west. Portions of the slope along the west edge of the high school site are inclined at approximately 30 to 35 degrees. No areas of the site meet the criteria for classification as a Steep Slope Hazard Area. The existing slopes appear to have performed well, with no visual indication of unusual erosion or slope instability. No detailed quantitative assessment of site slopes was completed as part of this study, and none is warranted, in our opinion.

6.0 SEISMIC HAZARDS AND MITIGATIONS

Earthquakes occur regularly in the Puget Lowland. The majority of these events are small and are usually not felt by people. However, large earthquakes do occur, as evidenced by the 1949, 7.2-magnitude event; the 1965, 6.5-magnitude event; and the 2001, 6.8-magnitude event. The 1949 earthquake appears to have been the largest in this region during recorded history and was centered in the Olympia area. Evaluation of earthquake return rates indicates that an earthquake of the magnitude between 5.5 and 6.0 is likely within a given 20-year period.

Generally, there are three types of potential geologic hazards associated with large seismic events: 1) surficial ground rupture, 2) liquefaction, and 3) ground motion. The potential for each of these hazards to adversely impact the proposed project is discussed below.

6.1 Surficial Ground Rupture

Generally, the largest earthquakes that have occurred in the Puget Sound area are sub-crustal events with epicenters ranging from 50 to 70 kilometers in depth. Earthquakes that are

generated at such depths usually do not result in fault rupture at the ground surface. Current research indicates that surficial ground rupture is possible in areas close to the Seattle and Tacoma Fault Zones, the closest known fault zones to the project site. The site is approximately 6 miles south of the mapped limits of the Seattle Fault Zone and 7 miles north of the mapped limits of the Tacoma Fault Zone. In our opinion, the risk of surficial ground rupture at the site due to seismic faulting is low due to the separation distance from the site to known fault zones.

6.2 Liquefaction

Liquefaction is a process through which unconsolidated soil loses strength as a result of vibratory shaking, such as that which occurs during a seismic event. During normal conditions, the weight of the soil is supported by both grain-to-grain contacts and by the pressure within the pore spaces of the soil below the water table. Extreme vibratory shaking can disrupt the grain-to-grain contact, increase the pore pressure, and result in a decrease in soil shear strength. The soil is said to be liquefied when nearly all of the weight of the soil is supported by pore pressure alone. Liquefaction can result in deformation of the sediment and settlement of overlying structures. Areas most susceptible to liquefaction include those areas underlain by clean sand or coarse silt with low relative densities accompanied by a shallow water table.

In our opinion, the potential risk of damage to the proposed development by liquefaction is low due to the high relative density of the underlying sediments. No detailed quantitative liquefaction assessment was completed as part of this study, and none is warranted, in our opinion.

6.3 Ground Motion/Seismic Site Class (2018 *International Building Code*)

Structural design of the building should follow 2018 *International Building Code* (IBC) standards. We recommend that the project be designed in accordance with seismic Site Class D in accordance with the 2018 IBC, and the publication *American Society of Civil Engineers* (ASCE) 7 referenced therein, the most recent version of which is ASCE 7-10.

7.0 EROSION HAZARDS AND MITIGATIONS

The site may contain localized areas that meet SeaTac criteria for classification as Erosion Hazard Areas. Erosion Hazard designation does not result in substantial restrictions on site development beyond normal construction site erosion controls that are required for all projects. To mitigate the construction site erosion potential, project plans should include implementation of temporary erosion controls in accordance with local standards of practice. Control methods should include limiting mass earthwork to seasonally drier periods, typically April 1 to October 31, use of perimeter silt fences, stabilized construction entrances, and straw mulch in exposed areas. Removal of existing vegetation should be limited to those areas that are required to construct the project, and new landscaping and vegetation with equivalent erosion mitigation

potential should be established as soon as possible after grading is complete. During construction, surface water should be collected as close as possible to the source to minimize silt entrainment that could require treatment or detention prior to discharge and track-out onto streets should be avoided. Timely implementation of permanent drainage control measures should also be a part of the project plans, and will help reduce erosion and generation of silty surface water onsite.

III. PRELIMINARY DESIGN RECOMMENDATIONS

8.0 INTRODUCTION

Our explorations indicate that, from a geotechnical engineering standpoint, the proposed project is feasible provided the recommendations contained herein are properly followed. At the time this report was written, a site layout had not been selected.

Native soils suitable for structural support were observed at depths ranging from 9 to greater than 21.5 feet below the existing ground surface. Existing fill that was observed above the native soils is relatively well compacted on average. This report presents geotechnical engineering recommendations that will result in new foundations supported by existing fill. Relying on existing fill for structural support will save substantial costs, but will result in some additional risk of post-construction settlement. Sections 9.0, 11.0, and 17.0 of this report provide additional recommendations, a more detailed discussion of the costs and benefits of relying on existing fill for structural support, and provide other alternatives if relying on existing fill for structural support is not acceptable. Also provided are recommendations for future study to fill in subsurface data gaps as part of the final design of the project.

Due to the presence of existing fill overlying saturated Vashon advance outwash deposits, we do not consider stormwater infiltration feasible at this site.

Since this report is preliminary, AESI should be allowed to review the final project plans once they have been developed to update our recommendations, as necessary.

9.0 SITE PREPARATION

Erosion control should be established around the perimeter of the project to satisfy SeaTac requirements. Site preparation should include removal of all existing pavement, structures, buried utilities, and any other deleterious materials from below building pads, new paving areas, and other planned structures. After any required demolition is complete, disturbed soils below finished grade resulting from demolition activities should be removed or recompacted.

Existing fill should be addressed after demolition, stripping, and excavation to grade. We anticipate that all subgrades for new structures will be underlain by existing fill. Existing fill should be visually evaluated to verify that it is free of organics and demolition waste, and should be proof-rolled under a loaded truck to verify that it is firm and unyielding. Where previously inaccessible portions of new building pads are made accessible by demolition of existing structures, confirmatory test pits should be dug to observe existing fill. Where existing fill is loose,

yielding, organic, or otherwise unsuitable for structural support, remedial preparation plans should be prepared.

9.1 Buried Utility Construction and Backfill

We recommend that buried utilities be constructed by excavating to the planned depth and placing utility bedding and backfill in accordance with civil engineering plans and project specifications. Where existing grade-sensitive utilities will be underlain by existing fill, the existing fill should be compacted at the base of utility trenches. Any yielding soils should be removed and replaced with structural fill as defined in project specifications and outlined in this report.

If new utilities will cross below new foundations or retaining walls, the utilities should be backfilled with structural fill as described in this report and project specifications. The utilities themselves should be confirmed to be competent to support surcharge loads that will be imposed by planned foundations and retaining walls.

9.2 Temporary Cut Slopes

In our opinion, stable construction slopes should be the responsibility of the contractor and should be determined during construction based on the conditions encountered at that time. For estimating purposes, however, we anticipate that temporary, unsupported cut slopes in medium dense to dense fill sediments be planned at a maximum slope of 1.5H:1V (Horizontal:Vertical). Steeper temporary slopes may be feasible if needed depending on site-specific conditions, but may not be needed for the project as currently proposed. Temporary cut slopes may need to be adjusted in the field at the time of construction based on the presence of surface water or perched seepage zones. As is typical with earthwork operations, some sloughing and raveling may occur, and cut slopes may have to be adjusted in the field. In addition, WISHA/OSHA regulations should be followed at all times. If steeper or deeper cuts are required, then temporary shoring may be necessary.

9.3 Site Disturbance

The on-site soils contain a high percentage of fine-grained material, which makes them moisture-sensitive and subject to disturbance when wet. The contractor must use care during site preparation and excavation operations so that the underlying soils are not softened, particularly during wet weather conditions. If disturbance occurs in areas of conventional footings, the softened soils should be removed and the area brought to grade with clean crushed rock fill. Because of the moisture-sensitive nature of the soils, we anticipate that wet weather construction would significantly increase the earthwork costs over dry weather construction.

9.4 Winter Construction

The existing fill material and portions of the Vashon advance outwash contain substantial silt and are considered highly moisture-sensitive. Soils excavated onsite will likely require drying during favorable dry weather conditions to allow their reuse in structural fill applications. Care should be taken to seal all earthwork areas during mass grading at the end of each workday by grading all surfaces to drain and sealing them with a smooth-drum roller. Stockpiled soils that will be reused in structural fill applications should be covered whenever rain is possible.

If winter construction is expected, crushed rock fill should be used to provide construction staging areas where exposed soil is present. The stripped subgrade should be observed by the geotechnical engineer, and should then be covered with a geotextile fabric, such as Mirafi 500X or equivalent. Once the fabric is placed, we recommend using a crushed rock fill layer at least 10 inches thick in areas where construction equipment will be used. Soil-cement treatment is another approach to providing a workable site during the winter. We are available to provide more detailed soil-cement treatment recommendations on request and if allowed by the governing jurisdiction.

9.5 Frozen Subgrades

If earthwork takes place during freezing conditions, all exposed subgrades should be allowed to thaw, and then be recompacted prior to placing subsequent lifts of structural fill. Alternatively, the frozen material could be stripped from the subgrade to reveal unfrozen soil prior to placing subsequent lifts of fill. The frozen soil should not be reused as structural fill until allowed to thaw and adjusted to the proper moisture content, which may not be possible during winter months.

10.0 STRUCTURAL FILL

Should structural fill be necessary, it should be placed and compacted according to the recommendations presented in this section and requirements included in project specifications. All references to structural fill in this report refer to subgrade preparation, fill type, placement, and compaction of materials, as discussed in this section. If a percentage of compaction is specified under another section of this report, the value given in that section should be used.

Structural fill is defined as non-organic soil, acceptable to the geotechnical engineer, placed in maximum 8-inch loose lifts, with each lift being compacted to at least 95 percent of the modified Proctor maximum dry density using ASTM D-1557 as the standard. In the case of roadway and utility trench filling, the backfill should be placed and compacted in accordance with City of SeaTac standards.

The contractor should note that AESI should evaluate any proposed fill soils prior to their use in fills. This would require that we have a sample of the material at least 3 business days in advance of filling activities to perform a Proctor test and determine its field compaction standard. Soils in which the amount of fine-grained material (smaller than the No. 200 sieve) is greater than approximately 5 percent (measured on the minus No. 4 sieve size) should be considered moisture-sensitive. Use of moisture-sensitive soil in structural fills is not recommended during the winter months or under wet site and weather conditions. The on-site soils are moisture-sensitive and have natural moisture contents over optimum for compaction and will likely require moisture-conditioning before use as structural fill. In addition, construction equipment traversing the site when the soils are wet can cause considerable disturbance. If import soil is required, a select import material consisting of a clean, free-draining gravel and/or sand should be used. Free-draining fill consists of non-organic soil with the amount of fine-grained material limited to 5 percent by weight when measured on the minus No. 4 sieve fraction and at least 30 percent retained on the No. 4 sieve. City of Seattle Mineral Aggregate Type 17 (*Seattle 2020 Standard Specifications for Municipal Construction 9-03.14*) is one example of a suitable import aggregate specification.

A representative from our firm should observe the subgrades and be present during placement of structural fill to observe the work and perform a representative number of in-place density tests. In this way, the adequacy of the earthwork may be evaluated as filling progresses and any problem areas may be corrected at that time. It is important to understand that taking random compaction tests on a part-time basis will not assure uniformity or acceptable performance of a fill. As such, we are available to aid the owner in developing a suitable monitoring and testing frequency.

11.0 FOUNDATIONS

The following report sections provide recommendations for support of new footings on existing fill. Relying on existing fill for foundation support could result in post-construction settlement if undiscovered adverse conditions are present within the existing fill. Those risks are offset by substantial construction cost savings compared to approaches that do not rely on existing fill for structural support. Another alternative would be to provide support for the new building that does not rely on existing fill. Existing fill could be removed and recompacted below new buildings, or compacted aggregate piers could be used to improve existing fill. We are available on request to provide additional recommendations related to those alternative approaches.

11.1 Shallow Foundations

Spread footings may be used for building support when founded directly on medium dense to dense, existing fill soils. We recommend that foundations be designed using an allowable

foundation soil bearing pressure of 2,500 pounds per square foot (psf), including both dead and live loads.

Perimeter footings should be buried at least 18 inches into the surrounding soil for frost protection. However, all footings must penetrate to the prescribed bearing stratum, and no footing should be founded in or above organic or loose soils. All footings should have a minimum width of 18 inches.

It should be noted that the area bound by lines extending downward at 1H:1V from any footing must not intersect another footing or intersect a filled area that has not been compacted to at least 95 percent of ASTM D-1557. In addition, a 1.5H:1V line extending down from any footing must not daylight because sloughing or raveling may eventually undermine the footing. Thus, footings should not be placed near the edge of steps or cuts in the bearing soils.

Anticipated settlement of footings founded as described above should be on the order of up to 1.5 inches. Disturbed soil not removed from footing excavations prior to footing placement could result in increased settlements. All footing areas should be inspected by AESI prior to placing concrete to verify that the design bearing capacity of the soils has been attained and that construction conforms to the recommendations contained in this report. Such inspections may be required by the governing municipality. Perimeter footing drains should be provided as discussed under the "Drainage Considerations" section of this report.

11.2 Maintaining Adjacent Foundation Support

We understand that portions of the existing school will remain in service until the new school is complete. We recommend that support soils for existing foundations not be disturbed unless such disturbance is unavoidable and underpinning or some other temporary foundation support is implemented. Foundation support soils should be considered to extend down and away from existing foundations at an angle of 1H:1V. Where it is necessary to excavate into support soils for existing foundations, we recommend that AESI participate in planning to reduce risks of settlement to the existing structure. Possible strategies might include staged completion of rock trenches in small increments, use of alternate foundation support methods, or underpinning existing footings prior to excavation.

11.3 Seismic Upgrades to Existing Gymnasium

The existing gymnasium building may be retained and upgraded as part of the project. The project structural engineer may design supplementary foundations to accommodate seismic loading or new structural loads. The shallow foundation recommendations presented above may be applied to foundations added to the existing gymnasium. Recommendations in Section 11.2 regarding maintaining support for existing foundations during construction also apply. If the seismic upgrades require substantial foundation upload resistance, deep foundation elements

such as pin piles are sometimes used to provide uplift capacity. Geotechnical recommendations for design of pin piles is beyond the scope of the current preliminary study, but we are available on request to provide additional recommendations related to renovating the existing gymnasium.

12.0 DRAINAGE CONSIDERATIONS

Traffic across the on-site soils when they are damp or wet will result in disturbance of the otherwise firm stratum. Therefore, during site work and construction, the contractor should provide surface drainage and subgrade protection, as necessary.

Any retaining walls and all perimeter foundation walls should be provided with a drain at the footing elevation. Drains should consist of rigid, perforated, PVC pipe surrounded by washed gravel. The level of the perforations in the pipe should be set at the bottom of the footing, and the drains should be constructed with sufficient gradient to allow gravity discharge away from the building. The perforations should be located on the lower portion of the pipe. In addition, any retaining or subgrade walls should be lined with a minimum, 12-inch-thick, washed gravel blanket, backfilled completely with free-draining material over the full height of the wall (excluding the first 1 foot below the surface). Composite drainage mats such as Mira Drain 6000 installed in accordance with the manufacturer’s recommendations may be used in lieu of the free-draining aggregate blanket for walls that will not be completed as habitable space on the interior. This drainage aggregate or composite should tie into and freely communicate with the footing drains. Roof and surface runoff should not discharge into the footing drain system, but should be handled by a separate, rigid, tightline drain.

To minimize erosion, stormwater discharge or concentrated runoff should not be allowed to flow down any steep slopes. In planning, exterior grades adjacent to walls should be sloped downward away from the structures at an inclination of at least 3 percent to achieve surface drainage. Runoff water from impervious surfaces should be collected by a storm drain system that discharges into the site stormwater system.

13.0 FLOOR SUPPORT

Floor slabs can be supported directly by medium dense to dense existing fill soils prepared as recommended in the “Site Preparation” section of this report, or by new structural fill placed above medium dense to dense existing fill soils.

All structural fill placed beneath the slab must be compacted to at least 95 percent of ASTM D-1557. The floors should be cast atop a minimum of 4 inches of washed pea gravel or washed crushed rock to act as a capillary break where moisture migration through the slabs is to

be controlled. The capillary break material should be overlain by a 10-mil-thick vapor barrier material prior to concrete placement.

14.0 FOUNDATION WALLS

The following preliminary recommendations may be applied to conventional walls up to 8 feet tall. We should be allowed to offer situation-specific input for taller walls. All backfill behind foundation walls or around foundation units should be placed as per our recommendations for structural fill and as described in this section of the report. Horizontally backfilled walls, which are free to yield laterally at least 0.1 percent of their height, may be designed to resist lateral earth pressure represented by an equivalent fluid equal to 35 pounds per cubic foot (pcf). Fully restrained, horizontally backfilled, rigid walls that cannot yield should be designed for an equivalent fluid of 50 pcf. Walls with sloping backfill up to a maximum gradient of 2H:1V should be designed using an equivalent fluid of 55 pcf for yielding conditions or 75 pcf for fully restrained conditions. If parking areas are adjacent to walls, a surcharge equivalent to 2 feet of soil should be added to the wall height in determining lateral design forces.

As required by the 2018 IBC, retaining wall design should include a seismic surcharge pressure in addition to the equivalent fluid pressures presented above. Considering the site soils and the recommended wall backfill materials, we recommend a seismic surcharge pressure of 5H and 10H psf, where H is the wall height in feet for the “active” and “at-rest” loading conditions, respectively. The seismic surcharge should be modeled as a rectangular distribution with the resultant applied at the midpoint of the walls. If the project will be permitted under a later version of the IBC, we should be allowed to review seismic surcharge recommendations presented above.

The lateral pressures presented above are based on the conditions of a uniform backfill consisting of excavated on-site soils, or imported structural fill compacted to 90 percent of ASTM D-1557 within about 3 feet of the wall. A higher degree of compaction is not recommended, as this will increase the pressure acting on the walls. A lower compaction may result in settlement of the slab-on-grade or other structures supported above the walls. Thus, the compaction level is critical and must be tested by our firm during placement. Surcharges from adjacent footings or heavy construction equipment must be added to the above values. Perimeter footing drains should be provided for all retaining walls, as discussed under the “Drainage Considerations” section of this report. It is imperative that proper drainage be provided so that hydrostatic pressures do not develop against the walls. Wall drainage recommendations are presented in Section 12.0 of this report.

14.1 Passive Resistance and Friction Factors

Lateral loads can be resisted by friction between the foundation and the natural soils or supporting structural fill soils, and by passive earth pressure acting on the buried portions of the foundations. The foundations must be backfilled with structural fill and compacted to at least 95 percent of the maximum dry density to achieve the passive resistance provided below. We recommend the following allowable design parameters which include a factor of safety of 1.5:

- Passive equivalent fluid = 250 pcf
- Coefficient of friction = 0.35

15.0 INFILTRATION FEASIBILITY

The feasibility of stormwater infiltration depends upon the presence of a suitable receptor native soil of sufficient thickness, extent, permeability, and vertical separation from groundwater. Our explorations completed for this study encountered existing fill underlain by Vashon advance outwash sediments. Existing fill soils are not a suitable infiltration receptor based on grain size and City of SeaTac design guidelines that typically do not allow infiltration into fill. Our explorations have demonstrated that saturated conditions exist within the lower portion of the fill and the Vashon advance outwash.

Due to the presence of existing fill overlying saturated Vashon advance outwash, we do not consider infiltration to be feasible at this site.

16.0 PAVEMENT AND SIDEWALK RECOMMENDATIONS

The pavement sections included in this report section are for driveway and parking areas onsite, and are not applicable to right-of-way improvements. At this time, we are not aware of any planned right-of-way improvements; however, if any new paving of public streets is required, we should be allowed to offer situation-specific recommendations.

Pavement and sidewalk areas should be prepared in accordance with the “Site Preparation” section of this report. If the stripped native soil or existing fill pavement subgrade can be compacted to 95 percent of ASTM D-1557 and is firm and unyielding, no additional overexcavation is required. Soft or yielding areas should be overexcavated to provide a suitable subgrade and backfilled with structural fill.

New paving may include areas subject only to light traffic loads from passenger vehicles driving and parking, and may also include areas subject to heavier loading from vehicles that may include buses, fire trucks, food service trucks, and garbage trucks. In light traffic areas, we recommend a

pavement section consisting of 3 inches of hot-mix asphalt (HMA) underlain by 4 inches of crushed surfacing base course, such as City of Seattle mineral aggregate Type 2, as the recommended minimum in areas of planned passenger car lanes and parking. In heavy traffic areas, a minimum pavement section consisting of 4 inches of HMA underlain by 2 inches of crushed surfacing top course, such as City of Seattle mineral aggregate Type 1, and 4 inches of crushed surfacing base course, such as City of Seattle mineral aggregate Type 2, is recommended. The crushed rock will provide improved and consistent drainage, which will extend the service life of paved areas. The crushed rock courses must be compacted to 95 percent of the maximum density, as determined by ASTM D-1557. All paving materials should meet gradation criteria contained in the current Washington State Department of Transportation (WSDOT) Standard Specifications.

Depending on construction staging and desired performance, the crushed base course material may be substituted with asphalt treated base (ATB) beneath the final asphalt surfacing if desired. The substitution of ATB should be as follows: 4 inches of crushed rock can be substituted with 3 inches of ATB, and 6 inches of crushed rock may be substituted with 4 inches of ATB. ATB should be placed over a native or structural fill subgrade compacted to a minimum of 95 percent relative density, and a 1½- to 2-inch thickness of crushed rock to act as a working surface. If ATB is used for construction access and staging areas, some rutting and disturbance of the ATB surface should be expected to result from construction traffic. The general contractor should remove affected areas and replace them with properly compacted ATB prior to final surfacing.

17.0 RECOMMENDATIONS FOR FUTURE STUDY

The current scope of work is to prepare a preliminary project design to be used for budgeting and planning. Final design is expected to be completed at a later time. This report provides recommendations that rely on existing fill to support new structures. The existing fill was observed to be relatively well compacted on average, though there were localized areas where compaction of the existing fill was less. Leaving existing fill in place will save substantial construction costs. Risks of future settlement will be reduced if the following steps are completed during final design:

- When a final project layout is selected, complete additional subsurface explorations as needed to confirm the condition of existing fill in the areas of planned new buildings.
- Where future building pads are covered by existing buildings to be demolished, complete confirmatory subsurface explorations in areas vacated after demolition of the existing buildings is complete.
- If building locations are selected that are underlain by existing fill that is not well compacted, provide remedial preparation of existing fill as warranted based on conditions.

- If completion of future subsurface explorations is not desired, or the potential for unanticipated post-construction settlement resulting from undiscovered adverse conditions in the existing fill are not acceptable, select a foundation support option such as aggregate piers that does not rely on existing fill for structural support.

18.0 PROJECT DESIGN AND CONSTRUCTION MONITORING

We recommend that AESI perform a geotechnical review of the plans prior to final design completion. In this way, we can confirm that our recommendations have been correctly interpreted and implemented in the design. The City of SeaTac may require a plan review by the geotechnical engineer as a condition of permitting.

The City of SeaTac may also require geotechnical special inspections during construction and preparation of a final summary letter when construction is complete. We are available to provide geotechnical engineering services during construction. The integrity of the earthwork and foundations depends on proper site preparation and construction procedures. In addition, engineering decisions may have to be made in the field in the event that variations in subsurface conditions become apparent.

We have enjoyed working with you on this study and are confident these recommendations will aid in the successful completion of your project. If you should have any questions or require further assistance, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

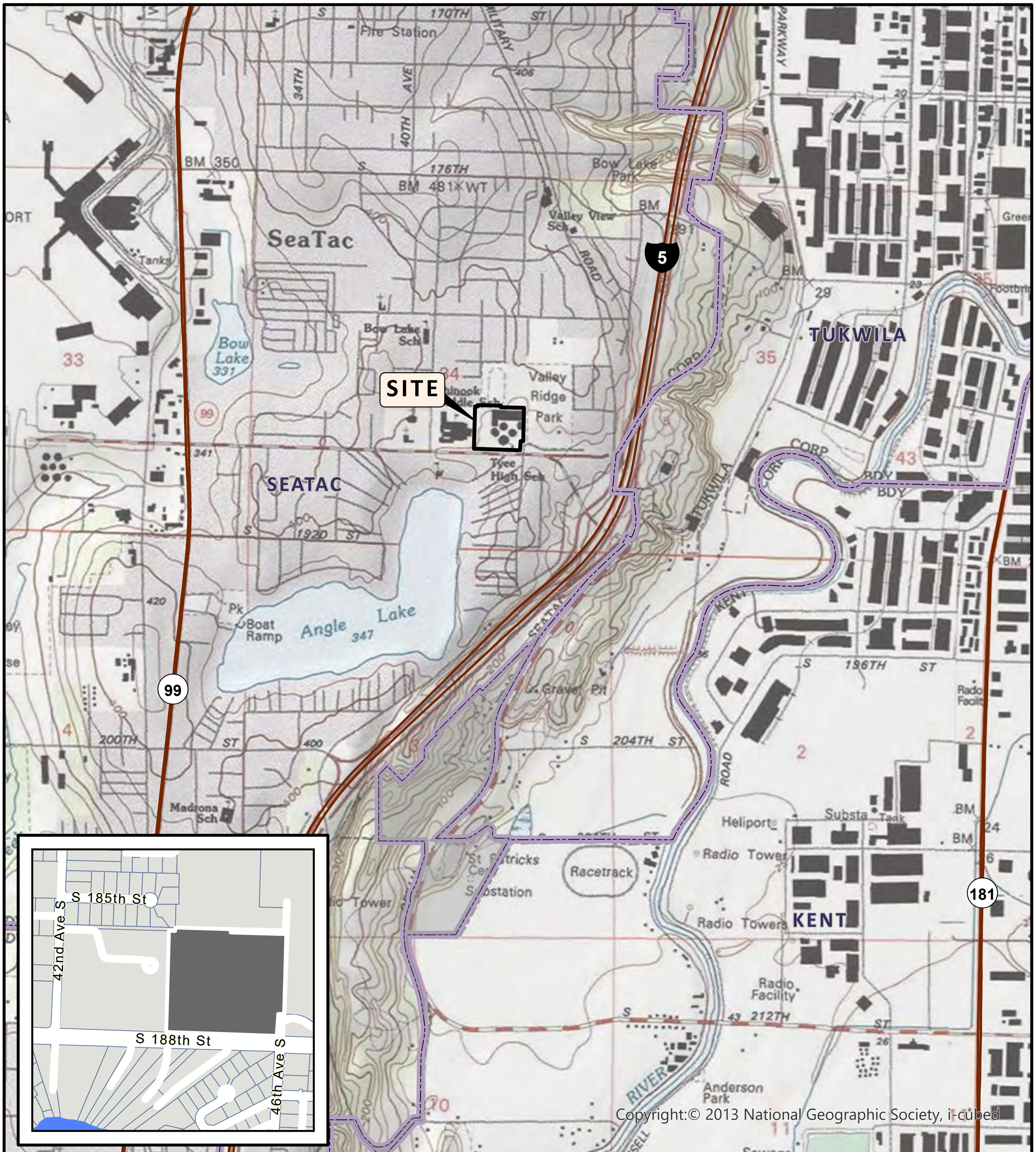
Joshua S. P. Greer, G.I.T.
Staff Geologist

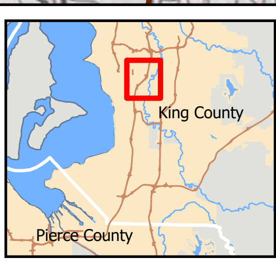
Bruce Guenzler

Bruce W. Guenzler, L.E.G.
Associate Geologist

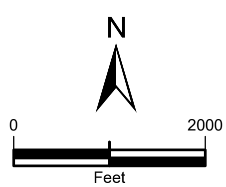
Kurt D. Merriman, P.E.
Senior Principal Engineer

Attachments:	Figure 1:	Vicinity Map
	Figure 2:	Site and Exploration Plan
	Appendix A:	Exploration Logs, Laboratory Testing Results





DATA SOURCES / REFERENCES:
USGS: 7.5' SERIES TOPOGRAPHIC MAPS, ESRI/I-CUBED/NGS 2013
KING CO: STREETS, CITY LIMITS, PARCELS, PARKS 3/20
LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE



NOTE: BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

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VICINITY MAP

TYEE HIGH SCHOOL REPLACEMENT SEATAC, WASHINGTON

PROJ NO.	DATE:	FIGURE:
20200075E001	5/20	1

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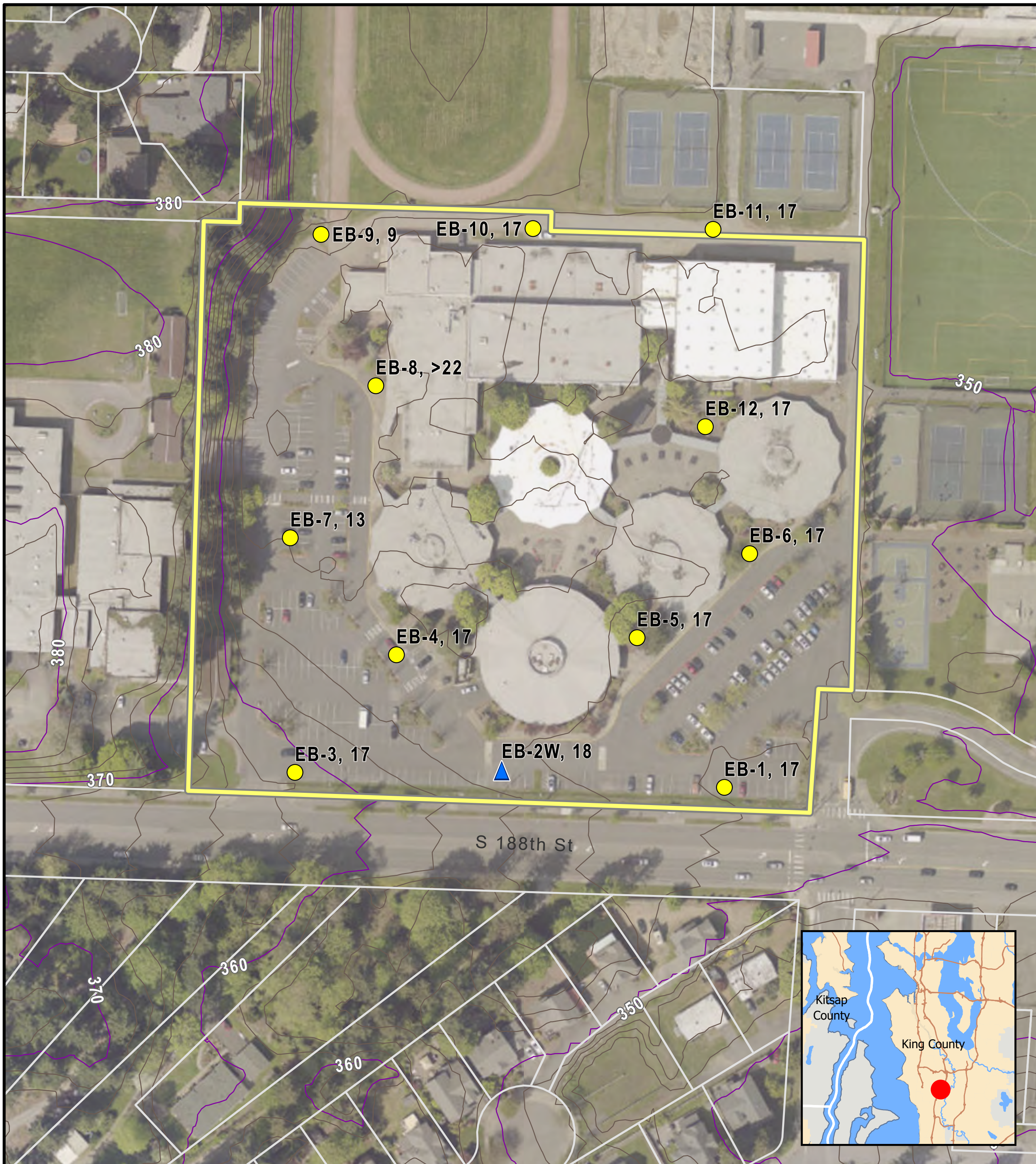

SITE

EXPLORATION BORING, OBSERVED FILL DEPTH (FT)

MONITORING WELL, OBSERVED FILL DEPTH (FT)

PARCEL

CONTOUR 10 FT

CONTOUR 2 FT

DATA SOURCES / REFERENCES:
PSLC: KING COUNTY 2016, GRID CELL SIZE IS 3'.
DELIVERY 2 FLOWN 2/25/16 - 3/28/16
CONTOURS FROM LIDAR
KING CO: STREETS, PARCELS, 3/20, AERIAL: PICTOMETRY INT. 2019
LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

N

0 150
Feet

NOTE: BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION

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EXISTING SITE AND EXPLORATION PLAN

TYEE HIGH SCHOOL REPLACEMENT
SEATAC, WASHINGTON

PROJ NO.	DATE:	FIGURE:
20200075E001	5/20	2

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APPENDIX A

Exploration Logs

Laboratory Testing Results

Major Divisions			Symbol	Description
Coarse-Grained Soils - More than 50% (1) Retained on No. 200 Sieve	Gravels - More than 50% (1) of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines (5)	**GW**	Well-graded gravel and gravel with sand, little to no fines
			GP	Poorly-graded gravel and gravel with sand, little to no fines
		≥12% Fines (5)	**GM**	Silty gravel and silty gravel with sand
			GC	Clayey gravel and clayey gravel with sand
	Sands - 50% (1) or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines (5)	**SW**	Well-graded sand and sand with gravel, little to no fines
			SP	Poorly-graded sand and sand with gravel, little to no fines
		≥12% Fines (5)	**SM**	Silty sand and silty sand with gravel
			SC	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50% (1) or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50		**ML**	Silt, sandy silt, gravelly silt, silt with sand or gravel
			CL	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		**MH**	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			CH	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			**PT**	Peat, muck and other highly organic soils

Terms Describing Relative Density and Consistency

	Density	SPT (2) blows/foot
Coarse-Grained Soils	Very Loose	0 to 4
	Loose	4 to 10
	Medium Dense	10 to 30
	Dense	30 to 50
	Very Dense	>50
	Consistency	**SPT (2) blows/foot**
Fine-Grained Soils	Very Soft	0 to 2
	Soft	2 to 4
	Medium Stiff	4 to 8
	Stiff	8 to 15
	Very Stiff	15 to 30
	Hard	>30

Test Symbols

G = Grain Size
M = Moisture Content
A = Atterberg Limits
C = Chemical
DD = Dry Density
K = Permeability

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

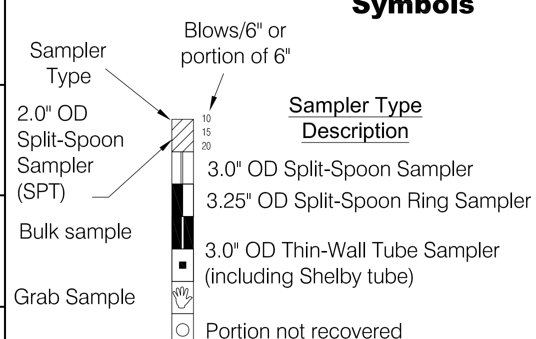
(3) Estimated Percentage

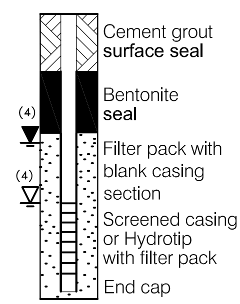
Component	Percentage by Weight
Trace	<5
Some	5 to <12
Modifier (silty, sandy, gravelly)	12 to <30
Very *modifier* (silty, sandy, gravelly)	30 to <50

Moisture Content

Dry - Absence of moisture, dusty, dry to the touch
Slightly Moist - Perceptible moisture
Moist - Damp but no visible water
Very Moist - Water visible but not free draining
Wet - Visible free water, usually from below water table

Symbols





(1) Percentage by dry weight
(2) (SPT) Standard Penetration Test (ASTM D-1586)
(3) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)
(4) Depth of ground water
ATD = At time of drilling
Static water level (date)
(5) Combined USCS symbols used for fines between 5% and 12%

Classifications of soils in this report are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.

blocks \ dwg \ log_key.dwg LAYOUT: Layout 4 -2014 Qty Chng

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EXPLORATION LOG KEY

FIGURE A1

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Exploration Boring

Project Number	Exploration Number	Sheet
20200075E001	EB-1	1 of 1

Project Name	Tyee High School Replacement	Ground Surface Elevation (ft)	~352
Location	SeaTac, WA	Datum	NAVD 88
Driller/Equipment	Boretec 1 / EC55 Track Rig	Date Start/Finish	5/5/20,5/5/20
Hammer Weight/Drop	140# / 30"	Hole Diameter (in)	6.25

Depth (ft)	Samples	DESCRIPTION	Water Level	Blows/6"	Blows/Foot
0		**Asphalt - 2 inches**			
		Crushed Rock - 3 inches			
		Fill			
	S-1	Slightly moist, brown to gray, sandy, GRAVEL, some silt to silty (GP-GM).		14 29 32	61
5	S-2	Difficult digging, grinding through gravel. Becomes moist and brown; sampler bouncing on rock; poor recovery; blowcounts possibly overstated (GP-GM).		50/4"	50/4"
10	S-3	Slightly moist, brown to gray (likely due to fractured gravel), sandy, GRAVEL, some silt to silty (GP-GM).		22 44 50/5"	50/5"
15	S-4			27 50/6"	50/6"
		Vashon Advance Outwash	ATD (18 ft)		
20	S-5	Very moist to wet, brown, fine to medium SAND, some silt, trace gravel; massively bedded (SP-SM).		18 35 35	70
25					

Bottom of exploration boring at 21.5 feet
Groundwater encountered at 18 feet.

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JG
Approved by: JHS

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Geologic & Monitoring Well Construction Log

Project Number	Well Number	Sheet
20200075E001	EB-2W	1 of 2

Project Name	Tyee High School Replacement	Location	SeaTac, WA
Elevation (Top of Well Casing)	~355	Surface Elevation (ft)	~355
Water Level Elevation	~333.8	Date Start/Finish	5/5/20,5/5/20
Drilling/Equipment	Boretec 1 / EC55 Track Rig	Hole Diameter (in)	7.25
Hammer Weight/Drop	140# / 30"		

Depth (ft)	Water Level	WELL CONSTRUCTION	ST	Blows/ 6"	Graphic Symbol	DESCRIPTION
0		Flush mount monument with bolting lid Compression well cap Concrete 0 to 3 feet				**Asphalt - 3 inches** **Crushed Rock - 3 inches** **Fill**
				50/5"		Moist, brown, sandy, GRAVEL; poor recovery; sampler bouncing on a rock; blowcounts likely overstated (GP).
5				8 50/6"		Moist, brown, silty, gravelly, fine SAND; blowcounts possibly overstated (SM). Difficult drilling 6 to 51 feet.
10		Bentonite chips 3 to 35 feet		16 34 50/6"		Moist, brown, silty, gravelly, fine SAND to sandy, silty, GRAVEL; frequent broken gravels in sampler (SM-GM).
15				19 34 42		Moist, brown, silty, sandy, GRAVEL (GM).
						Vashon Advance Outwash
20	▽	2-inch I.D. PVC casing 0 to 39 feet		16 26 31		Moist, brown, fine SAND, some silt to silty; massively bedded with occasional silty interbeds (SM/SP-SM).
25	▼			15 25 29		Becomes wet.

Sampler Type (ST):

2" OD Split Spoon Sampler (SPT)	No Recovery	M - Moisture
3" OD Split Spoon Sampler (D & M)	Ring Sample	▽ Water Level (5/12/20)
Grab Sample	Shelby Tube Sample	▼ Water Level at time of drilling (ATD)

Logged by: JG
Approved by: JHS

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Geologic & Monitoring Well Construction Log

Project Number	Well Number	Sheet
20200075E001	EB-2W	2 of 2

Project Name	Tyee High School Replacement	Location	SeaTac, WA
Elevation (Top of Well Casing)	~355	Surface Elevation (ft)	~355
Water Level Elevation	~333.8	Date Start/Finish	5/5/20,5/5/20
Drilling/Equipment	Boretec 1 / EC55 Track Rig	Hole Diameter (in)	7.25
Hammer Weight/Drop	140# / 30"		

Depth (ft)	Water Level	WELL CONSTRUCTION	ST	Blows/6"	Graphic Symbol	DESCRIPTION
				8 21 40		
35		Sand pack 35 to 49 feet		17 27 34		
40				19 32 50		Becomes very moist and silty.
45		2-inch I.D. PVC well screen 0.010-inch slot width 39 to 49 feet		13 33 47		
50		Pointed PVC end cap with threaded connecions and O-rings		37 50/4"		Upper 6 inches: very moist, brown, fine SAND, some silt; massively bedded (SP-SM). Lower 6 inches: wet, sandy, GRAVEL, some silt (GP-GM).
		Well tag # BJI 175				Boring terminated at 51 feet Well completed at 49 feet on 5/5/20. Groundwater encountered at 25 feet.
55						

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- ▽ Water Level (5/12/20)
- ▼ Water Level at time of drilling (ATD)

Logged by: JG
Approved by: JHS

NWWELL- B 20200075E001.GPJ BORING.GDT 5/27/20

Exploration Boring

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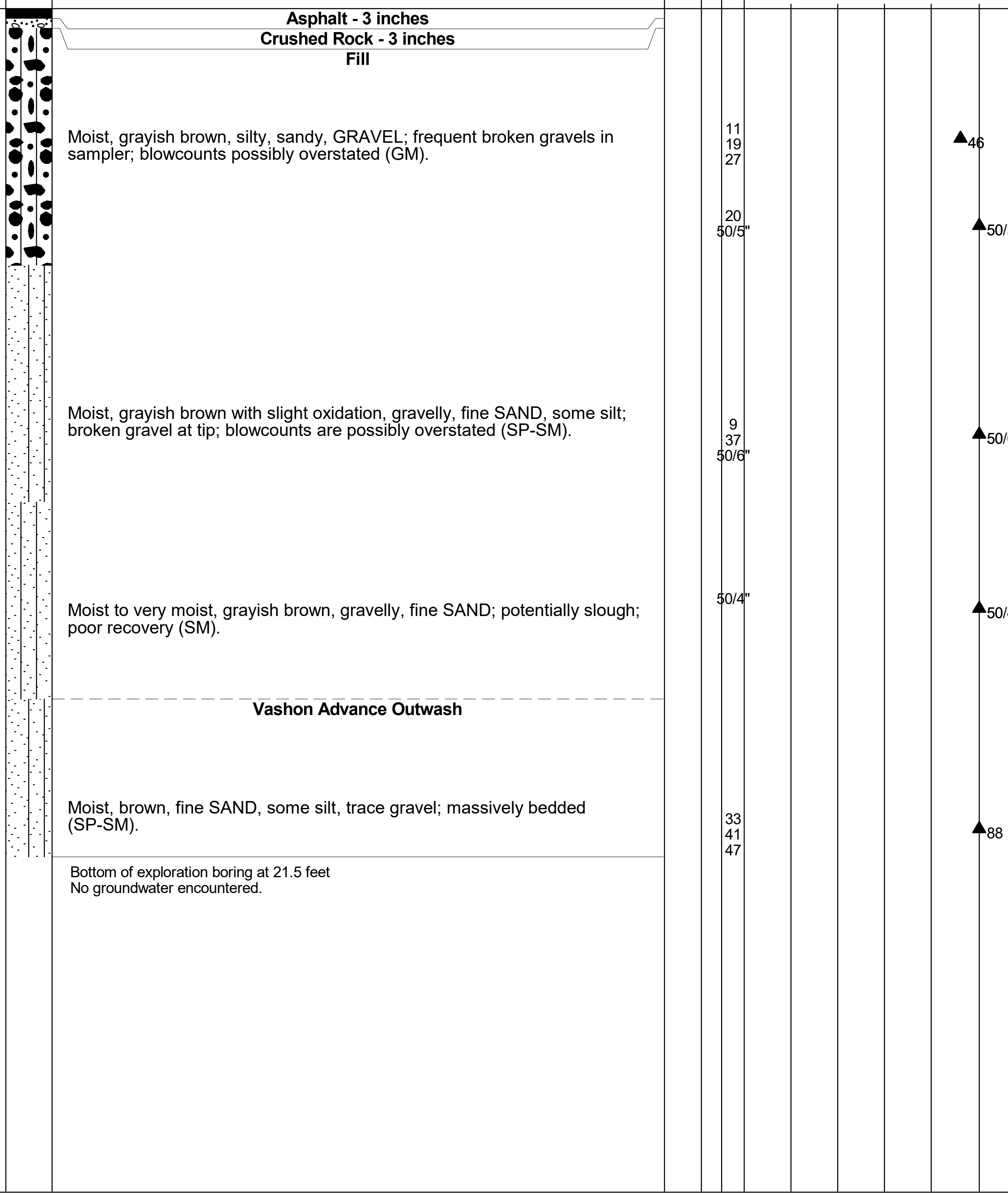
Project Number	Exploration Number	Sheet
20200075E001	EB-3	1 of 1

Project Name: Tyee High School Replacement
Location: SeaTac, WA
Driller/Equipment: Boretec 1 / EC55 Track Rig
Hammer Weight/Drop: 140# / 30"

Ground Surface Elevation (ft): ~361
Datum: NAVD 88
Date Start/Finish: 5/4/20,5/4/20
Hole Diameter (in): 6.25

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
0		**Asphalt - 3 inches**		
		Crushed Rock - 3 inches		
		Fill		
	S-1	Moist, grayish brown, silty, sandy, GRAVEL; frequent broken gravels in sampler; blowcounts possibly overstated (GM).	11 19 27	46
5	S-2		20 50/5"	50/5"
10	S-3	Moist, grayish brown with slight oxidation, gravelly, fine SAND, some silt; broken gravel at tip; blowcounts are possibly overstated (SP-SM).	9 37 50/6"	50/6"
15	S-4	Moist to very moist, grayish brown, gravelly, fine SAND; potentially slough; poor recovery (SM).	50/4"	50/4"
		Vashon Advance Outwash		
20	S-5	Moist, brown, fine SAND, some silt, trace gravel; massively bedded (SP-SM).	33 41 47	88
		Bottom of exploration boring at 21.5 feet No groundwater encountered.		
25				



Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JG
Approved by: JHS

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Exploration Boring

Project Number	Exploration Number	Sheet
20200075E001	EB-4	1 of 1

Project Name	Tyee High School Replacement	Ground Surface Elevation (ft)	~355
Location	SeaTac, WA	Datum	NAVD 88
Driller/Equipment	Boretec 1 / EC55 Track Rig	Date Start/Finish	5/4/20,5/4/20
Hammer Weight/Drop	140# / 30"	Hole Diameter (in)	6.25

Depth (ft)	S T	Samples	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot	Other Tests
0			**Asphalt - 2 inches**					
			Crushed Rock - 3 inches					
			Fill					
		S-1	Moist, grayish brown, gravelly, fine SAND, some silt to silty (SP-SM/SM). Difficult drilling, machine grinding on gravel.			16 28 31	59	
5		S-2	Sampler bouncing on rock; blowcounts are possibly overstated.			39 50/3"	50/3"	
10		S-3	Moist, grayish brown with occasional pockets of dark gray, sandy, GRAVEL, some silt (GP-GM).			25 50/4"	50/4"	
15		S-4				50/6"	50/6"	
			Vashon Advance Outwash					
					▼ (19 ft)			
20		S-5	Very moist to wet, brown, gravelly, fine SAND, some silt; massively bedded with occasional silty interbeds (SP-SM).			33 41 47	88	
			Bottom of exploration boring at 21.5 feet Groundwater encountered at 19 feet.					
25								

Blows/Foot scale: 10, 20, 30, 40

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JG
Approved by: JHS

Exploration Boring

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Project Number	Exploration Number	Sheet
20200075E001	EB-5	1 of 1

Project Name: Tyee High School Replacement
Location: SeaTac, WA
Driller/Equipment: Boretec 1 / EC55 Track Rig
Hammer Weight/Drop: 140# / 30"

Ground Surface Elevation (ft): ~353
Datum: NAVD 88
Date Start/Finish: 5/4/20,5/4/20
Hole Diameter (in): 6.25

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
0		**Grass / Topsoil - 6 inches**		
		Fill		
	S-1	Poor recovery, rock stuck in sampler; blowcounts likely overstated.	12 15 14	29
		Difficult drilling 4 to 21 feet.		
5	S-2	Moist, light brown, silty, fine SAND, some gravel (SM).	11 8 8	16
10	S-3	Moist, grayish brown to brown, sandy, GRAVEL, some silt to silty; occasional clasts of dark gray silt (GP-GM).	22 50/5"	50/5"
15	S-4	Moist, brownish gray, silty, SAND, some gravel (SM).	50/6"	50/6"
		Vashon Advance Outwash		
20	S-5	Moist, brown, fine to medium SAND, some silt, some gravel; massively bedded (SP-SM).	15 50/5"	50/5"
		Bottom of exploration boring at 21 feet No groundwater encountered.		
25				

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JG
Approved by: JHS

Exploration Boring

associated earth sciences incorporated

Project Number	Exploration Number	Sheet
20200075E001	EB-6	1 of 1

Project Name: Tyee High School Replacement
Location: SeaTac, WA
Driller/Equipment: Boretec 1 / EC55 Track Rig
Hammer Weight/Drop: 140# / 30"

Ground Surface Elevation (ft): ~353
Datum: NAVD 88
Date Start/Finish: 5/4/20,5/4/20
Hole Diameter (in): 6.25

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
0		**Grass / Topsoil - 6 inches**		
		Fill		
	S-1	Moist, brown, silty, gravelly, fine SAND; small amount of black odorous soil at tip (SM). Difficult drilling 3 to 21.5 feet.	12, 50/6"	50/6"
5	S-2	Slightly moist, tan to gray, gravelly, fine SAND, some silt; frequent broken gravels in sampler (SP-SM).	35, 50/6"	50/6"
10	S-3	Moist, brown to dark gray, silty, sandy GRAVEL (GM).	26, 50/4"	50/4"
15	S-4	Becomes wet (GM). (Water level at time of drilling)	26, 50/6"	50/6"
		Vashon Advance Outwash		
20	S-5	Very moist to wet, brown, fine to medium SAND, some gravel, some silt; massively bedded (SP-SM).	23, 41, 42	83
		Bottom of exploration boring at 21.5 feet. Groundwater encountered at 15 feet.		
25				

Column headings also include: S T; Graphic Symbol; Well Completion; Water Level; Other Tests. Blows/Foot scale: 10, 20, 30, 40.

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JG
Approved by: JHS

AESIBOR 20200075E001.GPJ May 27, 2020

Exploration Boring

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Project Number	Exploration Number	Sheet
20200075E001	EB-7	1 of 1

Project Name: Tyee High School Replacement
Location: SeaTac, WA
Driller/Equipment: Boretec 1 / EC55 Track Rig
Hammer Weight/Drop: 140# / 30"

Ground Surface Elevation (ft): ~354
Datum: NAVD 88
Date Start/Finish: 5/4/20,5/4/20
Hole Diameter (in): 6.25

Depth (ft)	S T	Samples	DESCRIPTION	Water Level	Blows/6"	Blows/Foot
0			**Asphalt - 3 inches**			
			Crushed Rock - 3 inches			
			Fill			
		S-1	No recovery, sample tube bouncing on a rock. Difficult drilling 3 to 26 feet.		50/3"	50/3"
5		S-2	Moist, brown, fine SAND, some gravel, some silt (SP-SM).		19, 50/6"	50/6"
10		S-3	Moist, grayish brown, sandy, GRAVEL, some silt to silty (GP-GM/GM).		19, 35, 38	73
			Vashon Advance Outwash			
15		S-4	Moist, brown, silty, SAND; massively bedded with occasional siltier strata (SM).		12, 19, 26	45
19				▼		
20		S-5	Becomes very moist to wet.		7, 18, 50/4"	50/4"
25		S-6			15, 23, 21	44

Bottom of exploration boring at 26.5 feet
Groundwater encountered at 19 feet.

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JG
Approved by: JHS

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Exploration Boring

Project Number	Exploration Number	Sheet
20200075E001	EB-8	1 of 1

Project Name: Tyee High School Replacement
Location: SeaTac, WA
Driller/Equipment: Boretec 1 / EC55 Track Rig
Hammer Weight/Drop: 140# / 30"

Ground Surface Elevation (ft): ~354
Datum: NAVD 88
Date Start/Finish: 5/4/20,5/4/20
Hole Diameter (in): 6.25

Depth (ft)	Samples	DESCRIPTION	Water Level	Blows/6"	Blows/Foot
0		**Grass / Topsoil - 8 inches**			
		Fill			
	S-1	Poor recovery, mostly topsoil slough.		11 19 19	38
		Difficult drilling 4 to 21.5 feet.			
5	S-2	Moist, brownish gray, silty, sandy, GRAVEL, frequent broken gravel in sampler (GM).		23 34 46	80
10	S-3	Very moist, grayish brown, gravelly, silty, fine SAND to sandy, silty, GRAVEL (SM-GM).		50/3"	50/3"
14			▼ (ATD)		
15	S-4	Wet, brown, silty, fine SAND, some gravel (SM).		50/6"	50/6"
20	S-5	Wet, brown, silty, sandy, GRAVEL (GM).		41 50/4"	50/4"
21.5		Bottom of exploration boring at 21.5 feet Groundwater encountered at 14 feet.			

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JG
Approved by: JHS

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Exploration Boring

Project Number	Exploration Number	Sheet
20200075E001	EB-9	1 of 1

Project Name: Tyee High School Replacement
Location: SeaTac, WA
Driller/Equipment: Boretec 1 / EC55 Track Rig
Hammer Weight/Drop: 140# / 30"

Ground Surface Elevation (ft): ~354
Datum: NAVD 88
Date Start/Finish: 5/4/20,5/4/20
Hole Diameter (in): 6.25

Depth (ft)	Samples	DESCRIPTION	Water Level	Blows/6"	Blows/Foot
0		**Grass / Topsoil - 8 inches**			
		Fill			
	S-1	Moist, brown, silty, sandy, GRAVEL (GM).		21 12 7	19
5	S-2	Moist, brown, silty, fine SAND, some gravel, trace organics (SM).		5 4 2	6
		Vashon Advance Outwash			
10	S-3	Difficult drilling. Moist, brown, fine SAND, some silt, trace gravel; massively bedded with occasional silty interbeds (SP-SM).		16 17 32	49
15	S-4	Ranges to some gravel (SP-SM).		34 50/4"	50/4"
20	S-5	Very moist to wet, fine to medium SAND, some silt, some gravel (SP-SM).	ATD (20 ft)	19 35 45	80
25		Bottom of exploration boring at 21.5 feet. Groundwater encountered at 20 feet.			

Column headers: Depth (ft), ST, Samples, Graphic Symbol, DESCRIPTION, Well Completion, Water Level, Blows/6", Blows/Foot (10, 20, 30, 40), Other Tests

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JG
Approved by: JHS

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Exploration Boring

Project Number	Exploration Number	Sheet
20200075E001	EB-10	1 of 1

Project Name: Tyee High School Replacement
Location: SeaTac, WA
Driller/Equipment: Boretec 1 / EC55 Track Rig
Hammer Weight/Drop: 140# / 30"

Ground Surface Elevation (ft): ~354
Datum: NAVD 88
Date Start/Finish: 5/4/20,5/4/20
Hole Diameter (in): 6.25

Depth (ft)	S T	Samples	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
0			**Grass / Topsoil - 6 inches**					
			Fill					
		S-1	Moist, brown to gray with pockets of dark gray, silty, sandy, GRAVEL (GM).			11 10 8	18	
5		S-2				8 6 6	12	
			Difficult drilling 9 to 26.5 feet.					
10		S-3	Moist, brown, sandy, GRAVEL, some silt; frequent broken gravel in sampler (GP-GM).			10 50/6"	50/6"	
					▼ (14 ft)			
15		S-4				18 50/6"	50/6"	
			Vashon Advance Outwash					
20		S-5	Wet, brown, fine to medium SAND, some silt, some gravel; massively bedded (SP-SM).			11 50/6"	50/6"	
25		S-6				21 50/6"	50/6"	
			Bottom of exploration boring at 26.5 feet Groundwater encountered at 14 feet.					

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JG
Approved by: JHS

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Exploration Boring

Project Number	Exploration Number	Sheet
20200075E001	EB-11	1 of 1

Project Name: Tyee High School Replacement
Location: SeaTac, WA
Driller/Equipment: Boretec 1 / EC55 Track Rig
Hammer Weight/Drop: 140# / 30"

Ground Surface Elevation (ft): ~353
Datum: NAVD 88
Date Start/Finish: 5/5/20,5/5/20
Hole Diameter (in): 6.25

Depth (ft)	S T	Samples	DESCRIPTION	Water Level	Blows/6"	Blows/Foot	Other Tests
0			**Gravel - 3 inches**				
			Fill				
		S-1	Moist, brown to dark gray, silty, fine SAND, some gravel, trace organics (SM).		10 14 8	22	
5		S-2			9 9 10	19	
10		S-3	Moist, dark gray, silty, fine SAND, trace gravel, trace fine organics; broken gravel at sampler tip, blowcounts possibly overstated (SM). Increase in drill action and grinding on gravel at 10 feet.		50/4"	50/4"	
14				ATD			
15		S-4	Wet, brown, sandy, GRAVEL, some silt (GP-GM).		37 50/5"	50/5"	
			Vashon Advance Outwash				
20		S-5	Wet, brown, fine SAND, some silt, some gravel; massively bedded with occasional silty interbeds (SP-SM).		17 32 38	70	
			Bottom of exploration boring at 21.5 feet Groundwater encountered at 14 feet.				
25							

Sampler Type (ST):
- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JG
Approved by: JHS

Exploration Boring

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Project Number	Exploration Number	Sheet
20200075E001	EB-12	1 of 1

Project Name	Tyee High School Replacement	Ground Surface Elevation (ft)	~353
Location	SeaTac, WA	Datum	NAVD 88
Driller/Equipment	Boretec 1 / EC55 Track Rig	Date Start/Finish	5/4/20,5/4/20
Hammer Weight/Drop	140# / 30"	Hole Diameter (in)	6.25

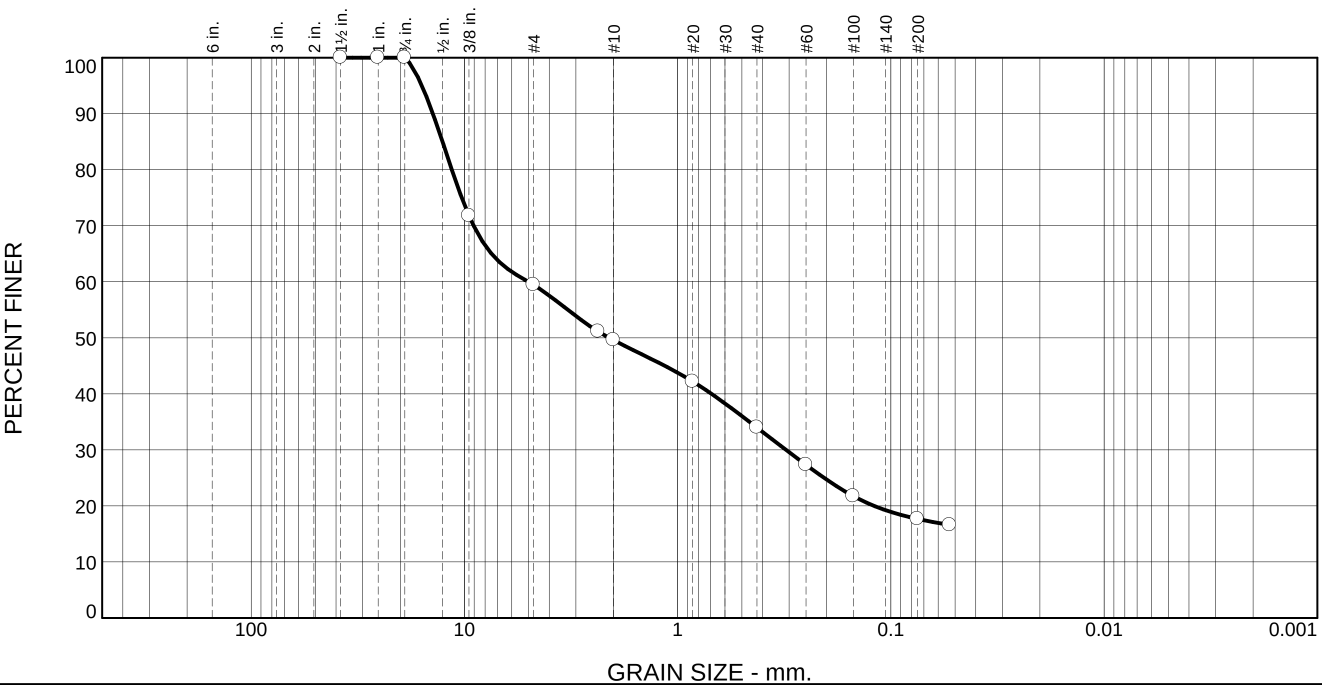
Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
0				**Grass / Topsoil - 6 inches**					
				Fill					
~3.5		S-1		Moist, brown to gray, silty, gravelly, fine SAND, trace fine organics and debris (SM).			6 5 4	9	
5		S-2		Becomes moist to very moist.			5 2 3	5	
				Difficult drilling 8 to 21.5 feet.					
10		S-3		Moist, brown, silty, sandy, GRAVEL (GM).			23 38 45	83	
15		S-4					21 25 45	70	
				Vashon Advance Outwash		▼			
20		S-5		Very moist to wet, brown, fine SAND, some silt, some gravel; massively bedded (SP-SM).			28 41 50/6"	50/6"	
				Bottom of exploration boring at 21.5 feet Groundwater encountered at 18 feet.					
25									

Sampler Type (ST):

- 2" OD Split Spoon Sampler (SPT)
- 3" OD Split Spoon Sampler (D & M)
- Grab Sample
- No Recovery
- Ring Sample
- Shelby Tube Sample
- M - Moisture
- Water Level ()
- Water Level at time of drilling (ATD)

Logged by: JG
Approved by: JHS

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	40.5	9.9	15.6	16.3	17.7	

TEST RESULTS			
Opening Size	**Percent Finer**	**Spec.* (Percent)**	**Pass? (X=Fail)**
1-1/2"	100.0		
1"	100.0		
3/4"	100.0		
3/8"	71.8		
#4	59.5		
#8	51.1		
#10	49.6		
#20	42.2		
#40	34.0		
#60	27.3		
#100	21.7		
#200	17.7		
#270	16.6		

* (no specification provided)

Material Description

silty sand with gravel

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=**

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 14.0626 D_{85}= 12.6769 D_{60}= 5.0158
D_{50}= 2.0957 D_{30}= 0.3102 D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 5/7/20 **Date Tested:** 5/15/20
Tested By: CC
Checked By: BG
Title:

Source of Sample: On-site **Depth:** 15'
Sample Number: EB-5
Date Sampled: 5/4/20

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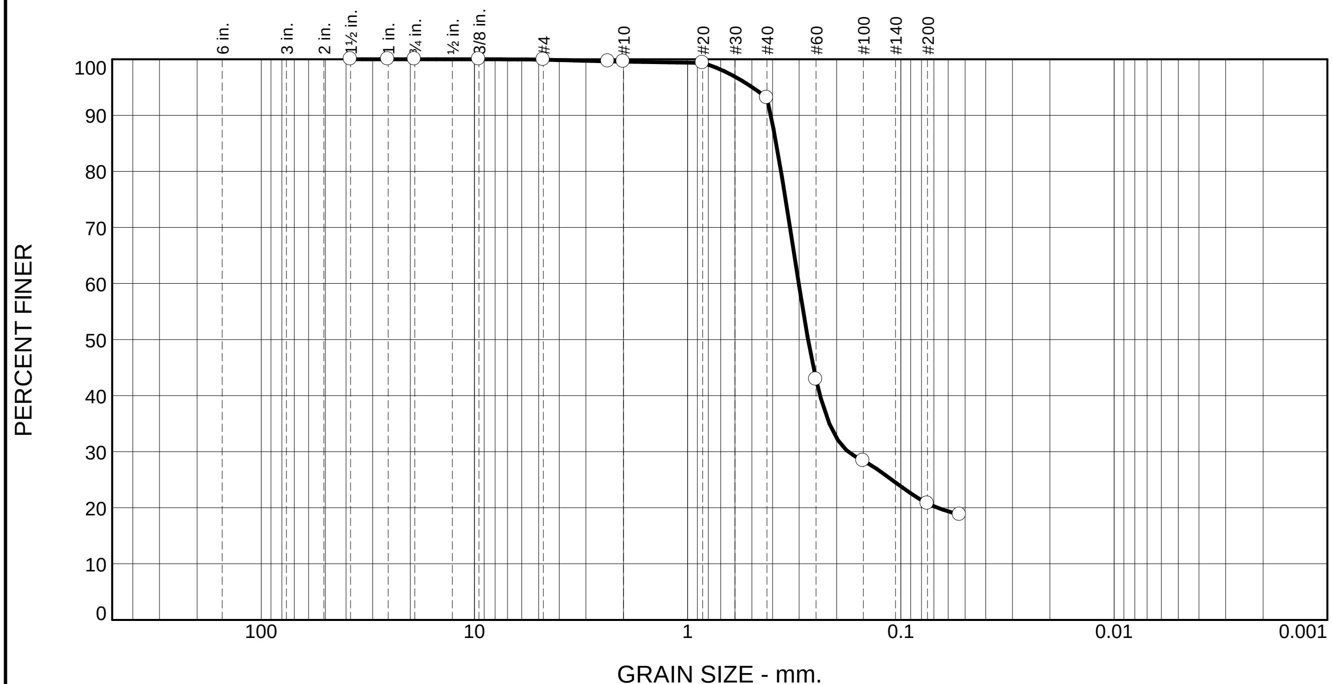
Client: Highline School Dist No. 401, Capital Projects
Project: Tyee High School Replacement

Project No: 20200075E001 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	0.3	6.5	72.3	20.8	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1-1/2"	100.0		
1"	100.0		
3/4"	100.0		
3/8"	100.0		
#4	99.9		
#8	99.6		
#10	99.6		
#20	99.4		
#40	93.1		
#60	42.9		
#100	28.4		
#200	20.8		
#270	18.8		

* (no specification provided)

Material Description

silty sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=**

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.4076 D_{85}= 0.3844 D_{60}= 0.3015
D_{50}= 0.2725 D_{30}= 0.1766 D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 5/7/20 **Date Tested:** 5/15/20

Tested By: CC

Checked By: BG

Title:

Source of Sample: On-site **Depth:** 15' **Date Sampled:** 5/4/20
Sample Number: EB-7

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Client: Highline School Dist No. 401, Capital Projects
Project: Tyee High School Replacement

Project No: 20200075E001 **Figure**