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Subsurface Exploration, Infiltration Assessment,
and Geotechnical Evaluation

SUNRISE ELEMENTARY SCHOOL
Puyallup, Washington

Prepared For:
PUYALLUP SCHOOL DISTRICT

Project No. 160628E001
August 18, 2017

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August 18, 2017
Project No. 160628E001

Puyallup School District
323 - 12th Street NW
Puyallup, Washington 98371

Attention: Larry Vandeberg
Assistant Director of Construction Management

Subject: Subsurface Exploration, Infiltration Assessment,
and Geotechnical Evaluation
Sunrise Elementary School
2323 - 39th Avenue SE
Puyallup, Washington

Dear Mr. Vandeberg:

Associated Earth Sciences, Inc. (AESI) is pleased to submit this report describing our subsurface exploration, stormwater infiltration assessment, and geotechnical engineering evaluation concerning the planned replacement of Sunrise Elementary School in Puyallup, Washington. All services were completed in general accordance with our proposal letter dated November 15, 2016, and our subsequent change order proposals designated COP#1, COP#2, and COP#3. AESI's services were authorized by means of your *Agreement for Consulting Services* documents dated November 18, 2016, and April 21, 2017, as well as your subsequent Purchase Orders.

We have enjoyed working with you on this study and are confident that the recommendations presented in this report will aid in the successful completion of your project. If you should have any questions, or if we can be of additional help to you, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Tacoma, Washington

James M. Brisbine, P.E., L.G., L.E.G.
Senior Associate Geotechnical Engineer

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SUBSURFACE EXPLORATION, INFILTRATION ASSESSMENT, AND GEOTECHNICAL EVALUATION

SUNRISE ELEMENTARY SCHOOL

Puyallup, Washington

Prepared for:
Puyallup School District
323 - 12th Street NW
Puyallup, Washington 98371

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1.0 PROJECT AND SITE DESCRIPTION

The project site comprises an existing elementary school campus located in the South Hill area of Puyallup, as shown on the attached "Vicinity Map" (Figure 1). This campus is visually delineated by residential properties on the north, east, and west, and by 39th Avenue East on the south. It has a nearly square shape that measures approximately 600 feet by 630 feet overall and covers about 8 acres. Presently, the campus is occupied by several school buildings, two parking lots, a bus loop, a perimeter driveway, and several playfields. Our attached "Site and Exploration Plan" (Figure 2) illustrates the site boundaries and existing features.

Development plans call for removing most or all of the existing facilities and then constructing a new elementary school building on the western half of the site. Improvements will also include a natural-turf playfield in the northeastern quadrant; a playshed and several hard-surface playgrounds in the area between the building and playfield; and two new parking lots, a bus loop, and a car loop in the southern part of the site. Figure 2 shows the proposed locations for these new features.

The new school building will be a three-story structure composed of wood and steel framing, with a finished-floor elevation of 504 feet. We assume that foundation and floor loads will be moderate and typical for a building of this type. Site grading will involve moderate cuts and fills, thereby requiring several retaining walls ranging up to 5 feet high. We understand that stormwater runoff will be infiltrated in two on-site, bottomless vaults extending to a depth of about 10 feet below the new parking lots. Stormwater infiltration below the new playfield is also expected. Some combination of conventional and permeable pavements—using flexible and/or rigid materials—will be used for parking lots, driveways, sidewalks, and playgrounds.

2.0 PURPOSE AND SCOPE

Associated Earth Sciences, Inc. (AESI) performed this study to characterize subsurface conditions below the site, such that we can derive geotechnical conclusions and recommendations concerning design criteria and earthwork considerations. Our scope of work included the following tasks.

- Reviewed topographic maps, geologic maps, site layout drawings, aerial photos, and other available information pertaining to the site vicinity.
- Performed a visual surface reconnaissance of the site and immediate surroundings.
- Advanced eighteen exploration borings (designated EB-1 through EB-18) to a maximum depth of about 35 feet, at strategic locations across the site.
- Installed four ground water monitoring wells (designated EB-10w through EB-13w) to depths ranging from about 21 to 35 feet.

- Advanced four exploration pits and performed four infiltration tests (designated IT-1 through IT-4) at strategic locations across the site.
- Conducted six laboratory grain-size (sieve) tests on representative samples of the on-site soils.
- Submitted two samples of the near-surface soils to an independent analytical laboratory for cation exchange capacity and organic content testing.
- Visually classified all soil samples obtained from our explorations.
- Analyzed all research, field, and laboratory data in context with the proposed site development features.
- Prepared this report summarizing our geotechnical findings, conclusions, and recommendations.

Figure 2 shows the locations of all subsurface explorations and field tests with respect to proposed site features. Appendix A contains our exploration logs, Appendix B contains our field testing results, and Appendix C contains our laboratory testing results.

3.0 FIELD EXPLORATION PROCEDURES

We explored subsurface conditions at the site in four separate phases: an initial phase of exploration borings on December 22-23, 2016; a second phase of well installations on June 27, 2017; a third phase of exploration pits and infiltration tests on July 10-11, 2017; and a fourth phase of exploration borings on August 2, 2017. The number, locations, and depths of our explorations were completed within the constraints of surface access, utility conflicts, and project budgets. Our exploration procedures are described below. The various types of sediments, as well as the depths where characteristics of the sediments changed, are indicated on the exploration logs presented in Appendix A. Soil contact depths shown on the logs should be regarded as only an approximation; the actual changes between sediment types are often gradational and/or undulating.

The conclusions and recommendations presented in this report are based, in part, on conditions encountered by our explorations completed for this study. Due to the nature of subsurface exploratory work, it is necessary to interpolate and extrapolate soil conditions between and beyond the field explorations. Differing subsurface conditions could be present outside the area of the explorations due to the random nature of deposition and the alteration of topography by past grading and/or filling. The nature and extent of any variations between the field explorations might not become fully evident until construction. If variations are observed at that time, it could be necessary to modify specific conclusions or recommendations in this report.

3.1 Exploration Borings

All exploration borings were performed by Holocene Drilling, Inc., working under subcontract to AESI. Each boring was completed by advancing an 8-inch outside-diameter, hollow-stem auger with a track-mounted drill rig. During the drilling process, disturbed but representative soil samples were obtained at 2½- or 5-foot-depth intervals using the Standard Penetration Test (SPT) procedure in accordance with the *American Society for Testing and Materials* (ASTM) procedure D-1586. After drilling, each borehole was backfilled with bentonite chips, and the surface was patched with concrete.

The SPT testing and sampling procedure 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 represents the Standard Penetration Resistance (also known as the "N-value"). If a total of 50 blows is reached within one 6-inch interval, the N-value is recorded as 50 blows for the corresponding number of inches of penetration. The N-value provides a measure of the relative density of granular soils or the relative consistency of cohesive soils. Higher N-values correspond to a denser or stiffer soil. Our measured N-values are plotted on the exploration boring logs presented in Appendix A.

All exploration borings were continuously observed and logged by an AESI geologist. The samples obtained from the split-barrel sampler were classified in the field, and representative portions were placed in watertight containers. The samples were then transported to our laboratory for further visual classification and/or testing. Soil descriptions shown on our exploration logs are based on N-values, drilling action, field observations, and laboratory classifications.

3.2 Monitoring Wells

All ground water monitoring wells were installed by Holocene Drilling, Inc. in conjunction with our exploration borings. Each well consists of a 2-inch-diameter polyvinyl chloride (PVC) Schedule-40 well casing with threaded connections, the lower 10 feet of which is finely slotted (0.020-inch machine slot) well screen to allow water inflow. The annular space around the well screen was backfilled with clean sand, and the upper portion of annulus was sealed with bentonite chips and concrete. A flush-mounted steel monument was placed over the top of the wellhead for protection. The as-built configuration is illustrated on the boring logs in Appendix A. Several weeks after installation, an AESI representative developed the wells by adding and then bailing out several well-volumes of water.

3.3 Exploration Pits

All exploration pits were performed by Northwest Excavating & Trucking, working under subcontract to AESI. Each pit was dug using a track-mounted excavator so as to allow direct, visual observation of subsurface conditions. Materials encountered in the exploration pits were studied and classified in the field by a geologist from our firm. Before we left the site, all exploration pits were backfilled with excavated soils, the surface was bucket-tamped, and subsequently patched with sod or asphalt. Selected samples were then transported to our Kirkland laboratory or independent laboratories for further visual classification and/or testing.

3.4 Infiltration Tests

Our infiltration test methods generally corresponded to the procedure for a small-scale Pilot Infiltration Test (PIT) as described by the Washington State Department of Ecology (Ecology) in their 2014 *Stormwater Management Manual for Western Washington* (SWMMWW), which has been adopted by the City of Puyallup as of January 1, 2017. All tests were conducted in open pits at depths between about 3 and 10 feet below existing ground surface. Potable water from a rented water truck was introduced into the test pit using a hose attached to an electronic flow meter with digital flow and totalizer readouts. The discharge hose was equipped with a diffuser to minimize turbulence and scouring of the pit subgrade.

Each test included a *constant-head phase* and a *falling-head phase*. During the first (constant head) phase of each test, the test pit was filled with water to a height of about 6 to 8 inches, then maintained for approximately 7 hours. The total time of soil saturation was about 7 hours. At the conclusion of the constant-head phase, the water flow was shut off and a falling-head phase was started. During this second phase, the water level drop in the test pit was measured at approximately 5- to 15-minute intervals on a staff gauge marked in 0.01-foot increments. The field infiltration rate was calculated using the average flow rate per time step, while adjusting for the change in storage within the pit.

After completing each test, we observed the test pit subgrade being overexcavated to the limits of the excavating equipment, about 15 to 20 feet below ground surface. This allowed us to observe the types of sediments that received the infiltration testing water, and to identify any sediment layers that would have restricted the downward flow of such water.

4.0 SITE CONDITIONS

The following text sections describe current site conditions, including development features, regional and local topography, regional geology, local soils, and local ground water. Our sources of information include topographic and geologic maps published by the U.S. Geological Survey (USGS) and aerial photographs published by Google Earth.

4.1 Development Features

Presently, the northeastern portion of the campus is occupied by a group of school buildings, including two large classroom/administration buildings and two small portable classrooms. An access driveway wraps around these buildings. The southeastern portion of the site is covered by a parking lot and bus loop, whereas the western portion is covered by a large, grassy playfield, a running track, and a small, paved playground. Our exploratory borings that were located within hardscape areas disclosed 2 to 3 inches of asphalt pavement and 4 inches of concrete slab.

4.2 Regional and Local Topography

The project site is located near the eastern edge of an expansive topographic plateau that abuts the Puyallup River valley. Regional surface grades across the plateau are moderately undulating and hummocky, which is typical for a post-glacial landscape. Within this landscape, the site sits atop a low, broad hummock. Local surface grades across the site vicinity slope downward to the northwest at a gentle to moderate angle until terminating in a shallow valley that separates adjacent hummocks.

On-site surface grades are fairly flat, with elevations ranging from about 516 feet at the southeastern corner to about 496 feet at the northwestern corner (project datum). It appears that up to 7 feet of cutting and filling was performed during the original school construction, resulting in two large, flat terraces that are separated by a rockery wall. The playfield currently occupies the lower (western) terrace, and the buildings currently occupy the upper (eastern) terrace.

4.3 Regional Geology

The 2006 USGS draft *Geologic Map of the Puyallup 7.5-Minute Quadrangle* (1:24,000 scale) indicates that the project site lies near the contact between two Vashon-age glacial deposits. The area underlying the site and extending far to the east is mapped as an ice-contact deposit. This geologic unit can include glacial outwash, lacustrine (lake) sediments, and/or glacial lodgement till. Texturally, it tends to contain combinations of silt, sand, gravel, and cobbles. Densities are variable, and thicknesses can range from several feet to several tens of feet. Ice-contact deposits are often overlain by recessional outwash and often underlain by lodgement till and/or advance outwash.

The shallow valley closely west of the site is mapped as an outwash deposit known as "Steilacoom Gravels." This geologic unit was deposited in large glacial meltwater channels and is found in many valleys throughout Pierce County. It typically comprises a coarse-grained mixture of sands, gravels, and cobbles, with a total thickness ranging from several feet to several tens of feet.

4.4 Local Soils

Our subsurface exploration borings and pits confirmed the presence of Vashon-age glacial deposits below the site, as shown on the regional geology map. We interpreted a general soil sequence that comprises lodgement till over advance outwash. We also observed surficial fill soils in most explored locations. The following paragraphs describe our stratigraphic observations, and the exploration logs contained in Appendix A provide additional subsurface information.

Surficial Fill: Many of our explorations disclosed fill soils (or reworked native soils) mantling the ground surface. These fill soils consisted of loose to medium dense, silty sands and gravelly sands in most borings, as well as some stiff, sandy, gravelly silt in boring EB-6. Small quantities of organic material were present in random locations. Total fill thicknesses ranged from 1½ feet to 10 feet, with the greatest amounts generally observed in the central and northwestern parts of the site.

Lodgement Till: Exploration borings EB-1 through EB-4, and EB-17, which were located in the western and northern parts of the site, revealed native lodgement till below the surficial fill layer. This deposit generally consisted of silty sands with gravel. Densities were typically medium dense in the upper weathered portion of the deposit, then became dense to very dense at greater depths. Total thicknesses ranged from about 3 feet in EB-4 to more than 15 feet in EB-1. We infer that the lodgement till was originally present below the eastern and southern parts of the site but was stripped during the past school construction.

Advance Outwash: All of our exploration borings except EB-1, which was located at the southwestern corner of the site, disclosed advance outwash below the fill or lodgement till layers. This outwash deposit consisted of fine to coarse sand with variable amounts of gravels, some silt, and scattered cobbles. It was typically dense to very dense, although an upper weathered zone of medium dense soil was observed in several locations. Where encountered, the advance outwash extended beyond the termination depth of each boring. It should be noted that three of our borings (EB-5, EB-7, and EB-8) met premature refusal on gravels, cobbles, or boulders within the outwash deposit.

4.5 Regional and Local Ground Water

Regional ground water is expected to exist within the Vashon advance outwash approximately at an elevation of 300 feet (USGS datum). This prediction is based on regional ground water mapping presented in the USGS Scientific Investigations Report 2015–5068, titled *Hydrogeologic Framework, Groundwater Movement, and Water Budget in the Puyallup River Watershed and Vicinity, Pierce and King Counties, Washington*. In addition, a widespread layer of shallow perched water would be expected on top of the unweathered lodgement till or above silty zones in the fill during the wetter times of the year.

All exploratory borings and pits revealed fairly dry conditions below the site at the time of our fieldwork, which extended from late December 2016 to early August 2017. Aside from a perched water lens at a depth of about 15 feet in EB-1, none of our borings or pits encountered significant ground water within the maximum depth of exploration (35 feet), and soil conditions were generally damp or moist rather than wet or saturated. Furthermore, all four of our monitoring wells disclosed dry conditions during and after installation. It should be noted, however, that ground water levels could fluctuate due to changes in season, precipitation patterns, off-site development, and other factors. AESI will be monitoring on-site ground water levels throughout the 2017-18 wet season.

5.0 INFILTRATION ASSESSMENT

We understand that the City of Puyallup has adopted the Ecology 2014 SWMMWW. The following paragraphs describe our infiltration assessment of the site in context with the SWMMWW.

5.1 Stratigraphic Considerations

Our subsurface explorations revealed a general stratigraphic sequence comprising surficial fill soils over Vashon lodgement till over Vashon advance outwash. The latter deposit extended to our maximum exploration depth (35 feet) and likely extends many tens of feet beyond that depth. Our in-house grain-size test results, which are presented graphically in Appendix C, showed that the advance outwash soils have a gravel content ranging from 27 to 68 percent, a sand content ranging from 25 to 67 percent, and a fines (silt and clay) content ranging from 6 to 15 percent. Given the thickness and composition of the advance outwash deposit, we infer that it represents a generally favorable receptor material for stormwater infiltration.

5.2 Hydrogeologic Considerations

We observed generally dry conditions to a depth of 35 feet, which was the maximum depth of our on-site subsurface explorations and monitoring wells. Although ground water levels typically rise during the wet season, we do not anticipate that the advance outwash deposit will become fully saturated, considering that it likely extends to depths much greater than 35 feet. The lack of high ground water within the advance outwash deposit further indicates that it represents a favorable receptor material for stormwater infiltration. Nonetheless, we will monitor on-site ground water levels throughout the 2017-18 wet season in order to verify this conclusion.

5.3 Infiltration Test Results

Our scope of work included four field infiltration tests performed within the advance outwash deposit at strategic locations across the project site. Tests IT-1 and IT-2 were performed near the proposed infiltration vault locations at a depth of about 10 feet below existing grades, whereas tests IT-3 and IT-4 were performed within the proposed playfield footprint at depths of about 3 to 5 feet below existing grades. At the proposed vault locations, we measured short-term infiltration rates of 4.1 inches per hour (in/hr) and 4.8 in/hr in tests IT-1 and IT-2, respectively. At the proposed playfield, we measured short-term infiltration rates of 20.7 in/hr and 18.1 in/hr in tests IT-3 and IT-4, respectively. The lower rates in tests IT-1 and IT-2 likely reflect the silt interbeds present below the test subgrades. Our field infiltration testing data are presented in Appendix B and are summarized in Table 1, below.

The aforementioned short-term infiltration rates are considered to be uncorrected and, therefore, non-conservative for design purposes. As such, Ecology's SWMMWW requires that a series of partial correction factors be applied to these short-term values. The design infiltration rates were derived using the correction factors for site variability (CF_v), testing (CF_t), and maintenance (CF_m), per the following formulas:

Total Correction Factor = CF_T = CF_v x CF_t x CF_m

and

K_{sat} design = K_{sat} initial x CF_T

where K_{sat} design and K_{sat} initial are the design and measured infiltration rates, respectively.

The specific factors derived for individual test results are summarized in Table 1. The corrected infiltration rates shown in the last column of Table 1 represent the maximum allowable long-term design rates after each total correction factor (CF_T) has been applied. These long-term design rates are 1.5 and 1.7 in/hr for the proposed vault subgrades, and 6.0 and 8.2 in/hr for the proposed playfield subgrades. All design values assume that subgrades will be excavated to the depths tested, and that actual subgrade soils are consistent with those encountered at our test locations.

Table 1
Summary of Infiltration Rates and Correction Factors

Data Source	Uncorrected Infiltration Rate (in/hr)	Correction Factors				Corrected Infiltration Rate (in/hr)
		CF_v	CF_t	CF_m	CF_T	
IT-1 (vault area)	4.1	0.8 [1]	0.5 [2]	0.9 [3]	0.36	1.5
IT-2 (vault area)	4.8	0.8 [1]	0.5 [2]	0.9 [3]	0.36	1.7
IT-3 (playfield area)	18.8	0.8 [1]	0.5 [2]	0.8 [4]	0.32	6.0
IT-4 (playfield area)	25.6	0.8 [1]	0.5 [3]	0.8 [4]	0.32	8.2

Notes: in/hr - inches per hour
1. This value reflects the somewhat variable permeability conditions within the advance outwash.
2. This value reflects the prescribed correction factor of 0.5 for a small-scale Pilot Infiltration Test.
3 This value reflects a fairly high level of control over influent quality and long-term maintenance for the vaults.
4. This value reflects a moderate level of control over influent quality and long-term maintenance for the playfield.

5.4 Water-Quality Treatment Considerations

If the native soils are proposed to be used for in-situ water-quality treatment purposes, the SWMMWW requires that infiltration subgrade soils have a cation exchange capacity (CEC) greater than 5 milliequivalents per 100 grams (meq/100g) and an organic content (OC) of at least 1 percent. We obtained two shallow samples from the proposed playfield area and submitted them to Spectra Laboratories in Tacoma for determination of these soil properties. Their laboratory testing results are contained in Appendix C and are summarized in Table 2. The soil samples were found to have an average CEC of 7.2 meq/100g and an average OC of 1.8 percent. Both of these average values exceed the minimum requirements of the SWMMWW. It should be noted that water-quality requirements do not apply to infiltration facilities used only for flow control.

Table 2
Summary of Soil Properties for Water-Quality Treatment Assessment

Soil Sample Designation	Soil Sample Depth (feet)	Cation Exchange Capacity (meq/100g)	Organic Content (percent)
IT-3	2½	5.3	1.0
IT-4	2½	9.1	2.6
Average	--	**7.2**	**1.8**

meq/100g - milliequivalents per 100 grams

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on our surface reconnaissance, subsurface explorations, field testing, and document research, we conclude that the proposed site development is feasible from a geotechnical standpoint, contingent on proper design implementation and construction practices. Our geotechnical conclusions and recommendations concerning general considerations, site preparations, foundations, slab-on-grade floors, drainage systems, retaining walls, pavement sections, and structural fill are presented in subsequent text sections.

Specification Codes: The following reference documents are cited for specification purposes within this report.

- ASTM: Refers to the latest manual published by the *American Society for Testing and Materials* (ASTM).
- SWMMWW: Refers to the 2014 *Stormwater Management Manual for Western Washington* published by the Washington State Department of Ecology (Ecology).

- WSDOT: Refers to the 2014 edition of *Standard Specifications for Road, Bridge, and Municipal Construction* published by the Washington State Department of Transportation (WSDOT).

6.1 General Considerations

We offer the following comments, conclusions, and recommendations concerning general geotechnical design and construction issues affecting the overall project.

Geological Hazards: Our evaluation did not reveal any geological hazards associated with steep slopes, erosion zones, landslide zones, or abandoned landfills in the site vicinity. In addition, we infer that the dense glacial deposits underlying the site represent a negligible hazard with respect to seismically induced liquefaction. Earthquake activity is obviously a widespread hazard throughout Western Washington, but the risk of associated shaking and ground rupture does not appear to be any higher at this site than elsewhere in eastern Pierce County. Consequently, the proposed site development is not constrained by any prevailing geological hazards, in our opinion.

Foundation Considerations: Our subsurface explorations encountered dense to very dense native lodgement till and advance outwash at variable depths across the site. Such soils are generally favorable for supporting new structures on conventional spread footings. In the proposed building footprint, however, we observed a layer of uncontrolled fill (or looser native soil) ranging from 5 to 10 feet thick. These upper soils are less suitable for structural support due to the risk of excessive or non-uniform settlements. Consequently, the new school building will require special foundations or some type of subgrade mitigation. Ancillary structures that are less sensitive to long-term settlements (such as the playshed) can be supported on partially mitigated fill soil if greater settlement risk can be tolerated.

Seismic Site Class: The 2015 *International Building Code* (IBC) assigns a seismic Site Class on the basis of geological conditions prevailing within a depth of 100 feet below the local ground surface. Although our subsurface explorations did not extend to such a depth, we infer from shallower soil observations and from available geologic maps that the subsurface conditions correspond to Site Class "C" as defined by the IBC.

Infiltration Vaults: Our explorations revealed that the proposed infiltration vault locations are underlain by fill material over native lodgement till over native advance outwash. The advance outwash deposit, which we observed at depths ranging from 9 to 12 feet below existing grades, appears to be a favorable receptor for stormwater infiltration. In our opinion, infiltration vaults can be used if each vault extends downward sufficiently deep to reach advance outwash soils. Based on our field testing, we recommend assuming a long-term (corrected) design infiltration rate of 1.5 and 1.6 in/hr for the eastern and western vault locations, respectively. AESI should be allowed to observe the vault subgrades at the time of construction, in order to verify that actual soil conditions are consistent with our assumptions.

Playfield Infiltration: Our explorations revealed that the proposed playfield is mantled by fill material overlying native advance outwash at depths ranging from 1½ to 3 feet below existing grades. We infer that the advance outwash deposit represents a favorable receptor for stormwater infiltration. Based on our field testing, we recommend assuming a long-term (corrected) design infiltration rate of 2.0 in/hr for the overall playfield subgrade. Furthermore, our laboratory CEC and OC tests indicate that the playfield subgrade soils meet the Ecology SWMMWW requirements for water-quality treatment purposes. AESI should be allowed to observe the playfield subgrade at the time of construction, in order to verify that actual soil conditions are consistent with our assumptions.

Earthwork Scheduling: Our explorations indicate that much of the on-site soils comprise silty sands with some gravel. These silty soils are moisture-sensitive and highly susceptible to disturbance when wet. As such, we expect that most of the on-site soils will be suitable for reuse as structural fill during periods of dry weather, but they would be difficult to reuse during periods of wet weather. Earthwork should be scheduled for the dry season in order to maximize the potential for reusing on-site soils. Greater export and import quantities should be expected during the wet season.

6.2 Site Preparation

Preparation of the project site will involve tasks such as demolition, temporary drainage, stripping, cutting, erosion control, and subgrade compaction. The paragraphs below presents our geotechnical comments and recommendations concerning these various site issues.

Site Demolition: We anticipate that initial site preparation will involve demolition of most or all existing site structures. We recommend that any underground foundation elements or abandoned utilities be removed as part of the demolition work. Removal of any underground storage tanks, if present, would require special environmental oversight; AESI is available to assist with such a task upon request.

Temporary Drainage: Any sources of surface or near-surface water that could potentially enter the construction zones should be intercepted and diverted before stripping and excavating activities begin. We tentatively anticipate that a system of temporary swales or berms placed around the construction zone will adequately intercept most off-site surface water runoff. Because the selection of an appropriate drainage system will depend on the water quantity, season, weather conditions, construction sequence, and contractor's methods, final decisions regarding temporary drainage details are best made in the field at the time of construction.

Clearing and Stripping: After surface and near-surface water sources have been controlled, the construction zones should be cleared and stripped of all existing vegetation, sod, topsoil, pavements, and other surface features. Our exploration borings disclosed about 6 to 12 inches of sod and organic topsoil mantling landscaped or undeveloped areas, about 2 to 3 inches of asphalt concrete in paved areas, and about 4 inches of concrete in slab areas. However, the actual thicknesses could vary considerably from one location to another.

Site Excavations: Based on our exploration borings, on-site excavations will generally encounter low-density fill soils overlying dense to very dense lodgement till overlying dense to very dense glacial outwash. We anticipate that these soils can be excavated with conventional earthworking equipment, although the lodgement till will present hard digging. It should also be noted that three of our borings (EB-5, EB-7, and EB-8) met premature refusal on gravels, cobbles, or boulders within the glacial outwash deposit.

Temporary Cut Slopes: All temporary cut slopes associated with site grading and excavations should be suitably inclined to mitigate the potential for sloughing and collapse. For the various soil deposits that will likely be encountered onsite during earthwork, we tentatively infer that the following maximum inclinations (given as a horizontal to vertical, or "H:V" ratio) could be planned. However, appropriate inclinations will depend on the actual soil and ground water conditions encountered during earthwork. Ultimately, the site contractor must be responsible for maintaining safe excavation slopes that comply with applicable regulations.

Cuts in Dense Glacial Lodgement Till Deposits: 0.75H:1V
Cuts in Dense Glacial Outwash Deposits: 1.0H:1V
Cuts in Loose to Medium Dense Fill Deposits: 1.5H:1V

Weather Considerations: It should be realized that if the stripping or grading operations proceed during wet weather, greater stripping depths will likely be necessary to remove moisture-sensitive subgrade soil areas that become saturated and disturbed. For this reason, site earthwork should be avoided during periods of wet weather. During the summer months, sprinkling will likely be needed to moisture-condition soils that have become too dry.

Erosion Control Measures: Because stripped surfaces and soil stockpiles are typically a source of runoff sediments, they should be given particular attention. If earthwork occurs during wet weather, we recommend that all stripped surfaces be covered with straw to reduce runoff erosion. Similarly, soil stockpiles and cut slopes should be covered with plastic sheeting for erosion protection. We also recommend that silt fences, berms, and/or swales be maintained around stripped areas and stockpiles in order to capture runoff water and thereby reduce the downslope sediment transport. Stripped areas should be revegetated as soon as possible, also reducing the potential for erosion.

Runoff Water: On-site stormwater runoff water should be conveyed to appropriate temporary detention and treatment facilities, rather than to any permanent infiltration facilities. In order to avoid siltation and fouling of the receptor soils, all permanent infiltration systems must remain off-line during construction. We recommend that stormwater runoff not be routed to the new infiltration facilities until the site is stabilized and all runoff water is clear.

6.3 Building Foundations

In our opinion, the new school building should gain support from the dense to very dense lodgement till and advance outwash soils underlying the site. However, because these glacial deposits are mantled by uncontrolled fill soils and/or loose to medium dense native soils within the building footprint, subgrade remediation or special foundations will be needed. We offer the following comments and recommendations concerning design and construction of spread footings and alternative foundation systems. For foundation planning purposes, the approximate depths to a suitable bearing horizon are indicated on Figure 2.

Footing Depths and Widths: For frost and erosion protection, the bottoms of all exterior footings should bear at least 18 inches below adjacent outside grades, whereas the bottoms of interior footings need bear only 12 inches below the surrounding slab or crawl-space level. To reduce post-construction settlements, continuous (wall) and isolated (column) footings should be at least 18 and 24 inches wide, respectively. It should be noted, however, that greater depths or widths might be needed for other reasons, as determined by the project structural engineer.

Bearing Provisions for School Building: We recommend that the new school building gain support from the native, dense to very dense, lodgement till or advance outwash deposits underlying the site. Suitable bearing soils were observed at depths ranging from 5 to 10 feet below existing grades, as indicated on Figure 2. Where bearing soils are too deep for shallow footings, four different support options are available, as described below and as shown on the attached “Footing Support Diagrams” (Figure 3).

- *Option 1 - Footings on Aggregate Fill Bearing Pads:* Overexcavate the upper soils as needed to reach the bearing horizon. Replace the overexcavated soils with angular aggregate (ideally, 2-inch “railroad ballast”) to support the new footings. The aggregate fill prism should extend outward at a 0.5H:1V angle from the footing edges, as shown on Figure 3, and should be bucket-tamped to achieve a firm condition. Compared to the other three options, this option involves a larger amount of earthwork to establish suitable bearing conditions but a lower unit cost for backfill material.
- *Option 2 - Footings on Flowable Fill Bearing Pads:* Overexcavate the upper soils as needed to reach the bearing horizon. Replace the overexcavated soils with either lean-mix concrete (LMC) or controlled-density fill (CDF) to support the new footings. The LMC or CDF prism should extend outward at a 0.25H:1V angle from the footing edges, as shown on Figure 3. Compared to the other three options, this option involves a moderate amount of earthwork to establish suitable bearing conditions, and a high unit cost for the backfill.
- *Option 3 - Footings on Aggregate Piers:* Install an array of compacted aggregate piers to support the new footings. “Geopier” is a tradename for the most common type of aggregate pier, but other types might be locally available. Regardless of type, we

recommend that all aggregate piers extend at least 1 foot into the bearing layer, as shown on Figure 3. Due to the proprietary nature of aggregate piers, the specialty contractor should be responsible for determining the spacing, diameter, materials, and other details needed to achieve the minimum allowable static bearing capacity stated below for the new footings. Compared to the other three options, this option would reduce the total quantity of imported and exported soils but would require a specialty contractor and a higher unit cost.

- *Option 4 - Footings on Pin Piles:* Install an array of driven steel pipes, or "pin piles," to support the new structures. Pin piles are commonly available in diameters ranging from 2 inches to 6 inches, and they provide corresponding allowable load capacities ranging from 4 kips to 30 kips. Regardless of size, all pin piles should be driven downward to a point of refusal. AESI can provide additional geotechnical details if pin piles are selected for foundation support. The project structural engineer should be responsible for determining the appropriate diameter, spacing, and connection details. Compared to the other three options, this option would eliminate the need for importing and exporting soils but would require a specialty contractor and a high material cost. As such, it is likely not as cost-effective for the entire school building but might be useful for localized support of special structures.

Foundation Bearing Capacities: For the first three bearing options described above, we recommend that all footings be designed for the following maximum allowable bearing capacities. These values are stated in pounds per square foot (psf). Static capacities incorporate a safety factor of 2.0 or more and a seismic safety factor of 1.5 or more.

Static Allowable Bearing Capacity:	6,000 psf
Seismic Allowable Bearing Capacity:	9,000 psf

School Building Settlements: We estimate that total post-construction settlements of properly designed footings bearing on properly prepared subgrades will not exceed 1 inch. Differential settlements between new foundation elements over horizontal spans on the order of 50 feet could approach ¾ inch. In all cases, these settlements would be reduced if the actual design bearing pressures are lower than our recommended maximum allowable pressures.

Bearing Provisions for Ancillary Structures: The robust bearing provisions described above for the school building might not be considered necessary and cost-effective for relatively lightweight ancillary structures, such as the new playshed. In our opinion, ancillary structures could be supported on existing firm fill soils if the risk of greater-than-normal long-term settlements are tolerable. As a compromise between performance and cost, we recommend that the upper 12 inches of existing fill be overexcavated and replaced with angular aggregate (per Option 1 above). An allowable static bearing capacity of 2,500 psf would be appropriate for footing design purposes.

Footing and Stemwall Backfill: To provide erosion protection and lateral load resistance, we recommend that backfill be placed on both sides of the footings and stemwalls after the concrete has cured. Either on-site or imported granular soils can be used for this purpose. All footing and stemwall backfill soil should be compacted to a uniform density of at least 90 percent (based on ASTM D-1557).

Lateral Resistance: Footings and stemwalls that have been properly backfilled as described above will resist lateral loads by means of both passive earth pressure and base friction. We recommend using the following allowable values. These earth pressures are stated in pounds per cubic foot (pcf), and they incorporate static and transient (wind or seismic) safety factors of at least 1.5 and 1.1, respectively. Allowable base friction, which includes a safety factor of 1.5, can be combined with the respective passive pressure to resist static and transient loads.

Allowable Static Passive Pressure:	300 pcf
Allowable Transient Passive Pressure:	400 pcf
Base Friction Coefficient:	0.35

Subgrade Verification and Construction Monitoring: Footings should never be cast atop loose, soft, organic, or frozen soil, slough, debris, uncontrolled fill, or surfaces covered by standing water. We recommend that the condition of all subgrades be verified by an AESI representative before any concrete is poured. If aggregate piers are used, we should be retained to monitor the installation process.

6.4 Slab-On-Grade Floors

Because floor slabs typically carry a light load in comparison to building foundations, they allow more latitude concerning support options. This is especially important in the central, southwestern, and northwestern parts of the site, where a thick layer of uncontrolled fill soil was observed. Although long-term settlements could be minimized by overexcavating and replacing all uncontrolled fill below new floor slabs, the owner may elect to accept the risk of somewhat greater settlements in exchange for the lower cost of a partial subgrade improvement option. We offer the following comments and recommendations for slab-on-grade floors.

Subgrade Preparation: Based on our exploration borings, we anticipate that new floor subgrades in some areas will consist of medium dense to very dense native lodgement till or advance outwash. These native soils will provide favorable support for new floors. However, in site areas that are underlain by a significant thickness of uncontrolled fill soils, we recommend that the subgrade be excavated by an additional 18 inches (minimum) to accommodate a granular subbase course, as described below. For all locations, the exposed subgrade should be compacted to a firm and unyielding condition using a heavy vibratory roller. Any localized zones of soft, organic, or wet soils observed over the subgrades should be overexcavated and replaced with granular structural fill.

Floor Sections: A conventional slab-on-grade floor section typically comprises a reinforced concrete slab over a plastic vapor retarder over an aggregate base and, in some cases, a granular subbase. Assuming that the slab has a conventional thickness on the order of 4 or 5 inches and is subjected to typical loads, we recommend the following underslab layers (top to bottom) and minimum thicknesses.

Vapor Retarder:	10 mils
Base Course:	4 inches
Subbase Course:	18 inches

Subbase Course: In areas that are underlain by a significant thickness of uncontrolled fill soils, we recommend that a granular subbase course be placed under the floor slabs. A subbase course helps to provide more-uniform slab support over variable subgrade conditions, thereby reducing long-term differential settlements. For this purpose, we recommend using a well-graded sand and gravel, such as “Ballast” per WSDOT 9-03.9(1) or “Gravel Borrow” per WSDOT 9-03.14. Other acceptable options include crushed recycled concrete having a texture comparable to the aforementioned WSDOT materials. In all cases, the subbase should be compacted with a vibratory roller to achieve a uniform density of at least 90 percent (based on ASTM D-1557).

Base Course: A base course serves as both a capillary break layer and a leveling layer for the floor slabs. Ideally, the base course would consist of clean, uniform, well-rounded gravel, such as $^5/_8$-inch or $^7/_8$-inch washed rock. It would also be acceptable to use a washed, angular gravel or crushed rock for this purpose. In all cases, the base course should be lightly compacted to create a firm, smooth surface.

Vapor Retarder: A vapor retarder consists of heavy-duty plastic sheeting that is placed between the base course and floor slab. In our opinion, a vapor retarder provides a significant benefit by reducing the amount of ground moisture that penetrates the floor slab. We recommend that a vapor retarder be installed beneath all floor areas that will be covered by carpet, wood, tile, or any other moisture-sensitive materials. The vapor retarder should be selected on the basis of allowable vapor transmission rates for the planned floor finish materials, and be installed in strict accordance with the manufacturer’s guidelines.

Floor Settlements: If the subgrade and underslab layers are properly constructed, we estimate that total post-construction static settlements of a slab-on-grade floor bearing on native soil will not exceed ¾ inch under conventional loading conditions. Slab-on-grade floors with a subbase course bearing on uncontrolled fill could experience total settlements ranging up to 1½ inches. In all cases, differential settlements across the length or width of the floor could approach one-half of the actual total settlement.

Subgrade Verification and Construction Monitoring: Floor slab sections should never be placed atop loose, soft, organic, or frozen soil, slough, debris, or surfaces covered by standing water.

We recommend that an AESI representative be allowed to monitor all floor slab construction to verify suitable conditions. Our monitoring services would include probings of subgrade soils, observation of underslab fill layers, and a check of layer thicknesses.

6.5 Drainage Systems

In order to reduce the risk of future moisture problems, all new buildings should be provided with permanent drainage systems. We offer the following recommendations and comments regarding various drainage elements and related features.

Foundation Drains: We recommend that new buildings be encircled with a perimeter foundation drain to collect exterior seepage water. Each drain should consist of a 4-inch-diameter, rigid, perforated pipe within an envelope of pea gravel or washed rock, extending at least 6 inches on all sides of the pipe. The gravel envelope should be wrapped with filter fabric (such as Mirafi 140N) to reduce the migration of fines from the surrounding soils. Ideally, the drain invert would be installed no more than 8 inches above or below the base of the perimeter footings or grade beams.

Subfloor Drains: Based on the soil and ground water conditions observed in our site explorations, we currently do not infer a need for drains beneath the floor slabs if the foundation drains are properly installed. However, the final decision regarding the need for subfloor drains should be made at the time of construction, after the floor subgrade has been exposed and the foundation walls have been cast.

Runoff Water: Roof downspouts, parking lot drains, and drains from any other runoff surfaces should not be tied into the perforated piping system of the foundation drains. Instead, the runoff water collected from such sources should be routed through a separate tightline piping system. Also, final site grades should be sloped so that surface water flows away from the buildings rather than ponding near the foundation walls.

6.6 Backfilled Retaining Walls

We anticipate that backfilled concrete retaining walls might be used in certain buildings or exterior site locations. Furthermore, any subsurface vault walls should also be designed as backfilled retaining walls. Our design and construction recommendations for new backfilled retaining walls are presented below.

Wall Foundations: To avoid excessive differential settlement of any new retaining wall, it should be supported on non-organic native soils in accordance with our recommendations presented in the "Building Foundations" section of this report. The allowable static and transient bearing capacities presented in that section would apply to the wall footings.

Static Lateral Earth Pressures: Yielding (cantilever) walls that are allowed to deflect more than 0.005 times the wall height should be designed to withstand an appropriate static *active* lateral earth pressure. Non-yielding (restrained) walls that are allowed to deflect less than 0.005 times the wall height should be designed to withstand an appropriate static *at-rest* lateral earth pressure. These pressures act over the entire back of the wall and vary with the backslope inclination. For retaining walls with a level or 2H:1V backslope and well-drained conditions, we recommend using the following values, which are given in pcf of equivalent fluid pressure.

Static Active Earth Pressure with Level Backslope:	35 pcf
Static Active Earth Pressure with 2H:1V Backslope:	50 pcf
Static At-Rest Earth Pressure with Level Backslope:	55 pcf
Static At-Rest Earth Pressure with 2H:1V Backslope:	80 pcf

Static Lateral Surcharge Pressures: Any backslope load located within a 45-degree plane projected upward from the wall base will apply a lateral surcharge on the wall. Possible sources of surcharge loading include parking lots, traffic lanes, and structure footings. These surcharge pressures act over the portion of wall adjacent to the load source. For distributed vertical loads, active and at-rest static lateral surcharge pressures can be approximated by multiplying the vertical pressure “Q” (in psf) by the appropriate coefficient shown below. We recommend using a vertical pressure of 250 psf to model traffic and parking loads behind the wall.

Static Active Surcharge Pressure:	0.30(Q) psf
Static At-Rest Surcharge Pressure:	0.45(Q) psf

Seismic Lateral Surcharge Pressures: The total static pressures acting on a wall should be increased to account for seismic surcharge loadings resulting from lateral earthquake motions. These surcharge pressures act over the entire back of the wall and vary with the backslope inclination, the seismic acceleration, and the wall height. For retaining walls with a level backslope, active and at-rest seismic lateral surcharge pressures can be approximated by multiplying the wall height “H” (in feet) by the appropriate coefficient shown below.

Seismic Active Surcharge Pressure:	8(H) psf
Seismic At-Rest Surcharge Pressure:	12(H) psf

Curtain Drains: A curtain drain is a vertical layer of drainage material placed against the back of a wall to dissipate hydrostatic pressures. We recommend that a curtain of washed gravel be used behind all walls. This curtain drain should extend outward at least 12 inches from the wall and should extend upward nearly to the ground surface. The backslope directly above this drain should be capped with asphalt or concrete or a layer of low-permeability soil.

Heel Drains: A heel drain is a horizontal drainage element placed behind the rearward projection (heel) of a wall foundation to collect water from the curtain drain. We recommend that a heel drain be included behind the subject wall. The heel drain should comprise a

4-inch-diameter perforated pipe surrounded by at least 6 inches of washed gravel, all wrapped with filter fabric (such as Mirafi 140N). The drainpipe should then be connected to a tightline discharge pipe that routes water to an appropriate location.

Backfill Soil: We recommend that all backfill placed behind the curtain drain consist of granular structural fill. Suitable materials include imported, well-graded sand and gravel, such as "Ballast" per WSDOT 9-03.9(1) or "Gravel Borrow" per WSDOT 9-03.14. Most of the on-site native sands and gravels would also be suitable for this purpose. If the backfill soil contains more than 10 percent fines, a layer of filter fabric (such as Mirafi 140N) should be placed between the curtain drain and backfill.

Backfill Compaction: Because soil compactors place significant lateral pressures on walls, we recommend that only small, hand-operated compaction equipment be used within 3 feet of a wall. Also, the soil within 3 feet should be compacted to a density as close as possible to 90 percent of the maximum dry density (based on ASTM D-1557). A greater degree of compaction closely behind the wall would increase the lateral earth pressure, whereas a lesser degree of compaction might lead to excessive post-construction settlements. Structural backfill placed more than 3 feet behind the wall should be compacted to a density of at least 95 percent.

Construction Monitoring: We recommend that an AESI representative be allowed to monitor all retaining wall construction. Our monitoring services would include verification of foundation systems, observation of drainage components, and testing of backfill compaction.

6.7 Conventional Pavement Sections

We understand that conventional flexible (asphalt concrete) pavements might be used in the new car parking areas and driveways, whereas rigid (cement concrete) pavement might be used for the bus loop and/or certain other locations. The following comments and recommendations are given for pavement design and construction purposes.

Soil Design Values: Soil conditions can be defined by a California Bearing Ratio (CBR), which quantitatively predicts the effects of wheel loads imposed on a saturated subgrade. Although our scope of work did not include a CBR test on the surficial site soils, we infer from our observations and limited textural testing that a CBR value on the order of 5 to 8 would likely be appropriate for pavement design purposes.

Traffic Design Values: Traffic conditions can be defined by a Traffic Index (TI), which quantifies the combined effects of projected car and truck traffic. Although no specific traffic data was available at the time of our analysis, we estimate that a TI of 3.0 to 4.0 would likely be appropriate for the car parking areas. A higher TI of about 5.0 to 6.0 appears appropriate for driveways and other areas that are occasionally or periodically subjected to school buses, delivery trucks, and other heavy vehicles.

Flexible Pavement Sections: A flexible pavement section typically comprises an asphalt concrete pavement (ACP) over a crushed aggregate base (CAB). In most cases, a granular subbase is included below the CAB, but this could be deleted for pavement sections that sit directly on native outwash sands and gravels. Our recommended minimum thicknesses for flexible pavement sections, which are based on the aforementioned design values and a 20-year lifespan, are shown below.

Car Parking Lots
Asphalt Concrete Pavement (ACP): 2½ inches
Crushed Aggregate Base Course (CAB): 3 inches
Granular Subbase Course (GSB): 6 inches

Bus Loops and Access Driveways
Asphalt Concrete Pavement (ACP): 4 inches
Crushed Aggregate Base Course (CAB): 4 inches
Granular Subbase Course (GSB): 12 inches

Rigid Pavement Sections: A rigid pavement section typically comprises a cement concrete pavement (CCP) over a CAB. In some cases, a granular subbase is included below the CAB, but this could be deleted for pavement sections that sit directly on native glacial till or native outwash sands and gravels. We recommend the following minimum thicknesses for a rigid pavement section that is subjected to school buses and occasional delivery trucks. Pavements and slabs that are subjected to frequent truck traffic or to other heavy structural loads would require a special design.

Bus Loops and Access Driveways
Cement Concrete Pavement (CCP): 7 inches
Crushed Aggregate Base Course (CAB): 2 inches
Granular Subbase Course (GSB): 6 inches

Subgrade Preparation: All pavement subgrades should be compacted to a firm and unyielding condition before any pavement layers are placed. We recommend using a heavy vibratory-drum roller for granular (sand and gravel) subgrades. The resulting subgrade condition should then be verified by proof-rolling with a loaded dump truck or other heavy construction vehicle, in the presence of an AESI representative. Any localized zones of soft, organic-rich, or debris-laden soils disclosed during proof-rolling should be overexcavated and replaced with compacted structural fill.

Granular Subbase: A subbase course helps to provide more-uniform structural support for a pavement section bearing on existing fill. For the subbase course, we recommend using an imported, well-graded sand and gravel, such as “Ballast” per WSDOT 9-03.9(1) or “Gravel Borrow” per WSDOT 9-03.14. It would also be acceptable to use a crushed recycled concrete, provided that it meets the same general textural criteria as the aforementioned WSDOT materials. In all cases, the subbase should be vibratory-compacted to achieve a uniform density of at least 95 percent (based on ASTM D-1557).

Crushed Aggregate Base: We recommend that all CAB material conform to the criteria for "Crushed Surfacing Base Course" per WSDOT 9-03.9(3). In the interest of using recycled materials from on-site or off-site sources, it would be acceptable to substitute up to 20 percent of the CAB with crushed cement concrete, provided that the final mixture meets the same grain-size criteria as the aforementioned WSDOT material. Regardless of composition, all CAB material should be compacted to a minimum density of 95 percent based on the modified Proctor maximum dry density (per ASTM D-1557).

Asphalt Concrete Pavement: We recommend that the ACP aggregate gradation conform to the control points for a ½-inch mix (per WSDOT 9-03.8(6)) and that the binder conform to Performance Grade 58-22 criteria (per WSDOT 9-02.1(4)). We also recommend that the ACP be compacted to a target average density of 92 percent, with no individual locations compacted to less than 90 percent nor more than 96 percent, based on the Rice theoretical maximum density for that material (per ASTM D-2041).

Cement Concrete Pavement: We recommend that the CCP consist of Portland cement concrete with a minimum compressive strength of 4,000 pounds per square inch (psi) and a minimum rupture modulus of 500. We also recommend that the concrete be reinforced with a welded wire mesh, such as W2-6x6, positioned at a one-third depth within the CCP layer.

Pavement Life and Maintenance: It should be realized that conventional asphaltic pavements are not maintenance-free. The foregoing pavement sections represent our minimum recommendations for an average level of performance during a 20-year design life; therefore, an average level of maintenance will likely be required. Furthermore, a 20-year pavement life typically assumes that an overlay will be placed after about 10 years. Thicker asphalt, base, and subbase courses would offer better long-term performance, but would cost more initially; thinner courses would be more susceptible to "alligator" cracking and other failure modes. As such, pavement design can be considered a compromise between a high initial cost and low maintenance costs versus a low initial cost and higher maintenance costs.

6.8 Permeable Pavement Sections

We understand that permeable pavements are being considered for use in new parking areas, driveways, bus loops, sidewalks, and/or playgrounds. These permeable pavements might include a combination of flexible (asphalt concrete) and rigid (cement concrete) surfacing. Our geotechnical comments and recommendations concerning permeable pavements are presented in the following paragraphs.

Structural Design Values: For design of permeable flexible and rigid pavement sections, we have assumed the same soil and traffic design values discussed in the "Conventional Pavement

Sections" portion of this report. It should be noted that driveways are assumed to be subjected to delivery trucks, but not garbage trucks or other very heavy vehicles.

Subgrade Infiltration: We anticipate that subgrade infiltration conditions will vary greatly below the permeable pavements. Some subgrade areas will consist of sandy fill soils or native outwash soils, which will provide moderate infiltration rates, whereas other subgrade areas will consist of native lodgement till, which will provide a very low rate. For design purposes, we recommend that an overall average subgrade infiltration rate of 1.0 in/hr be assumed.

Permeable Pavement Layers: A permeable pavement section typically comprises a porous asphalt concrete pavement (PACP) or pervious cement concrete pavement (PCCP) over an aggregate drainage base (ADB). In some situations, an aggregate choker base (ACC) is placed between the pavement and base courses, but we regard this as an optional item to be used at the discretion of the civil engineer or paving contractor. Our recommended minimum layer thicknesses for various on-site uses are shown below.

Hardtop Playgrounds and Walkways - Flexible Section

Porous Asphalt Concrete Pavement (PACP):	2 inches
Aggregate Drainage Base (ADB):	6 inches

Hardtop Playgrounds and Walkways - Rigid Section

Pervious Cement Concrete Pavement (PCCP):	4 inches
Aggregate Drainage Base (ADB):	6 inches

Car Parking Lots - Flexible Section

Porous Asphalt Concrete Pavement (PACP):	3 inches
Aggregate Drainage Base (ADB):	10 inches

Bus Loops and Access Driveways - Flexible Section

Porous Asphalt Concrete Pavement (PACP):	5 inches
Aggregate Drainage Base (ADB):	14 inches

Bus Loops and Access Driveways - Rigid Section

Pervious Cement Concrete Pavement (PCCP):	7 inches
Aggregate Drainage Base (ADB):	12 inches

Subgrade Preparation: All pervious pavement subgrades should be lightly compacted to achieve a firm condition. However, excessive compaction should be avoided because it can reduce the infiltration characteristics of the subgrade soils. After compaction, the surface should be hand-raked or gently scarified to eliminate any "soil skin" that has formed.

Filter Fabric: If the subgrade consists of silt or clay soils, we recommend that a layer of non-woven filter fabric (such as Mirafi 140N) be placed between the prepared subgrade and the ADB layer. This fabric will help prevent migration of native soils into the ADB gravel.

Aggregate Drainage Base: The ADB serves as both a reservoir and discharge layer for stormwater. As such, the actual thickness might need to be increased beyond our recommended minimum if greater storage capacity is required. Regardless of thickness, we recommend using an imported, uniform, coarse, angular gravel meeting the specifications of "Permeable Ballast" per WSDOT 9-03.9(2) or "No. 3 Stone" per ASTM C-33. The ADB material should be lightly compacted to achieve a reasonably firm and stable condition, but excessive compaction should be avoided.

Aggregate Choker Course: Because the ADB consists of a moderately large-grained material, some contractors prefer to cover it with a choker course to serve as a leveling layer. Where a choker course is desired, we recommend using 2 inches of imported, uniform, medium-grained, angular gravel meeting the specifications of "No. 57 Stone" per ASTM C-33. The choker course should be lightly compacted to achieve a reasonably firm, smooth, and stable condition, but excessive compaction should be avoided.

Porous Asphalt Concrete Pavement: We recommend that PACP use an aggregate consisting of uniform, small- to medium-grained, crushed gravel meeting the specifications of "No. 8 Stone" per ASTM C-33. The binder should conform to PG 70-22 criteria and should be placed at a ratio of 5.75 to 6.00 percent by weight. We also recommend that the PACP be compacted to a firm condition by means of approximately two passes with a heavy vibratory roller. Excessive compaction should be avoided. Ultimately, the finished PACP should provide a minimum infiltration rate of 200 in/hr.

Pervious Cement Concrete Pavement: We recommend that PCCP use an aggregate consisting of uniform, small- to medium-grained, crushed gravel meeting the specifications of "No. 8 Stone" per ASTM C-33. Typically, the concrete paste is a six-sack mix with a water/cement ratio in the range of 0.27 to 0.35. Ultimately, the finished PCCP should provide a minimum compressive strength of 2,000 psi, and a minimum infiltration rate of 200 in/hr.

Pavement Life and Maintenance: It should be realized that all permeable pavements require routine maintenance to maintain their permeability. The entire surface should be vacuum swept at least once per year under normal conditions; if the pavement is exposed to dirt, excessive traffic, or turbid water, then vacuum sweeping should be performed more frequently. In addition, routine structural maintenance, such as patching, will likely be required over the 20-year pavement life.

6.9 Structural Fill

The term *structural fill* refers to any materials placed under foundations, retaining walls, slab-on-grade floors, sidewalks, pavements, and other such features. Our comments, conclusions, and recommendations concerning structural fill are presented in the following paragraphs.

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

Structural Fill Materials: For general use, a well-graded mixture of sand and gravel with a low fines content (commonly called "gravel borrow" or "pit-run") provides an economical structural fill material. For specialized applications, it may be necessary to use a highly processed material such as crushed rock, quarry spalls, clean sand, granulithic gravel, pea gravel, drain rock, CDF, or LMC. Recycled asphalt or concrete, which are derived from pulverizing the parent materials, are also potentially useful as structural fill in certain applications. Soils used for structural fill should not contain any organic matter, debris, environmental contaminants, or individual particles greater than about 6 inches in diameter.

On-Site Soils: Because moderate grading appears necessary at the site, it is expected that moderate quantities of on-site native soils will be generated during earthwork activities. Most of these on-site soils will likely consist of silty sands with gravel (lodgement till and existing fill) and gravelly sands with some silt (advance outwash). We anticipate that all of these non-organic soils can be reused as structural fill during the summer months. However, the silty sands will be difficult to reuse during the wet season or during isolated periods of rainy weather. Furthermore, any organic-rich native or fill soils would not be suitable for reuse as structural fill at any time of year.

Fill Placement and Compaction: Structural fill materials should be placed in horizontal lifts not exceeding about 12 inches in loose thickness. Unless stated otherwise in this report, we recommend that each lift then be thoroughly compacted with a mechanical compactor to a uniform density of at least 95 percent, based on the modified Proctor test (per ASTM D-1557). Compaction is not necessary for certain structural fill materials, such as pea gravel, drain rock, quarry spalls, CDF, and LMC.

Subgrade Verification and Compaction Testing: Regardless of material or location, all structural fill should be placed over firm, unyielding subgrades prepared in accordance with our various recommendations for site preparation. The condition of all subgrades should be verified by an AESI representative before soil or concrete placement begins. Also, fill soil compaction should be verified by means of in-place density testing, hand-probing, proof-rolling, or other appropriate methods performed during fill placement so that the adequacy of soil compaction efforts may be evaluated as earthwork progresses.

7.0 CLOSURE

AESI has prepared this report for the exclusive use of our client and their agents, for specific application to this project. Within the limitations of scope and schedule, our services have been performed in accordance with generally accepted local geotechnical engineering practices in effect at the time our report was prepared. No other warranty, express or implied, is made.

We appreciate the opportunity to be of continued service to you on this project. Should you have any questions regarding this report or other geotechnical aspects of the project, please call us at your earliest convenience.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
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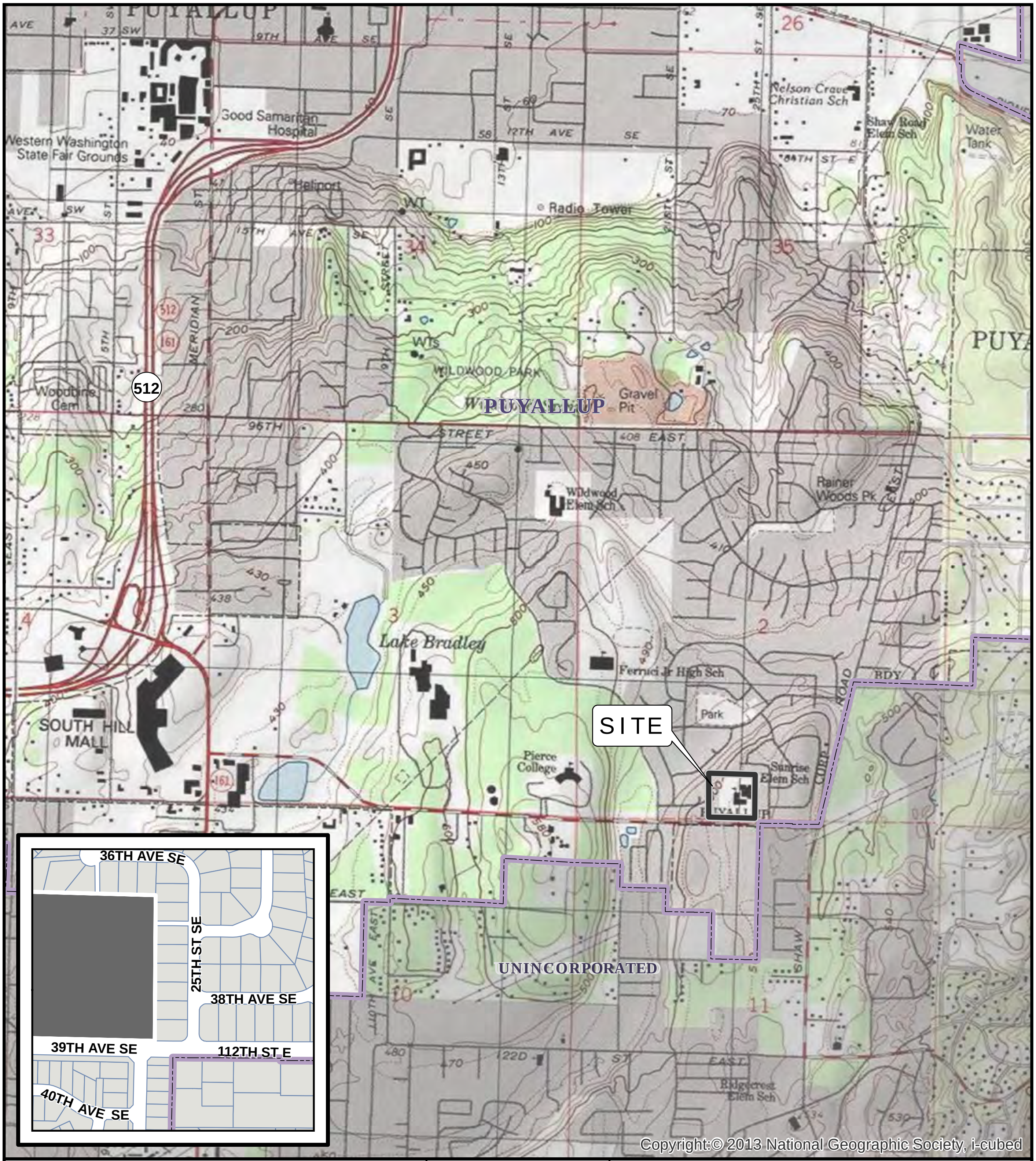

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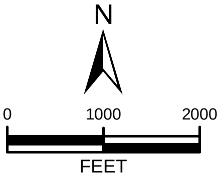

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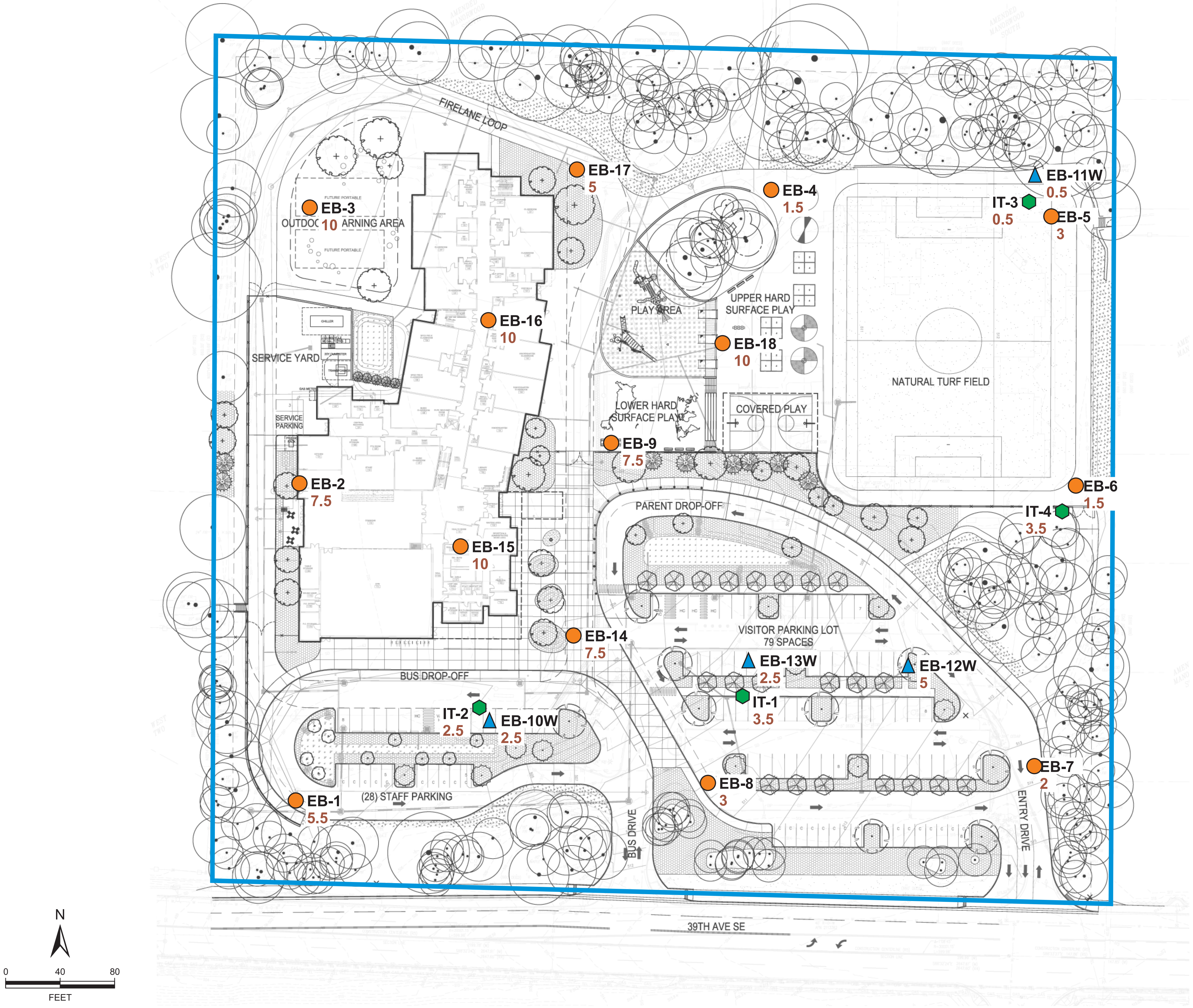

LEGEND:

● **EB**	EXPLORATION BORING
▲ **MW**	MONITORING WELL
⬢ **IT**	INFILTRATION TEST
XX.X	DEPTH (FT) TO BEARING BELOW EXISTING GRADE
—	SITE BOUNDARY

CONTOUR INTERVAL = 1'

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

NOTES:

1. BASE MAP REFERENCE: WEISMAN DESIGN GROUP, SCHOOL REPLACEMENT LANDSCAPE SITE PLAN, SHEET L-100, SCHEMATIC DESIGN 4/21/17, PROGRESS PRINT 6/23/2017

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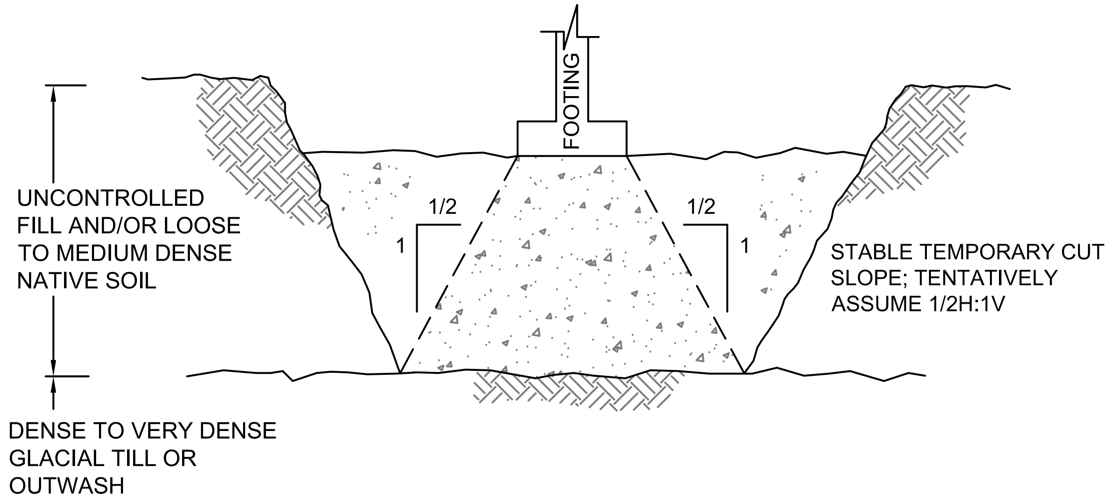
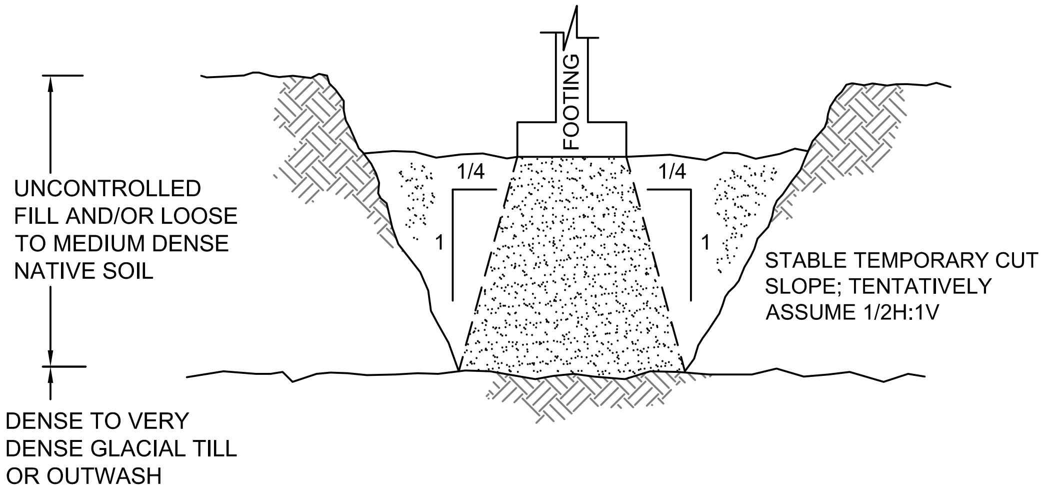
SITE AND EXPLORATION PLAN

SUNRISE ELEMENTARY SCHOOL
PUYALLUP, WASHINGTON

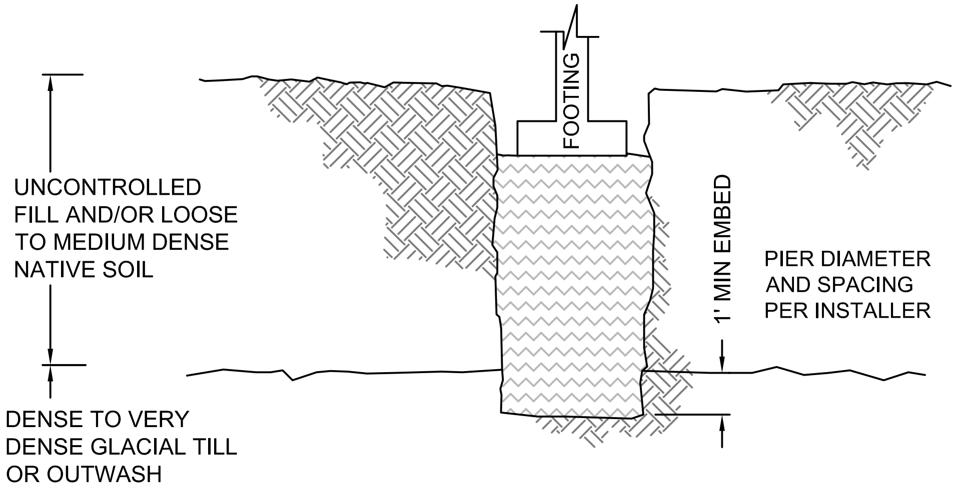
PROJ NO.	DATE:	FIGURE:
160628E001	8/17	2



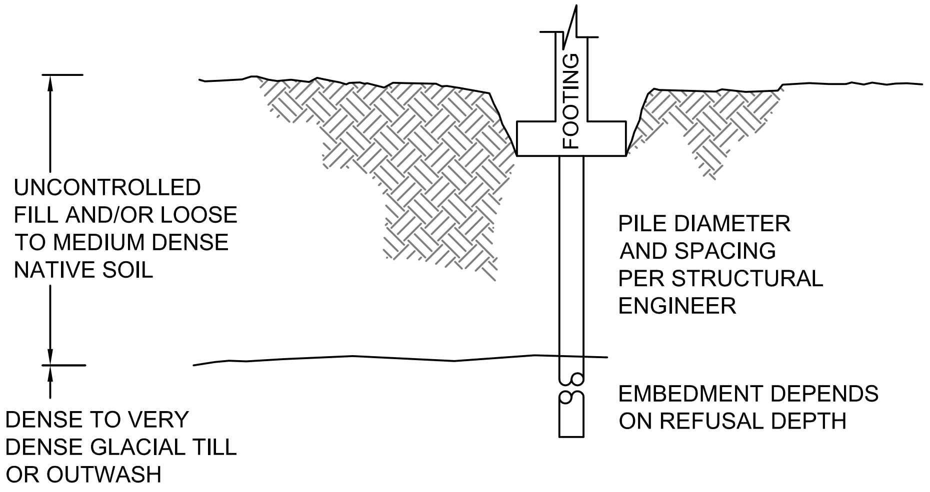
OPTION 1
OVEREXCAVATE AND REPLACE WITH QUARRY SPALLS OR RAILROAD BALLAST;
ALLOWABLE STATIC BEARING PRESSURE = 6000psf



OPTION 2
OVEREXCAVATE AND REPLACE WITH LEAN MIX CONCRETE [LMC]
OR CONTROLLED DENSITY FILL [CDF];
ALLOWABLE STATIC BEARING PRESSURE = 6000psf



OPTION 3
INSTALL COMPACTED AGGREGATE PIERS;
ALLOWABLE STATIC BEARING PRESSURE = 6000psf



OPTION 4
INSTALL DRIVEN STEEL PIN PILES TO REFUSAL;
ALLOWABLE PILE CAPACITIES RANGE FROM
4 KIPS TO 30 KIPS DEPENDING ON PILE DIAMETER.

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE

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FOOTING SUPPORT DIAGRAMS

SUNRISE ELEMENTARY SCHOOL
PUYALLUP, WASHINGTON

PROJ NO.	DATE:	FIGURE:
160628E001	1/17	3

APPENDIX A

Exploration Logs

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)

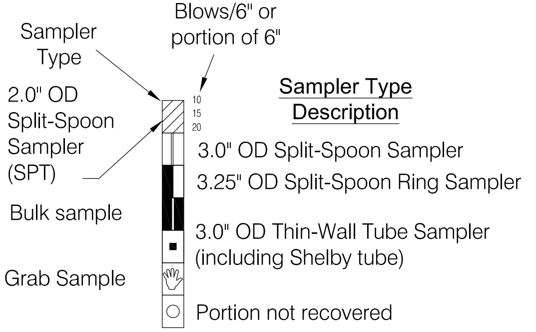
(3) Estimated Percentage

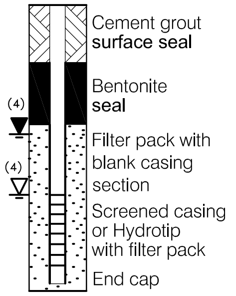
Component	Percentage by Weight
Trace	<5
Some	5 to <12
Modifier (silty, sandy, gravelly)	12 to <30
Very *modifier* (silty, sandy, gravelly)	30 to <50

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.

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EXPLORATION LOG KEY

FIGURE A1

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

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Exploration Log

Project Number	Exploration Number	Sheet
160628E001	EB-1	1 of 1

Project Name Sunrise Elementary School
Location Puyallup, WA
Driller/Equipment Holocene Drilling, Inc. / Track Mtd D-50 HSA
Hammer Weight/Drop 140# / 30"
Ground Surface Elevation (ft) 501.7
Datum Project Datum
Date Start/Finish 12/22/16,12/22/16
Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
	✋	S-1		**Asphalt - 2 inches** **Fill - Uncontrolled** Slightly moist to moist, brown, silty, fine to medium SAND, some fine gravel; unsorted (SM).					
	☐	S-2		No recovery.			12 8 2	▲10	
5		S-3		Loose to medium dense, slightly moist, grayish brown to gray, very silty, fine SAND, trace fine gravel; unsorted (SM). Medium dense, slightly moist, brown, silty, fine to medium SAND, some fine gravel; unsorted (SM).			2 9 12	▲21	
10		S-4		Medium dense to dense, slightly moist, brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM). **Weathered Vashon Lodgement Till** Dense, slightly moist, brown, silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).			10 15 20	▲35	
				Vashon Lodgement Till					
15		S-5		Very dense, wet, brown, very silty, fine SAND, some fine to coarse gravel; unsorted (SM). Driller notes perched water making cuttings wet to BOH.			50/3"	▲50/3"	
20		S-6		Very dense, wet, brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).			26 50/3"	▲76/9"	

Bottom of exploration boring at 20.8 feet
Ground water encountered at 15 feet (perched water); no other ground water encountered.
Backfilled with bentonite chips and patched with concrete.

Sampler Type (ST):

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

Logged by: LBK
Approved by: JMB

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Exploration Log

Project Number	Exploration Number	Sheet
160628E001	EB-2	1 of 1

Project Name Sunrise Elementary School
Location Puyallup, WA
Driller/Equipment Holocene Drilling, Inc. / Track Mtd D-50 HSA
Hammer Weight/Drop 140# / 30"
Ground Surface Elevation (ft) 501.6
Datum Project Datum
Date Start/Finish 12/22/16,12/22/16
Hole Diameter (in) 8 inches

Depth (ft)	ST	Samples	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot	Other Tests
	🖑	S-1	**Sod / Fill - Uncontrolled** Moist, brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).					
	▯	S-2	**Fill - Uncontrolled** Medium dense, slightly moist to moist, brown with orange mottling, silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).			10 15 14	▲29	
5	▯	S-3	Medium dense, moist to very moist, brown, fine to medium SAND, some silt, some fine to coarse gravel; unsorted (SP-SM).			10 9 12	▲21	
10	▯	S-4	**Vashon Advance Outwash** Dense, slightly moist, grayish brown, fine to coarse SAND, some fine to coarse gravel, trace silt; weakly stratified (SW).			15 21 22	▲43	
15	▯	S-5	Very dense, slightly moist, grayish brown, silty, gravelly, fine to coarse SAND; weakly stratified (SM).			22 28 50/6"	▲78/12"	
20	▯	S-6	Very dense, slightly moist, gray, very silty, medium to coarse SAND, some fine gravel; weakly stratified (SM). Very dense, slightly moist, grayish brown, fine to coarse SAND, some fine to coarse gravel, trace silt; stratified (SW). Bottom of exploration boring at 20.5 feet No ground water encountered. Backfilled with bentonite chips and replaced sod.			50/6"	▲50/6"	

Sampler Type (ST):

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

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Exploration Log

Project Number	Exploration Number	Sheet
160628E001	EB-3	1 of 1

Project Name	Sunrise Elementary School	Ground Surface Elevation (ft)	502.1
Location	Puyallup, WA	Datum	Project Datum
Driller/Equipment	Holocene Drilling, Inc. / Track Mtd D-50 HSA	Date Start/Finish	12/22/16,12/22/16
Hammer Weight/Drop	140# / 30"	Hole Diameter (in)	8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
				Sod / Fill - Uncontrolled					
	✋	S-1		Moist, dark brown, silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).					
	▯	S-2		Loose to medium dense, very moist, brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).			1 5 8	▲13	
5	▯	S-3		Medium dense, very moist, dark brown, silty, gravelly, fine to medium SAND, some organics; unsorted; blow counts likely overstated due to gravel content (SM).			1 18 14	▲32	
				Vashon Lodgement Till					
10	▯	S-4		Very dense, slightly moist, grayish brown, very silty, fine SAND, some fine to coarse gravel; unsorted (SM).			9 21 30	▲51	
				Vashon Advance Outwash					
15	▯	S-5		Very dense, slightly moist, grayish brown, gravelly, fine to coarse SAND, some to trace silt; stratified (SW-SM).			15 31 50/6"	▲81/12"	
20	▯	S-6		No recovery; bouncing on gravel.			50/1"	▲50/1"	

Bottom of exploration boring at 20.1 feet
No ground water encountered.
Backfilled with bentonite chips and replaced sod.

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)

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Exploration Log

Project Number	Exploration Number	Sheet
160628E001	EB-4	1 of 1

Project Name: Sunrise Elementary School
Location: Puyallup, WA
Driller/Equipment: Holocene Drilling, Inc. / Track Mtd D-50 HSA
Hammer Weight/Drop: 140# / 30"
Ground Surface Elevation (ft): 511.3
Datum: Project Datum
Date Start/Finish: 12/22/16,12/22/16
Hole Diameter (in): 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot	Other Tests
	✋	S-1		**Fill - Uncontrolled** Slightly moist, dark brown, silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).					
	▯	S-2		**Weathered Vashon Advance Outwash** Medium dense, slightly moist, grayish brown, fine to coarse SAND, some fine to coarse gravel, some to trace silt; weakly stratified (SW-SM).			7 7 14	▲21	
5	▯	S-3		**Vashon Advance Outwash** Dense, slightly moist, grayish brown, gravelly, fine to coarse SAND, trace silt; stratified (SW).			8 19 30	▲49	
10	▯	S-4		Dense, slightly moist, grayish brown, fine to medium SAND, some fine to coarse gravel, some coarse sand, trace silt, with thin (<1/16 inch thick) silt stringers; stratified (SW).			16 18 21	▲39	
15	▯	S-5		Very dense, slightly moist, grayish brown, gravelly, fine to medium SAND, trace silt, with thin (1/8 to 1/16 inch thick) silt stringers (SP).			8 40 42	▲82	
20	▯	S-6		Very dense, slightly moist, grayish brown with faint iron-oxide staining, gravelly, fine to coarse SAND, some silt; weakly cemented; weakly stratified (SW-SM).			32 50/6"	▲82/12"	

Blows/Foot scale: 10 20 30 40

Bottom of exploration boring at 21 feet
No ground water encountered.
Backfilled with bentonite chips.

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)

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Exploration Log

Project Number	Exploration Number	Sheet
160628E001	EB-5	1 of 1

Project Name: Sunrise Elementary School
Location: Puyallup, WA
Driller/Equipment: Holocene Drilling, Inc. / Track Mtd D-50 HSA
Hammer Weight/Drop: 140# / 30"
Ground Surface Elevation (ft): 511.9
Datum: Project Datum
Date Start/Finish: 12/22/16,12/22/16
Hole Diameter (in): 8 inches

Depth (ft)	S T	Samples	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
	🖑	S-1	**Gravel - 2 inches** **Fill - Uncontrolled** Loose to medium dense, slightly moist, brown, gravelly, fine to medium SAND, some silt (SW).					
			As above, very silty (SM).					
	▯	S-2	**Vashon Advance Outwash** Very dense, slightly moist, grayish brown, medium SAND, some fine sand, some coarse sand, some gravel (SW).			15 40 29	▲69	
5	▯	S-3	Very dense, slightly moist, grayish brown, medium SAND, some fine sand, some coarse sand, some gravel (SW). Some cobbles/boulders noted in cuttings. Becomes very silty; cemented (SM).			18 50/5"	▲68/11"	
			Boulder obstruction.					
10			Bottom of exploration boring at 9 feet Due to refusal. Attempt to redrill also resulted in refusal at 9 feet. No ground water encountered. Backfilled with bentonite chips.					
15								
20								

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)

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Exploration Log

Project Number	Exploration Number	Sheet
160628E001	EB-6	1 of 1

Project Name: Sunrise Elementary School
Location: Puyallup, WA
Driller/Equipment: Holocene Drilling, Inc. / Track Mtd D-50 HSA
Hammer Weight/Drop: 140# / 30"

Ground Surface Elevation (ft): 511
Datum: Project Datum
Date Start/Finish: 12/22/16,12/22/16
Hole Diameter (in): 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
		S-1		**Asphalt - 2 inches** **Fill - Uncontrolled** Stiff, slightly moist, dark brown, sandy, gravelly SILT (ML).					
		S-2		**Weathered Vashon Advance Outwash** Medium dense, slightly moist to moist, gray brown, medium SAND, some fine sand, some coarse sand, some gravel, trace pulverized gravel (SP).			5 10 16	▲26	
5		S-3		**Vashon Advance Outwash** Dense, slightly moist, grayish brown, fine to medium SAND, some gravel, some silt, some pulverized oversized gravel; slightly cemented (SP-SM).			12 17 20	▲37	
10		S-4		Very dense, slightly moist, grayish brown, gravelly, silty, medium SAND, some fine sand, some coarse sand, trace pulverized gravel; slightly cemented (SM).			30 35 39	▲74	
15		S-5		Very dense, slightly moist, grayish brown, very gravelly, medium SAND, trace fine sand, trace coarse sand, trace silt, trace pulverized gravel (SP).			35 50/6"	▲85/12"	
20		S-6		**Older Till ?** - Very dense, slightly moist, gray, very silty, fine to medium SAND, trace gravel; poor recovery (SM).			50/4"	▲50/4"	

Bottom of exploration boring at 20.5 feet
No ground water encountered.
Backfilled with bentonite chips and patched with concrete..

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)

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Exploration Log

Project Number	Exploration Number	Sheet
160628E001	EB-7	1 of 1

Project Name: Sunrise Elementary School
Location: Puyallup, WA
Driller/Equipment: Holocene Drilling, Inc. / Track Mtd D-50 HSA
Hammer Weight/Drop: 140# / 30"
Ground Surface Elevation (ft): 512.9
Datum: Project Datum
Date Start/Finish: 12/23/16,12/23/16
Hole Diameter (in): 8 inches

Depth (ft)	S T	Samples	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot	Other Tests
			Asphalt - 3 inches					
	🖑	S-1	**Fill - Uncontrolled** Slightly moist, brown, silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).					
			Vashon Advance Outwash					
		S-2	Dense, slightly moist, grayish brown, fine to coarse SAND, some fine to coarse gravel, trace silt; stratified (SW).			8 17 21	▲38	
5		S-3	Very dense, slightly moist, grayish brown, gravelly, fine to coarse SAND, trace silt; stratified; poor recovery (SW). Driller notes very gravelly conditions.			17 32 43	▲75	
10		S-4	Very dense, slightly moist, grayish brown, sandy GRAVEL, some to trace silt; stratified (GW). Driller notes very difficult drilling conditions.			14 50/2"	▲64/8"	
			Bottom of exploration boring at 11 feet Due to refusal. No ground water encountered. Backfilled with bentonite chips and patched with concrete.					
15								
20								

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: LBK
Approved by: JMB

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Exploration Log

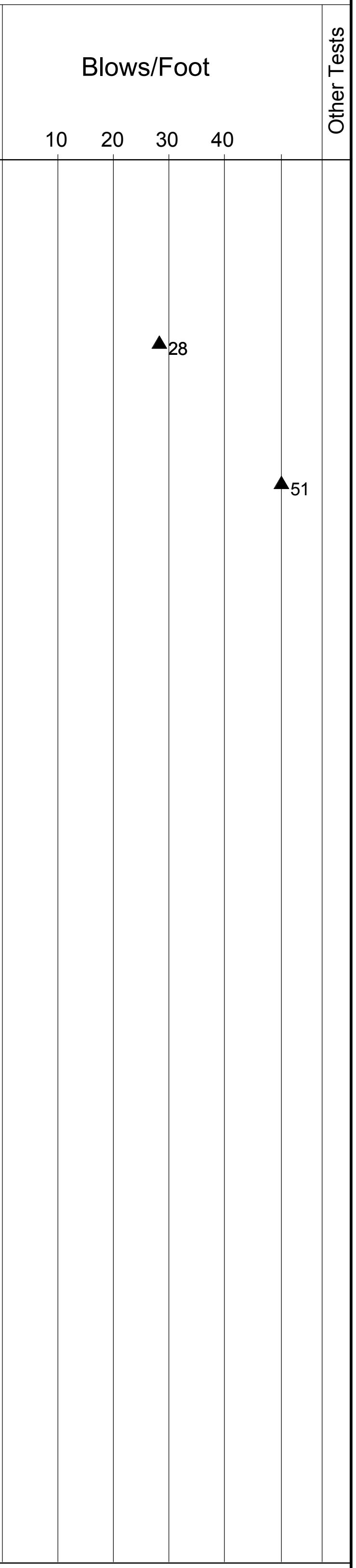
Project Number	Exploration Number	Sheet
160628E001	EB-8	1 of 1

Project Name	Sunrise Elementary School	Ground Surface Elevation (ft)	509.7
Location	Puyallup, WA	Datum	Project Datum
Driller/Equipment	Holocene Drilling, Inc. / Track Mtd D-50 HSA	Date Start/Finish	12/23/16,12/23/16
Hammer Weight/Drop	140# / 30"	Hole Diameter (in)	8 inches

Depth (ft)	S T	Samples	DESCRIPTION	Blows/6"
			Asphalt - 3 inches	
	✋	S-1	**Fill - Uncontrolled** Wet, brown, silty, gravelly, fine to coarse SAND; unsorted (SM).	
		S-2	Loose to medium dense, very moist, brown, silty, gravelly, fine to coarse SAND; unsorted (SM).	4 8 20
			Weathered Vashon Advance Outwash Medium dense, slightly moist, grayish brown with faint iron-oxide staining, gravelly, fine to medium SAND, some to trace silt; stratified; poor recovery (SP-SM).	
5		S-3	**Vashon Advance Outwash** Very dense, slightly moist, grayish brown, gravelly, fine to coarse SAND, trace silt; stratified (SW). Driller notes very difficult drilling conditions due to large gravel. Possible cobbles. Difficulty advancing borehole and lifting cuttings.	5 25 26
10				
15				
20				

Bottom of exploration boring at 7.5 feet
Due to refusal caused by consolidated coarse gravels. No ground water encountered.
Backfilled with bentonite chips and patched with concrete.

Well Completion | Water Level | Other Tests



Sampler Type (ST):

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

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Exploration Log

Project Number	Exploration Number	Sheet
160628E001	EB-9	1 of 1

Project Name: Sunrise Elementary School
Location: Puyallup, WA
Driller/Equipment: Holocene Drilling, Inc. / Track Mtd D-50 HSA
Hammer Weight/Drop: 140# / 30"
Ground Surface Elevation (ft): 510.5
Datum: Project Datum
Date Start/Finish: 12/23/16,12/23/16
Hole Diameter (in): 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot 10 20 30 40	Other Tests
				Concrete - 4 inches					
				Fill - Uncontrolled					
		S-1		Wet, brown, very silty, fine to coarse SAND, some gravel; unsorted (SM).					
		S-2		Loose to medium dense, wet, brown, silty, gravelly, fine to coarse SAND; unsorted (SM).			3 5 5	▲10	
5		S-3		Loose to medium dense, slightly moist, dark brown, very silty, fine SAND, some gravel, some organics (SM). Loose to medium dense, slightly moist, orange, very silty, fine to medium SAND, trace gravel, some organics, some wood fragments; unsorted (SM).			4 4 5	▲9	
				Vashon Advance Outwash					
				Driller notes harder / difficult drilling and thinks change to native formation from fill.					
10		S-4		Very dense, slightly moist, grayish brown, gravelly, fine to medium SAND, some silt; stratified; weakly cemented (SP-SM).			31 33 50/6"	▲83/12"	
15		S-5		Very dense, slightly moist, grayish brown, gravelly, fine to coarse SAND, some silt; stratified; weakly cemented (SW-SM).			15 28 32	▲60	
20		S-6		Very dense, slightly moist to moist, grayish brown with faint iron-oxide staining, gravelly, fine to coarse SAND, some to trace silt; stratified; weakly cemented (SW).			27 50/6"	▲77/12"	
				Bottom of exploration boring at 21 feet No ground water encountered. Backfilled with bentonite chips and patched with concrete.					

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: LBK
Approved by: JMB

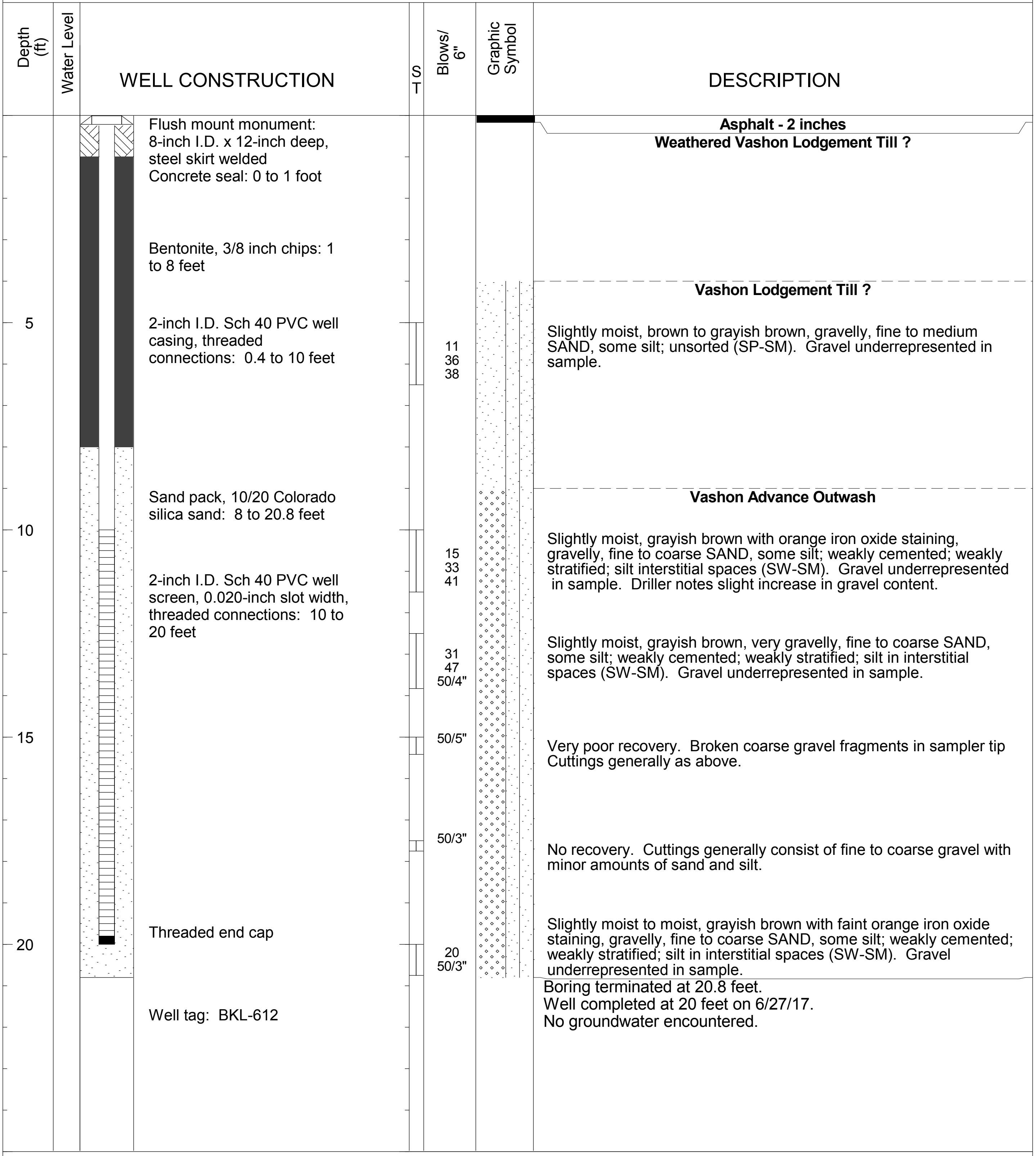
associated earth sciences incorporated

Geologic & Monitoring Well Construction Log

Project Number	Well Number	Sheet
160628E002	EB-10W	1 of 1

Project Name Sunrise Elementary School
Elevation (Top of Well Casing) 503
Water Level Elevation N/A
Drilling/Equipment Holocene Drilling, Inc.
Hammer Weight/Drop 140# / 30"

Location Puyallup, WA
Surface Elevation (ft) 503.5 / Project Datum
Date Start/Finish 6/27/17,6/27/17
Hole Diameter (in) 8 inches



Depth (ft)	Water Level	WELL CONSTRUCTION	S T	Blows/ 6"	Graphic Symbol	DESCRIPTION
		Flush mount monument: 8-inch I.D. x 12-inch deep, steel skirt welded Concrete seal: 0 to 1 foot				**Asphalt - 2 inches** **Weathered Vashon Lodgement Till ?**
		Bentonite, 3/8 inch chips: 1 to 8 feet				
						Vashon Lodgement Till ?
5		2-inch I.D. Sch 40 PVC well casing, threaded connections: 0.4 to 10 feet		11 36 38		Slightly moist, brown to grayish brown, gravelly, fine to medium SAND, some silt; unsorted (SP-SM). Gravel underrepresented in sample.
		Sand pack, 10/20 Colorado silica sand: 8 to 20.8 feet				**Vashon Advance Outwash**
10		2-inch I.D. Sch 40 PVC well screen, 0.020-inch slot width, threaded connections: 10 to 20 feet		15 33 41		Slightly moist, grayish brown with orange iron oxide staining, gravelly, fine to coarse SAND, some silt; weakly cemented; weakly stratified; silt interstitial spaces (SW-SM). Gravel underrepresented in sample. Driller notes slight increase in gravel content.
				31 47 50/4"		Slightly moist, grayish brown, very gravelly, fine to coarse SAND, some silt; weakly cemented; weakly stratified; silt in interstitial spaces (SW-SM). Gravel underrepresented in sample.
15				50/5"		Very poor recovery. Broken coarse gravel fragments in sampler tip Cuttings generally as above.
				50/3"		No recovery. Cuttings generally consist of fine to coarse gravel with minor amounts of sand and silt.
20		Threaded end cap		20 50/3"		Slightly moist to moist, grayish brown with faint orange iron oxide staining, gravelly, fine to coarse SAND, some silt; weakly cemented; weakly stratified; silt in interstitial spaces (SW-SM). Gravel underrepresented in sample.
		Well tag: BKL-612				Boring terminated at 20.8 feet. Well completed at 20 feet on 6/27/17. No groundwater encountered.

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: LBK
Approved by: JMB

associated earth sciences incorporated

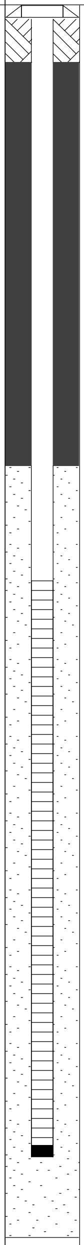
Geologic & Monitoring Well Construction Log

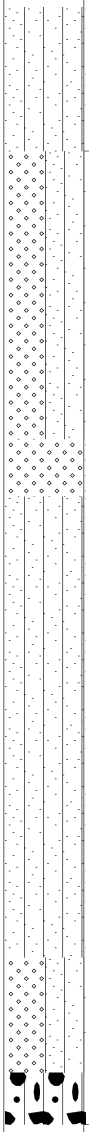
Project Number	Well Number	Sheet
160628E002	EB-11W	1 of 1

Project Name: Sunrise Elementary School
Elevation (Top of Well Casing): 510.5
Water Level Elevation: N/A
Drilling/Equipment: Holocene Drilling, Inc.
Hammer Weight/Drop: 140# / 30"

Location: Puyallup, WA
Surface Elevation (ft): 511 / Project Datum
Date Start/Finish: 6/27/17,6/27/17
Hole Diameter (in): 8 inches

Depth (ft)	Water Level	WELL CONSTRUCTION	S T	Blows/ 6"	Graphic Symbol	DESCRIPTION
		Flush mount monument: 8-inch I.D. x 12-inch deep, steel skirt welded Concrete seal: 0 to 1 foot				**Grass / Weathered Vashon Lodgement Till**
		Bentonite, 3/8 inch chips: 1 to 8 feet		26 45 27		Slightly moist, brown, silty, gravelly, fine to medium SAND; unsorted (SM). Blow counts possibly overstated. Gravel content underrepresented in sample.
5		2-inch I.D. Sch 40 PVC well casing, threaded connections: 0.4 to 10 feet		13 27 4		**Vashon Advance Outwash** Slightly moist, brown to grayish brown, gravelly, fine to medium SAND, some silt; weakly stratified (SW-SM). Gravel underrepresented in sample.
				19 25 24		Slightly moist, brown to grayish brown with faint orange iron oxide staining, very gravelly, fine to coarse SAND, some silt; weakly cemented; weakly stratified; silt in interstitial spaces (SW-SM). Gravel underrepresented in sample.
10		Sand pack, 10/20 Colorado silica sand: 8 to 21.4 feet 2-inch I.D. Sch 40 PVC well screen, 0.020-inch slot width, threaded connections: 10 to 20 feet		14 25 50/4"		Slightly moist, grayish brown, fine to coarse SAND, some fine gravel, trace silt; stratified (SW). Slightly moist, grayish brown with orange iron oxide staining, silty, gravelly, fine to coarse SAND; weakly stratified; silt in interstitial spaces (SM).
15				24 50/4"		Slightly moist to moist, grayish brown with orange iron oxide staining, very silty, gravelly, fine to coarse SAND; weakly cemented; weakly stratified; silt in interstitial spaces (SM).
20		Threaded end cap		32 36 50/5"		Moist, grayish brown, fine to coarse SAND, some fine gravel, some silt; stratified (SW-SM). Moist to very moist, orangish brown, very silty, fine GRAVEL, some sand; weakly stratified; silt in interstitial spaces (GM).
		Well tag: BKL-613				Boring terminated at 21.4 feet. Well completed at 20 feet on 6/27/17. No groundwater encountered.





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: LBK
Approved by: JMB

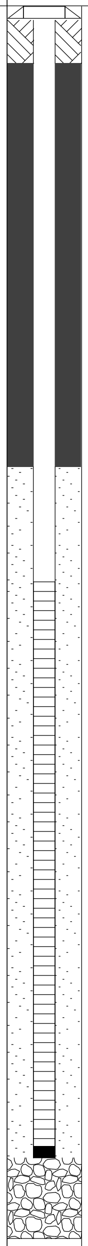
associated earth sciences incorporated

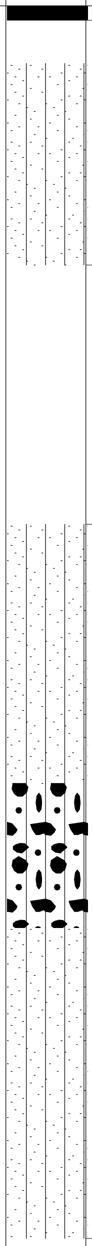
Geologic & Monitoring Well Construction Log

Project Number	Well Number	Sheet
160628E002	EB-12W	1 of 1

Project Name: Sunrise Elementary School
Elevation (Top of Well Casing): 511
Water Level Elevation: N/A
Drilling/Equipment: Holocene Drilling, Inc.
Hammer Weight/Drop: 140# / 30"

Location: Puyallup, WA
Surface Elevation (ft): 511.5 / Project Datum
Date Start/Finish: 6/27/17,6/27/17
Hole Diameter (in): 8 inches





Depth (ft)	Water Level	WELL CONSTRUCTION	ST	Blows/ 6"	Graphic Symbol	DESCRIPTION
0		Flush mount monument: 8-inch I.D. x 12-inch deep, steel skirt welded Concrete seal: 0 to 1 foot				**Asphalt - 3 inches** **Weathered Vashon Lodgement Till ? / Fill - Uncontrolled ?**
		Bentonite, 3/8 inch chips: 1 to 8 feet		22 26 24		Slightly moist, brown, very silty, gravelly, fine to medium SAND; unsorted (SM). Partial recovery due to coarse gravel in sampler tip.
5		2-inch I.D. Sch 40 PVC well casing, threaded connections: 0.4 to 10 feet		17 34 50/6"		**Vashon Lodgement Till ?** No recovery. Cuttings generally consist of fine to coarse gravel with minor amounts of sand and silt.
				50/5"		Very poor recovery; coarse gravel fragments only. Cuttings generally consist of gravel and sand with minor amounts of silt.
		Sand pack, 10/20 Colorado silica sand: 8 to 20 feet				**Vashon Advance Outwash**
10		2-inch I.D. Sch 40 PVC well screen, 0.020-inch slot width, threaded connections: 10 to 20 feet		20 28 42		Slightly moist, grayish brown with orange staining, silty, gravelly, fine to coarse SAND; weakly cemented; weakly stratified; silt in interstitial spaces (SM). Gravel underrepresented in sample.
15				22 45 50/6"		Slightly moist, grayish brown, very silty, fine to coarse GRAVEL, some fine to coarse sand; unsorted (GM). Slightly moist, grayish brown with orange iron oxide staining, silty, fine to coarse SAND, some gravel; weakly cemented; weakly stratified; silt in interstitial spaces (SM).
20		Threaded end cap Slough: 20 to 21.4		11 24 50/5"		Moist, grayish brown with orange mottling, silty, gravelly, fine to coarse SAND; cemented; areas of weak stratification (SM)
		Well tag: BKL-614				Boring terminated at 21.4 feet. Well completed at 20 feet on 6/27/17. No groundwater encountered.

Sampler Type (ST):

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

Logged by: LBK
Approved by: JMB

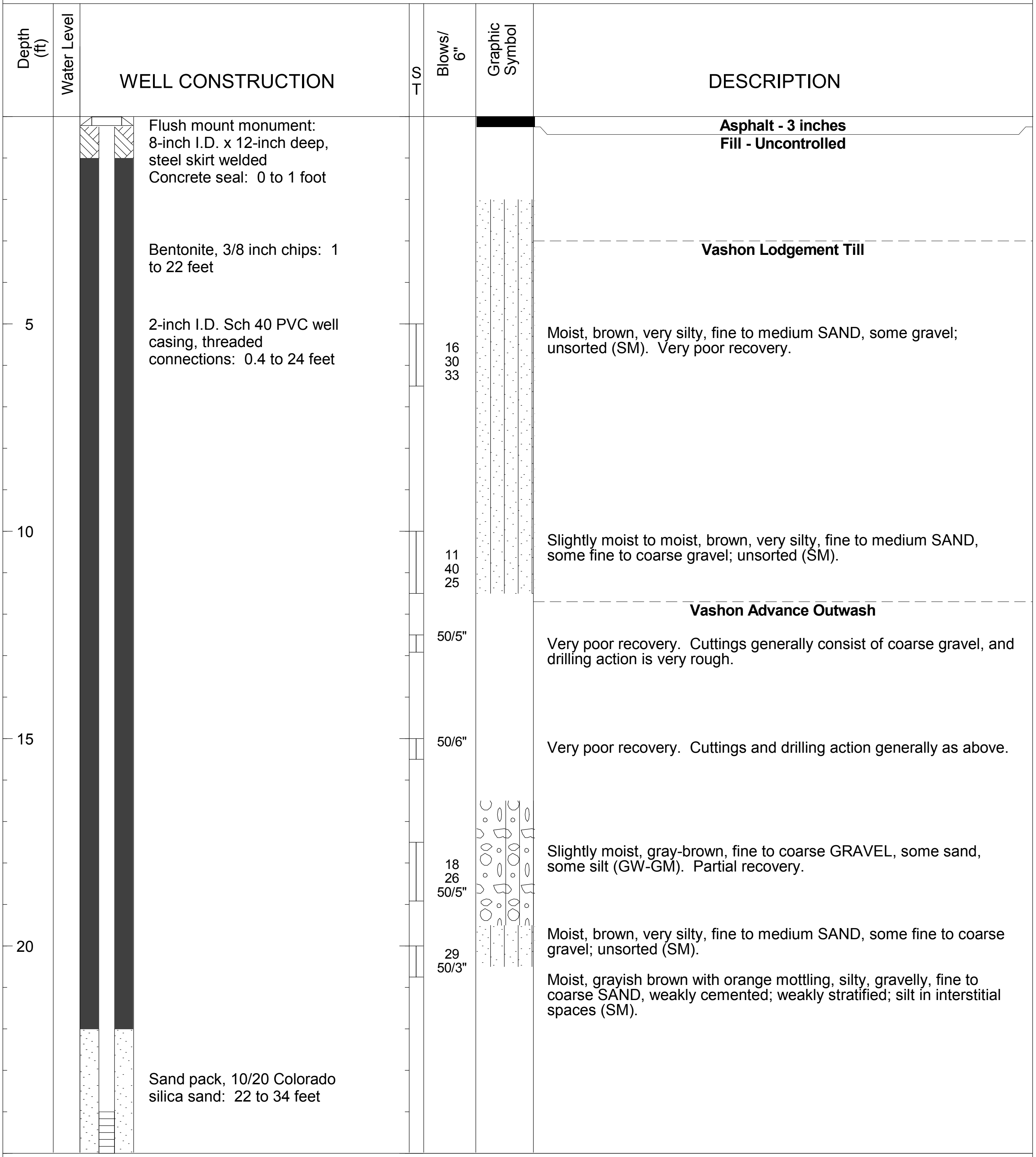
associated earth sciences incorporated

Geologic & Monitoring Well Construction Log

Project Number	Well Number	Sheet
160628E002	EB-13W	1 of 2

Project Name: Sunrise Elementary School
Elevation (Top of Well Casing): 509.5
Water Level Elevation: N/A
Drilling/Equipment: Holocene Drilling, Inc.
Hammer Weight/Drop: 140# / 30"

Location: Puyallup, WA
Surface Elevation (ft): 510 / Project Datum
Date Start/Finish: 6/27/17,6/27/17
Hole Diameter (in): 8 inches



Depth (ft)	Water Level	WELL CONSTRUCTION	S T	Blows/ 6"	Graphic Symbol	DESCRIPTION
		Flush mount monument: 8-inch I.D. x 12-inch deep, steel skirt welded Concrete seal: 0 to 1 foot				**Asphalt - 3 inches** **Fill - Uncontrolled**
		Bentonite, 3/8 inch chips: 1 to 22 feet				**Vashon Lodgement Till**
5		2-inch I.D. Sch 40 PVC well casing, threaded connections: 0.4 to 24 feet		16 30 33		Moist, brown, very silty, fine to medium SAND, some gravel; unsorted (SM). Very poor recovery.
10				11 40 25		Slightly moist to moist, brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).
						Vashon Advance Outwash
				50/5"		Very poor recovery. Cuttings generally consist of coarse gravel, and drilling action is very rough.
15				50/6"		Very poor recovery. Cuttings and drilling action generally as above.
				18 26 50/5"		Slightly moist, gray-brown, fine to coarse GRAVEL, some sand, some silt (GW-GM). Partial recovery.
20				29 50/3"		Moist, brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM). Moist, grayish brown with orange mottling, silty, gravelly, fine to coarse SAND, weakly cemented; weakly stratified; silt in interstitial spaces (SM).
		Sand pack, 10/20 Colorado silica sand: 22 to 34 feet				

Sampler Type (ST):

▯ 2" OD Split Spoon Sampler (SPT)	▯ No Recovery	M - Moisture	**Logged by:** LBK
▯ 3" OD Split Spoon Sampler (D & M)	▮ Ring Sample	▽ Water Level ()	**Approved by:** JMB
Grab Sample	Shelby Tube Sample	▼ Water Level at time of drilling (ATD)	

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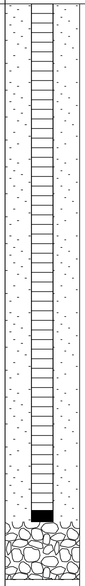
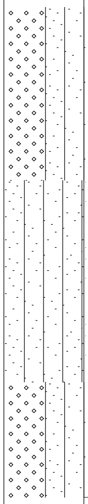
Geologic & Monitoring Well Construction Log

Project Number	Well Number	Sheet
160628E002	EB-13W	2 of 2

Project Name Sunrise Elementary School
Elevation (Top of Well Casing) 509.5
Water Level Elevation N/A
Drilling/Equipment Holocene Drilling, Inc.
Hammer Weight/Drop 140# / 30"

Location Puyallup, WA
Surface Elevation (ft) 510 / Project Datum
Date Start/Finish 6/27/17,6/27/17
Hole Diameter (in) 8 inches





Depth (ft)	Water Level	WELL CONSTRUCTION	S T	Blows/ 6"	Graphic Symbol	DESCRIPTION
		2-inch I.D. Sch 40 PVC well screen, 0.020-inch slot width, threaded connections: 24 to 34 feet		24 50/2"		Slightly moist, grayish brown with orange iron oxide staining, silty, fine to coarse SAND, some fine to coarse gravel; weakly cemented; weakly stratified; silt in interstitial spaces (SM).
				6 50/5"		Slightly moist to moist, grayish brown with orange iron oxide staining, gravelly, fine to coarse SAND, some silt; stratified (SW-SM). Upper 6 inches of sample was slough and not collected or logged.
30				50/3"		Very moist, grayish brown, silty, fine to coarse SAND, some fine to coarse gravel; weakly stratified (SM).
		Threaded end cap Slough: 34 to 35 feet		36 50/4"		Very moist, grayish brown, silty, gravelly, fine to coarse SAND; weakly stratified (SM). Slightly moist, grayish brown, gravelly, fine to coarse SAND, some silt; stratified (SW-SM). Gravel fragments in tip.
35		Well tag: BKL-615		50/0"		Boring terminated at 35 feet. Well completed at 34 feet on 6/27/17. No groundwater encountered.
40						
45						

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: LBK
Approved by: JMB

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Exploration Log

Project Number	Exploration Number	Sheet
160628E001	EB-14	1 of 1

Project Name: Sunrise Elementary School
Location: Puyallup, WA
Driller/Equipment: Holocene Drilling, Inc. / Track Mtd D-50 HSA
Hammer Weight/Drop: 140# / 30"
Ground Surface Elevation (ft): 504
Datum: Project Datum
Date Start/Finish: 8/2/17,8/2/17
Hole Diameter (in): 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot 10 20 30 40	Other Tests
				Sod / Fill - Uncontrolled					
	▯	S-1		Dry, light brown, very silty, fine SAND, some fine to coarse gravel (SM). Gravel underrepresented in sample. Blow counts likely overstated due to gravel content.			50/6"	▲50/6"	
				Vashon Recessional Outwash ?					
5	▯	S-2		Slightly moist to dry, brown, fine to coarse SAND, some fine to coarse gravel, trace silt; weakly stratified (SW). Abundant coarse gravel in cuttings.			14 13 7	▲20	
				Vashon Advance Outwash					
	▯	S-3		Slightly moist, brown with orange iron oxide mottling, very silty, fine to coarse SAND, some fine to coarse gravel; silt in interstitial spaces (SM).			29 23 33	▲56	
10	▯	S-4		Slightly moist to moist, brown with orange iron oxide mottling, silty, gravelly, fine to coarse SAND; weakly stratified; abundant gravel fragments; gravel content underrepresented in sample (SM).			25 37 39	▲76	
	▯	S-5		Slightly moist, grayish brown, fine to medium SAND, trace fine gravel, trace silt grading to fine SAND, some silt, trace fine to coarse gravel; massive (SP/SP-SM).			21 37 50/3"	▲87/9"	
15	▯	S-6		Slightly moist to moist, grayish brown with faint orange iron oxide mottling, silty, gravelly, fine to coarse SAND;vague stratification (SM).			50/6"	▲50/6"	
	▯	S-7		Slightly moist, grayish brown, very gravelly, silty, fine to coarse GRAVEL; weakly stratified; silt interstitial spaces; abundant coarse gravel fragments (SM).			32 50/6"	▲82/12"	
20	▯	S-8		Moist, brown with orange iron oxide mottling, very silty, fine to coarse SAND, some fine to coarse gravel; areas of vague stratification; scattered gravel fragments (SM).			50/6"	▲50/6"	

Bottom of exploration boring at 20.5 feet
No ground water encountered.
Backfilled with bentonite and replaced sod.

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: LBK
Approved by: JMB

associated earth sciences incorporated

Exploration Log

Project Number	Exploration Number	Sheet
160628E001	EB-15	1 of 1

Project Name: Sunrise Elementary School
Location: Puyallup, WA
Driller/Equipment: Holocene Drilling, Inc. / Track Mtd D-50 HSA
Hammer Weight/Drop: 140# / 30"
Ground Surface Elevation (ft): 503
Datum: Project Datum
Date Start/Finish: 8/2/17,8/2/17
Hole Diameter (in): 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot 10 20 30 40	Other Tests
				Sod / Fill - Uncontrolled ? / Vashon Ice Contact ?					
		S-1		Moist, orangish brown, very silty, fine to medium SAND; unsorted (SM). Poor recovery.			2 5 3	8	
5		S-2		Slightly moist, orangish brown, very silty, fine SAND; unsorted (SM). Slightly moist, brown, silty, fine to medium SAND, some coarse sand, some fine gravel; massive (SM).			10 16 13	29	
		S-3		Slightly moist, brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted.			5 19 25	34	
10				**Vashon Advance Outwash**					
		S-4		Slightly moist, brown with fain orange iron oxide mottling, fine to medium SAND, some fine gravel, some silt; weakly stratified (SP-SM). Slightly moist, brown with orange iron oxide mottling, silty, gravelly, fine to coarse SAND; vague stratification; abundant gravel fragments (SM).			19 32 39	71	
		S-5		No recovery. Pounding on gravel. Cuttings generally consist of grayish brown, sand and gravel with minor amounts of silt.			50/6"	50/6"	
15		S-6		Slightly moist, grayish brown to brown, gravelly, fine to medium SAND, some silt; weak stratification (SP-SM). Slightly moist, grayish brown to brown, fine SAND, some gravel, some silt; massive (SP-SM).			31 50/3"	81/9"	
		S-7		Slightly moist, grayish brown, very silty, fine to coarse SAND, some fine to coarse gravel; unsorted; abundant gravel fragments (SM).			50/6"	50/6"	
20		S-8		Moist, grayish brown with orange iron oxide mottling, silty, gravelly, fine to coarse SAND; weakly stratified; silt in interstitial spaces; abundant gravel fragments (SM).			16 50/6"	66/12"	
				Bottom of exploration boring at 21 feet No ground water encountered. Backfilled with bentonite and replaced sod.					

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: LBK
Approved by: JMB

associated earth sciences incorporated

Exploration Log

Project Number	Exploration Number	Sheet
160628E001	EB-16	1 of 1

Project Name: Sunrise Elementary School
Location: Puyallup, WA
Driller/Equipment: Holocene Drilling, Inc. / Track Mtd D-50 HSA
Hammer Weight/Drop: 140# / 30"

Ground Surface Elevation (ft): 504
Datum: Project Datum
Date Start/Finish: 8/2/17,8/2/17
Hole Diameter (in): 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot (10 20 30 40)	Other Tests
				Sod / Fill - Uncontrolled					
		S-1		Dry, brown, very silty, fine SAND, trace gravel; unsorted (SM). Poor recovery.			10 11 7	18	
5		S-2		Slightly moist, orangish brown, silty, gravelly, fine to coarse SAND; unsorted (SM).			12 11 13	24	
		S-3		Dry to slightly moist, brown, silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).			8 18 22	40	
				Vashon Advance Outwash ?					
10		S-4		Slightly moist, grayish brown, gravelly, fine to medium SAND, some silt; weakly stratified; abundant gravel fragments (SP-SM). Partial recovery due to coarse gravel in sampler tip.			19 32 35	67	
				Vashon Advance Outwash					
		S-5		Slightly moist, grayish brown with orange iron oxide mottling, silty, gravelly, fine to coarse SAND; weakly stratified; areas of some to trace silt; abundant gravel fragments (SM).			10 28 29	57	
15		S-6		As above.			38 50/6"	88/12"	
		S-7		Very moist, brown to grayish brown, sandy, gravelly, SILT (ML).			50/3"	50/3"	
20		S-8		Moist, grayish brown, fine to medium SAND, some to trace silt, trace fine gravel; massive (SP).			50/6"	50/6"	

Bottom of exploration boring at 20.5 feet
No ground water encountered.
Backfilled with bentonite chips and replaced sod.

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: LBK
Approved by: JMB

associated earth sciences incorporated

Exploration Log

Project Number	Exploration Number	Sheet
160628E001	EB-17	1 of 1

Project Name: Sunrise Elementary School
Location: Puyallup, WA
Driller/Equipment: Holocene Drilling, Inc. / Track Mtd D-50 HSA
Hammer Weight/Drop: 140# / 30"
Ground Surface Elevation (ft): 506
Datum: Project Datum
Date Start/Finish: 8/2/17,8/2/17
Hole Diameter (in): 8 inches

Depth (ft)	S T	Samples	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot 10 20 30 40	Other Tests
			Sod / Fill - Uncontrolled					
		S-1	Dry, light brown, very silty, fine SAND, trace fine to coarse gravel; unsorted (SM). Poor recovery.			26 23 29	▲52	
5			**Vashon Lodgement Till**					
		S-2	Slightly moist, grayish brown with orange mottling, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).			18 43 21	▲64	
		S-3	Slightly moist, grayish brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).			8 29 27	▲56	
10			**Vashon Advance Outwash**					
		S-4	Moist, grayish brown, silty, gravelly, fine to coarse SAND; weakly stratified; abundant gravel fragments (SM).			10 27 17	▲44	
		S-5	Slightly moist, grayish brown, sandy, GRAVEL, some silt; abundant gravel fragments (GW-GM).			50/6"	▲50/6"	
15		S-6	Slightly moist, grayish brown, silty, sandy, GRAVEL; abundant gravel fragments (GM).			50/6"	▲50/6"	
		S-7	No recovery. Pounding on gravel.			50/3"	▲50/3"	
20		S-8	Moist, grayish brown, silty, gravelly, fine to coarse SAND; vague stratification; abundant gravel fragments (SM).			50/4"	▲50/4"	
			Bottom of exploration boring at 20.4 feet No ground water encountered. Backfilled with bentonite and replaced sod.					

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: LBK
Approved by: JMB

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Exploration Log

Project Number	Exploration Number	Sheet
160628E001	EB-18	1 of 1

Project Name Sunrise Elementary School
Location Puyallup, WA
Driller/Equipment Holocene Drilling, Inc. / Track Mtd D-50 HSA
Hammer Weight/Drop 140# / 30"
Ground Surface Elevation (ft) 511
Datum Project Datum
Date Start/Finish 8/2/17,8/2/17
Hole Diameter (in) 8 inches

Depth (ft)	ST	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot 10 20 30 40	Other Tests
				Gravel Cover / Fill - Uncontrolled					
		S-1		Slightly moist to moist, brown with orange iron oxide mottling, silty, gravelly, fine to coarse SAND; unsorted (SM).			5 5 5	10	
5		S-2		Slightly moist, orangish brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).			4 3 1	4	
		S-3		Slightly moist, grayish brown, very silty, fine to medium SAND, some fine gravel; scattered organics; unsorted (SM).			12 50/6"	62/12"	
				Vashon Advance Outwash					
10		S-4		Slightly moist, grayish brown, silty, fine to coarse SAND, some fine to coarse gravel; weakly stratified (SM).			15 36 28	64	
		S-5		Slightly moist, grayish brown, silty, gravelly, fine to coarse SAND; weakly stratified (SM).			31 43 50/6"	93/12"	
15		S-6		No recovery. Cuttings generally as above.			50/4"	50/4"	
				Bottom of exploration boring at 15.4 feet No ground water encountered. Backfilled with bentonite and replaced gravel.					
20									

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: LBK
Approved by: JMB

LOG OF EXPLORATION PIT NO. IT-1

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Asphalt and Crushed Rock Base Coarse
	Fill ?
1	Medium dense, moist, brown, fine to medium SAND, some fine gravel, trace silt; unsorted (SP).
2	Medium dense, moist, brown, fan to coarse SAND, some fine to coarse gravel, trace silt; unsorted (SP).
3	
	Vashon Lodgement Till
4	Dense, moist, grayish brown, silty, fine to coarse SAND, some fine to coarse gravel (SM); diamict.
5	
6	**Vashon Advance Outwash**
7	Dense, moist, grayish brown, very silty, medium to coarse SAND, some fine to coarse gravel; weakly stratified (SM).
8	
9	
10	Dense, moist, gray, sandy, fine to coarse GRAVEL, some silt; thickly bedded (GP-GM).
11	
12	Dense, moist, grayish brown, silty, medium to coarse SAND, some fine to coarse gravel; stratified with silt seams (SM).
13	
14	
15	
16	Bottom of exploration pit at depth 15 feet No seepage. No caving. Moisture content higher than representative due to infiltration test. Infiltration test performed at 10 feet.
17	
18	
19	
20	

Sunrise Elementary
Puyallup, WA

Logged by: ART

Approved by: JMB

associated earth sciences incorporated

Project No. 160628E002

7/10/17

LOG OF EXPLORATION PIT NO. IT-2

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Weathered Vashon Lodgement Till
1	Medium dense, dry, brown with faint orange mottling, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).
2	
3	**Vashon Lodgement Till**
4	Dense to very dense, slightly moist, brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).
5	**Vashon Advance Outwash** Dense to very dense, slightly moist, grayish brown, gravelly, fine to coarse SAND, some silt, trace cobble; stratified (SW-SM).
6	
7	Becomes moist.
8	
9	Discontinuous silt lenses (2 to 4 inches thick).
10	Ranges to sandy, GRAVEL, some silt (GP-GM).
11	
12	
13	Dense to very dense, wet, grayish brown, very gravelly, fine to coarse SAND, some silt, some cobbles; stratified (SW-SM).
14	
15	
16	Bottom of exploration pit at depth 15 feet Water perched at 13 feet after dig out. Moisture content higher than representative due to infiltration test. Infiltration test performed at 10 feet.
17	
18	
19	
20	

Sunrise Elementary
Puyallup, WA

Logged by: LBK

Approved by: JMB

associated earth sciences incorporated

Project No. 160628E002

7/10/17

LOG OF EXPLORATION PIT NO. IT-3

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Gravel Parking
	Fill
1	Medium dense, moist, brown, gravelly fine to coarse SAND, some silt; cementation; diamict (SP).
2	Dense, moist, grayish brown, fine to coarse SAND, some fine to medium gravel, trace silt; cementation; diamict (SP).
	Vashon Advance Outwash
3	Dense, brown, fine to medium SAND, some fine to medium gravel, trace boulders, trace silt; stratified (SP).
4	
5	Dense, wet, brown, gravelly, SAND (primarily medium), some silt, trace cobble; thickly bedded (SP).
6	
7	Dense, wet, brown, fine to medium SAND, some fine to coarse gravel, trace cobble, trace silt; thickly bedded (SP).
8	
9	
10	
11	Bottom of exploration pit at depth 10 feet Moisture content higher than representative due to infiltration test. Infiltration test performed at 3 feet.
12	
13	
14	
15	
16	
17	
18	
19	
20	

Sunrise Elementary
Puyallup, WA

Logged by: ART

Approved by: JMB

associated earth sciences incorporated

Project No. 160628E002

7/11/17

LOG OF EXPLORATION PIT NO. IT-4

Depth (ft)

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplfication of actual conditions encountered.

DESCRIPTION

Fill

1 Medium dense, dry, light brown, silty, fine to coarse SAND, some fine to coarse gravel; unsorted (SM).

2

3

Vashon Advance Outwash

4 Dense, slightly moist, brown to grayish brown, very gravelly, fine to coarse SAND, some silt; weakly stratified (SW-SM).

5 Occasional cobble.

6

7 Dense to very dense, wet, grayish brown, gravelly, fine to coarse SAND, trace silt, trace cobble; stratified (SW).

8

9

10

11 Bottom of exploration pit at depth 10 feet
No perched water after dig out. Moisture content higher than representative due to infiltration test. Infiltration test performed at 4.7 feet.

12

13

14

15

16

17

18

19

20

Sunrise Elementary
Puyallup, WA

Logged by: LBK
Approved by: JMB

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Project No. 160628E002

7/11/17

APPENDIX B

Field Testing Results

Small Scale Pilot Infiltration Test Data

Project Name Sunrise Elementary
Project Number 160628E002
Date 7/10/2017
Weather Clear, 70's
Test No. IT-1
Meter NW Excavating, 0.3-3 gpm
Water Source Hose bib from school

Pit Area (ft) 3.5x5
Pit Area (ft^2) 15.0
Test Depth (ft) 10
Receptor Soils Advance outwash

Testing Performed By ART

Elapsed Time (minutes)						
Time	**Incre-mental**	**Total**	**Flow Rate (gpm)**	**Stage (feet)**	**Totalizer (gallons)**	**Comments**
8:37:00	0	0	1.94	0.00	0.0	Start
8:40:00	3	3		0.00	0.0	Swapped Meters
8:42:00	2	5	20.22	0.31	26.8	
8:43:00	1	6	20.22	0.53	60.6	
8:44:00	1	7	8.39	0.79	96.1	Flow down to 7.11
8:47:00	3	10	8.39	0.81	106.6	
8:49:00	2	12	7.11	0.88	127.0	
8:52:00	3	15	7.11	0.93	141.7	Water Off
8:53:00	1	16	0.00	0.96	149.0	
8:54:00	1	17	0.00	0.94	149.0	
8:56:00	2	19	0.00	0.87	149.0	
8:59:00	3	22	0.00	0.84	149.0	
9:01:00	2	24	0.00	0.80	149.0	
9:03:00	2	26	0.00	0.78	149.0	
9:05:00	2	28	0.00	0.72	149.0	
9:08:00	3	31	0.00	0.70	149.0	
9:13:00	5	36	0.00	0.67	149.0	
9:16:00	3	39	0.00	0.62	149.0	
9:18:00	2	41	0.00	0.60	149.0	FH calc of ~10 iph
9:22:00	4	45	0.00	0.58	149.0	
9:26:00	4	49	0.42	0.56	149.0	Meter Swapped
9:28:00	2	51	0.42	0.56	156.8	
9:32:00	4	55	0.44	0.52	158.6	
9:35:00	3	58	0.43	0.50	160.1	Flow up to 0.5
9:37:00	2	60	0.50	0.50	161.0	
9:40:00	3	63	0.50	0.50	162.4	
9:45:00	5	68	0.50	0.50	164.6	
9:59:00	14	82	0.50	0.48	171.8	Flow up to 0.58
10:10:00	11	93	0.58	0.46	178.7	Flow up to 0.62
10:20:00	10	103	0.62	0.46	184.5	
10:32:00	12	115	0.62	0.46	192.3	Flow up to 0.68
10:39:00	7	122	0.68	0.45	197.0	
10:54:00	15	137	0.68	0.46	206.3	
11:05:00	11	148	0.68	0.46	214.5	
11:19:00	14	162	0.68	0.46	223.6	
11:30:00	11	173	0.68	0.46	231.1	
11:44:00	14	187	0.69	0.46	240.7	
11:59:00	15	202	0.68	0.47	251.0	
12:15:00	16	218	0.69	0.47	262.7	Flow down to 0.66
12:30:00	15	233	0.66	0.49	272.0	

Elapsed Time (minutes)						
Time	**Incre-mental**	**Total**	**Flow Rate (gpm)**	**Stage (feet)**	**Totalizer (gallons)**	**Comments**
12:45:00	15	248	0.66	0.48	282.2	
12:59:00	14	262	0.66	0.48	291.7	
13:15:00	16	278	0.66	0.48	302.2	
13:29:00	14	292	0.66	0.48	311.5	
13:45:00	16	308	0.66	0.48	322.4	
14:00:00	15	323	0.64	0.48	331.8	
14:14:00	14	337	0.66	0.48	341.2	
14:29:00	15	352	0.66	0.48	351.1	
14:44:00	15	367	0.66	0.48	360.6	
14:59:00	15	382	0.67	0.48	370.8	
15:15:00	16	398	0.67	0.48	381.2	
15:30:00	15	413	0.67	0.48	391.0	
15:37:00	7	420	0.66	0.48	395.8	Water Off/ Falling Head
15:40:15	3.25	423.25		0.46		
15:43:20	3.08	426.33		0.44		
15:46:15	2.92	429.25		0.42		
15:48:20	2.08	431.33		0.40		
15:51:40	3.33	434.67		0.38		
15:57:30	5.83	440.50		0.36		
16:00:05	2.58	443.08		0.34		
16:05:37	5.53	448.62		0.32		
16:08:15	2.63	451.25		0.30		
16:11:10	2.92	454.17		0.28		
16:18:35	7.42	461.58		0.26		
16:21:15	2.67	464.25		0.24		
16:23:15	2.00	466.25		0.22		
16:25:53	2.63	468.88		0.20		end of calc for FH
16:29:14	3.35	472.23		0.18		
16:32:48	3.57	475.80		0.16		
16:35:30	2.70	478.50		0.14		
16:37:15	1.75	480.25		0.12		
16:40:27	3.20	483.45		0.10		

Average Infiltration Rate during last hour of inflow:	3.6	in/hour	
Average Infiltration Rate during falling head:	4.1	in/hour	

Small Scale Pilot Infiltration Test Data

Project Name	Sunrise Elementary	**Pit Area (ft)**	3.4 x 4
Project Number	160628E002	**Pit Area (ft^2)**	13.6
Date	7/10/2017	**Test Depth (ft)**	10
Weather	Clear, 70's	**Receptor Soils**	Advance outwash
Test No.	IT-2		
Meter	NW Excavating, 0.3-3 gpm		
Water Source	NW Excavating, Water Truck	**Testing Performed By**	LBK

Elapsed Time (minutes)						
Time	**Incre-mental**	**Total**	**Flow Rate (gpm)**	**Stage (feet)**	**Totalizer (gallons)**	**Comments**
9:32:00	0	0	5.35	0.00	0.0	Water On
9:38:00	6	6	5.35	0.30	32.3	
9:41:00	3	9	5.46	0.40	44.4	
9:43:00	2	11	5.40	0.50	57.4	Flow down to 2.5
9:48:00	5	16	2.57	0.55	70.8	Flow down to 2.0
9:50:00	2	18	2.05	0.58	75.1	Flow down to 1.0
9:53:00	3	21	1.05	0.58	77.5	Meter Swapped
9:54:00	1	22	1.02	0.56	77.5	
9:56:00	2	24	1.03	0.55	80.5	
10:01:00	5	29	1.03	0.55	85.2	Flow down to 0.69
10:17:00	16	45	0.69	0.48	99.1	
10:30:00	13	58	0.69	0.46	108.0	Flow up to 0.85
10:45:00	15	73	0.83	0.46	120.3	
11:00:00	15	88	0.83	0.48	132.6	
11:15:00	15	103	0.83	0.51	145.0	Flow down to 0.75
11:30:00	15	118	0.77	0.53	157.0	
11:45:00	15	133	0.77	0.54	168.0	
12:00:00	15	148	0.77	0.55	179.5	Flow down to 0.70
12:15:00	15	163	0.70	0.54	190.2	
12:30:00	15	178	0.70	0.54	200.4	
12:45:00	15	193	0.70	0.54	210.9	
13:00:00	15	208	0.70	0.54	221.2	
13:15:00	15	223	0.70	0.52	231.6	
13:30:00	15	238	0.70	0.52	242.0	
13:45:00	15	253	0.69	0.52	252.4	
14:00:00	15	268	0.69	0.51	262.7	
14:15:00	15	283	0.69	0.51	273.1	
14:30:00	15	298	0.69	0.51	283.4	
14:45:00	15	313	0.69	0.51	293.7	
15:00:00	15	328	0.67	0.50	303.9	
15:15:00	15	343	0.69	0.50	314.5	
15:30:00	15	358	0.69	0.50	324.7	
15:35:00	5	363	0.69	0.50	327.9	
15:40:00	5	368	0.69	0.50	331.3	
15:45:00	5	373	0.69	0.50	334.7	
15:50:00	5	378	0.69	0.50	338.2	
15:55:00	5	383	0.69	0.50	341.5	
16:00:00	5	388	0.69	0.50	344.9	
16:05:00	5	393	0.69	0.50	348.2	
16:10:00	5	398	0.69	0.50	351.7	

Elapsed Time (minutes)						
Time	Incre-mental	Total	Flow Rate (gpm)	Stage (feet)	Totalizer (gallons)	Comments
16:15:00	5	403	0.69	0.50	355.1	
16:20:00	5	408	0.69	0.50	358.5	
16:25:00	5	413	0.69	0.50	360.9	
16:30:00	5	418	0.69	0.50	365.3	water off, begin
16:35:50	5.83	423.83		0.48		falling head
16:42:13	6.38	430.22		0.46		
16:47:06	4.88	435.10		0.44		
16:50:12	3.10	438.20		0.40		
16:56:02	5.83	444.03		0.32		
16:58:38	2.60	446.63		0.30		
17:01:09	2.52	449.15		0.28		
17:06:11	5.03	454.18		0.26		
17:08:56	2.75	456.93		0.24		end of calc for FH
17:14:46	5.83	462.77		0.20		end of calc for FH
17:17:19	2.55	465.32		0.18		
17:21:57	4.63	469.95		0.14		
17:25:11	3.23	473.18		0.10		

Average Infiltration Rate during last hour of inflow:	4.8	in/hour	
Average Infiltration Rate during falling head:	4.8	in/hour	

Small Scale Pilot Infiltration Test Data

Project Name	Sunrise Elementary	**Pit Area (ft)**	3.5 x 5
Project Number	160628E002	**Pit Area (ft^2)**	17.5
Date	7/11/2017	**Test Depth (ft)**	2.8
Weather	Clear, 60's	**Receptor Soils**	Advance outwash
Test No.	IT-3		
Meter	NW Excavating, 0.3-3 gpm		
Water Source	NW Excavating, Water Truck	**Testing Performed By**	ART

Elapsed Time (minutes)						
Time	**Incre-mental**	**Total**	**Flow Rate (gpm)**	**Stage (feet)**	**Totalizer (gallons)**	**Comments**
7:45:00	0	0	0.00	0.00	0.0	Water On
7:47:00	2	2	1.54	0.00	2.7	
7:50:00	3	5	1.39	0.10	7.1	
7:58:00	8	13	1.33	0.12	18.1	
8:08:00	10	23	1.33	0.14	31.2	
8:21:00	13	36	1.33	0.14	48.6	
8:29:00	8	44	1.34	0.14	59.5	mid-flow Meter off
8:32:00	3	47	2.26	0.14	59.5	
8:34:00	2	49	2.26	0.14	66.1	low-flow Meter on
8:39:00	5	54	4.02	0.18	81.3	
8:41:00	2	56	4.02	0.22	88.4	
8:43:00	2	58	4.02	0.26	96.3	
8:45:00	2	60	4.02	0.30	106.3	
8:53:00	8	68	4.02	0.40	138.4	
9:10:00	17	85	4.07	0.50	208.4	
9:15:00	5	90	3.55	0.48	221.2	
9:31:00	16	106	3.60	0.48	282.2	flow down
9:44:00	13	119	3.60	0.50	327.3	
10:00:00	16	135	3.66	0.50	385.0	
10:15:00	15	150	3.60	0.50	437.4	
10:29:00	14	164	3.55	0.50	490.6	
10:45:00	16	180	3.55	0.50	544.1	
10:59:00	14	194	3.55	0.50	597.0	
11:14:00	15	209	3.50	0.50	649.0	
11:29:00	15	224	3.50	0.50	700.3	
11:44:00	15	239	3.50	0.50	752.4	
11:59:00	15	254	3.40	0.50	804.6	
12:14:00	15	269	3.50	0.50	855.8	
12:29:00	15	284	3.50	0.50	911.3	
12:44:00	15	299	3.50	0.50	964.3	
12:59:00	15	314	3.50	0.50	1016.1	
13:15:00	16	330	3.66	0.50	1068.9	
13:29:00	14	344	3.55	0.50	1125.2	
13:44:00	15	359	3.55	0.50	1175.1	
14:03:00	19	378	3.50	0.50	1242.5	
14:15:00	12	390	3.50	0.50	1279.6	
14:30:00	15	405	3.45	0.50	1331.2	
14:45:00	15	420	3.50	0.50	1383.2	Water Off / Falling Head
14:45:20	0.33	420.3		0.48		
14:45:30	0.17	420.5		0.46		

Elapsed Time (minutes)						
Time	Incre- mental	Total	Flow Rate (gpm)	Stage (feet)	Totalizer (gallons)	Comments
14:46:07	0.62	421.1		0.44		
14:46:55	0.80	421.9		0.42		
14:47:25	0.50	422.4		0.40		
14:48:20	0.92	423.3		0.38		
14:49:15	0.92	424.3		0.36		
14:49:57	0.70	425.0		0.34		
14:50:40	0.72	425.7		0.32		
14:51:11	0.52	426.2		0.30		
14:52:25	1.23	427.4		0.28		
14:53:05	0.67	428.1		0.26		
14:53:50	0.75	428.8		0.24		
14:54:30	0.67	429.5		0.22		
14:55:04	0.57	430.1		0.20		end of calc for FH
14:55:55	0.85	430.9		0.18		
14:56:35	0.67	431.6		0.16		
14:57:06	0.52	432.1		0.14		
14:57:31	0.42	432.5		0.12		
14:57:55	0.40	432.9		0.10		

Average Infiltration Rate during last hour of inflow:	18.8	in/hour	
Average Infiltration Rate during falling head:	20.7	in/hour	

CONSTANT HEAD DATA

Project Name	Sunrise Elementary	**Pit Area (ft)**	3.4 x 4
Project Number	160628E002	**Pit Area (ft^2)**	13.6
Date	7/11/2017	**Test Depth (ft)**	4.7
Weather	Clear, 60's	**Receptor Soils**	Advance Outwash
Test No.	IT-4		
Meter	NW Excavating, 0.3-3 gpm		
Water Source	Hose bib from school	**Testing Performed By**	LBK

Elapsed Time (minutes)						
Time	**Incre-mental**	**Total**	**Flow Rate (gpm)**	**Stage (feet)**	**Totalizer (gallons)**	**Comments**
8:59:00	0	0	3.69	0.00	0.0	Water On
9:08:00	9	9	3.71	0.18	34.2	
9:10:00	2	11	3.71	0.23	46.4	
9:15:00	5	16	3.73	0.28	60.1	
9:20:00	5	21	3.71	0.31	78.6	
9:25:00	5	26	3.73	0.35	97.3	
9:30:00	5	31	3.75	0.39	116.0	
9:35:00	5	36	3.74	0.41	134.6	
9:40:00	5	41	3.74	0.46	153.2	
9:45:00	5	46	3.74	0.47	171.8	
10:00:00	15	61	3.76	0.49	227.9	
10:15:00	15	76	3.74	0.51	283.9	Flow down to 2.88
10:30:00	15	91	2.88	0.46	329.9	Flow up to 3.25
10:45:00	15	106	3.22	0.42	376.5	Flow up to 3.6
11:00:00	15	121	3.61	0.46	429.8	
11:15:00	15	136	3.63	0.48	483.1	
11:30:00	15	151	3.61	0.48	537.1	
11:45:00	15	166	3.62	0.48	594.8	
12:00:00	15	181	3.63	0.48	647.3	
12:15:00	15	196	3.61	0.48	699.5	
12:30:00	15	211	3.61	0.49	753.7	
12:45:00	15	226	3.62	0.50	808.1	
13:00:00	15	241	3.62	0.50	862.5	
13:15:00	15	256	3.60	0.51	916.3	
13:30:00	15	271	3.60	0.51	970.4	
13:45:00	15	286	3.61	0.51	1024.4	
14:00:00	15	301	3.62	0.51	1078.3	
14:19:00	19	320	3.62	0.52	1146.8	
14:30:00	11	331	3.61	0.52	1186.6	
14:45:00	15	346	3.62	0.52	1240.7	
15:00:00	15	361	3.61	0.52	1294.9	
15:15:00	15	376	3.59	0.52	1349.1	
15:30:00	15	391	3.60	0.52	1403.4	
15:45:00	15	406	3.62	0.52	1457.6	
16:00:00	15	421	3.62	0.52	1512.0	Water Off / Falling Head
16:02:13	2.22	423.22		0.50		
16:03:46	1.55	424.77		0.48		
16:06:09	2.38	427.15		0.45		
16:07:01	0.87	428.02		0.40		
16:08:09	1.13	429.15		0.38		
16:09:07	0.97	430.12		0.35		
16:10:41	1.57	431.68		0.31		

Elapsed Time (minutes)						
Time	Incre-mental	Total	Flow Rate (gpm)	Stage (feet)	Totalizer (gallons)	Comments
16:11:44	1.05	432.73		0.29		
16:12:41	0.95	433.68		0.27		
16:13:24	0.72	434.40		0.25		
16:14:07	0.72	435.12		0.23		
16:15:19	1.20	436.32		0.20		
16:15:58	0.65	436.97		0.18		
16:17:13	1.25	438.22		0.15		
16:18:10	0.95	439.17		0.10		

Average Infiltration Rate during last hour of inflow:	25.6	in/hour	
Average Infiltration Rate during falling head:	18.1	in/hour	

Note:

APPENDIX C

Laboratory Testing Results

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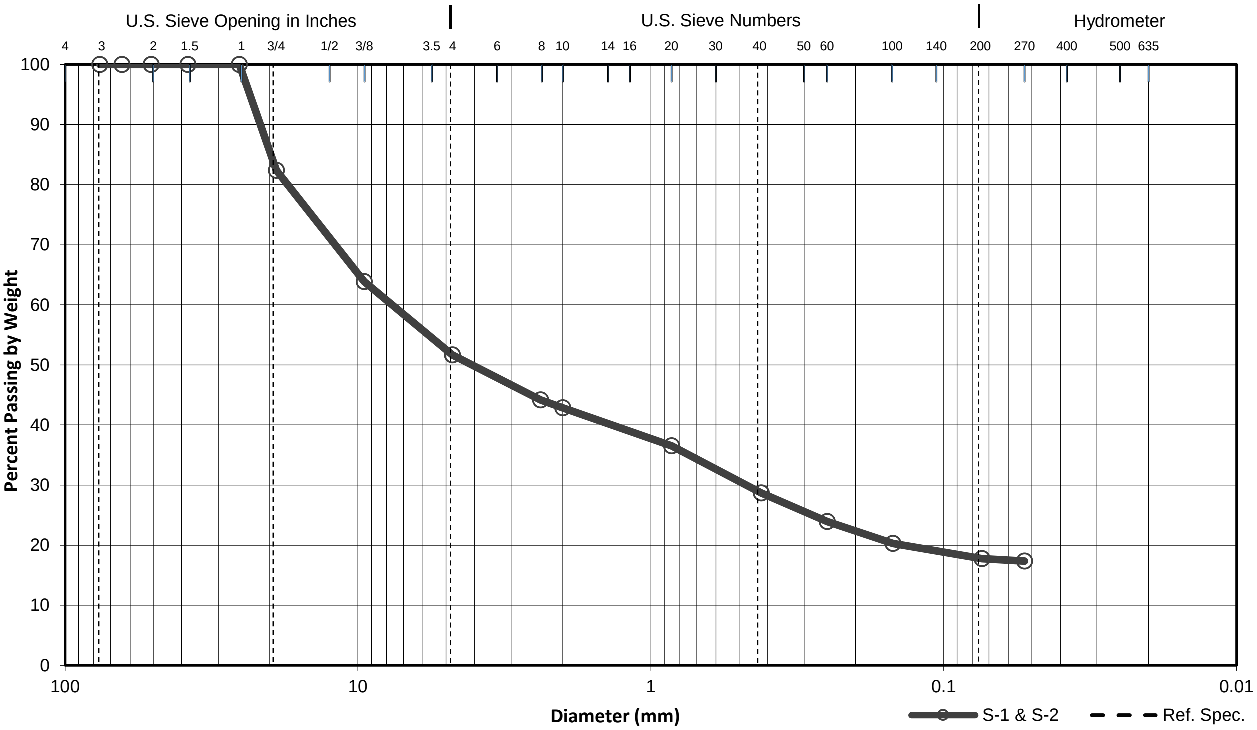
GRAIN SIZE ANALYSIS - MECHANICAL ASTM D422

Project Name	Project Number	Date Sampled	Date Tested	Tested By
Sunrise Elementary	**TE160628A**	**12/2/2016**	**1/16/2017**	**BP**
Sample Source	Sample No.	Depth (ft)	Soil Description	
EB-5	**S-1 & S-2**	**0-4**	**silty, very sandy GRAVEL (GM)**	
Total Sample Dry Wt. (g)	Moisture Content (%)	D_{10} (mm)	Reference Specification	
1690.3	**0**	**<0.01**		



Cobb.	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Sieve No.	Diam. (mm)	Cum. Wt. Ret. (g)	% Ret. by Wt.	% Passing by Wt.	% Specs. Pass. by Wt.	
					Min	Max
3	76.1		0.0	100.0		
2.5	64		0.0	100.0		
2	50.8		0.0	100.0		
1.5	38.1		0.0	100.0		
1	25.4		0.0	100.0		
3/4	19	297.6	17.6	82.4		
3/8	9.51	611.1	36.2	63.8		
#4	4.76	817.2	48.3	51.7		
#8	2.38	943.4	55.8	44.2		
#10	2	966.0	57.1	42.9		
#20	0.85	1073.0	63.5	36.5		
#40	0.42	1205.1	71.3	28.7		
#60	0.25	1285.8	76.1	23.9		
#100	0.149	1347.5	79.7	20.3		
#200	0.074	1390.2	82.2	17.8		
#270	0.053	1396.9	82.6	17.4		

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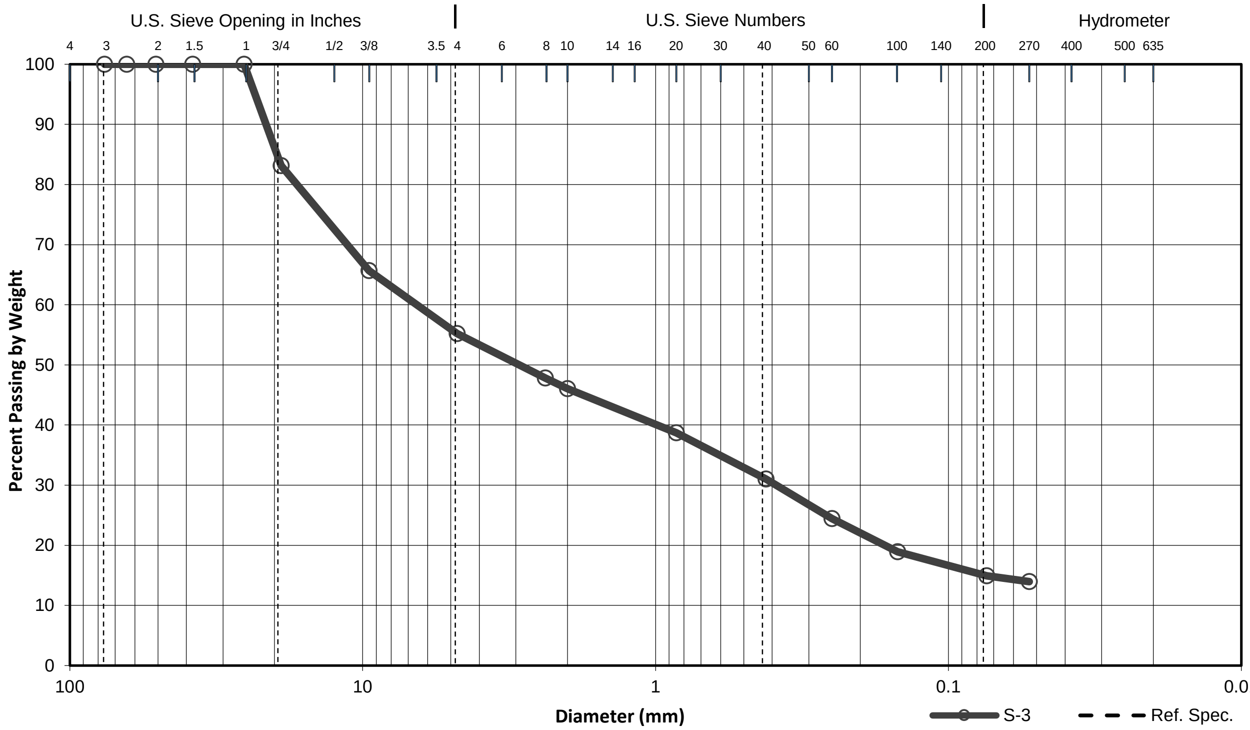
GRAIN SIZE ANALYSIS - MECHANICAL ASTM D422

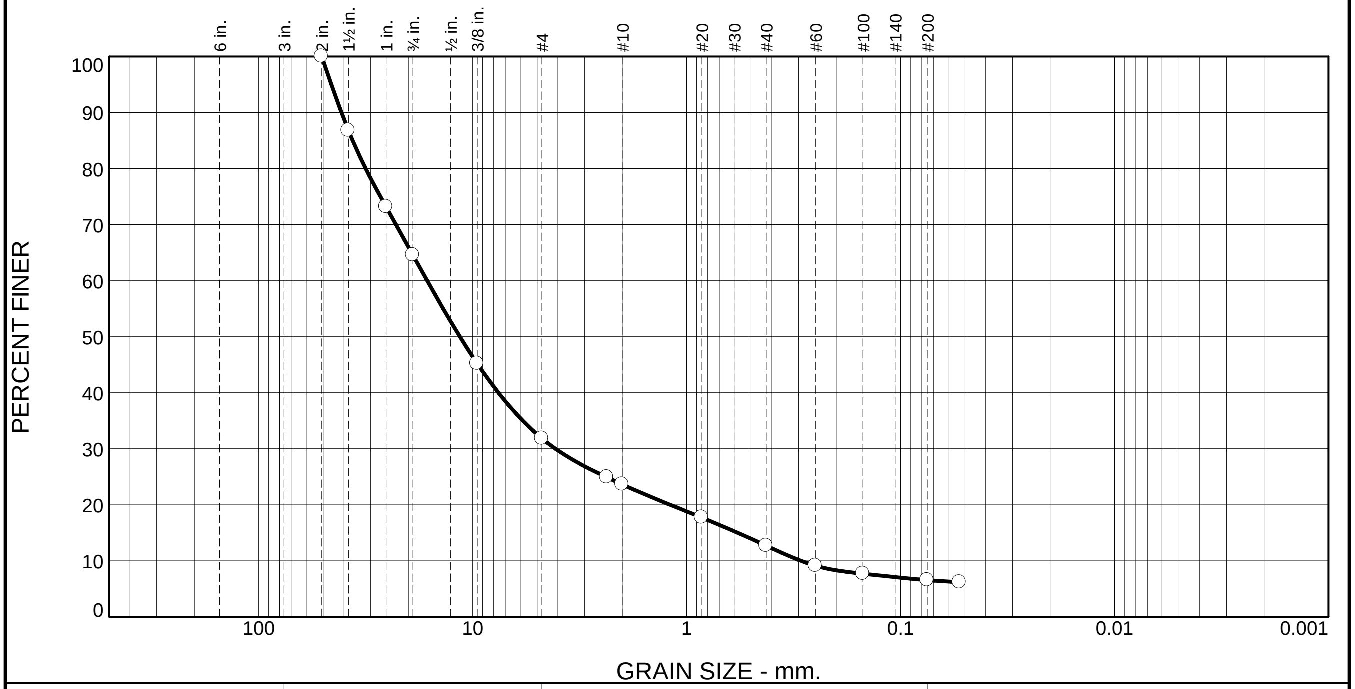
Project Name	Project Number	Date Sampled	Date Tested	Tested By
Sunrise Elementary	**TE160628A**	**12/2/2016**	**1/13/2017**	**BP**
Sample Source	Sample No.	Depth (ft)	Soil Description	
EB-6	**S-3**	**5-6**	**silty, very sandy GRAVEL (GM)**	
Total Sample Dry Wt. (g)	Moisture Content (%)	D_{10} (mm)	Reference Specification	
484.5	**0**	**~0.01**		



Cobb.	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Sieve No.	Diam. (mm)	Cum. Wt. Ret. (g)	% Ret. by Wt.	% Passing by Wt.	% Specs. Pass. by Wt.	
					Min	Max
3	76.1		0.0	100.0		
2.5	64		0.0	100.0		
2	50.8		0.0	100.0		
1.5	38.1		0.0	100.0		
1	25.4		0.0	100.0		
3/4	19	81.6	16.8	83.2		
3/8	9.51	166.3	34.3	65.7		
#4	4.76	216.9	44.8	55.2		
#8	2.38	252.9	52.2	47.8		
#10	2	261.5	54.0	46.0		
#20	0.85	297.0	61.3	38.7		
#40	0.42	334.1	69.0	31.0		
#60	0.25	366.2	75.6	24.4		
#100	0.149	392.8	81.1	18.9		
#200	0.074	412.2	85.1	14.9		
#270	0.053	416.8	86.0	14.0		

Particle Size Distribution Report



<table>
<tr><th rowspan="2">% +3"</th><th colspan="2">% Gravel</th><th colspan="3">% Sand</th><th colspan="2">% Fines</th></tr>
<tr><th>Coarse</th><th>Fine</th><th>Coarse</th><th>Medium</th><th>Fine</th><th>Silt</th><th>Clay</th></tr>
<tr><td>0</td><td>35</td><td>33</td><td>8</td><td>11</td><td>6</td><td colspan="2">7</td></tr>
</table>

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
2	100		
1.5	87		
1	73		
.75	65		
.375	45		
#4	32		
#8	25		
#10	24		
#20	18		
#40	13		
#60	9		
#100	8		
#200	6.5		
#270	6.2		

* (no specification provided)

Material Description

Sandy Gravel Some Silt

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}=	41.0889	D_{85}=	36.4295	D_{60}=	16.3328
D_{50}=	11.4840	D_{30}=	4.1085	D_{15}=	0.5781
D_{10}=	0.2928	C_u=	55.78	C_c=	3.53

Remarks

Date Received: 7-18-17 **Date Tested:** 7-21-17

Tested By: BN

Checked By: JB

Title:

Location: Onsite

Sample Number: IT-1 **Depth:** 10'

Date Sampled: 7-18-17

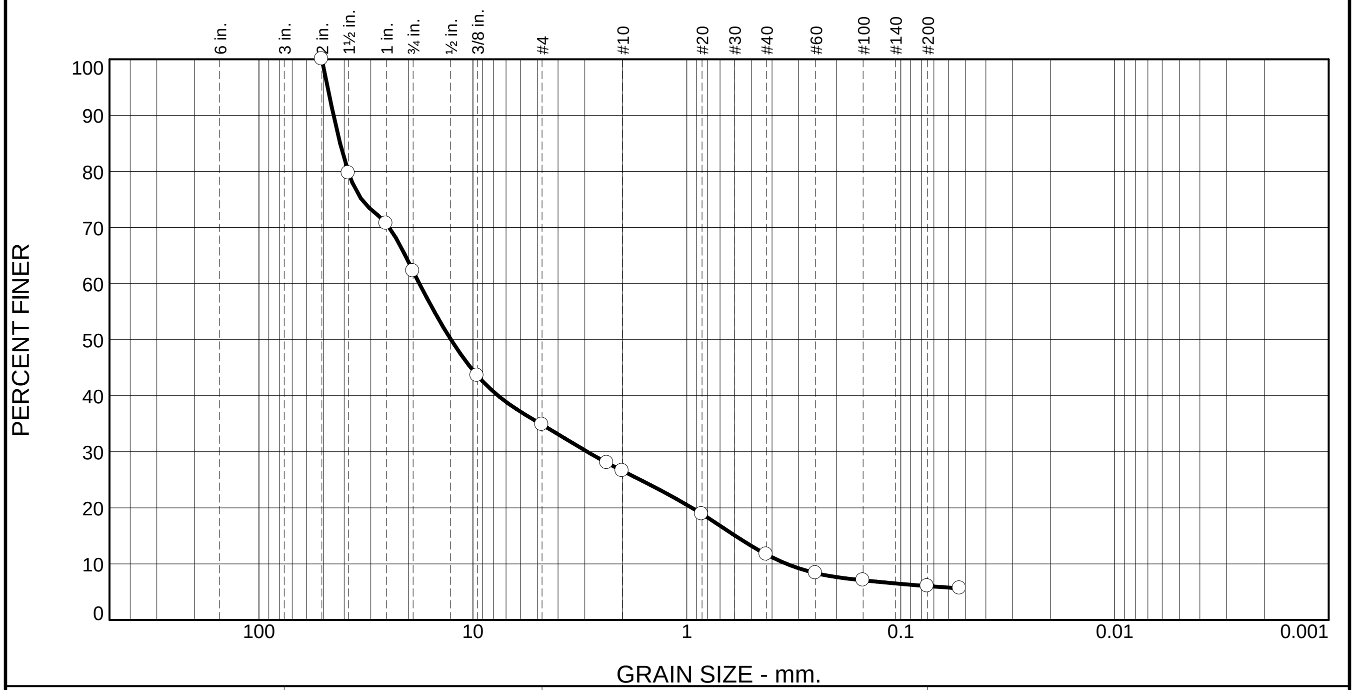
associated earth sciences incorporated

Client: Puyallup School District

Project: Sunrise Elementary School

Project No: 160628 E002 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	38	27	8	15	6	6	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
2	100		
1.5	80		
1	71		
.75	62		
.375	44		
#4	35		
#8	28		
#10	27		
#20	19		
#40	12		
#60	8		
#100	7		
#200	6.0		
#270	5.7		

* (no specification provided)

Material Description

Sandy Gravel Some Silt

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 44.8257	D_{85}= 41.7868	D_{60}= 17.8067
D_{50}= 12.6641	D_{30}= 2.9209	D_{15}= 0.5925
D_{10}= 0.3409	C_u= 52.24	C_c= 1.41

Remarks

Date Received: 7-18-17 **Date Tested:** 7-21-17

Tested By: BN

Checked By: JB

Title:

Location: Onsite

Sample Number: IT-2 **Depth:** 10'

Date Sampled: 7-18-17

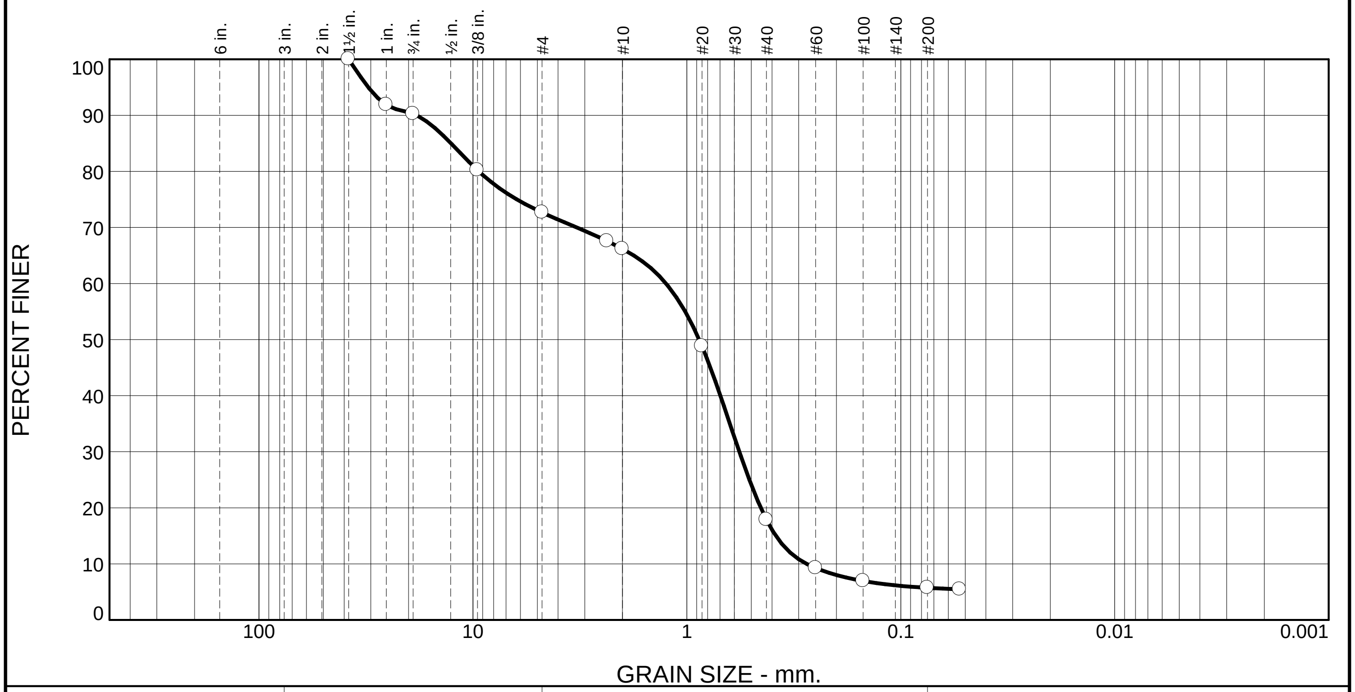
associated earth sciences incorporated

Client: Puyallup School District

Project: Sunrise Elementary School

Project No: 160628 E002 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	10	17	7	48	12	6	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100		
1	92		
.75	90		
.375	80		
#4	73		
#8	68		
#10	66		
#20	49		
#40	18		
#60	9		
#100	7		
#200	5.7		
#270	5.5		

* (no specification provided)

Material Description

Gravelly Sand Some Silt

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 18.3596 D_{85}= 12.6605 D_{60}= 1.2518
D_{50}= 0.8761 D_{30}= 0.5683 D_{15}= 0.3836
D_{10}= 0.2752 C_u= 4.55 C_c= 0.94

Remarks

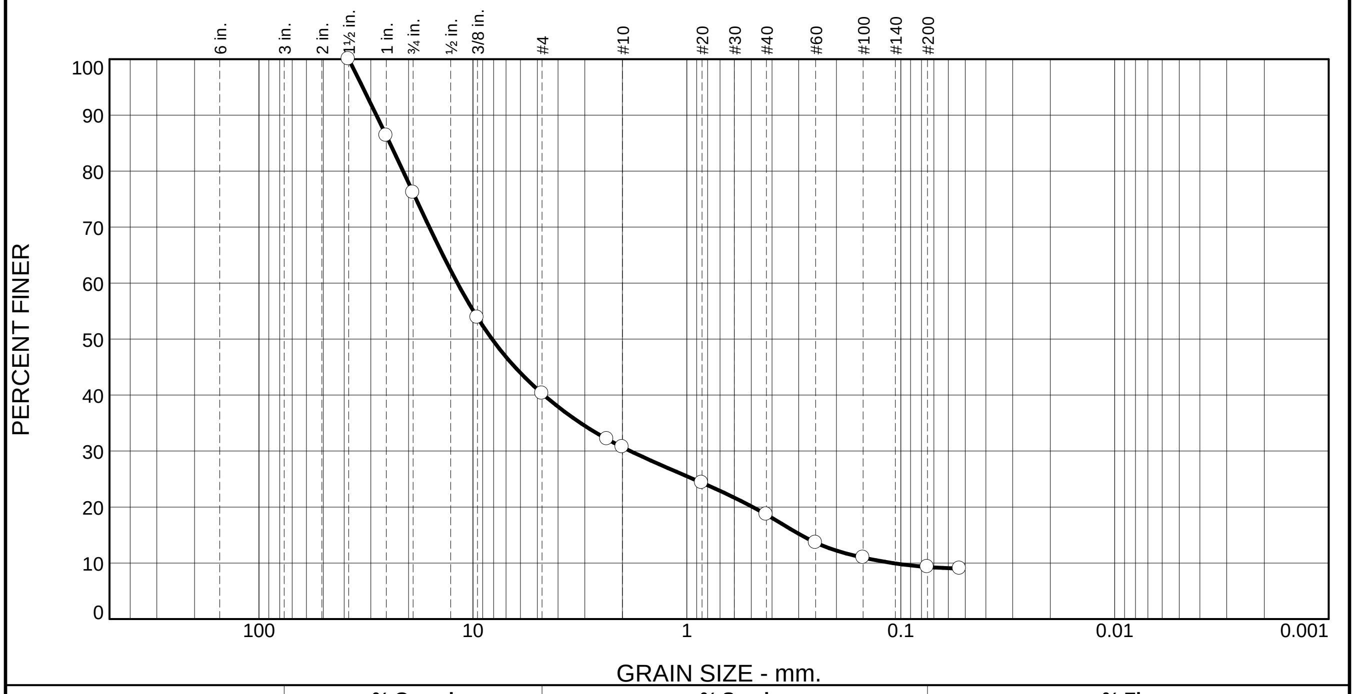
Date Received: 7-18-17 **Date Tested:** 7-21-17
Tested By: BN
Checked By: JB
Title:

Location: Onsite
Sample Number: IT-3 **Depth:** 5'
Date Sampled: 7-18-17

associated earth sciences incorporated

Client: Puyallup School District
Project: Sunrise Elementary School
Project No: 160628 E002 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	24	36	9	12	10	9	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100		
1	86		
.75	76		
.375	54		
#4	40		
#8	32		
#10	31		
#20	24		
#40	19		
#60	14		
#100	11		
#200	9.3		
#270	9.0		

* (no specification provided)

Material Description

Very Sandy Gravel Some Silt

Atterberg Limits (ASTM D 4318)

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

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 28.2532 D_{85}= 24.4408 D_{60}= 11.8096
D_{50}= 8.1391 D_{30}= 1.8331 D_{15}= 0.2927
D_{10}= 0.1088 C_u= 108.51 C_c= 2.61

Remarks

Date Received: 7-18-17 **Date Tested:** 7-21-17
Tested By: BN
Checked By: JB
Title:

Location: Onsite
Sample Number: IT-4 **Depth:** 4.5'
Date Sampled: 7-18-17

associated earth sciences incorporated

Client: Puyallup School District
Project: Sunrise Elementary School
Project No: 160628 E002 **Figure**

SPECTRA Laboratories *...Where experience matters*

2221 Ross Way • Tacoma, WA 98421 • (253) 272-4850 • Fax (253) 572-9838 • www.spectra-lab.com

07/28/2017

Associated Earth Sciences, Inc
911 5th Ave
Kirkland, WA 98033

P.O.#: 160628E002
Project: Sunrise Elementary School
Sample Matrix: Soil
Date Sampled: 07/11/2017
Date Received: 07/18/2017
Spectra Project: 2017070414

Client ID	Spectra #	Analyte	Result	Units	Method
IT-3 @ 2.5 ft	1	Organic Matter	1.0	wt. % Dry	ASTM D-2974-13
IT-3 @ 2.5 ft	1	Cation Exchange Capacity	5.3	Na, mEq/ 100g	SW846 9081
IT-4 @ 2.5 ft	2	Organic Matter	2.6	wt. % Dry	ASTM D-2974-13
IT-4 @ 2.5 ft	2	Cation Exchange Capacity	9.1	Na, mEq/ 100g	SW846 9081

SPECTRA LABORATORIES

Jeffrey Cooper, Laboratory Manager

a7/scj

SPECTRA Laboratories
2221 Ross Way, Tacoma, WA 98421
(253) 272-4850 Fax (253) 572-9838
www.spectra-lab.com info@spectra-lab.com

SPECIAL INSTRUCTIONS/COMMENTS:

CHAIN OF CUSTODY

SPECTRA PROJECT # 201707 0414

Return Samples: Y [✓ N] Page 1 of 1 STANDARD ☒ RUSH ☐

CLIENT: Associated Earth Sciences, Inc
ADDRESS: 1552 Commerce St, Suite 102, Tacoma, WA 98402
ADDRESS CHANGE ☐
PROJECT: Sunrise Elementary School
CONTACT: Lara Koger cc Jim Brisbine
SAMPLED BY: Lara Koger
PHONE: 253-722-2992 FAX: 253-722-2993
e-MAIL: lkoger@aesgeo.com jbrisbine@aesgeo.com Prefer FAX ☐ or e-MAIL ☒
PURCHASE ORDER # 160628E002

	SAMPLE ID	DATE SAMPLED	TIME SAMPLED	MATRIX	NUMBER OF CONTAINERS
1	IT-3 @ 2.5 ft	7/11/2017	0730	Soil	1
2	IT-4 @ 2.5 ft	7/11/2017	0800	Soil	1
3					
4					
5					
6					
7					
8					
9					
10					

	HYDROCARBONS							ORGANICS						METALS						OTHER										
	NWTPH-HCID	BTEX	BTEX/NWTPH-G	NWTPH-G	NWTPH-Dx	1664 SGT-HEM (TPH)	1664 HEM (FOG)	8260/624 VOA	8260 CHLOR SOLVENTS	8270-625 SEMI VOA	8270 PAH/PNA	8082/608 PCB		TOTAL METALS RCRA 8	TOTAL METALS (SPECIFY)		TCLP METALS RCRA 8	TCLP METALS (SPECIFY)		PH 9040/9045	TX/TOX/EOX	TURBIDITY	FLASH POINT	BOD	SOLIDS (SPECIFY)	organic content	cation exchange capacity			
1																										X	X			
2																										X	X			
3																														
4																														
5																														
6																														
7																														
8																														
9																														
10																														

LAB USE ONLY

	SIGNATURE	PRINTED NAME	COMPANY	DATE	TIME
RELINQUISHED BY	Lara Koger	Lara Koger	Associated Earth Sciences	7/18/2017	12:15
RECEIVED BY		Kaitlyn Rilly	Spectra	7/18/17	12:15
RELINQUISHED BY					
RECEIVED BY					

Payment Terms: Net 30 days. Past due accounts subject to 1 1/2% per month interest. Customer agrees to pay all costs of collection including reasonable attorney's fees and all other costs of collection regardless of whether suit is filed in Pierce Co., WA venue. *Spectra Laboratories, LLC*