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*Subsurface Exploration and
Geotechnical Engineering Evaluation*

NORTHWOOD ELEMENTARY SCHOOL

Edgewood, Washington

Prepared For:

PUYALLUP SCHOOL DISTRICT

Project No. TE160417A

October 10, 2016



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

Attention: Larry Vandeberg
Assistant Director of Construction Management

Subject: Subsurface Exploration and Geotechnical Engineering Evaluation
Northwood Elementary School
9805 - 24th Street East
Edgewood, Washington

Dear Mr. Vandeberg:

Associated Earth Sciences, Inc. (AESI) is pleased to submit this report describing our subsurface exploration and geotechnical engineering evaluation concerning the planned replacement of Northwood Elementary School in Pierce County, Washington. Our services were completed in general accordance with our proposal dated August 8, 2016, and were authorized by your *Agreement for Consulting Services* dated August 1, 2016.

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. Brisbane, P.E., L.G., L.E.G.
Senior Associate Geotechnical Engineer

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**SUBSURFACE EXPLORATION AND
GEOTECHNICAL ENGINEERING EVALUATION**

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Edgewood, Washington

Prepared for:

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

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October 10, 2016
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1.0 PROJECT AND SITE DESCRIPTION

The project site comprises an existing elementary school campus located within the city of Edgewood in northern Pierce County, as shown on the attached "Vicinity Map" (Figure 1). This campus is visually delineated by residential properties and farmland on the west and north, by residential and commercial properties on the east, and by 24th Street East on the south. It has a roughly rectangular shape that measures approximately 600 feet by 1,200 feet overall and covers about 16 acres. 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 on the site. Two different conceptual layouts are presently under consideration. One layout ("Group 1") shows all new buildings, a parking lot, and a bus loop in the southwestern quadrant of the site, whereas the second layout ("Group 2") shows new buildings and a parking lot in the northeastern quadrant and a bus loop in the northwestern quadrant. Presumably, all new buildings will be one- or two-story structures composed of steel framing or masonry. Judging by the relatively gentle surface grades, it appears that site grading will involve fairly minor cuts and fills. We understand that storm water runoff will be infiltrated onsite if the subsurface soils render this feasible; if not, then storm water would likely need to be detained onsite and then conveyed offsite.

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 geologic hazards, site preparation, building foundations, floor slabs, retaining walls, drainage systems, pavements, and structural fill. 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 ten exploration borings (designated EB-1 through EB-10) to a maximum depth of about 51 feet, at strategic locations across the site.
- Visually classified all soil samples obtained from our explorations.
- Conducted two laboratory grain-size (sieve) tests on representative samples of the near-surface soils.
- 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 with respect to existing site features. Appendix A contains our exploration logs, and Appendix B contains our laboratory testing results.

3.0 FIELD EXPLORATION PROCEDURES

We explored subsurface conditions at the site on August 30 through September 1, 2016. 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 truck-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 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. Soil descriptions shown on our exploration logs are based on N-values, drilling action, field observations, and laboratory classifications.

4.0 SITE CONDITIONS

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

4.1 Existing Site Development

Presently, the northwestern portion of the campus is occupied by a group of school buildings and associated parking lots, while the northeastern and southwestern portions are occupied by grassy playfields and a storm water detention pond. The southeastern portion is heavily vegetated and appears to be undeveloped.

4.2 Regional and Local Topography

The project site is located on a broad topographic plateau that separates the Puyallup River valley from the White River valley. Regional surface grades across this plateau are moderately undulating and hummocky, which is typical for a post-glacial landscape. Local surface grades across the site vicinity slope gently downward to the north, south, and west, and gently upward to the east. Surprise Lake lies about ½ mile northwest of the site. Within the site boundaries, the ground surface is relatively flat, with an average surface elevation of approximately 360 feet (USGS datum).

4.3 Regional Geology

The 2006 draft *Geologic Map of the Puyallup 7.5-Minute Quadrangle* (1:24,000 scale) indicates that the entire project site vicinity is underlain by Vashon-age glacial lodgement till. This deposit normally comprises an unsorted mixture of silts, sands, gravels, and cobbles. Characteristically, lodgement till possesses a very high density, very high shear strength, and very low permeability. The thickness of this deposit typically ranges from several feet to several

tens of feet. Lodgement till is often mantled by Vashon recessional outwash and/or underlain by advance outwash, both of which are mapped within ½ mile of the site.

4.4 Regional Hydrology

Several deep ground water wells have been installed in the site vicinity for municipal or residential water production purposes. Our review of the well drilling logs indicates that ground water was encountered within sand and gravel layers at approximate depths of 300, 600, and 800 feet below surface grades. One older (1987) log indicates that a static water level was observed at a depth of 80 feet, but this might simply refer to a relatively thin water-bearing soil deposit rather than a water table.

4.5 Local Soils

Our subsurface explorations confirmed the presence of lodgement till below the site, as shown on the regional geology map. However, this deposit is mantled by fill soils and native marsh or lacustrine (lake) sediments in certain locations. The following paragraphs describe our stratigraphic observations, and the exploration logs contained in Appendix A provide additional subsurface information.

Surficial Fill: Half of our exploration borings disclosed a surficial layer that appeared to be fill soils or reworked native soils. This layer variously consisted of medium dense, silty sands and/or medium stiff to stiff, sandy silts. Thicknesses ranged from 1 to 4½ feet.

Marsh and Lake Deposits: Below the surficial fill layer, three of our exploration borings (EB-1, EB-7, and EB-9) revealed a deposit of silt with small amounts of sand or gravel, and variable quantities of roots and organic matter. Consistencies ranged from medium stiff to very stiff, and thicknesses ranged from about 8 to 15 feet. Faint laminae were visible in some samples. These sediments appear to be marsh and/or lake deposits that were later covered by fill soil. All three borings were located in the southwestern portion of the site, where little development has occurred.

Lodgement Till: All ten of our exploration borings disclosed a deposit of sands, silty sands, and gravelly sands, ranging from medium dense to very dense. We interpret these soils to be lodgement till, as shown on the regional geology map, and they extended beyond the termination depths of all borings. At most locations, the till exhibited an upper weathered zone ranging from 2 to 6 feet thick. It should be noted that we detected a strong diesel odor at a depth of about 9 feet within the lodgement till in boring EB-6, which was centered on the southern half of the site.

4.6 Local Ground Water

At the time of drilling, five of our exploration borings encountered ground water seepage at depths ranging from 11 to 33 feet below surface grades. These seepage occurrences appeared to represent isolated ground water zones within the lodgement till deposit, rather than a true ground water table. The presence of orange mottling within the shallow on-site soils indicates that perched water forms during the wet season. At any time of year, ground water levels could fluctuate due to changes in precipitation patterns, off-site development, and other factors.

We understand that a shallow ground water well was installed at the site in 2009, presumably for exploratory purposes. Although we were not able to find this well in the field, we did obtain a copy of the well driller's log. The log shows that the well extended to a depth of 25 feet, and that a sand and gravel layer was observed between depths of 21 and 25 feet. No ground water level is shown on the log.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on our surface reconnaissance, subsurface explorations, 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, excavations, foundations, slab-on-grade floors, drainage systems, pavement sections, and structural fill are presented in the following text sections. The following specification codes are cited herein.

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

5.1 General Considerations

We offer the following comments, conclusions, and recommendations concerning general geotechnical design 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 northern Pierce County. Consequently, the proposed site development is not constrained by any prevailing geological hazards, in our opinion.

Bearing and Non-Bearing Soils: Our subsurface explorations encountered medium dense to very dense native lodgement till at fairly shallow depths across most of the site. Such soils are generally favorable for support of new buildings and other structures. In the southern part of the site, however, we observed a thick deposit of silts with a variable organic content, likely representing some combination of marsh and/or lake sediments. These silts are much less suitable for support of new buildings. Consequently, any new buildings constructed in the southern part of the site would likely require special foundations or some type of subgrade mitigation.

Earthwork Scheduling: Our explorations indicate that the on-site soils generally comprise silty sands, along with localized zones of silt. These existing 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.

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" over most of the site, but the southern part of the site might need to be downgraded to Site Class "D" due to the presence of marsh and lake deposits. If new school buildings are planned for this part of the site, additional subsurface explorations will be necessary to further assess the soil conditions.

Infiltration Potential: Based on our explorations, the entire site is underlain by lodgement till. As noted previously, lodgement till typically has a very low permeability due to its high density, low porosity, and high content of fine-grained material; consequently, these near-surface soils are not considered a suitable receptor horizon for shallow infiltration systems such as trenches and ponds. Under some circumstances, deep Underground Injection Control (UIC) wells can be used to access suitable infiltration receptor soils (typically advance outwash) below the lodgement till. However, our explorations did not encounter suitable soils within their maximum depth of 51 feet. If a UIC feasibility assessment is desired, it will be necessary to advance a boring to a greater depth (perhaps on the order of 75 to 100 feet) and install a monitoring well to measure ground water depths. We are available to discuss this approach further upon request.

Additional Geotechnical Explorations: Because a final site layout had not been determined at the time of this study, our geotechnical exploration program was intended to provide an overview of subsurface conditions across the entire site. Additional explorations should be performed at specific building locations after the site layout plan has been finalized. AESI would be happy to submit a scope and fee estimate for such additional work upon request.

Environmental Considerations: As previously noted, we detected a diesel odor within the native lodgement till soils at a depth of about 9 feet in boring EB-6. Due to the inherently low vertical permeability of lodgement till, we infer that this constituent likely migrated laterally from elsewhere on or off the site. Additional environmental sampling and testing would be necessary to better characterize this contaminant source. AESI can perform such services in conjunction with our additional geotechnical exploration program, if requested.

5.2 Site Preparation

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

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, with an additional 12 to 24 inches of organic fill in localized areas. However, the actual thicknesses could vary considerably from one location to another.

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.

5.3 Building Foundations

The very dense lodgement till underlying the northern part of the site at relatively shallow depths is generally favorable for supporting new buildings on spread footings. In contrast, the marsh and lake sediments observed at the southern part of the site are not well-suited for conventional spread footings, due to the risk of unpredictable or excessive long-term settlements. We offer the following comments and recommendations concerning design and construction of spread footings.

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: We recommend that all footings gain support from the native, medium dense to very dense, lodgement till soils underlying the site. Suitable bearing soils were observed at depths ranging from about 0 to 4½ feet below existing grades across most of the site. In the southern part of the site, these bearing soils are overlain by up to 20 feet of uncontrolled fill and marsh or lake sediments. These depths are indicated on Figure 2 for general planning purposes. 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 lodgement till 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 (Horizontal:Vertical) 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. As such, it is most appropriate for locations where suitable bearing soils lie within about 3 to 6 feet of ground surface.

Option 2 - Footings on Flowable Fill Bearing Pads: Overexcavate the upper soils as needed to reach the lodgement till 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 fill. As such, it is most appropriate for locations where suitable bearing soils lie within about 4 to 8 feet of ground surface.

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 lodgement till deposit, as shown on Figure 3. Due to the proprietary nature of aggregate piers, the specialty contractor should be responsible for determining the spacing, diameters, 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. As such, it is most appropriate for locations where suitable bearing soils lie more than about 6 to 8 feet below ground surface.

Option 4 - Footings on Pin Piles: Install an array of driven steel pipes, or “pin piles,” to support the new footings. Pin piles are available in diameters ranging from 2 inches to 6 inches, with corresponding allowable 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 footing support. The project structural engineer should be responsible for determining the appropriate diameters, 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 most appropriate for locations where suitable bearing soils lie more than about 8 to 10 feet below ground surface.

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:	3,000 psf
Seismic Allowable Bearing Capacity:	4,000 psf

Footing 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.

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.

5.4 Slab-On-Grade Floors

Because floor slabs typically carry a light load in comparison to building foundations, they allow more latitude concerning support options. However, special bearing provisions will likely be needed in the southern part of the site where organic-rich marsh sediments were observed. We offer the following comments and recommendations for slab-on-grade floors.

Conventional Subgrade Preparation: Based on our exploration borings, we anticipate that new floor subgrades in most areas will consist of medium dense to very dense granular soils or medium stiff to very stiff silts. Any localized zones of soft, organic, or wet soils observed over the subgrades should be overexcavated and replaced with granular structural fill. Next, we recommend that the entire subgrade areas be covered with a woven separation geotextile, such as Mirafi 500X or equivalent.

Special Subgrade Preparation: Our exploration boring EB-1 encountered organic-rich marsh sediments extending to a depth of about 10 feet. In this area, we recommend that all organic-rich soils be overexcavated and replaced with structural fill in order to reduce the risk of excessive long-term settlements. Our recommendations presented in the "Structural Fill" section of this report should be followed for fill placement and compaction. Other recommendations can likely be developed after additional explorations have been performed.

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

Vapor Retarder:	10 mils
Base Course:	4 inches
Subbase Course:	12 inches

Subbase Course: A subbase course helps to provide more-uniform structural support for a floor slab, thereby reducing long-term differential settlements. For the subbase, 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 static roller to achieve a uniform density of at least 90 percent (based on ASTM D-1557).

Base Course: The base course serves as both a capillary break layer and a leveling layer for the floor slab. 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 the slab-on-grade floor will not exceed 1 inch under conventional loading conditions. 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.

5.5 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 drain. 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 building rather than ponding near the foundation walls.

5.6 Backfilled Retaining Walls

We anticipate that backfilled concrete retaining walls might be used in certain buildings. Furthermore, any site walls or 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.

5.7 Pavement Sections

We understand that conventional flexible (asphalt concrete) pavements will likely be used in the new car parking areas and driveways, whereas rigid (cement concrete) pavement will likely 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. This value corresponds to a subgrade modulus of about 100 to 200 pounds per cubic inch (pci).

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 some cases, a granular subbase is included below the CAB, but we do not infer a need for a subbase at this site. 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 Truck Driveways

Asphalt Concrete Pavement (ACP):	4 inches
Crushed Aggregate Base Course (CAB):	4 inches
Granular Subbase Course (GSB):	9 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 we do not infer a need for a subbase at this site. 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 Truck Driveways

Cement Concrete Pavement (CCP):	7 inches
Crushed Aggregate Base Course (CAB):	3 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. 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.

5.8 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, granolithic gravel, pea gravel, drain rock, controlled-density fill (CDF), or lean-mix concrete (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, gravelly sands, and, to a lesser extent, silts. We anticipate that the on-site silty sands and gravelly sands can be reused as structural fill during the summer months, but these soils will be difficult to reuse during the wet season or during isolated periods of rainy weather. The on-site silts would be somewhat difficult to reuse even during the dry season and would be nearly impossible to reuse during the wet season.

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.

6.0 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.

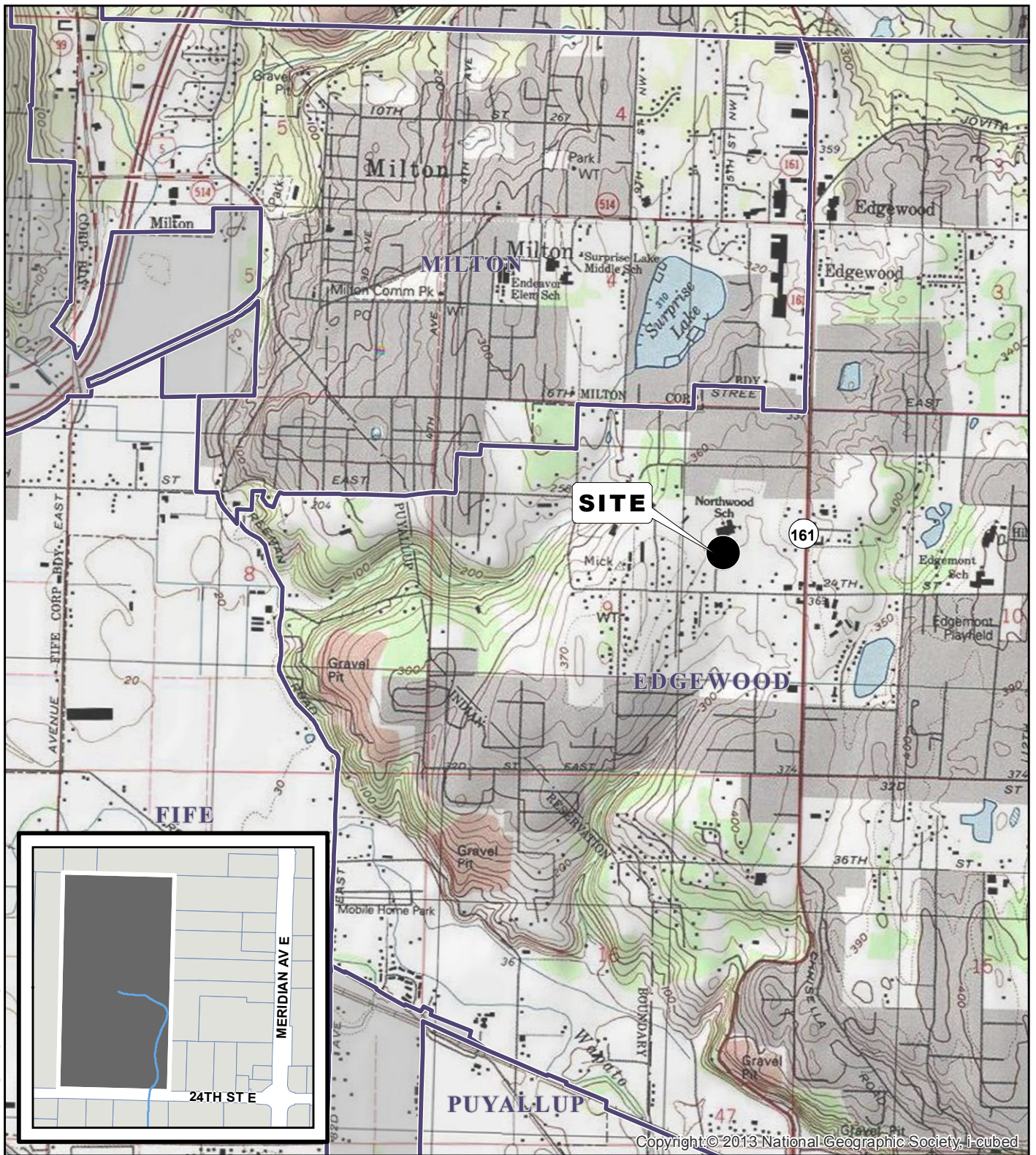
Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Tacoma, Washington



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



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

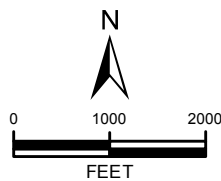


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DATA SOURCES / REFERENCES:
USGS: 24K SERIES TOPOGRAPHIC MAPS
PIERCE CO: STREETS, CITY LIMITS, PARCELS 2015

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE



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



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VICINITY MAP
NORTHWOOD ELEMENTARY
SCHOOL
EDGEWOOD, WASHINGTON

PROJ NO.

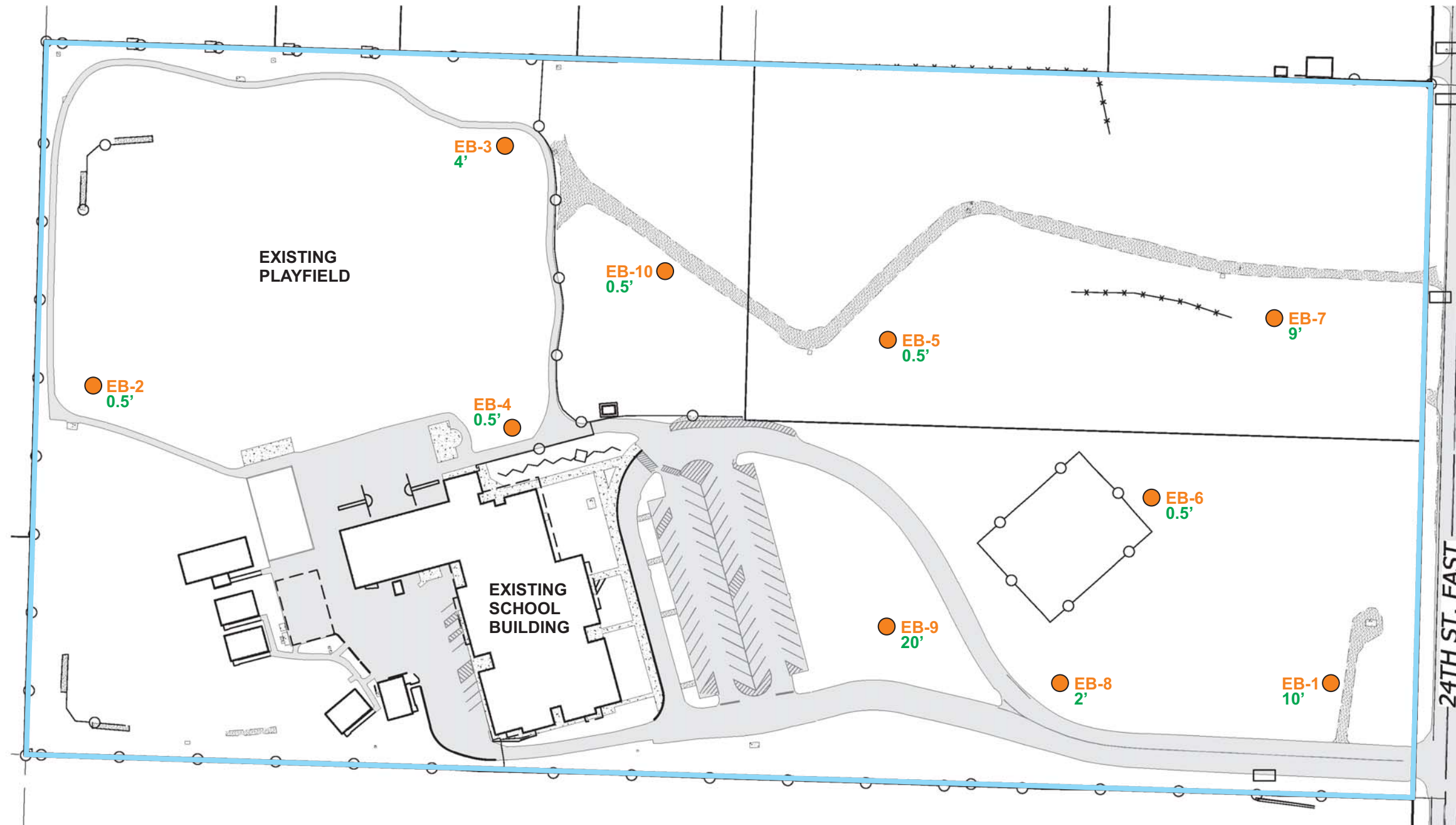
TE160417A

DATE:

9/16

FIGURE:

1



LEGEND:

- **EB** EXPLORATION BORING
- 10' APPROXIMATE DEPTH OF GRANULAR BEARING SOILS
- SITE BOUNDARY

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

NOTES:

1. BASE MAP REFERENCE: SITTS & HILL ENGINEERS, INC., NORTHWOOD ELEMENTARY, SHEET 1 OF 1, 09-09-2016

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



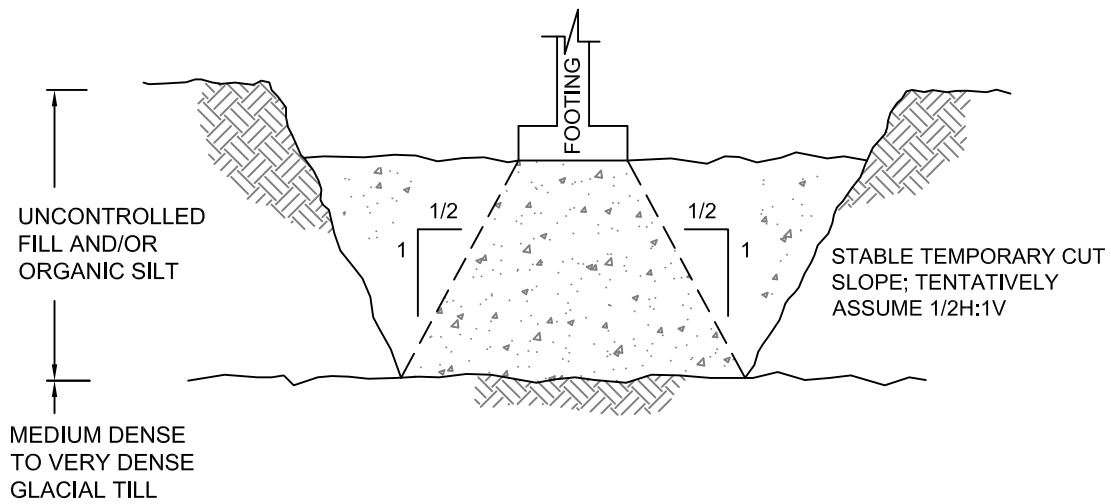
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SITE AND EXPLORATION PLAN

NORTHWOOD ELEMENTARY SCHOOL
EDGEWOOD, WASHINGTON

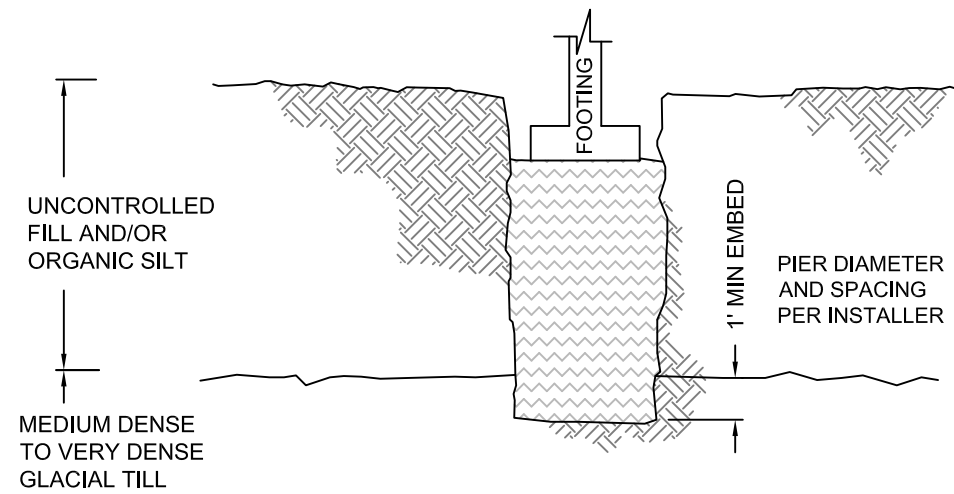
PROJ NO.	DATE:	FIGURE:
TE160417A	9/16	2

160417 Northwood Elem \ 160417 F3 Footings.dwg LAYOUT: F3 support



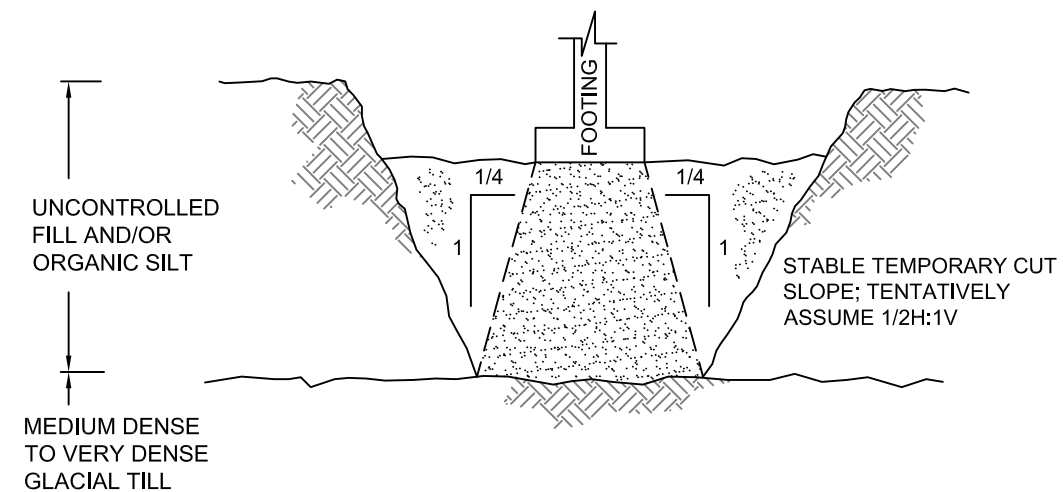
OPTION 1

OVEREXCAVATE AND REPLACE WITH QUARRY SPALLS OR RAILROAD BALLAST;
ALLOWABLE STATIC BEARING PRESSURE = 3000psf



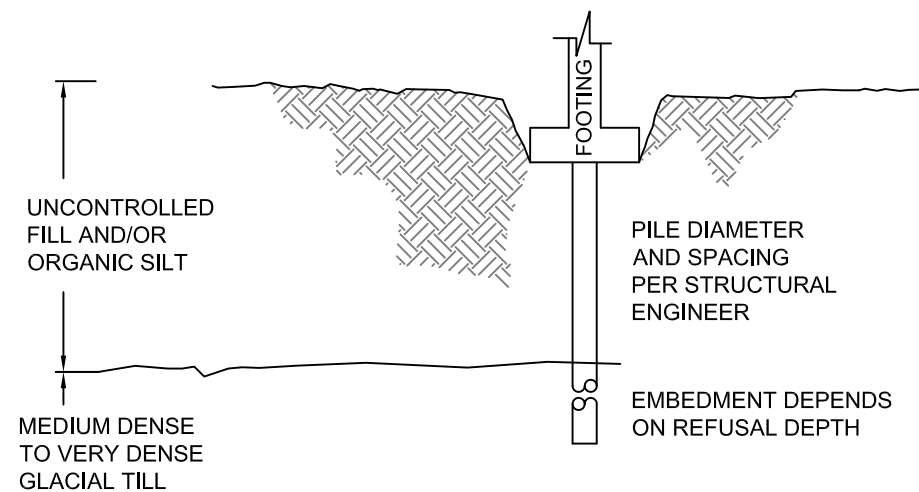
OPTION 3

INSTALL COMPACTED AGGREGATE PIERS;
ALLOWABLE STATIC BEARING PRESSURE = 3000psf



OPTION 2

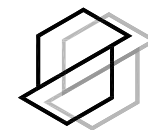
OVEREXCAVATE AND REPLACE WITH LEAN MIX CONCRETE [LMC]
OR CONTROLLED DENSITY FILL [CDF];
ALLOWABLE STATIC BEARING PRESSURE = 3000psf



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

NORTHWOOD ELEMENTARY SCHOOL
EDGEWOOD, WASHINGTON

PROJ NO.	DATE:	FIGURE:
TE160417A	9/16	3

APPENDIX A

Exploration Logs

Coarse-Grained Soils - More than 50% ⁽¹⁾ Retained on No. 200 Sieve				Terms Describing Relative Density and Consistency			
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		Density SPT⁽²⁾ blows/foot Very Loose0 to 4 Loose4 to 10 Medium Dense10 to 30 Dense30 to 50 Very Dense>50 Consistency SPT⁽²⁾ blows/foot Very Soft0 to 2 Soft2 to 4 Medium Stiff4 to 8 Stiff8 to 15 Very Stiff15 to 30 Hard>30 Test Symbols G = Grain Size M = Moisture Content A = Atterberg Limits C = Chemical DD = Dry Density K = Permeability
		≥12% Fines ⁽⁵⁾		GP	Poorly-graded gravel and gravel with sand, little to no fines		
Sands - 50% ⁽¹⁾ or More of Coarse Fraction Passes No. 4 Sieve		≤5% Fines ⁽⁵⁾		GM	Silty gravel and silty gravel with sand		
		≥12% Fines ⁽⁵⁾		GC	Clayey gravel and clayey gravel with sand		
		≤5% Fines ⁽⁵⁾		SW	Well-graded sand and sand with gravel, little to no fines		
Sands - 50% ⁽¹⁾ or More of Coarse Fraction Passes No. 4 Sieve		≤5% Fines ⁽⁵⁾		SP	Poorly-graded sand and sand with gravel, little to no fines		
		≥12% Fines ⁽⁵⁾		SM	Silty sand and silty sand with gravel		
		≥12% Fines ⁽⁵⁾		SC	Clayey sand and clayey sand with gravel		
Fine-Grained Soils - 50% ⁽¹⁾ or More Passes No. 200 Sieve		Silt 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		
		Silt 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				

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		Moisture Content
Component	Percentage by Weight	
Trace	<5	
Some	5 to <12	
Modifier	12 to <30	Dry - Absence of moisture, dusty, dry to the touch
(silty, sandy, gravelly)		
Very modifier	30 to <50	
(silty, sandy, gravelly)		
		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	
Sampler Type	Blows/6" or portion of 6"
2.0" OD Split-Spoon Sampler (SPT)	10 15 20
Bulk sample	3.0" OD Split-Spoon Sampler
Grab Sample	3.25" OD Split-Spoon Ring Sampler
	3.0" OD Thin-Wall Tube Sampler (including Shelby tube)
	Portion not recovered

Cement grout surface seal
Bentonite seal
(4) ATD
(4) Static
Filter pack with blank casing section
Screened casing or Hydrotip with filter pack
End cap

(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



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Exploration Log

Project Number
TE160417A

Exploration Number
EB-1

Sheet
1 of 3

Project Name Northwood Elementary School
Location Edgewood, WA
Driller/Equipment Holocene Drilling, Inc. / Truck-Mounted HSA
Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) _____
Datum N/A
Date Start/Finish 8/30/16, 8/30/16
Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6" Blows/ft	Blows/Foot				Other Tests
								10	20	30	40	
				Fill Slightly moist, brown, gravelly, fine to coarse SAND, some silt; unsorted (SW).								
		S-1		Marsh Deposits								
5		S-2		Medium stiff to stiff, moist, dark brown with gray mottling, SILT, some fine sand; abundant organics and roots (ML).		2 2 6	▲8					
10		S-3		Weathered Lodgement Till Dense, slightly moist to moist, greenish gray with brown mottling, very silty, fine to medium SAND, some gravel; unsorted (SM). Becomes gray-brown.		10 13 21	▲34					
15		S-4		Vashon Lodgement Till Very dense, very moist to wet, gray-brown, very silty, fine to medium SAND, some gravel; unsorted (SM). Driller notes seepage.		13 27 35	▼62					

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
TE160417A

Exploration Number
EB-1

Sheet
2 of 3

Project Name Northwood Elementary School
Location Edgewood, WA
Driller/Equipment Holocene Drilling, Inc. / Truck-Mounted HSA
Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) _____
Datum N/A
Date Start/Finish 8/30/16, 8/30/16
Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6" Blows/6"	Blows/Foot				Other Tests
								10	20	30	40	
20		S-5		Very dense, very moist, gray to brownish gray interbedded (2 to 3 inches thick) fine SAND, trace silt, and medium to coarse SAND, trace silt (SP). Upper 6 inches blow counts understated due to water. Hard, moist to very moist, brown, SILT, trace gravel (ML). Driller notes last 2 inches driving on a gravel.		8 27 50/2"						▲ 77/8"
		S-6		Very dense, very moist to moist, brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM). Upper 6 inches understated due to water.		12 36 37						▲ 73
25		S-7		Very dense, moist to very moist, brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted; with thin (1/16 to 1/8 inch thick) seams of finely laminated, very fine to fine SAND (SM/SP).		16 27 50/5"						▲ 77/11"
		S-8		Very dense, moist, brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).		24 50/4"						▲ 74/10"
30		S-9		Very dense, moist, brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted; with interbeds (1/2 to 1 inch thick) fine to coarse SAND, trace silt (SM/SW).		4 9 48						▲ 57
		S-10		As above.		28 50/3"						▲ 78/9"
35		S-11		Very poor recovery.		39 50/1"						▲ 89/7"

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
TE160417A

Exploration Number
EB-1

Sheet
3 of 3

Project Name Northwood Elementary School Ground Surface Elevation (ft) _____
Location Edgewood, WA Datum N/A
Driller/Equipment Holocene Drilling, Inc. / Truck-Mounted HSA Date Start/Finish 8/30/16, 8/30/16
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/6"	Blows/Foot				Other Tests
								10	20	30	40	
40		S-12		Very dense, slightly moist, brown, very silty, fine SAND, trace gravel; unsorted (SM).			20 32 50/5"					▲ 82/11"
45		S-13		Very dense, slightly moist, brown, fine to coarse SAND, some silt, trace gravel; weakly stratified (SM).			50/6"					▲ 50/6"
50		S-14		Very dense, slightly moist, brown, very silty, fine to medium SAND, trace gravel; unsorted (SM). Very dense, slightly moist, brown, fine to coarse SAND, some silt, trace gravel; weakly stratified (SW). Very dense, slightly moist, brown, very silty, fine to medium SAND, some gravel; unsorted (SM). Bottom of exploration boring at 50.7 feet Seepage encountered at 16 feet.			12 50/2"					▲ 62/8"
55												

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



3" OD Split Spoon Sampler (D & M)



Grab Sample



No Recovery



Ring Sample



Shelby Tube Sample

M - Moisture



Water Level ()



Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB



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Exploration Log

Project Number
TE160417A

Exploration Number
EB-2

Sheet
1 of 3

Project Name Northwood Elementary School
Location Edgewood, WA
Driller/Equipment Holocene Drilling, Inc. / Truck-Mounted HSA
Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) _____
Datum N/A
Date Start/Finish 8/31/16, 8/31/16
Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6" Blows/6"	Blows/Foot				Other Tests
								10	20	30	40	
				Sod / Topsoil								
				Weathered Vashon Lodgement Till								
		S-1		Slightly moist to moist, brown, silty, fine to medium SAND, some gravel; unsorted (SM).								
5		S-2		Very dense, slightly moist to moist, brown with orange mottling, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).			16 22 31					▲ 53
				Vashon Lodgement Till								
				Becomes gray-brown at 6 feet.								
10		S-3		Very dense, slightly moist, gray-brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).			15 43 50/4"					▲ 93/10"
				Driller notes seepage.		▼						
15		S-4		As above.			17 50/5"					▲ 67/11"

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
TE160417A

Exploration Number
EB-2

Sheet
2 of 3

Project Name
Northwood Elementary School

Location
Edgewood, WA

Driller/Equipment
Holocene Drilling, Inc. / Truck-Mounted HSA

Hammer Weight/Drop
140# / 30"

Ground Surface Elevation (ft)

Datum

N/A

Date Start/Finish
8/31/16, 8/31/16

Hole Diameter (in)
8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6" Blows/6"	Blows/Foot				Other Tests
								10	20	30	40	
20		S-5		As above.			41 50/2"					▲ 91/8"
25		S-6		No recovery; driller notes pound on a gravel.			50/1"					▲ 50/1"
30		S-7		Very dense, moist, gray-brown, very silty, fine to coarse SAND, some fine to coarse gravel; unsorted (SM).			32 50/2"					▲ 82/8"
35		S-8		Very dense, very moist, gray-brown, very silty, fine to coarse SAND, some fine to coarse gravel (SM). Driller adds small amount of water.			50/3"					▲ 50/3"

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
TE160417A

Exploration Number
EB-2

Sheet
3 of 3

Project Name Northwood Elementary School
Location Edgewood, WA
Driller/Equipment Holocene Drilling, Inc. / Truck-Mounted HSA
Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) _____
Datum N/A
Date Start/Finish 8/31/16, 8/31/16
Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6" Blows/6"	Blows/Foot				Other Tests
								10	20	30	40	
40		S-9		Very dense, moist, gray-brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).			50/6"					▲ 50/6"
45		S-10		Very dense, very moist, gray-brown, silty, fine to coarse SAND (SW). Very dense, very moist to moist, gray-brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).			50/5"					▲ 50/5"
50		S-11		Very dense, very moist to wet, gray-brown, silty, fine to coarse SAND; massive (SM). Very dense, moist to very moist, gray-brown, very silty, fine to medium SAND, some silt; unsorted (SM).			40 50/3"					▲ 90/9"
55				Bottom of exploration boring at 50.75 feet Seepage encountered at approximately 13 and 33 feet.								

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



3" OD Split Spoon Sampler (D & M)



Grab Sample



No Recovery



Ring Sample



Shelby Tube Sample

M - Moisture



Water Level ()



Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB



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earth sciences
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Exploration Log

Project Number
TE160417A

Exploration Number
EB-3

Sheet
1 of 1

Project Name Northwood Elementary School
Location Edgewood, WA
Driller/Equipment Holocene Drilling, Inc. / Truck-Mounted HSA
Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) _____
Datum N/A
Date Start/Finish 8/31/16, 8/31/16
Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6" Blows/ft	Blows/Foot				Other Tests
								10	20	30	40	
				Sod / Topsoil								
				Fill								
		S-1		Slightly moist, brown, very silty, fine to medium SAND, some fine to coarse gravel; some roots (SM).								
5		S-2		Weathered Vashon Lodgement Till Very stiff, moist, brown with orange mottling, SILT, some fine to medium sand, trace gravel (ML). Medium dense, slightly moist, brown, fine to coarse SAND, some silt, some fine to coarse gravel (SW).		4 6 21				▲27		
10		S-3		Vashon Lodgement Till Medium dense to dense, slightly moist, brown, silty, fine to medium SAND, trace gravel; unsorted; poor recovery (SM). Seepage observed.		19 17 13				▲30		
15		S-4		Very dense, moist, brown, very silty, fine to medium SAND, trace fine to coarse gravel; unsorted (SM).		22 26 41						▲67
				Bottom of exploration boring at 16.5 feet Seepage encountered at 13 feet.								

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



3" OD Split Spoon Sampler (D & M)



Grab Sample



No Recovery



Ring Sample



Shelby Tube Sample

M - Moisture



Water Level ()



Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB



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Exploration Log

Project Number
TE160417A

Exploration Number
EB-4

Sheet
1 of 1

Project Name Northwood Elementary School
Location Edgewood, WA
Driller/Equipment Holocene Drilling, Inc. / Truck-Mounted HSA
Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) _____
Datum N/A
Date Start/Finish 8/31/16, 8/31/16
Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6" Blows/ft	Blows/Foot				Other Tests
								10	20	30	40	
				Weathered Vashon Lodgement Till								
		S-1		Slightly moist, brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).								
		S-2		Medium dense, slightly moist, brown with faint orange mottling, very silty, fine to medium SAND, some gravel; unsorted (SM).								
				Vashon Lodgement Till								
				Dense, slightly moist, gray-brown, very silty, fine to medium SAND, trace gravel; unsorted (SM).		9 14 20					▲34	
5		S-3		Dense, moist, gray-brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted; poor recovery, 2 inches slough in sampler; upper 6 inches blow counts likely understated due to slough (SM).		8 19 18					▲37	
10		S-4		Dense, moist, gray-brown, very silty, fine to medium SAND, some gravel; unsorted; poor recovery (SM).		17 15 17					▲32	
15		S-5		As above; becomes very dense.		50/3"						▲50/3"
				Bottom of exploration boring at 15.25 feet No ground water 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



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Exploration Log

Project Number
TE160417A

Exploration Number
EB-5

Sheet
1 of 1

Project Name Northwood Elementary School
Location Edgewood, WA
Driller/Equipment Holocene Drilling, Inc. / Truck-Mounted HSA
Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) _____
Datum N/A
Date Start/Finish 8/31/16, 8/31/16
Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot				Other Tests
								10	20	30	40	
5		S-1		Grass / Topsoil								
				Weathered Vashon Lodgement Till								
				Dry, orangish brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM).								
				Vashon Lodgement Till								
10		S-2		Very dense, slightly moist, gray-brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted; some fine to medium sand seams (<16 inches thick) (SM).		21 40 38						▲78
				As above.								
15		S-3				12 50/6"						▲62/12"
20		S-4		Dense, moist, gray-brown, very silty, fine to medium SAND, some gravel; unsorted (SM).		6 20 26						▲46
25				Bottom of exploration boring at 11.5 feet No ground water 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



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Exploration Log

Project Number
TE160417A

Exploration Number
EB-6

Sheet
1 of 1

Project Name Northwood Elementary School
Location Edgewood, WA
Driller/Equipment Holocene Drilling, Inc. / Truck-Mounted HSA
Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) _____
Datum N/A
Date Start/Finish 8/31/16, 8/31/16
Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6" Blows/ft	Blows/Foot				Other Tests
								10	20	30	40	
5		S-1		Grass / Topsoil Weathered Vashon Lodgement Till Dry, orangish brown, very silty, fine SAND, trace gravel; some roots (SM).								
		S-2		Very dense, dry, orangish brown, very silty, fine to medium SAND, some gravel; unsorted (SM). Becomes gray-brown with some orange mottling.		12 26 27						▲ 53
		S-3		Vashon Lodgement Till Very dense, slightly moist, gray-brown, very silty, fine to medium SAND, trace silt; unsorted; slough in upper 6 inches of sample; blow counts likely overstated due to slough (SM). Strong diesel odor; terminate boring.		13 26 33						▲ 59
10				Bottom of exploration boring at 10 feet No ground water encountered.								
15												

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
TE160417A

Exploration Number
EB-7

Sheet
1 of 1

Project Name Northwood Elementary School
Location Edgewood, WA
Driller/Equipment Holocene Drilling, Inc. / Truck-Mounted HSA
Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) _____
Datum N/A
Date Start/Finish 9/1/16, 9/1/16
Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6" Blows/6"	Blows/Foot				Other Tests
								10	20	30	40	
5		S-1		Grass / Topsoil								
				Fill								
				Slightly moist, orangish brown, very silty, fine SAND, trace gravel; abundant roots (SM).								
				Marsh Deposit								
				Stiff to very stiff, slightly moist, gray-brown with faint orange staining, SILT, trace organics and rootlets; fine laminae (ML).		4 6 9		▲15				
5		S-2		Medium stiff to stiff, very moist, gray-brown, SILT, some very fine sand; fine laminae; slightly plastic (ML/MH).		3 4 5		▲9				
10		S-3		Vashon Lodgement Till		7 18 20						
10		S-4		Dense, moist to very moist, gray-brown, silty, fine to coarse SAND, trace fine to coarse gravel; unsorted (SM).								
15		S-5		Very dense, wet, gray-brown, silty, gravelly, fine to medium SAND; unsorted (SM).		13 28 50/6"						
				Driller notes ~4 feet of water in hole (seepage).								
				Bottom of exploration boring at 16.5 feet Seepage encountered at approximately 11 feet.								

Sampler Type (ST):



2" OD Split Spoon Sampler (SPT)



3" OD Split Spoon Sampler (D & M)



Grab Sample



No Recovery



Ring Sample



Shelby Tube Sample

M - Moisture



Water Level ()



Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB



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Exploration Log

Project Number
TE160417A

Exploration Number
EB-8

Sheet
1 of 1

Project Name Northwood Elementary School
Location Edgewood, WA
Driller/Equipment Holocene Drilling, Inc. / Truck-Mounted HSA
Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) _____
Datum N/A
Date Start/Finish 9/1/16, 9/1/16
Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6" Blows/ft	Blows/Foot				Other Tests
								10	20	30	40	
5		S-1		Grass / Topsoil								
				Fill								
				Dry to slightly moist, orangish brown, very silty, fine to medium SAND, some fine to coarse gravel, some organics and rootlets; unsorted (SM).								
				Weathered Vashon Lodgement Till								
10		S-2		Medium dense to dense, slightly moist, brown with heavy orange mottling, silty, gravelly, fine to medium SAND; unsorted (SM).		12 16 16				▲32		
15		S-3		Very stiff, very moist, gray-brown with faint orange mottling, fine to medium sandy SILT, trace gravel; unsorted (ML).		11 16 9				▲25		
20		S-4		Vashon Lodgement Till								
				Dense, very moist to wet, gray-brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted; poor recovery (SM).		18 19 20				▲39		
25				Bottom of exploration boring at 11.5 feet No ground water 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



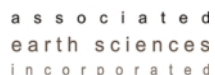
Water Level ()



Water Level at time of drilling (ATD)

Logged by: LBK

Approved by: JMB



Project Number
TE160417A

Exploration Number
EB-9

Sheet
1 of 2

Project Name	Northwood Elementary School
Location	Edgewood, WA
Driller/Equipment	Holocene Drilling, Inc. / Truck-Mounted HSA
Hammer Weight/Drop	140# / 30"

Ground Surface Elevation (ft)	
Datum	N/A
Date Start/Finish	9/1/16, 9/1/16
Hole Diameter (in)	8 inches

AE SIBOR 160417.GPJ September 12, 2016

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
TE160417A

Exploration Number
EB-9

Sheet
2 of 2

Project Name Northwood Elementary School
Location Edgewood, WA
Driller/Equipment Holocene Drilling, Inc. / Truck-Mounted HSA
Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) _____
Datum N/A
Date Start/Finish 9/1/16, 9/1/16
Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6" Blows/6"	Blows/Foot				Other Tests
								10	20	30	40	
20		S-6		Vashon Lodgement Till Dense to medium dense, wet, brownish gray, fine to coarse SAND, trace silt; massive (SW). Dense, wet, gray-brown, silty, gravelly, fine to medium SAND; unsorted (SM).		13 18 22					▲40	
25		S-7		Dense, wet, gray-brown, silty, fine to medium SAND, some fine to coarse gravel; unsorted (SM). Bottom of exploration boring at 25.9 feet Seepage encountered from approximately 19 to 21 feet.		13 50/5"						▲63/11"
30												
35												

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
TE160417A

Exploration Number
EB-10

Sheet
1 of 1

Project Name Northwood Elementary School
Location Edgewood, WA
Driller/Equipment Holocene Drilling, Inc. / Truck-Mounted HSA
Hammer Weight/Drop 140# / 30"

Ground Surface Elevation (ft) _____
Datum N/A
Date Start/Finish 9/1/16, 9/1/16
Hole Diameter (in) 8 inches

Depth (ft)	S T	Samples	Graphic Symbol	DESCRIPTION	Well Completion	Water Level	Blows/6"	Blows/Foot				Other Tests
								10	20	30	40	
5		S-1		Grass / Topsoil								
				Weathered Vashon Lodgement Till								
				Dry to slightly moist, orangish brown, very silty, fine SAND, some fine to coarse gravel; unsorted (SM).								
				Vashon Lodgement Till								
10		S-2		Very dense, slightly moist, gray-brown, silty, fine to coarse SAND, some fine to coarse gravel; unsorted (SM).			21 29 24					▲53
				Dense, slightly moist to moist, gray-brown, very silty, fine to medium SAND, some fine to coarse gravel; unsorted; partial recovery ~9 inches (SM).			20 18 16					▲34
15		S-3		Dense, moist, gray-brown, silty, fine to medium SAND, some fine to coarse gravel, some coarse sand; unsorted; partial recovery ~9 inches (SM).			12 17 22					▲39
				Bottom of exploration boring at 11.5 feet No ground water 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

APPENDIX B

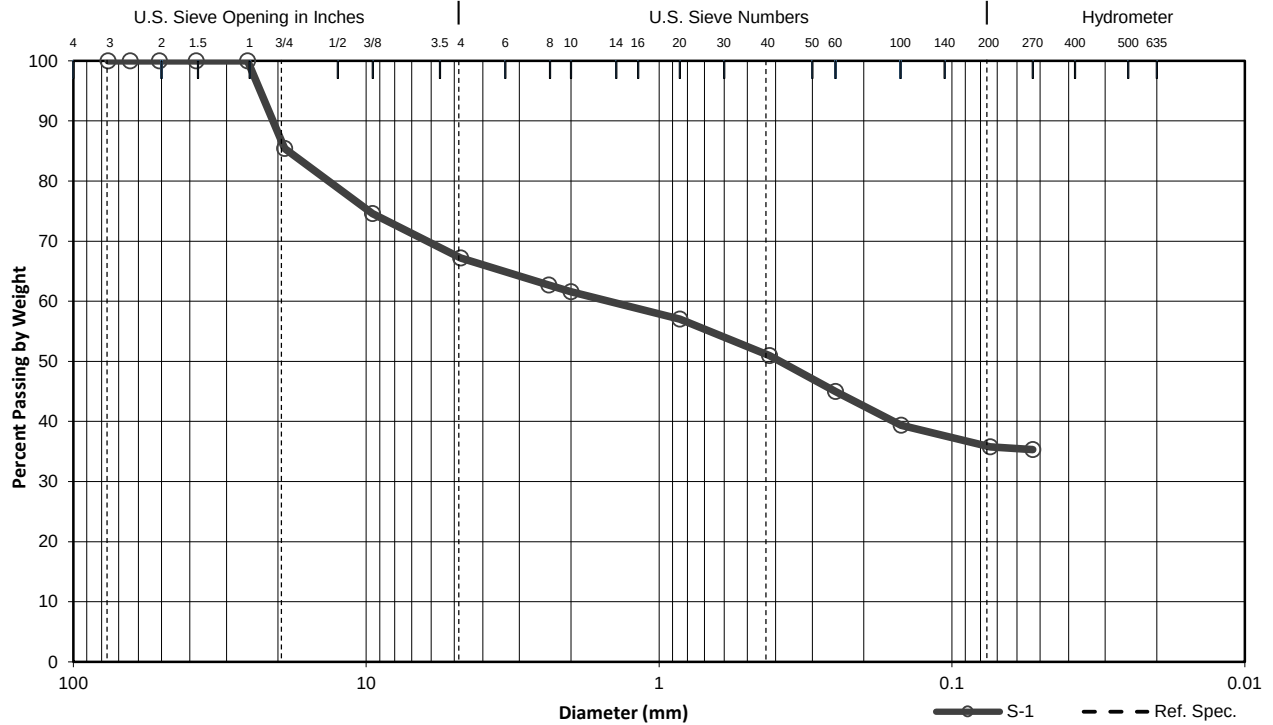
Laboratory Testing Results



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GRAIN SIZE ANALYSIS - MECHANICAL ASTM D422

Project Name Northwood Elementary	Project Number TE160417A	Date Sampled 9/7/2016	Date Tested 9/19/2016	Tested By MS
Sample Source EB-4	Sample No. S-1	Depth (ft) 2.5-5	Soil Description very sandy, very gravelly, SILT (GM)	
Total Sample Dry Wt. (g) 941.9	Moisture Content (%) 8	D ₁₀ (mm) <0.01	Reference Specification	



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

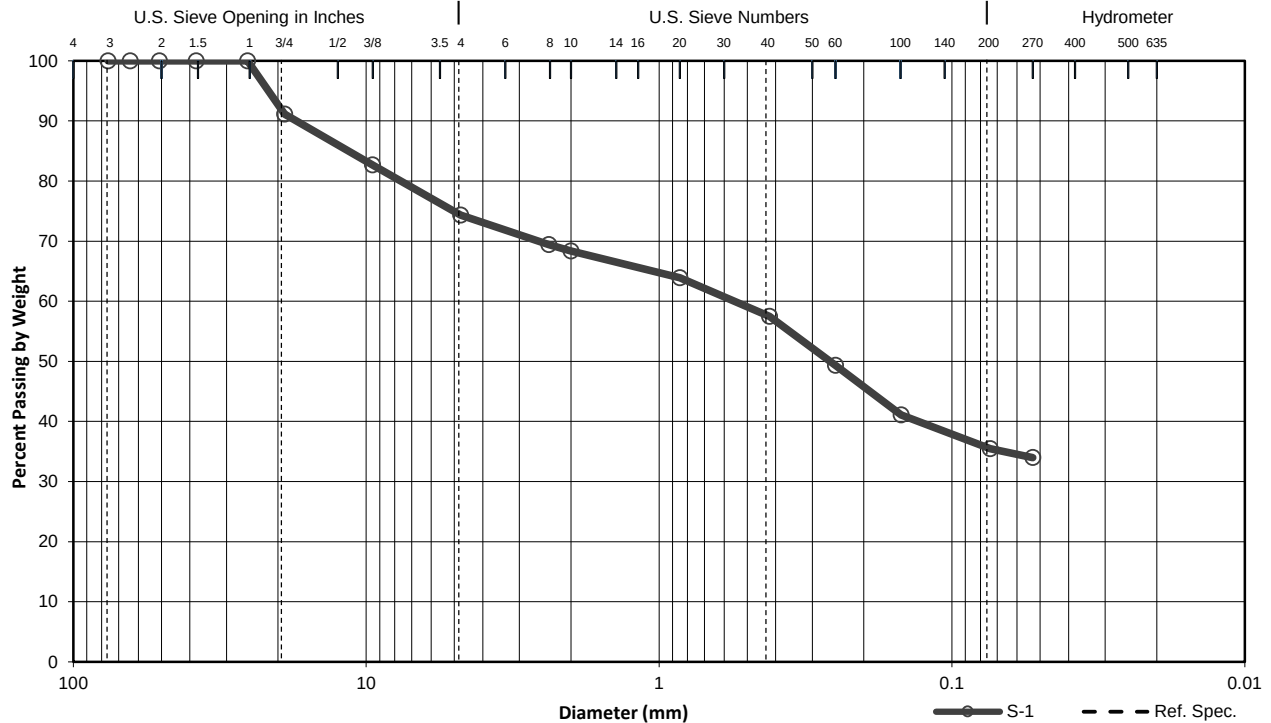
Sieve No.	Diam. (mm)	Cum. Wt. Ret. (g)	% Ret. by Wt.	% Passing by Wt.	% Specs. Pass. by Wt.	
					Min	Max
3	76.1		0.0	100.0		
2.5	64		0.0	100.0		
2	50.8		0.0	100.0		
1.5	38.1		0.0	100.0		
1	25.4		0.0	100.0		
3/4	19	137.3	14.6	85.4		
3/8	9.51	239.3	25.4	74.6		
#4	4.76	309.0	32.8	67.2		
#8	2.38	351.2	37.3	62.7		
#10	2	361.7	38.4	61.6		
#20	0.85	404.5	42.9	57.1		
#40	0.42	461.8	49.0	51.0		
#60	0.25	518.3	55.0	45.0		
#100	0.149	571.2	60.6	39.4		
#200	0.074	605.0	64.2	35.8		
#270	0.053	609.2	64.7	35.3		



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GRAIN SIZE ANALYSIS - MECHANICAL ASTM D422

Project Name Northwood Elementary	Project Number TE160417A	Date Sampled 9/7/2016	Date Tested 9/19/2016	Tested By MS
Sample Source EB-8	Sample No. S-1	Depth (ft) 2.5-5	Soil Description gravelly, very silty SAND (SM)	
Total Sample Dry Wt. (g) 1128.1	Moisture Content (%) 12	D ₁₀ (mm) <0.01	Reference Specification	



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	100.0	8.9	91.1		
3/8	9.51	195.5	17.3	82.7		
#4	4.76	289.3	25.6	74.4		
#8	2.38	344.7	30.6	69.4		
#10	2	356.8	31.6	68.4		
#20	0.85	407.0	36.1	63.9		
#40	0.42	480.0	42.5	57.5		
#60	0.25	571.4	50.6	49.4		
#100	0.149	664.4	58.9	41.1		
#200	0.074	727.9	64.5	35.5		
#270	0.053	744.8	66.0	34.0		