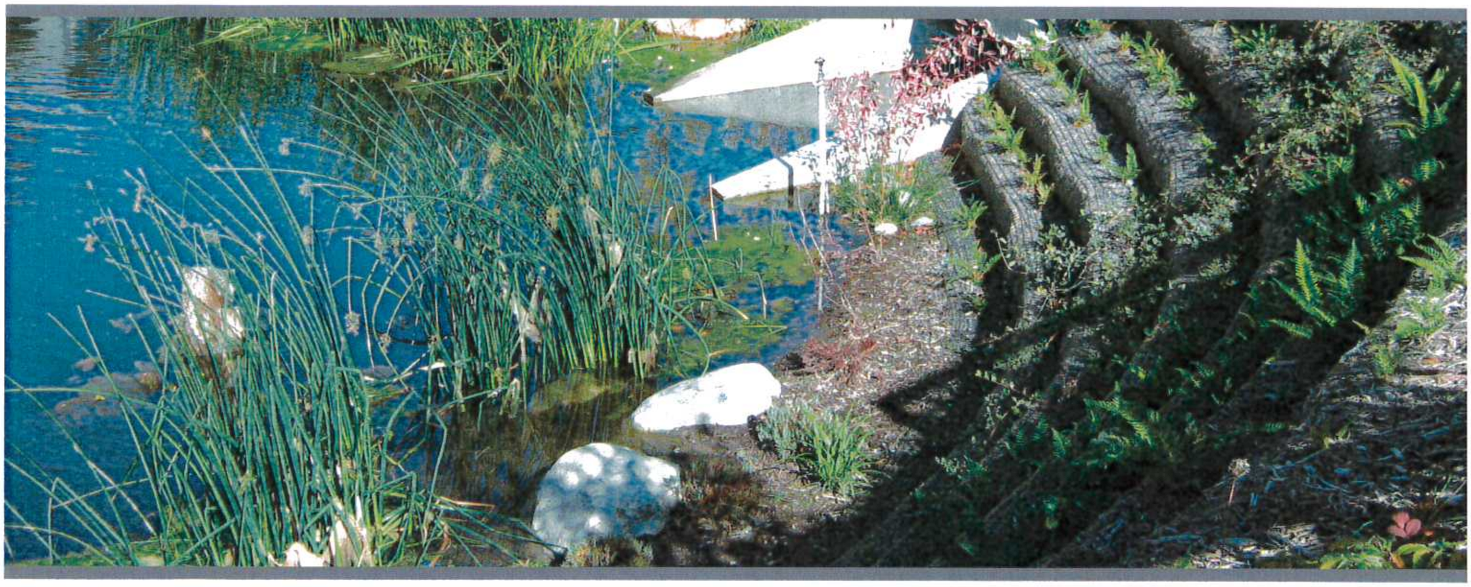
ATTACHMENT 13

associated earth sciences incorporated



Subsurface Exploration and
Geotechnical Engineering Evaluation

ROSE HILL WEST ASSEMBLAGE

Redmond, Washington

Prepared For:

LAIRD HOLDINGS LLC

Project No. 160687E001
February 20, 2017
Revised May 18, 2018
Revised September 24, 2018

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ATTACHMENT 13

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incorporated

February 20, 2017
Revised May 18, 2018
Revised September 24, 2018
Project No. 160687E001

Laird Holdings LLC
1916 126th Avenue SE
Bellevue, Washington 98005

Attention: Mr. Kelly Foster

Subject: Subsurface Exploration and Geotechnical Engineering Evaluation
Rose Hill West Assemblage
NE 97th Street & 138th Avenue NE
Redmond, Washington

Dear Mr. Foster:

Associated Earth Sciences, Inc. (AESI) is pleased to submit this report describing our subsurface exploration and geotechnical engineering evaluation concerning your planned residential properties in Redmond, King County, Washington. Our services were completed in general accordance with our proposal dated December 19, 2016 and the change order dated January 26, 2017.

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.
Kirkland, Washington

Matthew A. Miller, P.E.
Principal Geotechnical Engineer

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ATTACHMENT 13

SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING EVALUATION

ROSE HILL WEST ASSEMBLAGE

Redmond, Washington

Prepared for:
Laird Holdings LLC
1916 126th Avenue SE
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February 20, 2017
Revised May 18, 2018
Revised September 24, 2018
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1.0 PROJECT AND SITE DESCRIPTION

The project site comprises five contiguous residential/commercial parcels located in the City of Redmond, as shown on the attached "Vicinity Map" (Figure 1). These combined parcels form an area that measures approximately 7 acres. It is visually delineated by 138th Avenue NE on the east, by the powerline easement on the west, by undeveloped land on the south, and by single-family residences on the north. Presently, the site is occupied by three houses, multiple garages and machinery. Our attached "Site and Exploration Plan" (Figure 2) illustrates the site boundaries and existing features.

Development plans call for constructing 31 new single-family residential lots on the site. According to our latest correspondence with Laird Holdings LLC and the civil engineer, KPFF, the residences will be spread throughout the site with a proposed storm water detention facility located at the north end of the site adjacent to Lots 1 and 2. The new buildings will be multi-story, wood-frame structures. The sites appear to be relatively level surface grades; it appears that site grading will involve minor cuts and fills. Storm water runoff will 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 seven exploration pits (designated EP-1 through EP-7) to a maximum depth of about 9½ feet, at strategic locations across the site.
- Advanced one exploration boring (designated EB-1) to a maximum depth of about 55 feet.
- Reviewed borings from an environmental assessment of the site.
- 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 with respect to existing and proposed site features. Appendix A contains our exploration logs.

3.0 FIELD EXPLORATION PROCEDURES

We explored subsurface conditions at the site on January 18, 2017 with exploration pits and advanced a single boring on February 8, 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 Pits

All exploration pits were performed by Northwest Excavating, Inc., 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 geotechnical engineer from our firm. Before we left the site, all exploration pits were backfilled with excavated soils, the surface was bucket-tamped, and existing sod was replaced. Selected samples were then transported to our Kirkland laboratory or an independent laboratory for further visual classification and/or testing.

Exploration pit EP-7 was backfilled shortly after excavation due to the amount of water seeping into the excavation. We observed very rapid seepage at approximately 1 foot below the ground and quickly dug until we encountered a dense material at approximately 3½ feet. We then quickly backfilled the excavation without being able to review the sidewall material or collect additional samples. For this reason an exploration pit log was not prepared.

3.2 Exploration Boring/Well

A single exploration boring was advanced to approximately 55 feet by Environmental Drilling, Inc., working under subcontract to AESI, in order to observe the deeper soil for infiltration susceptibility. We installed a piezometer in order to measure an accurate ground water level. Selected samples were then transported to our Kirkland laboratory or an independent laboratory for further visual classification and/or testing.

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

The properties that constitute the project site contain various residential and commercial structures and associated garages. A 100-foot-wide transmission line easement runs along the west side of the site.

4.2 Regional and Local Topography

The project site is located near the western edge of Rose Hill. This hillslope descends to the south and the west at a moderate to steep angle. Local surface grades also descend from east to west across the site, with surface elevations ranging from a maximum of about 300 feet to a minimum of about 290 feet over the majority of the site. Beyond the southern boundary and off the site the topography extends onto the sloped region and slopes downward to the southwest from elevations of 290 to 220 feet.

4.3 Regional Geology

The 1993 *Geologic Map of Surficial Deposits in the Seattle 30' by 60' Quadrangle, Washington* (1:100,000 scale) indicates that 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, glacial 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 related glacial deposits.

4.4 Local Soils

Our subsurface explorations confirmed the presence of Vashon lodgement till, as shown on the regional geology map. Our exploration boring encountered Vashon lodgement till over a transitional advance outwash that varied from silty unsorted deposits to interbedded stratifications of sand with some silt and gravel and silty sand with some gravel. Surficial topsoil and/or fill soils were also present in most locations. The following paragraphs describe our stratigraphic observations, and the exploration logs contained in Appendix A provide additional subsurface information.

Topsoil/Undocumented Fill: Nearly all of our exploration pits disclosed a layer of organic-rich topsoil at or near the ground surface; oftentimes this material was mixed up with the soil beneath indicating previous grading activity. This topsoil/undocumented fill was observed to range from 1½ to 3½ feet thick.

Lodgement Till: At depths ranging from 1½ to 3½ feet below ground, our exploration boring and exploration pits disclosed a deposit of Vashon lodgement till. This deposit consisted of predominantly sandy material with variable silt and gravel contents, ranging from medium dense to very dense. At most locations, the till exhibited an upper weathered zone ranging from 1 to 3 feet thick. The unweathered till extended beyond the termination depth of each pit.

Advance Outwash: Our exploration boring, which was located near the corner of NE 97th Street and 138th Avenue NE, revealed a deposit of very dense sand with stratified sand layers with estimated fines contents ranging from 3 to 25 percent. We interpret this deposit to be a transitional Vashon advance outwash which accounts for interbedded layers with high fines contents. This unit was first encountered at a depth of 30 feet below the ground.

Older Sediments: Beneath the advance outwash, EB-1 encountered a deposit of very dense silty sand with some gravel. Due to the stratigraphic position of this unit, we infer that it is composed of pre-Fraser till.

4.5 Local Ground Water

Our exploration pits, which were excavated during day 2 of a 2-day rainstorm event, encountered minor to rapid ground water seepage at depths ranging from 1 to 2 feet below surface. This seepage appeared to emanate from surface water perched on top of the Vashon lodgement till. In our exploration boring, we observed wet cuttings near depths of 32 feet and 52 feet and measured a static ground water level of 32 feet after drilling was completed. Both of these occurrences likely represent perched water atop the siltier stratifications. All observed seepage at the site probably reflects elevated ground water levels due to heavy precipitation over the past several months. At any time of year, ground water levels could fluctuate due to changes in season, precipitation patterns, off-site development, and other factors.

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 preparation, 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).
- 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 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 King County. Consequently, the proposed site development is not constrained by any prevailing geological hazards, in our opinion.

At the request of the City of Redmond a slope stability analysis was performed for the slope to the south of the currently proposed development area. The results were stated in a previous memo dated February 11, 2018. In this memo the analysis indicated that adequate factors of safety were available in both the static and seismic cases.

Foundation Considerations: Our explorations revealed that the site is underlain by medium dense to very dense, native, glacial sands, and silty sands. These native soils are generally suitable for supporting the new buildings on conventional spread footings that impose a low to moderate bearing pressure. However, it is likely that some localized zones of unsuitable soil exist within the building footprint, thereby requiring remedial measures.

Earthwork Scheduling: Our explorations indicate that much of the on-site soil contains a moderate amount of silt. 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 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" as defined by the IBC.

Site Excavations: Most of our exploration pits encountered minor to rapid inflow seepage at near the surface. Consequently, we expect that any site excavations for underground utilities, storm water vaults, or other subsurface features will likely incur seepage problems. The earthwork contractor should be prepared to install ditches, sumpholes, on-demand pumps, wellpoints, or other dewatering systems as needed for the actual conditions.

Infiltration Potential: Our recent explorations revealed that the site is underlain by predominantly glacially consolidated granular (sand and gravel) soils with variable silt contents. Although granular soils may have adequate permeability, we observed that they contained a substantial amount of fine-grained material within the Vashon lodgement till. In our soil test boring we encountered Vashon advance outwash, however this material was observed to contain stratified layers with high fines contents. It is therefore our opinion that the site is not suitable for storm water infiltration systems such as trenches, ponds, or permeable pavements.

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, debris-laden soils, and other surface features. Our exploration pits disclosed about 1½ to 3½ feet of undocumented fill with organic-rich topsoil mantling and intermixed.

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.

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 Till Deposits:	1.0H:1V
Cuts in Loose to Medium Dense Granular Deposits:	1.5H:1V
Cuts in Saturated Soil Deposits:	3.0H:1V

5.3 Building Foundations

The dense to very dense and very stiff to hard glacial soils underlying the central part of the site at relatively shallow depths are generally favorable for supporting the residential structures on conventional spread footings. 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 medium dense to very dense or stiff to hard, native soils (lodgement till, advance outwash, or older pre-Vashon sediments) underlying the site. These bearing soils were observed at shallow depths across the site. If any soft, loose, organic-rich, or debris-laden soils are found below footing subgrades, these deleterious materials should be overexcavated and replaced with granular fill compacted to a density of at least 95 percent of the maximum dry density (per ASTM D-1557).

Foundation Bearing Capacities: Based on the bearing provisions 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), and they incorporate a static 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 placed. If subgrade overexcavations are performed, we should be retained to monitor and test the backfill soils.

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. We offer the following comments and recommendations for slab-on-grade floors.

Subgrade Preparation: Based on our exploration pits, we anticipate that new floor subgrades will consist of medium dense to very dense native soils. If any soft, loose, organic-rich, or debris-laden soils are found below footing subgrades, these deleterious materials should be overexcavated and replaced with granular fill compacted to a density of at least 95 percent of the maximum dry density (per ASTM D-1557).

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 each layer.

Vapor Retarder:	10 mils
Base Course:	4 inches
Subbase Course:	6 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 vibratory 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 compacted to a firm and unyielding condition.

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 and testing 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.

Underslab Drains: Based on the soil and ground water conditions observed in our site explorations, we currently recommend that underslab drains be installed below all basement floors. The underslab drainage system should comprise a parallel array of 4-inch-diameter, rigid, perforated pipes within a 6-inch envelope of pea gravel or washed rock. The gravel envelope should be wrapped with filter fabric (such as Mirafi 140N) to reduce the migration of fines from the surrounding soils. Preliminarily, a pipe spacing of 15 feet can be assumed. However, the final decisions regarding drainage details should be made at the time of construction, after the floor subgrade has been exposed.

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 and underslab 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 building rather than ponding near the foundation walls.

Detention System:

All storm water will be collected and conveyed to a vault in Tract C along the eastern edge of the site. From there the storm water will be tightlined into the Rose Hill East conveyance system, northeast of the site.

5.6 Conventional Pavement Sections

We understand that conventional flexible (asphalt concrete) pavement will likely be used in the new car drive lanes and driveways. 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 20 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 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) over a granular subbase (GSB). Our recommended minimum thicknesses for flexible pavement sections, which are based on the aforementioned design values and a 20-year lifespan, are shown below.

Drive Lanes	
Asphalt Concrete Pavement (ACP):	4 inches
Crushed Aggregate Base Course (CAB):	6 inches
Granular Subbase Course (GSB):	6 inches
Driveways	
Asphalt Concrete Pavement (ACP):	3 inches
Crushed Aggregate Base Course (CAB):	4 inches
Granular Subbase Course (GSB):	8 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 64-22 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).

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.

5.7 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, 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, sandy silts, and, to a lesser extent, gravelly sands. 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).

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

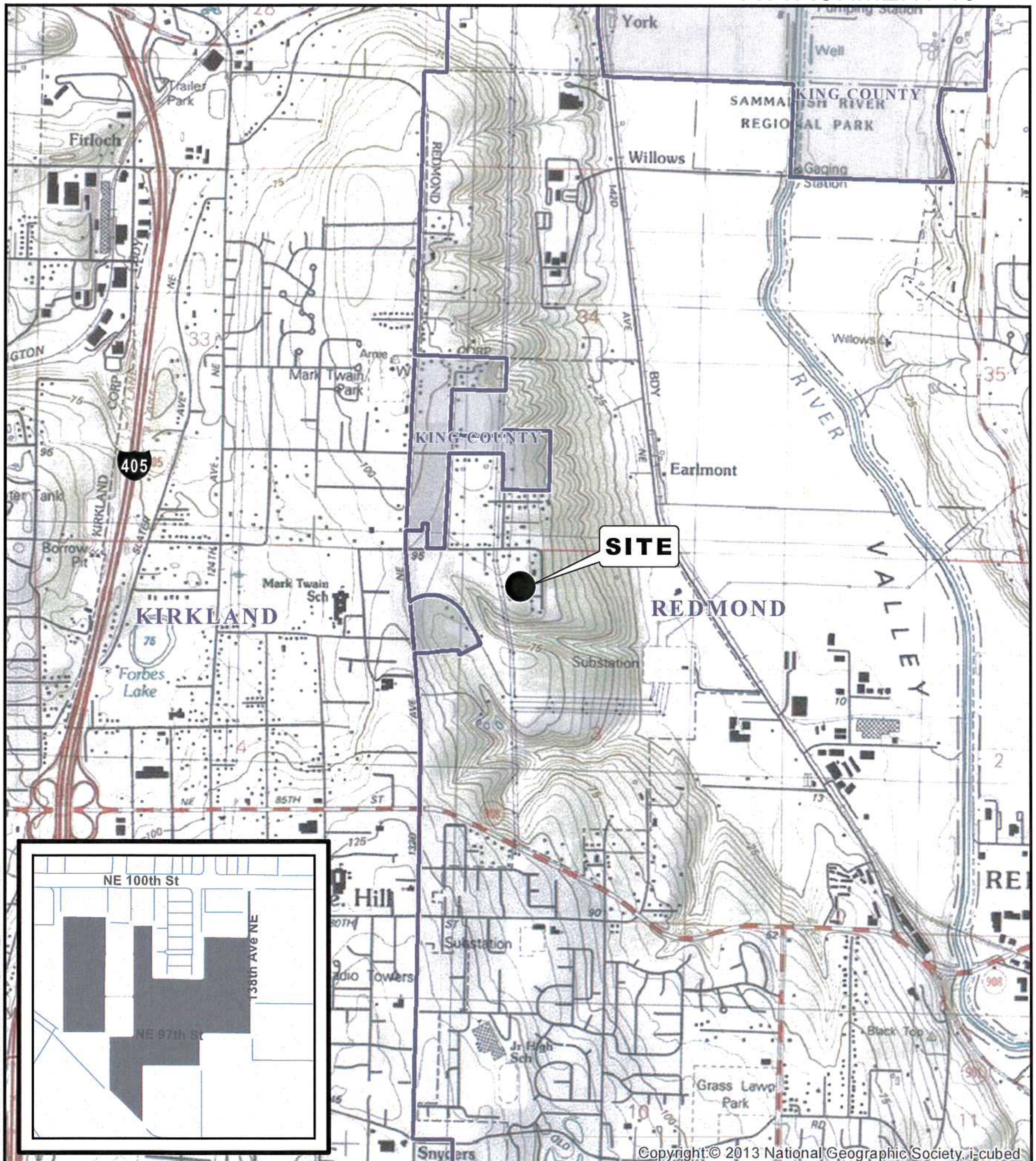
AESI has prepared this report for the exclusive use of our client and their agents, for specific application to this project. Within the limitations of scope and schedule, our services have been performed in accordance with generally accepted local geotechnical engineering practices in effect at the 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.
Kirkland, Washington

Matthew A. Miller, P.E.
Principal Geotechnical Engineer

ATTACHMENT 13



DATA SOURCES / REFERENCES:
USGS: 24K SERIES TOPOGRAPHIC MAPS
KING CO: STREETS, CITY LIMITS, PARCELS 2016

LOCATIONS AND DISTANCES SHOWN ARE APPROXIMATE

N

0 1000 2000
FEET

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

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VICINITY MAP

ROSE HILL WEST ASSEMBLAGE
REDMOND, WASHINGTON

PROJ NO.	DATE:	FIGURE:
EE160687A	2/17	1

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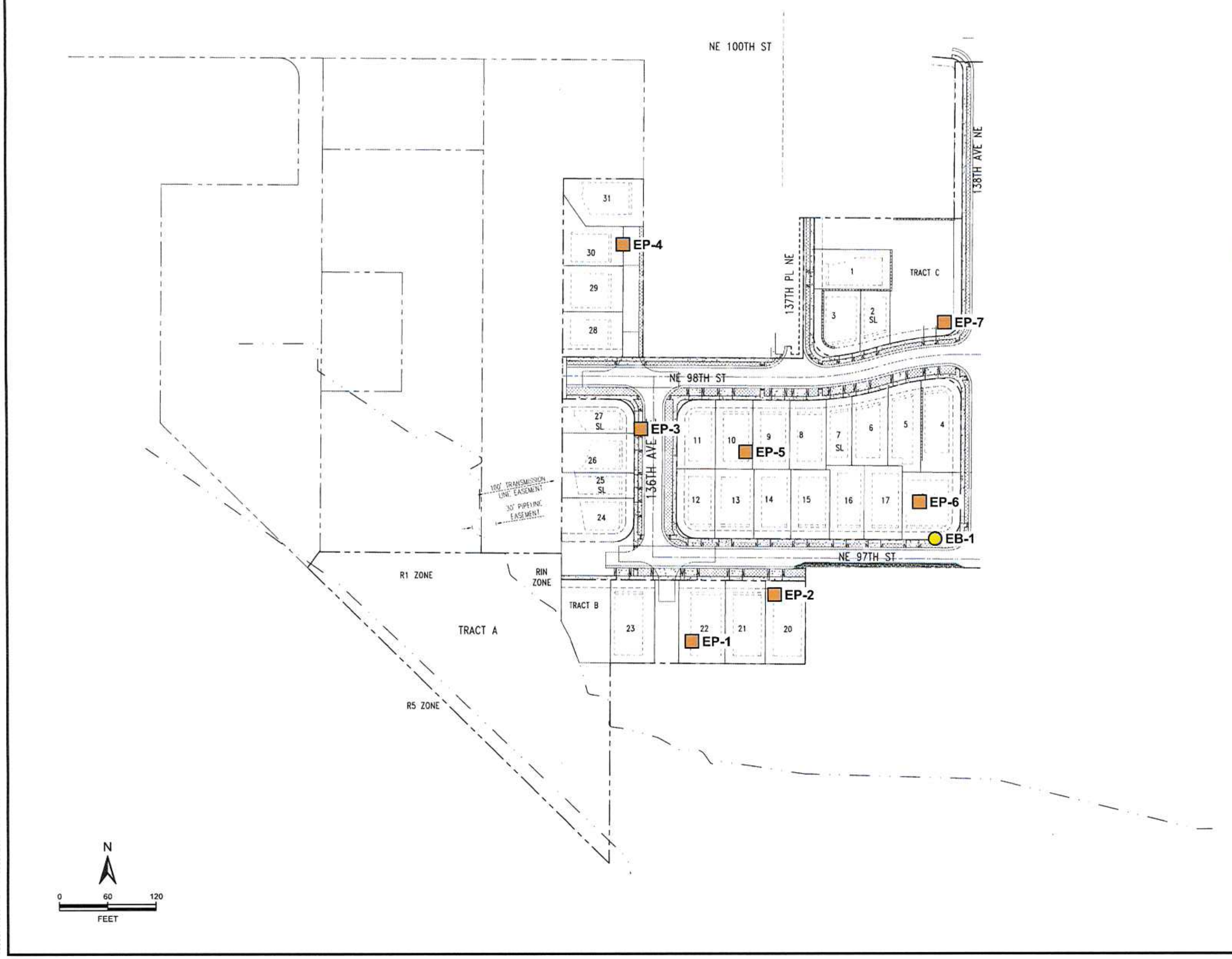
ATTACHMENT 13



LEGEND:

- EB EXPLORATION BORING
- EP EXPLORATION PIT

CONTOUR INTERVAL = N/A

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

NOTES:
1. BASE MAP REFERENCE: KPFF, SITE PLAN, UNTITLED, UNDATED.

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

ROSE HILL WEST ASSEMBLAGE
REDMOND, WASHINGTON

PROJ NO.	DATE:	FIGURE:
160687E001	9/18	2

160687 Rose Hill W \ 160687E001 F2 S-E.cdr

APPENDIX A

Exploration Logs

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

Terms Describing Relative Density and Consistency

	Density	SPT[2] blows/foot
Coarse-Grained Soils	Very Loose	0 to 4
	Loose	4 to 10
	Medium Dense	10 to 30
	Dense	30 to 50
	Very Dense	>50

	Consistency	SPT[2] blows/foot
Fine-Grained Soils	Very Soft	0 to 2
	Soft	2 to 4
	Medium Stiff	4 to 8
	Stiff	8 to 15
	Very Stiff	15 to 30
	Hard	>30

Test Symbols

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

Component Definitions

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

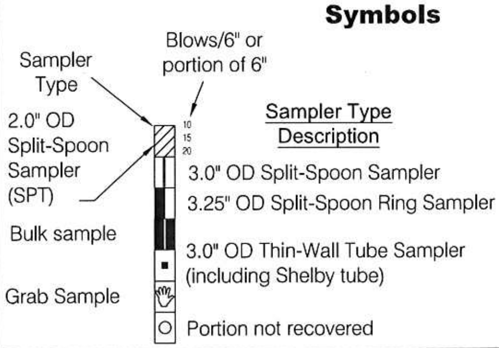
(3) Estimated Percentage

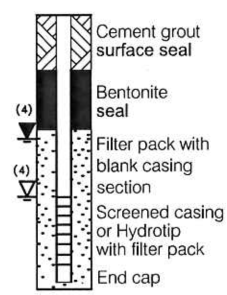
Component	Percentage by Weight
Trace	<5
Some	5 to <12
Modifier (silty, sandy, gravelly)	12 to <30
Very *modifier* (silty, sandy, gravelly)	30 to <50

Moisture Content

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

Symbols





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

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

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EXPLORATION LOG KEY

FIGURE A1

ATTACHMENT 13

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Exploration Log

Project Number	Exploration Number	Sheet
EE160687A	EB-1	1 of 2

Project Name: Rose Hill West Assemblage
Location: Redmond, WA
Driller/Equipment: EDI / HSA
Hammer Weight/Drop: 140# / 30"
Ground Surface Elevation (ft):
Datum: N/A
Date Start/Finish: 2/8/17,2/8/17
Hole Diameter (in): 4 inches

Depth (ft)	Samples	DESCRIPTION	Blows/6"	Blows/Foot
0		**Fill** Loose, moist, dark brown, intermixed TOPSOIL and silty SAND, some gravel, cobbles and wood debris (SM).		
		Vashon Lodgement Till		
8	S-1	Very dense, moist, brown, silty, fine to medium SAND, some gravel; unsorted (SM).	19 36 50/4"	86/10"
13	S-2	Very dense, moist, brown, silty, fine to medium SAND, some gravel; unsorted (SM).	35 50/5"	50/5"
18	S-3	Very dense, moist, gray, silty, fine to coarse SAND, some gravel; unsorted (SM).	50/6"	50/6"
23	S-4	Very dense, moist, brown, silty, fine to medium SAND, some gravel; unsorted (SM).	50/4"	50/4"
28	S-5	Very dense, moist, brown, silty, fine to medium SAND, some gravel; unsorted (SM).	32 50/3"	50/3"
30		**Transitional Advance Outwash - varies from unsorted to stratified**		
33	S-6	Very dense, moist, brown, interbedded silty, fine to medium SAND, some gravel (SM) and medium SAND, trace gravel and silt (SP-SM).	50/6"	50/6"
35		Wet cuttings observed.		
38	S-7	Very dense, moist, brown, silty, fine to medium SAND, some gravel; unsorted (SM).	50/6"	50/6"

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: SGP
Approved by: JHS

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Exploration Log

Project Number	Exploration Number	Sheet
EE160687A	EB-1	2 of 2

Project Name: Rose Hill West Assemblage
Location: Redmond, WA
Driller/Equipment: EDI / HSA
Hammer Weight/Drop: 140# / 30"

Ground Surface Elevation (ft):
Datum: N/A
Date Start/Finish: 2/8/17,2/8/17
Hole Diameter (in): 4 inches

Depth (ft)	ST	Samples	DESCRIPTION	Water Level	Blows/6"	Blows/Foot
		S-8	Very dense, very moist, brown, fine to medium SAND, some silt and gravel; unsorted (SM).		26 50/4"	50/4"
45						
		S-9	Very dense, moist, brown, fine to medium SAND, some silt and gravel; unsorted (SM).		39 50/4"	50/4"
50						
		S-10	Very dense, moist, brown, fine to medium SAND, some silt and gravel; unsorted (SM).	ATD	50/6"	50/6"
55			**Pre-Fraser Till**			
		S-11	Very dense, moist, brown, silty, fine to medium SAND, some gravel; unsorted (SM). Bottom of exploration boring at 58 feet		50/6"	50/6"
60						
65						
70						
75						

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: SGP
Approved by: JHS

LOG OF EXPLORATION PIT NO. EP-1

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**
1	**Fill** Medium dense, wet, brown, silty, fine to coarse SAND, some gravel; unsorted (SM).
2	**Vashon Lodgement Till** Very stiff, moist, brown-gray, sandy SILT; unsorted (ML).
3	
4	
5	
6	
7	
8	Very dense, moist, brown, silty, medium SAND, trace gravel; unsorted (SM).
9	
10	Bottom of exploration pit at depth 9 feet Seepage at 1.5 feet. Caving at 1.5 feet.
11	
12	
13	
14	
15	
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17	
18	
19	
20	

KCTP3 160687.GPJ February 20, 2017

Rose Hill West Assemblage
Redmond, WA

Logged by: SGP
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Project No. EE160687A

1/18/17

LOG OF EXPLORATION PIT NO. EP-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
	Topsoil
	Fill
1	Loose, wet, black-brown, sandy SILT, some gravel and organics (ML).
2	
3	
	Vashon Lodgement Till
4	Dense to very dense, moist, gray-brown, silty, fine to medium SAND, trace gravel; unsorted (SM).
5	
6	
7	
8	
9	
10	Bottom of exploration pit at depth 9.5 feet Seepage at 2 feet. Caving at 2 feet.
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

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Rose Hill West Assemblage
Redmond, WA

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Project No. EE160687A

1/18/17

LOG OF EXPLORATION PIT NO. EP-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
	Topsoil
1	Loose, wet, dark brown, TOPSOIL, some sand.
2	**Vashon Lodgement Till**
3	Very stiff, moist, red-brown, sandy SILT; unsorted (ML).
4	Hard, moist, brown, sandy SILT; unsorted (ML).
5	
6	
7	Bottom of exploration pit at depth 6 feet Seepage at 2 feet. Caving at 2 feet.
8	
9	
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Rose Hill West Assemblage
Redmond, WA

Logged by: SGP

Approved by: JHS

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Project No. EE160687A

1/18/17

LOG OF EXPLORATION PIT NO. EP-4

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
0–2	**Fill** Medium dense, wet, brown, very silty, fine to medium SAND, trace gravel; unsorted (SM).
2–5.5	**Vashon Lodgement Till** Dense, moist, brown, silty, fine to medium SAND, trace gravel (SM). Very dense, moist, gray, silty, fine to medium SAND, some gravel and cobbles (SM).
5.5–20	Bottom of exploration pit at depth 5.5 feet Seepage at 1.5 feet. Caving at 1.5 feet.

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

Rose Hill West Assemblage
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Project No. EE160687A
1/18/17

KCTP3 160687.GPJ February 20, 2017

LOG OF EXPLORATION PIT NO. EP-5

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
	Fill
1	Loose to medium dense, wet, dark brown, TOPSOIL.
2	**Vashon Lodgement Till**
3	Dense, moist, red-brown, silty, predominantly fine SAND, some gravel and cobbles (SM).
4	
5	Very dense, moist, gray, silty, fine to coarse SAND, some gravel and cobbles (SM).
6	
7	
8	
9	Bottom of exploration pit at depth 8 feet Seepage at 1.5 feet. Caving at 1.5 feet.
10	
11	
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KCTP3 160687.GPJ February 20, 2017

Rose Hill West Assemblage
Redmond, WA

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Project No. EE160687A

1/18/17

LOG OF EXPLORATION PIT NO. EP-6

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
1	**Fill** Loose, very wet, brown, intermixed TOPSOIL and silty SAND, some gravel, cobbles and wood debris (SM).
2–4	**Vashon Lodgement Till** Dense to very dense, moist, brown, silty, fine to coarse SAND, trace gravel; oxidized; unsorted (SM).
5	Bottom of exploration pit at depth 4 feet Seepage at 1 foot. Caving at 1 foot.
6–20	

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Redmond, WA

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1/18/17