DRAFT

# GEOTECHNICAL REPORT

**Summit View Development**
**16445 International Boulevard**
**SeaTac, Washington**

**Project No. T-8882**

## Terra Associates, Inc.

**Prepared for:**

**Bonney Watson Funeral Homes**
**SeaTac, Washington**

**April 26, 2023**

TERRA ASSOCIATES, Inc.
Consultants in Geotechnical Engineering, Geology
and
Environmental Earth Sciences

April 26, 2023
Project No. T-8882

DRAFT

Mr. Cameron Smock
Bonney Watson Funeral Homes
16445 International Boulevard
SeaTac, Washington 98188

Subject: Geotechnical Report
Summit View Development
16445 International Boulevard
SeaTac, Washington

Dear Mr. Smock:

As requested, we have conducted a geotechnical engineering study for the subject project. The attached report presents our findings and recommendations for the geotechnical aspects of project design and construction.

Our field exploration indicates that in general, the soil conditions at the site consisted of approximately three inches of organic topsoil over approximately four and one-half to five and one-half feet of possible fill soils composed of very loose to medium dense sandy silt with varying gravel content overlying approximately two to five feet of medium stiff to very stiff silt with varying sand and gravel content over medium dense to very dense silty sand with varying gravel content to the termination of the test borings. There were three exceptions to this general condition. Test Boring B-1 terminated in a dense sand with silt and gravel layer. In Test Boring B-3 we did not observe any silt soils. In Test Boring B-6 we observed very dense silty sand with gravel material underlying approximately three and one-half inches of asphalt pavement to the termination of the test boring. We did not observe any indication of groundwater seepage during our explorations.

In our opinion, the native soil on the site will be suitable for support of the proposed development, provided the recommendations presented in this report are incorporated into project design and construction.

12220 113th Avenue NE, Ste. 130, Kirkland, Washington 98034
Phone (425) 821-7777

We trust the information presented in this report is sufficient for your current needs. If you have any questions or require additional information, please call.

Sincerely yours,
**TERRA ASSOCIATES, INC.**

DRAFT

Michael J. Xenos, E.I.T.
Staff Engineer

Carolyn S. Decker, P.E.
President

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## 1.0 PROJECT DESCRIPTION

The project consists of developing the southwestern portion of the site with an approximately 7,200 square-foot building, two infiltration trenches, and associated access and utilities. Based on a conceptual grading and drainage plan, prepared by Barghausen Consulting Engineers, dated November 4, 2022, cuts and fills ranging from approximately one to five feet will be required to achieve a finished floor elevation of 442.0 feet.

The preliminary grading plans indicate two infiltration trenches are planned to the west and southeast of the proposed building to manage site stormwater.

We would expect that the structure will be a one-to two-story wood-framed building constructed at grade. Structural loading should be relatively light, with bearing walls carrying loads of 2 to 3 kips per foot and isolated columns carrying maximum loads of 30 to 50 kips.

The recommendations in the following sections of this report are based on our understanding of the preceding design features. We should review design drawings as they become available to verify our recommendations have been properly interpreted and to supplement them, if required.

## 2.0 SCOPE OF WORK

We completed our work in accordance with our authorized proposal, dated March 10, 2023. Accordingly, on April 5, 2023, we observed soil and groundwater conditions at 6 test borings advanced with a hollow-stem auger to maximum depths ranging from approximately 10 to 20 feet below existing grades. Using the information obtained from the subsurface exploration, we performed analyses to develop geotechnical recommendations for project design and construction.

Specifically, this report addresses the following:

- Soil and groundwater conditions.
- Critical Areas per the City of SeaTac Municipal Code.
- Seismic Site Class per the current International Building Code (IBC).
- Site preparation and grading.
- Excavations.
- Foundation support.
- Slab-on-grade floors.

- Stormwater facilities.
- Infiltration feasibility.
- Drainage.
- Utilities.
- Pavements.

It should be noted, recommendations outlined in this report regarding drainage are associated with soil strength, design earth pressures, erosion, and stability. Design and performance issues with respect to moisture as it relates to the structure environment are beyond Terra Associates, Inc.'s purview. A building envelope specialist or contactor should be consulted to address these issues, as needed.

## 3.0 SITE CONDITIONS

### 3.1 Surface

The site consists of the southwestern approximately 0.6 acres of a single tax parcel totaling about 2.16 acres located west of 16445 International Boulevard in SeaTac, Washington. The approximate site location is shown on Figure 1.

The project site is currently undeveloped and consists of an open space covered with grass lawn. Site topography consists of a slight slope that descends from the northwest to the southeast with an overall relief of approximately eight feet.

### 3.2 Subsurface

The soils observed in the test borings generally consisted of approximately three inches of organic topsoil over approximately four and one-half to five and one-half feet of possible fill soils composed of very loose to medium dense sandy silt with varying gravel content overlying approximately two to five feet of medium stiff to very stiff silt with varying sand and gravel content over medium dense to very dense silty sand with varying gravel content to the termination of the test borings. There were three exceptions to this general condition. Test Boring B-1 terminated in a dense sand with silt and gravel layer. In Test Boring B-3 we did not observe any silt soils. In Test Boring B-6 we observed very dense silty sand with gravel material underlying approximately three and one-half inches of asphalt pavement to the termination of the test boring.

The *Lidar-Revised Geologic Map of the Des Moines 7.5' Quadrangle, King County, Washington* by R.W. Tabor and D.B. Booth (2017) maps the site as Modified Land (m) overlying glacially derived Advance Outwash Deposits (Qva). The very loose to medium dense possible fill soils and underlying medium stiff to very stiff silt deposits are consistent with these mapped descriptions. However, the deeper medium dense to very dense silty sand deposits are more consistent with Till (Qvt) which is mapped approximately 675 feet to the east of the site.

The preceding discussion is intended to be a general review of the soil conditions encountered. For more detailed descriptions, please refer to the Test Boring Logs in Appendix A. The approximate locations of the test borings are shown on the Exploration Location Plan, Figure 2.

## 3.3 Groundwater

We did not observe any groundwater or indication of groundwater seepage during our explorations. However, we did observe mottling in native soils near their contact with the possible fill soils, which typically indicates that a shallow perched groundwater table develops during the winter months.

The occurrence of shallow perched groundwater is typical for sites underlain by fine-grained soils. We expect perched groundwater levels and flow rates will fluctuate seasonally and will typically reach their highest levels during and shortly following the wet winter months (November through May). Test Borings B-1 and B-6 were converted to groundwater monitoring wells and will be instrumented with automatic level loggers and the groundwater will be monitored for the 2023-2024 wet season.

## 3.4 Critical Areas

Section 15.700.015 of the City of SeaTac Municipal Code (SMC) defines critical areas as "…areas in the City which are subject to natural hazards or those land features which support unique, fragile or valuable natural resources including fishes, wildlife and other organisms and their habitat, and such resources which carry, hold or purify water in their natural state. Critical areas include coal mine hazard areas, erosion hazard areas, flood hazard areas, landslide hazard areas, seismic hazard areas, steep slope hazard areas, streams, volcanic hazard areas, wetlands and critical aquifer recharge areas." We evaluated site conditions for the presence of geologic critical areas. Discussions related to erosion, landslides, coal mine, volcanic, and seismic hazards are given below.

### *3.4.1 Erosion Hazard Areas*

The SMC does not specifically define erosion hazard areas. The onsite soils are classified as Urban land, 5 to 20 percent slopes, by the United States Department of Agriculture Natural Resources Conservation Service. (NRCS). Based on the soils observed in the test borings and existing site topography, it is our opinion that the onsite soils have a low to moderate susceptibility to erosion when exposed. Therefore, an erosion hazard does not exist at the site in our opinion.

We did not observe any indications of significant active erosion at the site. However, the potential for soil erosion will increase during construction. In our opinion, proper implementation and maintenance of Best Management Practices (BMPs) for erosion prevention and sediment control, in conjunction with appropriate site drainage, will adequately mitigate the erosion potential in the planned development area. BMPs for erosion prevention and sediment control must be in place prior to and throughout grading activity at the site.

### *3.4.2 Landslide Hazard Areas*

The SMC does not specifically define landslide hazard areas. Site topography consists of a slight slope descending from the northwest to the southeast with an overall vertical relief of approximately eight feet. Additionally, the native soils underlying the site consist of medium dense to very dense sand with silt to silty sandy, and medium stiff to very stiff silt. No groundwater seepage was observed in the test borings or along the slope. Based on the soil and groundwater conditions observed at the site, along with existing site topography, it is our opinion that a landslide hazard does not exist at the site.

### *3.4.3 Coal Mine Hazard Areas.*

The SMC does not specifically define coal mine hazard areas. No evidence of adits, tunnels, drifts, shafts, or other mine workings were observed while onsite. Additionally, the Washington State Department of Natural Resources map titled *Inactive and Abandoned Mines,* dated September 2004, shows no evidence of underground mine development in the vicinity of the site. Therefore, it is our opinion that a coal mine hazard does not exist at the site.

### *3.4.4 Volcanic Hazard Areas*

The SMC does not specifically define volcanic hazard areas. The site is not located within a pyroclastic-flow hazard zone, or a lahar inundation zone as shown on the Washington State Department of Natural Resources Geologic Hazards Single Topic Map. Therefore, it is our opinion that the site does not exist within a volcanic hazard area.

### *3.4.5 Seismic Hazard Areas*

Section 15.700.015 of the SMC defines seismic hazard areas as "…areas in the City subject to severe risk of earthquake damage as a result of soil liquefaction in areas underlain by cohesionless soils of low density and usually in association with a shallow groundwater table or other seismically induced settlement."

A review of a map titled *Faults and Earthquakes in Washington State*, dated 2014, by Jessica L. Czajkowski and Jeffrey D. Bowman shows the closest fault to the site, the southeastern portion of the Seattle Fault Zone, is located approximately 5 miles north of the site. Quarternary-age activity of the fault (rupture within the last two million years) is predicted to have occurred during the Holocene, or within the last 11,700 years. Accordingly, during a seismic event, the risk of ground rupture along a fault line at the site is low.

Liquefaction is a phenomenon where there is a reduction or complete loss of soil strength due to an increase in water pressure induced by vibrations. Liquefaction mainly affects geologically recent deposits of fine-grained sands underlying the groundwater table. Soils of this nature derive their strength from intergranular friction. The generated water pressure or pore pressure essentially separates the soil grains and eliminates this intergranular friction, thus eliminating the soil's strength.

The site is currently mapped on the Washington State DNR's Geologic Hazards Single Topic Map as having very low liquefaction potential. Based on the soil and groundwater conditions we observed, it is our opinion that the risk for soil liquefaction occurring at the site is negligible due to the relative density of the soils and amount of cohesive material that would be sufficient to resist the cyclical loading of a seismic event. Therefore, in our opinion, the site does not exist with a seismic hazard area per the SMC.

### 3.5 Seismic Site Class

Based on soil conditions observed in the test borings, and our knowledge of the area geology, per Chapter 16 of the current International Building Code (IBC), Site Class "D" should be used in structural design.

## 4.0 DISCUSSION AND RECOMMENDATIONS

### 4.1 General

Based on our study, there are no geotechnical considerations that would preclude development of the site as currently planned. The residential buildings can be supported on conventional spread footings bearing on competent native soils, competent reworked possible fill soils, or on new structural fill placed on the competent soils observed below the organic surface horizon. Pavement and floor slabs can be similarly supported.

The upper approximately four to seven feet of material observed in Test Borings B-1 through B-4 consisted of possible fill soils composed of very loose to loose silty sand to sandy silt. In structural areas where these materials are present, we recommend over excavating the material by approximately two feet, compacting the exposed soils, and restoring the over excavated areas to grade using new structural fill following the recommendations outlined below.

The soils encountered at the site contain a sufficient amount of soil fines that will make them difficult to compact as structural fill when too wet. The ability to use the native soils from site excavations as structural fill will depend on its moisture content and the prevailing weather conditions at the time of construction. If grading activities take place during winter, the owner should be prepared to import clean granular material for use as structural fill and backfill.

The following sections provide detailed recommendations regarding the preceding issues and other geotechnical design considerations. These recommendations should be incorporated into the final design drawings and construction specifications.

### 4.2 Site Preparation and Grading

To prepare the site for construction, all vegetation, organic surface soils, and other deleterious material should be stripped and removed from the site. Surface stripping depths of approximately three inches should be expected to remove the organic surface soils and vegetation. Abandoned utility pipes that fall outside of new building areas can be left in place provided they are sealed to prevent intrusion of groundwater seepage and soil. Organic topsoil will not be suitable for use as structural fill but may be used for limited depths in nonstructural areas.

Once clearing and stripping operations are complete, cut and fill operations can be initiated to establish desired building grades. Prior to placing fill, all exposed bearing surfaces should be observed by a representative of Terra Associates, Inc. to verify soil conditions are as expected and suitable for support of new fill or building elements. Our representative may request a proof roll using heavy rubber-tired equipment to determine if any isolated soft and yielding areas are present. If excessively yielding areas are observed and they cannot be stabilized in place by compaction, the affected soils should be excavated and removed to firm bearing and grade restored with new structural fill. If the depth of excavation to remove unstable soils is excessive, the use of geotextile fabrics, such as Mirafi 500X or an equivalent fabric can be used in conjunction with clean granular structural fill. Our experience has shown, in general, that a minimum of 18 inches of a clean, granular structural fill placed and compacted over the geotextile fabric should establish a stable bearing surface.

The upper approximately four to seven feet of material observed in Test Boring B-1 through B-4 consisted of possible fill soils composed of very loose to loose silty sand to sandy silt. In structural areas where these materials are present, we recommend over excavating the material by approximately two feet, compacting the exposed soils in place, and restoring the over excavated areas to grade using new structural fill following the recommendations outlined below. The lateral extent of the over excavation should be determined in the field during grading.

Our study indicates that the native and possible fill soils encountered at the site contain a sufficient amount of soil fines that will make them difficult to compact as structural fill when too wet or too dry. The ability to use these soils from site excavations as structural fill will depend on its moisture content, the prevailing weather conditions at the time of construction and the contractor's ability to compact these soils. If wet soil is encountered, the contractor will need to dry the soils by aeration during dry weather conditions. Alternatively, the use of an additive, such as Portland cement, cement kiln dust (CKD), or lime to stabilize the soil moisture can be considered. If the soil is amended, additional Best Management Practices (BMPs) addressing the potential for elevated pH levels will need to be included in the Stormwater Pollution Prevention Program (SWPPP) prepared with the Temporary Erosion and Sedimentation Control (TESC) plan.

If grading activities are planned during the wet winter months, or if they are initiated during the summer and extend into fall and winter, the owner should be prepared to import wet-weather structural fill. For this purpose, we recommend importing a granular soil that meets the following grading requirements:

| **U.S. Sieve Size** | **Percent Passing** |
|---|---|
| 6 inches | 100 |
| No. 4 | 75 maximum |
| No. 200 | 5 maximum* |

* Based on the 3/4-inch fraction.

Prior to use, Terra Associates, Inc. should examine and test all materials imported to the site for use as structural fill.

Structural fill should be placed in uniform loose layers not exceeding 12 inches and compacted to a minimum of 95 percent of the soil's maximum dry density, as determined by American Society for Testing and Materials (ASTM) Test Designation D-1557 (Modified Proctor). The moisture content of the soil at the time of compaction should be within two percent of its optimum, as determined by this ASTM standard. In nonstructural areas, the degree of compaction can be reduced to 90 percent.

## 4.3 Excavations

All excavations at the site associated with confined spaces, such as utility trenches, must be completed in accordance with local, state, and federal requirements. Based on regulations outlined in the Washington Industrial Safety and Health Act (WISHA), the upper very loose to dense sand with silt, silty sand, and sandy silt soils would be classified as Type C soils. The medium stiff to very stiff silt soils would be classified as Type B soils. The lower very dense silty sand soils would be classified as Type A soils.

Accordingly, temporary excavations in Type C soils should have their slopes laid back at an inclination of 1.5:1 (Horizontal: Vertical) or flatter, from the toe to the crest of the slope. Side slopes in Type B soils can be laid back at a slope inclination of 1:1 or flatter. Side slopes in Type A soils can be laid back at a slope inclination of 0.75:1 or flatter. For temporary excavation slopes less than 8 feet in height in Type A soils, the lower 3.5 feet can be cut to a vertical condition, with a 0.75:1 slope graded above. For temporary excavation slopes greater than 8 feet in height up to a maximum height of 12 feet, the slope above the 3.5-foot vertical portion will need to be laid back at a minimum slope inclination of 1:1. No vertical cut with a backslope immediately above is allowed for excavation depths exceeding 12 feet. In this case, a four-foot vertical cut with an equivalent horizontal bench to the cut slope toe is required.

All exposed temporary slope faces that will remain open for an extended period of time should be covered with a durable reinforced plastic membrane during construction to prevent slope raveling and rutting during periods of precipitation.

Groundwater seepage should be anticipated within excavations during the wet winter season. We anticipate that the volume of water and rate of flow into the excavation will be relatively minor and are not expected to impact the stability of the excavations when completed, as described. Conventional sump pumping procedures, along with a system of collection trenches, if necessary, should be capable of maintaining a relative dry excavation for construction purposes.

The above information is provided solely for the benefit of the owner and other design consultants and should not be construed to imply that Terra Associates, Inc. assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project general contractor.

## 4.4 Foundation Support

The building may be supported on conventional spread footing foundations bearing on competent native soils, on competent reworked possible fill soils, or on new structural fill placed above the competent soils. Foundation subgrade should be prepared as recommended in Section 4.2 of this report. Perimeter foundations exposed to the weather should bear a minimum depth of one and one-half feet below final exterior grades for frost protection. Interior foundations can be constructed at any convenient depth below the floor slab.

The native and possible fill soils will be easily disturbed by normal construction activity particularly when wet. Care will need to be exercised during construction to avoid excessively disturbing the subgrade. If disturbed, the material should be removed and footings lowered to undisturbed material or grade restored with structural fill. During wet-weather conditions, to avoid disturbance, consideration should be given to protecting the fill foundation subgrade with a four-inch layer of crushed rock or lean mix concrete.

Foundations bearing on competent soils can be dimensioned for a net allowable bearing capacity of 2,500 pounds per square foot (psf). For short-term loads, such as wind and seismic, a one-third increase in this allowable capacity can be used. With structural loading as anticipated and this bearing stress applied, estimated total settlements are less than one inch.

For designing foundations to resist lateral loads, a base friction coefficient of 0.35 can be used. Passive earth pressures acting on the side of the footing and buried portion of the foundation stem wall can also be considered. We recommend calculating this lateral resistance using an equivalent fluid weight of 350 pcf. We recommend not including the upper 12 inches of soil in this computation because they can be affected by weather or disturbed by future grading activity. This value assumes the foundation will be constructed neat against native soil, or backfilled with structural fill as described in Section 4.2 of this report. The values recommended include a safety factor of 1.5.

## 4.5 Slab-on-Grade Floors

Slab-on-grade floors may be supported on subgrade prepared as recommended in Section 4.2 of this report. Immediately below the floor slab, we recommend placing a four-inch-thick capillary break layer composed of clean, coarse sand or fine gravel that has less than five percent passing the No. 200 sieve. This material will reduce the potential for upward capillary movement of water through the underlying soil and subsequent wetting of the floor slab.

The capillary break layer will not prevent moisture intrusion through the slab caused by water vapor transmission. Where moisture by vapor transmission is undesirable, such as covered floor areas, a common practice is to place a durable plastic membrane on the capillary break layer and then cover the membrane with a layer of clean sand or fine gravel to protect it from damage during construction and to aid in uniform curing of the concrete slab. It should be noted, if the sand or gravel layer overlying the membrane is saturated prior to pouring the slab, it will not be effective in assisting uniform curing of the slab and can actually serve as a water supply for moisture bleeding through the slab, potentially affecting floor coverings. Therefore, in our opinion, covering the membrane with a layer of sand or gravel should be avoided if floor slab construction occurs during the wet winter months and the layer cannot be effectively drained.

We recommend floor designers and contractors refer to the current American Concrete Institute (ACI) Manual of Concrete Practice for further information regarding vapor barrier installation below slab-on-grade floors.

## 4.6 Stormwater Facilities

Site stormwater plans were not available at the time of this report.

***Detention Vault***

We expect the bottom of the excavations for a detention vault will expose medium dense to very dense sand with silt to silty sand. Vault foundations supported by these native soils may be designed for an allowable bearing capacity of 4,000 psf. For short-term loads, such as seismic, a one-third increase in this allowable capacity can be used.

Vault walls should be designed as below-grade retaining walls. The magnitude of earth pressure development on engineered retaining walls will partly depend on the quality of the wall backfill. We recommend placing and compacting wall backfill as structural fill as described in Section 4.2 of this report. To prevent overstressing the walls during backfilling, heavy construction machinery should not be operated within five feet of the wall. Wall backfill in this zone should be compacted with hand-operated equipment. To prevent hydrostatic pressure development, wall drainage must also be installed. A typical wall drainage detail is shown on Figure 3.

With wall backfill placed and compacted as recommended and drainage properly installed, we recommend designing unrestrained walls for an active earth pressure equivalent to a fluid weighing 35 pounds per cubic foot (pcf). For restrained walls, an additional uniform load of 100 pounds per square foot (psf) should be added to the 35 pcf. To account for typical traffic surcharge loading, the walls can be designed for an additional imaginary height of two feet (two-foot soil surcharge). For evaluation of below-grade walls under seismic loading, an additional uniform lateral pressure equivalent to 8H psf, where H is the height of the below-grade portion of the wall in feet, can be used. These values assume a horizontal backfill condition and that no other surcharge loading such as traffic, sloping embankments, or adjacent buildings will act on the wall. If such conditions exist, then the imposed loading must be included in the wall design. Friction at the base of foundations and passive earth pressure will provide resistance to these lateral loads. Values for these parameters are given in Section 4.5 of this report.

If it is not possible to discharge collected water at the footing invert elevation, the invert elevation of the wall drainpipe could be set equivalent to the outfall invert. For any portion of the wall that falls below the invert elevation of the wall drain, an earth pressure equivalent to a fluid weighing 85 pcf should be used.

***Stormwater Ponds***

If fill berms are constructed, the berm locations should be stripped of topsoil, duff, and soils containing organic material prior to the placement of fill. The fill berms should be constructed by placing structural fill in accordance with recommendations outlined in Section 4.2 of this report. Material used to construct pond berms should consist of predominately granular soils with a maximum size of three inches and a minimum of 20 percent fines. Terra Associates, Inc. should examine and test all onsite or imported materials proposed for use as berm fill prior to their use.

Due to the exposure to fluctuating stored water levels and wave action, soils exposed on the interior side slopes of the ponds may be subject to some risk of periodic shallow instability or sloughing. Establishing interior slopes at a 3:1 gradient will significantly reduce or eliminate this potential. Exterior berm slopes and interior slopes above the maximum water surface should be graded to a finished inclination no steeper than 2:1. Finished slope faces should be thoroughly compacted and vegetated to guard against erosion.

We should review the stormwater plans when they are completed and revise our recommendations, if required.

## 4.7 Infiltration Feasibility

As noted above, the preliminary grading plans indicate two infiltration trenches are planned along the west and southeast of the proposed building. The native glacially consolidated soils composed of dense to very dense silty sand to silty sand with gravel and very stiff silt with sand with gravel observed in Test Borings B-1 and B-6 characteristically exhibit low permeabilities and would not be a suitable receptor soil for discharge of development stormwater using infiltration/retention basins. These soils could, however, support the use of low impact development (LID) techniques such as shallow gravel trenches, shallow bioretention cells, or permeable pavements for managing a minor component of the runoff. Designing these elements with an infiltration component equivalent to 0.2 inches per hour would be feasible in our opinion.

The permeability of the native outwash soils will be significantly impacted by the intrusion of soil fines (silt- and clay-sized particles). A relatively minor amount of soil fines can reduce the permeability of the formation by a factor of ten. The greatest exposure to soil fines contamination will occur during mass grading and construction. Therefore, we recommend that the Temporary Erosion and Sedimentation Control (TESC) plans route construction stormwater to a location other than the permanent infiltration facility.

## 4.8 Drainage

### *Surface*

Final exterior grades should promote free and positive drainage away from the site at all times. Water must not be allowed to pond or collect adjacent to foundations or within the immediate building areas. We recommend providing a positive drainage gradient away from the building perimeter. If this gradient cannot be provided, surface water should be collected adjacent to the structures and directed to appropriate storm facilities.

### *Subsurface*

We recommend installing perimeter foundation drains adjacent to shallow foundations. The drains can be laid to grade at an invert elevation equivalent to the bottom of footing grade. The drains can consist of four-inch diameter perforated PVC pipe enveloped in washed pea gravel-sized drainage aggregate. The aggregate should extend six inches above and to the sides of the pipe. Roof and foundation drains should be tightlined separately to the storm drains. All drains should be provided with cleanouts at easily accessible locations.

## 4.9 Utilities

Utility pipes should be bedded and backfilled in accordance with American Public Works Association (APWA) or the local jurisdictional specifications. At a minimum, trench backfill should be placed and compacted as structural fill as described in Section 4.2 of this report. As noted, most native soils excavated on the site should be suitable for use as backfill material during dry weather conditions. However, if utility construction takes place during the wet winter months, it will likely be necessary to import suitable wet weather fill for utility trench backfilling.

## 4.10 Pavements

Pavement subgrades should be prepared as described in Section 4.2 of this report. Regardless of the degree of relative compaction achieved, the subgrade must be firm and relatively unyielding before paving. The subgrade should be proofrolled with heavy rubber-tired construction equipment such as a loaded 10-yard dump truck to verify this condition.

The pavement design section is dependent upon the supporting capability of the subgrade soils and the traffic conditions to which it will be subjected. For commercial access, with traffic consisting mainly of light passenger vehicles with only occasional heavy traffic, and with a stable subgrade prepared as recommended, we recommend the following pavement sections:

- Two inches of Hot Mix Asphalt (HMA) over four inches of Crushed Rock Base (CRB)
- Three and one-half inches of full depth HMA

The paving materials used should conform to the Washington State Department of Transportation (WSDOT) specifications for half-inch class HMA and CRB.

Long-term pavement performance will depend upon surface drainage. A poorly drained pavement section will be subject to premature failure as a result of surface water infiltrating into the subgrade soils and reducing their supporting capability. For optimum pavement performance, we recommend surface drainage gradients of at least two percent. Some degree of longitudinal and transverse cracking of the pavement surface should be expected over time. Regular maintenance should be planned to seal cracks when they occur.

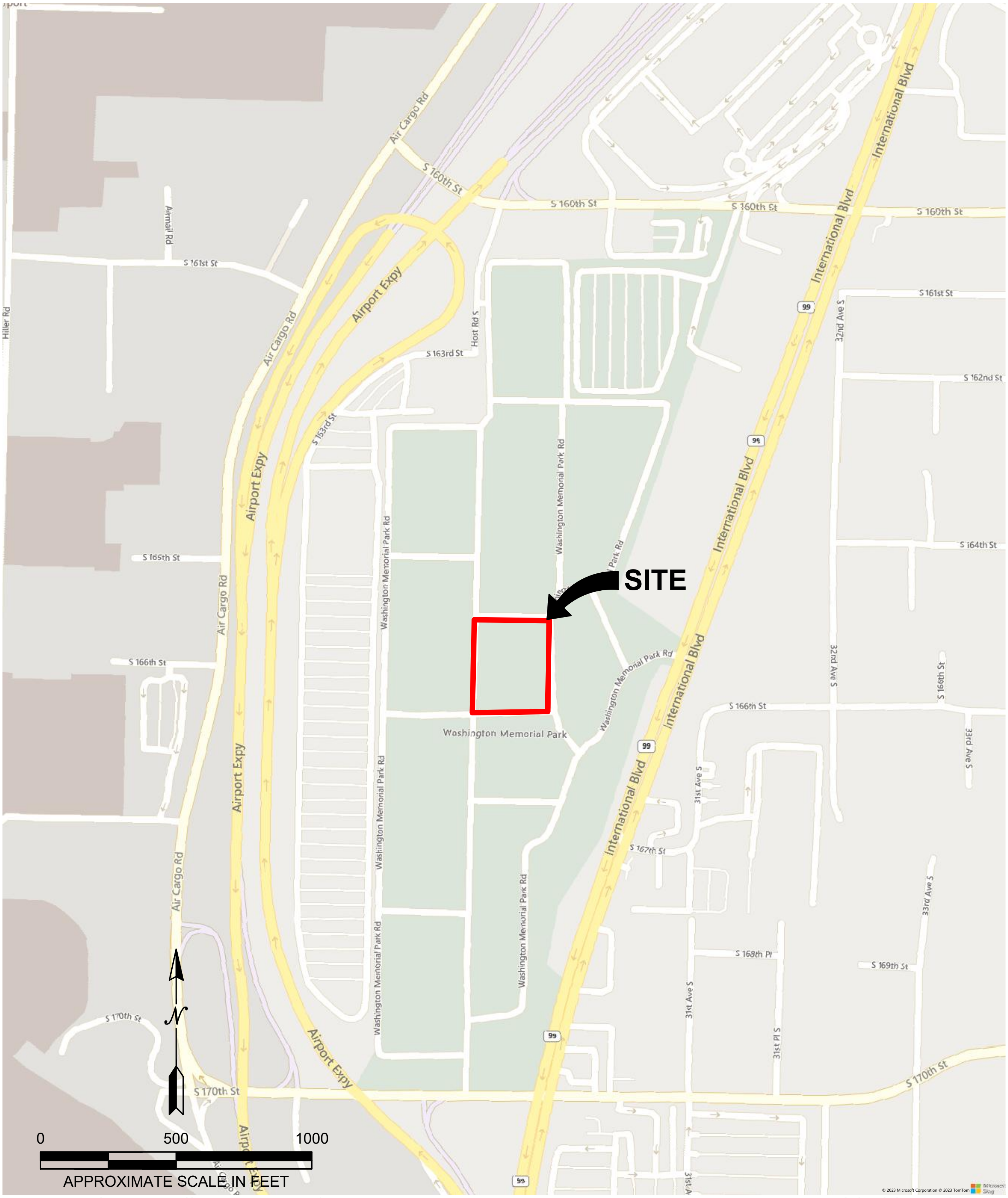
# 5.0 ADDITIONAL SERVICES

Terra Associates, Inc. should review the final design drawings and specifications in order to verify earthwork and foundation recommendations have been properly interpreted and implemented in project design. We should also provide geotechnical service during construction to observe compliance with our design concepts, specifications, and recommendations. This will allow for design changes if subsurface conditions differ from those anticipated prior to the start of construction.

## 6.0 LIMITATIONS

We prepared this report in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made. This report is the copyrighted property of Terra Associates, Inc. and is intended for specific application to the Summit View Development project in SeaTac, Washington. This report is for the exclusive use of Bonney Watson Funeral Homes, and their authorized representatives.

The analyses and recommendations presented in this report are based on data obtained from the subsurface explorations completed onsite. Variations in soil conditions can occur, the nature and extent of which may not become evident until construction. If variations appear evident, Terra Associates, Inc. should be requested to reevaluate the recommendations in this report prior to proceeding with construction.




REFERENCE: https://www.bing.com/maps

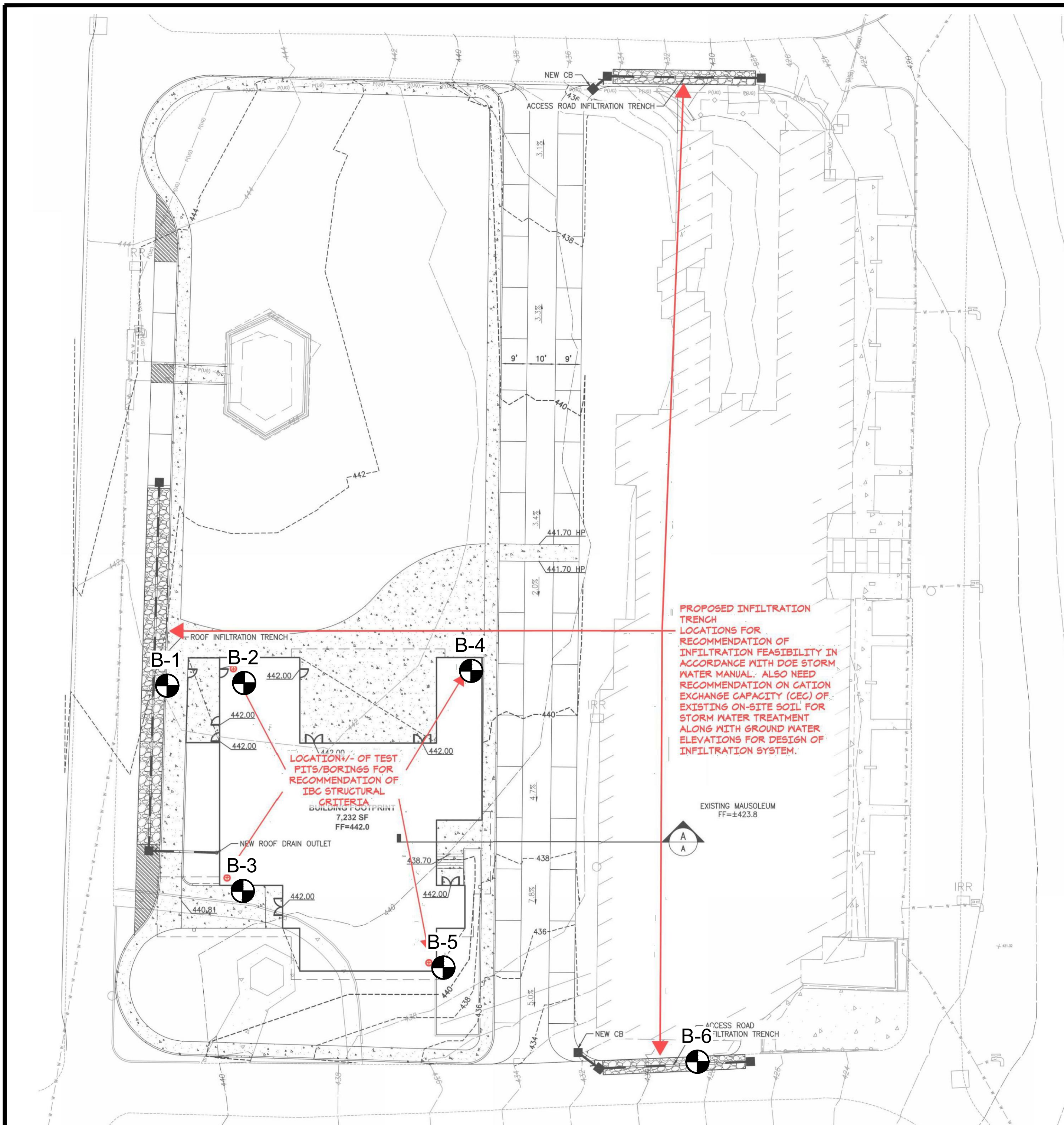
ACCESSED 4/2023

**Terra Associates, Inc.**

Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

VICINITY MAP
SUMMIT VIEW DEVELOPMENT
SEATAC, WASHINGTON

| Proj.No. T-8882 | Date: APR 2023 | Figure 1 |
|---|---|---|




**NOTE:**

THIS SITE PLAN IS SCHEMATIC. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE. IT IS INTENDED FOR REFERENCE ONLY AND SHOULD NOT BE USED FOR DESIGN OR CONSTRUCTION PURPOSES.

**REFERENCE:** SITE PLAN PROVIDED BY BARGHAUSEN.

**LEGEND:**

APPROXIMATE BORING LOCATION

0 20 40

APPROXIMATE SCALE IN FEET

N

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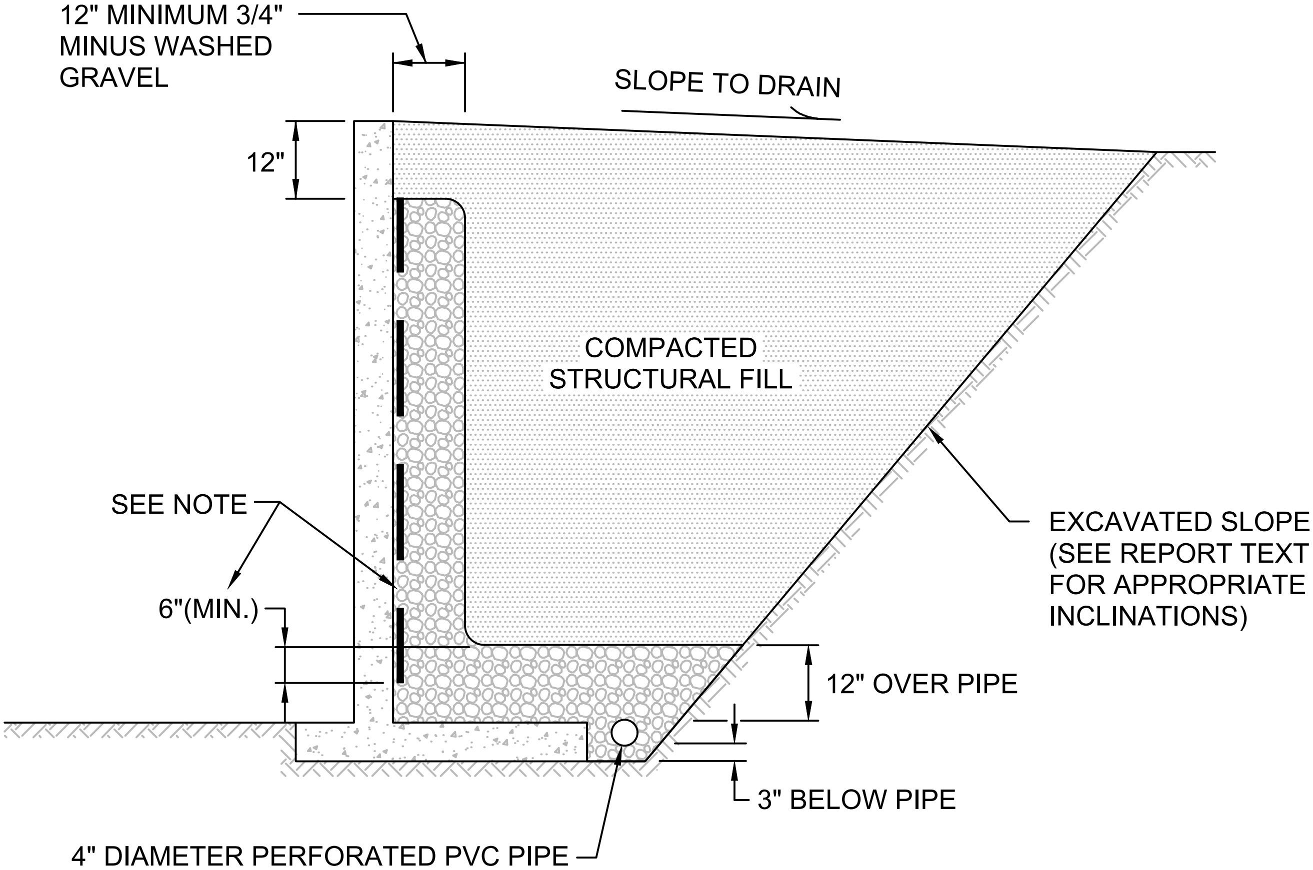
Environmental Earth Sciences

EXPLORATION LOCATION PLAN
SUMMIT VIEW DEVELOPMENT
SEATAC, WASHINGTON

| Proj.No. T-8882 | Date: APR 2023 | Figure 2 |
|---|---|---|




**NOT TO SCALE**

**NOTE:**

MIRADRAIN G100N PREFABRICATED DRAINAGE PANELS OR SIMILAR PRODUCT CAN BE SUBSTITUTED FOR THE 12-INCH WIDE GRAVEL DRAIN BEHIND WALL. DRAINAGE PANELS SHOULD EXTEND A MINIMUM OF SIX INCHES INTO 12-INCH THICK DRAINAGE GRAVEL LAYER OVER PERFORATED DRAIN PIPE.

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TYPICAL WALL DRAINAGE DETAIL
SUMMIT VIEW DEVELOPMENT
SEATAC, WASHINGTON

| Proj.No. T-8882 | Date: APR 2023 | Figure 3 |
|---|---|---|

## APPENDIX A
## FIELD EXPLORATION AND LABORATORY TESTING

**Summit View Development**
**16445 International Boulevard**
**SeaTac, Washington**

On April 5, 2023, we investigated subsurface conditions at the site at 6 test borings advanced with a hollow-stem auger to maximum depths ranging from approximately 10 to 20 feet below existing site grades. The test boring locations were approximately determined using GPS coordinates obtained from Google Earth. The approximate test boring locations are shown on Figure 2. The Test Boring Logs are presented as Figures A-2 through A-7.

A geotechnical engineer from our office conducted the field exploration. Our representative classified the soil conditions encountered, maintained a log of each test boring, obtained representative soil samples, and recorded water levels observed during drilling. During drilling, soil samples were obtained in general accordance with ASTM Test Designation D-1586. Using this procedure, a 2-inch (outside diameter) split barrel sampler is driven into the ground 18 inches using a 140-pound hammer free falling from a height of 30 inches. The number of blows required to drive the sampler 12 inches after an initial 6-inch set is referred to as the Standard Penetration Resistance value or N value. This is an index related to the consistency of cohesive soils and relative density of cohesionless materials. N values obtained for each sampling interval are recorded on the Test Boring Logs, Figures A-2 through A-7. All soil samples were visually classified in accordance with the Unified Soil Classification System (USCS) described on Figure A-1.

Representative soil samples obtained from the test borings were placed in sealed plastic bags and taken to our laboratory for further examination and testing. The moisture content of each sample was measured and is reported on the Test Boring Logs. Grain size analyses were performed on select soil samples. The results are shown on Figures A-8 and A-9.

| MAJOR DIVISIONS | | | | LETTER SYMBOL | TYPICAL DESCRIPTION |
|---|---|---|---|---|---|
| **COARSE GRAINED SOILS** More than 50% material larger than No. 200 sieve size | **GRAVELS** More than 50% of coarse fraction is larger than No. 4 sieve | Clean Gravels (less than 5% fines) | | GW | Well-graded gravels, gravel-sand mixtures, little or no fines. |
| | | | | GP | Poorly-graded gravels, gravel-sand mixtures, little or no fines. |
| | | Gravels with fines | | GM | Silty gravels, gravel-sand-silt mixtures, non-plastic fines. |
| | | | | GC | Clayey gravels, gravel-sand-clay mixtures, plastic fines. |
| | **SANDS** More than 50% of coarse fraction is smaller than No. 4 sieve | Clean Sands (less than 5% fines) | | SW | Well-graded sands, sands with gravel, little or no fines. |
| | | | | SP | Poorly-graded sands, sands with gravel, little or no fines. |
| | | Sands with fines | | SM | Silty sands, sand-silt mixtures, non-plastic fines. |
| | | | | SC | Clayey sands, sand-clay mixtures, plastic fines. |
| **FINE GRAINED SOILS** More than 50% material smaller than No. 200 sieve size | **SILTS AND CLAYS** Liquid Limit is less than 50% | | | ML | Inorganic silts, rock flour, clayey silts with slight plasticity. |
| | | | | CL | Inorganic clays of low to medium plasticity. (Lean clay) |
| | | | | OL | Organic silts and organic clays of low plasticity. |
| | **SILTS AND CLAYS** Liquid Limit is greater than 50% | | | MH | Inorganic silts, elastic. |
| | | | | CH | Inorganic clays of high plasticity. (Fat clay) |
| | | | | OH | Organic clays of high plasticity. |
| HIGHLY ORGANIC SOILS | | | | PT | Peat. |

**DEFINITION OF TERMS AND SYMBOLS**

**COHESIONLESS**

| Density | Standard Penetration Resistance in Blows/Foot |
|---|---|
| Very Loose | 0-4 |
| Loose | 4-10 |
| Medium Dense | 10-30 |
| Dense | 30-50 |
| Very Dense | >50 |

**COHESIVE**

| Consistancy | Standard Penetration Resistance in Blows/Foot |
|---|---|
| Very Soft | 0-2 |
| Soft | 2-4 |
| Medium Stiff | 4-8 |
| Stiff | 8-16 |
| Very Stiff | 16-32 |
| Hard | >32 |

| Symbol | Definition |
|---|---|
| I | 2" OUTSIDE DIAMETER SPILT SPOON SAMPLER |
| II | 2.4" INSIDE DIAMETER RING SAMPLER OR SHELBY TUBE SAMPLER |
| ▼ | WATER LEVEL (Date) |
| Tr | TORVANE READINGS, tsf |
| Pp | PENETROMETER READING, tsf |
| DD | DRY DENSITY, pounds per cubic foot |
| LL | LIQUID LIMIT, percent |
| PI | PLASTIC INDEX |
| N | STANDARD PENETRATION, blows per foot |

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UNIFIED SOIL CLASSIFICATION SYSTEM
SUMMIT VIEW DEVELOPMENT
SEATAC, WASHINGTON

| Proj.No. T-8882 | Date: APR 2023 | Figure A-1 |
|---|---|---|

# LOG OF BORING NO. B-1

**Figure No.** A-2

**Project:** Summit View Development **Project No:** T-8882 **Date Drilled:** April 5, 2023

**Client:** Bonney Watson Funeral Homes **Driller:** BoreTec **Logged By:** MJX

**Location:** SeaTac, Washington **Depth to Groundwater:** NA **Approx. Elev:** NA

| Depth (ft) | Soil Description | Consistency/ Relative Density | SPT (N) Blows / foot | Moisture Content (%) |
|---|---|---|---|---|
| 0 | (3-inches organic TOPSOIL)<br><br>FILL?: Brown silty SAND, fine to coarse sand, moist, scattered rootlets, trace fine gravel, occasional charcoal fragments. (SM) | Very Loose | 3 | 24.7 |
| 5 | | Loose | 9 | 31.9<br>16.1 |
| | Brownish-gray silty SAND with gravel, fine to coarse sand, fine to coarse gravel, moist, slightly mottled, occasional rootlet. (SM) | | | |
| | Brownish-gray SILT with sand and gravel, fine sand, fine to coarse gravel, moist, mottled. (ML) | Very Stiff | 22 | 11.7 |
| 10 | Gray SAND with silt and gravel, fine to coarse sand, fine to coarse gravel, moist. (SP-SM) | Dense | 41 | 5.6 |
| | Test Pit terminated at approximately 10 feet.<br><br>No groundwater seepage observed.<br><br>Test Boring converted to groundwater monitoring well. | | | |
| 15 | | | | |

SPT scale: 10 30 50

Observ. Well

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

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# LOG OF BORING NO. B-2

**Figure No.** A-3

**Project:** Summit View Development **Project No:** T-8882 **Date Drilled:** April 5, 2023

**Client:** Bonney Watson Funeral Homes **Driller:** BoreTec **Logged By:** MJX

**Location:** SeaTac, Washington **Depth to Groundwater:** NA **Approx. Elev:** NA

| Depth (ft) | Soil Description | Consistency/ Relative Density | SPT (N) Blows / foot | Moisture Content (%) |
|---|---|---|---|---|
| 0 | (3-inches organic TOPSOIL)<br><br>FILL?: Brown sandy SILT, fine to medium sand, moist, trace rootlets, trace gravel. (ML) | Loose | 7 | 17.4 |
| 5 | Brownish-gray SILT to clayey SILT, moist, mottled, trace sand, trace gravel, occasional rootlet. (ML) | Medium Stiff | 5 | 21.6 |
| | | | 20 | 9.0 |
| | Gray silty SAND to silty SAND with gravel, fine to coarse sand, fine to coarse gravel, moist, occasional sandy silt layer. (SM) | Medium Dense | | |
| 10 | | Very Dense | 85/11" | 7.5 |
| | | | 87 | 8.6 |
| 15 | *Trace sand with silt seams observed* | | 78 | 5.6 |
| 20 | | | 50/6" | 7.3 |
| | Test Boring terminated at approximately 20 feet.<br><br>No groundwater seepage observed. | | | |
| 25 | | | | |

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

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# LOG OF BORING NO. B-3

**Figure No.** A-4

**Project:** Summit View Development **Project No:** T-8882 **Date Drilled:** April 5, 2023

**Client:** Bonney Watson Funeral Homes **Driller:** BoreTec **Logged By:** MJX

**Location:** SeaTac, Washington **Depth to Groundwater:** NA **Approx. Elev:** NA

| Depth (ft) | Soil Description | Consistency/ Relative Density | SPT (N) Blows / foot | Moisture Content (%) |
|---|---|---|---|---|
| 0 | (3-inches organic TOPSOIL) | | | |
| 2.5 | FILL?: Brown sandy SILT, fine to coarse sand, moist, trace gravel, occasional rootlet, occasional charcoal fragment. (ML) | Loose | 4 | 22.1 |
| 5 | Brown silty SAND with gravel, fine to coarse sand, fine to coarse gravel, moist. (SM) | Medium Dense | 18 | 17.9 |
| 7.5 | Gray silty SAND to silty SAND with gravel, fine to coarse sand, fine to coarse gravel, moist. (SM) | Dense | 38 | 6.1 |
| 10 | | Dense | 48 | 8.4 |
| 12.5 | *Trace sand layers and occasional silt layer observed* | Very Dense | 54 | 7.8 |
| 15 | | Very Dense | 50/6" | 8.5 |
| 20 | *Trace sand with silt seams observed* | Very Dense | 66 | 10.4 |
| | Test Boring terminated at approximately 20 feet. No groundwater seepage observed. | | | |
| 25 | | | | |

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

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# LOG OF BORING NO. B-4

**Figure No.** A-5

**Project:** Summit View Development **Project No:** T-8882 **Date Drilled:** April 5, 2023

**Client:** Bonney Watson Funeral Homes **Driller:** BoreTec **Logged By:** MJX

**Location:** SeaTac, Washington **Depth to Groundwater:** NA **Approx. Elev:** NA

| Depth (ft) | Soil Description | Consistency/ Relative Density | SPT (N) Blows / foot | Moisture Content (%) |
|---|---|---|---|---|
| 0 | (3-inches organic TOPSOIL) | | | |
| 2.5 | FILL?: Grayish-brown sandy SILT with gravel, fine to coarse sand, fine to coarse gravel, moist, mottled, trace rootlet, occasional charcoal fragment. (ML) | Very Loose | 3 | 20.2 |
| 5 | Gray SILT with gravel, fine to coarse gravel, moist to wet, mottled, trace sand seams. (ML) | Stiff | 11 | 17.7 |
| 7.5 | | Very Stiff | 16 | 19.4 |
| 10 | Gray silty SAND to silty SAND with gravel, fine to coarse sand, fine to coarse gravel, moist, occasional silt seam. (SM) | Dense | 32 | 9.9 |
| 12.5 | | Very Dense | 53 | 7.2 |
| 15 | | Very Dense | 50/4" | 12.0 |
| 20 | *Trace sand with silt layers observed* | Very Dense | 75 | 9.2 |
| 25 | Test Boring terminated at approximately 20 feet. No groundwater seepage observed. | | | |

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

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# LOG OF BORING NO. B-5

**Figure No.** A-6

**Project:** Summit View Development **Project No:** T-8882 **Date Drilled:** April 5, 2023

**Client:** Bonney Watson Funeral Homes **Driller:** BoreTec **Logged By:** MJX

**Location:** SeaTac, Washington **Depth to Groundwater:** NA **Approx. Elev:** NA

| Depth (ft) | Soil Description | Consistency/ Relative Density | SPT (N) Blows / foot | Moisture Content (%) |
|---|---|---|---|---|
| 0 | (3-inches organic TOPSOIL)<br><br>FILL?: Brown sandy SILT with gravel, fine to coarse sand, fine to coarse gravel, moist, scattered rootlets. (ML) | Medium Dense | 13 | 14.6 |
| 5 | Brownish-gray SILT with sand and gravel, fine to coarse sand, fine to coarse gravel, moist, mottled. (ML) | Stiff | 12 | 18.0 |
| | Gray clayey SILT, moist, mottled, trace gravel. (ML) | Very Stiff | 25 | 21.8 |
| 10 | Gray SAND with silt, fine to coarse sand, moist, trace gravel, interbedded silt seams. (SP-SM) | Medium Dense | 26 | 11.4 |
| | Gray silty SAND with gravel, fine to coarse sand, fine to coarse gravel, moist. (SM) | Very Dense | 50/5" | 8.1 |
| 15 | | Very Dense | 50/3" | 8.1 |
| 20 | *Interbedded sand seams observed* | Dense | 49 | 9.4 |
| | Test Boring terminated at approximately 20 feet.<br><br>No groundwater seepage observed. | | | |
| 25 | | | | |

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

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# LOG OF BORING NO. B-6

**Figure No.** A-7

**Project:** Summit View Development **Project No:** T-8882 **Date Drilled:** April 5, 2023

**Client:** Bonney Watson Funeral Homes **Driller:** BoreTec **Logged By:** MJX

**Location:** SeaTac, Washington **Depth to Groundwater:** NA **Approx. Elev:** NA

| Depth (ft) | Sample Interval | Soil Description | Consistency/ Relative Density | SPT (N) Blows / foot (10, 30, 50) | Moisture Content (%) | Observ. Well |
|---|---|---|---|---|---|---|
| 0 | | (3.5-inches HOT MIX ASPHALT)<br><br>Gray silty SAND to silty SAND with gravel, fine to coarse sand, fine to coarse gravel. (SM) | Very Dense | | | |
| | | *Occasional sand layer observed* | | 52 | 6.0 | |
| 5 | | | | 85 | 6.0 | |
| | | | | 50/6" | 8.1 | |
| 10 | | *Interbedded sand layers observed* | Medium Dense | 26 | 9.0 | |
| | | Test Boring terminated at approximately 10 feet.<br><br>No groundwater seepage observed.<br><br>Test Boring converted to groundwater monitoring well. | | | | |
| 15 | | | | | | |

NOTE: This borehole log has been prepared for geotechnical purposes. This information pertains only to this boring location and should not be interpeted as being indicative of other areas of the site

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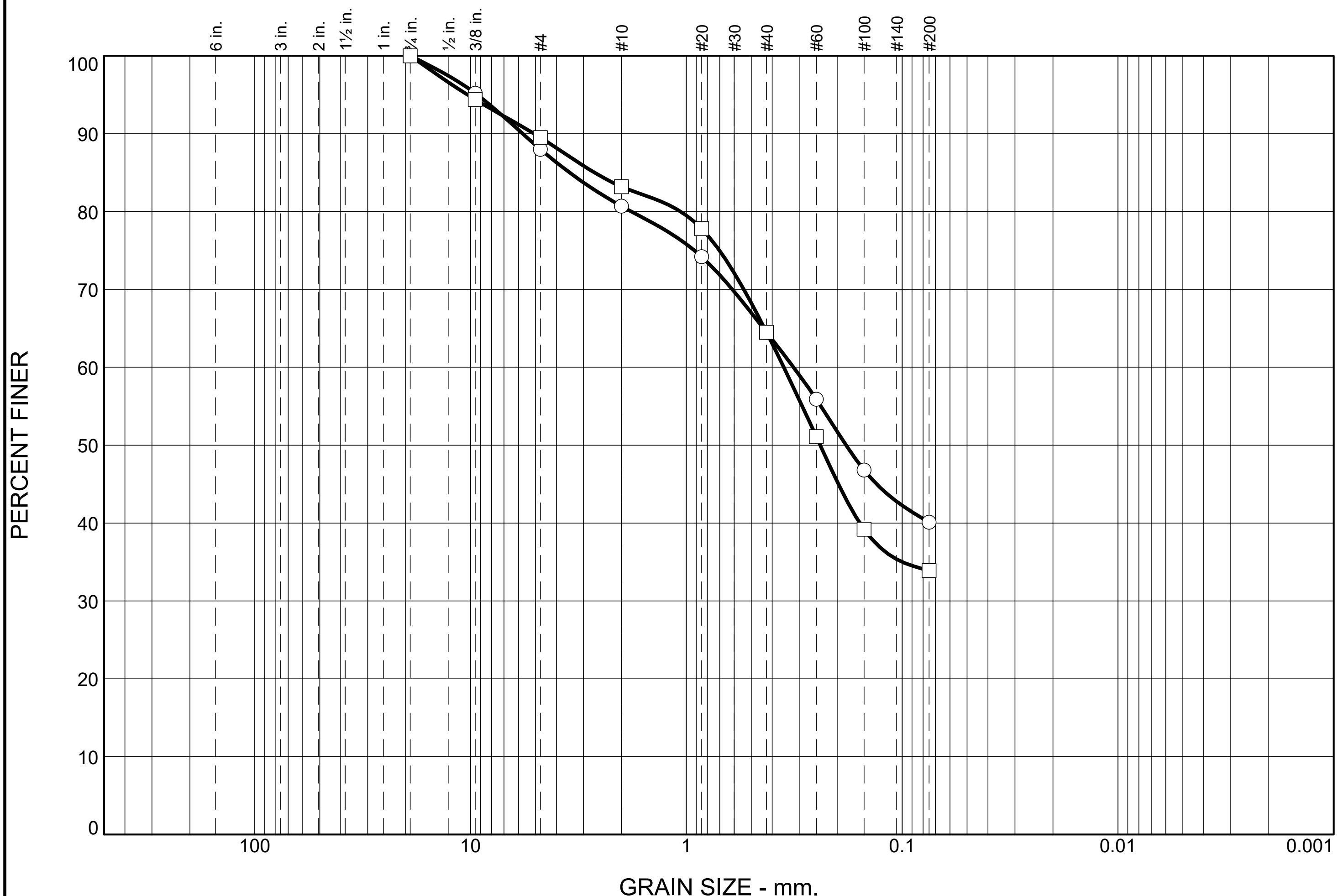
# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 12.0 | 7.3 | 16.2 | 24.4 | 40.1 | |
| □ | 0.0 | 0.0 | 10.5 | 6.3 | 18.7 | 30.6 | 33.9 | |
| | | | | | | | | |

| | LL | PL | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ | | | 3.4738 | 0.3185 | 0.1818 | | | | | |
| □ | | | 2.6618 | 0.3534 | 0.2398 | | | | | |
| | | | | | | | | | | |

| Material Description | USCS | AASHTO |
|---|---|---|
| ○ silty SAND | SM | |
| □ silty SAND | SM | |

**Project No.** T-8882 **Client:** Bonney Watson Funeral Homes

**Project:** Summit View Development

○ **Location:** Test Boring B-1 **Depth:** 2.5 feet **Sample Number:** 1

□ **Location:** Test Boring B-3 **Depth:** 20 feet **Sample Number:** 7

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**Kirkland, WA**

**Remarks:**

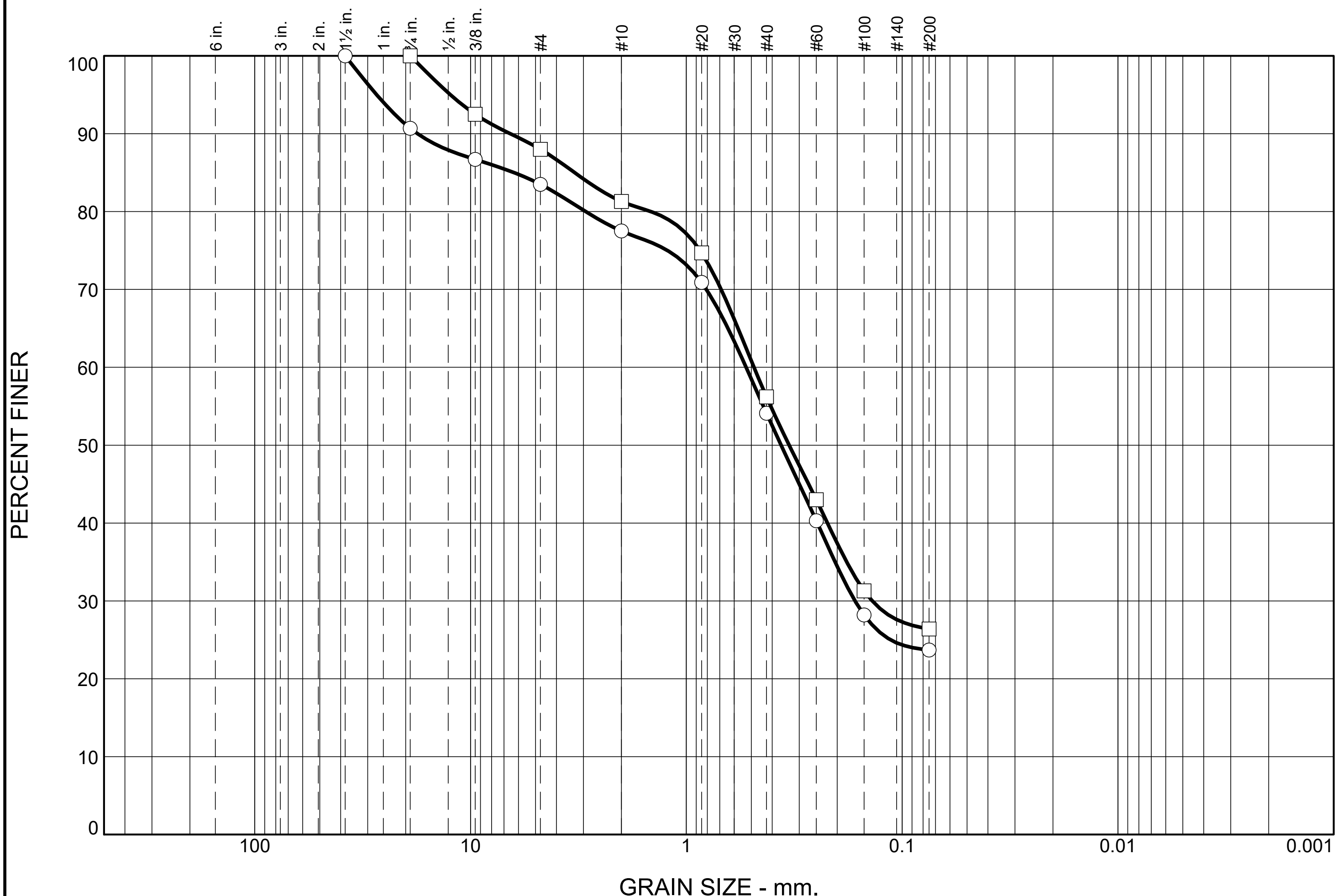
○Tested on April 11, 2023

□Tested on April 11, 2023

**Figure** A-8

**Tested By:** KJ

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 9.3 | 7.2 | 6.0 | 23.4 | 30.4 | 23.7 | |
| □ | 0.0 | 0.0 | 12.0 | 6.7 | 25.1 | 29.8 | 26.4 | |
| | | | | | | | | |

| | LL | PL | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ | | | 6.2794 | 0.5286 | 0.3636 | 0.1652 | | | | |
| □ | | | 3.2921 | 0.4858 | 0.3337 | 0.1375 | | | | |
| | | | | | | | | | | |

| Material Description | USCS | AASHTO |
|---|---|---|
| ○ silty SAND with gravel | SM | |
| □ silty SAND | SM | |

**Project No.** T-8882 **Client:** Bonney Watson Funeral Homes

**Project:** Summit View Development

○ **Location:** Test Boring B-4 **Depth:** 12.5 feet **Sample Number:** 5

□ **Location:** Test Boring B-6 **Depth:** 5 feet **Sample Number:** 2

**Remarks:**

○ Tested on April 11, 2023

□ Tested on April 11, 2023

**Terra Associates, Inc.**

**Kirkland, WA**

**Figure** A-9

**Tested By:** KJ