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# GEOTECHNICAL REPORT

**5 Degrees**
**North 147th Street and Meridian Avenue North**
**Shoreline, Washington**

**Project No. T-8268**

**Terra Associates, Inc.**

**Prepared for:**

**Pulte Homes of Washington, Inc.**
**Bellevue, Washington**

**December 13, 2019**

DEV20-1621

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# TERRA ASSOCIATES, Inc.

Consultants in Geotechnical Engineering, Geology
and
Environmental Earth Sciences

December 13, 2019
Project No. T-8268

Mr. Jim Sprott
Pulte Homes of Washington, Inc.
3535 Factoria Boulevard, Suite 600
Bellevue, Washington 98006

Subject: Geotechnical Report
5 Degrees
North 147th Street and Meridian Avenue North
Shoreline, Washington

Dear Mr. Sprott:

As requested, we 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.

The soils observed in our test borings consist of six inches of topsoil and organics overlying glacially derived silty sand and sand soils. The soils are primarily medium dense to very dense, with two- to four-foot thick layers of loose soils found in two of the test borings. No groundwater was observed in any of the test borings.

In our opinion, there are no geotechnical conditions that would preclude the project, as currently planned. Structures can be supported on conventional spread footings bearing on competent native soil or on structural fill placed on competent native soil subgrades. Floor slabs and driveway pavement can be similarly supported.

Detailed recommendations addressing these issues and other geotechnical design considerations are presented in the attached report. We trust the information presented is sufficient for your current needs. If you have any questions or require additional information, please call.

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

Kevin P. Roberts, P.E.
Geotechnical Engineer

CAROLYN S. DECKER
STATE OF WASHINGTON
47016
REGISTERED
PROFESSIONAL ENGINEER

12-13-19

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# Geotechnical Report
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# North 147th Street and Meridian Avenue North
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## 1.0 PROJECT DESCRIPTION

The proposed project consists of redeveloping the site with eight townhome buildings and associated utility and access improvements. A review of preliminary architectural plans, dated October 24, 2019, prepared by Board & Vellum Architecture and Design indicates buildings will be constructed with three levels and will include at-grade garages. Drive aisle access will be from North 147th and North 148th Streets. Based on the overall relatively level site topography, we expect minor grading will be required to achieve finished building and drive aisle grades.

We anticipate the structures will be constructed with wood framing. Foundation loads should be relatively light, in the range of 3 to 5 kips per foot for bearing walls and 75 to 125 kips for isolated columns.

The recommendations in this report are based on the design features discussed above. If actual features vary or changes are made, we should review the plans in order to modify our recommendations, as required. We should review final design drawings and specifications to verify that our recommendations have been properly interpreted and incorporated into the project design.

## 2.0 SCOPE OF WORK

On November 27, 2019, we explored subsurface conditions at the site by drilling 5 test borings to depths of 15.5 feet to 16.5 feet below existing grades using a track-mounted drill rig. Using the information obtained from our subsurface exploration and office review, we performed analyses to develop geotechnical engineering recommendations for project design and construction. Specifically, this report addresses the following:

- Soil and groundwater conditions
- Geologic hazards per the City of Shoreline Municipal Code
- Seismic Site Class
- Site preparation and grading
- Excavations
- Foundations
- Slab-on-grade floors
- Lateral earth pressures
- Infiltration feasibility including Low Impact Development (LID) techniques
- Drainage
- Utilities
- Pavements

It should be noted that 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' purview. A building envelope specialist or contractor should be consulted to address these issues, as needed.

## 3.0 SITE CONDITIONS

### 3.1 Surface

The site as currently shown on the plans consists of seven tax parcels totaling approximately 1.34 acres of land. The parcels are located east of Meridian Avenue North between North 147th and North 148th Streets in Shoreline, Washington. Four additional parcels located at 2122, 2132, 2142, and 2150 North 147th Street were recently added to the project site for future project expansion. The approximate location of the site is shown on Figure 1.

Single-story, single-family residences currently occupy each parcel. The site's overall topography is relatively flat. Site vegetation generally consists of grass lawn and landscape trees and shrubs. Several mature conifers are located at the central portion of the site.

### 3.2 Soils

The soils observed in our test borings generally consist of six inches of topsoil and organics overlying variably thick layers of glacially derived silty sand and sand with silt. Test Boring B-4 showed a 3-inch thick layer of surface asphalt overlying the silty sand soils.

Each of the test borings found silty sand with variable gravel content to depths ranging from seven feet in Test Borings B-2 and B-5 to 14.5 feet at the location of Test Boring B-4. The silty sand soils are generally in a medium dense to very condition. Loose silty sands were observed to a depth of approximately four feet at Test Boring B-1, and between depths of 4.5 feet and seven feet in Test Boring B-2.

Layers of dense to very dense sand and sand with silt were observed beneath the silty sand soils in each of the test borings. Except for Test Boring B-1, which was terminated in silty sands, the test borings were terminated within sand or sand with silt soils.

*The Geologic Map of Seattle – A Progress Report* by Kathy Goetz Troost et al, dated 2005, shows the site soils mapped as Till (Qvt). The loose to very dense silty sand soils observed in the test borings are generally consistent with weathered and unweathered horizons of this soil unit.

Detailed descriptions of the subsurface conditions observed in our site explorations are presented on the Test Boring Logs in Appendix A. The approximate test boring locations are shown on Figure 2.

## 3.3 Groundwater

No groundwater was observed during drilling of the site's test borings. In addition, we observed no mottling of soils that would indicate fluctuating or seasonal perched groundwater levels at the site.

## 3.4 Geologic Hazards

We evaluated site conditions for the presence of geologic hazards as designated in the Shoreline Municipal Code (SMC).

### *3.4.1 Landslide Hazard Areas*

Chapter 20.80.220 A. of the SMC defines landslide hazard areas as "…those areas potentially subject to landslide activity based on a combination of geologic, topographic, and hydrogeologic factors as classified in Subsection B of this section with slopes 15 percent or steeper within a vertical elevation change of at least 10 feet or all areas of prior landslide activity regardless of slope…"

The relatively level topography at the site precludes the existence of landslide hazard areas as defined in SMC.

### *3.4.2 Seismic Hazard Areas*

Chapter 20.80.220 C. of the SMC defines seismic hazard areas as "…lands that due to a combination of soil and ground water conditions, are subject to risk of ground shaking, lateral spreading, subsidence, or liquefaction of soils during earthquakes. These areas are typically underlain by soft or loose saturated soils (such as alluvium) or peat deposits and have a shallow ground water table."

Based on the predominantly medium dense to very dense nature of the site soils and absence of groundwater, it is our opinion that there is no risk for damage resulting from soil liquefaction or subsidence during a severe seismic event. Accordingly, in our opinion, unusual seismic hazard areas do not exist at the site, and design in accordance with local building codes for determining seismic forces would adequately mitigate impacts associated with ground shaking.

### *3.4.3 Erosion Hazard Areas*

Chapter 20.80.220 D. of the SMC defines erosion hazard areas as "…lands or areas underlain by soils identified by the U.S. Department of Agriculture Natural Resources Conservation Service (formerly the Soil Conservation Service) as having "severe" or "very severe" erosion hazards. This includes, but is not limited to, the following group of soils when they occur on slopes of 15 percent or greater: Alderwood-Kitsap (AkF), Alderwood gravelly sandy loam (AgD), Kitsap silt loam (KpD), Everett (EvD), and Indianola (InD)."

NRCS soil maps indicate the site lies within a "No Data" area. Based on the site's level topography and glacial till soils, the soils would likely be classified as *Alderwood gravelly sandy loam, 0 to 8 percent slopes (AgB).* The erosion hazard of this soil type is listed as "slight." Accordingly, it is our opinion that no erosion hazard areas are present at the site.

Regardless of erosion hazard designation, the site soils will be susceptible to erosion when exposed during construction. In our opinion, the erosion potential of site soils would be adequately mitigated with proper implementation and maintenance of City of Shoreline approved Best Management Practices (BMPs) for erosion prevention and sedimentation control during construction.

### 3.5 Seismic Site Class

Based on the site soil conditions and our knowledge of the area geology, per the 2018 International Building Code (IBC), site class "C" should be used in structural design.

## 4.0 DISCUSSION AND RECOMMENDATIONS

### 4.1 General

Based on our study, it is our opinion that the site is suitable for the proposed construction from a geotechnical standpoint. Undisturbed bearing surfaces composed of the native medium dense to very dense silty sand soils, or structural fill placed on these soils will provide suitable support for conventional spread footing foundations. Floor slabs and the driveway can be similarly supported. The sites' loose silty sand soils identified at Test Borings B-1 and B-2 will not be suitable for direct support of foundations but can be densified in place by compaction to achieve adequate bearing support.

The silty sand soils contain a sufficient percentage of fines (silt- and clay-sized particles) such that they will be difficult to compact as structural fill when too wet or too dry. If earthwork activities will take place during the winter season, the owner should be prepared to import free-draining granular material for use as structural fill and backfill.

Detailed recommendations regarding these issues and other geotechnical design considerations are provided in the following sections of this report. 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 demolition debris should be removed from areas of planned construction. Soils containing organic material will not be suitable for use as structural fill but may be used for limited depths in nonstructural areas. Stripping depths of up to six inches should be expected. We recommend removing all building demolition debris prior to preparing subgrades for new construction. Demolition of existing structures should include removal of existing buried utilities and building foundations. Abandoned utility pipes that exist outside of new building areas can be left in place provided they are sealed to prevent intrusion of groundwater seepage and soil.

To reduce the potential for subgrade disturbance, particularly during wet weather, consideration should be given to placing a four-inch layer of one- to two-inch sized crushed rock or a four-inch layer of lean concrete on completed foundation and slab subgrades to serve as a working surface.

Undisturbed surfaces of the site's medium dense to very dense silty sand soils, or structural fill placed on these soils will be suitable for support of building foundations, slabs, and pavements. As discussed above, where loose soils such as those identified at the locations of Borings B-1 and B-2 are observed in footing excavations, we recommend that these soils be densified in place by compaction to establish adequate foundation subgrade support. In general, 12 inches of scarification and recompaction should be sufficient to achieve suitable bearing.

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 building elements or new structural fill. Depending on the weather conditions, moisture conditioning of the silty sands may be required to facilitate compaction and densification in place. If excessively yielding areas are observed and 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.

Our study indicates that the silty sand soils contain a sufficient percentage of fines (silt and clay size particles) that will make them difficult to compact as structural fill if they are too wet or too dry. The ability to use these soils as structural fill will depend on their moisture content and the prevailing weather conditions when site grading activities take place.

In our opinion, structural fill and backfill imported to the site should consist of a granular soil that meets the following minimum grading requirements:

| U.S. Sieve Size | Percent Passing |
|---|---|
| 6 inches | 100 |
| No. 4 | 75 maximum |
| No. 200 | 30 maximum* (dry weather)<br>5 maximum* (wet weather) |

* Based on the 3/4-inch fraction.

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

Structural fill should be placed in horizontal layers not exceeding 12 inches and compacted to a density equal to or greater than 95 percent of its maximum dry density, as determined by ASTM Test Designation D-698 (Standard Proctor). The moisture content of the soil at the time of compaction should be within two percent of its optimum, as determined by this same ASTM standard.

## 4.3 Excavations

All excavations at the site associated with confined spaces, such as utility trenches, must be completed in accordance with local, state, or federal requirements. Based on current WISHA regulations, the site's loose to medium dense silty sand soils would be classified as Type C soils. Accordingly, for temporary excavations of more than 4 feet and less than 20 feet in depth, the side slopes in Type C soils should be laid back at a slope inclination of 1.5:1 (Horizontal:Vertical) or flatter. The dense to very dense silty sand and sand with silt soils would be classified as Type B soils. For Type B soils, side slopes can be laid back at a slope inclination of 1:1 or flatter.

This 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 contractor.

## 4.4 Foundations

The buildings may be supported on conventional spread footing foundations bearing on competent native soils or on structural fills placed above these native soils. Foundation subgrades should be prepared as recommended in Section 4.2 of this report. Perimeter foundations exposed to the weather should be at a minimum depth of 18 inches below final exterior grades. Interior foundations can be constructed at any convenient depth below the floor slab.

We recommend designing foundations bearing on competent soil 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 in design. With the anticipated loads and this bearing stress applied, building settlements should be less than one-inch total and one-half inch differential.

A base friction coefficient of 0.35 can be used for designing foundations to resist lateral loads. Passive earth pressure acting on the sides of the footings may also be considered. We recommend calculating this lateral resistance using an equivalent fluid weight of 300 pounds per cubic foot (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 foundations will be constructed neat against competent native soil or the excavations are backfilled with structural fill, as described in Section 4.2 of this report. The recommended passive and friction values include a safety factor of 1.5.

## 4.5 Slab-on-Grade Floors

Slab-on-grade floors may be supported on a 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 three 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 aid in uniform curing of the concrete slab. It should be noted that if the sand or gravel layer overlying the membrane is saturated prior to pouring the slab, it will be ineffective in assisting uniform curing of the slab and can actually serve as a water supply for moisture seeping through the slab that adversely affects 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.

## 4.6 Lateral Earth Pressures

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 guard against hydrostatic pressure development, wall drainage must also be installed. A typical recommended 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 that support level grades 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 psf should be added to the 35 pcf. For evaluation of wall performance under seismic loading, a uniform pressure equivalent to 8H psf, where H is the height of the below-grade portion of the wall, should be applied in addition to the static lateral earth pressure.

Friction at the base of foundations and passive earth pressure will provide resistance to these lateral loads. Values for these parameters are provided in Section 4.4 of this report

## 4.7 Drainage

### *Surface*

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

### *Subsurface*

We recommend installing a continuous drain along the outside lower edge of shallow perimeter building foundations. Foundation drains should be tightlined to an approved point of controlled discharge independent of the roof drain system. Subsurface drains must be laid with a gradient sufficient to promote positive flow to the point of discharge. All drains should be provided with cleanouts at easily accessible locations. These cleanouts should be serviced at least once every year.

## 4.8 Infiltration Feasibility

Across the site, we observed primarily silty sand with gravel, till, and till-like soils. Due to the high soil fines content and degree of consolidation, these soils exhibit relatively low permeability. This would preclude the use of retention facilities for discharge of development stormwater by infiltration at shallow depths at the site. Based on the existing topography of the site, it is our opinion that even low impact development (LID) techniques would not be suitable for the site as the stormwater would likely mound up in the facilities and cause minor local flooding to occur during rain events. Based on our observations, it is our opinion, that the site stormwater should be collected and controlled using conventional stormwater techniques.

## 4.9 Utilities

Utility pipes should be bedded and backfilled in accordance with American Public Works Association (APWA) or the City of Shoreline specifications. As a minimum, trench backfill should be placed and compacted as structural fill, as described in Section 4.2 of this report. As noted, depending on the soil moisture when excavated most inorganic native soils on the site should be suitable for use as backfill material during dry weather conditions. The contractor should be prepared to aerate soils to reduce moisture and facilitate proper compaction. 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

Drive aisle pavement subgrades should be prepared as described in the 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-tire 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 residential 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 section options:

- Two inches of hot mix asphalt (HMA) over four inches of crushed rock base (CRB)
- Full depth HMA – 3 ½ inches

The paving materials used should conform to the Washington State Department of Transportation (WSDOT) specifications for ½-inch class HMA and CRB.

Long-term pavement performance will depend on 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

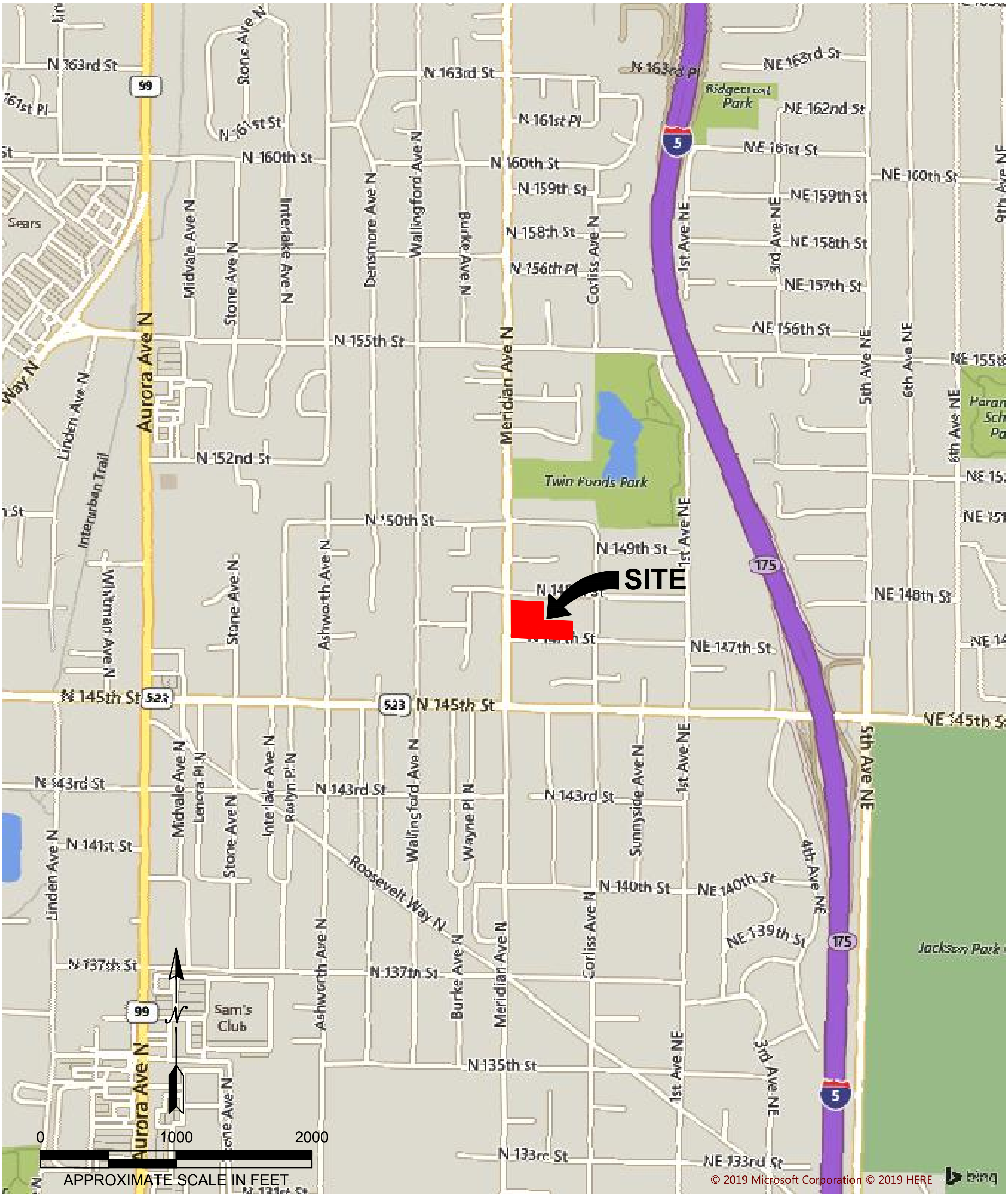
Terra Associates, Inc. should review the final designs and specifications to verify that earthwork and foundation recommendations have been properly interpreted and implemented in project design. We should also provide geotechnical services during construction to observe compliance with our design concepts, 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 5 Degrees project in Shoreline, Washington. This report is for the exclusive use of Pulte Homes of Washington, Inc. and their authorized representatives. No other warranty, expressed or implied, is made.

The analyses and recommendations presented in this report are based on data obtained from the test pits excavated at the site. 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.

EXHIBIT 5f




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

ACCESSED 12/12/19

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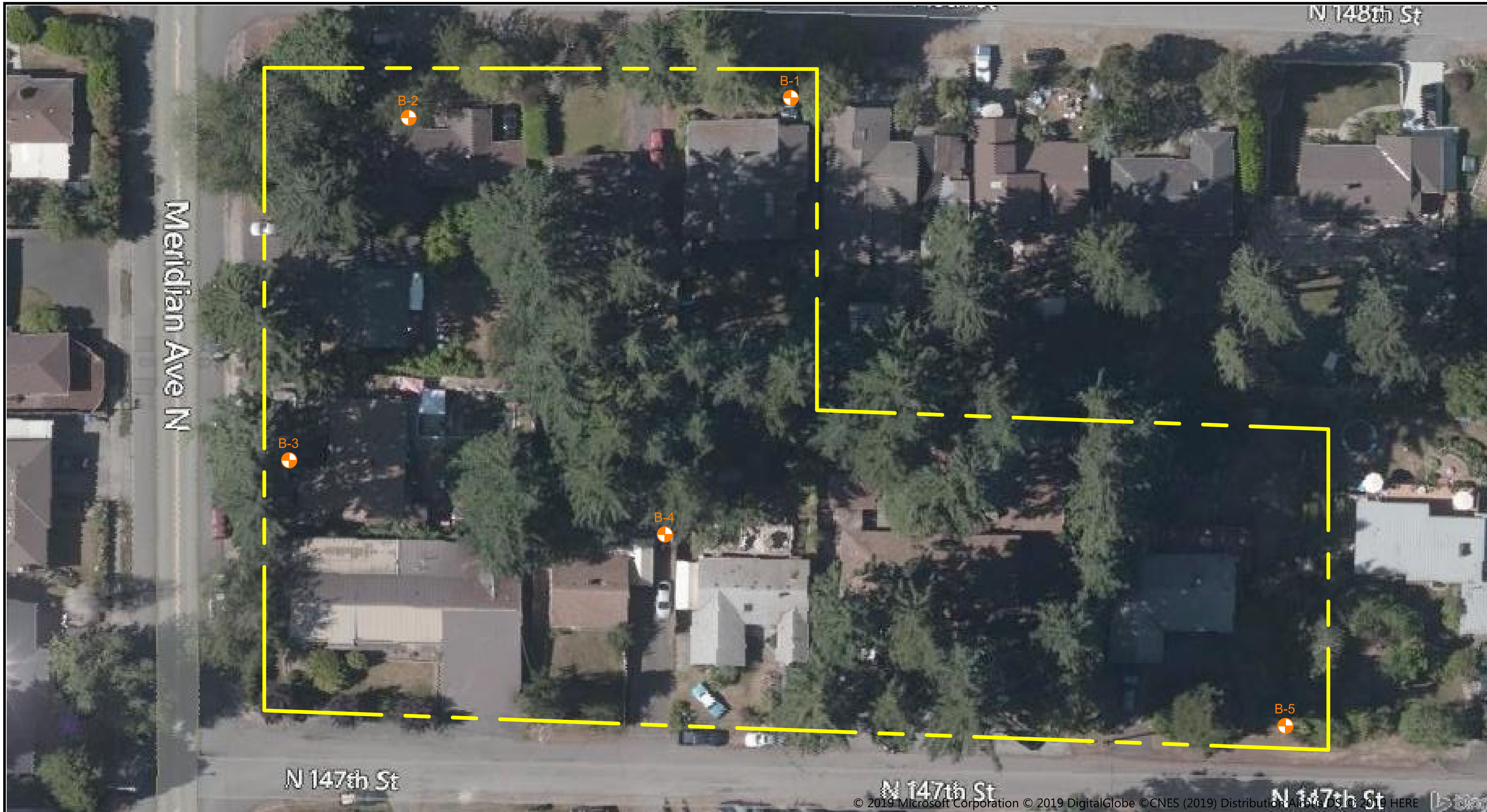
Geology and
Environmental Earth Sciences

VICINITY MAP
5 DEGREES
SHORELINE, WASHINGTON

| Proj.No. T-8268 | Date: DEC 2019 | Figure 1 |
|---|---|---|

EXHIBIT 5f




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

**LEGEND:**

APPROXIMATE BORING LOCATION

0 40 80

APPROXIMATE SCALE IN FEET

N

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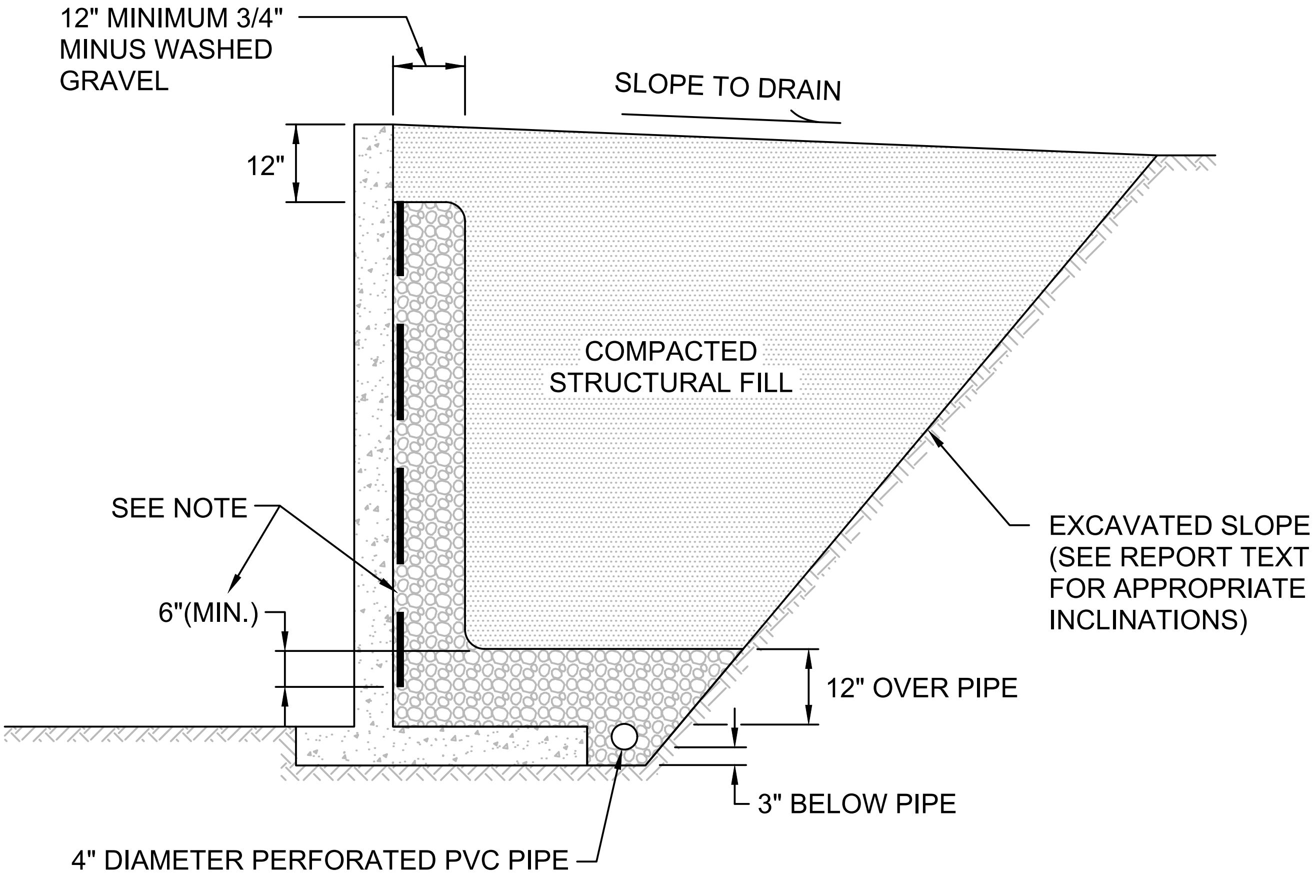
Geology and
Environmental Earth Sciences

EXPLORATION LOCATION PLAN
5 DEGREES
SHORELINE, WASHINGTON

| | | |
|---|---|---|
| Proj.No. T-8268 | Date: DEC 2019 | 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.

| | | | |
|---|---|---|---|
| **Terra Associates, Inc.** Consultants in Geotechnical Engineering Geology and Environmental Earth Sciences | TYPICAL WALL DRAINAGE DETAIL<br>5 DEGREES<br>SHORELINE, WASHINGTON | | |
| | Proj.No. T-8268 | Date: DEC 2019 | Figure 3 |

## APPENDIX A
## FIELD EXPLORATION AND LABORATORY TESTING

### 5 Degrees
### Shoreline, Washington

On November 27, 2019, we explored subsurface conditions at the site by drilling 5 test borings to depths of 15.5 and 16.5 feet below existing grades using a track-mounted drill rig. The test boring locations were approximately determined in the field by measuring from existing site features. The approximate test boring locations are shown on the attached Exploration Location Plan, Figure 2. Test Boring Logs are attached as Figures A-2 through A-6.

A geologist from our office conducted the field exploration. Our representative classified the soil conditions encountered, maintained a log of each hand hole, obtained representative soil samples, and recorded water levels observed during excavation. 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 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-6. All soil samples were visually classified in accordance with the Unified Soil Classification System (USCS) described on Figure A-1.

Representative soil samples collected from the test pits were placed in closed containers and taken to our laboratory for further examination and testing. Laboratory testing consisted of determining the soil moisture content of all samples and grain size distribution analyses of eight soil samples. The soil moistures are reported on the Test Boring Logs. The grain size distribution test results are shown on Figures A-7 through A-9.

EXHIBIT 5f

| 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

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

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

| | |
|---|---|
| | 2" OUTSIDE DIAMETER SPILT SPOON SAMPLER |
| | 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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Environmental Earth Sciences

UNIFIED SOIL CLASSIFICATION SYSTEM
5 DEGREES
SHORELINE, WASHINGTON

| Proj.No. T-8268 | Date: DEC 2019 | Figure A-1 |
|---|---|---|

EXHIBIT 5f

# LOG OF BORING NO. B-1

**Figure No.** A-2

**Project:** 5 Degrees **Project No:** T-8268 **Date Drilled:** November 27, 2019

**Client:** Pulte **Driller:** Boretec **Logged By:** EHE

**Location:** Shoreline, Washington **Depth to Groundwater:** N/A **Approx. Elev:** N/A

| Depth (ft) | Soil Description | Consistency/ Relative Density | SPT (N) Blows/foot | Moisture Content (%) |
|---|---|---|---|---|
| 0 | (6 inches TOPSOIL and ORGANICS) | | | |
| | FILL(?): Gray to brown silty SAND with gravel, fine sand, fine to medium gravel, dry to moist, minor organics. (SM) | Loose | 6 | 10.1 |
| 5 | Gray to tan silty SAND with gravel, fine to medium sand, fine to coarse gravel, dry to moist. (SM) | Very Dense | 50/6" | 7.4 |
| | | | 50/5" | 7.3 |
| 10 | | | 51 | 4.4 |
| | Gray to tan SAND with silt and gravel, fine to medium sand, fine to coarse gravel, dry to moist. (SP-SM) | | 57 | 3.7 |
| 15 | Gray to tan silty SAND with trace gravel, fine to medium sand, fine to medium gravel, dry to moist. (SM) | Dense | 32 | 5.6 |
| | Boring terminated at 16.5 feet.<br>No groundwater encountered. | | | |
| 20 | | | | |

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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EXHIBIT 5f

# LOG OF BORING NO. B-2

**Figure No.** A-3

**Project:** 5 Degrees **Project No:** T-8268 **Date Drilled:** November 27, 2019

**Client:** Pulte **Driller:** Boretec **Logged By:** EHE

**Location:** Shoreline, Washington **Depth to Groundwater:** N/A **Approx. Elev:** N/A

| Depth (ft) | Soil Description | Consistency/ Relative Density | SPT (N) Blows/foot | Moisture Content (%) |
|---|---|---|---|---|
| 0 | (6 inches TOPSOIL and ORGANICS)<br>FILL(?): Gray to brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, minor organics. (SM) | Medium Dense | 13 | 41.0 |
| 5 | | Loose | 6 | 4.1 |
| | Gray to tan SAND with silt and gravel, fine to coarse sand, fine to coarse gravel, moist. (SP-SM) | Dense | 37 | 3.9 |
| 10 | | | 45 | 4.2 |
| | | Very Dense | 71 | 4.7 |
| 15 | Gray to tan SAND with gravel, fine to medium sand, fine to coarse gravel, dry to moist. (SP) | | 68 | 4.9 |
| | Boring terminated at 16.5 feet.<br>No groundwater encountered. | | | |
| 20 | | | | |

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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EXHIBIT 5f

# LOG OF BORING NO. B-3

**Figure No.** A-4

**Project:** 5 Degrees **Project No:** T-8268 **Date Drilled:** November 27, 2019

**Client:** Pulte **Driller:** Boretec **Logged By:** EHE

**Location:** Shoreline, Washington **Depth to Groundwater:** N/A **Approx. Elev:** N/A

| Depth (ft) | Sample Interval | Soil Description | Consistency/ Relative Density | SPT (N) Blows/foot (10 30 50) | Moisture Content (%) |
|---|---|---|---|---|---|
| 0 | | (6 inches TOPSOIL and ORGANICS) | | | |
| | | Tan to dark brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, dry to moist. (SM) | Medium Dense | 28 | 14.6 |
| 5 | | Brown to dark brown silty SAND, fine to medium sand, moist, some gravel. (SM) | Very Dense | 50/6" | 29.3 |
| | | Gray to tan silty SAND with gravel, fine to medium sand, fine to coarse gravel, dry to moist. (SM) | Dense | 35 | 3.1 |
| 10 | | Gray to tan SAND with silt and gravel, fine sand, gravel, dry to moist. (SP-SM) | Dense | 44 | 3.1 |
| | | | | 44 | 3.2 |
| 15 | | | Very Dense | 50/6" | 3.2 |
| | | Boring terminated at 15.5 feet.<br>No groundwater seepage encountered. | | | |
| 20 | | | | | |

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:** 5 Degrees **Project No:** T-8268 **Date Drilled:** November 27, 2019

**Client:** Pulte **Driller:** Boretec **Logged By:** EHE

**Location:** Shoreline, Washington **Depth to Groundwater:** N/A **Approx. Elev:** N/A

| Depth (ft) | Soil Description | Consistency/ Relative Density | SPT (N) Blows/foot | Moisture Content (%) |
|---|---|---|---|---|
| 0 | (3 inches ASPHALT) | | | |
| | Gray to tan silty SAND with gravel, fine to medium sand, fine to coarse gravel, dry to moist. (SM) | Dense | 35 | 12.6 |
| 5 | | Very Dense | 50/2" | 10.0 |
| | | | 51 | 4.7 |
| 10 | | Dense | 40 | 5.2 |
| | | Very Dense | 63 | 4.8 |
| 15 | Brown-gray SAND with silt and gravel, fine to medium sand, moist. (SP-SM) | | 71 | 5.2 |
| | Boring terminated at 16.5 feet. No groundwater encountered. | | | |
| 20 | | | | |

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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EXHIBIT 5f

# LOG OF BORING NO. B-5

**Figure No.** A-6

**Project:** 5 Degrees **Project No:** T-8268 **Date Drilled:** November 27, 2019

**Client:** Pulte **Driller:** Boretec **Logged By:** EHE

**Location:** Shoreline, Washington **Depth to Groundwater:** N/A **Approx. Elev:** N/A

| Depth (ft) | Sample Interval | Soil Description | Consistency/ Relative Density | SPT (N) Blows/foot (10 30 50) | Moisture Content (%) |
|---|---|---|---|---|---|
| 0 | | (6 inches TOPSOIL and ORGANICS) | | | |
| | | Brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, dry to moist, minor organics. (SM) | Medium Dense | 29 | 26.4 |
| 5 | | Gray to tan silty SAND with some gravel, fine to coarse sand, fine to medium gravel, moist. (SM) | Dense | 37 | 8.3 |
| | | Gray to tan SAND with silt and gravel, fine to medium sand, fine to coarse gravel, dry to moist. (SP-SM) | Dense | 31 | 4.6 |
| 10 | | Gray to tan silty SAND, fine sand, dry to moist, trace gravel. (SM) | Medium Dense | 29 | 11.7 |
| | | Gray to tan SAND with gravel, fine to medium sand, fine gravel, dry to moist. (SP) | Very Dense | 54 | 3.8 |
| 15 | | | Very Dense | 89 | 7.4 |
| | | Boring terminated at 16.5 feet.<br>No groundwater encountered. | | | |
| 20 | | | | | |

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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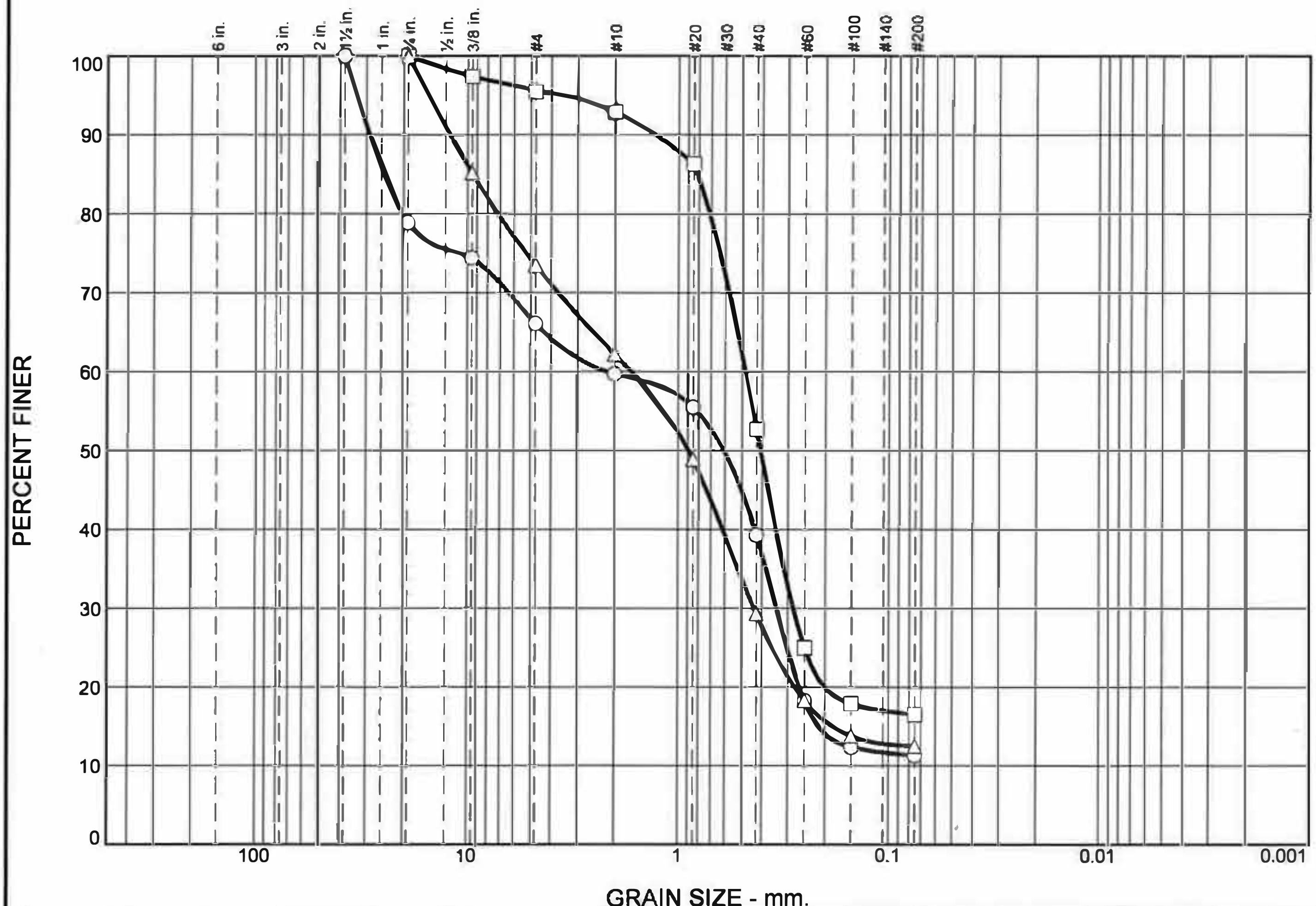
EXHIBIT 5f

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 21.1 | 12.8 | 6.4 | 20.4 | 28.0 | 11.3 | |
| □ | 0.0 | 0.0 | 4.5 | 2.6 | 40.2 | 36.2 | 16.5 | |
| △ | 0.0 | 0.0 | 26.5 | 11.3 | 32.9 | 16.8 | 12.5 | |

| | LL | PL | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ | | | 24.7012 | 2.1718 | 0.6075 | 0.3407 | 0.2141 | | | |
| □ | | | 0.8144 | 0.4807 | 0.4064 | 0.2835 | | | | |
| △ | | | 9.4269 | 1.6612 | 0.8914 | 0.4361 | 0.1834 | | | |

| Material Description | USCS | AASHTO |
|---|---|---|
| ○ SAND with silt | SP-SM | |
| □ Silty SAND | SM | |
| △ Silty SAND | SM | |

**Project No.** T-8268 **Client:** Pulte Homes of Washington

**Project:** 5 Degrees

○ **Location:** B-1 **Depth:** -12.5 feet

□ **Location:** B-1 **Depth:** -15 feet

△ **Location:** B-2 **Depth:** -5 feet

**Remarks:**

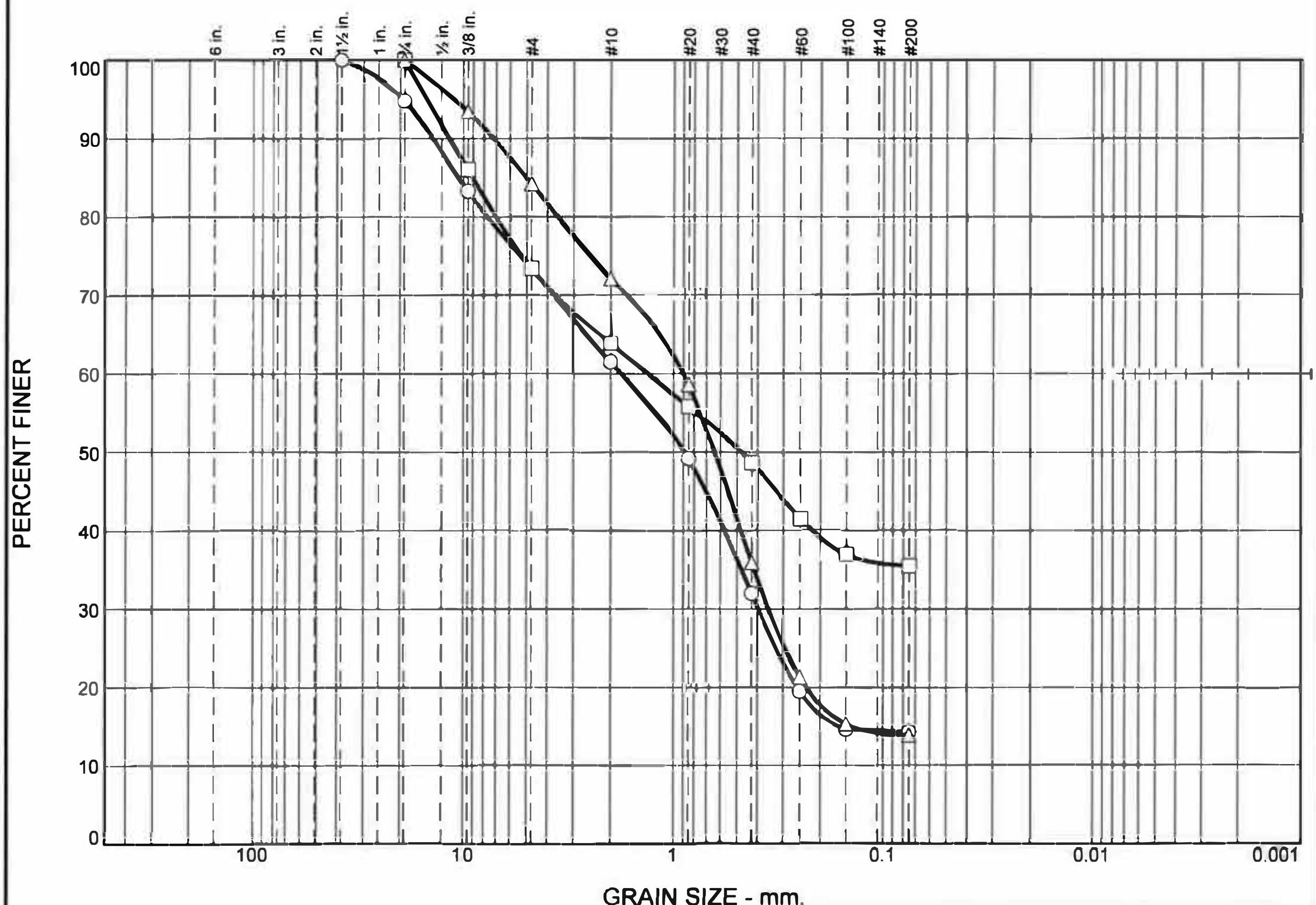
**Terra Associates, Inc.**

**Kirkland, WA**

**Figure** A-7

**Tested By:** FQ

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 5.2 | 21.4 | 11.9 | 29.5 | 17.7 | 14.3 | |
| □ | 0.0 | 0.0 | 26.6 | 9.5 | 15.2 | 13.2 | 35.5 | |
| △ | 0.0 | 0.0 | 15.8 | 12.1 | 36.2 | 22.0 | 13.9 | |

| | LL | PL | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ | | | 10.5249 | 1.7735 | 0.8857 | 0.3945 | 0.1635 | | | |
| □ | | | 9.0586 | 1.3258 | 0.4730 | | | | | |
| △ | | | 5.0206 | 0.8997 | 0.6388 | 0.3532 | 0.1418 | | | |

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

**Project No.** T-8268 **Client:** Pulte Homes of Washington

**Project:** 5 Degrees

○ **Location:** B-3 **Depth:** -7.5

□ **Location:** B-4 **Depth:** -5 feet

△ **Location:** B-4 **Depth:** -10 feet

**Remarks:**

**Terra Associates, Inc.**

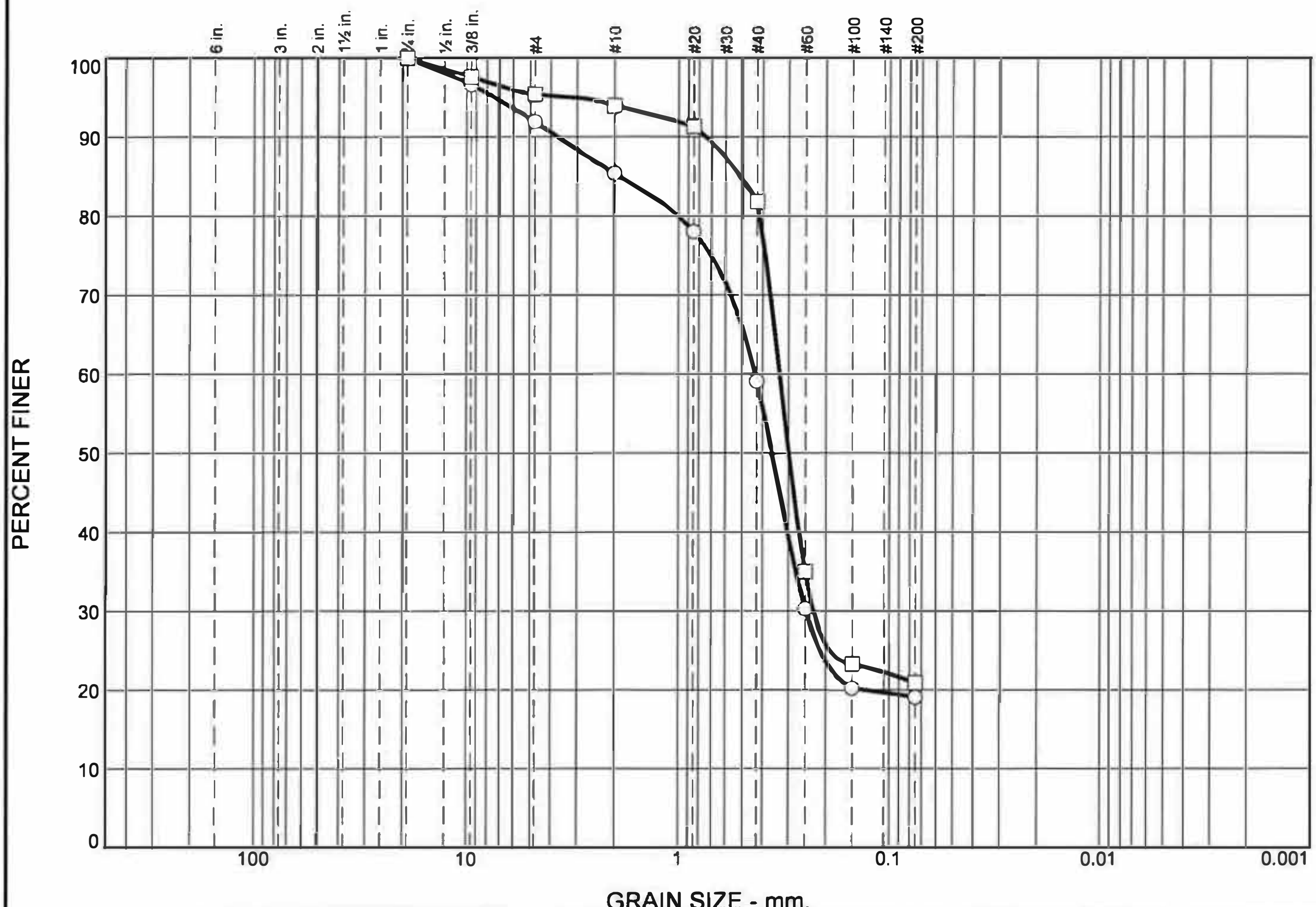
**Kirkland, WA**

**Figure** A-8

**Tested By:** FQ

EXHIBIT 5f

# Particle Size Distribution Report




| | % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| ○ | 0.0 | 0.0 | 8.1 | 6.5 | 26.3 | 40.0 | 19.1 | |
| □ | 0.0 | 0.0 | 4.6 | 1.5 | 12.1 | 60.9 | 20.9 | |
| | | | | | | | | |

| ☒ | LL | PL | $D_{85}$ | $D_{60}$ | $D_{50}$ | $D_{30}$ | $D_{15}$ | $D_{10}$ | $C_c$ | $C_u$ |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ | | | 1.8868 | 0.4330 | 0.3599 | 0.2482 | | | | |
| □ | | | 0.5119 | 0.3315 | 0.2994 | 0.2281 | | | | |
| | | | | | | | | | | |

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

**Project No.** T-8268 **Client:** Pulte Homes of Washington

**Project:** 5 Degrees

○ **Location:** B-5 **Depth:** -5 feet

□ **Location:** B-5 **Depth:** -10 feet

**Remarks:**

**Terra Associates, Inc.**

**Kirkland, WA**

**Figure** A-9

**Tested By:** FQ