Infiltration Assessment Report

Proposed Townhome Development
416 and 422 East Gilman Avenue
Arlington, WA 98223

Prepared For:

Rivertown Homes, LLC
Attn. Joe Brandvold
P.O. Box 1125
Snohomish, WA 98291

GEOTEST
1.888.251.5276
Bellingham | Arlington | Oak Harbor
www.geotest-inc.com

1.888.251.5276
Bellingham | Arlington | Oak Harbor
www.geotest-inc.com

December 8, 2022
Project No. 22-0872

Rivertown Homes, LLC
P.O. Box 1125
Snohomish, WA 98291

Attn.: **Mr. Joe Brandvold**

Regarding: **Infiltration Assessment Report**
Proposed Townhome Development
416 and 422 East Gilman Avenue
Arlington, WA 98223

Dear Mr. Brandvold,

As requested, GeoTest Services, Inc. [GeoTest] is pleased to submit the following report summarizing the results of our infiltration assessment for the proposed townhome development located at 416 and 422 East Gilman Avenue in Arlington, WA (see *Vicinity Map,* Figure 1). This report has been prepared in general accordance with the terms and conditions established in our services agreement dated September 22, 2022 and authorized by yourself.

GeoTest appreciates the opportunity to provide geotechnical services on this project and look forward to assisting you during the construction phase. Should you have any further questions regarding the information contained within the report, or if we may be of service in other regards, please contact the undersigned.

Respectfully,
GeoTest Services, Inc.

GERRY D. BAUTISTA
STATE OF WASHINGTON
51581
REGISTERED
PROFESSIONAL ENGINEER
12/8/22

Gunnar Sterlington, G.I.T.
Staff Geologist

Gerry D. Bautista, Jr., P.E.
Project Geotechnical Engineer

Enclosure: Geotechnical Engineering Report

TABLE OF CONTENTS

PURPOSE AND SCOPE OF SERVICES

The purpose of this evaluation is to establish general subsurface conditions beneath the site from which conclusions and recommendations pertaining to project design can be formulated. Our scope of services includes the following tasks:

- Explore soil and groundwater conditions underlying the site by excavating test pits with a track-mounted excavator to evaluate subsurface conditions (TP-1, TP-2, TP-3, and PIT).

- Perform one Pilot Infiltration Test (PIT) in accordance with the *Stormwater Management Manual for Western Washington* (SMMWW). This is the stormwater manual currently adopted by the City of Arlington.

- Perform laboratory testing on representative samples to classify and evaluate the engineering characteristics of the soils encountered and to assess on-site infiltration capability.

- Provide a summary of surface and subsurface soil and groundwater conditions observed at the site during our field exploration. The summary will also discuss the potential seasonal effects of groundwater.

Geotechnical recommendations for the proposed development (foundations, earth pressures, structural fill, etc.) and a geologic hazards assessment are outside of the scope of work of this report.

PROJECT DESCRIPTION

The project site comprises two rectangular-shaped residential lots, each approximately 0.34 acres in size, along the southern side of East Gilman Avenue in Arlington, WA.

- Western Parcel – 416 East Gilman Avenue (Parcel No. 00461801000400, 0.34 acres)
- Eastern Parcel – 422 East Gilman Avenue (Parcel No. 00461801000100, 0.34 acres)

GeoTest understands that the existing residences that exist on each property will be removed, and a unit-lot townhouse development will be constructed on both lots. Each lot will house three unit lots. GeoTest anticipates that the new building will utilize wood-frame construction with slab-on-grade floors. GeoTest expects that the building will be supported by shallow conventional foundations with light to moderate building loads.

The Civil Engineer (Cascade Surveying and Engineering) is requesting an infiltration assessment of the underlying soils in the vicinity of the proposed stormwater facilities. Information regarding

the type and location of these was not known at the time that this report was written. Geotechnical recommendations for the proposed development and a geologic hazards assessment are outside of the scope of work of this report.

SITE CONDITIONS

This section includes a description of the general surface and subsurface conditions observed at the project site during the time of our field investigation. Interpretations of site conditions are based on the results and review of available information, site reconnaissance, subsurface explorations, laboratory testing, and previous experience in the project vicinity.

Surface Conditions

The proposed area of development includes two parcels where a unit lot townhouse development will be constructed across both lots. The western parcel (#416) contains a one-story single-family residence with a basement that was originally constructed in 1923, and the eastern parcel (#422) contains a one-story residence that was originally constructed in 1957.

The site is relatively flat with the only slope located along the northern edge of both properties. A moderately steep slope approximately 10 to 15 feet in height parallels the northern edge of both lots. The slope is covered with coniferous trees and shrubbery. It appears that this is a historic cut slope that was made for previous grading of Gilman Avenue that parallels the northern side of both lots. Along the southern edge of each lot is a shared half paved half gravel alleyway. A single-family lot borders the western of lot at 416 East Gilman Avenue. North Talcott Street borders the eastern parcel boundaries. GeoTest observed a few existing utility alignments and easements around the parcels.

Image 1. A screenshot taken from *PDS Map Portal,* showing aerial view of the two subject parcels and the single-family residence to the west.

Image 2. Site conditions showing the relatively flat surface conditions and moderate slope to the north. Photo taken facing west. Images 2 and 3 taken on October 27, 2022.

Subsurface Soil Conditions

Subsurface conditions were explored by advancing three test pits (TP-1, TP-2, TP-3, and PIT) on October 27, 2022. Our explorations were advanced to depths ranging between 6 and 8 feet below the ground surface (BGS) using an excavator. Approximate locations of these explorations have been plotted on the *Site and Exploration Plan* (Figure 2).

The on-site subsurface soils generally consisted of about 1.1 to 1.2-feet of brown, loose, silty sand with appreciable organics that were interpreted to be topsoil. Underlying the topsoil in TP-1 and TP-2, GeoTest observed native, medium dense, tan to light brown, silty sandy gravel that was interpreted as the Arlington Sand member of the Recessional Outwash (referred to in this report as Arlington Gravel). At a depth of about 3.5 to 4 feet BGS in TP-1 and TP-2, the weathered Arlington Gravel graded to gray, unweathered Arlington Gravel. This soil was encountered to the maximum explored depth of TP-2.

In TP-3 and the PIT, the soils underlying the topsoil layer consisted of native, medium dense, tan to reddish brown, gravelly, silty sand, and can be interpreted as an Arlington Gravel similar to TP-1 and TP-2. These soils became unweathered at about 4 feet BGS. At the base of TP-1, TP-3, and PIT (approximately 6 to 7 feet BGS) is a hard, gray blue, gravelly, sandy silt interpreted as Till. The Glacial till was encountered to the maximum explored depth of these test pits.

See the attached *Site and Exploration Plan* (Figure 2) for the approximate locations of our explorations.

Image 3. Subsurface conditions within TP-3. Near surface soils consist of topsoil underlain by weathered silty sands and transitioning into unweathered sands with generally higher gravel contents at approximately 5 feet BGS. Note the gray blue, sandy silt at the base of the test pit.

General Geologic Conditions

Geologic information for the project site was obtained from the *Geologic Map of the Arlington East Quadrangle*, Snohomish County, Washington (Minard, 1985), published by the U.S. Geological Survey. According to the referenced map, subsurface soils in the vicinity of the project site consist of Arlington Gravel Member Recessional Glacial Outwash (Qvra) deposited during the

Fraser glaciation event. The Arlington Gravel Member generally consists of well-drained, stratified, outwash sand and gravel. Deposits range from 2 meters to 25 meters thick and are underlain by Vashon Till. Till consists of a mostly non-sorted mixture of clay, silt, sand, gravel, and diamicton with some lenses of stratified soils. This unit is typically dense to very dense or very stiff to hard due to the overriding ice from glacial advance and retreat, in which glaciers in the region were upwards to a mile thick.

Native soils encountered during our subsurface explorations were generally consistent with the mapped glacial deposits. For the purposes of this report, GeoTest will refer to both the weathered and unweathered Arlington Gravel member of the Recessional Outwash as "Arlington Gravel", and the Vashon Till as "Till".

Groundwater

Groundwater was not encountered at the time of our explorations. The groundwater conditions reported on the exploration logs are for the specific locations and dates indicated, and therefore may not be indicative of other locations and/or times. Groundwater levels are variable and groundwater conditions fluctuate depending on local subsurface conditions, precipitation, and changes in on-site and off-site use.

Due to the relative density of the underlying glacially consolidated soils, it is GeoTest's opinion that water has the potential to perch atop Till. Perched water is not representative of a wide-spread, regional aquifer. Rather, it is representative of surface water and near-surface interflow that collects over denser or siltier soils with reduced hydraulic conductivities. Perched water is typically less than a few feet in thickness and is typically present during extended periods of wet weather.

CONCLUSIONS AND RECOMMENDATIONS

Based on the evaluation of the data collected during this investigation, it is our opinion that the subsurface conditions at the site are suitable for the proposed development, provided the recommendations contained herein are incorporated into the project design.

Subsurface explorations on the project site exhibited approximately 1.1 to 1.2 feet of topsoil overlying medium-dense, weathered, sandy gravel to gravelly sand (Arlington Gravel) that became unweathered at approximately 3.5 to 4 feet BGS. Till was encountered at depth in TP-1, TP-3, and the PIT excavation at approximately 6 to 7 feet BGS.

A Pilot Infiltration Test conducted on the west parcel, in accordance with the *SMMWW*, found that the native Arlington Gravel soils had limited to moderate infiltration potential. Shallower stormwater facilities founded in the near-surface Arlington Gravel soils would be preferred over deep ponds founded in unweathered Till. GeoTest strongly recommends that the design of

infiltration facilities take into account the presence of Till at depth. It should also be noted that perched groundwater may be encountered atop the Till soils, although perched groundwater was not encountered in our explorations. The potential effects of infiltration facilities upslope from neighboring properties should be carefully considered during the stormwater design process for this project.

It should also be noted that a site development plan showing the building type, footprint, or stormwater facilities was not available to us at the time of writing this report. Thus, it must be expected that additional design services, possibly paired with additional field work and collaboration with the project Civil Engineer, will be needed to complete the stormwater design. Seasonal groundwater monitoring may be required by the City of Arlington and is outside the scope of this report.

Stormwater Infiltration Potential

Per the SMMWW, medium dense, predominately granular sand (Arlington Gravel) is suitable for infiltration. GeoTest performed one PIT test entirely within Arlington Gravel and our remaining explorations also exhibited similar native soils. Based on our findings, it is GeoTest's opinion that the Arlington Gravel soils are suitable for the conventional infiltration of stormwater. The results of our infiltration test are presented below.

Pilot Infiltration Test Results

GeoTest performed one small-scale PIT test on October 27, 2022, per the SMMWW in order to determine the initial saturated hydraulic conductivity rate (K_{sat} initial) in inches per hour. The base of the PIT was excavated to the dimensions of approximately 4 feet long by 4 feet wide, with an approximate elevation of 3 feet BGS. The bottom of the PIT extended into the native, poorly graded Arlington Gravel. Approximate ground elevations were obtained from the survey provided to us for this project.

Infiltration testing was conducted by discharging water into the flat-bottom excavation for a 6-hour "soaking period". The purpose of the 6-hour pre-soak was to allow the soils in the immediate vicinity of the test area to exhibit saturated conditions. Water was discharged into the excavation at a metered rate while keeping the water level within the testing area approximately fixed. The cumulative volume and instantaneous flow rates were recorded approximately every 15 to 30 minutes. Water for the infiltration testing was obtained from a water truck.

Following the 6-hour pre-soak and steady-state period, the water was shut off and a falling-head test was then conducted, where the rate of infiltration (the drop of the standing water) in inches per hour was recorded until fully drained. At the conclusion of the testing, the bottom of the PIT

was excavated an additional 3.5 to 4 feet to identify possible restrictive layers. GeoTest observed low permeability Till at the bottom of the PIT excavation (approximately 6.3 feet BGS).

Table 1 below presents topographic information for the surface elevations, the bottom of PIT elevation, and the regional groundwater table elevation:

Table 1
PIT Test Elevations

PIT ID	Test Date	Surface Elevation* (ft)	Bottom of PIT Elevation (ft)	Groundwater Elevation (ft)	Groundwater Separation (ft)
PIT	10/27/2022	134	131.5	NA	NA

*Surface elevation data is approximate and is derived from the survey provided to us dated July 2022.

Design Infiltration Rates

The initial, uncorrected hydraulic conductivity (K_{sat} initial) was calculated for the PIT using the infiltration rate recorded during the falling-head test. This is measured as change in depth per recorded time interval. The K_{sat} initial value is shown below in Table 2. GeoTest then determined the corrected, long-term infiltration rate (K_{sat} design) by applying the following correction factors in accordance with the SMMWW:

- Site variability and number of locations tests, $CF_v = 0.70$
- Test method (small-scale test), $CF_t = 0.50$
- Degree of influent control to prevent siltation and bio-buildup, $CF_m = 0.90$

Based on the encountered subsurface soil type and the elevated risk that infiltrating less than 5 vertical feet above a low permeability or restriction layer (Till) presents, GeoTest is recommending that an additional correction factor of 0.7 be included in the design. Table 2 provides a summary of the calculated infiltration rate determined at the PIT location:

Table 2
Calculated Infiltration Rate

PIT ID	K_{sat} Initial (in/hr)	Reduction Factor*	K_{sat} Design (in/hr)
PIT-1	10.6	0.18	1.9

*Total Reduction Factor = (0.70)(0.40)(0.90)(0.70) = 0.18

Based on our PIT result and analysis of the subsurface soils, the infiltration rates within the native, poorly graded Arlington Gravel at the test location was calculated to be **1.9 in/hr**. This rate is representative of an excavation that extends to an elevation of approximately 131.5 feet above mean sea level within the Arlington Gravel and/or a minimum separation of 3 feet between the bottom of facility and the interface with unweathered Till. It should be noted that this rate is only valid for a facility that is in the vicinity of the PIT. It should also be noted that Till was encountered at approximately 6 feet BGS in the PIT excavation and that facilities should not extend into Till.

Design Considerations

Stormwater infiltration potential is a function of the relative permeability of the site soils, and the separation between the base of the stormwater facility and the groundwater table. GeoTest assumed that the bottom of infiltration facilities would need to be placed within the near surface weathered or unweathered Arlington Gravel due to the low permeability Till that was encountered at depth during our explorations. During the PIT overexcavation, GeoTest encountered soils that were similar to those encountered in the other explorations that were performed on site.

Thus, for facility bottoms within the Arlington Gravel, GeoTest recommends that the Civil Engineer use a design infiltration rate of **1.9 inches per hour** for preliminary design purposes. The type, configuration, and depth of proposed stormwater facilities was not known at the time that this report was written. GeoTest should be given the opportunity to review the final drawings to confirm that the recommendations in this report have been incorporated into the design. Furthermore, GeoTest personnel should be on site during the excavation of stormwater facilities to confirm that suitable soil conditions have been encountered.

Stormwater Treatment

The stormwater facilities on-site may require some form of pollutant pretreatment with an amended soil prior to on-site infiltration or off-site discharge. The reuse of on-site topsoil is often the most sustainable and cost-effective method for pollutant treatment purposes. Cation exchange capacities, organic contents, and pH of site subsurface soils were also tested to determine possible pollutant treatment suitability.

Cation exchange capacity, organic content, and pH tests were performed by Northwest Agricultural Consultants on three soil samples collected from the explorations shown in Table 3. A summary of the laboratory test results is presented in Table 3 below.

Table 3 Cation Exchange Capacity, Organic Content, and pH Laboratory Test Results				
Test Pit ID	**Sample Depth (ft)**	**Cation Exchange Capacity (meq/100 grams)**	**Organic Content (%)**	**pH**
TP-2	0.6	12.2	5.07	6.0
TP-2	3.5	2.6	1.51	6.1
TP-3	0.9	17.0	8.69	5.9

Suitability for on-site pollutant treatment is determined in accordance with the Manual. Soils with an organic content of greater than or equal to 1 percent and a cation exchange capacity of greater than or equal to 5 meq/100 grams are characterized as suitable for stormwater treatment. Based on the results shown in Table 3, the native topsoil and near-surface Arlington Gravel soils (less than 3.5 feet BGS) found on site are suitable for stormwater treatment.

On-site soils can be amended by mixing higher silt content soils or adding mulch (or other admixtures) to elevate the cation exchange capacity and organic contents. On-site amended soil requires additional testing to confirm compliance with ecological regulations. GeoTest is available to perform additional laboratory testing as part of an expanded scope of services if the soil is to be amended. Alternatively, the owner may elect to import amended soils with the desired properties for planned treatment facilities.

Geotechnical Consultation and Construction Monitoring

GeoTest recommends that we be involved in the project design review process. The purpose of the review is to verify that the recommendations presented in this report are understood and incorporated in the design and specifications.

GeoTest is available to provide a full range of materials testing and special inspection during construction as required by the local building department and the International Building Code. This may include specific construction inspections on materials such as reinforced concrete, reinforced masonry, wood framing, and structural steel. These services are supported by our fully accredited materials testing laboratories.

USE OF THIS REPORT

GeoTest Services, Inc. has prepared this report for the exclusive use of Rivertown Homes, LLC and its design consultants for specific application to the design of the infiltration facilities for proposed townhome development project located at 416 and 422 East Gilman Avenue in Arlington, WA. Geotechnical recommendations for the proposed residences (foundations, earth pressures, structural fill, etc.) and a geologic hazards assessment are outside of the scope of work of this report. Use of this report by others is at the user's sole risk. This report is not applicable to other site locations. Our services are conducted in accordance with accepted practices of the geotechnical engineering profession; no other warranty, express or implied, is made as to the professional advice included in this report.

Our site explorations document subsurface conditions at the dates and locations indicated. It is not warranted that these conditions are representative of conditions at other locations and times. The analyses, conclusions, and recommendations contained in this report are based on site conditions to the limited depth and time of our explorations, a geological reconnaissance of the area, and a review of previously published geological information for the site. If variations in subsurface conditions are encountered during construction that differ from those contained within this report, GeoTest should be allowed to review the recommendations and, if necessary, make revisions. If there is a substantial lapse of time between submission of this report and the start of construction, or if conditions change due to construction operations at or adjacent to the project site, we recommend that we review this report to determine the applicability of the conclusions and recommendations contained herein.

The earthwork contractor is responsible to perform all work in conformance with all applicable WISHA/OSHA regulations. GeoTest Services, Inc. is not responsible for job site safety on this project, and this responsibility is specifically disclaimed.

Attachments:	Figure 1	Vicinity Map
	Figure 2	Site and Exploration Plan
	Figure 3	Soil Classification System and Key
	Figures 4 – 5	Log of Test Pits
	Figure 6	Grain Size Test Data
	Attached	Northwest Agricultural Consultants Results
	Attached	Report Limitations and Guidelines for its Use

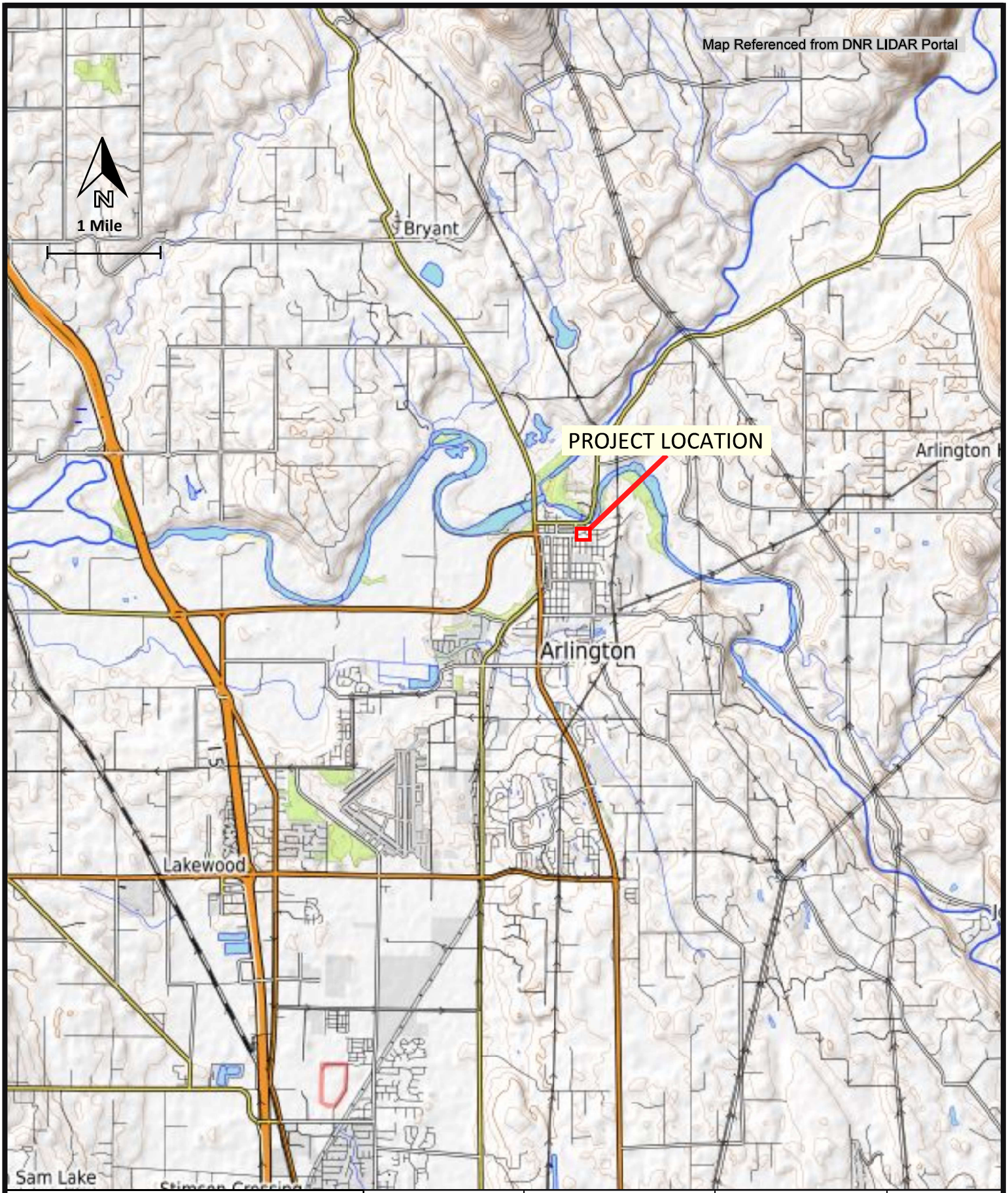
REFERENCES

Gariepy, D., Graul, C., Heye, A., Howie, D., Labib, F., & Song, K. (n.d.), *2019 Stormwater Management Manual for Western Washington* (2019 SMMWW) (pp. 1-1108) (United States, Washington State Department of Ecology).

Minard, J.P., 1985, *Geologic Map of the Arlington East Quadrangle, Snohomish County, Washington*: U.S. Geological Survey, Miscellaneous Field Studies Map MF-1739, scale 1:24,000

Snohomish County, Washington. *Snohomish County PDS Map Portal.* Retrieved in November 2022.

Washington Interactive Geologic Map. Washington State Department of Natural Resources - Online Web Services. Retrieved in November 2022.



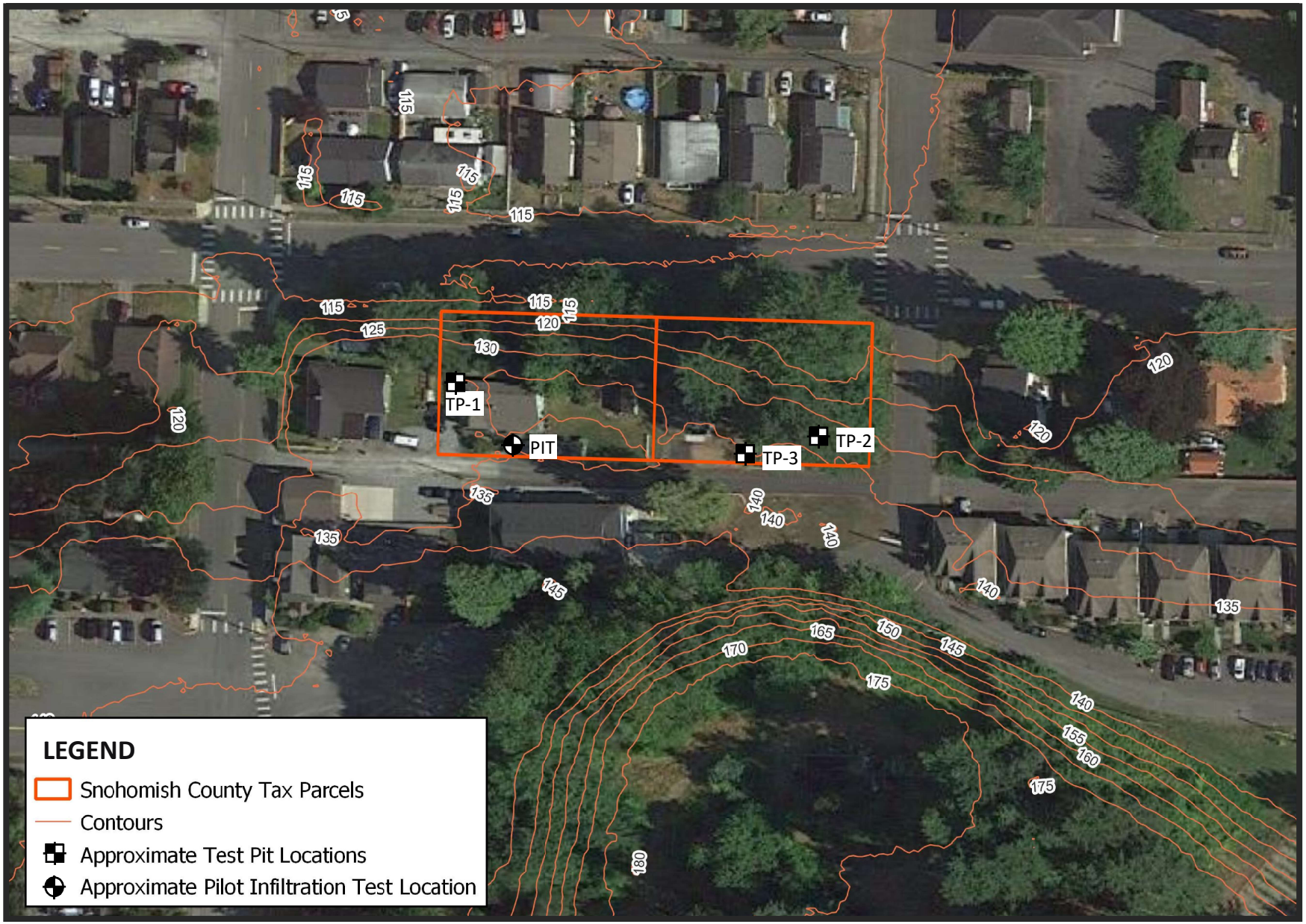
Date: 11-28-22	By: GS	Scale: As Shown	Project 22-0872

VICINITY MAP

PROPOSED TOWNHOME DEVELOPMENT
416/422 EAST GILMAN AVENUE
ARLINGTON, WA 98223

Figure 1

MAP REFERENCE GOOGLE SATELLITE



GEOTEST

Date: 12-5-22	By: GS	Scale: As Shown	Project 22-0872

SITE AND EXPLORATION PLAN

PROPOSED TOWNHOME DEVELOPMENT
416/422 EAST GILMAN AVENUE
ARLINGTON, WA 98223

Figure 2

Soil Classification System

MAJOR DIVISIONS			GRAPHIC SYMBOL	USCS LETTER SYMBOL	TYPICAL DESCRIPTIONS[1][2]
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL (More than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (Little or no fines)		GW	Well-graded gravel; gravel/sand mixture(s); little or no fines
				GP	Poorly graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)		GM	Silty gravel; gravel/sand/silt mixture(s)
				GC	Clayey gravel; gravel/sand/clay mixture(s)
	SAND AND SANDY SOIL (More than 50% of coarse fraction passed through No. 4 sieve)	CLEAN SAND (Little or no fines)		SW	Well-graded sand; gravelly sand; little or no fines
				SP	Poorly graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)		SM	Silty sand; sand/silt mixture(s)
				SC	Clayey sand; sand/clay mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY (Liquid limit less than 50)			ML	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity
				CL	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay
				OL	Organic silt; organic, silty clay of low plasticity
	SILT AND CLAY (Liquid limit greater than 50)			MH	Inorganic silt; micaceous or diatomaceous fine sand
				CH	Inorganic clay of high plasticity; fat clay
				OH	Organic clay of medium to high plasticity; organic silt
	HIGHLY ORGANIC SOIL			PT	Peat; humus; swamp soil with high organic content

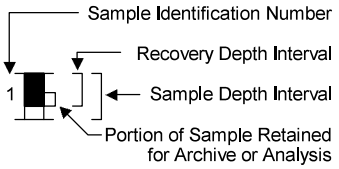
OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT		AC or PC	Asphalt concrete pavement or Portland cement pavement
ROCK		RK	Rock (See Rock Classification)
WOOD		WD	Wood, lumber, wood chips
DEBRIS		DB	Construction debris, garbage

Notes:
1. Soil descriptions are based on the general approach presented in the *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*, as outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the *Standard Test Method for Classification of Soils for Engineering Purposes*, as outlined in ASTM D 2487.
2. Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:

Primary Constituent: > 50% - "GRAVEL," "SAND," "SILT," "CLAY," etc.
Secondary Constituents: > 30% and ≤ 50% - "very gravelly," "very sandy," "very silty," etc.
> 12% and ≤ 30% - "gravelly," "sandy," "silty," etc.
Additional Constituents: > 5% and ≤ 12% - "slightly gravelly," "slightly sandy," "slightly silty," etc.
≤ 5% - "trace gravel," "trace sand," "trace silt," etc., or not noted.

Drilling and Sampling Key

SAMPLE NUMBER & INTERVAL



SAMPLER TYPE

Code	Description
a	3.25-inch O.D., 2.42-inch I.D. Split Spoon
b	2.00-inch O.D., 1.50-inch I.D. Split Spoon
c	Shelby Tube
d	Grab Sample
e	Other - See text if applicable
1	300-lb Hammer, 30-inch Drop
2	140-lb Hammer, 30-inch Drop
3	Pushed
4	Other - See text if applicable

Groundwater

▽ ATD — Approximate water elevation at time of drilling (ATD) or on date noted. Groundwater levels can fluctuate due to precipitation, seasonal conditions, and other factors.

Field and Lab Test Data

Code	Description
PP = 1.0	Pocket Penetrometer, tsf
TV = 0.5	Torvane, tsf
PID = 100	Photoionization Detector VOC screening, ppm
W = 10	Moisture Content, %
D = 120	Dry Density, pcf
-200 = 60	Material smaller than No. 200 sieve, %
GS	Grain Size - See separate figure for data
AL	Atterberg Limits - See separate figure for data
GT	Other Geotechnical Testing
CA	Chemical Analysis

GEOTEST

Proposed Townhome Dev.
416/422 East Gilman Avenue
Arlington, WA 98223

Soil Classification System and Key

Figure 3

PIT

SAMPLE DATA			SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Tracked Excavator Ground Elevation (ft): 134 Excavated By: PacNW Excavation/G.Sterlington	
0	14	d			SM/ OL	Loose, dark brown, damp, silty SAND abundant organics (Topsoil)	Groundwater not encountered.
					OL	Loose, dark brown, black, damp, silty SAND (Relict Topsoil)	
2	15	d	W = 31 GS		SM	Medium dense, reddish brown, damp, slightly gravelly, silty to very silty SAND (Arlington Gravel) -#4 rebar penatrated sidewall with some difficutly using a 5lb hammer at 2.3' BGS -PIT test performed at 2.5' BGS -Color grades to light brown to tan at 3.2' BGS	
4	16	d	W = 19 GS				
6	17	d			ML	-Large boulders ranging from 2-4' in diameter at 3.3' BGS Hard, tan to gray blue, damp, gravelly sandy SILT heavy oxidation (Glacial Till)	
8						Test Pit Completed 10/27/22 Total Depth of Test Pit = 6.3 ft.	

TP-1

SAMPLE DATA			SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Tracked Excavator Ground Elevation (ft): 134 Excavated By: PacNW Excavation/G.Sterlington	
0	1	d			SM/ OL	Loose, dark brown, damp, silty SAND abundant organics (Topsoil)	Groundwater not encountered.
					GP	Medium dense, tan to light brown, dry to damp, silty gravelly SAND with large cobbles and mottling (Arlington Gravel) -Large cobbles observed at 2.1' BGS -Pockets of course grained gray sand at 2.3' BGS -#4 rebar penatrated sidewall with some difficutly using a 5lb hammer at 2.8' BGS -Tree roots observed down to 3.5' BGS -Grades to tan and gray blue at 3.5' BGS -Slight imbrication of gravel observed at 5.2' BGS	
2	2	d					
4							
6	3	d	W = 3 GS		ML	Hard, tan to gray blue, damp, gravelly sandy SILT heavy oxidation (Glacial Till)	
	4	d					
8						Test Pit Completed 10/27/22 Total Depth of Test Pit = 6.7 ft.	

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

GEOTEST

Proposed Townhome Development
416/422 E. Gilman Avenue
Arlington, WA 98223

Log of Test Pits

Figure 4

TP-2

SAMPLE DATA			SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Tracked Excavator Ground Elevation (ft): 132 Excavated By: PacNW Excavation/G.Sterlington	
0					SM/ OL	Loose, dark brown, damp, slightly gravelly silty SAND abundant organics (Topsoil)	Groundwater not encountered.
	5	d			GP	Medium dense, tan to gray, dry, sandy GRAVEL, trace organics, slightly imbricated (Arlington Gravel) -Tree roots observed down to 2.8' BGS -#4 rebar penatrated sidewall with some difficutly using a 5lb hammer at 3.0' BGS -Color grades to gray at 4.1' BGS -Large cobbles 1-2.5' in diameter observed at 5.1' BGS	
2							
4	6	d					
	7	d					
6	8	d				Test Pit Terminated Due to Obstruction	
8							

Test Pit Completed 10/27/22
Total Depth of Test Pit = 6.8 ft.

TP-3

SAMPLE DATA			SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Tracked Excavator Ground Elevation (ft): 136 Excavated By: PacNW Excavation/G.Sterlington	
0					SM/ OL	Loose, dark brown, damp, silty SAND abundant organics, trace gravel (Topsoil)	Groundwater not encountered.
	9	d			SM	Medium dense, tan to light brown, damp, gravelly, silty SAND, trace gravel (Arlington Gravel)	
2							
4	10	d	W = 10 GS			-#4 rebar penatrated sidewall with some difficutly using a 5lb hammer at 3.6' BGS -Pockets of course grained sand observed at 3.7' BGS -Increase in course grained sand at 5.1' BGS -Color grades to brown to tan at 5.5' BGS	
	11	d					
6	12	d					
	13	d	W = 13 GS		SM	Hard, tan to gray, damp, gravelly sandy SILT (Glacial Till)	
8							

Test Pit Completed 10/27/22
Total Depth of Test Pit = 7.4 ft.

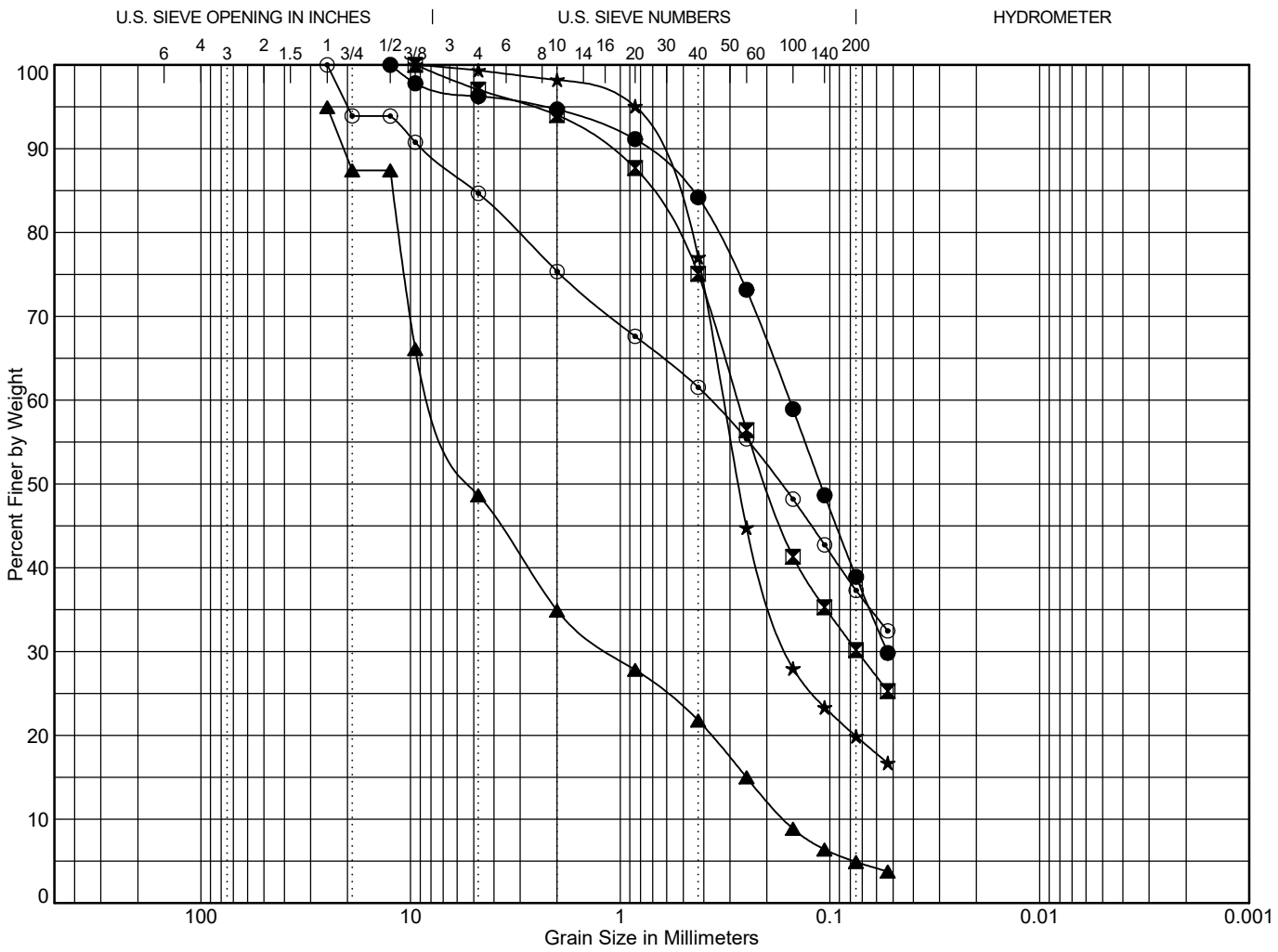
Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

GEOTEST

Proposed Townhome Development
416/422 E. Gilman Avenue
Arlington, WA 98223

Log of Test Pits

Figure 5



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Point		Depth	Classification	LL	PL	PI	C_c	C_u
●	PIT	2.5	Very silty SAND, trace gravel (SM)					
⊠	PIT	4.4	Very silty SAND, trace gravel (SM)					
▲	TP-1	5.8	Very sandy, poorly graded GRAVEL, trace silt (GP)				0.99	45.20
★	TP-3	3.3	Silty SAND, trace gravel (SM)					
⊙	TP-3	7.4	Very silty, gravelly, SAND (SM)					

Point		Depth	D_{90}	D_{60}	D_{50}	D_{30}	D_{10}	%Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines
●	PIT	2.5	0.758	0.156	0.111	0.053	0.025*	0.0	3.7	1.6	10.5	45.3	38.9
⊠	PIT	4.4	1.163	0.277	0.201	0.074	0.018*	0.0	3.0	3.0	18.9	44.9	30.2
▲	TP-1	5.8	20.876	7.456	5.011	1.106	0.165	7.5	38.8	13.8	13.1	16.9	4.9
★	TP-3	3.3	0.699	0.321	0.272	0.159	0.026*	0.0	0.7	1.1	21.2	57.1	19.9
⊙	TP-3	7.4	8.705	0.372	0.171	0.044*	0.011*	6.1	9.2	9.3	13.8	24.2	37.3

*Extrapolated from data

$C_c = D_{30}^2/(D_{60} * D_{10})$

$C_u = D_{60}/D_{10}$

To be well graded: $1 < C_c < 3$ and $C_u > 4$ for GW or $C_u > 6$ for SW

GEOTEST

Proposed Townhome Development
416/422 E. Gilman Avenue
Arlington, WA 98223

Grain Size Test Data

Figure 6

Northwest Agricultural Consultants

2545 W Falls Avenue
Kennewick, WA 99336
509.783.7450
www.nwag.com
lab@nwag.com

PAP-Accredited
NAPT

GeoTest Services Inc.
741 Marine Drive
Bellingham, WA 98225

Report: 61784-1-1
Date: November 2, 2022
Project No: 22-0872
Project Name: Proposed Townhomes

Sample ID	pH	Organic Matter	Cation Exchange Capacity
TP-2 @ 0.6’	6.0	5.07%	12.2 meq/100g
TP-2 @ 3.5’	6.1	1.51%	2.6 meq/100g
TP-3 @ 0.9’	5.9	8.69%	17.0 meq/100g
Method	**SM 4500-H^+ B**	**ASTM D2974**	**EPA 9081**

REPORT LIMITATIONS AND GUIDELINES FOR ITS USE[1]

Subsurface issues may cause construction delays, cost overruns, claims, and disputes. While you cannot eliminate all such risks, you can manage them. The following information is provided to help:

Geotechnical Services are Performed for Specific Purposes, Persons, and Projects

At GeoTest our geotechnical engineers and geologists structure their services to meet specific needs of our clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of an owner, a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared solely for the client. No one except you should rely on your geotechnical engineer who prepared it. And no one – not even you – should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report is Based on a Unique Set of Project-Specific Factors

GeoTest's geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the clients goals, objectives, and risk management preferences; the general nature of the structure involved its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless GeoTest, who conducted the study specifically states otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

1Information in this document is based upon material developed by ASFE, Professional Firms Practicing in the Geosciences(asfe.org)

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed, for example, from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed construction,
- alterations in drainage designs; or
- composition of the design team; the passage of time; man-made alterations and construction whether on or adjacent to the site; or by natural alterations and events, such as floods, earthquakes or groundwater fluctuations; or project ownership.

Always inform GeoTest's geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. Do not rely on the findings and conclusions of this report, whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. Always contact GeoTest before applying the report to determine if it is still relevant. A minor amount of additional testing or analysis will help determine if the report remains applicable.

Most Geotechnical and Geologic Findings are Professional Opinions

Our site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoTest's engineers and geologists review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ – sometimes significantly – from those indicated in your report. Retaining GeoTest who developed this report to provide construction observation is the most effective method of managing the risks associated with anticipated or unanticipated conditions.

1Information in this document is based upon material developed by ASFE, Professional Firms Practicing in the Geosciences(asfe.org)

A Report's Recommendations are Not Final

Do not over-rely on the construction recommendations included in this report. Those recommendations are not final, because geotechnical engineers or geologists develop them principally from judgment and opinion. GeoTest's geotechnical engineers or geologists can finalize their recommendations only by observing actual subsurface conditions revealed during construction. GeoTest cannot assume responsibility or liability for the report's recommendations if our firm does not perform the construction observation.

A Geotechnical Engineering or Geologic Report may be Subject to Misinterpretation

Misinterpretation of this report by other design team members can result in costly problems. Lower that risk by having GeoTest confer with appropriate members of the design team after submitting the report. Also, we suggest retaining GeoTest to review pertinent elements of the design teams plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having GeoTest participate in pre-bid and preconstruction conferences, and by providing construction observation.

Do not Redraw the Exploration Logs

Our geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors of omissions, the logs included in this report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable; but recognizes that separating logs from the report can elevate risk.

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, but preface it with a clearly written letter of transmittal. In that letter, consider advising the contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with GeoTest and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might you be in a position to give contractors the best information available, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

1Information in this document is based upon material developed by ASFE, Professional Firms Practicing in the Geosciences(asfe.org)

In addition, it is recommended that a contingency for unanticipated conditions be included in your project budget and schedule.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering or geology is far less exact than other engineering disciplines. This lack of understanding can create unrealistic expectations that can lead to disappointments, claims, and disputes. To help reduce risk, GeoTest includes an explanatory limitations section in our reports. Read these provisions closely. Ask questions and we encourage our clients or their representative to contact our office if you are unclear as to how these provisions apply to your project.

Environmental Concerns Are Not Covered in this Geotechnical or Geologic Report

The equipment, techniques, and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated containments, etc. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk management guidance. Do not rely on environmental report prepared for some one else.

Obtain Professional Assistance to Deal with Biological Pollutants

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts biological pollutants from growing on indoor surfaces. Biological pollutants includes but is not limited to molds, fungi, spores, bacteria and viruses. To be effective, all such strategies should be devised for the express purpose of prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional biological pollutant prevention consultant. Because just a small amount of water or moisture can lead to the development of severe biological infestations, a number of prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of this study, the geotechnical engineer or geologist in charge of this project is not a biological pollutant prevention consultant; none of the services preformed in connection with this geotechnical engineering or geological study were designed or conducted for the purpose of preventing biological infestations.

1Information in this document is based upon material developed by ASFE, Professional Firms Practicing in the Geosciences(asfe.org)