



August 26<sup>th</sup>, 2022

G-5422

Cascade Apartments, LLC  
c/o Mr. Simon Simon  
2812 Architecture  
Phone: (425) 252-2153  
Email: Simon@2812Architecture.com

**Subject: Revision to Geotechnical Engineering Investigation**  
Cascade Mixed-Use Building  
Parcel #: 31052100307300  
Arlington, Washington 98223

**Reference: "Piezometer Well Installation, Cascade Mixed-Use Building, Parcel #:  
31052100307300, Arlington, Washington," GEO Group Northwest, Inc.,  
G-5422-1, February 14<sup>th</sup>, 2022.**

Dear Cascade Apartments, LLC:

At your request, GEO Group Northwest, Inc., conducted a geotechnical engineering investigation for the proposed four-story mixed-use building at the above-subject location in the Smokey Point community of Arlington, Washington. The scope of our services included review of the area geologic map; assessment of subsurface soil and groundwater conditions; and preparation of this report of our findings, conclusions, and recommendations.

## **SITE CONDITIONS**

### **Site Description**

The project site is located in the Smokey Point community of Arlington, Washington, as illustrated in *Plate 1 – Site Location Map*. The parcel is approximately rectangular-shaped and is 80,399 square feet (1.84 acres) in size. The site is bounded by commercial developed property to the east and south, and by residential developed property to the west and north. The parcel

topography is generally level and averages approximately 125 feet of elevation above sea level. Currently, the site appears to be used as a trucking and construction staging area and the ground surface is surfaced with crushed rock. The central area of the parcel is not vegetated though the site perimeter has a variety of shrubs, blackberry bramble, and some trees.

## **SITE INVESTIGATION**

### **Geologic Overview**

According to published geologic mapping of the area, the underlying soils of the project site are identified as Marysville Sand Member (Qvrm) deposits consisting of loose to medium dense, clean sand with trace amounts of gravel and silt.

### **Subsurface Investigation**

On May 24<sup>th</sup>, 2021, Garrett Dean, Staff Engineering Geologist from our firm, visited the site to perform a visual reconnaissance of the site and investigate the subsurface soil conditions. In addition to our reconnaissance, we oversaw the drilling of two exploratory soil borings, B1 and B2. The boring locations are illustrated on *Plate 2 – Site Plan*.

The soils encountered in B-1 consisted of a surface layer of crushed rock base course, underlain with medium dense sand with some subrounded gravel to a depth of approximately 27.5 feet. Dense sand was encountered between approximately 27.5 and 32.5 feet of depth. Soils below the dense sand in B-1 consisted of medium stiff to stiff silt with trace sand to the bottom of the boring at a depth of 56.5 feet. Groundwater was encountered at a depth of approximately 7.5 feet below the ground surface in boring B-1.

The soil profile encountered in B-2 was comparable to what was observed in B-1. Soils encountered in B-2 consisted of a surface layer of crushed rock base course, underlain with medium dense sand with some subrounded gravel to a depth of approximately 47.5 feet. Dense sand of the same composition was encountered between approximately 47.5 and 52 feet below surface. The bottom sample of the boring, collected between approximately 55 and 56.5 feet below the surface, consisted of loose sand. Groundwater was encountered at a depth of approximately 7.5 feet below the ground surface in boring B-2. For information about the soils encountered, please refer to the boring log in *Appendix A*.

## SITE SEISMICITY AND SOIL LIQUEFACTION EVALUATION

In accordance with the 2018 International Building Code, the site classification is Site Class D (stiff soil). In our opinion, historic seismic activity of the area has caused prior settlement of the deposit, mitigating the potential for liquefaction and/or lateral spreading during a strong motion earthquake. Soils that typically are susceptible to liquefaction consist of saturated, fine to medium grained sandy soils with little or no fines which have standard penetration test (SPT) N values of 15 or less. Based on our site investigation borings B-1 and B-2, the corrected standard penetration blow counts are over 15, and not likely to liquefy under the design earthquake for the region. No seismic mitigation measures are recommended, with the exception of the addition of design criteria for seismically induced soil loads on permanent below-grade basement and retaining walls.

The seismic design parameters applicable for the site (per designation as Site Class D), per the 2015 IBC, are as follows:

$$\begin{array}{lll} S_s = 1.067g & S_{ms} = 1.145g & S_{ds} = 0.764g \\ S_1 = 0.381g & S_{m1} = \text{null} & S_{d1} = \text{null} \end{array}$$

The peak ground acceleration for the site, adjusted for site class effects, is 0.519g.

## CONCLUSIONS AND RECOMMENDATIONS

The following sections of this report present our recommendations regarding building support and soil bearing capacity, earthwork and excavation slopes, temporary excavation support, slab-on-grade floors, conventional concrete basement and retaining walls, and subsurface drainage. Specific recommendations regarding these subjects are presented in the following sections of this report.

### Shallow Groundwater Considerations

Groundwater was encountered at approximately 7.5 feet below the ground surface in the soil borings completed during our investigation. Groundwater has later been recorded in an installed piezometer well at depths as shallow as approximately 5.42 feet below the surface. Construction below the water table is possible, but very expensive. In our opinion, water stops and

waterproofing must be utilized for all wall to footing joints. Full waterproofing needs to be employed on all subsurface elements of the project (e.g., basement walls) that are to host living or storage space. We recommend excavations and construction for the proposed basement be completed when the water table is at its lowest during the summer months.

A piezometer well was installed at the site on January 31<sup>st</sup>, 2022 and has been measured monthly. The shallowest groundwater measurement was recorded at a depth of approximately 5.42 feet below surface grade at the site on February 2<sup>nd</sup>, 2022. The consecutive monthly well measurements can be observed in the table below.

Month	February	March	April	May	June	July	August
<b>Depth below approximate surface grade to groundwater (feet)</b>	5.42	5.72	5.80	5.92	5.79	6.26	6.99

## Foundations

Soils that are anticipated to be acceptable for building support were encountered at the surface near borings B-1 and B-2 of our investigation. Based on our findings, it is our opinion that the proposed building be supported on a rebar-reinforced structural slab founded on conventional concrete strip and column footings that bear directly on a 1-foot-thick crushed rock structural fill pad underlain with a layer of filter fabric over a subgrade of medium dense native soils. Our recommended design criteria for conventional footing foundations supported on a structural fill pad are provided below.

- Allowable bearing pressure, including all dead and live loads:
  - Undisturbed, medium dense or dense soil = 2,000 psf
  - Clean, crushed rock placed on medium dense or dense soil = 2,000 psf
- Minimum depth to base of perimeter footing below adjacent exterior grade = 18 inches
- Minimum depth to bottom of interior footings below top of floor slab = 12 inches
- Minimum width of wall footings = 16 inches
- Minimum lateral dimension of column footings = 24 inches
- Estimated post-construction settlement = ½ inch

- Estimated post-construction differential settlement across building width = ½ inch

A one-third increase in the above allowable bearing pressures can be used when considering short-term transitory wind or seismic loads.

Lateral loads against the building foundations can be resisted by friction between the foundation and the supporting subgrade or by passive earth pressure acting on the buried portions of the foundations. For the latter case, the foundations must be poured "neat" against the existing undisturbed soil or be backfilled with compacted structural fill. Our recommended parameters are as follows:

- Passive Pressure (Lateral Resistance)  
350 pcf, equivalent fluid weight, for structural fill or competent undisturbed native soil
- Coefficient of Friction (Friction Factor)  
0.35 for structural fill or competent undisturbed native soil

### **Conventional Retaining and Basement Walls**

Conventional concrete retaining or basement walls may be supported on spread footing foundations which are supported per the recommendations provided above in this report. Walls that are restrained horizontally are considered unyielding and should be designed for lateral soil pressure under the at-rest condition. Walls that are free to rotate should be designed for an active lateral soil pressure.

Groundwater was measured at a high of approximately 5.42 feet below the ground surface in February, 2022. Without a sump pump allowing for fully drained conditions, below grade walls must be designed with hydrostatic pressure from the assumed worst possible high-water condition in mind. The assumed worst-case high-water condition should be considered as a groundwater table elevation of 2.5 feet below the existing grade with fully saturated soil conditions below 2.5 feet below the existing grade.

- At-Rest Soil Pressure

Walls supported horizontally (i.e., floor framing) are considered unyielding and should be designed under the at-rest condition. We recommend using a design lateral soil pressure with an equivalent fluid density of 110 pcf for level, saturated soil conditions above the wall. Level, unsaturated soil conditions above the assumed worst-case high-water mark (2.5 feet below the existing grade) can be designed using a 45 pcf lateral soil pressure with an equivalent fluid density.

- Active Soil Pressure

Cantilever walls designed to yield an amount equal to 0.002 times the wall height should be designed under an active soil pressure condition. We recommend using a design lateral soil pressure with an equivalent fluid density of 100 pcf for level, saturated soil conditions above the wall. Level, unsaturated soil conditions above the assumed worst-case high-water mark (2.5 feet below the existing grade) can be designed using a 35 pcf lateral soil pressure with an equivalent fluid density.

- Seismic Earth Pressure

In addition to the above triangular lateral soil pressures, a rectangular pressure of  $8H$  should be added for permanent below grade walls to account for seismically induced dynamic soil loads. Where  $H$  is the overall height of the wall in feet.

- Passive Earth Pressure and Base Friction

The available passive earth pressure that can be mobilized to resist lateral forces may be assumed to be equal to 350 pcf equivalent fluid weight for both undisturbed soils and engineered structural fill. The base friction that can be generated between concrete and undisturbed bearing soils or engineered structural fill may be based on an assumed 0.35. The soil design parameters are allowable values and include a safety factor of 2.

The active and at-rest design pressures are based on hydrostatic wall conditions and do not include the effects of surcharges. For sloped ground above walls, a surcharge equivalent to 50 percent of the soil height above the wall (soil unit weight 125 pcf) should be used in addition to the above soil pressures. Traffic and construction equipment surcharge may be considered as a uniform surcharge equivalent to two (2) feet of soil acting over the full depth of the active

pressure. Restrained walls designed should be backfilled after completing their lateral restraint is in place or per the approval of the structural design engineer.

### **Concrete Slabs-on-Grade**

Slab-on-grade floors should be constructed on a firm, unyielding subgrade. During preparation of the slab subgrade, any areas of the subgrade that have been disturbed by construction activity should be either re-compacted or excavated and replaced with compacted structural fill.

Basement slabs must be watertight, structurally supported, and have a minimum thickness of 3 feet (36 inches) to resist uplift for the assumed worst-case high-water condition (water table at 2.5 feet below the existing grade with saturated soil conditions below the high-water mark).

Jointing between the basement slab-on-grade and the basement walls must have water stops capable of resisting the worst-case high-water conditions. We recommend that structural fill placement below slab-on-grade floors conform to the earthwork and grading recommendations provided in this report.

To avoid moisture build-up on the subgrade, the floor slab should be placed on a capillary break, which is in turn placed on the prepared subgrade. The capillary break should consist of a 6"-minimum thickness layer of crushed rock or gravel that contains no more than five percent material finer than a No. 4 sieve. A vapor barrier, such as a 10-mil plastic membrane, should be placed over the capillary break and taped or sealed to minimize water vapor transmission upward through the slab, if post-construction vapor transmission is undesirable. The basement floor slab capillary break should consist of a 12-inch-thick layer of clean, crushed rock underlain by a filter fabric such as Mirafi 180 N or equivalent, in addition to the above vapor barrier membrane.

### **Drainage**

Water should not be allowed to stand in areas where footings, slabs, or pavements are to be constructed. Final site grades should provide drainage away from the building structure.

Drainage should be installed against below-grade walls to reduce moisture intrusion and a buildup of hydrostatic pressure. To facilitate drainage behind below grade walls, we recommend installing a vertical drain mat (sheet drain) such as Miradrain 6000, or equivalent. Basement and retaining wall backfill should consist of 12 inches minimum of clean, crushed rock (1- to 2-inch size) separated from the native sands with filter fabric equivalent to Mirafi 180 N. The reason for the crushed rock and filter fabric is to allow the water to drain through without pulling any sand into the pump (described below) or the free-draining crushed rock. Footing drains are not required at the base of the walls since the crushed rock backfill and native sand soils are free-

draining. Soils at footing grades should be presumed saturated year-round. An illustration of the basement wall drainage is provided in *Plate 3 – Recommended Basement Wall Drainage*

### Emergency Sump Pump

We understand that an emergency sump pump will be installed in the basement to remove any water that may have infiltrated into the building interior. The sump pump is proposed to pipe through an oil-water separator before discharging to the street. The proposed emergency basement sump pump is recommended in our opinion. We also recommend that clean outs be installed to allow periodic maintenance of the pump system.

## **Grading and Earthwork**

### Erosion Control

Temporary erosion and sedimentation controls (TESCs), such as silt fences, should be installed down-gradient of the areas to be disturbed to prevent sediment-laden runoff from being discharged off site. Surface runoff should not be allowed to flow over the top of slopes into excavations. During wet weather, exposed soils should be covered with plastic sheeting or straw mulch. Stockpiled soils should be covered with plastic tarps. For permanent erosion control disturbed soils should be landscaped and mulched upon completion of the site work.

A construction entrance consisting of 2- to 4-inch size crushed rock should be installed to prevent tracking onto the street. The construction entrance area should be cleared and grubbed prior to rock placement and we recommend underlaying the rock with a woven geotextile such as Mirafi 500X, or equivalent, to provide separation between the rock and subgrade soil.

### Excavations and Slopes

Temporary excavation slopes should not be greater than the limits specified in local, state and federal government safety regulations. We recommend that temporary cuts greater than 4 feet in height be sloped at inclinations up to 1H:1V (Horizontal: Vertical) in loose to medium dense soils. Temporary excavations into very dense soils can be sloped near vertical under the observation of the geotechnical engineer. Permanent cut and fill slopes should be inclined no steeper than 2.5H:1V. Steeper permanent fill slopes can be achieved with the use of geogrid for lateral reinforcement. Slopes that are to be maintained or mowed should be sloped at 3H:1V, or less.

Fill slopes should consist of granular material compacted to a minimum of 90 percent of the material's maximum dry density. If supporting structural elements, the fill should be compacted to the structural fill specification of 92 percent.

Based on the subsurface findings, groundwater is anticipated during construction at depths as shallow as approximately 5.42 feet below the surface grade. If significant water seepage or other adverse conditions are encountered during excavation, placement of a fill pad should be placed as directed in the *Foundations* section of this report, and a sump pump installed to dewater the excavation. The crushed rock fill pad will mitigate drawing of the native sand soils into the pump system. The geotechnical engineer should be contacted to review the site conditions in the event that groundwater is encountered.

### Structural Fill

Structural fill is defined as fill soil supporting building foundations, floor slabs, pavements, sidewalks or other structures. Structural fill should be free of organic and other deleterious substances and have a maximum fragment size of 3 inches. For structural fill underlying footings and the basement slab, 1- to 2-inch crushed rock with no minus fraction should be used. The surficial sandy site soils were observed to contain trace proportions of fines and in our opinion may be used as structural fill for other elements of the project. In lieu of the sandy site soils, other materials such as recycled crushed concrete may be used.

Structural fill should be placed and compacted at or near the material's optimum moisture content and in lifts that are 10 inches thick or less. Below slab-on-grade floors, foundations, and other structural elements, structural fill should be compacted to a minimum of 92 percent of the material's maximum dry density, as determined by ASTM Test Designation D-1557 (Modified Proctor). For driveways, structural fill should be compacted to 90 percent, with the exception of the top 12 inches which should be compacted to 95 percent. Fill behind retaining walls and next to building foundation walls should consist of 1- to 2-inch clean, crushed rock.

Utility trench backfill within the City right-of-way should be compacted to the specifications required by the City, sewer or water district. Observation and compaction testing may be required at the time of fill placement to document and verify that the compaction specifications are achieved.

## **Pavements**

Provided the soil subgrade is dense and unyielding, we recommend an asphalt pavement section for light traffic loads consisting of 2 inches Class B asphalt concrete (1/2-inch HMA) over 4 inches of 5/8-minus crushed rock base. The pavement section for heavier traffic loads, such as for garbage trucks, should consist of 3 inches Class B asphalt concrete over 6 inches of 5/8-inch minus crushed rock base. The pavement section design should be provided by the project civil engineer.

Pavement performance is strictly related to the condition of the underlying subgrade. If the subgrade is inadequate, settlement and movement of the subgrade, such as alligating, can be reflected up through to the pavement surface no matter what pavement section is constructed. If loose subgrade soils are present, we recommend improving the subgrade by placing the pavement section on a minimum of 2 feet of granular structural fill or crushed rock. The subgrade below the structural fill should be compacted prior to placement of the structural fill and be evaluated by the geotechnical engineer. An unstable condition may require the use of a woven geotextile to separate the underlying soil from the granular overlying structural fill. For on-site pavement, structural fill should be compacted to a minimum of 90 percent, except for the top 12 inches which should be compacted to 95 percent of the materials maximum dry density based on ASTM D-1557 (Modified Proctor).

Prior to paving, the subgrade should be proof-rolled with a heavy piece of equipment, such as a loaded dump truck, under the observation of the geotechnical engineer, to verify that the subgrade is dense, unyielding, and suitable to support the pavement section. Soft or unstable subgrade identified during the proof-roll should be evaluated by the geotechnical engineer and stabilized prior to paving.

## **LIMITATIONS**

The findings and recommendations stated herein are based on field observations, our experience on similar projects and our professional judgment. The recommendations presented herein are our professional opinions derived in a manner consistent with the level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area and within the project schedule and budget constraints. No warranty is expressed or implied. In the event that site conditions are found to differ from those described in

this report, we should be notified so that the relevant recommendations in this report can be reevaluated and modified if appropriate.

## CLOSING

We appreciate the opportunity to provide you with geotechnical engineering services for this project. Please do not hesitate to contact us if you have any questions regarding this report.

Sincerely,

GEO GROUP NORTHWEST, INC.

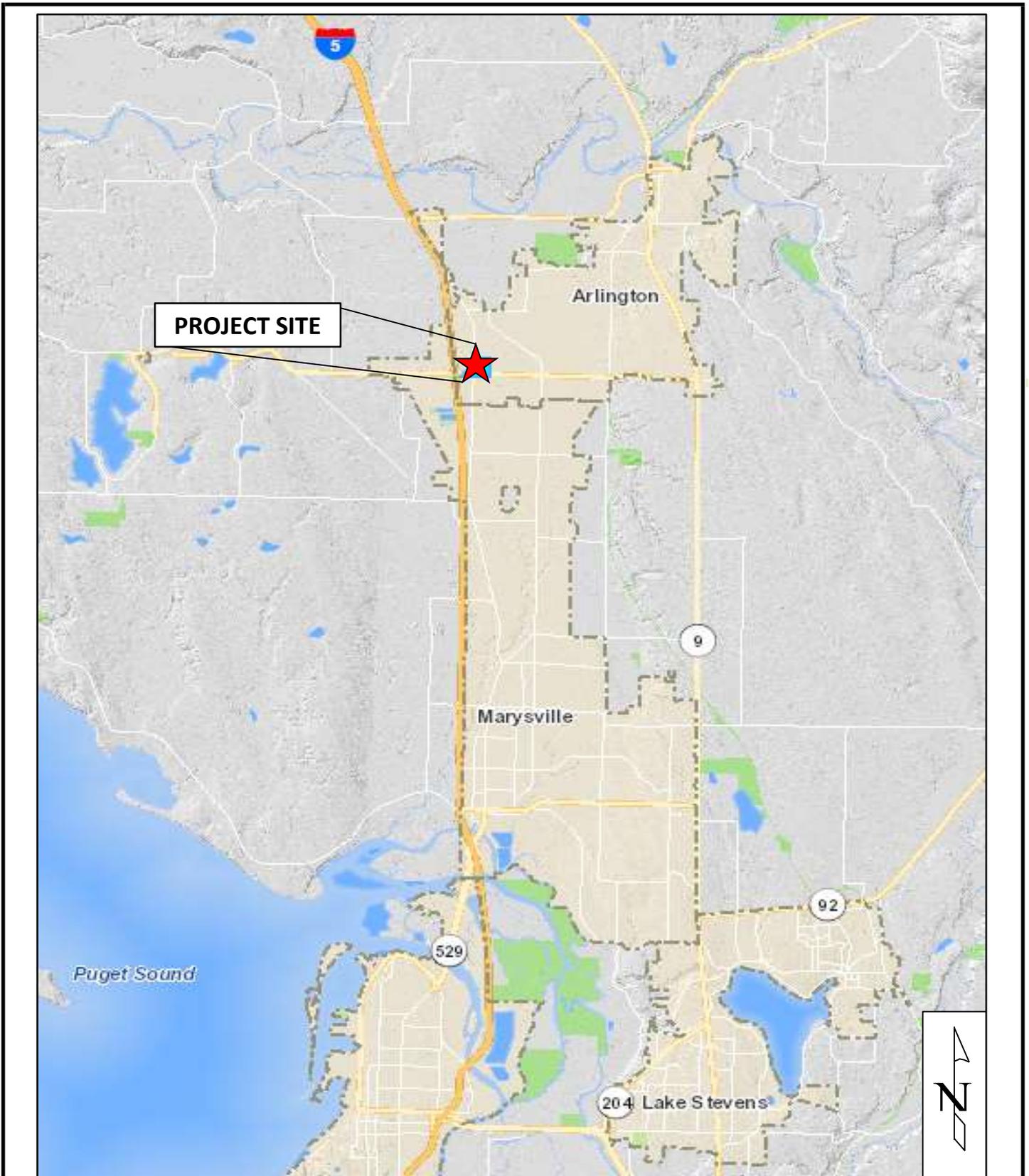


Garrett Dean, G.I.T.  
Staff Engineering Geologist

William Chang, P.E.  
Principal Engineer

### Attachments:

- Plate 1 – Site Location Map
- Plate 2 – Site Plan
- Plate 3 – Recommended Basement Wall Drain
- Appendix A – USCS Soil Classification & Soil Boring Logs



Source: Snohomish County Assessor | SCOPI, 2021



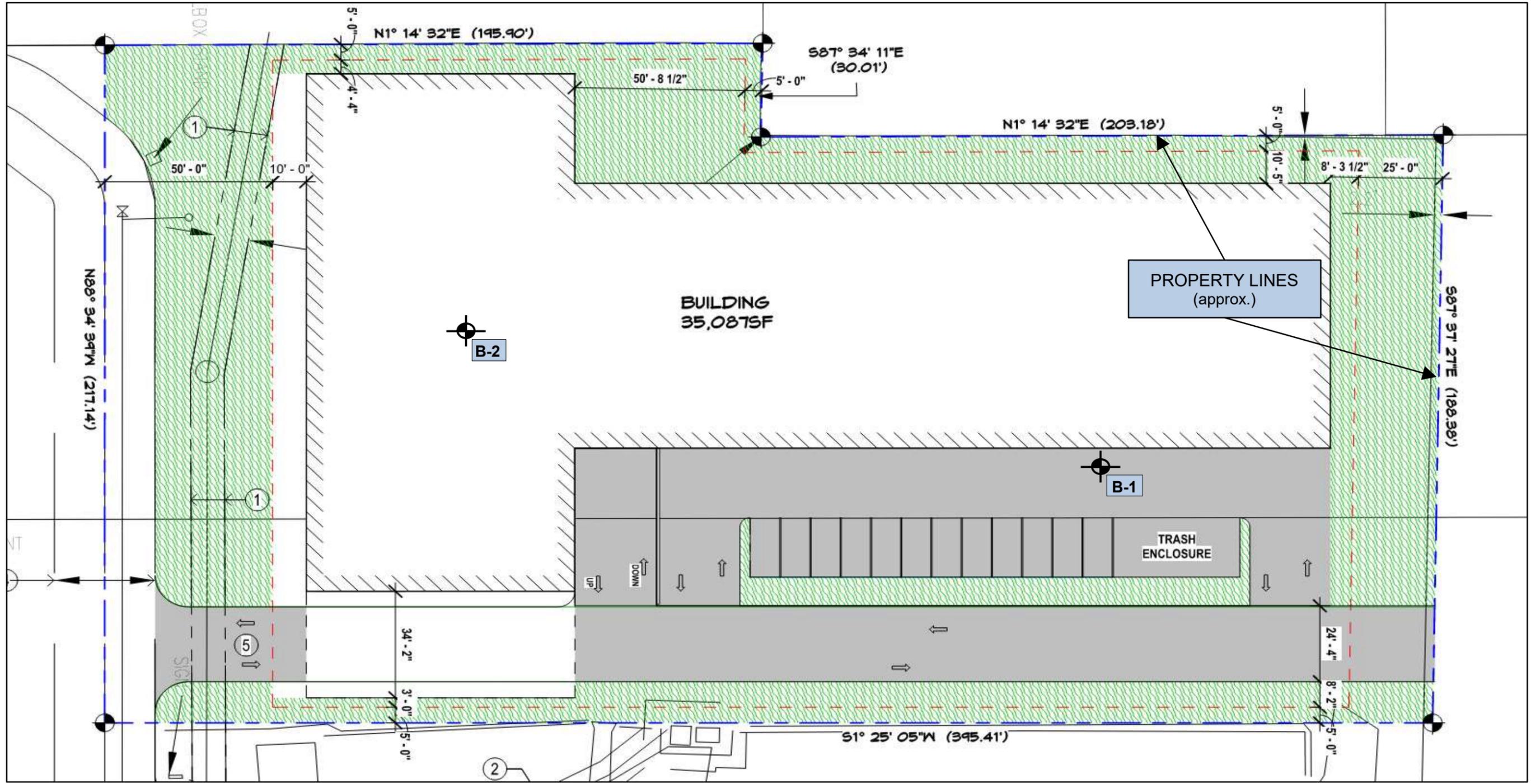
**Group Northwest, Inc.**

Geotechnical Engineers, Geologists, &  
Environmental Scientists

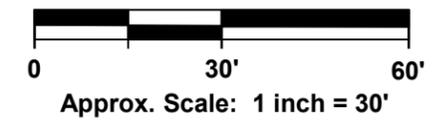
**SITE LOCATION MAP**

**CASCADE MIXED-USE BUILDING  
PARCEL #: 31052100307300  
ARLINGTON, WASHINGTON**

SCALE	NONE	DATE	8/26/2022	MADE	GD	CHKD	WC	JOB NO.	G-5422	PLATE	1
-------	------	------	-----------	------	----	------	----	---------	--------	-------	---




**Boring Number & Approximate Location**  
**B-#**



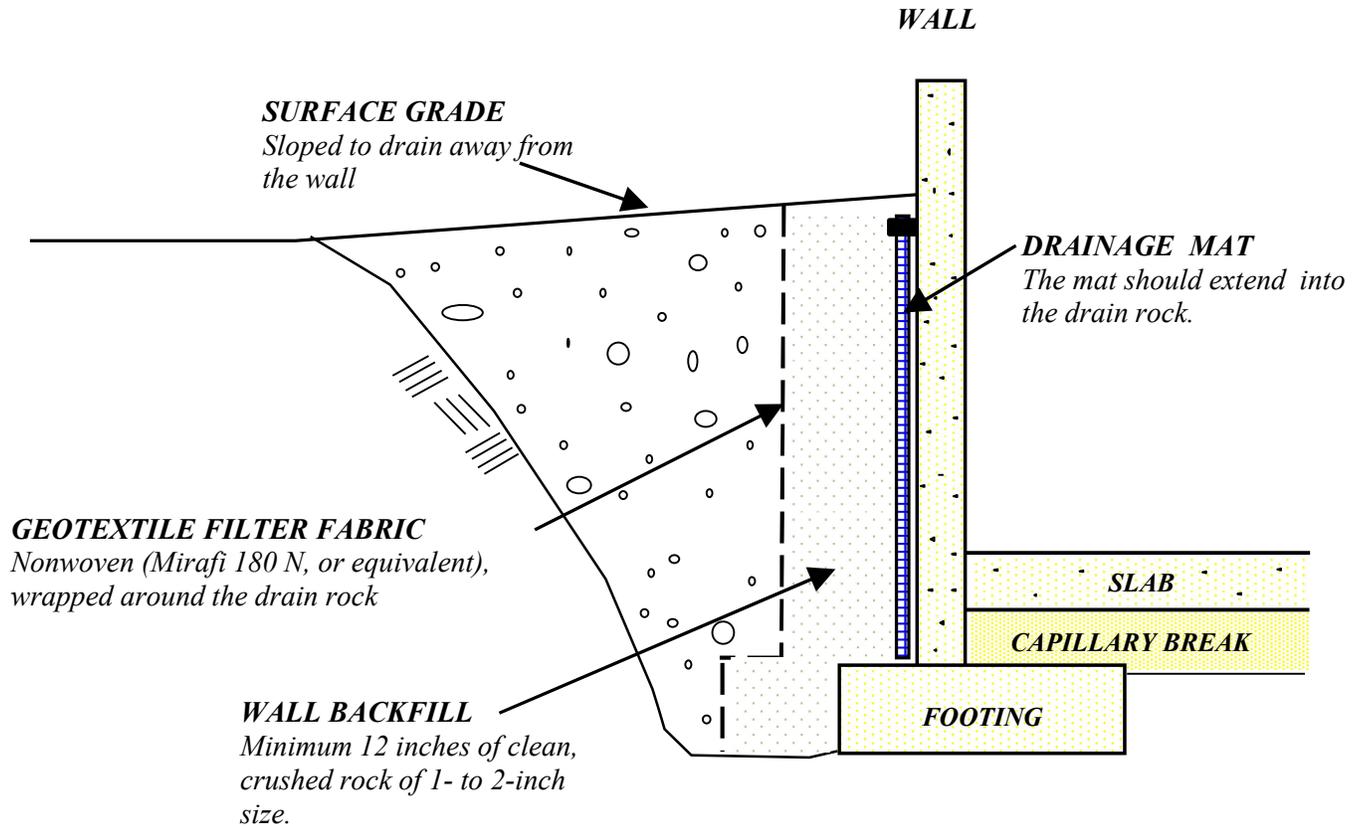

**Group Northwest, Inc.**  
 Geotechnical Engineers, Geologists, & Environmental Scientists

**SITE PLAN**  
 CASCADE MIXED-USE BUILDING  
 PARCEL #: 31052100307300  
 ARLINGTON, WASHINGTON

This Site Plan Adapted From Site Plan & Cover Sheet, Apartment Building for: ANPPR CORPORATION, Prepared 2812 Architecture, Dated March 9th, 2021

SCALE As Shown	DATE 8/26/22	MADE GD	CHKD WC	JOB NO. G-5422	PLATE 2
----------------	--------------	---------	---------	----------------	---------

# RECOMMENDED BASEMENT WALL DRAINAGE



**NOT TO SCALE**

Notes:

1. Basement slab-on-grade capillary break should consist of 12 inch thick layer of 1- to 2-inch clean, crushed rock underlain with filter fabric equivalent to Mirafi 180N.



**GEO Group Northwest, Inc.**

Geotechnical Engineers, Geologists, &  
Environmental Scientists

## RECOMMENDED BASEMENT WALL DRAINAGE

CASCADE MIXED-USE BUILDING  
PARCEL #: 32052100307300  
ARLINGTON, WASHINGTON

SCALE	NONE	DATE	8/26/2022	MADE	GD	CHKD	WC	JOB NO.	G-5422	PLATE	3
-------	------	------	-----------	------	----	------	----	---------	--------	-------	---

**APPENDIX A**

**G-5422**

**USCS SOIL CLASSIFICATION & SOIL BORING LOGS**

# LEGEND OF SOIL CLASSIFICATION AND PENETRATION TEST

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)							
MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA		
COARSE GRAINED SOILS  More Than Half by Weight Larger Than No. 200 Sieve	GRAVELS  (More Than Half Coarse Grains Larger Than No. 4 Sieve)	CLEAN GRAVELS	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURE, LITTLE OR NO FINES	DETERMINE PERCENTAGES OF GRAVEL AND SAND FROM GRAIN SIZE DISTRIBUTION CURVE.  COARSE GRAINED SOILS ARE CLASSIFIED AS FOLLOWS:  < 5% Fine Grained: GW, GP, SW, SP  > 12% Fine Grained: GM, GC, SM, SC;  5 to 12% Fine Grained: use dual symbols.	$C_u = (D_{60} / D_{10})$ greater than 4 $C_c = (D_{30} * D_{30} / D_{10} / D_{60})$ between 1 and 3	
		(little or no fines)	GP	POORLY GRADED GRAVELS, AND GRAVEL-SAND MIXTURES LITTLE OR NO FINES		NOT MEETING ABOVE REQUIREMENTS	
		DIRTY GRAVELS	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES		ATTERBERG LIMITS BELOW "A" LINE. or P.I. LESS THAN 4	
		(with some fines)	GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE. or P.I. MORE THAN 7	
	SANDS  (More Than Half Coarse Grains Smaller Than No. 4 Sieve)	CLEAN SANDS	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES		$C_u = (D_{60} / D_{10})$ greater than 6 $C_c = (D_{30} * D_{30} / D_{10} / D_{60})$ between 1 and 3	
		(little or no fines)	SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES		NOT MEETING ABOVE REQUIREMENTS	
		DIRTY SANDS	SM	SILTY SANDS, SAND-SILT MIXTURES		ATTERBERG LIMITS BELOW "A" LINE with P.I. LESS THAN 4	
		(with some fines)	SC	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE with P.I. MORE THAN 7	
	FINE-GRAINED SOILS  More Than Half by Weight Smaller Than No. 200 Sieve	SILTS  (Below A-Line on Plasticity Chart, Negligible Organic)	Liquid Limit < 50%	ML		INORGANIC SILTS, ROCK FLOUR, SANDY SILTS OF SLIGHT PLASTICITY	
			Liquid Limit > 50%	MH		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOIL	
CLAYS  (Above A-Line on Plasticity Chart, Negligible Organic)		Liquid Limit < 30%	CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, CLEAN CLAYS			
		Liquid Limit > 50%	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS			
ORGANIC SILTS & CLAYS  (Below A-Line on Plasticity Chart)		Liquid Limit < 50%	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY			
		Liquid Limit > 50%	OH	ORGANIC CLAYS OF HIGH PLASTICITY			
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS			

SOIL PARTICLE SIZE				
FRACTION	U.S. STANDARD SIEVE			
	Passing		Retained	
	Sieve	Size (mm)	Sieve	Size (mm)
SILT / CLAY	#200	0.075		
<b>SAND</b>				
FINE	#40	0.425	#200	0.075
MEDIUM	#10	0	#40	0.425
COURSE	#4	4.75	#10	2
<b>GRAVEL</b>				
FINE		19	#4	4.75
COURSE		76		19
<b>COBBLES</b>	76 mm to 203 mm			
<b>BOULDERS</b>	> 203 mm			
<b>ROCK FRAGMENTS</b>	> 76 mm			
<b>ROCK</b>	>0.76 cubic meter in volume			

GENERAL GUIDANCE OF SOIL ENGINEERING PROPERTIES FROM STANDARD PENETRATION TEST (SPT)								
SANDY SOILS				SILTY & CLAYEY SOILS				
Blow Counts N	Relative Density %	Friction Angle $\phi$ , degree	Description	Blow Counts N	Unconfined Strength $Q_u$ , tsf	Description		
0 - 4	0 - 15		Very Loose	< 2	< 0.25	Very soft		
4 - 10	15 - 35	26 - 30	Loose	2 - 4	0.25 - 0.50	Soft		
10 - 30	35 - 65	28 - 35	Medium Dense	4 - 8	0.50 - 1.00	Medium Stiff		
30 - 50	65 - 85	35 - 42	Dense	8 - 15	1.00 - 2.00	Stiff		
> 50	85 - 100	38 - 46	Very Dense	15 - 30	2.00 - 4.00	Very Stiff		
				> 30	> 4.00	Hard		

**Group Northwest, Inc.**  
 Geotechnical Engineers, Geologists,  
 & Environmental Scientists

13240 NE 20th Street, Suite 12  
 Phone (425) 649-8757

Bellvue, WA 98005  
 Fax (425) 649-8758

APPEND.   A1

# BORING NO. B - 1

Logged By: GD  
 Drilled By: GDP, Inc.

Date Drilled: 5/24/2021

Surface Elev. Approx. 125' ±

Depth ft.	Elevation	USCS Code	Description	Sample		SPT Blow Counts + Corrected N	Water Content %	Other Tests/ Comments
				Loc.	No.			
		<b>GW</b>	GRAVEL, crushed-rock base coarse on surface, then:					
5		<b>SW</b>	SAND, brown, dry, medium dense; fine to medium grained, some subrounded gravel, some oxidation staining	   		12,6,8 (N=14) (N'=25)	4.4	
		<b>SW</b>	SAND, brown/gray, dry, medium dense; fine to coarse grained, trace subrounded gravel, some oxidation staining	   		4,6,8 (N=14) (N'=22)	6.0	
	▽	<b>SW</b>	SAND, gray, wet, medium dense; fine to coarse grained, some subrounded gravel	   		8,8,9 (N=17) (N'=23)	11.8	Water in drill hole measured at 7.5' below the ground surface. Interpreted as height of groundwater table.
10		<b>SW</b>	SAND, as above	   		15,11,8 (N=19) (N'=23)	13.1	
		<b>SW</b>	SAND, as above	   		12,6,7 (N=13) (N'= 16)	15.3	
15		<b>SW</b>	SAND, gray, wet, medium dense; fine to coarse grained, trace subrounded gravel	   		2,5,7 (N=12) (N'=15)	22.4	
		<b>SW</b>	SAND, gray, wet, medium dense; fine to coarse grained, some subrounded gravel	   		10,9,8 (N=17) (N'=16)	16.1	
20								
25								

**LEGEND:** 2" O.D. SPT Sampler  
 3" O.D. California Sampler

▽ Water Level noted during drilling  
 ▼ Water Level measured at later time, as noted



**Group Northwest, Inc.**  
 Geotechnical Engineers, Geologists, &  
 Environmental Scientists

**BORING LOG**  
 CASCADE MIXED-USE BUILDING  
 PARCEL #: 31052100307300  
 ARLINGTON, WASHINGTON

**JOB NO.** G-5422      **DATE** 8/26/2022      **APPEND** A2

# BORING NO. B - 1

Logged By: GD  
 Drilled By: GDP, Inc.

Date Drilled: 5/24/2021

Surface Elev. Approx. 125' ±

Depth ft.	Elevation	USCS Code	Description	Sample		SPT Blow Counts + Corrected N	Water Content %	Other Tests/ Comments
				Loc.	No.			
30		SW	SAND, gray, wet, medium dense; fine to coarse grained, trace subrounded gravel			9,11,16 (N=27) (N'=22)	17.4	
		SW	SAND, gray, wet, dense; fine to medium grained, trace silt			16,18,15 (N=33) (N'=24)	25.5	
35		ML	SILT, gray, moist to wet, stiff			4,6,5 (N=11)	30.8	
40		ML	SILT, gray, moist to wet, medium stiff;			2,2,3 (N=5)	26.3	
45		ML	SILT, gray, moist to wet, medium stiff; trace fine to medium grained sand			3,3,3 (N=6)	37.9	
50								

**LEGEND:**  2" O.D. SPT Sampler  
 3" O.D. California Sampler

 Water Level noted during drilling  
 Water Level measured at later time, as noted



**Group Northwest, Inc.**  
 Geotechnical Engineers, Geologists, &  
 Environmental Scientists

## BORING LOG

**CASCADE MIXED-USE BUILDING  
 PARCEL #: 31052100307300  
 ARLINGTON, WASHINGTON**

**JOB NO.** G-5422      **DATE** 8/26/2022      **APPEND** A3

# BORING NO. B - 1

Logged By: GD  
 Drilled By: GDP, Inc.

Date Drilled: 5/24/2021

Surface Elev. Approx. 125' ±

Depth ft.	Elevation	USCS Code	Description	Sample		SPT Blow Counts + Corrected N	Water Content %	Other Tests/ Comments
				Loc.	No.			
55		ML	SILT, gray, moist to wet, stiff;	I		0,4,5 (N=9)	37.7	
		ML	SILT, gray, damp, stiff;	II		6,7,7 (N=14)	13.3	
60			Depth of boring: 56.5 feet. Drilling Method: Hollow-stem auger. Sampling Method: 2"-O.D. standard penetration test sampler driven with 140 lb. hammer and cathead. Groundwater encountered between approximately 7' and 7.5' during drilling.					
65								
70								
75								

**LEGEND:** 2" O.D. SPT Sampler  
 3" O.D. California Sampler

Water Level noted during drilling  
 Water Level measured at later time, as noted



**Group Northwest, Inc.**  
 Geotechnical Engineers, Geologists, &  
 Environmental Scientists

## BORING LOG

CASCADE MIXED-USE BUILDING  
 PARCEL #: 31052100307300  
 ARLINGTON, WASHINGTON

**JOB NO.** G-5422      **DATE** 8/26/2022      **APPEND** A4

# BORING NO. B - 2

Logged By: GD  
 Drilled By: GDP, Inc.

Date Drilled: 5/24/2021

Surface Elev. Approx. 125' ±

Depth ft.	Elevation	USCS Code	Description	Sample		SPT Blow Counts + Corrected N	Water Content %	Other Tests/ Comments
				Loc.	No.			
		<b>GW</b>	GRAVEL, crushed-rock base coarse on surface, then:					
5		<b>SW</b>	SAND, brown, damp, medium dense; fine to medium grained, some oxidation staining	   		4,9,8 (N=17) (N'=30)	6.4	
		<b>SW</b>	SAND, brown, damp to moist, medium dense; fine to coarse grained, some subrounded gravel, some oxidation staining	   		5,7,7 (N=14) (N'=22)	9.7	
	▽	<b>SW</b>	SAND, gray, wet, medium dense; fine to coarse grained, some subrounded gravel	   		6,9,10 (N=19) (N'=28)	12.3	Water in drill hole measured at 7.5' below the ground surface. Interpreted as height of groundwater table.
10		<b>SW</b>	SAND, as above	   		4,7,8 (N=15) (N'=19)	18.1	
		<b>SW</b>	SAND, gray, wet, medium dense; fine to coarse grained, trace subrounded gravel	   		2,5,6 (N=11) (N'=12)	20.6	
20		<b>SW</b>	SAND, gray, wet, medium dense; fine to medium grained, trace subrounded gravel	   		3,6,9 (N=15) (N'=14)	22.7	
25								

**LEGEND:** 2" O.D. SPT Sampler  
 3" O.D. California Sampler

Water Level noted during drilling  
 Water Level measured at later time, as noted



Group Northwest, Inc.

Geotechnical Engineers, Geologists, &  
Environmental Scientists

BORING LOG

CASCADE MIXED-USE BUILDING  
 PARCEL #: 31052100307300  
 ARLINGTON, WASHINGTON

JOB NO. G-5422      DATE 8/26/2022      APPEND A5

# BORING NO. B - 2

Logged By: GD  
 Drilled By: GDP, Inc.

Date Drilled: 5/24/2021

Surface Elev. Approx. 125' ±

Depth ft.	Elevation	USCS Code	Description	Sample		SPT Blow Counts + Corrected N	Water Content %	Other Tests/ Comments
				Loc.	No.			
30		SW	SAND, gray, wet, medium dense; fine to medium grained	I		5,5,6 (N=11) (N'=9)	21.0	
		SW	SAND, as above	II		6,9,13 (N=22) (N'=16)	24.9	
35		SW	SAND, as above	I		4,8,9 (N=17) (N'=11)	27.3	
40		SW	SAND, as above	I		5,11,11 (N=22) (N'=14)	23.5	
45		SW	SAND, as above	I		6,10,16 (N=26) (N'=15)	20.8	
50								

**LEGEND:**  2" O.D. SPT Sampler  
 3" O.D. California Sampler

 Water Level noted during drilling  
 Water Level measured at later time, as noted



**Group Northwest, Inc.**  
 Geotechnical Engineers, Geologists, &  
 Environmental Scientists

## BORING LOG

**CASCADE MIXED-USE BUILDING  
 PARCEL #: 31052100307300  
 ARLINGTON, WASHINGTON**

**JOB NO.** G-5422      **DATE** 8/26/2022      **APPEND** A6

# BORING NO. B - 2

Logged By: GD  
 Drilled By: GDP, Inc.

Date Drilled: 5/24/2021

Surface Elev. Approx. 125' ±

Depth ft.	Elevation	USCS Code	Description	Sample		SPT Blow Counts + Corrected N	Water Content %	Other Tests/ Comments
				Loc.	No.			
55		SW	SAND, gray, wet, dense; fine to coarse grained	I		17,18,23 (N=41) (N'=23)	17.3	
		SW	SAND, as above	I		5,2,2 (N=4) (N'=2)	19.9	Low blow counts suspected due to sand heave.
60			Depth of boring: 56.5 feet. Drilling Method: Hollow-stem auger. Sampling Method: 2"-O.D. standard penetration test sampler driven with 140 lb. hammer and cathead. Groundwater encountered between approximately 7' and 7.5' during drilling.					
65								
70								
75								

**LEGEND:** 2" O.D. SPT Sampler  
 3" O.D. California Sampler

Water Level noted during drilling  
 Water Level measured at later time, as noted



**Group Northwest, Inc.**  
 Geotechnical Engineers, Geologists, &  
 Environmental Scientists

## BORING LOG

CASCADE MIXED-USE BUILDING  
 PARCEL #: 31052100307300  
 ARLINGTON, WASHINGTON

**JOB NO.** G-5422      **DATE** 8/26/2022      **APPEND** A7