NELSON GEOTECHNICAL
ASSOCIATES, INC.

17311-135th Ave. N.E. Suite A-500
Woodinville, WA 98072
(425) 486-1669
www.nelsongeotech.com

March 10, 2020

RECEIVED
JUL 13 2020
PLANNING

Mr. Dylan Muzzy
Muzzy Building Company
6065 – 126th Avenue NE
Kirkland, WA 98034
VIA Email: dylanmuzzy0@gmail.com

Stormwater Infiltration Evaluation - UPDATED
Muzzy Building Company Cedar Avenue Residence Development Infiltration
225 Cedar Avenue
Snohomish, Washington
NGA Project No. 1161020

Dear Mr. Muzzy:

This letter documents our explorations and provides our opinions and recommendations for the feasibility of stormwater infiltration at the property located at 225 Cedar Avenue in Snohomish, Washington, as shown on the Vicinity Map in Figure 1.

INTRODUCTION

The subject site is currently vacent and the ground surface within the site is relatively level. The property is covered in grass with a patch of blackberries occupiying the eastern section of the lot. We understand that the proposed development will consist of developing a new multi-family residence within the central portion of the property.

We understand that stormwater from the proposed residence will likely be directed into an on-site infiltration system, if feasible. The City of Snohomish uses the 2019 Department of Ecology (DOE) Stormwater Management in Western Washington to determine the design infiltration rate and overall system sizing. According to this manual, we understand that long-term design infiltration rates for this site are to be determined by performing on-site infiltration testing consisting of the Small Pilot Infiltration Test (PIT). In accordance with this manual, the soil explorations need to extend to a minimum of one foot below the base of the proposed infiltration system.

SCOPE

The purpose of this study is to explore and characterize the subsurface conditions within the site and to provide opinions and recommendations for stormwater infiltration. Specifically, our scope of services included the following:

1. Review available soil and geologic maps of the area.
2. Explored the subsurface soil and groundwater conditions within the site with trackhoe-excavated test pits. Trackhoe was provided by the client. Water for testing was arranged by the client.
3. Perform grain-size sieve analysis on soil samples, as necessary.
4. Provide long-term design infiltration rates based on on-site Small Pilot Infiltration Testing (PIT) per the 2019 Department of Ecology (DOE) Stormwater Management in Western Washington Manual.
5. Provide recommendations for infiltration system installation.
6. Document the results of our findings, conclusions, and recommendations in a written geotechnical letter.

SITE CONDITIONS

Surface Conditions

The site consists of a rectangular shaped parcel covering approximately 0.18 acres. The site is currently vacent and is relatively level. Vegetation throughout the site consists of grass and blackberry bushes with sparse trees. The site is bounded to the north, south, and east by existing residencial properties, and to the west by Cedar Avenue. We did not observe surface water on the site during our visit on February 13, 2020.

Subsurface Conditions

Geology: The site is mapped on the Geologic map of the Snohomish quadrangle, Washington, by James P. Minard (USGS, 1985). The site is mapped as Older Alluvium (Qoal) with Recessional Outwash (Qvr) mapped directly to the north and west of the subject site. Older Alluvium is typically described as mostly clay, silt, and very fine-grained sand. Recessional outwash is described as well-drained stratified outwash sand and gravel. Our explorations encountered silty sand underlain by sandy gravel, consistent with the description of native older alluvium and recessional outwash deposits at depth, respectively.

Explorations: The subsurface conditions within the site were explored on February 13, 2020 by excavating two test pit explorations with a mini trackhoe excavator. The approximate location of our exlorations are shown on the Site Plan in Figure 2. A geologist from Nelson Geotechnical Associates, Inc. (NGA) was present during the explorations, collected samples of the soils encountered, and maintained a log of the explorations. The soils were visually classified in general accordance with the Unified Soil Classification System, presented as Figure 3. The logs of our explorations are presented as Figure 4. We present a brief summary of the subsurface conditions in the following paragraph. For a detailed description of the subsurface conditions, the exploration logs should be reviewed.

At the surface of Infiltration Pit 1, and Test Pit 1, we encountered approximately one foot of loose, dark brown to brown silty fine to medium grain sand with gravel, and roots, that we interpreted as surficial topsoil and/or undocumented fill soils. Underlying the upper surficial soils, we encountered 3.0 to 5.3 feet of very stiff, light brown to brown-gray silt with fine to medium grain sand and gravel that we interpreted as native alluvium deposits. Underlying the alluvium in each of our test pits, we encountered medium dense to dense, gray, fine to coarse sand and gravel which we interpreted as native recessional outwash. Infiltration Pit 1 and Test Pit 1 were terminated within the native glacial recessional outwash soils at respective depths of approximately 7.4 amd 5.0 feet below the existing ground surface.

Hydrogeologic Conditions

We did not encounter groundwater within our explorations. If groundwater is encountered during construction we would interpret this water as perched groundwater. Perched water occurs when surface water infiltrates through less dense, more permeable soils, such as topsoil and the weathered horizon, and accumulates on top of a less permeable soil. Perched water does not represent a regional groundwater "table" within the upper soil horizons. Perched water tends to vary spatially and is dependent upon the amount of rainfall. We would expect the amount of groundwater to decrease during drier times of the year and increase during wetter periods.

INFILTRATION TESTING

The subsurface soils at depth within our explorations generally consisted of fine to coarse grain sand and gravel that we interpreted as native glacial recessional outwash soils to the depths explored. In accordance with the 2019 Department of Ecology (DOE) Stormwater Management in Western Washington Manual, we conducted a Small PIT within Infiltration Pit 1, as shown on the attached Site Plan in Figure 2. Infiltration Pit 1 measured 4.0-feet long by 3.0-feet wide by 7.5-feet deep. Infiltration Pit 1 was filled with approximately four inches of water and this level was maintained for six hours for the pre-soak period. Due to the granular nature of the recessional outwash soils and the maximum

ouput of the on-site water source of 7.5 gallons per minute, we were only able to maintain a water level of four inches at the base of the pit. At the end of the pre-soak period, the water flow rate into the hole was monitored with a Great Plains Industries (GPI) TM 075 water flow meter for one hour.

After the 6-hour soaking period was completed, the water level was maintained at approximately four inches for one hour for the steady-state period of the test. The flow rate for Infiltration Pit 1 stabilized at 7.50 gallons per minute (450.00 gallons per hour), which equates to an approximate infiltration rate of 60.16 inches per hour. The water was shut off after the steady-state period and the water level within the pit was monitored. After 8.52 minutes, the water level within the pit had completely dissipated, resulting in an infiltration rate of 28.17 inches per hour.

CONCLUSIONS

It is our opinion that the granular recessional outwash soils soils encountered at depth within the site are suitable for traditional stormwater infiltration. The granular recessional outwash soils were generally encountered at depths in the range of 4.0 to 6.3 feet below the existing ground surface. We have selected an overall measured field rate of 28.17 inches per hour obtained from the falling head portion of the test within Infiltration Pit 1 be utilized in determining the long-term design infiltration rate for the infiltration systems within the site. We referenced the equation in Chapter 5 (Page 736) of the 2019 Department of Ecology (DOE) Stormwater Management in Western Washington Manual that applies correction factors to the field measured infiltration rate to generate a long-term design infiltration rate. Correction factors of 0.50, 0.90, and 0.90 were utilized in this equation for $F_{testing}$, $F_{geometry}$, $F_{plugging}$, respectively. Using these correction factors, we calculated a long-term design infiltration rate of 11.41 inches per hour to be utilized to design any on-site infiltration systems within the site, provided that the base of the system terminates within the native granular glacial outwash soils encountered at depth.

The storm water management systems should be designed and maintained in accordance with the 2019 Department of Ecology (DOE) Stormwater Management in Western Washington Manual and the City of Snohomish standards. We recommend that any proposed infiltration systems be placed as to not negatively impact any proposed or existing nearby structures and also meet all required setbacks from existing property lines, structures, and sensitive areas as discussed in the drainage manual. In general, infiltration systems should not be located within proposed fill areas within the site (associated with site grading or retaining wall backfill) as such condition could lead to failures of the placed fills and/or retaining structures. We should be retained to review infiltration design and oversee installation.

The stormwater manual recommends a five-foot separation between the base of an infiltration system and any underlying bedrock, impermeable horizon, or groundwater. We did not encounter any groundwater to the depths explored throughout the site, and granular soils appear to extend at depth below the silty shallow layer.

USE OF THIS LETTER

This letter was prepared for Mr. Muzzy and his agents, for use in planning and budgeting the above-referenced project only. Our services included an evaluation of the infiltration capability of the site soils at specific locations, and should not be considered as an in-depth geotechnical study of the site or an evaluation of the overall site stability. This letter may be used for bidding and estimating purposes, but our letter, conclusions, and interpretations should not be construed as a warranty of the subsurface conditions. The subsurface conditions between explorations may vary. A contingency for varying conditions should be incorporated into the project plans.

We recommend that NGA be retained to review the design plans and provide monitoring and consultation services during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed differ from those anticipated, and to evaluate whether or not earthwork activities comply with contract plans and specifications. We should be contacted a minimum of one week prior to construction activities and could attend pre-construction meetings if requested.

Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering practices in effect in this area at the time this letter was prepared. No other warranty, expressed or implied, is made. Our observations, findings, and opinions are a means to identify and reduce the inherent risks to the owner.

o-o-o

We appreciate the opportunity to provide service to you on this project. If you have any questions or require further information, please call.

Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.

Austin Slabaugh
Staff Geologist

State of Washington
2883
Licensed Geologist
LEE S. BELLAH

Lee S. Bellah, LG
Project Geologist

MAHER A SHEBL
STATE OF WASHINGTON
33246
REGISTERED
PROFESSIONAL ENGINEER

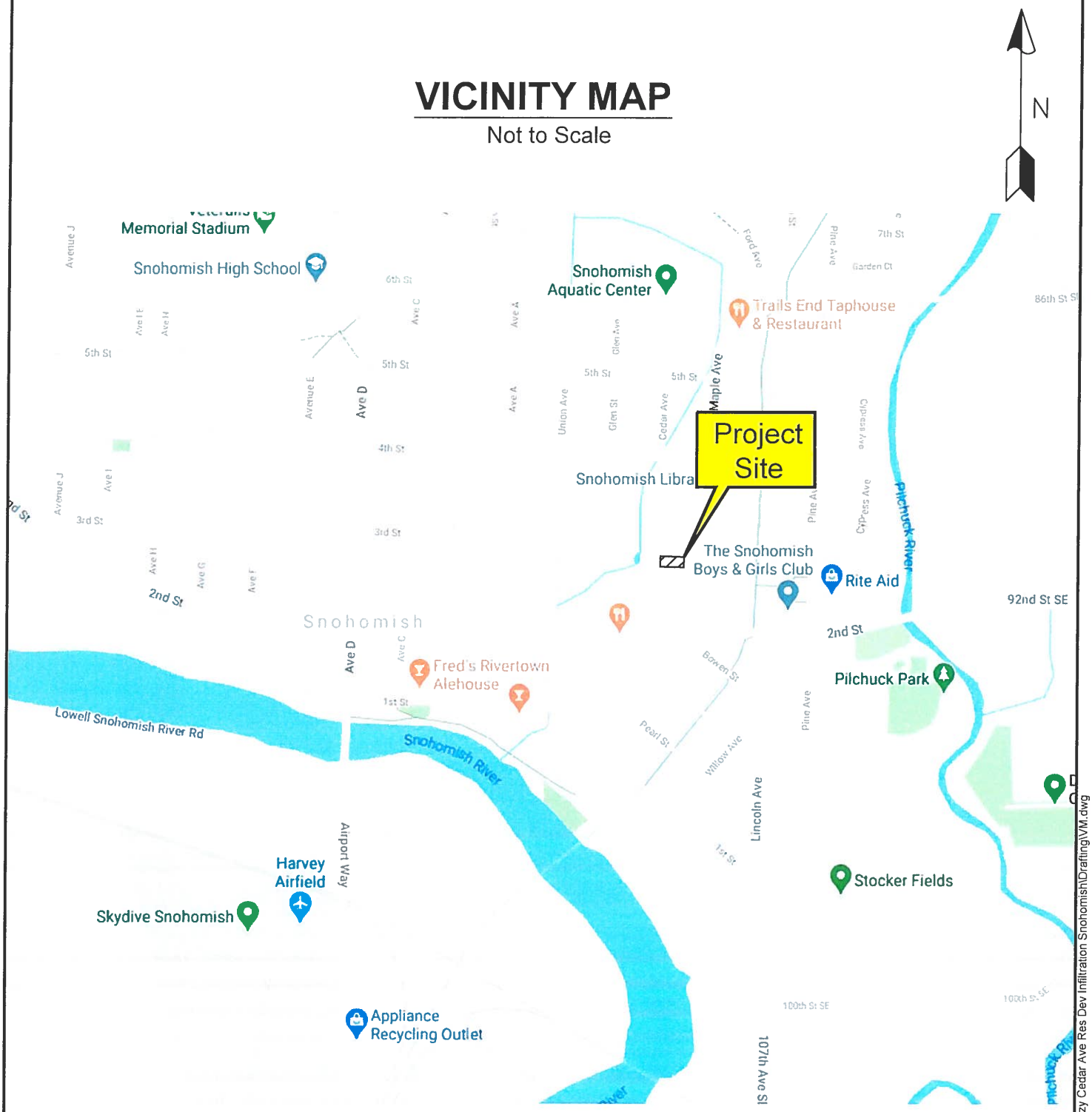
Maher A. Shebl, PhD, PE, M.ASCE
Senior Engineer

AJS:LSB:MAS:dy

Four Figures Attached

VICINITY MAP

Not to Scale



Snohomish, WA

Project Number 1161020	Muzzy Residence Development Infiltration Vicinity Map	NELSON GEOTECHNICAL ASSOCIATES, INC. NGA GEOTECHNICAL ENGINEERS & GEOLOGISTS Woodinville Office: 17311-135th Ave. NE. A-500, Woodinville, WA 98072, (425) 486-1669 / Fax 481-2510 East Wenatchee Office: 5526 Industry Lane, #2, East Wenatchee, WA 98802, (509) 665-7696 / Fax 665-7692 www.nelsongeotech.com	No.	Date	Revision	By	CK
Figure 1			1	2/19/20	Original	DPN	AJS

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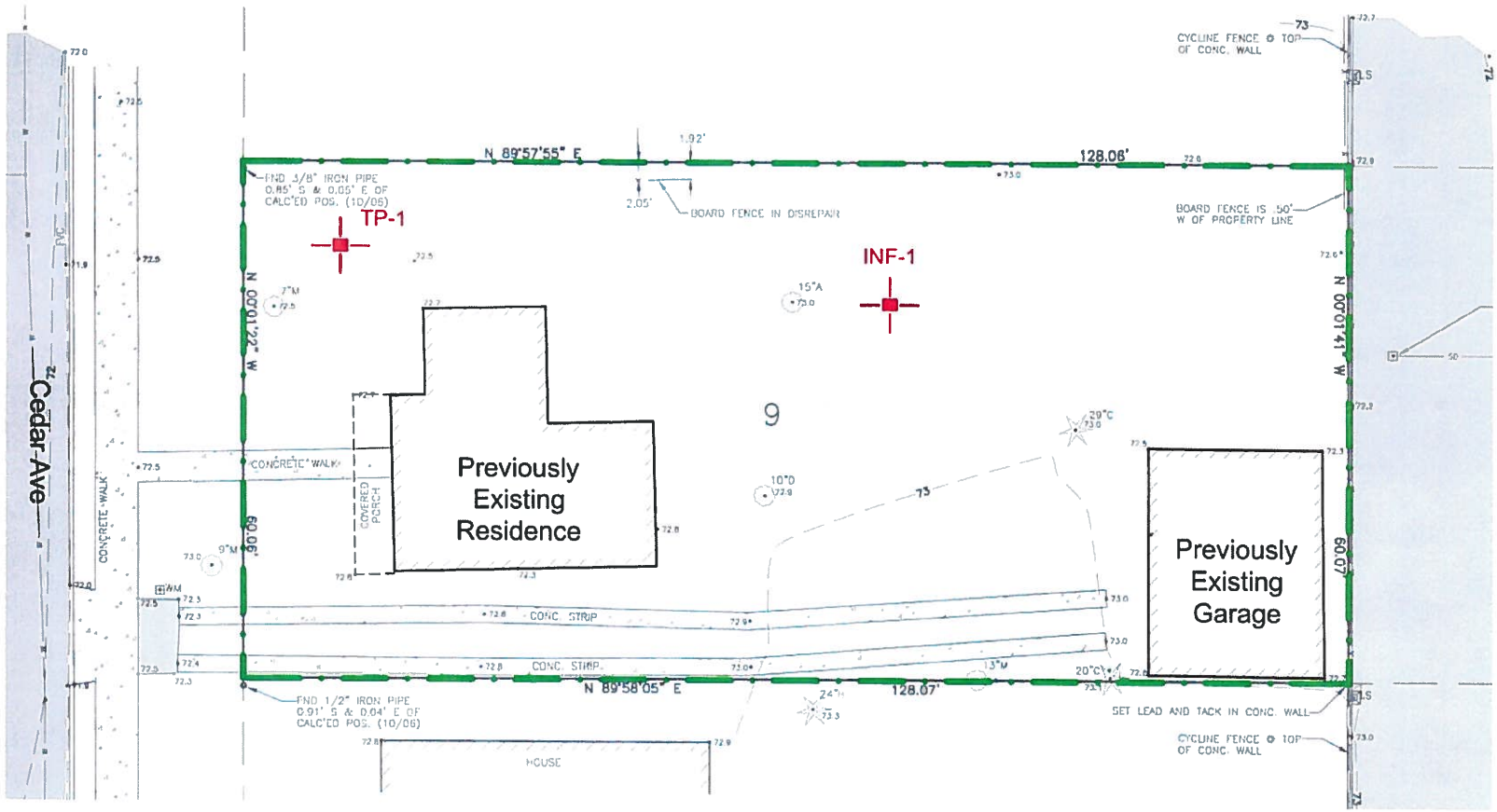
Site Plan



LEGEND

Property line

INF-1 — Number and approximate location of infiltration test pit

TP-1 — Number and approximate location of test pit

0 20 40

Scale: 1 inch = 20 feet

Reference: Site plan based on a plan dated November 1, 2006 titled "Cook," prepared by Mead Gilman & Assoc..

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Figure 2

Muzzy Residence
Development Infiltration
Site Plan

Nelson Geotechnical Associates, Inc.
Geotechnical Engineers & Geologists
Woodinville Office
17311-135th Ave NE, A-500
Woodinville, WA 98072
(425) 486-1669 / Fax: 481-2510
East Wenatchee Office
5326 Industry Lane, #2
East Wenatchee, WA 98802
(509) 665-7686 / Fax: 665-7692
www.nelsongeotech.com

No.	Date	Revision	By	CK
1	2/19/20	Original	DPN	AJS

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE - GRAINED SOILS MORE THAN 50 % RETAINED ON NO. 200 SIEVE	GRAVEL MORE THAN 50 % OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVEL	GW	WELL-GRADED, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND MORE THAN 50 % OF COARSE FRACTION PASSES NO. 4 SIEVE	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE - GRAINED SOILS MORE THAN 50 % PASSES NO. 200 SIEVE	SILT AND CLAY LIQUID LIMIT LESS THAN 50 %	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY LIQUID LIMIT 50 % OR MORE	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1) Field classification is based on visual examination of soil in general accordance with ASTM D 2488-93.

2) Soil classification using laboratory tests is based on ASTM D 2488-93.

3) Descriptions of soil density or consistency are based on interpretation of blowcount data, visual appearance of soils, and/or test data.

SOIL MOISTURE MODIFIERS:

Dry - Absence of moisture, dusty, dry to the touch

Moist - Damp, but no visible water.

Wet - Visible free water or saturated, usually soil is obtained from below water table

Project Number 1161020	Muzzy Residence Development Infiltration Soil Classification Chart	NELSON GEOTECHNICAL ASSOCIATES, INC. NGA GEOTECHNICAL ENGINEERS & GEOLOGISTS
Figure 3		Woodinville Office: 17311-135th Ave. NE, A-500, Woodinville, WA 98072, (425) 486-1669 / Fax: 481-2510 — East Wenatchee Office: 5526 Industry Lane, #2, East Wenatchee, WA 98802, (509) 665-7696 / Fax: 665-7692 — www.nelsongeotech.com

No.	Date	Revision	By	CK
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LOG OF EXPLORATION

DEPTH (FEET)	USC	SOIL DESCRIPTION
INFILTRATION PIT ONE		
0.0 – 1.0		GRASS UNDERLAIN BY DARK BROWN, SILTY FINE TO MEDIUM SAND WITH GRAVEL, ROOTS, AND ORGANICS, (LOOSE, MOIST) (**UNDOCUMENTED FILL**)
1.0 – 6.3	ML	TAN TO GRAY SILT WITH FINE TO MEDIUM SAND AND IRON OXIDE STAINING, GRAVEL, AND ROOTS (VERY STIFF, MOIST)
6.3 – 7.4	SP	GRAY, FINE TO COARSE SAND WITH GRAVEL, (MEDIUM DENSE TO DENSE, MOIST)
		SAMPLES WERE NOT COLLECTED GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED INFILTRATION PIT CAVING WAS NOT ENCOUNTERED INFILTRATION PIT WAS COMPLETED AT 7.4 FEET ON 2/13/2020
TEST PIT ONE		
0.0 – 1.0		GRASS UNDERLAIN BY DARK BROWN, SILTY FINE TO MEDIUM SAND WITH ROOTS, ORGANICS, AND GRAVEL (LOOSE, MOIST) (**UNDOCUMENTED FILL**)
1.0 – 4.0	ML	TAN TO GRAY, SILT WITH FINE TO MEDIUM SAND AND TRACE IRON OXIDE WEATHERING (MEDIUM DENSE TO DENSE, MOIST)
4.0 – 5.0	SP	GRAY, FINE TO COARSE SAND WITH GRAVEL, (MEDIUM DENSE TO DENSE, MOIST)
		SAMPLE WAS COLLECTED AT 5.0 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED TEST PIT CAVING WAS NOT ENCOUNTERED TEST PIT WAS COMPLETED AT 5.0 FEET ON 2/13/2020