NELSON GEOTECHNICAL ASSOCIATES. INC.

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September 6, 2023

Robert Linscott
9622 – 48th Drive NE
Marysville, WA 98270

c/o Land Resolutions, Inc.
ATTN: Jen Haugen
Via Email: jen@orcalsi.com

Geotechnical Engineering Evaluation
Linscott Residential and Duplex Development
9803– 48th Drive NE
Marysville, Washington
NGA File No. 1457123

Dear Robert:

We are pleased to submit the attached report titled ***"Geotechnical Engineering Evaluation – Linscott Residential and Duplex Development – 9803 - 48th Drive NE – Marysville, Washington."*** This report summarizes our observations of the existing surface and subsurface conditions within the site and provides general recommendations for the proposed site development. Our services were completed in general accordance with the proposal signed by you on June 28, 2023.

The property is currently occupied with a single-family residence within the western portion. The ground surface within the site is relatively level to gently sloping. We understand that the proposed development will include demolition of the existing home, division of the property into three lots, with construction of a combination of residences and duplexes within the site.

We explored the subsurface conditions within the site with three trackhoe excavated test pits. The explorations extended to depths in the range of 9.5 – 10.5 feet below the existing ground surface. Our explorations indicated that the site was underlain by surficial undocumented fill soils with competent recessional outwash soils at relatively shallow depths. We also installed two piezometers within our explorations in Test Pits One and Two to monitor ground water levels within the site.

It is our opinion that the proposed site development is feasible from a geotechnical engineering standpoint, provided that our recommendations for site development are incorporated into project plans. In general, the native glacial bearing soils underlying the site should adequately support the planned structures. Foundations should be advanced through any loose and/or undocumented fill soils down to the competent glacial bearing material interpreted to underlie the site, for bearing capacity and settlement considerations. These soils should generally be encountered approximately 1.0-foot below the existing ground surface, based on our explorations. If deeper areas of loose soils or undocumented fill are encountered in unexplored areas of the site, they should be removed and replaced with structural fill for foundation and pavement support.

Specific grading and stormwater plans had not been finalized at the time this report was prepared. However, we understand that stormwater from the proposed development may be directed into on-site infiltration systems, if feasible. The City of Marysville uses the Washington State Department of Ecology's 2019 Stormwater Management Manual for Western Washington. According to this manual, laboratory analysis of soil samples collected in the field can be used to determine the infiltration system design along with long-term design infiltration rates due to the site being located within recessional outwash soils. Based on the results of our sieve grain size analysis and soil explorations throughout the site, it is our opinion that stormwater infiltration is feasible within the onsite native soils. This is discussed in more detail in the attached report.

In the attached report, we have also provided general recommendations for site grading, slabs-on-grade, structural fill placement, erosion control, and drainage. We should be retained to review and comment on final development plans and observe the earthwork phase of construction. We also recommend that NGA be retained to 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 during construction differ from those anticipated, and to evaluate whether or not earthwork and foundation installation activities comply with contract plans and specifications.

It has been a pleasure to provide service to you on this project. Please contact us if you have any questions regarding this report or require further information.

Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.

Khaled M. Shawish, PE
Principal Engineer

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Linscott Residential and Duplex Development
9803– 48th Drive NE
Marysville, Washington

INTRODUCTION

This report presents the results of our geotechnical engineering investigation and evaluation of the planned residential developments. The project site is located at **9803 – 48th Drive NE in Marysville, Washington,** as shown on the Vicinity Map in Figure 1. The purpose of this study is to explore and characterize the site's surface and subsurface conditions and to provide geotechnical recommendations for the planned site development.

The property is currently occupied with a single-family residence within the western portion. The ground surface within the site is relatively level to gently sloping. We understand that the proposed development will include demolition of the existing home, division of the property into three lots, with construction of a combination of residences and duplexes within the site. Final stormwater plans have also not been developed; however, we understand that stormwater may be directed to on-site infiltration systems, if feasible. The existing site layout is shown on the Schematic Site Plan in Figure 2.

SCOPE

The purpose of this study is to explore and characterize the site surface and subsurface conditions and provide general recommendations for site development.

Specifically, our scope of services included the following:

1. Reviewing available soil and geologic maps of the area.
2. Exploring the subsurface soil and groundwater conditions within the site with trackhoe-excavated test pits. Trackhoe was subcontracted by NGA.
3. Determining feasibility of on-site stormwater infiltration.
4. Providing long-term design infiltration rates based on grain-size analysis per the 2019 Stormwater Management Manual for Western Washington (2019 SWMMWW).
5. Analyzing selected, representative soil samples obtained from our explorations for Cation Exchange Capacity (CEC) and organic content.
6. Installing piezometers within the test pit explorations throughout the site. Gravel backfill and well materials to be provided by NGA.
7. Providing recommendations for infiltration system installation.

8. Providing recommendations for site drainage and erosion control.
9. Providing recommendations for site preparation and earthwork.
10. Providing recommendations for foundation support.
11. Providing recommendations for temporary and permanent slopes.
12. Providing recommendations for slab and pavement subgrade preparation.
13. Documenting the results of our findings, conclusions, and recommendations in a written geotechnical report.
14. Providing monthly groundwater level monitoring during the rainy season months or longer as required by the City of Marysville.

SITE CONDITIONS

Surface Condition

The site consists of a roughly rectangular-shaped parcel covering approximately 0.77 acres in area. It is currently occupied by a single-family residence. The property is bordered by 48th Drive NE to the west, residential properties to the north, south, and east. Topographically, the site is relatively level to gently sloping. Vegetation within the site consists of grass yard areas, shrubs, brush, and young to mature trees. We did not observe surface water within the site during our site visit on July 25, 2023.

Subsurface Conditions

Geology: The site is mapped on the Geologic Map of the Marysville Quadrangle, Snohomish County, Washington, by James P. Minard (USGS, 1985). The site is mapped as the Marysville sand member of recessional outwash (Qvrm). Recessional outwash is generally described as a relatively clean mixture of sand, pebbles, and cobbles, all in variable amounts deposited by melt water from a receding glacier. The Marysville sand member is described as sand with fine gravel with occasional beds of silt and clay. Our explorations typically encountered undocumented fill underlain by fine to medium sand with varying amounts of gravel, and silt consistent with the description of native recessional outwash soils.

Explorations: The subsurface conditions within the site were explored on July 25, 2023 by excavating three test pits with a mini-trackhoe, two of which had piezometers installed, extending to depths in the range of 9.5 to 10.5 feet below the existing ground surface. The approximate locations of our explorations are shown on the Schematic Site Plan in Figure 2. A geologist from NGA was present during the explorations, examined the soils and geologic conditions encountered, obtained samples of the different soil types, and maintained logs of the test pits.

The soils were visually classified in general accordance with the Unified Soil Classification System, presented in Figure 3. The logs of our explorations are attached to this report and 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 logs of the explorations should be reviewed.

At the surface of all of the test pit explorations, we encountered approximately 1.0-foot of surficial topsoil. Below the surficial topsoil we encountered brown to gray-brown, fine to medium sand with varying amounts of gravel, silt, roots, and organics that we interpreted to be recessional outwash soils at depth. All of our explorations were terminated within the native recessional outwash soils at depths in the range of 9.5 to 10.5 feet below the existing ground surface.

Hydrogeologic Conditions

We did not encounter groundwater seepage within our explorations at the time of our initial site visit. If water is encountered within the site, we would interpret this to be associated with the regional groundwater within the site. We would expect the depth to groundwater to increase during drier times of the year and decrease during wetter periods.

We will revisit the site three times during the wet season to measure the groundwater levels within the piezometer installed within Test Pits One and Two, as necessary. The installed piezometers consisted of perforated 1.25” PVC pipe, and the void spaces in the boreholes were filled with pea gravel and capped with a surficial seal of topsoil. Water level readings were taken at the time of installation with a water level indicator however, there was no water present within the piezometers at this time.

SENSITIVE AREA EVALUATION

Seismic Hazard

We reviewed the 2018 International Building Code (IBC) for seismic site classification for this project. Since competent glacial soils are inferred to underlie the site at depth, the site conditions best fit the IBC description for Site Class D. **Table 1** below provides seismic design parameters for the site that are in conformance with the 2018 IBC, which specifies a design earthquake having a two percent probability of occurrence in 50 years (return interval of 2,475 years), and the 2008 USGS seismic hazard maps.

Table 1. 2018 IBC Seismic Design Parameters

Site Class	Spectral Acceleration at 0.2 sec. (g) S_s	Spectral Acceleration at 1.0 sec. (g) S_1	Site Coefficients		Design Spectral Response Parameters	
			F_a	F_v	S_{DS}	S_{D1}
D	1.095	0.390	1.062	Null	0.775	Null

The spectral response accelerations were obtained from the USGS Earthquake Hazards Program Interpolated Probabilistic Ground Motion website (2008 data) for the project latitude and longitude. Hazards associated with seismic activity include liquefaction potential and amplification of ground motion. Liquefaction is caused by a rise in pore pressures in a loose, fine sand deposit beneath the groundwater table. It is our opinion that the medium dense or better glacial deposits interpreted to underlie the site and nearby vicinity have a low potential for liquefaction or amplification of ground motion.

Erosion Hazard

The criteria used for determination of the erosion hazard for affected areas include soil type, slope gradient, vegetation cover, and groundwater conditions. The erosion sensitivity is related to vegetative cover and the specific surface soil types, which are related to the underlying geologic soil units. The Soil Survey of Snohomish County Area, Washington, by the Natural Resources Conservation Service (NRCS), was reviewed to determine the erosion hazard of the on-site soils. The surface soils for this site were mapped as Ragnar fine sandy loam, 0 to 8 percent slopes. The erosion hazard for this material is not listed; however, it is our opinion that the erosion hazard for site soils should be low in areas where the site is not disturbed and moderate where soils are exposed.

LABORATORY ANALYSES

We completed two grain-size analyses on materials sampled from our test pit explorations. Specifically, we completed grain-size analyses on selected samples from Test Pit One at a depth of 2.25 feet and Test Pit Two at a depth of 6.75 feet. Using the USDA textural triangle, both samples are classified as sand. The results of the gradation analysis are presented as Figures 5 and 6.

In accordance with the 2019 SWMMWW infiltration facilities that double as treatment facilities will need to be tested for Cation Exchange Capacity (USEPA method 9081) and Organic Content (ASTM D 2974) to determine if the soil is adequate for removing the target pollutants.

Cation Exchange Capacity (CEC) and Organic Content tests were conducted by AMTest Laboratories on soil samples obtained from the site as shown on **Tables 2 and 3** below, respectively. The 2019 SWMMWW requires soil to be used for treatment to have a CEC greater or equal to 5 milliequivalents (meq) CEC per 100 grams (CEC/100g). The manual also specifies that filtration soils must have a minimum of 1.0 percent organic content. Based on the test results, the native glacial site soils tested at a depth of 2.25 feet meet these requirements while the soil sample tested at 6.75 feet do not meet these requirements. The test results are attached to this report as **Appendix A.** The test results are also summarized in the following **Tables 2 and 3**.

Table 2. Cation Test Results

Test Pit Number	Depth (Feet)	Cation Test Results (CEC/100g)	Suitable for Filtration (Yes/No)
Test Pit 1	2.25	5.5	Yes
Test Pit 2	6.75	1.5	No

Table 3. Organic Content Results

Test Pit Number	Depth (Feet)	Organic Content Results (Percent)	Suitable for Filtration (Yes/No)
Test Pit 1	2.25	3.4	Yes
Test Pit 2	6.75	4.9	Yes

CONCLUSIONS AND RECOMMENDATIONS

General

It is our opinion that the planned development within the site is generally feasible from a geotechnical standpoint. Our explorations indicated that the site was generally underlain by competent native recessional outwash soils at shallow depths throughout the site. The native glacial bearing soils encountered at depth should provide adequate support for foundation, slab, and pavement loads. We recommend that the planned structure be designed utilizing conventional shallow foundations. Footings should extend through any loose soil or undocumented fill soils and be founded on the underlying medium dense or better native glacial soils, or structural fill extending to these soils.

The medium dense or better native glacial bearing soils should typically be encountered approximately 1.0-foot below the existing surface, based on our explorations. We should note that localized areas of deeper unsuitable soils and/or undocumented fill could be encountered at this site. This condition would require additional excavations in foundation, slab, and pavement areas to remove the unsuitable soils. Based on the results of our grain size sieve analyses and soil explorations throughout the site, it is our opinion that stormwater infiltration is feasible within the onsite native glacial soils. This is further discussed in the **Site Drainage** section of this report.

The surficial soils encountered on this site are considered moisture-sensitive and will disturb easily when wet. We recommend that construction take place during the drier summer months, if possible. If construction is to take place during wet weather, the soils may disturb, and additional expenses and delays may be expected due to the wet conditions. Additional expenses could include the need for placing a blanket of rock spalls to protect exposed subgrades and construction traffic areas. Some of the native on-site soils may be suitable for use as structural fill depending on the moisture content of the soil during construction. NGA should be retained to determine if the on-site soils can be used as structural fill material during construction.

Erosion Control

The erosion hazard for the on-site soils is interpreted to be slight to moderate for exposed soils, but actual erosion potential will be dependent on how the site is graded and how water is allowed to concentrate. Best Management Practices (BMPs) should be used to control erosion. Areas disturbed during construction should be protected from erosion. Erosion control measures may include diverting surface water away from the stripped or disturbed areas. Silt fences and/or straw bales should be erected to prevent muddy water from leaving the site. Disturbed areas should be planted as soon as practical, and the vegetation should be maintained until it is established. The erosion potential of areas not stripped of vegetation should be low.

Site Preparation and Grading

After erosion control measures are implemented, site preparation should consist of stripping the topsoil, undocumented fill and loose soils from foundation, slab, pavement areas, and other structural areas, to expose medium dense or better native bearing glacial soils. The stripped soil should be removed from the site or stockpiled for later use as a landscaping fill. Based on our observations, we anticipate stripping depths of 1.0-foot, depending on the specific locations. However, additional stripping may be required if areas of deeper undocumented fill and/or loose soil are encountered in unexplored areas of the site.

After site stripping, if the exposed subgrade is deemed loose, it should be compacted to a non-yielding condition and then proof-rolled with a heavy rubber-tired piece of equipment. Areas observed to pump or weave during the proof-roll test should be reworked to structural fill specifications or over-excavated and replaced with properly compacted structural fill or rock spalls. If loose soils are encountered in the pavement areas, the loose soils should be removed and replaced with rock spalls or granular structural fill. If significant surface water flow is encountered during construction, this flow should be diverted around areas to be developed, and the exposed subgrades should be maintained in a semi-dry condition.

If wet conditions are encountered, alternative site stripping and grading techniques might be necessary. These could include using large excavators equipped with wide tracks and a smooth bucket to complete site grading and covering exposed subgrade with a layer of crushed rock for protection. If wet conditions are encountered or construction is attempted in wet weather, the subgrade should not be compacted as this could cause further subgrade disturbance. In wet conditions, it may be necessary to cover the exposed subgrade with a layer of crushed rock as soon as it is exposed to protect the moisture sensitive soils from disturbance by machine or foot traffic during construction. The prepared subgrade should be protected from construction traffic and surface water should be diverted around areas of prepared subgrade.

The site soils are considered to be moisture-sensitive and will disturb easily when wet. We recommend that construction take place during the drier summer months if possible. However, if construction takes place during the wet season, additional expenses and delays should be expected due to the wet conditions. Additional expenses could include the need for placing a blanket of rock spalls on exposed subgrades, construction traffic areas, and paved areas prior to placing structural fill.

Wet weather grading will also require additional erosion control and site drainage measures. Some of the native on-site soils may be suitable for use as structural fill, depending on the moisture content of the soil at the time of construction. NGA should be retained to evaluate the suitability of all on-site and imported structural fill material during construction.

Temporary and Permanent Slopes

Temporary cut slope stability is a function of many factors, including the type and consistency of soils, depth of the cut, surcharge loads adjacent to the excavation, length of time a cut remains open, and the presence of surface or groundwater. It is exceedingly difficult under these variable conditions to estimate a stable, temporary, cut slope angle. Therefore, it should be the responsibility of the contractor to maintain safe slope configurations at all times as indicated in OSHA guidelines for cut slopes. The following information is provided solely for the benefit of the owner and other design consultants and should not be construed to imply that Nelson Geotechnical Associates, Inc. assumes responsibility for job site safety. Job site safety is the sole responsibility of the project contractor.

For planning purposes, we recommend that temporary cuts in the upper undocumented fill/surficial soils be no steeper than 2 Horizontal to 1 Vertical (2H:1V). Temporary cuts in the competent native glacial till soils at depth should be no steeper than 1H:1V. If significant groundwater seepage or surface water flow were encountered, we would expect that flatter inclinations would be necessary. We recommend that cut slopes be protected from erosion. The slope protection measures may include covering cut slopes with plastic sheeting and diverting surface runoff away from the top of cut slopes. We do not recommend vertical slopes for cuts deeper than four feet if worker access is necessary. We recommend that cut slope heights and inclinations conform to appropriate OSHA/WISHA regulations. Permanent cut and fill slopes should be no steeper than 2H:1V. However, flatter inclinations may be required in areas where loose soils are encountered. Permanent slopes should be vegetated, and the vegetative cover maintained until established.

Foundations

Conventional shallow spread foundations should be placed on medium dense or better native glacial soils or be supported on structural fill or rock spalls extending to those soils. Native medium dense or better glacial bearing soils should be encountered approximately 1.0-foot below the existing ground surface based on our explorations.

Where undocumented fill or less dense soils are encountered at footing bearing elevation, the subgrade should be over-excavated to expose native bearing soil. The over-excavation may be filled with structural fill, or the footings may be extended down to the competent native soils. If footings are supported on structural fill, the fill zone should extend outside the edges of the footing a distance equal to half of the depth of the over-excavation below the bottom of the footing. In case of excessive undocumented fill thickness, deep foundation options may be required. NGA is available to work with the structural engineer to explore those options.

Footings should extend at least 18 inches below the lowest adjacent finished ground surface for frost protection and bearing capacity considerations. Foundations should be designed in accordance with the 2018 IBC. Footing widths should be based on the anticipated loads and allowable soil bearing pressure. Water should not be allowed to accumulate in footing trenches. All loose or disturbed soil should be removed from the foundation excavation prior to placing concrete.

For foundations constructed as outlined above, we recommend an allowable bearing pressure of not more than 2,000 pounds per square foot (psf) be used for the design of footings founded on the medium dense or better native soils or structural fill extending to the competent native bearing material. The foundation bearing soil should be evaluated by a representative of NGA. We should be consulted if higher bearing pressures are needed. Current IBC guidelines should be used when considering increased allowable bearing pressure for short-term transitory wind or seismic loads. Potential foundation settlement using the recommended allowable bearing pressure is estimated to be less than 1-inch total and ½-inch differential between adjacent footings or across a distance of about 20 feet, based on our experience with similar projects. Lateral loads may be resisted by friction on the base of the footing and passive resistance against the subsurface portions of the foundation. A coefficient of friction of 0.35 may be used to calculate the base friction and should be applied to the vertical dead load only. Passive resistance may be calculated as a triangular equivalent fluid pressure distribution. An equivalent fluid density of 200 pounds per cubic foot (pcf) should be used for passive resistance design for a level ground surface adjacent to the footing. This level surface should extend a distance equal to at least three times the footing depth. These recommended values incorporate safety factors of 1.5 and 2.0 applied to the estimated ultimate values for frictional and passive resistance, respectively. To achieve this value of passive resistance, the foundations should be poured "neat" against the native medium dense soils or compacted fill should be used as backfill against the front of the footing. We recommend that the upper one foot of soil be neglected when calculating the passive resistance.

Structural Fill

General: Fill placed beneath foundations, pavement, or other settlement-sensitive structures should be placed as structural fill. Structural fill, by definition, is placed in accordance with prescribed methods and standards, and is monitored by an experienced geotechnical professional or soils technician. Field monitoring procedures would include the performance of a representative number of in-place density tests to document the attainment of the desired degree of relative compaction. The area to receive the fill should be suitably prepared as described in the **Site Preparation and Grading** subsection prior to beginning fill placement.

Materials: Structural fill should consist of a good quality, granular soil, free of organics and other deleterious material, and be well graded to a maximum size of about three inches. All-weather fill should contain no more than five-percent fines (soil finer than U.S. No. 200 sieve, based on that fraction passing the U.S. 3/4-inch sieve). Some of the more granular native on-site soils may be suitable for use as structural fill, but this will be highly dependent on the moisture content of these soils at the time of construction. We should be retained to evaluate all proposed structural fill material prior to placement.

Fill Placement: Following subgrade preparation, placement of structural fill may proceed. All filling should be accomplished in uniform lifts up to eight inches thick. Each lift should be spread evenly and be thoroughly compacted prior to placement of subsequent lifts. All structural fill underlying building areas and pavement subgrade should be compacted to a minimum of 95 percent of its maximum dry density. Maximum dry density, in this report, refers to that density as determined by the ASTM D-1557 Compaction Test procedure. The moisture content of the soils to be compacted should be within about two percent of optimum so that a readily compactable condition exists. It may be necessary to over-excavate and remove wet soils in cases where drying to a compactable condition is not feasible. All compaction should be accomplished by equipment of a type and size sufficient to attain the desired degree of compaction and should be tested.

Slab-on-Grade

Slabs-on-grade should be supported on subgrade soils prepared as described in the **Site Preparation and Grading** subsection of this report. We recommend that all floor slabs be underlain by at least six inches of free-draining gravel with less than three percent by weight of the material passing Sieve #200 for use as a capillary break. A suitable vapor barrier, such as heavy plastic sheeting (6-mil, minimum), should be placed over the capillary break material. An additional 2-inch-thick moist sand layer may be used to cover the vapor barrier. This sand layer may be used to protect the vapor barrier membrane and to aid in curing the concrete.

Pavements

Pavement subgrade preparation and structural filling where required, should be completed as recommended in the **Site Preparation and Grading** and **Structural Fill** subsections of this report. The pavement subgrade should be proof-rolled with a heavy, rubber-tired piece of equipment, to identify soft or yielding areas that require repair. The pavement section should be underlain by a stable subgrade. We should be retained to observe the proof-rolling and recommend repairs prior to placement of the asphalt or hard surfaces.

Utilities

We recommend that underground utilities be bedded with a minimum six inches of pea gravel prior to backfilling the trench with on-site or imported material. Trenches within settlement sensitive areas should be compacted to 95 percent of the modified proctor as described in the **Structural Fill** subsection of this report. Trench backfill should be compacted to a minimum of 95 percent of the modified proctor maximum dry density. Trenches located in non-structural areas and five feet below roadway subgrade should be compacted to a minimum 90 percent of the maximum dry density. The trench backfill compaction should be tested.

Site Drainage

Infiltration: We performed two grain-size analyses on selected soil samples obtained within the site in accordance with the Department of Ecology 2019 Stormwater Management Manual for Western Washington. Laboratory tests were performed on samples taken from Test Pit One at 2.25 feet and Test Pit Two at 6.75 feet. The results of the sieve analyses are presented as Figures 5 and 6. Based on the laboratory analysis, the soils encountered in both of our explorations are classified as sand as defined by the USDA Textural Triangle.

An equation provided in Section V-5.4 of the Department of Ecology 2019 Stormwater Management Manual for Western Washington was used to determine the infiltration capabilities of the site soil utilizing data from the grain-size analyses. Based on this equation and information obtained from the grain-size analyses, initial short-term infiltration rates in the range of 64.64 to 83.31 inches/hour were calculated. We also referenced Table V-5.1 of the manual to provide an adequate correction factor to infiltration rates obtained from the above equation to calculate a long-term design rate. Correction factors of 0.80, 0.40, and 0.90 were utilized in this equation for CF_v, CF_t, CF_m, respectively. We applied the correction factors to the most conservative rate obtained from the grain-size analysis calculations which is 64.64 inches/hour and computed a long-term design infiltration rate of 18.62 inches per hour. We recommend a maximum design rate of 10 inches per hour be utilized to design on-site infiltration systems founded within the native granular outwash soils encountered at relatively shallow depths throughout the property. We recommend that any infiltration system be extended down through the unsuitable undocumented fill soils and founded within the native granular outwash soils. Based on our explorations, the native granular outwash soils should be encountered at approximately 1.0-foot below the existing ground surface. We should be retained during construction to evaluate the soils exposed in the infiltration systems to verify that the soils are appropriate for infiltration.

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 groundwater seepage within our explorations to the depths explored. We do not anticipate that the groundwater levels would fluctuate significantly throughout the year based on our understating of the nearby vicinity. In our opinion, on-site stormwater infiltration systems founded in the native granular outwash sands should be feasible and should not be adversely impacted by the underlying groundwater table. The cation exchange capacity (CEC) of the on-site soils was also evaluated and found that the shallower soils in Test Pit One at 2.25 feet meet the minimum value required by the design manual; however, the deeper soils found in Test Pit Two at 6.75 feet was found to be below the minimum value required. We recommend that the infiltration soils be amended, as needed to satisfy CEC requirements as well as City of Marysville code; however, the design rates should be verified though on-site testing during construction.

Surface Drainage: The finished ground surface should be graded such that stormwater is directed to an approved stormwater collection system. Water should not be allowed to stand in any areas where footings, slabs, or pavements are to be constructed. Final site grades should allow for drainage away from the residence. We suggest that the finished ground be sloped at a minimum downward gradient of three percent, for a distance of at least 10 feet away from the residences. Surface water should be collected by permanent catch basins and drain lines and be discharged into an approved discharge system. The overflow water should be directed to discharge into an approved location. Water should never be allowed to flow over the site slopes either during or after construction.

Subsurface Drainage: If groundwater is encountered during construction, we recommend that the contractor slope the bottom of the excavation and collect the water into ditches and small sump pits where the water can be pumped out and routed into a permanent storm drain. We recommend the use of footing drains around the structures. Footing drains should be installed at least one foot below planned finished floor elevation. The drains should consist of a minimum 4-inch-diameter, rigid, slotted or perforated, PVC pipe surrounded by free-draining material wrapped in a filter fabric. We recommend that the free-draining material consist of an 18-inch-wide zone of clean (less than three-percent fines), granular material placed along the back of walls. Pea gravel is an acceptable drain material. The free-draining material should extend up the wall to one foot below the finished surface. The top foot of backfill should consist of impermeable soil placed over plastic sheeting or building paper to minimize surface water or fines migration into the footing drain. Footing drains should discharge into tightlines leading to an approved collection and discharge point with convenient cleanouts to prolong the useful life of the drains. Roof drains should not be connected to wall or footing drains.

CONSTRUCTION MONITORING

We should be retained to provide construction monitoring services during the earthwork phase of the project to evaluate subgrade conditions, temporary cut conditions, fill compaction, and drainage system installation.

USE OF THIS REPORT

NGA has prepared this report for **Robert Linscott** and associated agents, for use in the planning and design of the development on this site only. The scope of our work does not include services related to construction safety precautions and our recommendations are not intended to direct the contractors' methods, techniques, sequences, or procedures, except as specifically described in our report for consideration in design. There are possible variations in subsurface conditions between the explorations and also with time. Our report, conclusions, and interpretations should not be construed as a warranty of subsurface conditions. A contingency for unanticipated conditions should be included in the budget and schedule.

We recommend that NGA be retained to 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 and foundation installation 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 report 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.

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It has been a pleasure to provide service to you on this project. If you have any questions or require further information, please call.

Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.

Faith K. Stelter
Staff Geologist I

9.06.2023

Khaled M. Shawish, PE
Principal

FKS:DJO:KMS:dy

Attachments: Six Figures
Appendix A

VICINITY MAP

Not to Scale

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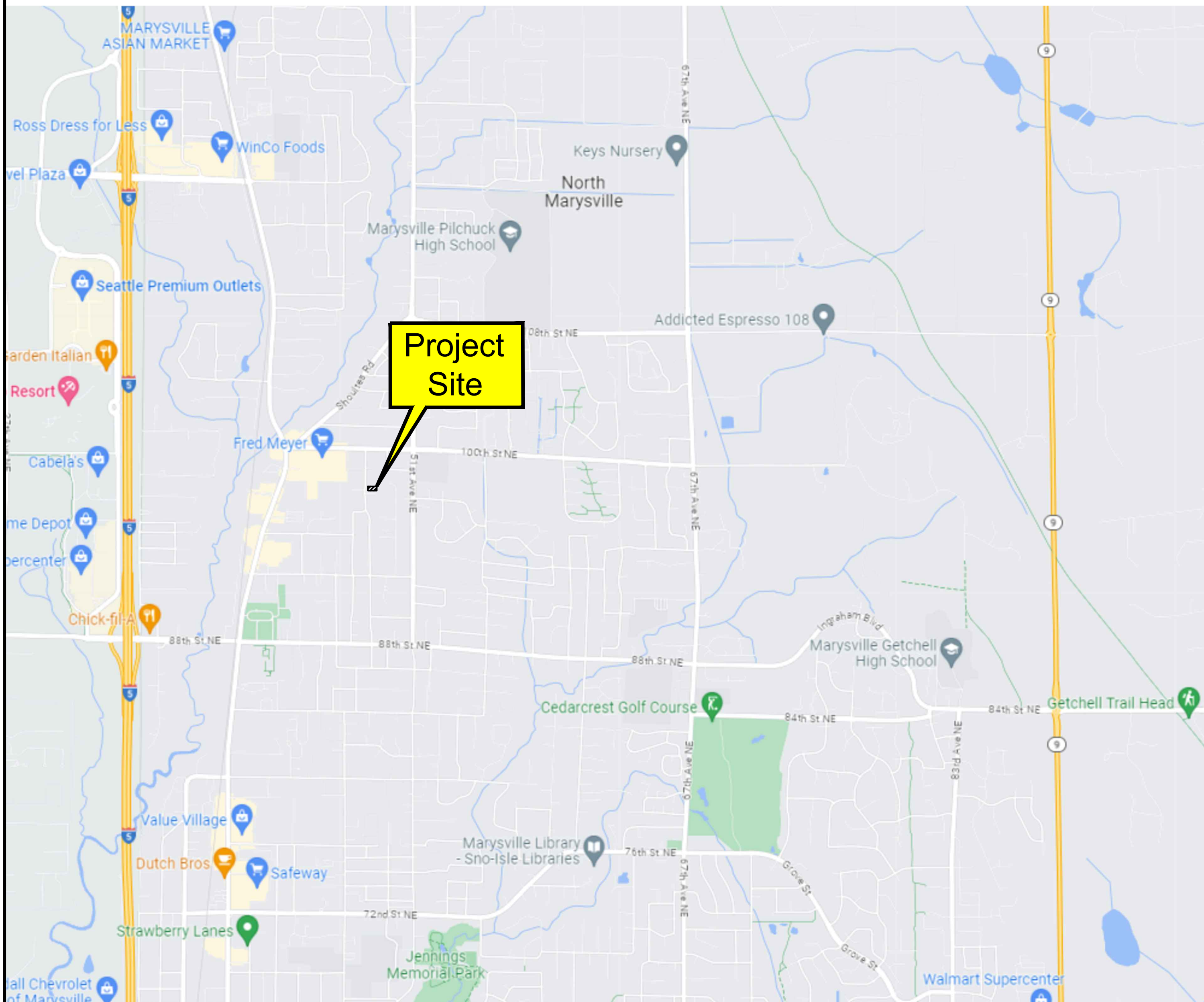

Snohomish County, WA

Project Number 1457123	Linscott Residential and Duplex Development Vicinity Map	NELSON GEOTECHNICAL ASSOCIATES, INC	No.	Date	Revision	By	CK
Figure 1		Woodinville Office 17311-135th Ave. NE, A-500 Woodinville, WA 98072 (425) 486-1669 / Fax: 481-2510; Wenatchee Office 105 Palouse St. Wenatchee, WA 98801 (509) 665-7696 / Fax: 665-7692; www.nelsongeotech.com	1	7/26/23	Original	ABT	DJO

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Site Plan

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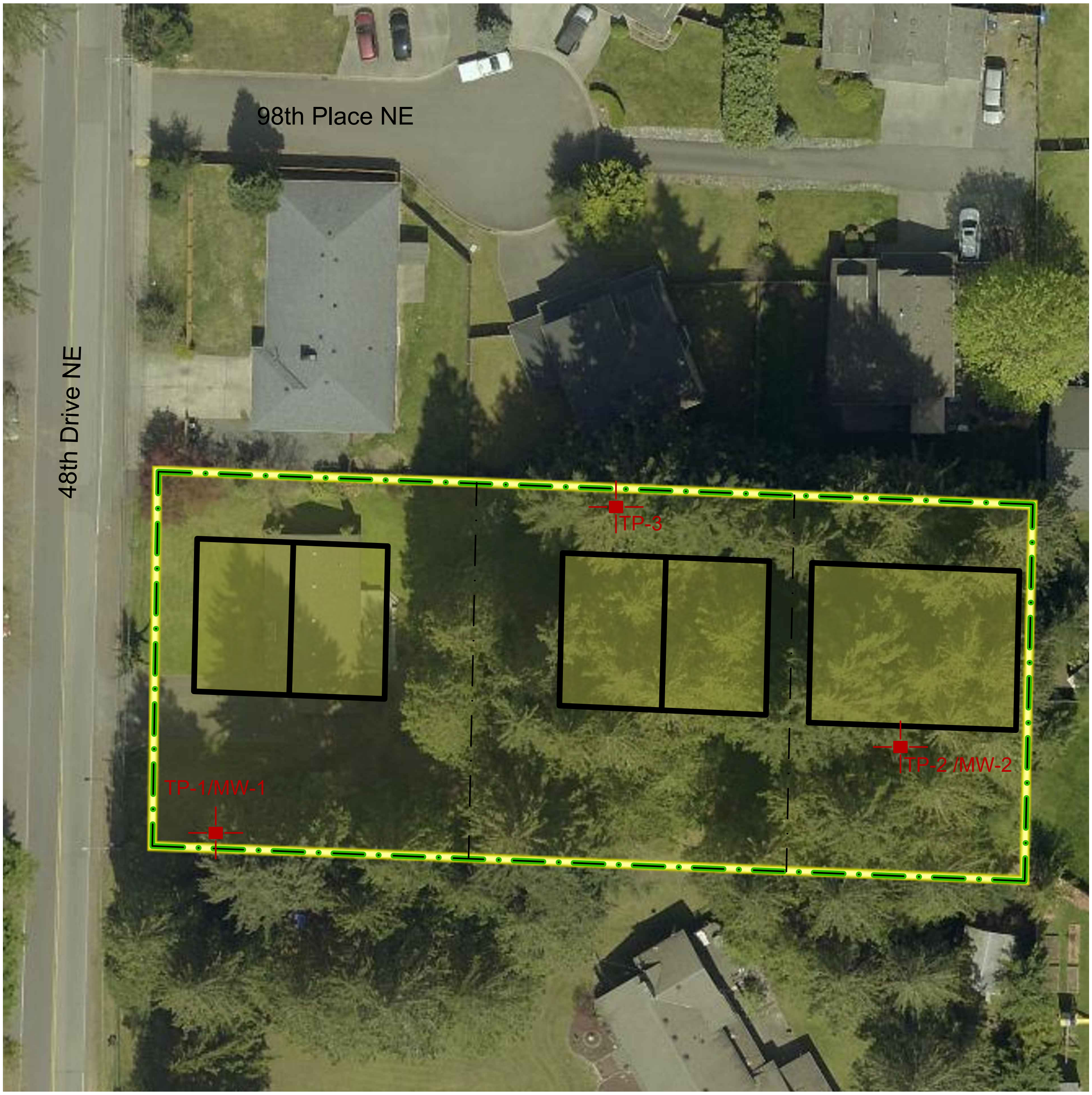

LEGEND

Current Property line

Proposed Property line

TP-1/MW-1 Number and approximate location of test pit/monitoring well

Proposed Residence Structures

0 50 100

Approximate Scale: 1 inch = 50 feet

Reference: Site Plan based on a plan dated June 26, 2023 titled "Preliminary Short Plat Map For Linscott - Kirk SP," provided by Land Resolutions

Project Number 1457123	Linscott Residential and Duplex Development Site Plan	NELSON GEOTECHNICAL ASSOCIATES, INC
Figure 2		www.nelsongeotech.com

Woodinville Office
17311-135th Ave. NE, A-500
Woodinville, WA 98072
(425) 486-1669 / Fax: 481-2510

Wenatchee Office
105 Palouse St.
Wenatchee, WA 98801
(509) 665-7696 / Fax: 665-7692

No.	Date	Revision	By	CK
1	7/26/23	Original	ABT	DJO

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UNIFIED SOIL CLASSIFICATION SYSTEM

<table>
<tr><th colspan="3">MAJOR DIVISIONS</th><th>GROUP SYMBOL</th><th>GROUP NAME</th></tr>
<tr><td rowspan="8">COARSE - GRAINED SOILS

MORE THAN 50 % RETAINED ON NO. 200 SIEVE</td><td rowspan="4">GRAVEL

MORE THAN 50 % OF COARSE FRACTION RETAINED ON NO. 4 SIEVE</td><td rowspan="2">CLEAN GRAVEL</td><td>GW</td><td>WELL-GRADED, FINE TO COARSE GRAVEL</td></tr>
<tr><td>GP</td><td>POORLY-GRADED GRAVEL</td></tr>
<tr><td rowspan="2">GRAVEL WITH FINES</td><td>GM</td><td>SILTY GRAVEL</td></tr>
<tr><td>GC</td><td>CLAYEY GRAVEL</td></tr>
<tr><td rowspan="4">SAND

MORE THAN 50 % OF COARSE FRACTION PASSES NO. 4 SIEVE</td><td rowspan="2">CLEAN SAND</td><td>SW</td><td>WELL-GRADED SAND, FINE TO COARSE SAND</td></tr>
<tr><td>SP</td><td>POORLY GRADED SAND</td></tr>
<tr><td rowspan="2">SAND WITH FINES</td><td>SM</td><td>SILTY SAND</td></tr>
<tr><td>SC</td><td>CLAYEY SAND</td></tr>
<tr><td rowspan="6">FINE - GRAINED SOILS

MORE THAN 50 % PASSES NO. 200 SIEVE</td><td rowspan="3">SILT AND CLAY

LIQUID LIMIT LESS THAN 50 %</td><td rowspan="2">INORGANIC</td><td>ML</td><td>SILT</td></tr>
<tr><td>CL</td><td>CLAY</td></tr>
<tr><td>ORGANIC</td><td>OL</td><td>ORGANIC SILT, ORGANIC CLAY</td></tr>
<tr><td rowspan="3">SILT AND CLAY

LIQUID LIMIT 50 % OR MORE</td><td rowspan="2">INORGANIC</td><td>MH</td><td>SILT OF HIGH PLASTICITY, ELASTIC SILT</td></tr>
<tr><td>CH</td><td>CLAY OF HIGH PLASTICITY, FAT CLAY</td></tr>
<tr><td>ORGANIC</td><td>OH</td><td>ORGANIC CLAY, ORGANIC SILT</td></tr>
<tr><td colspan="3">HIGHLY ORGANIC SOILS</td><td>PT</td><td>PEAT</td></tr>
</table>

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 1457123	Linscott Residential and Duplex Development Soil Classification Chart	NELSON GEOTECHNICAL ASSOCIATES, INC
Figure 3		

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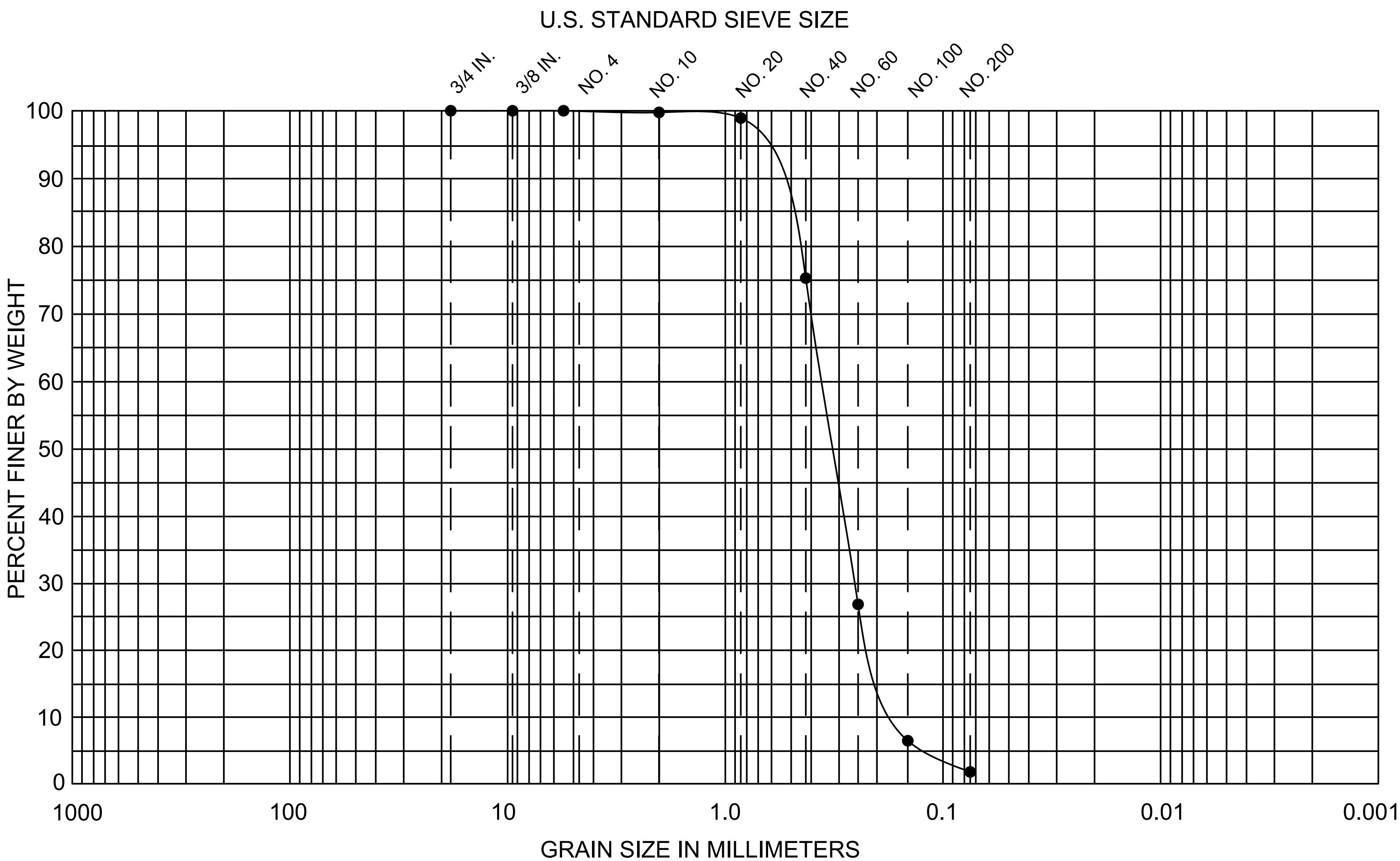
LOG OF EXPLORATION

DEPTH (FEET)	USC	SOIL DESCRIPTION
TEST PIT ONE / MONITORING WELL ONE		
0.0 – 1.0		GRASS UNDERLAIN BY BROWN, SILTY, FINE TO MEDIUM SAND WITH TRACE GRAVEL, ROOTS, AND ORGANICS (LOOSE, MOIST) (**TOPSOIL/FILL**)
1.0 – 2.5	SP-SM	BROWN, FINE TO MEDIUM SAND WITH SILT, TRACE GRAVEL, AND TRACE ORGANICS (LOOSE TO MEDIUM DENSE, MOIST)
2.5 – 6.0	SP	GRAY-BROWN, FINE TO MEDIUM SAND WITH TRACE GRAVEL AND ROOTS (MEDIUM DENSE, MOIST)
6.0 – 8.0	SP-SM	GRAY-BROWN, FINE TO MEDIUM SAND WITH SILT, TRACE GRAVEL, AND ROOTS (MEDIUM DENSE, MOIST)
8.0 – 9.5	SP	GRAY, FINE TO MEDIUM SAND
		SAMPLES WERE COLLECTED AT 2.25 AND 7.5 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED MODERATE TEST PIT CAVING WAS ENCOUNTERED AT 2.5 TEST PIT WAS TERMINATED AT 9.5 FEET ON 7/25/23
TEST PIT TWO / MONITORING WELL TWO		
0.0 – 1.0		BRUSH AND FOREST DUFF UNDERLAIN BY DARK BROWN TO BROWN, SILTY, FINE TO MEDIUM SAND WITH GRAVEL, ROOTS, AND ORGANICS (LOOSE, MOIST) (**TOPSOIL**)
1.0 – 3.5	SP	BROWN, FINE TO MEDIUM SAND WITH TRACE GRAVEL, ROOTS, AND ORGANICS (LOOSE TO MEDIUM DENSE, MOIST)
3.5 – 10.0	SP	GRAY TO GRAY-BROWN, FINE TO MEDIUM SAND (???)
		SAMPLES WERE COLLECTED AT 3.0 AND 6.75 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED MODERATE TEST PIT CAVING WAS ENCOUNTERED AT 3.0 FEET TEST PIT WAS TERMINATED AT 10.0 FEET ON 7/25/23
TEST PIT THREE		
0.0 – 1.0		BRUSH AND FOREST DUFF UNDERLAIN BY DARK BROWN TO BROWN, SILTY, FINE TO MEDIUM SAND WITH GRAVEL, ROOTS, AND ORGANICS (**TOPSOIL**)
1.0 – 9.5	SP	LIGHT GRAY-BROWN, FINE TO MEDIUM SAND WITH ROOTS AND TRACE GRAVEL (LOOSE TO MEDIUM DENSE, MOIST)
9.5 – 10.5	SP	GRAY TO GRAY-BROWN, FINE TO MEDIUM SAND WITH TRACE GRAVEL (MEDIUM DENSE, MOIST)
		SAMPLES WERE COLLECTED AT 3.0, 9.0, AND 10.0 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED MODERATE TEST PIT CAVING WAS ENCOUNTERED AT 2.0 FEET TEST PIT WAS TERMINATED AT 10.5 FEET ON 7/25/23



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

U.S.C. SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH	SOIL DESCRIPTION	SOIL DISTRIBUTION
●SP	TP-2	6.75 feet	Gray-brown to brown, fine to medium sand with trace silt	Gravel = 0% Sand = 98% Silt/Clay = 2%

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Linscott Residential and Duplex Development
Sieve Analysis

Project Number
1457123

Figure 5

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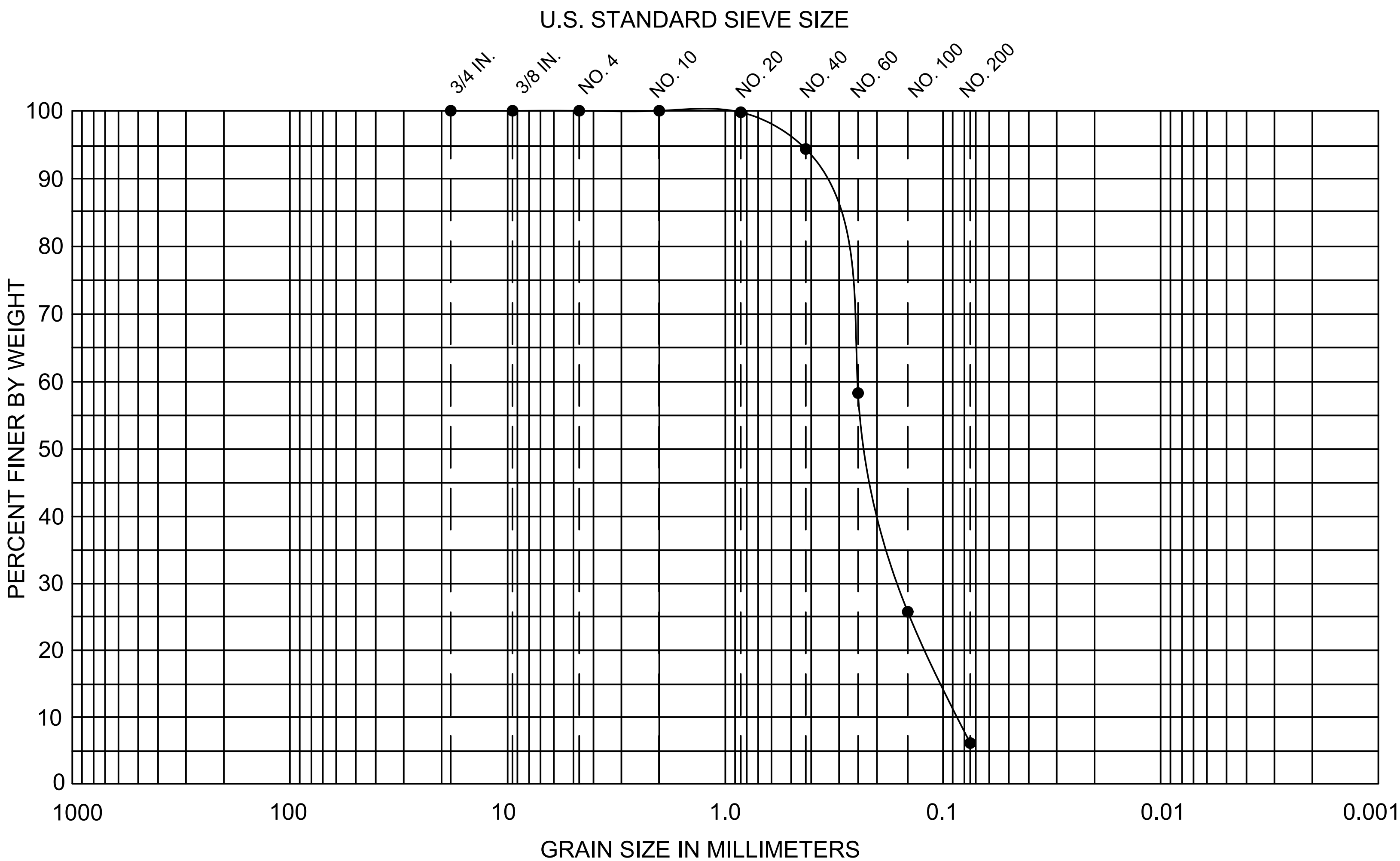

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

U.S.C. SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH	SOIL DESCRIPTION	SOIL DISTRIBUTION
●SP-SM	TP-3	3.0 feet	Light brown to brown-gray, fine to medium sand with silt	Gravel = 0% Sand = 94% Silt/Clay = 6%

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Linscott Residential and Duplex Development
Sieve Analysis

Project Number
1457123

Figure 6

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APPENDIX A

Am Test Inc.
13600 NE 126TH PL
Suite C
Kirkland, WA 98034
(425) 885-1664
www.amtestlab.com

Professional Analytical Services

ANALYSIS REPORT

NELSON GEOTECH
17311 135TH AVE NE
WOODINVILLE, WA 98072
Attention: FAITH STELTER
Project Name: 48TH DR NE
Project #: 1457123
All results reported on an as received basis.

Date Received: 07/25/23
Date Reported: 8/14/23

AMTEST Identification Number	**23-A012698**
Client Identification	**TP-1 @ 2.25**
Sampling Date	**07/25/23**

Conventionals

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cation Exchange Capacity	5.5	meq/100g		0.5	SW-846 9081	HV	08/03/23

Miscellaneous

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANLST	DATE
Organic Matter	3.4	%			SM 2540G	HV	08/10/23

NELSON GEOTECH
Project Name: 48TH DR NE
AmTest ID: 23-A012699

AMTEST Identification Number **23-A012699**
Client Identification **TP-2 @ 6.75**
Sampling Date **07/25/23**

Conventionals

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANALYST	DATE
Cation Exchange Capacity	1.5	meq/100g		0.5	SW-846 9081	HV	08/03/23

Miscellaneous

PARAMETER	RESULT	UNITS	Q	D.L.	METHOD	ANLST	DATE
Organic Matter	4.9	%			SM 2540G	HV	08/10/23

Kathy Fugiel
President