NELSON GEOTECHNICAL ASSOCIATES, INC.
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May 1, 2018

Mr. Matt Echelbarger
16304 Broadway Avenue
Snohomish, Washington 98296

Geotechnical Engineering Evaluation
10th Street Apartments Development
1101 – 10th Street
Snohomish, Washington
NGA Job No. 1032718

Dear Mr. Echelbarger:

We are pleased to submit the attached report titled "**Geotechnical Engineering Evaluation – 10th Street Apartments Development – 1101 - 10th Street – Snohomish, Washington."** This report summarizes our observations of the existing surface and subsurface conditions within the property, and provides general recommendations for the proposed site development. The parcel number for the property is 00487700001903. Our services were completed in general accordance with the proposal signed by you on March 14, 2018.

The site is currently undeveloped and sparsely vegetated with grass, underbrush, and young to mature trees. The topography within the site is generally level to gently sloping, however a steep south-facing slope extends from 10th street within the northern portion of the property down into the site. We understand that the proposed development consists of constructing four new condominium structures. Final grading and stormwater plans were not available at the time this report was prepared. For our use in preparing this proposal, we have been provided with a preliminary building layout prepared by Architectural Design Associates, dated February 8, 2018.

We explored the proposed development area and site slopes with eight trackhoe excavated test pits. Our explorations indicated that the site was generally underlain by undocumented fill with competent native glacial soils at relatively shallow depths.

It is our opinion that the planned development is feasible from a geotechnical standpoint, provided that our recommendations are incorporated into the design and construction of this project. We have recommended that the new structures be founded on medium dense or better native glacial soils for bearing capacity and settlement considerations. These soils should generally be encountered approximately 1.0 to 4.5 feet below the existing ground surface, based on our explorations. Deeper areas of loose soil and/or undocumented fill could also exist within unexplored areas of the site. If undocumented fill is encountered in unexplored areas of the site, it should be removed and replaced with structural fill for foundation and pavement support, or foundations should be extended down to be supported directly on the native glacial soils.

It is also our opinion that the soils that underlie the site and form the core of the site slopes should be stable with respect to deep-seated earth movements, due to their inherent strength and slope geometry. However, there is a potential for shallow sloughing and erosion events to occur on the steeper site slopes within the property. In the attached report, we have also included recommendations for site grading, foundation support, retaining walls and site drainage.

We recommend that Nelson Geotechnical Associates (NGA) be retained to review the geotechnical aspects of the project plans prior to 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 the work 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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Geotechnical Engineering Evaluation
10th Street Apartments Development
1101 – 10th Street
Snohomish, Washington

INTRODUCTION

This report presents the results of our geotechnical engineering investigation and evaluation of the planned 10th Street Apartments Development project located at 1101 – 10th Street in Snohomish, 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.

Topography within the site is generally level to gently sloping from north to south. A steep south-facing slope borders the northern edge of the property adjacent to 10th Street. The site is currently vacant and sparsely to heavily vegetated with underbrush and scattered young to mature trees. We understand that the proposed development consists of constructing 4 new apartment building structures, along with associated underground utilities and pavements. Final grading and stormwater plans were not available at the time this report was prepared. The existing and proposed site layout is shown on the Schematic Site Plan in Figure 2.

For our use in preparing this report, we have been provided with a preliminary building layout dated February 8, 2018 prepared by Architectural Design Associates.

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 includes the following:

1. Review available soil and geologic maps of the area.
2. Explore the subsurface soil and groundwater conditions within the site with test pit soil explorations. Track-hoe to be provided by NGA.
3. Perform grain-size sieve analysis on soil samples, as necessary.
4. Evaluate current stability conditions on the steep slopes adjacent to the site.
5. Provide recommendations for earthwork and foundation support.
6. Provide recommendations for temporary and permanent slopes.
7. Provide recommendations for retaining walls.
8. Provide recommendations for slab subgrade preparation.
9. Provide recommendations for site drainage and erosion control.
10. Document the results of our findings, conclusions, and recommendations in a written geotechnical report.

SITE CONDITIONS

Surface Conditions

The site consists of an irregular-shaped parcel covering approximately 2.04 acres. The lot is currently vacant and vegetated with underbrush and scattered trees throughout the property. A wetlands area is situated in the southeast corner of the site and the designated 100-foot buffer extends in close proximity to the proposed Building D in the southwestern portion of the site. A steep south-facing slope descends from the northern property line along 10th Street into the site at an approximate gradient of 33 degrees (65 percent), as shown on Cross Section A-A' in Figure 3. The overall height of the bank directly adjacent to the right-of-way is approximately 10 feet. The majority of the site, south of the short section of steep slope is relatively level to gently sloping. The ground surface also slopes gently to moderately to the east along the eastern portion of the property adjacent to the proposed Building B. The site is bounded to the north by 10th Street, to the south and west by existing commercial properties, and to the east by an existing residential property. We did not observe surface water or seepage emitting from the site slopes within the site during our visit on March 28, 2018. We also did not observe any indications of recent slope movement within the property during our site visit.

Subsurface Conditions

Geology: The geologic units for this area are shown on Geologic map of the Snohomish quadrangle, Snohomish County, Washington, by Minard, J.P. (USGS, 1985). The site is mapped as recessional outwash (Qva). Recessional outwash is described as a well-drained and stratified sand and gravel. Our explorations typically encountered undocumented fill/topsoil underlain by competent light brown to gray-brown, fine to medium sand with gravel, consistent with the description of recessional outwash deposits.

Explorations: The subsurface conditions within the properties were explored on March 28, 2018 by monitoring eight trackhoe excavated test pits to approximate depths in the range of 3.0 to 8.0 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 pit explorations.

The soils were visually classified in general accordance with the Unified Soil Classification System, presented in Figure 4. The logs of our test pits are attached to this report and are presented as Figures 5 and 6. We present a brief summary of the subsurface conditions in the following paragraphs. For a detailed description of the subsurface conditions, the test pit logs should be reviewed.

At the surface of our test pit explorations we generally encountered 0.7 to 4.5 feet of dark brown to brown, silty fine to medium sand with varying amounts of gravel, organics, roots, and garbage, which we interpreted as undocumented fill soils and/or topsoil. Underlying the fill and topsoil we encountered gray-brown to brown, fine to coarse sand with varying amounts of silt, gravel, and iron-oxide staining, which we interpreted as native outwash type deposits. Test Pits 1 through 8 terminated at respective depths of 7.0, 8.0, 8.0, 5.0, 5.5, 7.0, 8.0, and 3.0 feet below the existing ground surface.

Hydrogeologic Conditions

Groundwater seepage was not encountered in our explorations. If groundwater is encountered on this site, we would interpret this water to be perched water. Perched water occurs when surface water infiltrates. 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 perched groundwater to decrease during drier times of the year and increase during wetter periods.

SENSITIVE AREA EVALUATION

Seismic Hazard

The 2015 International Building Code (IBC) seismic design section provides a basis for seismic design of structures. Since medium dense or better glacial outwash soils were generally encountered underlying 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 2015 IBC, which specifies a design earthquake having a 2% probability of occurrence in 50 years (return interval of 2,475 years), and the 2008 USGS seismic hazard maps.

Table 1 – 2015 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	1.341	0.509	1.000	1.500	0.894	0.509

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 competent glacial outwash material interpreted to underlie the site has a low potential for liquefaction or amplification of ground motion.

The glacial soils interpreted to form the core of the site slopes is considered stable with respect to deep-seated slope failures. All slopes have the potential for shallow sloughing failures during seismic events. Such events should not affect the planned structures provided the foundations are designed with the recommended embedment values and the slope and drainage systems are maintained as described in this report.

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 Conservation Service (SCS) lists the northern half of the site as Tokul gravelly medial loam, 8 to 15 percent slopes and the southern half of the site as Tokul gravelly medial loam, 0 to 8 percent slopes. The erosion hazard is listed as slight for both soil units. Based on our observations and the material encountered, we would interpret this site as having a low to moderate erosion hazard where the surficial soils are exposed. It is our opinion that the erosion hazard for site soils should be low in areas where the site is not disturbed.

Landslide Hazard/Slope Stability

The criteria used for evaluation of landslide hazards include soil type, slope gradient, and groundwater conditions. The majority of the property and the proposed development areas are situated on relatively level to gently sloping ground. A steep and short section of south-facing slope descends from the northern property line from 10th Street at an approximate gradient of 33 degrees (65 percent). We did not observe evidence of significant instability within or in the immediate vicinity of the property during our investigation, such as deep-seated landsliding. We also did not observe groundwater seepage or recent signs of erosion or sloughing on the slope at the time of our visit.

Relatively shallow sloughing failures as well as surficial erosion are natural processes and should be expected on the steeper slope during extreme weather conditions. It is our opinion that while there is potential for erosion, soil creep, and shallow failures within the loose surficial soils on the steep embankment below the road, there is not a significant potential for deep-seated slope failures under current site conditions. Proper site grading and drainage as well as adequate foundation placement as recommended in this report should help maintain current stability conditions.

CONCLUSIONS AND RECOMMENDATIONS

General

It is our opinion that the planned development within the site is feasible from a geotechnical standpoint. It is also our opinion that the native soils that underlie the site and form the core of the site slopes should be stable with respect to deep-seated earth movements, due to their inherent strength and slope geometry. Proper erosion and drainage control measures as recommended in this report should reduce this potential. Our explorations indicated that the site is underlain by surficial undocumented fill soils with medium dense or better native glacial soils at depth. These glacial soils should provide adequate support for foundation, slab, and pavement loads. We recommend that the structure be designed utilizing shallow foundations. Footings should extend through any loose surficial soil and be keyed into the underlying competent native soils. These soils should be encountered roughly 1.0 to 4.5 feet below the existing ground surface. 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. No excavations should be planned within or near the existing roadway embankment unless shoring walls are to be placed as part of such effort.

The soils encountered on this site are considered moisture-sensitive and will disturb easily when wet. To lessen the potential impacts of construction on the slopes and to reduce cost overruns and delays, we recommend that construction take place during the drier summer months. If construction takes place during the rainy months, additional expenses and delays should be expected. Additional expenses could include the need for placing erosion control and temporary drainage measures to protect the slopes, the need for placing a blanket of rock spalls on exposed subgrades, and construction traffic areas prior to placing structural fill, and the need for importing all-weather material for structural fill.

Erosion Control and Slope Protection Measures

The erosion hazard for the on-site soils are listed as slight but the actual hazard 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 or flowing over the slopes. Stockpiles should be covered with plastic sheeting during wet weather. Disturbed areas should be planted as soon as practical and the vegetation should be maintained until it is established. The erosion potential for areas not stripped of vegetation should be low to moderate.

The clearing of vegetation within the area of the proposed developments should not create stability concerns provided the disturbed areas outside the building areas are revegetated as soon as practical and protected from erosion. In areas that are disturbed during or after construction, planting, hydro seeding, and/or straw mulching are effective ways to minimize erosion and allow vegetation to be re-established rapidly.

Site Preparation and Grading

After erosion control measures are implemented, site preparation should consist of stripping any loose soils and undocumented fill to expose medium dense or better native soil in foundation, slab-on-grade, and pavement areas. The stripped materials should be removed from the site or stockpiled for later use as landscaping fill. Based on our observations, we anticipate stripping depths of 1.0 to 4.5 feet, depending on the specific locations. Additional stripping may be required if areas of deeper undocumented fill and/or loose soil are encountered in unexplored areas of the site.

If the ground surface, after site stripping, should appear to be loose, it should be compacted to a non-yielding condition. Areas observed to pump or weave during compaction should be over-excavated and replaced with properly compacted structural fill or rock spalls. If loose soils are encountered in any slab 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.

This site is underlain by moisture-sensitive soils. Due to these conditions, special site stripping and grading techniques might be necessary, especially if grading is attempted in wet weather. These could include using large excavators equipped with wide tracks and a smooth bucket to complete site grading and promptly covering exposed subgrades 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 prepared subgrade. Shallow groundwater, if encountered, should be intercepted with cut-off drains and routed around the planned grading area, or the groundwater should be controlled with sump-pumps or dewatering systems. Failure to follow these recommendations could cause erosion and failures on the slopes, as well as result in inadequate subgrades.

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 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 site soils be no steeper than 1.5 Horizontal to 1 Vertical (1.5H: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. If the above inclinations cannot be met due to property line constraints and/or worker access issues, we recommend that shoring be considered for the planned cuts. We are available to provide specific recommendations for temporary shoring once grading plans have been finalized.

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 undisturbed medium dense or better native soils. Medium dense to dense soils should be encountered roughly 1.0 to 4.5 feet below the ground surface based on our explorations; however, loose soil may be encountered in unexplored areas of the site. Where undocumented fill or less dense soils are encountered at footing bearing elevation, the subgrade should be over-excavated to expose suitable bearing soil.

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 2015 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 design 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 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.

Retaining Walls

We understand retaining walls may be incorporated into the building design. In general, the lateral pressure acting on subsurface retaining walls is dependent on the nature and density of the soil behind the wall, the amount of lateral wall movement which can occur as backfill is placed, wall drainage conditions, and the inclination of the backfill. For walls that are free to yield at the top at least one thousandth of the height of the wall (active condition), soil pressures will be less than if movement is limited by such factors as wall stiffness or bracing (at-rest condition). We recommend that walls supporting horizontal backfill and not subjected to hydrostatic forces, be designed using a triangular earth pressure distribution equivalent to that exerted by a fluid with a density of 40 pcf for yielding (active condition) walls, and 60 pcf for non-yielding (at-rest condition) walls. A seismic design loading of 8H in psf should also be included in the wall design where "H" is the total height of the wall. The walls should also be designed to resist a uniform surcharge of 200 psf to account for traffic loads.

These recommended lateral earth pressures are for a drained granular backfill and are based on the assumption of a horizontal ground surface behind the wall for a distance of at least the subsurface height of the wall, and do not account for surcharge loads except as provided above. Additional lateral earth pressures should be considered for surcharge loads acting adjacent to subsurface walls and within a distance equal to the subsurface height of the wall. This would include the effects of surcharges such as special traffic loads, floor slab loads, slopes, or other surface loads. We could consult with the structural engineer regarding additional loads on retaining walls during final design, if needed.

The lateral pressures on walls may be resisted by friction between the foundation and subgrade soil, and by passive resistance acting on the below-grade portion of the foundation. Recommendations for frictional and passive resistance to lateral loads are presented in the **Foundations** subsection of this report.

All wall backfill should be well compacted as outlined in the **Structural Fill** subsection of this report. Care should be taken to prevent the buildup of excess lateral soil pressures due to over-compaction of the wall backfill. This can be accomplished by placing wall backfill in 8-inch loose lifts and compacting the backfill with small, hand-operated compactors within a distance behind the wall equal to at least one-half the height of the wall. The thickness of the loose lifts should be reduced to accommodate the lower compactive energy of the hand-operated equipment. The recommended level of compaction should still be maintained.

Permanent drainage systems should be installed for retaining walls. Recommendations for these systems are found in the **Subsurface Drainage** subsection of this report. We recommend that we be retained to evaluate the proposed wall drain backfill material and observe installation of the drainage systems.

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. Sloping areas to receive fill should be benched using a minimum 8-foot wide horizontal benches into competent soils.

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 on-site soils found at depth 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.

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. We recommend that the capillary break be hydraulically connected to the footing drain system to allow free drainage from under the slab. 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 minimum of six inches of clean granular pit run. 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 12 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% of the modified proctor as described in the **Structural Fill** subsection of this report. Trenches located in non-structural areas should be compacted to a minimum 90% of the maximum dry density.

Site Drainage

Surface Drainage: Final site grades should allow for drainage away from site slopes and away from the planned residence areas. We suggest that the finished ground be sloped at a minimum gradient of three percent for a distance of at least 10 feet away from the building. Runoff generated on this site should be collected and routed into a permanent discharge system. This should include all downspouts and runoff generated on all hard surfaces and yards areas. Under no circumstances should water be allowed to flow uncontrolled over the slopes. Water should not be allowed to collect in any area where footings or slabs are to be constructed.

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 of the excavation and routed into a suitable outlet. We recommend that the structure roof down spouts and footing drains be tightlined to an appropriate discharge location.

We recommend the use of footing drains around 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. Washed rock is an acceptable drain material, or drainage composite may be used instead. The free-draining material should extend up the wall to one foot below the finished surface. The top foot of soil should consist of low permeability soil placed over plastic sheeting or building paper to minimize the migration of surface water or silt into the

footing drain. Footing drains should discharge into tightlines leading to an appropriate 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 recommend that we be retained to provide construction monitoring services to evaluate conditions encountered in the field with respect to anticipated conditions, to provide recommendations for design changes should the conditions differ from anticipated, and to evaluate whether construction activities comply with contract plans and specifications.

USE OF THIS REPORT

NGA has prepared this report for Mr. Matt Echelbarger and his agents, for use in the planning and design of the development on these sites 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 we be retained to review the project plans after they have been developed to determine that recommendations in the report were incorporated into project plans.

We recommend that NGA be retained to review final plans prior to 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 the work 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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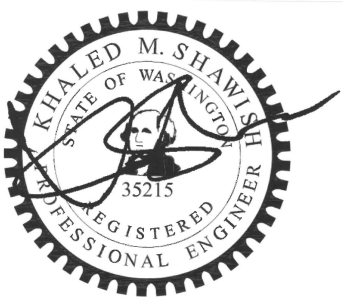
It has been a pleasure to provide service to you on this project. If you have any questions or require further information, please call.

Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.

Alex B. Rinaldi, GIT
Staff Geologist



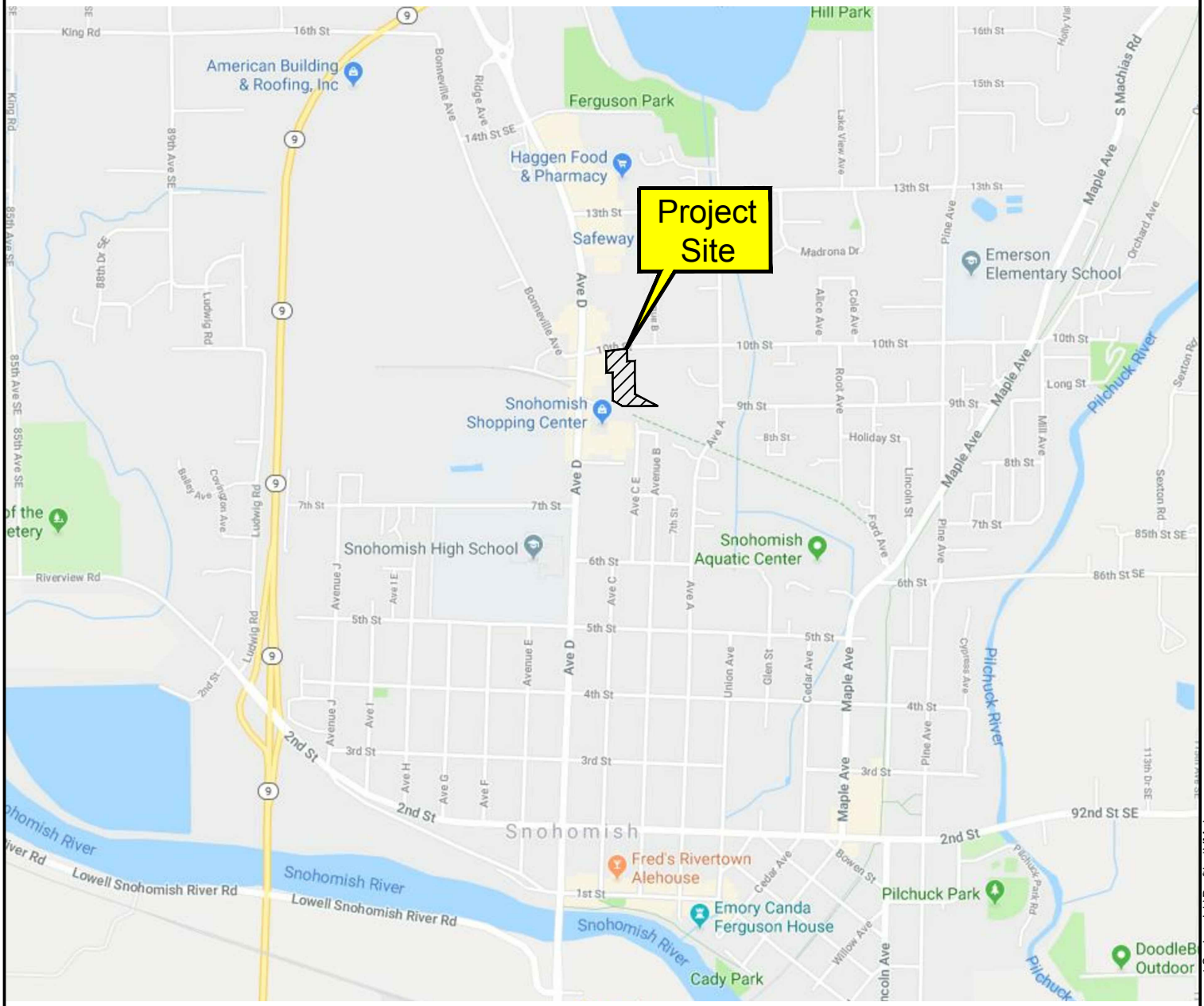
Khaled M. Shawish, PE
Principal

ABR: KMS:dy

Six Figures Attached

VICINITY MAP

Not to Scale



Snohomish, WA

Project Number	Project Name	Author	No.	Date	Revision	By	CK
1032718	10th Street Apartments	NELSON GEOTECHNICAL ASSOCIATES, INC.	1	4/9/18	Original	DPN	ABR
Figure 1	Vicinity Map	NGA GEOTECHNICAL ENGINEERS & GEOLOGISTS					

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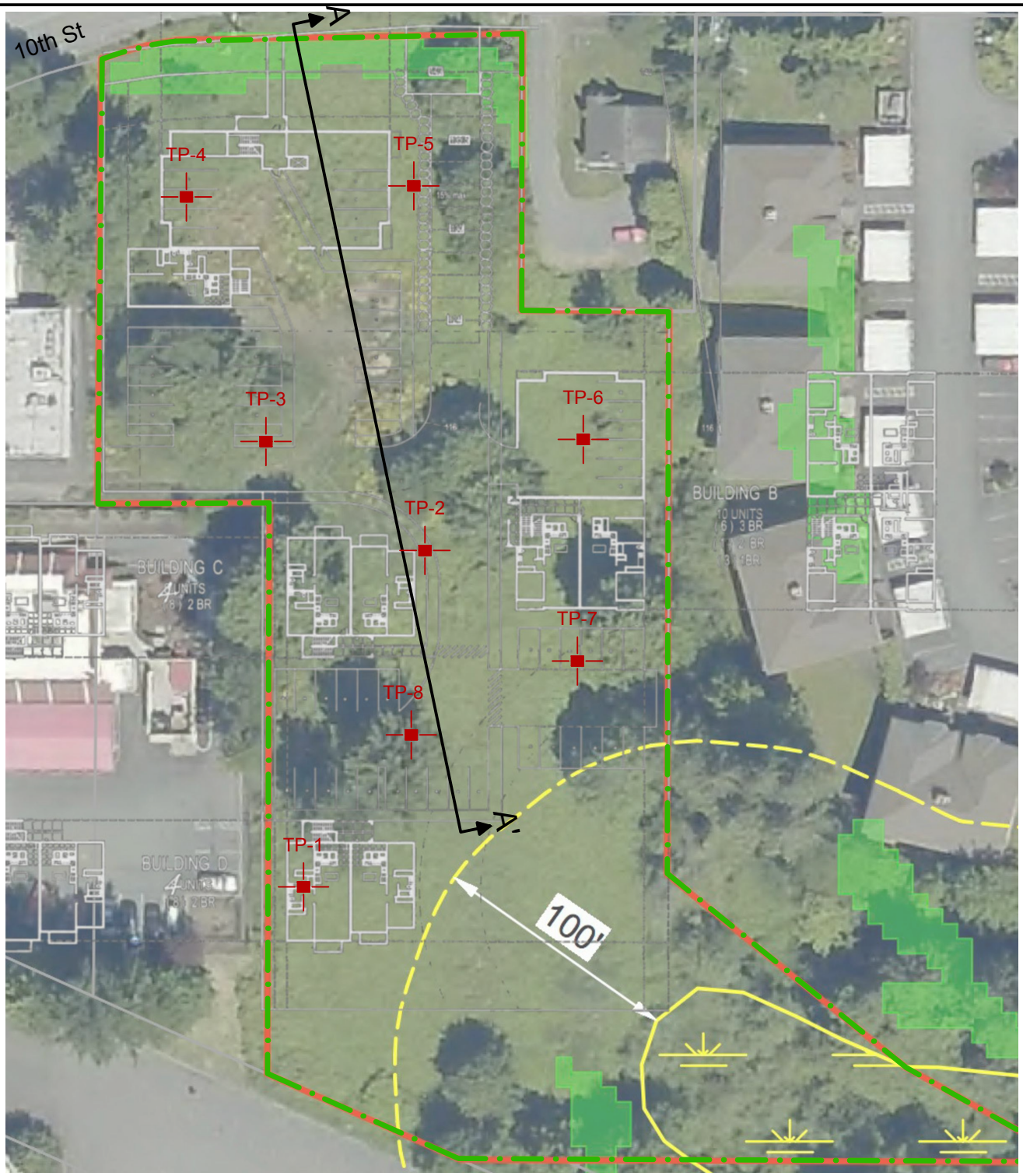

LEGEND

Property line

TP-1

Number and approximate location of test pit

A A'

Approximate location of cross-section

0 60 120

Scale: 1 inch = 60 feet

Reference: Site Plan based on a plan dated March 22, 2016 titled "NE 13th Street Short Plat," provided by Jeremy Sather with LDC, Inc.

Project Number 1032418	10th Street Apartments Site Plan	Nelson Geotechnical Associates, Inc. NGA Geotechnical Engineers & Geologists	No.	Date	Revision	By	CK
Figure 2			1	4/9/18	Original	DPN	ABR

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Project Number
1032718

Figure 3

10th Street Apartments
Cross-Section A-A'

NELSON GEOTECHNICAL ASSOCIATES, INC.
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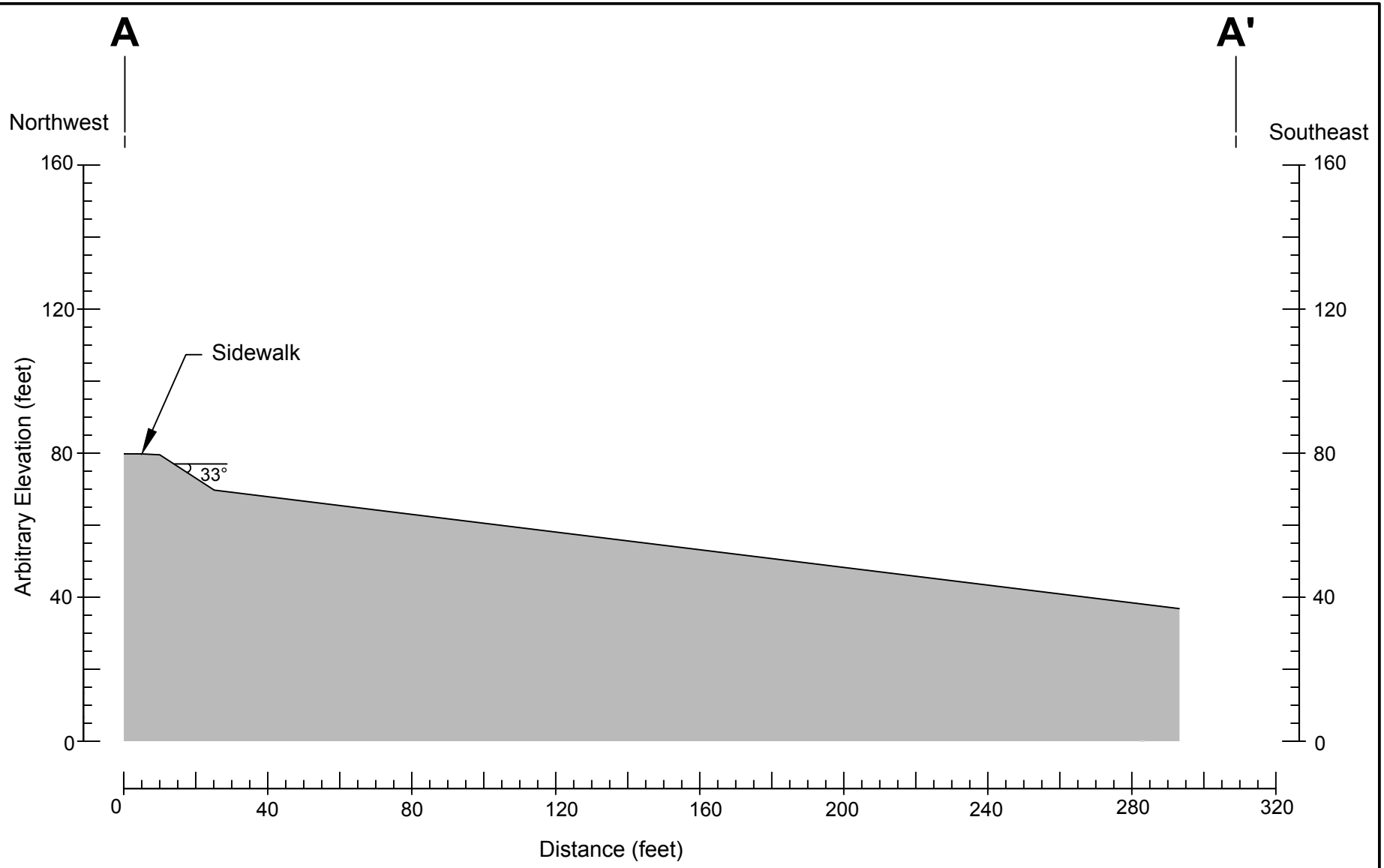

Exploration

Test Pit Designation → TP-1

Groundwater Level During Exploration →

Geologic Contact (approximate) → ?—?

NOTES:
1) Stratigraphic conditions are interpolated between the explorations. Actual conditions may vary.
2) Elevations are arbitrary.

Reference: Cross Section is based on field measurements using a hand-held clinometer and 100-ft tape measure.

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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 1032418	10th Street Apartments Soil Classification Chart	NELSON GEOTECHNICAL ASSOCIATES, INC. NGA GEOTECHNICAL ENGINEERS & GEOLOGISTS
Figure 4		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

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LOG OF EXPLORATION

DEPTH (FEET)	USC	SOIL DESCRIPTION
TEST PIT ONE		
0.0 – 2.7		DARK BROWN TO GRAY-BROWN, SILTY FINE TO MEDIUM SAND WITH GRAVEL, ROOTS, TRACE METAL SCRAPS AND CONCRETE RUBBLE (LOOSE TO MEDIUM DENSE, MOIST) (**TOPSOIL/UNDOCUMENTED FILL**)
2.7 – 7.0	SP-SM	GRAY-BROWN, FINE TO MEDIUM SAND WITH SILT, GRAVEL, AND TRACE IRON-OXIDE STAINING (MEDIUM DENSE TO DENSE, MOIST)
		SAMPLE WAS COLLECTED AT 3.0 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED SLIGHT TEST PIT CAVING WAS ENCOUNTERED FROM 3.0 TO 7.0 FEET TEST PIT WAS COMPLETED AT 7.0 FEET ON 3/28/2018
TEST PIT TWO		
0.0 – 0.7		DARK BROWN, ORGANIC-RICH SILTY FINE TO MEDIUM SAND WITH GRAVEL AND ROOTS (LOOSE TO MEDIUM DENSE, MOIST) (**TOPSOIL**)
0.7 – 3.0	SP-SM	ORANGE-BROWN, FINE TO COARSE SAND WITH GRAVEL, SILT, SCATTERED ROOTS, AND IRON-OXIDE WEATHERING (MEDIUM DENSE TO DENSE, MOIST)
3.0 – 6.0	SP-SM	GRAY, FINE TO COARSE SAND WITH GRAVEL, COBBLES, AND TRACE ROOTS (MEDIUM DENSE TO DENSE, MOIST)
6.0 – 8.0	ML	TAN TO ORANGE-BROWN, SILT WITH FINE TO MEDIUM SAND, IRON-OXIDE STAINING, AND TRACE ROOTS (MEDIUM DENSE TO DENSE, MOIST)
		SAMPLES WERE COLLECTED AT 4.5 AND 8.0 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED SLIGHT TEST PIT CAVING WAS ENCOUNTERED FROM 3.0 TO 6.0 FEET TEST PIT WAS COMPLETED AT 8.0 FEET ON 3/28/2018
TEST PIT THREE		
0.0 – 3.0		DARK BROWN TO REDDISH BROWN, SILTY FINE TO MEDIUM SAND WITH GRAVEL, ROOTS, WOOD DEBRIS, AND TRACE METAL SCRAPS (LOOSE TO MEDIUM DENSE, MOIST) (**TOPSOIL, UNDOCUMENTED FILL**)
3.0 – 7.0	SP-SM	GRAY, FINE TO MEDIUM SAND WITH SILT, TRACE GRAVEL AND IRON-OXIDE STAINING (MEDIUM DENSE TO DENSE, MOIST)
7.0 – 8.0	SP-SM	GRAY, FINE TO COARSE SAND WITH GRAVEL, SILT, COBBLES, AND IRON-OXIDE WEATHERING (MEDIUM DENSE TO DENSE, MOIST)
		SAMPLE WAS COLLECTED AT 4.5 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED SLIGHT TEST PIT CAVING WAS ENCOUNTERED FROM 7.0 TO 8.0 FEET TEST PIT WAS COMPLETED AT 8.0 FEET ON 3/28/2018
TEST PIT FOUR		
0.0 – 1.0		DARK BROWN TO BROWN, SILTY GRAVEL WITH FINE TO MEDIUM SAND, ROOTS, AND ORGANICS (MEDIUM DENSE, MOIST) (**TOPSOIL**)
1.0 – 5.0	GP-GM	GRAY, GRAVELLY FINE TO COARSE SAND WITH SILT, COBBLES, AND TRACE IRON-OXIDE STAINING (MEDIUM DENSE TO DENSE, MOIST)
		SAMPLE WAS NOT COLLECTED GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED SLIGHT TO MODERATE TEST PIT CAVING WAS ENCOUNTERED FROM 1.0 TO 5.0 FEET TEST PIT WAS COMPLETED AT 5.0 FEET ON 3/28/2018

LOG OF EXPLORATION

DEPTH (FEET)	USC	SOIL DESCRIPTION
TEST PIT FIVE		
0.0 – 0.6		DARK BROWN TO REDDISH BROWN, ORGANIC-RICH FINE TO MEDIUM SAND WITH SILT, ROOTS, AND IRON-OXIDE WEATHERING (LOOSE TO MEDIUM DENSE, MOIST) (**TOPSOIL**)
0.6 – 5.5	GP-GM	GRAY, GRAVELLY FINE TO COARSE SAND WITH SILT, IRON-OXIDE STAINING, AND COBBLES (MEDIUM DENSE TO DENSE, MOIST) SAMPLE WAS COLLECTED AT 5.5 FEET GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED SLIGHT TO MODERATE TEST PIT CAVING WAS ENCOUNTERED FROM 0.6 TO 5.5 FEET TEST PIT WAS COMPLETED AT 5.5 FEET ON 3/28/2018
TEST PIT SIX		
0.0 – 2.5		DARK BROWN TO REDDISH BROWN, ORGANIC-RICH SILTY FINE TO MEDIUM SAND WITH ROOTS AND IRON-OXIDE WEATHERING (LOOSE TO MEDIUM DENSE, MOIST) (**TOPSOIL**)
2.5 – 7.0	SP-SM	LIGHT BROWN, FINE TO MEDIUM SAND WITH SILT, TRACE GRAVEL AND ROOTS (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 7.0 FEET ON 3/28/2018
TEST PIT SEVEN		
0.0 – 4.5		BROWN, ORGANIC-RICH SILTY FINE TO MEDIUM SAND WITH GRAVEL, ROOTS, TRACE BRICK FRAGMENTS, AND PLASTIC SCRAPS (LOOSE TO MEDIUM DENSE, MOIST) (**TOPSOIL/UNDOCUMENTED FILL**)
4.5 – 7.0	SM	LIGHT BROWN TO ORANGE-BROWN, SILTY FINE TO MEDIUM SAND WITH GRAVEL, IRON-OXIDE STAINING, AND TRACE ROOTS (MEDIUM DENSE TO DENSE, MOIST)
7.0 – 8.0	SP-SM	GRAY, FINE TO MEDIUM SAND WITH SILT (MEDIUM DENSE TO DENSE, MOIST) SAMPLE WAS NOT COLLECTED GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED TEST PIT CAVING WAS NOT ENCOUNTERED TEST PIT WAS COMPLETED AT 8.0 FEET ON 3/28/2018
TEST PIT EIGHT		
0.0 – 2.0		DARK BROWN, SILTY FINE TO MEDIUM SAND WITH ROOTS, ORGANICS, GRAVEL, AND TRACE BRICK FRAGMENTS (LOOSE TO MEDIUM DENSE, MOIST) (**UNDOCUMENTED FILL**)
2.0 – 3.0	SM	LIGHT BROWN TO ORANGE-BROWN, SILTY FINE TO MEDIUM SAND WITH GRAVEL, IRON-OXIDE STAINING, AND TRACE ROOTS (MEDIUM DENSE TO DENSE, MOIST) SAMPLE WAS NOT COLLECTED GROUNDWATER SEEPAGE WAS NOT ENCOUNTERED TEST PIT CAVING WAS NOT ENCOUNTERED TEST PIT WAS COMPLETED AT 3.0 FEET ON 3/28/2018