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November 30, 2018

Mr. John Robinett
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Geotechnical Engineering Evaluation
Tokatee Property Residential Development
17819 - 25th Avenue NE
Marysville, Washington
NGA Project No. 1063418

Dear Mr. Robinett:

We are pleased to submit the attached report titled **"Geotechnical Engineering Evaluation – Tokatee Property Residential Development – 17819 - 25th Avenue 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 October 22, 2018.

The site is composed of two properties that are currently occupied by a vacant shop structure within the northern portion of the site. The remaining portions of site are covered with grass and miscellaneous vegetation. The ground surface throughout the site is relatively level. We understand that the proposed development will likely include removal of the existing site structures and subdividing the properties into 36 separate lots along with construction of associated access roadways. We also understand that new single-family residences, along with underground utilities, would be constructed in the individual lots and roadways, respectively. Specific grading and stormwater handling plans were not available at the time this report was prepared. However, we do understand that stormwater generated within the property may be directed to onsite infiltrations systems, if feasible.

We monitored the excavation of eight test pit explorations within the site on November 5, 2018. Our explorations indicated that the site was underlain by competent, native glacial outwash soils at depth, below a surficial layer of topsoil and/or undocumented fill.

We have concluded that the site planned development is feasible. We have recommended that the new structures be founded on the medium dense or better native glacial soils for bearing capacity and settlement considerations. These soils should generally be encountered approximately one to three feet below the existing ground surface, based on our explorations. However, deeper areas of loose soil and/or undocumented fill could also exist within unexplored areas of the site.

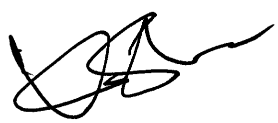
Infiltration analysis in accordance with the Washington State Department of Ecology 2014 Stormwater Management Manual for Western Washington was also performed. The subsurface soils generally consisted of light brown to gray, fine to coarse sand with generally low silt content. Due to the granular nature of the site soils and the soils be classified as recessional outwash, infiltration rates were determined by performing several grain size analyses on samples obtained at various depths throughout the site. Based on our laboratory analyses and the granular nature of the native outwash soils encountered throughout the site, it is our opinion that shallow stormwater infiltration systems are feasible within this site.

In the attached report, we have also provided general recommendations for site grading, foundation support, slabs-on-grade, retaining walls, 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 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

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Tokatee Property Residential Development
17819 – 25th Avenue NE
Marysville, Washington

INTRODUCTION

This report presents the results of our geotechnical engineering investigation and evaluation of the planned Tokatee Property Residential Development project. The project site is located at 17819 – 25th Avenue 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 site is composed of two properties that are currently occupied by a vacant shop structure within the northern portion of the site. The remaining portions of site are covered with grass and miscellaneous vegetation. The ground surface throughout the site is relatively level. We understand that the proposed development will likely include removal of the existing site structures and subdividing the properties into 36 separate lots along with construction of associated access roadways. We also understand that new single-family residences, along with underground utilities, would be constructed in the individual lots and roadways, respectively. Specific grading and stormwater handling plans were not available at the time this report was prepared. However, we do understand that stormwater generated within the property may be directed to onsite infiltrations systems, if feasible. The proposed site layout is shown on the 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. Review available soil and geologic maps of the area.
2. Explored the subsurface soil and groundwater conditions within the site with trackhoe-excavated test pits. Trackhoe was subcontracted by NGA.
3. Conduct laboratory analyses on selected soil samples, as needed.
4. Provide recommendations for earthwork, foundation support, and slab on grade subgrades.
5. Provide recommendations for pavement subgrade preparation.
6. Provide recommendations for temporary and permanent slopes.
7. Determine feasibility of on-site stormwater infiltration.
8. Provide long-term design infiltration rates based on grain-size analysis per the 2014 DOE Stormwater Manual.

9. Install piezometers within the test pit explorations throughtout the site, as needed. Gravel backfill and well materials was provided by NGA.
10. Provide recommendations for infiltration system installation.
11. Provide recommendations for site drainage and erosion control.
12. Document the results of our findings, conclusions, and recommendations in a written geotechnical report.
13. Provide monthly groundwater level monitoring during the rainy season months or longer as required by the City of Marysville, as requested.

SITE CONDITIONS

Surface Conditions

The site consists of two, relatively level and rectangular-shaped parcels covering a total area of approximately 4.93 acres. The property is currently occupied with a shop structure within the north-central portion of the property. The property is vegetated with grass, underbrush, and young to mature trees. The site is bounded to the north, south, and east by existing residential properties, and to the west by 25th Avenue NE. We did not observe surface water throughout the site during our site visits on November 5, 2018 and November 28, 2018.

Subsurface Conditions

Geology: The geologic units for this area are shown in the Geologic map of the Arlington West 7.5 minute Quadrangle, Snohomish County, Washington, by James P. Minard (1985). The site is mapped as Marysville Sand Member (Qvrm). The Marysville sand is described as a mostly well-drained, stratified to massive outwash sand. Our explorations generally encountered a surficial layer of topsoil and/or fill underlain by medium dense to dense, fine to medium sand with gravel, cobbles, and relatively low silt content, consistent with the description of Marysville sand soils at depth.

Explorations: The subsurface conditions throughout the site were explored on November 5, 2018 by excavating eight test pits to depths ranging from 7.0 to 9.0 feet below the existing ground surface using a mini-trackhoe. The approximate locations of our explorations are shown on the 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 explorations.

The soils were visually classified in general accordance with the Unified Soil Classification System, presented in Figure 3. The logs of our test pits are attached to this report and are presented as Figures 4 and 5. We present a brief summary of the subsurface conditions in the following paragraph. For a detailed description of the subsurface conditions, the test pit logs should be reviewed.

At the surface of each exploration, we generally encountered approximately 1.5 to 2.0 feet of brown to dark brown, organic-rich silty fine to medium sand with gravel, roots, and trace plastic, which we interpreted as topsoil and/or undocumented fill soils. Underlying the topsoil and undocumented fill soils in all of our explorations, we generally encountered medium dense to dense, orange-brown to gray fine to coarse sand with varying amounts of silt and gravel that we interpreted as native Marysville outwash sand. Test Pits 1 through 8 were terminated within the native outwash soils at depths in the range of 7.0 to 9.0 feet below the existing ground surface.

Hydrogeologic Conditions

Moderate to severe groundwater seepage was encountered in all of our explorations at a depth of 5.8 to 7.5 feet below the ground surface. We interpret this groundwater to be associated with the regional groundwater table within the area. We would expect the levels of groundwater to slightly decrease during drier times of the year and increase during wetter periods. We installed four piezometers within Test Pits 2, and 6 through 8; since groundwater was encountered at depths as shallow as 5.8 feet during our site visit on November 5, 2018. Please refer to the Site Plan in Figure 2 for piezometer monitoring well locations. We returned to read the depth of the groundwater within the wells again on November 28, 2018 and obtained water levels of 4.7, 5.2, 5.1, and 5.2 feet below the existing ground surface within Monitoring Wells 1 through 4. Due to our explorations being performed within the fall months, we anticipate groundwater levels to likely rise during wetter periods. The seasonal high groundwater elevation would need to be determined in the wetter winter months by monitoring the groundwater piezometers during that time.

SENSITIVE AREA EVALUATION

Seismic Hazard

The 2018 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 2018 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 – 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	1.091	0.426	1.064	1.574	0.773	0.447

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.

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) classifies the site as Lynnwood loamy sand, 0 to 3 percent slopes. Based on our experience in the area and our observations in the field, it is our opinion that the site would have a slight erosion hazard for areas where the soils are exposed. It is our opinion that the erosion hazard for site soils should be low in areas where vegetation is not disturbed.

LABORATORY ANALYSIS

We performed four grain-size analyses on a selected soil samples obtained from the site. The laboratory test was performed on samples taken from Test Pit 1 at 3.5 feet, Test Pit 2 at 8.0 feet, Test Pit 4 at 4.0 feet, and Test Pit 5 at 5.5 feet. In general, the soils tested are classified as fine to coarse sand with gravel and trace silt. The results of the sieve analysis are presented as Figures 6 through 9.

CONCLUSIONS AND RECOMMENDATIONS

General

It is our opinion, from a geotechnical standpoint, that the site planned development is feasible. Our explorations indicated that the site was underlain by a surficial topsoil and/or undocumented fill soils with competent glacial outwash soils at relatively shallow depths. The native glacial soils should provide adequate support for foundation, slab, and pavement loads. We recommend that the new structures be designed utilizing shallow foundations. Footings should extend through any loose soil, and be founded on the underlying medium dense or better native bearing soil, or structural fill extending to these soils. The competent soil should typically be encountered approximately one to three feet below the existing surface. We should note that deeper areas of unsuitable soils and/or undocumented fill could be encountered in the unexplored areas of the site. This condition, if encountered, would require deeper excavations in foundation, slab, and pavement areas to remove the unsuitable soils.

It is our opinion that the native, granular outwash soils encountered at depth within our explorations are suitable for stormwater infiltration. However, we did encounter the regional groundwater table at approximately 5.8 to 7.5 feet below the exitsing ground surface during our site visit on November 5, 2018 and between approximately 4.7 and 5.2 feet below the existing ground surface on November 28, 2018. The stormwater manual recommends a five-foot separation between the base of an infiltration system and any underlying bedrock, impermeable horizon, or groundwater. Based on our experience within the vicinity of the site, it is our opinion that the observed groundwater table is greatly influenced by precipitation and varies throughout the year. Based on our observations within our explorations and experience in the nearby vicinity, it is our opinion that the seasonal high groundwater table may be as shallow as 3.0 to 4.0 feet below the existing ground surface. However, this would need to be verified by monitoring the groundwater levels during the wet season. As such, we have installed four piezometers in Test Pits 2 and 6 through 8 in order to monitor the groundwater level during the wetter period of the year, as warranted.

To provide the greatest separation from the seasonal high groundwater level, we recommend that any proposed infiltration systems consist of shallow systems such as rain gardens and/or bio-retention swales. We recommend that the base of the systems be as shallow as possible but should be founded within the native granular soils encountered at relatively shallow depths throughout the site. Specific recommendations regarding these shallow infiltration systems are included in the **Shallow Infiltration System Design** subsection of this report.

The separation of the proposed infiltration system and the seasonal high groundwater levels can be reduced provided additional analyses are performed. In our experience for the project vicinity, it is commonly necessary to conduct winter season explorations or monitoring through the wet season to verify seasonal high water levels where limited-separation infiltration design is proposed. This is typically coupled with a mounding analysis to establish minimum separation criteria and to verify the proposed facility operation is viable for the native soils and design infiltration rate. NGA can provide these additional services if required at the request of the client. The client should be aware that additional site characterization and analysis may be required for final infiltration facility design and municipal approval given the subsurface conditions encountered.

The City of Marysville utilizes the 2014 Washington State Department of Ecology Stormwater Management Manual for Western Washington to determine long-term design infiltration rates for the site. 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 type soils that have not been glacially overridden. We performed four grain-size analyses in accordance with the manual to determine the infiltration capabilities of the site soils. Based on the tests, it is our opinion that on-site infiltration of stormwater runoff into the native granular outwash soils should be feasible. A long term design infiltration rate of 10.0 inches per hour should be used in the design of the stormwater handling systems within this site. We have included details of our on-site infiltration testing in the **Infiltration Testing** subsection of this report.

Erosion Control

The erosion hazard for the on-site soils is interpreted to be slight 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 removing loose soils, topsoil, and any undocumented fill from foundations, slab, and pavement areas, to expose medium dense or better native glacial soils at depth. The stripped soil should be removed from the site or stockpiled for later use as a landscaping fill. Based on our observations, we anticipate native, medium dense or better bearing soil to be encountered at approximately one to three feet across the site. We should note that deeper areas of unsuitable soils and/or undocumented fill could be encountered in the unexplored areas of the site. This condition, if encountered, would require deeper excavations in foundation, slab, and pavement areas to remove the unsuitable soils. After site preparation, 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 foundation areas, the loose soils should be removed and replaced with rock spalls. 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 grading techniques might be necessary. These techniques 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.

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 on-site soils be no steeper than 2 Horizontal to 1 Vertical (2H:1V). If significant groundwater seepage or surface water flow were encountered, we would expect that flatter inclinations would be necessary. Excavations below the water table will require temporary shoring in the form of trench boxes along with dewatering. This should be determined during final design based on depths and location of deeper excavations. .

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 3H: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 bearing soils, or be supported on structural fill or rock spalls extending to those soils. Medium dense soils should be encountered approximately one to three feet below ground surface based on our explorations. We should note that deeper areas of unsuitable soils and/or undocumented fill could be encountered in the 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. The over-excavation may be filled with structural fill, or the footing may be extended down to the competent native bearing soils. If footings are supported on structural fill, the fill zone should extend outside the edges of the footing a distance equal to one half of the depth of the over-excavation below the bottom of the footing.

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 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 rock spalls 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. 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 may be suitable for use as structural fill depending on the moisture content of the soil during 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. 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 is optional, and is intended to 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 or crushed rock. We should be retained to observe the proof-rolling and recommend subgrade 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% 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. Utility excavations below the water table will require temporary shoring in the form of trench boxes and also dewatering. This should be determined during final design based on depths and locations of underground utilities. Trench backfill compaction should be tested.

Infiltration Testing

We performed four grain-size analyses on selected soil samples obtained within the site in accordance with the 2014 Washington State Department of Ecology (WSDOE) Stormwater Management Manual for Western Washington. Test Pit 1 at 3.5 feet, Test Pit 2 at 8.0 feet, Test Pit 4 at 4.0 feet, and Test Pit 5 at 5.5 feet. The results of the sieve analyses are presented as Figures 6 through 9. Based on the laboratory analysis, the soils encountered in our explorations within the proposed infiltration area meet the classification of sand in the USDA Textural Triangle.

An equation provided in Section 3.3.6.3 of the 2014 WSDOE 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 40.06 to 502.08 inches/hour were calculated. We also referenced Table 3.3.1 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 0.90, 0.40, and 0.90 were utilized in this equation for CF_v, CF_t, CF_m, respectively. Using these correction factors, we applied it to the most conservative rate obtained from the grain-size analysis calculations which is 40.06 inches per hour, and calculated a long-term design infiltration rate of 12.98 inches per hour. We recommend utilizing a maximum infiltration rate of 10.0 inches per hour for the design on-site infiltration systems founded within the granular native outwash sand soils encountered at depth within the property. We recommend that any infiltration systems be extended down through any unsuitable undocumented fill soils or topsoils and founded within the clean native granular outwash soils. Based on our explorations, the native granular outwash soils should be encountered at depths in the range of one to three feet 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.

Shallow Infiltration System Design

Due to the potential for relativley shallow seasonal high groundwater within the site, we recommend that any infiltration systems proposed for the development consist of shallow infiltration systems such as rain gardens or bio-retention swales to maintain adequate separation from the seasonal high groundwater. We recommend that the rain gardens and bio-retention swales be designed and sized in accordance with the 2014 WSDOE Stormwater Management Manual for Western Washington utilizing the above recommended long-term design infiltration rate. The base of the shallow infiltration systems should be extended through the upper silty soils and down to expose the granular outwash soils. Based on our explorations, these granular outwash soils should typically be encountered from 1.0 to 3.0 feet below the existing ground surface. Due to the overall depth of the granular outwash soils, the base of the shallow infiltration system may be higher than the granular outwash soils at depth. If this is the case, we recommend that the base of the shallow infiltration system be overexcavated down to expose the granular outwash soils and the overexcavation then backfilled with drain rock up to the base of the infiltration system. Amended soils could then be placed over the drain rock. We also recommend that an appropriate overflow system be incorporated into the design of the shallow infiltration systems if feasible. The inside and outside slopes of the shallow infiltration systems should be no steeper than 3H:1V. The shallow infiltration systems should be covered with erosion control material, as needed, and then planted with vegetation. We should review final infiltration system design and monitor the system installation.

Site Drainage

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 residences. 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 residences. Surface water should be collected by permanent catch basins and drain lines, and be discharged into an approved discharge system.

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. For relatively deep excavations under the groundwater table, more elaborate dewatering systems will be needed. This should be determined by the general contractor based on anticipated depths and site conditions at the time of construction.

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. Pea gravel is an acceptable drain material. The free-draining material should extend up 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 Mr. John Robinett and his 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 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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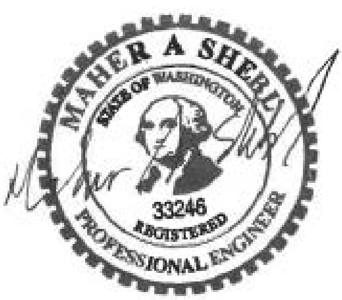
It has been a pleasure to provide service to you on this project. If you have any questions or require further information, please call.

Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.

Lee S. Bellah, LG
Project Geologist



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

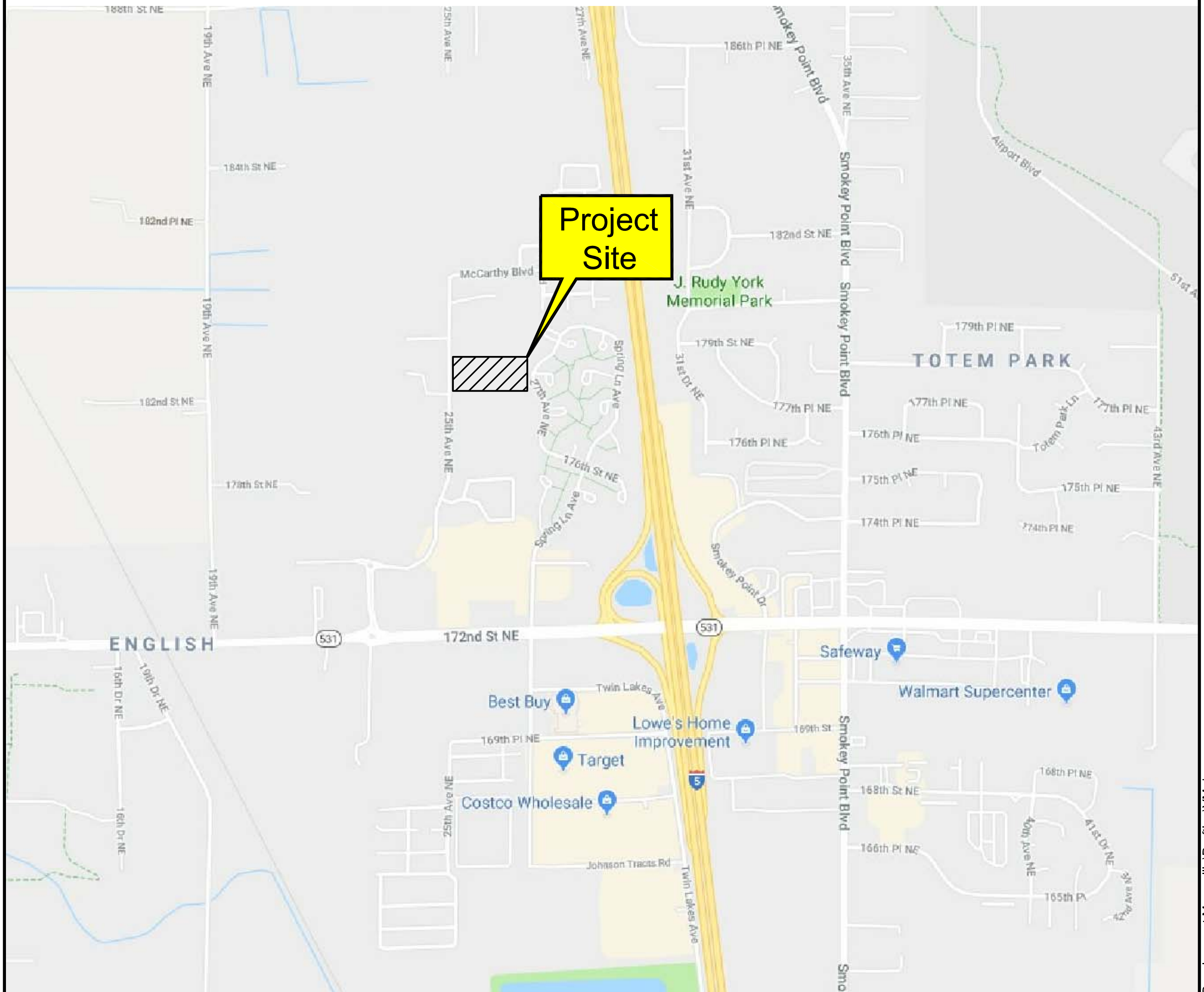
LSB:MAS:dy

Nine Figures Attached

VICINITY MAP

Not to Scale

N



Marysville, WA

Project Number 1063418	Tokatee Property Residential Development Vicinity Map	Nelson Geotechnical Associates, Inc. Geotechnical Engineers & Geologists	No.	Date	Revision	By	CK
Figure 1		Woodinville Office 17311-135th Ave. NE, A-500 Woodinville, WA 98072 (425) 486-1669 / Fax: 481-2510 www.nelsongeotech.com East Wenatchee Office 5526 Industry Lane, #2 East Wenatchee, WA 98802 (509) 665-7696 / Fax: 665-7692	1	11/8/18	Original	DPN	ABR

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Site Plan

LEGEND

Property line

TP-1 — Number and approximate location of test pit

MW-1 — Number and approximate location of monitoring well

0 100 200

Scale: 1 inch = 100 feet

Reference: Site plan based on a plan dated September 11, 2018 titled "Preliminary Plat Map of Prestige," prepared by Land Resolutions.

Project Number 10634-18

Figure 2

Tokatee Property Residential Development Site Plan

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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 1063418	Tokatee Property Residential Development Soil Classification Chart	NELSON GEOTECHNICAL ASSOCIATES, INC.	No.	Date	Revision	By	CK
Figure 3			1	11/8/18	Original	DPN	ABR

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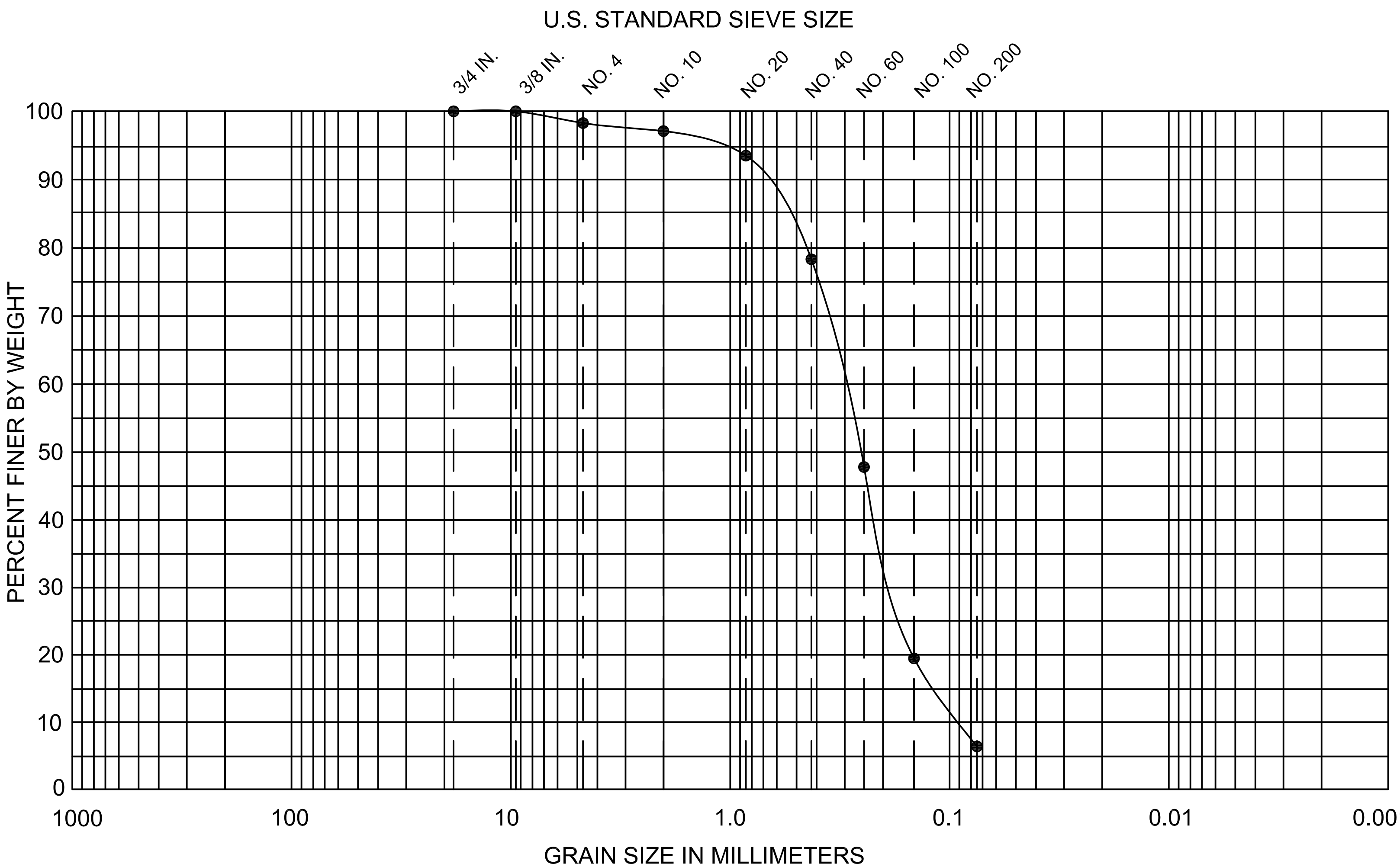
LOG OF EXPLORATION

DEPTH (FEET)	USC	SOIL DESCRIPTION
TEST PIT ONE		
0.0 – 1.5		DARK BROWN TO ORANGE-BROWN, SILTY FINE TO MEDIUM SAND WITH GRAVEL, ROOTS, AND ORGANICS (LOOSE TO MEDIUM DENSE, MOIST) (**TOPSOIL**)
1.5 – 7.0	SP-SM	LIGHT BROWN TO GRAY, FINE TO MEDIUM SAND WITH TRACE SILT, GRAVEL, AND TRACE ROOTS (MEDIUM DENSE TO DENSE, MOIST)
7.0 – 9.0	SP	GRAY, FINE TO COARSE SAND WITH TRACE SILT AND GRAVEL (MEDIUM DENSE TO DENSE, MOIST TO WET)
		SAMPLE WAS COLLECTED AT 3.5 FEET GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 7.5 FEET SLIGHT TO MODERATE TEST PIT CAVING WAS ENCOUNTERED FROM 7.0 TO 9.0 FEET TEST PIT WAS COMPLETED AT 9.0 FEET ON 11/5/2018
TEST PIT TWO		
0.0 – 1.7		DARK BROWN TO ORANGE-BROWN, SILTY FINE TO MEDIUM SAND WITH GRAVEL, ROOTS, ORGANICS, AND TRACE ASH (LOOSE TO MEDIUM DENSE, MOIST) (**TOPSOIL/FILL**)
1.7 – 5.5	SP	LIGHT BROWN TO GRAY, FINE TO MEDIUM SAND WITH TRACE SILT, IRON-OXIDE STAINING, AND TRACE GRAVEL (MEDIUM DENSE TO DENSE, MOIST)
5.5 – 8.0	SP	GRAY, FINE TO COARSE SAND WITH TRACE SILT AND GRAVEL (MEDIUM DENSE TO DENSE, MOIST TO WET)
		SAMPLE WAS COLLECTED AT 8.0 FEET GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 5.8 FEET SLIGHT TO MODERATE TEST PIT CAVING WAS ENCOUNTERED FROM 6.0 TO 8.0 FEET TEST PIT WAS COMPLETED AT 8.0 FEET ON 11/5/2018
TEST PIT THREE		
0.0 – 2.0		DARK BROWN TO ORANGE-BROWN, SILTY FINE TO MEDIUM SAND WITH GRAVEL, ROOTS, ORGANICS, AND TRACE ASH (LOOSE TO MEDIUM DENSE, MOIST) (**TOPSOIL/FILL**)
2.0 – 6.0	SP	LIGHT BROWN TO GRAY, FINE TO MEDIUM SAND WITH TRACE SILT, IRON-OXIDE STAINING, AND GRAVEL (MEDIUM DENSE TO DENSE, MOIST)
6.0 – 7.5	SP	GRAY, FINE TO COARSE SAND WITH TRACE SILT AND GRAVEL (MEDIUM DENSE TO DENSE, MOIST TO WET)
		SAMPLE WAS COLLECTED AT 7.0 FEET GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 6.0 FEET SLIGHT TO MODERATE TEST PIT CAVING WAS ENCOUNTERED FROM 6.0 TO 7.5 FEET TEST PIT WAS COMPLETED AT 7.5 FEET ON 11/5/2018
TEST PIT FOUR		
0.0 – 2.0		DARK BROWN TO REDDISH BROWN, SILTY FINE TO MEDIUM SAND WITH ROOTS AND ORGANICS (LOOSE TO MEDIUM DENSE, MOIST) (**TOPSOIL**)
2.0 – 6.5	SP	LIGHT BROWN TO GRAY, FINE TO MEDIUM SAND WITH TRACE SILT, IRON-OXIDE STAINING, GRAVEL, AND TRACE ROOTS (MEDIUM DENSE TO DENSE, MOIST)
6.5 – 8.0	SP	GRAY, FINE TO COARSE SAND WITH TRACE SILT AND GRAVEL (MEDIUM DENSE TO DENSE, MOIST TO WET)
		SAMPLE WAS COLLECTED AT 4.0 FEET GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 7.5 FEET SLIGHT TO MODERATE TEST PIT CAVING WAS ENCOUNTERED FROM 6.0 TO 8.0 FEET TEST PIT WAS COMPLETED AT 8.0 FEET ON 11/5/2018

LOG OF EXPLORATION

DEPTH (FEET)	USC	SOIL DESCRIPTION
TEST PIT FIVE		
0.0 – 1.6		DARK BROWN, SILTY FINE TO MEDIUM SAND WITH ROOTS, GRAVEL, AND WOOD DEBRIS (LOOSE TO MEDIUM DENSE, MOIST) (**TOPSOIL**)
1.6 – 5.0	SP	LIGHT BROWN TO ORANGE-BROWN, FINE TO MEDIUM SAND WITH TRACE SILT, IRON-OXIDE STAINING, GRAVEL, AND TRACE ROOTS (MEDIUM DENSE TO DENSE, MOIST)
5.0 – 7.0	SP	GRAY, FINE TO COARSE SAND WITH TRACE SILT AND GRAVEL (MEDIUM DENSE TO DENSE, MOIST TO WET)
		SAMPLE WAS COLLECTED AT 5.5 FEET GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 6.6 FEET SLIGHT TO MODERATE TEST PIT CAVING WAS ENCOUNTERED FROM 5.0 TO 7.0 FEET TEST PIT WAS COMPLETED AT 7.0 FEET ON 11/5/2018
TEST PIT SIX		
0.0 – 1.3		DARK BROWN TO ORANGE-BROWN, SILTY FINE TO MEDIUM SAND WITH ROOTS, GRAVEL, AND ORGANICS (LOOSE TO MEDIUM DENSE, MOIST) (**TOPSOIL**)
1.3 – 6.0	SP	LIGHT BROWN TO GRAY-BROWN, FINE TO MEDIUM SAND WITH TRACE SILT, IRON-OXIDE STAINING, GRAVEL, AND TRACE ROOTS (MEDIUM DENSE TO DENSE, MOIST)
6.0 – 8.0	SP	GRAY, FINE TO COARSE SAND WITH TRACE SILT AND GRAVEL (MEDIUM DENSE TO DENSE, MOIST TO WET)
		SAMPLE WAS NOT COLLECTED GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 7.0 FEET SLIGHT TO MODERATE TEST PIT CAVING WAS ENCOUNTERED FROM 6.0 TO 8.0 FEET TEST PIT WAS COMPLETED AT 8.0 FEET ON 11/5/2018
TEST PIT SEVEN		
0.0 – 2.0		DARK BROWN, SILTY FINE TO MEDIUM SAND WITH ROOTS, GRAVEL, AND ORGANICS (LOOSE TO MEDIUM DENSE, MOIST) (**TOPSOIL**)
2.0 – 6.5	SP	LIGHT BROWN, FINE TO MEDIUM SAND WITH TRACE SILT, IRON-OXIDE STAINING, GRAVEL, AND TRACE ROOTS (MEDIUM DENSE TO DENSE, MOIST)
6.5 – 8.0	SP	GRAY, FINE TO COARSE SAND WITH TRACE SILT AND GRAVEL (MEDIUM DENSE TO DENSE, MOIST TO WET)
		SAMPLE WAS COLLECTED AT 7.0 FEET GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 7.0 FEET SLIGHT TO MODERATE TEST PIT CAVING WAS ENCOUNTERED FROM 6.0 TO 8.0 FEET TEST PIT WAS COMPLETED AT 8.0 FEET ON 11/5/2018
TEST PIT EIGHT		
0.0 – 2.0		DARK BROWN, SILTY FINE TO MEDIUM SAND WITH ROOTS, GRAVEL, AND ORGANICS (LOOSE TO MEDIUM DENSE, MOIST) (**TOPSOIL**)
2.0 – 6.0	SP	LIGHT BROWN, FINE TO MEDIUM SAND WITH TRACE SILT, IRON-OXIDE STAINING, GRAVEL, AND TRACE ROOTS (MEDIUM DENSE TO DENSE, MOIST)
6.0 – 8.0	SP	GRAY, FINE TO COARSE SAND WITH TRACE SILT AND GRAVEL (MEDIUM DENSE TO DENSE, MOIST TO WET)
		SAMPLE WAS COLLECTED AT 7.0 FEET GROUNDWATER SEEPAGE WAS ENCOUNTERED AT 7.0 FEET SLIGHT TO MODERATE TEST PIT CAVING WAS ENCOUNTERED FROM 6.0 TO 8.0 FEET TEST PIT WAS COMPLETED AT 8.0 FEET ON 11/5/2018



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-1	3.5 feet	Fine to medium sand with silt and trace gravel	Gravel = 1% Sand = 92% Silt/Clay = 7%

Project Number 1063418
Figure 6

Tokatee Property Residential Development
Sieve Analysis

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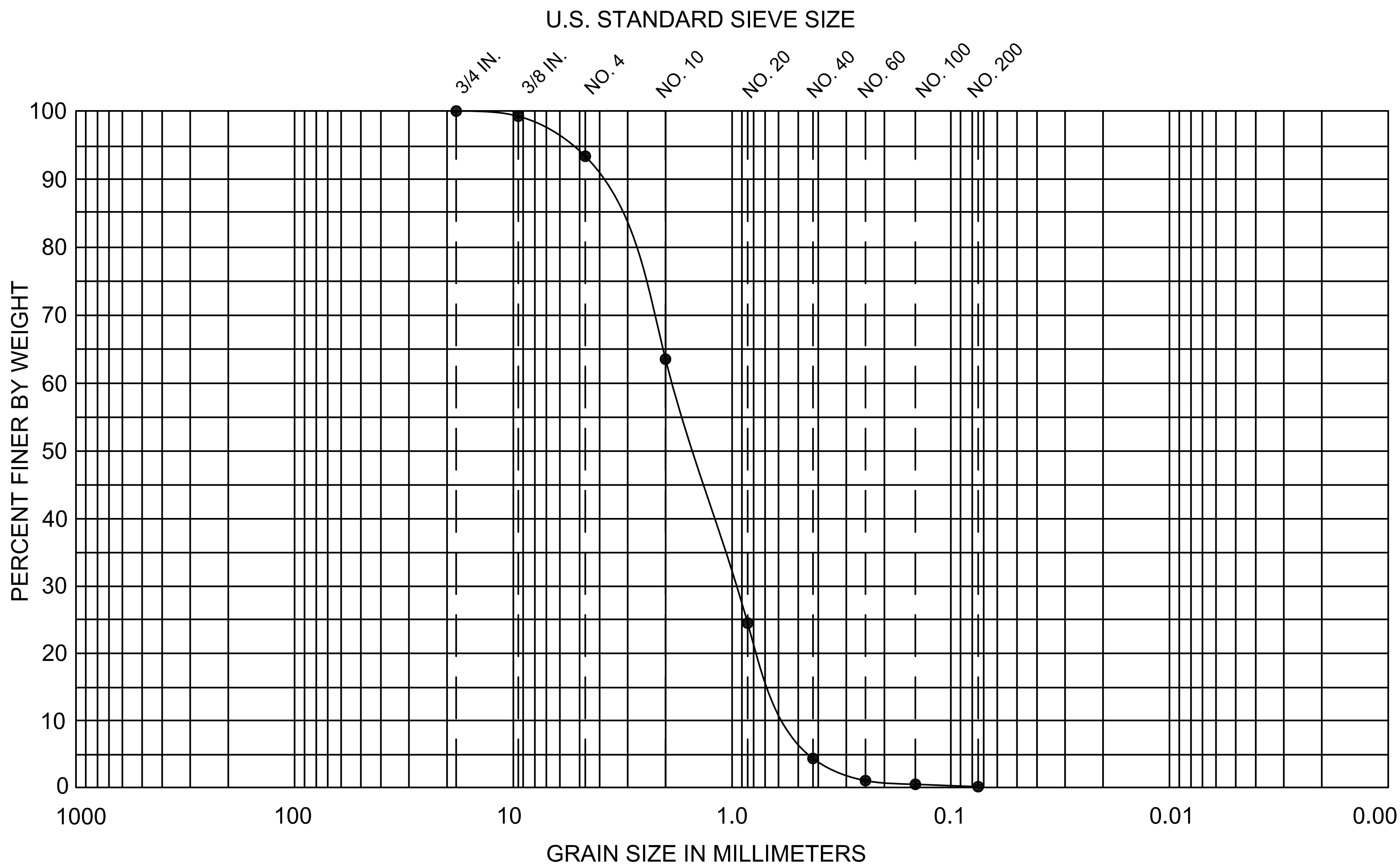

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

U.S.C. SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH	SOIL DESCRIPTION	SOIL DISTRIBUTION
● SP	TP-2	8.0 feet	Medium to coarse sand with trace gravel	Gravel = 12% Sand = 88% Silt/Clay = 0%

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Figure 7

Tokatee Property Residential Development
Sieve Analysis

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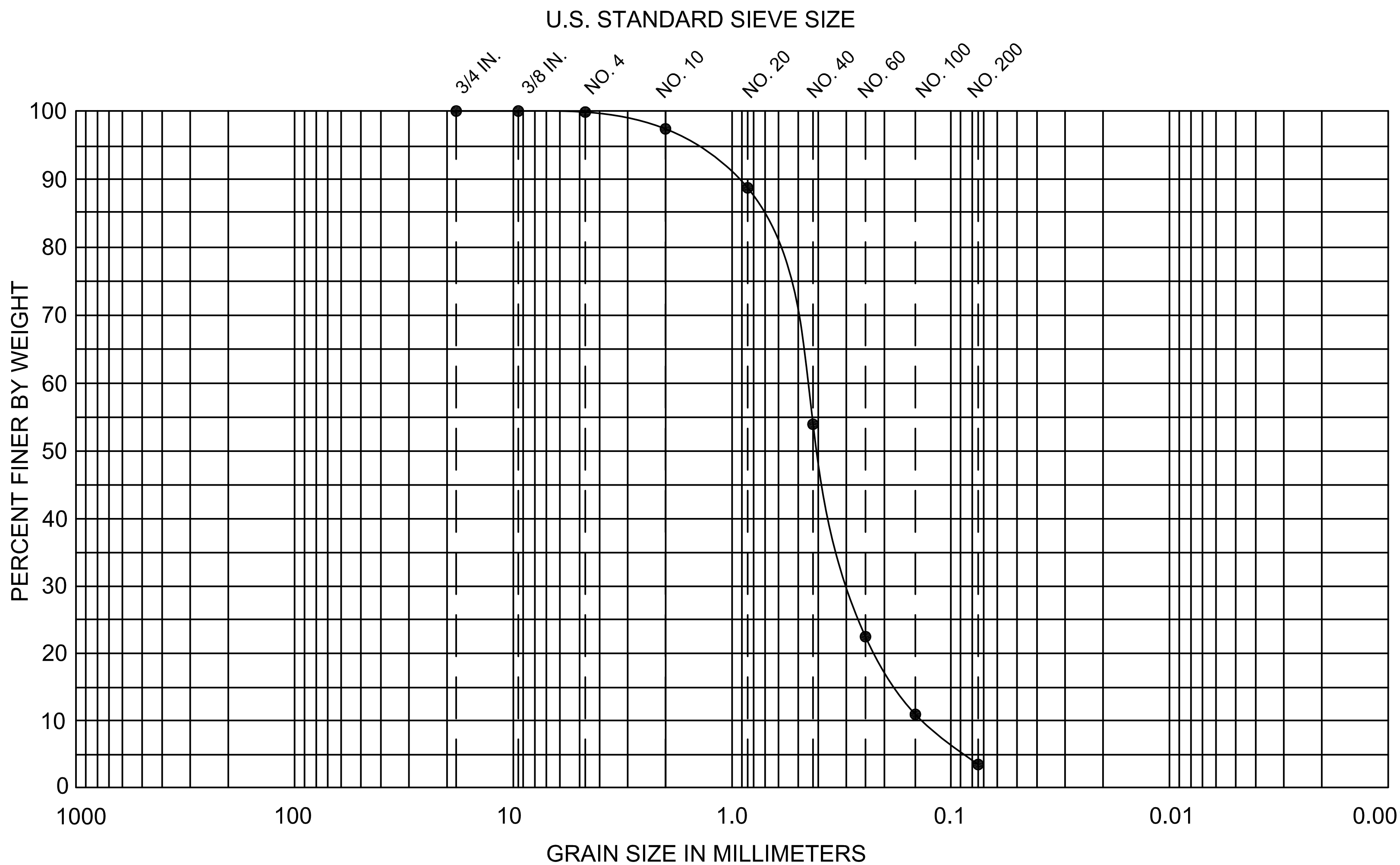

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

U.S.C. SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH	SOIL DESCRIPTION	SOIL DISTRIBUTION
●SP	TP-4	4.0 feet	Fine to medium sand with trace silt	Gravel = 0% Sand = 96% Silt/Clay = 4%

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Figure 8

Tokatee Property Residential
Development
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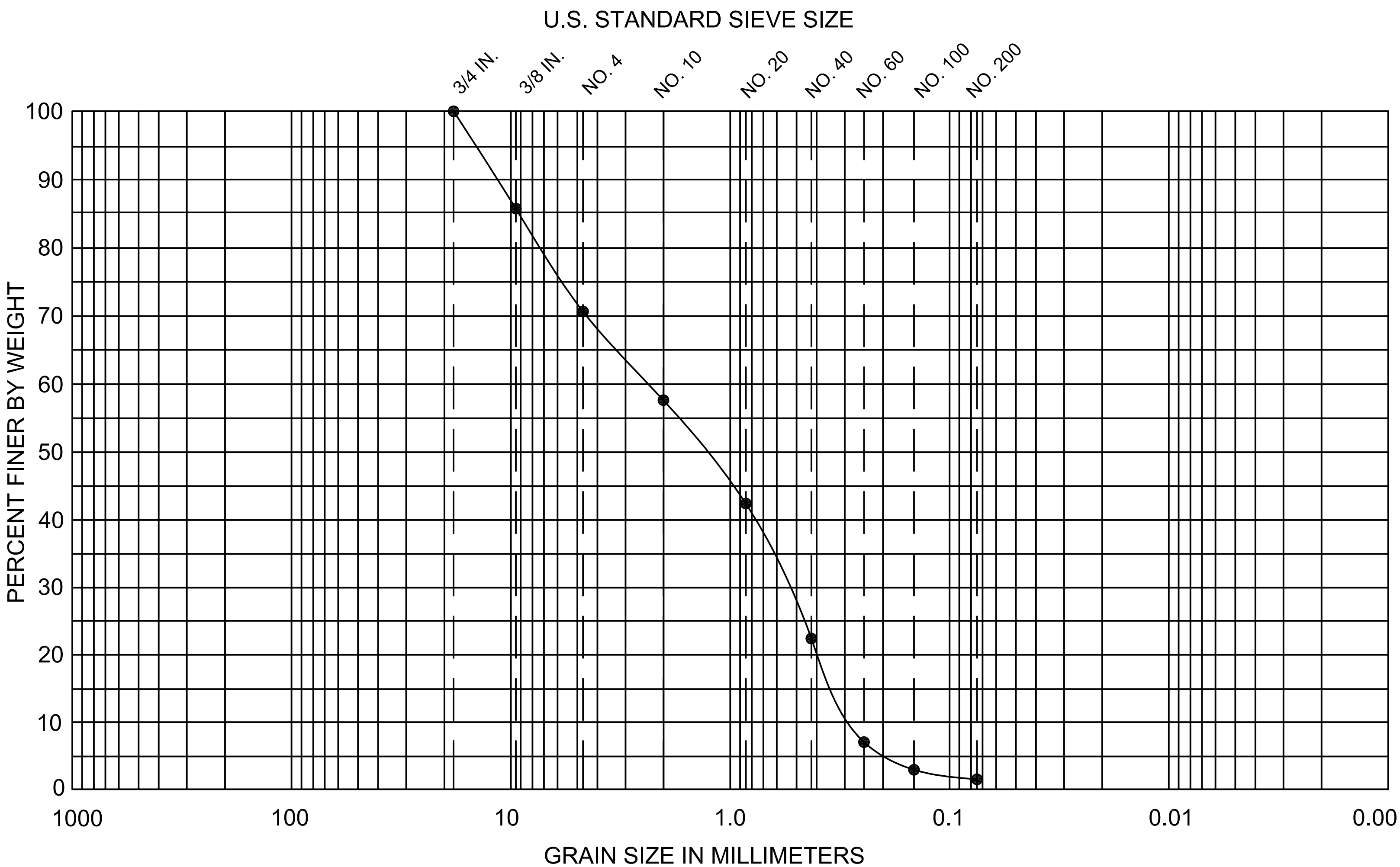

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

U.S.C. SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH	SOIL DESCRIPTION	SOIL DISTRIBUTION
●SP	TP-5	5.5 feet	Fine to coarse sand with gravel and trace silt	Gravel = 29% Sand = 69% Silt/Clay = 2%

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Figure 9

Tokatee Property Residential Development
Sieve Analysis

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