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**Geotechnical Engineering
Construction Inspections
Foundations
Materials Testing**

Date: 6-15-18 REV 1-20-21
Project: 18108 and 18107 -
213th Ave Ct E.
File #: 20-0016 Rev

**Anthony Hicks
9010 Wild Moose Ct. SE
Olympia, WA. 98501**

Attn: Mr. Anthony Hicks

**Re: Geological Assesment- Landslide Hazard Geotechnical Report
18108 and 18107 213th Ave Ct. E
Orting, WA. 98360
Parcel # 0519341042**

INTRODUCTION

This report summarizes the results of our geotechnical report for the Parcel # 0519341042 (Vacant Land) near the town of Orting, WA. The investigation was performed after verbal notification to proceed was received from Mr. Hicks. The location of the site is shown relative to the surrounding area on the vicinity map located in Appendix I.

Our understanding of the project is based on our discussions with Mr. Hicks, our review of the site map, and our site visits/explorations. The subsurface exploration program consisted of digging 8 test pits, performing sieve analysis,(Appendix IV) on samples obtained from the test pits, and reviewing the onsite soils shown in the soil logs as shown in the Appendix III. The test pit locations were observed by our engineer, who collected samples of the soils exposed. The site plan with test hole locations is shown in Appendix II.

The vacant land is located to the east-northeast of the City of Orting. The site currently is vacant and has no known associated septic or water well onsite from our understanding. Proposed locations for potential septic and water wells have been reviewed and approved by the Tacoma Pierce County Health Department.

The results of this investigation, together with our recommendations, are to be found in the following report. The purpose of our services is to evaluate the surface and subsurface conditions at the site as a basis for providing geotechnical recommendations and design criteria for the project and satisfy the requirements of the Pierce County Critical Areas Ordinance.

Specifically, our scope of services for this project will include the following:

1. Review the available geologic, hydro geologic, and geotechnical data for the site area.
2. Conduct a geologic reconnaissance of the site area.
3. Explore the subsurface conditions at the site by digging test pits.
4. Evaluate the landslide and erosion hazards at the site per the Pierce County Critical Areas Ordinance regulations.
5. Provide geotechnical recommendations for site grading including site preparation, subgrade preparation, fill placement criteria (including hillside grading), suitability of onsite soils for use as structural fill, temporary and permanent cut and fill slopes, drainage and erosion control measures.



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SITE CONDITIONS

SURFACE CONDITIONS

The site is located to the east- northeast of Orting, Washington. The proposed layout of the site is shown on the Site Plan, Appendix II.

We conducted a detailed reconnaissance of the site area. At this time we excavated and inspected the test pits (Shown on Site Plan in Appendix II). These test pit boring logs are included in Appendix III. The vertical relief of the project is approximately 210 feet. The site will be accessed from driveways that enter from 213th Ave. Ct. E that transects the center of the parcel. The property is surrounded on all sides by 3 plus acre lots with single family residences on them.

We observed some evidence of slight erosion and rock falls at the time of our site visit. The site is fully vegetated, however some steeper slopes remain exposed from the cut slopes that were made to clear the way for 213th Ave. Ct. E. through the parcel. There is some evidence of slight surficial sloughing. No evidence of deep-seated slope instability was observed in the site area at the time of our site visit.

The majority of the site is currently covered in trees and ground cover vegetation. This vegetation includes blackberry bushes, vine maple, and ferns.

GEOLOGIC CONDITIONS

The geology of the area as compared to the “USDA Soil Conservation Service (SCS), Soil Survey of Pierce County Area, Washington. 1979” was consistent with the materials found onsite. The area is mapped as a Barneston gravelly coarse SANDY loam (3D) and Barneston gravelly coarse SANDY loam (3E). These soils formed in gravelly glacial outwash under conifers along the foothills of the Cascades. The existing topography, as well as the surficial and shallow subsurface soils in the area is the result of the most recent Vashon stade of the Frasier glaciations of 12,000 to 15,000 years ago, and weathering and erosion that has occurred since. A description of the surficial soils is included in the “Site Soils” section of this report.

CLIMATE OF AREA

The climate of the site and surrounding area as taken from the USDA Soil Conservation Service Survey 1979 consists of a moderate climate; the mean annual air temperature is about 50 degrees F. The average annual precipitation is 45-70 inches. The frost-free season is about 180 days.

SITE SOILS

The USDA Soil Conservation Service (SCS), Soil Survey of Pierce County Area, Washington. 1979 has mapped the site soils as Barneston gravelly coarse SANDY loam (3D) and Barneston gravelly coarse SANDY loam (3E). The SCS classifies the Barneston gravelly coarse SANDY loam (3D and 3E) as having a rapid permeability. A low available water capacity. Surface runoff is medium (3D) to rapid (3E), and there is a moderate erosion hazard for the 3D soils and severe erosion hazard for the 3E soils due to slope limitations. According to the SCS, these soils only have building limitations due to slopes. We observed some active erosion but no major slope disturbance in the site area during our reconnaissance.



SUBSURFACE EXPLORATIONS

Subsurface conditions at the site were evaluated by excavating 8 test pits with an excavator. The test pits extend to depths ranging from 3 to 10 feet below existing ground surface. The approximate locations of the test pits are indicated on the attached Site Plan, Appendix II. Some locations were not accessible during our site investigation due to lack of adequate access.

Our engineer inspected the test pits, maintained logs of the subsurface conditions, and obtained representative samples, as needed. The soils encountered were visually classified in accordance with ASTM D-2488. All of the boring logs from the test pits are included in Appendix III. Laboratory testing results of select samples taken from the test holes is located in Appendix IV.

SUBSURFACE CONDITIONS

The subsurface conditions at the site consisted of sands, gravels, and cobbles at various depths. The gravelly coarse sand loam soils were encountered in all 8 test pits. The gravelly coarse sandy loam thickness is greater than 8 feet in the locations of our test pits. These depths were determined as a result of the extent of our test pits. Due to the presence of cut slopes and exposed soils along the roadway, visible observations were made for soils makeup and that was compared to adjacent test hole data in order to provide a more accurate account of the actual geologic conditions. The site soils are determined to be rather homogenous and consistent with the SCS classification.

No groundwater seepage was observed in our test pits. Based on the near surface soils perched groundwater conditions are not probable. The slope was visually inspected for any evidence of a perched water table. No signs of water seepage were found on the slope.

SLOPE STABILITY

The Barneston gravelly coarse sandy loam soils (3D and 3E) are located throughout the entire project area.

Slopes as steep as 80 percent were observed in places on the project site. Approximate site slopes are shown on the site plan, in Appendix II.

The sites of the proposed single-family residences will be created on either side of 213th Ave Ct. E. (roadway) after sufficient grading has been completed. The roadway dissects the site leaving approximately 1/2 of the property to the west and the other 1/2 to the east of the roadway, the site slopes on either side are between 20 to 80 percent. Specifically the slopes adjacent to the roadway were cut at some point in the past to allow for the roadway to go through and in most cases are 50 to 65 percent slopes. On the west half of the parcel, the west facing slope has site slopes that are between 40 to 80 percent (Represented by cross section A to A' on our Slope Model shown in Appendix VI). The west half of the parcel, the east facing slope has site slopes that are between 20 to 60 percent (Represented by cross section B to B' on our Slope Model shown in Appendix VI). On the east half the west facing slope has site slopes between 20 to 60 percent (Represented by cross section C to C' on our Slope Model shown in Appendix VI). The roadway (213th Ave. Ct. E.) that runs down the middle of the parcel and accesses the site currently has slopes of up to 20 percent however after grading is completed it will have slopes of less than 12 percent.

The site will need to undergo grading activities that will change the slopes on both sides of the roadway and in the roadway.

The shear strength value (phi angle) of the Barneston soils which are found throughout the site is assumed to be 28 degrees as determined by published data for similar soil types.



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No immediate evidence of deep-seated landslide activity or significant erosion was observed at the site at the time of our site visits. Some signs of rock fall were present as evidenced by large cobbles and boulders near the slope bottoms or level areas along the slope. Weathering, erosion, and the resulting surficial erosion, sloughing and shallow land sliding are natural processes that can affect steep slope areas. Instability of this nature is typically confined to the upper weathered or disturbed zone, which has been disturbed and has a lower strength. Evidence of slight local surficial erosion, raveling and sloughing were observed in the site area at the time of our visit. This appears to be due to the artificial steepening of the cut slopes where the roadway was put in.

Weathering typically occurs in the upper 2 to 3 feet and is a result, of root penetration, wet/dry cycles, and freeze/thaw cycles. Erosion control should be implemented during the construction of the site. Stabilization of all slopes exposed during construction is essential to erosion control. It is also recommended that all finished slopes over 25% be roughened (tracked BMP C130) or have an erosion control mulch placed on the slope (BMP E 1.15) if vegetation is stripped from the site. With the site slopes in their current configuration a single point discharge of any water is not advised. If water is to be discharged towards any slope some form of dispersion shall be used to reduce the velocity of the point discharge.

HYDROLOGIC CONDITIONS

Groundwater was not encountered in any of the borings. We did not locate any seeps on the faces of any of the site slopes. The native gravelly coarse sandy soils are rapid draining. Site stormwater can be directly percolated into the site soils using splash blocks or sloped to a vegetative buffer in accordance with the current Pierce County Stormwater Manual. Due to the rapid permeability and the depth of the soil it is not anticipated to adversely affect the slope stability of the site (i.e. excess pore pressures on slope soils).

SITE INFILTRATION

According to the USDA Soil Conservation Service (SCS), Soil Survey of Pierce County Area, Washington. 1979 Table 11 "Physical and Chemical Properties of Soils" the Barneston gravelly coarse sandy loam (3D and E) has a typical permeability of greater than 20 inches per hour, at 13 to 60 inches below subgrade.



CONCLUSIONS AND RECOMMENDATIONS

GENERAL

Based on the results of our site reconnaissance, laboratory testing, subsurface exploration program, and our experience in the area, it is our opinion that the site is suitable for construction. The conclusions contained within this report is to address the potential of a landslide/erosion hazard as indicated by the Pierce County Planning and Land Services Critical Areas Ordinance as it pertains to the subject property.

Currently the proposed location of the single family residence structures and associated out buildings that may include a future barn and shop/garage have not been specifically sited. A more general location has been cited however, this location may change. The proposed location of single family residence and outbuildings is shown on the site plan found in Appendix II.

After the recommended site grading has occurred, all areas will be stable relative to deep-seated failure and should not be affected by the proposed construction if the recommendations within this report are followed. For areas of cut and fill the recommendations contained within this report should be adhered to for placement of the fill materials. Proper erosion/sediment and drainage control measures will reduce or eliminate the potential for erosion in these areas, and improve slope stability.

We do feel that roof stormwater runoff can be directed to splash blocks and then directly infiltrated into the site soils for disposal. A vapor barrier is recommended for all construction that consists of slabs on grade.

LANDSLIDE- HAZARD AREAS INDICATORS

Classification

The Pierce County Critical Areas Ordinance defines a landslide hazard area as areas potentially subject to mass movement due to a combination of geologic, seismic, topographic, hydrologic, or man made factors. Landslide hazard area can be identified by the presence of any of the following indicators. 1) Areas of historic failures, including areas of unstable, old, and recent slides or landslide debris within a head scarp. or 2) Areas with active bluff retreat that exhibit continuing sloughing, or calving of bluff sediments, resulting in a vertical or steep bluff face with little or no vegetation. or 3) Slopes steeper than 20 percent with a vertical relief of 20 feet or more and hillsides that intersect geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock. or 4) slopes that are parallel or sub-parallel to planes of weakness, such as bedding planes, joint systems, fault planes in subsurface materials. or 5) Areas exhibiting geomorphological features indicative of past slope failure, such as hummocky ground, back-rotated benches on slopes. or 6) Areas with tension cracks or ground fractures along and/or near the edge of the top of a bluff or ravine. or 7) Areas with structures that exhibit structural damage such as settling and cracking of building foundations or separation of steps or porch from a main structure that located near the edge of a bluff or ravine. or 8) the occurrence of toppling, leaning, bowed, or jackstrawed trees that are caused by the disruption of the ground surface by active movement. or 9) Areas with slopes containing soft or liquefiable soils. or 10) Areas where gullying and surface erosion have caused dissection of the bluff edge or slope face as a result of drainage or discharge from pipes, culverts, ditches, and natural drainage courses. or 11) Areas where seeps or springs or indicators (e.g. vegetation types) of a shallow groundwater table are observed on or adjacent to the face of the slope. or 12) Any area with a slope of 40 percent or steeper and with a vertical relief of 15 or more feet, except those manmade slopes created under the design and inspection of a geotechnical professional or slopes composed of competent bedrock. 13) Areas that are at risk of mass movement due to a seismic event. or 14) Areas that include alluvial or colluvial fans located at the base of steep slopes and drainages.

- 1) There was no evidence that would indicate historic failures or landslides on the site.



- 2) Some active bluff retreat was found onsite, particularly in the areas where the roadway was cut through the existing slope. This has created 2 slopes on each side of the roadway that show some signs of active bluff retreat.
- 3) The parcel does not meet all criteria necessary. The subsurface soils appear to be homogenous and contain only Barneston gravelly coarse SANDY loam (3D and 3E).
- 4) Slopes were not found to be parallel or sub parallel to planes of weakness.
- 5) No signs of geomorphological features were found that would indicate past slope failures were found onsite.
- 6) There were no tension cracks found on the site near the tops of slopes.
- 7) No structures were found onsite.
- 8) The site has some evidence of bowed or jackstrawed trees, particularly in the area that the 213th Ave. Ct. E roadway was cut through the slope creating potentially dangerous side slopes.
- 9) The onsite soils are classified as having a low to very low liquefaction susceptibility. The site was reviewed using the Pierce County Liquefaction Susceptibility Map.
- 10) No signs of gullying or surface erosion causing dissection of the bluff edge or slope face as a result of drainage or discharge.
- 11) No signs of seeps or springs were found on or adjacent to the face of the slope.
- 12) The lot has slopes that are 40 percent or more. The site slopes are shown on the site plan, in Appendix II.
- 13) The area appears to be unstable and at risk of mass movement due to a seismic event as determined by the Slope Modeling shown in Appendix VI.
- 14) The site is not located at the base of a steep slope and does not contain alluvial or colluvial fans.

Based on this, the lot does exhibit four of the technical criteria as described above and may contain landslide hazard indicators. The soils at the site are mapped as Barneston gravelly coarse sandy loam soils (3D and 3E) soils.

POTENTIAL LANDSLIDE HAZARD AREAS REVIEW

Potential landslide hazard areas are those areas where the suspected risk of slope instability and landslide is sufficient to require a Geological Assessment to assess the potential for active landslide activity. Potential landslide hazard areas are determined using the following criteria: 1) Areas identified on the Coastal Zone Atlas of Washington, Volume VII, Pierce County as either U (unstable), Urs (unstable recent slide), Uos (unstable old slide), I (intermediate), or M (modified) and any adjacent areas within 300 feet. or 2) Areas identified on the Pierce County topographic maps as having slopes greater than 20 percent with a vertical relief of greater than 20 feet and any adjacent areas within a distance of 65 feet. or 3) Areas that possess one or more of the landslide hazard area indicators and any adjacent areas within a distance of 65 feet. or 4) Areas not reflected on the Coastal Zone Atlas that have been determined to be active through a geological assessment process. or 5) Areas identified on the Pierce County topographic maps as having slopes greater than 50 percent with a vertical relief of greater than 100 feet and any adjacent areas within a distance of 300 feet.

- 1) The Coastal Zone Atlas of Washington, Volume VII, Pierce County does not show the parcel.
- 2) The site slopes are greater than 20 percent with a vertical relief of greater than 20 feet.
- 3) The site possesses four of the fourteen possible landslide hazard area indicators.
- 4) Areas were not listed in the Coastal Zone Atlas of Washington, Volume VII, Pierce County. Areas were determined to be slightly active (slight surficial erosion and rockfall) through the geologic assessment process.
- 5) Areas were identified as having slopes greater than 50 percent with a vertical relief of greater than 100 feet.

LANDSLIDE HAZARD AREA CATEGORIES

Landslide hazard areas are classified into categories which reflect each landslide hazard areas past landslide activity and the potential for future landslide activity based on an analysis of slope instability. The following Active Landslide Areas and Stable Areas are defined and categorized as follows. These areas are all shown graphically in Appendix II.

**Active Landslide Areas**

A composite of the active landslides and/or unstable areas, including that portion of the top of slope and slope face subject to failure and sliding as well as toe of slope areas subject to impact from down slope run-out, identified and mapped during the geological assessment of the site. An active landslide hazard exhibits one or more of the following: A) Areas of historical landslide movement on a site which have occurred in the past century including areas identified on the Coastal Zone Atlas of Washington, Volume VII, Pierce County as Urs (unstable recent slide). or B) Unstable areas that exhibit geological and geomorphologic evidence of past slope instability or landsliding or possess landslide hazard area indicators (stratigraphy, ground water conditions, etc.), that have been determined through the geologic assessment process to be presently failing or may be subject to future landslide activity. The impact of the proposed development activities will be considered in defining the extent of the active landslide areas. or C) If interim areas are located between areas identified through the geological assessment process as an active landslide hazard area. Interim areas will be considered part of the active landslide hazard area if the required top of slope or toe of slope landslide hazard area buffer encompasses the area.

- A) The site does not exhibit signs of historical landslide movement.
- B) Geologic indicators were not found onsite that would indicate past slope instability, landsliding, or future landsliding. However through slope modeling it was determined that future landsliding is a very real possibility. The site is currently not developed but the current roadway is at risk of slides from either side of the roadway because the adjacent site slopes were not cut to a sufficiently stable angle- essentially potentially cutting the roadway access off.
- C) No interim areas were found on this site, no active landslide hazards were found onsite.

Stable Areas

Areas that have been identified as potential landslide hazard areas, but, through the geological assessment process, meet one of the following conditions: A) No landslide hazard area indicators actually exist that indicates the potential for future landslide activity to occur. or B) A slope stability analysis has indicated that there is no apparent landslide potential. or C) Adequate engineering or structural measures have been provided in a geological assessment- geotechnical report that mitigates the potential for a future landslide to occur as a result of current or past development activity. or D) A geological assessment has been performed and the results of that assessment indicate that an area is not an active landslide hazard area.

- A) Landslide hazard area indicators exist that would indicate the potential for future landslide activity. This potential future landslide activity was modeled using the Slope W program. Results are found in Appendix VI.
- B) Slope stability analysis was performed on the site using the Slope W program. Results are found in Appendix VI.
- C) There is need for engineering or structural measures to keep the site stable from future landslide activity. It is recommended that the site be graded in such a manner that the site slopes will become stable and all landslide hazards will be alleviated.
- D) A geological assessment has been performed and it has been determined that the site does contain an active landslide hazard area. There is potential for an active landslide hazard area if the cut slopes adjacent to the roadway are not addressed properly.

As defined by the Pierce County Critical Areas Ordinance areas that have been determined to be stable or are converted into a stable area by the implementation of engineering or structural measures are not considered a landslide hazard critical area.

Therefore we assert that the regardless of the landslide hazard indicators- the site will become stable after the slopes have been graded, in accordance with our recommendations, to create a stable condition onsite.

SLOPE STABILITY

Based on our field observations, explorations, laboratory testing, slope stability analysis, and our experience with the soil types encountered on the property, we conclude that the site slopes appear to have potential of deep-seated failure in their present configuration. It is our sentiment that the site can be permanently stabilized to avoid future land slide potential with the proper site grading. The current site has two knobs on either side of the roadway and in its current configuration it is potentially unstable. Proper grading of both knobs will produce stable site slopes and provide a solution for the future land sliding potential. Slope stability for the site was modled using the Slope W program, results are found in Appendix VI



Drainage shall be directly infiltrated into the site soils after some form of dispersion (splash blocks, vegetative strips) to reduce the water velocity to avoid point discharge that may cause an erosive surface.

All construction onsite should conform to the applicable Pierce County Standards.

As previously discussed, weathering, erosion, and the resulting surficial sloughing and land sliding are natural processes that affect slope areas. Significant weathering typically occurs in the upper 2 to 3 feet and is a result of root penetration, wet/dry cycles, and freeze/thaw cycles. These processes can be managed and the risk reduced by proper storm water runoff and proper erosion control. Erosion control recommendations for the slope and buffer areas are provided in the “Building Setback” and “Erosion Control” sections of this report.

BUILDING SETBACK

A building setback area, from landslide hazard areas is required unless evaluated and reduced by a licensed professional engineer. Clearing, grading, and filling within the setback area may be allowed if slope stability or the erosion hazard will not be adversely impacted.

The Building Setback as described in the Pierce County Critical Areas Ordinance may be measured from the bottom of the footing to the top of the slope or from the face of the structure to the toe of the critical slope. After the appropriate site grading has occurred, it is our recommendation that a 50 foot setback from the top of the western most slope (west of the roadway) is advised. Unless the area is re-evaluated once the slope has undergone the recommended grading and it is determined that the recommended 50 feet setback can be reduced.

As previously discussed, weathering, erosion, and the resulting surficial sloughing and shallow land sliding are natural processes that affect slope areas. As noted minor evidence of surficial raveling or sloughing was observed in the sloping portion of the site. To manage and reduce the potential for these natural processes, we recommend the following:

1. No drainage of concentrated surface water or significant sheet flow onto or near the slope area. Drainage from all impervious areas (i.e. roof, paved drive ways) should be directed to an approved stormwater dissipation device (i.e. splash blocks, vegetative strips, surface roughening)
2. No filling within the buffer or setback zone unless retained by engineered retaining walls, constructed as an engineered fill, or approved by a geotechnical engineer.

LATERAL EARTH PRESSURES

Lateral earth pressures are dependent upon the backfill materials and their configuration and moisture content. Three inch minus sand and gravel mixtures that are free draining are recommended for backfilling walls greater than four feet tall. There may be below grade retaining walls or walls designed for retaining earthen fills on this project. The following values may be used for the native site soils for this site.

Earth Pressure Coefficients		Earth Pressure			
	Active, K_a :	0.361	Active:	46	lbs./ft ³
	At Rest, K_o :	0.531	At Rest:	68	lbs./ft ³
	Passive, K_p :	2.770	Passive:	355	lbs./ft ³
		Coefficient of Friction:		0.35	
Values were obtained based on a unit weight of 128 pcf, and a phi angle of 28 degrees					



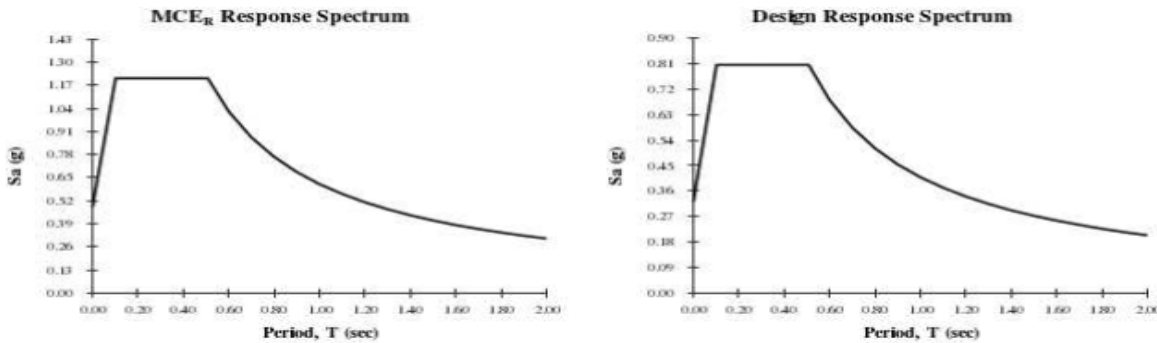
GEOSEISMIC SETTING

Per the 2015 International Building Code (I.B.C.) the onsite soils are a Site Class C. All building structures on this project should be designed per the Code Requirements for such a seismic classification. These types of soils have a shear wave velocity in the range of 1,200 to 2,500 ft/sec and an undrained shear strength greater than 2000 psf with blow counts greater than 50 blows per foot. The following may be used for the seismic coefficients. See Appendix V for full USGS report.

USGS-Provided Output

$S_S = 1.208 \text{ g}$	$S_{MS} = 1.208 \text{ g}$	$S_{DS} = 0.805 \text{ g}$
$S_1 = 0.456 \text{ g}$	$S_{M1} = 0.613 \text{ g}$	$S_{D1} = 0.409 \text{ g}$

For information on how the S_S and S_1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.



Although this information is a product of the U.S. Geological Survey, we provide no warranty, expressed or implied, as to the accuracy of the data contained therein. This tool is not a substitute for technical subject-matter knowledge.

LIQUEFACTION POTENTIAL

In our review of the Washington State Department of Natural Resources Liquefaction Susceptibility Map created by Palmer, Magsino, Bilderback, Poelstra, Folger, and Niggemann. The project site is listed as having a Very Low to Low Liquefaction Susceptibility potential. See Appendix V for detailed map.

Liquefaction is a phenomenon in which strong earthquake shaking causes a soil to rapidly lose its strength and behave like quicksand. Liquefaction typically occurs in artificial fills and in areas of loose sandy soils that are saturated with water, such as low-lying coastal areas, lake shores, and river valleys. When soil strength is lost during liquefaction, the consequences can be catastrophic.

EROSION CONTROL

It is our opinion that the potential erosion hazard is not a limiting factor for the proposed construction. At the time of our original site visit the original vegetation was still on the site. The site was vegetated with grasses, blackberry bushes, and trees. This includes the critical areas such as the slope and buffer area. Temporary erosion control measures may be necessary during construction. Permanent erosion control measures are required as soon as they are feasible to install. Temporary erosion control measures may include, plastic covering, temporary seeding, surface roughening, mulching, and matting. Permanent erosion control measures may include permanent seeding and planting, sodding, surface roughening, and topsoiling then seeding. Permanent erosion control should be established on the site as soon as possible.



BLUFF RETREAT

We would expect over time that there may be small surficial failures on the slope because of weathering that typically occurs in the upper 2 to 3 feet and is a result, generally of root penetration, wet/dry cycles, and freeze/thaw cycles. This is not deep seated failure and is only surficial in nature; this may lead to bluff retreat which typically occurs at a rate of 1 foot per 10 years. This average rate includes for the potential of catastrophic events such as seismic activity or a one-hundred-year storm event. With properly maintained vegetation and localized control of stormwater the rate of bluff retreat can be sufficiently controlled or possibly eliminated.

SLOPE IMPACT ANALYSIS

As discussed previously we have modeled the site slopes in their current configuration and also modeled the site slope after our recommendation of site grading has occurred. Slope models can be found in Appendix VI. After the site slopes have been graded in accordance with our recommendations, we do not anticipate that the proposed construction will have any off-site impacts. On-site care should be taken during construction to make sure that runoff caused by wet weather is directed away from all open excavations and from site slopes. The site is stable enough to support the proposed construction within the recommendations made herein.

All fill placed onsite shall be completed in accordance with the recommendations contained within the "Earthwork" section of this report. The site soils are suitable to be placed as fill. Should soils need to be placed on the site slopes they should be benched into the slope in accordance with our cut/fill recommendations. We also recommend that any temporary cut slopes be shored in accordance with proper Labor and Industry standards in a safe manner.

SLOPE RECOMMENDATIONS

The site currently has slopes directly adjacent to the roadway (213th Ave. Ct. E), where it appears that the roadway was cut through the existing knob. Each of the slopes on either side of the road way show signs of active rockfall, as evidenced by the cobbles in the ditchline, some slight surficial erosion in places along the face of the slopes, and some jackstrawed or bowed trees. The slope to the far west side of the parcel is the longest. Some signs of jackstrawed or bowed trees were found but no evidence was found of mass movement either present or historical was found. Due to the way the road transects the site and it essentially makes a knob along the west side of the roadway and a knob along the east side of the roadway. Although there is no signs of an active slide on the site there are indicators that exist that show a potential slide could be possible. However it is our recommendation to allieviate the potential for sliding on the parcel by grading each of the knob portions of the site, that are on either side of the roadway, to a final elevation that is near or below the elevation of the existing roadway through the site. This will create a much more stable site along both sides of the roadway and will create stable building pads for the proposed houses and out buildings.



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EARTHWORK

CLEARING AND SITE PREPERATION

Excessively organic top soils generally undergo high volume changes when subjected to loads. This is detrimental to the behavior of walls, structural fills, and foundations placed upon them. It is recommended that excessively organic top soils be stripped from these areas to depths of 6-12 inches and wasted or stockpiled for later use. Exact depths of stripping should be adjusted in the field to as sure that the entire root zone is removed. It is recommended that the final exposed subgrade be inspected by a representative of the soils engineer. This inspection should verify that all organic material has been removed. Any soft spots or deflecting areas should be removed to sound bearing and replaced with structural fill.

If placement of fill material is required, the exposed subgrade areas should be compacted to a firm and unyielding surface prior to placement of structural fill. Prior to placement of structural fill over exposed compacted subgrade either a proof roll test or "Tee" probe verification shall be verified by a geotechnical professional to assure the subgrade is firm and unyielding. If structural fill is to be placed along the site slopes it should be keyed or benched into the existing slope. During placement a geotechnical professional shall be onsite to monitor the placement and the compaction of the structural fill materials.

Any soft, loose, or otherwise unsuitable areas determined during inspection should be over excavated and replaced with structural fill, based on the recommendations of structural fill.

STRUCTURAL FILL

All fill material placed within the area below structures, behind retaining walls, or under driveways should be placed as structural fill. The structural fill should be placed in horizontal lifts of 8-12 inches per loose lift. Fill should be compacted to at least 95 percent MDD in (maximum dry density as determined in accordance with ASTM D-1557).

The appropriate lift thickness will depend on the compaction equipment used. 8 inch lifts for walk behind compactors and 18 inch lifts for all vibratory rollers/hoe pacs/diesel sleds. We recommend that density tests shall be performed on all structural fill placed under structures, roadways, or behind retaining walls to ensure that it meets the above requirements. At least 1 test per lift per 50 lineal feet shall be taken.

The suitability of material for use as structural fill will depend on the gradation and moisture content of the soils. As the amount of fines (material passing the No. 200 sieve) increases, soil becomes increasingly sensitive to small changes in moisture content and adequate compaction becomes more difficult to achieve. During wet weather, we recommend the use of a well-graded sand and gravel with less than 10 percent (by weight) passing the No. 200 sieve based on that fraction passing the ¾ inch sieve. If prolonged dry weather prevails during the earthwork and foundation installation phase of construction, a somewhat higher (up to 15 percent) fines content will be acceptable.

Material placed for structural fill should be free of debris, organic matter, trash, and cobbles greater than 6 inches in diameter. The moisture content of the material should be +/- 3 percent of optimum moisture.

SUITABILITY OF ONSITE SOILS AS FILL

The onsite soils – Barneston gravelly coarse sandy loam (3D and E) materials are suitable for use as structural fill.



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CUT AND FILL SLOPES

Cut slopes may be necessary during grading operations and utility installation. All temporary cut slopes and shoring must comply with the provisions of the Washington Administrative Code (WAC) Title 296, Part N, "Excavation, Trenching, and Shoring". All job site safety issues and precautions are the responsibility of the contractor providing the services.

It should be noted that the possibility of the Barneston gravelly coarse sandy loam (3D and E) soils raveling due to their rounded nature and lack of cohesion is a possible issue in the absence of proper shoring. Care should be taken when excavating the native soils to ensure that the site cuts are stable or sloped to a stable condition.

Surface drainage should be directed away from all slope faces. Some minor raveling may occur with time. All disturbed slopes should be seeded as soon as practical to facilitate the development of a protective vegetative cover or otherwise protected.

SITE DRAINAGE

All ground surfaces, pavements, and sidewalks should be sloped away from the structures. Site stormwater should be directly percolated into the site soils.



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SUMMARY

RECOMMENDATIONS

After the site has undergone the proposed grading it will be structurally sound to build on either side of the current roadway. Once grading has been completed, there will be no limitations on the location of the house and outbuildings other than the setback from the top of the western most slope that was described above. Any site fills shall be placed in accordance with the recommendations contained within this report. Site shall be revegetated for erosion control purposes as soon as possible after construction activities have been completed.

Construction sequencing will be an important aspect to the successful completion of this project. It is unclear how the excavation and grading activities will be contracted out. It is our recommendation that one grading and excavation contractor regrade the entire site at one time prior to allowing the builders onsite for construction. This will allow the excavation contractor to create a plan to grade the entire site without the interference of additional building contractors in the way. Once the site is close to the proposed grades the excavation contractor and the building contractor should work together to adequately locate proposed the building sites and provide for a workable location for the building contractors to start construction.

IMPACT ANALYSIS

We do not anticipate that the proposed construction associated with site preparation or building for the Single Family Residences will have any off-site impacts. On-site care should be taken during construction to make sure that runoff caused by wet weather is directed away from all open excavations. The site is stable enough to support the proposed construction within the recommendations made herein.

LIMITATIONS

We have prepared this report for use by Mr. Hicks and members of his design and construction team. The data used in preparing this report and this report should be provided to prospective subcontractors for compliance purposes only. Our report, conclusions, and interpretations are based on data collected from test pits and a site reconnaissance. Should changes occur that do not correspond to conditions described herein we should be notified so as to address those changes or conditions.

The scope of our services does not include services related to environmental remediation and construction safety precautions. Our recommendations are not intended to direct the contractor's methods, techniques, sequences, or procedures, except as specifically described in our report.

CERTIFICATION STATEMENT

The services described in this report were prepared under responsible charge of Jason Bell. Jason Bell meets the qualifications contained in Title 18E, Section 18E.80.030 to prepare a landslide hazard geological assessment. Jason Bell understands the requirements of the current Landslide Hazard Area Chapter 18E.80 and the definitions of the applicable terms contained within Chapter 18.25. Individuals under responsible charge of Jason Bell have performed a landslide hazard geological assessment, conducted field investigation, and researched historic records on or in the vicinity of the above referenced site. In my opinion, the scope of services completed for this project is adequate to meet the requirements of the Pierce County Planning and Land Services Department.



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SUMMARY

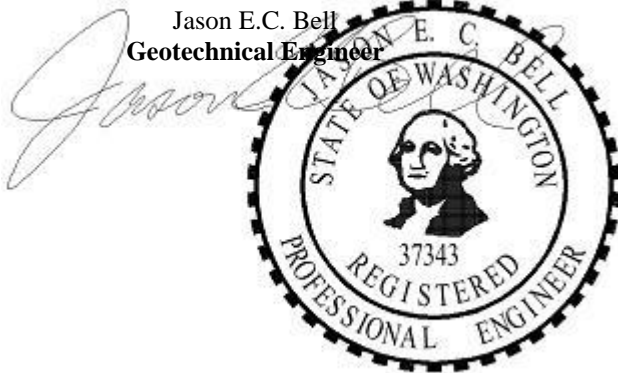
Overall the site is suitable for the proposed construction once it has been graded in accordance with our recommendations. Drainage should be directed away from any exposed site slopes as much as is feasible to avoid creating a possible erosive surface. Possible erosive surfaces can be reduced by maintaining vegetation within the buffer areas and along any slopes. The vegetative cover is very important to help minimize erosion. The potential for erosion for this soil type is based largely on the slopes associated with the formation. Our grading recommendations will greatly reduce the high potential for erosion and instead create a much more stable site.

If you have any questions concerning the test results, the procedures used, or if we can be of any further assistance please call on us at **(253) 405-4654**.

Respectfully Submitted,

JECB

Jason E.C. Bell
Geotechnical Engineer





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APPENDIX I

VICINITY MAP



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APPENDIX II

SITE PLANS WITH BORING LOG LOCATIONS (PRE-GRADING AND POST GRADING)



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INSERT SHEET S-1 (PRE-GRADING)



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INSERT SHEET S-2 (POST-GRADING)



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APPENDIX III

BORING LOGS



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Depth (Ft)	Field Description	Change in Soils	% M	Comments
0.5	Duff/Topsoil (0-0.5')			Silty Gravelly SAND (SM) with organics , dark brown, dry, loose, homogenous
1.0				
1.5	GRAVEL (GP) (0.5'-6')			Sandy GRAVEL (GP) with cobbles and trace silt, light brown grey, medium dense, dry, and homogenous (no cohesion)
2.0				
2.5				
3.0				Note- Top 3' very cobbly
3.5				
4.0				
4.5				
5.0				
5.5				
6.0				
6.5				
7.0				
7.5				
8.0				
8.5				
9.0				
9.5				
10.0				6'- Bottom of Test Pit Groundwater was not encountered



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Project: 18108 and 18107 -
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Date: 5/12/2018		File #: 182XX 213 Ct Ave		
Boring Log #: TH-#2		Client: ARH		
Boring Type: Test Pit		Depth Drilled: 5.0 feet		
Depth (Ft)	Field Description	Change in Soils	% M	Comments
0.5	Duff/Topsail (0-0.5')			Silty Gravelly SAND (SM) with organics , dark brown, dry, loose, homogenous
1.0				
1.5	GRAVEL (GP) (0.5'-5')			Sandy GRAVEL (GP) with cobbles and trace silt, light brown grey, medium dense, dry, and homogenous (no cohesion)
2.0				
2.5				
3.0				Note- Top 3' very cobbly
3.5				
4.0				
4.5				
5.0				
5.5				
6.0				
6.5				
7.0				5 feet Bottom of Test Pit
7.5				No groundwater was encountered
8.0				
8.5				
9.0				
9.5				
10.0				



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Depth (Ft)	Field Description	Change in Soils	% M	Comments
0.5	Duff/Topsail (0-0.5')			Silty Gravelly SAND (SM) with organics , dark brown, dry, loose, homogenous
1.0				
1.5	GRAVEL (GP) (0.5'-4')			GRAVEL (GP) with cobbles , light brown grey, medium dense, dry, and homogenous (no cohesion)
2.0				
2.5				
3.0				Note- Cobbles full depth- No structure kept caving- Created Glory Hole
3.5				
4.0				
4.5				
5.0				
5.5				
6.0				4 feet Bottom of Test Pit
6.5				No groundwater was encountered
7.0				
7.5				
8.0				
8.5				
9.0				
9.5				
10.0				
10.5				
11.0				



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Date: 5/12/2018		File #: 182XX 213 Ct Ave		
Boring Log #: TH-#4		File #: E		
Boring Type: Test Pit		Client: ARH		
		Depth Drilled: 2.0 feet		
Depth (Ft)	Field Description	Change in Soils	% M	Comments
0.5	SAND (SP) (0'-2')			Gravelly SAND (SP), reddish brown, medium dense, dry, and homogenous (no cohesion)
1.0				
1.5				
2.0				
2.5				
3.0				
3.5				2'- Bottom of Test Pit
4.0				No groundwater was encountered
4.5				
5.0				
5.5				
6.0				
6.5				
7.0				
7.5				
8.0				
8.5				
9.0				
9.5				
10.0				
10.5				
11.0				



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Date: 5/12/2018		File #: 182XX 213 Ct Ave		
Boring Log #: TH-#5		File #: E		
Boring Type: Test Pit		Client: ARH		
		Depth Drilled: 3.0 feet		
Depth (Ft)	Field Description	Change in Soils	% M	Comments
0.5	Duff/Topsail (0-0.5')			Silty Gravelly SAND (SM) with organics , dark brown, dry, loose, homogenous
1.0				
1.5	GRAVEL (GP) (0.5'-3')			Sandy GRAVEL (GP) with cobbles and trace silt, light brown grey, medium dense, dry, and homogenous (no cohesion)
2.0				
2.5				
3.0				
3.5				
4.0				
4.5				
5.0				
5.5				3'- Bottom of Test Pit
6.0				No groundwater was encountered
6.5				
7.0				
7.5				
8.0				
8.5				
9.0				
9.5				
10.0				
10.5				
11.0				



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Depth (Ft)	Field Description	Change in Soils	% M	Comments
0.5	Duff/Topsail (0-0.5')			Silty Gravelly SAND (SM) with organics , dark brown, dry, loose, homogenous
1.0				
1.5	GRAVEL (GP) (0.5'-3')			Sandy GRAVEL (GP) with cobbles and trace silt, light brown grey, medium dense, dry, and homogenous (no cohesion)
2.0				
2.5				
3.0				
3.5				
4.0				
4.5				3'- Bottom of Test Pit
5.0				No groundwater was encountered
5.5				
6.0				
6.5				
7.0				
7.5				
8.0				
8.5				
9.0				
9.5				
10.0				
10.5				
11.0				



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Depth (Ft)	Field Description	Change in Soils	% M	Comments
0.5	Duff/Topsail (0-0.5')			Silty Gravelly SAND (SM) with organics , dark brown, dry, loose, homogenous
1.0				
1.5	GRAVEL (GP) (0.5'-4')			Sandy GRAVEL (GP) with cobbles, light brown grey, medium dense, dry, and homogenous (no cohesion)
2.0				
2.5				
3.0				Note- Top 3' very cobbly
3.5				
4.0				
4.5	SAND (SP) (4.5'-7')			Gravelly SAND (SP), reddish brown, medium dense, dry, and homogenous (no cohesion)
5.0				
5.5				
6.0				
6.5				
7.0				
7.5				
8.0				7'- Bottom of Test Pit
8.5				No groundwater was encountered
9.0				
9.5				
10.0				
10.5				
11.0				



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Date: 5/12/2018		File #: 182XX 213 Ct Ave		
Boring Log #: TH-#8		File #: E		
Boring Type: Test Pit		Client: ARH		
		Depth Drilled: 6.0 feet		
Depth (Ft)	Field Description	Change in Soils	% M	Comments
0.5	Duff/Topsoil (0-0.5')			Silty Gravelly SAND (SM) with organics , dark brown, dry, loose, homogenous
1.0				
1.5	GRAVEL (GP) (0.5'-6')			Sandy GRAVEL (GP) with cobbles and trace silt, light brown grey, medium dense, dry, and homogenous (no cohesion)
2.0				
2.5				
3.0				Note- Top 2' very cobbly
3.5				
4.0				
4.5				
5.0				
5.5				
6.0				
6.5				
7.0				6'- Bottom of Test Pit
7.5				No groundwater was encountered
8.0				
8.5				
9.0				
9.5				
10.0				
10.5				
11.0				



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APPENDIX IV

LAB TESTING

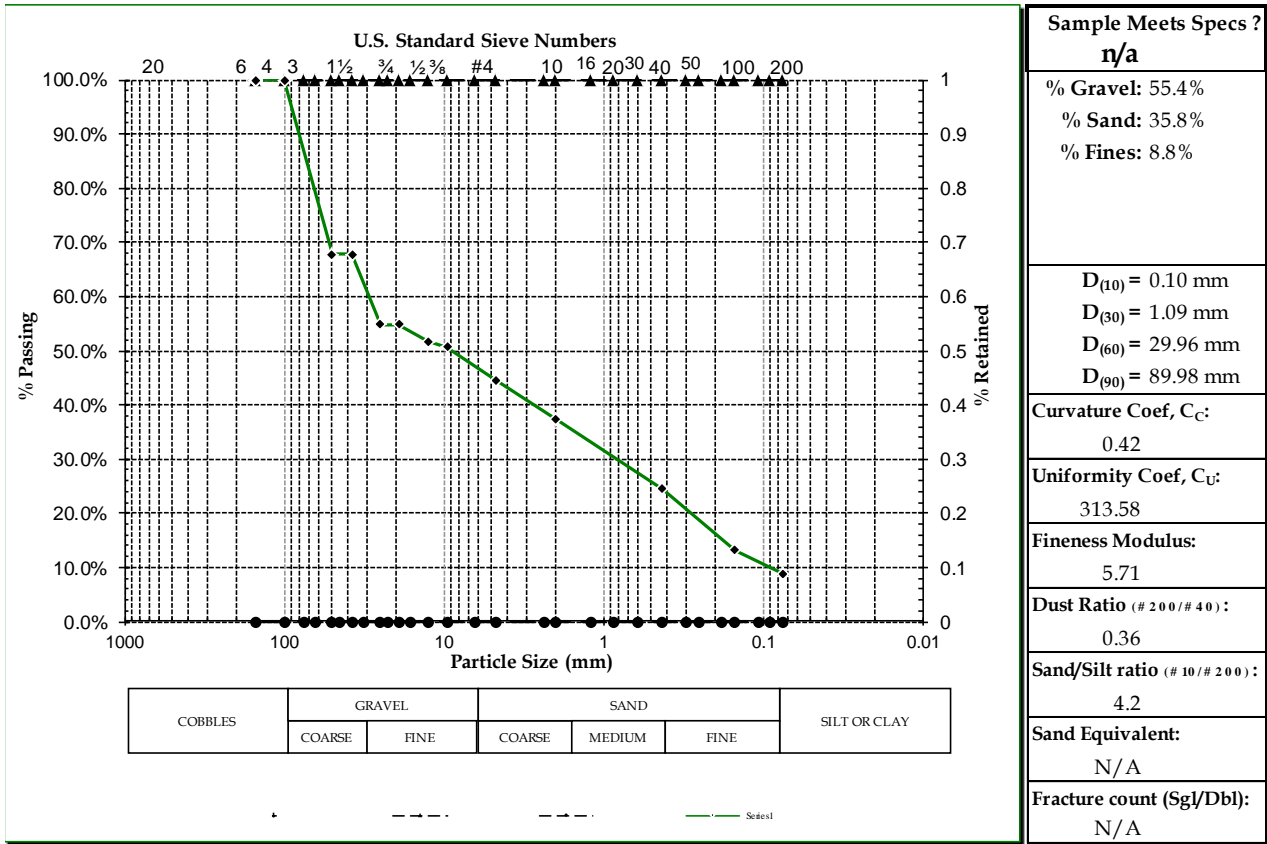


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Date: 6-15-18 REV 1-20-21
Project: 18108 and 18107 -
213th Ave Ct E.
File #: 20-0016 Rev

Date Received: 5/12/18	Sample Description: TH-1 - 5' BSG	Source: TH-1 - 5' BSG	Unified Soils Classification System: GP-GM, Poorly graded Gravel with Silt and Sand
Project: 182XX 213th Ave Ct E	Location: TH-1 - 5' BSG	Sample #: 18-0026A	Specifications: No Specs



Coarse Aggregate		Actual Cumulative	Interpolated Cumulative	Specs		Fine Aggregate		Actual Cumulative	Interpolated Cumulative	Specs	
Sieve Size US	Metric	Percent Passing	Percent Passing	Max	Min	Sieve Size US	Metric	Percent Passing	Percent Passing	Max	Min
6.00"	150.00	100.0%	100.0%			#4	4.75	44.6%	44.6%		
4.00"	100.00	100.0%	100.0%			#8	2.360		38.4%		
3.00"	75.00		83.9%			#10	2.000	37.5%	37.5%		
2.50"	63.00		76.1%			#16	1.180		30.7%		
2.00"	50.00	67.8%	67.8%			#20	0.850		28.0%		
1.75"	45.00		67.8%			#30	0.600		25.9%		
1.50"	37.50	67.8%	67.8%			#40	0.425	24.5%	24.5%		
1.25"	31.50		61.6%			#50	0.300		19.3%		
1.00"	25.00	54.9%	54.9%			#60	0.250		17.2%		
7/8"	22.40		54.9%			#80	0.180		14.3%		
3/4"	19.00	54.9%	54.9%			#100	0.150	13.1%	13.1%		
5/8"	16.00		53.5%			#140	0.106		10.6%		
1/2"	12.50	51.8%	51.8%			#170	0.090		9.7%		
3/8"	9.50	50.6%	50.6%			#200	0.075	8.8%	8.8%		
1/4"	6.30		46.6%								

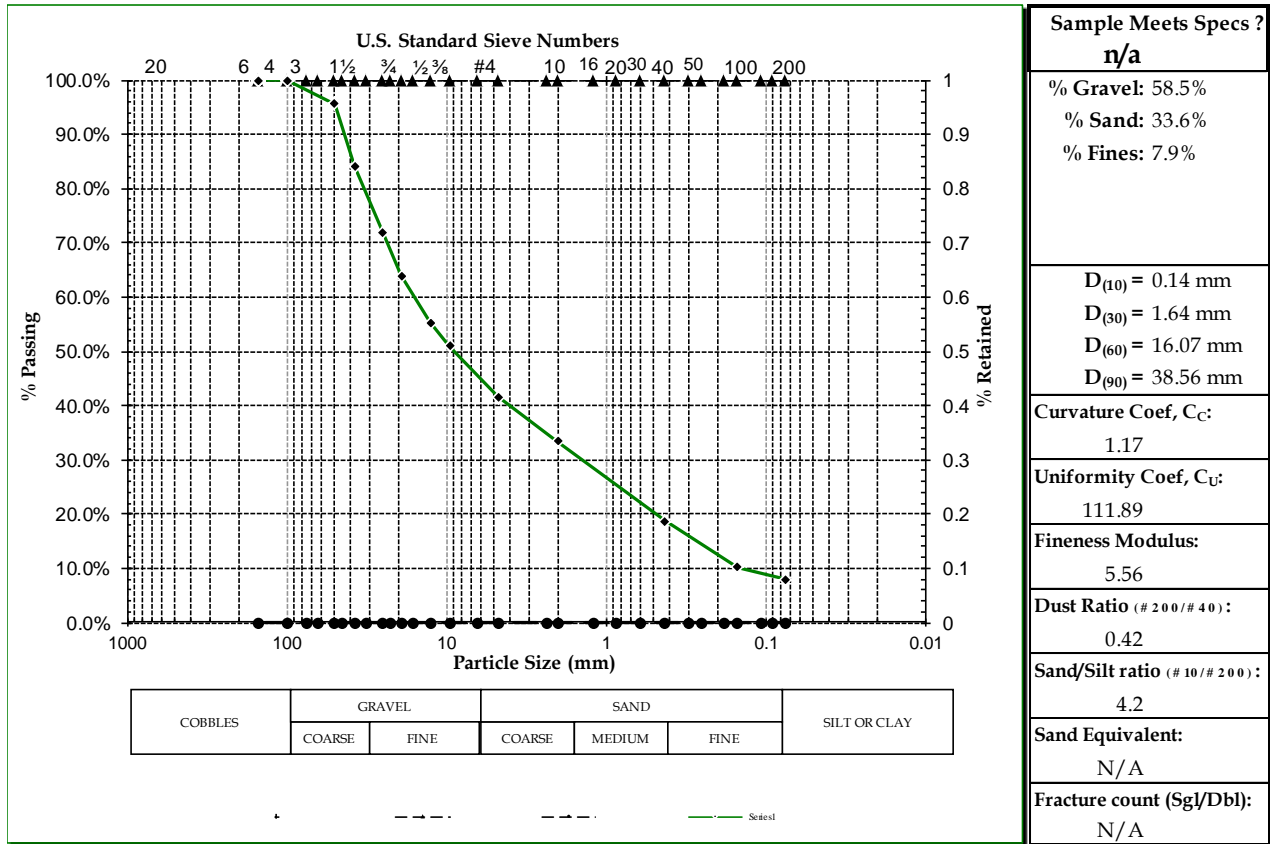


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**Geotechnical Engineering
Construction Inspections
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Date: 6-15-18 REV 1-20-21
Project: 18108 and 18107 -
213th Ave Ct E.
File #: 20-0016 Rev

Date Received: 5/12/18	Sample Description: TH-2 - 4' BSG	Source: TH-2 - 4' BSGGW-GC, Well-graded Gravel with Silty Clay and Sand	Unified Soils Classification System:
Project: 182XX 213th Ave Ct E	Location: TH-2 - 4' BSG	Sample #: 18-0026B	Specifications: No Specs



Coarse Aggregate		Actual Cumulative	Interpolated Cumulative	Fine Aggregate		Actual Cumulative	Interpolated Cumulative		
Sieve Size	Percent Passing	Percent Passing	Specs Max	Specs Min	Sieve Size	Percent Passing	Percent Passing	Specs Max	Specs Min
US	Metric				US	Metric			
6.00"	150.00	100.0%			#4	4.75	41.6%	41.6%	
4.00"	100.00	100.0%			#8	2.360	33.3%	34.4%	
3.00"	75.00	97.8%			#10	2.000	25.7%	25.7%	
2.50"	63.00	96.7%			#16	1.180	20.3%	20.3%	
2.00"	50.00	95.5%			#20	0.850	18.6%	18.6%	
1.75"	45.00	91.0%			#30	0.600	14.8%	14.8%	
1.50"	37.50	84.2%			#40	0.425	11.1%	11.1%	
1.25"	31.50	78.3%			#50	0.300	10.2%	10.2%	
1.00"	25.00	71.8%			#60	0.250	8.9%	8.4%	
7/8"	22.40	68.4%			#80	0.180	7.9%	7.9%	
3/4"	19.00	63.9%			#100	0.150			
5/8"	16.00	59.9%			#140	0.106			
1/2"	12.50	55.3%			#170	0.090			
3/8"	9.50	51.0%			#200	0.075			
1/4"	6.30	44.6%							

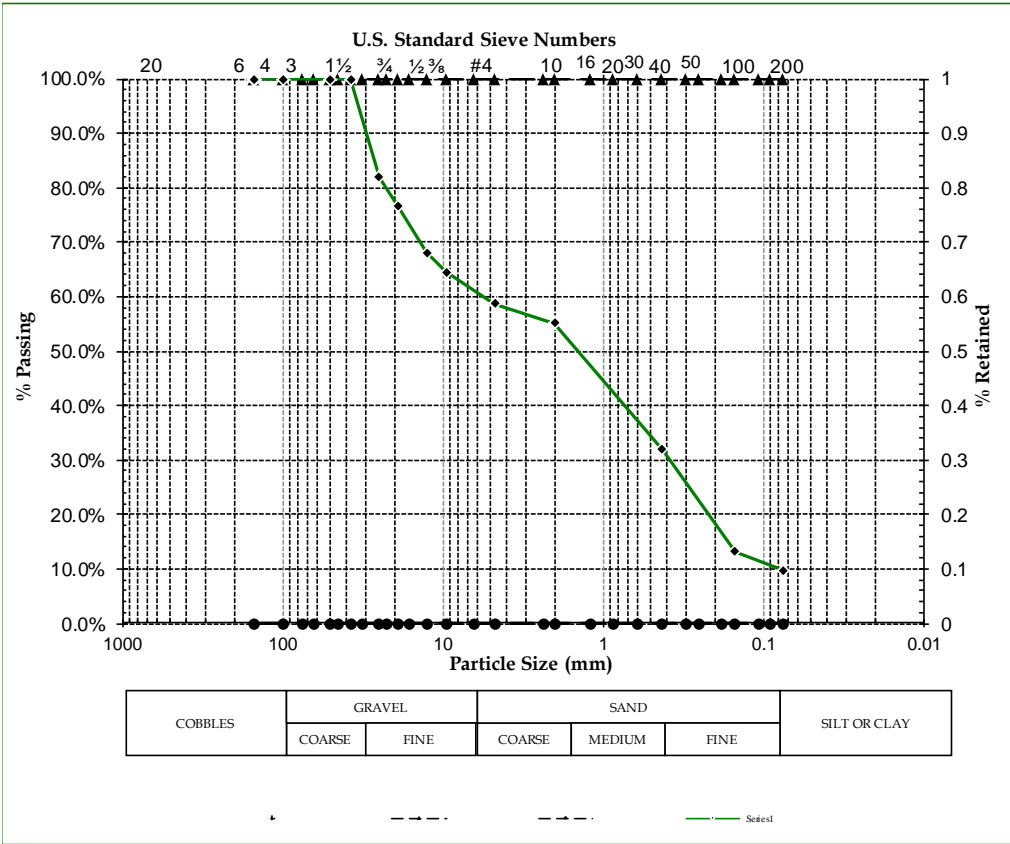


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Date: 6-15-18 REV 1-20-21
Project: 18108 and 18107 -
213th Ave Ct E.
File #: 20-0016 Rev

Date Received: 5/12/18	Sample Description: TH- 5 - 3' BSG	Source: TH- 5 - 3' BSG	Unified Soils Classification System: SP-SM, Poorly graded Sand with Silt and Gravel
Project: 182XX 213th Ave Ct E	Location: TH- 5 - 3' BSG	Sample # 18-0026C	Specifications: No Specs



Sample Meets Specs ? n/a
% Gravel: 41.3%
% Sand: 48.9%
% Fines: 9.8%
D ₍₁₀₎ = 0.08 mm
D ₍₃₀₎ = 0.40 mm
D ₍₆₀₎ = 5.81 mm
D ₍₉₀₎ = 30.33 mm
Curvature Coef, C _c : 0.34
Uniformity Coef, C _u : 73.49
Fineness Modulus: 4.31
Dust Ratio (# 200/# 40): 0.31
Sand/Silt ratio (# 10/# 200): 5.6
Sand Equivalent: N/A
Fracture count (Sgl/Dbf): N/A

Coarse Aggregate		Actual	Interpolated	Specs		Fine Aggregate		Actual	Interpolated	Specs	
Sieve Size	Metric	Percent Passing	Percent Passing	Max	Min	Sieve Size	Metric	Percent Passing	Percent Passing	Max	Min
6.00"	150.00	100.0%	100.0%			#4	4.75	58.7%	58.7%		
4.00"	100.00	100.0%	100.0%			#8	2.360		55.6%		
3.00"	75.00		100.0%			#10	2.000	55.1%	55.1%		
2.50"	63.00		100.0%			#16	1.180		43.0%		
2.00"	50.00	100.0%	100.0%			#20	0.850		38.2%		
1.75"	45.00		100.0%			#30	0.600		34.5%		
1.50"	37.50	100.0%	100.0%			#40	0.425	31.9%	31.9%		
1.25"	31.50		91.3%			#50	0.300		23.4%		
1.00"	25.00	81.9%	81.9%			#60	0.250		20.0%		
7/8"	22.40		79.6%			#80	0.180		15.2%		
3/4"	19.00	76.7%	76.7%			#100	0.150	13.1%	13.1%		
5/8"	16.00		72.7%			#140	0.106		11.2%		
1/2"	12.50	68.0%	68.0%			#170	0.090		10.5%		
3/8"	9.50	64.5%	64.5%			#200	0.075	9.8%	9.8%		
1/4"	6.30		60.6%								

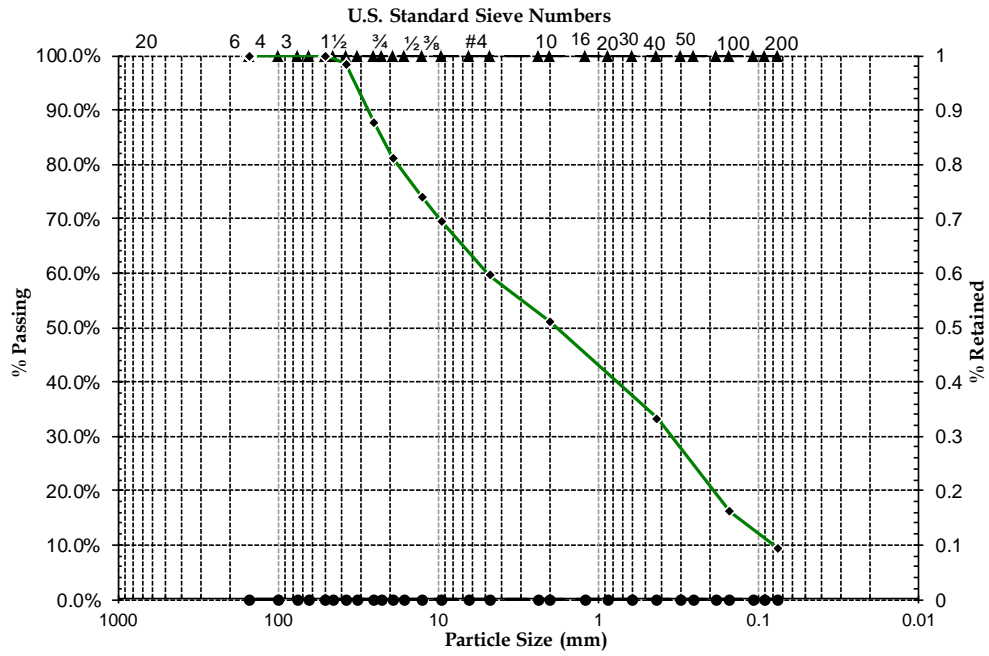


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**Geotechnical Engineering
Construction Inspections
Foundations
Materials Testing**

Date: 6-15-18 REV 1-20-21
Project: 18108 and 18107 -
213th Ave Ct E.
File #: 20-0016 Rev

Date Received: 5/12/18	Sample Description: TH-6 - 3' BSG	Source: TH-6 - 3' BSG	Unified Soils Classification System: SP-SM, Poorly graded Sand with Silt and Gravel
Project: 182XX 213th Ave Ct E	Location: TH-6 - 3' BSG	Sample #: 18-0026D	Specifications: No Specs



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample Meets Specs ? n/a
% Gravel: 40.4%
% Sand: 50.2%
% Fines: 9.4%
D ₍₁₀₎ = 0.08 mm
D ₍₃₀₎ = 0.37 mm
D ₍₆₀₎ = 4.95 mm
D ₍₉₀₎ = 19.89 mm
Curvature Coef, C _c : 0.34
Uniformity Coef, C _u : 60.73
Fineness Modulus: 4.20
Dust Ratio (# 200/# 40): 0.28
Sand/Silt ratio (# 10/# 200): 5.4
Sand Equivalent: N/A
Fracture count (Sgl/Dbf): N/A

Coarse Aggregate		Actual Percent Passing	Interpolated Percent Passing	Specs Max	Specs Min	Fine Aggregate		Actual Percent Passing	Interpolated Percent Passing	Specs Max	Specs Min
Sieve Size US	Metric	Percent Passing	Percent Passing			Sieve Size US	Metric	Percent Passing	Percent Passing		
6.00"	150.00		100.0%			#4	4.75	59.6%	59.6%		
4.00"	100.00		100.0%			#8	2.360		52.3%		
3.00"	75.00		100.0%			#10	2.000	51.2%	51.2%		
2.50"	63.00		100.0%			#16	1.180		41.8%		
2.00"	50.00	100.0%	100.0%			#20	0.850		38.1%		
1.75"	45.00		99.4%			#30	0.600		35.2%		
1.50"	37.50	98.5%	98.5%			#40	0.425	33.2%	33.2%		
1.25"	31.50		93.3%			#50	0.300		25.5%		
1.00"	25.00	87.6%	87.6%			#60	0.250		22.4%		
7/8"	22.40		84.8%			#80	0.180		18.0%		
3/4"	19.00	81.1%	81.1%			#100	0.150	16.1%	16.1%		
5/8"	16.00		77.8%			#140	0.106		12.2%		
1/2"	12.50	74.0%	74.0%			#170	0.090		10.8%		
3/8"	9.50	69.6%	69.6%			#200	0.075	9.4%	9.4%		
1/4"	6.30		62.8%								

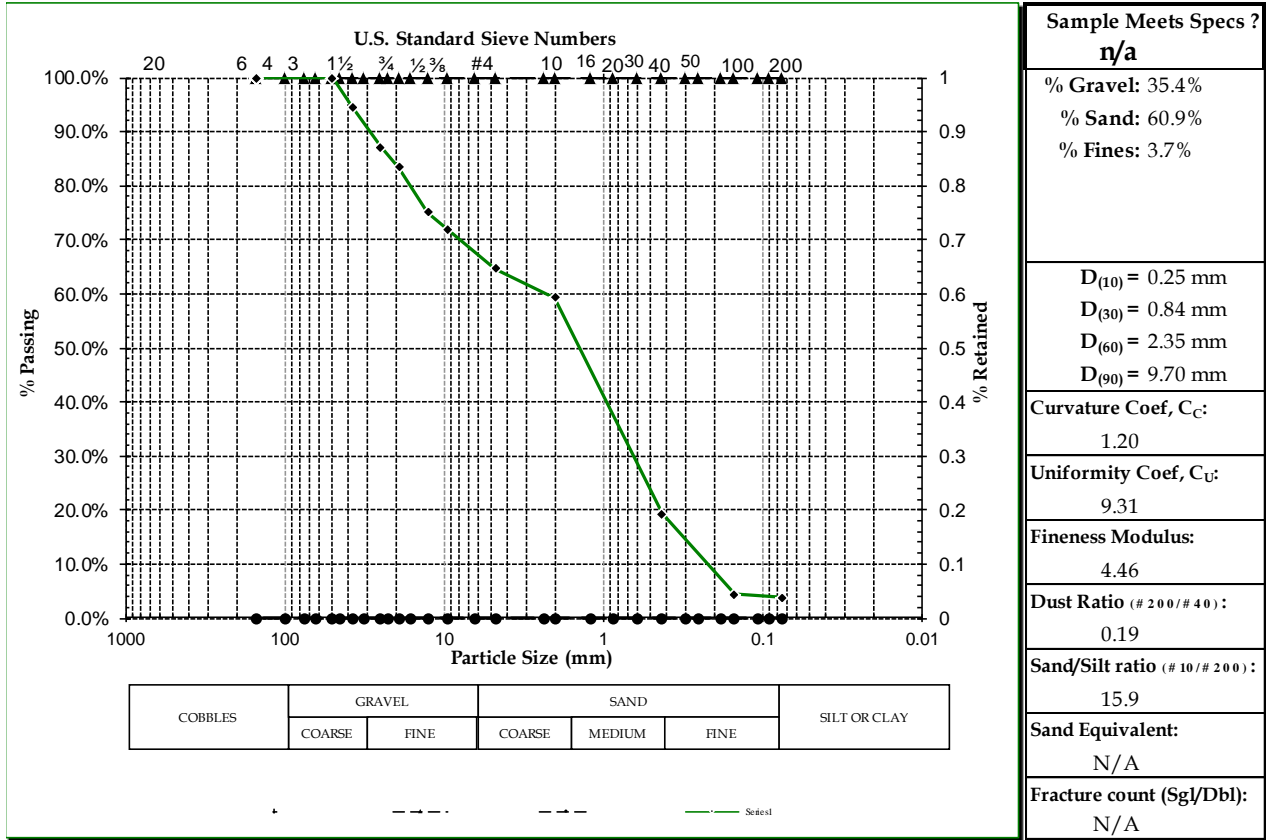


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**Geotechnical Engineering
Construction Inspections
Foundations
Materials Testing**

Date: 6-15-18 REV 1-20-21
Project: 18108 and 18107 -
213th Ave Ct E.
File #: 20-0016 Rev

Date Received: 5/12/18	Sample Description: TH-7 - 2' BSG	Source: TH-7 - 2' BSG	Unified Soils Classification System: SW, Well-graded Sand with Gravel
Project: 182XX 213th Ave Ct E	Location: TH-7 - 2' BSG	Sample #: 18-0026F	Specifications: No Specs



Actual		Interpolated		Actual		Interpolated			
Coarse Aggregate		Cumulative	Cumulative	Fine Aggregate		Cumulative	Cumulative		
Sieve Size	Percent	Percent	Specs	Specs	Sieve Size	Percent	Percent	Specs	Specs
US	Metric	Passing	Max	Min	US	Passing	Passing	Max	Min
6.00"	150.00	100.0%			#4	64.6%	64.6%		
4.00"	100.00	100.0%			#8		60.0%		
3.00"	75.00	100.0%			#10	59.3%	59.3%		
2.50"	63.00	100.0%			#16		38.5%		
2.00"	50.00	100.0%			#20		30.1%		
1.75"	45.00		97.8%		#30		23.8%		
1.50"	37.50	94.5%	94.5%		#40	19.3%	19.3%		
1.25"	31.50		90.9%		#50		12.6%		
1.00"	25.00	87.1%	87.1%		#60		9.9%		
7/8"	22.40		85.5%		#80		6.1%		
3/4"	19.00	83.4%	83.4%		#100	4.4%	4.4%		
5/8"	16.00		79.6%		#140		4.0%		
1/2"	12.50	75.1%	75.1%		#170		3.9%		
3/8"	9.50	71.9%	71.9%		#200	3.7%	3.7%		
1/4"	6.30		67.0%						

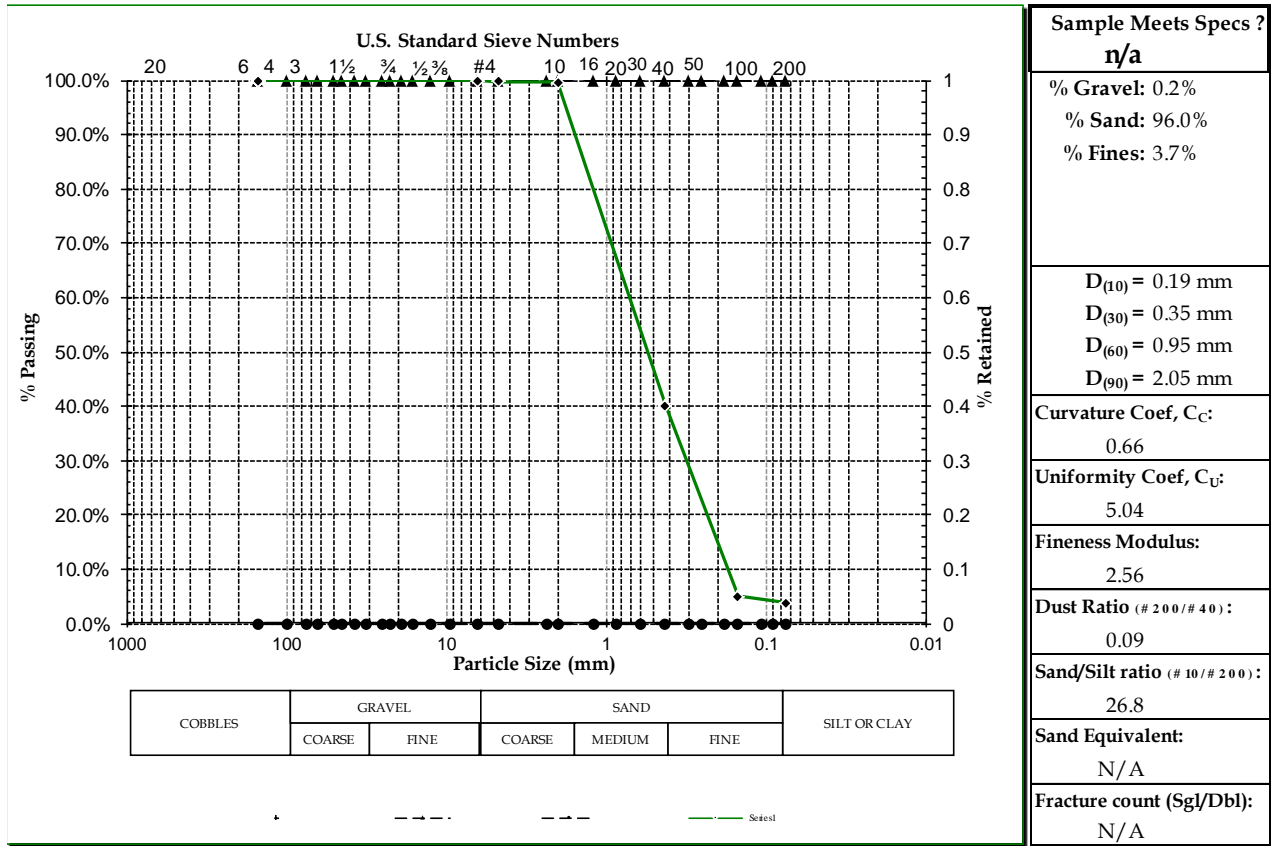


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**Geotechnical Engineering
Construction Inspections
Foundations
Materials Testing**

Date: 6-15-18 REV 1-20-21
Project: 18108 and 18107 -
213th Ave Ct E.
File #: 20-0016 Rev

Date Received: 5/12/18	Sample Description: TH-7 - 5' BSG	Source: TH-7 - 5' BSG	Unified Soils Classification System: SP, Poorly graded Sand
Project: 182XX 213th Ave Ct E	Location: TH-7 - 5' BSG	Sample #: 18-0026E	Specifications: No Specs



Actual		Interpolated				Actual		Interpolated			
Coarse Aggregate		Cumulative		Cumulative		Fine Aggregate		Cumulative		Cumulative	
Sieve Size	Percent	Percent	Specs	Specs	Sieve Size	Percent	Percent	Specs	Specs		
US	Metric	Passing	Passing	Max	Min	US	Metric	Passing	Passing	Max	Min
6.00"	150.00		100.0%			#4	4.75	99.8%	99.8%		
4.00"	100.00		100.0%			#8	2.360		99.6%		
3.00"	75.00		100.0%			#10	2.000	99.6%	99.6%		
2.50"	63.00		100.0%			#16	1.180		68.6%		
2.00"	50.00		100.0%			#20	0.850		56.1%		
1.75"	45.00		100.0%			#30	0.600		46.7%		
1.50"	37.50		100.0%			#40	0.425	40.1%	40.1%		
1.25"	31.50		100.0%			#50	0.300		24.2%		
1.00"	25.00		100.0%			#60	0.250		17.8%		
7/8"	22.40		100.0%			#80	0.180		8.9%		
3/4"	19.00		100.0%			#100	0.150	5.0%	5.0%		
5/8"	16.00		100.0%			#140	0.106		4.3%		
1/2"	12.50		100.0%			#170	0.090		4.0%		
3/8"	9.50		100.0%			#200	0.075	3.7%	3.7%		
1/4"	6.30	100.0%	100.0%								

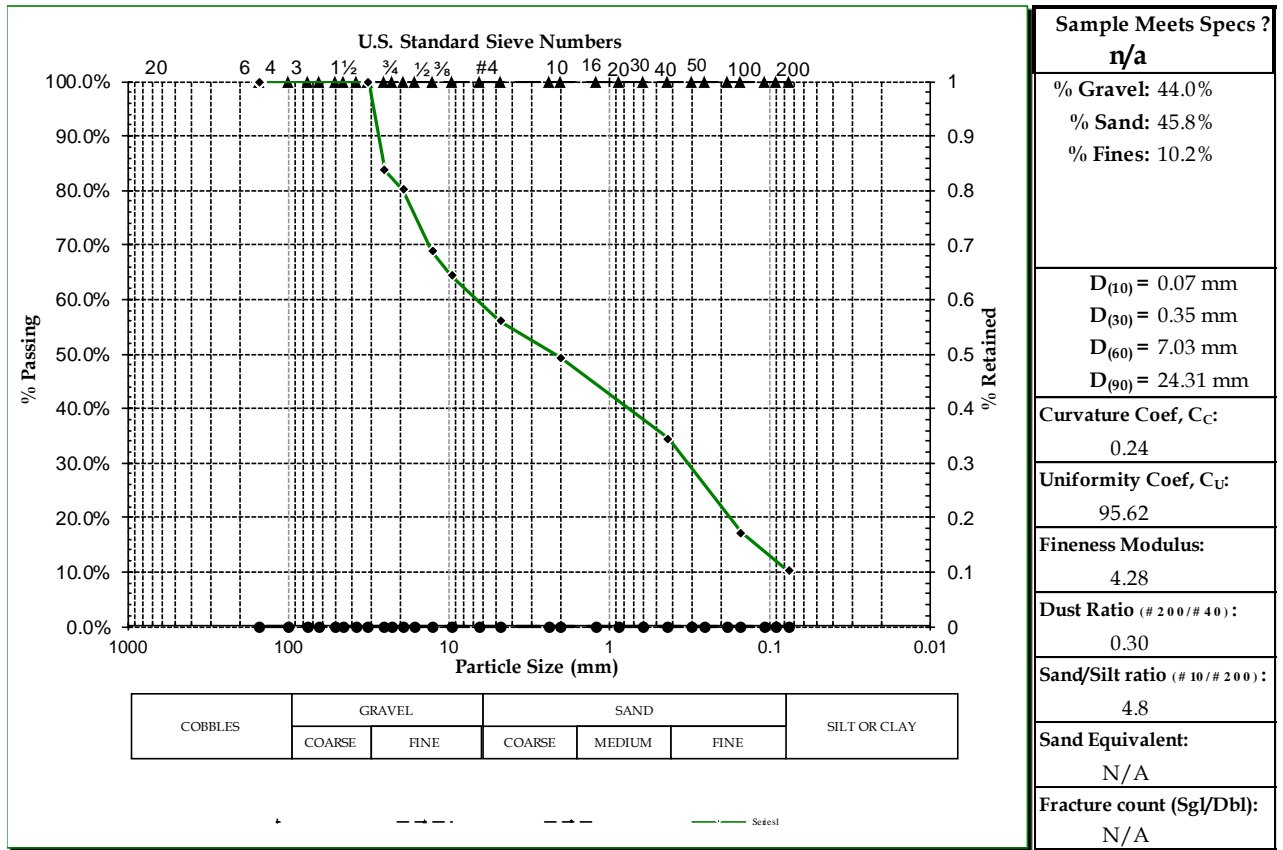


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**Geotechnical Engineering
Construction Inspections
Foundations
Materials Testing**

Date: 6-15-18 REV 1-20-21
Project: 18108 and 18107 -
213th Ave Ct E.
File #: 20-0016 Rev

Date Received: 5/12/18	Sample Description: TH- 8 - 5' BSG	Source: TH- 8 - 5' BSG	Unified Soils Classification System: SP-SM, Poorly graded Sand with Silt and Gravel
Project: 182XX 213th Ave Ct E	Location: TH- 8 - 5' BSG	Sample # 18-0026G	Specifications: No Specs



Sample Meets Specs ? n/a
% Gravel: 44.0%
% Sand: 45.8%
% Fines: 10.2%
D ₍₁₀₎ = 0.07 mm
D ₍₃₀₎ = 0.35 mm
D ₍₆₀₎ = 7.03 mm
D ₍₉₀₎ = 24.31 mm
Curvature Coef, C _c : 0.24
Uniformity Coef, C _u : 95.62
Fineness Modulus: 4.28
Dust Ratio (# 200/# 40): 0.30
Sand/Silt ratio (# 10/# 200): 4.8
Sand Equivalent: N/A
Fracture count (Sgl/Dbf): N/A

Coarse Aggregate		Actual Cumulative	Interpolated Cumulative	Specs		Fine Aggregate		Actual Cumulative	Interpolated Cumulative	Specs	
Sieve Size	Metric	Percent Passing	Percent Passing	Max	Min	Sieve Size	Metric	Percent Passing	Percent Passing	Max	Min
6.00"	150.00		100.0%			#4	4.75	56.0%	56.0%		
4.00"	100.00		100.0%			#8	2.360		50.2%		
3.00"	75.00		100.0%			#10	2.000	49.3%	49.3%		
2.50"	63.00		100.0%			#16	1.180		41.6%		
2.00"	50.00		100.0%			#20	0.850		38.5%		
1.75"	45.00		100.0%			#30	0.600		36.1%		
1.50"	37.50		100.0%			#40	0.425	34.4%	34.4%		
1.25"	31.50	100.0%	100.0%			#50	0.300		26.6%		
1.00"	25.00	83.7%	83.7%			#60	0.250		23.5%		
7/8"	22.40		82.2%			#80	0.180		19.1%		
3/4"	19.00	80.2%	80.2%			#100	0.150	17.2%	17.2%		
5/8"	16.00		74.9%			#140	0.106		13.1%		
1/2"	12.50	68.8%	68.8%			#170	0.090		11.6%		
3/8"	9.50	64.3%	64.3%			#200	0.075	10.2%	10.2%		
1/4"	6.30		58.7%								



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**Geotechnical Engineering
Construction Inspections
Foundations
Materials Testing**

Date: 6-15-18 REV 1-20-21
Project: 18108 and 18107 -
213th Ave Ct E.
File #: 20-0016 Rev

APPENDIX V

LIQUEFACTION MAP

USGS- GEOSEISMIC REPORT











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**Geotechnical Engineering
Construction Inspections
Foundations
Materials Testing**

Date: 6-15-18 REV 1-20-21
Project: 18108 and 18107 -
213th Ave Ct E.
File #: 20-0016 Rev



EXPLANATION

-  Liquefaction susceptibility: HIGH
-  Liquefaction susceptibility: MODERATE to HIGH
-  Liquefaction susceptibility: MODERATE
-  Liquefaction susceptibility: LOW to MODERATE
-  Liquefaction susceptibility: LOW
-  Liquefaction susceptibility: VERY LOW to LOW
-  Liquefaction susceptibility: VERY LOW
-  Bedrock



USGS Design Maps Summary Report

User-Specified Input

Report Title 182XX 213th Ave Ct. E
Mon July 2, 2018 00:48:15 UTC

Building Code Reference Document 2012/2015 International Building Code
(which utilizes USGS hazard data available in 2008)

Site Coordinates 47.09104°N, 122.14915°W

Site Soil Classification Site Class C – “Very Dense Soil and Soft Rock”

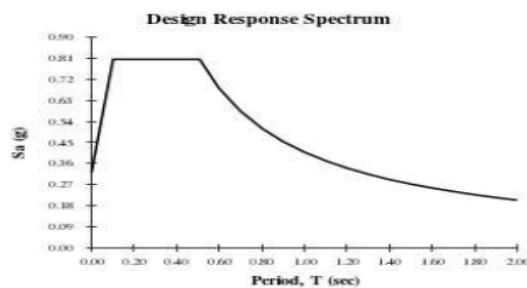
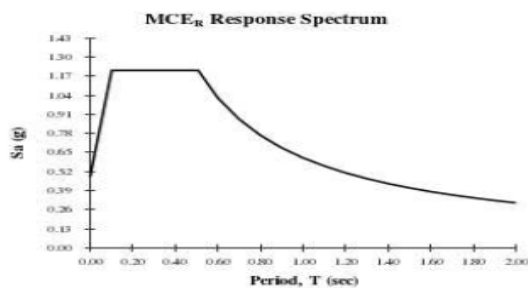
Risk Category I/II/III



USGS-Provided Output

$S_S = 1.208 \text{ g}$	$S_{MS} = 1.208 \text{ g}$	$S_{DS} = 0.805 \text{ g}$
$S_1 = 0.456 \text{ g}$	$S_{M1} = 0.613 \text{ g}$	$S_{D1} = 0.409 \text{ g}$

For information on how the S_S and S_1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the “2009 NEHRP” building code reference document.



Although this information is a product of the U.S. Geological Survey, we provide no warranty, expressed or implied, as to the accuracy of the data contained therein. This tool is not a substitute for technical subject-matter knowledge.



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Geotechnical Engineering
Construction Inspections
Foundations
Materials Testing

Date: 6-15-18 REV 1-20-21
Project: 18108 and 18107 -
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APPENDIX VI

SLOPE MODELS (CROSS SECTIONS)

