INSIGHT GEOLOGIC, INC.

December 16, 2021

Sound Built Homes
P.O. Box 73790
Puyallup, Washington 98373
Attention: Evan Mann

Report - Revised
Geotechnical and Stormwater Investigation
Three Lakes Crossing Development
6715 and 6609 Henderson Blvd SE
Tumwater, Washington
Project No. 362-007-01

INTRODUCTION

Insight Geologic, Inc. is pleased to provide our report for the evaluation of site soil conditions as they relate to geotechnical properties and the infiltration and disposal of stormwater at the proposed residential development to be located at 6715 and 6609 Henderson Blvd SE in Tumwater, Washington. The location of the site is shown relative to surrounding physical features in the Vicinity Map, Figure 1. The project site consists of three parcels of land (Parcel No. 79300000100, 79300000101 and 12701320105) comprising approximately 9.73 acres.

The site is currently developed with a single-family residence. We understand that the proposed development will include forty-five single-family lots and appurtenant drive areas. Stormwater runoff for the development is to be infiltrated on-site.

SCOPE OF SERVICES

The purpose of our services was to evaluate subsurface soil conditions as they relate to geotechnical conditions and the infiltration and disposal of stormwater from the proposed site improvements. We proposed to perform our evaluation in general accordance with the procedures outlined in the City of Tumwater Drainage Design and Erosion Control Manual (2009 Manual). The specific tasks performed are outlined below:

Geotechnical Investigation

1. Provided for the location of subsurface utilities on the site. We performed this task by notifying the "One Call" system.
2. Conducted a site reconnaissance to evaluate and mark proposed test pit and drilling locations at the site, and for truck-mounted drilling rig access.

3. Excavated twelve (12) exploratory test pits across the site using a track-mounted excavator provided by Johnson & Maddox. The test pits were excavated to a depth of 8 feet below ground surface and backfilled at the end of the day
4. Collected representative soil samples from the test pits for laboratory analysis.
5. Logged the soils exposed in the test pits in general accordance with ASTM D2487-06.
6. Provided for laboratory testing of the soils. We performed gradation analyses to evaluate bearing capacity and stormwater infiltration rates.
7. Provided preliminary infiltration rates for the soils using the "Detailed Method" as described in the Manual.
8. Prepared a report summarizing our field activities including our recommendations for site preparation and grading, bearing capacity, seismic class, temporary and final cut slopes, earth pressures, suitability of the on-site soils for use as fill.

Stormwater Investigation

9. Drilled two exploratory boreholes in the area of the proposed infiltration structure to evaluate soils for infiltration and depth to groundwater. Borings were drilled using a truck-mounted drilling rig.
10. Maintained logs of the soil encountered in the boreholes. Soils were described in general accordance with the Unified Soil Classification System and presented on the field logs.
11. Conducted grain-size analyses on selected soil samples from the borings to determine design stormwater infiltration rates for the project using the grain-size method described in the Manual.
12. Provided for the analysis of cation exchange capacity and organic content of the soils to evaluate the treatment capability for stormwater disposal. We analyzed 4 samples in the infiltration locations.
13. Prepared a report for review by the City of Tumwater summarizing our design infiltration rates and estimated high groundwater elevations for the site.

FINDINGS

Surface Conditions

The project site consists of three parcels forming a roughly square shaped area and totaling about 9.73 acres. The site topography is gently rolling with elevations ranging from approximately 152 feet above mean sea level (MSL) along the edge of the glacial kettle along the southern edge of the site to about 184 feet MSL along the upland on the eastern portion of the site. A small kettle depression is located adjacent to the southern edge of the site with the base at an elevation of approximately 148 feet MSL. A gently sloping and shallow draw runs along the central portion of the site at an elevation of approximately 166 feet above MSL. The site is bounded by Henderson Boulevard SE to the east and residential properties to the west, south, and north. The site is currently developed with multiple single-family residences and a retail business along the eastern edge of the property and fronting Henderson Boulevard SE. These structures are to be removed prior to the beginning of construction activities. The northwest portion of the property is vegetated with a moderately dense growth of Douglas fir trees. The remainder of the property is predominantly grass fields with isolated fir trees.

Geology

Based on our review of available published geologic maps, Vashon age glacial recessional outwash deposits underlie the project site and surrounding area. This material is described as recessional sands in kettle walls. This material was deposited around the margins of glacially-formed kettle lakes, during the waning stages of the most recent glacial period in the Puget Sound. These deposits are not glacially consolidated.

Subsurface Explorations

We explored subsurface conditions at the site on September 15 and 16, 2021, by excavating twelve test pits and advancing two borings in the locations as shown on the Site Plan, Figure 2. The test pits were excavated by Johnson & Maddox using a track-mounted excavator. The exploratory borings were completed by Standard Environmental Probe using a truck-mounted, direct-push drill rig. A geologist from Insight Geologic monitored the explorations and maintained a log of the conditions encountered. The test pits were completed to a depth of approximately 8 feet bgs and the borings were completed to a depth of 30 feet bgs. The soils were visually classified in general accordance with the system described in ASTM D2487-06. A copy of the explorations is contained in Attachment A.

Monitoring wells, consisting of 1-inch diameter casing and screen, were installed in each of the borings to a depth of 30 feet bgs. The monitoring wells were completed within locking, tamper-resistant steel covers, installed flush with the surrounding grade. The monitoring well construction details are included in Attachment A. For the purposes of this report, groundwater elevations were based on estimated ground surface elevations obtained from the Thurston County Geodata website digital elevation model.

Soil Conditions

Soil conditions encountered were generally consistent across the site. Underlying approximately 6 inches forest duff or sod, we generally encountered dark brown to brown fine to medium sand with silt and varying percentages of gravel (SP-SM), in a loose to medium dense and dry to moist condition. The upper 3 feet of soil was generally dry and test pits within the wooded portions of the site contained abundant roots in the upper soils.

The surficial soils encountered at the site are generally consistent with Indianola loamy sand, which is mapped for the area. This soil is generally formed from glacial outwash and generally has restrictive layers occurring at depths greater than 7 feet below grade. Percolation is generally high to very high, according to the U.S. Department of Agriculture Soil Survey.

Groundwater Conditions

Groundwater was encountered in boring B-2 at a depth of approximately 21 feet bgs. Based on the approximate surface location, this correlated to an approximate elevation of 137 feet above sea level. Two larger wetlands located to the west and east of the site appear to contain water year-round at or near an elevation of 139 feet above mean sea level. No evidence of intermediate perched water was encountered within the explorations.

Laboratory Testing

We selected eleven soil samples for gradation analyses in general accordance with ASTM D422 to define soil class and obtain parameters for stormwater infiltration calculations. We also selected four samples for analysis of the Cation Exchange Capacity (CEC) and organic content by an outside laboratory according to EPA method 9081. Our geotechnical laboratory tests, CEC analysis, and organic content results are presented in Attachment B.

Cation Exchange Capacity Evaluation

According to the City of Tumwater 2018 Stormwater Design Manual (2018 Manual), soils used in bioretention facilities must have a minimum Cation Exchange Capacity (CEC) of 5 milliequivalents (meq) per 100 grams of soil. CEC is an intrinsic characteristic of soils, which depends on the soil's grain size, pH, organic, and moisture content. The CEC of a soil is also a proportional measure of the soil's ability to chemically bind with negatively charged ions in pollutants and remove them from infiltrated stormwater.

Four samples were selected from the gallery locations for CEC analysis. The samples were delivered to Soiltest Farm Consultants, Inc., in Moses Lake, Washington, and analyzed in accordance with the requirements of the 2016 Manual using EPA method 9081, Cation Exchange Capacity of Soils (Sodium Acetate) and for organic content. The laboratory analysis indicated that the samples analyzed had CECs of between 5.4 and 3.4 meq/100g and organic contents of between 1.3 and 0.1 percent. The laboratory results are provided in Attachment B and summarized in Table 1.

Table 1. Cation Exchange Capacity Results

Boring Number	Depth (feet bgs)	CEC (meq/100g)	Organic Content (percent)
MW-1	0.0 – 5.0	5.4	1.1
MW-1	5.0 – 10.0	5.3	0.4
MW-2	0.0 – 5.0	4.8	1.3
MW-2	5.0 – 10.0	3.4	0.1

STORMWATER INFILTRATION

We completed a stormwater infiltration rate evaluation in general accordance with the 2018 City of Tumwater Drainage Design and Erosion Control Manual (2018 Manual) as required for projects located within the City of Tumwater UGA. The 2018 Manual uses a detailed method that utilizes the relationship between the D10, D60, and D90 results of the ASTM grain-size distribution analyses, along with site specific correction factors to estimate long-term design infiltration rates.

Based on our gradation analyses, we estimate that the preliminary long-term design infiltration rate (F_{design}) for the proposed stormwater infiltration system is 10.2 inches per hour, based on the location on the site and after applying the appropriate correction factors. Our calculations assume that stormwater infiltration will occur at a depth of at 5 feet bgs as part of an infiltration gallery and groundwater is at a depth of approximately 21 feet bgs. Infiltration rates can change depending on

the final geometry of the infiltration facility. The results of our stormwater infiltration evaluation are presented in Table 1 and Attachment C.

Table 2. Design Infiltration Rates – ASTM Method

Exploration	Unit	Depth Range (feet)	D_{10} Value	D_{60} Value	D_{90} Value	Correction Factor Plugging	Correction Factor Geometry	Correction Factor Testing Methodology	Long-Term Design Infiltration Rate (Inches per hour)
MW-2	SP-SM	5.0 – 10.0	0.09	0.35	6.5	0.8	0.85	0.4	10.2
	SP-SM	10.0 – 15.0	0.08	0.21	0.34				
	SP-SM	15.0 – 20.0	0.14	0.43	11.0				
	GP-GM	20.0 – 21.0	0.15	11.0	23.0				

SEISMIC DESIGN CONSIDERATIONS

General

We understand that seismic design will likely be performed using the 2018 IBC standards. The following parameters may be used in computing seismic base shear forces:

Table 3. 2018 IBC Seismic Design Parameters

Spectral Response Accel. at Short Periods (SS) = 1.379
Spectral Response Accel. at 1 Second Periods (S1) = 0.515
Site Class = D
Site Coefficient (FA) = 1.0
Site Coefficient (FV) = 1.785

Ground Rupture

Because of the location of the site with respect to the nearest known active crustal faults, and the presence of a relatively thick layer of glacial outwash deposits, it is our opinion that the risk of ground rupture at the site due to surface faulting is low.

Soil Liquefaction

Liquefaction refers to a condition where vibration or shaking of the ground, usually from earthquake forces, results in the development of excess pore water pressures in saturated soils, and a subsequent loss of stiffness in the soil occurs. Liquefaction also causes a temporary reduction of soil shear strength and bearing capacity, which can cause settlement of the ground surface above the liquefied soil layers. In general, soils that are most susceptible to liquefaction include saturated, loose to medium dense, clean to silty sands and non-plastic silts within 50 feet of ground surface.

Based on our review of the *Liquefaction Susceptibility Map of Thurston County (Palmer, 2004)*, the project site is identified to have a low to moderate potential risk for soil liquefaction. Based on our experience with detailed seismic studies in the Olympia and Tumwater area, including areas that are

mapped within the same recessional outwash soil deposits as the project site, we concur with the reviewed map. It is our opinion that there is a moderate risk for soil liquefaction at the site. Additional investigation and evaluation would be needed to further define this risk.

Seismic Compression

Seismic compression is defined as the accrual of contractive volumetric strains in unsaturated soils during strong shaking from earthquakes (Stewart et al., 2004). Loose to medium dense clean sands and non-plastic silts are particularly prone to seismic compression settlement. Seismic compression settlement is most prevalent on slopes, but it can also occur on flat ground. It is our opinion that the upper 15 feet of the soil profile at the site has a moderate risk for seismic compression settlement.

Seismic Settlement Discussion

Based on the materials encountered in our explorations, it is our preliminary opinion that seismic settlements (liquefaction-induced plus seismic compression) could potentially total a few inches at the site as the result of an IBC design level earthquake. We are available upon request to perform deep subsurface explorations and detailed seismic settlement estimates during the design phase.

Seismic Slope Instability

The maximum inclination of the slopes on the southern portion of the site are approximately 15 percent and we did not observe signs of slope instability during our site work. In our opinion, there is a low to moderate risk of seismic slope instability at the project site under current conditions. If slope instability due to a seismic event did occur, it could result in damage to the stormwater infiltration gallery due to seismically induced liquification as a result of elevated moisture contents from the stormwater gallery location as well as residential lots near the steepest slopes.

Lateral Spreading

Lateral spreading involves the lateral displacement of surficial blocks of non-liquefied soil when an underlying soil layer liquefies. Lateral spreading generally develops in areas where sloping ground or large grade changes are present. Based on our limited understanding of the subsurface conditions along the southern site slope, it is our opinion that there could be a low to moderate risk for the development of lateral spreading as a result of an IBC design level earthquake.

Seismic Slope Deformation Discussion

In our experience, it is unlikely that the potential slope deformations described above (seismic compression or lateral spreading) would be mitigated for in the typical design of residential buildings. If necessary, we are available to perform detailed slope stability/lateral spreading evaluations to include borings and/or CPT soundings at the site.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our review, subsurface explorations, and engineering analyses, it is our opinion that the proposed development is feasible from a geotechnical standpoint. We recommend that the proposed structures be supported on shallow concrete foundations that are designed using an allowable soil bearing capacity of 2,000 pounds per square foot (psf) when founded within the sand with silt units.

The soils encountered in our explorations are typically in a loose condition near ground surface. To limit the potential for structure settlement, we recommend that shallow foundations and slabs-on-grade be established on a minimum 1-foot thick layer of structural fill. Depending on final grading plans and the time of year earthwork is performed; it could be practical to reuse a portion of the on-site soils as structural fill under the foundations/slabs.

Stormwater infiltration at the site is feasible. We have provided a design infiltration rate of 10.2 inches per hour for the proposed stormwater infiltration systems, based on the location and depth of stormwater infiltration at the site.

Earthwork

General

We anticipate that site development earthwork will include removal of the existing residential buildings, clearing and stripping of existing vegetation, preparing subgrades, excavating for utility trenches, and placing and compacting structural fill. We expect that the majority of site grading can be accomplished with conventional earth moving equipment in proper working order.

Our explorations did not encounter appreciable amounts of debris or unsuitable soils associated with past site development. Still, it is possible that concrete slabs, abandoned utility lines or other development features from the existing residence could be encountered during construction. The contractor should be prepared to deal with these conditions.

Clearing and Stripping

Clearing and stripping should consist of removing surface and subsurface deleterious materials including sod/topsoil, trees, brush, debris and other unsuitable loose/soft or organic materials. Stripping and clearing should extend at least 5 feet beyond all structures and areas to receive structural fill.

We estimate that a stripping depth of about 0.5 feet will be required to remove the surficial organic layer encountered in several of our explorations. Deeper stripping depths may be required if additional unsuitable soils are exposed during stripping operations. We recommend that trees be removed by overturning so that the majority of roots are also removed. Depressions created by tree or stump removal should be backfilled with structural fill and properly compacted.

Subgrade Preparation

After stripping and excavating to the proposed subgrade elevation, and before placing structural fill or foundation concrete, the exposed subgrade should be thoroughly compacted to a firm and unyielding condition. The exposed subgrade should then be proof-rolled using loaded, rubber-tired heavy equipment. We recommend that Insight Geologic be retained to observe the proof-rolling prior to placement of structural fill or foundation concrete. Areas of limited access that cannot be proof-rolled can be evaluated using a steel probe rod. If soft or otherwise unsuitable areas are revealed during proof-rolling or probing, that cannot be compacted to a stable and uniformly firm condition, we generally recommend that: 1) the subgrade soils be scarified (e.g., with a ripper or farmer's disc), aerated and recompacted; or 2) the unsuitable soils be overexcavated and replaced with structural fill.

Temporary Excavations and Groundwater Handling

Excavations deeper than 4 feet should be shored or laid back at a stable slope if workers are required to enter. Shoring and temporary slope inclinations must conform to the provisions of Title 296 Washington Administrative Code (WAC), Part N, "Excavation, Trenching and Shoring." Regardless of the soil type encountered in the excavation, shoring, trench boxes or sloped sidewalls were required under the Washington Industrial Safety and Health Act (WISHA). The contract documents should specify that the contractor is responsible for selecting excavation and dewatering methods, monitoring the excavations for safety and providing shoring, as required, to protect personnel and structures.

In general, temporary cut slopes should be inclined no steeper than about 1.5H:1V (horizontal: vertical). This guideline assumes that all surface loads are kept at a minimum distance of at least one-half the depth of the cut away from the top of the slope, and that significant seepage is not present on the slope face. Flatter cut slopes were necessary where significant seepage occurs or if large voids are created during excavation. Some sloughing and raveling of cut slopes should be expected. Temporary covering with heavy plastic sheeting should be used to protect slopes during periods of wet weather.

We anticipate that if perched groundwater is encountered during construction can be handled adequately with sumps, pumps, and/or diversion ditches. Groundwater handling needs will generally be lower during the late summer and early fall months. We recommend that the contractor performing the work be made responsible for controlling and collecting groundwater encountered during construction.

Permanent Slopes

We anticipate that permanent slopes will be utilized along slopes leading to wetland area south of the site. Where permanent slopes are necessary, we recommend the slopes be constructed at a maximum inclination of 2H:1V. Where 2H:1V permanent slopes are not feasible, protective facings and/or retaining structures should be considered.

To achieve uniform compaction, we recommend that fill slopes be overbuilt and subsequently cut back to expose well-compacted fill. Fill placement on slopes should be benched into the slope face and include keyways. The configuration of the bench and keyway depends on the equipment being used. Bench excavations should be level and extend into the slope face. We recommend that a vertical cut of about 3 feet be maintained for benched excavations. Keyways should be about 1-1/2 times the width of the equipment used for grading or compaction.

Erosion Control

We anticipate that erosion control measures such as silt fences, straw bales and sand bags will generally be adequate during development. Temporary erosion control should be provided during construction activities and until permanent erosion control measures are functional. Surface water runoff should be properly contained and channeled using drainage ditches, berms, swales, and tightlines, and should not discharge onto sloped areas. Any disturbed sloped areas should be protected with a temporary covering until new vegetation can take effect. Jute or coconut fiber matting, excelsior matting or clear plastic sheeting is suitable for this purpose. Graded or disturbed slopes should be tracked in-place with the equipment running perpendicular to the slope contours so that the

track marks provide a texture to help resist erosion. Ultimately, erosion control measures should be in accordance with local regulations and should be clearly described on project plans.

Wet Weather Earthwork

Some of the near surface soils contain up to about 14 percent fines. When the moisture content of the soil is more than a few percent above the optimum moisture content, the soil will become unstable and it may become difficult or impossible to meet the required compaction criteria. Disturbance of near surface soils should be expected if earthwork is completed during periods of wet weather.

The wet weather season in this area generally begins in October and continues through May. However, periods of wet weather may occur during any month of the year. If wet weather earthwork is unavoidable, we recommend that:

- The ground surface is sloped so that surface water is collected and directed away from the work area to an approved collection/dispersion point.
- Earthwork activities not take place during periods of heavy precipitation.
- Slopes with exposed soil be covered with plastic sheeting or otherwise protected from erosion.
- Measures are taken to prevent on-site soil and soil stockpiles from becoming wet or unstable. Sealing the surficial soil by rolling with a smooth-drum roller prior to periods of precipitation should reduce the extent that the soil becomes wet or unstable.
- Construction traffic is restricted to specific areas of the site, preferably areas that are surfaced with materials not susceptible to wet weather disturbance.
- A minimum 1-foot thick layer of 4- to 6-inch quarry spalls is used in high traffic areas of the site to protect the subgrade soil from disturbance.
- Contingencies are included in the project schedule and budget to allow for the above elements.

Structural Fill Materials

General

Material used for structural fill should be free of debris, organic material and rock fragments larger than 3 inches. The workability of material for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines increases, soil becomes increasingly more sensitive to small changes in moisture content and adequate compaction becomes more difficult or impossible to achieve.

On-Site Soil

We anticipate that the majority of the on-site soils encountered during construction will consist of the sands with silt located at or near the surface of the site. It is our opinion that this material is a suitable source for structural fill during a significant portion of the year. However, we anticipate that thin lifts (6-inches thick or less) will likely be needed to obtain structural fill compaction specifications. On-site materials used as structural fill should be free of roots, organic matter and other deleterious materials and particles larger than 3 inches in diameter.

Select Granular Fill

Select granular fill should consist of imported, well-graded sand and gravel or crushed rock with a maximum particle size of 3 inches and less than 5 percent passing a U.S. Standard No. 200 sieve based on the minus ¾-inch fraction. Organic matter, debris or other deleterious material should not be present. In our experience, "gravel borrow" as described in Section 9-03.14(1) of the 2020 WSDOT Standard Specifications is typically a suitable source for select granular fill during periods of wet weather, provided that the percent passing a U.S. Standard No. 200 sieve is less than 5 percent based on the minus ¾-inch fraction.

Structural Fill Placement and Compaction

General

Structural fill should be placed on an approved subgrade that consists of uniformly firm and unyielding inorganic native soils or compacted structural fill. Structural fill should be compacted at a moisture content near optimum. The optimum moisture content varies with the soil gradation and should be evaluated during construction.

Structural fill should be placed in uniform, horizontal lifts and uniformly densified with vibratory compaction equipment. The maximum lift thickness will vary depending on the material and compaction equipment used, but should generally not exceed the loose thicknesses provided on Table 4. Structural fill materials should be compacted in accordance with the compaction criteria provided in Table 5.

Table 4. Recommended Uncompacted Lift Thickness

Compaction Equipment	Recommended Uncompacted Fill Thickness (inches)	
	Granular Materials Maximum Particle Size ≤ 1 1/2 inch	Granular Materials Maximum Particle Size > 1 1/2 inch
Hand Tools (Plate Compactors and Jumping Jacks)	4 – 8	Not Recommended
Rubber-tire Equipment	10 – 12	6 – 8
Light Roller	10 – 12	8 – 10
Heavy Roller	12 – 18	12 – 16
Hoe Pack Equipment	18 – 24	12 – 16

Note: The above table is intended to serve as a guideline and should not be included in the project specifications.

Table 5. Recommended Compaction Criteria in Structural Fill Zones

Fill Type	Percent Maximum Dry Density Determined by ASTM Test Method D 1557 at ±3% of Optimum Moisture		
	0 to 2 Feet Below Subgrade	> 2 Feet Below Subgrade	Pipe Zone
Imported or On-site Granular, Maximum Particle Size < 1-1/4-inch	95	95	-----

Imported or On-site Granular, Maximum Particle Size >1-1/4-inch	N/A (Proof-roll)	N/A (Proof-roll)	-----
Trench Backfill[1]	95	92	90

Note: [1]Trench backfill above the pipe zone in nonstructural areas should be compacted to at least 85 percent.

Shallow Foundation Support

General

We recommend that the proposed structure be founded on continuous wall or isolated column footings, bearing on a minimum 1-foot thick overexcavation and replacement with compacted structural fill where underlying soils are not able to be compacted as structural fill. The structural fill zone should extend to a horizontal distance equal to the overexcavation depth on each side of the footing. The actual overexcavation depth will vary, depending on the conditions encountered.

We recommend that a representative from Insight Geologic observe the foundation surfaces before overexcavation, and before placing structural fill in overexcavations. This representative should confirm that adequate bearing surfaces have been prepared and that the soil conditions are as anticipated. Unsuitable foundation bearing soils should be recompacted or removed and replaced with compacted structural fill, as recommended by the geotechnical engineer.

Bearing Capacity and Footing Dimensions

We recommend an allowable soil bearing pressure of 2,000 psf for shallow foundations that are supported as recommended. This allowable bearing pressure applies to long-term dead and live loads exclusive of the weight of the footing and any overlying backfill. The allowable soil bearing pressure can be increased by one-third when considering total loads, including transient loads such as those induced by wind and seismic forces.

We recommend a minimum width of 18 inches for continuous wall footings and 2 feet for isolated column footings. For settlement considerations, we have assumed a maximum width of 4 feet for continuous wall footings and 6 feet for isolated column footings.

Perimeter footings should be embedded at least 12 inches below the lowest adjacent grade where the ground is flat. Interior footings should be embedded a minimum of 6 inches below the nearest adjacent grade.

Settlement

We estimate that total settlement of footings that are designed and constructed as recommended should be less than 1 inch. We estimate that differential settlements should be ½ inch or less between comparably loaded isolated footings or along 50 feet of continuous footing. We anticipate that the settlement will occur essentially as loads are applied during construction.

Lateral Load Resistance

Lateral loads on shallow foundation elements may be resisted by passive resistance on the sides of footings and by friction on the base of footings. Passive resistance may be estimated using an equivalent fluid density of 300 pounds per cubic foot (pcf), assuming that the footings are backfilled with structural fill. Frictional resistance may be estimated using 0.25 for the coefficient of base friction.

The lateral resistance values provided above incorporate a factor of safety of 1.5. The passive earth pressure and friction components can be combined, provided that the passive component does not exceed two-thirds of the total. The top foot of soil should be neglected when calculating passive resistance, unless the foundation perimeter area is covered by a slab-on-grade or pavement.

Slabs-On-Grade

Slabs-on-grade should be established on a minimum 1-foot thick section of structural fill extending to an approved bearing surface. A modulus of vertical subgrade reaction (subgrade modulus) can be used to design slabs-on-grade. The subgrade modulus varies based on the dimensions of the slab and the magnitude of applied loads on the slab surface; slabs with larger dimensions and loads are influenced by soils to a greater depth. We recommend a modulus value of 250 pounds per cubic inch (pci) for design of on-grade floor slabs with floor loads up to 500 psf. We are available to provide alternate subgrade modulus recommendations during design, based on specific loading information.

We recommend that slabs-on-grade in interior spaces be underlain by a minimum 4-inch thick capillary break layer to reduce the potential for moisture migration into the slab. The capillary break material should consist of a well-graded sand and gravel or crushed rock containing less than 5 percent fines based on the fraction passing the ¾-inch sieve. The 4-inch thick capillary break layer can be included when calculating the minimum 1-foot thick structural fill section beneath the slab. If dry slabs are required (e.g., where adhesives are used to anchor carpet or tile to the slab), a waterproofing liner should be placed below the slab to act as a vapor barrier

.

Subsurface Drainage

It is our opinion that foundation footing drains and underslab drains are likely unnecessary for the proposed structures. The majority of subsurface site soils are well draining and it is unlikely that subsurface drains would produce water. The soils are suitable for roof runoff drywells and should be classified as Group A for the purposes of design.

Conventional Retaining Walls

General

While we do not anticipate that retaining walls will be utilized for the proposed project, the following sections provide general guidelines for retaining wall design on this site. We should be contacted during the design phase to review retaining wall plans and provide supplemental recommendations, if needed.

Drainage

Positive drainage is imperative behind any retaining structure. This can be accomplished by using a zone of free-draining material behind the wall with perforated pipes to collect water seepage. The drainage material should consist of coarse sand and gravel containing less than 5 percent fines based on the fraction of material passing the ¾-inch sieve. The wall drainage zone should extend horizontally at least 12 inches from the back of the wall. If a stacked block wall is constructed, we recommend that a barrier such as a non-woven geotextile filter fabric be placed against the back of the wall to prevent loss of the drainage material through the wall joints.

A perforated smooth-walled rigid PVC pipe, having a minimum diameter of 4 inches, should be placed at the bottom of the drainage zone along the entire length of the wall. Drainpipes should discharge to a tightline leading to an appropriate collection and disposal system. An adequate number of cleanouts should be incorporated into the design of the drains in order to provide access for regular maintenance. Roof downspouts, perimeter drains or other types of drainage systems should not be connected to retaining wall drain systems.

Design Parameters

We recommend an active lateral earth pressure of 37 pcf (equivalent fluid density) for a level backfill condition. This assumes that the top of the wall is not structurally restrained and is free to rotate. For restrained walls that are fixed against rotation (at-rest condition), an equivalent fluid density of 56 pcf can be used for the level backfill condition. For seismic conditions, we recommend a uniform lateral pressure of 14H psf (where H is the height of the wall) be added to the lateral pressures. This seismic pressure assumes a peak ground acceleration of 0.32 g. Note that if the retaining system is designed as a braced system but is expected to yield a small amount during a seismic event, the active earth pressure condition may be assumed and combined with the seismic surcharge.

The recommended earth pressure values do not include the effects of surcharges from surface loads or structures. If vehicles were operated within one-half the height of the wall, a traffic surcharge should be added to the wall pressure. The traffic surcharge can be approximated by the equivalent weight of an additional 2 feet of backfill behind the wall. Other surcharge loads, such as construction equipment, staging areas and stockpiled fill, should be considered on a case-by-case basis.

DOCUMENT REVIEW AND CONSTRUCTION OBSERVATION

We recommend that we be retained to review the portions of the plans and specifications that pertain to earthwork construction and stormwater infiltration. We recommend that monitoring, testing and consultation be performed during construction to confirm that the conditions encountered are consistent with our explorations and our stated design assumptions. Insight Geologic would be pleased to provide these services upon request.

REFERENCES

City of Tumwater, Drainage Design and Erosion Control Manual, 2018.

International Code Council, International Building Code, 2018.

Seismic Compression of As-compacted Fill Soils with Variable Levels of Fines Content and Fines Plasticity, Department of Civil and Environmental Engineering, University of California, Los Angeles, July 2004.

Washington State Department of Transportation (WSDOT), Standard Specifications for Road, Bridge and Municipal Construction Manual, 2020.

LIMITATIONS

We have prepared this geotechnical and stormwater evaluation report for the exclusive use of Sound Built Homes and their authorized agents for the proposed residential development project to be located on Tumwater Boulevard SE in Tumwater, Washington.

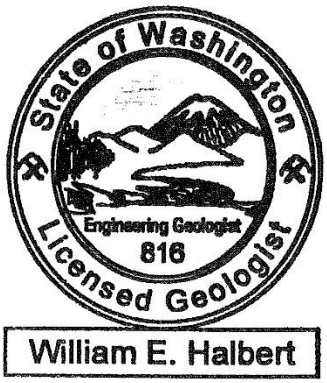
Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions, expressed or implied, should be understood.

Please refer to Attachment C titled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.

We appreciate the opportunity to be of service to you on this project. Please contact us if you have questions or require additional information.

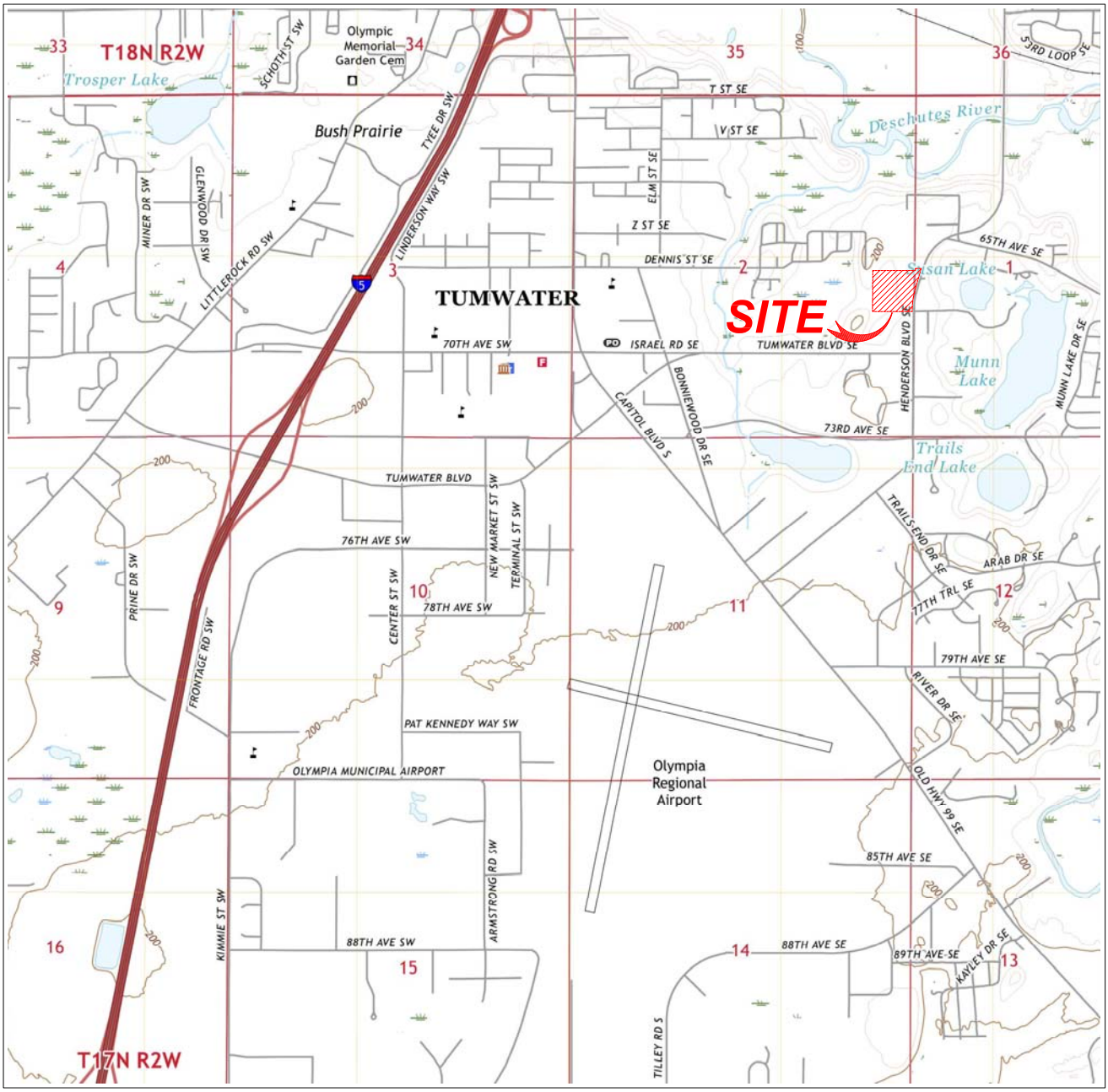
Respectfully Submitted,
INSIGHT GEOLOGIC, INC.

William E. Halbert, L.E.G., L.HG.
Principal



Attachments

FIGURES



Source: USGS (c) 2021

MAYTOWN QUADRANGLE
WASHINGTON - THURSTON COUNTY
7.5-MINUTE SERIES
Year 2015

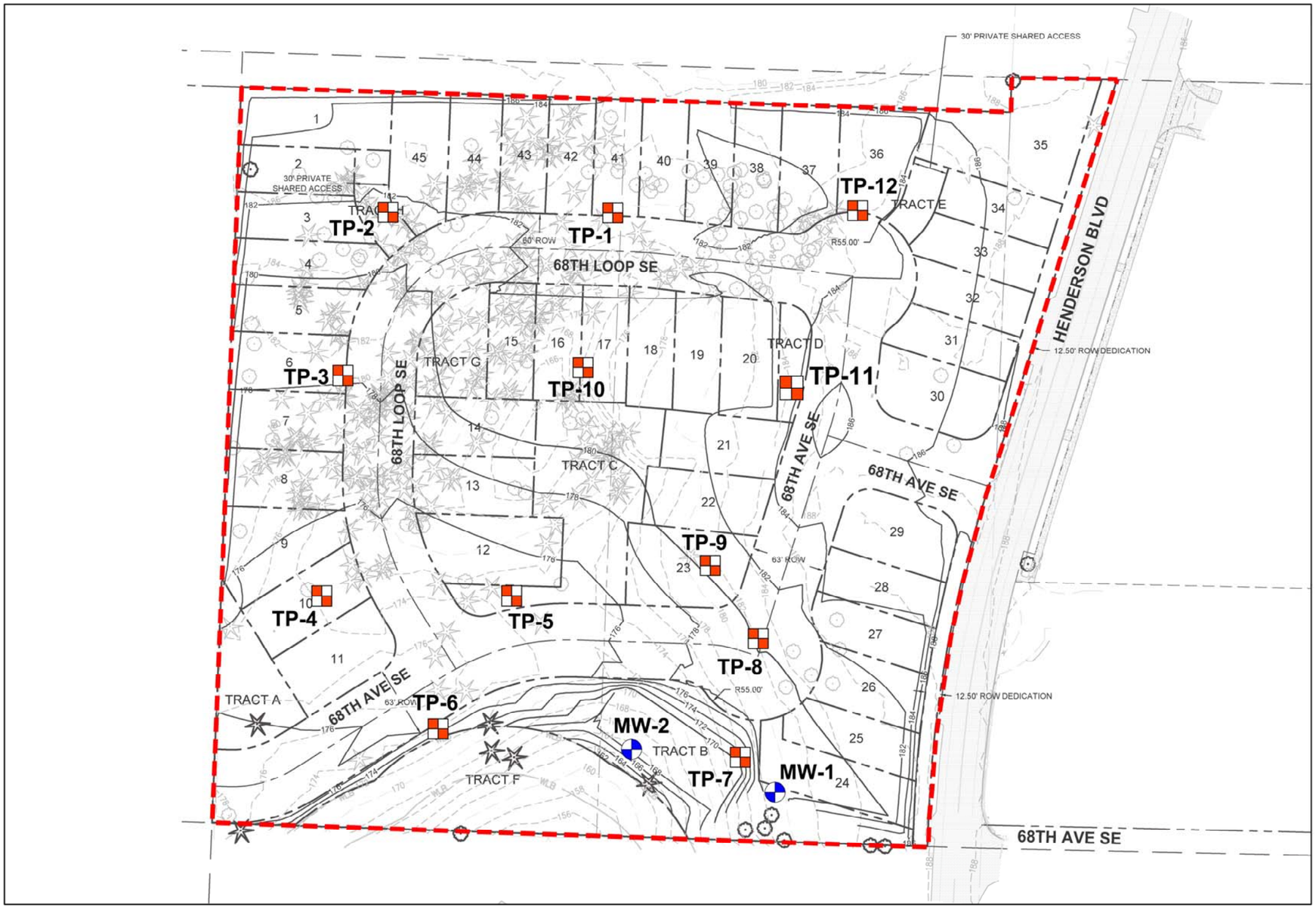
SCALE: 1" = 2500'

THREE LAKES CROSSING DEVELOPMENT

TUMWATER, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 1
Vicinity Map



LEGEND:

- **TP-1** APPROXIMATE TEST PIT LOCATION
- **MW-1** APPROXIMATE SOIL BORING LOCATION
- APPROXIMATE PROJECT BOUNDARY

SCALE: 1"=100'

INSIGHT GEOLOGIC, INC.

THREE LAKES CROSSING DEVELOPMENT

TUMWATER, WASHINGTON

Figure 2

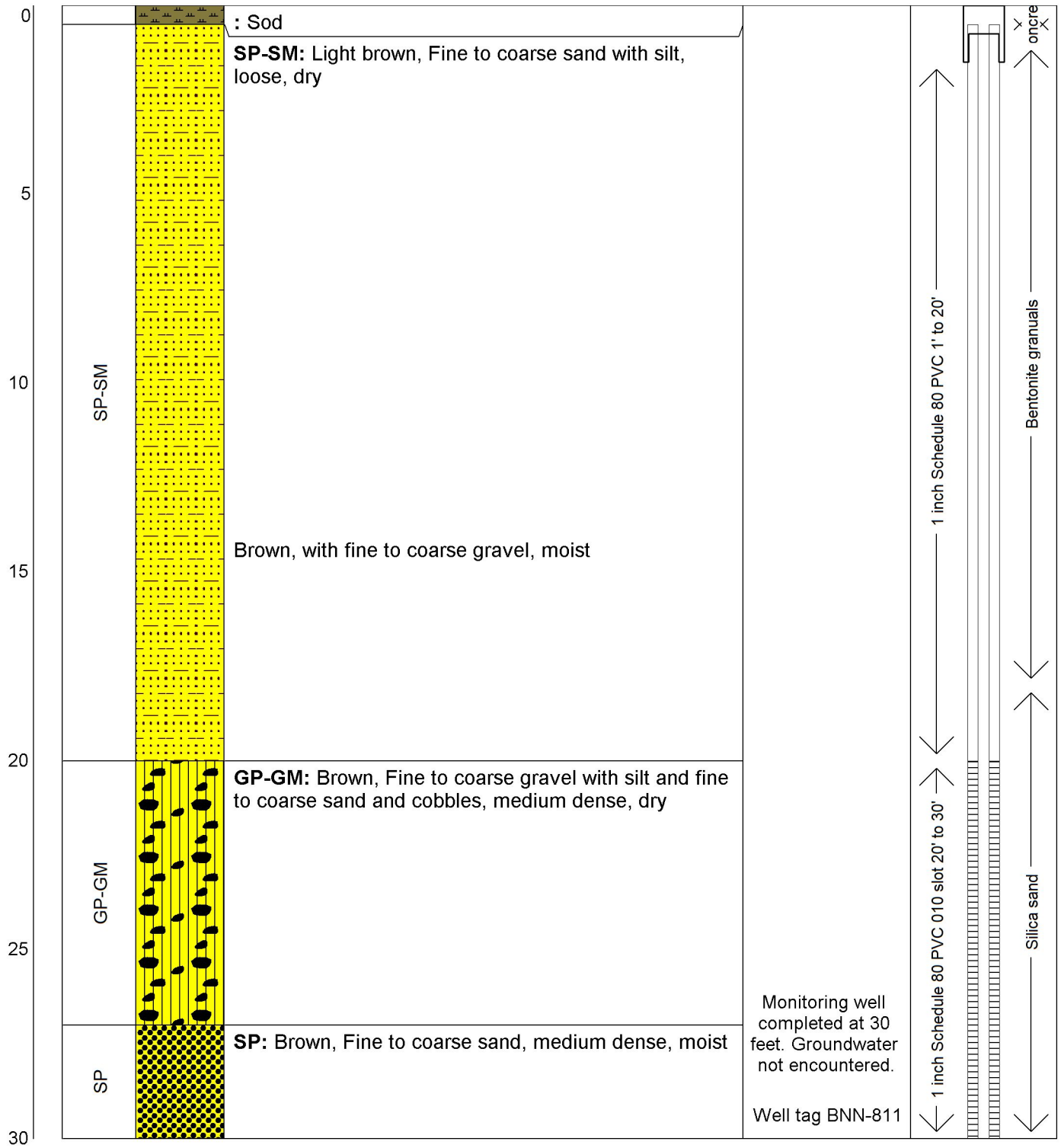
Site Plan

ATTACHMENT A
EXPLORATION LOGS

PROJECT: **SBH - Three Lakes Crossing**
PROJECT NO.: **362-007-01**
LOCATION: **Tumwater, Washington**

MW-1

DATE: **9/16/21**
TOTAL DEPTH: **30**



INSIGHT GEOLOGIC, INC.

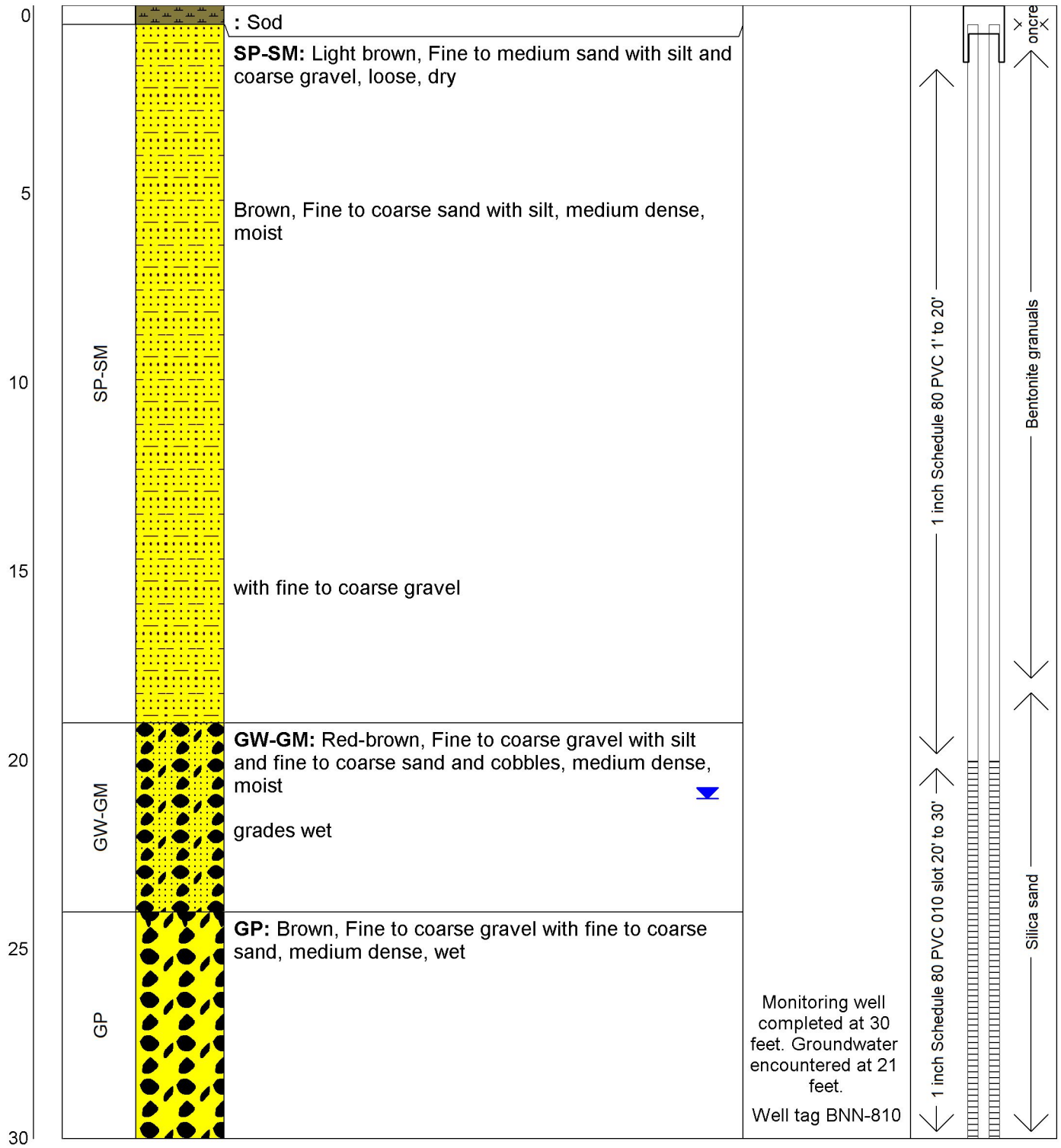
Drilling Contractor: **Standard Environmental Probe**
Drilling Equipment: **Geoprobe 5410**
Logged By: **Neal Graham**

Figure A-2

PROJECT: **SBH - Three Lakes Crossing**
PROJECT NO.: **362-007-01**
LOCATION: **Tumwater, Washington**

MW-2

DATE: **9/16/21**
TOTAL DEPTH: **30**



INSIGHT GEOLOGIC, INC.

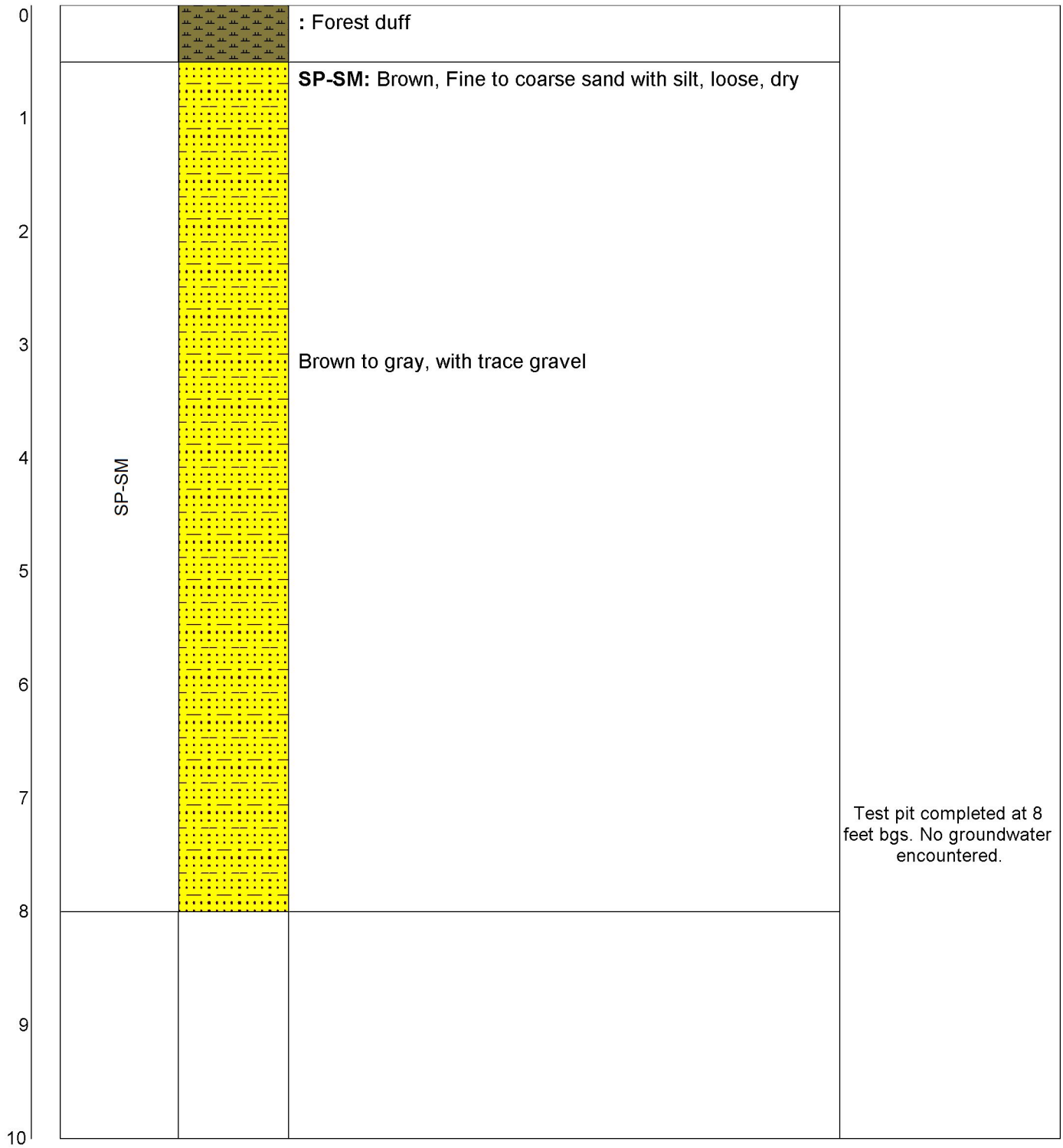
Drilling Contractor: **Standard Environmental Probe**
Drilling Equipment: **Geoprobe 5410**
Logged By: **Neal Graham**

Figure A-3

PROJECT: Three Lakes Crossing
PROJECT NO.: 362-007-01
LOCATION: Tumwater, Washington

TP-1

DATE: 9/15/21
TOTAL DEPTH: 8



INSIGHT GEOLOGIC, INC.

Operator **Johnson Maddox**
Equipment: **John Deere 160C LC Excavator**
Logged By: **Neal Graham**

Figure A-4

PROJECT: Three Lakes Crossing
PROJECT NO.: 362-007-01
LOCATION: Tumwater, Washington

TP-2

DATE: 9/15/21
TOTAL DEPTH: 8

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0			: Forest duff	
1	SP-SM		**SP-SM:** Brown, Fine to coarse sand with silt and fine to coarse gravel and abundent roots, loose, dry	
2				
3				
4			Light brown, Fine to medium sand with silt and fine to coarse gravel	
5				
6				
7				Test pit completed at 8 foot. No groundwater encountered.
8				
9				
10				

INSIGHT GEOLOGIC, INC.

Operator **Johnson Maddox**
Equipment: **John Deere 160C LC Excavator**
Logged By: **Neal Graham**

Figure A-5

PROJECT: Three Lakes Crossing
PROJECT NO.: 362-007-01
LOCATION: Tumwater, Washington

TP-3

DATE: 9/15/21
TOTAL DEPTH: 8

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0			: Forest duff	
1	SP-SM		**SP-SM:** Brown, Fine to medium sand with silt and trace fine to coarse gravel and abundent roots, loose, dry	
2				
3				
4			Light brown to gray, with coarse sand and fine to coarse gravel	
5				
6			Moist	
7				Test pit completed at 8 foot. No groundwater encountered.
8				
9				
10				

INSIGHT GEOLOGIC, INC.

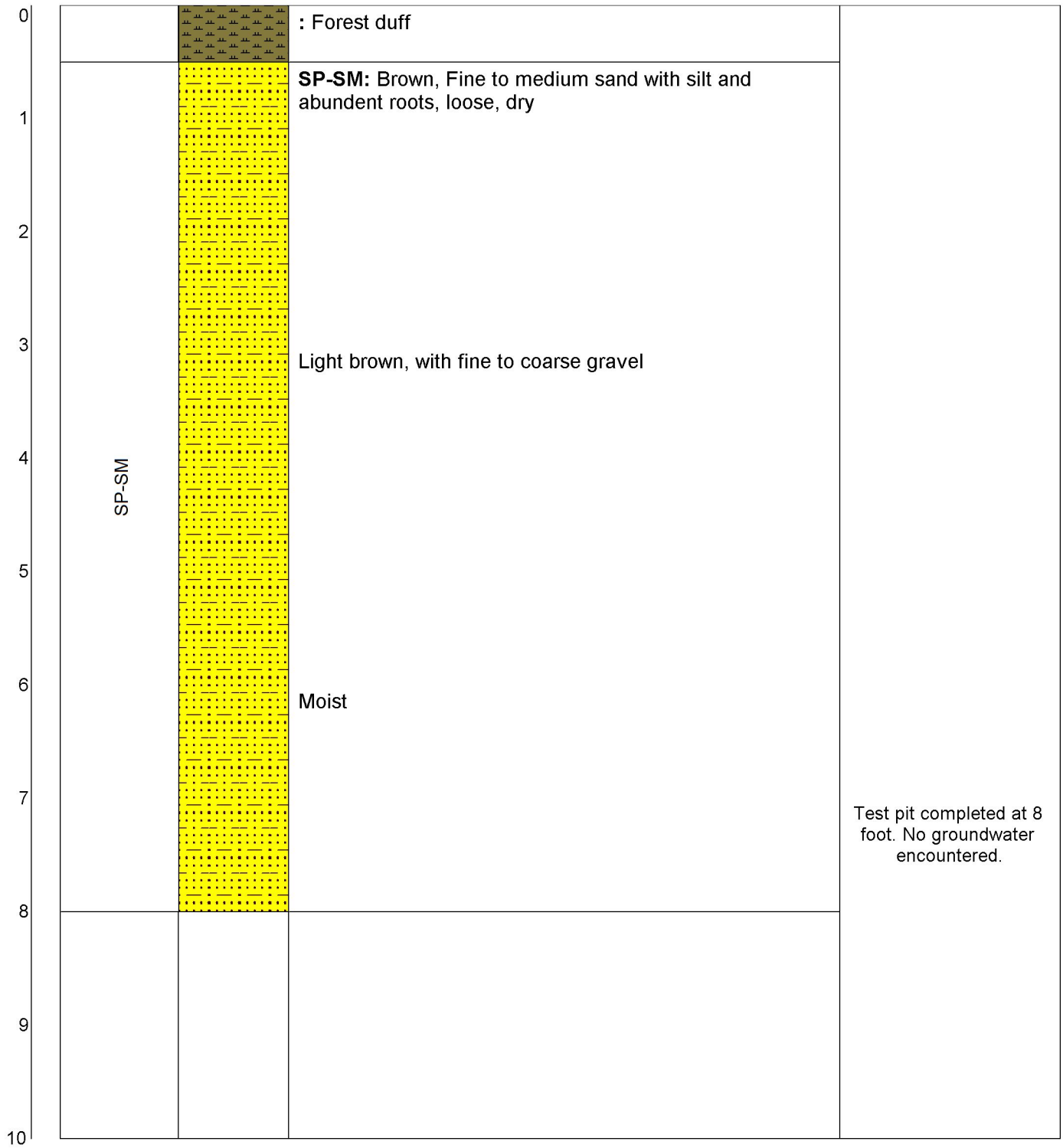
Operator **Johnson Maddox**
Equipment: **John Deere 160C LC Excavator**
Logged By: **Neal Graham**

Figure A-6

PROJECT: Three Lakes Crossing
PROJECT NO.: 362-007-01
LOCATION: Tumwater, Washington

TP-4

DATE: 9/15/21
TOTAL DEPTH: 8



INSIGHT GEOLOGIC, INC.

Operator **Johnson Maddox**
Equipment: **John Deere 160C LC Excavator**
Logged By: **Neal Graham**

Figure A-7

PROJECT: Three Lakes Crossing
PROJECT NO.: 362-007-01
LOCATION: Tumwater, Washington

TP-5

DATE: 9/15/21
TOTAL DEPTH: 8

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0			: Sod	
1	SP-SM		**SP-SM:** Light brown, Fine to medium sand with silt and fine to coarse gravel, medium dense, dry	
2				
3				
4				
5				
6				
7				Test pit completed at 8 foot. No groundwater encountered.
8				
9				
10				

INSIGHT GEOLOGIC, INC.

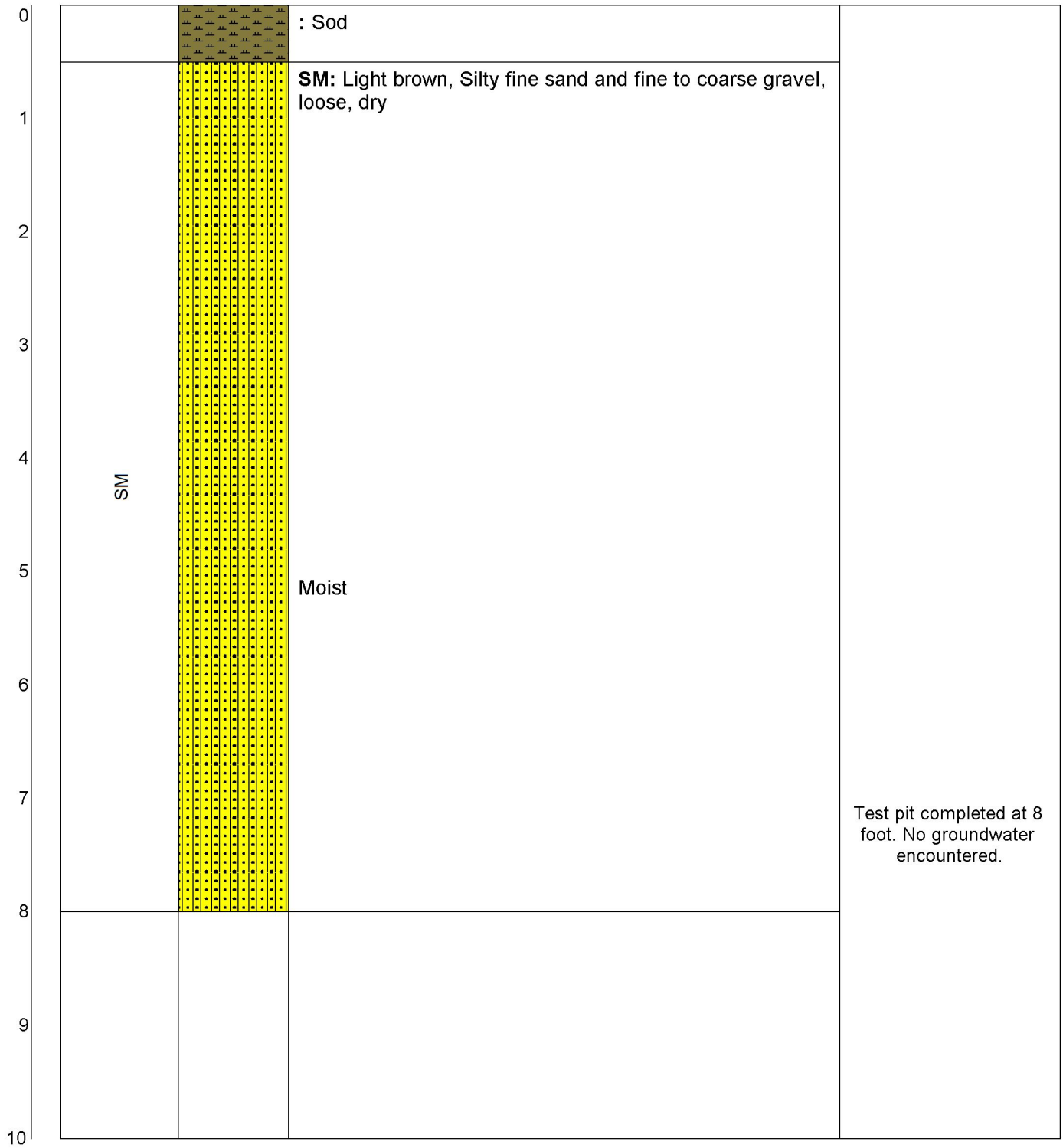
Operator **Johnson Maddox**
Equipment: **John Deere 160C LC Excavator**
Logged By: **Neal Graham**

Figure A-8

PROJECT: Three Lakes Crossing
PROJECT NO.: 362-007-01
LOCATION: Tumwater, Washington

TP-6

DATE: 9/15/21
TOTAL DEPTH: 8



INSIGHT GEOLOGIC, INC.

Operator Johnson Maddox
Equipment: John Deere 160C LC Excavator
Logged By: Neal Graham

Figure A-9

PROJECT: Three Lakes Crossing
PROJECT NO.: 362-007-01
LOCATION: Tumwater, Washington

TP-7

DATE: 9/15/21
TOTAL DEPTH: 8

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0			: Sod	
1	SP-SM		**SP-SM:** Light brown, Fine to medium sand with silt and fine to coarse gravel, loose, dry	
2				
3				
4				
5			Brown, with coarse sand, moist	
6				
7				Test pit completed at 8 foot. No groundwater encountered.
8				
9				
10				

INSIGHT GEOLOGIC, INC.

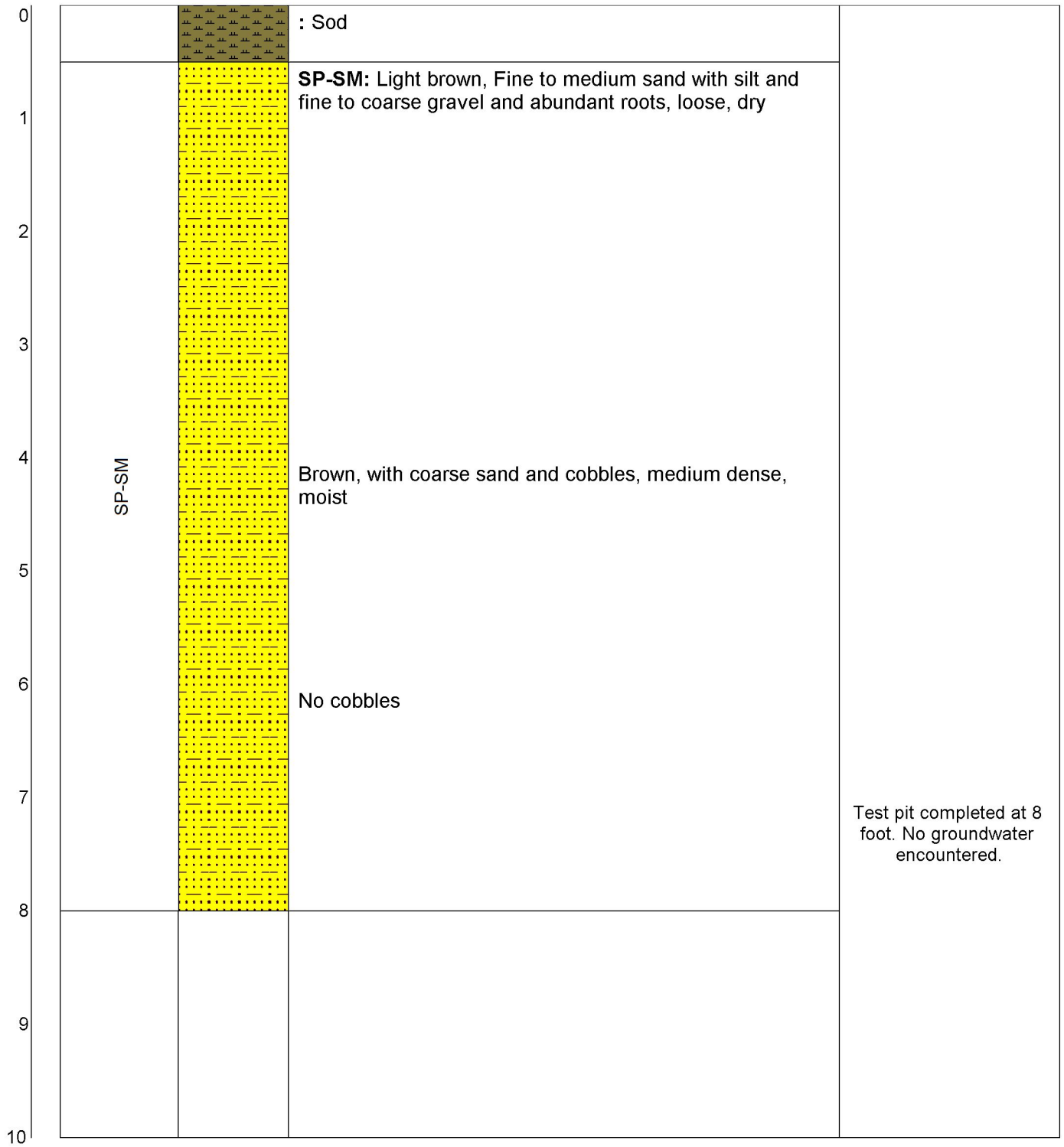
Operator **Johnson Maddox**
Equipment: **John Deere 160C LC Excavator**
Logged By: **Neal Graham**

Figure A-10

PROJECT: Three Lakes Crossing
PROJECT NO.: 362-007-01
LOCATION: Tumwater, Washington

TP-8

DATE: 9/15/21
TOTAL DEPTH: 8



INSIGHT GEOLOGIC, INC.

Operator Johnson Maddox
Equipment: John Deere 160C LC Excavator
Logged By: Neal Graham

Figure A-11

PROJECT: Three Lakes Crossing
PROJECT NO.: 362-007-01
LOCATION: Tumwater, Washington

TP-9

DATE: 9/15/21
TOTAL DEPTH: 8

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0			: Sod	
1	SP-SM		**SP-SM:** Light brown, Fine to medium sand with silt and trace roots, loose, dry	
2				
3				
4			Brown, with coarse sand and trace fine to coarse gravel, moist	
5				
6				
7				Test pit completed at 8 foot. No groundwater encountered.
8				
9				
10				

INSIGHT GEOLOGIC, INC.

Operator **Johnson Maddox**
Equipment: **John Deere 160C LC Excavator**
Logged By: **Neal Graham**

Figure A-12

PROJECT: Three Lakes Crossing
PROJECT NO.: 362-007-01
LOCATION: Tumwater, Washington

TP-10

DATE: 9/15/21
TOTAL DEPTH: 8

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0			: Sod	
1	SP-SM		**SP-SM:** Light brown, Fine to medium sand with silt and abundant roots, loose, dry	
2				
3				
4			Brown, with coarse sand, moist	
5				
6				
7				Test pit completed at 8 foot. No groundwater encountered.
8				
9				
10				

INSIGHT GEOLOGIC, INC.

Operator **Johnson Maddox**
Equipment: **John Deere 160C LC Excavator**
Logged By: **Neal Graham**

Figure A-13

PROJECT: Three Lakes Crossing
PROJECT NO.: 362-007-01
LOCATION: Tumwater, Washington

TP-11

DATE: 9/15/21
TOTAL DEPTH: 8

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0			: Sod	
1	SP-SM		**SP-SM:** Light brown, Fine to medium sand with silt and fine to coarse gravel, loose, dry	
3	SP		**SP:** Brown, Fine to medium sand with fine to coarse gravel and cobbles, loose, moist	Test pit completed at 8 foot. No groundwater encountered.
8				
10				

INSIGHT GEOLOGIC, INC.

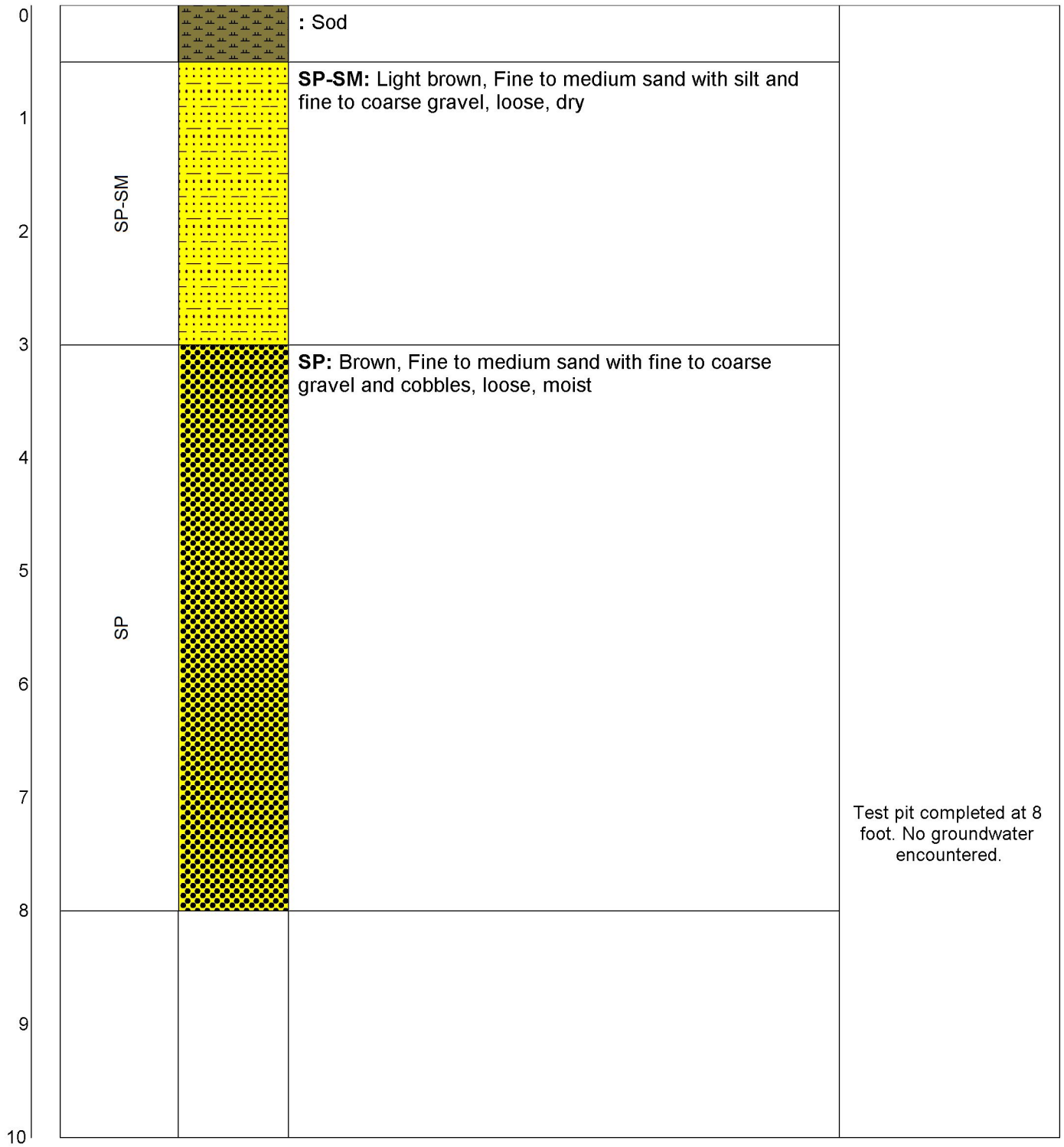
Operator **Johnson Maddox**
Equipment: **John Deere 160C LC Excavator**
Logged By: **Neal Graham**

Figure A-14

PROJECT: Three Lakes Crossing
PROJECT NO.: 362-007-01
LOCATION: Tumwater, Washington

TP-12

DATE: 9/15/21
TOTAL DEPTH: 8



INSIGHT GEOLOGIC, INC.

Operator **Johnson Maddox**
Equipment: **John Deere 160C LC Excavator**
Logged By: **Neal Graham**

Figure A-15

ATTACHMENT B
LABORATORY ANALYSES RESULTS

Gradation Analysis Summary Data

Job Name: Three Lakes Crossing
Job Number: 362-007-01
Date Tested: 9/17/21
Tested By: Dalton Prichard

Sample Location: TP-2
Sample Name: TP-2 4.0' - 8.0'
Depth: 4 - 8 Feet

Moisture Content (%) 5.1%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	93.3
3/8 in. (9.5-mm)	87.8
No. 4 (4.75-mm)	87.3
No. 10 (2.00-mm)	86.1
No. 20 (.850-mm)	81.5
No. 40 (.425-mm)	61.4
No. 60 (.250-mm)	30.6
No. 100 (.150-mm)	16.6
No. 200 (.075-mm)	6.6

Size Fraction	Percent by Weight
Coarse Gravel	6.7
Fine Gravel	5.9
Coarse Sand	1.2
Medium Sand	24.7
Fine Sand	54.8
Fines	6.6
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.10
D_{30}	0.25
D_{60}	0.42
D_{90}	13.00
Cc	1.57
Cu	4.42

ASTM Classification
Group Name: **Poorly Graded Sand with Silt**
Symbol: **SP-SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Three Lakes Crossing
Job Number: 362-007-01
Date Tested: 9/17/21
Tested By: Dalton Prichard

Sample Location: TP-6
Sample Name: TP-6 0.0' - 5.0'
Depth: 0 - 5 Feet

Moisture Content (%) 4.7%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	100.0
No. 4 (4.75-mm)	100.0
No. 10 (2.00-mm)	99.6
No. 20 (.850-mm)	98.8
No. 40 (.425-mm)	92.1
No. 60 (.250-mm)	69.0
No. 100 (.150-mm)	35.9
No. 200 (.075-mm)	14.3

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.0
Coarse Sand	0.4
Medium Sand	7.5
Fine Sand	77.8
Fines	14.3
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.07
D_{30}	0.14
D_{60}	0.21
D_{90}	0.40
Cc	1.44
Cu	3.23

ASTM Classification
Group Name: **Silty Sand**
Symbol: **SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Three Lakes Crossing
Job Number: 362-007-01
Date Tested: 9/17/21
Tested By: Dalton Prichard

Sample Location: TP-9
Sample Name: TP-9 4.0' - 8.0'
Depth: 4 - 8 Feet

Moisture Content (%) 8.0%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	100.0
No. 4 (4.75-mm)	99.2
No. 10 (2.00-mm)	98.5
No. 20 (.850-mm)	96.7
No. 40 (.425-mm)	81.3
No. 60 (.250-mm)	43.7
No. 100 (.150-mm)	14.3
No. 200 (.075-mm)	5.0

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.8
Coarse Sand	0.7
Medium Sand	17.2
Fine Sand	76.3
Fines	5.0
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.13
D_{30}	0.20
D_{60}	0.31
D_{90}	0.56
Cc	1.01
Cu	2.35

ASTM Classification
Group Name: **Poorly Graded Sand with Silt**
Symbol: **SP-SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Three Lakes Crossing
Job Number: 362-007-01
Date Tested: 9/17/21
Tested By: Dalton Prichard

Sample Location: TP-10
Sample Name: TP-10 0.0' - 4.0'
Depth: 0 - 4 Feet

Moisture Content (%) 8.1%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	99.2
No. 4 (4.75-mm)	98.4
No. 10 (2.00-mm)	97.9
No. 20 (.850-mm)	94.9
No. 40 (.425-mm)	74.8
No. 60 (.250-mm)	40.3
No. 100 (.150-mm)	23.4
No. 200 (.075-mm)	9.7

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	1.6
Coarse Sand	0.5
Medium Sand	23.1
Fine Sand	65.1
Fines	9.7
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.08
D_{30}	0.19
D_{60}	0.34
D_{90}	0.67
Cc	1.42
Cu	4.53

ASTM Classification
Group Name: **Poorly Graded Sand with Silt**
Symbol: **SP-SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Three Lakes Crossing
Job Number: 362-007-01
Date Tested: 9/17/21
Tested By: Dalton Prichard

Sample Location: TP-12
Sample Name: TP-12 3.0' - 8.0'
Depth: 3 - 8 Feet

Moisture Content (%) 3.7%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	84.3
3/8 in. (9.5-mm)	70.1
No. 4 (4.75-mm)	65.0
No. 10 (2.00-mm)	61.4
No. 20 (.850-mm)	55.9
No. 40 (.425-mm)	34.5
No. 60 (.250-mm)	9.2
No. 100 (.150-mm)	2.9
No. 200 (.075-mm)	1.0

Size Fraction	Percent by Weight
Coarse Gravel	15.7
Fine Gravel	19.3
Coarse Sand	3.5
Medium Sand	26.9
Fine Sand	33.5
Fines	1.0
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.26
D_{30}	0.38
D_{60}	1.40
D_{90}	24.00
Cc	0.40
Cu	5.38

ASTM Classification
Group Name: **Poorly Graded Sand with Gravel**
Symbol: **SP**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Three Lakes Crossing
Job Number: 362-007-01
Date Tested: 9/17/21
Tested By: Dalton Prichard

Sample Location: MW-2
Sample Name: MW-2 0.0' - 5.0'
Depth: 0 - 5 Feet

Moisture Content (%) 4.7%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	94.3
3/4 in. (19.0)	94.3
3/8 in. (9.5-mm)	94.3
No. 4 (4.75-mm)	94.3
No. 10 (2.00-mm)	94.0
No. 20 (.850-mm)	92.7
No. 40 (.425-mm)	80.7
No. 60 (.250-mm)	46.1
No. 100 (.150-mm)	26.2
No. 200 (.075-mm)	11.1

Size Fraction	Percent by Weight
Coarse Gravel	5.7
Fine Gravel	0.0
Coarse Sand	0.3
Medium Sand	13.2
Fine Sand	69.6
Fines	11.1
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.07
D_{30}	0.16
D_{60}	0.31
D_{90}	7.50
Cc	1.18
Cu	4.43

ASTM Classification
Group Name: **Poorly Graded Sand with Silt**
Symbol: **SP-SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Three Lakes Crossing
Job Number: 362-007-01
Date Tested: 9/17/21
Tested By: Dalton Prichard

Sample Location: MW-2
Sample Name: MW-2 5.0' - 10.0'
Depth: 5 - 10 Feet

Moisture Content (%) 5.8%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	100.0
No. 4 (4.75-mm)	99.6
No. 10 (2.00-mm)	99.3
No. 20 (.850-mm)	97.4
No. 40 (.425-mm)	77.7
No. 60 (.250-mm)	36.3
No. 100 (.150-mm)	18.0
No. 200 (.075-mm)	6.6

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.4
Coarse Sand	0.4
Medium Sand	21.6
Fine Sand	71.1
Fines	6.6
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.09
D_{30}	0.21
D_{60}	0.35
D_{90}	6.50
Cc	1.38
Cu	3.85

ASTM Classification
Group Name: **Poorly Graded Sand with Silt**
Symbol: **SP-SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Three Lakes Crossing
Job Number: 362-007-01
Date Tested: 9/17/21
Tested By: Dalton Prichard

Sample Location: MW-2
Sample Name: MW-2 10.0' - 15.0'
Depth: 10 - 15 Feet

Moisture Content (%) 7.7%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	100.0
No. 4 (4.75-mm)	100.0
No. 10 (2.00-mm)	99.9
No. 20 (.850-mm)	99.7
No. 40 (.425-mm)	97.5
No. 60 (.250-mm)	74.5
No. 100 (.150-mm)	27.9
No. 200 (.075-mm)	7.1

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.0
Coarse Sand	0.1
Medium Sand	2.5
Fine Sand	90.4
Fines	7.1
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.08
D_{30}	0.16
D_{60}	0.21
D_{90}	0.34
Cc	1.40
Cu	2.56

ASTM Classification
Group Name: **Poorly Graded Sand with Silt**
Symbol: **SP-SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Three Lakes Crossing
Job Number: 362-007-01
Date Tested: 9/17/21
Tested By: Dalton Prichard

Sample Location: MW-2
Sample Name: MW-2 15.0' - 20.0'
Depth: 15 - 20 Feet

Moisture Content (%) 9.1%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	94.9
3/8 in. (9.5-mm)	89.0
No. 4 (4.75-mm)	83.9
No. 10 (2.00-mm)	80.0
No. 20 (.850-mm)	75.7
No. 40 (.425-mm)	59.7
No. 60 (.250-mm)	30.6
No. 100 (.150-mm)	11.9
No. 200 (.075-mm)	5.7

Size Fraction	Percent by Weight
Coarse Gravel	5.1
Fine Gravel	11.0
Coarse Sand	4.0
Medium Sand	20.3
Fine Sand	54.0
Fines	5.7
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.14
D_{30}	0.25
D_{60}	0.43
D_{90}	11.00
Cc	1.04
Cu	3.07

ASTM Classification
Group Name: **Poorly Graded Sand with Gravel and Silt**
Symbol: **SP-SM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Three Lakes Crossing
Job Number: 362-007-01
Date Tested: 9/17/21
Tested By: Dalton Prichard

Sample Location: MW-2
Sample Name: MW-2 20.0' - 25.0'
Depth: 20 - 25 Feet

Moisture Content (%) 7.1%

Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	83.5
3/8 in. (9.5-mm)	54.0
No. 4 (4.75-mm)	42.7
No. 10 (2.00-mm)	34.1
No. 20 (.850-mm)	25.6
No. 40 (.425-mm)	20.2
No. 60 (.250-mm)	15.5
No. 100 (.150-mm)	9.9
No. 200 (.075-mm)	6.0

Size Fraction	Percent by Weight
Coarse Gravel	16.5
Fine Gravel	40.8
Coarse Sand	8.6
Medium Sand	13.9
Fine Sand	14.2
Fines	6.0
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.15
D_{30}	1.40
D_{60}	11.00
D_{90}	23.00
Cc	1.19
Cu	73.33

ASTM Classification
Group Name: **Well Graded Gravel with Sand and Silt**
Symbol: **GW-GM**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Three Lakes Crossing
Job Number: 362-007-01
Date Tested: 9/17/21
Tested By: Dalton Prichard

Sample Location: MW-2
Sample Name: MW-2 25.0' - 30.0'
Depth: 25 - 30 Feet

Moisture Content (%) 11.8%

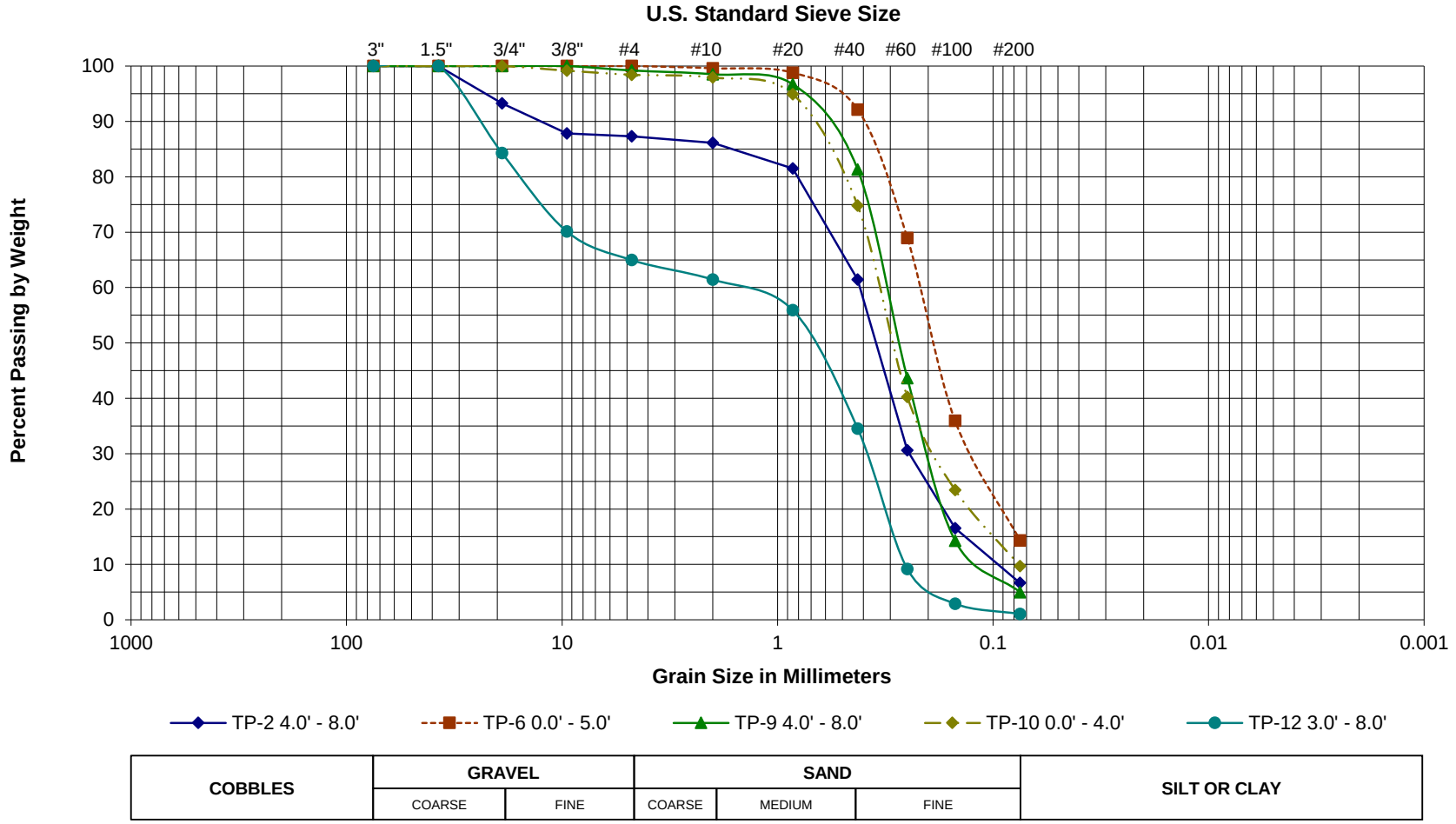
Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	85.9
3/8 in. (9.5-mm)	56.3
No. 4 (4.75-mm)	45.3
No. 10 (2.00-mm)	35.7
No. 20 (.850-mm)	28.3
No. 40 (.425-mm)	18.5
No. 60 (.250-mm)	10.6
No. 100 (.150-mm)	6.8
No. 200 (.075-mm)	4.0

Size Fraction	Percent by Weight
Coarse Gravel	14.1
Fine Gravel	40.6
Coarse Sand	9.6
Medium Sand	17.3
Fine Sand	14.5
Fines	4.0
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.24
D_{30}	1.00
D_{60}	10.50
D_{90}	22.00
Cc	0.40
Cu	43.75

ASTM Classification
Group Name: **Poorly Graded Gravel with Sand**
Symbol: **GP**

INSIGHT GEOLOGIC, INC.



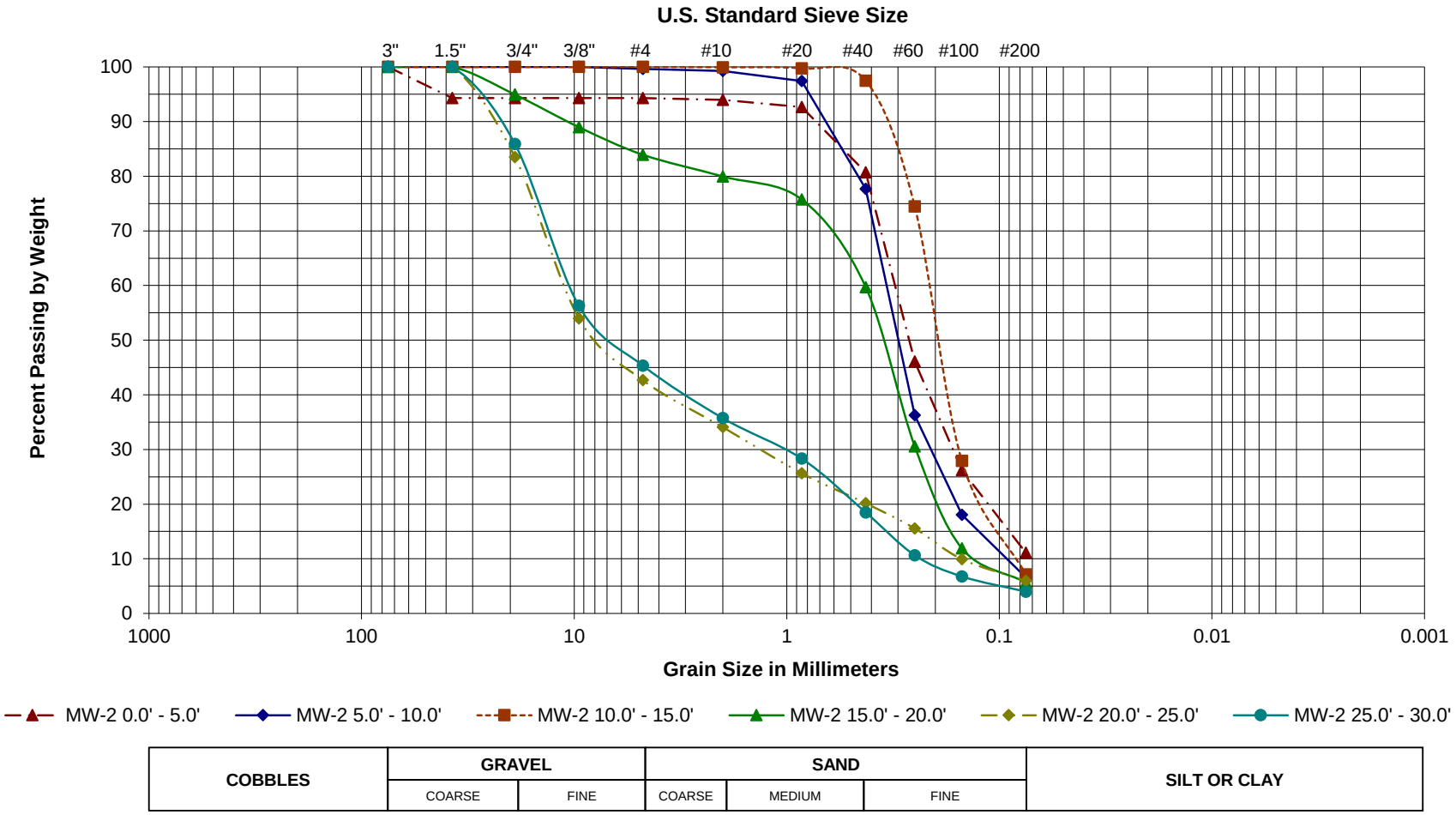
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

THREE LAKES CROSSING

TUMWATER, WASHINGTON

INSIGHT GEOLOGIC, INC.

Graph 1
Gradation Analysis Results



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

THREE LAKES CROSSING

TUMWATER, WASHINGTON

INSIGHT GEOLOGIC, INC.

Graph 2
Gradation Analysis Results

ATTACHMENT C
REPORT LIMITATIONS AND GUIDELINES FOR USE

ATTACHMENT C

REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This attachment provides information to help you manage your risks with respect to the use of this report.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This report has been prepared for the exclusive use of Sound Built Homes (Client) and their authorized agents. This report may be made available to regulatory agencies for review. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

Insight Geologic Inc. structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

Insight Geologic, Inc. considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless Insight Geologic specifically indicates otherwise, do not rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

If important changes are made after the date of this report, Insight Geologic should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

---

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org .

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or ground water fluctuations. Always contact Insight Geologic before applying a report to determine if it remains applicable.

MOST GEOTECHNICAL AND GEOLOGIC FINDINGS ARE PROFESSIONAL OPINIONS

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Insight Geologic reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

GEOTECHNICAL ENGINEERING REPORT RECOMMENDATIONS ARE NOT FINAL

Do not over-rely on the preliminary construction recommendations included in this report. These recommendations are not final, because they were developed principally from Insight Geologic's professional judgment and opinion. Insight Geologic's recommendations can be finalized only by observing actual subsurface conditions revealed during construction. Insight Geologic cannot assume responsibility or liability for this report's recommendations if we do not perform construction observation.

Sufficient monitoring, testing and consultation by Insight Geologic should be provided 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 activities are completed in accordance with our recommendations. Retaining Insight Geologic for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having Insight Geologic confer with appropriate members of the design team after submitting the report. Also retain Insight Geologic to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having Insight Geologic participate in pre-bid and pre-construction conferences, and by providing construction observation.

DO NOT REDRAW THE EXPLORATION LOGS

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or

other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

GIVE CONTRACTORS A COMPLETE REPORT AND GUIDANCE

Some owners and design professionals believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with Insight Geologic and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might an owner be in a position to give contractors the best information available, while requiring them to at least share the financial responsibilities stemming from unanticipated conditions. Further, a contingency for unanticipated conditions should be included in your project budget and schedule.

CONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS

Our geotechnical recommendations are not intended to direct the contractor’s procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and to adjacent properties.

READ THESE PROVISIONS CLOSELY

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. Insight Geologic includes these explanatory “limitations” provisions in our reports to help reduce such risks. Please confer with Insight Geologic if you are unclear how these “Report Limitations and Guidelines for Use” apply to your project or site.

GEOTECHNICAL, GEOLOGIC AND ENVIRONMENTAL REPORTS SHOULD NOT BE INTERCHANGED

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.