INSIGHT GEOLOGIC, INC.

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Pettibon System
2118 Jackson Hwy
Chehalis Washington 98532
Attention: Chad O'Mealy

Report
Geotechnical and Stormwater Evaluation
Alderwood Terrace Single Family Revision
2118 Jackson Highway
Chehalis, Washington
Project No. 369-005-02

INTRODUCTION

Insight Geologic is pleased to provide our report of geotechnical investigation of subsurface conditions as they relate to the proposed revisions to the Alderwood Terrace Project properties located at 2118 Jackson Highway in Chehalis, Washington (Lewis County Parcel Nos. 017492009000, 005605069024, and 005605069022). The project site has been increased to three parcels and a total of approximately 15.19 acres. The approximate location of the subject site is shown relative to surrounding physical features in the Vicinity Map, Figure 1.

Insight Geologic has previously completed an evaluation of the largest of the three parcels which total 10.29 acres and which is located to the south of the site. The properties include a steep slope upward from the Chehalis River valley. We understand that the project has been revised to include two additional parcels and changed from multi-family apartments to multiple single-family residences, and that stormwater will be collected and managed on-site. Two of the parcels are located within the City of Chehalis city limits and one parcel is located within the jurisdiction of Lewis County.

SCOPE OF SERVICES

The purpose of our services was to evaluate subsurface conditions as they pertain to stormwater and geotechnical parameters, including slope stability for the proposed project. The specific scope of services performed for this project included:

1. Evaluated critical slopes on and adjacent to the parcels relative to the potential for critical area ordinance hazards in conformance with the appropriate jurisdiction CAO.
2. Provided for the location of subsurface utilities on the property. We performed this task by notifying the "One Call" utility notification system.

3. Provided for access to the boring locations. Pettibone Systems supplied the excavator and operator for this task.
4. Drilled five (5) exploratory borings to evaluate subsurface conditions. Three borings were completed on the additional parcels to evaluate the slope stability and geotechnical parameters, and two borings were completed on the original parcel to account for the revised site plan.
5. Excavated a series of exploratory test pits for shallow geotechnical parameters across the site using a small, track-mounted excavator. The test pits were excavated to a depth of approximately 2 to 8 feet below ground surface and backfilled at the end of the day. Pettibone Systems supplied the excavator and operator for this task.
6. Logged the soils encountered in the explorations in general accordance with the Unified Soil Classification System (ASTM D2487). Detailed logs of the explorations were completed in the field.
7. Collected representative soil samples from the borings and test pits as needed, for laboratory analyses to include grain-size distribution and plasticity.
8. Revised our report containing the results of our additional investigation and taking into account the revised development plan, which will include a summary of our field activities along with recommendations for site clearing and grading, geotechnical parameters including bearing pressure, active and passive earth pressures, paving recommendations and recommendations for building foundations, as well as stormwater recommendations.

SITE CONDITIONS

Surface Conditions

The project site consists of three parcels and is located on the southwest-facing slope of the northeast bank of the Chehalis River valley. The site descends from an elevation of approximately 420 feet above mean sea level (MSL) near the north corner of the property to an elevation of approximately 230 feet MSL along Jackson Highway. The site is bounded by Jackson Highway to the southwest, residential properties to the west and southeast, and undeveloped land to the northeast and north. The largest parcel (10.3 acres) is partially developed with a commercial building and associated fenced storage yard located in the level portion of the site, adjacent to Jackson Highway. The remainder of this parcel and the small parcel (0.54 acres) located on the northeast edge of the site is sloped and lightly wooded with deciduous trees such as alder. The understory has been cleared. Multiple access roads used during logging activities cross the slopes. The third parcel (4.36 acres) located on the northwest side of the development area is wooded with evergreen and deciduous trees with a moderately thick understory of ferns, blackberries, ivy, grasses, and woody shrubs. Based on multiple measurements made using a hand-held clinometer, the site slopes to the west and southwest with generally with slopes that range from 25 to 35 percent. A limited area of the north corner of the site has slopes that reach 50 percent.

Geology

Based on our review of available published geologic maps, Quaternary age mass wasting deposits (mostly landslides) underlie the project site and surrounding area. Underlying the mapped mass wasting deposits and forming the adjacent hillside are deposits mapped as Oligocene-Eocene

marine sedimentary rocks of the Lincoln Creek Formation. These deposits generally consist of siltstone and sandstone as shown on the Geologic Map, Figure 3.

Subsurface Explorations

We explored subsurface conditions at the site on June 4 and June 9, 2021, by excavating nine test pits and advancing five borings in the locations as shown on the Site Plan, Figure 2. The test pits were excavated by a track-mounted excavator subcontracted by Pettibon System. The exploratory borings were completed by Holocene Drilling using a track-mounted hollow stem auger drill rig. A geologist from Insight Geologic monitored the explorations and maintained a log of the conditions encountered. The test pits were completed between 2.5 and 8 feet bgs and the borings were completed to a depth of between 16.5 and 26.5 feet bgs. The soils were visually classified in general accordance with the system described in ASTM D2487-06. Exploration logs are contained in Attachment A.

Soil Conditions

Soil conditions encountered generally varied across the site. Soils in boring B-1, B-3, and B-4 consisted of brown silt (MH) in a medium-stiff to hard and moist condition depths of between 5 and 15 feet bgs overlying weathered siltstone and sandstone bedrock. Boring B-2 consisted of approximately 6 feet of silt (MH) in a moist and medium dense condition overlying brown silty fine sand grading to sandstone at a depth of 10 feet bgs. Soils in boring B-5 consisted of brown silty sand with gravel (SM) in a very dense and moist condition which grades to the underlying sandstone at a depth of 10 feet bgs. In general, bedrock was moderately to highly weathered and weakly to well consolidated. In addition, the transition from soils to bedrock was gradual with decreasing weathering and increasing competency with depth.

Underlying approximately 6 to 12 inches of sod or forest duff, the test pits generally encountered several feet of silt in a medium-stiff and moist condition overlying stiff to hard silts or the underlying bedrock. Several test pits, including TP-1, TP-2, TP-6, and TP-7 encountered hard silt that easily fractured into 4-to-6-inch pieces directly overlying bedrock at a depth of less than 5 feet bgs.

The surficial soils encountered are generally consistent with Centralia loam, Scamman silty clay loam, and Galvin silt loam, which are mapped for the area as shown in Figure 4. These soils are generally formed from residuum from siltstone and sandstones. These soils generally have restrictive layers occurring greater than 7 feet below grade. Percolation ranges from moderately low to moderately high, with rates between 0.06 to 0.57 inches per hour within the Scammam and Galvin soils and 0.57 to 1.98 inches per hour within the Centralia soils, according to the U.S. Department of Agriculture Soil Survey.

Groundwater Conditions

Groundwater was not encountered within any of the explorations completed at the site. Explorations were completed in June and likely represent groundwater conditions in the drier summer months.

Laboratory Testing

We selected five grain-size analyses in general accordance with ASTM D422, six samples were evaluated by plasticity index tests in general accordance with ASTM D4318 to define soil class and engineering properties of the soil, and 15 samples were evaluated for moisture content in general accordance with ASTM D2216. Soil testing indicated that the soils generally are identified as elastic silts with liquid limits ranging from 54 to 82 percent and plasticity ranging from 17 to 31 percent. Soil evaluated from the upper 10 feet of each boring generally presented the highest plasticity and liquid limit. One additional sample each was identified as a lean clay and silt. Our laboratory test results are provided in Attachment B.

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 1. 2018 IBC Seismic Design Parameters

Spectral Response Accel. at Short Periods (S_S) = 1.166
Spectral Response Accel. at 1 Second Periods (S_1) = 0.479
Site Class = D
Site Coefficient (F_A) = 1.336
Site Coefficient (F_V) = 1.821

Ground Rupture

Because of the location of the site with respect to the nearest known active crustal faults, 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 Lewis 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 Chehalis 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 low 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 10 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 reaches 50 percent in a limited area of the site with the majority of the slopes up to 35 percent. We did not observe signs of slope instability during our site work. In our opinion, there is a 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 structures directly supported by the failing soils.

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 understanding of the subsurface conditions at the site, it is our opinion that there could be a moderate risk for the development of lateral spreading as a result of an IBC design level earthquake.

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 1,000 pounds per square foot (psf). This capacity may be increased to 1,500 psf by extending the footing excavations to the underlying stiff siltstone layer and backfilling to the subgrade elevation with compacted structural fill. If higher footing capacities are needed, we recommend the installation of small diameter pipe piles driven to refusal. The diameter and spacing of the piles would need to be calculated by a structural engineer.

The soils encountered in our explorations are typically in a medium-stiff condition near ground surface. To limit the potential for structural settlement, we recommend that the soft surficial silt be removed from beneath areas of shallow foundations and that the shallow foundations and slabs-on-grade be established on a minimum 1-foot thick layer of compacted structural fill extending to the stiffer unweathered soil. We do not recommend the reuse of the on-site soils as structural fill under the foundations/slabs. Reuse of the silt soils will require significant moisture conditioning and compaction efforts and is unlikely to be sufficiently compacted as structural fill.

Stormwater infiltration at the site is not feasible along the slopes of the hillside based on shallow bedrock units and relatively impermeable soils at the site. Soils located near the surface at the base of the slopes are mapped as Galvin silt soils and can effectively be considered impermeable with estimated infiltration rates of 0.06 to 0.2 inches per hour. We recommend that stormwater be detained and released off-site.

In accordance with the Lewis County Critical Area Ordinance, the site would be designated as a Landslide Hazard Area due to being mapped as mass wasting deposits. However, based on our subsurface evaluation of the site, it is our opinion that the slope is not composed of landslide debris, and therefore does not represent a Landslide Hazard Area as per the Lewis County Critical Areas Ordinance. Evaluation of Lidar imagery as shown on Figure 3 and our site evaluation did not find evidence of typical geomorphology associated with mass wasting deposits and soils consistent with mass wasting deposits were not found within the exploration completed on-site, with the exception of soft soils located at the toe of the slope. The maximum slope inclination encountered across the majority of the site was up to 35 percent and no areas that exceed 15 percent were observed having groundwater seepage with interbedded geology. In addition, we did not observe indications of current or past large-scale slope failure, such as slump blocks, back-tilted slopes, or ponded water on the slope. No geologic contacts which would serve as sources of slope failure were observed.

A limited area near the northern corner of the northwest parcel contains slopes that exceed 35 percent and are greater than 10 feet in height. This area is classified as a steep slope hazard area as per the Lewis County Critical Areas Ordinance. We recommend that this area have a 50-foot setback from the top and toe of the steep slope for any structures. Based on the limited height of the steep slope area, it may be possible to eliminate the steep slope area by grading the area to a slope below 35 percent or support of the hillslope using a properly engineered retaining structure.

Earthwork

General

We anticipate that site development earthwork will include removing existing vegetation, stripping sod/topsoil materials, preparing subgrades, excavating for utility trenches, installing ground improvements, and placing and compacting structural fill. The soils at the site contain a high percentage of fines and will be moisture sensitive through most of the year. These materials may be difficult to operate on or compact during wet weather. The operation of heavy equipment at the site under wet conditions or when the soils are above optimum moisture content can be expected to result in considerable disturbance to the exposed subgrade soils. We recommend that earthwork be undertaken during periods of dry weather to reduce grading costs using tracked, low ground pressure equipment. Compaction of native soils should be conducted using a sheeps-foot roller and not a smooth vibratory drum roller.

Our explorations did not encounter appreciable amounts of debris associated with past site development other than minor construction debris at the base of the slope. However, it is possible that buried debris or other development features could be encountered during construction near the base of the slope. 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 to 1 foot will be required to remove vegetation and unsuitable topsoil encountered in our explorations. Deeper stripping depths may be required if additional unsuitable soils are exposed during stripping operations.

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 are 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 will be 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 it 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 for the proposed project. 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 sandbags 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

The near-surface soils are predominantly silt. 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 will be 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 silt with a high moisture content. It is our opinion that this material is not a suitable source for structural fill during a significant portion of the year. It will likely be difficult or impossible to compact this material without significant effort to reduce the moisture content prior to placement. It is our opinion that the silts encountered during excavation and grading should be wasted and hauled off-site, as it is not reusable as structural fill. Reuse of the silt soils would require significant moisture conditioning and compaction efforts and is unlikely to be able to be sufficiently compacted. Addition of cement dust to the soils may improve over-wet conditions to achieve suitable compaction. Additionally, we do not recommend the use of native soils as non-structural fill, such as for yard areas, without close consultation with Insight Geologic.

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 2. Structural fill materials should be compacted in accordance with the compaction criteria provided in Table 3.

Table 2. Recommended Uncompacted Lift Thickness

Compaction Equipment	Recommended Uncompacted Lift 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 3. 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 structures be founded on continuous wall or isolated column footings or other footings properly designed by a structural engineer, bearing on a minimum 1-foot thick overexcavation and replacement with compacted structural fill. The footing overexcavation should remove the medium stiff silt located below the footing when found. 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.

Due to the sloped nature of the site, we anticipate that significant grading will occur during the development of the site and building pads. Where grading activities expose the underlying siltstone in the area of the proposed residential structures we recommend a setback equal to twice the lateral distance of the exposed soil portion of the cut. For the slopes identified at the site ranging from 25 to 35 percent, this distance ranges from 28 to 42 feet from the slope edge.

We recommend that a representative of Insight Geologic observe the foundation surfaces before overexcavation, and before placing structural fill in the footing excavations. 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 1,000 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 the total settlement of footings that are designed and constructed as recommended should be less than 1 inch. We estimate that differential settlement 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.

Subsurface Drainage

It is our opinion that foundation footing drains are likely necessary for the proposed structure. The site soils consist of silt and are generally poorly draining. Footing drains should be routed to existing on-site or planned storm drainage.

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 (Kp) may be estimated using an

equivalent fluid density of 200 pounds per cubic foot (pcf), assuming that the footings are backfilled with structural fill. Active earth pressure (Ka) for the soil is 55 pcf as equivalent fluid density. Frictional resistance may be estimated using 0.20 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 150 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.

Conventional Retaining Walls

General

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 55 pcf 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 75 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 will be 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.

Pavement Design

We recommend a pavement section for the proposed roadway to consist of the following minimum compacted thicknesses placed on a properly prepared subgrade: 8 inches of gravel base placed on a geo-grid over compacted native soil, 2 inches of crushed surfacing top course, (CSTC), and 3 inches of commercial asphalt concrete pavement. Alternatively, the pavement section may consist of 6 inches of asphalt-treated base and 3 inches of commercial asphalt concrete.

It should be realized that asphaltic pavements are not maintenance free. Our recommended pavement section represents our minimum recommendation for an average level of performance during a 20-year design life; therefore, an average level of maintenance will likely be required. A 20-year pavement life typically assumes that an overlay will be placed after about 12 years. Thicker asphalt, base and subbase courses would offer better long-term performance, but would cost more initially. Conversely, thinner courses would be more susceptible to “alligator” cracking and other failure modes. As such, pavement design can be considered a compromise between a high initial cost and low maintenance costs versus a low initial cost and higher maintenance costs.

The native subgrade soils are anticipated to consist of silt. Based on our experience with similar soil types, our analysis is based on a California Bearing Ratio (CBR) value of 15 percent. These values assume the upper foot of subgrade soils will be compacted to a minimum of 95 percent of the modified proctor maximum dry density.

We recommend the following regarding asphalt pavement materials and pavement construction.

- Subgrade Preparation: Upper 12 inches of pavement subgrade should be proof-rolled and inspected for deflection. Areas showing more than ½-inch deflection during proof rolling should be over excavated and replaced with gravel base.
- Subbase Course: We recommend that the subbase conforms to Section 9-03.10, Gravel Base, of the 2020 WSDOT/APWA Standard Specifications for Road, Bridge and Municipal Construction (Standard Specifications). The Gravel Base shall be placed and compacted in accordance with Section 4-02 of the Standard Specifications.
- Base Course: We recommend that the crushed aggregate base course conforms to Section 9-03.9(3), Crushed Surfacing Top Course, (CSTC) of the WSDOT Standard Specifications. The CSTC shall be placed and compacted in accordance with Section 4-04 of the Standard Specifications.
- Asphalt Concrete: We recommend that the asphalt concrete be Commercial Asphalt conforming to Sections 9-02 and 9-03 of the Standard Specifications. We also recommend that the Commercial Asphalt be placed and compacted in accordance with Section 5-04 of the Standard Specifications.

Compaction: All base material should be compacted to at least 95 percent of the maximum dry density determined in accordance with ASTM D1557. We recommend that asphalt be compacted to a minimum of 92 percent of the Rice (theoretical maximum) density or 96 percent of Marshall (maximum laboratory) density.

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. 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

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 Pettibon System and their authorized agents, for the proposed Alderwood Terrace Single Family project located at 2118 Jackson Highway in Chehalis, 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

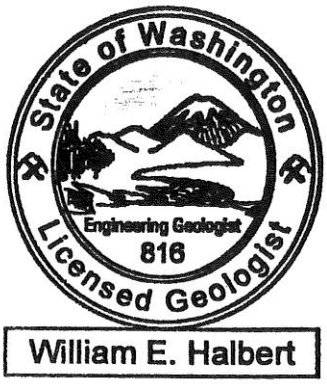
the time this report was prepared. No warranty or other conditions, expressed or implied, should be understood.

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.

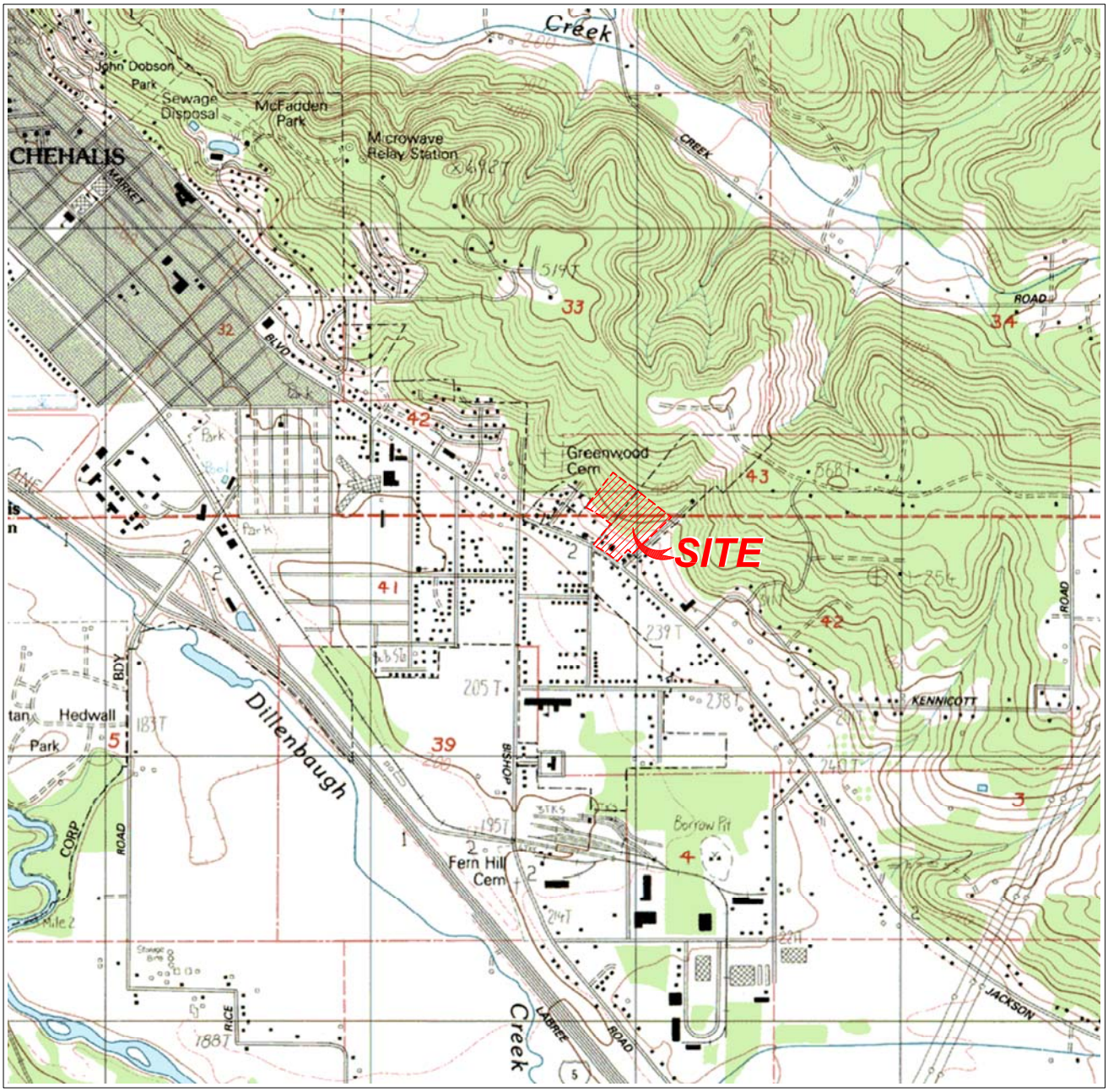
Respectfully Submitted,
INSIGHT GEOLOGIC, INC.

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



Attachments

FIGURES



CENTRALIA, WASHINGTON
7.5 MINUTE QUADRANGLE
Year 1993

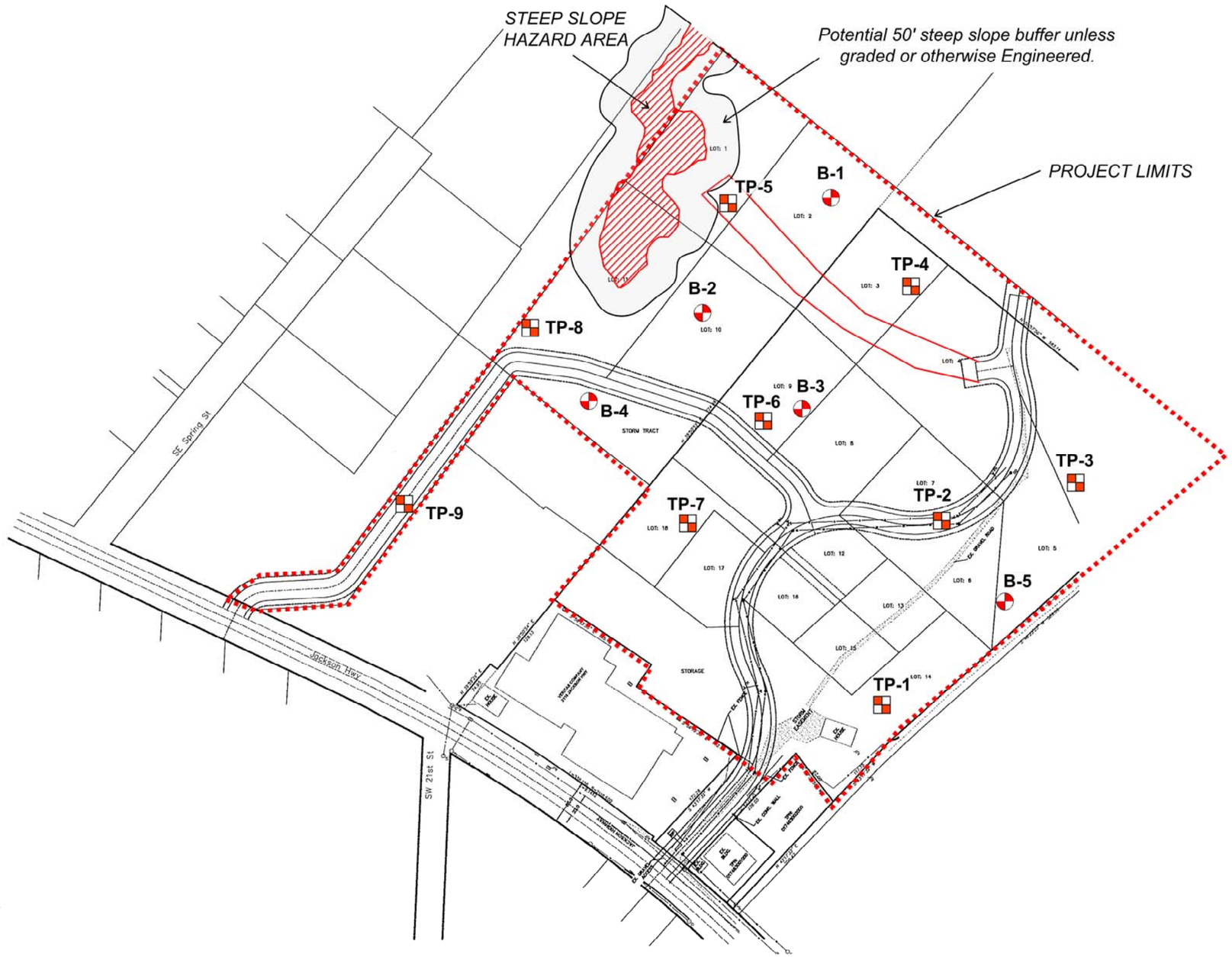
SCALE: 1: 24000

ALDERWOOD TERRACE SINGLE FAMILY

CHEHALIS, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 1
Vicinity Map



LEGEND:

B-1 APPROXIMATE SOIL BORING LOCATION

TP-1 APPROXIMATE TEST PIT LOCATION

SCALE: 1"=175'

SOURCE: RB Engineering

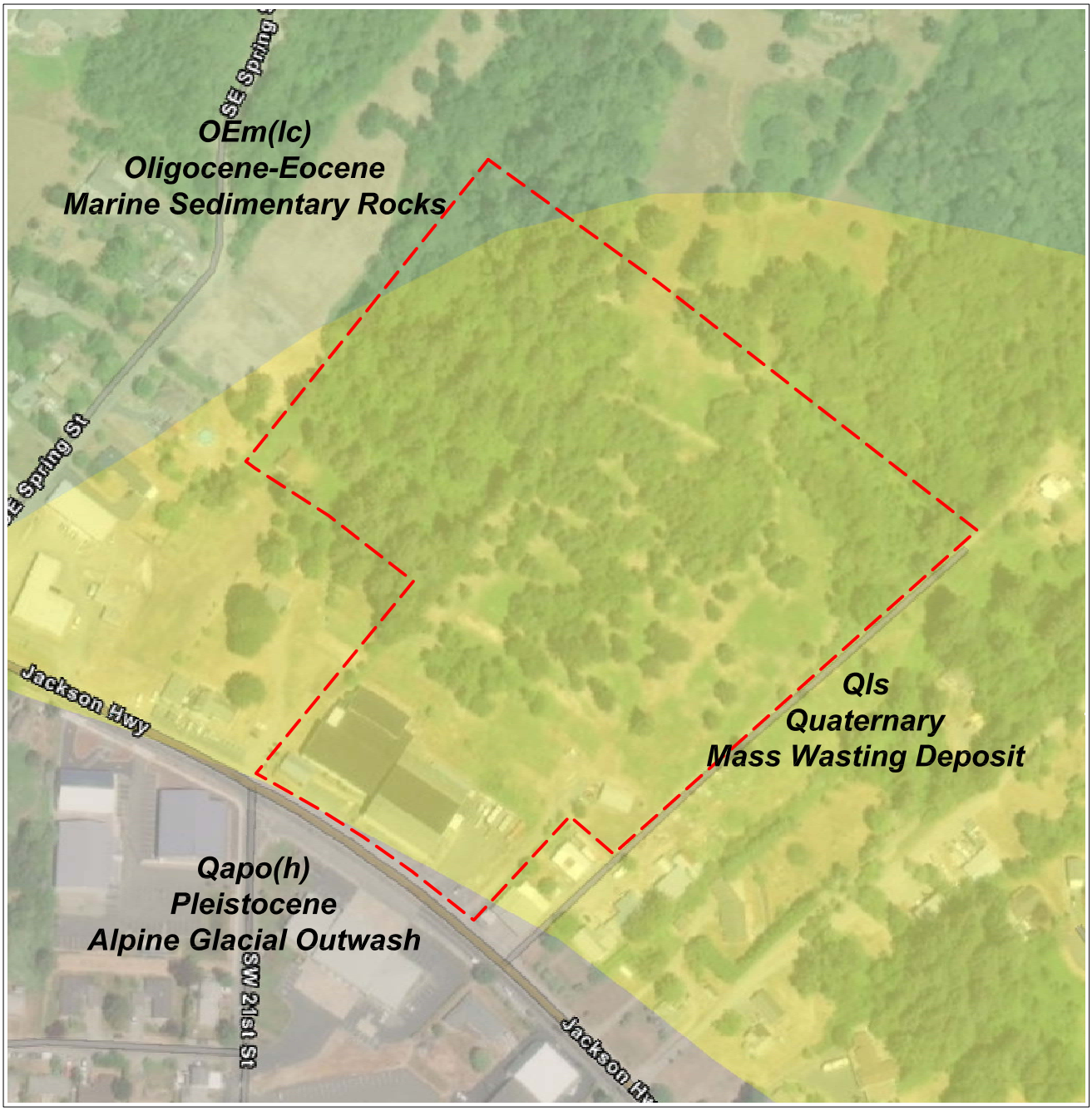
ALDERWOOD TERRACE SINGLE FAMILY

CHEHALIS, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 2

Site Plan



Source: WA DOR

LEGEND:

APPROXIMATE PROJECT BOUNDARY

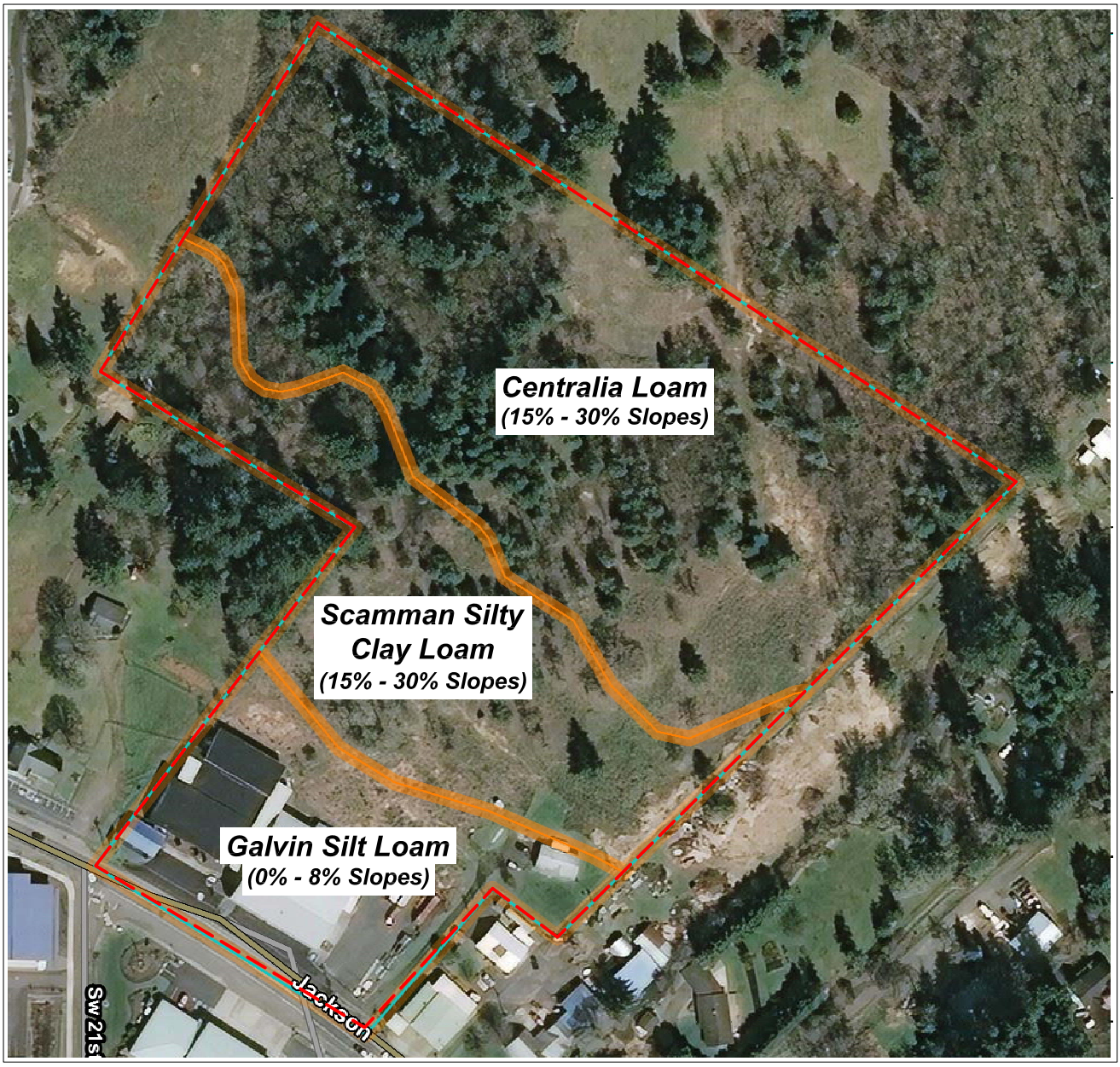
N.T.S.

ALDERWOOD TERRACE SINGLE FAMILY

CHEHALIS, WASHINGTON

INSIGHT GEOLOGIC, INC.

Figure 3
Geologic Map



Source: USDA NRCS

LEGEND:

APPROXIMATE PROJECT BOUNDARY

N.T.S.

ALDERWOOD TERRACE SINGLE FAMILY

CHEHALIS, WASHINGTON

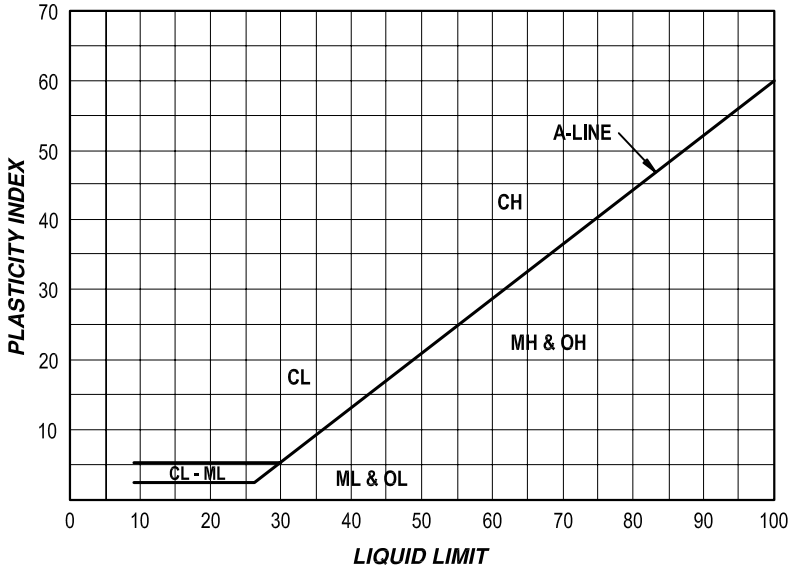
INSIGHT GEOLOGIC, INC.

Figure 4
Soil Map

ATTACHMENT A
EXPLORATION LOGS

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS	GROUP NAME
COARSE GRAINED SOILS (MORE THAN 50% RETAINED ON NO. 200 SIEVE)	GRAVEL AND GRAVELLY SOILS (MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE)	CLEAN GRAVEL <5% FINES	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY GRADED GRAVEL
		GRAVEL WITH FINES >12% FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND AND SANDY SOILS (MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE)	CLEAN SAND <5% FINES	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY GRADED SAND
		SAND WITH FINES >12% FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE GRAINED SOILS (MORE THAN 50% PASSING NO. 200 SIEVE)	SILTS AND CLAYS (LIQUID LIMIT LESS THAN 50)	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILTS AND CLAYS (LIQUID LIMIT 50 OR MORE)	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT



SOIL MOISTURE MODIFIERS:
DRY - ABSENCE OF MOISTURE, DUSTY, DRY TO THE TOUCH
MOIST - DAMP, BUT NO VISIBLE WATER
WET - VISIBLE FREE WATER OR SATURATED, USUALLY SOIL IS OBTAINED BELOW WATER TABLE

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS	TYPICAL DESCRIPTION
CC	CEMENT CONCRETE
AC	ASPHALT CONCRETE
CR	CRUSHED ROCK / QUARRY SPALLS
TS	TOPSOIL/SOD/DUFF

GROUNDWATER EXPLORATION SYMBOLS

- MEASURED GROUNDWATER LEVEL IN EXPLORATION, WELL, OR PIEZOMETER
- GROUNDWATER OBSERVED AT TIME OF EXPLORATION
- PERCHED WATER OBSERVED AT TIME OF EXPLORATION
- MEASURED FREE PRODUCT IN WELL OR PIEZOMETER

STRATIGRAPHIC CONTACT

- APPROXIMATE CONTACT BETWEEN SOIL STRATA OR GEOLOGIC UNIT
- APPROXIMATE LOCATION OF SOIL STRATA CHANGE WITHIN GEOLOGIC SOIL UNIT
- APPROXIMATE GRADUAL CHANGE BETWEEN SOIL STRATA OR GEOLOGIC SOIL UNIT
- APPROXIMATE GRADUAL CHANGE OF SOIL STRATA WITHIN GEOLOGIC SOIL UNIT

LABORATORY / FIELD TEST CLASSIFICATIONS

- **%F** PERECENT FINES
- **AL** ATTERBERG LIMITS
- **CA** CHEMICAL ANALYSIS
- **CP** LABORATORY COMPACTION TEST
- **CS** CONSOLIDATION TEST
- **DS** DIRECT SHEAR
- **HA** HYDROMETER ANALYSIS
- **MC** MOISTURE CONTENT
- **MD** MOISTURE CONTENT AND DRY DENSITY
- **OC** ORGANIC COMPOUND
- **PM** PERMEABILITY OR HYDRAULIC CONDUCTIVITY
- **PP** POCKET PENETROMETER
- **SA** SIEVE ANALYSIS
- **TX** TRIAXIAL COMPRESSION
- **UC** UNCONFINED COMPRESSION
- **VS** VANE SHEAR

SAMPLER SYMBOLS

- 2.4 INCH I.D. SPLIT BARREL
- DIRECT-PUSH
- STANDARD PENETRATION TEST
- SHELBY TUBE
- PISTON
- BULK OR GRAB

SHEEN CLASSIFICATIONS

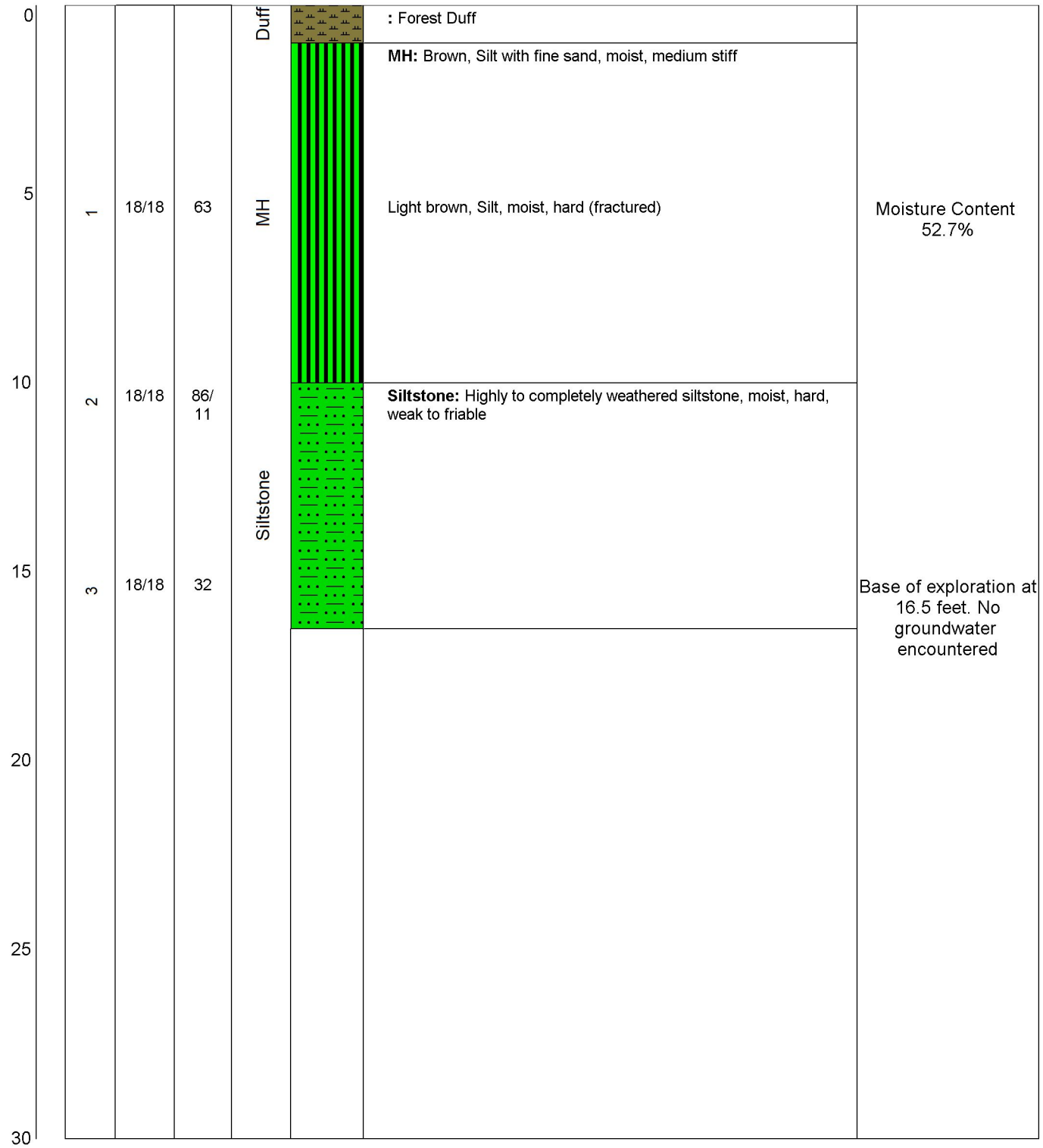
- **NS** NO VISIBLE SHEEN
- **SS** SLIGHT SHEEN
- **MS** MODERATE SHEEN
- **HS** HEAVY SHEEN
- **NT** NOT TESTED

PROJECT: **Alderwood Terrace Single Family** | DATE: **6/4/21**

PROJECT NO.: **369-005-02**

B-1

LOCATION: **Chehalis, Washington** | TOTAL DEPTH: **16.5**



INSIGHT GEOLOGIC, INC.

Drilling Contractor: **Holocene** | Driller: **Kevin**

Drill Equipment: **Diedrich D-70 Turbo** | Drill Method: **HSA**

Logged By: **ARJ**

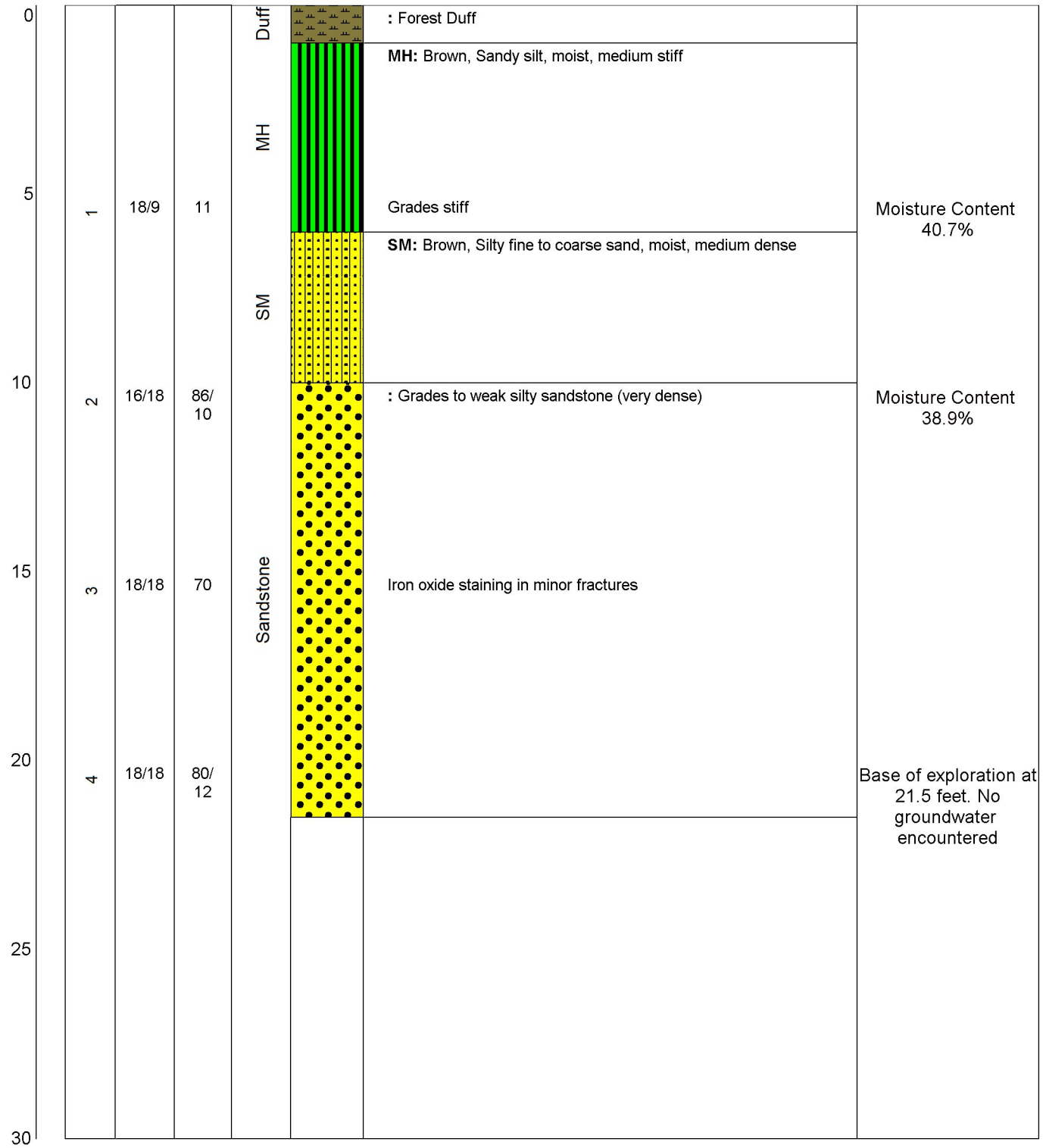
Figure A-2

PROJECT: **Alderwood Terrace Single Family** DATE: **6/4/21**

PROJECT NO.: **369-005-02**

B-2

LOCATION: **Chehalis, Washington** TOTAL DEPTH: **21.5**



INSIGHT GEOLOGIC, INC.

Drilling Contractor: **Holocene** Driller: **Kevin**

Drill Equipment: **Diedrich D-70 Turbo** Drill Method: **HSA**

Logged By: **ARJ**

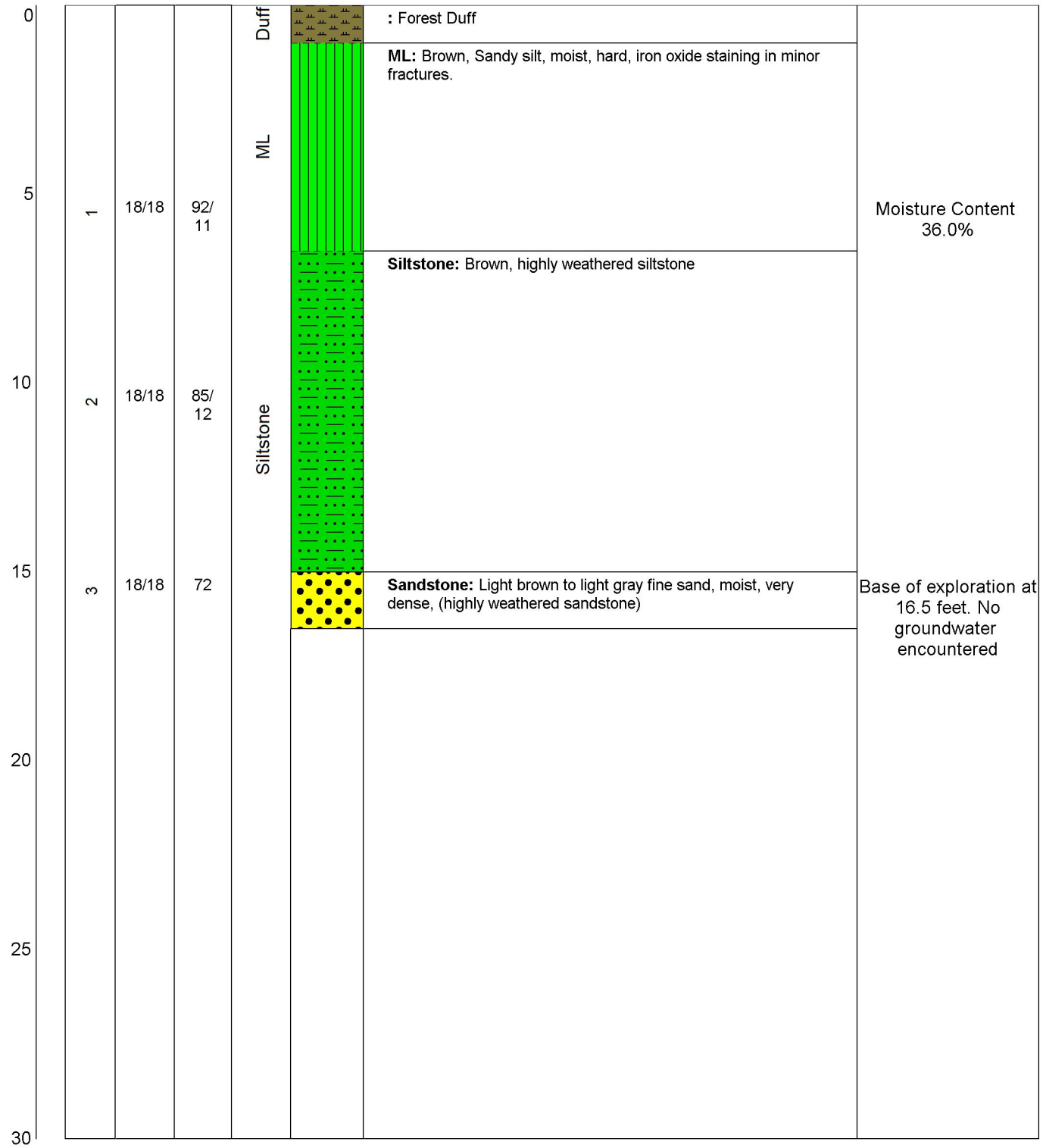
Figure A-3

PROJECT: **Alderwood Terrace Single Family** | DATE: **6/4/21**

PROJECT NO.: **369-005-02**

B-3

LOCATION: **Chehalis, Washington** | TOTAL DEPTH: **16.5**



INSIGHT GEOLOGIC, INC.

Drilling Contractor: **Holocene** | Driller: **Kevin**

Drill Equipment: **Diedrich D-70 Turbo** | Drill Method: **HSA**

Logged By: **ARJ**

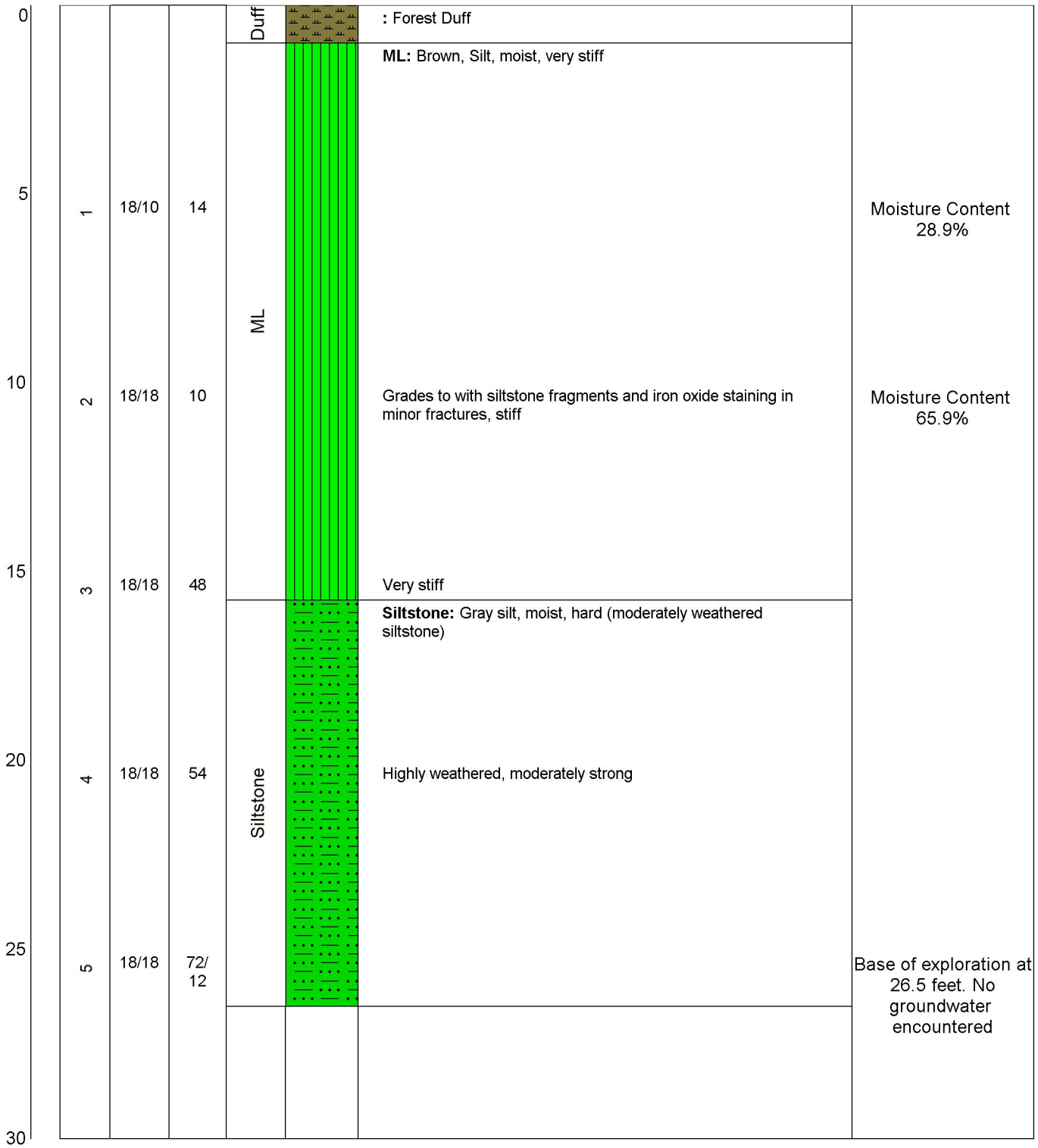
Figure A-4

PROJECT: **Alderwood Terrace Single Family** | DATE: **6/4/21**

PROJECT NO.: **369-005-02**

B-4

LOCATION: **Chehalis, Washington** | TOTAL DEPTH: **26.5**



INSIGHT GEOLOGIC, INC.

Drilling Contractor: **Holocene** | Driller: **Kevin**

Drill Equipment: **Diedrich D-70 Turbo** | Drill Method: **HSA**

Logged By: **ARJ**

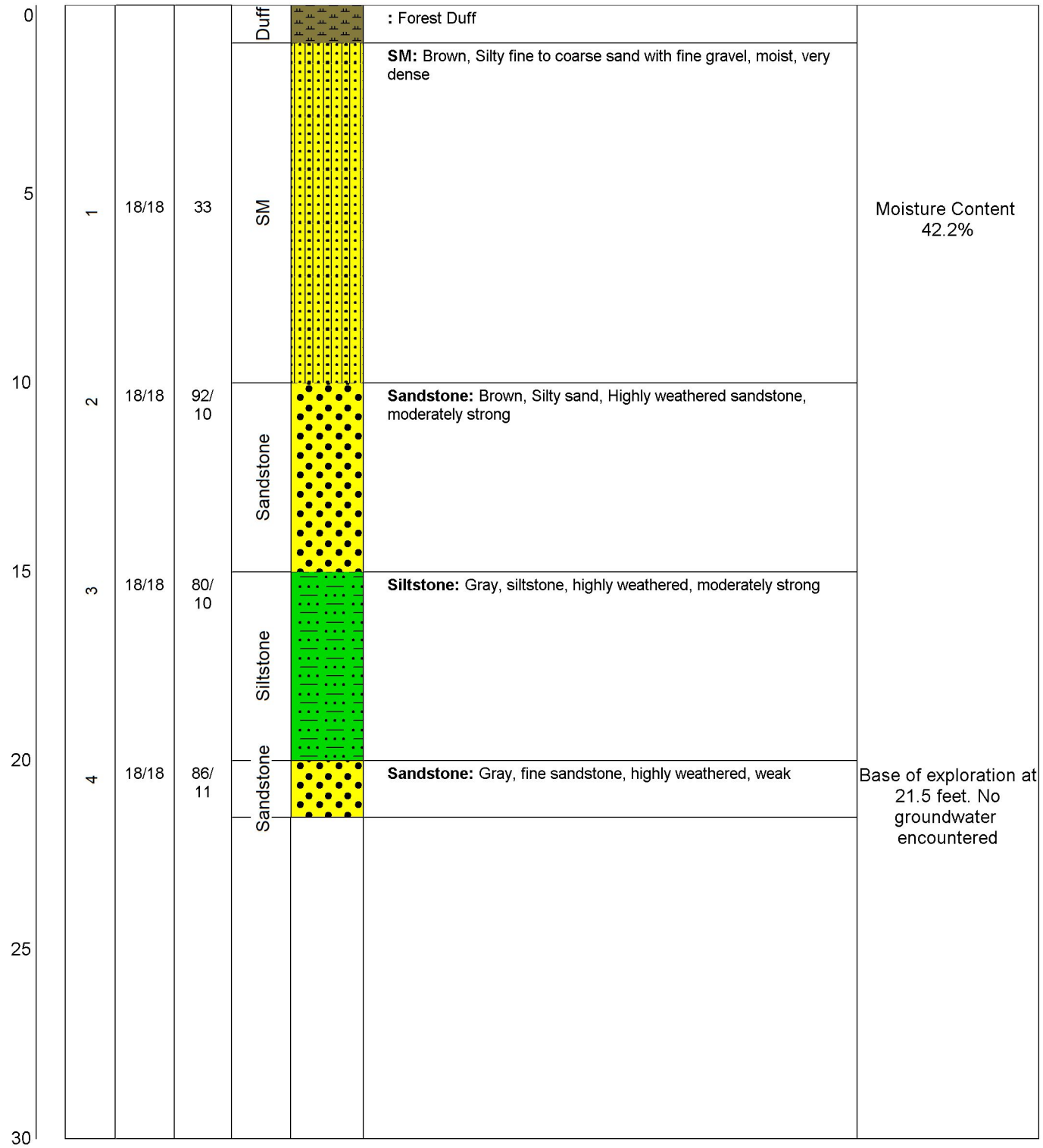
Figure A-5

PROJECT: **Alderwood Terrace Single Family** DATE: **6/4/21**

PROJECT NO.: **369-005-02**

B-5

LOCATION: **Chehalis, Washington** TOTAL DEPTH: **21.5**



INSIGHT GEOLOGIC, INC.

Drilling Contractor: **Holocene** Driller: **Kevin**

Drill Equipment: **Diedrich D-70 Turbo** Drill Method: **HSA**

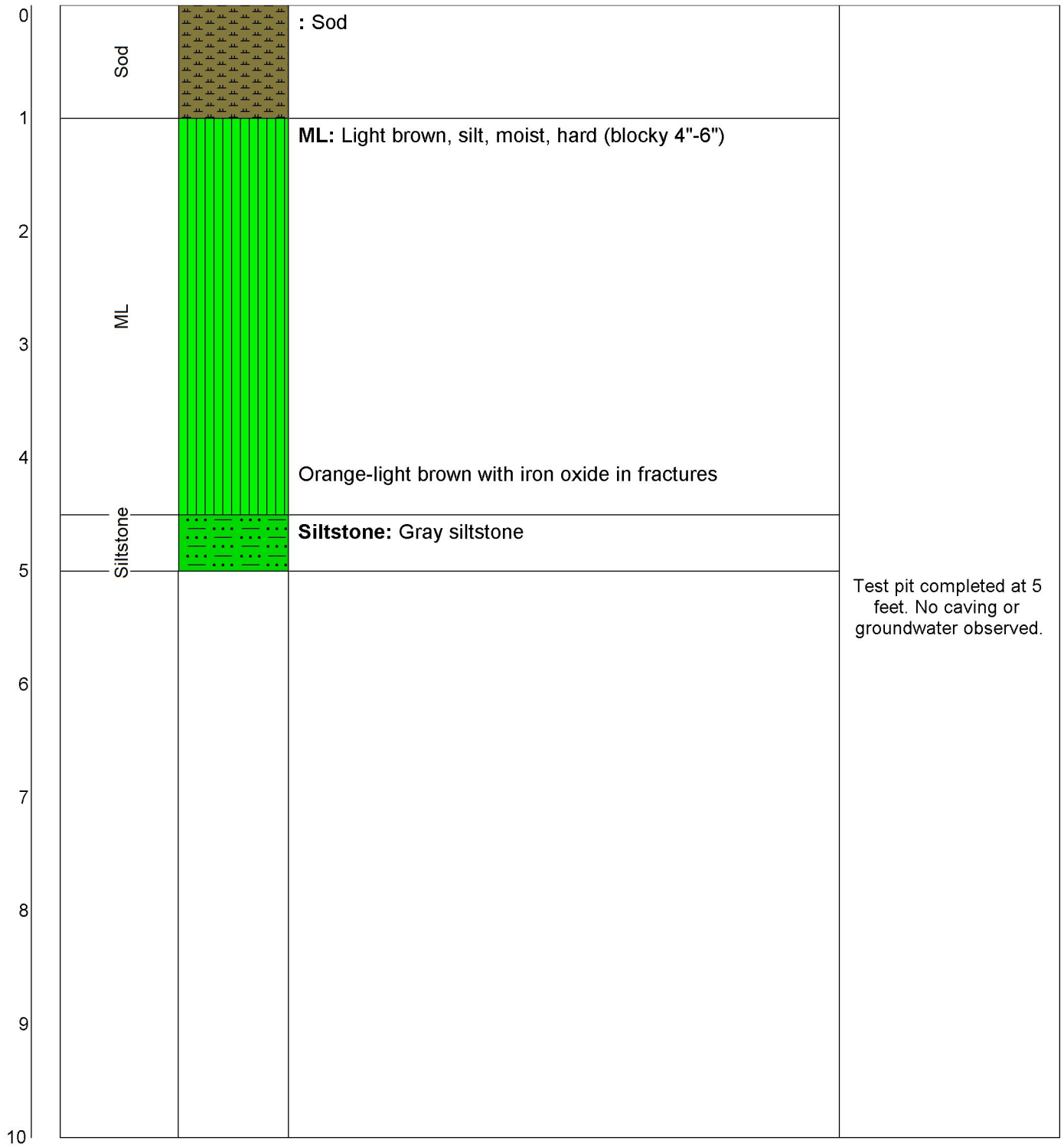
Logged By: **ARJ**

Figure A-6

PROJECT: Alderwood Terrace Single Family
PROJECT NO.: 369-005-02
LOCATION: Chehalis, Washington

TP-1

DATE: 6/9/21
TOTAL DEPTH: 5



INSIGHT GEOLOGIC, INC.

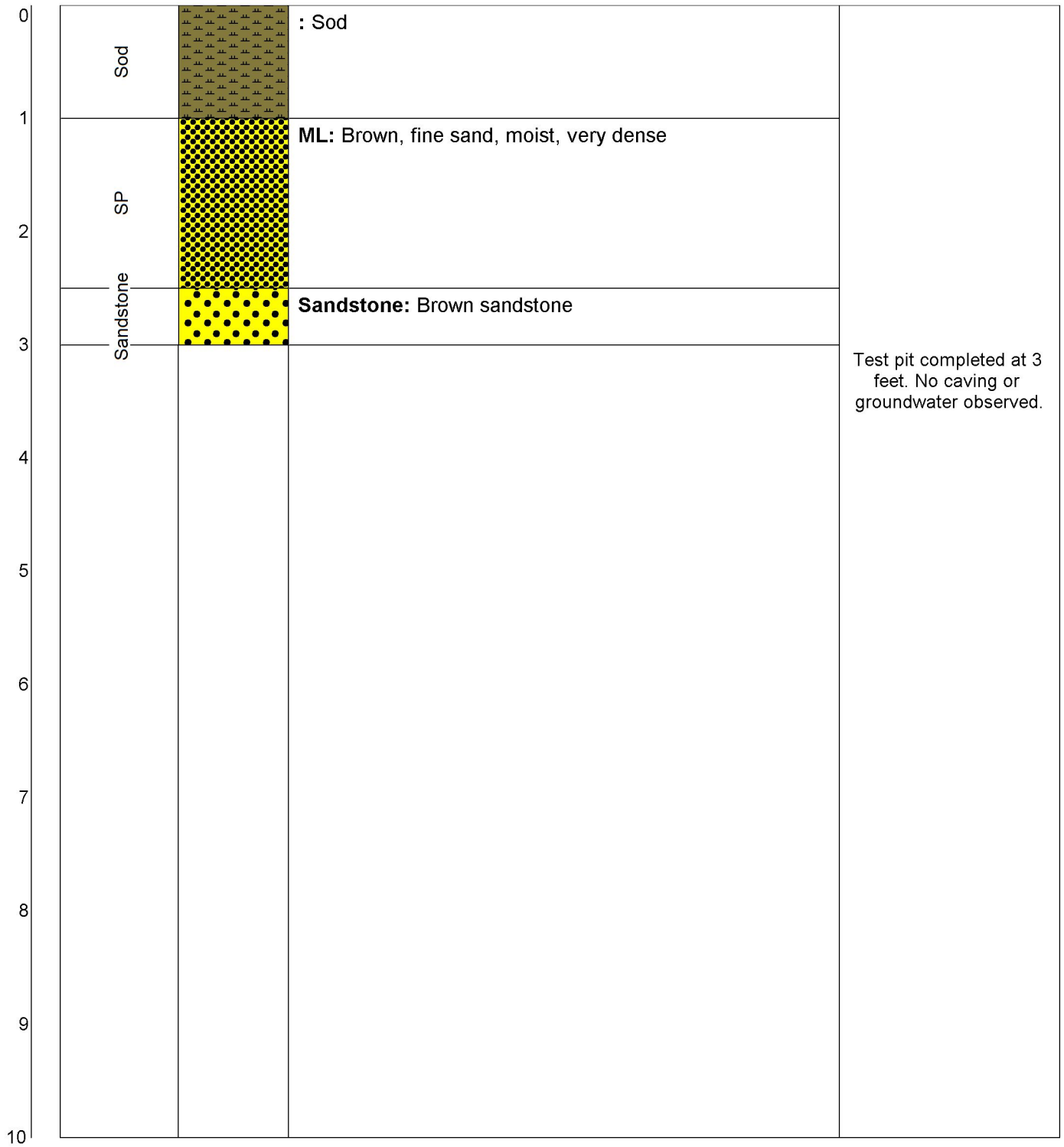
Operator **Pettibon System**
Equipment: **Track Excavator**
Logged By: **ARJ**

Figure A-7

PROJECT: Alderwood Terrace Single Family
PROJECT NO.: 369-005-02
LOCATION: Chehalis, Washington

TP-2

DATE: 6/9/21
TOTAL DEPTH: 3



INSIGHT GEOLOGIC, INC.

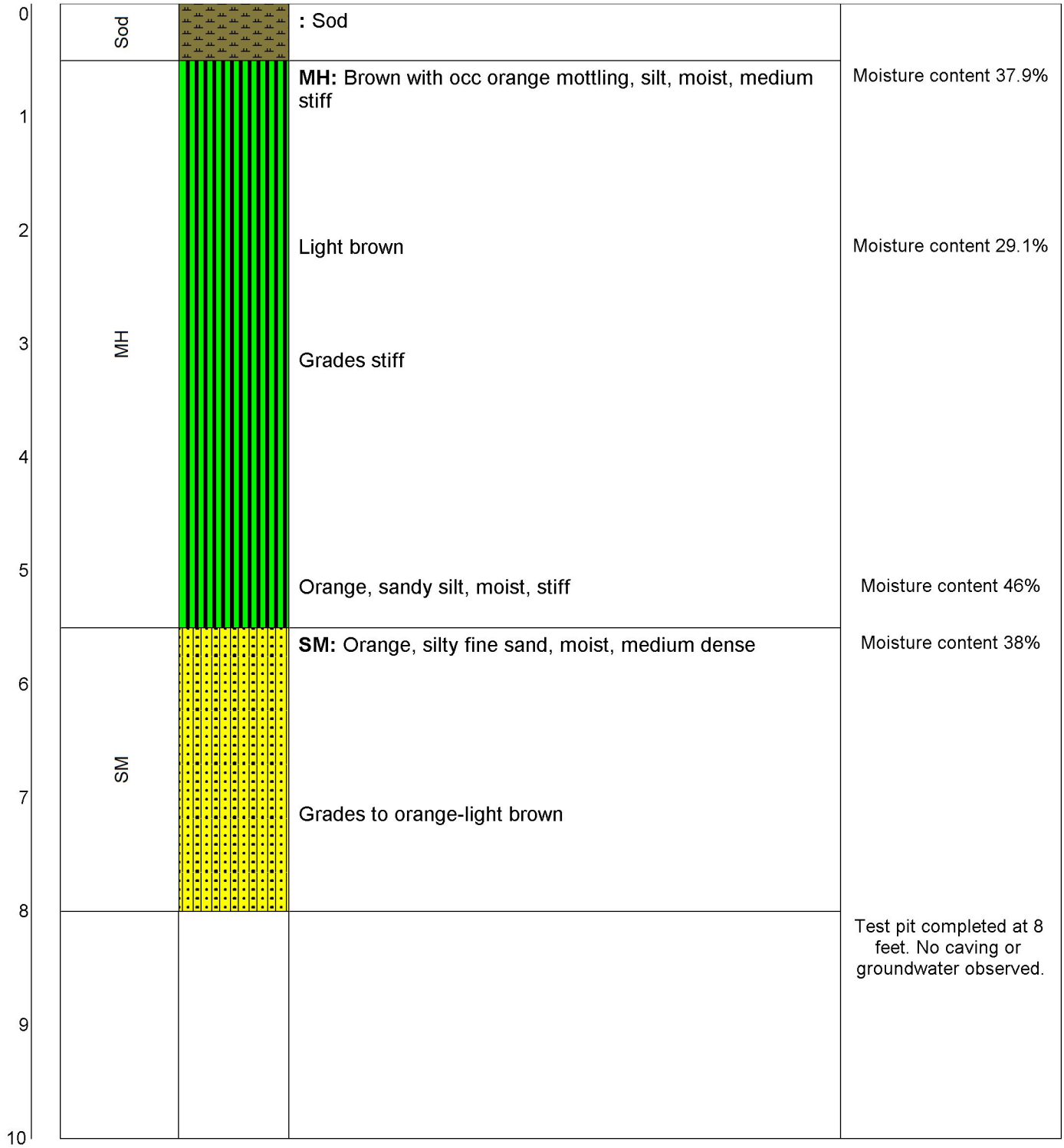
Operator **Pettibon System**
Equipment: **Track Excavator**
Logged By: **ARJ**

Figure A-8

PROJECT: Alderwood Terrace Single Family
PROJECT NO.: 369-005-02
LOCATION: Chehalis, Washington

TP-3

DATE: 6/9/21
TOTAL DEPTH: 8



INSIGHT GEOLOGIC, INC.

Operator **Pettibon System**
Equipment: **Track Excavator**
Logged By: **ARJ**

Figure A-9

PROJECT: Alderwood Terrace Single Family
PROJECT NO.: 369-005-02
LOCATION: Chehalis, Washington

TP-4

DATE: 6/9/21
TOTAL DEPTH: 8

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0	Sod		: Sod	
1	MH		**MH:** Brown, silt, moist, medium stiff	Moisture content 47.7%
2			Grades to light brown	
3			Grades stiff	Moisture content 41.5%
4				
5				
6				
7				
8				Test pit completed at 8 feet. No caving or groundwater observed.
9				
10				

INSIGHT GEOLOGIC, INC.

Operator **Pettibon System**
Equipment: **Track Excavator**
Logged By: **ARJ**

Figure A-10

PROJECT: Alderwood Terrace Single Family
PROJECT NO.: 369-005-02
LOCATION: Chehalis, Washington

TP-5

DATE: 6/9/21
TOTAL DEPTH: 7

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0	Duff		: Duff	
1	MH		**MH:** Brown, silt, moist, medium stiff	Moisture content 24.3%
2			Grades to light brown with occ orange mottling	
3				Moisture content 23.5%
4			Grades to gray brown	
5			Grades stiff	
6			Grades hard	Moisture content 16.5%
7				Test pit completed at 7 feet. No caving or groundwater observed.
8				
9				
10				

INSIGHT GEOLOGIC, INC.

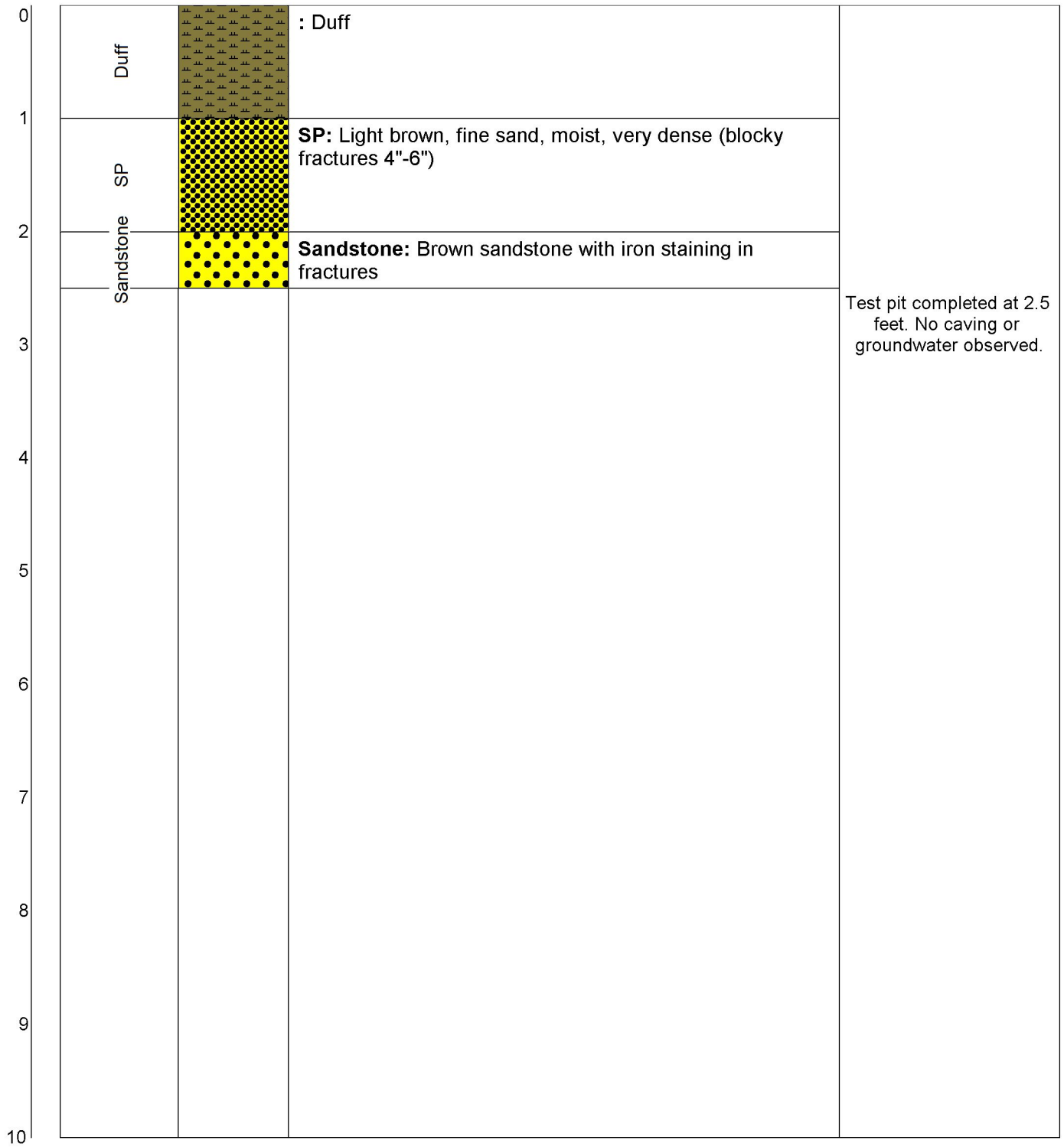
Operator **Pettibon System**
Equipment: **Track Excavator**
Logged By: **ARJ**

Figure A-11

PROJECT: Alderwood Terrace Single Family
PROJECT NO.: 369-005-02
LOCATION: Chehalis, Washington

TP-6

DATE: 6/9/21
TOTAL DEPTH: 2.5



INSIGHT GEOLOGIC, INC.

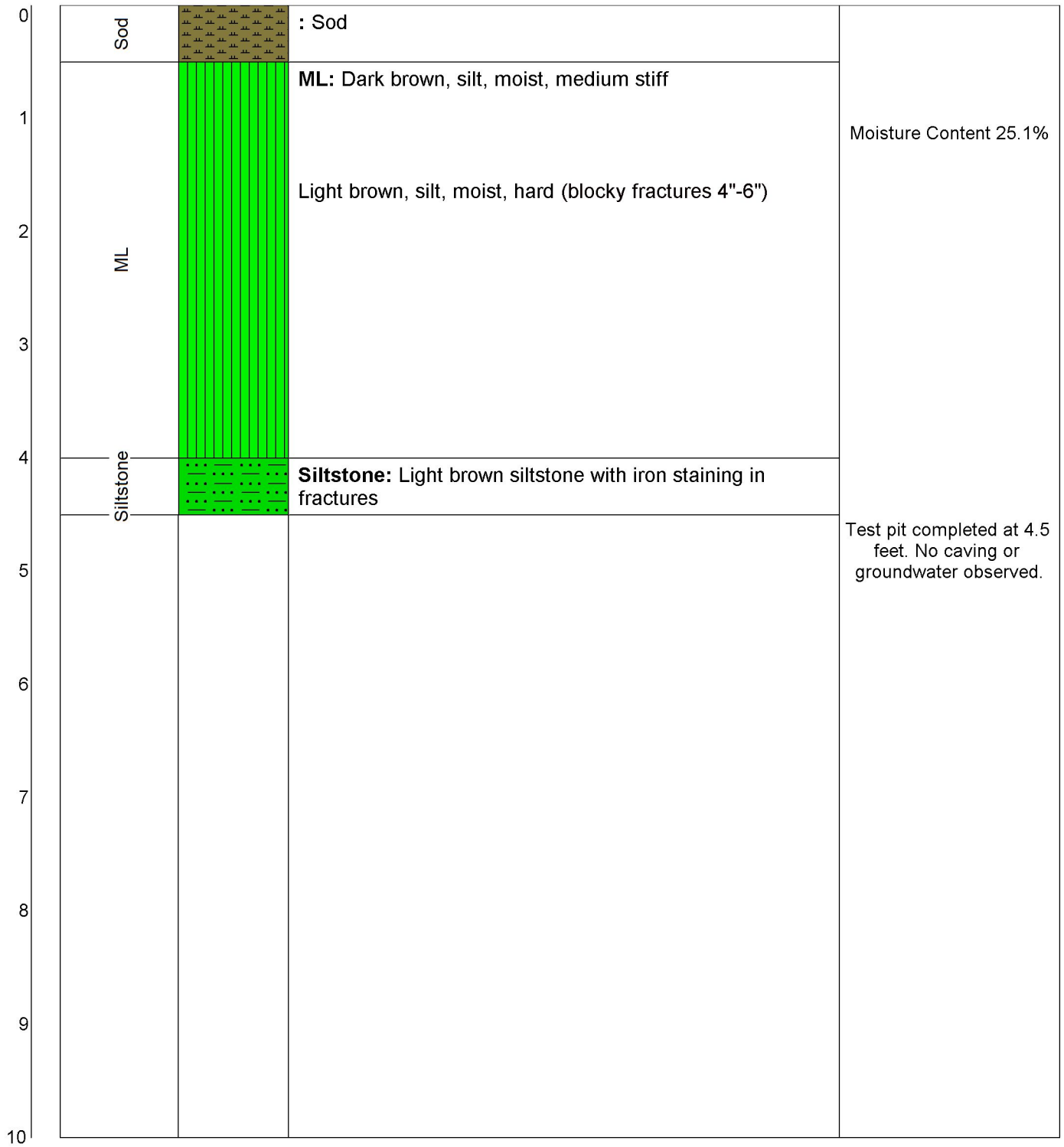
Operator **Pettibon System**
Equipment: **Track Excavator**
Logged By: **ARJ**

Figure A-12

PROJECT: Alderwood Terrace Single Family
PROJECT NO.: 369-005-02
LOCATION: Chehalis, Washington

TP-7

DATE: 6/9/21
TOTAL DEPTH: 4.5



INSIGHT GEOLOGIC, INC.

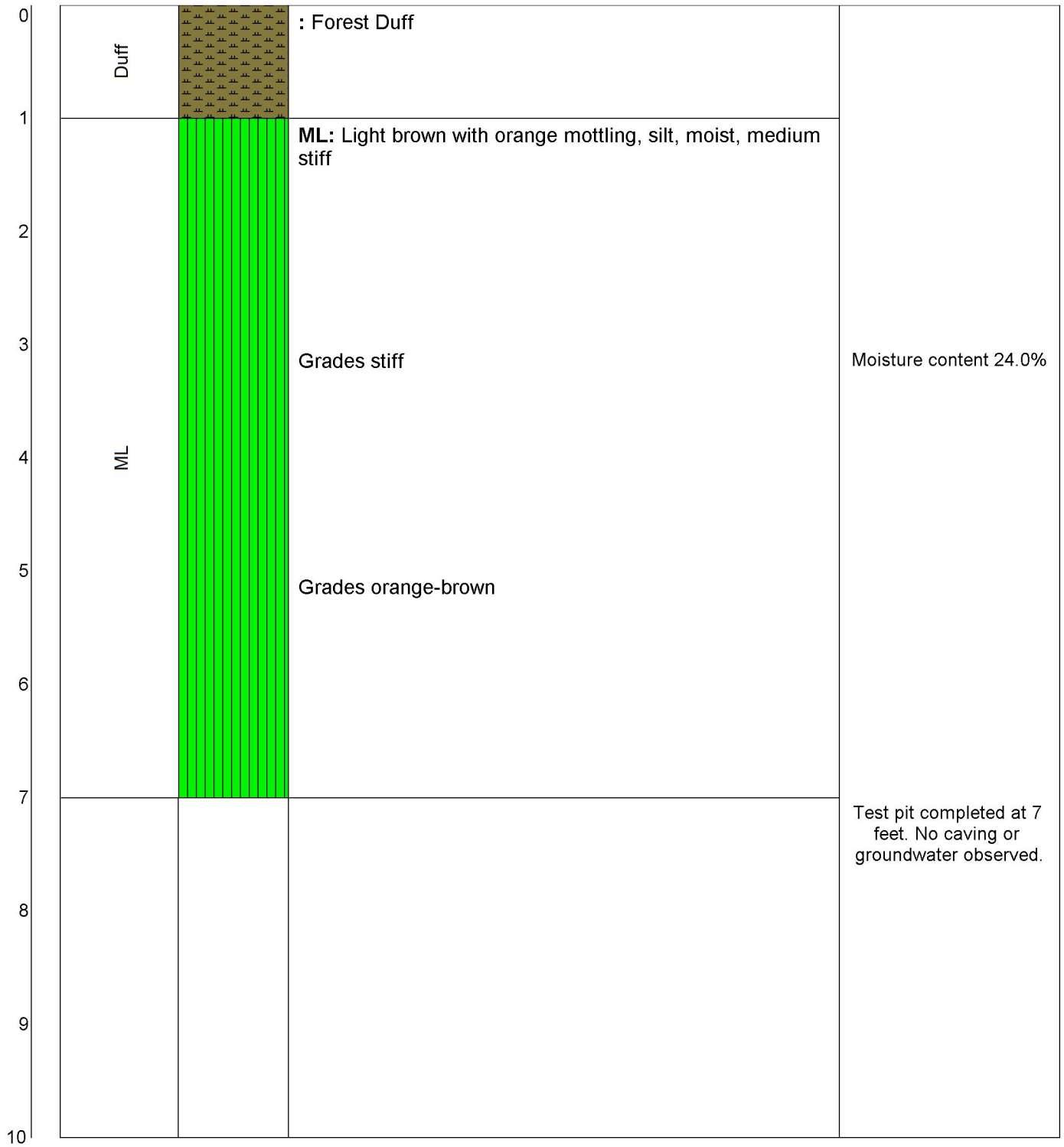
Operator **Pettibon System**
Equipment: **Track Excavator**
Logged By: **ARJ**

Figure A-13

PROJECT: Alderwood Terrace Single Family
PROJECT NO.: 369-005-02
LOCATION: Chehalis, Washington

TP-8

DATE: 6/9/21
TOTAL DEPTH: 7



INSIGHT GEOLOGIC, INC.

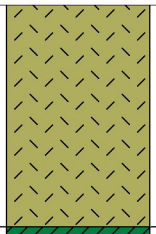
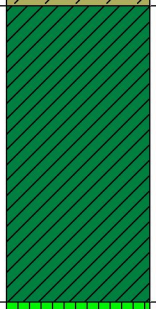
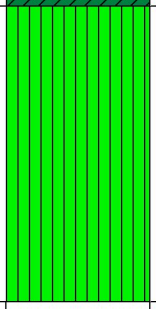
Operator **Pettibon System**
Equipment: **Track Excavator**
Logged By: **ARJ**

Figure A-14

PROJECT: Alderwood Terrace Single Family
PROJECT NO.: 369-005-02
LOCATION: Chehalis, Washington

TP-9

DATE: 6/9/21
TOTAL DEPTH: 5.5

DEPTH (FT)	U.S.C.S.	LITHOLOGY	SOIL DESCRIPTION	REMARKS AND OTHER TESTS
0	Crushed rock		: Crushed rock	
2	CL		**CL:** Light brown-orange mottled, clay, moist, medium stiff	Moisture Content 25.8%
4	ML		**ML:** Light brown-gray, silt, moist, stiff	
6				Test pit completed at 5.5 feet. No caving or groundwater observed.
10				

INSIGHT GEOLOGIC, INC.

Operator **Pettibon System**
Equipment: **Track Excavator**
Logged By: **ARJ**

Figure A-15

ATTACHMENT B
LABORATORY ANALYSES RESULTS

Gradation Analysis Summary Data

Job Name: Alderwood Terrace Single Family
Job Number: 369-005-02
Date Tested: 7/7/21
Tested By: Neal Graham

Sample Location: B-2
Sample Name: B-2 10.0' - 11.5'
Depth: 10 - 11.5 Feet

Moisture Content (%) 38.9%

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)	98.3
No. 10 (2.00-mm)	91.4
No. 20 (.850-mm)	87.2
No. 40 (.425-mm)	83.9
No. 60 (.250-mm)	81.2
No. 100 (.150-mm)	77.1
No. 200 (.075-mm)	48.7

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	1.7
Coarse Sand	6.9
Medium Sand	7.5
Fine Sand	35.3
Fines	48.7
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.00
D_{60}	0.10
D_{90}	1.50
Cc	- -
Cu	- -

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

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Alderwood Terrace Single Family
Job Number: 369-005-02
Date Tested: 7/7/21
Tested By: Neal Graham

Sample Location: B-3
Sample Name: B-3 5.0' - 6.5'
Depth: 5 - 6.5 Feet

Moisture Content (%) 36.0%

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)	95.4
No. 10 (2.00-mm)	82.8
No. 20 (.850-mm)	76.7
No. 40 (.425-mm)	73.7
No. 60 (.250-mm)	71.8
No. 100 (.150-mm)	69.3
No. 200 (.075-mm)	53.6

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	4.6
Coarse Sand	12.6
Medium Sand	9.1
Fine Sand	20.1
Fines	53.6
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.00
D_{60}	0.10
D_{90}	3.25
Cc	- -
Cu	- -

ASTM Classification
Group Name: **Sandy Silt**
Symbol: **ML**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Alderwood Terrace Single Family
Job Number: 369-005-02
Date Tested: 7/7/21
Tested By: Neal Graham

Sample Location: B-5
Sample Name: B-5 5.0' - 6.5'
Depth: 5 - 6.5 Feet

Moisture Content (%) 42.2%

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)	84.0
No. 10 (2.00-mm)	66.7
No. 20 (.850-mm)	58.2
No. 40 (.425-mm)	54.0
No. 60 (.250-mm)	50.8
No. 100 (.150-mm)	47.3
No. 200 (.075-mm)	38.0

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	16.0
Coarse Sand	17.3
Medium Sand	12.7
Fine Sand	16.0
Fines	38.0
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.00
D_{60}	1.05
D_{90}	6.00
Cc	- -
Cu	- -

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

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Alderwood Terrace Single Family
Job Number: 369-005-02
Date Tested: 7/7/21
Tested By: Neal Graham

Sample Location: TP-3
Sample Name: TP-3 5.0' - 5.5'
Depth: 5 - 5.5 Feet

Moisture Content (%) 46.0%

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)	100.0
No. 10 (2.00-mm)	99.9
No. 20 (.850-mm)	99.2
No. 40 (.425-mm)	97.7
No. 60 (.250-mm)	95.8
No. 100 (.150-mm)	92.4
No. 200 (.075-mm)	63.4

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.0
Coarse Sand	0.1
Medium Sand	2.3
Fine Sand	34.3
Fines	63.4
Total	**100.0**

LL - -
PL - -
PI - -

D_{10} 0.00
D_{30} 0.00
D_{60} 0.00
D_{90} 0.14

Cc - -
Cu - -

ASTM Classification
Group Name: **Sandy Silt**
Symbol: **ML**

INSIGHT GEOLOGIC, INC.

Gradation Analysis Summary Data

Job Name: Alderwood Terrace Single Family
Job Number: 369-005-02
Date Tested: 7/7/21
Tested By: Neal Graham

Sample Location: TP-3
Sample Name: TP-3 5.5' - 8.0'
Depth: 5.5 - 8.0 Feet

Moisture Content (%) 38.7%

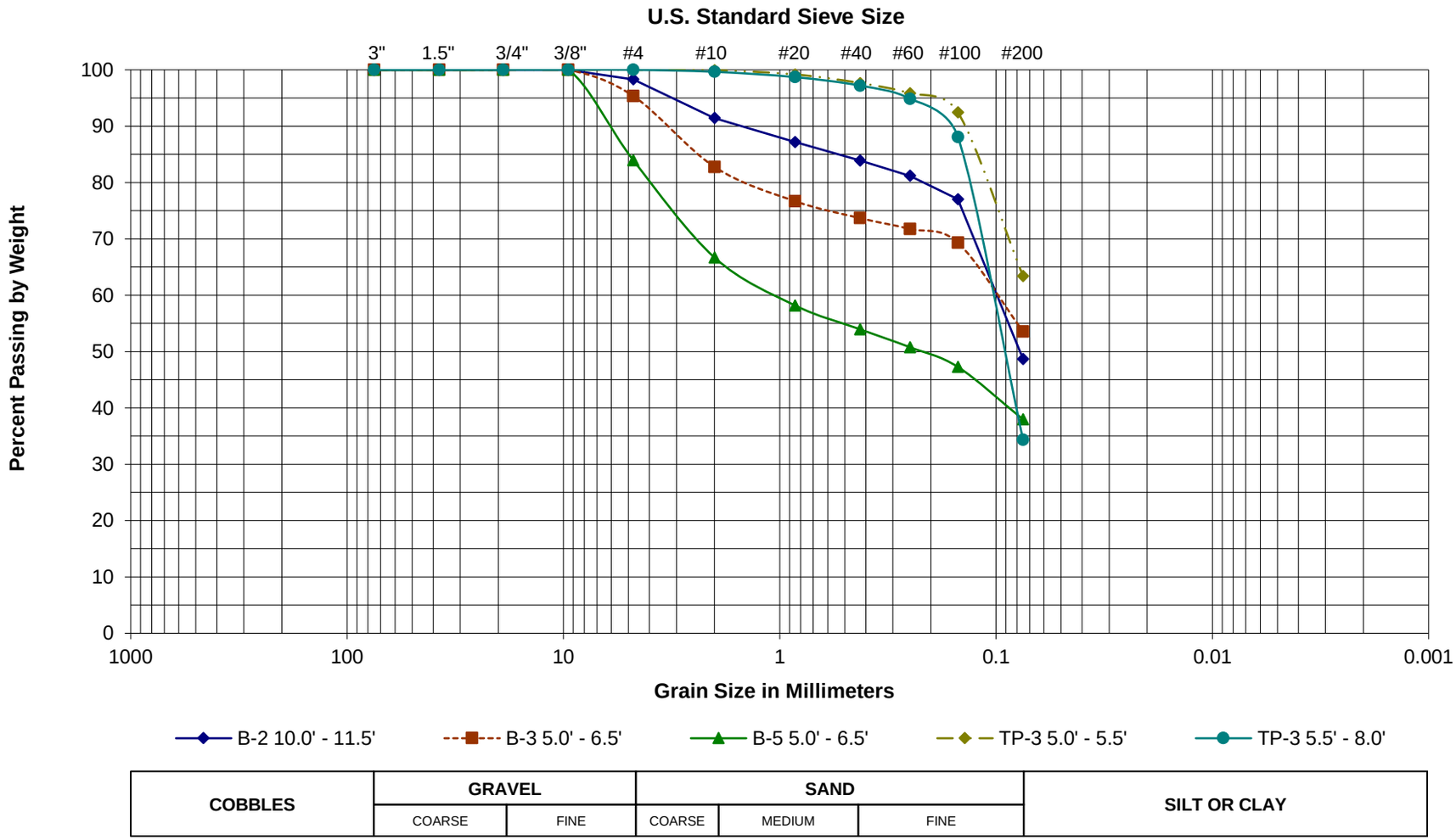
Sieve Size	Percent Passing
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	100.0
No. 4 (4.75-mm)	100.0
No. 10 (2.00-mm)	99.7
No. 20 (.850-mm)	98.7
No. 40 (.425-mm)	97.2
No. 60 (.250-mm)	94.9
No. 100 (.150-mm)	88.1
No. 200 (.075-mm)	34.3

Size Fraction	Percent by Weight
Coarse Gravel	0.0
Fine Gravel	0.0
Coarse Sand	0.3
Medium Sand	2.4
Fine Sand	62.9
Fines	34.3
Total	**100.0**

LL	- -
PL	- -
PI	- -
D_{10}	0.00
D_{30}	0.00
D_{60}	0.10
D_{90}	0.16
Cc	- -
Cu	- -

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

INSIGHT GEOLOGIC, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

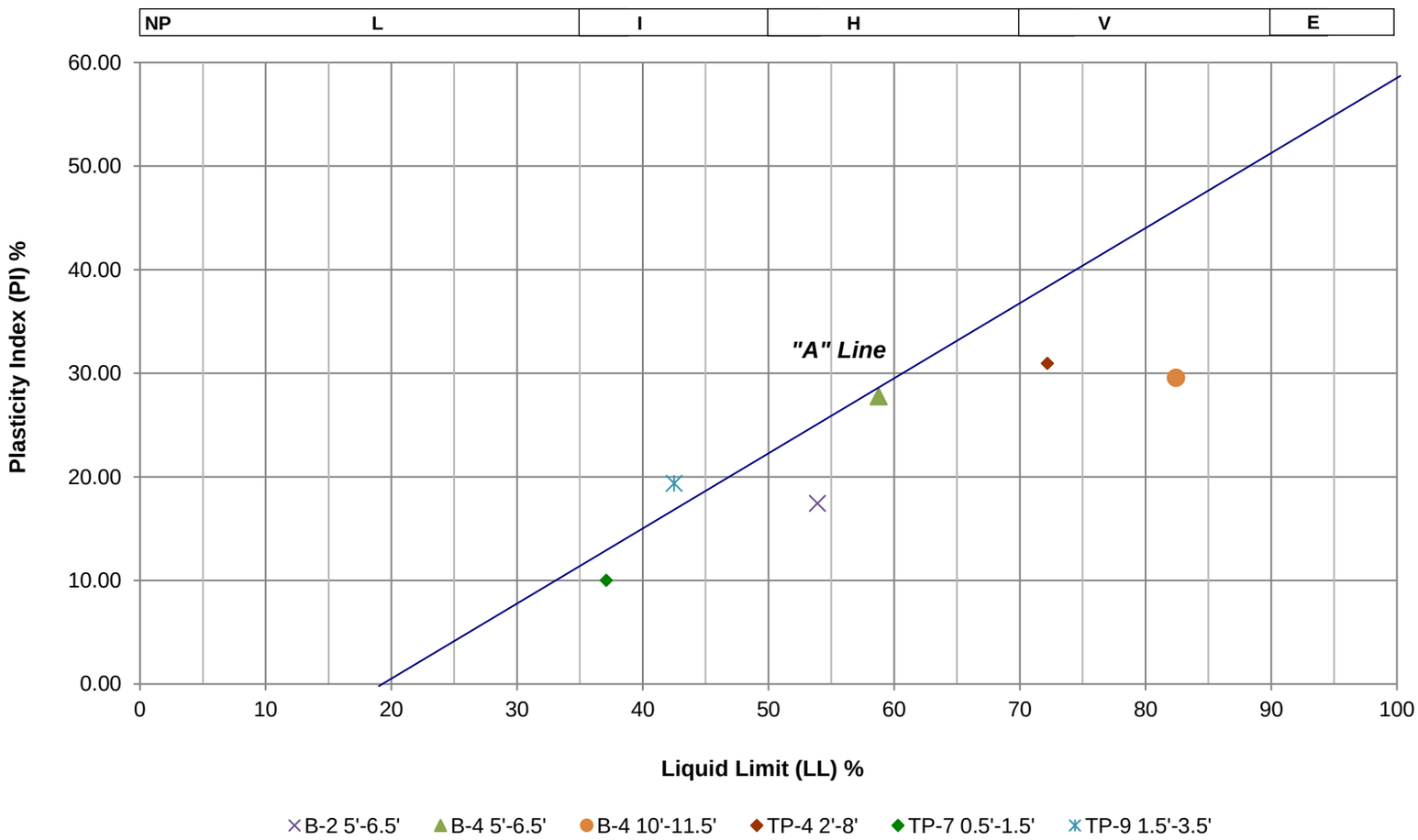
ALDERWOOD TERRACE SINGLE FAMILY

CHEHALIS, WASHINGTON

INSIGHT GEOLOGIC, INC.

Graph 1
Gradation Analysis Results

Plasticity Chart



Key: Plasticity Symbol = **NP** - Non-Plastic **L -** Low **I -** Intermediate **H** - High **V -** Very High **E** - Extremely High

INSIGHT GEOLOGIC, INC.

Graph 2
Plastic Limit Test 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 Pettibon System (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.

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[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.