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November 15, 2021

Legacy Development Group
PO Box 4
Hood River, Oregon 97031
Attention: Cameron Curtis, President

Phone: (541) 490-6339
E-mail: cameron@curtishomesllc.com

Subject: **Geotechnical Investigation Report**
Proposed Spring Street Subdivision
Klickitat County Tax Lot No. 0310247500400
Intersection of Northwest Spring Street and Northwest Cherry Hill Road
White Salmon, Klickitat County, Washington
EEI Report No. 20-071-1

Dear Mr. Curtis:

Earth Engineers, Inc. (EEI) is pleased to provide our attached Geotechnical Investigation Report for the above referenced project. This report includes the results of our field investigation, an evaluation of geotechnical factors that may influence the proposed construction, and geotechnical recommendations for the proposed structures and general site development.

We appreciate the opportunity to perform this geotechnical study and look forward to continued participation during the design and construction phases of this project. If you have any questions pertaining to this report, or if we may be of further service, please contact our office.

Sincerely,
Earth Engineers, Inc.

Troy Hull, P.E.
Principal Geotechnical Engineer

Jacqui Boyer
Geotechnical Engineering Associate

Attachment: Geotechnical Investigation Report

Distribution (electronic copy only): Addressee

GEOTECHNICAL INVESTIGATION REPORT

For the:

Proposed Spring Street Subdivision
Klickitat County Tax Lot No. 0310247500400
Intersection of Northwest Spring Street
and Northwest Chery Hill Road
White Salmon, Klickitat County, Washington

Prepared for:

Legacy Development Group
PO Box 4
Hood River, Oregon 97031
Attention: Cameron Curtis

Prepared by:

Earth Engineers, Inc.
2411 Southeast 8th Avenue
Camas, Washington 98607
Phone: 360-567-1806

EEI Report No. 21-071-1

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Geotechnical Engineering Associate

TROY M. HULL
38707

EXPIRES 09/06/ 23

Troy Hull, P.E.
Principal Geotechnical Engineer

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1.0 PROJECT INFORMATION

1.1 Project Authorization

Earth Engineers, Inc. (EEI) has completed a geotechnical investigation report for the proposed development to be located on Klickitat County Tax Lot No. 0310247500400 off of Northwest Spring Street near the intersection with Northwest Cherry Hill Road in White Salmon, Klickitat County, Washington. Our geotechnical services were authorized by Cameron Curtis with Legacy Development Group on September 24, 2021 by signing our Proposal No. 21-P066-R1 issued on February 18, 2021 and revised on May 6, 2021.

1.2 Project Description

Our current understanding of the project is based on the information Greg Hagbery (formerly with Legacy Development Group) provided to EEI Geotechnical Engineering Associate Jacqui Boyer via e-mail on February 17, 2021. We have also been provided with the following documents pertaining to the project:

- **A survey titled “Cherry Hill Estates” prepared by T.N. Trantrow Surveying, P.L.S. dated July 21, 1992.** This survey shows the boundaries of the subject property with respect to the surrounding properties. The survey indicates that the subject 7.93-acre property is Lot 4 of the Cherry Hill Estates.

- **A conceptual plan titled “Pre-App Proposal” prepared by Legacy Development Group Inc. dated January 2021.** This plan shows the preliminary neighborhood layout of the proposed subdivision, including the proposed roadway and lot divisions on the property. See Figure 1 below. The plan also shows a site location map for the subject property with respect to its vicinity. It should be noted that it is our understanding these plans are preliminary.

- **A survey titled “Property Boundary Survey for Curtis Homes, Location: Tract of Land Located in the Northeast Quarter of the Northeast Quarter of Section 24, Township 3 North, Range 10 East, Willamette Meridian, Klickitat County, Washington” prepared by Terra Surveying, dated December 2020.** This topographic property survey shows the existing property topography with 1-foot contour lines, and elevations based on the N.A.V.D. 99 vertical datum.

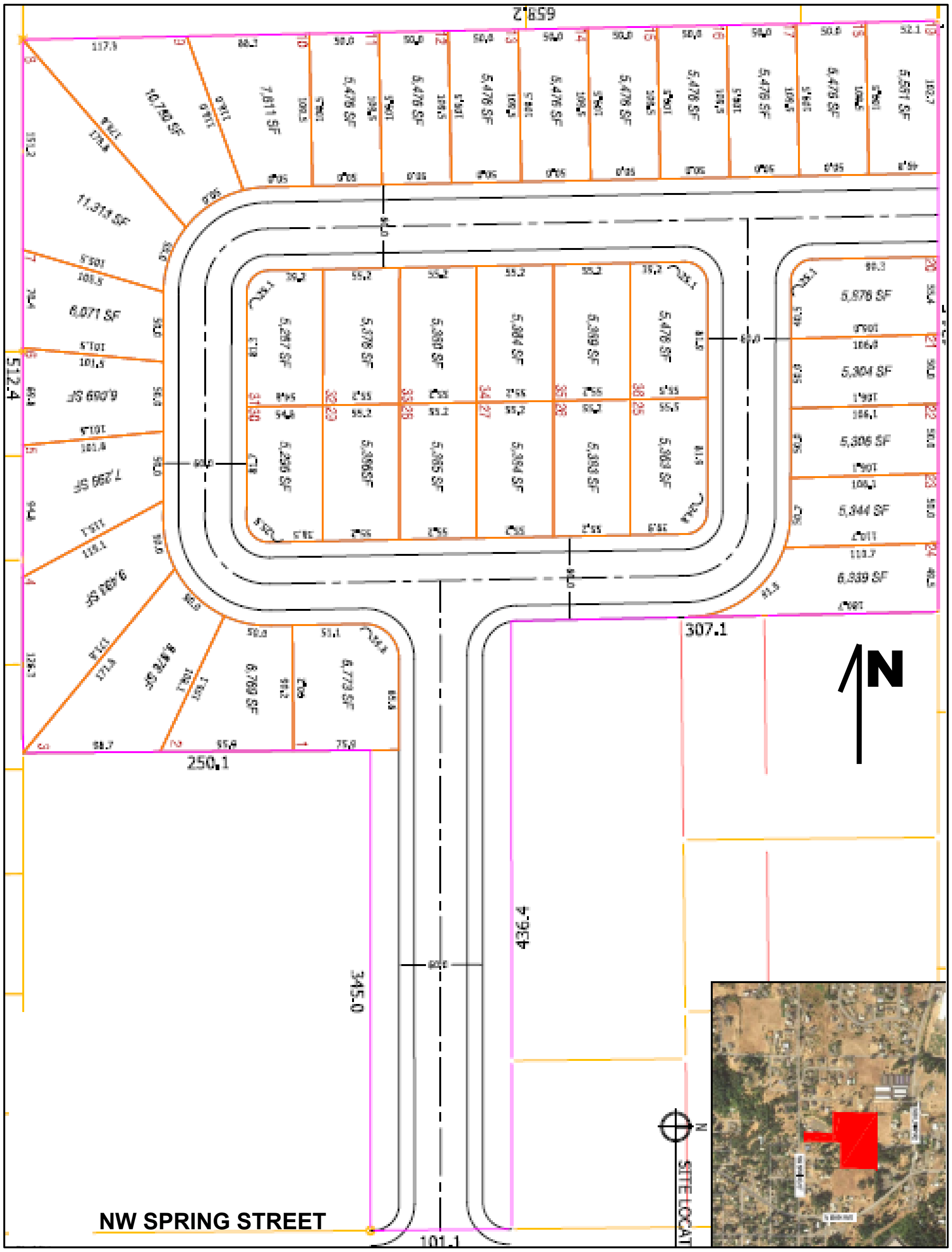

Figure 1: Preliminary site plan for the subject property. The subject property is outlined in pink and the proposed lots are outlined in orange. Base plan source: referenced above.

As shown on Figure 1 above, we understand that the plan is to divide the subject property into 36 residential lots ranging in size from 5,287 square feet to 11,313 square feet. The plan indicates that the proposed roadway is 60-feet wide, and accesses the property from Northwest Spring Street to the south.

At this time, we have not been provided detailed design drawings for the project. For the purposes of this report, we are assuming maximum house foundation loads of 3 kips per linear foot for wall footings, 40 kips for column footings, and 150 psf for floor slabs. We also assume maximum cuts and fills will be minimal, on the order of 2 feet. Finally, we have assumed that the proposed subdivision residences will be constructed in accordance with the 2018 International Residential Code (IRC).

1.3 Purpose and Scope of Services

In order to provide geotechnical recommendations for the proposed development, we performed a subsurface investigation to better define the subsurface soil, rock, and groundwater properties. We performed 11 test pits (TP-1 through TP-11) around the subject property. The depths of the explorations ranged from 4 to 9.5 feet. In order to characterize soil strength, we supplemented some of the test pits with drive probe testing.

Select soil samples collected from the test pits were tested in the laboratory to determine the material's properties for our evaluation. Laboratory testing was accomplished in general accordance with ASTM procedures.

This report briefly outlines the testing procedures, presents available project information, describes the site and subsurface conditions, and presents geotechnical recommendations regarding the development of the single family residential lots as follows:

- A discussion of subsurface conditions encountered including pertinent soil and rock properties as well as the encountered groundwater conditions.
- Geotechnical related recommendations for foundation design including allowable bearing capacity and estimated settlements.
- A qualitative evaluation of slope stability.
- Seismic design parameters in accordance with the ASCE 7-16.
- Structural fill recommendations, including an evaluation of whether the in-situ soils can be used as structural fill.
- Floor slab support recommendations.
- Retaining wall design parameter recommendations, including earth pressures, backfill and drainage.
- Construction recommendations including wet/dry weather site preparation and drainage recommendations.
- Asphaltic concrete pavement section thickness design recommendations based on an assumed CBR value, as well as assumed traffic loading conditions.
- Discussions on geotechnical issues that may impact the project.

2.0 SITE AND SUBSURFACE CONDITIONS

2.1 Site Location and Description

As noted above, the project area is located on Klickitat County Tax Lot No. 0310247500400 in White Salmon, Washington. The property is accessed from Northwest Spring Street to the south, and is bounded by residential properties to the west, north and east. See Figure 2 below for the project vicinity map.

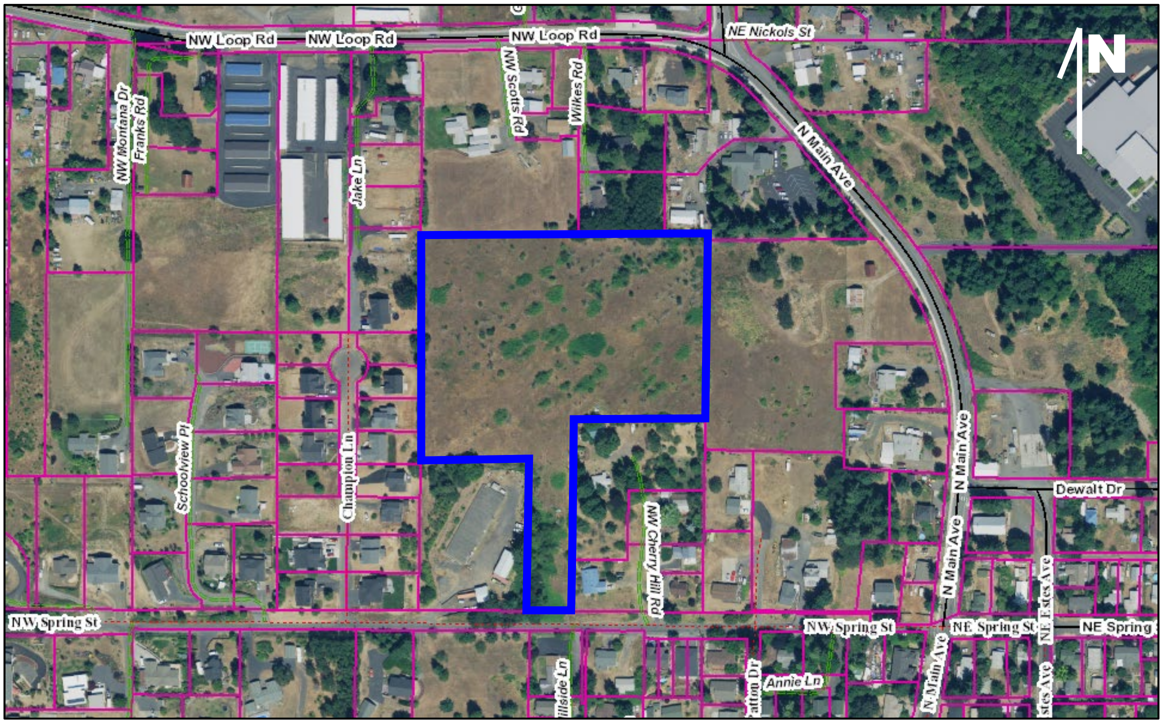

Figure 2: Vicinity map (base map source - http://imap.klickitatcounty.org/). The subject property is outlined in blue.

At the time of our investigation, the property was vacant. The site was vegetated with grass, shrubs, scattered trees, and blackberry bushes. It should be noted that some of the vegetation appeared burned. There is also an access road in the southern portion of the property off of Northwest Spring Street.

In terms of topography, the subject property is generally sloping down to the northeast at about 7H:1V (Horizontal:Vertical). Slopes in the area of the proposed lots (i.e. the northern portion of the property) are up to about 3.5H:1V. The steepest slope on the subject property is located along the access road (i.e. the southern portion of the property), up to 1.9H:1V. See Appendix B for the site topography taken from the survey referenced above.

While on site, we did not observe signs of previous or current soil movement, such as leaning tree trunks, clearly identifiable landslide head scarps, or surface cracking in the soils. See Photos 1 through 4 below for current site conditions.

Photo 1: Current site conditions (taken from TP-3, facing northeast).

Photo 2: Current site conditions (taken from TP-4, facing north).

Photo 3: Current site conditions (taken from TP-8, facing southwest).

Photo 4: Current site conditions (taken from TP-11, facing Northwest Spring Street to the south).

2.2 Mapped Geology and Soils

The underlying geologic unit mapped in the area of the subject property is Qtb – Olivine basalt and andesite from the upper Miocene to Quaternary[1].

We reviewed the United States Department of Agriculture (USDA) Soil Survey[2] to define the surface soils on the subject property. The USDA maps the soils on the subject property to be Unit 86B-Chemawa ashy loam on 8 to 15 percent slopes, and 86C-Chemawa ashy loam on 15 to 30 percent slopes. This well drained soil unit is formed on terraces from a parent material of volcanic ash. A typical profile for this soil unit is ashy loam overlying ashy silt loam with a depth to a restrictive feature of more than 80 inches.

As part of our due diligence for this report, we reviewed the Washington State Department of Natural Resources (DNR) Geologic Information Portal (https://geologyportal.dnr.wa.gov/). According to the DNR portal, portions of the property are mapped within a moderate susceptibility to shallow landslides. It should be noted that the portal does not map any historic landslide deposits or fault lines on or in proximity to the subject property. In addition, the portal does not map the subject property within a liquefaction susceptibility area due to the presence of shallow bedrock.

According to the USGS Fault and Fold Database of the United States, the Hood River fault zone is located approximately 2.9 miles south of the site and the Faults near the Dalles is approximately 5.5 miles northeast of the site. The Hood River fault zone defines the eastern margin of a half graben, and is described to contain normal right lateral faults with a slip rate of less than 0.2mm/year[3]. The Faults near the Dalles are described as northwest striking, right-lateral strike slip faults, and are categorized as having a slip rate of less than 0.2mm/year, although no slip data in Quaternary deposits are available[4].

2.3 Subsurface Materials

As stated above, we explored the site with 11 test pits (TP-1 through TP-11) located around the subject property. The test pits were advanced by Legacy Development Group of Hood River, Oregon using an excavator with a 2-foot wide toothed bucket. In addition, we performed supplemental drive probe testing at TP-5, TP-8, and TP-10. For the approximate exploration locations, see the “Exploration Location Plan” in Appendix B. Results of the test pits are reported in Appendix C. Upon completion, the test pits were loosely backfilled with the excavated soil and tamped down with the excavator bucket.

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[1] Bela, J.L, 1982, Geologic and Neotectonic Evaluation of North-Central Oregon: The Dalles 1 degree x 2 degree Quadrangle, Oregon Department of Geology and Mineral Industries, Geological Map Series 27, scale 1:250,000.

[2] Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/.

[3] Personius, S.F., compiler, 2002, Fault number 866, Hood River fault zone, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults.

[4] Personius, S.F., and Lidke, D.J., compilers, 2003, Fault number 580, Faults near The Dalles, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults.

Drive probe tests extended from the ground surface at the locations referenced above to the depth of drive probe refusal. The drive probe test is based on a “relative density” exploration device used to determine the distribution and to estimate strength of the subsurface soil units. The resistance to penetration is measured in blows-per-½-foot of an 11-pound hammer which free falls roughly 39 inches driving a 3/4-inch outside diameter pipe with a 1-inch diameter endcap into the ground. This measure of resistance to penetration can be used to estimate relative density of soils. For a more detailed description of this geotechnical exploration method, please refer to the Slope Stability Reference Guide for National Forests in the United States, Volume I, USDA, EM-7170-13, August 1994, P 317-321. Results of the drive probe tests are reported in the exploration logs in Appendix C.

Select soil samples were tested in the laboratory to determine material properties for our evaluation. Laboratory testing was accomplished generally in accordance with ASTM procedures. The testing performed included moisture content tests (ASTM D2216), and fines content determinations (ASTM D1140). The test results have been included on the exploration logs located in Appendix C.

Generally, we encountered a surficial layer of topsoil overlying fill soils, overlying native soils with decomposed rock, which eventually transitioned to bedrock with depth. The thickness of the strata varied across the site. Each individual stratum encountered is discussed in further detail below.

TOPSOIL

The surficial layer encountered in all of our explorations consisted of a dry to moist, light brown sandy silt with rootlets. The thickness of this stratum in our test pits was 6 to 12 inches.

FILL/TILLED SOILS

In all of our test pits, we encountered what we interpret to be fill/tilled soils underlying the surficial topsoil layer. The soil was generally a light brown to brown sandy silt to silty sand with rootlets, wood chips and charcoal pieces. We also encountered boulders, as well as wood, plastic and metal debris within this stratum. It is possible these organic soils are the result of agricultural tilling or clearing the area in the past. Laboratory moisture content testing on samples obtained within this stratum ranged from 9 to 12 percent, indicating a dry condition. Fines content laboratory testing for samples obtained within this stratum ranged from 39 to 89 percent passing the #200 sieve. Based on the excavator digging effort and supplementary drive probe testing, we consider this stratum to be medium stiff/medium dense to very stiff/very dense. The fill/tilled soils extended to depths ranging from 2 to 4 feet bgs in our explorations. It should be noted that this stratum extended to the terminal depth of our exploration at TP-6 due to practical digging refusal on a boulder.

NATIVE SOILS

In all of our explorations (except for TP-6), we encountered native soils underlying the fill soils. The soil was generally an orange-brown to reddish brown to dark brown silt with varying amounts of sand. We also encountered decomposed rock fragments in this stratum (red to black to gray to white). Laboratory moisture content testing on samples obtained within this stratum ranged from

8 to 50 percent, indicating a dry to wet condition. It should be noted that the relatively high moisture content was likely a result of the decomposed rock encountered in this stratum (i.e. the material may hold a significant amount of moisture, but it did not visually appear wet). While in the field, the native soils generally appeared to be moist. Fines content testing on samples obtained within this stratum ranged from 60 to 98 percent passing the #200 sieve. Based on the excavator digging effort and supplementary drive probe testing, we consider this native silt stratum to be very stiff to hard. The silt stratum extended to the terminal depths of our explorations at depths ranging from 5 to 9.5 feet bgs. It should be noted that all of our test pits terminated due to practical digging refusal on hard soil/decomposed rock, except for TP-5 and TP-8 which were terminated due to practical excavator reach.

The above subsurface description is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The exploration logs included in the Appendices should be reviewed for specific information at specific locations. These records include soil descriptions, stratifications, and locations of the samples. The stratifications shown on the logs represent the conditions only at the actual exploration locations. Variations may occur and should be expected between locations. The stratifications represent the approximate boundary between subsurface materials and the actual transition may be gradual. The fill extent at each exploration location was estimated based on an examination of the soil samples, the presence of foreign materials, field measurements, and the subsurface data. The explorations performed are not adequate to accurately identify the full extent of existing fill soil across the site. Consequently, the actual fill soil extent may be much greater than that shown on the exploration logs and discussed herein. The samples that were not altered by laboratory testing will be retained for at least 90 days from the date of this report and then will be discarded.

2.4 Groundwater Information

Groundwater was not observed during out subsurface investigation. According to a historical well log (available from http://apps.wrd.state. or.us/apps/gw/well_log/) drilled approximately 700 feet north of the property, static groundwater was encountered 325 feet below the ground surface.

Although a static groundwater level was not encountered at the time of our subsurface investigation, it is possible for a perched groundwater level to be present within the depths explored at some future time depending upon climatic and rainfall conditions. In general, we do not expect that groundwater will influence the proposed construction.

2.5 Seismic Design Parameters and Hazards

In accordance with ASCE 7-16, we recommend a Site Class C (very dense soil and soft rock profile) for this site when considering the average of the upper 100 feet of bearing material beneath the foundations. This recommendation is based on the results of our subsurface investigation as well as our understanding of the local geology.

Inputting our recommended Site Class as well as the site latitude and longitude into the Seismic Design Maps (SEAOC/OSHPD) website (http://seismicmaps.org), we obtained the seismic design parameters shown in Table 1 below.

Table 1: Seismic Design Parameter Recommendations (ASCE 7-16)

Parameter	Recommendation
Site Class	C
S_s	0.512g
S_1	0.235g
F_a	1.295
F_v	1.500
S_{MS} (=S_s x F_a)	0.663g
S_{M1} (=S_1 x F_v)	0.353g
S_{DS} (=2/3 x S_s x F_a)	0.442g
Design PGA (=S_{DS}/2.5)	0.177g
MCE_G PGA	0.228g
F_{PGA}	1.200
PGA_M (=MCE_G PGA x F_{PGA})	0.273g

Note: Site latitude = 45.736933, longitude = -121.488038

The return interval for these ground motions is 2 percent probability of exceedance in 50 years.

As stated above, the property is not mapped within a liquefaction hazard zone; which coincides with the findings of our subsurface investigation. Because we do not consider the soils to be liquefiable (and because there are not any significant slopes on the property), there is not a risk of seismically induced lateral spreading.

With respect to slope stability, we do not consider the subject property to be oversteepened and at risk of sliding given the subject property slopes are generally not steeper than 2H:1V (except for a portion of the proposed access road). The slopes steeper than 2H:1V along the access road should be regraded to be 2H:1V to avoid the risk of shallow soil movement.

3.0 EVALUATION AND FOUNDATION RECOMMENDATIONS

3.1 Geotechnical Discussion

The following geotechnical factors may influence the proposed construction:

1. **Presence of possible fill/tilled soils** – As stated above, we encountered rootlets in the upper soils at all of our test pits to depths ranging from 2 to 4 feet bgs. It is possible these organic soils are the result of agricultural tilling or clearing the area in the past. The presence of such materials could result in excess settlements and unsatisfactory foundation performance. As such, for structures (i.e. buildings, pavement, retaining walls, etc.) we recommend overexcavating the fill/tilled soils down to the hard native soils encountered at depths of 2 to 4 feet bgs (i.e. any new foundations for the proposed subdivision penetrate through the compressible soils to bear on the sandy silt soils).

2. **Moisture sensitive soils** – The fine-grained portion of the soils encountered at the site are expected to be moisture sensitive. The increase in moisture content during periods of wet weather can cause significant reduction in the soil strength and support capabilities and will also be slow to dry. As such, water should not be allowed to collect in foundation excavations or on prepared subgrades, and care should be taken when operating construction equipment on the exposed subgrade. While not required, we recommend consideration be given to performing construction in the dry summer months to reduce the risk of damaging the site soils with the construction equipment. See more detailed recommendations for drainage in Section 4.1.

3. **Practical digging refusal encountered** – In our subsurface investigation, all of the test pits terminated with practical excavation refusal on hard soil/decomposed rock (except for TP-5 and TP-8 which were terminated due to practical excavator reach). The depth to practical excavation refusal ranged from 4 to 9.5 feet in our explorations. Excavations through this stratum may be difficult and require specialized equipment.

4. **Lack of detailed design drawings** – We have not been provided with a detailed design drawing set for the proposed construction. Once the drawings for the project are complete, we should review those drawings to determine if the design complies with our recommendations or if our recommendations need to be modified.

In summary, provided the recommendations in this report are adhered to, we do not foresee any major issues that would preclude the proposed construction. The above-mentioned factors are listed to draw the attention of the reader to the issues to address during design and construction of the proposed development.

3.2 General Site Preparation

Prior to the start of any earthwork, the test pit locations performed for our subsurface investigation, that fall under or adjacent to structurally improved areas, should be located, excavated to their bottoms, and backfilled with well-graded granular structural fill in properly compacted lifts, under the observation of a representative of the Geotechnical Engineer.

We envision that the topsoil, vegetation, roots, soft soils, and any other deleterious soils will need to be stripped from beneath the proposed building areas and proposed roadways. Topsoil in our test pits ranged from about 6 to 12 inches thick. In addition, as stated above, beneath new structures we recommend overexcavating the fill/tilled soils encountered across the property to depths ranging from 2 feet to 4 feet. It should be expected that the depth of these materials may vary across the site. A representative of the Geotechnical Engineer should determine the depth of removal at the time of construction.

After stripping and excavating to the proposed subgrade level, as required, the building areas and roadways should be inspected by a representative of the Geotechnical Engineer and proofrolled with a fully loaded, tandem axle, rubber tire dump truck or water truck. Soils that are observed to rut or deflect excessively under the moving load, or are otherwise judged to be unsuitable, should be undercut and replaced with properly compacted fill. If the subgrade cannot be accessed with a dump truck, then the subgrade will need to be visually evaluated by a representative of the Geotechnical Engineer by soil probing.

Any utilities present beneath the proposed construction will need to be located and rerouted as necessary and any abandoned pipes or utility conduits should be removed to inhibit the potential for subsurface erosion. Utility trench excavations should be backfilled with properly compacted structural fill as discussed in Section 3.3 below.

3.3 Structural Fill

Structural fill should be free of organics or other deleterious materials, have a maximum particle size less than 3 inches, be relatively well graded, and have a liquid limit less than 45 and plasticity index less than 25. In our professional opinion the onsite native soils are likely not appropriate for use as structural fill due to their variable, fine grained, moisture sensitive nature. As such, it may be more practical to import granular, well graded, crushed rock gravel structural fill. We recommend all structural fill be moisture conditioned to within 3 percentage points below and 2 percentage points above optimum moisture as determined by ASTM D1557 (Modified Proctor). If water must be added, it should be uniformly applied and thoroughly mixed into the soil by disking or scarifying.

Fill should be placed in relatively uniform horizontal lifts on the prepared subgrade which has been stripped of deleterious materials and approved by the Geotechnical Engineer or their representative. If loose soils exist on the prepared subgrades, they should be re-compacted. Each loose lift should be about 1-foot thick. The type of compaction equipment used will ultimately determine the maximum lift thickness. Structural fill should be compacted to at least 92 percent of the maximum dry density as determined by ASTM D1557. Each lift of compacted engineered fill should be tested by a representative of the Geotechnical Engineer prior to placement of subsequent lifts.

Any structural fill placed on slopes at or greater than 5H:1V should be properly benched. Level benches excavated into the existing slope should be a minimum of 4 feet wide laterally, and should be cut into the slope for no more than every five feet of vertical rise. The placement of fill should begin at the base of the fill. All benches should be inspected by a representative of the Geotechnical Engineer and approved prior to placement of structural fill lifts. If evidence of seepage is observed in the bench excavations, a supplemental drainage system may need to be designed and installed to prevent hydrostatic pressure buildup behind the fill. Final fill and/or cut slopes should be kept at or below a slope of 2H:1V. The fill should extend horizontally outward beyond the exterior perimeter of the building and pavements at least 5 feet and 3 feet respectively, prior to sloping.

To reiterate, each lift of compacted engineered fill should be tested by a representative of the Geotechnical Engineer prior to placement of subsequent lifts.

3.4 Foundation Recommendations

Once the site has been properly prepared as discussed above, the proposed residences can be supported on a conventional shallow foundation system. Spread footings for building columns and continuous footings for bearing walls can be designed for an allowable soil bearing pressure of up to 2,000 psf for foundations bearing on the very stiff to hard native soils first encountered in our test pits at depths of about 2 to 4 feet bgs, or on properly compacted, granular structural fill overlying the native soils. The above allowable soil bearing pressure can be increased by one-third when including short-term wind or seismic loads. Minimum footing dimensions should be in compliance with the 2018 IRC.

Lateral frictional resistance between the base of footings and the subgrade can be expressed as the applied vertical load multiplied by a coefficient of friction of 0.30 for concrete foundations bearing directly on the very stiff to hard native soils or structural fill. In addition, lateral loads may be resisted by passive earth pressures based on an equivalent fluid pressure of 300 pounds per cubic foot (pcf) for footings poured “neat” against the above-mentioned soil. These are ultimate values—we recommend a factor of safety of 1.5 be applied to the equivalent fluid pressure, which is appropriate due to the amount of movement required to develop full passive resistance. To be clear, no safety factor has been applied to the friction factor recommended above either.

Exterior footings and foundations in unheated areas should be located at a depth of at least 18 inches below the final exterior grade to provide adequate frost protection. If the residences are to be constructed during the winter months or if the foundation soils will likely be subjected to freezing temperatures after foundation construction, then the foundation soils should be adequately protected from freezing. Otherwise, interior foundations can be located at nominal depths compatible with architectural and structural considerations.

The foundation excavations should be observed by a representative of the Geotechnical Engineer prior to steel or concrete placement to assess that the foundation materials are capable of supporting the design loads and are consistent with the materials discussed in this report. Unsuitable soil zones encountered at the bottom of the foundation excavations should be removed and replaced with properly compacted structural fill as directed by the Geotechnical Engineer.

After opening, foundation excavations should be observed and concrete placed as quickly as possible to avoid exposure of the excavation to wetting and drying. Surface run-off water should be drained away from the excavations and not be allowed to pond. If possible, the foundation concrete should be placed during the same day the excavation is made. If the soils will be exposed for more than 2 days or for any length of time during precipitation events, consideration should be given to placing a thin layer of rock atop the exposed subgrade to protect it from the elements.

Based on the known subsurface conditions we anticipate that properly designed and constructed foundations could experience maximum total and differential settlements on the order of 1-inch and 1/2-inch, respectively.

We recommend that the perimeter foundations include footing drains on the exterior of the buildings. The footing drains typically consist of a 3 or 4 inch diameter perforated drain pipe placed in a trench excavated next to the base of the footing and surrounded on the sides and above by drain rock. To increase the drain pipe life, we recommend it be sleeved with a sock (i.e. filter fabric). Footing drains do a have a useful life and eventually need to be replaced—because they can get silted up. Footing drains should be discharged to an approved outlet point and should not be connected directly to crawl space drains or storm drains, unless there is a backflow preventer installed to prevent the different drain lines from backing up into each other.

3.5 Floor Slab Recommendations

For the purposes of this report, we have assumed that maximum floor slab loads will not exceed 150 psf. Based on the existing soil conditions, the design of slabs-on-grade can be based on a subgrade modulus (k) of 150 pci. This subgrade modulus value represents an anticipated value which would be obtained in a standard in-situ plate test with a 1-foot square plate.

It is our professional opinion that the floor slabs can be grade supported on a minimum of 6 inches of properly compacted well-graded granular structural fill placed on the very stiff to hard native soils first encountered in our test pits at depths of about 2 to 4 feet bgs. The structural fill should be placed as outlined in Section 3.3 above. The floor slabs should have an adequate number of joints to reduce cracking resulting from any differential movement and shrinkage.

Where feasible, the slab area native subgrade should be proof-rolled with a heavily loaded tandem axel dump truck, or similar rubber-tired vehicle, to identify as “soft” spots prior to the placement of any structural fill. Soils that are observed to rut or deflect excessively under the moving load, or are otherwise judged to be unsuitable, should be undercut and replaced with properly compacted structural fill. In the case that the subgrade area is not accessible to a large rubber-tired vehicle, the Geotechnical Engineer’s representative may need to approve the slab subgrade using a steel probe rod.

The 6-inch thick well graded granular structural fill should provide a capillary break to limit migration of moisture through the slab. If additional protection against moisture vapor is desired, a vapor retarding membrane may also be incorporated into the design. Factors such as cost, special considerations for construction, and the floor covering suggest that decisions on the use of vapor retarding membranes be made by the project design team, the contractor, and the owner.

3.6 Retaining Wall Recommendations

While we are not aware of any specific retaining walls for the project, we are providing these general recommendations for preliminary planning purposes. Once more detailed plans are known about retaining walls, we should be provided the drawings so that we can update our recommendations if necessary. For the purposes of this report, we have assumed that no walls will be greater than 10 feet tall.

Retaining wall footings should be designed in accordance with the recommendations contained in Section 3.4 above. Lateral earth pressures on walls, which are not restrained at the top, may be calculated on the basis of an “active” equivalent fluid pressure of 35 pcf for level backfill, and 60 pcf for sloping backfill with a maximum 2H:1V slope. Lateral earth pressures on walls that are restrained from yielding at the top (i.e. stem walls) may be calculated on the basis of an “at-rest” equivalent fluid pressure of 55 pcf for level backfill, and 90 pcf for sloping backfill with a maximum 2H:1V slope. The stated equivalent fluid pressures do not include surcharge loads, such as foundation, vehicle, equipment, etc., adjacent to walls, hydrostatic pressure buildup, or earthquake loading. Surcharge loads on walls should be calculated based on the attached formulas shown in Appendix E.

We recommend that retaining walls be designed for an earth pressure determined using the Mononobe-Okabe method to mitigate future seismic forces. Our calculations were based on one-half of the Design Peak Ground Acceleration (PGA) value of 0.177g, which was obtained from Table 1 above. We have assumed that the retained soil/rock will have a minimum friction angle of 29 degrees and a total unit weight of about 115 pounds per cubic foot. For seismic loading on retaining walls with level backfill, new research indicates that the seismic load is to be applied at 1/3 H of the wall instead of 2/3 H, where H is the height of the wall[5]. We recommend that a Mononobe-Okabe earthquake thrust per linear foot of 4.7 psf * H^2 be applied at 1/3 H, where H is the height of the wall measured in feet. Note that the recommended earthquake thrust value is appropriate for slopes

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[5] Lew, M., et al (2010). “Seismic Earth Pressures on Depp Building Basements,” SEAOC 2010 Convention Proceedings, Indian Wells, CA.

behind the retaining wall of up to 10 degrees. For a maximum 2H:1V slope, we recommend 16 psf * H^2. This assumes a granular backfill retained by the walls.

All backfill for retaining walls should be select granular material, such as sand or crushed rock with a maximum particle size between ¾ and 1 ½ inches, having less than 5 percent material passing the No. 200 sieve. Because of their fines content, the native soils do not meet this requirement, and it will be necessary to import material to the project for wall backfill. Non-expansive soils can be used for the last 18 to 24 inches of backfill, thus acting as a seal to the granular backfill. All backfill behind retaining walls should be moisture conditioned to within ± 2 percent of optimum moisture content, and compacted to a minimum of 90 percent of the material's maximum dry density as determined in accordance with ASTM D1557 (Modified Proctor). This recommendation applies to all backfill located within a horizontal distance equal to 75 percent of the wall height, but should be no less than 4 feet.

An adequate subsurface drain system will need to be designed and installed behind retaining walls to prevent hydrostatic buildup. A waterproofing system should be designed for any basement walls where moisture intrusion is not desirable.

3.7 Pavement Section Thickness Recommendations

After the site has been stripped and prepared in accordance with Section 3.2 of this report (i.e. the fill is overexcavated), the pavement subgrade should be proofrolled with a fully loaded dual axle dump truck. Areas found to be soft or yielding under the weight of a dump truck should be overexcavated as recommended by the Geotechnical Engineer’s representative and replaced with additional crushed rock gravel fill.

The pavement section thickness recommendations presented below in Tables 2 and 3 are considered typical and minimum for the assumed parameters. In order to achieve the assumed 20-year design life, pavement does need regular maintenance to protect the underlying subgrade from being damaged. The primary concern is subgrade water saturation which can cause it to weaken. Proper site drainage should be maintained to protect pavement areas. In addition, cracks that develop in the pavement should be sealed on a regular basis.

Using the AASHTO method of flexible pavement design, the following design parameters have been assumed:

- An assumed California Bearing Ratio (CBR) value of 20 for the very stiff to hard native soils.
- A pavement life of 20 years.
- A terminal serviceability (Pt) of 2 (i.e. poor pavement condition).
- A regional factor (R) of 3.0.
- Assumed total car trips of:
  - 10 cars per day for car parking (which equates to 2.2 daily equivalent single axle loads, ESALs)

- 60 cars per day for drive lanes (which equates to 13.4 daily equivalent single axle loads, ESALs)

The project Civil Engineer should review our assumptions to confirm they are appropriate for the anticipated traffic loading. See Tables 2 and 3 below for recommended pavement section thicknesses based on the above assumptions.

Table 2: Asphaltic Concrete - Recommended Minimum Thicknesses (inches)

Pavement Materials	Parking Areas	Drive Lanes
Asphaltic Concrete	2.5 inches	3 inches
Crushed Aggregate Base Course (less than 5% fines)	6 inches	6 inches

Table 3: Portland Cement Concrete - Recommended Minimum Thicknesses (inches)

Pavement Materials	Parking Areas	Drive Lanes
Portland Cement Concrete	6 inches	6 inches
Crushed Aggregate Base Course (less than 5% fines)	6 inches	6 inches

Asphaltic concrete materials should be compacted to at least 91 percent of the material's theoretical maximum density as determined in general accordance with ASTM D2041 (Rice Specific Gravity). The crushed aggregate base course should consist of well-graded crushed stone with a maximum particle size no greater than 2 inches. Aggregate base course materials should be free of organics or other deleterious materials, be relatively clean (i.e. less than 5 percent soil passing the U.S. #200 sieve), well graded, and have a liquid limit less than 45 and plasticity index less than 25. The base course should be moisture conditioned to within 2 percent of optimum and compacted to a minimum of 95 percent of ASTM D1557 as outlined in Section 3.3 of this report. When placed, the lift base course thickness should generally not exceed 12 inches prior to compacting. The type of compaction equipment used will ultimately determine the maximum lift thickness. In addition, we recommend that the structural fill be placed within +/- 2 percent of the optimum moisture for that material.

4.0 CONSTRUCTION CONSIDERATIONS

EEI should be retained to provide observation and testing of construction activities involved in the foundation, earthwork, and related activities of this project. EEI cannot accept any responsibility for any conditions that deviate from those described in this report, nor for the performance of the foundations if not engaged to also provide construction observation for this project.

4.1 Moisture Sensitive Soils/Weather Related Concerns

The soils encountered at this site are expected to be sensitive to disturbances caused by construction traffic and to changes in moisture content. During wet weather periods, increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. In addition, soils that become wet may be slow to dry and thus significantly retard the progress of grading and compaction activities. It will, therefore, be advantageous to perform earthwork and foundation construction activities during dry weather.

4.2 Drainage and Groundwater Considerations

Water should not be allowed to collect in the foundation excavations or on prepared subgrades for the floor sections during construction. Positive site drainage should be maintained throughout construction activities. Undercut or excavated areas should be sloped toward one corner to facilitate removal of any collected rainwater, groundwater, or surface runoff. If groundwater is encountered, a system of sumps and pumps may be required to keep footing excavations drained until the footing is placed to prevent softening of the subgrade soils.

A site grading plan should be developed to provide rapid drainage of surface water permanently away from the building areas and to inhibit infiltration of surface water around the perimeter of the building and beneath slabs. The grades should be sloped away from the building areas. Roof runoff should be piped (tightlined) away from the subdivision residences and commercial buildings. As discussed in Section 3.4, we recommend the foundations include footing drains on the exterior of the homes.

4.3 Excavations

In Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its “Construction Standards for Excavations, 29 CFR, part 1926, Subpart P”. This document and subsequent updates were issued to better insure the safety of workmen entering trenches or excavations. It is mandated by this federal regulation that excavations, whether they be utility trenches, basement excavations or footing excavations, be constructed in accordance with the new OSHA guidelines. It is our understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations.

We are providing this information solely as a service to our client. EEI does not assume responsibility for construction site safety or the contractor's compliance with local, state, and federal safety or other regulations.

5.0 REPORT LIMITATIONS

As is standard practice in the geotechnical industry, the conclusions contained in our report are considered preliminary because they are based on assumptions made about the soil, rock, and groundwater conditions exposed at the site during our subsurface investigation. A more complete extent of the actual subsurface conditions can only be identified when they are exposed during construction. Therefore, EEI should be retained as your consultant during construction to observe the actual conditions and to provide our final conclusions. If a different geotechnical consultant is retained to perform geotechnical inspection during construction, then they should be relied upon to provide final design conclusions and recommendations and should assume the role of geotechnical engineer of record, as is the typical procedure required by the governing jurisdiction.

The geotechnical recommendations presented in this report are based on the available project information, and the subsurface materials described in this report. If any of the noted information is incorrect, please inform EEI in writing so that we may amend the recommendations presented in this report, if appropriate, and if desired by the client. EEI will not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

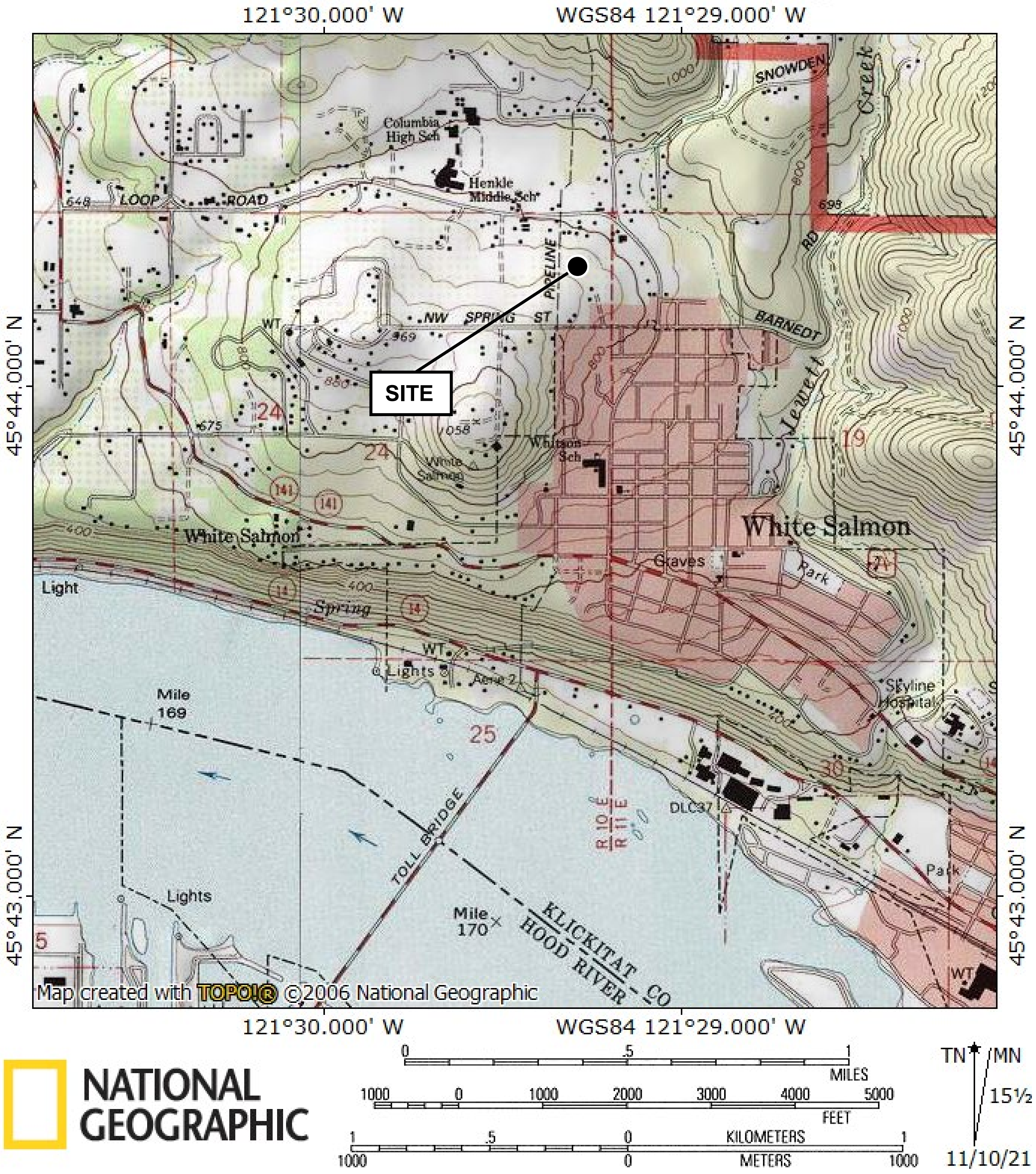
Once construction plans are finalized and a grading plan has been prepared, EEI should be retained to review those plans, and modify our existing recommendations related to the proposed construction, if determined to be necessary.

The Geotechnical Engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

This report has been prepared for the exclusive use of our client, Legacy Development Group for the proposed Spring Street Subdivision located on Klickitat County Tax Lot No. 0310247500400 off of Spring Street near the intersection with Northwest Cherry Hill Road in White Salmon, Klickitat County, Washington. EEI does not authorize the use of the advice herein nor the reliance upon the report by third parties without prior written authorization by EEI.

APPENDICES

APPENDIX A – SITE LOCATION PLAN



NATIONAL GEOGRAPHIC

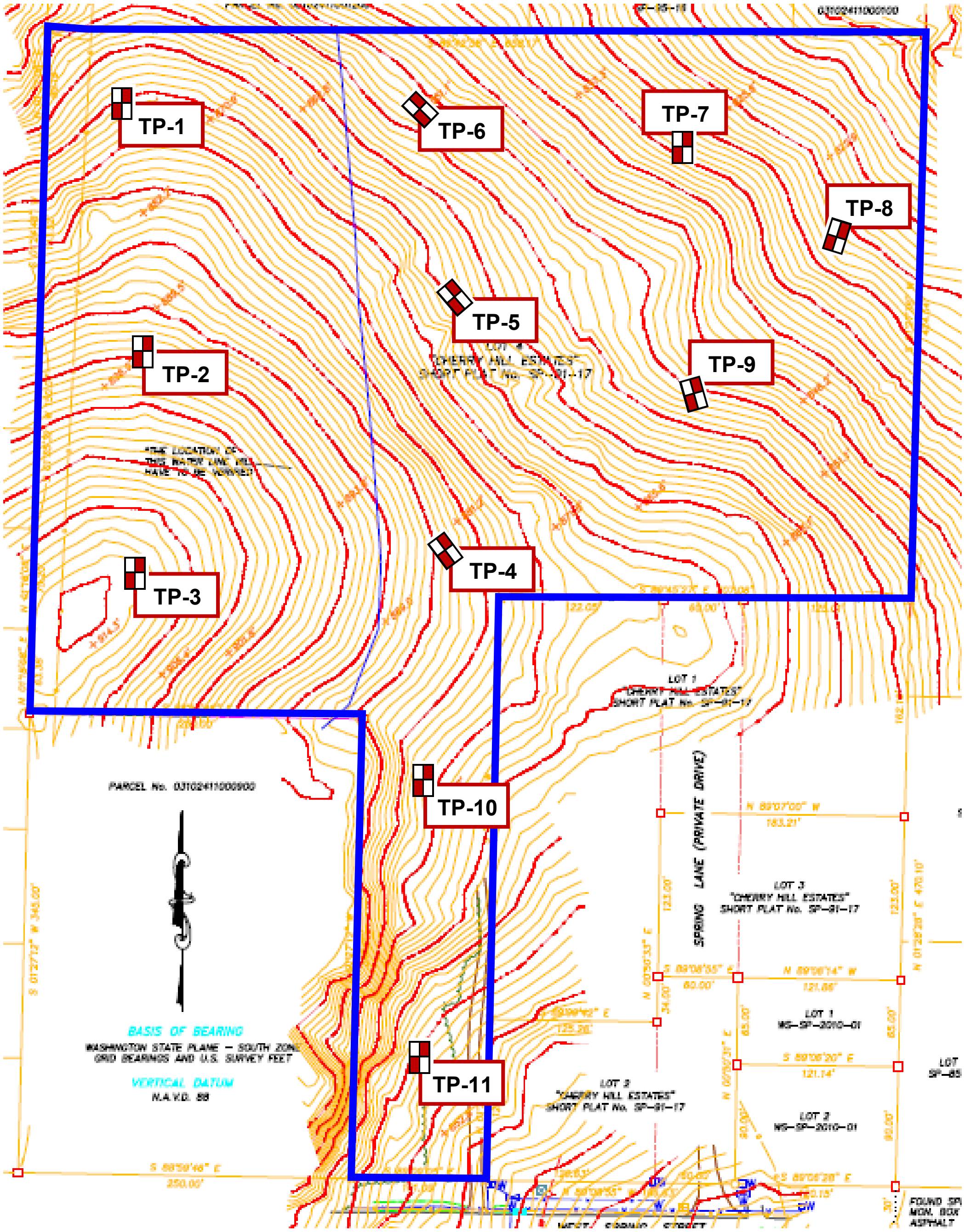
Earth Engineers, Inc.

Proposed Spring Street Subdivision
Klickitat County Tax Lot No. 0310247500400
Intersection of Northwest Spring Street
and Northwest Cherry Hill Road
White Salmon, Klickitat County, Washington

Report No.
21-071-1

November 15, 2021

APPENDIX B – SITE EXPLORATION PLAN



▨ = Approximate Test Pit Location

Base plan source: "Property Boundary Survey for Curtis Homes" prepared by Terra Surveying, dated December 2020.

Earth Engineers, Inc.	**Proposed Spring Street Subdivision** **Klickitat County Tax Lot No. 0310247500400** **Intersection of Northwest Spring Street** **and Northwest Cherry Hill Road** **White Salmon, Klickitat County, Washington**	**Report No.** **21-071-1** **November 15, 2021**

Earth Engineers, Inc.

Appendix C: Test Pit TP-1

Sheet 1 of 1

Client: Legacy Development Group
Project: Proposed Spring Street Subdivision
Site Address: Tax Lot No. 0310247500400
White Salmon, Klickitat County, Washington
Location of Exploration: See Appendix B
Logged By: Jacqui Boyer

Report Number: 21-071-1
Excavation Contractor: Legacy Development Group
Excavation Method: Excavator with 2 foot toothed bucket
Excavation Equipment: Takeuchi TB240
Approximate Ground Surface Elevation (ft msl): 875
Date of Exploration: October 15, 2021

		Lithology		Sampling Data								
Depth (ft)	Water Level	Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	Digging Effort	Drive Probe Blows Per 6 Inches 0 20 40 60	Pocket Pen. (tsf)	Moisture Content (%)	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Remarks
0			Topsoil - light brown sandy silt with rootlets, dry to moist (8-inches thick)		Mod.							
1			Fill - brown silt with few to little sand, rootlets, wood chips and charcoal pieces, dry, medium stiff to very stiff	GRAB 1			2.5	9	89			possible tilled soils
2			Silt (ML) - brown to reddish brown sandy silt with decomposed rock fragments (black to red) and few gravel, moist, very stiff to hard	GRAB 2				36	60			
3					Hard		4.5+					scraping on hard soil
4												
5												
			dark brown to red to orange to gray decomposed basalt encountered	GRAB 3				28	98			practical digging refusal on hard soil/decomposed rock
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												

Notes: Test pit terminated at a depth of approximately 6 feet bgs. Groundwater was not encountered at the time of the exploration. Test pit loosely backfilled with excavated soil on 10/15/2021. Approximate elevation interpolated from survey titled "Property Boundary Survey for Curtis Homes" prepared by Terra Surveying, dated December 2020.

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Appendix C: Test Pit TP-2

Sheet 1 of 1

Client: Legacy Development Group
Project: Proposed Spring Street Subdivision
Site Address: Tax Lot No. 0310247500400
White Salmon, Klickitat County, Washington
Location of Exploration: See Appendix B
Logged By: Jacqui Boyer

Report Number: 21-071-1
Excavation Contractor: Legacy Development Group
Excavation Method: Excavator with 2 foot toothed bucket
Excavation Equipment: Takeuchi TB240
Approximate Ground Surface Elevation (ft msl): 895
Date of Exploration: October 15, 2021

		Lithology		Sampling Data								
Depth (ft)	Water Level	Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	Digging Effort	Drive Probe Blows Per 6 Inches 0 20 40 60	Pocket Pen. (tsf)	Moisture Content (%)	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Remarks
0		▨	Topsoil - light brown sandy silt with rootlets, dry to moist (10-inches thick)		Easy							
1		▨	Fill - light brown sandy silt with rootlets, wood chips and charcoal pieces, dry, medium stiff to very stiff									possible tilled soils
2		▨	Silt (ML) - orange-brown to reddish brown sandy silt with decomposed rock fragments (black to red), moist, very stiff to hard	GRAB 1	Mod.		4.5+	50				
3												
4				GRAB 2				24				
5												
6			dark brown to red to orange to gray decomposed basalt encountered	GRAB 3	Hard			36				
7												practical digging refusal on hard soil/decomposed rock
8												

9
10
11
12
13
14
15

Notes: Test pit terminated at a depth of approximately 8 feet bgs. Groundwater was not encountered at the time of the exploration. Test pit loosely backfilled with excavated soil on 10/15/2021. Approximate elevation interpolated from survey titled "Property Boundary Survey for Curtis Homes" prepared by Terra Surveying, dated December 2020.

Earth Engineers, Inc.

Appendix C: Test Pit TP-3

Sheet 1 of 1

Client: Legacy Development Group
Project: Proposed Spring Street Subdivision
Site Address: Tax Lot No. 0310247500400
White Salmon, Klickitat County, Washington
Location of Exploration: See Appendix B
Logged By: Jacqui Boyer

Report Number: 21-071-1
Excavation Contractor: Legacy Development Group
Excavation Method: Excavator with 2 foot toothed bucket
Excavation Equipment: Takeuchi TB240
Approximate Ground Surface Elevation (ft msl): 914
Date of Exploration: October 15, 2021

		Lithology		Sampling Data								
Depth (ft)	Water Level	Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	Digging Effort	Drive Probe Blows Per 6 Inches (0 20 40 60)	Pocket Pen. (tsf)	Moisture Content (%)	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Remarks
0			Topsoil - light brown sandy silt with rootlets, dry to moist (12-inches thick)		Mod.							
1			Fill - light brown sandy silt with rootlets, wood chips and charcoal pieces, dry, medium stiff to very stiff	GRAB 1				10				possible tilled soils
2												
3												
			Silt (ML) - brown silt with few sand and gravel, decomposed rock fragments (black to red), moist, very stiff to hard	GRAB 2				15	94			
4					Hard							
				GRAB 3				15				
5			dark brown to red to orange to white decomposed basalt encountered									
				GRAB 4				19	95			
6												practical digging refusal on hard soil/decomposed rock
7												
8												
9												
10												
11												
12												
13												
14												
15												

Notes: Test pit terminated at a depth of approximately 7 feet bgs. Groundwater was not encountered at the time of the exploration. Test pit loosely backfilled with excavated soil on 10/15/2021. Approximate elevation interpolated from survey titled "Property Boundary Survey for Curtis Homes" prepared by Terra Surveying, dated December 2020.

Earth Engineers, Inc.

Appendix C: Test Pit TP-4

Sheet 1 of 1

Client: Legacy Development Group
Project: Proposed Spring Street Subdivision
Site Address: Tax Lot No. 0310247500400
White Salmon, Klickitat County, Washington
Location of Exploration: See Appendix B
Logged By: Jacqui Boyer

Report Number: 21-071-1
Excavation Contractor: Legacy Development Group
Excavation Method: Excavator with 2 foot toothed bucket
Excavation Equipment: Takeuchi TB240
Approximate Ground Surface Elevation (ft msl): 884
Date of Exploration: October 15, 2021

		Lithology		Sampling Data								
Depth (ft)	Water Level	Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	Digging Effort	Drive Probe Blows Per 6 Inches 0 20 40 60	Pocket Pen. (tsf)	Moisture Content (%)	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Remarks
0			Topsoil - light brown sandy silt with rootlets, dry to moist (6-inches thick)		Easy							
			Fill - light brown sandy silt with rootlets, wood chips and charcoal pieces, dry, medium stiff to very stiff		Mod.							possible tilled soils
1												
2												
3			Silt (ML) - reddish brown sandy silt with decomposed rock fragments (black to red), moist, very stiff to hard									
4				GRAB 1	Hard			41				
5												
				GRAB 2				43				
6												
7				GRAB 3				44				practical digging refusal on consolidated soil
8												
9												
10												
11												
12												
13												
14												
15												

Notes: Test pit terminated at a depth of approximately 8 feet bgs. Groundwater was not encountered at the time of the exploration. Test pit loosely backfilled with excavated soil on 10/15/2021. Approximate elevation interpolated from survey titled "Property Boundary Survey for Curtis Homes" prepared by Terra Surveying, dated December 2020.

Earth Engineers, Inc.

Appendix C: Test Pit TP-5

Sheet 1 of 1

Client: Legacy Development Group
Project: Proposed Spring Street Subdivision
Site Address: Tax Lot No. 0310247500400
White Salmon, Klickitat County, Washington
Location of Exploration: See Appendix B
Logged By: Jacqui Boyer

Report Number: 21-071-1
Excavation Contractor: Legacy Development Group
Excavation Method: Excavator with 2 foot toothed bucket
Excavation Equipment: Takeuchi TB240
Approximate Ground Surface Elevation (ft msl): 870
Date of Exploration: October 15, 2021

		Lithology		Sampling Data								
Depth (ft)	Water Level	Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	Digging Effort	Drive Probe Blows Per 6 Inches (0 20 40 60)	Pocket Pen. (tsf)	Moisture Content (%)	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Remarks
0			Topsoil - light brown sandy silt with rootlets, dry to moist (6-inches thick)		Easy	5						
			Fill - brown sandy silt with rootlets, wood chips and charcoal pieces, dry, medium stiff to hard			5						possible tilled soils
1						12						
						10						
2						12						
						16						
3					Mod.	39						
						32						
4			Silt (ML) - reddish brown sandy silt with decomposed rock fragments (black to red), moist, hard			47						
						50						drive probe refusal at 5-inches
5				GRAB 1				39				
6												
7					Hard							
				GRAB 2				44				
8												
												practical refusal due to excavator reach
9												

10
11
12
13
14
15

Notes: Test pit terminated at a depth of approximately 9 feet bgs. Drive probe terminated at a depth of approximately 5 feet bgs. Groundwater was not encountered at the time of the exploration. Test pit loosely backfilled with excavated soil on 10/15/2021. Approximate elevation interpolated from survey titled "Property Boundary Survey for Curtis Homes" prepared by Terra Surveying, dated December 2020.

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Appendix C: Test Pit TP-6

Sheet 1 of 1

Client: Legacy Development Group
Project: Proposed Spring Street Subdivision
Site Address: Tax Lot No. 0310247500400
White Salmon, Klickitat County, Washington
Location of Exploration: See Appendix B
Logged By: Jacqui Boyer

Report Number: 21-071-1
Excavation Contractor: Legacy Development Group
Excavation Method: Excavator with 2 foot toothed bucket
Excavation Equipment: Takeuchi TB240
Approximate Ground Surface Elevation (ft msl): 857
Date of Exploration: October 15, 2021

Depth (ft)	Water Level	Lithology		Sampling Data								
		Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	Digging Effort	Drive Probe Blows Per 6 Inches 0 20 40 60	Pocket Pen. (tsf)	Moisture Content (%)	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Remarks
0			Topsoil - light brown sandy silt with rootlets, dry to moist (6-inches thick)		Easy							
			Fill - brown silty sand with rootlets, wood chips and broken rock pieces, dry, medium dense to very dense									possible tilled soils
1												
2												
3					Mod.							
			boulder encountered	GRAB 1				12	39			practical digging refusal on boulder
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												

Notes: Test pit terminated at a depth of approximately 4 feet bgs. Groundwater was not encountered at the time of the exploration. Test pit loosely backfilled with excavated soil on 10/15/2021. Approximate elevation interpolated from survey titled "Property Boundary Survey for Curtis Homes" prepared by Terra Surveying, dated December 2020.

Earth Engineers, Inc.

Appendix C: Test Pit TP-7

Sheet 1 of 1

Client: Legacy Development Group
Project: Proposed Spring Street Subdivision
Site Address: Tax Lot No. 0310247500400
White Salmon, Klickitat County, Washington
Location of Exploration: See Appendix B
Logged By: Jacqui Boyer

Report Number: 21-071-1
Excavation Contractor: Legacy Development Group
Excavation Method: Excavator with 2 foot toothed bucket
Excavation Equipment: Takeuchi TB240
Approximate Ground Surface Elevation (ft msl): 840
Date of Exploration: October 15, 2021

Depth (ft)	Water Level	Lithology		Sampling Data								
		Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	Digging Effort	Drive Probe Blows Per 6 Inches (0 20 40 60)	Pocket Pen. (tsf)	Moisture Content (%)	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Remarks
0			Topsoil - light brown sandy silt with rootlets, dry to moist (8-inches thick)		Easy							
1			Fill - light brown sandy silt with rootlets, wood chips and charcoal pieces, dry, medium stiff to very stiff white plastic debris encountered (abandoned pipe)									possible tilled soils
2												
3			Silt (ML) - orange-brown to reddish brown sandy silt with decomposed rock fragments (black to red), moist, very stiff to hard		Mod.							
4				GRAB 1				41				
5					Hard							practical digging refusal on hard soil/decomposed rock
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												

Notes: Test pit terminated at a depth of approximately 6 feet bgs. Groundwater was not encountered at the time of the exploration. Test pit loosely backfilled with excavated soil on 10/15/2021. Approximate elevation interpolated from survey titled "Property Boundary Survey for Curtis Homes” prepared by Terra Surveying, dated December 2020.

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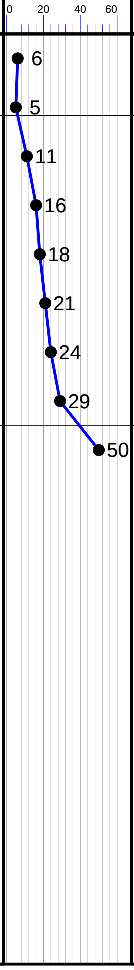
Appendix C: Test Pit TP-8

Sheet 1 of 1

Client: Legacy Development Group
Project: Proposed Spring Street Subdivision
Site Address: Tax Lot No. 0310247500400
White Salmon, Klickitat County, Washington
Location of Exploration: See Appendix B
Logged By: Jacqui Boyer

Report Number: 21-071-1
Excavation Contractor: Legacy Development Group
Excavation Method: Excavator with 2 foot toothed bucket
Excavation Equipment: Takeuchi TB240
Approximate Ground Surface Elevation (ft msl): 833
Date of Exploration: October 15, 2021



		Lithology		Sampling Data								
Depth (ft)	Water Level	Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	Digging Effort	Drive Probe Blows Per 6 Inches (0 20 40 60)	Pocket Pen. (tsf)	Moisture Content (%)	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Remarks
0			Topsoil - light brown sandy silt with rootlets, dry to moist (10-inches thick)		Easy	6 5						
1			Fill - light brown sandy silt with rootlets, wood chips and charcoal pieces, dry, medium stiff to very stiff	GRAB 1		11 16		12				possible tilled soils
2						18 21						
3						24 29						
4			Silt (ML) - light brown to brown silt with few sand, decomposed rock fragments (black to red), moist, very stiff to hard		Mod.	50						drive probe refusal at 2-inches
5				GRAB 2				24	91			
6					Hard							
7												
8												
9			weathered rock fragments encountered	GRAB 3				24				practical refusal due to excavator reach
10												
11												
12												
13												
14												
15												

Notes: Test pit terminated at a depth of approximately 9.5 feet bgs. Drive probe terminated at a depth of approximately 4.5 feet bgs. Groundwater was not encountered at the time of the exploration. Test pit loosely backfilled with excavated soil on 10/15/2021. Approximate elevation interpolated from survey titled "Property Boundary Survey for Curtis Homes" prepared by Terra Surveying, dated December 2020.

Earth Engineers, Inc.

Appendix C: Test Pit TP-9

Sheet 1 of 1

Client: Legacy Development Group
Project: Proposed Spring Street Subdivision
Site Address: Tax Lot No. 0310247500400
White Salmon, Klickitat County, Washington
Location of Exploration: See Appendix B
Logged By: Jacqui Boyer

Report Number: 21-071-1
Excavation Contractor: Legacy Development Group
Excavation Method: Excavator with 2 foot toothed bucket
Excavation Equipment: Takeuchi TB240
Approximate Ground Surface Elevation (ft msl): 859
Date of Exploration: October 15, 2021

Depth (ft)	Water Level	Lithology Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sampling Data Sample Number	Digging Effort	Drive Probe Blows Per 6 Inches 0 20 40 60	Pocket Pen. (tsf)	Moisture Content (%)	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Remarks
0			Topsoil - light brown sandy silt with rootlets, dry to moist (8-inches thick)		Easy							
1			Fill - light brown sandy silt with rootlets, wood chips and charcoal pieces, dry to moist, medium stiff to very stiff									possible tilled soils
2					Mod.							
3			Silt (ML) - brown to dark brown silt with few sand, decomposed rock fragments (black to red), moist, very stiff to hard									
4				GRAB 1				44				
5				GRAB 2	Hard			44				practical digging refusal on hard soil/decomposed rock
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												

Notes: Test pit terminated at a depth of approximately 5.5 feet bgs. Groundwater was not encountered at the time of the exploration. Test pit loosely backfilled with excavated soil on 10/15/2021. Approximate elevation interpolated from survey titled "Property Boundary Survey for Curtis Homes" prepared by Terra Surveying, dated December 2020.

Earth Engineers, Inc.

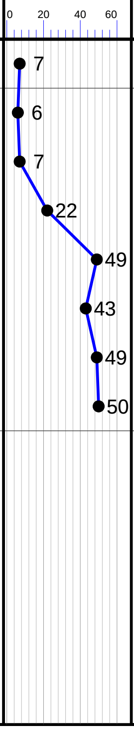
Appendix C: Test Pit TP-10

Sheet 1 of 1

Client: Legacy Development Group
Project: Proposed Spring Street Subdivision
Site Address: Tax Lot No. 0310247500400
White Salmon, Klickitat County, Washington
Location of Exploration: See Appendix B
Logged By: Jacqui Boyer

Report Number: 21-071-1
Excavation Contractor: Legacy Development Group
Excavation Method: Excavator with 2 foot toothed bucket
Excavation Equipment: Takeuchi TB240
Approximate Ground Surface Elevation (ft msl): 876
Date of Exploration: October 15, 2021

		Lithology		Sampling Data								
Depth (ft)	Water Level	Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	Digging Effort	Drive Probe Blows Per 6 Inches	Pocket Pen. (tsf)	Moisture Content (%)	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Remarks
0			Topsoil - light brown sandy silt with rootlets, dry to moist (6-inches thick)		Easy	7						
			Fill - light brown sandy silt with rootlets, wood chips and charcoal pieces, dry to moist, medium stiff to hard			6						possible tilled soils
1						7						
			metal debris and wood debris encountered			22						
2			4-inch thick tree root encountered			49						
						43						
3						49						
						50						drive probe refusal at 3-inches
4			Silt (ML) - gray-brown to dark brown silt with few to little sand and gravel, decomposed rock fragments (black to red), moist, hard		Mod.							
5				GRAB 1				29	90			
6					Hard							
7												
8												
9												
10												
11												
12												
13												
14												
15												



Notes: Test pit terminated at a depth of approximately 7 feet bgs. Drive probe terminated at a depth of approximately 4 feet bgs. Groundwater was not encountered at the time of the exploration. Test pit loosely backfilled with excavated soil on 10/15/2021. Approximate elevation interpolated from survey titled "Property Boundary Survey for Curtis Homes" prepared by Terra Surveying, dated December 2020.

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Appendix C: Test Pit TP-11

Sheet 1 of 1

Client: Legacy Development Group	Report Number: 21-071-1
Project: Proposed Spring Street Subdivision	Excavation Contractor: Legacy Development Group
Site Address: Tax Lot No. 0310247500400	Excavation Method: Excavator with 2 foot toothed bucket
White Salmon, Klickitat County, Washington	Excavation Equipment: Takeuchi TB240
Location of Exploration: See Appendix B	Approximate Ground Surface Elevation (ft msl): 860
Logged By: Jacqui Boyer	Date of Exploration: October 15, 2021

		Lithology		Sampling Data								
Depth (ft)	Water Level	Lithologic Symbol	Geologic Description of Soil and Rock Strata	Sample Number	Digging Effort	Drive Probe Blows Per 6 Inches 0 20 40 60	Pocket Pen. (tsf)	Moisture Content (%)	% Passing #200 Sieve	Liquid Limit	Plastic Limit	Remarks
0			Topsoil - light brown sandy silt with rootlets, dry to moist (8-inches thick)		Easy							
1 2 3			Fill - light brown sandy silt with rootlets, wood chips and charcoal pieces, dry to moist, medium stiff to very stiff	GRAB 1	Mod.			9				possible tilled soils
4			Silt (ML) - red to brown sandy silt with decomposed rock fragments (black to red), dry to moist, very stiff to hard	GRAB 2	Hard			8	81			practical digging refusal on hard soil/decomposed rock
5 6 7 8 9 10 11 12 13 14 15												

Notes: Test pit terminated at a depth of approximately 5 feet bgs. Groundwater was not encountered at the time of the exploration. Test pit loosely backfilled with excavated soil on 10/15/2021. Approximate elevation interpolated from survey titled "Property Boundary Survey for Curtis Homes” prepared by Terra Surveying, dated December 2020.

APPENDIX D: SOIL CLASSIFICATION LEGEND

APPARENT CONSISTENCY OF COHESIVE SOILS (PECK, HANSON & THORNBURN 1974, AASHTO 1988)

Descriptor	SPT N_{60} (blows/foot)*	Pocket Penetrometer, Qp (tsf)	Torvane (tsf)	Field Approximation
Very Soft	< 2	< 0.25	< 0.12	Easily penetrated several inches by fist
Soft	2 – 4	0.25 – 0.50	0.12 – 0.25	Easily penetrated several inches by thumb
Medium Stiff	5 – 8	0.50 – 1.0	0.25 – 0.50	Penetrated several inches by thumb w/moderate effort
Stiff	9 – 15	1.0 – 2.0	0.50 – 1.0	Readily indented by thumbnail
Very Stiff	16 – 30	2.0 – 4.0	1.0 – 2.0	Indented by thumb but penetrated only with great effort
Hard	> 30	> 4.0	> 2.0	Indented by thumbnail with difficulty

* Using SPT N_{60} is considered a crude approximation for cohesive soils.

APPARENT DENSITY OF COHESIONLESS SOILS (AASHTO 1988)

Descriptor	SPT N_{60} Value (blows/foot)
Very Loose	0 – 4
Loose	5 – 10
Medium Dense	11 – 30
Dense	31 – 50
Very Dense	> 50

MOISTURE (ASTM D2488-06)

Descriptor	Criteria
Dry	Absence of moisture, dusty, dry to the touch, well below optimum moisture content (per ASTM D698 or D1557)
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table, well above optimum moisture content (per ASTM D698 or D1557)

PERCENT OR PROPORTION OF SOILS (ASTM D2488-06)

Descriptor	Criteria
Trace	Particles are present but estimated < 5%
Few	5 – 10%
Little	15 – 25%
Some	30 – 45%
Mostly	50 – 100%
Percentages are estimated to nearest 5% in the field. Use "about" unless percentages are based on laboratory testing.	

SOIL PARTICLE SIZE (ASTM D2488-06)

Descriptor	Size
Boulder	> 12 inches
Cobble	3 to 12 inches
Gravel - Coarse Fine	¾ inch to 3 inches No. 4 sieve to ¾ inch
Sand - Coarse Medium Fine	No. 10 to No. 4 sieve (4.75mm) No. 40 to No. 10 sieve (2mm) No. 200 to No. 40 sieve (.425mm)
Silt and Clay ("fines")	Passing No. 200 sieve (0.075mm)

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D2488)

Major Division			Group Symbol	Description
Coarse Grained Soils (more than 50% retained on #200 sieve)	**Gravel** (50% or more retained on No. 4 sieve)	Clean Gravel	GW	Well-graded gravels and gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
		Gravel with fines	GM	Silty gravels and gravel-sand-silt mixtures
			GC	Clayey gravels and gravel-sand-clay mixtures
	Sand (> 50% passing No. 4 sieve)	Clean sand	SW	Well-graded sands and gravelly sands, little or no fines
			SP	Poorly-graded sands and gravelly sands, little or no fines
		Sand with fines	SM	Silty sands and sand-silt mixtures
			SC	Clayey sands and sand-clay mixtures
Fine Grained Soils (50% or more passing #200 sieve)	**Silt and Clay** (liquid limit < 50)		ML	Inorganic silts, rock flour and clayey silts
			CL	Inorganic clays of low-medium plasticity, gravelly, sandy & lean clays
			OL	Organic silts and organic silty clays of low plasticity
	Silt and Clay (liquid limit > 50)		MH	Inorganic silts and clayey silts
			CH	Inorganic clays or high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
Highly Organic Soils			PT	Peat, muck and other highly organic soils

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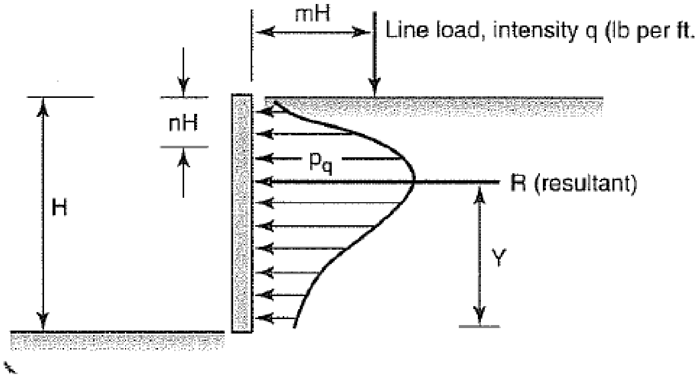
GRAPHIC SYMBOL LEGEND

GRAB	☒	Grab sample
SPT	■	Standard Penetration Test (2" OD), ASTM D1586
ST	▨	Shelby Tube, ASTM D1587 (pushed)
DM	▤	Dames and Moore ring sampler (3.25" OD and 140-pound hammer)
CORE	▥	Rock coring

APPENDIX E: SURCHARGE-INDUCED LATERAL EARTH PRESSURES FOR WALL DESIGN

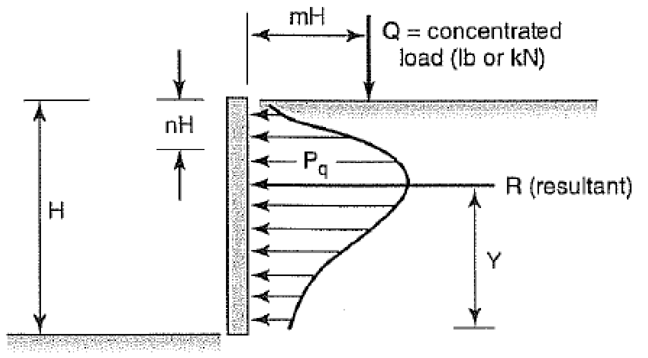
LINE LOAD (applicable for retaining walls not exceeding 20 feet in height):



m	R	Y
0.2	0.55q	0.60 H
0.4	0.55q	0.58 H
0.6	$\frac{0.64q}{m^2+1}$	0.52 H

Figure 16-28 Pressure distribution against vertical wall resulting from line load of intensity *q*.

CONCENTRATED POINT LOAD (applicable for retaining walls not exceeding 20 feet in height):



m	R	Y
0.2	$0.78\frac{Q}{H}$	0.59 H
0.4	$0.78\frac{Q}{H}$	0.59 H
0.6	$0.48\frac{Q}{H}$	0.48 H

Figure 16-27 Pressure distribution against vertical wall resulting from point load, *Q*.

AREAL LOAD:

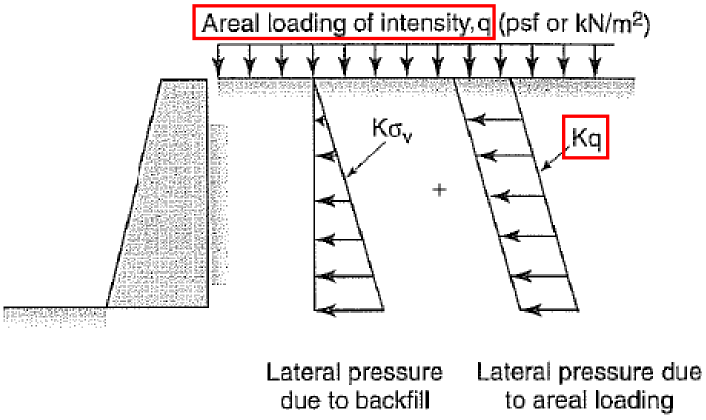
Figure 16-26 Influence of areal loading on wall pressures.

use K=0.4 for active condition (i.e. top of wall allowed to deflect laterally)

use K=0.9 for at-rest condition (i.e. top of wall not allowed to deflect laterally)

Resultant, R = K * q * H

Where H = wall height (feet)



Source of Figures: McCarthy, D.F., 1998, "Essentials of Soil Mechanics and foundations, Basic Geotechnics, Fifth Edition."

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Proposed Spring Street Subdivision
Klickitat County Tax Lot No. 0310247500400
Intersection of Northwest Spring Street
and Northwest Cherry Hill Road
White Salmon, Klickitat County, Washington

Report No. 20-071-1

November 15, 2021