HARDMAN GEOTECHNICAL SERVICES INC.
Practical, Cost-Effective Geotechnical Solutions

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Subject: **GEOTECHNICAL ENGINEERING REPORT**
SOUTH COOPER MOUNTAIN
SW SCHOLLS FERRY ROAD AND SW 175TH AVENUE / ROY ROGERS ROAD
BEAVERTON, OREGON

This report presents the results of a geotechnical engineering study conducted by Hardman Geotechnical Services Inc. (HGSI) for the above referenced project (herein referred to as the "site"). The purpose of this study was to evaluate subsurface conditions at the site and to provide geotechnical recommendations for site grading, foundation design, and construction.

This report compiles all geotechnical explorations, analyses, conclusions and recommendations from previous reports prepared under the supervision of the writer. This report completely replaces the previous reports covering South Cooper Mountain site area (GeoPacific, 2013; GeoPacific, 2014). Information from these previous reports is used with permission of the owner.

SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The site is irregularly shaped, roughly 100 acres, and located in the northeast quadrant of the intersection of SW Scholls Ferry Road and SW 175th Avenue / Roy Rogers Road in Beaverton, Oregon (Figure 1). Topography is predominantly gently to moderately sloping to the south with grades of about 2 to 20 percent in the areas to be developed. A steep slope area with inclinations up to about 31% is present in the north-central portion of the site, in an area outside the proposed development (Figure 2B). Maximum elevation is about 470 feet above mean sea level (MSL) in the north-central portion of the site. The southeast corner of the property is at the lowest elevation, about The western portion of the site is a cultivated field currently in clover. The eastern portion of the site was recently logged and currently is vegetated with grass, weeds, brush and a few trees. The site is currently undeveloped and to our knowledge there are no existing structures.

The current preliminary grading plan for South Cooper Mountain shows 374 lots for multi- and single-family homes, new private streets and associated underground utilities (Figures 2A through 2F). Phase 5 is a large area that will be mass graded, presumably for commercial or multi-family residential construction. Maximum fill height / cut depth will be about 15 feet. Retaining walls up to about 8 feet high are shown at various locations on the preliminary grading plans.

Planned streets will cross existing drainages in at least two locations. At these locations we understand open-bottom culverts, box culverts or other crossing structures will be constructed. Retaining walls may also be needed as wing walls at the ends of the culverts to reduce the amount of fill required within existing drainages.

REGIONAL AND LOCAL GEOLOGIC SETTING

Regionally, the subject site lies within the Willamette Valley/Puget Sound lowland, a broad structural depression situated between the Coast Range on the west and the Cascade Range on the east. A series of discontinuous faults subdivide the Willamette Valley into a mosaic of fault-bounded, structural blocks (Yeats et al., 1996). Uplifted structural blocks form bedrock highlands, while down-warped structural blocks form sedimentary basins.

The subject site is underlain by Quaternary age (last 1.6 million years) loess, a windblown silt deposit that mantles older deposits, basalt bedrock, and elevated areas in the Portland region (Beeson et al., 1989; Madin, 1990). The loess generally consists of massive silt deposited following repeated catastrophic flooding events in the Willamette Valley, the last of which occurred about 10,000 years ago. In localized areas, the loess includes buried paleosols that developed between depositional events. Regionally, the total thickness of loess ranges from 5 feet to greater than 100 feet.

Published regional geologic mapping indicates that the subject site is underlain by the Boring Lava lithologic unit which consists of basaltic and basaltic andesite lava flows erupted from a series of local volcanic vents during Plio-Pleistocene time (about 600,000 thousand to 2.6 million years ago) (Madin, 1990). The total thickness of the Boring Lava unit ranges from greater than 600 feet near vents to less than 50 feet on the outer margins.

At least three major source zones capable of generating damaging earthquakes are thought to exist in the vicinity of the subject site. These include the Portland Hills Fault Zone, the Gales Creek-Newberg-Mt. Angel Structural Zone, and the Cascadia Subduction Zone. These potential source zones have been accounted for in seismic design parameters dictated by the current building code, as presented in the *Seismic Design* section below. None of these potential source zones are located on the subject site.

FIELD EXPLORATION

Backhoe test pits and hand auger borings were performed on various portions of the site as reported in previous geotechnical studies (GeoPacific; 2013, 2014). Test pits TP-1 through TP-9 and hand auger borings HA-8 through HA-15 were excavated in August 14 and September 5, 2013 in the western portion of the site (Figures 2A through 2F). As reported in GeoPacific (2013), these test pits extended to depths ranging from 3.5 to 8 feet bgs, and hand auger borings were drilled to depth of 4.5 to 5 feet bgs. Test pits TP-1 through TP-20 from GeoPacific (2014) were excavated on the Dyches Property in the eastern portion of the site on May 12 and 13, 2014 [test pit logs erroneously indicate 2013]. These test pits extended to depths ranging from about 6.5 to 11.5 feet bgs.

Test pit and hand auger boring locations are shown approximately on Figures 2A and 2F, with different colors used to differentiate between test pits of the same number from different previous reports. It should be noted that exploration locations were determined in the field by pacing or taping distances from apparent property corners and other site features shown on the plans provided. As such, the locations of the explorations should be considered approximate.

At the completion of the test pit logging, the test pits were backfilled with the excavated spoils and tamped with the backhoe bucket. This backfill should not be expected to behave as compacted structural fill and some minor settling of the ground surface may occur.

Explorations were conducted under the full-time observation of geotechnical personnel. Soil samples were classified in the field and representative portions were placed in relatively air-tight plastic bags. These soil samples were then returned to the laboratory for further examination and laboratory testing. Pertinent information including soil sample depths, stratigraphy, soil engineering characteristics, and groundwater occurrence was recorded. Soils were classified in general accordance with the Unified Soil Classification System.

Summary test pit logs are attached. The stratigraphic contacts shown on the individual logs represent the approximate boundaries between soil types. The actual transitions may be more gradual. The soil and groundwater conditions depicted are only for the specific dates and locations reported, and therefore, are not necessarily representative of other locations and times.

SUBSURFACE CONDITIONS

The following discussion is a summary of subsurface conditions encountered in the explorations. For more detailed information regarding subsurface conditions at specific exploration locations, refer to the attached test pit logs. Also, please note that subsurface conditions can vary between exploration locations, as discussed in the *Uncertainty and Limitations* section below.

Soils and Rock

On-site soils are anticipated to consist of topsoil, Willamette Formation silt, residual soil, and weathered basalt bedrock as described below.

Undocumented Fill – Undocumented fill was not encountered in explorations conducted for this study. However, there is a potential for old fill to be encountered on site, in areas beyond the locations of our test pits.

Topsoil – In all test pits and hand auger borings, the ground surface was directly underlain by a topsoil horizon. In the cultivated field area the topsoil was comprised of a tilled zone. These soils generally consisted of brown, highly to moderately organic silt. Native topsoil deposits generally ranged from about 8 to 12 inches thick; the tilled zone extended to depths of about 12 to 24 inches below the ground surface (bgs).

Willamette Formation – Underlying the topsoil horizon in all test pits and borings on the west side of the site (GeoPacific, 2013); and test pits TP-1 through TP-3 and TP-6 through TP-20 on the east side of the site (GeoPacific, 2014), we encountered silt belonging to the Willamette Formation. These soils were typically stiff to very stiff, light brown, clayey silt with subtle to strong orange and gray mottling. Soil belonging to the Willamette Formation extended to depths of about 2 to 8.5 feet bgs.

Residual Soil – Directly underlying the topsoil horizon in test pits TP-4 and TP-5 and underlying the Willamette Formation in test pits TP-1 through TP-3 and TP-6 through TP-20 the explorations on the east side of the site (GeoPacific, 2014) encountered residual soil derived from in-place weathering of the underlying Columbia River Basalt Formation. On the west side of the site (GeoPacific, 2013), residual soils were encountered in TP-2 through TP-7. These soils were typically very stiff, light

reddish-brown clayey silt to silty clay with weathered basalt fragments and subtle to strong orange and gray mottling.

Weathered Basalt Bedrock (Columbia River Basalt Formation) – Underlying the residual soil in test pits TP-3 through TP-5, TP-8 through TP-11, TP-13, TP-15, and TP-16 we encountered weathered basalt bedrock belonging to the Columbia River Basalt Formation (east side of site; GeoPacific, 2014). On the west side of the site weathered basalt bedrock was encountered in TP-2 and TP-3 (GeoPacific, 2013). The basalt was extremely soft (R0) to soft (R2) and contained trace light reddish-brown clayey silt to silty clay matrix. Practical refusal with a medium sized excavator was encountered on medium hard (R3) basalt in several of the test pits as summarized below.

Table 1. Locations and Depths of Refusal on Medium Hard (R3) Basalt

Previous Report	Test Pit	Depth to top of Weathered Basalt (feet)	Depth of Refusal with Medium Sized Excavator (feet)
GeoPacific (2013)	TP-2	4	5.75
	TP-3	3	3.5
GeoPacific (2014)	TP-8	4.5	6.5
	TP-9	5	8
	TP-15	8	8.5

Other locations of hard rock may be present on site beyond the depths and locations of the borings and test pits performed to date. Also, please note that a larger excavator would likely have met refusal at greater depths than those indicated in Table 1.

Groundwater

During the field exploration, groundwater seepage was encountered in test pits TP-2, TP-6, TP-14, and TP-16 through TP-20 on the east side of the site (GeoPacific, 2014) at depths of 4 to 11.5 feet. On the west side of the site (GeoPacific, 2013, groundwater seepage was encountered only in TP-7 at a depth of about 8 feet. Discharge was visually estimated at ¼ to 2 gallons per minute. Perched groundwater conditions often occur over fine-grained native deposits such as those beneath the site, particularly during the wet season. It is anticipated that groundwater conditions will vary depending on the season, local subsurface conditions, changes in site utilization, and other factors.

SLOPE STABILITY AND CWS SLOPE SETBACK

Natural site grades within the limits of proposed development generally range between about 3 and 20 percent. Slopes in the north-central portion of the site, outside the area to be developed, are as steep as about 31 percent. Regional geologic mapping and the Oregon Department of Geology and Mineral Industries online landslide database (SLIDO) show no mapped landslides on or in the vicinity of the subject site (Madin, 1990; Oregon DOGAMI, 2014).

Based on results of this study it is our opinion that on-site slopes in the vicinity of the proposed homes have adequate factors of safety considering gross (overall) stability. Construction of the proposed homes should not impact slope stability. We recommend that surface runoff be collected and water discharged to the storm drain system. In no case should uncontrolled stormwater runoff be allowed to flow over slopes. It should be noted that this evaluation is based on limited observation of surficial features, the subsurface explorations

performed and review of available geologic literature. Deep subsurface explorations and quantification of slope stability factors of safety using numerical methods were beyond the scope of this study.

Clean Water Services (CWS) allows a 15-foot minimum slope setback, with a geotechnical engineer's review. Based on information available at present, it is our opinion that a 15-foot setback is adequate for development on the South Cooper Mountain site.

CONCLUSIONS AND RECOMMENDATIONS

Results of this study indicate that the proposed development is geotechnically feasible provided that the recommendations of this report are incorporated in the design and construction phases of the project. The following report sections present conclusions and recommendations regarding site preparation, engineered fill and rock fills, fill slope keying and benching, wet weather earthwork, structural foundations, footing drains, drainage crossing culverts, seismic design, excavating conditions and trench backfill, pavement sections, and erosion control considerations. The recommendations of this report assume that the structures will have raised floors and crawlspaces. If structures are planned with basements or concrete slab-on-grade floors, HGSI should be contacted for additional recommendations regarding basement retaining wall design and drainage, concrete floor slabs and moisture protection, or other issues.

Site Preparation and Undocumented Fill Removal

Proposed areas to receive engineered fill should first be cleared of vegetation and any loose debris or undocumented fill (if encountered), and debris from clearing should be removed from the site. Organic-rich topsoil should be stripped to the relatively inorganic native soils. We anticipate that the depth of stripping will be an average of roughly 8 to 12 inches over most of the site. Deeper stripping will be needed in areas that have abundant root balls (where dense trees are present), been tilled in the past, or areas of localized fill deposits, etc. In the existing cultivated fields, the underlying tilled zone material should be ripped and recompacted. Some deep mixing or tilling may be needed to achieve a compactible moisture content in the tilled materials. The final depth of stripping removal may vary depending on local subsurface conditions and the contractor's methods, and should be determined on the basis of a site inspection after the initial stripping has been performed.

Stripped organic soil should be stockpiled only in designated areas or removed from the site and stripping operations should be observed and documented by HGSI. Any existing subsurface structures (tile drains, old utility lines, septic leach fields, etc.) beneath structures and pavements should be removed and the excavations backfilled with engineered fill.

In construction areas, once stripping is approved, the area should be ripped or tilled to a depth of 12 inches, moisture conditioned, and compacted in-place prior to the placement of engineered fill or crushed aggregate base for pavement. Exposed subgrade soils should be evaluated by HGSI. For large areas, this evaluation is normally performed by proof-rolling the exposed subgrade with a fully loaded scraper or dump truck. For smaller areas where access is restricted, the subgrade should be evaluated by probing the soil with a steel probe.

Soft/loose soils identified during subgrade preparation should be compacted to a firm and unyielding condition or over-excavated and replaced with engineered fill, as described below. The depth of overexcavation, if required, should be evaluated by HGSI at the time of construction.

Engineered Fill and Rock Fills

On-site native soils are anticipated to be suitable for use as engineered fill during dry weather, provided they are adequately moisture conditioned prior to compacting. Imported fill material should be reviewed by the geotechnical engineer prior to being imported to the site. Oversize material greater than 6 inches in size should not be used within 3 feet of foundation footings, and material greater than 12 inches in diameter should not be used in engineered fill.

Engineered fill should be compacted in horizontal lifts not exceeding 8 inches for soil fill, and 12 inches for rock fill, using conventional compaction equipment. We recommend that engineered fill be compacted to at least 95 percent of the maximum dry density determined by ASTM D698 (Standard Proctor) or equivalent. On-site soils may be wet or dry of optimum; therefore, we anticipate that moisture conditioning of native soil will be necessary for compaction operations. Where rock fills are placed on site, the fill materials should be watered during placement, and compacted to a firm and unyielding state with a large vibratory sheepsfoot compactor. Conventional density testing will not be feasible for rock fills, and fill compaction efforts should be verified by HGSI observing the compaction methods, and proof-rolling with heavy construction equipment.

Proper test frequency and earthwork documentation usually requires daily observation and testing during stripping, rough grading, and placement of engineered fill. Field density testing should conform to ASTM D2922 and D3017, or D1556. Engineered fill should be periodically observed and tested by HGSI. Typically, one density test is performed for at least every 2 vertical feet of fill placed or every 500 yd^3, whichever requires more testing. Because testing is performed on an on-call basis, we recommend that the earthwork contractor be held contractually responsible for test scheduling and frequency.

Fill Slope Keying and Benching

We recommend that fill slopes for the project be planned no steeper than 2H:1V and be constructed in accordance with the Fill Slope Detail, Figure 3. For fill slopes constructed at 2H:1V or flatter, and comprised of engineered fill placed and compacted as recommended herein, we anticipate that adequate factors of safety against global failure will be maintained.

Prior to placing compacted fill against the existing natural slopes, all loose undocumented fill, topsoil, and soft soils must first be removed. Adequate benching must be maintained. Fill slope keyways should be constructed with a minimum depth of 2 feet and minimum width of H/3 (10 feet minimum), where H equals the vertical height between the base and top of the fill slope. Both benches and keyways should be roughly horizontal in the down slope direction. A subdrain should be incorporated in the fill slope keyway, and HGSI should observe the keyway excavations prior to the placement of fill.

Measures should be taken to prevent surficial instability and/or erosion of embankment material. This can be accomplished by conscientious compaction of the embankment fills all the way out to the slope face, by maintaining adequate drainage, and planting the slope face as soon as possible after construction. To achieve the specified relative compaction at the slope face, it may be necessary to overbuild the slopes several feet, and then trim back to design finish grade. In our experience, compaction of slope faces by "track-walking" is generally ineffective and is therefore not recommended.

Wet Weather Earthwork

The on-site soils are moisture sensitive and may be difficult to handle or traverse with construction equipment during periods of wet weather. Earthwork is typically most economical when performed under dry weather conditions. Earthwork performed during the wet-weather season will probably require

expensive measures such as cement treatment or imported granular material to compact fill to the recommended engineering specifications. If earthwork is to be performed or fill is to be placed in wet weather or under wet conditions when soil moisture content is difficult to control, the following recommendations should be incorporated into the contract specifications.

- Earthwork should be performed in small areas to minimize exposure to wet weather. Excavation or the removal of unsuitable soils should be followed promptly by the placement and compaction of clean engineered fill. The size and type of construction equipment used may have to be limited to prevent soil disturbance. Under some circumstances, it may be necessary to excavate soils with a backhoe to minimize subgrade disturbance caused by equipment traffic;
- The ground surface within the construction area should be graded to promote run-off of surface water and to prevent the ponding of water;
- Material used as engineered fill should consist of clean, granular soil containing less than about 7 percent fines. The fines should be non-plastic. Alternatively, cement treatment of on-site soils may be performed to facilitate wet weather placement;
- The ground surface within the construction area should be sealed by a smooth drum vibratory roller, or equivalent, and under no circumstances should be left uncompacted and exposed to moisture. Soils which become too wet for compaction should be removed and replaced with clean granular materials;
- Excavation and placement of fill should be observed by the geotechnical engineer to verify that all unsuitable materials are removed and suitable compaction and site drainage is achieved; and
- Bales of straw and/or geotextile silt fences should be strategically located to control erosion.

If cement or lime treatment is used to facilitate wet weather construction, HGSI should be contacted to provide additional recommendations and field monitoring.

Structural Foundations

Based on our understanding of the proposed project and the results of our exploration program, and assuming our recommendations for site preparation are followed, native deposits and/or engineered fill soils will be encountered at or near the foundation level of the proposed structures. These soils are generally stiff to very stiff and should provide adequate support of the structural loads.

Shallow, conventional isolated or continuous spread footings may be used to support the proposed structures, provided they are founded on competent native soils, or compacted engineered fill placed directly upon the competent native soils. We recommend a maximum allowable bearing pressure of 2,000 pounds per square foot (psf) for designing the footings. The recommended maximum allowable bearing pressure may be increased by 1/3 for short term transient conditions such as wind and seismic loading. Minimum footing depths and widths should be determined by the project engineer/architect in accordance with applicable design codes.

Within the crawlspace, cuts between excavated terraces should be made at 1H:1V or flatter. Where there is insufficient room for a 1H:1V cut, particularly below any footings, it may be necessary to construct interior retaining wall(s) to ensure adequate support.

Assuming construction is accomplished as recommended herein, and for the foundation loads anticipated, we estimate total settlement of spread foundations of less than about 1 inch and differential settlement between two adjacent load-bearing components supported on competent soil of less than about ½ inch. We anticipate that the majority of the estimated settlement will occur during construction, as loads are applied.

Wind, earthquakes, and unbalanced earth loads will subject the proposed structure to lateral forces. Lateral forces on a structure will be resisted by a combination of sliding resistance of its base or footing on the underlying soil and passive earth pressure against the buried portions of the structure. For use in design, a coefficient of friction of 0.5 may be assumed along the interface between the base of the footing and subgrade soils. Passive earth pressure for buried portions of structures may be calculated using an equivalent fluid weight of 390 pounds per cubic foot (pcf), assuming footings are cast against dense, natural soils or engineered fill. The recommended coefficient of friction and passive earth pressure values do not include a safety factor. The upper 12 inches of soil should be neglected in passive pressure computations unless it is protected by pavement or slabs on grade.

Footing excavations should be trimmed neat and the bottom of the excavation should be carefully prepared. All loose or softened soil should be removed from the footing excavation prior to placing reinforcing steel bars. We recommend that footing excavations be observed by HGSI prior to placing steel and concrete, to verify that the recommendations of this report have been followed, and that an appropriate bearing stratum has been exposed.

Foundations for the new building should be located such that a 7-foot minimum setback is present between the outside edge of the footing and exterior slope faces. This recommendation does not apply to footings within the crawlspace of the building.

Footing and Roof Drains

We understand that the proposed homes will be raised floor, and that no concrete slab-on-grade floors will be used in living areas. Based on experience with standard local construction practices, perimeter footing drains are not required for raised wood floors with crawlspaces. However, if perimeter footing drains are not utilized, then positive exterior drainage away from the foundation, positive crawlspace drainage to an adequate low-point drain exiting the foundation, visqueen covering the exposed ground in the crawlspace, and crawlspace ventilation (foundation vents) become even more important. The homebuyers should be informed and educated that some slow flowing water in the crawlspaces is considered normal and not necessarily detrimental to the home given these other design elements incorporated into its construction. Evaluation of the potential for mold to develop in crawl spaces is beyond our area of expertise.

If it is desired to reduce the potential for moist crawl spaces, footing drains may be installed. Where used, the outside edge of all perimeter footings should be provided with a drainage system consisting of minimum 3-inch diameter, perforated plastic pipe embedded in a minimum of 1 ft^3 per lineal foot of clean crushed drain rock or 1½"- ¼" drain rock. The drain pipe and surrounding drain rock should be wrapped in non-woven geotextile (Mirafi 140N, or approved equivalent) to minimize the potential for clogging and/or ground loss due to piping. Water collected from the footing drains should be directed into the local storm drain system or other suitable outlet. A minimum 0.5 percent fall should be maintained throughout the drain and non-perforated pipe outlet. Down spouts and roof drains should not be connected to the foundation drains in order to reduce the potential for clogging. The footing drains should include clean-outs to allow periodic maintenance and inspection. Grades around the proposed structure should be sloped such that surface water drains away from the building.

Drainage Crossing Culverts

The following report sections address geotechnical issues for stream crossing culvert structures, including foundation support, construction dewatering, lateral earth pressures, and backfill placement and compaction.

Foundation Support

We understand the drainage crossings will consist of one or more open-bottom structures, or possibly elliptical culverts with the bottom backfilled to simulate natural streambed sediments. Based on the subsurface conditions observed in the test pit explorations, we anticipate the exposure of medium stiff to stiff clayey silt soils at the invert elevation of the new culvert. In a relatively undisturbed state, these natural soils should provide suitable support for the proposed crossing structures. Soft organic-rich soils may also be encountered, especially within the existing channel. Such soils, and any other organic-rich deposits, are considered unsuitable for support of the culverts and if encountered, we recommend they be removed and replaced with 3- or 4-inch minus quarry rock.

Foundation soils should be prepared by overexcavating to a depth of 18 inches below footing bottom elevation, and backfilling the overexcavation zone with 4-inch minus quarry spalls material. This material should be compacted to a firm and unyielding state, but care should be taken to avoid overcompaction which could result in pumping foundation soils. For subgrade soils prepared in this manner, we recommend the proposed culverts be designed for a maximum allowable bearing pressure of 3,500 psf. The recommended maximum allowable bearing pressure may be increased by a factor of 1.33 for short term transient conditions such as wind and seismic loading. For culvert foundations designed and constructed as recommended herein, we estimate total settlements of 1½ inches, and differential settlement of ¾ inch.

If structural footings are used for the crossing structure(s), they should be embedded below the depth of anticipated scour. It should be noted that evaluation of stream bed scour is beyond the scope of this study.

If the crossing structure consists of elliptical culvert(s) with the bottom of the culvert backfilled, the 18-inch-deep overexcavation beneath the bottom of the culvert will not be needed due to the much lower bearing pressure compared to structural footings. A leveling course of compacted crushed rock is recommended, with a minimum of 6 inches or greater if recommended by the manufacturer.

Culvert footing excavations should be observed by the geotechnical engineer prior to formwork and pouring concrete, to verify that soil conditions are as anticipated and adequate to support the planned loads.

Construction Dewatering

Based on the subsurface conditions observed in our explorations, it is anticipated that groundwater will be encountered during installation of the crossing structure(s). If shallow groundwater is encountered, we expect that it can be controlled using ditches, sumps, and pumps; however, the need for and type of dewatering system required will depend on the depth of the excavations, the groundwater level at the time of construction, and the level of water in the creek. Regardless of the dewatering system used, it should be installed and operated such that natural soils are prevented from being removed along with the groundwater.

Lateral Earth Pressures

Lateral earth pressures against below-grade structures will depend upon the inclination of any adjacent slopes, type of backfill, degree of wall restraint, method of backfill placement, degree of backfill compaction, drainage provisions, and magnitude and location of any surcharge loads. At-rest soil pressure is exerted on a subsurface structure or wall when it is restrained against rotation.

Assuming the culvert structure(s) will be designed to allow movement of the culvert walls sufficient to allow use of active earth pressure conditions, the below-grade structure walls should be designed for a horizontal equivalent fluid pressure of 31 pounds per cubic foot (pcf) above the design groundwater level and 77 pcf below the design groundwater level. The value of 77 pcf includes hydrostatic pressure. For restrained walls, the at-rest earth pressure values recommended for design would be 50 pcf and 88 pcf above and below the groundwater level respectively. For the purposes of design, we suggest assuming a static groundwater level at the maximum anticipated stream level.

The above recommendations regarding lateral earth pressures assume that the backfill behind the walls of the culverts will consist of properly compacted structural fill, and do not include adjacent surcharge loads. If the below-grade structure will be subjected to the influence of surcharge loading within a horizontal distance equal to or less than the height of the walls, the walls should be designed for the additional horizontal pressure using a suitable method for modeling surcharge loads.

Lateral loads will be resisted by passive earth pressures on the sides of the footings and by friction on the base of the footings. Passive resistance may be evaluated using an equivalent fluid density of 390 pcf. The top of the triangular passive pressure distribution should begin at a depth of 1 foot below the ground surface. Frictional resistance can be evaluated using 0.5 for the coefficient of base friction against the bottom of spread footings bearing on the recommended quarry rock or crushed rock leveling pad. These values are ultimate and a suitable factor of safety should be incorporated in design.

Backfill Placement and Compaction

We recommend that the backfill for the culvert crossing consist of ¾"-0 crushed rock. For these backfill materials, we recommend assuming a total unit weight of 130 pcf for use in design. During placement of the initial lifts, the backfill material should not be bulldozed into the excavation or dropped directly on the culvert. Furthermore, heavy vibratory equipment should not be permitted to operate directly over the structure until a minimum of 3 feet of backfill has been placed, or in accordance with the manufacturer's recommendations, whichever is more restrictive.

In order to minimize subsequent settlement of the excavation backfill and potential impacts of such settlement, it is recommended that backfill soils be placed in horizontal lifts less than 12 inches in thickness, and compacted to at least 95 percent of maximum dry density, as determined using test method ASTM D 698 (Standard Proctor). When access constraints prohibit the use of heavy equipment, smaller equipment can be used, but the soil must be placed in thin enough lifts to achieve the required compaction.

Retaining Wall Design and Construction Recommendations

Based on the sloping topography on site, we anticipate that site retaining walls may be incorporated into the final grading plan. Retaining walls may also be needed as wing walls along the ends of drainage crossing culverts. Retaining wall locations and types have not yet been determined, although we anticipate the walls will consist most likely of Lock and Load, Allan Block, Keystone, or other geogrid-reinforced systems. HGSI should be consulted to provide retaining wall design and construction recommendations when the wall type, locations and elevations are finalized.

Seismic Design

Structures should be designed to resist earthquake loading in accordance with the methodology described in the 2009 International Residential Code (IRC) for One- and Two-Family Dwellings, with applicable Oregon

Structural Specialty Code (OSSC) revisions. We recommend Site Class D be used for design per the OSSC, Table 1613.5.2. Design values determined for the site using the USGS (United States Geological Survey) *Seismic Design Tool* utility are summarized below in Table 2. For this purpose we used a latitude and longitude from near the center of the overall site.

Table 2. Recommended Earthquake Ground Motion Parameters (2009 IRC)

Parameter	Value
Location (Lat, Long), degrees	45.4306, -122.8517
Mapped Spectral Acceleration Values (MCE):	
Short Period, S_s	0.910 g
Site-Specific Seismic Factors for **Site Class D**:	
F_a	1.136
Residential Site Value = 2/3 x F_a x S_s	0.689 g
Residential Seismic Design Category	D_1

Soil liquefaction is a phenomenon wherein saturated soil deposits temporarily lose strength and behave as a liquid in response to earthquake shaking. Soil liquefaction is generally limited to loose, granular soils located below the water table. Following development, on-site soils will consist predominantly of engineered fill or native fine-grained soils, which are not considered susceptible to liquefaction. Therefore, it is our opinion that special design or construction measures are not required to mitigate the effects of liquefaction.

Excavating Conditions and Utility Trenches

We anticipate that on-site soils can generally be excavated using conventional heavy equipment such as scrapers and trackhoes. Practical refusal on medium hard (R3) basalt was encountered with a medium sized backhoe at depths ranging from about 3.5 to 8.5 feet bgs in various test pits as summarized in Table 1. Similar rock conditions may be encountered in other areas beyond the test pit locations. Deep cuts in the basalt bedrock unit may require heavy ripping and/or use of pneumatic rock breaking equipment.

Where excavations deeper than about 10 feet are planned we recommend performing additional excavator test pits to the maximum depth of construction to determine the potential presence of hard rock. For the deep cut along SW Friendly Lane, it may be necessary to drill using diamond core barrel methods to evaluate rock rippability.

Maintenance of safe working conditions, including temporary excavation stability, is the responsibility of the contractor. Actual slope inclinations at the time of construction should be determined based on safety requirements and actual soil and groundwater conditions. All temporary cuts in excess of 4 feet in height should be sloped in accordance with U.S. Occupational Safety and Health Administration (OSHA) regulations (29 CFR Part 1926), or be shored. The existing native soils classify as Type B Soil and temporary excavation side slope inclinations as steep as 1H:1V may be assumed for planning purposes. This cut slope inclination is applicable to excavations above the water table only.

Perched groundwater is likely to be encountered during wet weather season and should be anticipated in excavations and utility trenches.

Vibrations created by traffic and construction equipment may cause some caving and raveling of excavation walls. In such an event, lateral support for the excavation walls should be provided by the contractor to

prevent loss of ground support and possible distress to existing or previously constructed structural improvements.

PVC pipe should be installed in accordance with the procedures specified in ASTM D2321. We recommend that structural trench backfill be compacted to at least 95% of the maximum dry density obtained by Standard Proctor (ASTM D698) or equivalent. Initial backfill lift thicknesses for a ¾"-0 crushed aggregate base may need to be as great as 4 feet to reduce the risk of flattening underlying flexible pipe. Subsequent lift thickness should not exceed 1 foot. If imported granular fill material is used, then the lifts for large vibrating plate-compaction equipment (e.g. hoe compactor attachments) may be up to 2 feet, provided that proper compaction is being achieved and each lift is tested. Use of large vibrating compaction equipment should be carefully monitored near existing structures and improvements due to the potential for vibration-induced damage.

Adequate density testing should be performed during construction to verify that the recommended relative compaction is achieved. Typically, at least one density test is taken for every 4 vertical feet of backfill on each 200-lineal-foot section of trench.

Pavement Section Design and Construction

Pavement Section Design and Construction recommendations are presented below for onsite residential streets, and a neighborhood route planned as part of the development. A discussion of wet weather earthwork pavement sections is also provided.

Local Residential Streets

For design of local residential streets, we used an estimated resilient modulus of 7,500 pci for existing subgrade soils. This correlates to a CBR value of 5, the lower bound test result in obtained from DCP testing on the nearby River Terrace Northwest site. For the purposes of our pavement section design, we assumed the local residential streets would be subjected to an initial two-way ADT (average daily traffic count) of 700 vehicles. For this analysis we assumed 2 percent of the vehicles will be heavy trucks (FHWA Class 5 or greater). Assuming an annual growth rate of about 3 percent and using the methodology presented in the 1993 AASHTO (American Association of State Highway and Transportation Officials) pavement design guidelines, we estimated the number of ESAL's (18-kip equivalent single axle loads) for a 20-year performance period to be approximately 123,700.

Results of our pavement section analysis indicate a required Structural Number of 2.35 for the conditions analyzed. A design pavement section consisting of 3 inches of asphaltic concrete (AC), over 2 inches of ¾"-0 crushed rock top course, over 8 inches of 1½"-0 crushed rock base course, provides a pavement section meeting the design criterion. Therefore, it is our opinion that this pavement section may be used for the subject local residential streets.

Neighborhood Route

For design of new neighborhood route constructed as part of the development, we used an estimated resilient modulus of 7,500 pci for existing subgrade soils as discussed previously.

For the purposes of our pavement section design, we assumed the neighborhood route would be subjected to an initial two-way ADT (average daily traffic count) of 1,500 vehicles per day. For this analysis we assumed 3 percent of the vehicles will be heavy trucks (FHWA Class 5 or greater). Assuming an annual growth rate of about 3 percent and using the methodology presented in the 1993

AASHTO (American Association of State Highway and Transportation Officials) pavement design guidelines, we estimated the number of ESAL's (18-kip equivalent single axle loads) for a 20-year performance period to be approximately 397,500.

Results of our pavement section analysis indicate a required Structural Number of 2.85 for the conditions analyzed. A design pavement section consisting of 4 inches of asphaltic concrete (AC), over 2 inches of ¾"-0 crushed rock top course, over 10 inches of 1½"-0 crushed rock base course, provides a pavement section meeting the design criterion for the planned neighborhood route.

Construction Recommendations

The geotechnical recommendations for subgrade preparation and pavement section material placement and compaction contained in the above-referenced geotechnical report remain applicable. In particular, base rock should be compacted to a minimum of 95 percent of Modified Proctor (ASTM D1557 or AASHTO T-180). It is our opinion that the 3-inch-thick AC layer should be placed and compacted in a single lift, to a minimum of 92% of Rice Density. For the neighborhood route, where AC thickness is greater than 3 inches, we anticipate the paving will be completed in two lifts. In this case, the bottom lift of AC should be compacted to 91% of maximum Rice Density and the top lift should be compacted to 92% of the same standard.

During placement of pavement section materials, density testing should be performed to verify compliance with project specifications. We recommend at least one density test per each lift of crushed rock or AC, for each 150- to 200-foot length of roadway improvements.

Wet Weather Pavement Sections

The following wet weather pavement section recommendations are intended for use in situations where it is not feasible to compact the subgrade soils to project requirements, due to wet subgrade soil conditions and/or construction during wet weather. For planning purposes, we recommend a wet weather section with a minimum subgrade deepening of 6 inches to accommodate a working subbase of additional 1½"-0 crushed rock. Geotextile fabric, Mirafi 500x or equivalent, should be placed on subgrade soils prior to placement of base rock.

In some instances it may be preferable to use Special Treated Base (STB) in combination with overexcavation and increasing the thickness of the rock section. HGSI should be consulted for additional recommendations regarding use of STB in wet weather pavement sections if it is desired to pursue this alternative. Also, cement treating of the roadway subbase is considered sufficient wet weather treatment without an increase in base rock thickness.

With implementation of the above recommendations, it is our opinion that the resulting pavement section will provide equivalent or greater structural strength than the dry weather pavement section currently planned. However, it should be noted that construction in wet weather is risky and the performance of pavement subgrades depend on a number of factors including the weather conditions, the contractor's methods, and the amount of traffic the road is subjected to. There is a potential that soft spots may develop even with implementation of the wet weather provisions recommended in this letter. If soft spots in the subgrade are identified during roadway excavation, or develop prior to paving, the soft spots should be overexcavated and backfilled with additional crushed rock.

During subgrade excavation, care should be taken to avoid disturbing the subgrade soils. Removals should be performed using an excavator with a smooth-bladed bucket. Truck traffic should be limited until an adequate working surface has been established. We suggest that the crushed rock be

spread using bulldozer equipment rather than dump trucks, to reduce the amount of traffic and potential disturbance of subgrade soils.

Care should be taken to avoid overcompaction of the base course materials, which could create pumping, unstable subgrade soil conditions. Heavy and/or vibratory compaction efforts should be applied with caution. Following placement and compaction of the crushed rock to project specifications (95% of Modified Proctor), a finish proof-roll should be performed before paving.

The above recommendations are subject to field verification. HGSI should be on-site during construction to verify subgrade strength and to take density tests on the engineered fill, base rock and asphaltic pavement materials.

Erosion Control Considerations

During our field exploration program, we did not observe soil types that would be considered highly susceptible to erosion. In our opinion, the primary concern regarding erosion potential will occur during construction, in areas that have been stripped of vegetation. Erosion at the site during construction can be minimized by implementing the project erosion control plan, which should include judicious use of "bio-bags," straw and silt fences. Where used, these erosion control devices should be in place and remain in place throughout site preparation and construction.

Erosion and sedimentation of exposed soils can also be minimized by quickly re-vegetating exposed areas of soil, and by staging construction such that large areas of the project site are not denuded and exposed at the same time. Areas of exposed soil requiring immediate and/or temporary protection against exposure should be covered with either mulch or erosion control netting/blankets. Areas of exposed soil requiring permanent stabilization should be seeded with an approved grass seed mixture, or hydroseeded with an approved seed-mulch-fertilizer mixture.

UNCERTAINTIES AND LIMITATIONS

We have prepared this report for West Hills Development/Arbor Homes and their consultants for use in design of this project only. This report should be provided in its entirety to prospective contractors for bidding and estimating purposes; however, the conclusions and interpretations presented in this report should not be construed as a warranty of the subsurface conditions. Experience has shown that soil and groundwater conditions can vary significantly over small distances. If, during future site operations, subsurface conditions are encountered which vary appreciably from those described herein, HGSI should be notified for review of the recommendations of this report, and revision of such if necessary.

Sufficient geotechnical monitoring, testing and consultation should be provided during construction to confirm that the conditions encountered are consistent with those indicated by explorations. Recommendations for design changes will be provided should conditions revealed during construction differ from those anticipated, and to verify that the geotechnical aspects of construction comply with the contract plans and specifications.

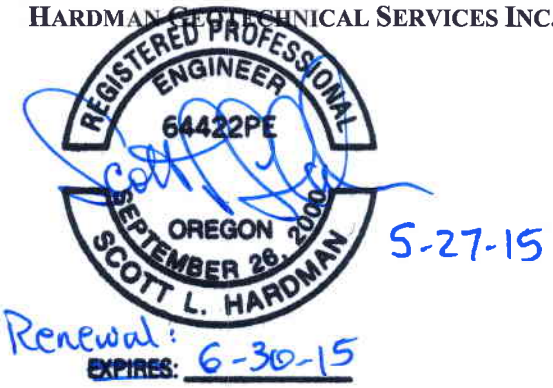
Within the limitations of scope, schedule and budget, HGSI executed these services in accordance with generally accepted professional principles and practices in the field of geotechnical engineering at the time the report was prepared. No warranty, expressed or implied, is made. The scope of our work did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous or toxic substances in the soil, surface water, or groundwater at this site.

May 27, 2015
HGSI Project No. 15-1827

We appreciate this opportunity to be of service.

Sincerely,

HARDMAN GEOTECHNICAL SERVICES INC.



Scott L. Hardman, G.E., P.E.
Principal Geotechnical Engineer

Attachments: References
Figure 1 – Vicinity Map
Figure 2A – Site and Exploration Plan – Northwest
Figure 2B – Site and Exploration Plan – North
Figure 2C – Site and Exploration Plan – Northeast
Figure 2D – Site and Exploration Plan – Southeast
Figure 2E – Site and Exploration Plan – South
Figure 2F – Site and Exploration Plan - Southwest
Figure 3 – Fill Slope Detail
Logs of Test Pits TP-1 through TP-9 and
Hand Auger Borings HA-8 through HA-15 from GeoPacific (2013)
Logs of Test Pits TP-1 through TP-20 from GeoPacific (2014)

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Beeson, M.H., Tolan, T.L., and Madin, I.P., 1991, Geologic map of the Portland Quadrangle, Multnomah, and Washington Counties, Oregon: Oregon Department of Geology and Mineral Industries Geological Map Series GMS-75, scale 1:24,000.

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GeoPacific Engineering, Inc., 2014, Preliminary Geotechnical Engineering Report, Dyches Property, SW Scholls Ferry Road, T2S R1W Section 6 Tax Lot 103, Washington County, Oregon; consultant report dated May 27.

Ma, L., Madin, I.P., Duplantis, S., and Williams, K.J., 2012, Lidar-based surficial geologic map and database of the greater Portland, Oregon, area, Clackamas, Columbia, Marion, Multnomah, Washington and Yamhill Counties, Oregon, and Clark County, Washington, 2012: Oregon Department of Geology and Mineral Industries Geological Map O-12-02.

Madin, I.P., 1990, Earthquake hazard geology maps of the Portland metropolitan area, Oregon: Oregon Department of Geology and Mineral Industries Open-File Report 0-90-2, scale 1:24,000, 22 p.

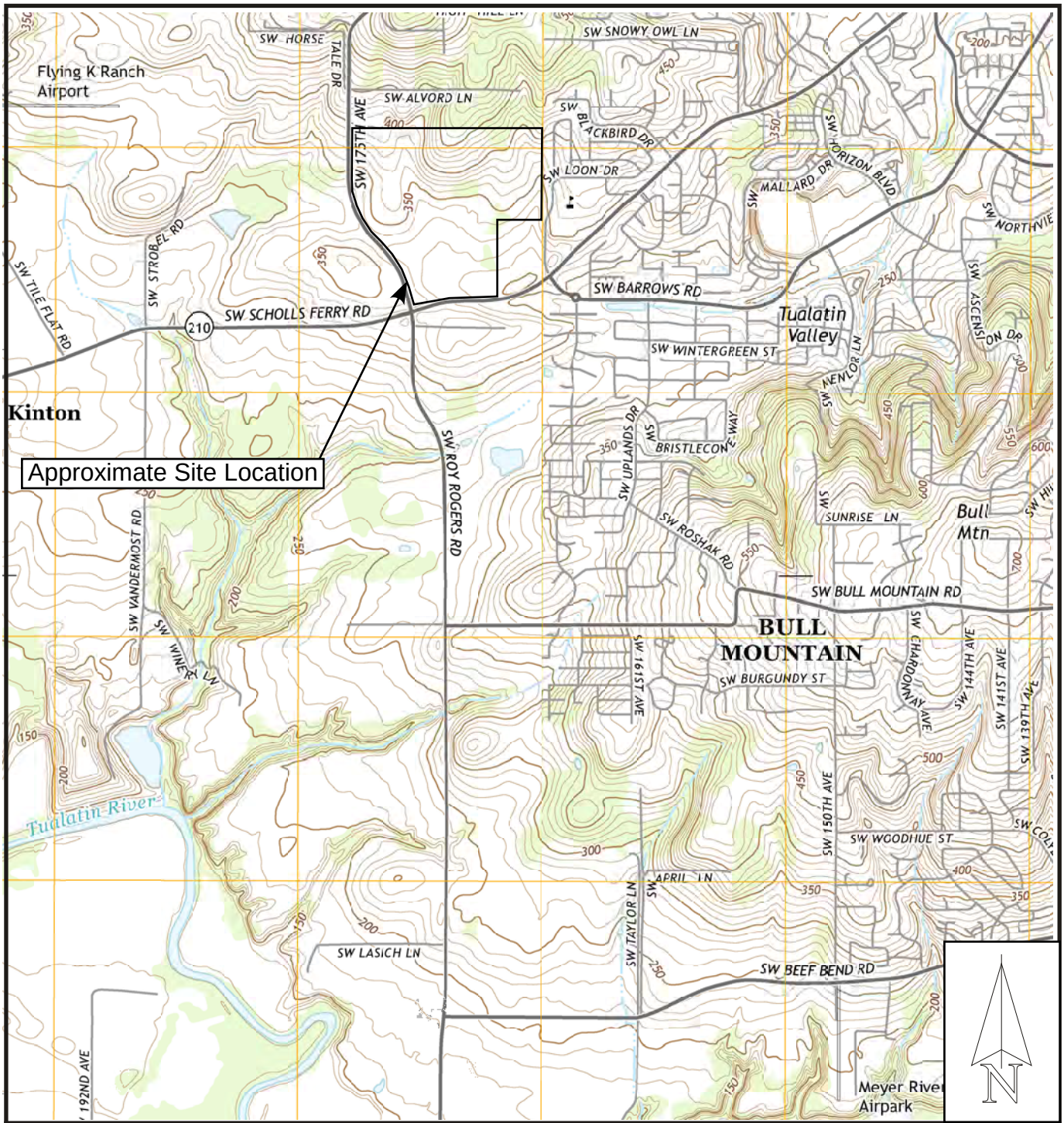
Oregon Department of Geology and Mineral Industries SLIDO, Version 3.2, updated December 29, 2014. http://oregongeology.org/slido

Yeats, R.S., Graven, E.P., Werner, K.S., Goldfinger, C., and Popowski, T., 1996, Tectonics of the Willamette Valley, Oregon: in Assessing earthquake hazards and reducing risk in the Pacific Northwest, Vol. 1: U.S. Geological Survey Professional Paper 1560, P. 183-222, 5 plates, scale 1:100,000.

HARDMAN GEOTECHNICAL SERVICES INC.

Practical, Cost-Effective Geotechnical Solutions

VICINITY MAP



Legend

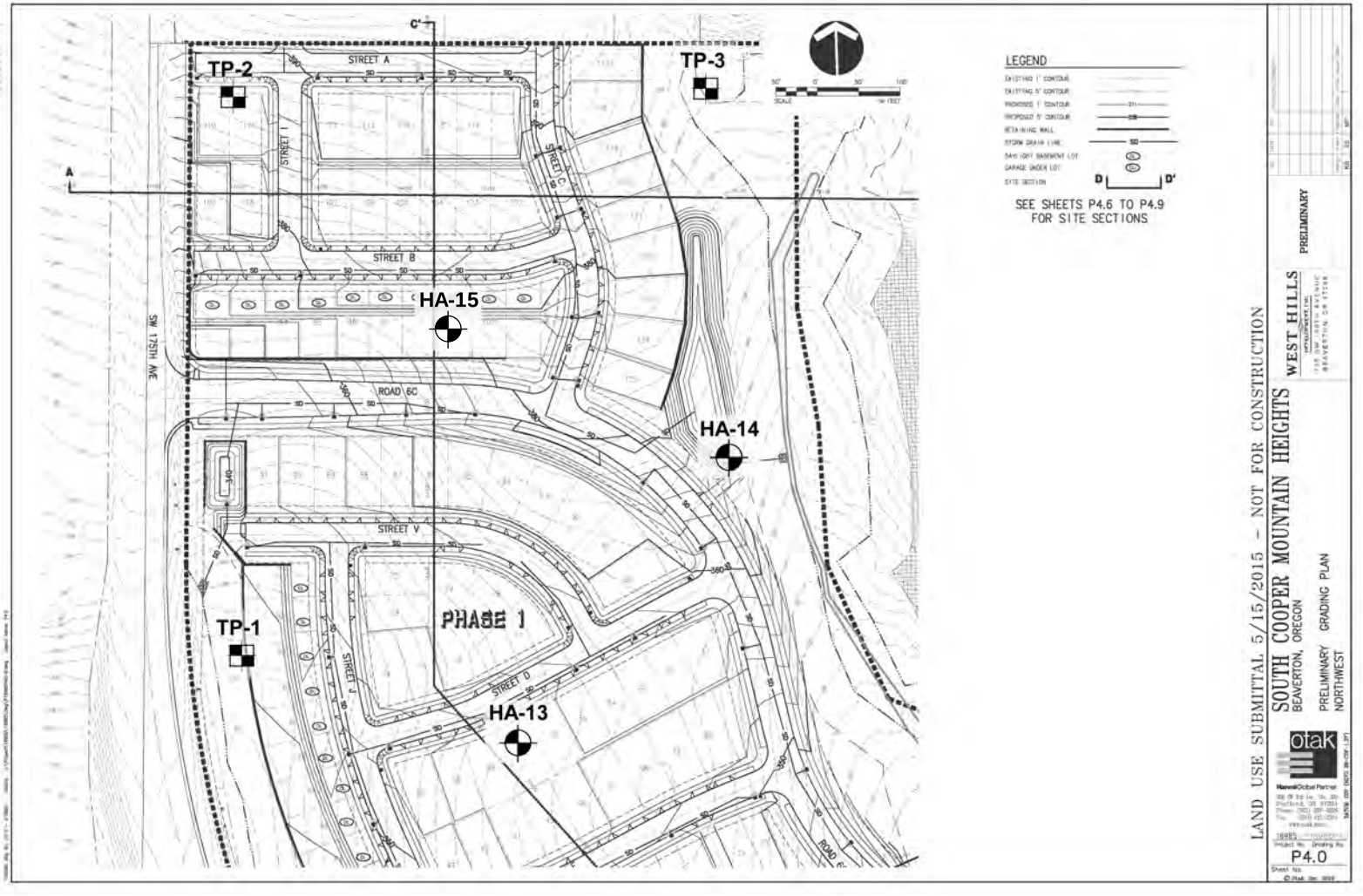
Approx. Scale: 1 inch = 2000 feet

Base Map: USGS Beaverton Quadrangle Map, from US Topo, 2014

Project: South Cooper Mountain Beaverton, Oregon	Project No. 15-1827	FIGURE 1

HARDMAN GEOTECHNICAL SERVICES INC.
Practical, Cost-Effective Geotechnical Solutions

SITE AND EXPLORATION PLAN NORTHWEST



Legend

TP-1 Test Pit Designation and Approximate Location (GeoPacific, 2013)

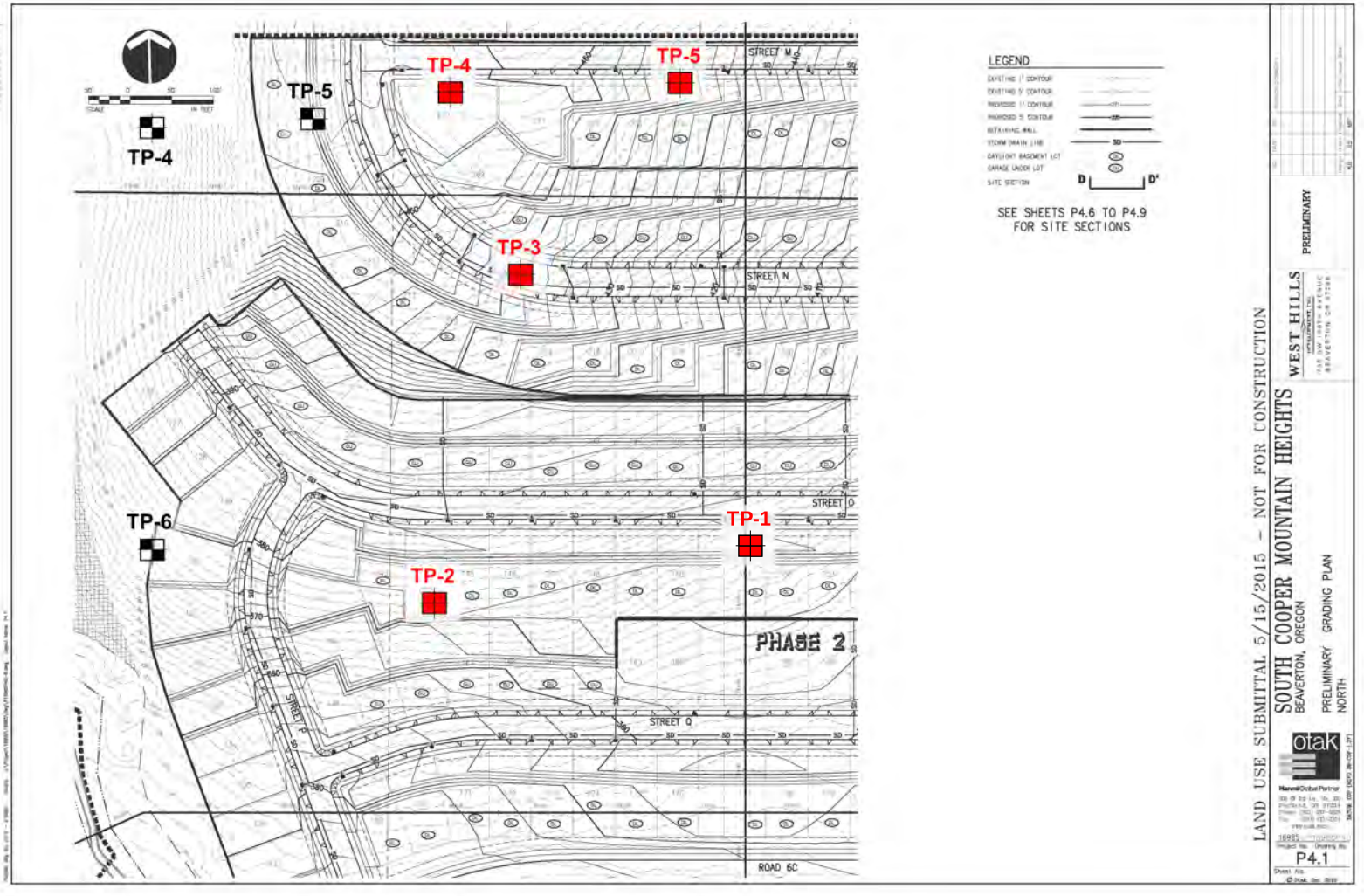
HA-1 Hand Auger Boring Designation and Approximate Location (GeoPacific, 2013

TP-1 Test Pit Designation and Approximate Location (GeoPacific, 2014)

Project: South Cooper Mountain Beaverton, Oregon	Project No. 15-1827	FIGURE 2A

HARDMAN GEOTECHNICAL SERVICES INC.
Practical, Cost-Effective Geotechnical Solutions

SITE AND EXPLORATION PLAN NORTH



Legend

TP-1 Test Pit Designation and Approximate Location (GeoPacific, 2013)

HA-1 Hand Auger Boring Designation and Approximate Location (GeoPacific, 2013

TP-1 Test Pit Designation and Approximate Location (GeoPacific, 2014)

Project: South Cooper Mountain Beaverton, Oregon	Project No. 15-1827	FIGURE 2B

HARDMAN GEOTECHNICAL SERVICES INC.
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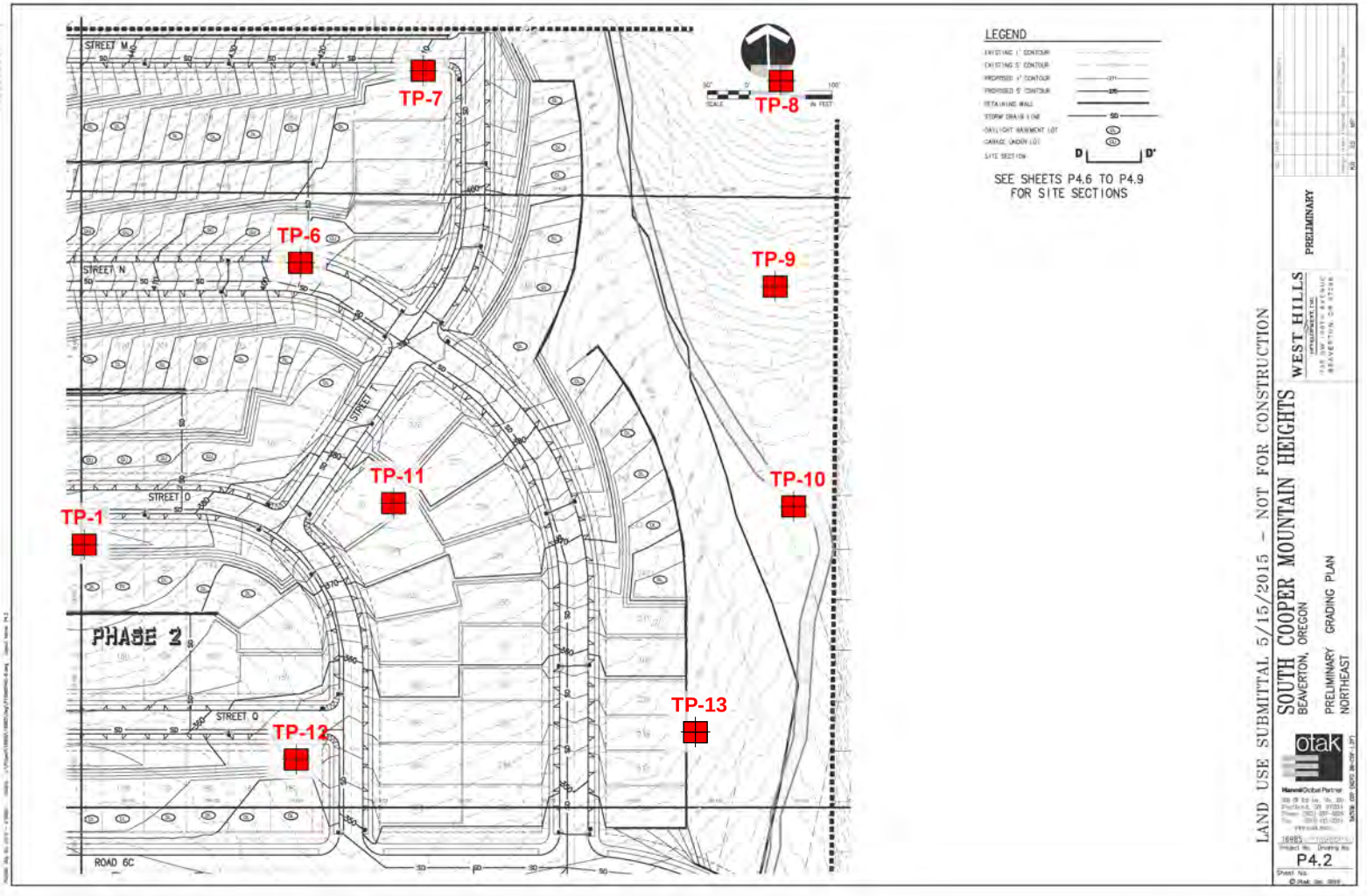
SITE AND EXPLORATION PLAN NORTHEAST



Legend

TP-1 Test Pit Designation and Approximate Location (GeoPacific, 2013)

HA-1 Hand Auger Boring Designation and Approximate Location (GeoPacific, 2013

TP-1 Test Pit Designation and Approximate Location (GeoPacific, 2014)

Project: South Cooper Mountain Beaverton, Oregon	Project No. 15-1827	FIGURE 2C

HARDMAN GEOTECHNICAL SERVICES INC.
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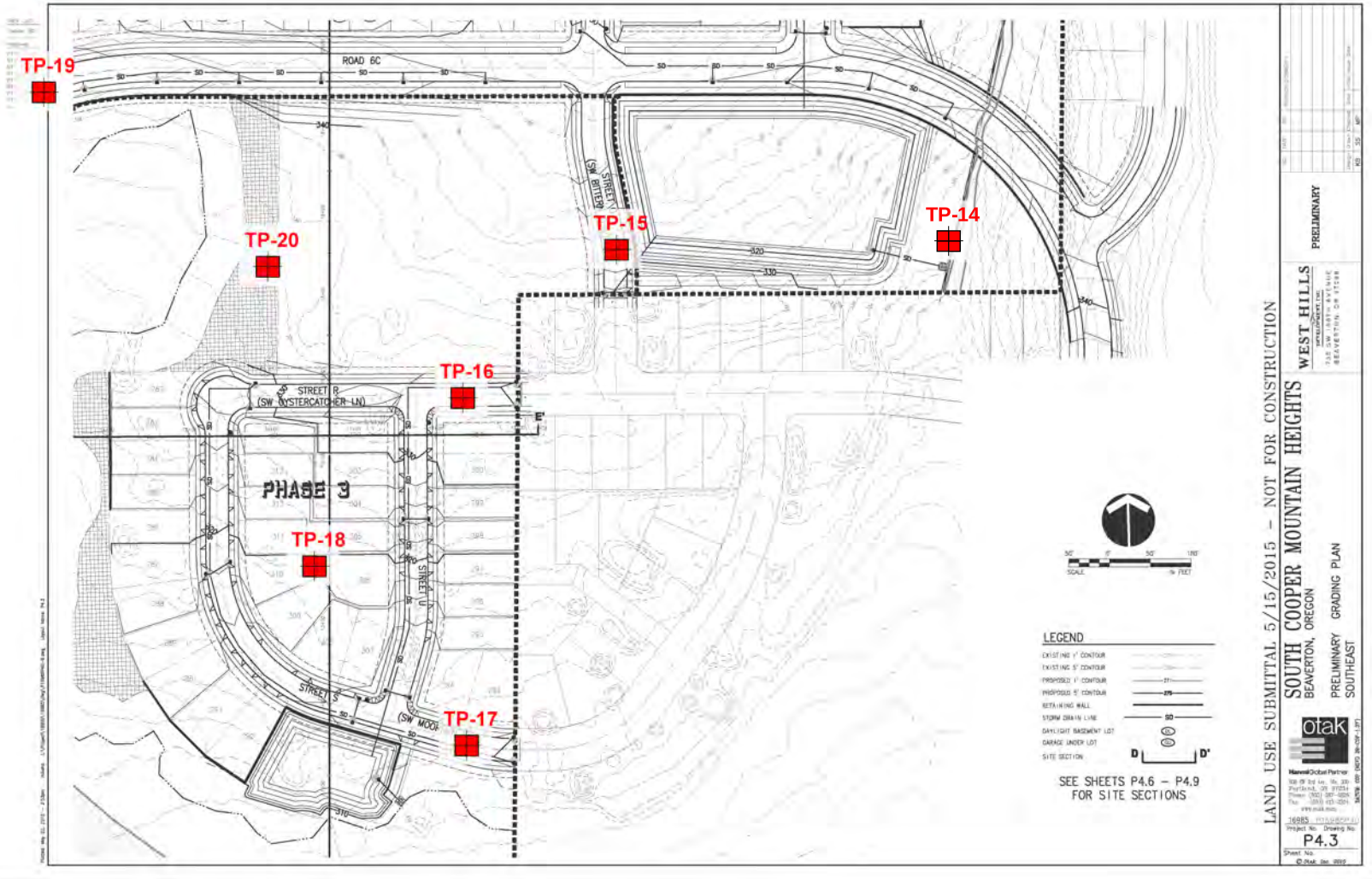
SITE AND EXPLORATION PLAN SOUTHEAST



Legend

TP-1 Test Pit Designation and Approximate Location (GeoPacific, 2013)

HA-1 Hand Auger Boring Designation and Approximate Location (GeoPacific, 2013

TP-1 Test Pit Designation and Approximate Location (GeoPacific, 2014)

Project: South Cooper Mountain Beaverton, Oregon	Project No. 15-1827	FIGURE 2D

HARDMAN GEOTECHNICAL SERVICES INC.
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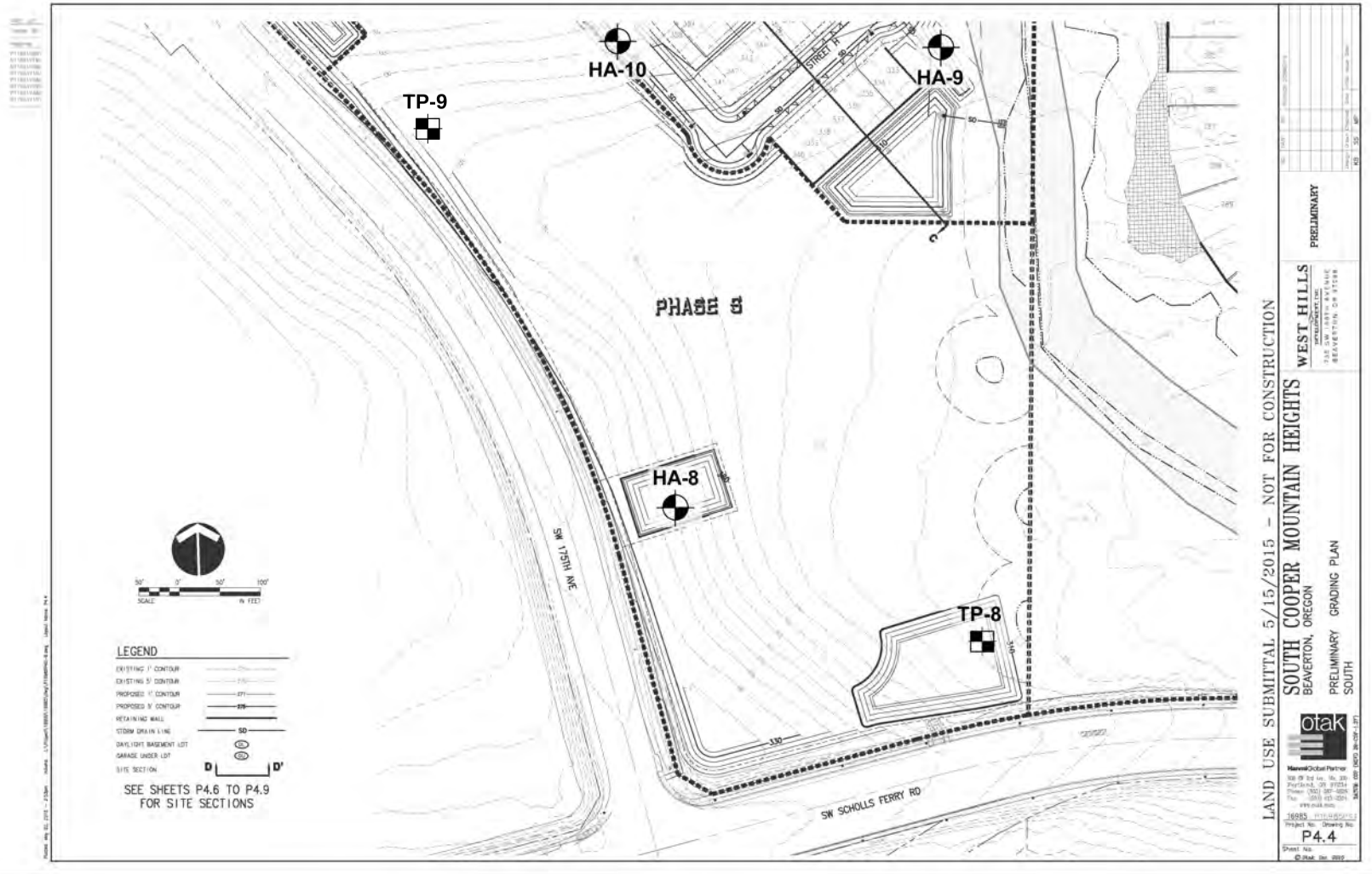
SITE AND EXPLORATION PLAN SOUTH



Legend

TP-1 Test Pit Designation and Approximate Location (GeoPacific, 2013)

HA-1 Hand Auger Boring Designation and Approximate Location (GeoPacific, 2013

TP-1 Test Pit Designation and Approximate Location (GeoPacific, 2014)

Project: South Cooper Mountain Beaverton, Oregon	Project No. 15-1827	FIGURE 2E

HARDMAN GEOTECHNICAL SERVICES INC.
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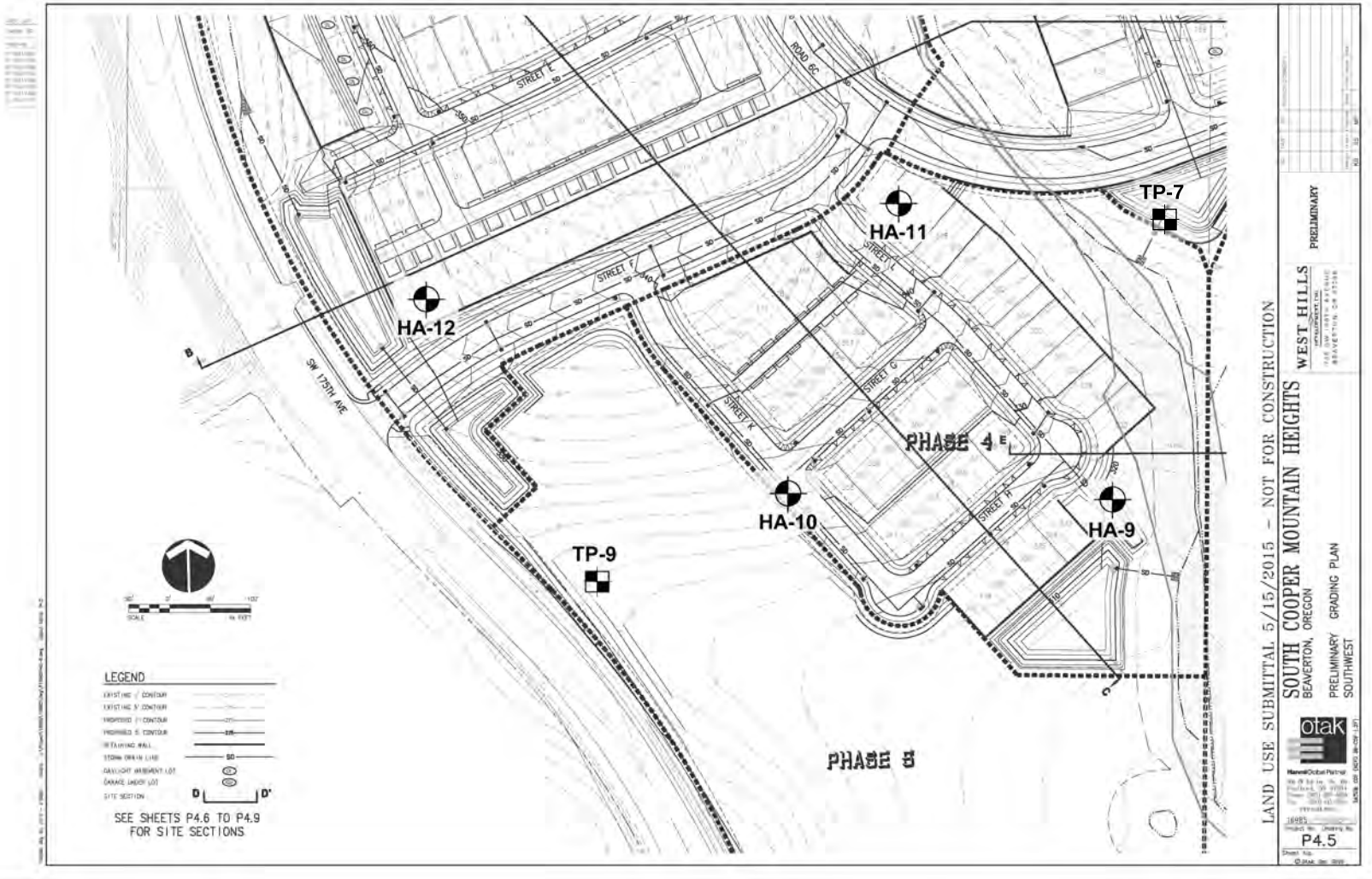
SITE AND EXPLORATION PLAN SOUTHWEST



Legend

TP-1 Test Pit Designation and Approximate Location (GeoPacific, 2013)

HA-1 Hand Auger Boring Designation and Approximate Location (GeoPacific, 2013

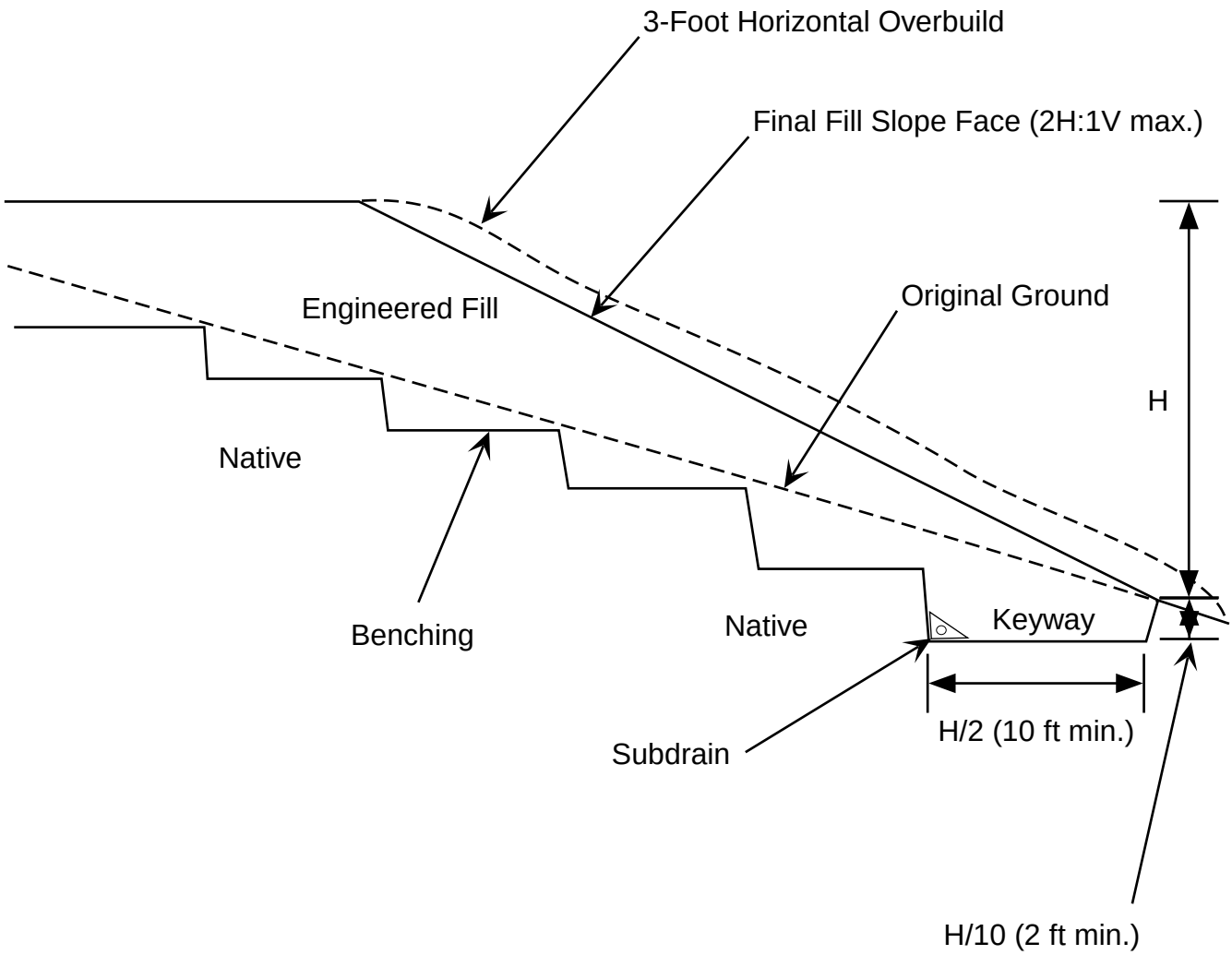
TP-1 Test Pit Designation and Approximate Location (GeoPacific, 2014)

Project: South Cooper Mountain Beaverton, Oregon	Project No. 15-1827	FIGURE 2F

HARDMAN GEOTECHNICAL SERVICES INC.
Practical, Cost-Effective Geotechnical Solutions

FILL SLOPE DETAIL

TYPICAL KEYWAY, BENCHING & FILL SLOPE DESIGN



Recommended subdrain is minimum 3-inch-diameter ADS Heavy Duty grade (or equivalent), perforated plastic pipe enveloped in a minimum of 3 cubic feet per lineal foot of 2" to 1/2" open-graded gravel drain rock wrapped with geotextile filter fabric (Mirafi 140N or equivalent).

Project: South Cooper Mountain Beaverton, Oregon	Project No. 15-1827	FIGURE 3

LOGS OF TEST PITS TP-1 THROUGH TP-9

and

HAND AUGER BORINGS HA-8 THROUGH HA-15

EXCERPTED FROM GeoPacific (2013)

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: SW 175th and Scholls Ferry Property Washington County, Oregon	Project No. 13-3137	Test Pit No. **TP- 1**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	4.5					Low to moderately organic SILT (OL-ML), trace gravel fill, brown, trace organic matter throughout, loose, moist (Tilled Topsoil Horizon)
2	4.5					Stiff, SILT (ML), trace gravel fill, light brown, micaceous, subtle orange and gray mottling, moist (Willamette Formation)
3	4.5					Stiff to very stiff, clayey SILT (ML), light brown to gray, micaceous, subtle orange and gray mottling, trace charcoal clasts, moist (Willamette Formation)
4	4.5					
5						
6						
7						
8						Test Pit Terminated at 8 Feet.
9						
10						Note: No seepage or groundwater encountered.
11						
12						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 8/14/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: SW 175th and Scholls Ferry Property
Washington County, Oregon

Project No. 13-3137

Test Pit No. **TP-2**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
						Low organic SILT (OL-ML), brown, roots throughout, loose, moist (Topsoil)
1	4.5					Stiff to very stiff, clayey SILT (ML), light brown, micaceous, subtle orange and gray mottling, moist (Willamette Formation)
2	4.5					
3	4.5					
4	4.5					
5						Very stiff, silty CLAY to clayey SILT (CL-ML), with weathered gray basalt, light reddish brown, moist (Residual Soil)
6						Practical Refusal on Soft (R2) Basalt at 5.75 Feet.
7						Note: No seepage or groundwater encountered.
8						
9						
10						
11						
12						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 8/14/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: SW 175th and Scholls Ferry Property
Washington County, Oregon

Project No. 13-3137

Test Pit No. **TP-3**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
						Low organic SILT (OL-ML), brown, roots throughout, loose, moist (Topsoil)
1	4.5					Stiff to very stiff, clayey SILT (ML), light brown, micaceous, subtle orange and gray mottling, moist (Willamette Formation)
2	4.5					
3	4.5					Very stiff, silty CLAY to clayey SILT (CL-ML), with weathered gray basalt, light reddish brown, moist (Residual Soil)
4						Practical Refusal on Very Soft (R1) to Soft (R2) Basalt at 3.5 Feet.
5						Note: No seepage or groundwater encountered.
6						
7						
8						
9						
10						
11						
12						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 8/14/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: SW 175th and Scholls Ferry Property Washington County, Oregon	Project No. 13-3137	Test Pit No. **TP- 4**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	4.5					Moderately organic SILT (OL-ML), dark brown, trace roots throughout, loose, moist (Topsoil Horizon)
2	4.5					Stiff to very stiff, clayey SILT (ML), light brown to gray, micaceous, strong orange and gray mottling, moist (Willamette Formation)
3	4.5					
4	4.5					
5						Very stiff, silty CLAY to clayey SILT (CL-ML), light reddish brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
6						
7						
8						Test Pit Terminated at 8 Feet.
9						
10						Note: No seepage or groundwater encountered.
11						
12						

LEGEND

Bag Sample | Bucket Sample | Shelby Tube Sample | Seepage | Water Bearing Zone | Water Level at Abandonment

Date Excavated: 8/14/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: SW 175th and Scholls Ferry Property Washington County, Oregon	Project No. 13-3137	Test Pit No. **TP- 5**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	4.5					Moderately organic SILT (OL-ML), dark brown, trace roots throughout, loose, moist (Topsoil Horizon)
2	4.5					Stiff to very stiff, clayey SILT (ML), light brown to gray, micaceous, strong orange and gray mottling, moist (Willamette Formation)
3	4.5					
4	4.5					
5						
6						
7						Very stiff, silty CLAY to clayey SILT (CL-ML), light reddish brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
8						Test Pit Terminated at 8 Feet.
9						
10						Note: No seepage or groundwater encountered.
11						
12						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 8/14/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: SW 175th and Scholls Ferry Property Washington County, Oregon	Project No. 13-3137	Test Pit No. **TP- 6**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	4.5					Moderately organic SILT (OL-ML), dark brown, trace roots throughout, loose, moist (Topsoil Horizon)
2	4.5					Stiff to very stiff, clayey SILT (ML), light brown to gray, micaceous, subtle orange and gray mottling, moist (Willamette Formation)
3	4.5					
4	4.5					
5						
6						Very stiff, silty CLAY to clayey SILT (CL-ML), light reddish brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
7						
8						Test Pit Terminated at 7.5 Feet.
9						Note: No seepage or groundwater encountered.
10						
11						
12						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 8/14/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: SW 175th and Scholls Ferry Property Washington County, Oregon	Project No. 13-3137	Test Pit No. **TP- 7**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	4.5					Moderately organic SILT (OL-ML), dark brown, trace roots throughout, loose, moist (Topsoil Horizon)
2	4.5					Stiff to very stiff, clayey SILT (ML), light brown to gray, micaceous, strong orange and gray mottling, moist (Willamette Formation)
3	3.5					
4	4.5					
5						
6						Very stiff, silty CLAY to clayey SILT (CL-ML), light reddish brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
7						
8						Test Pit Terminated at 8 Feet.
9						
10						Note: Groundwater seepage encountered at 8 feet. Discharge visually estimated at less than 1 gallon per minute.
11						
12						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 8/14/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: SW 175th and Scholls Ferry Property Washington County, Oregon	Project No. 13-3137	Test Pit No. **TP- 8**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	2.0					Moderately organic SILT (OL-ML), dark brown, trace roots throughout, loose, moist (Topsoil Horizon)
2	4.5					
3	4.5					Stiff to very stiff, clayey SILT (ML), light brown to gray, micaceous, subtle to strong orange and gray mottling, moist (Willamette Formation)
4	3.5					
5						
6						
7						
8						Test Pit Terminated at 8 Feet.
9						
10						Note: No seepage or groundwater encountered.
11						
12						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 8/14/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: SW 175th and Scholls Ferry Property Washington County, Oregon	Project No. 13-3137	Test Pit No. **TP- 9**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	4.5					Low organic SILT (OL-ML), dark brown, trace roots throughout, loose, moist (Topsoil Horizon)
2	4.5					Stiff to very stiff, clayey SILT (ML), light brown to gray, micaceous, subtle to strong orange and gray mottling, moist (Willamette Formation)
3	4.5					
4	4.5					
5						
6						Test Pit Terminated at 6 Feet.
7						Note: No seepage or groundwater encountered.
8						
9						
10						
11						
12						

LEGEND

Bag Sample (100 to 1,000 g) | Bucket Sample (5 Gal. Bucket) | Shelby Tube Sample | Seepage | Water Bearing Zone | Water Level at Abandonment

Date Excavated: 8/14/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

HAND AUGER LOG

Project: SW 175th and Scholls Ferry Property Washington County, Oregon	Project No. 13-3137	Boring No. **HA-8**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1						Low organic SILT (OL-ML), brown, trace organic matter throughout, loose, moist (Tilled Topsoil Horizon)
2						
3						Stiff to very stiff, SILT (ML), light brown, micaceous, strong orange and gray mottling, trace black staining, moist (Willamette Formation)
4						
5						Boring Terminated at 5 Feet.
6						Note: No seepage or groundwater encountered.
7						
8						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 9/5/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

HAND AUGER LOG

Project: SW 175th and Scholls Ferry Property Washington County, Oregon	Project No. 13-3137	Boring No. **HA-9**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1						Low organic SILT (OL-ML), brown, trace organic matter throughout, loose, moist (Tilled Topsoil Horizon)
2						Stiff to very stiff, SILT (ML), light brown, micaceous, strong orange and gray mottling, trace black staining, moist (Willamette Formation)
3						Stiff, silty CLAY (CL), brown, strong orange and gray mottling, moist (Willamette Formation)
4						Stiff to very stiff, sandy SILT (ML), light brown, micaceous, strong orange and gray mottling, trace black staining, moist (Willamette Formation)
5						Boring Terminated at 5 Feet.
6						Note: No seepage or groundwater encountered.
7						
8						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 9/5/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

HAND AUGER LOG

Project: SW 175th and Scholls Ferry Property Washington County, Oregon	Project No. 13-3137	Boring No. **HA-10**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
0						Low organic SILT (OL-ML), brown, trace organic matter throughout, loose, moist (Tilled Topsoil Horizon)
1						
2						Stiff, SILT (ML), light brown, micaceous, strong to subtle orange and gray mottling, trace black staining, moist (Willamette Formation)
3						
4						
5						Boring Terminated at 5 Feet. Note: No seepage or groundwater encountered.
6						
7						
8						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 9/5/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

HAND AUGER LOG

Project: SW 175th and Scholls Ferry Property Washington County, Oregon	Project No. 13-3137	Boring No. **HA-11**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
0						Low organic SILT (OL-ML), brown, trace organic matter throughout, loose, moist (Tilled Topsoil Horizon)
1						
2						Stiff to very stiff, clayey SILT (ML), light brown, micaceous, strong orange and gray mottling, trace black staining, moist (Willamette Formation)
3						
4						
5						Boring Terminated at 5 Feet. Note: No seepage or groundwater encountered.
6						
7						
8						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 9/5/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

HAND AUGER LOG

Project: SW 175th and Scholls Ferry Property
Washington County, Oregon

Project No. 13-3137

Boring No. **HA-12**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
0						Low organic SILT (OL-ML), brown, trace organic matter throughout, loose, moist (Tilled Topsoil Horizon)
1						
2						Stiff to very stiff, SILT (ML), light brown, micaceous, strong orange mottling, trace black staining, moist (Willamette Formation)
3						
4						
5						Boring Terminated at 5 Feet.
6						Note: No seepage or groundwater encountered.
7						
8						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 9/5/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

HAND AUGER LOG

Project: SW 175th and Scholls Ferry Property
Washington County, Oregon

Project No. 13-3137

Boring No. **HA- 13**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1						Low organic SILT (OL-ML), brown, trace organic matter throughout, loose, moist (Tilled Topsoil Horizon)
2						Stiff to very stiff, clayey SILT (ML), light brown, micaceous, subtle orange and gray mottling, moist (Willamette Formation)
3						
4						
5						Boring Terminated at 4.5 Feet.
6						Note: No seepage or groundwater encountered.
7						
8						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 9/5/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

HAND AUGER LOG

Project: SW 175th and Scholls Ferry Property Washington County, Oregon	Project No. 13-3137	Boring No. **HA- 14**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1						Low organic SILT (OL-ML), brown, trace organic matter throughout, loose, moist (Tilled Topsoil Horizon)
2						Stiff to very stiff, clayey SILT (ML), light brown, micaceous, subtle to strong orange and gray mottling, moist (Willamette Formation)
3						
4						
5						Boring Terminated at 4.5 Feet.
6						Note: No seepage or groundwater encountered.
7						
8						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 9/5/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

HAND AUGER LOG

Project: SW 175th and Scholls Ferry Property Washington County, Oregon	Project No. 13-3137	Boring No. **HA- 15**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
0						Low to moderately organic SILT (OL-ML), brown, trace organic matter throughout, loose, moist (Tilled Topsoil Horizon)
1						
2						Stiff to very stiff, clayey SILT (ML), light brown, micaceous, subtle orange and gray mottling, moist (Willamette Formation)
3						
4						
5						Boring Terminated at 5 Feet.
6						Note: No seepage or groundwater encountered.
7						
8						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 9/5/2013
Logged By: B. Rapp
Surface Elevation:

LOGS OF TEST PITS TP-1 THROUGH TP-20

EXCERPTED FROM GeoPacific (2014)

GeoPacific Engineering, Inc.
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Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP- 1**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	2.0					Moderately organic SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil Horizon)
2	2.0					
3	3.0					Stiff to very stiff, clayey SILT (ML), light brown, micaceous, subtle to strong orange and gray mottling, trace black staining, moist (Willamette Formation)
4	4.0					
5						
6						
7						
8						Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), light reddish-brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
9						Test Pit Terminated at 9 Feet.
10						
11						Note: No seepage or groundwater encountered.
12						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP-2**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	1.0					Moderately to highly organic SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil Horizon)
	2.0					
2	3.5					
3	4.5					Stiff to very stiff, clayey SILT (ML), light brown, micaceous, subtle to strong orange and gray mottling, trace black staining, trace roots to 3 feet, moist (Willamette Formation)
4	4.5					
5						
6						
7						
8						
9						Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), trace gray basalt fragments, light reddish-brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
10						Test Pit Terminated at 10 Feet.
11						Note: Groundwater seepage encountered at 10 feet. Discharge visually estimated at 1/4 gallon per minute.
12						

LEGEND

Bag Sample (100 to 1,000 g) | Bucket Sample (5 Gal Bucket) | Shelby Tube Sample | Seepage | Water Bearing Zone | Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation:

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Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP-3**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	1.5					Moderately organic SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil Horizon)
2	2.0					Stiff to very stiff, clayey SILT (ML), light brown, micaceous, subtle to strong orange and gray mottling, trace black staining, trace roots to 3.5 feet, moist (Willamette Formation)
3	3.0					
4	3.5					
5						Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), trace gray basalt fragments, light reddish-brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
6						
7						Extremely soft to soft (R0-R2), highly weathered BASALT, trace reddish-brown silty clay to clayey silt matrix, gray, black staining, trace yellow secondary mineralization, moist (Columbia River Basalt)
8						
9						Test Pit Terminated at 9 Feet.
10						Note: No seepage or groundwater encountered.
11						
12						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP-4**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	2.0					Moderately organic SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil Horizon)
2	2.5					Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), trace gray basalt fragments, light reddish-brown, subtle orange and gray mottling, trace fine roots to 4 feet, trace black staining, moist (Residual Soil)
3	4.5					
4	3.5					
5						
6						
7						Extremely soft to soft (R0-R2), highly weathered BASALT, trace reddish-brown silty clay to clayey silt matrix, gray, black staining, trace yellow secondary mineralization, moist (Columbia River Basalt)
8						
9						
10						Test Pit Terminated at 10 Feet.
11						Note: No seepage or groundwater encountered.
12						

LEGEND

Bag Sample | Bucket Sample | Shelby Tube Sample | Seepage | Water Bearing Zone | Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP-5**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	1.5					Moderately organic SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil Horizon)
2	2.0					Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), trace gray basalt fragments, light reddish-brown, subtle orange and gray mottling, trace fine roots to 4 feet, trace black staining, moist (Residual Soil)
3	2.0					
4	3.5					
5						
6						
7						
8						Extremely soft to very soft (R0-R1), highly weathered BASALT, trace reddish-brown silty clay to clayey silt matrix, gray, vesicular, black staining, trace yellow secondary mineralization, moist (Columbia River Basalt)
9						
10						Test Pit Terminated at 9.5 Feet.
11						Note: No seepage or groundwater encountered.
12						

LEGEND

Bag Sample | Bucket Sample | Shelby Tube Sample | Seepage | Water Bearing Zone | Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
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Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP-6**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	3.0					Moderately organic SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil Horizon)
2	2.5					
3	3.5					Stiff to very stiff, clayey SILT (ML), light brown, micaceous, subtle to strong orange and gray mottling, trace black staining, moist (Willamette Formation)
4	3.0					
5						
6						
7						Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), light reddish-brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
8						
9						Test Pit Terminated at 9 Feet.
10						
11						Note: Groundwater seepage encountered at 7 feet. Discharge visually estimated at 1/4 gallon per minute.
12						

LEGEND

Bag Sample (100 to 1,000 g) | Bucket Sample (5 Gal Bucket) | Shelby Tube Sample | Seepage | Water Bearing Zone | Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
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Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP- 7**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	1.5					Moderately organic SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil Horizon)
2	2.0					
3	3.0					Stiff to very stiff, clayey SILT (ML), light brown, micaceous, subtle to strong orange and gray mottling, trace black staining, moist (Willamette Formation)
4	2.0					
5						
6						
7						Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), trace subrounded gray basalt fragments, light reddish-brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
8						
9						
10						Test Pit Terminated at 10 Feet.
11						
12						Note: No seepage or groundwater encountered.

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP-8**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	1.5					Moderately organic SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil Horizon)
2	2.0					Stiff to very stiff, clayey SILT (ML), light brown, micaceous, subtle to strong orange and gray mottling, trace black staining, moist (Willamette Formation)
3	3.0					
4	3.5					Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), light reddish-brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
5						Extremely soft to soft (R0-R2), highly weathered BASALT, trace reddish-brown silty clay to clayey silt matrix, gray, vesicular, black staining, trace secondary mineralization, moist (Columbia River Basalt)
6						
7						Practical Refusal on Medium Hard (R3) Basalt at 6.5 Feet.
8						Note: No seepage or groundwater encountered.
9						
10						
11						
12						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation:

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Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP-9**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
0						Moderately organic SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil Horizon)
1	1.5					Stiff to very stiff, clayey SILT (ML), light brown, micaceous, strong orange and gray mottling, trace black staining, moist (Willamette Formation)
2	1.5					
3	3.5					Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), light reddish-brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
4	4.5					
5						Extremely soft to soft (R0-R2), highly weathered BASALT, trace reddish-brown silty clay to clayey silt matrix, gray, vesicular, black staining, trace secondary mineralization, moist (Columbia River Basalt)
6						
7						
8						Practical Refusal on Medium Hard (R3) Basalt at 8 Feet.
9						
10						Note: No seepage or groundwater encountered.
11						
12						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
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Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP-10**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	2.0					Moderately organic SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil Horizon)
2	2.0					
3	2.5					Stiff to very stiff, clayey SILT (ML), light brown, micaceous, subtle to strong orange and gray mottling, trace black staining, moist (Willamette Formation)
4	3.0					
5						
6						
7						Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), light reddish-brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
8						
9						Extremely soft to very soft (R0-R1), highly weathered BASALT, trace reddish-brown silty clay to clayey silt matrix, gray, vesicular, black staining, trace secondary mineralization, moist (Columbia River Basalt)
10						Test Pit Terminated at 9.5 Feet.
11						Note: No seepage or groundwater encountered.
12						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation:

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TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP-11**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	2.5					Moderately organic SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil Horizon)
2	2.5					
3	2.0					Stiff to very stiff, clayey SILT (ML), light brown, micaceous, subtle to strong orange and gray mottling, trace roots to 3 feet, trace black staining, moist (Willamette Formation)
4	2.5					
5						
6						
7						Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), trace gray basalt fragments, light reddish-brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
8						
9						Extremely soft to very soft (R0-R1), highly weathered BASALT, trace reddish-brown silty clay to clayey silt matrix, gray, vesicular, black staining, trace secondary mineralization, moist (Columbia River Basalt)
10						
11						Test Pit Terminated at 11 Feet.
12						Note: No seepage or groundwater encountered.

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP-12**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	4.0					Moderately organic SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil Horizon)
2	3.0					
3	1.5					Stiff to very stiff, clayey SILT (ML), light brown, micaceous, subtle to strong orange and gray mottling, trace black staining, moist (Willamette Formation)
4	1.5					
5						
6						
7						Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), light reddish-brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
8						
9						
10						
11						Test Pit Terminated at 10.5 Feet.
12						Note: No seepage or groundwater encountered.

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
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TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP-13**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	1.0					Moderately organic SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil Horizon)
2	2.0					
3	1.5					Stiff to very stiff, clayey SILT (ML), light brown, micaceous, subtle to strong orange and gray mottling, trace black staining, moist (Willamette Formation)
4	4.0					
5						
6						
7						
8						Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), light reddish-brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
9						
10						Extremely soft to soft (R0-R2), highly weathered BASALT, trace reddish-brown silty clay to clayey silt matrix, gray, vesicular, black staining, trace secondary mineralization, moist (Columbia River Basalt)
11						Test Pit Terminated at 10 Feet.
12						Note: No seepage or groundwater encountered.

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation:

GeoPacific Engineering, Inc.
14835 SW 72nd Avenue
Portland, Oregon 97224
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TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP-14**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	1.0					Moderately to highly organic SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil Horizon)
2	1.5					
3	2.5					Medium stiff to stiff, clayey SILT (ML), light brown, micaceous, subtle to strong orange and gray mottling, significant sidewall caving from 4 to 7 feet, trace black staining, moist (Willamette Formation)
4	2.0					
5						
6						
7						Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), light reddish-brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
8						
9						Test Pit Terminated at 9 Feet.
10						
11						Note: Groundwater seepage encountered at 4 to 7 feet. Discharge visually estimated at 2 gallons per minute.
12						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation:

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TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP-15**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	4.5					Moderately organic SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil Horizon)
2	3.5					Stiff to very stiff, clayey SILT (ML), light brown, micaceous, strong orange and gray mottling, trace black staining, moist (Willamette Formation)
3	2.0					
4	4.0					
5						
6						
7						Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), light reddish-brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
8						Soft (R2), highly weathered BASALT, trace reddish-brown silty clay to clayey silt matrix, gray, vesicular, moist (Columbia River Basalt)
9						Practical Refusal on Medium Hard (R3) Basalt at 8.5 Feet.
10						Note: No seepage or groundwater encountered.
11						
12						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation:

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TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP-16**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	3.5					Moderately organic SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil Horizon)
2	3.0					
3	2.5					Stiff to very stiff, clayey SILT (ML), light brown, micaceous, subtle to strong orange and gray mottling, trace black staining, trace roots, moist (Willamette Formation)
4	3.5					
5						
6						
7						
8						
9						Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), trace gray basalt fragments, light reddish-brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
10						
11						Extremely soft to very soft (R0-R1), highly weathered BASALT, trace reddish-brown silty clay to clayey silt matrix, gray, black staining, trace yellow secondary mineralization, moist (Columbia River Basalt)
12						Test Pit Terminated at 11.5 Feet. Note: Groundwater seepage encountered at 11.5 feet. Discharge visually estimated at 1/4 gallon per minute.

LEGEND

Bag Sample | Bucket Sample | Shelby Tube Sample | Seepage | Water Bearing Zone | Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation:

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TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP-17**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	2.0					Low to moderately organic SILT (OL-ML), brown, fine roots throughout, loose, moist (Topsoil Horizon)
2	1.5					
3	3.0					Stiff to very stiff, clayey SILT (ML), light brown, micaceous, subtle to strong orange and gray mottling, trace roots to 3.5 feet, trace black staining, moist (Willamette Formation)
4	2.5					
5						
6						
7						Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), light reddish-brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
8						
9						Test Pit Terminated at 9 Feet.
10						
11						Note: Groundwater seepage encountered at 4 to 7 feet. Discharge visually estimated at 1 gallon per minute.
12						

LEGEND

Bag Sample (100 to 1,000 g) | Bucket Sample (5 Gal. Bucket) | Shelby Tube Sample | Seepage | Water Bearing Zone | Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation:

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TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP-18**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	3.0					Moderately to highly organic SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil Horizon)
2	2.5					
3	3.5					Medium stiff to stiff, clayey SILT (ML), light brown, micaceous, subtle to strong orange and gray mottling, trace roots to 3.5 feet, trace black staining, moist (Willamette Formation)
4	3.5					
5						
6						
7					~~	
8						Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), light reddish-brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
9						Test Pit Terminated at 9 Feet.
10						
11						Note: Groundwater seepage encountered at 7 feet. Discharge visually estimated at 1/4 gallon per minute.
12						

LEGEND

Bag Sample | Bucket Sample | Shelby Tube Sample | Seepage | Water Bearing Zone | Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation:

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TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP-19**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	2.0					Moderately organic SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil Horizon)
2	2.0					
3	3.5					Stiff to very stiff, clayey SILT (ML), light brown, micaceous, subtle to strong orange and gray mottling, trace roots to 3 feet, trace black staining, moist (Willamette Formation)
4	2.5					
5						
6						
7						
8						Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), light reddish-brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
9						
10						Test Pit Terminated at 9.5 Feet.
11						Note: Groundwater seepage encountered at 8 feet. Discharge visually estimated at 1/4 gallon per minute.
12						

LEGEND

Bag Sample | Bucket Sample | Shelby Tube Sample | Seepage | Water Bearing Zone | Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation:

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TEST PIT LOG

Project: Dyches Property
Washington County, Oregon

Project No. 14-3396

Test Pit No. **TP-20**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	In-Situ Dry Density (lb/ft³)	Moisture Content (%)	Water Bearing Zone	Material Description
1	1.5					Moderately organic SILT (OL-ML), dark brown, fine roots throughout, loose, moist (Topsoil Horizon)
2	2.5					
3	4.5					Stiff to very stiff, clayey SILT (ML), light brown, micaceous, subtle to strong orange and gray mottling, trace roots to 3.5 feet, trace black staining, moist (Willamette Formation)
4	3.5					
5						
6						
7						Stiff to very stiff, silty CLAY to clayey SILT (CL-ML), light reddish-brown, subtle orange and gray mottling, trace black staining, moist (Residual Soil)
8						
9						Test Pit Terminated at 9 Feet.
10						
11						Note: Groundwater seepage encountered at 6 feet. Discharge visually estimated at 1/4 gallon per minute.
12						

LEGEND

Bag Sample

Bucket Sample


Shelby Tube Sample


Seepage


Water Bearing Zone


Water Level at Abandonment

Date Excavated: 5/12-13/2013
Logged By: B. Rapp
Surface Elevation: