Calculations required to be provided by the Permittee on site for all Inspections

GEOTECHNICAL REPORT

Wesley Homes Puyallup
39th Avenue SE
Puyallup, Washington

Project No. T-5915-3

PRRWF20250002

Terra Associates, Inc.

Prepared for:

Wesley Homes
Des Moines, Washington

October 28, 2015
Revised November 14, 2016

TERRA ASSOCIATES, Inc.
Consultants in Geotechnical Engineering, Geology
and
Environmental Earth Sciences

October 28, 2015
Revised November 14, 2016
Project No. T-5915-3

Mr. Kevin Anderson
Wesley Homes
815 South 216th Street
Des Moines, Washington 98198

Subject: Geotechnical Report
Wesley Homes Puyallup
39th Avenue SE
Puyallup, Washington

Dear Mr. Anderson:

As requested, we have conducted a geotechnical engineering study for the subject project. The attached report presents our findings and recommendations for the geotechnical aspects of project design and construction.

Our field exploration indicates the soil conditions generally consist of 2 to 18 inches of organic topsoil overlying glacial drift deposits composed of a varying mixture of silty sand, sand, gravel, and silt. In general, the soils were found in a medium dense to dense condition. The exception to this general condition was observed in Test Pit TP-103 where we observed approximately 13.5 feet of organic fill material overlying the native soils. Similar fill material was also observed in Test Pits TP-11 and TP-12 by GeoEngineers (2003) and Test Pit TP-8 by Terra Associates, Inc. (2006).

These fill soils observed are not suitable for building support and should be removed and replaced with new structural fill. Alternatively, the northern buildings may be supported on deep foundations such as pipe piles or on ground improved by installation of Geopiers.

In our opinion, the native soils on the site will be suitable for support of the proposed development provided the recommendations presented in this report are incorporated into project design and construction.

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We trust the information presented in this report is sufficient for your current needs. If you have any questions or require additional information, please call.

Sincerely yours,
TERRA ASSOCIATES, INC.

Carolyn S. Decker, P.E.
Project Engineer

11-14-16

Theodore J. Schepper, P.E.
President

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1.0 PROJECT DESCRIPTION

The project consists of developing the approximately 14-acre site with a senior housing complex. The complex will include a multi-story building, two brownstone buildings, a stormwater detention pond, and associated access and utility improvements. Based on the grading and storm drainage plan prepared by Barghausen Consulting Engineers dated April 6, 2016, grading to achieve building lot and roadway grades will consist of cuts and fills from 1 to 13 feet. Vertical grade transitions will be supported by retaining walls.

Stormwater will be collected and routed to a detention pond located in the southwest portion of the site. The pond will be formed by a combination of excavation below current site grade, construction of a fill containment berm along the northwest perimeter, and construction of a retaining wall along the east perimeter. The excavation required to achieve the floor elevation of 447.0 will extend 11 to 15 feet below current site grades. The fill depth required to achieve the berm crest elevation of 459.0 will range from 6 to 9 feet.

We expect the multi-story building and brownstone buildings to be wood-framed with slab-on-grade floors producing moderate foundation loads with bearing wall and isolated column loads ranging from about 4 to 6 kips per foot and 200 to 400 kips.

The recommendations in the following sections of this report are based on our understanding of the preceding design features. We should review design drawings as they become available to verify that our recommendations have been properly interpreted and to supplement them, if required.

2.0 SCOPE OF WORK

Our work was completed in accordance with our proposal dated June 1, 2015. Accordingly, on October 13, 2015, we excavated 12 test pits to a maximum depth of 15 feet below existing surface grades. Using the information obtained from our recent subsurface exploration, previous subsurface exploration, and laboratory testing, we performed analyses to develop geotechnical recommendations for project design and construction. Specifically, this report addresses the following:

- Soil and groundwater conditions
- Seismic Criteria per 2015 International Building Code (IBC)
- Geologic Hazards per City of Puyallup Municipal Code
- Site preparation and grading
- Slopes and embankments
- Excavations

- Foundations
- Slab-on-grade floors
- Stormwater detention pond
- Low Impact Development (LID) Methods
- Lateral earth pressure parameters for wall design
- Drainage
- Utilities
- Pavements

It should be noted that recommendations outlined in this report regarding drainage are associated with soil strength, design earth pressures, erosion, and stability. Design and performance issues with respect to moisture as it relates to the structure environment are beyond Terra Associates' purview. A building envelope specialist or contractor should be consulted to address these issues, as needed.

3.0 SITE CONDITIONS

3.1 Surface

The project site is located on the north side of 37th Avenue SE Street approximately 80 feet west of the intersection with 10th Street SE in Puyallup, Washington. The approximate location of the site is shown on the Vicinity Map, Figure 1.

The site is irregular in plan dimension measuring approximately 370 by 1,270 feet. An electrical substation exists east of the property. The majority of the project site slopes gently down towards the west. Overall relief across the site is about 50 feet. The western site margin is bounded by a west-facing slope with approximately 20 feet of local relief with a gradient of about 14 to 30 percent. The site is covered with large to medium-sized Evergreen and deciduous trees and moderate growth of underbrush.

3.2 Soils

In general, the soil conditions observed in the recent test pits consisted of 2 to 18 inches of organic topsoil overlying glacial drift deposits composed of varying mixtures of silty sand, sand, gravel, and silt. In general, the soils were found in a medium dense to dense condition. The exception to this general condition was observed in Test Pit TP-103 where we observed approximately 13.5 feet of organic fill material overlying the native soils. Similar fill material was also observed in Test Pits TP-11 and TP-12 by GeoEngineers (2003) and Test Pit TP-8 by Terra Associates, Inc. (2006).

The *Geologic Map of the South Half of The Tacoma Quadrangle, Washington, by Timothy J. Walsh*, dated 1987 maps the soils as Vashon glacial drift (Vdv). The Vashon glacial drift is described as recessional and interglacial stratified outwash sands and gravels, locally containing silts and clays. Native soil conditions we observed in our test pits are consistent with this mapped geology.

The preceding discussion is intended as a general review of the soil conditions encountered. A more detailed description of the subsurface conditions encountered is presented on the Test Pit Logs in Appendix A. The approximate test pit locations are shown on Figure 2. Figure 2 also shows the location of previous test pits excavated by GeoEngineers and Terra Associates, Inc. Previous test pit logs prepared by GeoEngineers and Terra Associates, Inc. are included in Appendix B.

3.3 Groundwater

We observed groundwater seepage in Test Pits TP-107, TP-109, and TP-110 between 7 and 11 feet below current site grades which equates to approximately elevation 443 to 445 feet relative to site elevations. The groundwater was observed flowing from a recessional gravel outwash layer. Previous site exploration test pits excavated by GeoEngineers in March 2003 encountered similar groundwater flows from this gravel layer at depths of five to nine feet below site grades. Based on the location of the test pits and elevation of the groundwater, it appears that the groundwater observed represents a localized shallow groundwater table residing in the gravel outwash.

Although we did not observe groundwater in the other test pits we did observe mottled or iron staining of the upper few feet of many of the soil layers indicating perched shallow groundwater tables likely develop during the normally wet winter months.

4.0 GEOLOGIC HAZARDS

4.1 Seismic Considerations

Section 21.06.210 (113) of the City of Puyallup Municipal Code (PMC) defines Seismic hazard areas as "areas that are subject to severe risk of damage as a result of earthquake-induced ground shaking, slope failure, settlement, or soil liquefaction."

Liquefaction is a phenomenon where there is a reduction or complete loss of soil strength due to an increase in water pressure induced by vibrations. Liquefaction mainly affects geologically recent deposits of fine-grained sand that are below the groundwater table. Soils of this nature derive their strength from intergranular friction. The generated water pressure or pore pressure essentially separates the soil grains and eliminates this intergranular friction; thus, eliminating the soil's strength.

Based on the soil and groundwater conditions we observed, it is our opinion that there is minimal risk for liquefaction related impacts to occur at this site during an earthquake.

Based on soil conditions observed in the test borings and our knowledge of the area geology, per Chapter 16 of the 2015 International Building Code (IBC), site class "C" should be used in structural design. Based on this site class, in accordance with the 2015 IBC, the following parameters should be used in computing seismic forces:

Seismic Design Parameters (IBC 2015)

Spectral response acceleration (Short Period), S_{Ms}	1.244
Spectral response acceleration (1 – Second Period), S_{M1}	0.632
Five percent damped .2 second period, S_{Ds}	0.829
Five percent damped 1.0 second period, S_{D1}	0.421

These values were determined using the latitude/longitude coordinates 47.156499/-122.283487 and the United States Geological Survey (USGS) Ground Motion Parameter Calculator accessed on November 9, 2016 at the web site http://earthquake.usgs.gov/designmaps/us/application.php.

4.2 Erosion

Section 21.06.210 (40) of the PMC defines Erosion hazard areas as "lands or areas underlain by soils identified by the U.S. Department of Agriculture Natural Resource Conservation Service (NRCS) as having "severe" or "very severe" erosion hazards. These include, but are not limited to, the following group of soils when they occur on slopes of 15 percent or greater: Alderwood gravelly sandy loam, Indianola gravelly loam, Kapowsin gravelly loam, Kitsap silt loam (KpD), and Xerochrepts."

The soils observed on-site are classified as Everett gravelly sand loam 0 to 6 percent slopes and Neilton gravelly loamy sand, 8 to 25 percent slopes by the United States Department of Agriculture Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service. With the existing slope gradients, these soils will have a slight to severe potential for erosion when exposed. Therefore, the site is an erosion hazard area as defined by the PMC.

Implementation of temporary and permanent Best Management Practices (BMPs) for preventing and controlling erosion will be required and will mitigate the erosion hazard. As a minimum, we recommend implementing the following erosion and sediment control BMPs prior to, during, and immediately following construction activities at the site.

Prevention

- Limit site clearing and grading activities to the relatively dry months (typically May through September).
- Limit disturbance to areas where construction is imminent.
- Locate temporary stockpiles of excavated soils no closer than ten feet from the crest of slopes.
- Provide temporary cover for cut slopes and soil stockpiles during periods of inactivity. Temporary cover may consist of durable plastic sheeting that is securely anchored to the ground surface or straw mulch.
- Establish permanent cover over exposed areas that will not be disturbed for a period of 30 days or more by seeding, in conjunction with a mulch cover or appropriate hydroseeding.

Containment

- Install a silt fence along site margins and downslope of areas that will be disturbed. The silt fence should be in place before clearing and grading is initiated.
- Intercept surface water flow and route the flow away from the slope to a stabilized discharge point. Surface water must not discharge at the top or onto the face of the steep slope.
- Provide on-site sediment retention for collected runoff.

The contractor should perform daily review and maintenance of all erosion and sedimentation control measures at the site.

4.3 Landslide Hazard

Section 21.06.210 (81) of the PMC defines Landslide Hazard areas as "areas that, due to a combination of site conditions like slope inclination and relative soil permeability are susceptible to landsliding."

With the soil conditions and existing slope gradients observed at the site, in our opinion the site does not contain any landslide hazard areas as defined by the PMC.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 General

Based on our study, from a geotechnical engineering perspective, the site is suitable for the proposed development. The competent inorganic native soils would provide suitable support for conventional spread footing foundations. Alternatively, if required by desired final building elevations, structural fill placed and compacted above these native soils can be used to support the building foundations. Floor slabs and pavements can be similarly supported.

The existing fill soils observed to depths of 15 feet in the northern area of the site will not be suitable for building support. These existing fills will either need to be removed and replaced with new structural fill or the building foundations and floor supported on piles driven or drilled through the fill into the underlying competent native soils. The lateral extent of the undocumented fill will need to be determined in the field during grading.

Some of the native soils encountered at the site contain a significant amount of fines and will be difficult to compact as structural fill when too wet. The ability to use native silty soils from site excavations as structural fill will depend on its moisture content and the prevailing weather conditions at the time of construction. If grading activities will take place during the winter season, the owner should be prepared to import free-draining granular material for use as structural fill and backfill. The cleaner gravelly sand and sand layers would be suitable for use as structural fill under most weather conditions. The existing organic fill material would not be suitable for reuse as structural fill.

Detailed recommendations regarding the above issues and other geotechnical design considerations are provided in the following sections. These recommendations should be incorporated into the final design drawings and construction specifications.

5.2 Site Preparation and Grading

To prepare the site for construction, existing surface vegetation and other deleterious materials should be stripped and removed. Based on conditions observed at the test pits, we would estimate that surface stripping depths of 2 to 18 inches will be required to remove site vegetation and associated near-surface organic debris. Vegetation debris from clearing operations should be removed from the site. Organic topsoil will not be suitable for use as structural fill, but may be used for limited depths in nonstructural areas.

If the northern building in the vicinity of Terra Test Pits TP-103 and TP-8 and GeoEngineers Test Pits TP-11 and TP-12 are not supported on piles, the existing fill will need to be removed and replaced with structural fill for building support. Excavations to remove the existing fill will, based on the test pits, extend to depths of at least 15 feet below current site grades. The lateral extent of the undocumented fill material will need to be determined in the field during grading.

Once clearing and stripping operations are complete, cut and fill operations can be initiated to establish desired grades. Prior to placing fill, all exposed bearing surfaces should be observed by a representative of Terra Associates to verify soil conditions are as expected and suitable for support of new fill. Our representative may request a proofroll using heavy rubber-tired equipment to determine if any isolated soft and yielding areas are present. If excessively yielding areas are observed, and they cannot be stabilized in place by compaction, the affected soils should be excavated and removed to firm bearing and grade restored with new structural fill. Beneath embankment fills or roadway subgrade if the depth of excavation to remove unstable soils is excessive, the use of geotextile fabrics, such as Mirafi 500X, or an equivalent fabric, can be used in conjunction with clean granular structural fill. Our experience has shown that, in general, a minimum of 18 inches of a clean, granular structural fill placed and compacted over the geotextile fabric should establish a stable bearing surface.

Some of the native soils encountered at the site contain a significant amount of fines and will be difficult to compact as structural fill when too wet. The ability to use native silty soils from site excavations as structural fill will depend on its moisture content and the prevailing weather conditions at the time of construction. If grading activities will take place during the winter season, the owner should be prepared to import free-draining granular material for use as structural fill and backfill. The cleaner sand and gravel layers would be suitable for use as structural fill under most weather conditions.

If imported fill is needed for site grading or subgrade preparation, we recommend that the fill consist of inorganic granular soil meeting the following gradation:

U.S. Sieve Size	Percent Passing
3 inches	100
No. 4	75 maximum
No. 200	5 maximum*

*Based on the 3/4-inch fraction.

Prior to use, Terra Associates, Inc. should examine and test all materials imported to the site for use as structural fill.

Structural fill should be placed in uniform loose layers not exceeding 12 inches and compacted to a minimum of 95 percent of the soil's maximum dry density, as determined by American Society for Testing and Materials (ASTM) Test Designation D-698 (Standard Proctor). The moisture content of the soil at the time of compaction should be within two percent of its optimum, as determined by this ASTM standard. In nonstructural areas the degree of compaction can be reduced to 90 percent.

5.3 Excavations

All excavations at the site associated with confined spaces, such as utility trenches and lower building levels, must be completed in accordance with local, state, or federal requirements. Based on current Washington State Industrial Safety and Health Administration (WISHA) regulations, the upper loose uncontrolled fill and medium dense to dense native soils at the site would be classified as Type C soils. The deeper very dense native soils would be classified as Type A soils.

Accordingly, temporary excavations in Type C soils should have their slopes laid back at an inclination of 1.5:1 (Horizontal:Vertical) or flatter, from the toe to the crest of the slope. Side slopes in Type A soils can be laid back at a slope inclination of 0.75:1 or flatter. For temporary excavation slopes less than 8 feet in height in Type A soils, the lower 3.5 feet can be cut to a vertical condition, with a 0.75:1 slope graded above. For temporary excavation slopes greater than 8 feet in height up to a maximum height of 12 feet, the slope above the 3.5-foot vertical portion will need to be laid back at a minimum slope inclination of 1:1. No vertical cut with a backslope immediately above is allowed for excavation depths that exceed 12 feet. In this case, a four-foot vertical cut with an equivalent horizontal bench to the cut slope toe is required. All exposed temporary slope faces that will remain open for an extended period of time should be covered with a durable reinforced plastic membrane during construction to prevent slope raveling and rutting during periods of precipitation.

Site exploration indicates the presence of a localized shallow groundwater table contained in the gravel outwash layer at depths of 5 to 11 feet below current site grades. Also perched groundwater development can be expected at the site during the winter season. The contactor should be prepared to dewater site excavations as needed to maintain stability and relatively dry working conditions. Dewatering using conventional sump pumps along with collector trenches at the excavation base or perimeter cut off drains to capture and control seepage before it enters the excavation will need to be considered.

The above information is provided solely for the benefit of the owner and other design consultants, and should not be construed to imply that Terra Associates, Inc. assumes responsibility for job site safety. Job site safety is the sole responsibility of the project contractor.

5.4 Slopes and Embankments

All permanent cut and fill slopes should be graded with a finished inclination of no greater than 2:1 (Horizontal:Vertical). Upon completion of grading, the slope face should be appropriately vegetated or provided with other physical means to guard against erosion. Final grades at the top of the slope must promote surface drainage away from the slope crest. Water must not be allowed to flow uncontrolled over the slope face. If surface runoff must be directed towards the slope, the runoff should be controlled at the top of the slope, piped in a closed conduit installed on the slope face, and taken to an appropriate point of discharge beyond the toe.

All fill placed for embankment construction should meet the structural fill requirements in Section 5.2 of this report. In addition, if the new fills will be placed over existing slopes of 20 percent or greater, the structural fill should be keyed and benched into competent native slope soils. Figure 3 presents a typical slope key and bench configuration. At minimum, a toe drain should be installed in the key cut as shown on Figure 3. Depending on seepage conditions, drains may also be required along individual benches excavated on the slope face especially along the pond slopes. The need for drains along the upper benches will be best determined in the field at the time of construction.

5.5 Foundations

Spread Footings

The buildings may be supported on conventional, isolated, or continuous spread footing foundations bearing on the competent undisturbed native soils or structural fill placed on undisturbed competent native soils. Spread footing foundations bearing on undisturbed subgrade composed of the native soils and compacted structural fill can be designed for a net allowable bearing capacity 3,000 pounds per square foot (psf). For short-term loads, such as wind and seismic, a one-third increase in the allowable bearing capacity may be used. For the structural loading expected, we estimate total settlement of isolated spread footings will be one-inch or less, with differential settlement of one-half inch and less.

For designing foundations to resist lateral loads, a base friction coefficient of 0.35 can be used. Passive earth pressures acting on the side of the footing can also be considered. We recommend calculating this lateral resistance using an equivalent fluid weight of 350 pcf. We recommend not including the upper 12 inches of soil in this computation because they can be affected by weather or disturbed by future grading activity. This value assumes the foundation will be constructed neat against competent fill soil or backfilled with structural fill. The recommended lateral resistance value includes a safety factor of 1.5.

The soils exposed at foundation levels for the large multi-unit buildings should be observed by Terra Associates, Inc. If loose or medium stiff silts are present at planned footing grades, these silts should be overexcavated and be replaced with structural fill or as an alternative, the foundations may be stepped down to bear on the underlying dense glacially consolidated soils.

The following sections address foundation options for the northern buildings underlain by loose fills.

Steel Pipe Piles

If excavation and replacement of existing fills for the northern buildings is determined to be uneconomical or unfeasible, a suitable alternative for foundation support is to transfer building loads through the uncontrolled fill to the underlying very dense or hard bearing strata using four-inch diameter steel pipe piles. The pipe piles should be driven to refusal using a minimum 850 foot-pound impact hammer. Refusal is defined as less than one-inch of pile penetration during 15 seconds of continuous driving.

Based on data from the test pits, we anticipate pile tip elevations will range from 15 to 20 feet below existing grades. Pipe pile installation may encounter some obstructions, such as wood debris and roots. If an obstruction is encountered during driving, the pile location should be excavated, the obstruction removed, and the area then refilled to grade before re-driving. Alternatively, flexibility in pile location can be included in the design to allow for relocating the pile a short distance in an attempt to avoid the obstruction.

Four-inch diameter steel pipe piles driven to refusal will develop an allowable axial capacity of ten tons per pile. For resistance to lateral loading, a lateral pile capacity of one-fourth of a ton can be used for vertically-placed piles. Pipe piles may be battered to increase their ability to resist lateral loads. We expect pile settlements would not exceed one-fourth of an inch.

Ground Improvement

As an alternative to piles, consideration can be given to using ground other improvement techniques to establish suitable support for conventional spread footing designs. Methods that could be considered include vibrated stone columns or Geopiers (aggregate rammed piers). Both of these methods create highly densified columns of graded aggregate that would extend through the upper softer soils a short depth into the underlying dense sands. Because of the methods used to construct the columns some improvement of the adjacent soils is also realized. Once constructed, conventional spread footing foundations can be designed to bear immediately above the stone column/Geopier locations.

These ground improvement techniques are typically completed on a design/build approach with both design and construction completed by a specialty contractor. We can assist in contracting and selecting the specialty contractor, if desired.

5.6 Slab-on-Grade Construction

Slab-on-grade may be supported on competent undisturbed bearing surfaces consisting of the native dense drift soils or structural fill placed above competent native soils. If the existing fill is not removed from below the northern buildings the floors should also be structurally supported on piles.

Immediately below the floor slab, we recommend placing a four-inch thick capillary break layer composed of clean, coarse sand or fine gravel that has less than three percent passing the No. 200 sieve. This material will reduce the potential for upward capillary movement of water through the underlying soil and subsequent wetting of the floor slab.

The capillary break layer will not prevent moisture intrusion through the slab caused by water vapor transmission. Where moisture by vapor transmission is undesirable, such as covered floor areas, a common practice is to place a durable plastic membrane on the capillary break layer and then cover the membrane with a layer of clean sand or fine gravel to protect it from damage during construction, and aid in uniform curing of the concrete slab. It should be noted that if the sand or gravel layer overlying the membrane is saturated prior to pouring the slab, it will be ineffective in assisting uniform curing of the slab, and can actually serve as a water supply for moisture seeping through the slab and affecting floor coverings. Therefore, in our opinion, covering the membrane with a layer of sand or gravel should be avoided if floor slab construction occurs during the wet winter months and the layer cannot be effectively drained. We recommend floor designers and contractors refer to the 2003 American Concrete Institute (ACI) Manual of Concrete Practice, Part 2, 302.1R-96, for further information regarding vapor barrier installation below slab-on-grade floors.

5.7 Lateral Earth Pressure on Below-Grade Building Walls

The magnitude of earth pressure development on below-grade walls will partly depend on the quality of the wall backfill. We recommend placing and compacting wall backfill as structural fill as described in Section 5.2 of this report. To guard against hydrostatic pressure development, wall drainage must also be installed. A typical recommended wall drainage detail is shown on Figure 4.

With wall backfill placed and compacted as recommended, and drainage properly installed, we recommend designing unrestrained walls for an active earth pressure equivalent to a fluid weighing 35 pounds per cubic foot (pcf). For restrained walls, an additional uniform load of 100 psf should be added to the 35 pcf. To account for typical traffic surcharge loading, the walls can be designed for an additional imaginary height of two feet (two-foot soil surcharge). For evaluation of wall performance under seismic loading, a uniform pressure equivalent to 8H psf, where H is the height of the below-grade portion of the wall should be applied in addition to the static lateral earth pressure. These values assume a horizontal backfill condition and that no other surcharge loading, sloping embankments, or adjacent buildings will act on the wall. If such conditions exist, then the imposed loading must be included in the wall design. Friction at the base of foundations and passive earth pressure will provide resistance to these lateral loads. Values for these parameters are provided in Section 5.5 of this report.

5.8 Stormwater Detention Pond

As mentioned above, a stormwater pond is planned for the site. The proposed pond floor is between 11 and 15 feet below existing site grades and is formed by a combination of excavation, fill containment berm construction, and wall construction. The fill depths for the berm construction are between six and nine feet. Fill used to form containment berms for the detention ponds should consist of native silty sand with gravel placed and compacted as structural fill. Interior pond slopes below the stored water level should be graded at 3:1 with exterior pond slopes at 2:1.

Our field exploration indicates that the soils in the area of the pond consist of dense gravel with silt and sand. Heavy groundwater flow was observed near elevations 443 to 445 feet in the test pits located in the larger pond area which is currently below the proposed bottom of pond elevation of 447 feet. This groundwater elevation would be expected to rise during the normally wet winter season. While the soils encountered at this pond site exhibit permeability characteristics that would be suitable for infiltration considerations the elevated groundwater table would preclude designing the pond as a retention facility. However, if there is a dead storage water quality component in the pond design, lining the pond to prevent infiltration losses of the dead storage component will need to be considered.

5.9 Drainage

Surface

Final exterior grades should promote free and positive drainage away from the site at all times. Water must not be allowed to pond or collect adjacent to foundations or within the immediate building area. We recommend providing a positive drainage gradient away from the building perimeter. If this gradient cannot be provided, surface water should be collected adjacent to the structures and disposed to appropriate storm facilities.

Surface water must not be allowed to flow uncontrolled over the crest of the site slopes and embankments. Surface water should be directed away from the slope crests to a point of collection and controlled discharge. If site grades do not allow for directing surface water away from the slopes, then water should be collected and tightlined down the slope face in a controlled manner.

Subsurface

We recommend installing perimeter foundation drains adjacent to shallow foundations. The drains can be laid to grade at an invert elevation equivalent to the bottom of footing grade. The drains can consist of four-inch diameter perforated PVC pipe that is enveloped in washed pea gravel-sized drainage aggregate. The aggregate should extend six inches above and to the sides of the pipe. Roof and foundation drains should be tightlined separately to the storm drains. All drains should be provided with cleanouts at easily accessible locations.

Infiltration

The drift soils composed of silty sand with gravel, silt, and sandy silt characteristically exhibits low permeability and would not be a suitable receptor soil for discharge of development stormwater using infiltration/retention facilities. While there are deposits of cleaner outwash soils also present within the drift deposits their random distribution and limited thickness would preclude designing and using infiltration systems, in our opinion. Conventional stormwater detention with controlled release to the drainage basin should be used to manage development stormwater.

5.10 Utilities

Utility pipes should be bedded and backfilled in accordance with American Public Works Association (APWA) specifications. For site utilities within city rights of way, bedding and backfill should be completed in accordance with City of Puyallup specifications. At minimum, trench backfill should be placed and compacted as structural fill, as described in the Section 5.2 of this report. As noted, soils excavated on-site should be suitable for use as backfill material during dry weather conditions. However, the contractor should be prepared to moisture condition the soils to facilitate proper compaction, as necessary and import suitable material during the wet winter months.

5.11 Pavements

The pavement design section is dependent upon the supporting capability of the subgrade soils and the traffic conditions to which it will be subjected. All subgrade should be prepared in accordance with the recommendations in Section 5.2 of this report. For traffic consisting mainly of light passenger and commercial vehicles with only occasional heavy traffic, and with a stable subgrade prepared as recommended, we recommend the following pavement sections:

- Two inches of Hot Mix Asphalt (HMA) over four inches of crushed rock base (CRB)
- Four inches full depth HMA

The paving materials used should conform to the current Washington State Department of Transportation (WSDOT) specifications for HMA and CRB surfacing.

Long-term pavement performance will depend on surface drainage. A poorly-drained pavement section will be subject to premature failure as a result of surface water infiltrating into the subgrade soils and reducing their supporting capability. For optimum pavement performance, we recommend surface drainage gradients of at least two percent. Some degree of longitudinal and transverse cracking of the pavement surface should be expected over time. Regular maintenance should be planned to seal cracks when they occur.

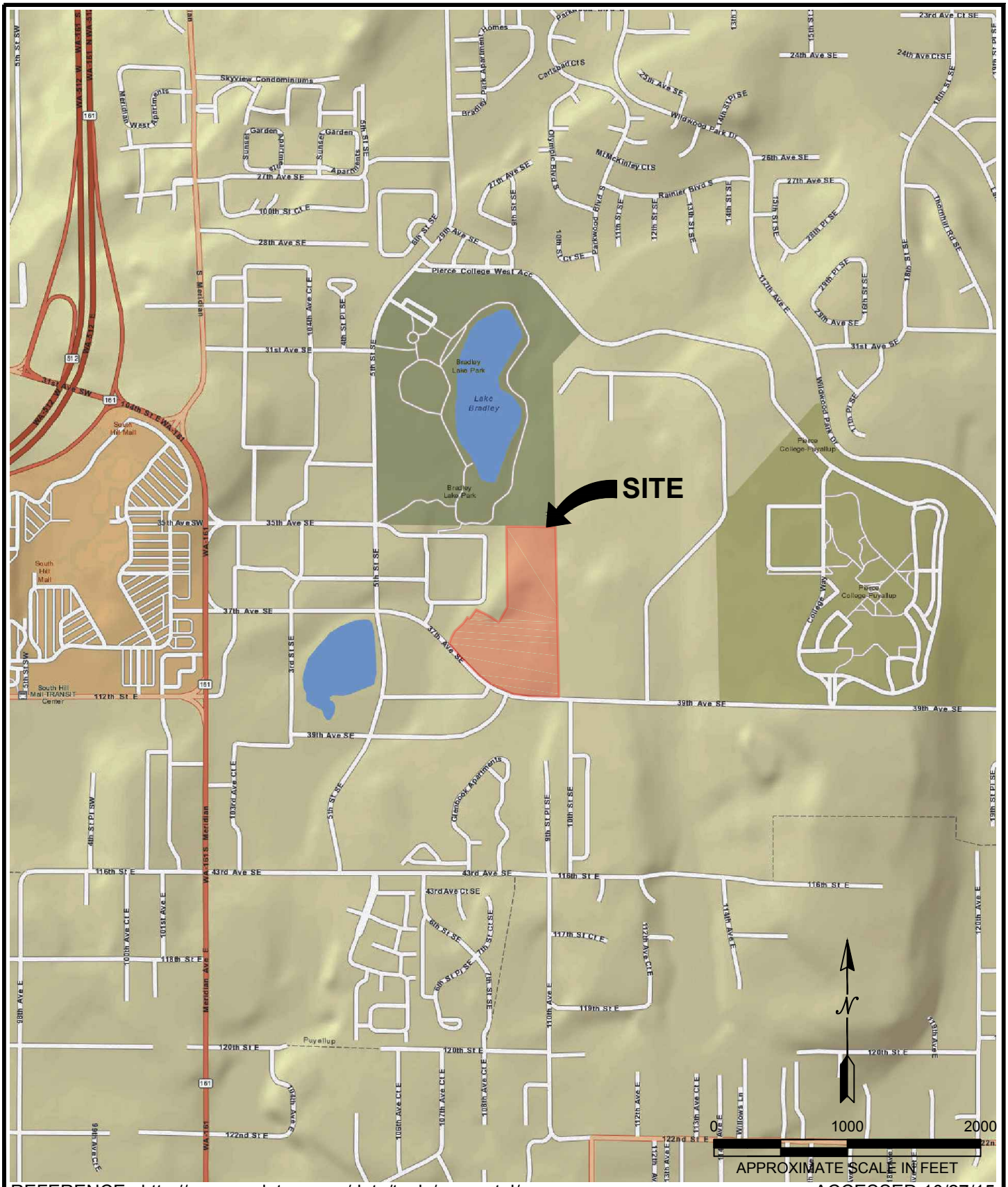
6.0 ADDITIONAL SERVICES

Terra Associates, Inc. should review the final design and specifications in order to verify that earthwork and foundation recommendations have been properly interpreted and implemented in project design. We should also provide geotechnical services during construction in order to observe compliance with the design concepts, specifications, and recommendations. This will allow for design changes if subsurface conditions differ from those anticipated prior to the start of construction.

7.0 LIMITATIONS

This report is the property of Terra Associates, Inc. and was prepared in accordance with generally accepted geotechnical engineering practices. This report is intended for specific application to the Wesley Homes Puyallup project and for the exclusive use of Wesley Homes and their authorized representatives. No other warranty, expressed or implied, is made.

The analyses and recommendations presented in this report are based upon data obtained from the test pits excavated on-site. Variations in soil conditions can occur, the nature and extent of which may not become evident until construction. If variations appear evident, Terra Associates, Inc. should be requested to reevaluate the recommendations in this report prior to proceeding with construction.

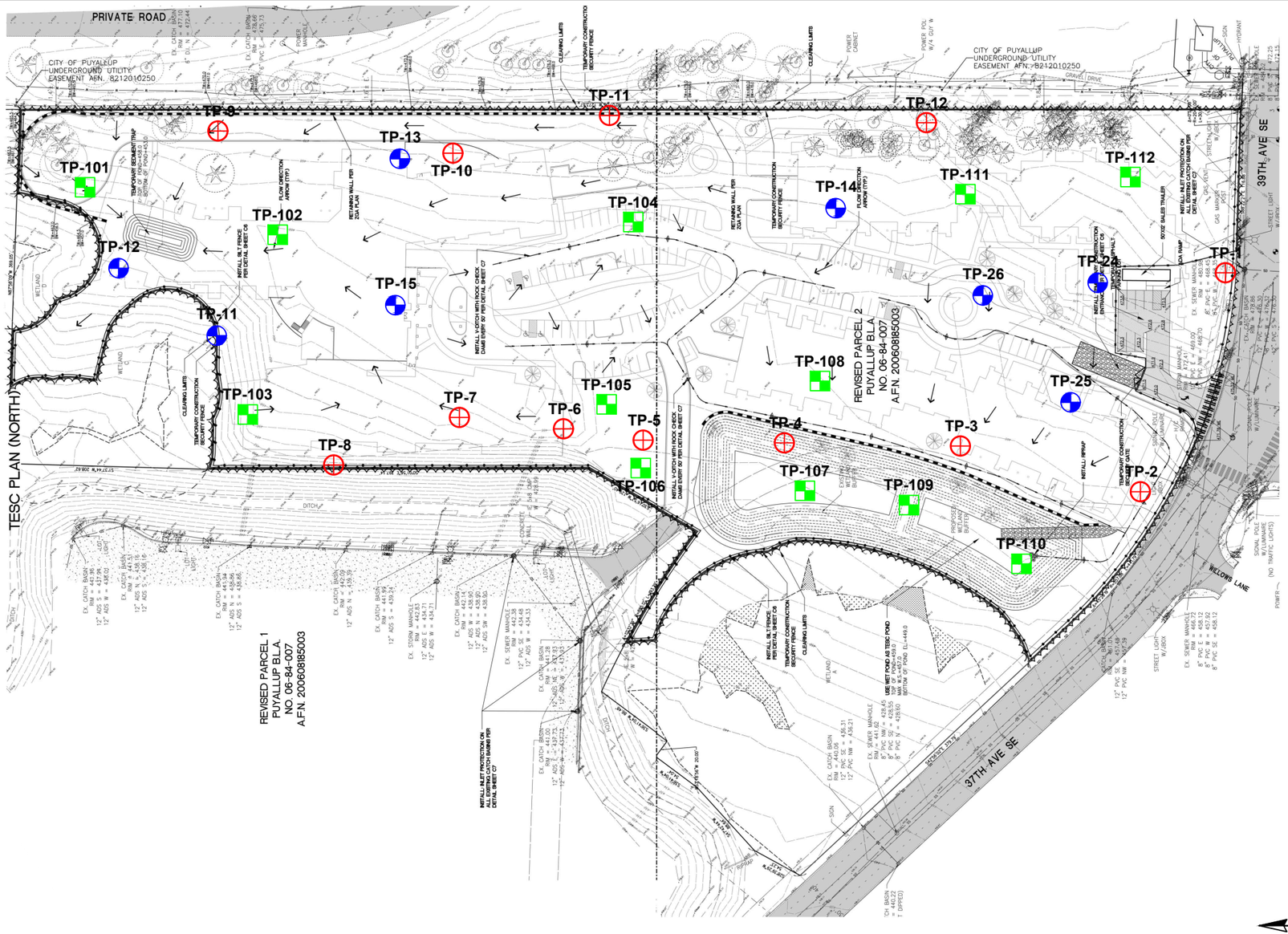


REFERENCE: http://www.wsdot.wa.gov/data/tools/geoportal/ ACCESSED 10/27/15

Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

VICINITY MAP
WESLEY HOMES PUYALLUP
PUYALLUP, WASHINGTON

Proj. No.T-5915-3	Date NOV 2016	Figure 1



NOTE:

THIS SITE PLAN IS SCHEMATIC. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE. IT IS INTENDED FOR REFERENCE ONLY AND SHOULD NOT BE USED FOR DESIGN OR CONSTRUCTION PURPOSES.

REFERENCE: SITE PLAN PROVIDED BY BARGHAUSEN.

LEGEND:

- APPROXIMATE TEST PIT LOCATION (TERRA 2015)
- APPROXIMATE TEST PIT LOCATION (GEO-ENGINEERS 2003)
- APPROXIMATE TEST PIT LOCATION (TERRA ASSOCIATES 2006)

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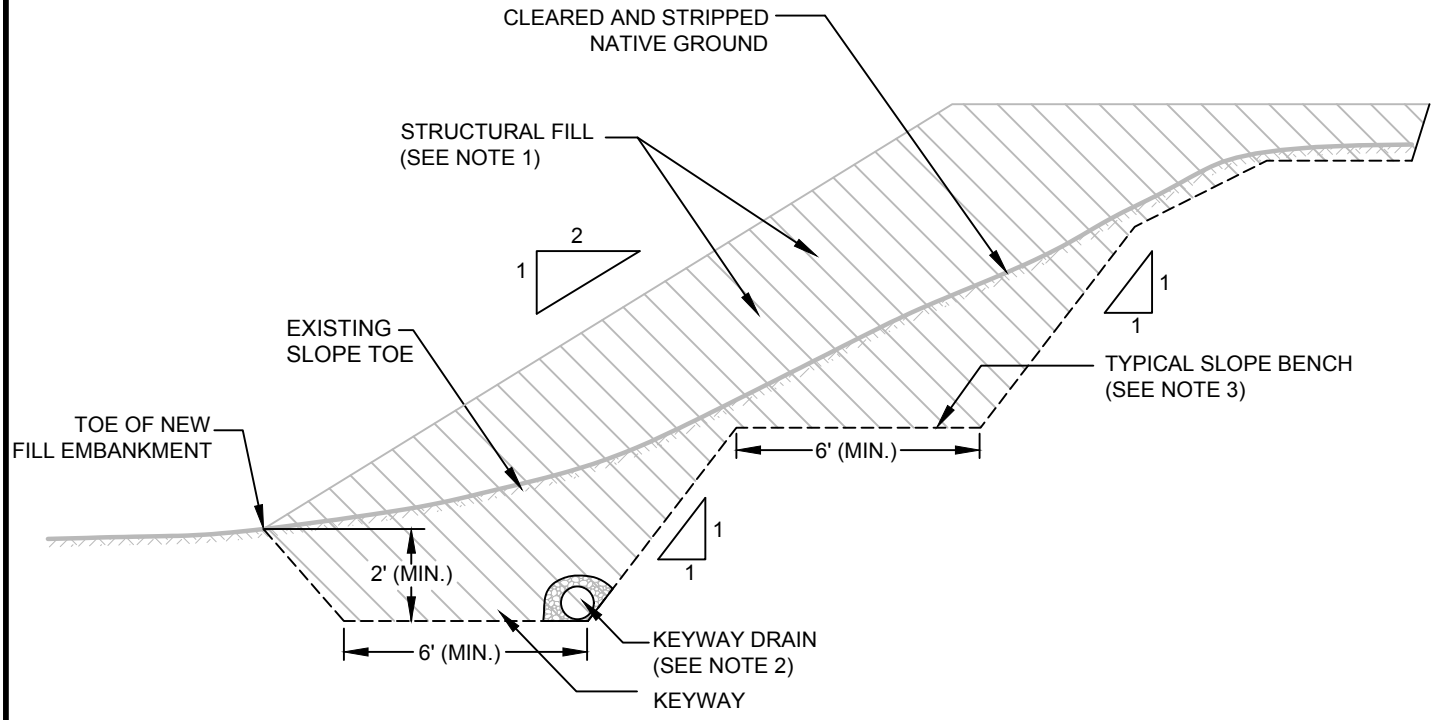
EXPLORATION LOCATION PLAN
WESLEY HOMES PUYALLUP
PUYALLUP, WASHINGTON

Proj. No.T-5915-3	Date NOV 2016	Figure 2



NOT TO SCALE

NOTES:

1) STRUCTURAL FILL SHALL BE COMPACTED TO A MINIMUM OF 95% OF ASTM D 698 MAXIMUM DRY DENSITY VALUE.
2) DRAINS SHALL CONSIST OF 6" DIA. PERFORATED PVC PIPE ENVELOPED IN 1 cu ft OF 3/4" WASHED GRAVEL. DRAIN PIPE SHALL BE DIRECTED TO THE STORM DRAIN SYSTEM OR APPROVED POINT OF DISCHARGE.
3) ADDITIONAL BENCHES AND BENCH DRAINS MAY BE REQUIRED BASED ON FIELD EVALUATION BY THE GEOTECHNICAL ENGINEER.

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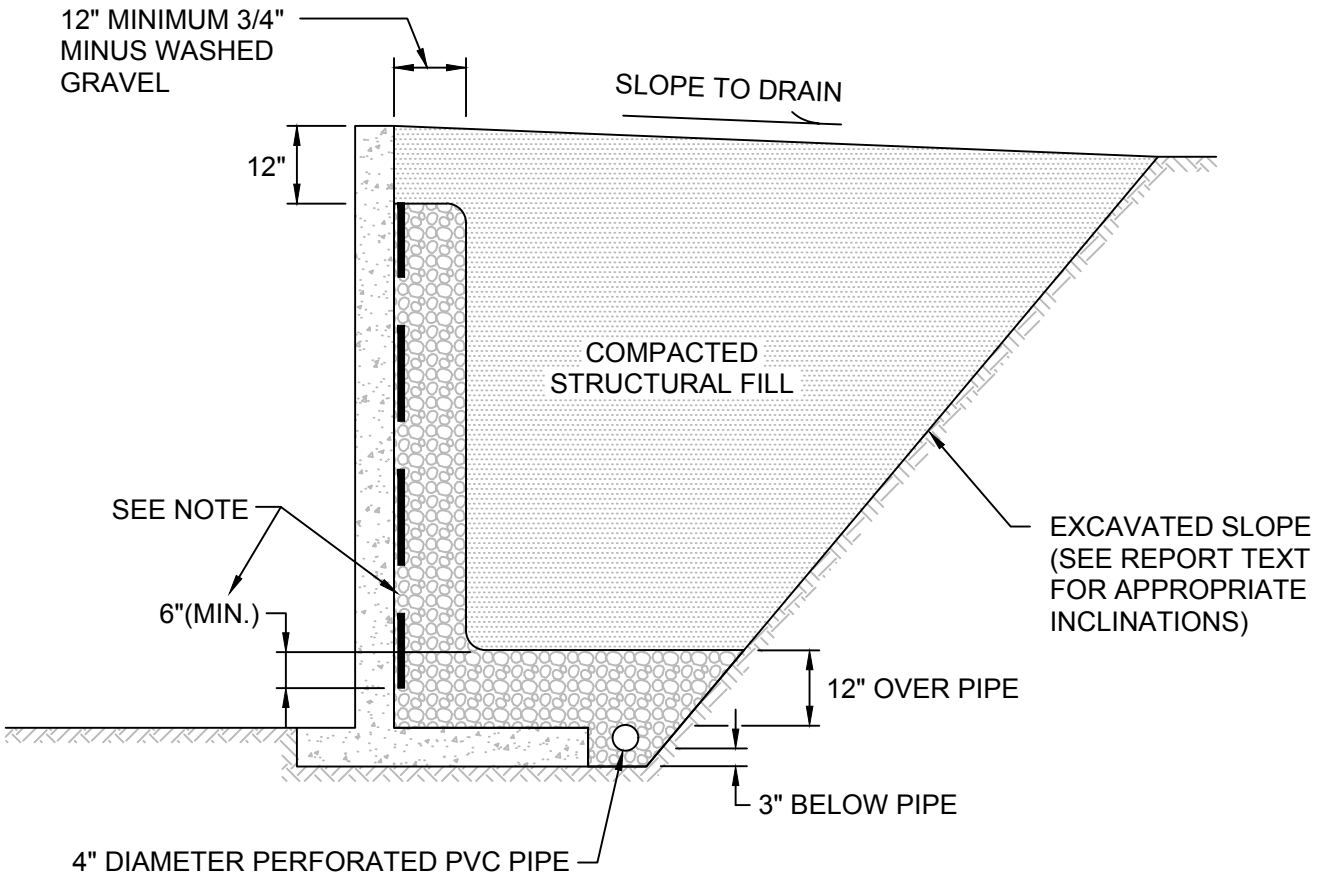
TYPICAL SLOPE KEY AND BENCH DETAIL
WESLEY HOMES PUYALLUP
PUYALLUP, WASHINGTON

Proj. No.T-5915-3	Date NOV 2016	Figure 3



NOT TO SCALE

NOTE:

MIRADRAIN G100N PREFABRICATED DRAINAGE PANELS OR SIMILAR PRODUCT CAN BE SUBSTITUTED FOR THE 12-INCH WIDE GRAVEL DRAIN BEHIND WALL. DRAINAGE PANELS SHOULD EXTEND A MINIMUM OF SIX INCHES INTO 12-INCH THICK DRAINAGE GRAVEL LAYER OVER PERFORATED DRAIN PIPE.

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TYPICAL WALL DRAINAGE DETAIL
WESLEY HOMES PUYALLUP
PUYALLUP, WASHINGTON

Proj. No.T-5915-3	Date OCT 2015	Figure 4

APPENDIX A
FIELD EXPLORATION AND LABORATORY TESTING

Wesley Homes Puyallup
Puyallup, Washington

On October 13, 2015, we completed our site exploration by observing soil and groundwater conditions at 12 test pits. The test pits were excavated using a track-mounted excavator to a maximum depth of 15 feet below existing site grades. Test pit locations were determined in the field by using GPS coordinates from Google Earth. The approximate location of the test pits is shown on the attached Exploration Location Plan, Figure 2. Test Pit Logs are attached as Figures A-2 through A-13.

A geotechnical engineer from our office conducted the field exploration. Our representative classified the soil conditions encountered, maintained a log of each test pit, obtained representative soil samples, and recorded water levels observed during excavation. All soil samples were visually classified in accordance with the Unified Soil Classification System (USCS) described on Figure A-1.

Representative soil samples obtained from the test pits and test borings were placed in closed containers and taken to our laboratory for further examination and testing. The moisture content of each sample was measured and is reported on the individual Test Boring Logs. Grain size analyses were performed on selected samples. The results of the grain size analyses are shown on Figures A-14 and A-15.

MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS (More than 50% material larger than No. 200 sieve size)	**GRAVELS** More than 50% of coarse fraction is larger than No. 4 sieve	Clean Gravels (less than 5% fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines.
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines.
			GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines.
	SANDS More than 50% of coarse fraction is smaller than No. 4 sieve	Clean Sands (less than 5% fines)	SW	Well-graded sands, sands with gravel, little or no fines.
			SP	Poorly-graded sands, sands with gravel, little or no fines.
		Sands with fines	SM	Silty sands, sand-silt mixtures, non-plastic fines.
			SC	Clayey sands, sand-clay mixtures, plastic fines.
FINE GRAINED SOILS (More than 50% material smaller than No. 200 sieve size)	**SILTS AND CLAYS** Liquid Limit is less than 50%		ML	Inorganic silts, rock flour, clayey silts with slight plasticity.
			CL	Inorganic clays of low to medium plasticity. (Lean clay)
			OL	Organic silts and organic clays of low plasticity.
	SILTS AND CLAYS Liquid Limit is greater than 50%		MH	Inorganic silts, elastic.
			CH	Inorganic clays of high plasticity. (Fat clay)
			OH	Organic clays of high plasticity.
HIGHLY ORGANIC SOILS			PT	Peat.

DEFINITION OF TERMS AND SYMBOLS

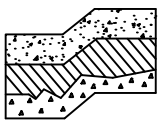
COHESIONLESS

Density	Standard Penetration Resistance in Blows/Foot
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	>50

COHESIVE

Consistancy	Standard Penetration Resistance in Blows/Foot
Very Soft	0-2
Soft	2-4
Medium Stiff	4-8
Stiff	8-16
Very Stiff	16-32
Hard	>32

I	2" OUTSIDE DIAMETER SPILT SPOON SAMPLER
‖	2.4" INSIDE DIAMETER RING SAMPLER OR SHELBY TUBE SAMPLER
▼	WATER LEVEL (Date)
Tr	TORVANE READINGS, tsf
Pp	PENETROMETER READING, tsf
DD	DRY DENSITY, pounds per cubic foot
LL	LIQUID LIMIT, percent
PI	PLASTIC INDEX
N	STANDARD PENETRATION, blows per foot



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UNIFIED SOIL CLASSIFICATION SYSTEM
WESLEY HOMES PUYALLUP
PUYALLUP, WASHINGTON

Proj. No.T-5915-3	Date NOV 2016	Figure A-1

LOG OF TEST PIT NO. TP-101

FIGURE A-2

PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** CSD

LOCATION: Puyallup, Washington **SURFACE CONDS:** Tall Understory **APPROX. ELEV:** 456 +/- Ft.

DATE LOGGED: October 13, 2015 **DEPTH TO GROUNDWATER:** N/A **DEPTH TO CAVING:** N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
1		Black silty SAND, fine grained, moist, heavy organic inclusions. (SM) (TOPSOIL)	Loose			
2	1	Brown SAND with silty and gravel, fine to medium grained, dry, roots. (SP-SM)	Medium Dense	8.1		
5	2	Gray silty SAND with gravel, fine to medium grained, moist, cemented. (SM)	Dense	6.7		
9	3	Brown SAND with gravel, medium to coarse grained, moist. (SP)	Dense	5.5		
10		Test pit terminated at approximately 10 feet. No groundwater seepage observed.				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. TP-102

FIGURE A-3

PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** CSD

LOCATION: Puyallup, Washington **SURFACE CONDS:** Low Grass/Weeds **APPROX. ELEV:** 458 +- Ft.

DATE LOGGED: October 13, 2015 **DEPTH TO GROUNDWATER:** N/A **DEPTH TO CAVING:** N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
1	1	(2 inches ORGANICS) Red-brown SAND with silt and gravel, fine to medium grained, moist. (SP-SM)	Medium Dense	3.1		
3		Gray SAND with gravel to GRAVEL with sand, medium to coarse grained, dry. (SP/GP)	Medium Dense			
6	2			36.9		
8	3	Gray SILT, fine grained, moist, very small sand interbeds, upper two feet mottled. LL=35 PL=26 PI=9	Medium Stiff	36.8		
11		Brown SAND with silt and gravel to GRAVEL with silt and sand, medium to coarse grained, wet to saturated. (SP-SM/GP-GM)	Dense			
13	4			12.1		
14		Test pit terminated at approximately 13 feet. No groundwater seepage observed.				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. TP-103

FIGURE A-4

PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** CSD

LOCATION: Puyallup, Washington **SURFACE CONDS:** Tall Blackberries **APPROX. ELEV:** 451 +/- Ft.

DATE LOGGED: October 13, 2015 **DEPTH TO GROUNDWATER:** N/A **DEPTH TO CAVING:** N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
1		(6 inches ORGANICS)				
1	1			10.4		
2						
3						
4						
5				18.5		
5	2					
6		FILL: black with some brown and gray silty sand with gravel and sand with silt and gravel, fine to medium grained, moist, heavy organic inclusions including large logs and cut wood.	Medium Dense			
7						
8						
9						
10						
11						
12						
13						
14		Gray silty SAND, fine to medium grained, wet. (SM)	Medium Dense			
15	3			21.2		
15		Test pit terminated at approximately 15 feet. No groundwater seepage observed.				
16						
17						
18						
19						
20						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. TP-104

FIGURE A-5

PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** CSD

LOCATION: Puyallup, Washington **SURFACE CONDS:** Tall Brush **APPROX. ELEV:** 458 +/- Ft.

DATE LOGGED: October 13, 2015 **DEPTH TO GROUNDWATER:** N/A **DEPTH TO CAVING:** N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
1	1	(8 inches ORGANICS) Brown SAND with silt and gravel to silty SAND with gravel, fine to medium grained, dry.	Medium Dense	10.4		
2						
3			Medium Dense			
4	2			6.5		
5		Gray silty GRAVEL with sand to silty SAND with gravel, fine to medium grained, moist, some cobbles. (GM/SM)	Dense			
6						
7						
8						
9		Gray SAND with silt and gravel, fine to coarse grained, wet. (SP-SM)	Dense			
10	3			11.0		
11		Test pit terminated at approximately 11 feet. No groundwater seepage observed.				
12						
13						
14						
15						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. TP-105

FIGURE A-6

PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** CSD

LOCATION: Puyallup, Washington **SURFACE CONDS:** Tall Blackberries **APPROX. ELEV:** 454 +/- Ft.

DATE LOGGED: October 13, 2015 **DEPTH TO GROUNDWATER:** N/A **DEPTH TO CAVING:** N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
1		(8 inches ORGANICS)				
1	1	Brown SAND with silt and gravel, fine to coarse grained, dry to moist, roots. (SP-SM)	Medium Dense	8.4		
2						
3						
4						
4	2			3.7		
5						
6		Gray SILT, fine grained, moist, upper two feet mottled. (ML)	Medium Stiff to Stiff			
7	3			19.8		
8						
9						
10						
10	4			19.4		
11		Test pit terminated at approximately 10.5 feet. No groundwater seepage observed.				
12						
13						
14						
15						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. TP-106

FIGURE A-7

PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** CSD

LOCATION: Puyallup, Washington **SURFACE CONDS:** Tall Grass **APPROX. ELEV:** 452 +/- Ft.

DATE LOGGED: October 13, 2015 **DEPTH TO GROUNDWATER:** N/A **DEPTH TO CAVING:** N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
0		(8 inches ORGANICS)				
1	1	Gray SAND, fine grained, moist, some silt and gravel. (SP)	Medium Dense	6.6		
5	2	Gray SILT, fine grained, moist, upper two feet mottled. (ML)	Medium Stiff to Very Stiff	18.8		
7	3			30.1		
10	4	Brown silty SAND with gravel, fine to medium grained, moist to wet. (SM)	Dense	13.1		
10.5		Test pit terminated at approximately 10.5 feet. No groundwater seepage observed.				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. TP-107

FIGURE A-8

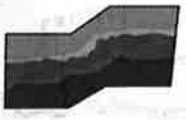
PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** CSD

LOCATION: Puyallup, Washington **SURFACE CONDS:** Forest Duff **APPROX. ELEV:** 452 +/- Ft.

DATE LOGGED: October 13, 2015 **DEPTH TO GROUNDWATER:** 7 Feet **DEPTH TO CAVING:** N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
1		Dark brown silty SAND, fine to medium grained, moist. (SM) (TOPSOIL)	Loose			
3	1	Gray silty SAND, fine grained, moist, roots. (SM)	Medium Dense	12.1		
6		Brown SAND with silt, medium to coarse grained, wet to saturated. (SP-SM)	Medium Dense			
7 ▼	2			21.7		
9		Brown GRAVEL with silt and sand, medium to coarse grained, saturated. (GP-GM)	Dense			
10	3			8.3		
		Test pit terminated at approximately 10 feet. Heavy groundwater seepage observed at 7 feet.				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.



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LOG OF TEST PIT NO. TP-108

FIGURE A-9

PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** CSD

LOCATION: Puyallup, Washington **SURFACE CONDS:** Tall Understory **APPROX. ELEV:** 456 +/- Ft.

DATE LOGGED: October 13, 2015 **DEPTH TO GROUNDWATER:** N/A **DEPTH TO CAVING:** N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
0		(8 inches ORGANICS)				
1	1			7.2		
2			Medium Dense			
3		Brown to gray silty SAND to silty SAND with gravel, fine grained, moist, some cementation. (SM)				
4						
5			Dense			
6	2			9.3		
7						
8	3			8.4		
9		Gray SAND with silt and gravel, medium to coarse grained, moist to wet. (SP-SM)	Dense			
10	4			13.9		
11		Test pit terminated at approximately 11 feet. No groundwater seepage observed.				
12						
13						
14						
15						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. TP-109

FIGURE A-10

PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** CSD

LOCATION: Puyallup, Washington **SURFACE CONDS:** Tall Brush **APPROX. ELEV:** 454 +/- Ft.

DATE LOGGED: October 13, 2015 **DEPTH TO GROUNDWATER:** 11.5 Feet **DEPTH TO CAVING:** N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
1	1	(8 inches ORGANICS)		15.1		
2		Gray sandy SILT to silty SAND, fine grained, moist. (ML/SM)	Medium Dense			
3						
4	2			5.8		
5						
6		Brown GRAVEL with sand, fine to medium grained, moist. (GP)	Medium Dense			
7						
8				8.0		
9	3					
10		Brown GRAVEL with silt and sand, medium to coarse grained, moist to saturated. (GP-GM)	Dense			
11						
12	4			13.4		
13		Test pit terminated at approximately 12 feet. Heavy groundwater seepage observed at 11.5 feet.				
14						
15						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. TP-110

FIGURE A-11

PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** CSD

LOCATION: Puyallup, Washington **SURFACE CONDS:** Tall Understory **APPROX. ELEV:** 454 +/- Ft.

DATE LOGGED: October 13, 2015 **DEPTH TO GROUNDWATER:** 11 Feet **DEPTH TO CAVING:** N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
		(8 inches ORGANICS)				
1	1	Gray SILT with sand, fine grained, moist, upper two feet mottled, trace gravel. (ML)	Medium Dense	14.8		
2						
3	2			4.9		
4		Brown GRAVEL with silt and sand, fine to coarse grained, moist. (GP-GM)				
5						
6		*At 6 feet soil becomes wet.				
7	3		Medium Dense	12.1		
8						
9						
10						
▼ 11		Test pit terminated at approximately 11 feet. Heavy groundwater seepage observed at 11 feet.				
12						
13						
14						
15						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. TP-111

FIGURE A-12

PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** CSD

LOCATION: Puyallup, Washington **SURFACE CONDS:** Tall Understory **APPROX. ELEV:** 466 +/- Ft.

DATE LOGGED: October 13, 2015 **DEPTH TO GROUNDWATER:** N/A **DEPTH TO CAVING:** N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
1		Dark brown silty SAND, fine grained, moist, heavy organic inclusions. (SM) (TOPSOIL)	Loose			
2						
3	1	Brown silty SAND with gravel, fine to medium grained, moist. (SM)	Medium Dense	12.6		
4						
5						
6	2		Medium Dense	11.4		
7		Gray silty SAND with gravel, fine to medium grained, moist, upper two feet mottled, occasional cobble/boulder. (SM)				
8			Dense			
9						
10	3			7.8		
11		Test pit terminated at approximately 11 feet. No groundwater seepage observed.				
12						
13						
14						
15						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. TP-112

FIGURE A-13

PROJECT NAME: Wesley Homes Puyallup **PROJ. NO:** T-5915-3 **LOGGED BY:** CSD

LOCATION: Puyallup, Washington **SURFACE CONDS:** Forest Duff **APPROX. ELEV:** 474 +/- Ft.

DATE LOGGED: October 13, 2015 **DEPTH TO GROUNDWATER:** N/A **DEPTH TO CAVING:** N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
1		Dark brown silty SAND, fine grained, moist, heavy organic inclusions. (SM) (TOPSOIL)	Loose			
2	1	Red-brown to brown SAND with silt and gravel to silty SAND with gravel, fine to medium grained, dry. (SP-SM/SM)	Medium Dense	7.6		
4	2	Brown GRAVEL with sand, medium to coarse grained, dry. (GP)	Medium Dense	1.9		
8	3	Gray silty SAND with gravel, fine to medium grained, moist. (SM)	Dense	5.8		
10		Test pit terminated at approximately 10 feet. No groundwater seepage observed.				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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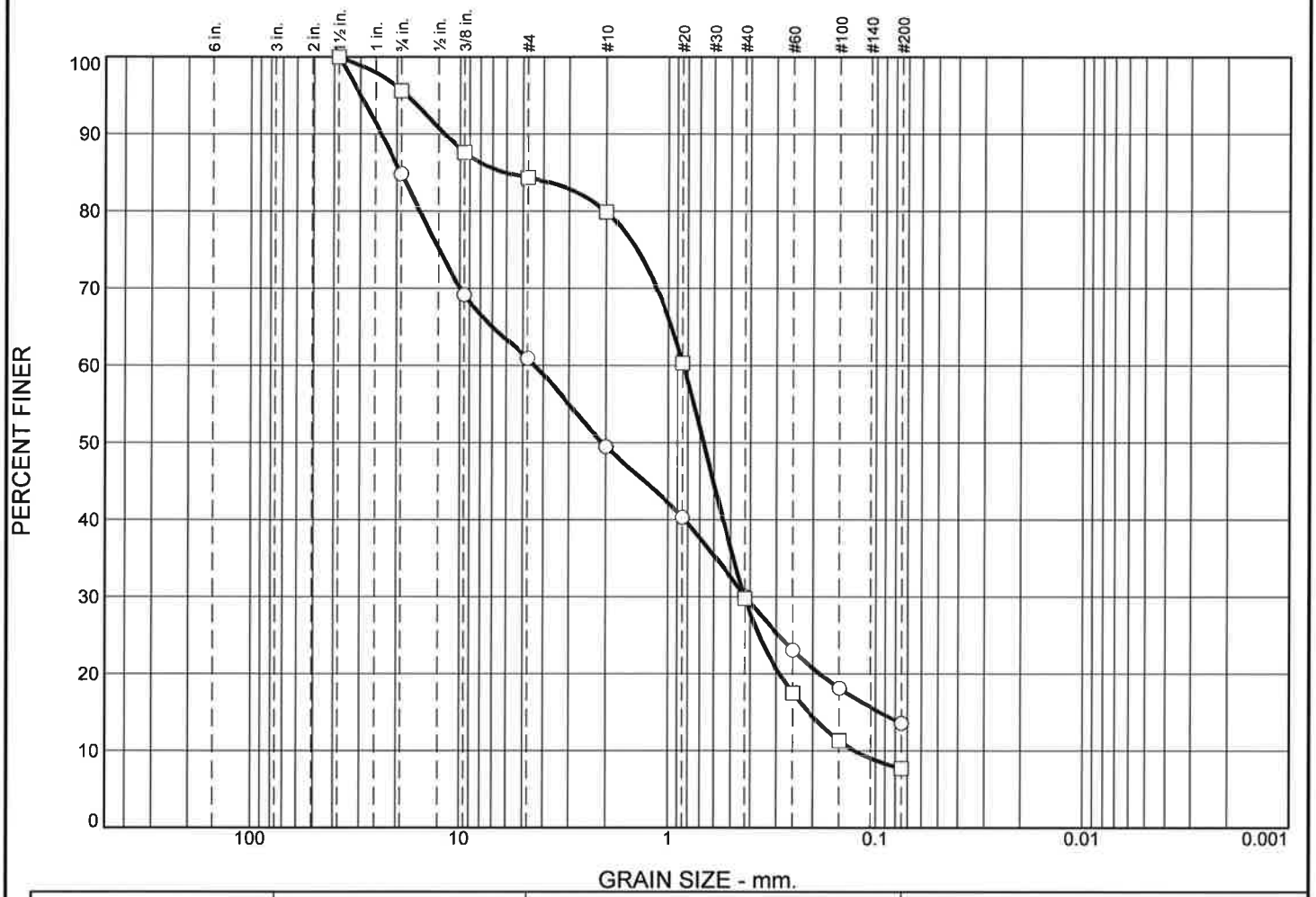
Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	15.2	23.9	11.4	19.4	16.5	13.6	
□	0.0	4.4	11.3	4.4	50.1	22.1	7.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			19.2109	4.4000	2.0841	0.4221	0.0955			
□			6.0908	0.8436	0.6729	0.4274	0.2101	0.1259	1.72	6.70

Material Description	USCS	AASHTO
○ Silty SAND with gravel	SM	
□ Well graded SAND with silt and gravel	SW-SM	

Project No. T-5915-3 **Client:** Wesley Homes

Project: Wesley Homes Puyallup

Puyallup, Washington

○ **Location:** Test Pit TP-101 **Depth:** -5.5 feet **Sample Number:** 2

□ **Location:** Test Pit TP-105 **Depth:** -1.5 feet **Sample Number:** 1

Remarks:

○ Tested on 10/15/2015

□ Tested on 10/15/2015

Terra Associates, Inc.

Kirkland, WA

Figure A-14

Tested By: FQ

Particle Size Distribution Report

	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	2.8	5.0	17.4	23.9	50.9	
□	0.0	32.1	25.3	6.9	22.1	9.1	4.5	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.9912	0.1722						
□			28.3351	14.6713	8.7037	1.1078	0.4626	0.3242	0.26	45.25

Material Description	USCS	AASHTO
○ Sandy SILT	ML	
□ Poorly graded GRAVEL with sand	GP	

Project No. T-5915-3 **Client:** Wesley Homes

Project: Wesley Homes Puyallup

Puyallup, Washington

○ **Location:** Test Pit TP-109 **Depth:** -1 foot **Sample Number:** 1

□ **Location:** Test Pit TP-109 **Depth:** -8.5 feet **Sample Number:** 3

Remarks:

○ Tested on 10/15/2015

□ Tested on 10/15/2015

Terra Associates, Inc.

Kirkland, WA

Figure A-15

Tested By: FQ

APPENDIX B

PREVIOUS TEST PIT LOGS

LOG OF TEST PIT NO. 1

FIGURE A-2

PROJECT NAME: Puyallup Senior Housing Project PROJ. NO: T-5915-1 LOGGED BY: TA

LOCATION: Puyallup, Washington SURFACE CONDS: ELEV: 474

DATE LOGGED: August 3, 2006 DEPTH TO GROUNDWATER: N/A DEPTH TO CAVING: N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
		(9 inches TOPSOIL)		2.5		
		Brown sandy GRAVEL, dry. (GP)	Dense			
5		Moist below 5 feet.				
10		Brown sandy GRAVEL, dry. (GP)	Dense	5.3		
15		Test pit terminated at 11 feet. No groundwater seepage was observed. No caving was observed.				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 2

FIGURE A-3

PROJECT NAME: Puyallup Senior Housing Project PROJ. NO: T-5915-1 LOGGED BY: TA

LOCATION: Puyallup, Washington SURFACE CONDS: ELEV: 458

DATE LOGGED: August 3, 2006 DEPTH TO GROUNDWATER: N/A DEPTH TO CAVING: N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
		(6 inches TOPSOIL)				
		Brown silty SAND, moist to dry. (SM)		8.3		
			Medium Dense			
5		Very dense below 5 feet.		11.4		
		Brown gravelly SAND, dry. (SP)	Very Dense			
10				4.5		
		Test pit terminated at 10 feet. No groundwater seepage was observed. No caving was observed.				
15						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 3

FIGURE A-4

PROJECT NAME: Puyallup Senior Housing Project PROJ. NO: T-5915-1 LOGGED BY: TA

LOCATION: Puyallup, Washington SURFACE CONDS: ELEV: 458

DATE LOGGED: August 3, 2006 DEPTH TO GROUNDWATER: N/A DEPTH TO CAVING: N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
		(12 inches TOPSOIL) Brown sandy SILT with gravels, oxidation staining, moist. (ML)	Medium Dense	11.7		
5		Gray sandy SILT, cemented, moist. (ML)	Dense	13.8		LL=21 PL=18 PI=3
10		Test pit terminated at 8 feet. No groundwater seepage was observed. No caving was observed.				
15						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 4

FIGURE A-5

PROJECT NAME: Puyallup Senior Housing Project PROJ. NO: T-5915-1 LOGGED BY: TA

LOCATION: Puyallup, Washington SURFACE CONDS: ELEV: 456

DATE LOGGED: August 3, 2006 DEPTH TO GROUNDWATER: N/A DEPTH TO CAVING: N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
		(6 inches TOPSOIL)				
		Brown gray silty SAND with oxidation staining, moist. (SM)		18.6		
		Very dense below 3 feet.				
5			Dense			
		Test pit terminated at 8 feet. No groundwater seepage was observed. No caving was observed.				
10						
15						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 5

FIGURE A-6

PROJECT NAME: Puyallup Senior Housing Project PROJ. NO: T-5915-1 LOGGED BY: TA

LOCATION: Puyallup, Washington SURFACE CONDS: ELEV: 453

DATE LOGGED: August 3, 2006 DEPTH TO GROUNDWATER: N/A DEPTH TO CAVING: N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
		(9 inches TOPSOIL)		11.6		
		Brown gray silty SAND with gravel, cemented, moist. (SM)	Very Dense	8.3		
5						
		Test pit terminated at 7 feet. No groundwater seepage was observed. No caving was observed.				
10						
15						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 6

FIGURE A-7

PROJECT NAME: Puyallup Senior Housing Project PROJ. NO: T-5915-1 LOGGED BY: TA

LOCATION: Puyallup, Washington SURFACE CONDS: ELEV: 458

DATE LOGGED: August 3, 2006 DEPTH TO GROUNDWATER: N/A DEPTH TO CAVING: N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
		(9 inches TOPSOIL) Brown SAND, dry to moist. (SP)	Medium Dense	8.3		
5		Brown sandy GRAVEL to gravelly SAND, moist. (GP-SP)	Dense to Very Dense	3.0 3.2		
10		Test pit terminated at 8 feet. No groundwater seepage was observed. No caving was observed.				
15						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 7

FIGURE A-8

PROJECT NAME: Puyallup Senior Housing Project PROJ. NO: T-5915-1 LOGGED BY: TA

LOCATION: Puyallup, Washington SURFACE CONDS: ELEV: 455

DATE LOGGED: August 3, 2006 DEPTH TO GROUNDWATER: N/A DEPTH TO CAVING: N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
		(12 inches TOPSOIL)		5.9		
		Brown gravelly SAND, dry. (SP)	Dense			
5						
		Brown SAND, dry. (SP)	Dense	5.2		
10		Brown gray sandy SILT to SILT with oxidation staining, moist. (ML)	Hard	23.4		
		Test pit terminated at 12 feet. No groundwater seepage was observed. No caving was observed.				
15						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 8

FIGURE A-9

PROJECT NAME: Puyallup Senior Housing Project PROJ. NO: T-5915-1 LOGGED BY: TA

LOCATION: Puyallup, Washington SURFACE CONDS: ELEV: 448

DATE LOGGED: August 3, 2006 DEPTH TO GROUNDWATER: N/A DEPTH TO CAVING: N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
		(6 inches TOPSOIL)		6.0		
				18.8		
		UNCONTROLLED FILL: dark brown black silty sand with decayed wood, trace branches, roots, moist. (SM)				
5			Loose			
10						
		Gray sandy SILT to SILT, moist. (ML)	Medium Stiff	29.5		
15		Test pit terminated at 15 feet. No groundwater seepage was observed. No caving was observed.				
20						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 9

FIGURE A-10

PROJECT NAME: Puyallup Senior Housing Project PROJ. NO: T-5915-1 LOGGED BY: TA

LOCATION: Puyallup, Washington SURFACE CONDS: ELEV: 462

DATE LOGGED: August 3, 2006 DEPTH TO GROUNDWATER: N/A DEPTH TO CAVING: N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
		(9 inches TOPSOIL) Brown silty SAND with gravel, dry. (SM)	Medium Dense	5.9		
5		Brown gravelly SAND, dry. (SP)	Very Dense	3.6		
		Test pit terminated at 8 feet. No groundwater seepage was observed. No caving was observed.				
10						
15						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 10

FIGURE A-11

PROJECT NAME: Puyallup Senior Housing Project PROJ. NO: T-5915-1 LOGGED BY: TA

LOCATION: Puyallup, Washington SURFACE CONDS: ELEV: 462

DATE LOGGED: August 3, 2006 DEPTH TO GROUNDWATER: N/A DEPTH TO CAVING: N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
		(9 inches TOPSOIL)		3.6		
		Brown silty SAND with gravel, dry to moist. (SM)	Medium Dense			
5						
		Test pit terminated at 6 feet. No groundwater seepage was observed. No caving was observed.				
10						
15						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 11

FIGURE A-12

PROJECT NAME: Puyallup Senior Housing Project PROJ. NO: T-5915-1 LOGGED BY: TA

LOCATION: Puyallup, Washington SURFACE CONDS: ELEV: 469

DATE LOGGED: August 3, 2006 DEPTH TO GROUNDWATER: N/A DEPTH TO CAVING: N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
		(12 inches TOPSOIL)		3.9		
		Yellow brown gravelly SAND, dry. (SP)	Very Dense			
5						
		Test pit terminated at 6 feet. No groundwater seepage was observed. No caving was observed.				
10						
15						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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Environmental Earth Sciences

LOG OF TEST PIT NO. 12

FIGURE A-13

PROJECT NAME: Puyallup Senior Housing Project PROJ. NO: T-5915-1 LOGGED BY: TA

LOCATION: Puyallup, Washington SURFACE CONDS: ELEV: 472

DATE LOGGED: August 3, 2006 DEPTH TO GROUNDWATER: N/A DEPTH TO CAVING: N/A

DEPTH (FT.)	SAMPLE NO.	DESCRIPTION	CONSISTENCY/ RELATIVE DENSITY	W (%)	POCKET PEN. (TSF)	REMARKS
		(9 inches TOPSOIL) Reddish-brown silty SAND with gravel, dry. (SM)	Medium Dense	8.4		
5		Brown sandy GRAVEL, dry. (GP)	Very Dense	5.8		
		Test pit terminated at 7 feet. No groundwater seepage was observed. No caving was observed.				
10						
15						

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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Date Excavated: 03/27/03 Logged by: EWH

Equipment: Case 580L Backhoe Surface Elevation (ft): 450

Elevation feet	Depth feet	Sample	Sample Number	Water	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, lbs/ft³	OTHER TESTS AND NOTES
450	0					SOD	2- to 6-inch grass and sod			
						SM	Black silty fine to coarse sand, trace organic material (loose, moist)			
						SM	Dark brown-black silty sand, trace gravel, occasional wood fragments (loose, moist) (fill)			
		X	1					31		
						SP-SM	Dark brown-black fine to coarse sand with silt and gravel, occasional organic material and cobbles (medium dense, moist) (fill)			
445	5			▼						
440	10	X	2					31		
435	15	X	3			SM	Green/gray silty fine sand with occasional coarse sand, fine gravel, roots (loose, moist) (native)			
430	20						Test pit completed at at depth of 15 feet on 03/27/03 Slow groundwater seepage observed at a depth of 5 feet Minor caving observed at depths between 0 and 2 feet			

Note: See Figure A-1 for explanation of symbols

The depths of the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

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LOG OF TEST PIT 11

Geo Engineers

Project: Puyallup Retail Center

Project Location: Puyallup, Washington

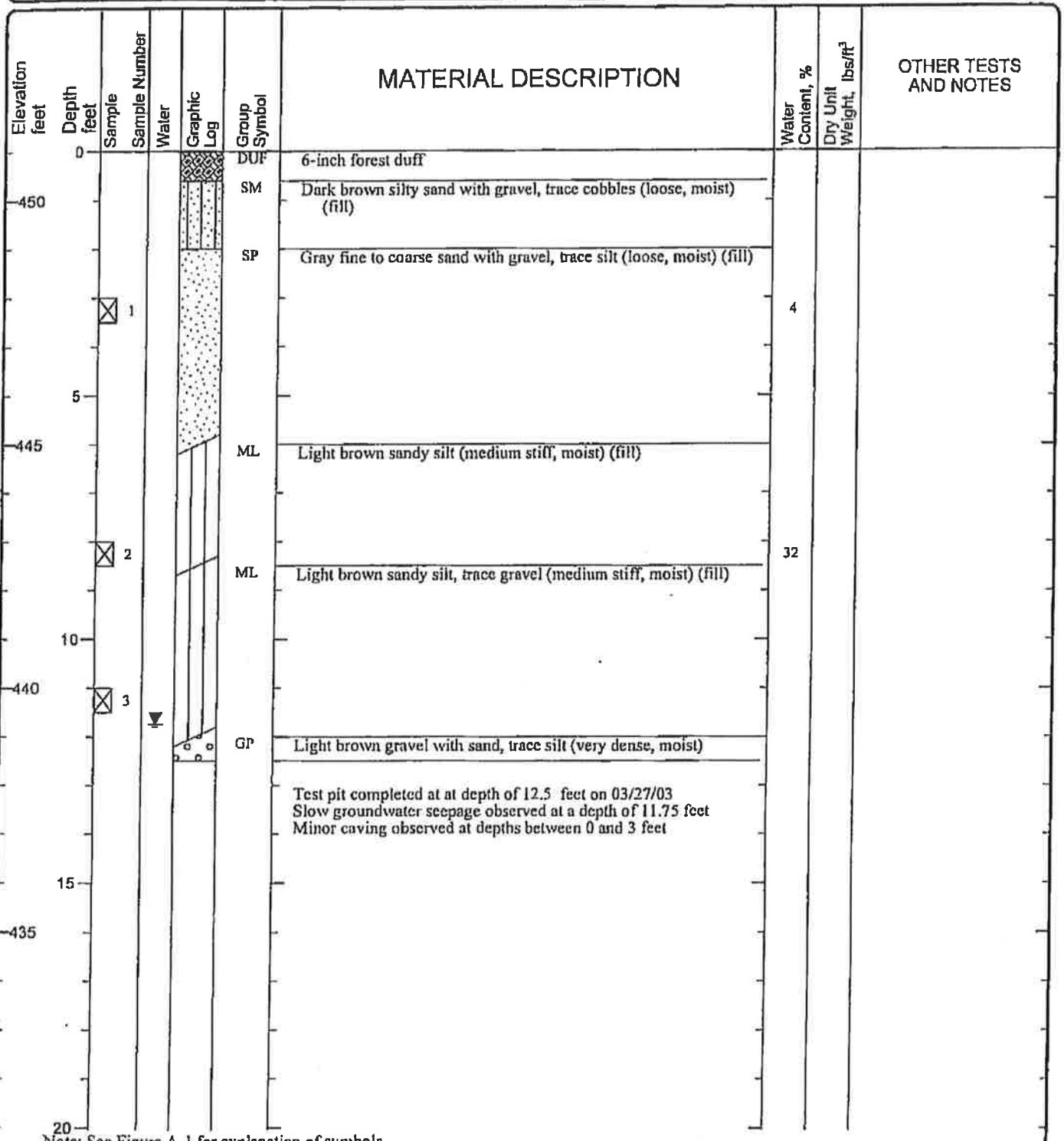
Project Number: 3443-002-00

Figure: A-12

Sheet 1 of 1

Date Excavated: 03/27/03 Logged by: EWH

Equipment: Case 580L Backhoe Surface Elevation (ft): 451



Note: See Figure A-1 for explanation of symbols

The depths of the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

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LOG OF TEST PIT 12

Geo Engineers

Project: Puyallup Retail Center

Project Location: Puyallup, Washington

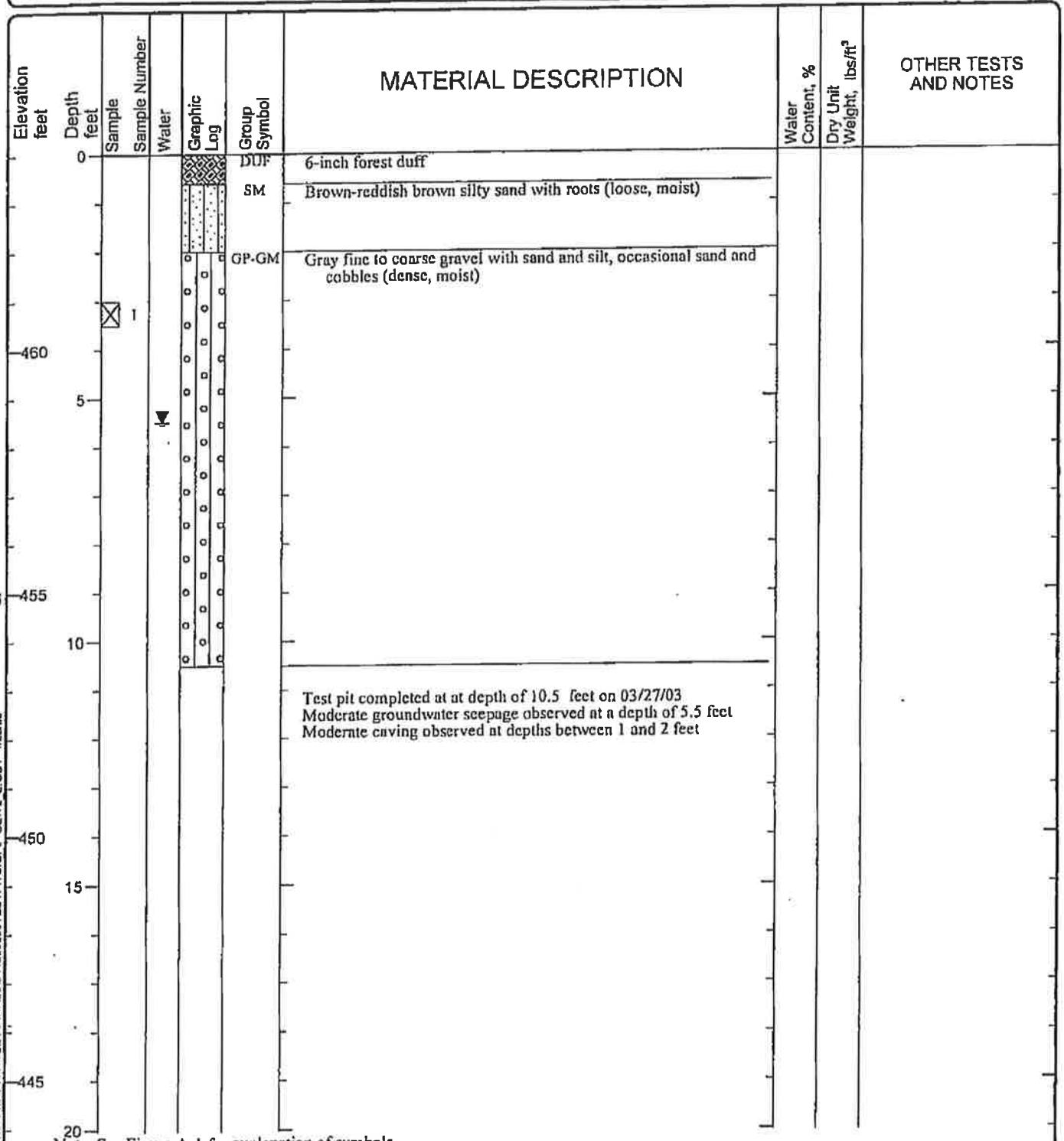
Project Number: 3443-002-00

Figure: A-13

Sheet 1 of 1

Date Excavated: 03/27/03 Logged by: EWH

Equipment: Case 580L Backhoe Surface Elevation (ft): 464



Note: See Figure A-1 for explanation of symbols
The depths of the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT 13

Geo Engineers

Project: Puyallup Retail Center
Project Location: Puyallup, Washington
Project Number: 3443-002-00

Figure: A-14
Sheet 1 of 1

Date Excavated: 03/27/03 Logged by: EWH

Equipment: Case 580L Backhoe Surface Elevation (ft): 460

Elevation feet	Depth feet	Sample	Sample Number	Water	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, lbs/ft³	OTHER TESTS AND NOTES
460	0					DUF	3- to 6-inch forest duff			
						SM	Brown silty sand with gravel (loose, moist)			
		X	1			GP	Gray fine to coarse gravel with sand, trace silt (dense, wet)			
455	5			▼						
450	10						Test pit completed at at depth of 10 feet on 03/27/03 Rapid groundwater seepage observed at a depth of 5 feet Slight caving observed at depths between 1 and 3 feet			
445	15									
440	20									

Note: See Figure A-1 for explanation of symbols
The depths of the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

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LOG OF TEST PIT 14

Geo Engineers

Project: Puyallup Retail Center
Project Location: Puyallup, Washington
Project Number: 3443-002-00

Figure: A-15
Sheet 1 of 1

Date Excavated: 03/27/03 Logged by: EWH

Equipment: Case 580L Backhoe Surface Elevation (ft): 467

Elevation feet	Depth feet	Sample	Sample Number	Water	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, lbs/ft³	OTHER TESTS AND NOTES
	0					SOD	6-inch grass and sod			
						SM	Brown silty sand with gravel, trace roots (loose, moist)			
465						GP	Gray fine to coarse gravel with sand, trace silt (medium dense, moist)			
		☒	1							
	5			▼						
460										
	10						Test pit completed at at depth of 10 feet on 03/27/03 Minor groundwater seepage observed at a depth of 6 feet Severe caving observed at depths between 2 and 10 feet			
455										
	15									
450										
	20									

Note: See Figure A-1 for explanation of symbols

The depths of the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

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LOG OF TEST PIT 15

Geo Engineers

Project: Puyallup Retail Center

Project Location: Puyallup, Washington

Project Number: 3443-002-00

Figure: A-16

Sheet 1 of 1

Date Excavated: 03/31/03 Logged by: KWG

Equipment: Case 580L Backhoe Surface Elevation (ft): 468

Elevation feet	Depth feet	Sample	Sample Number	Water	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, lbs/ft³	OTHER TESTS AND NOTES
	0					DUF	2- to 4-inch forest duff			
		X	1			SP-SM	Reddish brown fine sand with silt, occasional gravel (medium dense, moist)			
						GP	Gray fine to coarse gravel with sand, trace silt (dense, moist)			
		X	2							
465						SP	Gray fine to medium sand, trace silt and granite cobbles (dense, moist)			
		X	3							
	5									
		X	4			SM	Gray silty fine sand (very dense, moist)			
460							Test pit completed at at depth of 8 feet on 03/31/03 No groundwater seepage observed No caving observed			
	10									
455										
	15									
450										
	20									

Note: See Figure A-1 for explanation of symbols

The depths of the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT 24

Geo Engineers

Project: Puyallup Retail Center

Project Location: Puyallup, Washington

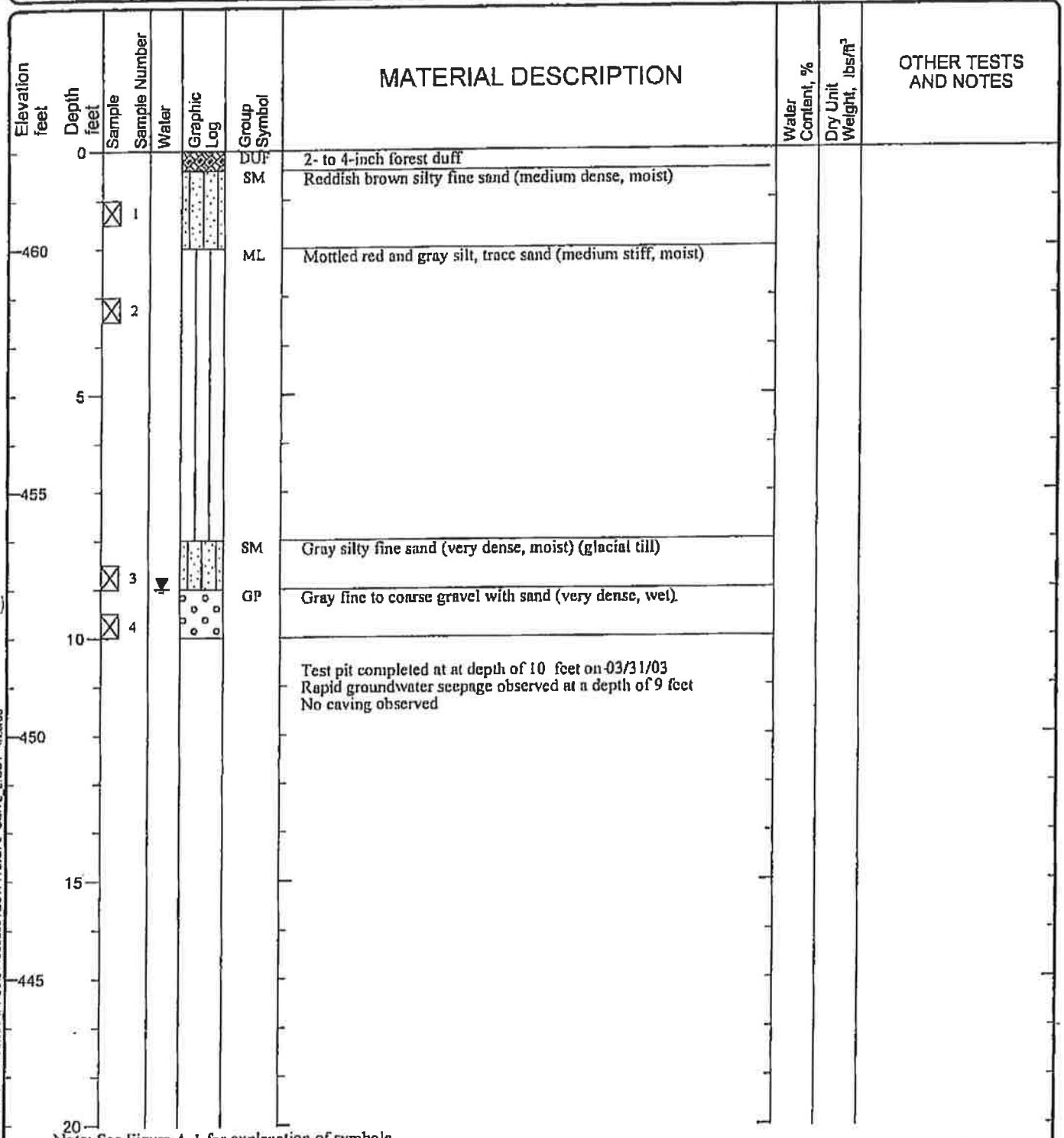
Project Number: 3443-002-00

Figure: A-25

Sheet 1 of 1

Date Excavated: 03/31/03 Logged by: KWG

Equipment: Case 580L Backhoe Surface Elevation (ft): 462



Note: See Figure A-1 for explanation of symbols

The depths of the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

LOG OF TEST PIT 25

Geo Engineers

Project: Puyallup Retail Center

Project Location: Puyallup, Washington

Project Number: 3443-002-00

Figure: A-26

Sheet 1 of 1

Date Excavated: 03/31/03 Logged by: KWG

Equipment: Case 580L Backhoe Surface Elevation (ft): 462

Elevation feet	Depth feet	Sample	Sample Number	Water	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, lbs/ft³	OTHER TESTS AND NOTES
	0					DUF	2- to 4-inch forest duff			
						SM	Reddish brown silty fine to medium sand, trace gravel (medium dense, moist)			
460				▼		SM	Reddish gray silty fine sand (dense, wet)			
		☒	1					22		%F = 45.7 Sieve Analysis
						GP	Gray fine to coarse gravel with sand, trace silt (dense, wet)			
	5	☒	2							
455										
							Test pit completed at at depth of 8 feet on 03/31/03 Rapid groundwater seepage observed at a depth of 2 feet Minor caving observed at depths between 2 and 4 feet			
	10									
450										
	15									
445										
	20									

Note: See Figure A-1 for explanation of symbols

The depths of the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

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3443-002-00 GEI

LOG OF TEST PIT 26

Geo Engineers

Project: Puyallup Retail Center

Project Location: Puyallup, Washington

Project Number: 3443-002-00

Figure: A-27

Sheet 1 of 1