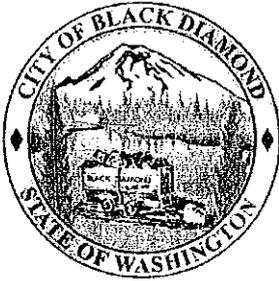
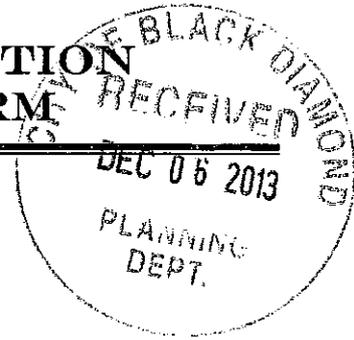


23.

Phase 2 Plat C Geotechnical Report, Golder Associates
December 5, 2013



REVISION/CORRECTION SUBMITTAL FORM



Submittal Requirements:

All revisions / correction submittals MUST contain the following:

1. A completed City of Black Diamond Revision/Correction submittal form
2. Two (2) sets of revised and/or corrected drawings/sheets (wet stamped by architect, if applicable).
3. Revised structural calculations, if applicable (must be stamped by engineer)
4. A written letter to the City that shows an itemized summary of your submittal (must include sheet and detail numbers)
5. All changes **MUST BE CLOUDED** or **HIGHLIGHTED** on each plan set

Date: 12/10/13

Permit #: PLN13-0027

Property Address: See Phase 2 Plat C drawings submitted 11/8/13
 Project Name: The Villages MPD Phase 2 Preliminary Plat C
 Contact Person: Colin Lund
 Phone: (425) 898-2120
 Email: clund@yanowbayholdings.com

TYPE OF SUBMITTAL:

- SUPPLEMENTAL REPORTS/INFORMATION (Phase 2 Plat C Geotechnical Report)
- () **REVISION:** A change the applicant has made to a plan that is either:
1. An approved plan already issued by the City or
 2. A project under current plan review
- () **CORRECTION:** An applicant response to a correction letter written by the City to the applicant

Permit Issued? () Yes (X) No *A plan check fee for revision is \$84 per hour with a minimum of \$42 for 1/2 hour

Please describe revision/correction submittal:

The Villages MPD Phase 2 Plat C Geotechnical Report dated 12/5/2013 prepared by Golder to supplement the Phase 2 Plat C preliminary plat application.

Sheets Affected: If more than two (2) sheets will be changed, please submit two (2) new full sets of plans. Revisions on issued permits only require submittal of the affected sheets.

For City Use Only:

REQ'D APPROVAL	CHECKED BY	ROUTE TO	DATE	INITIAL	COMMENTS	FEES
()	1. BUILDING	<u>[Signature]</u>	_____	_____	_____	_____
<u>[Signature]</u>	2. PLANNING	<u>[Signature]</u>	_____	_____	_____	_____
()	3. FIRE	_____	_____	_____	_____	_____
()	4. PW	_____	_____	_____	_____	_____
()	5	_____	_____	_____	_____	_____

TOTAL \$

PHASE 2 PLAT C GEOTECHNICAL REPORT

The Villages MPD
Black Diamond, Washington



Submitted To: BD Village Partners L.P.
10220 NE Points Drive, Suite 310
Kirkland, WA 98033

Submitted By: Golder Associates Inc.
18300 NE Union Hill Road, Suite 200
Redmond, WA 98052 USA

REPORT

December 5, 2013

063-1076-001.405

Table of Contents

1.0	SITE AND PROJECT DESCRIPTION	1
2.0	INVESTIGATION AND SUBSURFACE CONDITIONS	3
2.1	Soil	3
2.2	Groundwater.....	4
3.0	LABORATORY TEST RESULTS.....	5
4.0	SENSITIVE AREAS ASSESSMENT	6
4.1	Erosion Hazard.....	6
4.2	Landslides	6
4.3	Abandoned Mine Hazards.....	6
4.4	Seismic Hazards	6
4.5	Sensitive Aquifer Recharge Areas	7
5.0	ENGINEERING RECOMMENDATIONS	8
5.1	Seismic Design.....	8
5.1.1	Site Class	8
5.1.2	Ground Motion Parameters.....	8
5.1.3	Liquefaction Hazards	9
5.2	Shallow Foundation Design Criteria	10
5.3	Floor Slabs	11
5.4	Rockery Walls	12
5.4.1	Mechanically-Stabilized Earth (MSE) Walls.....	12
5.5	Pavements	13
5.5.2	Local Roads	14
5.6	Permanent Drainage Provisions	15
5.7	Roof Runoff Dispersal Trenches.....	16
6.0	CONSTRUCTION RECOMMENDATIONS.....	17
6.1	Site Preparation and Topsoil Removal	17
6.2	Site Grading and Earthworks	17
6.2.1	Use of Native Soils.....	17
6.2.2	Temporary and Permanent Slopes	18
6.2.3	Permanent Slopes	19
6.2.4	Structural Fill Specifications.....	19
6.3	Utility Backfill Specifications.....	21
6.4	Pavement Subgrade Preparation.....	22
6.4.1	Outwash Sand and Gravel Subgrade	23
6.4.2	Glacial Till Subgrade.....	23
6.4.3	Bio-Retention Cells	23
7.0	CLOSING	25
8.0	REFERENCES.....	26



List of Tables (in text)

Table 5-1	Capillary Break Gradation
Table 5-2	Recommended Pavement Section for Collector Roads
Table 5-3	Recommended Pavement Sections for Local Roads
Table 5-3	Compaction Specifications

List of Figures

Figure 1	Site and Exploration Plan
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List of Appendices

Appendix A	Exploration Records
Appendix B	Laboratory Test Results

1.0 SITE AND PROJECT DESCRIPTION

The Villages MPD Phase 2 Plat C Preliminary Plat project site (the "Phase 2 Plat C project site") consists of approximately 136 acres of undeveloped land in The Villages Master Planned Development south of Roberts Drive on the west side of Black Diamond City limits. The Phase 2 Plat C project site's development plans include construction of 203 residential single family lots and associated roads and utility improvements. Five future development tracts are included in the Phase 2 Plat C project site boundary (Figure 1).

The Phase 2 Plat C project site is situated on a north-south trending upland that ranges between approximately elevation 562 and 590 feet and is bounded by wetlands on the east (Rock Creek) and the west (Figure 1). The Phase 2 Plat C project site is vegetated with timber and under-brush. The land was previously used for timber harvesting and contains a logging road from the north and several foot trails. There is visual evidence of off-road vehicle and pedestrian use of the logging road and foot paths.

There are no visible surface water features on the development portion of the Phase 2 Plat C project site. Surface water runoff from the Phase 2 Plat C project site drains generally to the bordering wetlands on the east and west. The wetlands on the east recharge Rock Creek which flows to Lake Sawyer. The wetland to the west drains north between two ridges and terminates in a wetland adjacent to the north end of the Phase 2 Plat C project site. Surface water feeding the west wetland infiltrates into recessional outwash deposits which recharge a deeper aquifer that flows to the southwest. The groundwater flow in the shallow recessional outwash deposits located north and west of the Phase 2 Plat C project site is described in a previous Golder Associates, Inc. ("Golder") report (Golder 2010).

The Phase 2 Plat C project site grades will be modified to achieve uniform construction subgrade elevations and to provide for surface water drainage. Cuts and fills across most of the Phase 2 Plat C project site will be on the order of 10 feet or less with rockeries up to 6 feet in height proposed in several areas.

Low-impact design (LID) methods are being implemented for disposal of stormwater where feasible on the Phase 2 Plat C project site. Stormwater from Phase 2 Plat C project site's roads will be collected and directed to the Villages Phase 1A stormwater facility to the west of the Phase 2 Plat C project site where it will be infiltrated. A small amount of road runoff in the north end of the Phase 2 Plat C project site will be infiltrated in a bio-retention facility at the north end of the Phase 2 Plat C project site. The bio-retention facility will be designed in accordance with the Washington Department of Ecology Stormwater Management Manual for Western Washington (Ecology 2005).

Most of the roof runoff from homes within the Phase 2 Plat C project site will be directed to a series of dispersal trenches to be constructed in the bordering wetland buffers to the east and west to provide post



development water balance to the wetlands. The dispersal trenches will be designed in accordance with City of Black Diamond standard details for a flow dispersal trench. In the north end of the Phase 2 Plat C project site where permeable outwash soils are available, some of the roofs will be infiltrated in drywells. In the transition areas between surface till and outwash soils, some of the lot rooftops may be directed to the stormwater system. Runoff from roadways will be directed to the stormwater collection system which will convey the water to an infiltration facility to be constructed in Phase 1A to the west. The stormwater system will be designed by the project civil engineer in accordance with the Washington Department of Ecology Stormwater Management Manual for Western Washington (Ecology 2005).

2.0 INVESTIGATION AND SUBSURFACE CONDITIONS

Geotechnical field investigations were completed on and adjacent to the Phase 2 Plat C project site for the purpose of understanding the site soil and groundwater conditions. The explorations include 18 test pits and 2 boreholes/monitoring wells. The explorations were completed by Golder at various times since 2006. Monitoring well MW-24 installed at the north end of Phase 2 Plat C project site was vandalized and had to be abandoned. A replacement monitoring well MW-31 was installed near MW 24 in 2013. Five of the test pits were completed with shallow standpipe piezometers to allow for potential groundwater interflow water quality sampling. The approximate location of the explorations is shown in Figure 1. Summary records of the explorations are included in Appendix A.

2.1 Soil

The Phase 2 Plat C project site consists predominantly of an upland ridge underlain by Lodgement till (till). The north end of the Phase 2 Plat C project site ridge below approximately elevation 560 feet transitions to the surrounding lowland. The lowlands are underlain by recessional outwash (outwash) deposits overlying till. The till was deposited beneath the Vashon glacier and was draped over older glacial deposits. The topography of the till surface was eroded after deposition under the Vashon glacier by melt-water flowing under the glacier and by surface streams after retreat of the glacier. The melting glacier fed streams and rivers that scoured the surface of the till and deposited the recessional sand and gravel over the low lying till surface. The thickness of the outwash is variable depending somewhat on the depth of the scour into the underlying till unit.

The following is a summary of the soil units encountered on the Phase 2 Plat C project site. Summary exploration records in Appendix A contain more detailed descriptions of the subsurface conditions encountered at each exploration location.

- **Topsoil/Forest Duff** – Where not disturbed by previous site grading, our explorations encountered a layer of topsoil and forest duff that was typically less than 1-foot thick. The topsoil and vegetation layer was characterized by its dark brown color and the presence of roots and scattered organics. This unit is absent from gravel roads. In general the topsoil was thicker and better developed on the till uplands, and thinner covering the outwash deposits.
- **Recessional Outwash** – The recessional outwash deposit was encountered at the surface (below topsoil) at the north end of the Phase 2 Plat C project site. It consisted of fine to coarse gravel and fine to coarse sand with some cobbles and boulders and trace amounts of silt. The outwash deposit was generally loose to dense and caved in open excavations, limiting our ability to reach greater depths. The thickness of the outwash deposit increases at the north end of the Phase 2 Plat C project site to over 20 feet. It generally thinned to the south and terminated against the till upland. The recessional outwash is permeable and surface water readily infiltrates into the ground surface.



- **Lodgement Till** – Till was encountered at the surface in the upland portion of the Phase 2 Plat C project site. The till encountered in the explorations consisted of a silty, fine to coarse sand with varying amounts of gravel. The till unit was typically compact at the surface but quickly graded to dense to very dense. The high silt content and density of the till tends to restrict downward flow of surface water resulting in perched shallow interflow on slopes.

The stratification contacts indicated on the exploration records represent the approximate depth of boundaries between soil units. Actual transitions between soil units may be more gradual. Soil conditions between exploration locations may vary from those encountered. The nature and extent of soil variations between exploratory locations may not become evident until construction. In our opinion, variations in the observed soil conditions will not materially change the engineering recommendations of this report but may require that construction methods adjust to the soil conditions encountered.

2.2 Groundwater

Groundwater was not encountered in explorations on the Phase 2 Plat C project site. We would expect seepage to be encountered in the upper weathered portion of the till likely in the winter and early spring months. Groundwater was measured in monitoring well MW-31 just northwest of the Phase 2 Plat C project site at a depth of 22.4 feet in March 2013. Surface water from the wetland on the southwest side of the Phase 2 Plat C project site infiltrates into the recessional outwash deposits. At MW-31 the recessional outwash is 26-feet thick and overlies an older outwash deposit. Till would normally underlie the recessional outwash but it appears to have been eroded in this location. Therefore, the water infiltrates to the deeper outwash deposit. The aquifer in the deeper outwash deposit flows to the south and west based on previous explorations completed for The Villages MPD project.



3.0 LABORATORY TEST RESULTS

Grain size analyses were performed on two representative samples of recessional outwash collected from borehole MW-31. The grain size analyses were performed in general accordance with ASTM D-421, D-422, and D-4318. The purpose of the tests was to verify or modify the field soil classification and to evaluate infiltration characteristics. The results of the laboratory tests are presented in Appendix B.

4.0 SENSITIVE AREAS ASSESSMENT

Golder carried out an assessment of the geologic sensitive areas on the Phase 2 Plat C project site in accordance with the requirements of the City of Black Diamond Sensitive Areas Ordinance No.08-875 dated February 26, 2009 (Black Diamond 2009). The ordinance Section 19.10.405 designates five geologically hazardous areas: 1) erosion hazards, 2) landslide hazards, 3) abandoned mine hazards, 4) seismic hazards, and 5) sensitive aquifer recharge areas. Maps of steep slope areas (i.e. erosion hazard and landslide hazard area) and abandoned coal mine hazard areas are contained in the report titled "City of Black Diamond Sensitive Areas Ordinance - Best Available Science Review and Recommendations for Code Update", dated September 2008 (SAO BAS). These maps were reviewed for this report. Each of the geologic sensitive areas are discussed in the following section.

4.1 Erosion Hazard

Erosion hazards are defined in the SAO as: *"those areas with soils identified by the U.S. Department of Agriculture's Natural Resource Conservation Service as having a "moderate to severe", "severe", or "very severe" rill and inter-rill erosion hazard"*. The soil types mapped on the subject property by the NRCS include Alderwood Gravelly Sandy Loam (Ag), and Everett Gravelly Sandy Loam (Ev). Erosion hazards on these soil types are only associated with slopes greater than 15 percent. The project site contains only a few isolated areas of 15 percent slopes based on a slope analysis performed by Triad Associates Inc. However, none of the slopes are greater than 10 feet in height and do not present an erosion hazard.

4.2 Landslides

Landslide hazards are defined in the SAO as: *"areas potentially subject to landslides based on a combination of geologic, topographic, and hydrologic factors."* The Phase 2 Plat C project site does not contain any historic landslides and does not meet any of the criteria for landslide hazards contained in the SAO.

4.3 Abandoned Mine Hazards

The location of abandoned mine hazard areas in Black Diamond are shown in Figure 4-8 in the SAO BAS report. None of the Phase 2 Plat C project site is underlain by abandoned coal mines. The closest underground mine workings lie offsite to the east of the Phase 2 Plat C site property boundary, and consist of deep workings on the No.11 mine. The mine workings at this location are nearly 1,800 feet below the ground surface and pose no risk of subsidence or collapse to the Phase 2 Plat C project site.

4.4 Seismic Hazards

Seismic hazards are defined in the SAO as: *"areas subject to severe risk of damage as a result of earthquake-induced ground shaking, slope failure, soil liquefaction or surface faulting."* The Phase 2 Plat C project site does not contain any active surface faults and does not contain soils that have a moderate

or high risk of liquefaction. The nearest active fault is the Tacoma Fault zone located about 6 miles away from the Phase 2 Plat C project site. The Phase 2 Plat C project site is underlain by an unsaturated well-drained layer of recessional outwash sand and gravel over dense till which has a low risk of liquefaction during a seismic event.

4.5 Sensitive Aquifer Recharge Areas

Sensitive aquifer recharge areas are those in which surface water rapidly infiltrates into the ground. Section 19.10.500 of the SAO contains three categories of aquifer recharge areas based on the soil type found in those areas. The following information is from Table 19.10.500A.

Category I – Severe Aquifer Sensitivity: soil types, gravel, sand, peat

Category II – Moderate Aquifer Sensitivity: soil types, shrink/swell clay, sandy loam, loam, silt loam

Category III – Slight Aquifer Sensitivity: soil types, clay loam, muck, non-shrink/swell clay

The surface soil types at the Phase 2 Plat C project site consist of Alderwood gravelly sandy loam (Ag) and Everett gravelly sandy loam (Ev). In accordance with Table 19.10.500B, these soil types are classified as Category II – Moderate Aquifer Sensitivity. In accordance with the SAO, there are restricted uses on property within this category. They are defined in Section 19.10.500B1(a- i). The list includes such things as industrial processing, landfills, and underground hazardous material storage tanks (i.e., uses that are not included in the development plans for the Phase 2 Plat C project site).



5.0 ENGINEERING RECOMMENDATIONS

This section of the report presents our engineering recommendations based on subsurface explorations, review of available soils and geology maps, and geotechnical analyses completed for this investigation. The recommendations provided in this report are applicable to the Phase 2 Plat C project site based on our understanding of the project development information provided by the project team to Golder in October 2013. Final design features may be different and therefore revisions of these design recommendations may be necessary.

The proposed Phase 2 Plat C project site development is feasible from a geotechnical engineering standpoint. The current geotechnical explorations indicate that the subsurface conditions in the planned Phase 2 Plat C project site development area are suitable for site development using standard design and construction practices. The following sections present recommendations for site design and construction.

The recommendations contained in this report do not include an assessment of the presence or implication(s) of possible surface and/or subsurface contamination resulting from previous site activities and/or resulting from the introduction of materials from offsite sources. Recommendations that pertain to environmental issues are outside Golder's scope of services and have not been investigated or addressed in this report.

5.1 Seismic Design

The seismic design sections of the 2012 International Building Code (IBC) and the 2010 American Society of Civil Engineers Standard 7 (ASCE-7-10) provides information to be used as the basis for seismic design of structures.

5.1.1 Site Class

Section 1613 of the International Building Code (IBC) provides information on earthquake loads and site ground motion needed for liquefaction potential assessment. Based on the IBC design criteria, sites are classified based on the average soil profile properties in the first 100 feet below the ground surface. The deepest boring for the Phase 2 Plat C project site was advanced to a depth of over 100 feet below the existing ground surface. It is our opinion that the Phase 2 Plat C project site should be classified as a Class C site based on IBC Table 1613.5.2.

5.1.2 Ground Motion Parameters

Ground motion parameters used for design per the IBC include the Phase 2 Plat C project site coefficient and mapped spectral accelerations, which correspond to Site Class B conditions.

The following design parameters are based on the IBC Maximum Considered Earthquake (MCE) Ground Motion, the 0.2-second spectral acceleration (S_s), and the 1.0-second spectral acceleration (S_1) for the



Phase 2 Plat C project site. The interpolated probabilistic ground motion values in percent gravity were obtained from the US Geological Survey (USGS) website for Seismic Design Maps (USGS 2008). The following results were obtained for latitude 47.30750 and longitude -122.03401 (a point located near the center of the site):

■ Short (0.2 second) Spectral Response (S _s):	1.200 g
■ Long (1.0 second) Spectral Response (S ₁):	0.452 g

Note that these numbers correspond to Site Class B and must be adjusted for Site Class C using the IBC procedures.

The interpolated probabilistic ground motion values in percent gravity were obtained from the USGS java application for ground motion parameters (USGS 2011). Note that these values are adjusted for Site Class C.

F _a	1.0
F _v	1.348
S _{MS}	1.200 g
S _{M1}	0.609 g
S _{DS}	0.800 g
S _{D1}	0.406 g

5.1.3 Liquefaction Hazards

Liquefaction is a phenomenon by which soils lose shear strength for short periods during cyclic ground shaking such as occurs during an earthquake. Ground shaking of sufficient duration and intensity can result in a rapid increase in pore water pressure, causing the soil to behave as a fluid. To have potential for liquefaction, a soil must generally be cohesionless with a grain-size distribution within a specific range (generally sand and silt); it generally must be very loose to compact; it must be below the groundwater table; and it must be subjected to sufficient intensity and duration of ground shaking. After ground shaking stops, water may be expelled to the ground surface as the soil settlement occurs. The effects of liquefaction may include large, total and differential, settlement for structures founded in or above the liquefying soils.

Based on the relatively limited thickness of saturated soils encountered in our explorations, the compact to dense relative density in the recessional outwash soils, and the extensive presence of coarse sand, gravel, and cobbles, we consider the liquefaction potential to be low in the shallow (<20 feet deep) soils. The deeper soils consist of Lodgement till and older glacial soils that are dense to very dense and therefore also have a low potential for liquefaction.

5.2 Shallow Foundation Design Criteria

Conventional spread footings are feasible on existing compact (medium dense) to dense recessional outwash, compacted structural fill, undisturbed weathered till or lodgement till soils encountered in the shallow subsurface in our explorations. We recommend the following allowable bearing pressures for design:

Maximum Allowable Bearing Pressure

Compacted Structural Fill	2,500 per square foot
Undisturbed Compact (Medium Dense) to Dense Native Soil Till	4,000 per square foot
Compact to Dense Recessional Outwash	4,000 per square foot

These values are appropriate for all dead and live loads. A one-third increase is allowable for transient loads such as wind and seismic.

Settlement

Ground settlement is expected to occur as the structures are constructed. Consolidation (long-term, after construction) settlement is not expected at the Phase 2 Plat C project site. Maximum settlement of 1 inch is estimated with differential on the order of ½ inch during construction.

Lateral Dimensions

Continuous Spread Footings:	18 to 24 inches
Isolated Footings:	24 to 72 inches

Minimum Depth of Embedment

The standard of practice in western Washington is to embed footings a minimum of 18 inches below finished grade to reduce the potential for frost heave.

Lateral Load Resistance

Building foundations must resist lateral loads due to earth pressures, wind, and seismic events. For design purposes, these loads can be resisted simultaneously by:

BASE FRICTION: An allowable value of 0.35 can be assumed for base friction between the soil and spread footings. This value includes a factor of safety of 1.5.

PASSIVE RESISTANCE ON SIDES OF SHALLOW FOOTINGS: For design purposes, we recommend that the allowable passive pressure be based on a fluid with a density of 250 pounds per cubic foot (pcf) on the sides of buried footings. This value includes a factor of safety of 1.5.

5.3 Floor Slabs

Conventional slab-on-grade floors can be supported on a subgrade of the native bearing or on structural fill placed and compacted as noted in the subsection *Earthworks*. Slab-on-grade floors should not be founded on organic soils, loose native soils, or uncompacted or uncontrolled fills. We recommend that the geotechnical engineer verify the condition of all subgrades and overlying layers before any fill or concrete is placed. We recommend that floor slabs be underlain by a capillary break material, consisting of at least 4 inches of clean, free draining sand and gravel or crushed rock containing less than 2 percent fines passing the #200 sieve (based on the minus No. 4 sieve fraction) meeting the specification below in Table 5-1. Native sand and gravel that meet these specifications can be used for capillary break material.

Table 5-1: Capillary Break Gradation

Sieve Size of diameter (in)	% Passing
1"	100% Passing
No. 4	0% - 70%
No. 10	0% - 30%
No. 100	0% - 5%
No. 200	0% - 2%

Vapor transmission through floor slabs is an important consideration in the performance of floor coverings and controlling moisture in structures. Floor slab vapor transmission can be reduced through the use of suitable vapor retarders such as plastic sheeting placed between the capillary break and the floor slab, and/or specially formulated concrete mixes. Framed floors should also include vapor protection over any areas of bare soils and adequate crawl space ventilation and drainage should be provided. The identification of alternatives to prevent vapor transmission is outside of our expertise. A qualified architect or building envelope consultant can make recommendations for reducing vapor transmission through the slab, based on the building use and flooring specifications. We recommend that a building envelope or waterproofing expert be consulted in regards to the appropriate water proof system.

Vertical Deflections

Soil-supported slab-on-grade floors can deflect downward when vertical loads are applied, due to elastic compression of the subgrade. In our opinion, a subgrade reaction modulus of 200 pounds per cubic inch can be used to estimate deflections for slabs placed over structural fill or properly prepared native soil.

Note that this subgrade reaction modulus (Ks_1) is based on loading of a 1 foot by 1 foot plate and is intended to be used only for floor slabs; for heavily loaded conditions, consultation between the geotechnical engineer and the structural engineer would be needed to determine an appropriate modulus to be used for design.

5.4 Rockery Walls

The Phase 2 Plat C project site is gently sloping and rockery walls are planned to achieve developed site grades in several areas along the northeast and southwest site boundaries and between house lots near the center of the Phase 2 Plat C project site. The height of the rockeries as shown on the Phase 2 Plat C project site's civil grading plans is no greater than 8 feet.

We recommend that rockeries facing native soil cuts be limited to a maximum height of 4 feet in the recessional outwash deposits and 8 feet in the Lodgement till. Higher cut rockeries may be feasible but will be evaluated on a site specific basis and will require additional field explorations. Fill rockeries of up to 4 feet can be used to face cuts in controlled structural fill provided that there are no surcharges on the rockery and the fore and back slopes are flat. Higher fill rockeries should be designed by an engineer and use a geogrid reinforced fill soil and would also require additional site investigation. Geogrid reinforced walls are termed MSE walls (mechanically stabilized earth).

All rockery faces should be designed and built to meet the standards set by the Rockery Design and Construction Guidelines (FHWA 2006) which includes a specified wall batter, minimum rock sizes and quality, and a drainage layer behind the rockery. Alternative rockery designs can also be considered, but should be reviewed by the geotechnical engineer.

5.4.1 Mechanically-Stabilized Earth (MSE) Walls

MSE Walls are feasible at the Phase 2 Plat C project site based on the subsurface conditions. The recessional outwash and till should provide adequate subgrade bearing conditions for MSE walls. Depending on the height of the planned walls, additional geotechnical information may be needed for final design.

- **FILL PARAMETERS:** We recommend that a high quality, clean, well-graded sand and gravel fill be used. The fill should contain less than 10 percent fines. For design, the unit weight can be assumed equal to 130 pcf and an effective stress friction angle (ϕ') = 34 degrees. The in-situ soil values used for the retained soils behind the geogrid zone can be assumed to have a unit weight equal to 130 pcf and an effective stress friction angle (ϕ') = 30 degrees. Alternative types of fill can be considered; however different materials possess different strength parameters, which may result in retaining wall design changes and cost. If the wall contractor elects to use a silty backfill (> 10 percent fines), alternative design parameters and recommendations for improved drainage (curtain, blanket, and finger drains) and additional field testing will be required.

- **DRAINAGE:** Proper drainage is critical for retaining walls. MSE walls can perform poorly if the backfill behind the wall and/or in the reinforcement zone becomes saturated. Thus, it is essential to use free-draining fill within the zone of reinforcement in an MSE fill and within a width equal to the wall height for gravity walls. As an alternative, finer-grained fill can be considered provided a drainage blanket is placed in the fill behind the reinforcement to intercept and drain any seepage.

For MSE walls, typical geogrid reinforcement lengths are about 90 percent of the retained height for walls, assuming that there is no backslope or substantial surcharge loading. The length of the geogrid reinforcing will be longer for inclined backslopes or sloping frontslope.

The above parameters are general recommendations only. Once the Phase 2 Plat C project site's design plans are finalized, individual wall locations should be reviewed, and a formal retaining wall design created to include evaluation of long-term global stability and performance.

5.5 Pavements

The Phase 2 Plat C project site's pavement design recommendations are based on Section 3.2 "Roadway Design" and Section 3.3 "Streets" of the *City of Black Diamond – Engineering Design and Construction Standards 2009*. Recommended pavement sections are presented for different subgrade types (recessional outwash and till). The pavement sections were designed based on a 20-year performance period for local.

Soil design values for subgrade conditions were determined based on visual classification, laboratory testing, field observations, and correlated values. The outwash soils are considered to be "good," consisting of well-drained sand and gravel with silt content typically less than 5 percent at pavement subgrades. For these soils, the following soil parameters were estimated:

- Resilient modulus – 10,000 pounds per square inch (psi) for outwash sands and gravels subgrade
- Modulus of subgrade reaction – 200 pci (pounds per cubic inch; this value should be used for concrete pavement design only)

The glacial till soils contain more silt sized particles. If the subgrade becomes wet, it will not provide the same support for the pavement. For these soils, the following soil parameters were estimated:

- Resilient modulus – 5,000 psi for glacial till subgrade

The performance of the pavements will be related in part to the condition of the underlying subgrade. The possibility exists for variation in the soil subgrade conditions from those assumed for this analysis, which may affect the performance of pavement sections. Pavement designs assume that the pavement section is constructed on properly prepared and compacted native subgrade or structural fill as described in this



report. Flexible pavement materials and placement should be in accordance with the current version of *WSDOT Standard Specifications for Road, Bridge, and Municipal Construction* (2012).

5.5.1 Collector Roads

We used parameters from the *King County Road Design and Construction Standards* (2007) for certain design parameters. The parameters came from Chapter 4.04 and included the following:

- Reliability (R) – 85 percent
- Overall Standard Deviation (S₀) – 0.5
- Design Serviceability Loss (DPSI) – 1.5

For Average Daily Trips (ADT) on the collector roads, we assumed 4,400 ADT for the collector roads. *City of Black Diamond – Engineering Design and Construction Standards 2009* gives a range of 1,000 to 5,000 ADT for a neighborhood collector road. We assumed 5 percent of the average daily trips were trucks, 1 ESAL per truck, and 2 percent truck growth rate. Using these and the previously noted design parameters in the AASHTO Flexible Pavement Design Equation, we calculated a structural number. Based on the structural number and minimum pavement section for minor arterials in the *City of Black Diamond – Engineering Design and Construction Standards 2009*, the pavement sections in Table 5-2 for collector roads were calculated.

Table 5-2: Recommended Pavement Section for Collector Roads

Road Type/Soil Type	Asphalt	Top Coarse	Base Coarse
Collector (outwash subgrade)	5.5 inches AC	2 inches CSTC	6 inches Gravel Base*
Collector (glacial till subgrade)	5.5 inches AC	2 inches CSTC	18 inches Gravel Base*

Note: *Gravel Base can consist of outwash sands and gravels compacted to 95% of Modified Proctor.

In areas where the road will be constructed over glacial till subgrade, provisions (construction details) should be included to allow any low spots in the subgrade to drain. Otherwise the gravel base will act as a “bathtub,” holding watering and causing problems with the pavement.

5.5.2 Local Roads

Residential streets within the Phase 2 Plat C project site were considered local roads. We understand these roads will have asphalt travel lanes. The majority of the subgrade for these roads will consist of till with a portion of the north end of the Phase 2 Plat C project site consisting of recessional outwash.

We used parameters from the *King County Road Design and Construction Standards* (2007) for design of the local roads. The parameters came from Chapter 4.04 and included the following:



- Reliability (R) – 85 percent
- Overall Standard Deviation (S_0) – 0.5
- Design Serviceability Loss (DPSI) – 1.5

For ADT on the local roads, we assumed a value of 500. The *City of Black Diamond – Engineering Design and Construction Standards 2009* gives a range of 0 to 1,000 average daily traffic (ADT) for a local road.

We assumed 2 percent of the ADT were trucks, 1 equivalent single axel load (ESAL) per truck, and 2 percent truck growth rate. Using these and the previously noted design parameters in the AASHTO Flexible Pavement Design Equation, we calculated a structural number. Based on the structural number and minimum pavement section for local roads in the *City of Black Diamond – Engineering Design and Construction Standards 2009*, we calculated the pavement sections in Table 5-3 for Local Roads.

Table 5-3: Recommended Pavement Sections for Local Roads

Road Type/Soil Type	Asphalt	Top Coarse	Base Coarse
Local (outwash subgrade)	4 inches AC	2 inches CSTC	0 inches Gravel Base*
Local (glacial till subgrade)	4 inches AC	2 inches CSTC	6 inches Gravel Base*

Note: *Gravel Base can consist of outwash sands and gravels compacted to 95% of Modified Proctor.

In areas where the road will be constructed over glacial till subgrade, provisions (construction details) should be included to allow any low spots in the subgrade to drain. Otherwise the gravel base will act as a "bathtub", holding watering and causing problems with the pavement.

5.6 Permanent Drainage Provisions

Permanent control of surface water should be incorporated in the final grading design. It is important to separate all surface water drainage including roof downspouts from any building underdrain systems, including footing drains. The water collected from roof downspout and footing drains should be separately tightlined to an appropriate discharge or infiltration point. Cleanouts should be installed at strategic locations to allow for periodic maintenance of footing drain and downspout tightline systems. Subsurface drainage should include:

- **Footing Drains:** Footing drains should be provided for all buildings. The footing drains should consist of at least a 4-inch diameter perforated heavy walled PVC pipe surrounded by a minimum of 6 inches of drainage gravel with a minimum of 2 inches of drainage gravel below the pipe invert. Drainage gravel should meet WSDOT specification 9-03.12(4) for "Gravel Backfill for Drains". In no case should roof downspouts be connected to the footing drain system. Roof drainage should be collected and conveyed in a system separate from the footing drain system.
- **Wall Drainage:** Retaining walls and backfilled walls should include a permanent drainage system behind at the bottom of the wall. Wall drainage should include a wall



footing drain or wall heel drain consisting of at least a 4-inch diameter perforated heavy walled PVC pipe surrounded by at least 6 inches of drainage gravel. Drainage gravel should meet WSDOT specification 9-03.12(4) for "Gravel Backfill for Drains". The backfill against the wall (a "curtain drain") should consist of at least a 12-inch thickness of drainage gravel meeting WSDOT requirements for 9-03.12(4) for "Gravel Backfill for Drains" or equivalent. Alternatively, drainage composite material such as Miradrain may be placed behind the wall and connected to an appropriate drainage system to reduce hydrostatic pressures behind the wall. If silty native soils are used for backfill, a geotextile meeting WSDOT requirements for a "Geotextile for Soil Separation", 9-33.2(1), Table 3, should be placed between the drainage gravel and native soils. A relatively fine-grained soil should be placed within a foot of the ground surface to limit surface water infiltration and the slope behind the wall should be graded to drain away from the wall.

- **Drainage System Discharge:** The wall drainage system and footing drains should flow by gravity to a storm drainage system if feasible. If gravity flow is not feasible, the drainage system should run to a sump for pumping. The drainage system should be vented to the atmosphere in order to prevent a build-up of hydrostatic pressure, if a mechanical or electrical failure should occur.

5.7 Roof Runoff Dispersal Trenches

Roof runoff from most of the homes will be collected and directed to surface dispersal trenches installed in or near wetland buffers (to provide wetland recharge) on the northeast and southwest boundaries of the Phase 2 Plat C project site. The dispersal trenches will be installed in 50-foot long sections in accordance with the City of Black Diamond design standards for flow dispersal trenches. In areas where recessional outwash soils are present at the surface (northwest corner of the Phase 2 Plat C project site) house roof runoff will be infiltrated. House lots that are not suitable for either of the two previously mentioned drain methods will be routed to the stormwater system.

The Phase 2 Plat C stormwater system will include capture and conveyance from selected house lots and roadway pavements. The water will be conveyed to the Phase 1A Preliminary Plat stormwater facility where it will be treated and infiltrated.

6.0 CONSTRUCTION RECOMMENDATIONS

6.1 Site Preparation and Topsoil Removal

The Phase 2 Plat C project site preparation will include the removal of trees and vegetation from the site and stripping of the topsoil from areas to receive fill, roadways, and building pads. All trees, vegetation, and deleterious materials shall be grubbed and removed from the site. Topsoil shall be stripped from areas to receive structural fill, pavement areas, and building lots.

Topsoil stripping in the proposed bio-retention facility should be done carefully so that the underlying soil is not disturbed or compacted by the weight of construction equipment.

Based on information from test pit explorations, the topsoil thickness on the Phase 2 Plat C project site is relatively thin (approximately 9 inches) in areas underlain by recessional outwash, and about 12 inches in areas underlain by Lodgement till. These estimates will vary across the Phase 2 Plat C project site. The Phase 2 Plat C project site contains numerous roads and disturbed areas, such as the former gravel quarry where no or little topsoil is present. Topsoil strippings should either be exported from the site or stockpiled for use in landscaping areas after final site grading. Since topsoil stripping depth can have a significant cost impact and can be difficult to interpret, we recommend that a representative from Golder be on site during the topsoil stripping to provide more detailed recommendations on stripping depth and verify the assumptions based on the test pit observations.

Localized areas of deeper unsuitable soil (disturbed soil, organic soil, etc.) and debris such as logs should be anticipated during site preparation and stripping. Unsuitable soil and debris should be removed from beneath structures and pavements and other areas planned for development. Depending on the nature of the unsuitable soil, it may be reusable as structural fill with appropriate backfilling and compaction.

Exposed subgrades for footings, floors, pavements, and other structures should be compacted with a vibratory roller to a firm, unyielding state. Any localized zones of loose granular soils observed within a subgrade should be compacted to a density appropriate for planned development. Any organic, soft, or pumping soils observed within a subgrade should be overexcavated and replaced with a suitable structural fill material. Unsuitable excavated materials should not be mixed with materials to be used as structural fill.

6.2 Site Grading and Earthworks

6.2.1 Use of Native Soils

Grading may generate cut soils for potential use as structural fill under the conditions described below. The recessional outwash and glacial till soils are suitable for reuse as structural fill provided they can be

moisture conditioned and compacted to the specifications outlined in Section 6.2.4. The Phase 2 Plat C project site's soils are discussed below.

- **Surficial or Organic Soils:** Sod, duff, topsoil, and organic-rich soils at the site are *not* suitable for use as structural fill under any circumstances, due to their long-term compressibility. Consequently, these materials can be used only for non-structural purposes, such as in landscaping areas. The silty surface soil layer is also not expected to be reusable as structural fill.
- **Glacial Till:** The glacial till is suitable for reuse as structural fill. Till should be considered moisture sensitive due to its relative high silt content. It can become unworkable when wet and difficult to dry when the moisture content becomes over optimum for compaction. Air drying or mixing with soil drying admixtures or other drier soils may be feasible.
- **Recessional Outwash Sand and Gravel:** The outwash sand and gravel is suitable for reuse as structural fill. Depending on weather conditions, the existing moisture could be below optimum moisture content needed to achieve specified density, and the soil may need to have water added during placement and compaction. This soil unit typically has silt content near or below 5 percent and can be generally used in wet weather.

If imported material is needed for filling during wet weather, the project specifications should include provisions for using imported, clean, well-graded sand and gravel, such as "Gravel Borrow" per WSDOT: 9-03.14, except that the percent passing the U.S. No. 200 sieve should be no greater than 5 percent. Other imported soils may be used if approved by the geotechnical engineer and owner.

6.2.2 Temporary and Permanent Slopes

Safe temporary slopes are the responsibility of the contractor and should comply with all applicable OSHA and WISHA standards. Temporary stable cut slopes less than 8 feet in height can generally be constructed in the native site soils, using the following recommendations:

- Undocumented Fill – 1.5H:1V (Horizontal:Vertical)
- Till - 1H:1V

We did not encounter perched groundwater in our explorations. However, perched groundwater conditions should be anticipated during construction. If temporary cuts encounter groundwater seepage, they should be sloped at 2H:1V or flatter (as recommended by the geotechnical engineer at the time of construction) to prevent significant caving or sloughing. Temporary cuts in the loose soils are expected to have some raveling at the cut face. Temporary cut slopes in loose soil may need to be laid back flatter, if there is a change in material type or debris is encountered.

In the event that groundwater seepage is encountered during excavation, the contractor must install temporary drainage measures to protect the cut face and prevent degradation of the excavation area until permanent drainage measures can be constructed.

6.2.3 *Permanent Slopes*

All permanent cut slopes and fill slopes should be adequately inclined to minimize long-term raveling, sloughing, and erosion. We generally recommend that no slopes be steeper than 2H:1V. For all soil types, the use of flatter slopes, such as 3H:1V, would further reduce long-term erosion and facilitate re-vegetation. Slopes steeper than 3H:1V may experience erosion or sloughing during the first winter season or until vegetation is well established. On all slopes, a hardy vegetative groundcover should be established as soon as feasible to protect the slopes from erosion. Erosion control measures, including use of plastic sheeting can reduce erosion and sloughing and surficial slope damage. Permanently exposed slopes should be seeded with an appropriate species of vegetation to reduce erosion and improve stability of the surficial layer of soil.

6.2.4 *Structural Fill Specifications*

The term "structural fill" refers to any materials used for building pads, roadway embankments, and materials placed under foundations, retaining walls, slab-on-grade floors, sidewalks, pavements, and other such features. Golder's conclusions and recommendations concerning structural fill are presented in the following paragraphs.

Materials:

Structural fill should be free of organic and inorganic debris, be near the optimum moisture content, and capable of being compacted to the required specifications for application. Soils used for structural fill should generally not contain any organic matter or debris or any individual particles greater than about 6 inches in diameter. Typical structural fill materials include: 1) clean sand and gravel, 2) well-graded mixtures of sand and gravel (commonly called "gravel borrow" or "pit-run"), 3) mixtures of silt, sand, and gravel, 4) crushed rock, 5) quarry spalls, and 6) controlled-density fill (CDF). If the onsite soils do not meet the above criteria, or cannot be reworked to a suitable condition, we recommend using imported granular fill consisting of imported, clean, well-graded sand and gravel, such as "Gravel Borrow" per WSDOT: 9-03.14, except that the percent passing the U.S. No. 200 sieve should be no greater than 5 percent. Other fill materials may be used with approval of the engineer.

Fill Placement:

Fill should be placed in horizontal lifts not exceeding 12 inches in loose thickness, and each lift should be thoroughly compacted with a mechanical compactor. Any structural fill placed beneath footings should extend laterally outside of the footing base at a 1H:1V slope projected down and away from the bottom footing edge. If structural fill is to be placed in low lying areas that may contain ponded water (such as the existing gravel pit), then the subgrade should either be de-watered or a clean free draining fill or gravel should be used to backfill in the wet zone prior to placing and compacting the structural fill.

Compaction Criteria:

Using the Modified Proctor test (ASTM D1557) as a standard, we recommend that structural fill used for onsite applications be compacted to specifications listed in Table 5-4.

Table 5-4: Compaction Specifications

Fill Application	Minimum Compaction
Building pad	95 percent
Footing subgrade or bearing pad	95 percent
Slab-on-grade floor subgrade and subbase	95 percent
Retaining wall footing subgrade	95 percent
Roadway embankment	95 percent
Concrete slab subgrades	95 percent
Asphalt pavement base and subbase	95 percent
Asphalt pavement subgrade	95 percent
Retaining wall backfill	90 percent
Footing and stemwall backfill	90 percent
Landscaped Areas	85 percent

Subgrade Verification and Compaction Testing:

All structural fill should be placed over firm subgrades prepared in accordance with the recommendations in this report. The condition of all subgrades should be verified by the geotechnical engineer before filling or construction begins. With the exception of landscape areas, fill soil compaction should be verified by means of in place density tests performed during fill placement so that soil compaction may be evaluated as earthwork progresses.

Pavement and foundation subgrades should be maintained in a well compacted state and protected from degradation prior to paving or placing concrete. Protection measures may include restricted traffic, perimeter drain ditches, or placement of a protective gravel layer on the subgrade. Disturbed or wet areas should be removed and replaced by suitably compacted structural fill.

Soil Moisture:

The suitability of soils used for structural fill depends primarily on their grain size distribution and moisture content when they are placed. As the "fines" content (that soil fraction passing the U.S. No. 200 Sieve) increases, soils become more sensitive to small changes in moisture content. Soils containing more than about 5 percent fines (by weight) cannot be consistently compacted to a firm, unyielding condition when the moisture content is more than about 2 percentage points above or below optimum. If density tests taken in the fill indicate that compaction is not being achieved due to high moisture content, then the fill should be moisture-conditioned and re-compacted. If the required densities cannot be met, then the

material should be excavated and replaced. For fill placement during wet-weather site work, we recommend using soils that have fines content of 5 percent or less (by weight).

Wet Season Construction:

We understand that site grading may be completed during early spring or late fall when the risk of significant rainfall is higher than summer. The recessional outwash soils are not considered to be moisture-sensitive soils and can typically be worked in light rain conditions. However, the till soils are considered moisture sensitive and will rapidly deteriorate if worked in even light rainfall these soils will also deteriorate if the moisture content is more than a few percent over the optimum required for compaction.

Risks of wet season construction include:

Degradation of exposed subgrades: Subgrades exposed to rain and ponded water can degrade (e.g., have reduced bearing capacity) under traffic loads such as construction trucks and equipment. The amount of degradation is greatest for soils with higher silt content (such as the shallower soils at the site). The till and silty near surface soil will be most susceptible to degradation. This degradation will be evidenced by “pumping” and excessive mud and silt. In some cases, it may be possible to repair the subgrade in dryer weather by recompaction after the soil has dried out.

Excavated soil becoming too wet: If excavated soil stockpiles are not covered after excavation, the soil could become too wet to reuse, compact, or handle. If the soil becomes too wet, it may need to be dried out and reworked during dryer and warmer weather. Alternatively, soil drying admixtures could be evaluated for use on the site. The extent of impact on soils will vary – soils with higher silt content, such as the till will be most impacted by elevated moisture contents.

Imported Soil: In the unlikely event that onsite soils become too wet and construction needs to proceed using import backfill, we recommend that the import material contain less than 5 percent fines by weight passing the U.S. No. 200 sieve.

6.3 Utility Backfill Specifications

Maintaining safe utility excavations is the responsibility of the utility contractor. The soil and groundwater conditions in the utility excavations will vary across the site. Due to the cohesionless nature of the recessional outwash site soils, caving of the trench walls in these deposits should be anticipated. The Contractor should anticipate encountering cobbles and scattered boulders in the till and outwash. As appropriate, trench shoring should be used by the utility contractor. Existing underground utilities to be



abandoned should be plugged or removed so they do not provide a conduit for water and cause soil saturation or instability.

Utility Subgrades:

Based on our explorations, we expect that most utility excavations will extend into soils that will adequately support utility pipes, catch basins, vaults, and similar structures. If localized zones of soft or organic soils are encountered in utility excavations, we recommend that they be over-excavated as recommended by the geotechnical engineer and replaced with suitable structural fill compacted to a uniform density appropriate to the utility location.

Utility Bedding:

Utility pipes should be bedded on appropriate material that extends at least 6 inches outward from the pipe in all directions. For level or gently sloping pipes, we recommend using a clean, uniform, well-rounded material such as pea gravel or "Gravel Backfill for Pipe Bedding" per WSDOT: 9-03.12(3). For moderately or steeply sloping pipes, we recommend using a clean, uniform, angular material such as "Crushed Surfacing Top course" per WSDOT: 9-03.9(3), to reduce groundwater flow rates through the bedding.

Utility Backfill and Compaction:

The native till and outwash granular soils can be used as utility excavation backfill if they can be placed and compacted to the specifications in this report. If onsite soils cannot be compacted to the specification, such as during the wet season or during rainy periods, then an import backfill material meeting the WSDOT specification for Gravel Borrow 9-03.14 could be used.

Fill should be carefully placed and hand tamped to about 12 inches above the crown of the pipe before heavy compaction equipment is used. The remainder of the trench backfill should be placed in lifts having a loose thickness of no greater than 12 inches. We recommend that utility backfill soils be compacted to a density commensurate with the requirements of overlying structures or pavements as described in the *Structural Fill* section of this report.

6.4 Pavement Subgrade Preparation

Long-term pavement performance depends on appropriate asphalt or concrete design and thickness, but also depends on the subgrade soil type and proper preparation prior to paving. The current project design includes both concrete and asphalt pavement and subgrades consisting of till and outwash sand and gravel. In addition, there will be pervious asphalt in limited areas with pervious outwash sand and gravel subgrade.

6.4.1 *Outwash Sand and Gravel Subgrade*

When properly prepared, the outwash sand and gravel have good characteristics for pavement subgrade. This subgrade soil provides adequate load support, readily drains, and is not prone to swelling or frost heave. In general, the near surface outwash sand and gravel will be loose to compact. At a minimum, we recommend compacting the upper 12 inches of native material beneath roads to 95 percent of Modified Proctor.

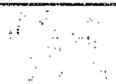
6.4.2 *Glacial Till Subgrade*

Under roads, any loose glacial till should be excavated to expose dense to very dense soils. Then care needs to be taken to protect the subgrade from disturbance. If exposed to rain and ponded water, the glacial till subgrade will degrade under traffic loads such as construction trucks and equipment. Low spots in the till subgrade should be mitigated with adequate drainage to avoid ponding of water within the pavement base coarse gravel.

In areas where the road will be constructed over glacial till subgrade, provisions (construction details) should be included to allow any low spots in the subgrade to drain. Otherwise the gravel base over the till will act as a "bathtub", holding water and causing problems with the pavement.

6.4.3 *Bio-Retention Cells*

Generally, the native subgrade soil under bio-retention cells is not compacted and care is taken to limit any traffic over the subgrade so that infiltration rates are not affected. Since some construction traffic is inevitable, Golder completed laboratory testing on recessional outwash sand samples from the Phase 1A project site, which is adjacent to the Phase 2 Plat C project site (Golder 2010) to evaluate the effects of soil compaction on permeability. The recessional outwash soil is fairly uniform across the Phase 1A project site and into the Phase 2 Plat C project site. We tested the permeability of an outwash sample in a natural condition (lightly compacted) and when compacted to 95 percent of the maximum dry density as determined by Modified Proctor (simulating a high degree of compaction). The results show that the permeability of the natural or un-compacted soil decreased from 0.5 centimeter per second to 0.16 centimeter per second when compacted to 95 percent Modified Proctor. Although this appears to be a significant decrease, the permeability and infiltration capacity of the compacted soil is still in the tens of inches per hour which is more than adequate for pervious pavement, rain garden and roof gutter downspout infiltration.



The most important consideration for the proper performance of permeable pavements and rain gardens is protection of the subgrade from contamination with soil fines. Soil fines can come from erosion of adjacent areas of till soils, mud from construction equipment tires, erosion of landscaped areas or topsoil stockpiles, and others. The sources and risks for contamination of the subgrade (and pavement, once constructed) will depend on the sequencing of construction and will change as construction progresses. Protection of the subgrade will be required in order to maintain permeability of the pavement or rain garden.

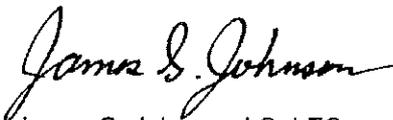
7.0 CLOSING

This report has been prepared exclusively for the use of BD Village Partners and their consultants and contractors for specific application for The Villages MPD, Phase 2 Plat C in Black Diamond, Washington. We encourage review of this report by bidders and/or contractors as it relates to factual data only (exploration records, laboratory test results). The conclusions and recommendations presented in this report are based on the explorations and observations completed for this study, review of previous geotechnical and geologic studies in the Phase 2 Plat C project area, and conversations with the project team. These conclusions and recommendations are not intended, nor should they be construed to represent, a warranty regarding the proposed development, but are forwarded to assist in the planning and design process.

Judgment has been applied in interpreting and presenting the results. Variations in subsurface conditions over small distances are common, and actual conditions encountered during construction may be different from those interpreted in this report.

The subsurface explorations were performed in general accordance with locally accepted geotechnical engineering practices, to provide information for the areas explored.

GOLDER ASSOCIATES INC.

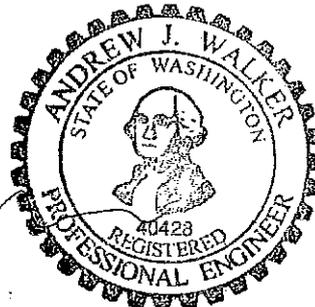


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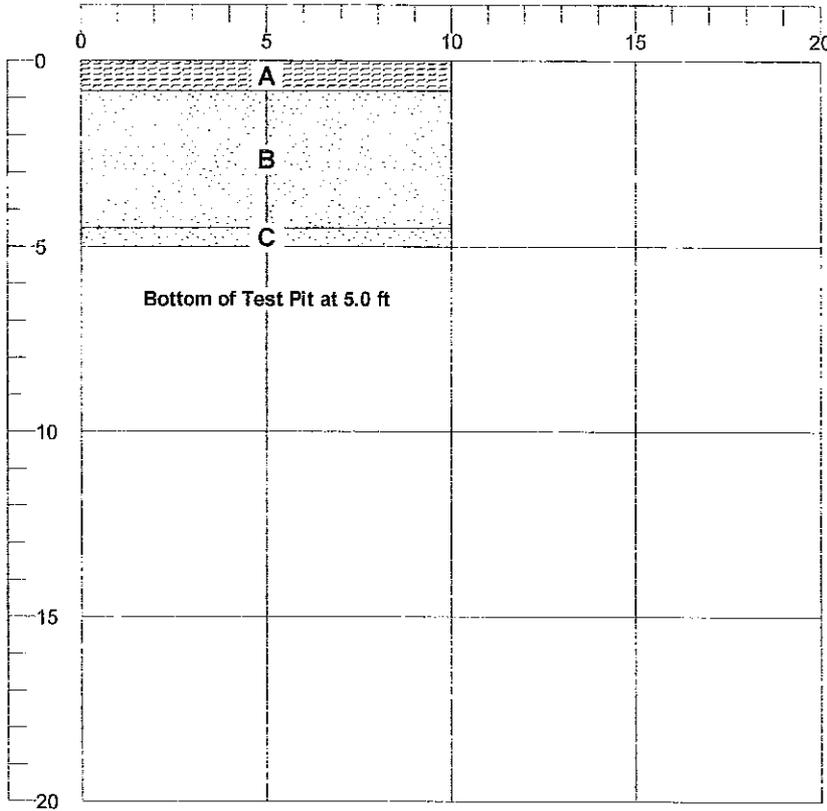
FIGURES

**APPENDIX A
EXPLORATION RECORDS**



LOG OF TEST PIT MWV29-01

Temp 60 °F Weather sunny Engineer J. Coleman Operator Jeremy
 Equipment Cat 312 C Contractor Builders Suppy Date 9/11/13
 Elevation 547.0 ft Datum MSL Job 063-1076.405
 Location Parcel V-29



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

- A** 0.0 - 0.8 ft: TOPSOIL
- B** 0.8 - 4.5 ft: (SP) SAND, fine to coarse, some silt, some gravel, fine to coarse, subrounded, trace roots in the upper few feet, brown grading to tan, nonstratified, (WEATHERED TILL), non-cohesive, moist, compact
- C** 4.5 - 5.0 ft: (SP) SAND, fine to coarse, some silt, some gravel, fine to coarse, subrounded, trace cobbles, subrounded, gray, nonstratified, cemented, (TILL), non-cohesive, moist very dense

TIME	DEPTH OF HOLE (ft)	DEPTH TO W/L (ft)	DEPTH TO SEEPAGE (ft)

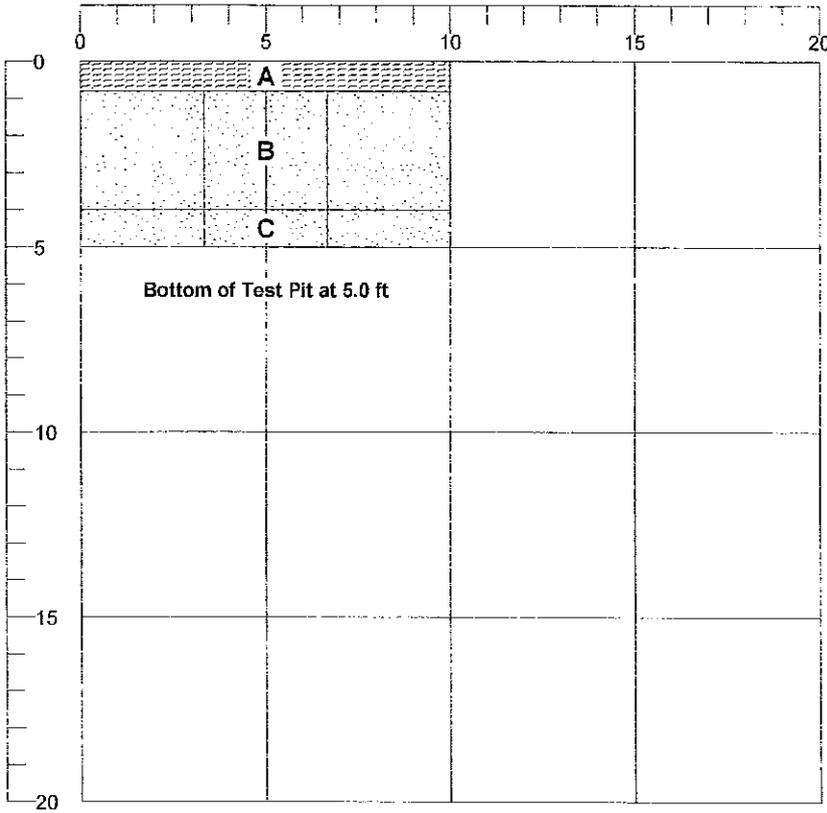
SPECIAL NOTES:

PVC well installed with 1.5 feet of hand slotted screen. Surface to 3 feet below the surface backfilled with soil from test pit. Filter sand from 3 to 5 feet below the surface. Bottom of well at 5 feet below the surface. Approximately 3 feet of PVC well casing stick-up above the ground surface. No monument installed. No groundwater observed at the time the pit was excavated. No caving of the pit sidewalls was observed. No soil samples collected.



LOG OF TEST PIT MWV29-02

Temp 60 °F Weather sunny Engineer J. Coleman Operator Jeremy
 Equipment Cat 312 C Contractor Builders Suppy Date 9/11/13
 Elevation 558.0 ft Datum MSL Job 063-1076.405
 Location Parcel V-29



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

- A** 0.0 - 0.8 ft: TOPSOIL
- B** 0.8 - 4.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, trace cobbles, subrounded, trace roots, brown grading to tan, with depth, nonstratified, (WEATHERED TILL), non-cohesive, moist, compact to dense
- C** 4.0 - 5.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, trace cobbles, subrounded, gray, nonstratified, (TILL), non-cohesive, moist, very dense

TIME	DEPTH OF HOLE (ft)	DEPTH TO W/L (ft)	DEPTH TO SEEPAGE (ft)

SPECIAL NOTES:

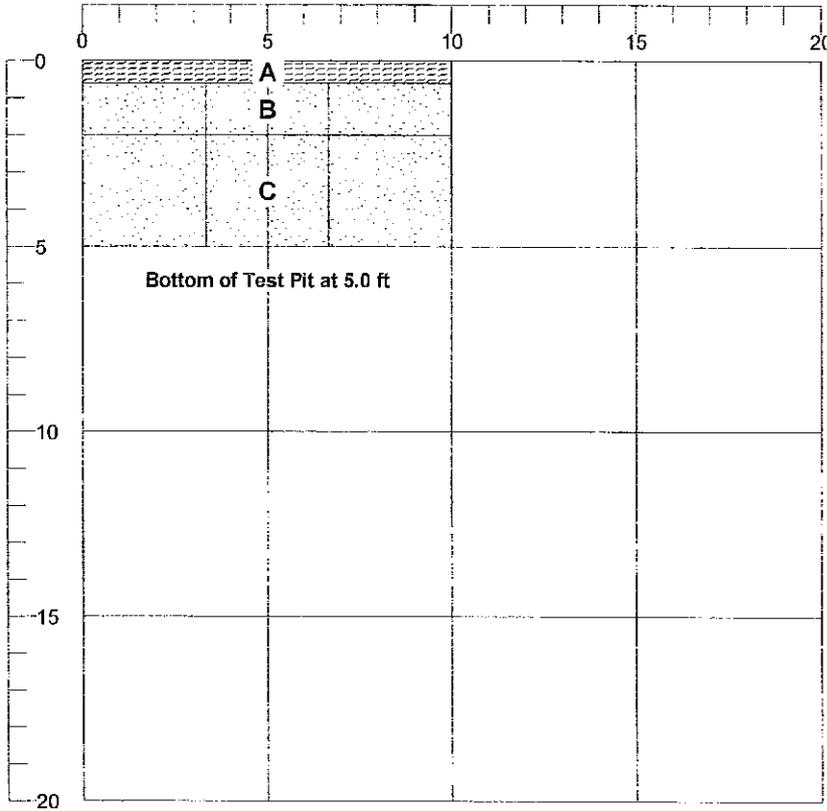
Eight feet of 2-inch diameter, PVC well installed with 1.5 feet of hand slotted screen. Lower end cap glued in-place. Upper end cap compression fitted. Surface to 3 feet below the surface backfilled with soil from test pit. Filter sand from 3 to 5 feet below the surface. Bottom of well at 5 feet below the surface. Approximately 3 feet of PVC well casing stick-up above the ground surface. No monument installed.

No groundwater observed at the time the pit was excavated. No caving of the pit sidewalls was observed. No soil samples collected.



LOG OF TEST PIT MWV29-03

Temp 65 °F Weather sunny Engineer J. Coleman Operator Jeremy
 Equipment Cat 312 C Contractor Builders Suppy Date 9/11/13
 Elevation 560.0 ft Datum MSL Job 063-1076.405
 Location Parcel V-29



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES	
A	0.0 - 0.6 ft: TOPSOIL
B	0.6 - 2.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, brown grading to tan, nonstratified, (WEATHERED TILL), non-cohesive, moist, compact to dense
C	2.0 - 5.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, trace cobbles, subrounded, gray, nonstratified, (TILL), non-cohesive, moist, very dense

TIME	DEPTH OF HOLE (ft)	DEPTH TO W/L (ft)	DEPTH TO SEEPAGE (ft)

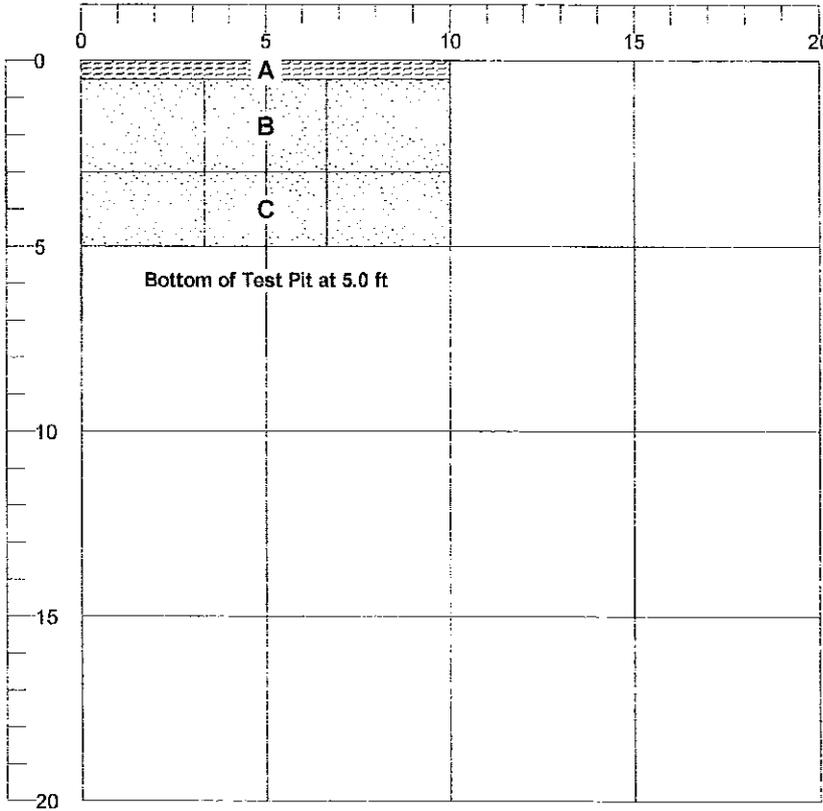
SPECIAL NOTES:
 Eight feet of 2-inch diameter, PVC well installed with 1.5 feet of hand slotted screen. Lower end cap glued in-place. Upper end cap compression fitted. Surface to 3 feet below the surface backfilled with soil from test pit. Filter sand from 3 to 5 feet below the surface. Bottom of well at 5 feet below the surface. Approximately 3 feet of PVC well casing stick-up above the ground surface. No monument installed.

No groundwater observed at the time the pit was excavated. No caving of the pit sidewalls was observed. No soil samples collected.



LOG OF TEST PIT MWV29-04

Temp 70 °F Weather sunny Engineer J. Coleman Operator Jeremy
 Equipment Cat 312 C Contractor Builders Suppy Date 9/11/13
 Elevation 566.0 ft Datum MSL Job 063-1076.405
 Location Parcel V-29



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES	
A	0.0 - 0.5 ft: TOPSOIL
B	0.5 - 3.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, brown grading to tan, nonstratified, (WEATHERED TILL), non-cohesive, moist, compact to dense
C	3.0 - 5.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, trace cobbles, subrounded, mottled gray, nonstratified, (TILL), non-cohesive, moist, very dense

TIME	DEPTH OF HOLE (ft)	DEPTH TO W/L (ft)	DEPTH TO SEEPAGE (ft)

SPECIAL NOTES:
 Eight feet of 2-inch diameter, PVC well installed with 1.5 feet of hand slotted screen. Lower end cap glued in-place. Upper end cap compression fitted. Surface to 3 feet below the surface backfilled with soil from test pit. Filter sand from 3 to 5 feet below the surface. Bottom of well at 5 feet below the surface. Approximately 3 feet of PVC well casing stick-up above the ground surface. No monument installed.

No groundwater observed at the time the pit was excavated. No caving of the pit sidewalls was observed. No soil samples collected.

LOG OF TEST PIT V29INFPTS.GPJ GLDR_WA.GDT 11/17/13

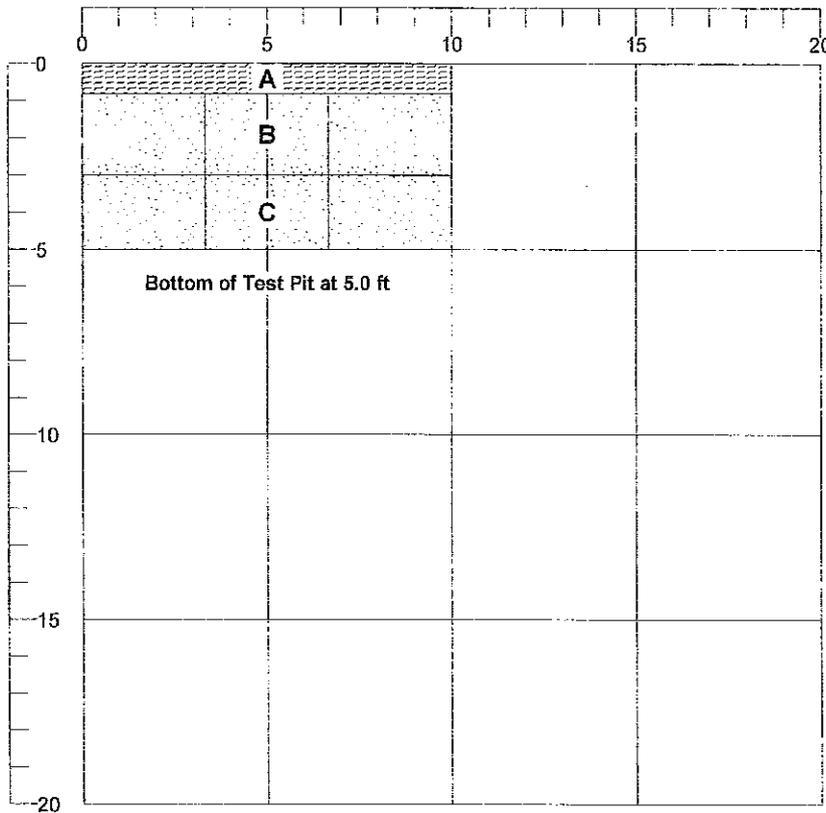


LOG OF TEST PIT MWV29-05

Temp 75 °F Weather sunny
 Equipment Cat 312 C
 Elevation 568.0 ft
 Location Parcel V-29

Engineer J. Coleman
 Contractor Builders Suppy
 Datum MSL

Operator Jeremy
 Date 9/11/13
 Job 063-1076.405



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES	
A	0.0 - 0.8 ft: TOPSOIL
B	0.8 - 3.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, brown grading to tan, nonstratified, (WEATHERED TILL), non-cohesive, moist, compact to dense
C	3.0 - 5.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, trace cobbles, subrounded, mottled gray, nonstratified, (TILL), non-cohesive, moist, very dense

TIME	DEPTH OF HOLE (ft)	DEPTH TO W/L (ft)	DEPTH TO SEEPAGE (ft)

SPECIAL NOTES:
 Eight feet of 2-inch diameter, PVC well installed with 1.5 feet of hand slotted screen. Lower end cap glued in-place. Upper end cap compression fitted. Surface to 3 feet below the surface backfilled with soil from test pit. Filter sand from 3 to 5 feet below the surface. Bottom of well at 5 feet below the surface. Approximately 3 feet of PVC well casing stick-up above the ground surface. No monument installed.

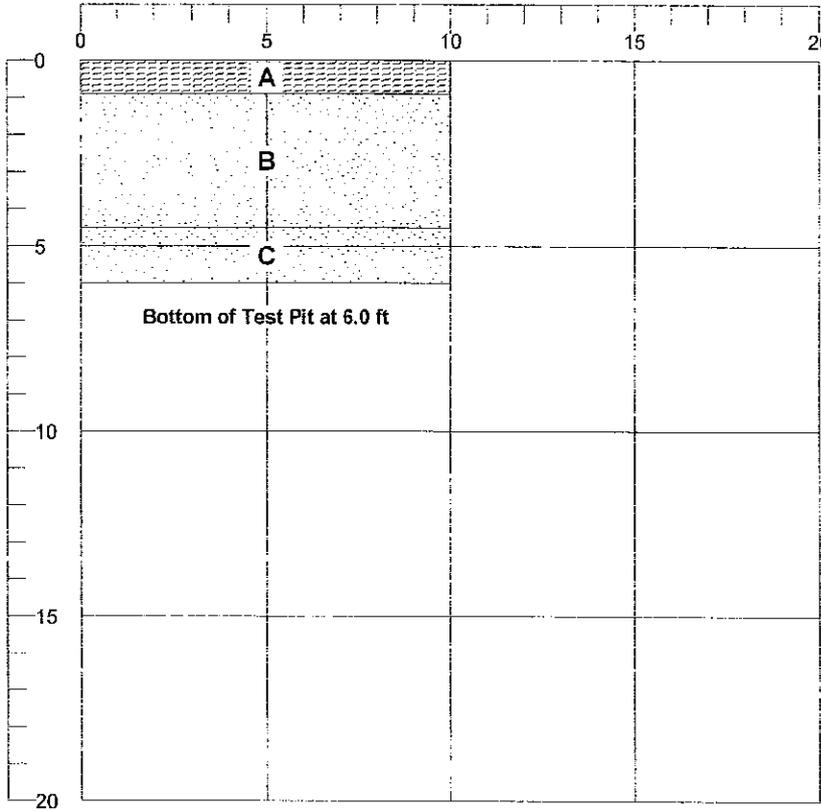
No groundwater observed at the time the pit was excavated. No caving of the pit sidewalls was observed. No soil samples collected.

LOG OF TEST PIT V29INFPTS.GPJ GLDR_WA.GDT 11/1/13



LOG OF TEST PIT TPV29-01

Temp 60 °F Weather sunny Engineer J. Coleman Operator Jeremy
 Equipment Cat 312 C Contractor Builders Suppy Date 9/10/13
 Elevation 551.0 ft Datum MSL Job 063-1076.405
 Location Parcel V-29



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)
1	1.0	
2	4.5	

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

- A** 0.0 - 0.9 ft: TOPSOIL
- B** 0.9 - 4.5 ft: (SP) SAND, fine to coarse, some silt, some gravel, fine to coarse, subrounded, trace roots in the upper few feet, brown grading to tan, nonstratified, (WEATHERED TILL), non-cohesive, moist, compact
- C** 4.5 - 6.0 ft: (SP) SAND, fine to coarse, some silt, some gravel, fine to coarse, subrounded, trace cobbles, subrounded, gray, nonstratified, cemented, (TILL), non-cohesive, moist very dense

TIME	DEPTH OF HOLE (ft)	DEPTH TO W/L (ft)	DEPTH TO SEEPAGE (ft)

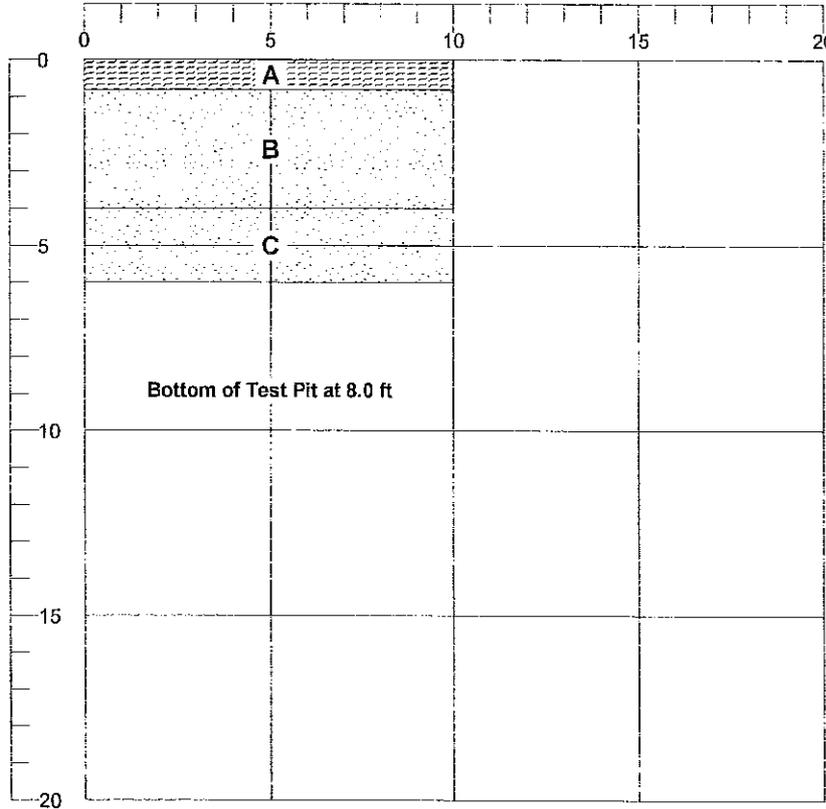
SPECIAL NOTES:

No groundwater observed at the time the pit was excavated. No caving of the pit sidewalls was observed. No soil samples collected.



LOG OF TEST PIT TPV29-02

Temp 60 °F Weather sunny Engineer J. Coleman Operator Jeremy
 Equipment Cat 312 C Contractor Builders Suppy Date 9/10/13
 Elevation 549.0 ft Datum MSL Job 063-1076.405
 Location Parcel V-29



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

- A** 0.0 - 0.8 ft: TOPSOIL
- B** 0.8 - 4.0 ft: (SP) SAND, fine to coarse, some gravel, fine to coarse, some silt, subrounded, trace roots in the upper few feet, brown grading to tan, nonstratified, (WEATHERED TILL), non-cohesive, moist, compact
- C** 4.0 - 6.0 ft: (SP) SAND, fine to coarse, some silt, some gravel, fine to coarse, subrounded, trace cobbles, subrounded, gray, nonstratified, (TILL), non-cohesive, moist very dense

TIME	DEPTH OF HOLE (ft)	DEPTH TO W/L (ft)	DEPTH TO SEEPAGE (ft)

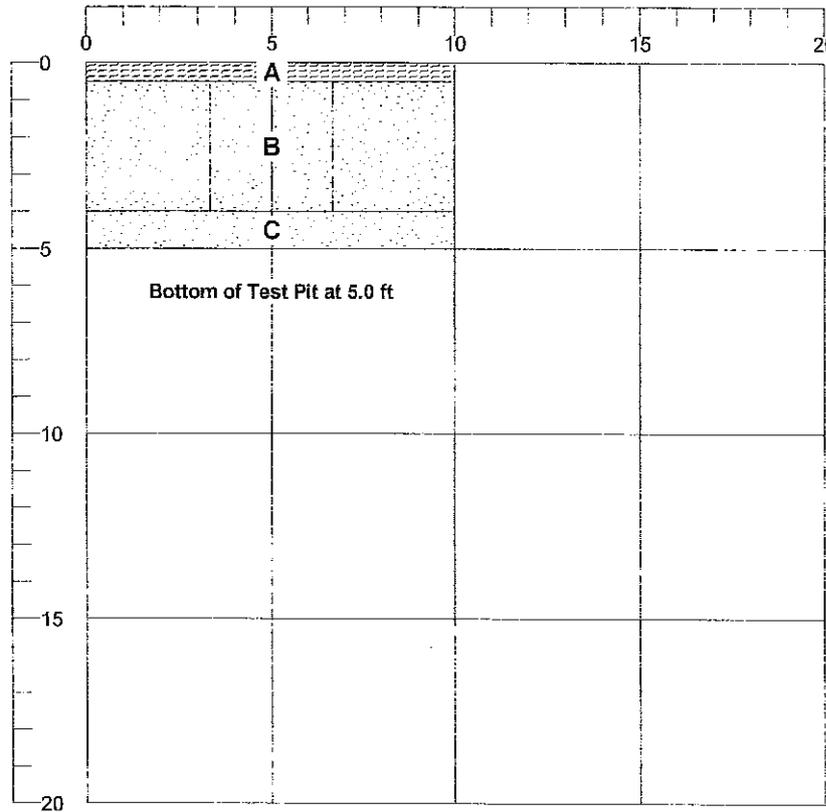
SPECIAL NOTES:

No groundwater observed at the time the pit was excavated. No caving of the pit sidewalls was observed. No soil samples collected.



LOG OF TEST PIT TPV29-03

Temp 60 °F Weather sunny Engineer J. Coleman Operator Jeremy
 Equipment Cat 312 C Contractor Builders Suppy Date 9/10/13
 Elevation 561.0 ft Datum MSL Job 063-1076.405
 Location Parcel V-29



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)
1	0.0	
2	4.0	

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

- A** 0.0 - 0.5 ft: TOPSOIL
- B** 0.5 - 4.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, trace cobbles, subrounded, trace roots, brown grading to tan, with depth, nonstratified, (WEATHERED TILL), non-cohesive, moist, compact to dense
- C** 4.0 - 5.0 ft: (SP) SAND, fine to coarse, some gravel, fine to coarse, subrounded, some silt, gray, nonstratified, (TILL), non-cohesive, moist, very dense

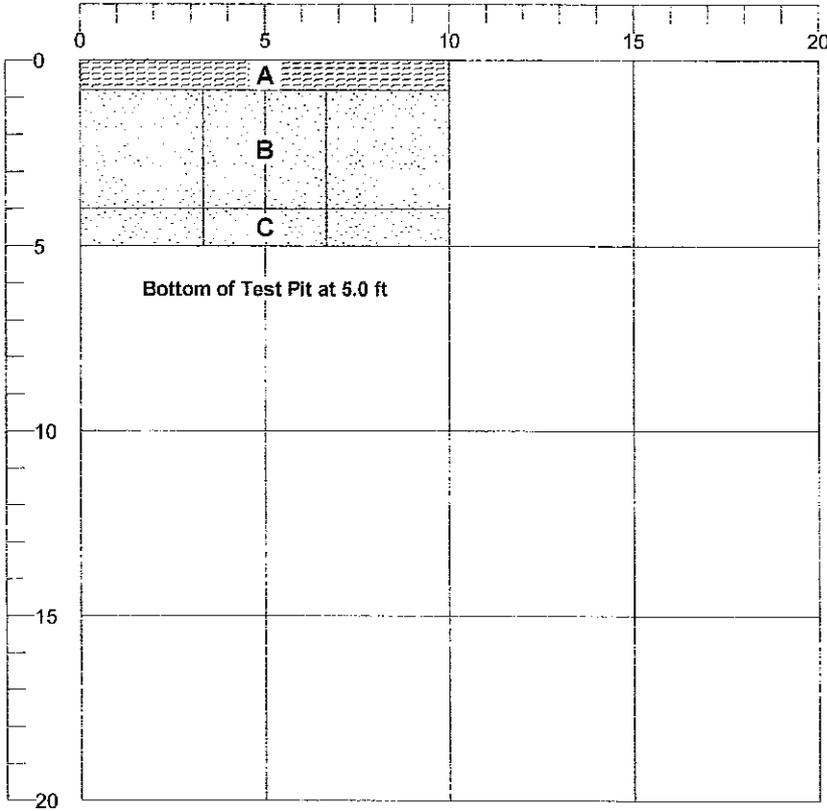
TIME	DEPTH OF HOLE (ft)	DEPTH TO W/L (ft)	DEPTH TO SEEPAGE (ft)

SPECIAL NOTES:
 No groundwater observed at the time the pit was excavated. No caving of the pit sidewalls was observed.



LOG OF TEST PIT TPV29-04

Temp 65 °F Weather sunny Engineer J. Coleman Operator Jeremy
 Equipment Cat 312 C Contractor Builders Suppy Date 9/10/13
 Elevation 558.0 ft Datum MSL Job 063-1076.405
 Location Parcel V-29



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

- A** 0.0 - 0.8 ft: TOPSOIL
- B** 0.8 - 4.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, trace cobbles, subrounded, trace roots, brown grading to tan, with depth, nonstratified, (WEATHERED TILL), non-cohesive, moist, compact to dense
- C** 4.0 - 5.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, trace cobbles, subrounded, gray, nonstratified, (TILL), non-cohesive, moist, very dense

TIME	DEPTH OF HOLE (ft)	DEPTH TO W/L (ft)	DEPTH TO SEEPAGE (ft)

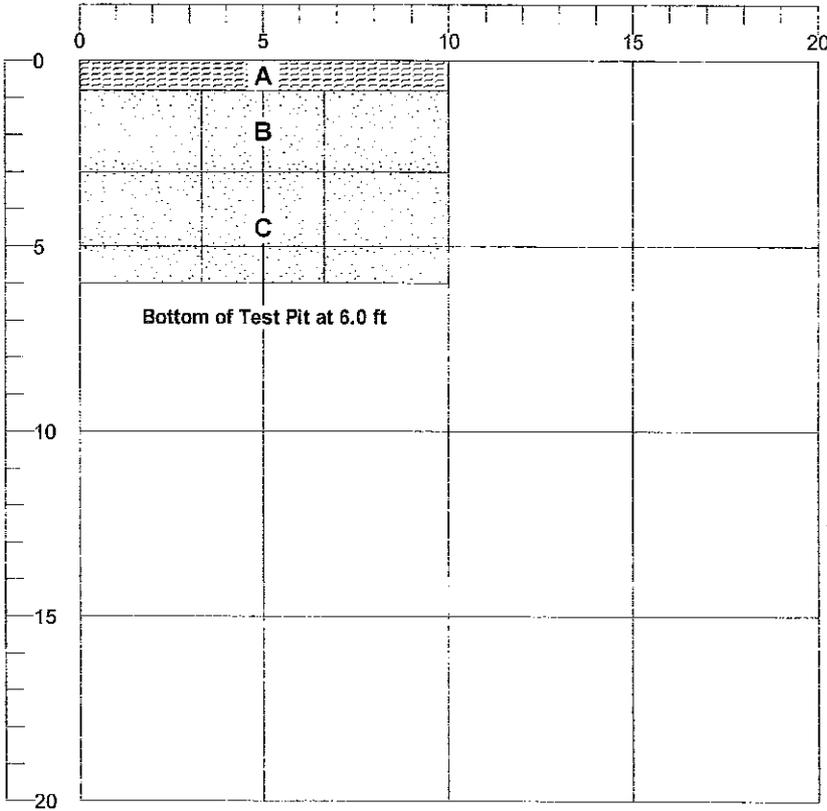
SPECIAL NOTES:

No groundwater observed at the time the pit was excavated. No caving of the pit sidewalls was observed. No soil samples collected.



LOG OF TEST PIT TPV29-05

Temp 65 °F Weather sunny Engineer J. Coleman Operator Jeremy
 Equipment Cat 312 C Contractor Builders Suppy Date 9/10/13
 Elevation 560.0 ft Datum MSL Job 063-1076.405
 Location Parcel V-29



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)
1	1.0	
2	3.0	

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

- A** 0.0 - 0.8 ft: TOPSOIL
- B** 0.8 - 3.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, brown grading to tan, nonstratified, (WEATHERED TILL), non-cohesive, moist, compact to dense
- C** 3.0 - 6.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, trace cobbles, subrounded, gray, nonstratified, (TILL), non-cohesive, moist, very dense

TIME	DEPTH OF HOLE (ft)	DEPTH TO W/L (ft)	DEPTH TO SEEPAGE (ft)

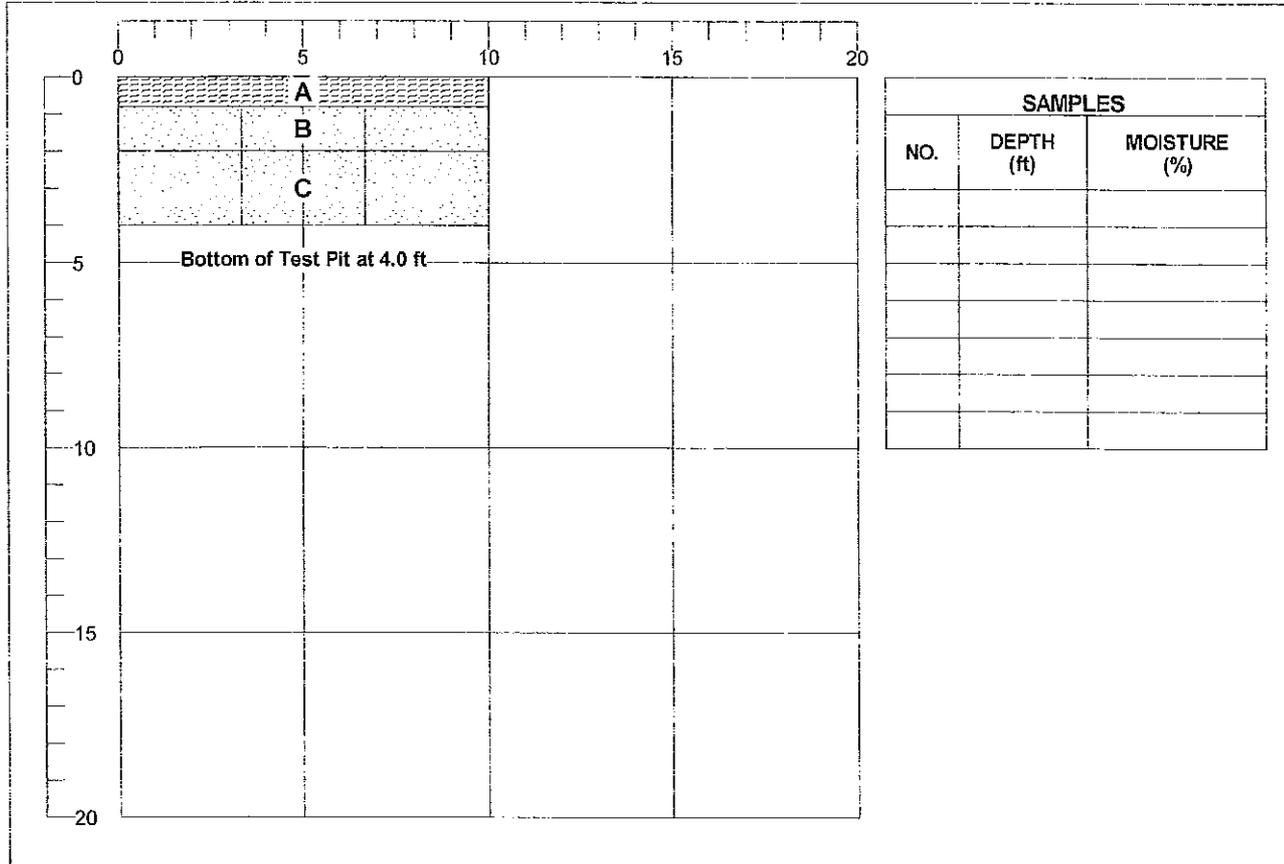
SPECIAL NOTES:

No groundwater observed at the time the pit was excavated. No caving of the pit sidewalls was observed.



LOG OF TEST PIT TPV29-06

Temp 70 °F Weather sunny Engineer J. Coleman Operator Jeremy
 Equipment Cat 312 C Contractor Builders Supply Date 9/10/13
 Elevation 564.0 ft Datum MSL Job 063-1076.405
 Location Parcel V-29



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

- A** 0.0 - 0.8 ft: TOPSOIL
- B** 0.8 - 2.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, brown grading to tan, nonstratified, (WEATHERED TILL), non-cohesive, moist, compact to dense
- C** 2.0 - 4.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, trace cobbles, subrounded, gray, nonstratified, (TILL), non-cohesive, moist, very dense

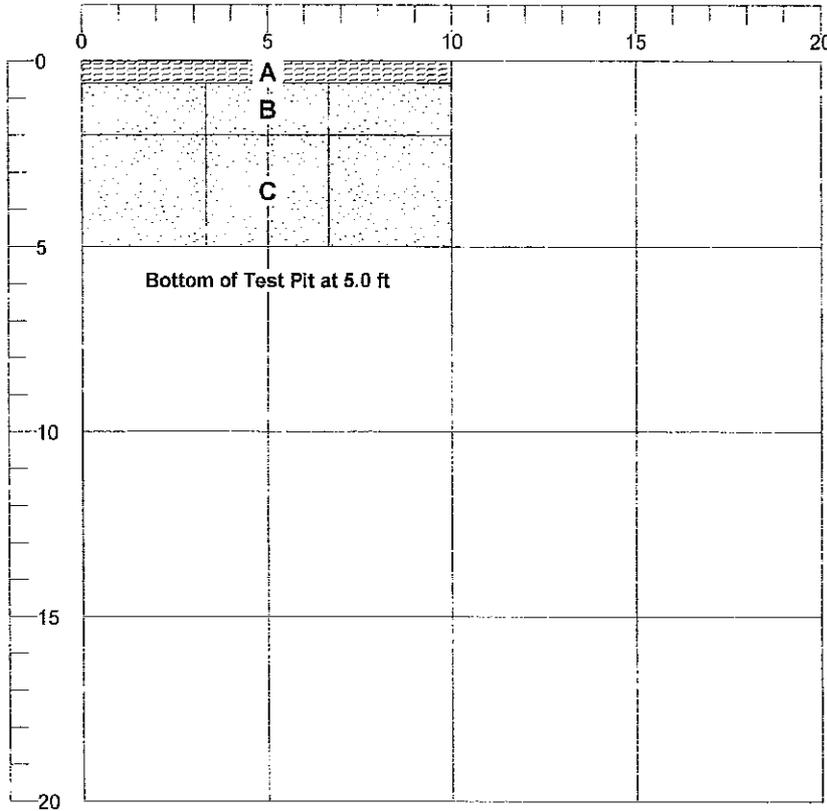
TIME	DEPTH OF HOLE (ft)	DEPTH TO W/L (ft)	DEPTH TO SEEPAGE (ft)

SPECIAL NOTES:
 No groundwater observed at the time the pit was excavated. No caving of the pit sidewalls was observed. No soil samples collected.



LOG OF TEST PIT TPV29-07

Temp 70 °F Weather sunny Engineer J. Coleman Operator Jeremy
 Equipment Cat 312 C Contractor Builders Suppy Date 9/10/13
 Elevation 561.0 ft Datum MSL Job 063-1076.405
 Location Parcel V-29



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)
1	1.0	
2	3.0	

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

- A** 0.0 - 0.6 ft: TOPSOIL
- B** 0.6 - 2.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, brown grading to tan, nonstratified, (WEATHERED TILL), non-cohesive, moist, compact to dense
- C** 2.0 - 5.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, trace cobbles, subrounded, gray, nonstratified, (TILL), non-cohesive, moist, very dense

TIME	DEPTH OF HOLE (ft)	DEPTH TO W/L (ft)	DEPTH TO SEEPAGE (ft)

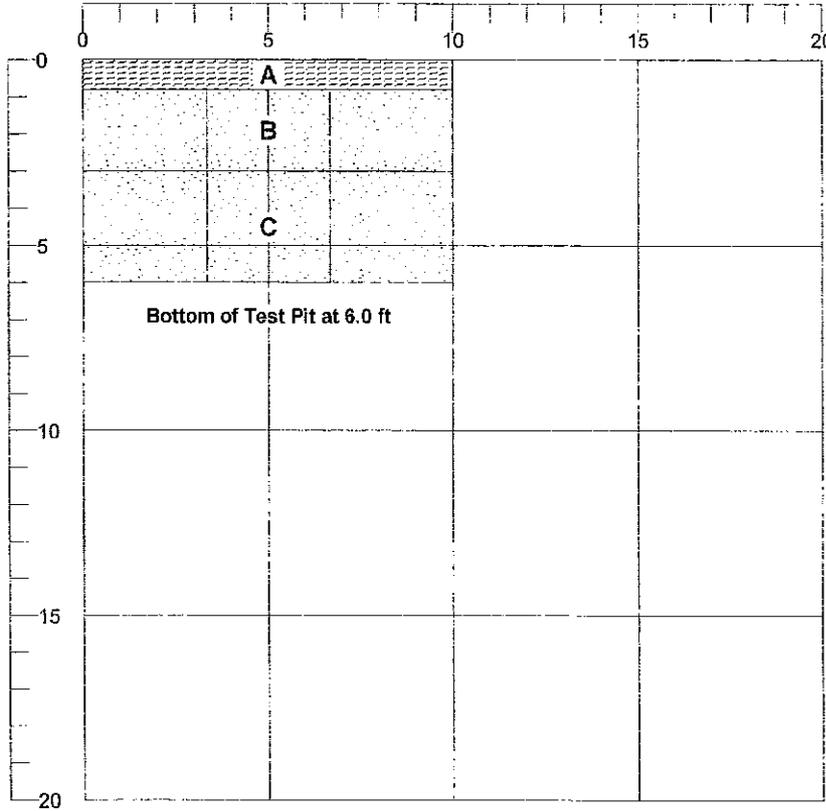
SPECIAL NOTES:

No groundwater observed at the time the pit was excavated. No caving of the pit sidewalls was observed.



LOG OF TEST PIT TPV29-08

Temp 75 °F Weather sunny Engineer J. Coleman Operator Jeremy
 Equipment Cat 312 C Contractor Builders Suppy Date 9/10/13
 Elevation 567.0 ft Datum MSL Job 063-1076.405
 Location Parcel V-29



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES	
A	0.0 - 0.8 ft: TOPSOIL
B	0.8 - 3.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, brown grading to tan, nonstratified, (WEATHERED TILL), non-cohesive, moist, compact to dense
C	3.0 - 6.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, trace cobbles, subrounded, gray, nonstratified, (TILL), non-cohesive, moist, very dense

TIME	DEPTH OF HOLE (ft)	DEPTH TO W/L (ft)	DEPTH TO SEEPAGE (ft)

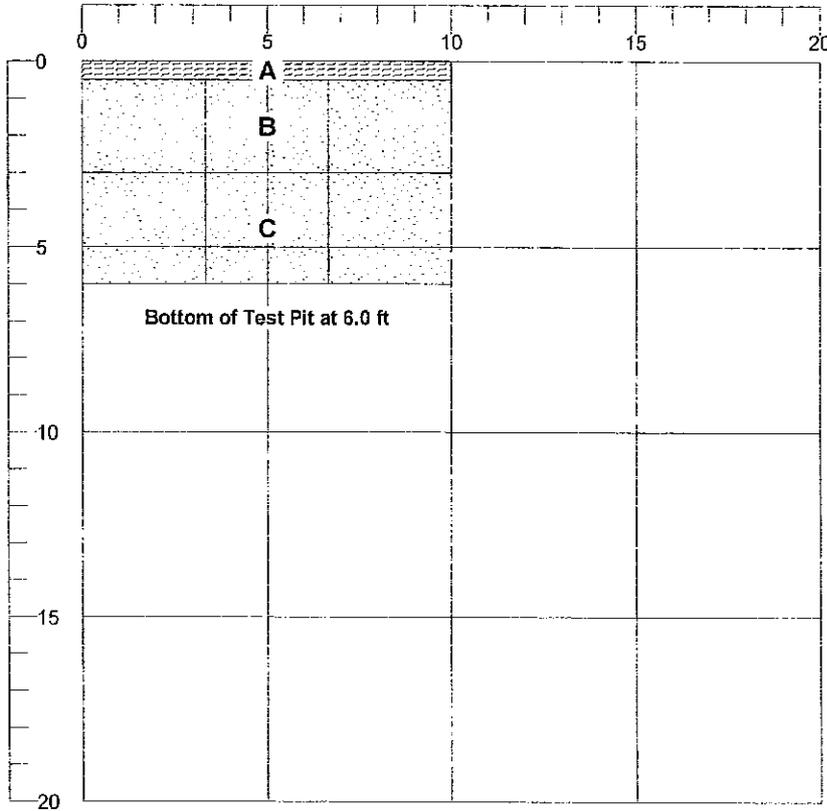
SPECIAL NOTES:
 No groundwater observed at the time the pit was excavated. No caving of the pit sidewalls was observed. No soil samples collected.

LOG OF TEST PIT V29INFPTS.GPJ GLDR_WA.GDT 11/1/13



LOG OF TEST PIT TPV29-09

Temp 75 °F Weather sunny Engineer J. Coleman Operator Jeremy
 Equipment Cat 312 C Contractor Builders Supply Date 9/10/13
 Elevation 566.0 ft Datum MSL Job 063-1076.405
 Location Parcel V-29



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)
1	1.0	
2	3.0	

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES	
A	0.0 - 0.5 ft: TOPSOIL
B	0.5 - 3.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, brown grading to tan, nonstratified, (WEATHERED TILL), non-cohesive, moist, compact to dense
C	3.0 - 6.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, trace cobbles, subrounded, mottled gray, nonstratified, (TILL), non-cohesive, moist, very dense

TIME	DEPTH OF HOLE (ft)	DEPTH TO W/L (ft)	DEPTH TO SEEPAGE (ft)

SPECIAL NOTES:
 No groundwater observed at the time the pit was excavated. No caving of the pit sidewalls was observed.

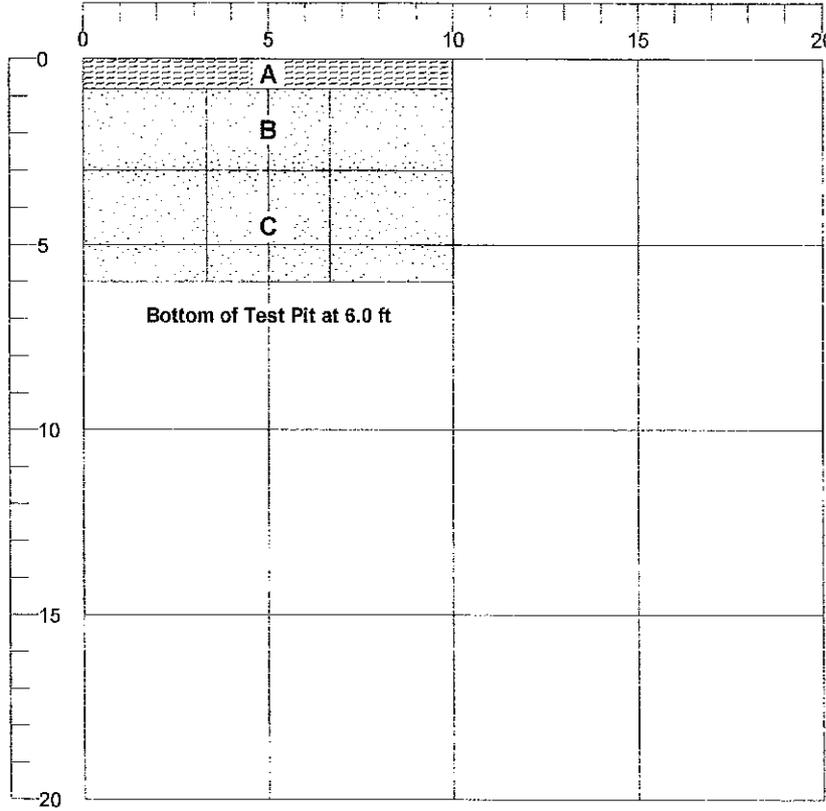


LOG OF TEST PIT TPV29-10

Temp 80 °F Weather sunny
 Equipment Cat 312 C
 Elevation 568.0 ft
 Location Parcel V-29

Engineer J. Coleman
 Contractor Builders Supply
 Datum MSL

Operator Jeremy
 Date 9/10/13
 Job 063-1076.405



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES	
A	0.0 - 0.8 ft: TOPSOIL
B	0.8 - 3.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, brown grading to tan, nonstratified, (WEATHERED TILL), non-cohesive, moist, compact to dense
C	3.0 - 6.0 ft: (SM) SILTY SAND, fine to coarse, some gravel, fine to coarse, subrounded, trace cobbles, subrounded, trace boulders, subrounded, mottled gray, nonstratified, (TILL), non-cohesive, moist, very dense

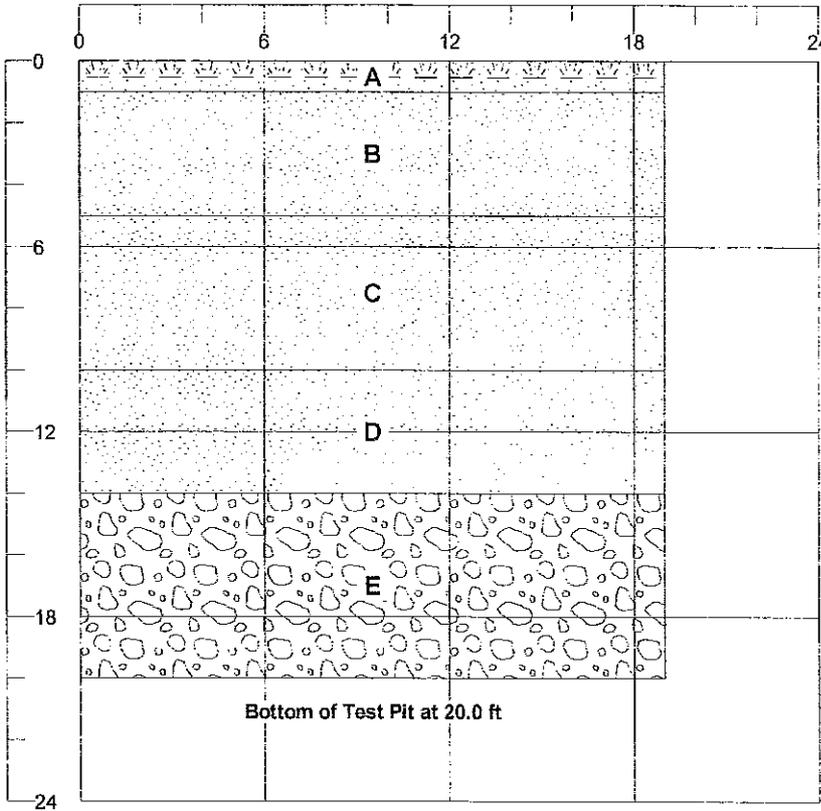
TIME	DEPTH OF HOLE (ft)	DEPTH TO W/L (ft)	DEPTH TO SEEPAGE (ft)

SPECIAL NOTES:
 No groundwater observed at the time the pit was excavated. No caving of the pit sidewalls was observed. No soil samples collected.



LOG OF TEST PIT TP-117

Temp 50 °F Weather Overcast Engineer T. Marshall Operator Matt
 Equipment Komatsu PC 200 Contractor Cascade Date 12/17/09
 Elevation 555.0 ft Datum Local Job 063-1076.201
 Location Black Diamond



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)
1	7.5	20.1
2	15.0	3.56
3	16.0	

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

- A** 0.0 - 1.0 ft: Loose, dark brown to reddish brown, non-stratified, silty fine to coarse SAND, some fine to coarse gravel, little roots, damp (TOPSOIL)
- B** 1.0 - 5.0 ft: Loose, reddish brown to olive gray, stratified, gravelly fine to coarse SAND, little cobbles, trace silt, roots damp (SP) [Qvr]
- C** 5.0 - 10.0 ft: Loose, olive gray, stratified, fine to coarse SAND, little fine gravel, trace silt, damp (SP) [Qvr]
- D** 10.0 - 14.0 ft: Loose to compact, mottled light gray, olive gray, and reddish brown, stratified, fine to coarse SAND, some silt, roots, damp (SP) [Qvr]
- E** 14.0 - 20.0 ft: Compact, olive gray, stratified, fine to coarse GRAVEL and fine to coarse SAND, some cobbles, trace silt, damp (GP) [Qvr]

TIME	DEPTH OF HOLE (ft)	DEPTH TO W/L (ft)	DEPTH TO SEEPAGE (ft)
10:40	0.0		
11:20	20.0		

SPECIAL NOTES:

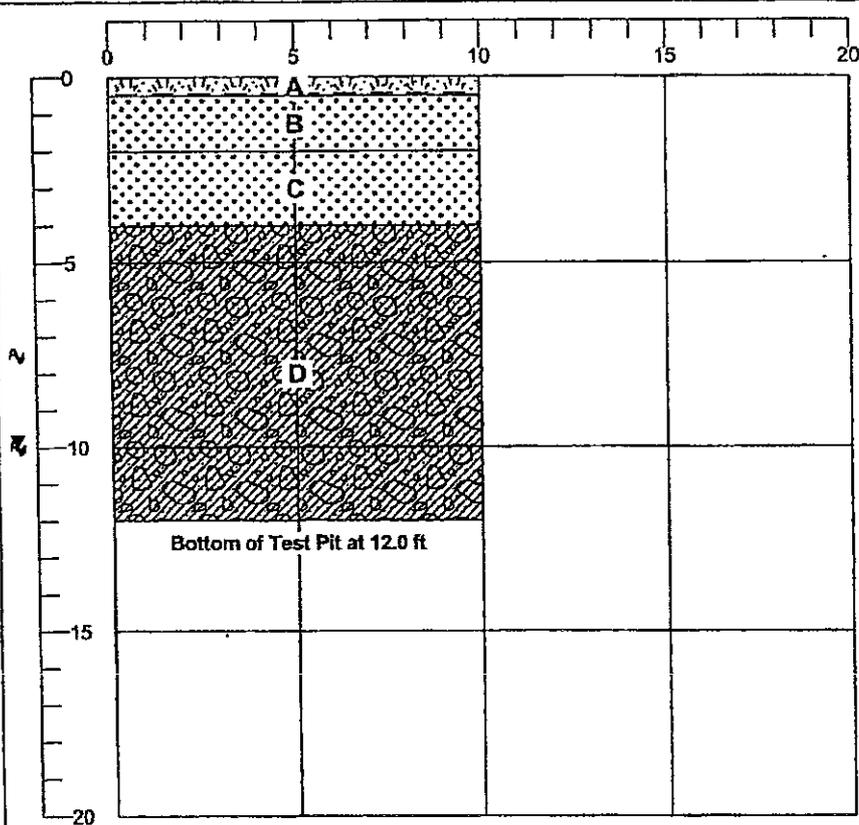
Some caving at 2' to 10' bgs, heavy caving at 14' to 20' bgs. No groundwater observed. Set well at 21' bgs. 22' well with 1.3' above ground surface.



Golder Associates

LOG OF TEST PIT TP-36

Temp 50 °F Weather Overcast Engineer A. Dennison Operator Tim
 Equipment 312 C Cat Trackhoe Contractor MidMountain Contractors Date March 22, 2006
 Elevation 561.0 ft Datum MSL Job 063-1076.200
 Location Black Diamond, WA



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)
1	1.5	
2	3.0	16.6
3	8.0	

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

- A** 0.0 - 0.5 ft: Loose, dark brown, non-stratified, silty fine to coarse SAND with some organics, moist (SM) (TOPSOIL/GRASS)
- B** 0.5 - 2.0 ft: Loose, orange-brown, non-stratified, silty fine to coarse SAND with little, subrounded, fine to coarse gravel, moist (SM) (WEATHERED LODGEMENT TILL)
- C** 2.0 - 4.0 ft: Loose, light brown, non-stratified, silty fine to coarse SAND with some, subrounded, fine to coarse gravel, moist (SM) (SLIGHTLY WEATHERED LODGEMENT TILL)
- D** 4.0 - 12.0 ft: Dense, gray, non-stratified, silty fine to coarse SAND with some, subrounded, fine to coarse gravel, little cobbles, trace boulders, moist (SM) (LODGEMENT TILL)

TIME	DEPTH OF HOLE (ft)	DEPTH TO W/L (ft)	DEPTH TO SEEPAGE (ft)
09:40	0.0		
09:45			7.5
10:00			10.0
10:15	12.0		

SPECIAL NOTES:
 No caving was observed.
 Minor ater seepage was observed at 7.5 and 10 feet.

LOG OF TEST PIT 063-1076.200_VILLAGES_TPS.GPJ_GLDOR_WA.GDT 4/20/06



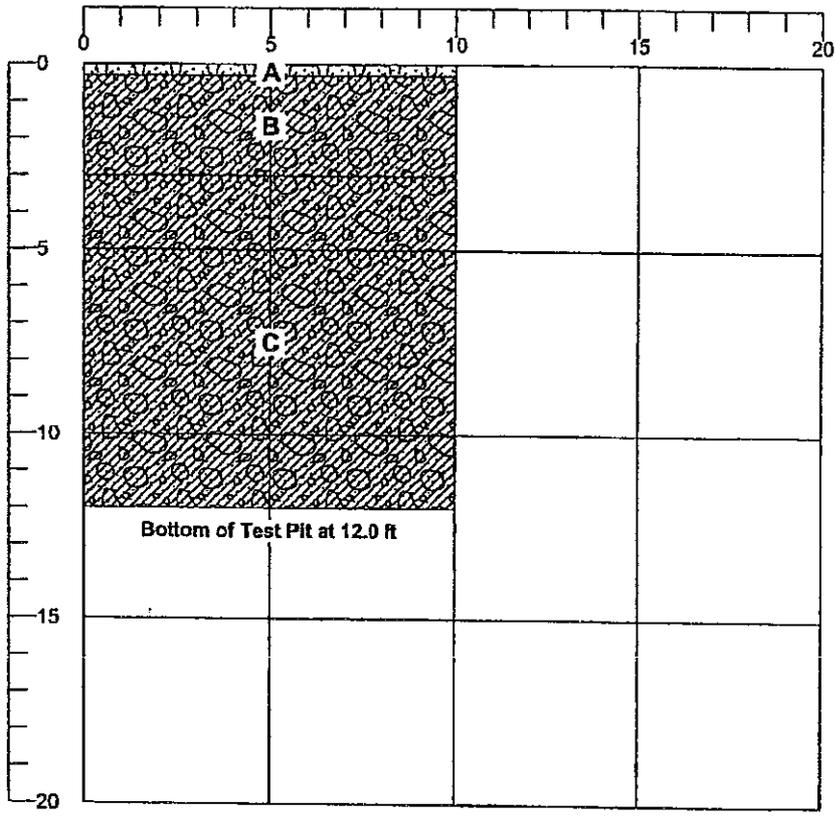
Golder Associates

LOG OF TEST PIT TP-37

Temp 50 °F Weather Overcast
Equipment 312 C Cat Trackhoe
Elevation 584.0 ft
Location Black Diamond, WA

Engineer A. Dennison
Contractor MidMountain Contractors
Datum MSL

Operator Tim
Date March 22, 2006
Job 063-1076.200



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)
1	7.0	13.9

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

- A** 0.0 - 0.3 ft: Loose, dark brown, non-stratified, silty fine to medium SAND with some organics, moist (SM) (TOPSOIL/FOREST DUFF)
- B** 0.3 - 3.0 ft: Loose to compact, orange-brown, non-stratified, silty fine to medium SAND with little, subrounded, fine to coarse gravel, moist (SM) (WEATHERED LODGEMENT TILL)
- C** 3.0 - 12.0 ft: Dense to very dense, gray, non-stratified, silty fine to coarse SAND with little, socketed, subrounded, fine to coarse gravel and trace cobbles, moist (SM) (WEATHERED LODGEMENT TILL)

TIME	DEPTH OF HOLE (ft)	DEPTH TO W/L (ft)	DEPTH TO SEEPAGE (ft)
10:30	0.0		
10:50	12.0		

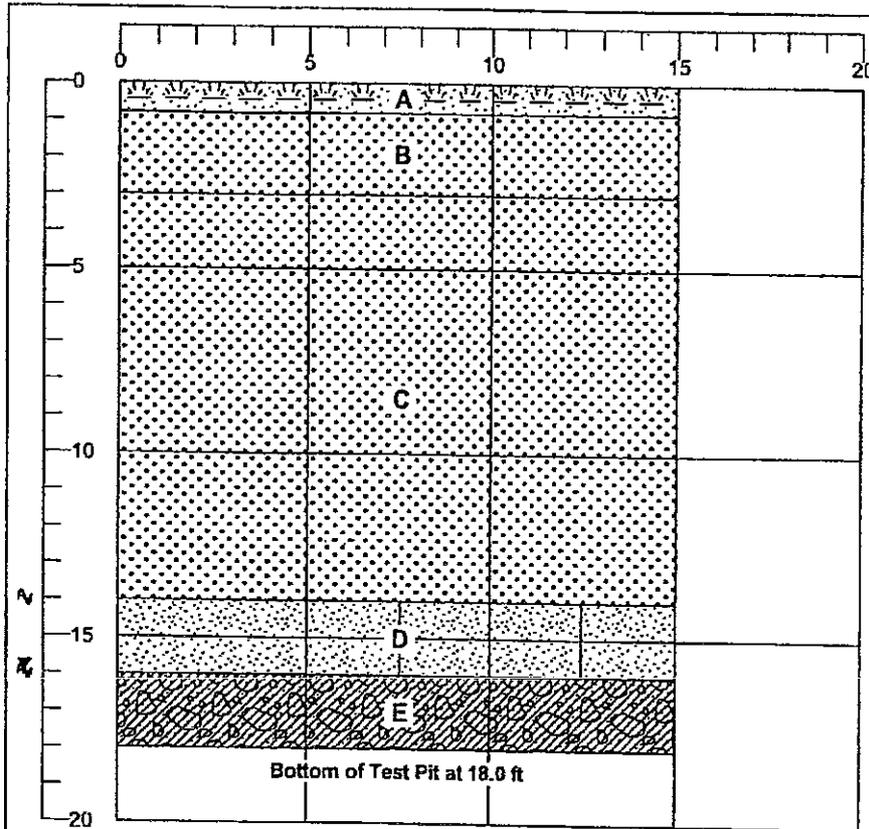
SPECIAL NOTES:
 No caving was observed.
 No water seepage was observed.

LOG OF TEST PIT 063-1076.200 VILLAGES_TPS.GPJ GLDR WA.GDT 4/20/06



LOG OF TEST PIT TP-38

Temp 50 °F Weather Overcast Engineer A. Dennison Operator Tim
 Equipment 312 C Cat Trackhoe Contractor MidMountain Contractors Date March 22, 2006
 Elevation 554.0 ft Datum MSL Job 063-1076.200
 Location Black Diamond, WA



SAMPLES		
NO.	DEPTH (ft)	MOISTURE (%)
1	2.0	
2	4.0	5.7
3	16.0	8.5
4	17.5	8.2

LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES	
A	0.0 - 0.8 ft: Loose, dark brown, non-stratified, silty fine to coarse SAND with some organics, moist (SM) (TOPSOIL)
B	0.8 - 3.0 ft: Loose, orange-brown, non-stratified, silty fine to coarse SAND with little, subrounded, fine to coarse gravel, moist (SM) (WEATHERED RECESSIONAL OUTWASH)
C	3.0 - 14.0 ft: Compact, brown-gray, non-stratified, fine to medium SAND with trace, subrounded, fine to coarse gravel, trace cobbles, and trace silt, damp (SP) (RECESSIONAL OUTWASH)
D	14.0 - 16.0 ft: Compact, gray, non-stratified, fine to coarse SAND with little silt and little fine gravel, moist (SW-SM) (TRANSITIONAL ZONE)
E	16.0 - 18.0 ft: Dense, gray-brown, non-stratified, silty fine to coarse SAND with some, subrounded, fine to coarse gravel and trace cobbles, moist (SM) (LODGE MENT TILL)

TIME	DEPTH OF HOLE (ft)	DEPTH TO W/L (ft)	DEPTH TO SEEPAGE (ft)
11:10	0.0		
11:20			14.0
11:25			16.0
11:45	18.0		

SPECIAL NOTES:
 Moderate caving was observed between 3 to 14 feet.
 Minor water seepage was observed at 16 feet.

LOG OF TEST PIT 063-1076.200 VILLAGES_TPS.GPJ GLDR_WA.GOT 4/20/06

RECORD OF BOREHOLE MW-24

SHEET 1 of 3

PROJECT: Black Diamond Villages
 PROJECT NUMBER: 063-1076-01.201
 LOCATION: 56 feet West of TP#117

DRILLING METHOD: RotoSonic
 DRILLING DATE: 03/10/2010
 DRILL RIG: Mini-Sonic

DATUM:
 AZIMUTH: N/A
 COORDINATES: not surveyed

ELEVATION: 557
 INCLINATION: -90

DEPTH (ft)	BORING METHOD	SOIL PROFILE				SAMPLES				PENETRATION RESISTANCE BLOWS / ft				NOTES WATER LEVELS GRAPHIC	
		DESCRIPTION	USCS	GRAPHIC LOG	ELEV	NUMBER	TYPE	BLOWS per 6 in 140 lb hammer 30 inch drop	N	REC ATT	WATER CONTENT (PERCENT)				
											W _p ———— W _L ———— W _u				
0	Continuous Core	0.0 - 2.5 Brown to red brown, silty fine to coarse SAND, some fine to coarse gravel, moist. (Outwash)	SM		554.5										2" SCH 40 PVC riser pipe, in cement seal with 4-foot stainless steel above ground monument
		2.5 - 6.0 Yellow gray to olive gray, fine to coarse SAND, trace silt, damp. (Outwash)	SP		2.5	1	GRAB								
5		6.0 - 9.0 Yellow gray to olive gray, fine to medium SAND, some fine to coarse gravel, little silt, damp. (Outwash)	SP		551.0	2	GRAB				1.0	10.0			
		9.0 - 11.0 Olive gray, silty SAND, some fine to coarse gravel, damp. (fill lens?)	SM		548.0	3	GRAB								
10		11.0 - 20.0 Olive gray, fine to coarse SAND and fine to coarse GRAVEL, trace silt, damp. (Outwash)	SM		546.0										
15		Interbeds of olive gray with iron-oxide staining, silty SAND, some fine to coarse gravel, damp. (3.0 feet)	SM			4	GRAB				1.0	10.0		2" SCH 40 PVC riser pipe with bentonite backfill	
20		Log continued on next page			537.0										

BOREHOLE RECORD_BOTHEVILLAGES MW-24 NEW FINAL.GPJ GLDR_WA.GDT 10/31/13

1 in to 3 ft
 DRILLING CONTRACTOR: Boart/Longyear
 DRILLER: Brian

LOGGED: TPM
 CHECKED: JGJ
 DATE: 4/1/2010



RECORD OF BOREHOLE MW-24

SHEET 2 of 3
ELEVATION: 557
INCLINATION: -90

PROJECT: Black Diamond Villages
PROJECT NUMBER: 063-1076-01.201
LOCATION: 56 feet West of TP#117

DRILLING METHOD: RotoSonic
DRILLING DATE: 03/10/2010
DRILL RIG: Mini-Sonic

DATUM:
AZIMUTH: N/A
COORDINATES: not surveyed

DEPTH (ft)	BORING METHOD	SOIL PROFILE			SAMPLES				PENETRATION RESISTANCE BLOWS / ft ■				NOTES WATER LEVELS GRAPHIC			
		DESCRIPTION	USCS	GRAPHIC LOG	ELEV.	NUMBER	TYPE	BLOWS per 6 in 140 lb hammer 30 inch drop	N	REC ATT	WATER CONTENT (PERCENT)					
											10	20		30	40	
20	Continuous Core	20.0 - 22.0 Olive gray, sandy fine to coarse GRAVEL, some silt, damp. (Till)	GP		20.0	5	GRAB									
		22.0 - 26.0 Gray to olive gray with iron-oxide staining, fine to coarse GRAVEL and COBBLES, little silt, damp. (Outwash)	GW		535.0 22.0											
25		26.0 - 27.0 Gray to brown, fine to medium SAND, some fine to coarse gravel, little silt, damp. (Outwash)	SP		531.0 26.0											
		27.0 - 27.5 Brown SILT, thinly bedded with dark brown SILT, moist	ML		530.0 27.0	6	GRAB									
		27.5 - 42.0 Olive gray, sandy fine to coarse GRAVEL, little silt, damp. (Outwash - Till transition)	GM		529.5 27.5											
30		Interbed of light orange brown with iron-oxide staining, SILT and fine to coarse GRAVEL, moist. (6.0 inches)	GM			7	GRAB									
		Interbed of light orange brown, clayey SILT and fine to coarse GRAVEL, little fine to medium sand, moist. (1.0 foot)	GM			8	GRAB									
		Interbed of dark red brown SILT, some fine gravel, little fine to medium sand, moist. (1.0 foot)	GP/GM			9	GRAB									
35		Interbed of dark red brown SILT, some fine gravel, little fine to medium sand, moist. (1.0 foot)	ML			10	GRAB			1.0	10.0					2" SCH 40 PVC riser pipe with filler sand backfill
		Interbed of light brown, silty fine to coarse GRAVEL, little fine to medium sand, moist to wet. (1.0 foot)	GM			11	GRAB									
40						12	GRAB									

Log continued on next page

BOREHOLE RECORD_BDTHEVILLAGES_MW24_NEW_FINAL.GPJ_GLDR_WA_GDT_10/31/13

1 in to 3 ft
DRILLING CONTRACTOR: Boart/Longyear
DRILLER: Brian

LOGGED: TPM
CHECKED: JGJ
DATE: 4/1/2010



RECORD OF BOREHOLE MW-31

SHEET 1 of 2
ELEVATION:
INCLINATION: -90

PROJECT: BD Villages/The Villages Proj DRILLING METHOD: Hollow Stem Auger DATUM: MSL
PROJECT NUMBER: 063-1076-001.210 DRILLING DATE: 4/5/2013 AZIMUTH: N/A
LOCATION: 59 degrees from North off MW-31 DRILL RIG: COORDINATES: not surveyed

DEPTH (ft)	BORING METHOD	SOIL PROFILE			SAMPLES				PENETRATION RESISTANCE BLOWS / ft				NOTES WATER LEVELS GRAPHIC		
		DESCRIPTION	USCS	GRAPHIC LOG	ELEV. DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in 140 lb hammer 30 inch drop	N	REC ATT	WATER CONTENT (PERCENT)				
											10	20		30	40
0	4-inch inner diameter hollow stem auger with 140 lbs down-hole hammer	0.0 - 1.0 Surface: grass, sod, wood debris.													
1.0 - 8.0 (SW) SAND, fine to coarse, some gravel, fine, rounded to subangular, trace silt, dark gray-brown, nonstratified, (OUTWASH), non-cohesive, damp, compact		SW		1.0											2-inch diameter PVC pipe embedded in concrete with flush-mount monument.
8.0 - 13.0 (SP) SAND, fine to medium, trace silt, laminations of yellow-brown silty sand, fine to medium, dark olive gray, stratified, (OUTWASH), non-cohesive, damp, compact		SP		8.0	1	HD	25-25-25	50	1.1 1.5						
13.0 - 26.0 (GP) GRAVEL, fine to coarse, and SAND, fine to coarse, rounded, trace silt, dark gray brown, (OUTWASH), non-cohesive, moist, very dense		GP		13.0	2	HD	18-22-25	47	1.5 1.5						
				3	HD	75/6"	>50	0.4 0.5							

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BOREHOLE RECORD MW-31 PHASE 210.GPJ_GLDR_WA.GDT 11/18/13

1 in to 3 ft
DRILLING CONTRACTOR: Cascade Drilling Inc
DRILLER: Curtis

LOGGED: T. Marshall
CHECKED: J. Johnson
DATE: 10/31/2013

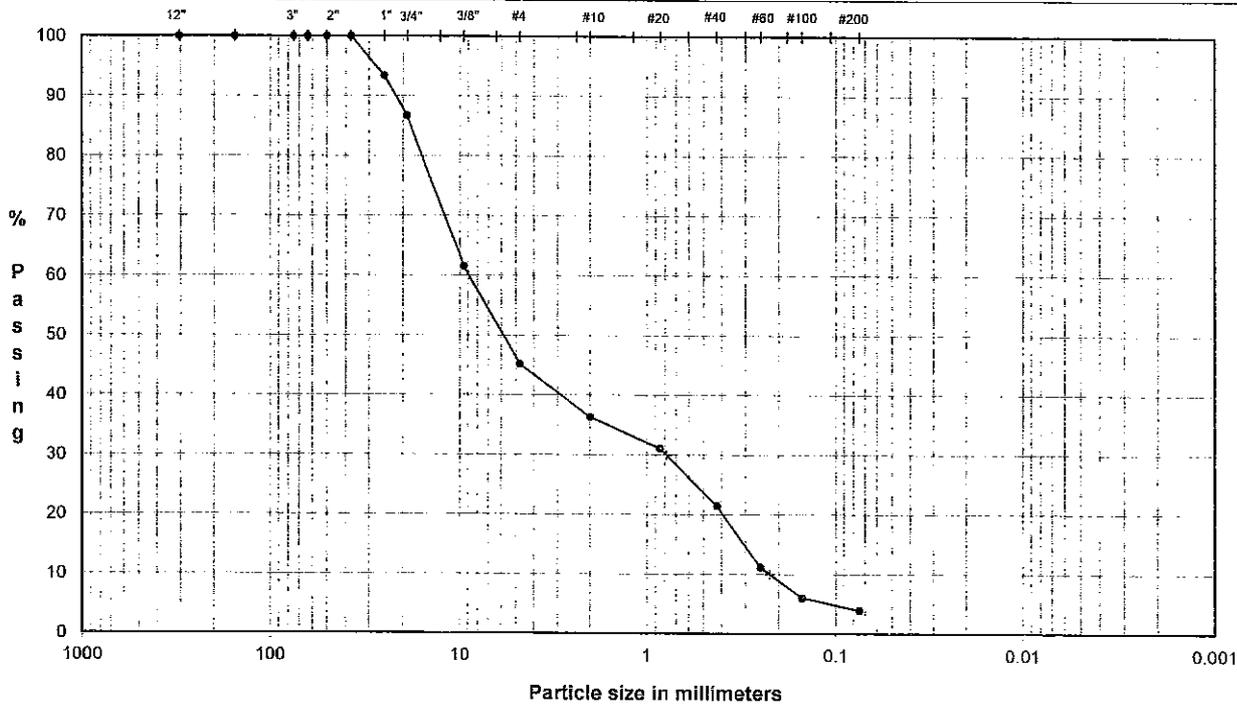


**APPENDIX B
LABORATORY TEST RESULTS**

PARTICLE SIZE DISTRIBUTION

ASTM D421, D422, D4318

PROJECT NAME: **BD / The Villages Lk Sawyer Intersection / WA**
 SAMPLE ID: **MW-31* S-5** Depth: **22.5-23.5ft**
 TYPE: **SS**



COBBLES	Coarse	Fine	Coarse	Medium	Fine	Silt or Clay
	GRAVEL		SAND			FINES

U.S. Standard Sieves Sizes and Numbers	Particle Size (mm)	% Passing	Classification	Percentage	
	12.0"	304.8	100.0	Cobbles	0.0
6.0"	154.2	100.0			
3.0"	75	100.0			
2.5"	63.5	100.0			
2.0"	50	100.0			
1.5"	37.5	100.0			
1.0"	25	93.4	Coarse Gravel	13.3	
0.75"	19	86.7			
0.375"	9.5	61.6	Fine Gravel	41.5	
#4	4.75	45.2			
#10	2.00	36.4	Coarse Sand	8.8	
#20	0.85	31.1			
#40	0.43	21.5	Medium Sand	14.9	
#60	0.25	11.2			
#100	0.15	6.0	Fine Sand	17.6	
#200	0.075	3.9			
				Finest	3.9

Moisture Content
5.85

D ₆₀ = 8.88	D ₃₀ = 0.78	D ₁₀ = 0.22
------------------------	------------------------	------------------------

Cu = D ₆₀ /D ₁₀ =	39.9	> 4
Cc = D ₃₀ ² /(D ₁₀ *D ₆₀) =	0.3	< 1

DESCRIPTION: fine to coarse GRAVEL and fine to coarse SAND
trace silt

USCS: GP

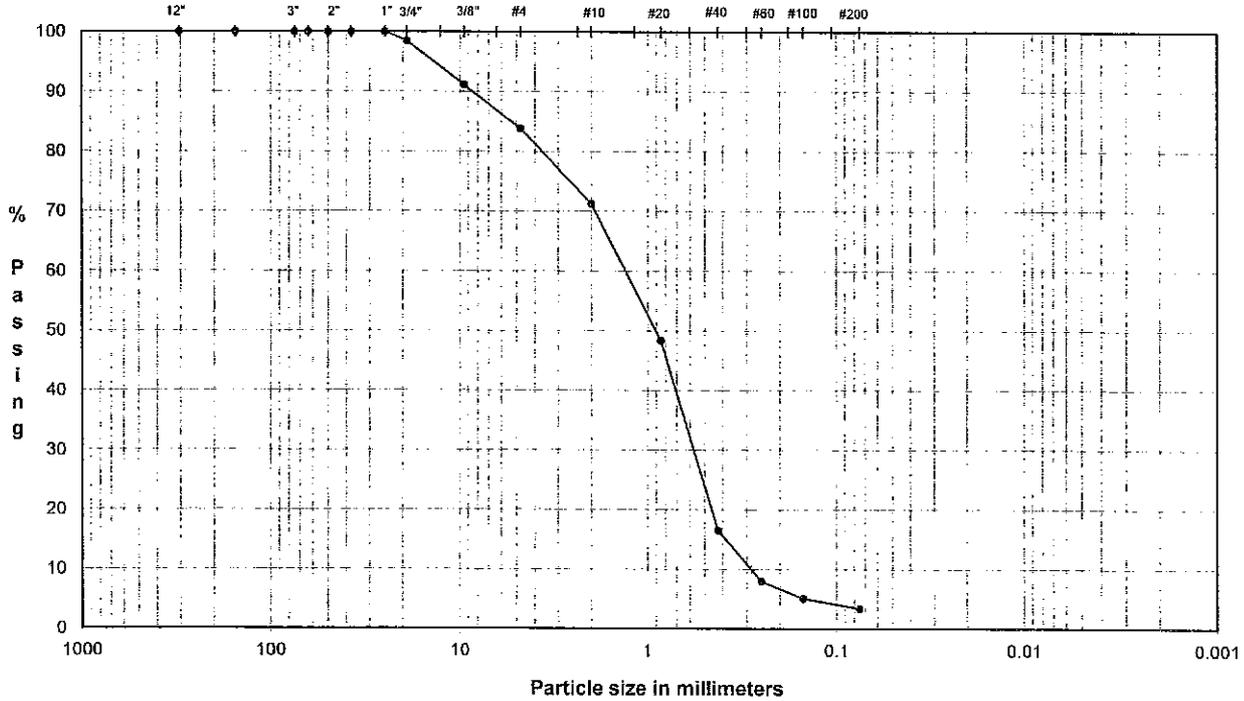
TECH	DE
DATE	4/8/13
CHECK	TCM
REVIEW	AJD

*Labeled in the field MW-27. Renumbered in the office after field work completed.

PARTICLE SIZE DISTRIBUTION

ASTM D421, D422, D4318

PROJECT NAME: BD / The Villages Lk Sawyer Intersection / WA
 SAMPLE ID: MW-31* S-7 Depth: 27.5-29ft
 TYPE: SS



COBBLES	Coarse	Fine	Coarse	Medium	Fine	Silt or Clay
	GRAVEL		SAND			FINES

U.S. Standard Sieves Sizes and Numbers	Particle Size (mm)	% Passing	Classification	Percentage	Moisture Content
	12.0"	304.8	100.0	Cobbles	
6.0"	154.2	100.0			
3.0"	75	100.0			
2.5"	63.5	100.0			
2.0"	50	100.0			
1.5"	37.5	100.0			
1.0"	25	100.0	Coarse Gravel	1.5	
0.75"	19	98.5			
0.375"	9.5	91.2	Fine Gravel	14.6	
#4	4.75	83.8			
#10	2.00	71.3	Coarse Sand	12.6	
#20	0.85	48.4			
#40	0.43	16.6	Medium Sand	54.7	
#60	0.25	8.0			
#100	0.15	5.1	Fine Sand	13.2	
#200	0.075	3.4			
Fines				3.4	

$D_{60} = 1.31$	$D_{30} = 0.57$	$D_{10} = 0.28$
$C_u = D_{60}/D_{10} = 4.6$	< 6	
$C_c = D_{30}^2 / (D_{10} \cdot D_{60}) = 0.9$	< 1	

DESCRIPTION: fine to coarse SAND
 some fine to coarse gravel, trace silt

USCS: SP

TECH	DE
DATE	4/8/13
CHECK	TCM
REVIEW	AJD

* Labeled in the field MW-27. Renumbered in the office after field work completed.