EXHIBIT 5
CUP16-02

SECTION 5 – GEOTECHNICAL REPORT

Geotechnical Site Investigation

Lacamas Elementary School

Camas, Washington

May 4, 2016

Geotechnical ■ Environmental ■ Special Inspections

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GEOTECHNICAL SITE INVESTIGATION
LACAMAS ELEMENTARY SCHOOL
CAMAS, WASHINGTON

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Site Location:	**1111 NE 232nd Avenue** **Parcel No. 175724000** **Camas, Washington**
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Date Prepared:	**May 4, 2016**

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1.0 INTRODUCTION

Columbia West Engineering, Inc. (Columbia West) was retained by Mahlum Architects, Inc. to conduct a geotechnical site investigation for the proposed Lacamas Elementary School project located in Camas, Washington. The purpose of the investigation was to observe and assess subsurface soil conditions at specific locations and provide geotechnical engineering analyses, planning, and design recommendations for proposed development. The specific scope of services was outlined in a proposal contract dated March 9, 2016. This report summarizes the investigation and provides field assessment documentation and laboratory analytical test reports. This report is subject to the limitations expressed in Section 6.0, *Conclusion and Limitations*, and Appendix E.

1.1 General Site Information

As indicated on Figures 1 and 2, the subject site consists of an existing residential property and generally undeveloped parcel located at 1111 NE 232nd Avenue in Camas, Washington. Proposed development will impact one tax parcel (175724000) totaling approximately 40 acres. The site is generally bound by NE 9th Street to the south, NE 232nd Avenue to the west, rural acreage to the east, and several residences to the north. The regulatory jurisdictional agency is the City of Camas, Washington. The approximate latitude and longitude are N 45° 37’ 49” and W 122° 25’ 58”, and the legal description is a portion of the NW ¼ of Section 27, T2N, R3E, Willamette Meridian.

1.2 Proposed Development

Correspondence with the design team indicates that proposed development includes new construction of an elementary school complex with one and two-story structures, athletic fields, play areas, and paved access driveways and parking lots. Proposed development also includes installation of underground utilities and stormwater management facilities. Columbia West has not reviewed a preliminary grading plan but understands that cut and fill will likely be proposed at the site. This report is based upon proposed development as described above and may not be applicable if modified.

2.0 REGIONAL GEOLOGY AND SOIL CONDITIONS

The subject site lies within the Willamette Valley/Puget Sound Lowland, a wide physiographic depression flanked by the mountainous Coast Range on the west and the Cascade Range on the east. Inclined or uplifted structural zones within the Willamette Valley/Puget Sound Lowland constitute highland areas and depressed structural zones form sediment-filled basins. The site is located on the eastern edge of the Portland/Vancouver Basin, an open, somewhat elliptical, northwest-trending syncline approximately 60 miles wide.

According to the *Geologic Map of the Lacamas Creek Quadrangle, Clark County, Washington* (US Geological Survey, Science Investigations Map 2924, 2006), near-surface soils are expected to consist of Pleistocene to Pliocene, unconsolidated to consolidated, thick-bedded, poorly- to well-sorted pebble to boulder sedimentary conglomerate of the Cascade Range and Columbia River Basalt Group (QTc).

The *Web Soil Survey (United States Department of Agriculture, Natural Resource Conservation Service [USDA NRCS], 2016 Website)* identifies surface soils as primarily Lauren loam in the east transitioning to Lauren gravelly loam in the west portion of the site. Lauren soils are generally coarse-textured with moderate to rapid permeability, moderate shear strength, and low shrink-swell potential. Lauren soils exhibit a slight erosion hazard based primarily on slope grade.

3.0 REGIONAL SEISMOLOGY

Recent research and subsurface mapping investigations within the Pacific Northwest appear to suggest the historic potential risk for a large earthquake event with strong localized ground movement may be underestimated. Past earthquakes in the Pacific Northwest appear to have caused landslides and ground subsidence, in addition to severe flooding near coastal areas. Earthquakes may also induce soil liquefaction, which occurs when elevated horizontal ground acceleration and velocity cause soil particles to interact as a fluid as opposed to a solid. Liquefaction of soil can result in lateral spreading and temporary loss of bearing capacity and shear strength.

There are at least four major known fault zones in the vicinity of the site that may be capable of generating potentially destructive horizontal accelerations. These fault zones are described briefly in the following text.

Portland Hills Fault Zone

The Portland Hills Fault Zone consists of several northwest-trending faults located along the northeastern margin of the Tualatin Mountains, also known as the Portland Hills, and the southwest margin of the Portland Basin. The fault zone is approximately 25 to 30 miles in length and is located approximately 17 miles west of the site. According to *Seismic Design Mapping, State of Oregon (Geomatrix Consultants, 1995),* there is no definitive consensus among geologists as to the zone fault type. Several alternate interpretations have been suggested.

According to the *USGS Earthquake Hazards Program*, the fault was originally mapped as a down-to-the-northeast normal fault, but has also been mapped as part of a regional-scale zone of right-lateral, oblique slip faults, and as a steep escarpment caused by asymmetrical folding above a south-west dipping, blind thrust fault. The Portland Hills fault offsets Miocene Columbia River Basalts, and Miocene to Pliocene sedimentary rocks of the Troutdale Formation. No fault scarps on surficial Quaternary deposits have been described along the fault trace, and the fault is mapped as buried by the Pleistocene aged Missoula flood deposits.

However, evidence suggests that fault movement has impacted shallow Holocene deposits and deeper Pleistocene sediments. Seismologists recorded a M3.2 earthquake thought to be associated with the fault zone near Kelly Point Park in November 2012, a M3.9 earthquake thought to be associated with the fault zone near Kelly Point Park in April 2003, and a M3.5 earthquake possibly associated with the fault zone occurred approximately 1.3 miles east of the fault in 1991. Therefore, the Portland Hills Fault Zone is generally thought to be potentially active and capable of producing possible damaging earthquakes.

Gales Creek-Newberg-Mt. Angel Fault Zone

Located approximately 35 miles southwest of the site, the northwest-striking, approximately 50-mile long Gales Creek-Newberg-Mt. Angel Structural Zone forms the northwestern boundary between the Oregon Coast Range and the Willamette Valley, and consists of a series of discontinuous northwest-trending faults. The southern end the fault zone forms the southwest margin of the Tualatin basin. Possible late-Quaternary geomorphic surface deformation may exist along the structural zone *(Geomatrix Consultants, 1995)*.

According to the *USGS Earthquake Hazards Program*, the Mount Angel fault is mapped as a high-angle, reverse-oblique fault, which offsets Miocene rocks of the Columbia River Basalts, and Miocene and Pliocene sedimentary rocks. The fault appears to have controlled emplacement of the Frenchman Spring Member of the Wanapum Basalts, and thus must have a history that predates the Miocene age of these rocks. No unequivocal evidence of deformation of Quaternary deposits has been described, but a thick sequence of sediments deposited by the Missoula floods covers much of the southern part of the fault trace.

Although no definitive evidence of impacts to Holocene sediments have clearly been identified, the Mount Angel fault appears to have been the location of minor earthquake swarms in 1990 near Woodburn, Oregon, and a M5.6 earthquake in March 1993 near Scotts Mills, approximately four miles south of the mapped extent of the Mt. Angel fault. It is unclear if the earthquake occurred along the fault zone or a parallel structure. Therefore, the Gales Creek-Newberg-Mt. Angel Structural Zone is considered potentially active.

Lacamas Lake-Sandy River Fault Zone

The northwest-trending Lacamas Lake Fault and northeast-trending Sandy River Fault intersect north of Camas, Washington approximately one mile south of the site, and form part of the northeastern margin of the Portland basin. According to *Geology and Groundwater Conditions of Clark County Washington (USGS Water Supply Paper 1600, Mundorff, 1964)* and the *Geologic Map of the Lake Oswego Quadrangle (Oregon DOGAMI Series GMS-59, 1989)*, the Lacamas Lake fault zone consists of shear contact between the Troutdale Formation and underlying Oligocene andesite-basalt bedrock. Secondary shear contact associated with the fault zone may have produced a series of prominent northwest-southeast geomorphic lineaments in proximity to the site.

According to the *USGS Earthquake Hazards Program* the fault has been mapped as a normal fault with down-to-the-southwest displacement, and has also been described as a steeply northeast or southwest-dipping, oblique, right-lateral, slip-fault. The trace of the Lacamas Lake fault is marked by the very linear lower reach of Lacamas Creek. No fault scarps on Quaternary surficial deposits have been described. The Lacamas Lake fault offsets Pliocene-aged sedimentary conglomerates generally identified as the Troutdale formation, and Pliocene to Pleistocene aged basalts generally identified as the Boring Lava formation.

Recent seismic reflection data across the probable trace of the fault under the Columbia River yielded no unequivocal evidence of displacement underlying the Missoula flood deposits, however, recorded mild seismic activity during the recent past indicates this area may be potentially seismogenic.

Cascadia Subduction Zone

The Cascadia Subduction Zone has recently been recognized as a potential source of strong earthquake activity in the Portland/Vancouver Basin. This phenomenon is the result of the earth’s large tectonic plate movement. Geologic evidence indicates that volcanic ocean floor activity along the Juan de Fuca ridge in the Pacific Ocean causes the Juan de Fuca Plate to perpetually move east and subduct under the North American Continental Plate. The subduction zone results in historic volcanic and potential earthquake activity in proximity to the plate interface, believed to lie approximately 20 to 50 miles west of the general location of the Oregon and Washington coast *(Geomatrix Consultants, 1995)*.

4.0 GEOTECHNICAL AND GEOLOGIC FIELD INVESTIGATION

A geotechnical field investigation consisting of visual reconnaissance, four soil borings (SB-1 through SB-4), eight test pits (TP-1 through TP-8), five hand-auger borings (HA-1 through HA-5), and five infiltration tests (IT-1 through IT-5) was conducted at the site on March 22, April 14 and 15, 2016. Soil borings were performed with a Deitrich D-50, track-mounted, mud-rotary drill system. Test pit exploration was performed with a track-mounted excavator. Subsurface soil profiles were logged in accordance with Unified Soil Classification System (USCS) specifications. Disturbed soil samples were collected from relevant soil horizons and submitted for laboratory analysis. Analytical laboratory test results are presented in Appendix A. Exploration locations are indicated on Figure 2. Subsurface exploration logs are presented in Appendix B. Soil descriptions and classification information are provided in Appendix C. Photo logs are presented in Appendix D.

4.1 Surface Investigation and Site Description

Situated upgradient and northeast of Lacamas Lake, the approximate 40-acre subject site has gently rolling topography with elevations ranging from approximately 210 to 270 feet amsl trending upward from southwest to northeast. Two residences exist along the western boundary of the site on NE 232nd Avenue with bands of trees aligning west and north site borders. According to a site-specific wetland study produced in 2014 by The Resource Company, Inc. several hydrogeomorphic wetlands are present within the subject site and a Lacamas Lake tributary transects the northern half of the site. Site vegetation primarily consists of grass in open areas with mature conifers and several oak trees concentrated near the existing residences and the Lacamas Lake tributary.

4.2 Subsurface Exploration and Investigation

Soil borings SB-1 through SB-4 were advanced at the site to a maximum depth of 50.2 feet below ground surface (bgs). Test pit explorations TP-1 through TP-8 were advanced to a maximum depth of 8 ½ feet bgs. Hand-auger borings HA-1 through HA-5 were advanced to a depth of eight feet bgs. Infiltration testing was conducted at depths ranging from 2 ½ to 5 feet within test pit excavations. Exploration locations were selected to observe subsurface soil characteristics in proximity to proposed development areas and are indicated on Figure 2.

4.2.1 Soil Type Description

The field investigation indicated the site is generally covered with approximately 6 to 8 inches of sod and topsoil in the observed locations. Underlying the topsoil layer, subsurface soils resembling the USDA Lauren soil series description were encountered. Subsurface lithology was reasonably consistent at explored locations and may generally be described by soil types identified in the following text.

Soil Type 1 – Clayey SAND

Soil Type 1 was observed to primarily consist of brown to orange, moist, medium dense, fine to medium textured clayey SAND. Soil Type 1 was encountered below the topsoil layer in all explorations (TP-1 through TP-8, HA-1 through HA-5, and SB-1 through SB-4). Standard penetration testing conducted within Soil Type 1 indicated blow counts ranging from 5 to 15 blows per foot.

Analytical laboratory testing conducted upon a representative soil sample obtained from exploration TP-8 indicated approximately 47 percent by weight passing the No. 200 sieve and an in situ moisture content of 29 percent. Atterberg Limits analysis indicated a liquid limit of 31 and plasticity index of 11. Soil Type 1 is classified as SC according to USCS specifications and A-6(2) according to AASHTO specifications.

Soil Type 2 – Silty SAND / Silty SAND with Gravel

Soil Type 2 was observed to primarily consist of brown-orange to yellow-black, moist to wet, medium dense to dense, silty SAND or silty SAND with gravel. Soil Type 2 was generally observed below Soil Type 1 in all explorations (TP-1 through TP-7, HA-1 through HA-5, and SB-1 through SB-4) and extended to depths of 15 to 20 feet below ground surface. Standard penetration testing (SPT) conducted within Soil Type 2 indicated blow counts ranging from eight blows per foot to refusal of the SPT sampler. Gravel content in Soil Type 2 was observed to be increasing with depth.

Analytical laboratory testing conducted upon representative soil samples obtained from explorations TP-1, SB-3 and SB-4 indicated approximately 14 to 16 percent by weight passing the No. 200 sieve, gravel contents ranging from 0 to 25 percent, and in situ moisture contents ranging from 22 to 29 percent. Atterberg Limits analysis indicated that

Soil Type 2 is non-plastic. Soil Type 2 is classified SM according to USCS specifications and A-2-4(0) according to AASHTO specifications.

Soil Type 3 – Sedimentary CONGLOMERATE

Soil Type 3 was observed to primarily consist of varicolored, weathered to competent, moist to wet, very dense, sedimentary CONGLOMERATE of subrounded to subangular gravels in a cemented matrix of sand, silt, and clay. Soil Type 3 may represent Pleistocene to Pliocene, unconsolidated to consolidated, thick-bedded, well-sorted pebble to cobble sedimentary deposits of the Cascade Range and Columbia River Basalt Group (QTc). Soil Type 3 was observed below Soil Type 2 in all soil boring explorations (SB-1 through SB-4) and test pit exploration TP-3, and extended to the maximum depth of exploration. Standard penetration testing conducted within Soil Type 3 indicated refusal of the SPT sampler.

4.2.2 Groundwater

Shallow groundwater conditions were observed across the site at depths ranging from 3 to 8 ½ feet below ground surface. Surface water and ephemeral streams were observed at several locations about the subject site. Approximate areas are indicated on Figure 2. Review of nearby well logs obtained from the State of Washington Department of Ecology indicates that static groundwater levels in the area may vary significantly. Variations in ground water elevations likely reflect the screened interval depth of these wells, changes in ground surface elevation, and the presence of multiple aquifers and confining units.

Groundwater levels are often subject to seasonal variance and may rise during extended periods of increased precipitation. Perched groundwater may also be present in localized areas. Seeps and springs may become evident during site grading, primarily along slopes or in areas cut below existing grade. Structures, roads, and drainage design should be planned accordingly. Piezometer installation and long-term monitoring, beyond the scope of this investigation, would be necessary to provide more detailed groundwater information.

5.0 DESIGN RECOMMENDATIONS

The geotechnical site investigation suggests the proposed development is generally compatible with surface and subsurface soils, provided the recommendations presented in this report are utilized and incorporated into the design and construction processes. The primary geotechnical concerns associated with the site are shallow groundwater, and fine-textured constituents of site soils. Design recommendations are presented in the following text sections.

5.1 Site Preparation and Grading

Vegetation, asphalt, organic material, unsuitable fill, and deleterious material that may be encountered should be cleared from areas identified for structures and site grading. Vegetation, other organic material, and debris should be removed from the site. Stripped topsoil should also be removed, or used only as landscape fill in nonstructural areas with slopes less than 25 percent. The stripping depth for sod and highly organic topsoil is anticipated to vary from 6 to 8 inches. The required stripping depth may increase in areas of existing fill, heavy organics, or previously existing structures. Actual stripping depths should be determined based upon visual observations made during construction when soil conditions are exposed. The post-construction maximum depth of landscape fill placed or spread at any location onsite should not exceed one foot.

Previously disturbed soil, debris, or unconsolidated fill encountered during grading or construction activities should be removed completely and thoroughly from structural areas. This includes old foundations, basement walls, utilities, associated soft soils, and debris. Existing fill and other previously disturbed soils or debris should be removed completely and thoroughly from structural areas. In some areas, existing fill may directly overlie vegetation and the original topsoil layer. This material should also be removed completely from structural areas. Upon removal of existing fill, Columbia West should observe the exposed subgrade. It should be noted that the limited scope of exploration conducted for this investigation cannot wholly eliminate uncertainty regarding the presence of unsuitable soils in areas not explored.

Test pits excavated during site exploration were backfilled loosely with onsite soils. These test pits should be located and properly backfilled with structural fill during site improvements construction.

Site grading activities should be performed in accordance with requirements specified in the 2012 *International Building Code* (IBC), Chapter 18 and Appendix J, with exceptions noted in the text herein. Site preparation, soil stripping, and grading activities should be observed and documented by Columbia West.

5.2 Engineered Structural Fill

Areas proposed for fill placement should be appropriately prepared as described in the preceding text. Surface soils should then be scarified and tilled to a depth of 12 inches. After scarification, soils should be moisture conditioned, compacted, and tested for compliance with recommended specifications by Columbia West prior to additional fill placement. Engineered structural fill should be placed in loose lifts not exceeding 12 inches in depth and compacted using standard conventional compaction equipment. The soil moisture content should be within two percentage points of optimum conditions. A field density at least equal to 95 percent of the maximum dry density, obtained from the standard Proctor moisture-density relationship test (ASTM D698), is recommended for structural fill placement. For engineered structural fill placed on sloped grades, the area should be benched to provide a horizontal surface for compaction.

Compaction of engineered structural fill should be verified by nuclear gauge field compaction testing performed in accordance with ASTM D6938. Field compaction testing should be performed for each vertical foot of engineered fill placed. Engineered fill placement should be observed by Columbia West.

Engineered structural fill placement activities should be performed during dry summer months if possible. Clean native soils may be suitable for use as structural fill if adequately moisture-conditioned to achieve recommended compaction specifications. Because they are moisture-sensitive, fine-textured soils are often difficult to excavate and compact during wet weather conditions. If adequate compaction is not achievable with clean fine-textured soils, import structural fill consisting of well-graded granular material with a maximum particle size of three inches and no more than five percent passing the No. 200 sieve is recommended.

Representative samples of proposed engineered structural fill should be submitted for laboratory analysis and approval by Columbia West prior to placement. Laboratory analyses should include particle-size gradation and standard Proctor moisture-density analysis.

5.3 Cut and Fill Slopes

Fill placed on existing grades steeper than 5H:1V should be horizontally benched at least 10 feet into the slope. Fill slopes greater than six feet in height should be vertically keyed into existing subsurface soil. A typical fill slope cross-section is shown in Figure 3. Drainage implementations, including subdrains or perforated drain pipe trenches, may also be necessary in proximity to cut and fill slopes if seeps or springs are encountered. Drainage design may be performed on a case-by-case basis. Extent, depth, and location of drainage may be determined in the field by the geotechnical engineer during construction when soil conditions are exposed. Failure to provide adequate drainage may result in soil sloughing, settlement, or erosion.

Final cut or fill slopes at the site should not exceed 2H:1V without individual slope stability analysis. The values above assume a minimum horizontal setback for loads of 10 feet from top of cut or fill slope face or overall slope height divided by three (H/3), whichever is greater. A minimum slope setback detail for structures is presented in Figure 4.

Concentrated drainage or water flow over the face of slopes should be prohibited, and adequate protection against erosion is required. Fill slopes should be constructed by placing fill material in maximum 12-inch level lifts, compacting as described in Section 5.2, *Engineered Structural Fill* and horizontally benching where appropriate. Fill slopes should be overbuilt, compacted, and trimmed at least two feet horizontally to provide adequate compaction of the outer slope face. Proper cut and fill slope construction is critical to overall project stability and should be observed and documented by Columbia West.

5.4 Foundations

Based upon correspondence with the design team, building foundations are anticipated to consist of shallow continuous perimeter or column spread footings. Footings should be designed by a licensed structural engineer and conform to the recommendations below. Typical building loads are not expected to exceed approximately 4 to 6 kips per foot for perimeter footings or 100 kips per column. If actual loading exceeds anticipated loading, additional analysis should be conducted for the specific load conditions and proposed footing dimensions.

The existing ground surface should be prepared as described in Section 5.1, *Site Preparation and Grading*, and Section 5.2, *Engineered Structural Fill*. Foundations should bear upon firm native soil or engineered structural fill.

To evaluate bearing capacity for proposed structures, serviceability and reliability of shear resistance for subsurface soils was considered. Allowable bearing capacity is typically a function of footing dimension and subsurface soil properties, including settlement and shear resistance. Based upon in situ field testing and laboratory analysis, the estimated allowable bearing capacity for well-drained foundations prepared as described above is 2,000 psf. Bearing capacity may be increased by one-third for transient lateral forces such as seismic or wind. The modulus of subgrade reaction is estimated to be 250 psi/inch. The estimated coefficient of friction between in situ compacted native soil or engineered structural fill and in-place poured concrete is 0.45. Lateral forces may also be resisted by an assumed passive soil equivalent fluid pressure of 250 psf/f against embedded footings. The upper six inches of soil should be neglected in passive pressure calculations.

Footings should extend to a depth at least 18 inches below lowest adjacent grade to provide adequate bearing capacity and protection against frost heave. Foundations constructed during wet weather conditions may require over-excavation of saturated subgrade soils and granular structural backfill prior to concrete placement. Over-excavation recommendations should be provided by Columbia West during foundation excavation and construction. Excavations adjacent to foundations should not extend within a 1.5H:1V angle projected down from the outside bottom footing edge without additional geotechnical analysis.

Foundations should not be permitted to bear upon existing fill or disturbed soil. Because soil is often heterogeneous and anisotropic, Columbia West should observe foundation excavations prior to placing forms or reinforcing bar to verify subgrade support conditions are as anticipated in this report.

5.5 Settlement

Total long-term static footing displacement for shallow foundations constructed as described in this report is not anticipated to exceed approximately 1 inch. Differential settlement between comparably loaded footing elements is not expected to exceed approximately ½ inch over a span of 50 feet. The resulting vertical displacement after loading may be due to elastic distortion, dissipation of excess pore pressure, or soil creep.

5.6 Excavation

To install utilities and construct site improvements, subsurface excavation is anticipated. Soils at the site were explored to a maximum depth of 50.2 feet using a truck-mounted mud-rotary drill rig and track-mounted excavator. Groundwater was encountered at depths ranging from 3 to 8 ½ feet within test pit explorations, however, perched groundwater layers may exist at shallower depths depending on seasonal fluctuations of the water table.

Apparent sedimentary conglomerate was encountered in all soil borings (SB-1 though SB-4) and within test pit TP-3. As indicated on the exploration logs provided in Appendix B, slow drilling and difficult excavation conditions were observed during subsurface exploration. Practical refusal of the excavator was also observed in the southwest corner of the site. Conglomerate conditions are anticipated to vary from firmly cemented with rock-like structure to semi-consolidated and highly weathered with soil-like excavation characteristics. Blasting is not anticipated, however, difficult excavation conditions will require appropriately sized equipment and potential specialized excavation techniques to construct site improvements.

Based upon laboratory analysis and field testing, near-surface soils may be Washington State Industrial Safety and Health Administration (WISHA) Type C. For temporary open-cut excavations deeper than four feet, but less than 20 feet in soils of these types, the maximum allowable slope is 1.5H:1V. WISHA soil type should be confirmed during field construction activities by the contractor. Soil is often anisotropic and heterogeneous, and it is possible that WISHA soil types determined in the field may differ from those described above.

The contractor should be held responsible for site safety, sloping, and shoring. Columbia West is not responsible for contractor activities and in no case should excavation be conducted in excess of all applicable local, state, and federal laws.

5.7 Lateral Earth Pressure

If retaining walls are proposed, lateral earth pressures should be carefully considered in the design process. Hydrostatic pressure and additional surcharge loading should also be considered. Retained material may include engineered structural backfill or undisturbed native soil. Structural wall backfill should consist of imported granular material meeting *Section 9-03.12(2)* of WSDOT Standard Specifications. Backfill should be prepared and compacted to at least 95 percent of maximum dry density as determined by the standard Proctor test (ASTM D698). Recommended parameters for lateral earth pressures for retained soils and engineered structural backfill consisting of imported granular fill meeting WSDOT specifications for *Gravel Backfill for Walls 9-03.12(2)* are presented in Table 1.

The design parameters presented in Table 1 are valid for static loading cases only and are based upon in situ existing soils or compacted granular backfill. The recommended earth pressures do not include surcharge loads, dynamic loading, hydrostatic pressure, or seismic design.

Table 1. Lateral Earth Pressure Parameters for Level Backfill

Retained Soil	Equivalent Fluid Pressure for Level Backfill			Wet Density	Drained Internal Angle of Friction
	At-rest	Active	Passive		
Undisturbed native Clayey SAND (Soil Type 1)	57 pcf	38 pcf	317 pcf	110 pcf	29°
Undisturbed native Silty SAND (Soil Type 2)	58 pcf	38 pcf	375 pcf	120 pcf	31°
Approved Backfill Material WSDOT 9-03.12(2) compacted aggregate backfill	52 pcf	32 pcf	568 pcf	135 pcf	38°

** The upper 6 inches of soil should be neglected in passive pressure calculations. If exterior grade from top or toe of retaining wall is sloped, Columbia West should be contacted to provide location-specific lateral earth pressures.*

If seismic design is required for unrestrained walls, seismic forces may be calculated by superimposing a uniform lateral force of $10H^2$ pounds per lineal foot of wall, where H is the total wall height in feet. The resultant force should be applied at 0.6H from the base of the wall.

A continuous one-foot-thick zone of free-draining, washed, open-graded 1-inch by 2-inch drain rock and a 4-inch perforated gravity drain pipe is assumed behind retaining walls. Geotextile filter fabric should be placed between the drain rock and backfill soil. Specifications for drainpipe design are presented in Section 5.11, *Drainage*. If walls cannot be gravity drained, saturated base conditions and/or applicable hydrostatic pressures should be assumed.

Final retaining wall design should be reviewed and approved by Columbia West. Retaining wall subgrade and backfill activities should also be observed and tested for compliance with recommended specifications by Columbia West during construction.

5.8 Seismic Design Considerations

According to the *United States Geologic Survey (USGS) 2012 Seismic Design Maps Summary Report,* the anticipated peak ground and maximum considered earthquake spectral response accelerations resulting from seismic activity for the subject site are summarized in Table 2.

Table 2. Approximate Probabilistic Ground Motion Values for 'firm rock' sites based on subject property longitude and latitude

	2% Probability of Exceedance in 50 yrs
Peak Ground Acceleration	0.38 g
0.2 sec Spectral Acceleration	0.88 g
1.0 sec Spectral Acceleration	0.37 g

The listed probabilistic ground motion values are based upon "firm rock" sites with an assumed shear wave velocity of 2,500 ft/s in the upper 100 feet of soil profile. These values should be adjusted for site class effects by applying site coefficients Fa and Fv as defined in 2012 IBC Tables 1613.3.3(1) and (2). The site coefficients are intended to more accurately characterize estimated peak ground and respective earthquake spectral response accelerations by considering site-specific soil characteristics and index properties.

Review of the *Site Class Map of Clark County, Washington (Washington State Department of Natural Resources, 2004),* indicates that site soils may be represented by Site Class C as defined in *2012 IBC Section 1613.3.2.* Observed subsurface exploration and site-specific testing indicate site soils may be represented by Site Class C. Site Class C indicates that minor amplification of seismic energy may occur during a seismic event due to subsurface conditions. However, this is typical for many areas within Clark County and will not prohibit development if properly accounted for during the design process.

Localized peak ground accelerations exceeding the adjusted values may occur in some areas in direct proximity to an earthquake's origin. This may be a result of amplification of seismic energy due to depth to competent bedrock, compression and shear wave velocity of bedrock, presence and thickness of loose, unconsolidated alluvial deposits, soil plasticity, grain size, and other factors.

Identification of specific seismic response spectra is beyond the scope of this investigation. If site structures are designed in accordance with recommendations specified in the 2012 IBC, the potential for peak ground accelerations in excess of the adjusted and amplified values should be understood.

5.9 Soil Liquefaction and Dynamic Settlement

According to the *Liquefaction Susceptibility Map of Clark County Washington (Washington State Department of Natural Resources, 2004)*, the site is mapped as very low susceptibility for liquefaction. Liquefaction, defined as the transformation of the behavior of a granular material from a solid to a liquid due to increased pore-water pressure and reduced effective stress, may occur when granular materials quickly compact under cyclic stresses caused by a seismic event. The effects of liquefaction may include immediate ground settlement and lateral spreading.

Soils most susceptible to liquefaction are generally saturated, cohesionless, loose to medium-dense sands within 50 feet of the ground surface. Recent research has also indicated that low plasticity silts and clays may also be subject to sand-like liquefaction behavior if the plasticity index determined by the Atterberg Limits analysis is less than 8. Potentially liquefiable soils located above the existing, historic, or expected ground water levels do not generally pose a liquefaction hazard. It is important to note that changes in perched ground water elevation may occur due to project development or other factors not observed at the time of investigation.

Based upon results of literature review, site-specific testing, and laboratory analysis, the potential for soil liquefaction significantly impacting proposed development is considered to be low.

5.10 Slope Reconnaissance and Slope Stability Assessment

According to *Clark County Maps Online* topographic mapping indicates elevation changes of 240 and 270 feet amsl on terrace slopes along the northern property boundary following a Lacamas Lake tributary. To observe geomorphic conditions, Columbia West personnel conducted visual and physical reconnaissance of the slopes. Soil boring and hand auger exploration was also conducted in the vicinity of the slopes. Subsurface soils in the observed location of soil borings SB-1 and SB-3, and hand augers HA-4 and HA-5 primarily consisted of medium dense to dense clayey sand underlain by medium dense to dense silty sand with increasing gravel and cobble presence at greater depths. In boring advancements, competent bedrock formation of the unnamed conglomerate was encountered to termination depth.

Field reconnaissance indicates that site slopes are generally planar and exhibit little to no signs of instability. Terrace slopes adjacent to the Lacamas Lake tributary spanning the north side of the site currently support heavy vegetation associated with mature conifer and deciduous trees and a dense understory of vines, shrubs, and ferns.

Based upon the results of our slope reconnaissance, subsurface exploration, and site research, slopes on the subject site do not exhibit signs of instability.

5.11 Drainage

At a minimum, site drainage should include surface water collection and conveyance to properly designed stormwater management structures and facilities. Drainage design in general should conform to City of Camas regulations. Finished site grading should be conducted with positive drainage away from structures. Depressions or shallow areas that may retain ponding water should be avoided. Roof drains, low-point drains, and perimeter foundation drains are recommended for structures. Drains should consist of separate systems and gravity flow with a minimum two-percent slope away from foundations into the stormwater system or approved discharge location.

Perimeter foundation drains should consist of 3-inch perforated PVC pipe surrounded by a minimum of 1 ft^3 of clean, washed drain rock per linear foot of pipe and wrapped with geotextile filter fabric. Open-graded drain rock with a maximum particle size of 3 inches and less than 2 percent passing the No. 200 sieve is recommended. Geotextile filter fabric should consist of Mirafi 140N or approved equivalent, with AOS between No. 70 and No. 100 sieve. The water permittivity should be greater than 1.5/sec. Figure 5 presents a typical foundation drain. Perimeter drains may limit increased hydrostatic pressure beneath footings and assist in reducing potential perched moisture areas.

Subdrains should also be considered if portions of the site are cut below surrounding grades. Shallow groundwater, springs, or seeps should be conveyed via drainage channel or perforated pipe into the stormwater management system or an approved discharge. Recommendations for design and installation of perforated drainage pipe may be performed on a case-by-case basis by Columbia West during construction. Failure to provide adequate surface and sub-surface drainage may result in soil slumping or unanticipated settlement of structures exceeding tolerable limits. A typical perforated drain pipe trench detail is presented in Figure 6.

Foundation drains and subdrains should be closely monitored after construction to assess their effectiveness. If additional surface or shallow subsurface seeps become evident, the drainage provisions may require modification or additional drains. Columbia West should be consulted to provide appropriate recommendations.

5.11.1 Drainage Mitigation

Review of preliminary site plans indicates that site improvements are proposed in proximity to shallow depressions and natural drainage features. Removal of thick organic layers and soft wet soils in these areas may result in excavation and backfill work being conducted at or near the shallow seasonal ground water table. Dewatering may be necessary and a drainage mat may be required to achieve sufficient elevation for fill placement. A typical drainage mat is shown on Figure 7. Observed areas that may require drainage mat mitigation are indicated on Figure 2. Columbia West should determine drainage mat location, extent, and thickness when subsurface conditions are exposed. Drainage mats may need to be constructed in conjunction with subdrains to convey captured water to an approved discharge location.

5.12 Infiltration Testing Results

To investigate the feasibility of subsurface disposal of stormwater, Columbia West conducted in situ infiltration testing at six locations within the project area on March 22, 2016. Results of in situ infiltration testing are presented in Table 3. Soil classifications presented in Table 3 are based upon visual observations and laboratory analysis. The recommended infiltration rates are presented as a coefficient of permeability (k) and have been reported without application of a factor of safety.

Table 3. Infiltration Test Data

Infiltration Test No.	Location (See Figure 2)	Approximate Test Depth (feet)	Approximate Depth to Groundwater (feet)	Soil Type**	Recommended Infiltration Rate, k* (inches/hour)	Passing No. 200 Sieve (%)
IT-1.1	TP-1	2.0	8.5	SC, Clayey SAND (Soil Type 1)**	0.2	-
IT-1.2		5.0		SM, Silty SAND (Soil Type 2)	5.9	14.3
IT-2.1	TP-2	5.0	8.0	SM, Silty SAND (Soil Type 2)**	0.2	-
IT-4.1	TP-4	2 ½	6	SM, Silty SAND (Soil Type 2)**	5.7	-
IT-8.1	TP-8	2.0	4.5	SC, Clayey SAND (Soil Type 1)	0.1	46.5

*Infiltration rate as defined by soil's approximate vertical coefficient of permeability (k).
**Based upon laboratory analysis when available.

As indicated on Figure 2, the tests were conducted within test pits TP-1, TP-2, TP-4, and TP-8 at depths ranging from 2 ½ to 5 feet below ground surface. Soils in the tested locations were observed and sampled where appropriate to adequately characterize the subsurface profile. Tested native soils are classified as clayey SAND (SC) and silty SAND (SM). Soil analytical laboratory test results are provided in Appendix A.

Single-ring, falling head infiltration testing was performed by inserting three- to six-inch diameter pipes into the soil at the indicated depths. The tests were conducted by filling the pipes with water and recording time and water level drop measurements. Using Darcy's Law for saturated flow in homogeneous media, the coefficient of permeability (k) was then calculated.

The reported infiltration rates, as defined by the soil coefficient of permeability, reflect approximate raw observed data, without application of a factor of safety. An appropriate soil correction factor should be applied to the observed infiltration rates prior to use in design calculations. The soil correction factor should be applied in addition to other factors of safety associated with civil design considerations.

Infiltration facilities should be protected from erosion, especially during construction. Improperly designed or constructed systems may become fouled or plugged with mud or micaceous sediment. Excavation and preparation of stormwater disposal facilities should be closely monitored by a geotechnical engineer. If possible, an emergency overflow discharge point should be provided.

It is important to note that site soil conditions and localized infiltration capability may be variable. Therefore, infiltration rates should be verified by additional testing during construction when subgrade soils are exposed. Subgrade soils should also be observed by Columbia West to verify soil index properties pertaining to infiltration are similar to those at the tested locations. The observed infiltration rates provided in Table 3 are based upon Columbia West's observations during limited subsurface exploration and may not be an accurate indicator of post-developed long-term system performance. It should be understood that systems may require additional infiltration capacity if construction verification testing or future performance indicate the system will not function according to original tested and designed parameters.

5.13 Bituminous Asphalt and Portland Cement Concrete

Correspondence with the design team indicates that proposed development includes asphalt paved access drives and parking lots for passenger cars, school buses, and garbage trucks. Columbia West conducted engineering analysis for flexible pavement design using the 1993 *AASHTO Guide for Design of Pavement Structures* in general accordance with Washington State Department of Transportation (WSDOT) structural design policy. Design Equivalent Single Axle Loads (ESALS) over a 20-year period are primarily based on the Traffic Analysis Report submitted by Charbonneau Engineering, LLC for Lacamas Elementary School and commonly published Load Equivalency Factors (LEFs). Minimum structural thickness recommendations and associated specifications for proposed flexible pavement structures are provided in Table 4.

Table 4. Flexible Pavement Section Recommendations

Pavement Section Layer	Minimum Layer Thickness		Specifications
	Passenger Car Parking and Access Drives*	Bus Parking and Access Drives	
Asphalt concrete surface HMA Class ½" PG 64-22	3 inches	4 inches	91 percent of maximum Rice density (AASHTO T-209)
Base course (WSDOT 9-03.9(3) 1¼"-0 crushed aggregate	8 inches	10 inches	95 percent of maximum modified Proctor density (AASHTO T-180)
Scarified and compacted subgrade material	12 inches	12 inches	Compacted to 95 percent of maximum standard Proctor density (AASHTO T-99)

* Design recommendations assume that passenger car parking and access drives are not subject to bus traffic.

For dry weather construction, pavement surface sections should bear upon competent subgrade consisting of scarified and compacted native soil or engineered structural fill. Wet weather pavement construction is discussed later in Section 5.14, *Wet Weather Construction Methods and Techniques*. Subgrade conditions should be evaluated and tested by Columbia West prior to placement of crushed aggregate base. Subgrade evaluation should include nuclear gauge density testing and wheel proof-roll observations conducted with a 12-cubic yard, double-axle dump truck or equivalent. Nuclear gauge density testing should be conducted at 150-foot intervals or as determined by the onsite geotechnical engineer. Subgrade soil should be compacted to at least 95 percent of the standard Proctor dry density, as determined by AASHTO T-180. Areas of observed deflection or rutting during proof-roll evaluation should be excavated to a firm surface and replaced with compacted crushed aggregate.

Crushed aggregate base should be compacted and tested in accordance with the specifications outlined above. Asphalt concrete pavement should be compacted to at least 91 percent of maximum Rice density. Nuclear gauge density testing should be conducted to verify adherence to recommended specifications. Testing frequency should be in accordance with Washington Department of Transportation and City of Camas specifications.

Portland cement concrete (PCC) curbs and sidewalks should be installed in accordance with City of Camas specifications. Aggregate base for PCC curb, sidewalk, and pavement structures should be observed, tested, and proof-rolled by Columbia West. Soft areas that deflect or rut should be stabilized prior to pouring concrete. Concrete should be tested during installation in accordance with ASTM C171, C138, C231, C143, C1064, and C31. This includes casting of cylinder specimen at a frequency of four cylinders per 100 cubic yards of poured concrete. Recommended field and analytical laboratory concrete testing includes slump, air entrainment, temperature, and unit weight.

5.14 Wet Weather Construction Methods and Techniques

Wet weather construction often results in significant shear strength reduction and soft areas that may rut or deflect. Installation of granular working layers may be necessary to provide a firm support base and sustain construction equipment. Granular layers should consist of all-weather gravel, 2x4-inch gabion, or other similar material (six-inch maximum size with less than five percent passing the No. 200 sieve).

Construction equipment traffic across exposed soil should be minimized. Equipment traffic induces dynamic loading, which may result in weak areas and significant reduction in shear strength for wet soils. Wet weather construction may also result in generation of significant excess quantities of soft wet soil. This material should be removed from the site or stockpiled in a designated area.

Construction during wet weather conditions may require increased base thickness. Over-excavation may be necessary to provide a firm base upon which to place crushed aggregate. Geotextile filter fabric is also recommended. Crushed aggregate base should be installed in a single lift with trucks end-dumping from an advancing pad of granular fill. During extended wet periods, stripping activities may also need to be conducted from an advancing pad of granular fill. Once installed, the crushed aggregate base should be compacted with several passes from a static drum roller. A vibratory compactor is not recommended because it may further disturb the subgrade. Subdrains may also be necessary to provide subgrade drainage and maintain structural integrity.

Crushed aggregate base should be compacted to at least 95 percent of maximum dry density according to the modified Proctor density test (AASHTO T180). Compaction should be verified by nuclear gauge density testing. Observation of a proof-roll with a loaded dump truck is also recommended as an indication of future pavement performance.

It should be understood that wet weather construction is risky and costly. Columbia West should observe and document wet weather construction activities. Proper construction methods and techniques are critical to overall project integrity.

5.15 Erosion Control Measures

Based upon field observations and laboratory testing, the erosion hazard for site soils in flat to shallow-gradient portions of the property is likely to be low. The potential for erosion generally increases in sloped areas. Therefore, disturbance to vegetation in sloped areas should be minimized during construction activities. Soil is also prone to erosion if unprotected and unvegetated during periods of increased precipitation. Erosion can be minimized by performing construction activities during dry summer months.

Site-specific erosion control measures should be implemented to address the maintenance of exposed areas. This may include silt fence, biofilter bags, straw wattles, or other suitable methods. During construction activities, exposed areas should be well-compacted and protected from erosion with visqueen, surface tactifier, or other means, as appropriate. Temporary slopes or exposed areas may be covered with straw, crushed aggregate, or riprap in localized areas to minimize erosion. Erosion and water runoff during wet weather conditions may be controlled by application of strategically placed channels and small detention depressions with overflow pipes.

After grading, exposed surfaces should be vegetated as soon as possible with erosion-resistant native vegetation. Jute mesh or straw may be applied to enhance vegetation. Once established, vegetation should be properly maintained. Disturbance to existing native vegetation and surrounding organic soil should also be minimized during construction activities.

5.16 Utility Installation

Utility installation may require subsurface excavation and trenching. Excavation, trenching and shoring should conform to federal (Occupational Safety and Health Administration) (OSHA) (29 CFR, Part 1926) and *WISHA* (WAC, Chapter 296-155) regulations. Site soils may slough when cut vertically and sudden precipitation events or perched groundwater may result in accumulation of water within excavation zones and trenches.

Utilities should be installed in general accordance with manufacturer's recommendations. Utility trench backfill should consist of crushed aggregate or other coarse-textured, free-draining material acceptable to the client, City of Camas, and Columbia West. Trench backfill material within 18 inches of the top of utility pipes should be hand compacted (i.e., no heavy compaction equipment). The remaining backfill should be compacted to at least

95 percent of maximum dry density as determined by the standard Proctor moisture-density test (ASTM D698). Clean, free-draining, fine bedding sand is recommended for use in the pipe zone. With exception of the pipe zone, backfill should be placed in loose lifts not exceeding 12 inches in thickness.

Compaction of utility trench backfill material should be verified by nuclear gauge field compaction testing performed in accordance with ASTM D6938. Field compaction testing should be performed at 200-foot intervals along the utility trench centerline at the surface and midpoint depth of the trench. Compaction frequency and specifications may be modified for non-structural areas in accordance with recommendations of the site geotechnical engineer.

6.0 CONCLUSION AND LIMITATIONS

This geotechnical site investigation report was prepared in accordance with accepted standard conventional principles and practices of geotechnical engineering. This investigation pertains only to material tested and observed as of the date of this report, and is based upon proposed site development as described in the text herein. This report is a professional opinion containing recommendations established by engineering interpretations of subsurface soils based upon conditions observed during site exploration. Soil conditions may differ between tested locations or over time. Slight variations may produce impacts to the performance of structural facilities if not adequately addressed. This underscores the importance of diligent QA/QC construction observation and testing to verify soil conditions are as anticipated in this report.

Therefore, this report contains several recommendations for field observation and testing by Columbia West personnel during construction activities. Columbia West cannot accept responsibility for deviations from recommendations described in this report. Future performance of structural facilities is often related to the degree of construction observation by qualified personnel. These services should be performed to the full extent recommended.

This report is not an environmental assessment and should not be construed as a representative warranty of site subsurface conditions. The discovery of adverse environmental conditions, or subsurface soils that deviate significantly from those described in this report, should immediately prompt further investigation. The above statements are in lieu of all other statements expressed or implied.

This report was prepared solely for the client and is not to be reproduced without prior authorization from Columbia West. Final engineering plans and specifications for the project should be reviewed and approved by Columbia West as they relate to geotechnical and grading issues prior to final design approval. Columbia West is not responsible for independent conclusions or recommendations made by other parties based upon information presented in this report. Unless a particular service was expressly included in the scope, it was not performed and there should be no assumptions based upon services not provided. Additional report limitations and important information about this document are presented in Appendix E. This information should be carefully read and understood by the client and other parties reviewing this document.

Sincerely,

COLUMBIA WEST ENGINEERING, Inc.

Jason L. Ordway, PE
Principal

JASON L. ORDWAY
STATE OF WASHINGTON
45261
REGISTERED
PROFESSIONAL ENGINEER

05-04-16

REFERENCES

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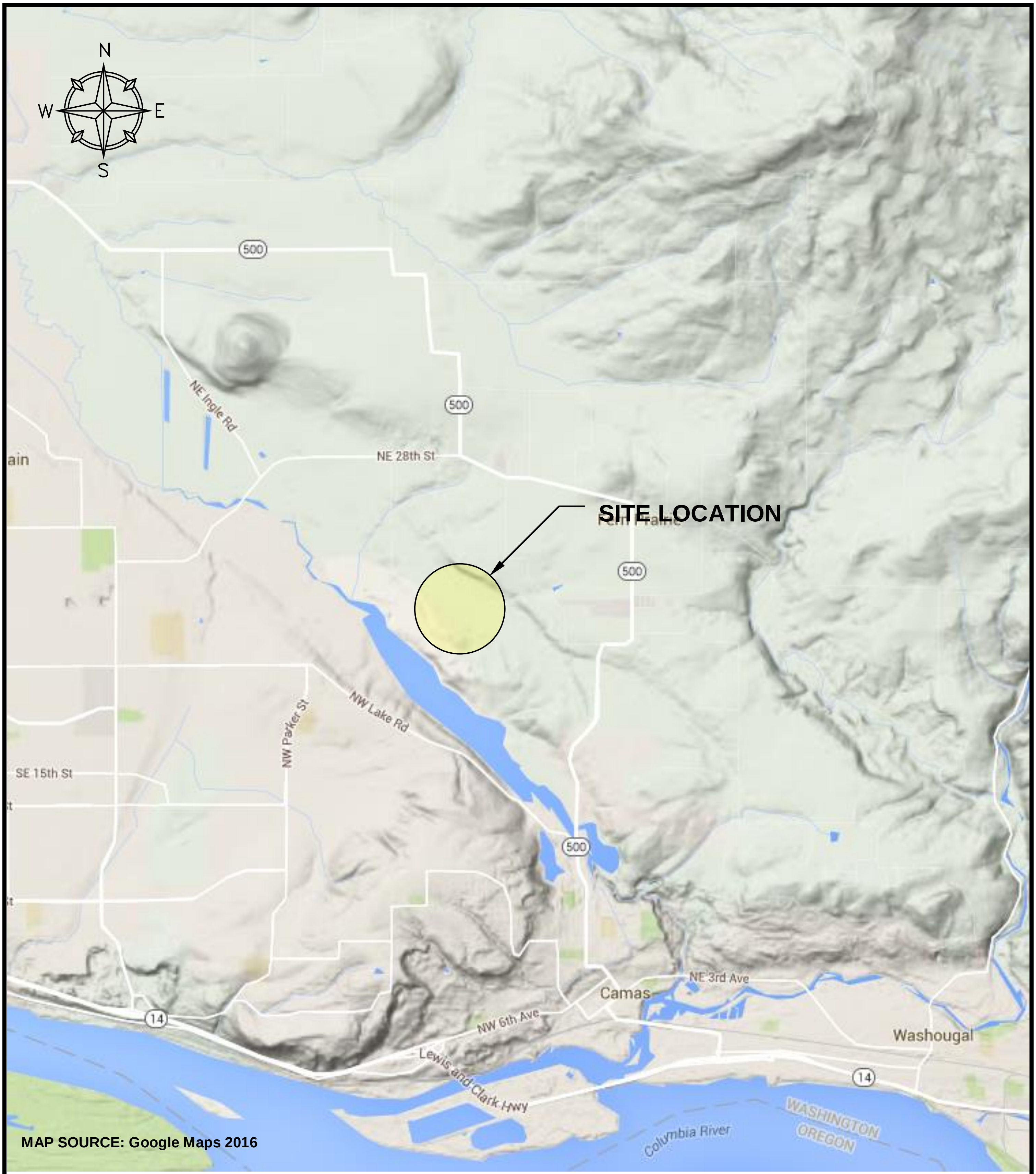
FIGURES



MAP SOURCE: Google Maps 2016

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Client: MAHLUM	Rev	By	Date
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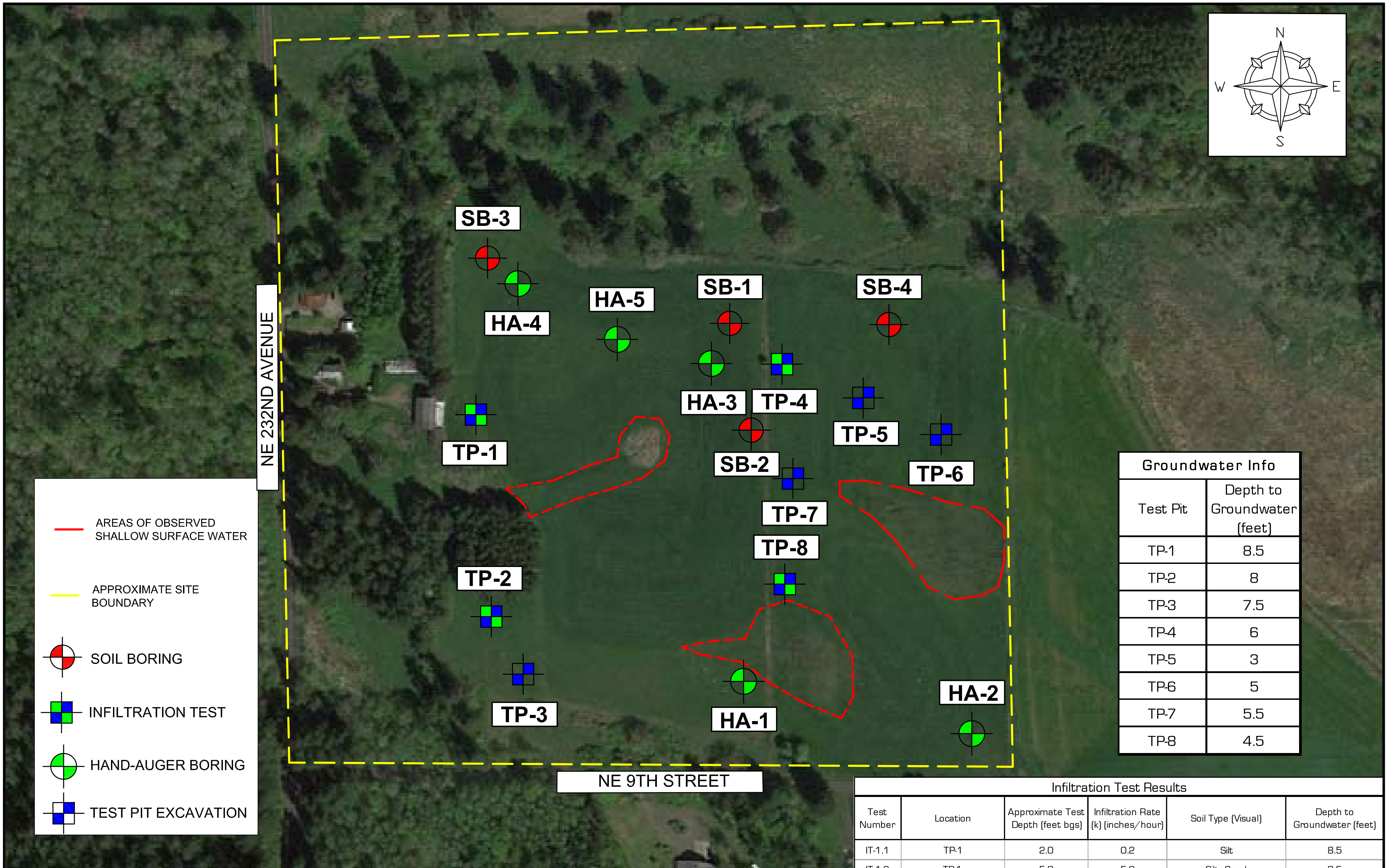
SITE LOCATION MAP

LACAMAS ELEMENTARY SCHOOL
CAMAS, WASHINGTON

FIGURE
1



Groundwater Info

Test Pit	Depth to Groundwater (feet)
TP-1	8.5
TP-2	8
TP-3	7.5
TP-4	6
TP-5	3
TP-6	5
TP-7	5.5
TP-8	4.5

Infiltration Test Results

Test Number	Location	Approximate Test Depth (feet bgs)	Infiltration Rate (k) (inches/hour)	Soil Type (Visual)	Depth to Groundwater (feet)
IT-1.1	TP-1	2.0	0.2	Silt	8.5
IT-1.2	TP-1	5.0	5.9	Silty Sand	8.5
IT-2.1	TP-2	5.0	0.2	Silty Sand	8
IT-4.1	TP-4	2.5	5.7	Silty Gravel with Sand	6
IT-8.1	TP-8	2.0	0.1	Silt	4.5

NOTES:
1. SITE LOCATION: 1111 NE 232ND AVENUE, CAMAS, WASHINGTON.
2. SITE CONSISTS OF PARCEL 175724000 TOTALING TO APPROXIMATELY 40 ACRES.
3. DRAWING IS NOT TO SCALE.
4. BASE MAP OBTAINED FROM GOOGLE EARTH.
5. SOIL EXPLORATION LOCATIONS ARE APPROXIMATE AND NOT SURVEYED.
6. TEST PITS AND HAND AUGERS BACKFILLED LOOSELY WITH ONSITE SOILS ON MARCH 22, 2016.
7. SOIL BORINGS BACKFILLED WITH BENTONITE ON APRIL 14 AND 15, 2016.

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EXPLORATION LOCATION MAP

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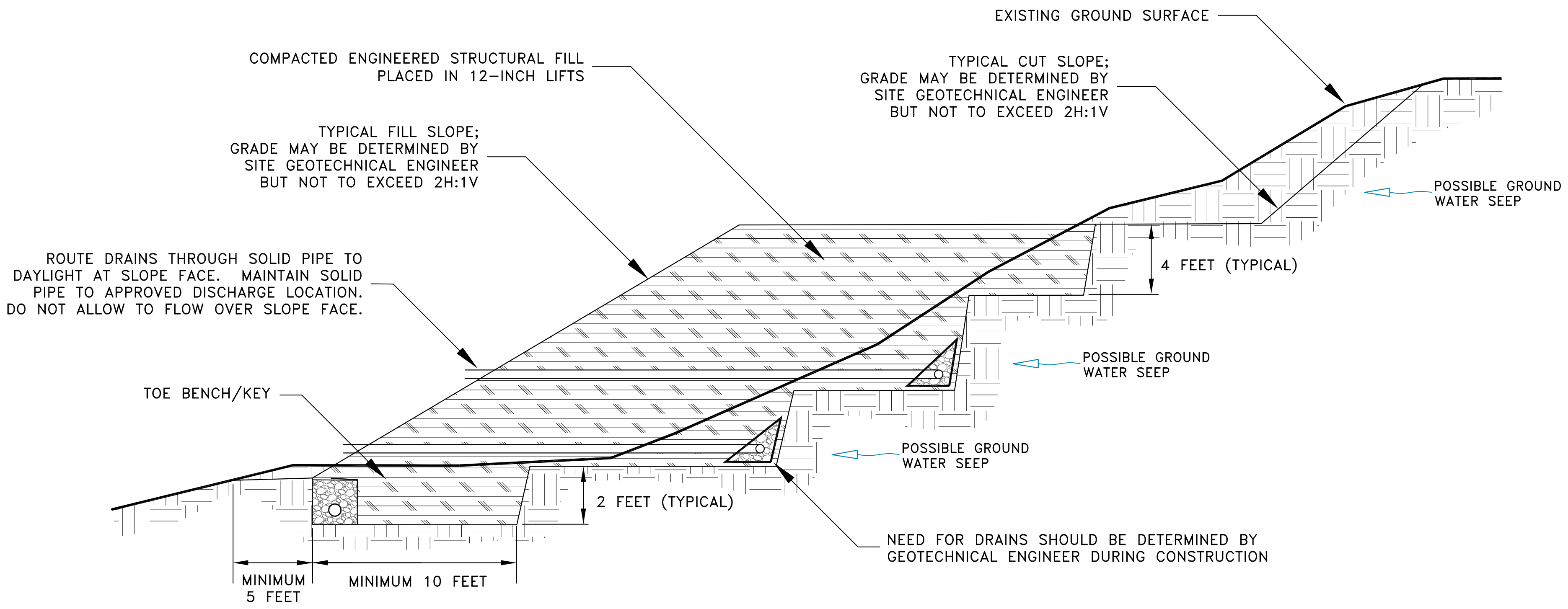
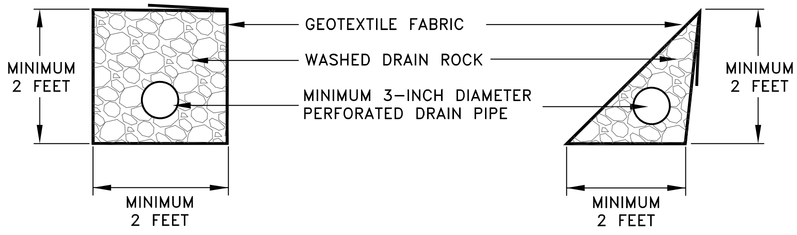
CAMAS, WASHINGTON

FIGURE
2

TYPICAL CUT AND FILL SLOPE CROSS-SECTION



TYPICAL DRAIN SECTION DETAIL



DRAIN SPECIFICATIONS

GEOTEXTILE FABRIC SHALL CONSIST OF MIRAFI 140N OR APPROVED EQUIVALENT WITH AOS BETWEEN No. 70 AND No. 100 SIEVE.

WASHED DRAIN ROCK SHALL BE OPEN-GRADED ANGULAR DRAIN ROCK WITH LESS THAN 2 PERCENT PASSING THE No. 200 SIEVE AND A MAXIMUM PARTICLE SIZE OF 3 INCHES.

NOTES:
1. DRAWING IS NOT TO SCALE.
2. SLOPES AND PROFILES SHOWN ARE APPROXIMATE.
3. DRAWING REPRESENTS TYPICAL FILL AND CUT SLOPE SECTION, AND MAY NOT BE SITE-SPECIFIC.

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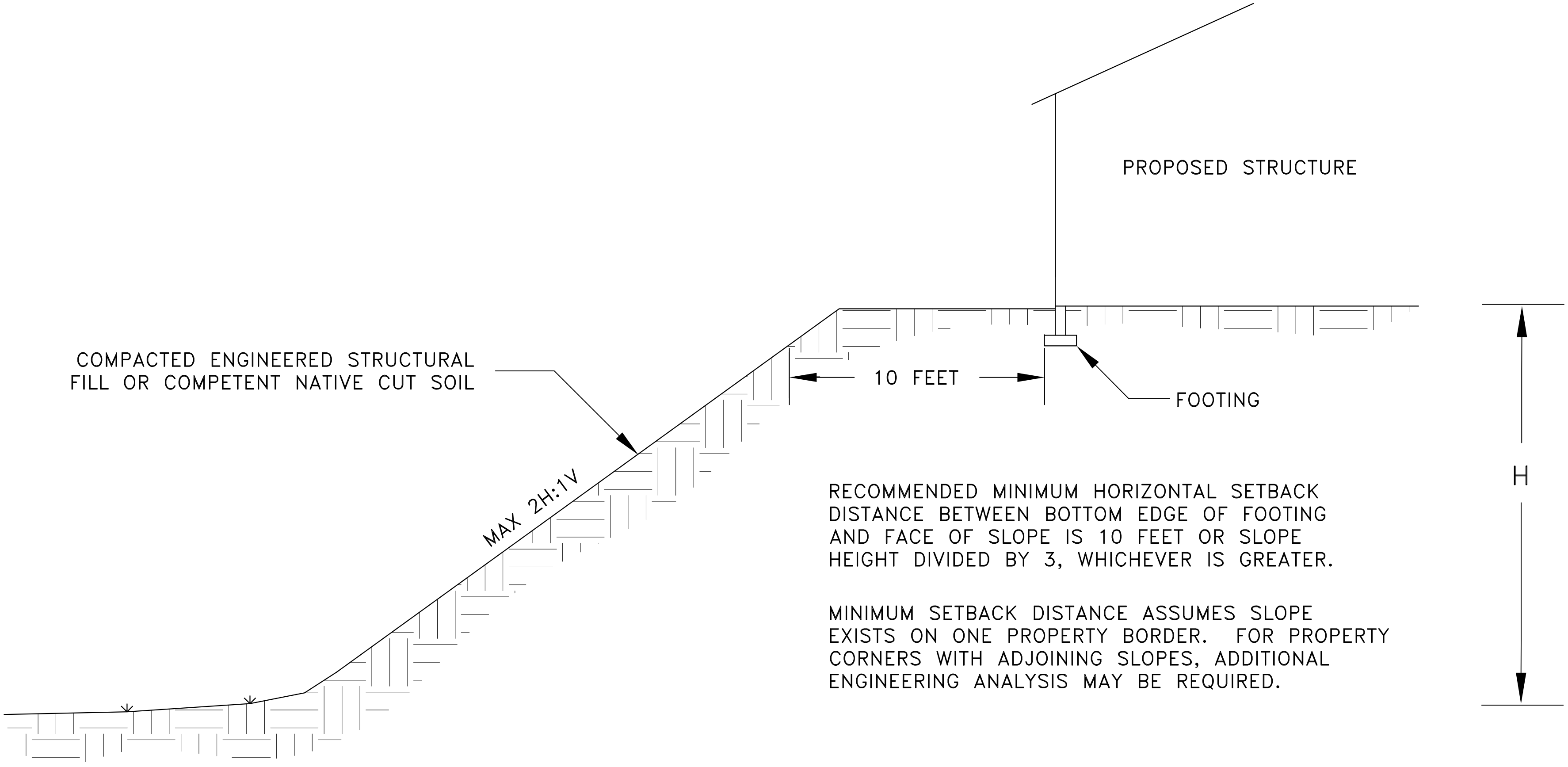
TYPICAL CUT AND FILL SLOPE CROSS-SECTION

LACAMAS ELEMENTARY SCHOOL
CAMAS, WASHINGTON

FIGURE
3

MINIMUM FOUNDATION SLOPE SETBACK DETAIL



RECOMMENDED MINIMUM HORIZONTAL SETBACK DISTANCE BETWEEN BOTTOM EDGE OF FOOTING AND FACE OF SLOPE IS 10 FEET OR SLOPE HEIGHT DIVIDED BY 3, WHICHEVER IS GREATER.

MINIMUM SETBACK DISTANCE ASSUMES SLOPE EXISTS ON ONE PROPERTY BORDER. FOR PROPERTY CORNERS WITH ADJOINING SLOPES, ADDITIONAL ENGINEERING ANALYSIS MAY BE REQUIRED.

NOTES:
1. DRAWING IS NOT TO SCALE.
2. SLOPES AND PROFILES SHOWN ARE APPROXIMATE.
3. DRAWING REPRESENTS TYPICAL FOUNDATION SETBACK DETAIL, AND MAY NOT BE SITE-SPECIFIC.

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MINIMUM FOUNDATION SLOPE SETBACK DETAIL

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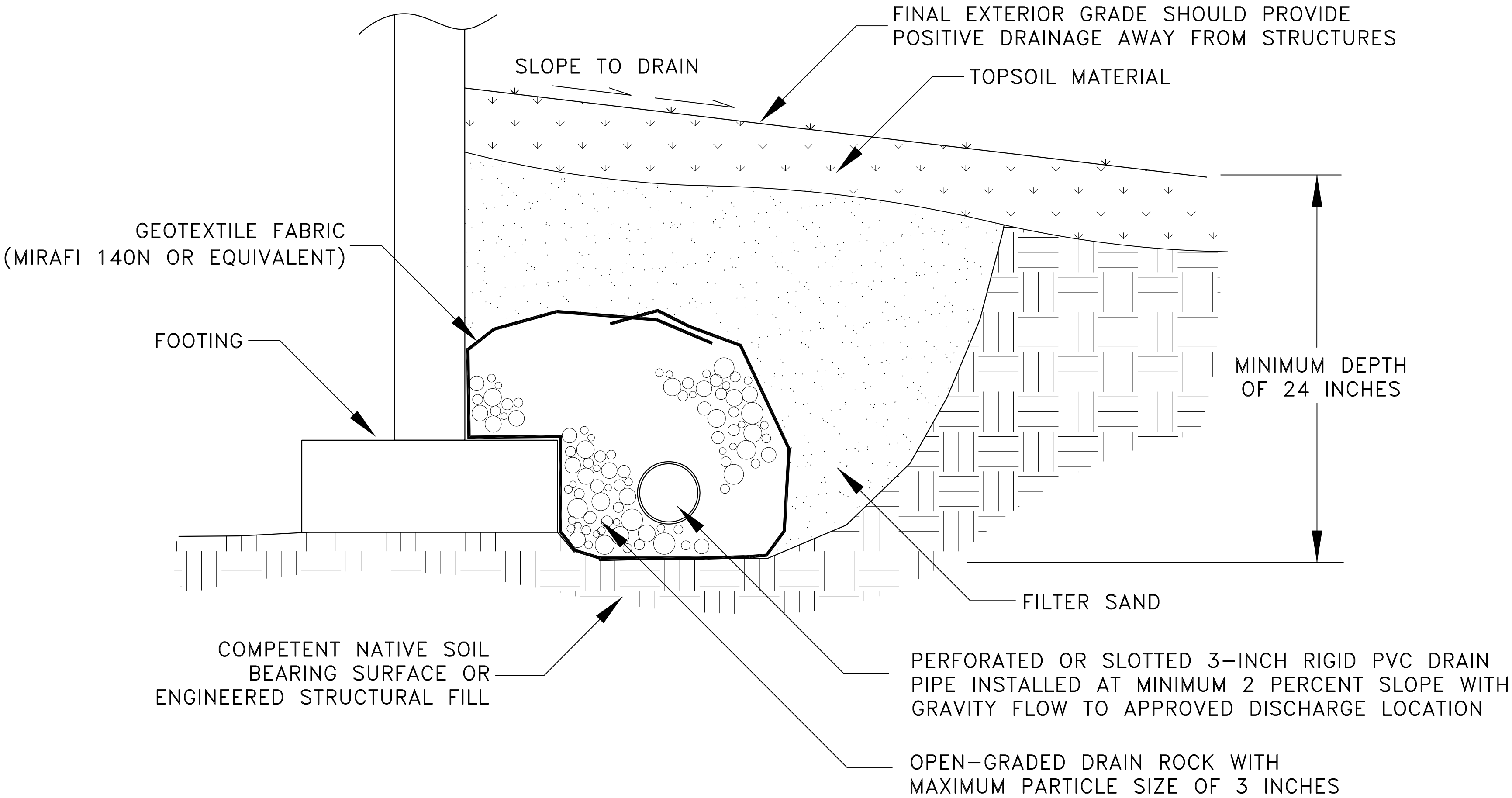
FIGURE
4

TYPICAL PERMITER FOOTING DRAIN DETAIL



NOTES:
1. DRAWING IS NOT TO SCALE.
2. DRAWING REPRESENTS TYPICAL FOOTING DRAIN DETAIL AND MAY NOT BE SITE-SPECIFIC

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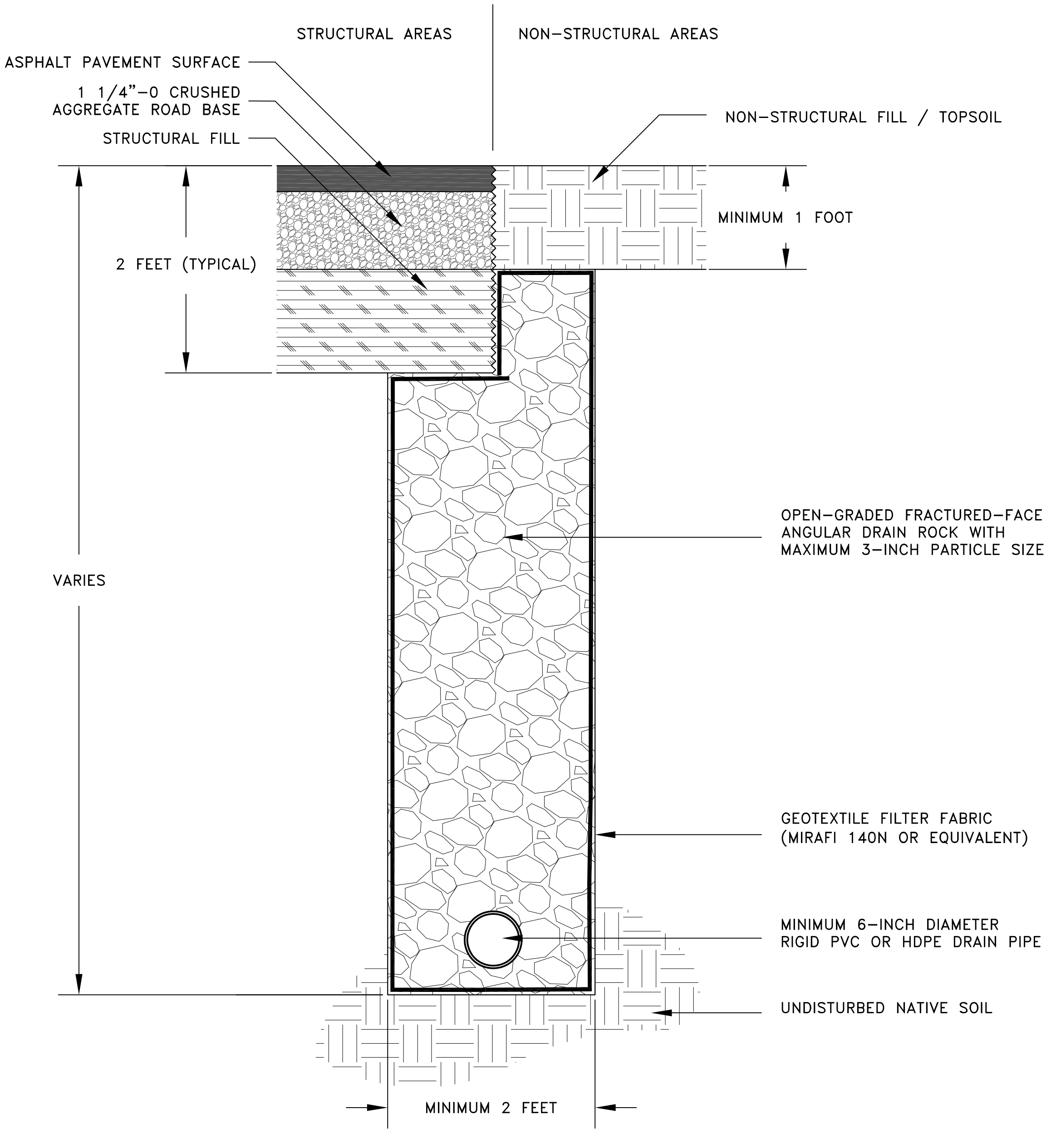
TYPICAL PERIMETER
FOOTING DRAIN DETAIL

LACAMAS ELEMENTARY SCHOOL
CAMAS, WASHINGTON

FIGURE
5

TYPICAL PERFORATED DRAIN PIPE TRENCH DETAIL



NOTE: LOCATION, INVERT ELEVATION, DEPTH OF TRENCH, AND EXTENT OF PERFORATED PIPE REQUIRED MAY BE MODIFIED BY THE GEOTECHNICAL ENGINEER DURING CONSTRUCTION BASED UPON FIELD OBSERVATION AND SITE-SPECIFIC SOIL CONDITIONS.

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TYPICAL PERFORATED
DRAIN PIPE TRENCH DETAIL

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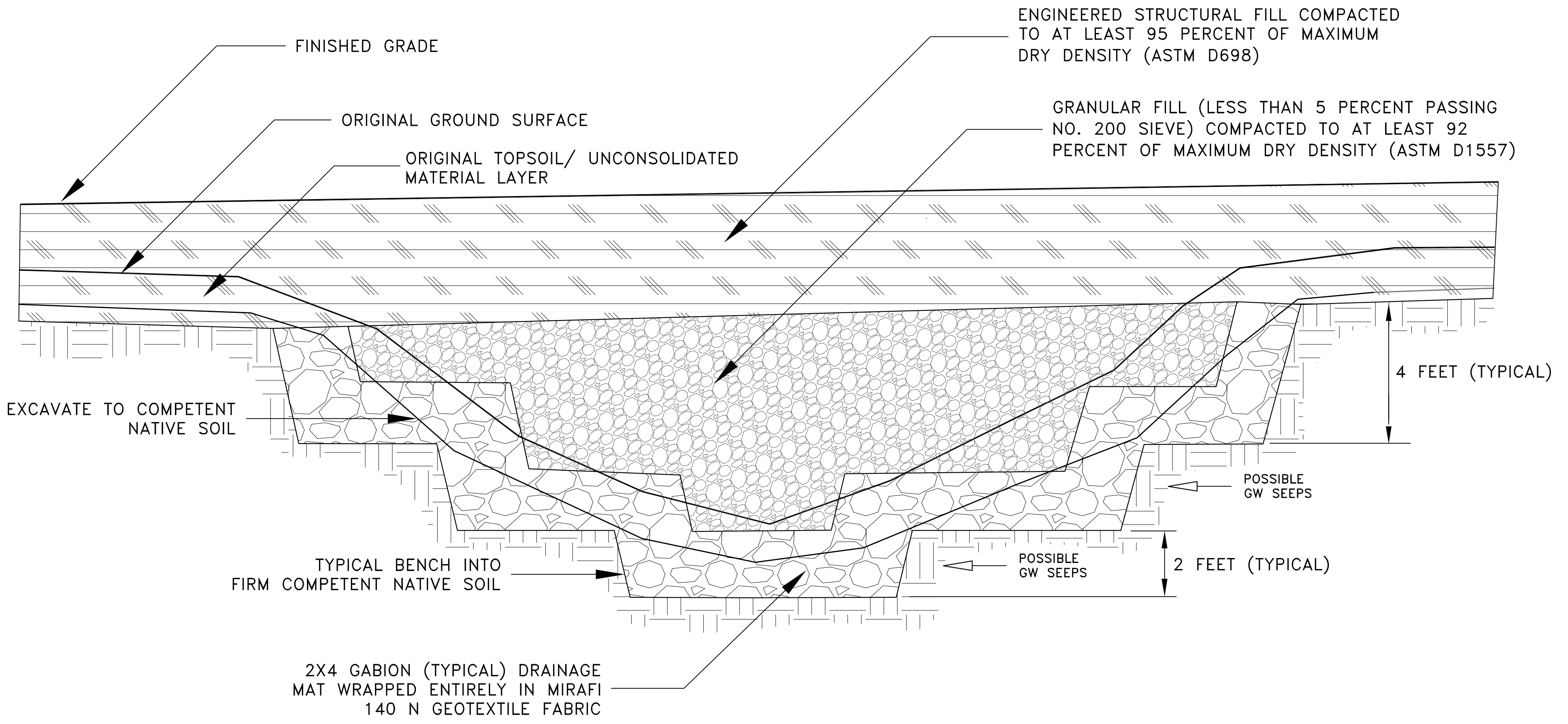
CAMAS, WASHINGTON

FIGURE
6

TYPICAL DRAINAGE MAT CROSS-SECTION



NOTES:
1. DRAWING IS NOT TO SCALE.
2. SLOPES AND PROFILES SHOWN ARE APPROXIMATE.
3. DRAWING REPRESENTS TYPICAL DRAINAGE MAT SECTION AND MAY NOT BE SITE-SPECIFIC.
4. DEPTH, LOCATION, EXTENT, AND THICKNESS OF GABION MAT AND GRANULAR FILL LAYER SHOULD BE DETERMINED IN THE FIELD BY COLUMBIA WEST.
5. DRAIN PIPE MAY BE NEEDED AT LOWEST GRADIENT POINT OF DRAINAGE MAT TO CONTROL AND DIRECT FLOW.

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TYPICAL DRAINAGE MAT SECTION

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FIGURE
7

APPENDIX A
LABORATORY TEST RESULTS

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Engineering, Inc

PARTICLE-SIZE ANALYSIS REPORT

PROJECT
Lacamas Heights Elementary School
Camas, Washington

CLIENT
Amy Copeland
Mahlum Architects, Inc.
1231 NW Hoyt Street #102
Portland, Oregon 97209

PROJECT NO.	LAB ID
16065	S16-220
REPORT DATE	FIELD ID
04/21/16	TP1.2
DATE SAMPLED	SAMPLED BY
03/22/16	HDG

MATERIAL DATA

MATERIAL SAMPLED
Silty SAND

MATERIAL SOURCE
Test Pit TP-01
depth = 5 feet

USCS SOIL TYPE
SM, Silty Sand

SPECIFICATIONS
none

AASHTO SOIL TYPE
A-2-4(0)

LABORATORY TEST DATA

LABORATORY EQUIPMENT
Rainhart "Mary Ann" Sifter 637

TEST PROCEDURE
ASTM D6913, D422

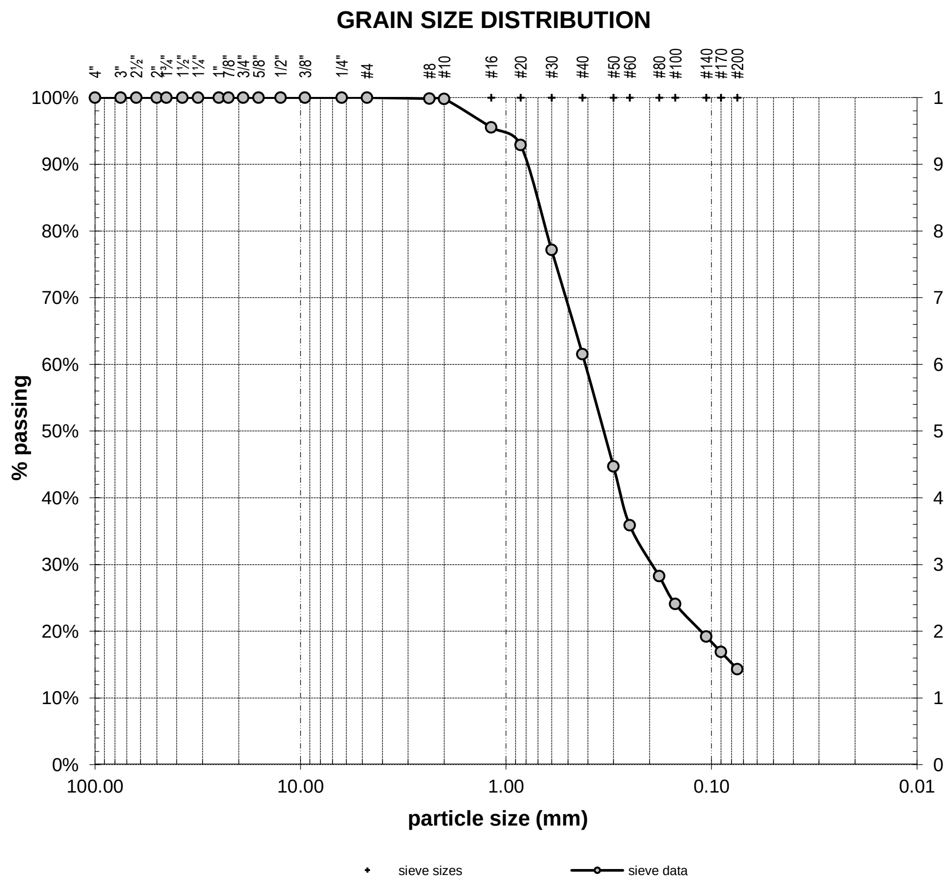
ADDITIONAL DATA

initial dry mass (g) = 199.7
as-received moisture content = 28.6%
liquid limit = 0
plastic limit = 0
plasticity index = 0
fineness modulus = n/a

coefficient of curvature, C_C = n/a
coefficient of uniformity, C_U = n/a
effective size, $D_{(10)}$ = n/a
$D_{(30)}$ = 0.194 mm
$D_{(60)}$ = 0.412 mm

SIEVE DATA

% gravel = 0.0%
% sand = 85.7%
% silt and clay = 14.3%



	SIEVE SIZE		PERCENT PASSING			
			SIEVE		SPECS	
	US	mm	act.	interp.	max	min
GRAVEL	6.00"	150.0		100.0%		
	4.00"	100.0		100.0%		
	3.00"	75.0		100.0%		
	2.50"	63.0		100.0%		
	2.00"	50.0		100.0%		
	1.75"	45.0		100.0%		
	1.50"	37.5		100.0%		
	1.25"	31.5		100.0%		
	1.00"	25.0		100.0%		
	7/8"	22.4		100.0%		
	3/4"	19.0		100.0%		
	5/8"	16.0		100.0%		
	1/2"	12.5		100.0%		
	3/8"	9.50		100.0%		
	1/4"	6.30		100.0%		
	#4	4.75	100.0%			
SAND	#8	2.36		99.8%		
	#10	2.00	99.8%			
	#16	1.18		95.5%		
	#20	0.850	92.9%			
	#30	0.600		77.1%		
	#40	0.425	61.5%			
	#50	0.300		44.7%		
	#60	0.250	35.9%			
	#80	0.180		28.3%		
	#100	0.150	24.1%			
	#140	0.106		19.2%		
	#170	0.090		16.9%		
	#200	0.075	14.3%			

DATE TESTED	TESTED BY
04/19/16	JMR

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PARTICLE-SIZE ANALYSIS REPORT

PROJECT
Lacamas Heights Elementary School
Camas, Washington

CLIENT
Amy Copeland
Mahlum Architects, Inc.
1231 NW Hoyt Street #102
Portland, Oregon 97209

PROJECT NO.: 16065
LAB ID: S16-221
REPORT DATE: 04/21/16
FIELD ID: TP8.1
DATE SAMPLED: 03/22/16
SAMPLED BY: HDG

MATERIAL DATA

MATERIAL SAMPLED: Clayey SAND

MATERIAL SOURCE: Test Pit TP-08
depth = 2 feet

USCS SOIL TYPE: SC, Clayey Sand

SPECIFICATIONS: none

AASHTO SOIL TYPE: A-6(2)

LABORATORY TEST DATA

LABORATORY EQUIPMENT: Rainhart "Mary Ann" Sifter 637

TEST PROCEDURE: ASTM D6913, D422

ADDITIONAL DATA

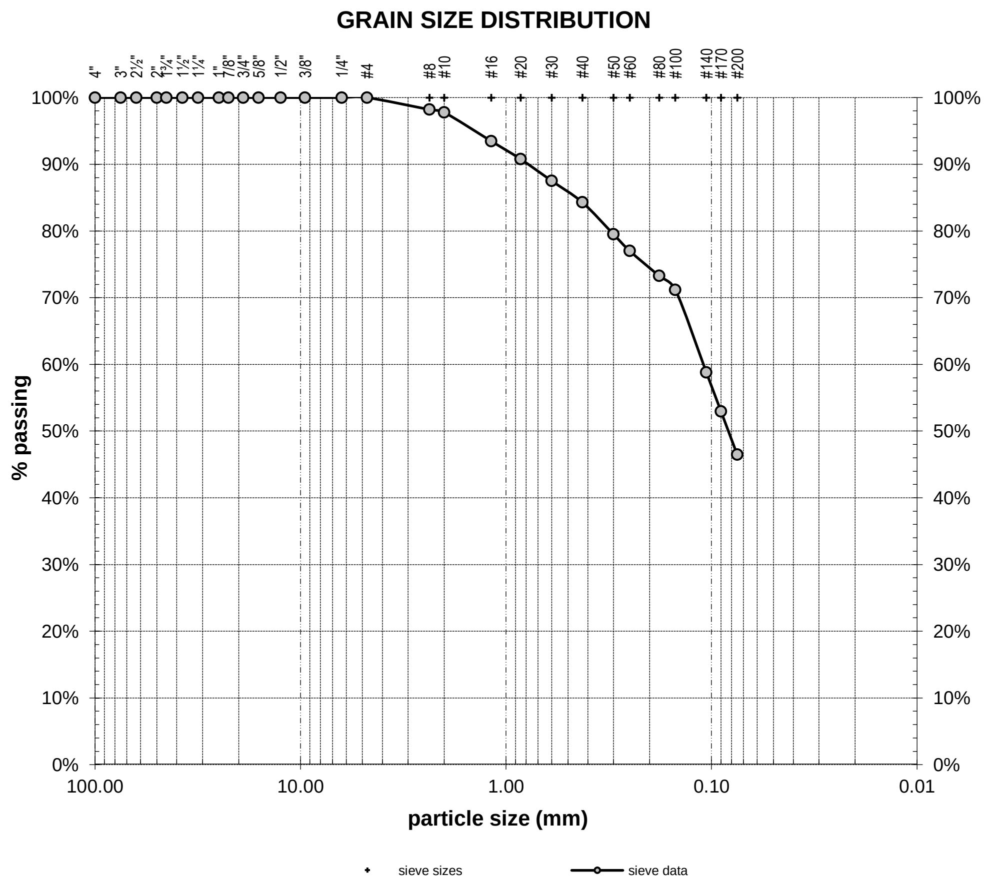
initial dry mass (g) = 207.0
as-received moisture content = 28.5%
liquid limit = 31
plastic limit = 20
plasticity index = 11
fineness modulus = n/a

coefficient of curvature, C_C = n/a
coefficient of uniformity, C_U = n/a
effective size, $D_{(10)}$ = n/a
$D_{(30)}$ = n/a
$D_{(60)}$ = 0.110 mm

SIEVE DATA

% gravel = 0.0%
% sand = 53.5%
% silt and clay = 46.5%

	SIEVE SIZE		PERCENT PASSING			
			SIEVE		SPECS	
	US	mm	act.	interp.	max	min
GRAVEL	6.00"	150.0		100.0%		
	4.00"	100.0		100.0%		
	3.00"	75.0		100.0%		
	2.50"	63.0		100.0%		
	2.00"	50.0		100.0%		
	1.75"	45.0		100.0%		
	1.50"	37.5		100.0%		
	1.25"	31.5		100.0%		
	1.00"	25.0		100.0%		
	7/8"	22.4		100.0%		
	3/4"	19.0		100.0%		
	5/8"	16.0		100.0%		
	1/2"	12.5		100.0%		
	3/8"	9.50		100.0%		
	1/4"	6.30		100.0%		
	#4	4.75	100.0%			
SAND	#8	2.36		98.2%		
	#10	2.00	97.8%			
	#16	1.18		93.5%		
	#20	0.850	90.8%			
	#30	0.600		87.5%		
	#40	0.425	84.3%			
	#50	0.300		79.5%		
	#60	0.250	77.0%			
	#80	0.180		73.3%		
	#100	0.150	71.2%			
	#140	0.106		58.8%		
	#170	0.090		53.0%		
	#200	0.075	46.5%			



DATE TESTED: 04/19/16
TESTED BY: JMR

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ATTERBERG LIMITS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Lacamas Heights Elementary School Camas, Washington	Amy Copeland Mahlum Architects, Inc. 1231 NW Hoyt Street #102 Portland, Oregon 97209	16065	S16-221
		REPORT DATE 04/21/16	FIELD ID TP8.1
		DATE SAMPLED 03/22/16	SAMPLED BY HDG

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Clayey SAND	Test Pit TP-08 depth = 2 feet	SC, Clayey Sand

LABORATORY TEST DATA

LABORATORY EQUIPMENT	TEST PROCEDURE
Liquid Limit Machine, Hand Rolled	ASTM D4318

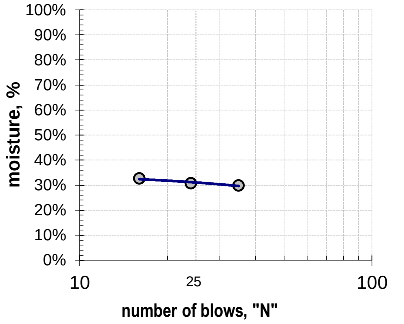
ATTERBERG LIMITS

liquid limit = 31
plastic limit = 20
plasticity index = 11

LIQUID LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	35.93	36.28	37.17	
dry soil + pan weight, g =	32.47	32.66	33.14	
pan weight, g =	20.87	20.86	20.80	
N (blows) =	35	24	16	
moisture, % =	29.8 %	30.7 %	32.7 %	

LIQUID LIMIT



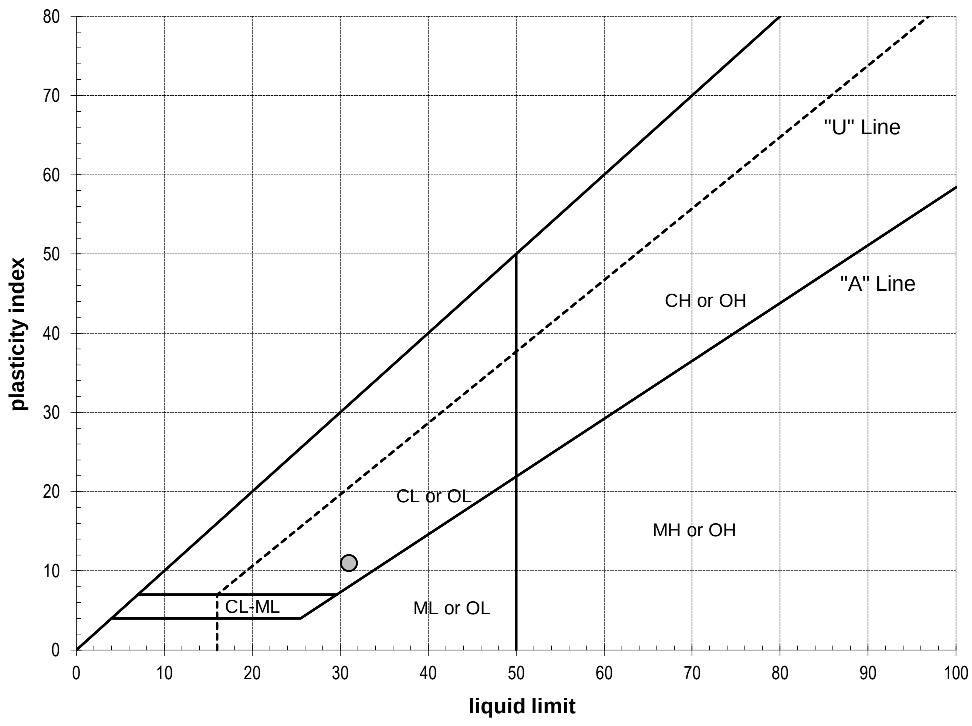
SHRINKAGE

shrinkage limit = n/a
shrinkage ratio = n/a

PLASTIC LIMIT DETERMINATION

	❶	❷	❸	❹
wet soil + pan weight, g =	27.36	27.51		
dry soil + pan weight, g =	26.25	26.38		
pan weight, g =	20.78	20.83		
moisture, % =	20.3 %	20.4 %		

PLASTICITY CHART



ADDITIONAL DATA

% gravel =	0.0%
% sand =	53.5%
% silt and clay =	46.5%
% silt =	n/a
% clay =	n/a
moisture content =	28.5%

DATE TESTED	TESTED BY
04/20/16	MJR

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PARTICLE-SIZE ANALYSIS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Lacamas Heights Elementary School Camas, Washington	Amy Copeland Mahlum Architects, Inc. 1231 NW Hoyt Street #102 Portland, Oregon 97209	16065	S16-222
		REPORT DATE	FIELD ID
		04/21/16	SB3.4
		DATE SAMPLED	SAMPLED BY
		04/15/16	HDG

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
silty sand	Soil Boring SB-03 depth = 10 feet	no data provided
SPECIFICATIONS		AASHTO SOIL TYPE
none		no data provided

LABORATORY TEST DATA

LABORATORY EQUIPMENT	TEST PROCEDURE
Rainhart "Mary Ann" Sifter 637	ASTM D6913, D422

ADDITIONAL DATA

initial dry mass (g) = 401.0
as-received moisture content = 21.6%
liquid limit = n/a
plastic limit = n/a
plasticity index = n/a
fineness modulus = n/a

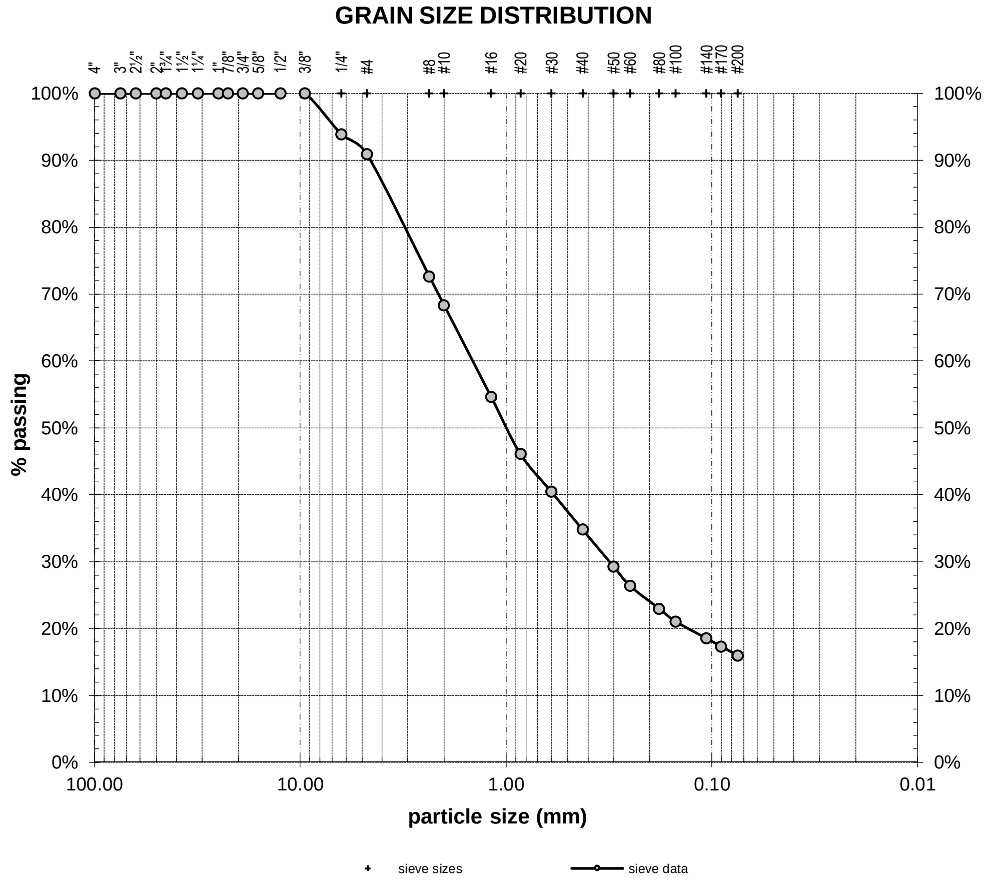
coefficient of curvature, C_C = n/a
coefficient of uniformity, C_U = n/a
effective size, $D_{(10)}$ = n/a
$D_{(30)}$ = 0.314 mm
$D_{(60)}$ = 1.451 mm

NOTE: Entire sample used for analysis.

SIEVE DATA

% gravel = 9.1%
% sand = 74.9%
% silt and clay = 16.0%

	SIEVE SIZE		PERCENT PASSING			
			SIEVE		SPECS	
	US	mm	act.	interp.	max	min
GRAVEL	6.00"	150.0		100.0%		
	4.00"	100.0		100.0%		
	3.00"	75.0		100.0%		
	2.50"	63.0		100.0%		
	2.00"	50.0		100.0%		
	1.75"	45.0		100.0%		
	1.50"	37.5		100.0%		
	1.25"	31.5		100.0%		
	1.00"	25.0		100.0%		
	7/8"	22.4		100.0%		
	3/4"	19.0		100.0%		
	5/8"	16.0		100.0%		
	1/2"	12.5		100.0%		
	3/8"	9.50	100.0%			
	1/4"	6.30	93.9%			
	#4	4.75	90.9%			
SAND	#8	2.36		72.7%		
	#10	2.00	68.4%			
	#16	1.18		54.6%		
	#20	0.850	46.1%			
	#30	0.600		40.4%		
	#40	0.425	34.8%			
	#50	0.300		29.3%		
	#60	0.250	26.4%			
	#80	0.180		23.0%		
	#100	0.150	21.1%			
	#140	0.106		18.5%		
	#170	0.090		17.3%		
	#200	0.075	16.0%			



DATE TESTED	TESTED BY
04/18/16	JMR

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PARTICLE-SIZE ANALYSIS REPORT

PROJECT	CLIENT	PROJECT NO.	LAB ID
Lacamas Heights Elementary School Camas, Washington	Amy Copeland Mahlum Architects, Inc. 1231 NW Hoyt Street #102 Portland, Oregon 97209	16065	S16-223
		REPORT DATE 04/21/16	FIELD ID SB4.5
		DATE SAMPLED 04/15/16	SAMPLED BY HDG

MATERIAL DATA

MATERIAL SAMPLED	MATERIAL SOURCE	USCS SOIL TYPE
Silty SAND with Gravel	Soil Boring SB-04 depth = 15 feet	SM, Silty Sand with Gravel

SPECIFICATIONS	AASHTO SOIL TYPE
none	no data provided

LABORATORY TEST DATA

LABORATORY EQUIPMENT	TEST PROCEDURE
Rainhart "Mary Ann" Sifter 637	ASTM D6913, D422

ADDITIONAL DATA

initial dry mass (g) = 309.0
as-received moisture content = 27.4%
liquid limit = 0
plastic limit = 0
plasticity index = 0
fineness modulus = n/a

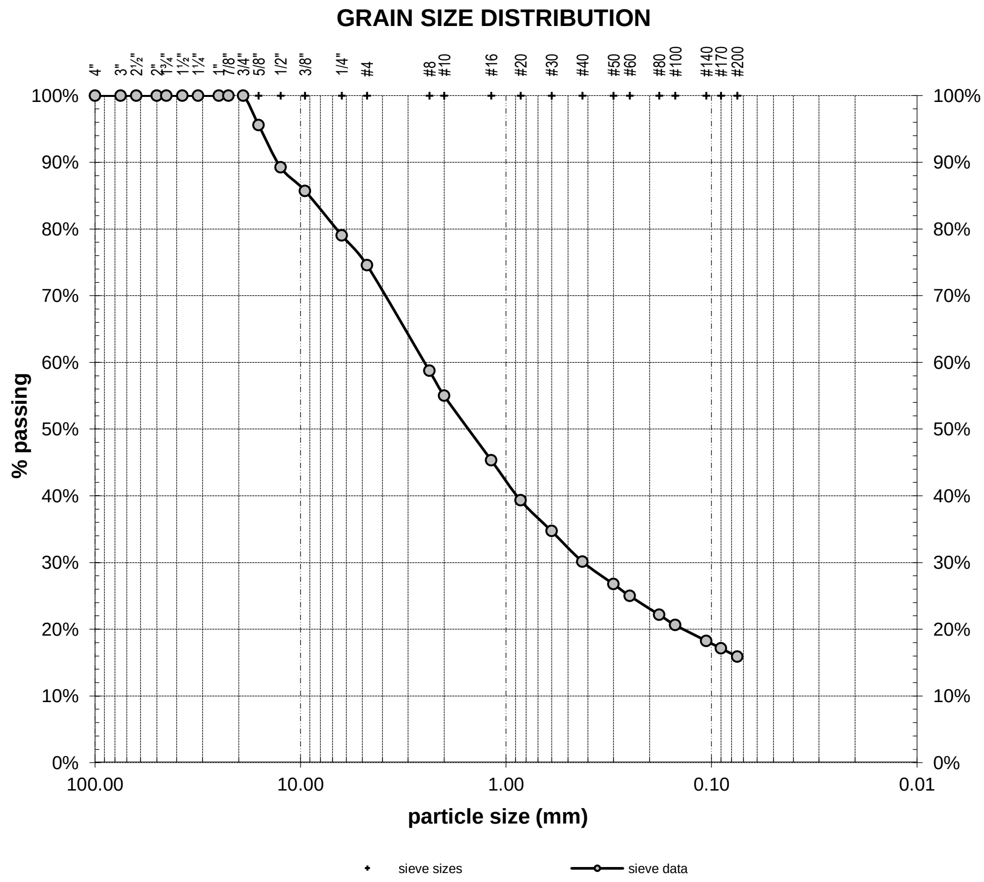
coefficient of curvature, C_C = n/a
coefficient of uniformity, C_U = n/a
effective size, $D_{(10)}$ = n/a
$D_{(30)}$ = 0.419 mm
$D_{(60)}$ = 2.496 mm

NOTE: Entire sample used for analysis.

SIEVE DATA

% gravel = 25.4%
% sand = 58.7%
% silt and clay = 15.9%

	SIEVE SIZE		PERCENT PASSING			
			SIEVE		SPECS	
	US	mm	act.	interp.	max	min
GRAVEL	6.00"	150.0		100.0%		
	4.00"	100.0		100.0%		
	3.00"	75.0		100.0%		
	2.50"	63.0		100.0%		
	2.00"	50.0		100.0%		
	1.75"	45.0		100.0%		
	1.50"	37.5		100.0%		
	1.25"	31.5		100.0%		
	1.00"	25.0		100.0%		
	7/8"	22.4		100.0%		
	3/4"	19.0	100.0%			
	5/8"	16.0		95.6%		
	1/2"	12.5	89.3%			
	3/8"	9.50	85.7%			
	1/4"	6.30	79.0%			
	#4	4.75	74.6%			
SAND	#8	2.36		58.7%		
	#10	2.00	55.0%			
	#16	1.18		45.3%		
	#20	0.850	39.3%			
	#30	0.600		34.7%		
	#40	0.425	30.1%			
	#50	0.300		26.8%		
	#60	0.250	25.0%			
	#80	0.180		22.2%		
	#100	0.150	20.6%			
	#140	0.106		18.2%		
	#170	0.090		17.1%		
	#200	0.075	15.9%			



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APPENDIX B
SUBSURFACE EXPLORATION LOGS

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HAND AUGER LOG

PROJECT NAME Lacamas Elementary School	CLIENT Mahlum Architects, Inc.		PROJECT NO. 16065	TEST PIT NO. HA-1
PROJECT LOCATION Camas, Washington	CONTRACTOR Columbia West	EQUIPMENT Hand Auger	ENGINEER HDG	DATE 3/22/16
TEST PIT LOCATION See Figure 2	APPROX. SURFACE ELEVATION 264 ft amsl	GROUNDWATER DEPTH 4 feet bgs	START TIME 0845	FINISH TIME 0945

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 6 to 8 inches of grass and topsoil.					
				SC		Brown clayey SAND, moist, medium dense, low plasticity. [Soil Type 1]					
						Fines decreasing with depth.					
▼		Lauren gravelly loam		SM		Brown-orange to yellow-black silty SAND, moist to wet, medium dense to dense, medium to coarse textured sand, trace subrounded to rounded gravels observed. [Soil Type 2]					
5											
						Bottom of hand auger at 8.0 feet. Groundwater encountered at 4.0 feet. Exploration refusal from gravel formation.					
10											

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HAND AUGER LOG

PROJECT NAME Lacamas Elementary School	CLIENT Mahlum Architects, Inc.	PROJECT NO. 16065	TEST PIT NO. HA-2
PROJECT LOCATION Camas, Washington	CONTRACTOR Columbia West EQUIPMENT Hand Auger	ENGINEER HDG	DATE 3/22/16
TEST PIT LOCATION See Figure 2	APPROX. SURFACE ELEVATION 278 ft amsl GROUNDWATER DEPTH not encountered	START TIME 0955	FINISH TIME 1035

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 6 to 8 inches of grass and topsoil.					
				SC	▨	Brown clayey SAND, moist, medium dense, low plasticity. [Soil Type 1]					
		Lauren gravelly loam		SM	▥	Brown-orange to yellow-black silty SAND, moist to wet, medium dense to dense, medium to coarse textured sand, trace subrounded to rounded gravels observed. [Soil Type 2] Fines decreasing with depth.					
5						Bottom of hand auger at 4.5 feet. Groundwater not encountered. Exploration refusal from gravel formation.					
10											

HAND AUGER LOG

PROJECT NAME Lacamas Elementary School	CLIENT Mahlum Architects, Inc.		PROJECT NO. 16065	TEST PIT NO. HA-3
PROJECT LOCATION Camas, Washington	CONTRACTOR Columbia West	EQUIPMENT Hand Auger	ENGINEER HDG	DATE 3/22/16
TEST PIT LOCATION See Figure 2	APPROX. SURFACE ELEVATION 270 ft amsl	GROUNDWATER DEPTH not encountered	START TIME 1040	FINISH TIME 1130

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0				TS		Approximately 6 to 8 inches of grass and topsoil.					
				SC	▨	Brown clayey SAND, moist, medium dense, low plasticity. [Soil Type 1] Fines decreasing with depth.					
		Lauren gravelly loam		SM	▥	Brown-orange to yellow-black silty SAND, moist to wet, medium dense to dense, medium to coarse textured sand, trace subrounded to rounded gravels observed. [Soil Type 2]					
						Bottom of hand auger at 3.0 feet. Groundwater not encountered. Exploration refusal from gravel formation.					
5											
10											

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HAND AUGER LOG

PROJECT NAME Lacamas Elementary School	CLIENT Mahlum Architects, Inc.		PROJECT NO. 16065	TEST PIT NO. HA-4
PROJECT LOCATION Camas, Washington	CONTRACTOR Columbia West	EQUIPMENT Hand Auger	ENGINEER HDG	DATE 3/22/16
TEST PIT LOCATION See Figure 2	APPROX. SURFACE ELEVATION 264 ft amsl	GROUNDWATER DEPTH not encountered	START TIME 1135	FINISH TIME 1205

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0					▒	Approximately 6 to 8 inches of grass and topsoil.					
				SC	▨	Brown clayey SAND, moist, medium dense, low plasticity. [Soil Type 1]					
		Lauren gravelly loam		SM	▥	Brown-orange to yellow-black silty SAND, moist to wet, medium dense to dense, medium to coarse textured sand, trace subrounded to rounded gravels observed. [Soil Type 2] Fines decreasing with depth.					
5						Bottom of hand auger at 4.0 feet. Groundwater not encountered. Exploration refusal from gravel formation.					
10											

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HAND AUGER LOG

PROJECT NAME: Lacamas Elementary School
CLIENT: Mahlum Architects, Inc.
PROJECT NO.: 16065
TEST PIT NO.: HA-5
PROJECT LOCATION: Camas, Washington
CONTRACTOR: Columbia West
EQUIPMENT: Hand Auger
ENGINEER: HDG
DATE: 3/22/16
TEST PIT LOCATION: See Figure 2
APPROX. SURFACE ELEVATION: 266 ft amsl
GROUNDWATER DEPTH: 7 feet bgs
START TIME: 1210
FINISH TIME: 1255

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 6 to 8 inches of grass and topsoil.					
				SC	▨	Brown clayey SAND, moist, medium dense, low plasticity. [Soil Type 1]					
		Lauren gravelly loam		SM	▥	Brown-orange to yellow-black silty SAND, moist to wet, medium dense to dense, medium to coarse textured sand, trace subrounded to rounded gravels observed. [Soil Type 2]					
5						Fines decreasing with depth.					
▼											
						Bottom of hand auger at 7.5 feet. Groundwater encountered at 7.0 feet. Exploration refusal from gravel formation.					
10											

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TEST PIT LOG

PROJECT NAME Lacamas Elementary School	CLIENT Mahlum Architects, Inc.		PROJECT NO. 16065	TEST PIT NO. TP-1
PROJECT LOCATION Camas, Washington	CONTRACTOR L&S Contractors	EQUIPMENT Excavator	ENGINEER HDG	DATE 3/22/16
TEST PIT LOCATION See Figure 2	APPROX. SURFACE ELEVATION 248 ft amsl	GROUNDWATER DEPTH 8.5 feet bgs	START TIME 0815	FINISH TIME 1150

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 6 to 8 inches of grass and topsoil.					
				SC	▨	Brown clayey SAND, moist, medium dense, low plasticity. [Soil Type 1]					IT-1.1 Depth = 2.0 ft k = 0.2 in/hr
5	TP1.2	Lauren gravelly loam	A-2-4(0)	SM	⁞	Brown-orange to yellow-black silty SAND, moist to wet, medium dense to dense, medium to coarse textured sand, trace subrounded to rounded gravels observed. [Soil Type 2] Roots observed to 5.0 feet below ground surface. Light cementation observed. Gravel content increasing with depth.	28.6	14.3	0	0	IT-1.2 Depth = 5.0 ft k = 5.9 in/hr
▼						Bottom of test pit at 8.5 feet. Groundwater encountered at 8.5 feet.					
10											

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TEST PIT LOG

PROJECT NAME Lacamas Elementary School	CLIENT Mahlum Architects, Inc.		PROJECT NO. 16065	TEST PIT NO. TP-2
PROJECT LOCATION Camas, Washington	CONTRACTOR L&S Contractors	EQUIPMENT Excavator	ENGINEER HDG	DATE 3/22/16
TEST PIT LOCATION See Figure 2	APPROX. SURFACE ELEVATION 234 ft amsl	GROUNDWATER DEPTH 8 feet bgs	START TIME 0845	FINISH TIME 1150

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 6 to 8 inches of grass and topsoil.					
				SC		Brown clayey SAND, moist, medium dense, low plasticity. [Soil Type 1]					
5		Lauren gravelly loam		SM		Brown-orange to yellow-black silty SAND, moist to wet, medium dense to dense, medium to coarse textured sand, trace subrounded to rounded gravels observed. [Soil Type 2] Fines decreasing with depth. Light cementation observed.					IT-2 Depth = 5.0 ft k = 0.2 in/hr
▼						Bottom of test pit at 8.0 feet. Groundwater encountered at 8.0 feet.					
10											

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TEST PIT LOG

PROJECT NAME Lacamas Elementary School	CLIENT Mahlum Architects, Inc.		PROJECT NO. 16065	TEST PIT NO. TP-3
PROJECT LOCATION Camas, Washington	CONTRACTOR L&S Contractors	EQUIPMENT Excavator	ENGINEER HDG	DATE 3/22/16
TEST PIT LOCATION See Figure 2	APPROX. SURFACE ELEVATION 234 ft amsl	GROUNDWATER DEPTH 7.5 feet bgs	START TIME 0910	FINISH TIME 0950

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 6 to 8 inches of grass and topsoil.					
				SC		Brown clayey SAND, moist, medium dense, low plasticity. [Soil Type 1]					
5		Lauren gravelly loam		SM		Brown-orange to yellow-black silty SAND, moist to wet, medium dense to dense, medium to coarse textured sand, trace subrounded to rounded gravels observed. [Soil Type 2] Light cementation observed. Difficult excavation.					
▼						Varicolored, weathered to competent CONGLOMERATE of subrounded to subangular gravels in a cemented matrix of sand, silt, and clay. Soils may represent the Pleistocene to Pliocene Unnamed Conglomerate member (QTc), Evarts, 2006; described as unconsolidated to consolidated, clast-supported, well-sorted gravels of igneous, metamorphic, and sedimentary composition. [Soil Type 3]					
						Bottom of test pit at 7.5 feet. Groundwater encountered at 7.5 feet.					
10											

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TEST PIT LOG

PROJECT NAME Lacamas Elementary School	CLIENT Mahlum Architects, Inc.	PROJECT NO. 16065	TEST PIT NO. TP-4
PROJECT LOCATION Camas, Washington	CONTRACTOR L&S Contractors	EQUIPMENT Excavator	ENGINEER HDG
			DATE 3/22/16
TEST PIT LOCATION See Figure 2	APPROX. SURFACE ELEVATION 270 ft amsl	GROUNDWATER DEPTH 6 feet bgs	START TIME 1010
			FINISH TIME 1110

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 6 to 8 inches of grass and topsoil.					
				SC		Brown clayey SAND, moist, medium dense, low plasticity. [Soil Type 1] Fines decreasing with depth.					IT-4 Depth = 2.5 ft k = 5.7 in/hr
5		Lauren loam		SM		Brown-orange to yellow-black silty SAND, moist to wet, medium dense to dense, medium to coarse textured sand, trace subrounded to rounded gravels observed. [Soil Type 2]					
▼						Bottom of test pit at 6.0 feet. Groundwater encountered at 6.0 feet.					
10											

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TEST PIT LOG

PROJECT NAME: Lacamas Elementary School
CLIENT: Mahlum Architects, Inc.
PROJECT NO.: 16065
TEST PIT NO.: TP-5
PROJECT LOCATION: Camas, Washington
CONTRACTOR: L&S Contractors
EQUIPMENT: Excavator
ENGINEER: HDG
DATE: 3/22/16
TEST PIT LOCATION: See Figure 2
APPROX. SURFACE ELEVATION: 270 ft amsl
GROUNDWATER DEPTH: 3 feet bgs
START TIME: 1100
FINISH TIME: 1120

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 6 to 8 inches of grass and topsoil.					
				SC		Brown clayey SAND, moist, medium dense, low plasticity. [Soil Type 1]					
		Lauren loam		SM		Brown-orange to yellow-black silty SAND, moist to wet, medium dense to dense, medium to coarse textured sand, trace subrounded to rounded gravels observed. [Soil Type 2]					
▼											
						Gravel content increasing with depth.					
5						Light cementation observed.					
						Subrounded to rounded gravels observed.					
						Bottom of test pit at 7.0 feet. Groundwater encountered at 3.0 feet.					
10											

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TEST PIT LOG

PROJECT NAME Lacamas Elementary School	CLIENT Mahlum Architects, Inc.		PROJECT NO. 16065	TEST PIT NO. TP-6
PROJECT LOCATION Camas, Washington	CONTRACTOR L&S Contractors	EQUIPMENT Excavator	ENGINEER HDG	DATE 3/22/16
TEST PIT LOCATION See Figure 2	APPROX. SURFACE ELEVATION 272 ft amsl	GROUNDWATER DEPTH 5 feet bgs	START TIME 1125	FINISH TIME 1145

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0					⁘	Approximately 6 to 8 inches of grass and topsoil.					
				SC	▨	Brown clayey SAND, moist, medium dense, low plasticity. [Soil Type 1] Fines decreasing with depth.					
		Lauren loam		SM	▥	Brown-orange to yellow-black silty SAND, moist to wet, medium dense to dense, medium to coarse textured sand, trace subrounded to rounded gravels observed. [Soil Type 2]					
▼ 5											
						Bottom of test pit at 6.0 feet. Groundwater encountered at 5.0 feet.					
10											

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TEST PIT LOG

PROJECT NAME Lacamas Elementary School	CLIENT Mahlum Architects, Inc.		PROJECT NO. 16065	TEST PIT NO. TP-7
PROJECT LOCATION Camas, Washington	CONTRACTOR L&S Contractors	EQUIPMENT Excavator	ENGINEER HDG	DATE 3/22/16
TEST PIT LOCATION See Figure 2	APPROX. SURFACE ELEVATION 270 ft amsl	GROUNDWATER DEPTH 5.5 feet bgs	START TIME 1150	FINISH TIME 1205

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 6 to 8 inches of grass and topsoil.					
				SC		Brown clayey SAND, moist, medium dense, low plasticity. [Soil Type 1]					
						Fines decreasing with depth.					
		Lauren loam		SM		Brown-orange to yellow-black silty SAND, moist to wet, medium dense to dense, medium to coarse textured sand, trace subrounded to rounded gravels observed. [Soil Type 2]					
5											
▼											
						Bottom of test pit at 6.0 feet. Groundwater encountered at 5.5 feet.					
10											

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TEST PIT LOG

PROJECT NAME Lacamas Elementary School	CLIENT Mahlum Architects, Inc.		PROJECT NO. 16065	TEST PIT NO. TP-8
PROJECT LOCATION Camas, Washington	CONTRACTOR L&S Contractors	EQUIPMENT Excavator	ENGINEER HDG	DATE 3/22/16
TEST PIT LOCATION See Figure 2	APPROX. SURFACE ELEVATION 270 ft amsl	GROUNDWATER DEPTH 4.5 feet bgs	START TIME 1210	FINISH TIME 1345

Depth (feet)	Sample Field ID	SCS Soil Survey Description	AASHTO Soil Type	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index	Infiltration Testing
0						Approximately 8 inches of grass and topsoil.					
	TP8.1		A-6(2)	SC	▨	Brown clayey SAND, moist, medium dense, low plasticity. [Soil Type 1]	28.5	46.5	31	11	IT-8 Depth = 2.0 ft k = 0.1 in/hr
▼											
5						Bottom of test pit at 4.5 feet. Groundwater encountered at 4.5 feet.					
10											

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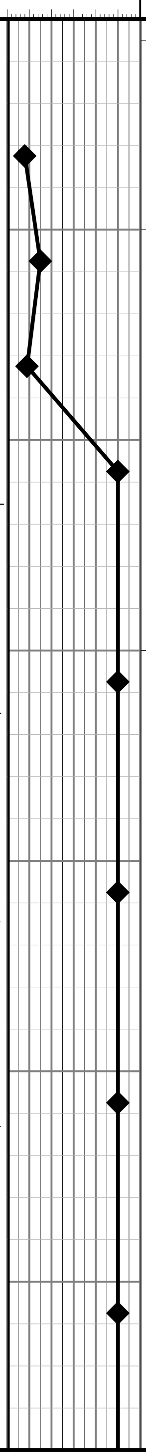
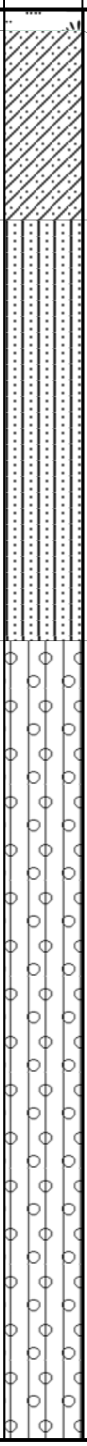
SOIL BORING LOG

PROJECT NAME Lacamas Elementary School	CLIENT Mahlum Architects, Inc.		PROJECT NO. 16065	BORING NO. SB-1
PROJECT LOCATION Camas, Washington	DRILLING CONTRACTOR Subsurface Technologies	DRILL RIG Deitrich D-50	ENGINEER/GEOLOGIST HDG	PAGE NO. 1 of 2
BORING LOCATION See Figure 2	DRILLING METHOD mud-rotary	SAMPLING METHOD SPT	START DATE 4/14/16	START TIME 1200
REMARKS none	APPROX. SURFACE ELEVATION 270 ft amsl	GROUNDWATER DEPTH N/A	FINISH DATE 4/14/16	FINISH TIME 1630

Depth (ft)	Elevation (ft amsl)	Field ID + Sample Type	SPT N-value (uncorrected)	USCS Soil Type	LITHOLOGIC DESCRIPTION AND REMARKS
0					Approximately 6 to 8 inches of grass and topsoil.
				SC	Brown clayey SAND, moist, medium dense, low plasticity. [Soil Type 1]
2	268				
		SPT SB-1.1	8		
4					
		SPT SB-1.2	15	SM	Brown-orange to yellow-black silty SAND, moist to wet, medium dense to dense, medium to coarse textured sand, trace subrounded to rounded gravels observed. [Soil Type 2]
6	264				
8		SPT SB-1.3	9		Gravel content increasing with depth.
10	260	SPT SB-1.4	50 REFUSAL 5"		Gravel content increasing with depth.
12					
14	256				[rig chatter]
		SPT SB-1.5	50 REFUSAL 4"		Varicolored, weathered to competent CONGLOMERATE of subrounded to subangular gravels in a cemented matrix of sand, silt, and clay. Soils may represent the Pleistocene to Pliocene Unnamed Conglomerate member (QTc), Evarts, 2006; described as unconsolidated to consolidated, clast-supported, well-sorted gravels of igneous, metamorphic, and sedimentary composition. [Soil Type 3]
16					
18	252				
20		SPT SB-1.6	50 REFUSAL 1"		
22	248				
24					[very slow drilling]
		SPT SB-1.7	50 REFUSAL 3"		
26	244				
28					
30	240	SPT SB-1.8	50 REFUSAL 1"		
32					
34	236				





laboratory soil properties (by symbol)	Moisture Content (%)	Passing No. 200 Sieve (%)	Liquid Limit	Plasticity Index
25 50 75	✕	✚	●	○

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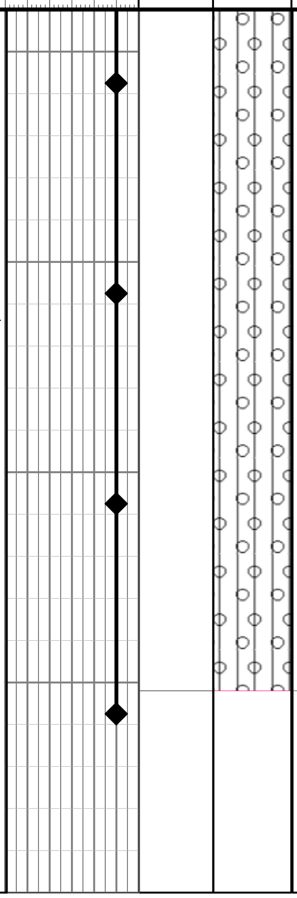
SOIL BORING LOG

PROJECT NAME Lacamas Elementary School	CLIENT Mahlum Architects, Inc.		PROJECT NO. 16065	BORING NO. SB-1
PROJECT LOCATION Camas, Washington	DRILLING CONTRACTOR Subsurface Technologies	DRILL RIG Deitrich D-50	ENGINEER/GEOLOGIST HDG	PAGE NO. 2 of 2
BORING LOCATION See Figure 2	DRILLING METHOD mud-rotary	SAMPLING METHOD SPT	START DATE 4/14/16	START TIME 1200
REMARKS none	APPROX. SURFACE ELEVATION 270 ft amsl	GROUNDWATER DEPTH N/A	FINISH DATE 4/14/16	FINISH TIME 1630



Depth (ft)	Elevation (ft amsl)	Field ID + Sample Type	SPT N-value (uncorrected) 0 10 20 30 40 50	USCS Soil Type	Graphic Log	LITHOLOGIC DESCRIPTION AND REMARKS	laboratory soil properties (by symbol) 25 50 75	Moisture Content (%) ✕	Passing No. 200 Sieve (%) ✚	Liquid Limit ●	Plasticity Index ○
34	236					[very slow drilling]					
36		SPT SB-1.9	50 REFUSAL 2"								
38	232										
40		SPT SB-1.10	50 REFUSAL 3"			[fine textured drilling spoils and rig chatter may indicate boulder presence]					
42	228										
44											
46	224	SPT SB-1.11	50 REFUSAL 2"								
48											
50	220	SPT SB-1.12	50 REFUSAL 1"			Soil boring terminated at 50.2 ft bgs. Groundwater not observed due to mud rotary drilling conditions.					
52											
54	216										

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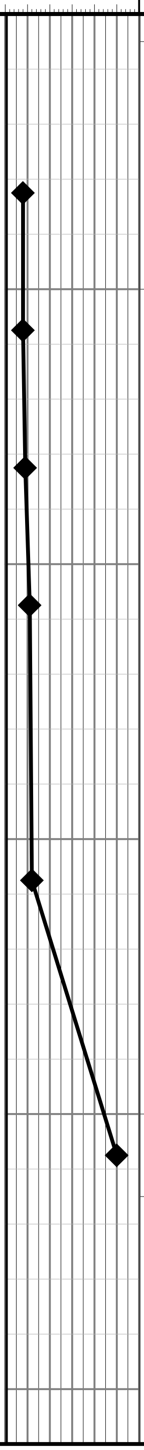
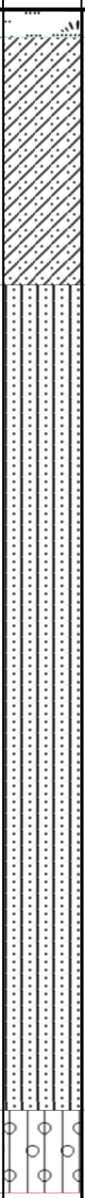
SOIL BORING LOG

PROJECT NAME Lacamas Elementary School	CLIENT Mahlum Architects, Inc.		PROJECT NO. 16065	BORING NO. SB-2
PROJECT LOCATION Camas, Washington	DRILLING CONTRACTOR Subsurface Technologies	DRILL RIG Deitrich D-50	ENGINEER/GEOLOGIST HDG	PAGE NO. 1 of 1
BORING LOCATION See Figure 2	DRILLING METHOD mud-rotary	SAMPLING METHOD SPT	START DATE 4/15/16	START TIME 0845
REMARKS none	APPROX. SURFACE ELEVATION 270 ft amsl	GROUNDWATER DEPTH N/A	FINISH DATE 4/15/16	FINISH TIME 0950





Depth (ft)	Elevation (ft amsl)	Field ID + Sample Type	SPT N-value (uncorrected)	USCS Soil Type	LITHOLOGIC DESCRIPTION AND REMARKS	laboratory soil properties (by symbol) 25 50 75	Moisture Content (%) ✕	Passing No. 200 Sieve (%) ✚	Liquid Limit ●	Plasticity Index ○
0	270				Approximately 6 to 8 inches of grass and topsoil.					
				SC	Brown clayey SAND, moist, medium dense, low plasticity. [Soil Type 1]					
2	268									
		SPT SB-2.1	8							
4	266									
		SPT SB-2.2	8	SM	Brown-orange to yellow-black silty SAND, moist to wet, medium dense to dense, medium to coarse textured sand, trace subrounded to rounded gravels observed. [Soil Type 2]					
6	264									
8	262	SPT SB-2.3	9		Gravel content increasing with depth.					
10	260	SPT SB-2.4	11		Gravel spoils observed in drill cuttings.					
12	258									
					[rig chatter]					
14	256									
		SPT SB-2.5	12							
16	254				Gravel content increasing with depth.					
18	252									
					[very slow drilling]					
20	250	SPT SB-2.6	50 REFUSAL 2"		Varicolored, weathered to competent CONGLOMERATE of subrounded to subangular gravels in a cemented matrix of sand, silt, and clay. Soils may represent the Pleistocene to Pliocene Unnamed Conglomerate member (QTc), Evarts, 2006; described as unconsolidated to consolidated, clast-supported, well-sorted gravels of igneous, metamorphic, and sedimentary composition. [Soil Type 3]					
22	248									
24	246				Soil boring terminated at 20.2 ft bgs. Groundwater not observed due to mud rotary drilling conditions.					
26	244									

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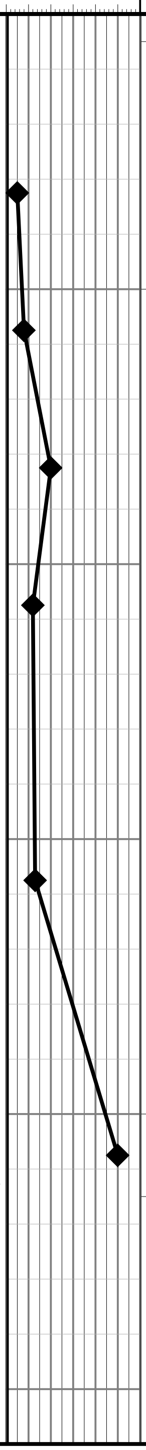
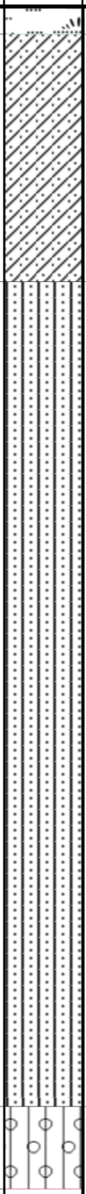
SOIL BORING LOG

PROJECT NAME Lacamas Elementary School	CLIENT Mahlum Architects, Inc.		PROJECT NO. 16065	BORING NO. SB-3
PROJECT LOCATION Camas, Washington	DRILLING CONTRACTOR Subsurface Technologies	DRILL RIG Deitrich D-50	ENGINEER/GEOLOGIST HDG	PAGE NO. 1 of 1
BORING LOCATION See Figure 2	DRILLING METHOD mud-rotary	SAMPLING METHOD SPT	START DATE 4/15/16	START TIME 1000
REMARKS none	APPROX. SURFACE ELEVATION 266 ft amsl	GROUNDWATER DEPTH N/A	FINISH DATE 4/15/16	FINISH TIME 1050





Depth (ft)	Elevation (ft amsl)	Field ID + Sample Type	SPT N-value (uncorrected)	USCS Soil Type	LITHOLOGIC DESCRIPTION AND REMARKS	laboratory soil properties (by symbol)	Moisture Content (%) ✕	Passing No. 200 Sieve (%) ✚	Liquid Limit ●	Plasticity Index ○
0	266				Approximately 6 to 8 inches of grass and topsoil.					
				SC	Brown clayey SAND, moist, medium dense, low plasticity. [Soil Type 1]					
2	264									
		SPT SB-3.1	5							
4	262									
				SM	Brown-orange to yellow-black silty SAND, moist to wet, medium dense to dense, medium to coarse textured sand, trace subrounded to rounded gravels observed. [Soil Type 2]					
		SPT SB-3.2	8							
6	260									
8	258	SPT SB-3.3	20							
10	256									
		SPT SB-3.4	12			✚✕	21.6	16		
12	254									
14	252									
					Gravel spoils observed in drill cuttings.					
		SPT SB-3.5	13							
16	250				Gravel content increasing with depth.					
18	248				[rig chatter]					
					[very slow drilling]					
20	246				Varicolored, weathered to competent CONGLOMERATE of subrounded to subangular gravels in a cemented matrix of sand, silt, and clay. Soils may represent the Pleistocene to Pliocene Unnamed Conglomerate member (QTc), Evarts, 2006; described as unconsolidated to consolidated, clast-supported, well-sorted gravels of igneous, metamorphic, and sedimentary composition. [Soil Type 3]					
		SPT SB-3.6	50 REFUSAL 3"							
22	244									
24	242				Soil boring terminated at 20.3 ft bgs. Groundwater not observed due to mud rotary drilling conditions.					
26	240									

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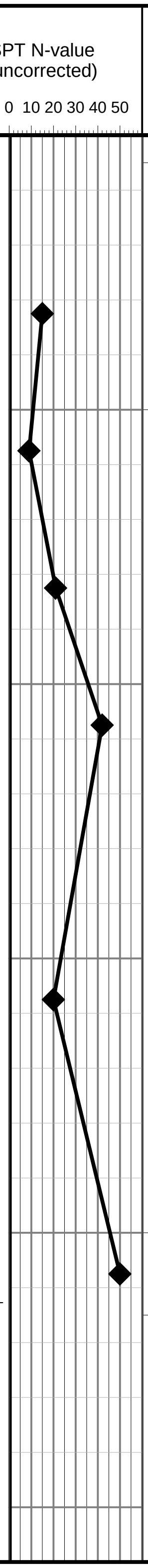
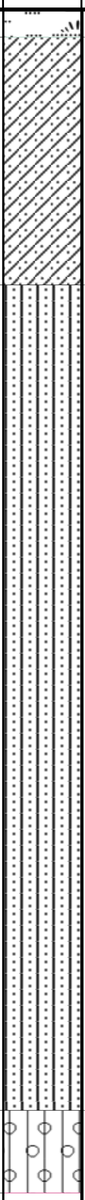
SOIL BORING LOG

PROJECT NAME Lacamas Elementary School	CLIENT Mahlum Architects, Inc.		PROJECT NO. 16065	BORING NO. SB-4
PROJECT LOCATION Camas, Washington	DRILLING CONTRACTOR Subsurface Technologies	DRILL RIG Deitrich D-50	ENGINEER/GEOLOGIST HDG	PAGE NO. 1 of 1
BORING LOCATION See Figure 2	DRILLING METHOD mud-rotary	SAMPLING METHOD SPT	START DATE 4/15/16	START TIME 1100
REMARKS none	APPROX. SURFACE ELEVATION 270 ft amsl	GROUNDWATER DEPTH N/A	FINISH DATE 4/15/16	FINISH TIME 1150





Depth (ft)	Elevation (ft amsl)	Field ID + Sample Type	SPT N-value (uncorrected)	USCS Soil Type	LITHOLOGIC DESCRIPTION AND REMARKS	Moisture Content (%) ✕	Passing No. 200 Sieve (%) ✚	Liquid Limit ●	Plasticity Index ○
0	270				Approximately 6 to 8 inches of grass and topsoil.				
				SC	Brown clayey SAND, moist, medium dense, low plasticity. [Soil Type 1]				
2	268	SPT SB-4.1	15						
4	266								
		SPT SB-4.2	9	SM	Brown-orange to yellow-black silty SAND, moist to wet, medium dense to dense, medium to coarse textured sand, trace subrounded to rounded gravels observed. [Soil Type 2]				
6	264								
8	262	SPT SB-4.3	21		Gravel content increasing with depth.				
10	260	SPT SB-4.4	42		[rig chatter]				
12	258				Gravel spoils observed in drill cuttings.				
14	256								
16	254	SPT SB-4.5	20			27.4	15.9		
18	252				[very slow drilling]				
20	250	SPT SB-4.6	50 REFUSAL 4"		Varicolored, weathered to competent CONGLOMERATE of subrounded to subangular gravels in a cemented matrix of sand, silt, and clay. Soils may represent the Pleistocene to Pliocene Unnamed Conglomerate member (QTc), Evarts, 2006; described as unconsolidated to consolidated, clast-supported, well-sorted gravels of igneous, metamorphic, and sedimentary composition. [Soil Type 3]				
22	248								
24	246				Soil boring terminated at 20.4 ft bgs. Groundwater not observed due to mud rotary drilling conditions.				
26	244								

laboratory soil properties (by symbol)
25 50 75

APPENDIX C
SOIL CLASSIFICATION INFORMATION

SOIL DESCRIPTION AND CLASSIFICATION GUIDELINES

Particle-Size Classification

COMPONENT	ASTM/USCS		AASHTO	
	size range	sieve size range	size range	sieve size range
Cobbles	> 75 mm	greater than 3 inches	> 75 mm	greater than 3 inches
Gravel	75 mm – 4.75 mm	3 inches to No. 4 sieve	75 mm – 2.00 mm	3 inches to No. 10 sieve
Coarse	75 mm – 19.0 mm	3 inches to 3/4-inch sieve	-	-
Fine	19.0 mm – 4.75 mm	3/4-inch to No. 4 sieve	-	-
Sand	4.75 mm – 0.075 mm	No. 4 to No. 200 sieve	2.00 mm – 0.075 mm	No. 10 to No. 200 sieve
Coarse	4.75 mm – 2.00 mm	No. 4 to No. 10 sieve	2.00 mm – 0.425 mm	No. 10 to No. 40 sieve
Medium	2.00 mm – 0.425 mm	No. 10 to No. 40 sieve	-	-
Fine	0.425 mm – 0.075 mm	No. 40 to No. 200 sieve	0.425 mm – 0.075 mm	No. 40 to No. 200 sieve
Fines (Silt and Clay)	< 0.075 mm	Passing No. 200 sieve	< 0.075 mm	Passing No. 200 sieve

Consistency for Cohesive Soil

CONSISTENCY	SPT N-VALUE (BLOWS PER FOOT)	POCKET PENETROMETER (UNCONFINED COMPRESSIVE STRENGTH, tsf)
Very Soft	2	less than 0.25
Soft	2 to 4	0.25 to 0.50
Medium Stiff	4 to 8	0.50 to 1.0
Stiff	8 to 15	1.0 to 2.0
Very Stiff	15 to 30	2.0 to 4.0
Hard	30 to 60	greater than 4.0
Very Hard	greater than 60	-

Relative Density for Granular Soil

RELATIVE DENSITY	SPT N-VALUE (BLOWS PER FOOT)
Very Loose	0 to 4
Loose	4 to 10
Medium Dense	10 to 30
Dense	30 to 50
Very Dense	more than 50

Moisture Designations

TERM	FIELD IDENTIFICATION
Dry	No moisture. Dusty or dry.
Damp	Some moisture. Cohesive soils are usually below plastic limit and are moldable.
Moist	Grains appear darkened, but no visible water is present. Cohesive soils will clump. Sand will bulk. Soils are often at or near plastic limit.
Wet	Visible water on larger grains. Sand and silt exhibit dilatancy. Cohesive soil can be readily remolded. Soil leaves wetness on the hand when squeezed. Soil is much wetter than optimum moisture content and is above plastic limit.

AASHTO SOIL CLASSIFICATION SYSTEM

TABLE 1. Classification of Soils and Soil-Aggregate Mixtures

	Granular Materials			Silt-Clay Materials			
General Classification	(35 Percent or Less Passing .075 mm)			(More than 35 Percent Passing 0.075)			
Group Classification	A-1	A-3	A-2	A-4	A-5	A-6	A-7
Sieve analysis, percent passing:							
2.00 mm (No. 10)	-	-	-				
0.425 mm (No. 40)	50 max	51 min	-	-	-	-	-
0.075 mm (No. 200)	25 max	10 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 0.425 mm (No. 40)							
Liquid limit				40 max	41 min	40 max	41 min
Plasticity index	6 max	N.P.		10 max	10 max	11 min	11 min
General rating as subgrade	Excellent to good			Fair to poor			

Note: The placing of A-3 before A-2 is necessary in the "left to right elimination process" and does not indicate superiority of A-3 over A-2.

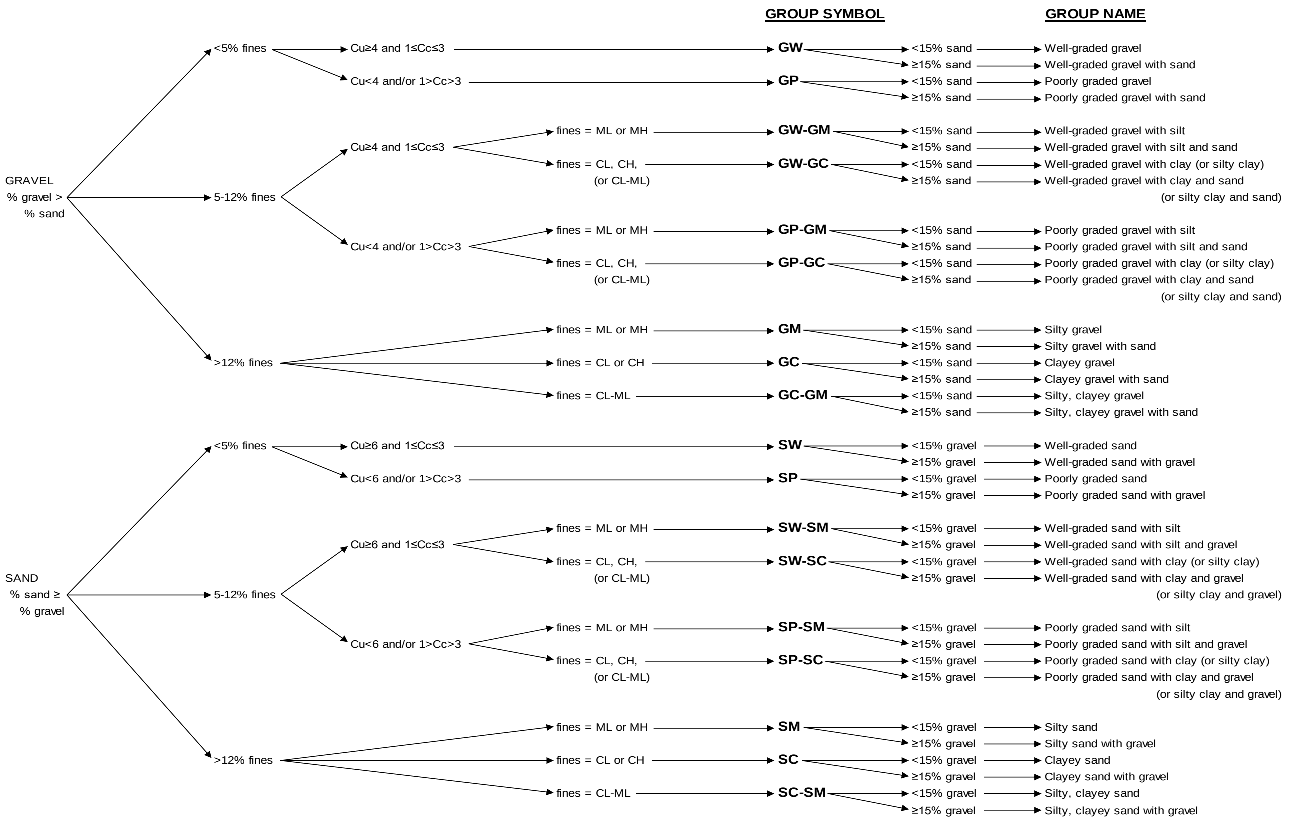
TABLE 2. Classification of Soils and Soil-Aggregate Mixtures

	Granular Materials							Silt-Clay Materials			
General Classification	(35 Percent or Less Passing 0.075 mm)							(More than 35 Percent Passing 0.075 mm)			
	A-1			A-2							A-7
Group Classification	A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6	A-2-7	A-4	A-5	A-6	A-7-5, A-7-6
Sieve analysis, percent passing:											
2.00 mm (No. 10)	50 max	-	-	-	-	-	-	-	-	-	-
0.425 mm (No. 40)	30 max	50 max	51 min	-	-	-	-	-	-	-	-
0.075 mm (No. 200)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 0.425 mm (No. 40)											
Liquid limit				40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
Plasticity index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11min
Usual types of significant constituent materials	Stone fragments, gravel and sand		Fine sand	Silty or clayey gravel and sand				Silty soils		Clayey soils	
General ratings as subgrade	Excellent to Good							Fair to poor			

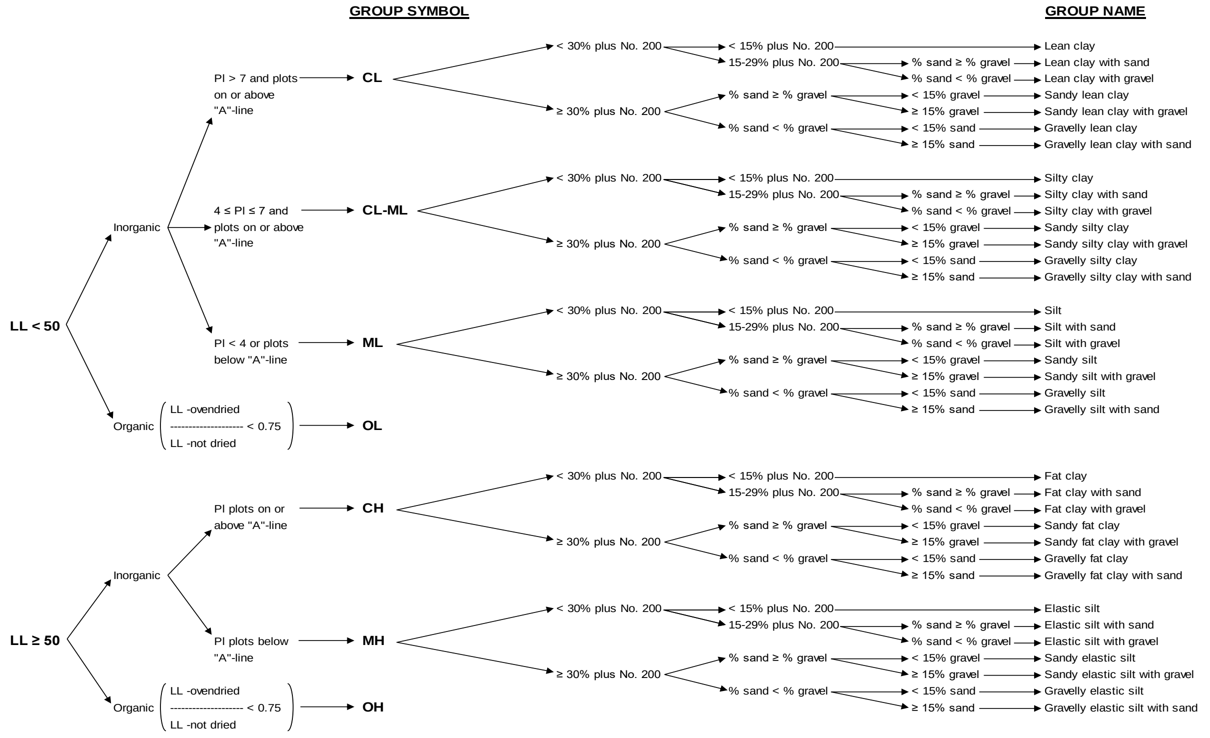
Note: Plasticity index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity index of A-7-6 subgroup is greater than LL minus 30 (see Figure 2).

AASHTO = American Association of State Highway and Transportation Officials

USCS SOIL CLASSIFICATION SYSTEM



Flow Chart for Classifying Coarse-Grained Soils (More Than 50% Retained on No. 200 Sieve)



Flow Chart for Classifying Fine-Grained Soil (50% or More Passes No. 200 Sieve)

APPENDIX D
PHOTO LOG

LACAMAS ELEMENTARY SCHOOL
CAMAS, WASHINGTON
PHOTO LOG

Site Overview, Facing Northwest from Southeast Corner

Infiltration Testing in Test Pit TP-1

LACAMAS ELEMENTARY SCHOOL
CAMAS, WASHINGTON
PHOTO LOG

Hand Auger Exploration, South Side of Site

Test Pit Exploration TP-2, Competent Gravels Observed at Groundwater Elevation

APPENDIX E
REPORT LIMITATIONS AND IMPORTANT INFORMATION

Geotechnical ■ Environmental ■ Special Inspections
Columbia West
Engineering, Inc

Date: May 4, 2015
Project: Lacamas Elementary School
Camas, Washington

Geotechnical and Environmental Report Limitations and Important Information

Report Purpose, Use, and Standard of Care

This report has been prepared in accordance with standard fundamental principles and practices of geotechnical engineering and/or environmental consulting, and in a manner consistent with the level of care and skill typical of currently practicing local engineers and consultants. This report has been prepared to meet the specific needs of specific individuals for the indicated site. It may not be adequate for use by other consultants, contractors, or engineers, or if change in project ownership has occurred. It should not be used for any other reason than its stated purpose without prior consultation with Columbia West Engineering, Inc. (Columbia West). It is a unique report and not applicable for any other site or project. If site conditions are altered, or if modifications to the project description or proposed plans are made after the date of this report, it may not be valid. Columbia West cannot accept responsibility for use of this report by other individuals for unauthorized purposes, or if problems occur resulting from changes in site conditions for which Columbia West was not aware or informed.

Report Conclusions and Preliminary Nature

This geotechnical or environmental report should be considered preliminary and summary in nature. The recommendations contained herein have been established by engineering interpretations of subsurface soils based upon conditions observed during site exploration. The exploration and associated laboratory analysis of collected representative samples identifies soil conditions at specific discreet locations. It is assumed that these conditions are indicative of actual conditions throughout the subject property. However, soil conditions may differ between tested locations at different seasonal times of the year, either by natural causes or human activity. Distinction between soil types may be more abrupt or gradual than indicated on the soil logs. This report is not intended to stand alone without understanding of concomitant instructions, correspondence, communication, or potential supplemental reports that may have been provided to the client.

Because this report is based upon observations obtained at the time of exploration, its adequacy may be compromised with time. This is particularly relevant in the case of natural disasters, earthquakes, floods, or other significant events. Report conclusions or interpretations may also be subject to revision if significant development or other manmade impacts occur within or in proximity to the subject property. Groundwater conditions, if presented in this report, reflect observed conditions at the time of investigation. These conditions may change annually, seasonally or as a result of adjacent development.

Additional Investigation and Construction QA/QC

Columbia West should be consulted prior to construction to assess whether additional investigation above and beyond that presented in this report is necessary. Even slight variations in soil or site conditions may produce impacts to the performance of structural facilities if not adequately addressed. This underscores the importance of diligent QA/QC construction observation and testing to verify soil conditions do not differ materially or significantly from the interpreted conditions utilized for preparation of this report.

Therefore, this report contains several recommendations for field observation and testing by Columbia West personnel during construction activities. Actual subsurface conditions are more readily observed and discerned during the earthwork phase of construction when soils are exposed. Columbia West cannot accept responsibility for deviations from recommendations described in this report or future performance of structural facilities if another consultant is retained during the construction phase or Columbia West is not engaged to provide construction observation to the full extent recommended.

Collected Samples

Uncontaminated samples of soil or rock collected in connection with this report will be retained for thirty days. Retention of such samples beyond thirty days will occur only at client's request and in return for payment of storage charges incurred. All contaminated or environmentally impacted materials or samples are the sole property of the client. Client maintains responsibility for proper disposal.

Report Contents

This geotechnical or environmental report should not be copied or duplicated unless in full, and even then only under prior written consent by Columbia West, as indicated in further detail in the following text section entitled *Report Ownership*. The recommendations, interpretations, and suggestions presented in this report are only understandable in context of reference to the whole report. Under no circumstances should the soil boring or test pit excavation logs, monitor well logs, or laboratory analytical reports be separated from the remainder of the report. The logs or reports should not be redrawn or summarized by other entities for inclusion in architectural or civil drawings, or other relevant applications.

Report Limitations for Contractors

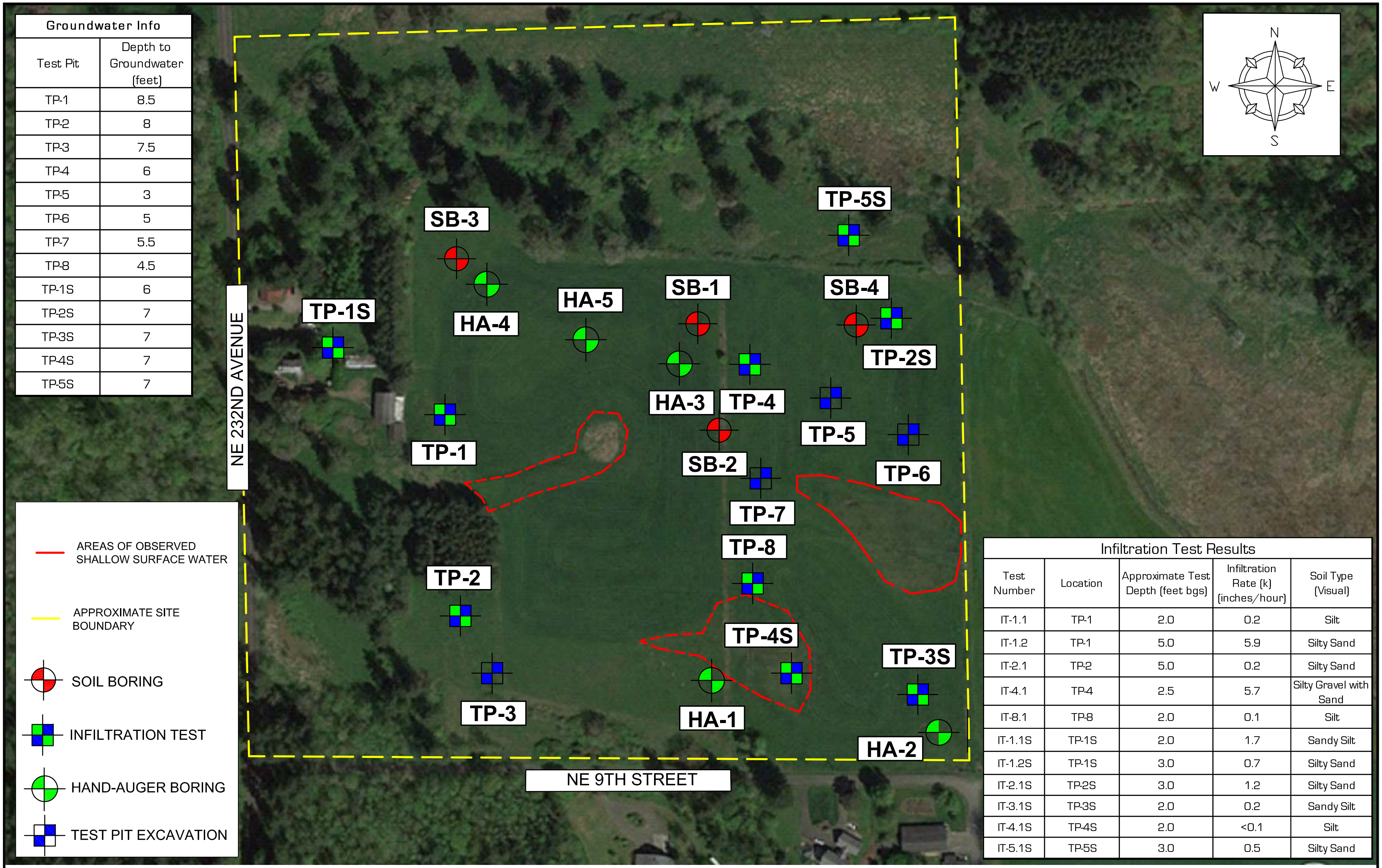
Geotechnical or environmental reports, unless otherwise specifically noted, are not prepared for the purpose of developing cost estimates or bids by contractors. The extent of exploration or investigation conducted as part of this report is usually less than that necessary for contractor's needs. Contractors should be advised of these report limitations, particularly as they relate to development of cost estimates. Contractors may gain valuable information from this report, but should rely upon their own interpretations as to how subsurface conditions may affect cost, feasibility, accessibility and other components of the project work. If believed necessary or relevant, contractors should conduct additional exploratory investigation to obtain satisfactory data for the purposes of developing adequate cost estimates. Clients or developers cannot insulate themselves from attendant liability by disclaiming accuracy for subsurface ground conditions without advising contractors appropriately and providing the best information possible to limit potential for cost overruns, construction problems, or misunderstandings.

Report Ownership

Columbia West retains the ownership and copyright property rights to this entire report and its contents, which may include, but may not be limited to, figures, text, logs, electronic media, drawings, laboratory reports, and appendices. This report was prepared solely for the client, and other relevant approved users or parties, and its distribution must be contingent upon prior express written consent by Columbia West. Furthermore, client or approved users may not use, lend, sell, copy, or distribute this document without express written consent by Columbia West. Client does not own nor have rights to electronic media files that constitute this report, and under no circumstances should said electronic files be distributed or copied. Electronic media is susceptible to unauthorized manipulation or modification, and may not be reliable.

Consultant Responsibility

Geotechnical and environmental engineering and consulting is much less exact than other scientific or engineering disciplines, and relies heavily upon experience, judgment, interpretation, and opinion often based upon media (soils) that are variable, anisotropic, and non-homogenous. This often results in unrealistic expectations, unwarranted claims, and uninformed disputes against a geotechnical or environmental consultant. To reduce potential for these problems and assist relevant parties in better understanding of risk, liability, and responsibility, geotechnical and environmental reports often provide definitive statements or clauses defining and outlining consultant responsibility. The client is encouraged to read these statements carefully and request additional information from Columbia West if necessary.



Groundwater Info

Test Pit	Depth to Groundwater (feet)
TP-1	8.5
TP-2	8
TP-3	7.5
TP-4	6
TP-5	3
TP-6	5
TP-7	5.5
TP-8	4.5
TP-1S	6
TP-2S	7
TP-3S	7
TP-4S	7
TP-5S	7

Infiltration Test Results

Test Number	Location	Approximate Test Depth (feet bgs)	Infiltration Rate (k) (inches/hour)	Soil Type (Visual)
IT-1.1	TP-1	2.0	0.2	Silt
IT-1.2	TP-1	5.0	5.9	Silty Sand
IT-2.1	TP-2	5.0	0.2	Silty Sand
IT-4.1	TP-4	2.5	5.7	Silty Gravel with Sand
IT-8.1	TP-8	2.0	0.1	Silt
IT-1.1S	TP-1S	2.0	1.7	Sandy Silt
IT-1.2S	TP-1S	3.0	0.7	Silty Sand
IT-2.1S	TP-2S	3.0	1.2	Silty Sand
IT-3.1S	TP-3S	2.0	0.2	Sandy Silt
IT-4.1S	TP-4S	2.0	<0.1	Silt
IT-5.1S	TP-5S	3.0	0.5	Silty Sand

NOTES:
1. SITE LOCATION: 1111 NE 232ND AVENUE, CAMAS, WASHINGTON.
2. SITE CONSISTS OF PARCEL 175724000 TOTALING TO APPROXIMATELY 40 ACRES.
3. DRAWING IS NOT TO SCALE.
4. BASE MAP OBTAINED FROM GOOGLE EARTH.
5. SOIL EXPLORATION LOCATIONS ARE APPROXIMATE AND NOT SURVEYED.
6. TEST PITS AND HAND AUGERS BACKFILLED LOOSELY WITH ONSITE SOILS ON MARCH 22, 2016.
7. SOIL BORINGS BACKFILLED WITH BENTONITE ON APRIL 14 AND 15, 2016.
8. SUPPLEMENTARY TEST PITS BACKFILLED LOOSELY WITH ONSITE SOILS ON OCTOBER 11, 2016.

PRELIMINARY DRAFT

Geotechnical • Environmental • Special Inspections
Columbia West
Engineering, Inc
11917 NE 95th STREET
VANCOUVER, WASHINGTON 98682
PHONE: 360-823-2900 FAX: 360-823-2901
www.columbiawestengineering.com

Design:
Checked: JLO
Client: MAHLUM
Job No: 16065
CAD File: FIGURE 2
Scale: NONE

Drawn: HDG
Date: 10/13/2016

Rev	By	Date

EXPLORATION LOCATION MAP

LACAMAS ELEMENTARY SCHOOL
CAMAS, WASHINGTON

FIGURE
2

Geotechnical ■ Environmental ■ Special Inspections
Columbia West Engineering, Inc

11917 NE 95th Street, Vancouver, Washington 98682
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TECHNICAL MEMORANDUM

DATE: November 9, 2016

TO: Amy Copeland

FROM: Jason L. Ordway, PE

RE: Soil Classification
New Lacamas Heights Elementary School
Camas, Washington
CWE WO: 16065

As requested, Columbia West Engineering, Inc. is pleased to submit this memorandum regarding soil classification for the above-referenced project located in Camas, Washington. The purpose of this memorandum is to provide soil classification information for use during stormwater facility design for the New Lacamas Heights Elementary School project. Site-specific groundwater and soil characteristics were observed while conducting subsurface exploration in proximity to proposed improvements. These observations were documented in Columbia West's site specific geotechnical report[1] dated May 4, 2016. Supplemental exploration was conducted on October 11, 2016. This memorandum is subject to limitations expressed within Columbia West's geotechnical report.

Soils observed within onsite explorations generally consisted of moist to wet, medium-dense to dense, silty or clayey SAND underlain by sedimentary conglomerate. Groundwater was encountered throughout the site at depths of approximately 3 to 8 ½ feet below ground surface. Surface water and ephemeral streams were observed at several locations. Several wetlands are mapped on the project site. Note that groundwater levels are subject to seasonal variance and may rise during extended periods of increased precipitation.

Infiltration Test Results and Soil Group Classification

To facilitate design of stormwater management infrastructure and appropriately classify site soils into representative hydrologic soil groups, Columbia West conducted in situ infiltration testing at the site. Infiltration test data is presented in Table 2. Infiltration testing results were used to help classify tested site soils into representative soil groups as defined by the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) and the locally calibrated *Western Washington Hydrology Model* (*Clark County WWHM*).

As published by USDA and presented in Table 1, USDA utilizes coefficient of permeability criteria (infiltration rates) and soil particle size to categorize tested soils into Soil Groups A through D. USDA qualitatively describes Soil Groups A through D respectively as exhibiting low, moderately low, moderately high, and high runoff potential based upon permeability characteristics. Dual classifications occur when soils exhibit increased runoff potential in a wet condition. The content of fine-textured soil increases from Soil Group A to D. Group A soils typically contain less than 10 percent clay whereas Group D soils typically have greater than 40 percent clay. As indicated in Table 1, USDA also considers groundwater elevations and depth to impermeable layers as factors relevant to classifying soils into an appropriate hydrologic soil group.

---

[1] Columbia West Engineering, Inc., Geotechnical Site Investigation, Lacamas Elementary School, Camas, Washington, May 4, 2016.

Table 1. USDA Criteria for Determination of Hydrologic Soil Group

Soil Properties	Hydrologic Soil Group			
	A	B	C	D
Saturated Hydraulic Conductivity (k) of the Least Transmissive Layer (inches per hour)	k > 5.67	1.42 < k ≤ 5.67	0.14 < k ≤ 1.42	k ≤ 0.14
	and	and	and	and/or
Depth to Water Impermeable Layer (inches)	20 to 40	20 to 40	20 to 40	< 20
	and	and	and	and/or
Depth to High Water Table (inches)	24 to 40	24 to 40	24 to 40	< 24

**Alternative criteria are designated for sites with groundwater and impermeable layers at depths greater than 40 inches.*

According to the *2015 Clark County Stormwater Manual* (Clark County, 2015), NRCS soil series in Clark County are grouped into five categories (Soil Groups 1 through 5 for the locally calibrated *WWHM*) based upon drainage characteristics, runoff potential, and experience with Clark County soils. Soil Groups 1 through 5 are described qualitatively as ranging from 'excessively drained' to 'wetland drained soils or mucks'. Soils at the site are mapped as Lauren loam and gravel. Minor areas of Cove and McBee soils are mapped in the northeast and southwest areas of the site along stream channels. As previously discussed, observed surface soils at the site consisted of silty or clayey sand. The default *Clark County WWHM* soil group classifications for Lauren series soils is Soil Group 1, excessively drained.

Table 2. Infiltration Test Results and Soil Group Classifications

Infiltration Test No.	Location	Approximate Test Depth (in)	Soil Type	USDA Soil Group Classification**	WWHM Soil Group Classification**	Observed Infiltration Rate* (in/hr)	Passing No. 200 Sieve (%)
IT-1.1	TP-1	24	ML, Silt	C/D	4	0.2	-
IT-1.2	TP-1	60	SM, Silty SAND	A/D	4	5.9	14.3
IT-2.1	TP-2	60	SM, Silty SAND	C/D	4	0.2	-
IT-4.1	TP-4	30	SM, Silty Gravel with Sand	A/D	4	5.7	-
IT-8.1	TP-8	24	SC, Clayey SAND	D	4	0.1	46.5
IT-1.1S	TP-1S	24	CL, Sandy Lean CLAY	B/D	4	1.7	53.8
IT-1.2S	TP-1S	36	SM, Silty SAND	C/D	4	0.7	22.3
IT-2.1S	TP-2S	36	GM, Silty GRAVEL with Sand	C/D	4	1.2	21.5
IT-3.1S	TP-3S	24	CL, Sandy Lean CLAY	C/D	4	0.2	63.1
IT-4.1S	TP-4S	24	ML, Sandy SILT	D	4	<0.1	53.2
IT-5.1S	TP-5S	36	SC, Clayey SAND with Gravel	C/D	4	0.5	44.4

*Infiltration rate as defined by soil's approximate vertical coefficient of permeability (k).

**USDA and WWHM classifications are based upon subsurface investigation, infiltration testing, laboratory test results, and observed in situ density for the tested locations.

Single-ring, falling head infiltration tests were performed by inserting standpipes into the soil at the noted depths. Tests were conducted by filling the pipes with water and measuring time relative to changes in hydraulic head. Using Darcy's Law for saturated flow in homogeneous media, the coefficient of permeability (k) was then calculated. Measured infiltration rates are presented as a coefficient of permeability (k) and have been reported without application of a factor of safety. It is important to note that site soil conditions and localized infiltration rates may be variable. Infiltration rates and classifications are based upon Columbia West's observations and testing during limited subsurface exploration.

As indicated in Table 2, in situ infiltration results ranged from less than 0.1 to 5.9 inches per hour in the tested locations. Review of Table 1 indicates that the measured infiltration rates generally meet the criteria for Hydrologic Soil Groups A through D as defined by USDA. However, site observations also indicate shallow ground water conditions, mapped wetlands, and ephemeral flows. Therefore, some site soils may be better represented by a dual classification of D to reflect higher runoff potential in wet soil conditions. Laboratory test results indicate tested soils at the site contain up to 63 percent fine-textured material, which is typical of Hydrologic Soil Group D. Based upon review of pages A-7 through A-10 of Appendix 2-A in the *2015 Clark County Stormwater Manual,* soil series classified as USDA Hydrologic Group D generally fall into *Clark County WWHM* Soil Groups 4 and 5 and mapped wetlands should be classified Soil Group 5.

Therefore, based upon site-specific infiltration testing, laboratory testing, indications of seasonal shallow groundwater, relatively impermeable conglomerate, mapped wetlands, ephemeral flows, in situ relative density, and review of published literature, tested site soils may be appropriately classified as Hydrologic Soil Group D and Soil Group 4 as defined by USDA and the *Clark County WWHM*.

Soil classifications are based upon field observations, in situ soil testing, and laboratory analysis as described in the text herein. Hydraulic conductivity, soil texture, depth to groundwater, and material gradation may vary. Columbia West appreciates the opportunity to provide geotechnical engineering services. Please call me at 360-823-2900 if you have any questions or need additional information.