ZipperGeo
Geoprofessional Consultants
www.zippergeo.com

Project No. 1128.01
August 26, 2021

Smokey Point Investments
4122 Factoria Boulevard SE, #402
Bellevue, WA 98006

Attention: Mr. Shale Undi

Subject: Geotechnical Report Update
Undi Commerce Park
14715 Smokey Point Boulevard Vicinity
Marysville, Washington

Dear Mr. Undi:

Zipper Geo Associates, LLC (ZGA) previously completed two geotechnical reports for the proposed Undi Commerce Park project located on a 27.5 acre site located in the vicinity of 14715 Smokey Point Boulevard, Marysville, Washington. Our initial report was issued on June 24, 2013. This report was essentially a preliminary report completed prior to development of detailed site development plans. Subsequently, more detailed site development plans were provided and we completed a revised report dated September 25, 2016. This report provided geotechnical recommendations specific to proposed development plans at that time. Both reports are attached for reference.

Recently, proposed development plans have changed. Based on a current site plan provided by Innova Architects, we understand the project will generally consist of the following:

- The overall project site has increased from 27.5 acres to approximately 48 acres. Land added to the current site plan includes approximately 9.9 acres south of the previously proposed development area and approximately 10.6 acres north of the previously proposed development area. The approximate limits of the previously proposed development area and the additional land added are shown on the attached Figure 1.

- The general development concept remains largely unchanged with the exception of revised building locations and sizes and additional buildings on the added land. Proposed improvements generally consist of 11 new single-story warehouse type buildings and related site improvements.

- We understand the new project is considering stormwater infiltration. The exact type, size, and location of stormwater infiltration facilities has yet to be determined.

The purpose of this letter is to provide our opinion on the current applicability of our previous reports considering the passage of time, revised development plans, and added project acreage.

Based on our conversations with you and review of recent aerial imagery, the project site that was the subject of our previous reports has not been modified or graded since our September 25, 2016 report was issued. As such, it is our opinion that the information and general conclusions contained in our previous reports remains valid.

As indicated above, we understand stormwater infiltration is being consider as part of the revised development plans. Our 2013 report contained feasibility-level recommendations for stormwater infiltration, and it is our opinion that the information, conclusions, and preliminary recommendations contained in our 2013 report remain valid. However, the City of Marysville current adopts the 2014 version of the DOE Stormwater Management Manual for Western Washington (SWMM). While the adopted stormwater manual has changed since our 2013 report, it is our opinion information provided in that report is adequate for preliminary design and further stormwater infiltration feasibility evaluation by the project civil engineering team.

Of particular importance with respect to stormwater infiltration at this site is the depth to seasonal high groundwater. The 2014 SWMM allows a minimum 3 foot separation between the seasonal high groundwater table and the bottom of infiltration facilities provided that a groundwater mounding analysis is completed and " the ground water mounding analysis, volumetric receptor capacity, and the design of the overflow and/or bypass structures are judged by the site professional to be adequate to prevent overtopping and meet the site suitability criteria". Over much of the proposed development area, we estimate seasonal high groundwater elevations are about 3 to 4 feet below existing site grades. Based on our estimated seasonal high groundwater elevation, we recommend the project team develop trial geometries for infiltration facilities using the preliminary design infiltration rate (2 in/hr) provided in our 2013 report. Once trial geometries are completed, additional geotechnical work will be required in order to provide final infiltration recommendations that meet the requirements outlined in the 2014 SWMM.

Our 2013 and 2016 studies included geotechnical subsurface explorations intended to characterize subsurface soil and groundwater conditions on the 27.5 acres previously proposed for development. Prior to final design, we recommend additional explorations be completed to adequately characterize subsurface soil and groundwater conditions on the additional 20.5 acres added to the project. Following the additional explorations, a revised geotechnical report should be prepared by ZGA to provide final geotechnical design recommendations which specifically address proposed improvements.

We trust this information meets your current needs. If we can be of further assistance, please do not hesitate to call us.

Respectfully submitted,
Zipper Geo Associates, LLC

ROBERT A. ROSS
38384
8/26/21

Robert A. Ross, P.E.
Principal

Attachments

UNDI COMMERCE PARK
MARYSVILLE, WASHINGTON

SITE PLAN

DATE: AUG. 2021	Job No. 1128.01
ZipperGeo Geoprofessional Consultants	FIGURE 1 SHT. 1 of 1

2013 GEOTECHNICAL REPORT

GEOTECHNICAL ENGINEERING REPORT

PROPOSED PROPERTY DEVELOPMENT
14600 BLOCK SMOKEY POINT BOULEVARD
MARYSVILLE, WASHINGTON

Project No. 1128.01
June 24, 2013

Prepared for:
Smokey Point Investments

Prepared by:

ZGA

Zipper Geo Associates, LLC
Geotechnical and Environmental Consultants
19023 36th Avenue W., Suite D
Lynnwood, WA 9803

Zipper Geo Associates, LLC
Geotechnical and Environmental Consulting

Project No. 1128.01
June 24, 2013

Smokey Point Investments
4122 Factoria Boulevard SE, #402
Bellevue, Washington 98006

Attention: Mr. Shale Undi

Subject: **Geotechnical Engineering Report**
Proposed Property Development
14600 Block Smokey Point Boulevard
Marysville, Washington

Dear Mr. Undi:

In accordance with your request and written authorization, Zipper Geo Associates, LLC (ZGA) has completed the subsurface explorations and geotechnical engineering evaluation for the proposed development of property located in the 14600 block of Smokey Point Boulevard in Marysville, Washington. This report presents the findings of the subsurface exploration and geotechnical recommendations for the project. Our work was completed in general accordance with our *Proposal for Geotechnical Evaluation and Report* (Proposal No. P-13156) dated April 23, 2013. Written authorization to proceed was provided by you on May 1, 2013. We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Zipper Geo Associates, LLC

6/24/13

Robert A. Ross
38384

Robert A. Ross, P.E.
Principal

John E. Zipper, P.E.
Managing Principal

Copies: Addressee (1)
Sierra Construction – Chris Fusetti (1)

19023 36th Avenue West, Suite D **Lynnwood, WA 98036** **(425) 582-9928**

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Cover Photo Credit: Google Earth

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PROPOSED DEVELOPMENT
14600 BLOCK SMOKEY POINT BOULEVARD
MARYSVILLE, WASHINGTON

Project No. 1128.01

June 24, 2013

INTRODUCTION

This report documents the surface and subsurface conditions encountered at the site and our geotechnical engineering recommendations for the proposed development of property located in the vicinity of 14600 Smokey Point Boulevard, Marysville, Washington. The project description, site conditions, and our geotechnical conclusions and design recommendations are presented in the text of this report. Supporting data including detailed exploration logs and field exploration procedures, results of laboratory testing and other supporting information are presented as appendices.

Our geotechnical engineering scope of services for the project included a literature review, site reconnaissance, subsurface exploration, laboratory testing, geotechnical engineering analysis, and preparation of this report. The subsurface evaluation consisted of completing 9 exploratory borings (designated B-1 through B-9) and 8 exploratory test pits. The conclusions and recommendations presented in this report should be considered preliminary as the project is currently at a conceptual level. As project plans become available, we should be provided an opportunity to review them to assess the need to revised conclusions and recommendations presented in this report and provide additional conclusions and recommendations if warranted.

PROJECT UNDERSTANDING

At the time this report was prepared, the project was at a conceptual level in the design process. Based on our conversations with the project design-build contractor (Sierra Construction) and review of a conceptual site plan dated March 15, 2013, we understand the proposed development will consist of design and construction of a freight distribution center type of building and related site improvements. The conceptual site plan indicates the building will be approximately 415,000 square feet in plan. Related site improvements are expected to include heavy-duty asphalt and/or concrete pavements to support truck traffic, light duty pavements for support of passenger vehicle traffic and underground utilities. The project may also include off-site improvements consisting of a stormwater management facility located south of the project site and just north of 140th Street NE.

Proposed grades for the development are not currently known. However, for purposes of preparing this report, we have assumed that grading will consist mostly of fills with a maximum anticipated thickness of five feet.

SURFACE CONDITIONS

The approximate location of the building site and off-site stormwater area are shown on the enclosed *Vicinity Map, Figure 1*. The proposed building site includes six parcels of undeveloped land totaling approximately 25 acres. The proposed off-site stormwater area consists of a small area near the south property boundary of a 30 acre site located south of the proposed building site. The building site is bordered to the north mostly by undeveloped land; to the south by developed industrial property; to the east by developed and undeveloped commercial/industrial property; and to the west by Smokey Point Boulevard.

Topographically, the building site is relatively flat with little topographic relief. However, the northern one third of the property appears to be about three to five feet higher than the southern one-third. The difference in elevation between these areas appears to be the result of grading activities (filling) that occurred in the past. Vegetation on about two-thirds of the building site consists of grass and sparse deciduous brush and trees. Vegetation on the remaining one-third of the building site consists of dense trees and brush.

There are several surface water drainage features on the building site. Near the northeast corner of the building site, there is an existing stromwater pond. The stormwater pond discharges to a ditch that parallels the east edge of the site. Based on our review of City of Marysville stream classification mapping, the ditch that parallels the east edge of the site is a "Non-regulated" stream. There is an existing drainage ditch that bisects the site from east to west near the center of building site. Standing water was not observed in any of these drainage features during our site visits in May, 2013.

There are underground utilities on the site. Specifically, an existing sanitary sewer that crosses the site from east to west near the middle of the site. An existing gas main apparently parallels the sanitary sewer a few feet south.

SUBSURFACE CONDITIONS

Regional Geology

We assessed the geologic setting of the site and the surrounding vicinity by reviewing the following publication:

- *Geologic Map of the Arlington West 7.5 Minute Quadrangle.* U.S. Geologic Survey, Map MF-1740, 1985.

The above-referenced geologic mapping indicates the site is underlain by Vashon Recessional Outwash, Marysville Sand Member. The Marysville Sand Member is described as mostly well-drained, stratified to massive outwash sand, some fine gravel, and some areas of silt and clay. The sediments were deposited by melt water flowing south from the stagnating and receding Vashon glacier. The Marysville Sand is reported to be at least 20 meters thick and may be twice that and likely underlain by Vashon Till.

Soil Conditions

The subsurface evaluation for this project included 8 borings (B-1 to B-8) and 8 test pits (TP-1 to TP-8) completed across the building site. One boring (B-9) was completed off-site in the vicinity of the proposed stormwater management area. Borings B-1 to B-3 and B-5 to B-9 were advanced to a maximum depth of about 26.5 feet below existing site grades. Boring B-4 was advanced to a depth of about 51.5 feet below existing site grade. All borings with the exception of B-9 were completed with hollow stem auger methods and fluid inside the auger to control heave. Tests pits were advanced to depths ranging from about 7 to 15 feet below existing site grades. The approximate exploration locations are shown on the *Site and Exploration Plan, Figure 2*. Soils were visually classified in general accordance with the Unified Soil Classification System. Descriptive logs of the subsurface explorations and the procedures utilized in the subsurface exploration program are presented in *Appendix A*. A generalized description of soil conditions encountered in the borings is presented below. Detailed descriptions of soils encountered are provided on the descriptive logs in *Appendix A*.

Borings B-1 to B-3 and test pits TP-1 to TP-3 were completed in the north half of the site in an area that appears to have been filled in the past. Surficial soil conditions observed in these borings generally consisted of about 5 to 8 inches of topsoil; however, in some explorations, about 6 inches of crushed gravel fill was observed. Below the surficial conditions, soils observed in explorations TP-1, TP-2, and B-1 to B-3 consisted of medium dense to dense, silty sand with variable gravel content (fill) extending to about 1 to 6 feet below existing site grades. Soils observed below the fill generally consisted of medium dense sands with trace to some silt to the completion depths. Test pit TP-8 was completed through an existing stockpile of fill material located near the northwest corner of the building site. Soils observed in this test pit generally consisted of silty sand with gravel, scattered coobles, wood waste and pieces of plastic conduit.

Surficial soil conditions observed in the remainder of the explorations completed on the building site generally consisted of about 6 to 18 inches of forest duff and/or topsoil. The forest duff and topsoil were generally underlain by loose to medium dense, mottled fine sand with variable silt content extending to a depth of about 3 ½ to 4 ½ feet below existing site grades. Thin lenses of discontinuous silt layers were observed within the mottled fine sand in some of the explorations. Soil conditions observed below the mottled sand generally consisted of medium dense to dense sands with trace to some silt. However, in boring B-4, very stiff, sandy silt was encountered between about 38 to 48 feet below existing site grade.

Boring B-9 was completed in the vicinity of the proposed stormwater management area located south of the building site near 140th Street NE. Soil conditions observed in boring B-9 generally consisted of about 4 inches of crushed rock fill underlain by loose to medium dense\ sand with some silt and trace gravel extending to about 15 feet below existing site grade. From 15 feet to the completion depth of 16.5 feet, medium dense, silty sand was observed.

Groundwater Conditions

Groundwater was observed in all explorations completed for this study with the exception of test pit TP-8. In explorations completed through fill soils in the northern region of the building site, groundwater was observed at about 4 to 6 feet below existing site grades. In the remainder of the explorations, groundwater was observed at about 3 to 4 feet below existing site grades. Groundwater seepage rates observed in test pit explorations was rapid. Extending test pit explorations below the groundwater table was difficult as severe caving of the excavation sidewalls was experienced below the groundwater table. Groundwater observed in the explorations is interpreted to be a regional shallow aquifer within the Marysville Sand unit. The saturated zone of this aquifer is estimated to be as thick as the sand unit (20 to 40 meters).

In order to monitor seasonal fluctuations in groundwater elevations, a groundwater monitoring well was installed in boring B-9 (off-site stormwater area). The groundwater elevation was measured in boring B-9 on May 14, 2013 at a depth of about 2.9 feet below existing grade.

Fluctuations in groundwater levels will likely occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the explorations were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher than indicated on the logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

Summary of Laboratory Testing

Laboratory testing was completed on selected samples obtained from our borings. Testing completed included moisture content, grain size analysis, moisture density (Proctor) and California Bearing Ratio (CBR) testing. A summary of test results is provided in the following paragraphs. Detailed lab testing results can be found in Appendix B.

Moisture content testing was completed on several samples obtained from above the groundwater table to evaluate the suitability for reuse of site soils as structural fill. Testing results indicate moisture contents (at the time of exploration) of samples obtained within the upper 2.5 feet of existing site grades ranged from about 11 to 28 percent. A modified Proctor (ASTM D1557) test was completed on a bulk sample of the sands obtained from test pit TP-6 at a depth of 1 to 2 feet below existing site grade. The test indicated an optimum moisture content of about 14 percent and a maximum dry density of about 111 pounds per cubic foot.

Grain size analysis testing was completed on a total of six samples. Grain size analyses of sand samples obtained from on-site explorations within the upper 4 feet of existing site grades contain about 4.5 to 8 percent fines. Grain site analysis of one sample obtained from off-site boring B-9 at a depth of 1 foot indicated a fines content of about 18.4 percent.

A CBR test was completed on a bulk sample obtained from test pit TP-6 at a depth of 1 to 2 feet below existing site grade. The test indicated a CBR of 13.6%.

CONCLUSIONS AND RECOMMENDATIONS

General

Based on our subsurface exploration program and associated research, we conclude that the proposed development is feasible from a geotechnical standpoint, contingent on proper design and construction practices and implementation of the recommendations presented in this report. Geotechnical engineering recommendations for foundation systems and other earthwork related phases of the project are outlined below. The recommendations contained in this report are based upon the results of field and laboratory testing (which are presented in *Appendices A and B*), engineering analyses, and our current understanding of the proposed project. ASTM and Washington State Department of Transportation (WSDOT) specification codes cited herein respectively refer to the current manual published by the American Society for Testing & Materials and the current edition of the *Standard Specifications for Road, Bridge, and Municipal Construction, (M41-10)*.

Seismic Design Considerations

The tectonic setting of western Washington is dominated by the Cascadia Subduction Zone formed by the Juan de Fuca plate subducting beneath the North American Plate. This setting leads to intraplate, crustal, and interplate earthquake sources. Seismic hazards relate to risks of injury to people and damage to property resulting from these three principle earthquake sources.

The seismic performance of the development was evaluated relative to seismic hazards resulting from ground shaking associated with a design seismic event as specified in the 2009 International Building Code (IBC). Conformance to the above criteria for seismic excitation does not constitute any kind of guarantee or assurance that significant structural damage or ground failure will not occur if a design seismic event occurs. The primary goal of the IBC seismic design procedure is to protect life and not to avoid all damage, since such design may be economically prohibitive. Following a major earthquake, a building may be damaged beyond repair, yet not collapse. The results of our seismic hazard analyses and recommended seismic design parameters are presented in the following sections.

Ground Surface Rupture: Based on our review of the USGS Quaternary age fault database for Washington State, there does not appear to be a mapped Quaternary fault within a 10 mile radius of the site. Based on the reviewed database, the risk of ground surface rupture at the site is low.

Landsliding: Based on the relatively flat topography of the site and surrounding vicinity, the risk of earthquake-induced landsliding is low.

Soil Liquefaction: Liquefaction is a phenomenon wherein saturated cohesionless soils build up excess pore water pressures during earthquake loading. Liquefaction typically occurs in loose soils, but may occur in denser soils if the ground shaking is sufficiently strong. The potential hazardous impacts of liquefaction include liquefaction-induced settlement and lateral spreading. ZGA completed a liquefaction analysis for the 2009 IBC design earthquake. Our liquefaction analysis was completed in general accordance with the procedures presented in the *Evaluation of Liquefaction Hazards in Washington State, WSDOT Research Report WA-RD 668.1, December 2008* prepared by Professor Steven L. Kramer at the University of Washington. In general, the procedure includes 1) evaluating if the site soils are susceptible to liquefaction, 2) determining if liquefaction will likely be initiated during the seismic event of interest, and 3) estimating the effects of liquefaction such as settlement and lateral spread.

Our liquefaction analyses for the proposed development was based on the deepest boring completed, boring B-4 and site-specific laboratory testing results. In general, site soils encountered within potential liquefaction depths for this evaluation included post-glacial, medium dense sands with trace to some silt. The approximate location of boring B-4 is depicted on the enclosed *Site and Exploration Plan, Figure 2*.

Liquefaction Susceptibility: We evaluated the susceptibility of the site soils on a Deposit-Level and Layer-Level in general accordance with Sections 4.2 and 4.4 of the referenced 2008 WSDOT report. Based on our evaluation, the post-glacial sand deposits are considered to have a low to moderate potential for liquefaction. For the IBC design event, our analysis indicates factors of safety against liquefaction ranging from approximately 1.0 to about 2.8.

Liquefaction Settlement: We estimate total liquefaction-induced settlement resulting from the IBC design event would be less than 1 inch. Differential seismic settlement is estimated to be ½ inch or less in 40 feet.

Lateral Spread: Lateral spreading is a phenomenon in which soil deposits which underlie a site can experience significant lateral displacements associated with the reduction in soil strength caused by soil liquefaction. This phenomenon tends to occur most commonly at sites where the soil deposits can flow toward a "free-face", such as a water body. Due to the lack of a "free-face" condition, the risk of lateral spreading at the site is low for the IBC design earthquake.

IBC Seismic Design Parameters**:** Based on site location and soil conditions, the values provided below are recommended for seismic design. The values provided below are based on the 2009 IBC as the building code reference document which makes use of 2002 USGS hazard data. Upon request, we can provide seismic design parameters based on the 2012 IBC as the building code reference document.

SUMMARY OF IBC SEISMIC DESIGN PARAMETERS

Description	Value
2009 IBC Site Classification [1]	D [1]
S_s Spectral Acceleration for a Short Period	1.064 g (Site Class B)
S_1 Spectral Acceleration for a 1-Second Period	0.368 g (site Class B)
F_a Site Coefficient for a Short Period	1.073 (Site Class D)
F_v Site Coefficient for a 1-Second Period	1.665 (Site Class D)
S_{MS} Maximum considered spectral response acceleration for a Short Period	1.145 g (Site Class D)
S_{M1} Maximum considered spectral response acceleration for a 1-Second Period	0.612 g (Site Class D)
S_{DS} Five-percent damped design spectral response acceleration for a Short Period	0.763 g (Site Class D)
S_{D1} Five-percent damped design spectral response acceleration for a 1-Second Period	0.408 g (Site Class D)

1. In general accordance with the *2009 International Building Code,* Table 1613.5.2. IBC Site Class is based on the average characteristics of the upper 100 feet of the subsurface profile.
2. The borings completed for this study extended to a maximum depth of 51.5 feet below grade. ZGA therefore determined the Site Class assuming that medium dense alluvial soils extend to 100 feet as suggested by published geologic maps for the project area.
3. Per 2009 IBC, Table 1613.5.2, any profile containing soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils.

Infiltration Feasibility

Our scope of services included a preliminary evaluation of infiltration feasibility onsite and at the proposed stormwater management area located in the southern portion of a property south of the proposed building site (shown on Figure 1). Based on our review of the City of Marysville (City) Municipal Code, stormwater management in the City is regulated by the 2005 Washing State Department of Ecology Stormwater Management Manual for Western Washington (2005 SWMM). To evaluate the feasibility of infiltration onsite and in the stormwater management area, we reviewed the geotechnical and hydrogeologic aspects of the 2005 SWMM Site Suitability Criteria (SSC). A summary and discussion of the SSC is presented below.

Infiltration Rates: We expect the primary infiltration receptor soil will consist of sands with trace to some silt observed in our explorations below the forest duff, topsoil and fill and above the groundwater table. The top of the sand infiltration receptor soil was observed at about 1.5 to 6 feet below existing site grades in the northern, previously filled area of the building site and at about 1 to 1.5 feet in other areas of the building site and stormwater management area.

On a preliminary basis, we evaluated infiltration rates of the expected infiltration receptor soils based on grain size analyses in general accordance with Section 3.3.6 of the 2005 SWMM. We completed a total of 5 grain size analyses of on-site soils and one grain size analysis from the off-site boring (B-9) completed in the proposed stormwater management area. Based on grain size analyses, the sands generally have a USDA textural classification of Sand and D_{10} values consistently about 0.1mm. Table 3.7 and 3.8 of the 2005 SWMM indicates a short-term infiltration rate of 8 inches per hour and a long-term infiltration rate of 2 inches per hour for USDA textural classification Sand with a D_{10} value of 0.1mm. It should be noted that, in some of our explorations, thin layers of less-permeable silts were observed in the upper sands. This less-permeable material would require removal and replacement with clean, granular fill for the above rates to be valid.

Site Suitability Criteria No. 1: SSC-1 relates to setback requirements. A summary and comment for geotechnical and hydrogeologic setback requirements is provided below.

- Drinking Water Supplies: SSC-1 requires infiltration facilities to be setback at least 100 feet from drinking water wells, septic tanks or drain fields, and springs used for public drinking water supplies. Additionally, infiltration facilities upgradient of drinking water supplies and within 1, 5, and 10-year travel zones must comply with Health Department requirements. In the vicinity of the project, Public drinking water is supplied by the City of Marysville municipal water supply system. Water sources for this system include wells. However, based on our review of mapping available on the Snohomish County web site (Snohomish County, Aquifer Recharge/Wellhead Protection dated October 1, 2007) the site does not appear to be located in a critical aquifer recharge or wellhead protection area.

- Slope Setback: SSC-1 requires a minimum setback of 50 feet from slopes greater than 15%. There are no slopes currently on the site greater than 15%. SSC-1 should be considered with respect to final grading plans.

- Structural Stability Due to Extended Saturation: SSC-1 requires analysis of the impacts of extended saturation on structural stability of infiltration receptor soils. To the extent possible, we recommend infiltration facilities not be located under heavy vehicle travel areas.

Site Suitability Criteria No. 4 and No. 6: SSC No. 4 indicates that "For infiltration facilities used for treatment purposes, the short-term infiltration rate shall be 2.4 inches per hour or less, to a depth of 2.5 times the maximum design pond water depth, or a minimum of 6 feet below the base of the infiltration facility." SSC No. 4 further indicates that "Long-term infiltration rates up to 2 inches per hour can also be considered (for treatment purposes), if the infiltration receptor is not a sole-source aquifer, and in the judgment of the site professional, the treatment soil has site characteristics comparable to those specified in SSC No. 6 to adequately control the target pollutants." As discussed above, the estimated short-term infiltration rate is 8 inches per hour and the estimated long-term infiltration rate is 2 inches per hour. Based on our review of information available on the EPA's website, the shallow aquifer in the Marysville area is not a sole-source aquifer. As a result, site soils that meet SSC No. 6 may be considered for treatment.

SSC No. 6 applies to infiltration facilities used for treatment and does not apply to facilities used for flow control. SSC No. 6 indicates that the receptor soil must have a minimum Cation Exchange Capacity (CEC) of 5 milliequivalents/100 grams of dry sample per USEPA Method 9081 with a minimum thickness of 18 inches. However, SSC No. 6 states that "Lower CEC content may be considered if it is based on a soil loading capacity determination for the target pollutants that is acceptable by the local jurisdiction". ZGA did not complete CEC testing on samples of the infiltration receptor soils as the location and elevations of infiltration facilities were not known at the time this report was prepared. However, based on our experience, the upper sands within about 1 to 2 feet below the topsoil layer may meet the CEC requirement. Once infiltration facilities are located, we recommend additional explorations and testing to meet 2005 SWMM requirements.

Site Suitability Criteria No. 5: SSC No. 5 indicates that the base of infiltration basins or systems shall be greater than or equal to 5 feet above the seasonal high groundwater table, bedrock, or the low permeability layer. A reduction in the recommended minimum separation between the seasonal high groundwater level and the base of the system may be considered if the groundwater mounding analysis, volumetric receptor capacity, and the design of the overflow and/or bypass structures are judged by the site professional to be adequate to prevent overtopping and meet the 2005 SWMM Site Suitability Criteria.

Based on our site explorations, the base of the system will be located less than 5 feet from the seasonal high groundwater table. As a result, a groundwater mounding analysis will be required to meet 2005 SWMM requirements. The use of on-site infiltration depends on sizing the infiltration system such that the receptor soils below the system can accept the water without water backing up into the system to an unacceptable degree. The development of a groundwater mound, or a localized rise in the local groundwater table, can adversely affect an infiltration system if the mound rises too high. In order to complete a groundwater mounding analysis, additional information will be required including the design geometry of the system and a design storm hydrograph.

Infiltration Best Management Practices (BMPs) Concepts

Infiltration BMPs are typically an open basin (pond) or buried perforated pipe. In general, it is our opinion that both types of infiltration BMPs are feasible at the building site as well as the stormwater management area. Additionally, permeable asphalt pavements could be considered in passenger vehicle parking stalls. We do not recommend the use of permeable asphalt pavements in areas exposed to heavy truck traffic.

A critical factor that will affect the design of such infiltration facilities is the separation of the bottom of the facility to seasonal high groundwater. Based on our review of a USGS report (The Ground-Water System and Ground-Water Quality in Western Snohomish County, Washington, 1997), seasonal high groundwater in the Marysville shallow aquifer occurs between February to May. Explorations for this report were completed in early May and indicate groundwater elevations about 6 to 7 feet below existing site grades in the northern, previously filled area of the building site and about 3 to 4 feet below existing site grades in the southern, unfilled portion of the building site and in the stormwater management area. We expect that groundwater elevations observed in our explorations are slightly lower than the seasonal high. Once a topographic survey becomes available, we can provide preliminary recommendations for seasonal high groundwater elevations across the site. Once preliminary design work is complete for infiltration facilities, additional geotechnical explorations as well as installation of groundwater monitoring wells and a groundwater mounding analysis will be required for final design in order to meet 2005 SWMM requirements. It should also be noted that the City does not allow infiltration into “fill” soils. However, based on our experience with a recent project, the City will allow infiltration into fill soils used as treatment media.

Site Preparation

Erosion Control Measures: Stripped surfaces and soil stockpiles are typically a source of runoff sediments. We recommend that silt fences, berms, and/or swales be installed around the downslope side of stripped areas and stockpiles in order to capture runoff water and sediment. If earthwork occurs during wet weather, we recommend that all stripped surfaces be covered with straw to reduce runoff erosion, whereas soil stockpiles should be protected with anchored plastic sheeting.

Temporary Drainage: Stripping, excavation, grading, and subgrade preparation should be performed in a manner and sequence that will provide drainage at all times and provide proper control of erosion. The site should be graded to prevent water from ponding in construction areas and/or flowing into and/or over excavations. Exposed grades should be crowned, sloped, and smooth-drum rolled at the end of each day to facilitate drainage if inclement weather is forecasted. Accumulated water must be removed from subgrades and work areas immediately and prior to performing further work in the area. Equipment access may be limited and the amount of soil rendered unfit for use as structural fill may be greatly increased if drainage efforts are not accomplished in a timely manner.

Demolition, Clearing, and Stripping: Based on conditions encountered in our borings, we expect stripping depths on the building site to remove forest duff and topsoil to vary from about 6 inches up to 1.5 feet. There are relic portions of previously existing buildings/houses in local areas along the west side of the building site. All elements of these previously existing structures should be demolished and properly disposed of off site.

As indicated above, there are two existing underground utilities that cross the central portion of the site in an east-west direction. Based on the conceptual site plan, the proposed building footprint is located over these utilities. As a result, we expect these utilities will need to be abandoned and relocated. We recommend the existing utilities be abandoned by full removal or grouting in place. When originally constructed, the backfill placed for these utilities was likely not compacted to a level suitable for building and foundation support. During construction we recommend the in-place utility trench backfill be density tested to evaluate the adequacy of the fill. The fill may require removal and replacement.

Subgrade Preparation: Once site preparation is complete, all areas that are at design subgrade elevation or areas that will receive new structural fill should be compacted to a firm and unyielding condition. As indicated above, groundwater levels at the site are very shallow. Compaction of the subgrade should be achieved by *static* rolling with a heavy, smooth drum compactor. Vibratory compaction of the subgrade at this site will tend to increase pore water pressure in soils below the groundwater table resulting in "pumping" of the subgrade. Some moisture conditioning of site soils may be required to achieve an appropriate moisture content for compaction within ±2 percent of the soils laboratory optimum moisture content. Our laboratory testing indicates that, at the time our explorations were completed, *insitu* moisture contents of the surficial soils were up to 28 percent at the time of drilling. Optimum moisture content of a sample of the near-surface sands tested for this report was 14 percent. As a result, moisture conditioning of site soils during construction may be required to achieve suitable moisture contents (plus or minus two percent of optimum) for compaction in areas. During wet weather, the surficial sands will quickly become unstable and soft.

Once compacted, subgrades should be evaluated through proof rolling with a loaded dump truck or heavy rubber-tired construction equipment weighing at least 20 tons to assess the subgrade adequacy and to detect soft and/or yielding soils. In the event that soft or yielding areas are detected during proof rolling, the upper 12 inches of subgrade should be scarified, moisture conditioned and re-compacted as necessary to obtain at least 95 percent of the maximum laboratory density (per ASTM D1557) and a firm, non-yielding condition. Those soils which are soft, yielding, or unable to be compacted to the specified criteria should be over-excavated and replaced with suitable material as recommended in the *Structural Fill* section of this report. As an alternate to subgrade compaction during wet site conditions or wet weather, the upper 12 inches of subgrade should be overexcavated to a firm, non-yielding and undisturbed condition and backfilled with compacted imported structural fill consisting of free-draining Gravel Borrow or crushed rock. In the event that wet site conditions preclude proof rolling the subgrade, a ZGA representative should evaluate the conditions via hand probing.

Once subgrades are compacted, it may be desirable to protect prepared subgrades such as building pads or haul roads. To protect stable subgrades, we recommend using crushed rock, crushed recycled concrete, or pitrun sand and gravel. The thickness of the protective layer should be determined at the time of construction and be based on the moisture condition of the soil and the amount of anticipated traffic.

Earthwork should be completed during drier periods of the year when soil moisture content can be controlled by aeration and drying. If earthwork or construction activities take place during extended periods of wet weather, exposed site soils will quickly become unstable or not be compactable. In the event the exposed subgrade becomes unstable, yielding, or unable to be compacted due to high moisture conditions, we recommend that the materials be removed to a sufficient depth in order to develop stable subgrade soils that can be compacted to the minimum recommended levels. The severity of construction problems will be dependent, in part, on the precautions that are taken by the contractor to protect the subgrade soils.

Subgrade Preparation at Infiltration Locations: Subgrade preparation at infiltration locations will differ from the general subgrade preparation recommendations, in order to provide for excavation to adequate receptor soils and in order to avoid over compaction of the receptor soils. Stormwater infiltration analyses and design recommendations are to be addressed in a supplemental report once additional information becomes available for the proposed facilities.

Freezing Conditions: If earthwork takes place during freezing conditions, all exposed subgrades should be allowed to thaw and then be compacted prior to placing subsequent lifts of structural fill. Alternatively, the frozen material could be stripped from the subgrade to expose unfrozen soil prior to placing subsequent lifts of fill or foundation components. The frozen soil should not be reused as structural fill until allowed to thaw and adjusted to the proper moisture content, which may not be possible during winter months.

Structural Fill Materials and Preparation

Structural fill includes any material placed below foundations and pavement sections, within utility trenches, and behind retaining walls. Prior to the placement of structural fill, all surfaces to receive fill should be prepared as previously recommended in the *Site Preparation* section of this report.

Laboratory Testing: We recommend that representative samples of proposed imported materials be submitted for laboratory testing at least one week prior to use. Tests completed on the samples should include moisture content, grain size analysis and modified proctor. These tests will provide an indication of the suitability of the material for use as structural fill and an indicator of support characteristics.

Re-Use of Site Soils as Structural Fill: Field and laboratory test data indicates that the native soils encountered on the site are suitable for re-use as general structural fill from a compositional standpoint provided the soil is placed and compacted in accordance with the compaction recommendations presented in this report. We expect that site grades will be raised and therefore re-use of site soils for structural fill will generally be limited to underground utility work. As indicated above, site soils at the time of our evaluation were wet of optimum. Additionally, excavations that extend more than about two to three feet below existing site grades in the non-filled portion of the site will encounter groundwater. As a result, we expect drying of wet, over-optimum soils will be required for re-use of site soils as structural fill. Drying of over-optimum moisture soils may be achieved by scarifying or windrowing surficial materials during extended periods of dry weather. If encountered, soils which are dry of optimum may be moistened through the application of water and thorough blending to facilitate a uniform moisture distribution in the soil prior to compaction.

We recommend that site soils used as structural fill have less than 4 percent organics by weight and have no woody debris greater than ½ inch in diameter. We recommend that all pieces of organic material greater than ½ inch in diameter be picked out of the fill before it is compacted. Any organic-rich soil derived from earthwork activities should be utilized in landscape areas or wasted from the site.

Imported Structural Fill: Imported structural fill may be required for raising site grades or for other reasons. The appropriate type of imported structural fill will be mostly dependent on weather and desired support characteristics. During dry weather, lesser quality fill such as Common Borrow can be used. However, during wet weather, higher quality, free draining fill such as Gravel Borrow is typically required. The appropriate type of imported fill will also depend on the desired support characteristics. Specifically, the use of high-quality fill such as Gravel Borrow for raising site grades under heavily loaded pavements or building foundations will result in higher-quality support characteristics as compared to Common Borrow. Higher quality support characteristics result in thinner pavement sections and higher allowable bearing pressures for building foundations. The *Building Foundations* and *Pavements* sections of this report provide recommendations for both high- and low-quality fills. The following paragraphs present general recommendations regarding imported structural fills.

During extended periods of dry weather, we recommend imported fill, at a minimum, meet the requirements of Common Borrow as specified in Section 9-03.14(3) of the 2012 Washington State Department of Transportation, *Standard Specifications for Road, Bridge, and Municipal Construction* (WSDOT Standard Specifications). During wet weather, higher-quality structural fill might be required, as Common Borrow may contain sufficient fines to be moisture sensitive. During wet weather we recommend that imported structural fill meet the requirements of Gravel Borrow as specified in Section 9-03.14(1) of the WSDOT Standard Specifications.

Special types of imported fill may be required below porous pavements or infiltration facilities. The gradation and compositional requirements of fill used below infiltration facilities should be coordinated/specified as part of infiltration facility design.

Retaining Wall Backfill: Retaining walls should include a drainage fill zone extending at least two feet back from the back face of wall for the entire wall height. The drainage fill should meet the requirements of Gravel Backfill for Walls as specified in Section 9-03.12(2) of the WSDOT Standard Specifications.

Moisture Content: The suitability of soil for use as structural fill will depend on the time of year, the moisture content of the soil, and the fines content (that portion passing the U.S. No. 200 sieve) of the soil. As the amount of fines increases, the soil becomes increasingly sensitive to small changes in moisture content. Soils containing more than about 5 percent fines (such as the near-surface on-site soils) cannot be consistently compacted to the appropriate levels when the moisture content is more than approximately 2 percent above or below the optimum moisture content (per ASTM D1557). Optimum moisture content is that moisture content which results in the greatest compacted dry density with a specified compactive effort.

Fill Placement: Structural fill should be placed in horizontal lifts not exceeding 10 inches in loose thickness. Each lift of fill should be compacted using compaction equipment suitable for the soil type and lift thickness. Each lift of fill should be compacted to the minimum levels recommended below based on the maximum laboratory dry density as determined by the ASTM D1557 Modified Proctor Compaction Test. Moisture content of fill at the time of placement should be within plus or minus 2 percent of optimum moisture content for compaction as determined by the ASTM D1557 test method.

Compaction Criteria: Our recommendations for soil compaction are summarized in the following table. Structural fill for roadways and utility trenches in municipal rights-of-way should be placed and compacted in accordance with the jurisdiction codes and standards. We recommend that a geotechnical engineer be present during grading so that an adequate number of density tests may be conducted as structural fill placement occurs. In this way, the adequacy of the earthwork may be evaluated as it proceeds.

Placing Fill on Slopes: Permanent fill placed on slopes steeper than 5H:\1V (Horizontal: Vertical) should be keyed and benched into natural soils of the underlying slope. We recommend that the base downslope key be cut into undisturbed native soil. The key slot should be at least 8 feet wide and 3 feet deep. The hillside benches cut into the native soil should be at least 4 feet in width. The face of the embankment should be compacted to the same relative compaction as the body of the fill. This may be accomplished by over-building the embankment and cutting back to the compacted core. Alternatively, the surface of the slope may be compacted as it is built, or upon completion of the embankment fill placement.

RECOMMENDED SOIL COMPACTION LEVELS	
Location	**Minimum Percent Compaction***
Stripped native subgrade soils, prior to fill placement (upper 12 inches), except infiltration areas	Firm and Unyielding Condition
Footing subgrades, fill or native (upper 12 inches)	95
All fill below building floor slabs and foundations	95
Upper 2 feet of fill below floor slabs and pavements	95
Pavement fill below two feet	90
Retaining wall backfill less than 3 feet from wall	90
Retaining wall backfill more than 3 feet from wall	95
Upper two feet of utility trench backfill	95
Utility trenches below two feet	90
Landscape Areas	90
* *ASTM D1557 Modified Proctor Maximum Dry Density*	

Construction Dewatering

Groundwater was observed in all explorations completed for this project. Groundwater flow rates into excavations that extend below the groundwater table at this site will be moderate to high. Based on our experience with other Marysville projects, dewatering methods for excavations that extend below the groundwater in Marysville Sand typically consisted of well points. For reference and planning purposes, a project currently under construction near the subject site is using jetted wells installed at 15 feet on center to a depth of about 25 feet below existing site grades for dewatering.

Dewatering should be expected for this project for excavations that extend below the groundwater table. The appropriate type of dewatering system should be determined by the contractor based on the conditions encountered, and should be designed and maintained by the contractor.

Utility Trenches

We recommend that utility trenching conform to all applicable federal, state, and local regulations, such as OSHA and WISHA, for open excavations. Trench excavation safety guidelines are presented in WAC Chapter 296-155 and WISHA RCW Chapter 49.17.

Trench Dewatering: Excavations for utilities and underground structures that extend below the groundwater table should be expected to encounter moderate to heavy groundwater seepage. Some caving of utility trench sidewalls should be anticipated in association with groundwater seepage. We recommend that any excavations within groundwater seepage zones be undertaken only when suitable dewatering equipment and temporary excavation shoring are available, or where space is available to flatten the sidewalls. Dewatering should be expected for this project if utilities will extend below the groundwater table. The appropriate type of dewatering system should be determined by the contractor based on the conditions encountered, and should be designed and maintained by the contractor.

Utility Subgrade Preparation: We recommend that all utility subgrades be firm and unyielding and free of all soils that are loose, disturbed, or pumping. Such soils should be removed and replaced, if necessary. All structural fill used to replace over-excavated soils should be compacted as recommended in the *Structural Fill* section of this report. If utility foundation soils are soft, we recommend that they be over-excavated 12 inches and replaced with crushed rock.

Structures such as manholes and catch basins which extend into soft soils should be underlain by at least 12 inches of crushed rock fill compacted to at least 90 percent of the modified Proctor maximum dry density. This granular material could consist of crushed rock, quarry spalls, or coarse crushed concrete. Alternatively, quarry spalls or pea gravel could be used until above the water level. It may be necessary to place a geotextile fabric over the native subgrade soils if they are too soft, to provide a separation between the bedding and subgrade soils.

Bedding: We recommend that a minimum of 4 inches of bedding material be placed above and below all utilities or in general accordance with the utility manufacturer's recommendations and local ordinances. We recommend that pipe bedding consist of Gravel Backfill for Pipe Zone Bedding as specified in Section 9-03.12(3) of the WSDOT Standard Specifications. All trenches should be wide enough to allow for compaction around the haunches of the pipe, or material such as pea gravel should be used below the spring line of the pipes to eliminate the need for mechanical compaction in this portion of the trenches. If water is encountered in the excavations, it should be removed prior to fill placement.

Trench Backfill: Materials, placement and compaction of utility trench backfill should be in accordance with the recommendations presented in the *Structural Fill* section of this report. We recommend that the initial lift thickness not exceed one foot unless recommended by the manufacturer to protect utilities from damage by compacting equipment. Light, hand operated compaction equipment may be utilized directly above utilities if damage resulting from heavier compaction equipment is of concern.

Temporary Shoring

We recommend that temporary shoring systems be used where excavations will be located adjacent to property lines, roadways or utilities, and might result in ground loss and damage to these facilities. A trench box is one type of support system which might be used. The zone between the trench box and the excavation face should be backfilled as necessary to limit ground movements. As an alternate, braced or unbraced shoring of various types could be considered. We anticipate that some form of temporary shoring system may be needed for utility installations, depending on their location and depth.

The lateral soil pressures acting on temporary excavation support systems will depend on the ground surface configuration adjacent to the trench, and the amount of lateral movement which can occur as the excavation is made. For support systems that are free to yield at the top at least one-thousandth of the height of the excavation, soil pressures will be less than if movements are limited by such factors as wall stiffness or bracing.

We recommend that yielding systems be designed using equivalent fluid densities of 35 and 85 pounds per cubic foot (pcf) for horizontal ground surfaces and ground surfaces inclined at 1.5H: 1V above the horizontal, respectively. For nonyielding systems, we recommend that the shoring be designed for a uniform lateral pressure of 25H in pounds per square foot (psf), where H is the depth of the planned excavation in feet below a level ground surface. Similarly, for a ground surface inclined at 1.5H: 1V, we recommend that nonyielding shoring be designed for a uniform lateral pressure of 55H.

The above recommended lateral soil pressures are based on a fully drained condition and do not include the effects of hydrostatic water pressures. In addition, the above values do not include the effects of surcharges (e.g., equipment loads, storage loads, traffic loads, or other surface loading). Hydrostatic water pressures and surcharge effects should be considered as appropriate.

Temporary and Permanent Slopes

Temporary excavation slope stability is a function of many factors, including:

- The presence and abundance of groundwater;
- The type and density of the various soil strata;
- The depth of cut;
- Surcharge loadings adjacent to the excavation; and
- The length of time the excavation remains open.

As the cut is deepened, or as the length of time an excavation is open, the likelihood of bank failure increases; therefore, maintenance of safe slopes and worker safety should remain the responsibility of the contractor, who is present at the site, able to observe changes in the soil conditions, and monitor the performance of the excavation.

It is exceedingly difficult under the variable circumstances to pre-establish a safe and “maintenance-free” temporary cut slope angle. Therefore, it should be the responsibility of the contractor to maintain safe temporary slope configurations since the contractor is continuously at the job site, able to observe the nature and condition of the cut slopes, and able to monitor the subsurface materials and groundwater conditions encountered. Unsupported vertical slopes or cuts deeper than 4 feet are not recommended if worker access is necessary. The cuts should be adequately sloped, shored, or supported to prevent injury to personnel from local sloughing and spalling. The excavation should conform to applicable Federal, State, and Local regulations.

According to Chapter 296-155 of the Washington Administrative Code (WAC), the contractor should make a determination of excavation side slopes based on classification of soils encountered at the time of excavation. Temporary cuts may need to be constructed at flatter angles based upon the soil moisture and groundwater conditions at the time of construction. Adjustments to the slope angles should be determined by the contractor at that time.

We recommend that all permanent cut or fill slopes constructed in native soils or with imported structural fill be designed at a 2H:1V (Horizontal: Vertical) inclination or flatter. If applicable, interior slopes of stormwater ponds should be inclined no steeper than 3H:1V.

All permanent cut and fill slopes should be adequately protected from erosion both temporarily and permanently. If the slopes are exposed to prolonged rainfall before vegetation becomes established, the surficial soils will be prone to erosion and possible shallow sloughing. We recommend covering permanent slopes with a rolled erosion protection material, such as Jute matting or Curlex II, if vegetation has not been established by the regional wet season (typically November through May).

Shallow Foundations

Based on our analyses, conventional spread footings will provide adequate support for the proposed building. We anticipate that foundation subgrade soils will generally consist of imported structural fill placed to raise site grades. Recommendations for shallow foundations are provided below.

Allowable Bearing Pressure: The allowable bearing capacity will be a function of the quality of fill used to raise site grades. Foundations supported on fill meeting the requirements for Common Borrow placed and compacted in accordance with this report may designed for a maximum allowable, net, bearing capacity of 2,000 psf. Foundations supported on fill meeting the requirements for Gravel Borrow placed and compacted in accordance with this report may be designed for a maximum allowable, net bearing capacity of 5,000 psf. A one-third increase of the bearing pressure may be used for short-term transient loads such as wind and seismic forces. The above-recommended allowable bearing pressure includes a 3.0 factor of safety.

Shallow Foundation Depth and Width: For frost protection, the bottom of all exterior footings should bear at least 18 inches below the lowest adjacent outside grade, whereas the bottoms of interior footings should bear at least 12 inches below the surrounding slab surface level. We recommend that all continuous wall and isolated column footings be at least 12 and 24 inches wide, respectively.

Lateral Resistance: Resistance to lateral loads can be developed through passive earth pressure on embedded foundation elements and base frictional resistance of foundation elements. For foundations support on and buried in Common Borrow fill, lateral resistance may be calculated assuming an ultimate passive resistance of 400 pcf equivalent fluid pressure (triangular distribution) and an ultimate base friction coefficient of 0.40. For foundations support on and buried in Gravel Borrow fill, lateral resistance may be calculated assuming an ultimate passive resistance of 500 pcf equivalent fluid pressure (triangular distribution) and an ultimate base friction coefficient of 0.55. An appropriate safety factor (or load/resistance factors) should be included for calculating resistance to lateral loads. For allowable stress design, we recommend a minimum 1.5 safety factor. We recommend that passive resistance be neglected in the upper 18 inches of embedment.

Estimated Static Settlement: Assuming the foundation subgrade soils are prepared in accordance with recommendations presented herein, we estimate that total and differential static settlements will be approximately 1-inch and ½-inch respectively over a distance of about 40 feet.

Estimated Seismic Settlement: As discussed above in the *Seismic Considerations* section of this report, we expect building foundations will experience liquefaction-related total settlement of less than 1 inch and ½ inch or less differential settlement in 40 feet.

Backfilled Permanent Retaining Walls

We expect the project may include backfilled, cast-in-place (c.i.p.) concrete retaining walls. For recommended bearing capacities and lateral resistance parameters, refer to the Shallow Foundations section above. Additional recommendations for these structures are provided below.

Lateral Earth Pressures: The lateral soil pressures acting on backfilled retaining walls will depend on the nature and density of the soil behind the wall, and the ability of the wall to yield in response to the earth loads. Yielding walls (i.e. walls that are free to translate or rotate) that are able to displace laterally at least 0.001H, where H is the height of the wall, may be designed for active earth pressures. Non-yielding walls (i.e. walls that are not free to translate or rotate) should be designed for at-rest earth pressures. Non-yielding walls include walls that are braced to another wall or structure, and wall corners.

Assuming that walls are backfilled and drained as described in the following paragraphs, we recommend that yielding walls supporting horizontal backfill be designed using an equivalent fluid density of 35 pcf (active earth pressure). Non-yielding walls should be designed using an equivalent fluid density of 50 pcf (at-rest earth pressure).

Design of permanent retaining walls should consider additional earth pressure resulting from the design seismic event. For the seismic case, yielding walls should be designed for a uniform (rectangular), total earth pressure distribution of 26H and non-yielding walls should be designed for a uniform, total earth pressure distribution of 47H. The recommended total earth pressure distributions for the seismic case include both the seismic and static components of earth pressures (i.e. the active or at-rest static components of 35 pcf or 50 pcf should *not* be added to the total uniform pressure distribution). For cantilever c.i.p. walls, the total earth pressure distributions for the seismic case should be applied from finished grade at the bottom of the wall to the top of wall.

The above-recommended lateral earth pressures do not include the effects of sloping backfill surfaces, surcharges such as traffic loads, other surface loading, or hydrostatic pressures. If such conditions exist, we should be consulted to provide revised earth pressure recommendations.

Adequate drainage measures must be installed to collect and direct subsurface water away from subgrade walls. All backfilled walls should include a drainage aggregate zone extending two feet from the back of wall for the full height of the wall. The drainage aggregate should consist of material meeting the requirements of WSDOT 9-03.12(2) Gravel Backfill for Walls. A minimum 4-inch diameter, perforated PVC drain pipe should be provided at the base of backfilled walls to collect and direct subsurface water to an appropriate discharge point. Drain pipe perforations should be protected using a non-woven filter fabric such as Mirafi 140N. Wall drainage systems should be independent of other drainage systems such as roof drains.

On-Grade Concrete Slabs

The following sections provide recommendations for on-grade floor slabs.

Subgrade Preparation: Subgrades for on-grade slabs should be prepared in accordance with the *Site Preparation* and *Structural Fill* sections of this report.

Capillary Break: To provide a capillary break, uniform slab bearing surface, and a minimum subgrade modulus of 150 pci, we recommend the on-grade slabs be underlain by a 6-inch thick layer of compacted, well-graded granular fill contain less than 5 percent fines, based on that soil fraction passing the U.S. No. 4 sieve. Alternatively, a clean angular gravel such as No. 7 aggregate per WSDOT: 9-03.1(4) C could be used for this purpose. Alternative capillary break materials should be submitted to the geotechnical engineer for review and approval before use.

Vapor Retarder: The use of a vapor retarder should be considered beneath concrete slabs on grade that will be covered with wood, tile, carpet or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture or is otherwise considered moisture-sensitive. When conditions warrant the use of a vapor retarder, the slab designer and contractor should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Drainage Considerations

Surface Drainage: Final site grades should be sloped to carry surface water away from buildings and other drainage-sensitive areas. Additionally, site grades should be designed such that concentrated runoff on softscape surfaces is avoided. Any surface runoff directed towards softscaped slopes should be collected at the top of the slope and routed to the bottom of the slope and discharged in a manner that prevents erosion.

Building Perimeter Footing Drains and Retaining Wall Drains: We recommend that the new buildings and retaining walls be provided with a footing drain system to reduce the risk of future moisture problems and the buildup of hydrostatic pressures. The footing drains should consist of a minimum 4-inch diameter, Schedule 40, rigid, perforated PVC pipe placed at the base of the heel of the footing with the perforations facing down. The pipe should be surrounded by a minimum of 6 inches of clean free-draining granular material conforming to WSDOT Standard Specification 9-03.12(4), Gravel Backfill for Drains. A non-woven filter fabric such as Mirafi 140N, or equivalent, should envelope the free-draining granular material. At appropriate intervals such that water backup does not occur, the drainpipe should be connected to a tightline system leading to a suitable discharge. Cleanouts should be provided for future maintenance. The footing drain system must be independent from the roof drain system.

Pavements

Pavement Life and Maintenance: It should be realized that asphaltic pavements are not maintenance-free. The following pavement sections represent our minimum recommendations for an average level of performance during a 20-year design life; therefore, an average level of maintenance will likely be required. A 20-year pavement life typically assumes that an overlay will be placed after about 12 years. Thicker asphalt, base, and subbase courses would offer better long-term performance, but would cost more initially. Conversely, thinner courses would be more susceptible to “alligator” cracking and other failure modes. As such, pavement design can be considered a compromise between a high initial cost and low maintenance costs versus a low initial cost and higher maintenance costs. The recommendations presented below are based on AASHTO design methodologies as presented in the 1993 AASHTO Guide for Design of Pavement Structures.

Design Traffic Volumes: At the time this report was prepared, design traffic volumes were not available. Traffic volume will have a significant impact on the recommended design pavement thicknesses. For pavement design, traffic volumes are based on Equivalent 18 kip Single Axle Loads (ESALs) For planning purposes, we developed pavement sections based on three different design traffic volumes as follows; 5 million, 10 million, and 20 million. The upper end of the traffic volume range would represent that which is required for a national discount retailer type distribution center.

Soil Design Values: The required pavement sections for a 20 year design life will be a function of the quality of fill used to raise site grades. For planning purposes, we developed pavement sections based on imported fill meeting the requirements for Common Borrow and Gravel Borrow. The pavement section recommendations below assume a minimum California Bearing Ratios (CBR) of 15 and 50 for imported Common and Gravel Borrow, respectively. The pavement sections recommended below assume a **minimum of 12 inches** of imported fill will be placed between stripped site grades and the bottom of the pavement section.

Other Pavement Design Parameters: The preliminary pavement sections provided below are based on the additional assumed pavement design parameters listed below. The parameters summarized below are based on the requirements of a national discount retailer type distribution center and should be confirmed or updated for final design.

- Initial Serviceability: 4.2
- Terminal Serviceability: 2.0
- Reliability: 90%
- Standard Deviation: 0.45 (flexible pavements) and 0.35 (rigid pavements)

Table 1: Preliminary Heavy-Duty Asphalt Pavement Section Recommendations

Design Traffic (ESALs)	Pavement Section[1]	
	Common Borrow Subgrade	Gravel Borrow Subgrade
5 million	4" ACP[2] over 8" CSTC	4" ACP[2] over 6" CSTC[3]
10 million	4" ACP[2] over 9" CSTC	4" ACP[2] over 6" CSTC[3]
20 million	4" ACP[2] over 11" CSTC	4" ACP[2] over 6" CSTC[3]

[1] ACP = Asphalt Concrete Pavement, CSTC = Crushed Surface Top Course
[2] Minimum asphalt thickness recommended by AASHTO for design traffic volume.
[3] Minimum CSTC thickness recommended by AASHTO for design traffic volume.

The values in Table 1 above are based on a minimum 4 inch asphalt thickness considering the assumed truck loading. Thinner asphalt might be feasible depending on the actual traffic loading. For areas that will be exposed to lightly loaded, passenger vehicle traffic, we recommend a pavement section consisting of 2 inches of asphalt pavement underlain by 4 inches of crushed rock base course.

Table 2: Preliminary Heavy-Duty Concrete Pavement Section Recommendations

Design Traffic (ESALs)	Pavement Section[1]	
	Common Borrow Subgrade	Gravel Borrow Subgrade
5 million	6.5" CCP over 6" CSTC	6" CCP over 6" CSTC
10 million	7.5" CCP over 8" CSTC	7" CCP over 8" CSTC
20 million	8.5" CCP over 8" CSTC	8" CCP over 8" CSTC

[1] CCP = Cement Concrete Pavement, CSTC = Crushed Surface Top Course

Materials and Construction: We recommend the following regarding asphalt pavement materials and pavement construction.

- Subgrade Preparation and Compaction: Upper 12 inches of native stripped subgrade should be prepared in accordance with the recommendations presented in the *Subgrade Preparation* section of this report, and all fill should be compacted in accordance with the recommendations presented in the *Structural Fill* section of this report.

- Asphalt Concrete: We recommend that the asphalt concrete conform to Section 9-02.1(4) for PG 58-22 or PG 64-22 Performance Graded Asphalt Binder as presented in the 2012 WSDOT Standard Specifications. We also recommend that the gradation of the asphalt aggregate conform to the aggregate gradation control points for ½-inch mixes as presented in Section 9-03.8(6), HMA Proportions of Materials.

- Base Course: We recommend that the crushed aggregate base course conform to Section 9-03.9(3) of the WSDOT Standard Specifications.

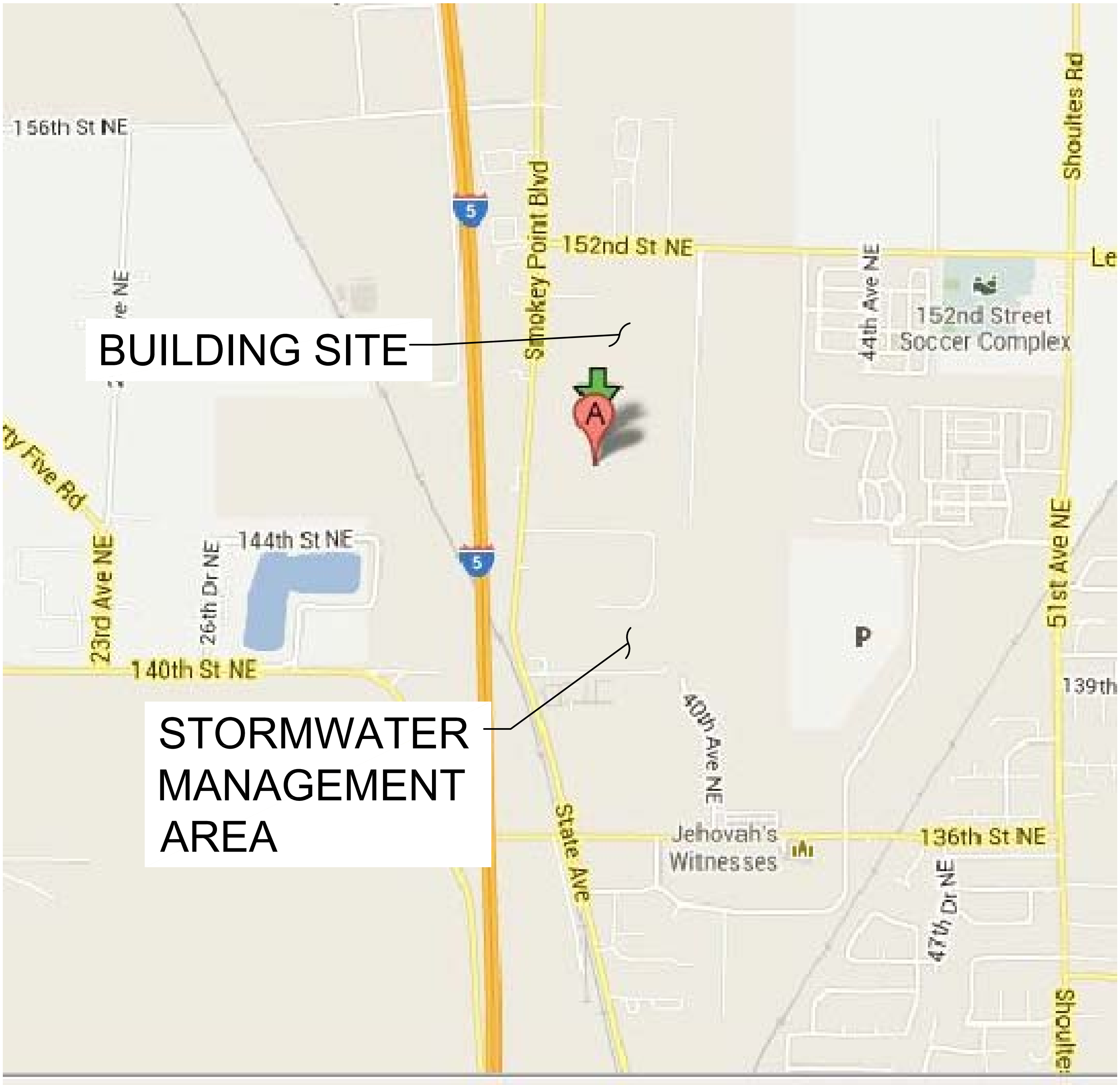
- Compaction and Paving: All base material should be compacted to at least 95 percent of the maximum dry density determined in accordance with ASTM D 1557. We recommend that asphalt be compacted to a minimum of 92 percent of the Rice (theoretical maximum) density or 96 percent of Marshall (Maximum laboratory) density. Placement and compaction of asphalt should conform to requirements of Section 5-04 of the 2012 WSDOT Standard Specifications.

CLOSURE

The analysis and recommendations presented in this report are based, in part, on the explorations completed for this study. The number, location, and depth of the explorations were completed within the constraints of budget and site access so as to yield the information to formulate our recommendations. Project plans were in the preliminary stage at the time this report was prepared. We therefore recommend Zipper Geo Associates, LLC be provided an opportunity to review the final plans and specifications when they become available in order to assess that the recommendations and design considerations presented in this report have been properly interpreted and implemented into the project design.

The performance of earthwork, structural fill, foundations, and pavements depend greatly on proper site preparation and construction procedures. We recommend that Zipper Geo Associates, LLC be retained to provide geotechnical engineering services during the earthwork-related construction phases of the project. If variations in subsurface conditions are observed at that time, a qualified geotechnical engineer could provide additional geotechnical recommendations to the contractor and design team in a timely manner as the project construction progresses.

This report has been prepared for the exclusive use of Smokey Point Investments, and their agents, for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Zipper Geo Associates, LLC reviews the changes and either verifies or modifies the conclusions of this report in writing.



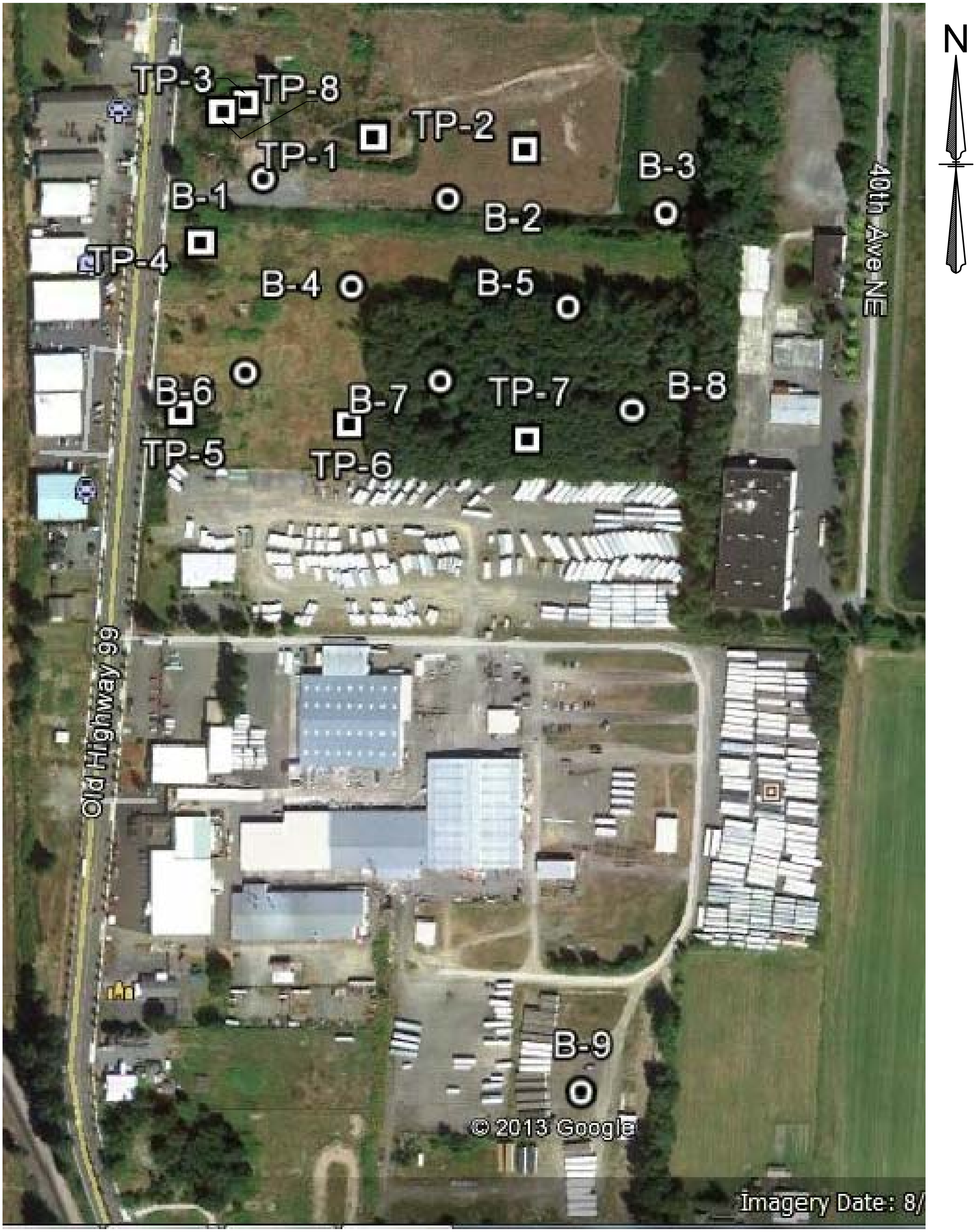
PROPOSED MARYSVILLE DEVELOPMENT
14600 BLOCK SMOKEY POINT BOULEVARD
MARYSVILLE, WASHINGTON

VICINITY MAP
(NOT TO SCALE)

DATE: JUNE 2013
Job No. 1128.01

Zipper Geo Associates, LLC
19023 36th Ave. W.,Suite D
Lynnwood, WA

FIGURE 1
SHT. 1 of 1



EXPLANATION:

● B-1 BORING AND APPROXIMATE LOCATION

■ TEST PIT AND APPROXIMATE LOCATION

PROPOSED MARYSVILLE DEVELOPMENT
14600 BLOCK SMOKEY POINT BOULEVARD
MARYSVILLE, WASHINGTON

SITE AND EXPLORATION PLAN
(NOT TO SCALE)

DATE: JUNE 2013 Job No. 1128.01

Zipper Geo Associates, LLC
19023 36th Ave. W.,Suite D
Lynnwood, WA

FIGURE 2
SHT. 1 of 1

APPENDIX A

SUBSURFACE EXPLORATION PROCEDURES & LOGS

APPENDIX A
SUBSURFACE EXPLORATION PROCEDURES AND LOGS

Field Exploration Description

Our field exploration for this project included 9 borings and 8 test pits completed on May 7 and 8, 2013. The approximate exploration locations are shown on the Site and Exploration Plan, Figure 2. Exploration locations were determined by hand-held GPS. The accuracy of the boring locations shown on Figure 2 should be considered to be about 15 feet. The approximate ground surface elevation at the exploration locations is not known. As such, the exploration locations and elevations should be considered accurate only to the degree implied by the means and methods used to define them. The vertical datum for the referenced survey is not known.

Boring Procedures

The borings were advanced using a Detrick D-50 track-mounted drill rig operated by an independent drilling company working under subcontract to ZGA. The borings were advanced using hollow stem auger drilling methods and drilling fluids (fluid cement grout) to limit heave inside the auger. An engineering geologist from our firm continuously observed the borings, logged the subsurface conditions encountered, and obtained representative soil samples. All samples were stored in moisture-tight containers and transported to our laboratory for further evaluation and testing. Samples were obtained by means of the Standard Penetration Test, thin wall Shelby tube sampler, and Dames and Moore ring sampler at 2.5- to 5-foot intervals throughout the drilling operation.

The Standard Penetration Test (ASTM: D-1586) procedure consists of driving a standard 2-inch outside diameter steel split spoon sampler 18 inches into the soil with a 140-pound hammer free falling 30 inches. The number of blows required to drive the sampler through each 6-inch interval is recorded, and the total number of blows struck during the final 12 inches is recorded as the Standard Penetration Resistance, or “blow count” (N value). If a total of 50 blows are struck within any 6-inch interval, the driving is stopped and the blow count is recorded as 50 blows for the actual penetration distance. The resulting Standard Penetration Resistance values indicate the relative density of granular soils and the relative consistency of cohesive soils.

The enclosed boring logs describe the vertical sequence of soils and materials encountered in each boring, based primarily upon our field classifications. Where a soil contact was observed to be gradational, our logs indicate the average contact depth. Where a soil type changed between sample intervals, we inferred the contact depth. Our logs also graphically indicate the blow count, sample type, sample number, and approximate depth of each soil sample obtained from the boring. If groundwater was encountered in a borehole, the approximate groundwater depth, and date of observation, are depicted on the log.

Test Pit Explorations

An independent contractor working under subcontract to our firm excavated the test pits through the use of a small trackhoe. An engineering geologist form our firm continuously observed the test pit excavations, logged the subsurface conditions, and obtained representative soil samples. The samples were stored in moisture tight containers and transported to our laboratory for further visual classification and testing. After we logged each test pit, the operator backfilled each with excavated soils tamped into place. Some settlement of the backfill should be expected over time.

The enclosed test pit logs indicate the vertical sequence of soils and materials encountered in each test pit, based primarily on our field classifications and supported by our subsequent laboratory testing. Where a soil contact was observed to be gradational or undulating, our logs indicate the average contact depth. We estimated the relative density and consistency of *in situ* soils by means of the excavation characteristics and by the sidewall stability. Our logs also indicate the approximate depths of any sidewall caving or groundwater seepage observed in the test pits, as well as all sample numbers and sampling locations.

Boring Location:	See Figure 1, Site and Exploration Plan	Drilling Company:	Geologic Drill	Bore Hole Dia.:	6"	**B-1**
Top Elevation:	-	Drilling Method:	Hollow Stem Auger	Hammer Type:	Auto	
Date Drilled:	5/7/2013	Drill Rig:	Track	Logged by:	RAR	

SOIL DESCRIPTION

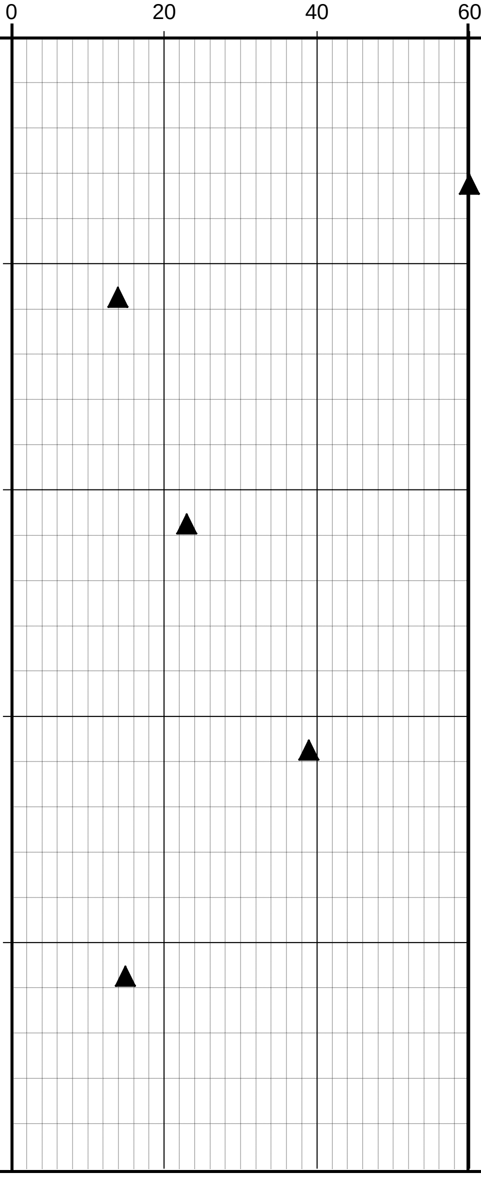
The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	SAMPLES Sample Number	SAMPLES Recovery	Ground Water	Blow Counts	Testing
0	Brown, moist, sandy GRAVEL (fill)					
	No recovery. Blow counts overstated due to gravel.	S-1	0		60	
5	Medium dense, wet to saturated, orange and brown, mottled, fine to medium SAND with trace to some silt	S-2	12	▼ ATD	14	
10	grades to saturated	S-3	12		23	
	Dense, saturated, orange and brown, gravelly SAND with trace silt					
15		S-4	12		39	
20	Medium dense, saturated, gray, fine to medium SAND with trace silt	S-5	12		15	
25						

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test

△ Hammer Weight and Drop: ____



SAMPLE LEGEND

I 2-inch O.D. split spoon sample

II 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

▨ Clean Sand

▨ Bentonite

■ Grout/Concrete

☰ Screened Casing

☐ Blank Casing

▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis

200W = 200 Wash Analysis

Consol. = Consolidation Test

Att. = Atterberg Limits

◇ % Fines (<0.075 mm)

○ % Water (Moisture) Content

Plastic Limit ├──○──┤ Liquid Limit

Natural Water Content

Marysville Distribution Center
14400 Smokey Point Blvd.
Marysville, Washington

Date: - Project No.: 1128.01

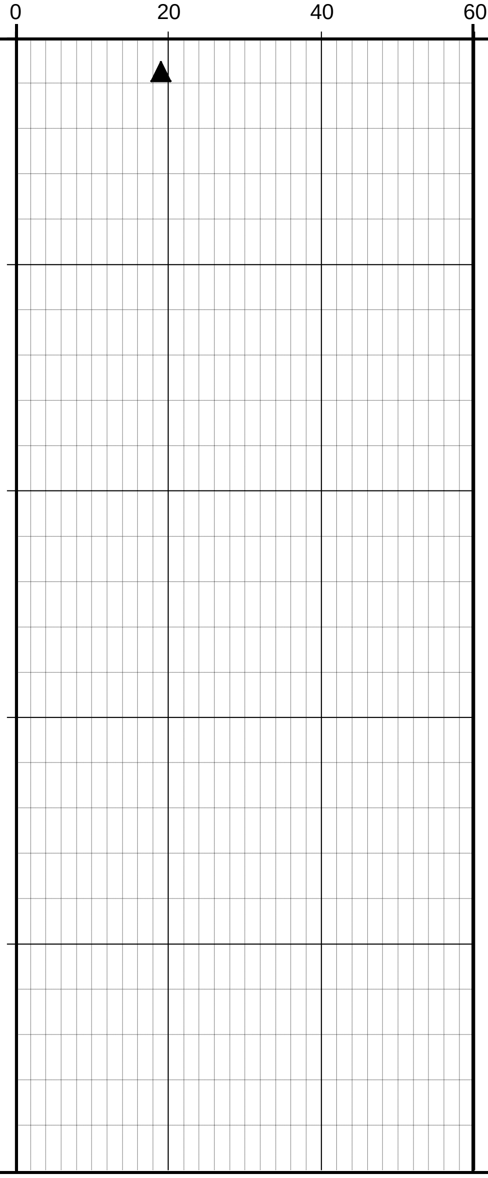
Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-1

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/7/2013
Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track
Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

B-1

Depth (ft)	SOIL DESCRIPTION *The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.*	Sample Number	SAMPLES	Recovery	Ground Water	PENETRATION RESISTANCE (blows/foot) ▲ Standard Penetration Test △ Hammer Weight and Drop:	Blow Counts	Testing
25		S-6	I	12		▲	19	
	Boring terminated at 26.5 feet. Groundwater observed at approximately 6 feet while drilling.							
30								
35								
40								
45								
50								



SAMPLE LEGEND

- I 2-inch O.D. split spoon sample
- Ⅱ 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

- ▨ Clean Sand
- ▨ Bentonite
- ■ Grout/Concrete
- ☰ Screened Casing
- ☐ Blank Casing
- ▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

TESTING KEY

GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

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Marysville, Washington

Date: -
Project No.: 1128.01

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Lynnwood, WA

BORING LOG: B-1

Page 2 of 2

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/7/2013

Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track

Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

B-2

SOIL DESCRIPTION

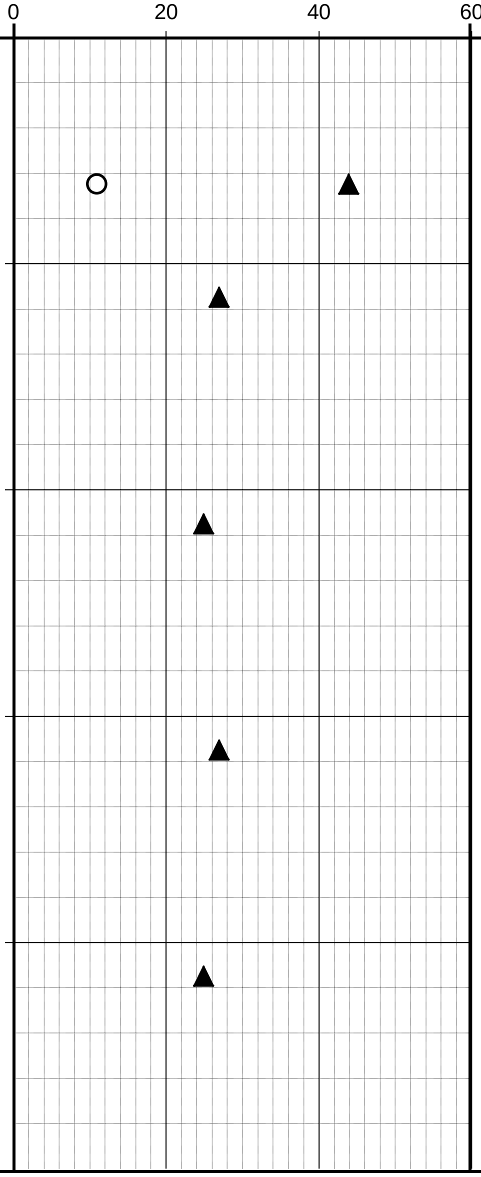
The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	Soil Description	Sample Number	Recovery	Ground Water	Blow Counts	Testing
0	4" Sod and topsoil. Moist, brown, silty, fine SAND with some gravel (fill)					
	Dense, moist, gray-brown, silty, fine SAND with some gravel (fill)	S-1	12		44	
5	grades to medium dense (fill)	S-2	12		27	
	Medium dense, wet to saturated, brown, fine SAND with some silt			▼ ATD		
10	Medium dense, saturated, gray, fine to medium SAND with trace silt	S-3	12		25	
15	grades to with trace gravel	S-4	12		27	
20		S-5	12		25	
25						

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test

△ Hammer Weight and Drop:



SAMPLE LEGEND

2-inch O.D. split spoon sample

3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

▨	Clean Sand
▩	Bentonite
■	Grout/Concrete
☰	Screened Casing
☐	Blank Casing
▼ 11/2/12	Groundwater level at time of drilling (ATD) or on date of measurement.

◇ % Fines (<0.075 mm)

○ % Water (Moisture) Content

Plastic Limit ├──○──┤ Liquid Limit

Natural Water Content

TESTING KEY

GSA = Grain Size Analysis

200W = 200 Wash Analysis

Consol. = Consolidation Test

Att. = Atterberg Limits

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Date: -
Project No.: 1128.01

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Lynnwood, WA

BORING LOG: B-2

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/7/2013
Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track
Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

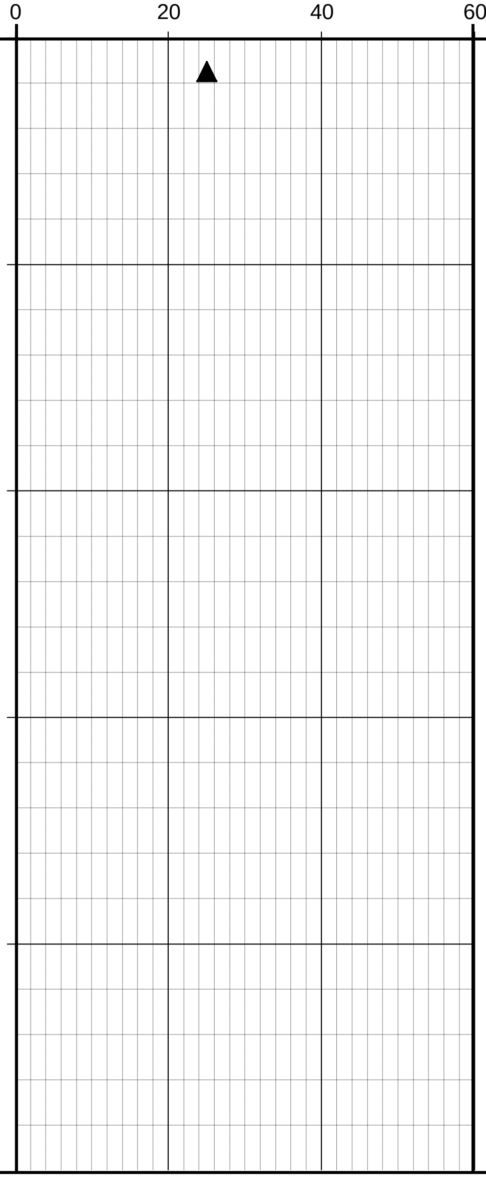
B-2

Depth (ft)	SOIL DESCRIPTION *The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.*	SAMPLES Sample Number	Recovery	Ground Water	Blow Counts	Testing
25		S-6	12		25	
	Boring terminated at 26.5 feet. Groundwater observed at approximately 7 feet while drilling.					
30						
35						
40						
45						
50						

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test

△ Hammer Weight and Drop:



SAMPLE LEGEND

- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

- ▨ Clean Sand
- ▨ Bentonite
- ■ Grout/Concrete
- ☰ Screened Casing
- ☐ Blank Casing
- ▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

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Project No.: 1128.01

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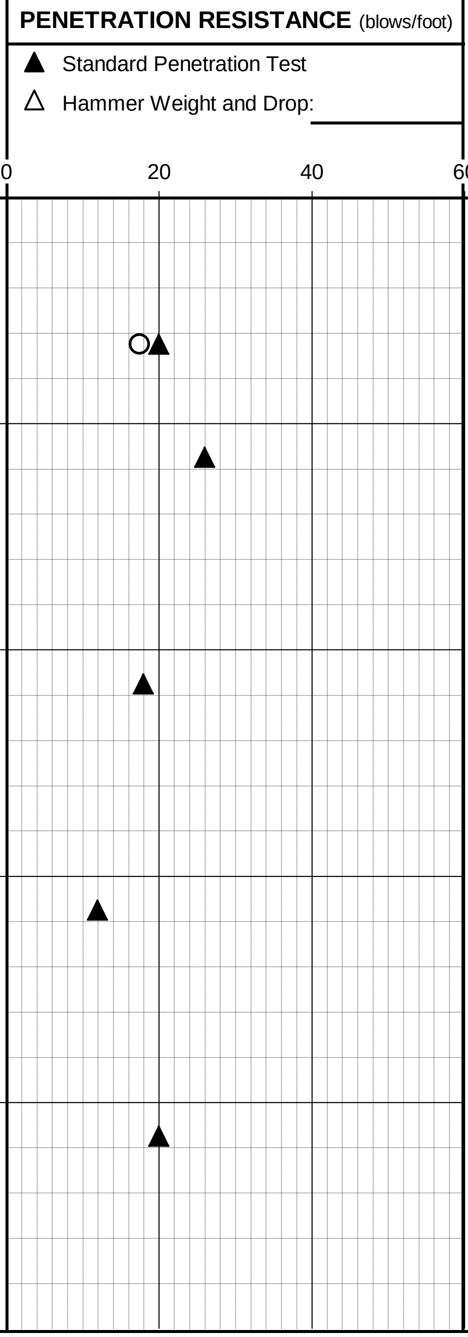
BORING LOG: B-2

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/7/2013
Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track
Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

B-3

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	Sample Number	Recovery	Ground Water	Blow Counts	Testing
0	6" Crushed gravel					
	Medium dense, wet, brown, silty, fine SAND (fill)	S-1	12		20	
5	Medium dense, wet to saturated, brown, fine SAND with some silt	S-2	12		26	
				▼ ATD		
10	Medium dense, wet to saturated, gray, fine to coarse SAND with trace silt	S-3	12		18	
15	grades to fine to medium SAND with trace to some silt	S-4	12		12	
20	grades to fine SAND with some silt	S-5	12		20	
25						



SAMPLE LEGEND

- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

- ▨ Clean Sand
- ▨ Bentonite
- ■ Grout/Concrete
- ☰ Screened Casing
- ☐ Blank Casing
- ▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

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BORING LOG: B-3

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/7/2013

Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track

Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

B-3

SOIL DESCRIPTION

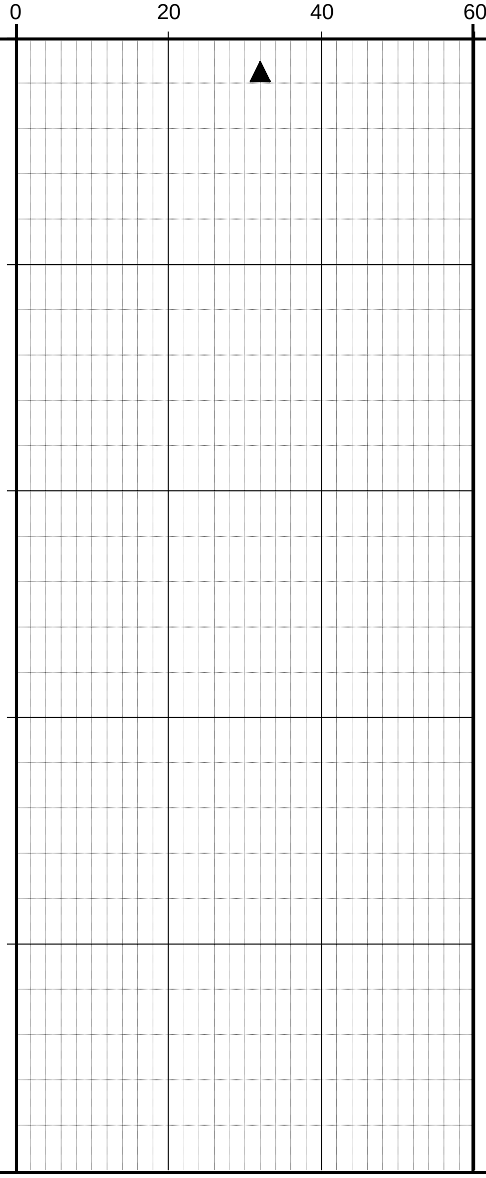
The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	SAMPLES Sample Number	SAMPLES Recovery	Ground Water	Blow Counts	Testing
25	grades to dense	S-6	12		32	
	Boring terminated at 26.5 feet. Groundwater observed at approximately 6 feet while drilling.					
30						
35						
40						
45						
50						

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test

△ Hammer Weight and Drop:



SAMPLE LEGEND

Ｉ 2-inch O.D. split spoon sample

Ⅱ 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

▨ Clean Sand

▨ Bentonite

■ Grout/Concrete

☰ Screened Casing

☐ Blank Casing

▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)

○ % Water (Moisture) Content

Plastic Limit ├──○──┤ Liquid Limit

Natural Water Content

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Project No.: 1128.01

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BORING LOG: B-3

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/8/2013

Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track

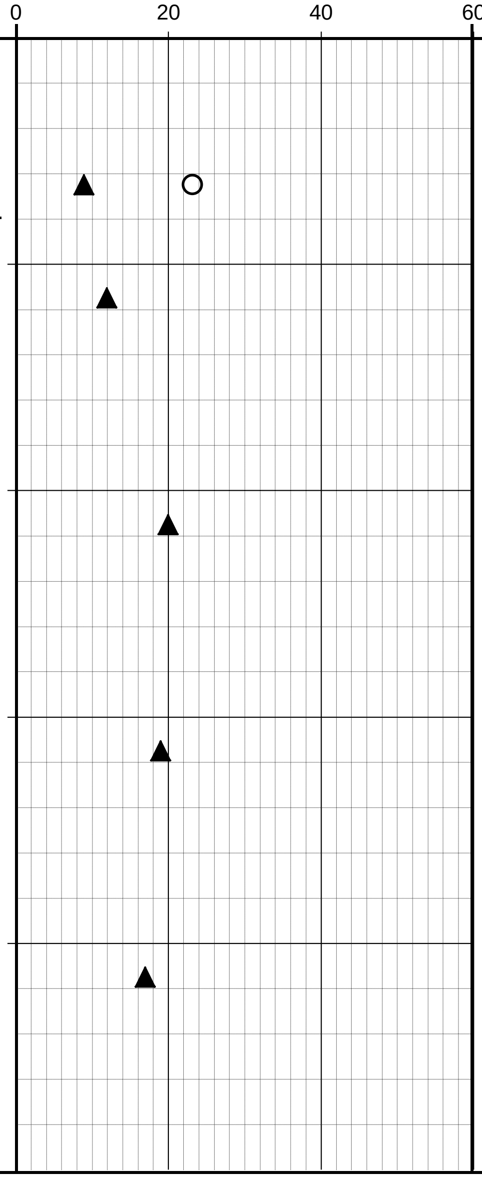
Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

B-4

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

PENETRATION RESISTANCE (blows/foot)
▲ Standard Penetration Test
△ Hammer Weight and Drop: ______

Depth (ft)	SOIL DESCRIPTION	Sample Number	Recovery	Ground Water	Blow Counts	Testing
0	12" Sod and topsoil					
	Loose, wet, orange and brown, mottled, fine to medium SAND with trace to some silt					
		S-1	12	▼ ATD	9	
5	Medium dense, saturated, gray, fine to medium sand with trace silt	S-2	12		12	
10	grades to with trace gravel	S-3	12		20	
15	Medium dense, saturated, gray, fine SAND with trace silt	S-4	12		19	
20		S-5	12		17	
25						



SAMPLE LEGEND
I 2-inch O.D. split spoon sample
II 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND
▨ Clean Sand
▨ Bentonite
■ Grout/Concrete
☰ Screened Casing
☐ Blank Casing
▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY
GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit |——○——| Liquid Limit
Natural Water Content

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Project No.: 1128.01

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BORING LOG: **B-4**

Page 1 of 3

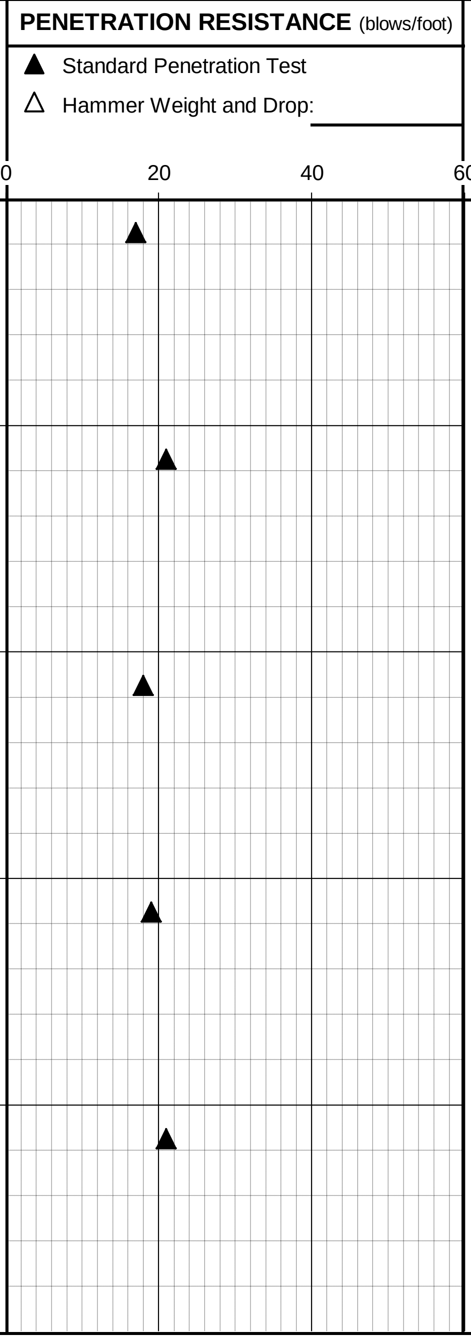
Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/8/2013
Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track
Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

B-4

SOIL DESCRIPTION

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	SAMPLES Sample Number	SAMPLES Recovery	Ground Water	Blow Counts	Testing
25	Medium dense, saturated, gray, fine SAND with trace silt	S-6	12		17	
30		S-7	12		21	
35		S-8	12		18	
40	Very stiff, saturated, gray, sandy SILT	S-9	12		19	
45		S-10	12		21	
50						



SAMPLE LEGEND

I 2-inch O.D. split spoon sample
II 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

▨ Clean Sand
▨ Bentonite
■ Grout/Concrete
☰ Screened Casing
☐ Blank Casing
▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

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Project No.: 1128.01

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BORING LOG: B-4

Boring Location: See Figure 1, Site and Exploration Plan
Drilling Company: Geologic Drill
Bore Hole Dia.: 6"
Top Elevation: -
Drilling Method: Hollow Stem Auger
Hammer Type: Auto
Date Drilled: 5/8/2013
Drill Rig: Track
Logged by: RAR

B-4

SOIL DESCRIPTION

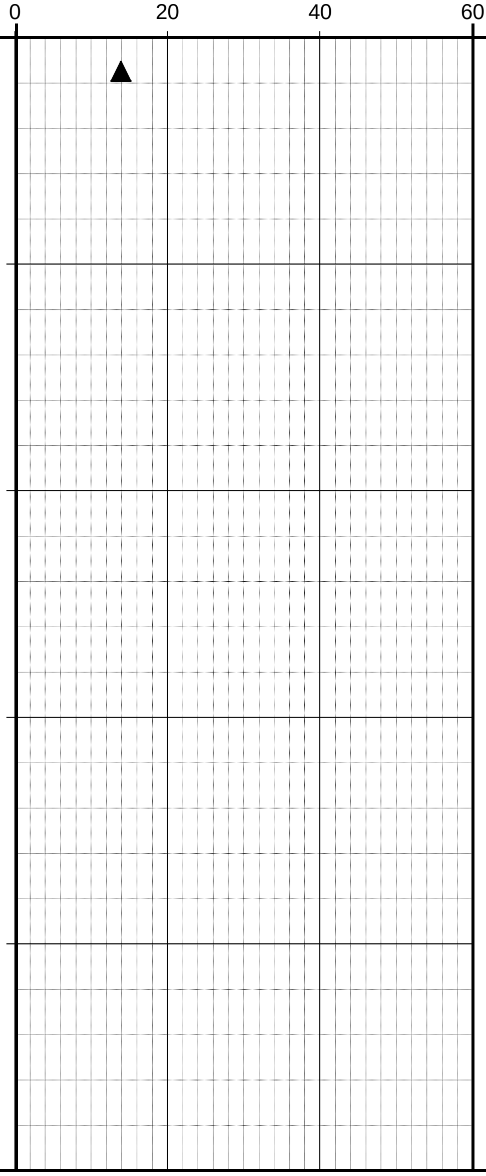
The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	Sample Number	SAMPLES	Recovery	Ground Water	Blow Counts	Testing
50	Medium dense, saturated, gray, fine SAND with trace to some silt	S-11	I	12		14	
	Boring terminated at 51.5 feet. Groundwater observed at approximately 4 feet while drilling.						
55							
60							
65							
70							
75							

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test

△ Hammer Weight and Drop:



SAMPLE LEGEND

I 2-inch O.D. split spoon sample

Ⅱ 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

▨ Clean Sand

▨ Bentonite

■ Grout/Concrete

☰ Screened Casing

☐ Blank Casing

▼ Groundwater level at time of drilling (ATD) or on date of measurement.

11/2/12

◇ % Fines (<0.075 mm)

○ % Water (Moisture) Content

Plastic Limit ├──○──┤ Liquid Limit

Natural Water Content

TESTING KEY

GSA = Grain Size Analysis

200W = 200 Wash Analysis

Consol. = Consolidation Test

Att. = Atterberg Limits

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Project No.: 1128.01

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Lynnwood, WA

BORING LOG: B-4

Boring Location:	See Figure 1, Site and Exploration Plan	Drilling Company:	Geologic Drill	Bore Hole Dia.:	6"
Top Elevation:	-	Drilling Method:	Hollow Stem Auger	Hammer Type:	Auto
Date Drilled:	5/8/2013	Drill Rig:	Track	Logged by:	RAR

B-5

SOIL DESCRIPTION

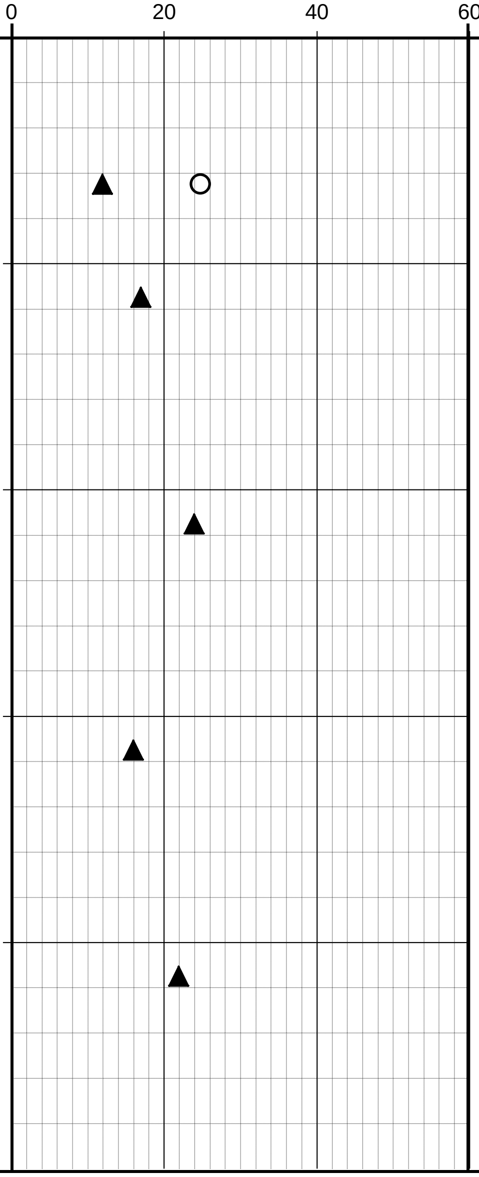
The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	Soil Description	Sample Number	Recovery	Ground Water	Blow Counts	Testing
0	18" Forest duff and topsoil					
	Medium dense, wet to saturated, orange and brown, mottled, fine SAND with some silt	S-1	12	▼ ATD	12	
5	Medium dense, saturated, gray, fine to medium SAND with trace silt	S-2	12		17	
10		S-3	12		24	
15		S-4	12		16	
20	grades to fine sand	S-5	12		22	
25						

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test

△ Hammer Weight and Drop:



SAMPLE LEGEND

I 2-inch O.D. split spoon sample

II 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

▨ Clean Sand

▨ Bentonite

■ Grout/Concrete

☰ Screened Casing

☐ Blank Casing

▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis

200W = 200 Wash Analysis

Consol. = Consolidation Test

Att. = Atterberg Limits

◇ % Fines (<0.075 mm)

○ % Water (Moisture) Content

Plastic Limit |—○—| Liquid Limit

Natural Water Content

Marysville Distribution Center
14400 Smokey Point Blvd.
Marysville, Washington

Date: - Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-5

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/8/2013
Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track
Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

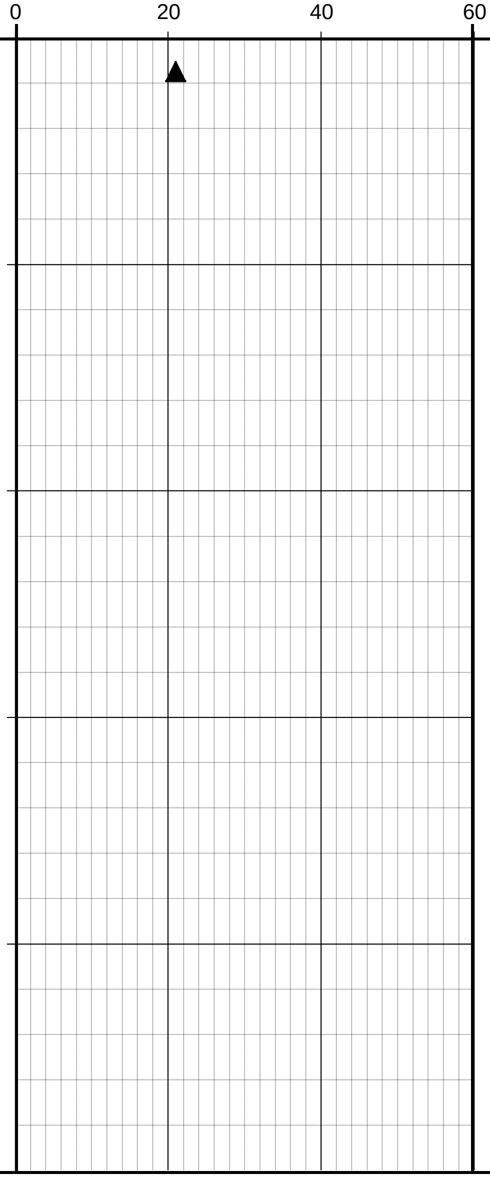
B-5

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	SAMPLES Sample Number	SAMPLES Recovery	Ground Water	Blow Counts	Testing
25		S-6	12		21	
	Boring terminated at 26.5 feet. Groundwater observed at approximately 4 feet while drilling.					
30						
35						
40						
45						
50						

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test
△ Hammer Weight and Drop:



SAMPLE LEGEND

I 2-inch O.D. split spoon sample
II 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

▨ Clean Sand
▨ Bentonite
■ Grout/Concrete
☰ Screened Casing
☐ Blank Casing
▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit |—○—| Liquid Limit
Natural Water Content

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Marysville, Washington

Date: -
Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-5

Boring Location: See Figure 1, Site and Exploration Plan
Surface Elevation: __ feet
Date Drilled: 5/8/2013

Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: D-50 Track

Bore Hole Dia.: 6-inch
Hammer Type: Auto
Logged by: DCW

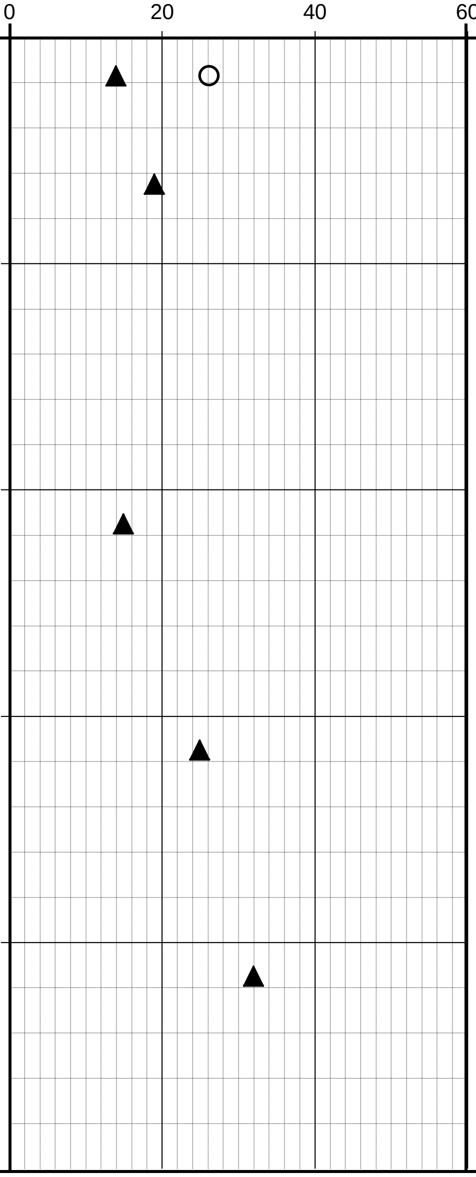
B-6

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	Sample Number	SAMPLES Recovery (inches)	Groundwater	Blow Counts	Testing
0	6 inches loose, moist, dark brown, silty fine SAND with fine roots (Topsoil) above loose to medium dense, dark brown and rust, silty fine SAND with trace organics	S-1	18		14	
	Medium dense moist, rust-brown, fine SAND with silt	S-2	18	▼ ATD	19	
5	Medium dense, saturated, gray-brown, fine SAND					
10		S-3	18		15	
	Medium dense, saturated, orange-brown, fine to medium SAND with trace coarse sand and fine gravel					
15		S-4	12		25	
20		S-5	14		32	
	Medium dense, saturated gray, fine SAND					
25						

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test
△ Hammer Weight and Drop: ______



SAMPLE LEGEND

I 2-inch O.D. split spoon sample
II 3-inch I.D. Shelby tube sample

MONITORING WELL LEGEN

▨ Clean Sand
▨ Bentonite
■ Grout/Concrete
▤ Screened Casing
☐ Blank Casing
▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
CEC - Cation Exchange Capacity

○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

Marysville Distribution Center
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Marysville, Washington

Date: 5/8/2013
Project No.: 1128.01

Zipper Geo Associates
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Lynnwood, WA

BORING LOG: **B-6**

Page 1 of 2

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: __ feet
Date Drilled: 5/8/2013
Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: D-50 Track
Bore Hole Dia.: 6-inch
Hammer Type: Auto
Logged by: DCW

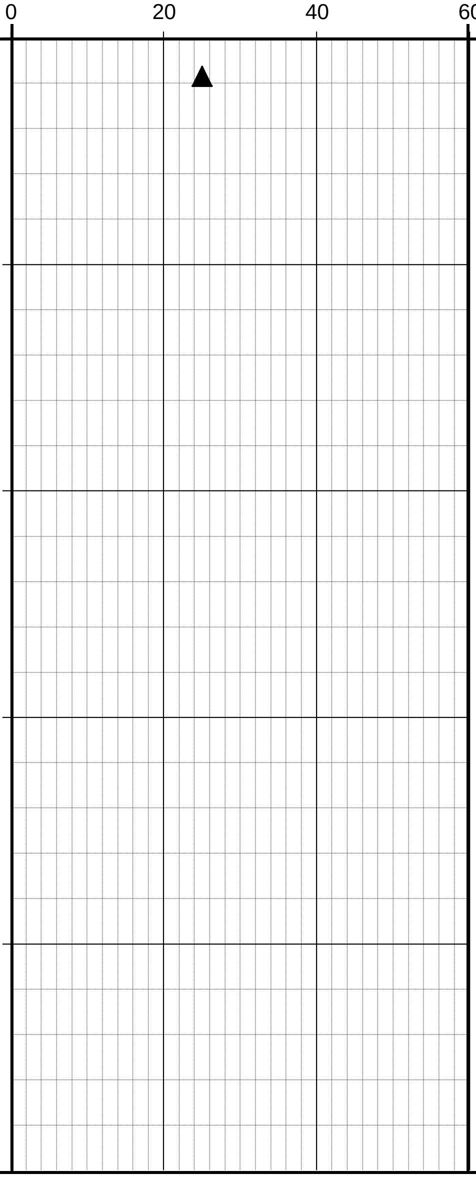
B-6

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	Sample Number	SAMPLES Recovery (inches)	Ground Water	Blow Counts	Testing
25	Medium dense, saturated, gray, fine SAND	S-6	18		25	
	Boring terminated at 26.5 feet. Groundwater observed at approximately 4 feet while drilling.					
30						
35						
40						
45						
50						

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test
△ Hammer Weight and Drop: ____



SAMPLE LEGEND
2-inch O.D. split spoon sample
3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND
▨ Clean Sand
▨ Bentonite
■ Grout/Concrete
☰ Screened Casing
☐ Blank Casing
▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY
GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

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Marysville, Washington

Date: 5/8/2013 Project No.: 1128.01

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Lynnwood, WA

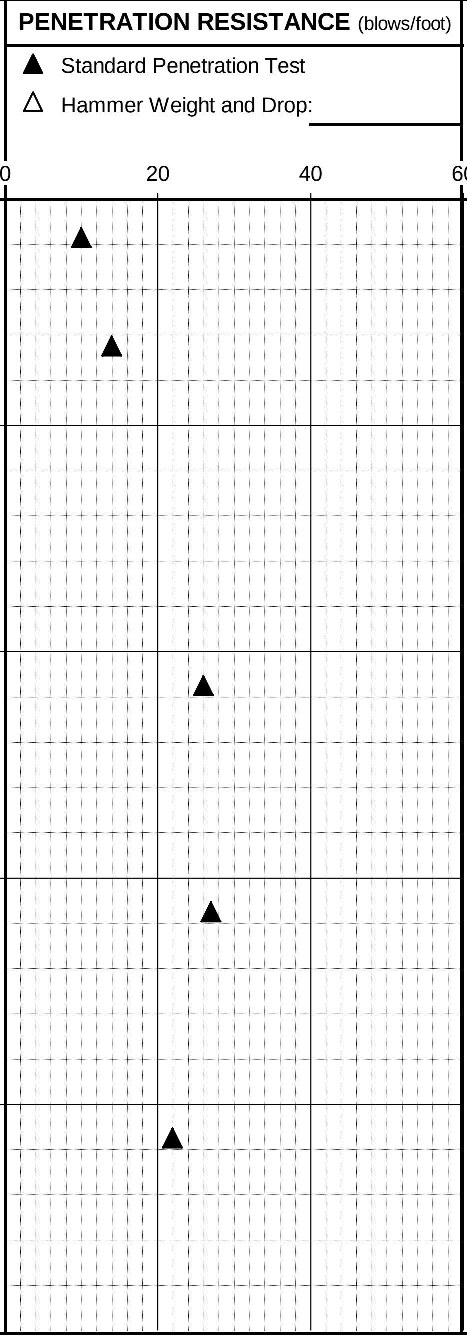
BORING LOG: B-6

Boring Location: See Figure 1, Site and Exploration Plan
Surface Elevation: __ feet
Date Drilled: 5/8/2013
Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: D-50 Track
Bore Hole Dia.: 6-inch
Hammer Type: Auto
Logged by: DCW

B-7

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	Sample Number	Recovery (inches)	Groundwater	Blow Counts	Testing
0	6 inches loose, wet, dark brown, organic silty SAND with fine roots (Topsoil) above loose, moist to wet, brown, fine to medium SAND	S-1	18		10	
	Medium dense, wet to saturated, gray-brown, fine to medium SAND	S-2	18	▼ ATD	14	
5						
	Medium dense, saturated, gray, fine to medium SAND with some coarse sand and trace fine gravel					
10		S-3	18		26	
15		S-4	12		27	
20		S-5	12		22	
	Medium dense, saturated, gray, fine to medium SAND with trace coarse sand and fine gravel					
25						



SAMPLE LEGEND

- I 2-inch O.D. split spoon sample
- II 3-inch I.D. Shelby tube sample

MONITORING WELL LEGEN

- ▒ Clean Sand
- ▨ Bentonite
- ■ Grout/Concrete
- ☰ Screened Casing
- ☐ Blank Casing
- ▼ Groundwater level at time of drilling (ATD) or on date of measurement. 11/2/12

TESTING KEY

GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
CEC - Cation Exchange Capacity

○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

Marysville Distribution Center
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Marysville, Washington

Date: 5/8/2013 Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-7

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: __ feet
Date Drilled: 5/8/2013

Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: D-50 Track

Bore Hole Dia.: 6-inch
Hammer Type: Auto
Logged by: DCW

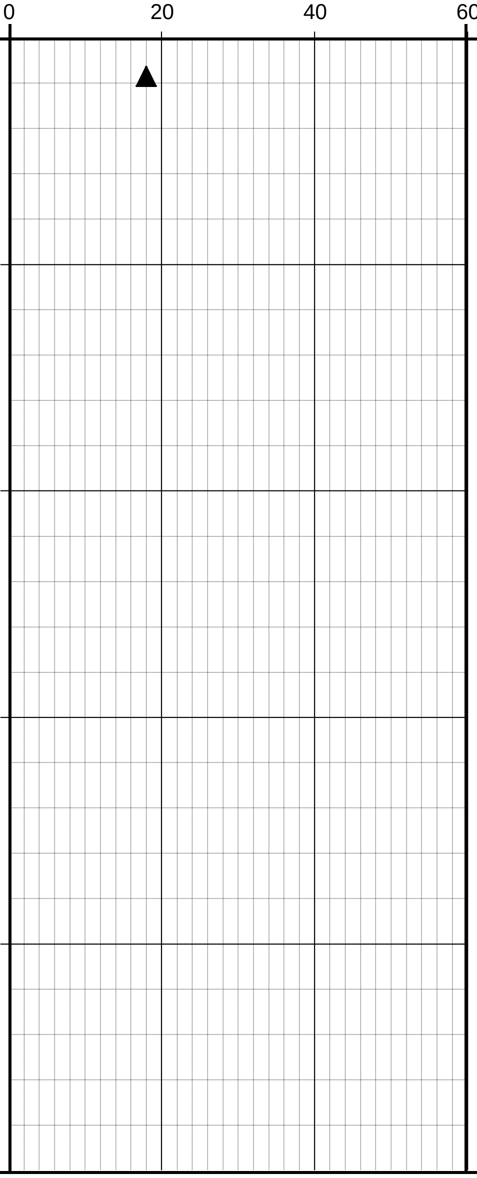
B-7

Depth (ft)	SOIL DESCRIPTION *The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.*	Sample Number	SAMPLES	Recovery (inches)	Ground Water	Blow Counts	Testing
25	Medium dense, saturated, gray, fine to medium SAND with trace coarse SAND and fine gravel	S-6	I	18		18	
	Boring terminated at 26.5 feet. Groundwater observed at approximately 4 feet while drilling.						
30							
35							
40							
45							
50							

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test

△ Hammer Weight and Drop: ____



SAMPLE LEGEND

I 2-inch O.D. split spoon sample

Ⅱ 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

▨	Clean Sand
▩	Bentonite
■	Grout/Concrete
☰	Screened Casing
□	Blank Casing
▼ 11/2/12	Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)

○ % Water (Moisture) Content

Plastic Limit ├──○──┤ Liquid Limit

Natural Water Content

Marysville Distribution Center
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Marysville, Washington

Date: 5/8/2013 Project No.: 1128.01

Zipper Geo Associates
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Lynnwood, WA

BORING LOG: B-7

Page 2 of 2

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/8/2013

Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track

Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

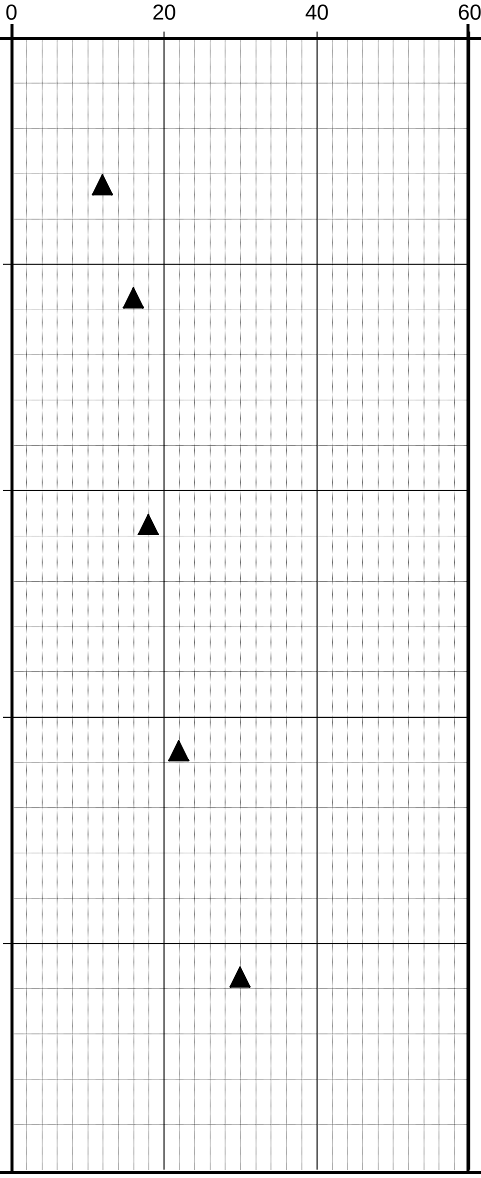
B-8

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	Sample Number	Recovery	Ground Water	Blow Counts	Testing
0	12" Forest duff and topsoil					
	Medium dense, wet, orange and brown, mottled, fine SAND with some silt	S-1	12	▼ ATD	12	
5	Medium dense, saturated, gray, fine to coarse SAND with trace to some gravel and trace silt	S-2	12		16	
10		S-3	12		18	
15		S-4	12		22	
20	grades to dense	S-5	12		30	
25						

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test
△ Hammer Weight and Drop: ______



SAMPLE LEGEND
- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND
- ▨ Clean Sand
- ▨ Bentonite
- ■ Grout/Concrete
- ☰ Screened Casing
- ☐ Blank Casing
- ▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY
GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

Marysville Distribution Center
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Marysville, Washington

Date: -
Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-8

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/8/2013

Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track

Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

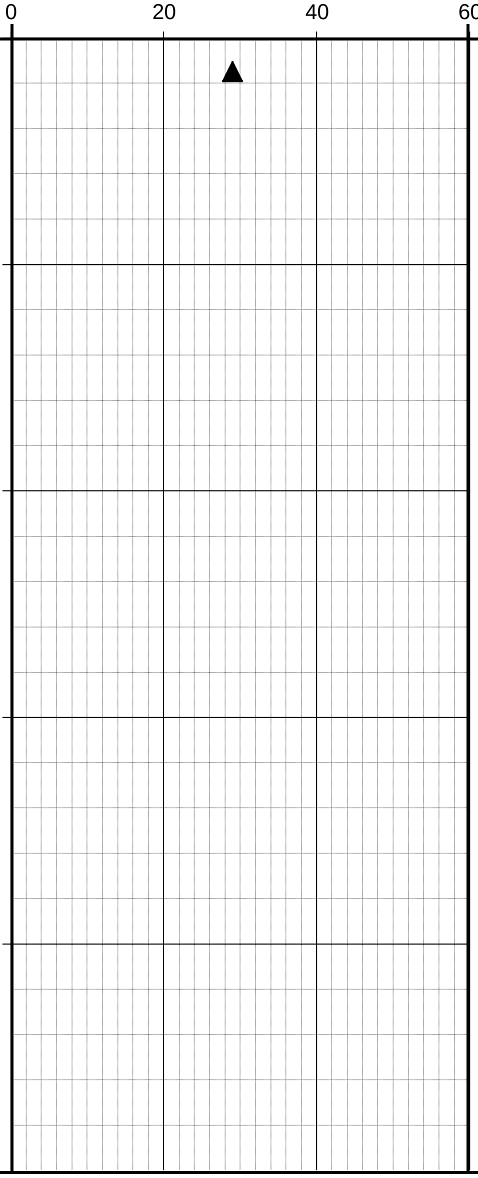
B-8

Depth (ft)	SOIL DESCRIPTION *The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.*	SAMPLES Sample Number	SAMPLES Recovery	Ground Water	Blow Counts	Testing
25	Medium dense, saturated, gray, fine SAND with trace silt	S-6	12		29	
	Boring terminated at 26.5 feet. Groundwater observed at approximately 4 feet while drilling.					
30						
35						
40						
45						
50						

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test

△ Hammer Weight and Drop:



SAMPLE LEGEND

- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

- ▨ Clean Sand
- ▨ Bentonite
- ■ Grout/Concrete
- ☰ Screened Casing
- ☐ Blank Casing
- ▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

Marysville Distribution Center
14400 Smokey Point Blvd.
Marysville, Washington

Date: -
Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-8

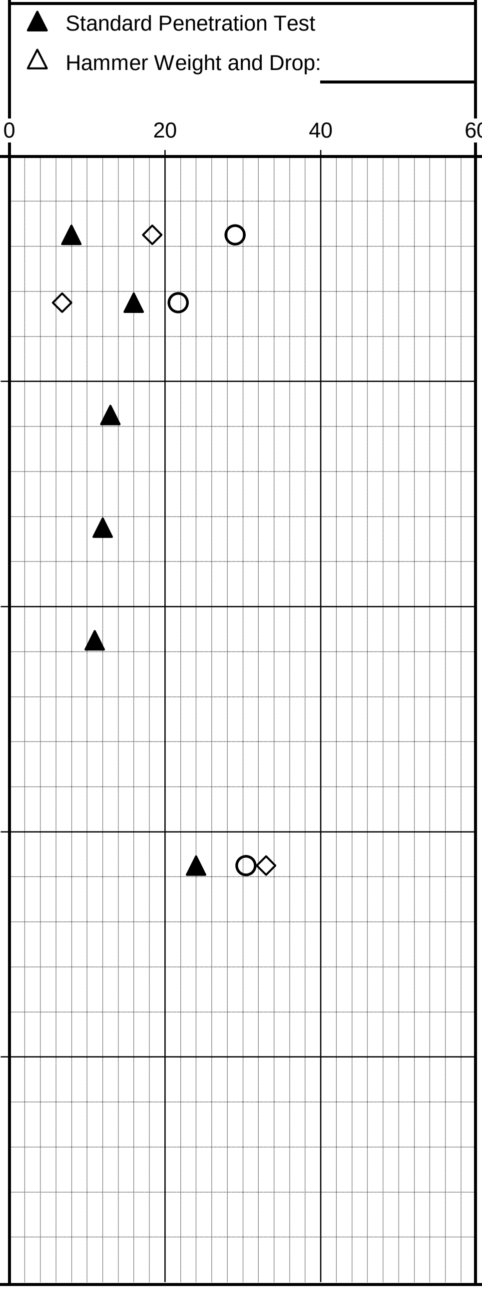
Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/8/2013
Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track
Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

B-9

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	Sample Number	Recovery	Ground Water	Blow Counts	Testing
0	4" crushed gravel (fill)					
	Loose, wet, brown, fine to medium SAND with silt	S-1	12		8	GSA
	Medium dense, saturated, gray, fine to medium SAND with some silt	S-2	12	▼ ATD	16	GSA
5	grades to medium to coarse with trace gravel	S-3	12		13	
		S-4	12		12	
10		S-5	12		11	
15	Medium dense, saturated, gray, silty fine SAND	S-6	12		24	200W
	Boring terminated at 16.5 feet. Groundwater observed at approximately 3 feet while drilling. Groundwater measured at 2.9 feet on 5-14-13 Groundwater measured at 3.5 feet on 6-18-13.					
20						
25						

PENETRATION RESISTANCE (blows/foot)



SAMPLE LEGEND

- I 2-inch O.D. split spoon sample
- II 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

- ░ Clean Sand
- ▨ Bentonite
- ■ Grout/Concrete
- ☰ Screened Casing
- □ Blank Casing
- ▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

TESTING KEY

GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

Marysville Distribution Center
14400 Smokey Point Blvd.
Marysville, Washington

Date: -
Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-9

ZIPPER GEO ASSOCIATES, LLC

19023 36th Avenue West, Suite D, Lynnwood, Washington 98036

Test Pit TP-1

Location: See Site And Exploration Plan, Figure 1
Approx. Ground Surface Elevation:

Project: Marysville Distr. Center
Project No: 1128.01
Date Drilled: 8 May 2013

Depth (ft)	Material Description	Sample	N_C	%M	Testing
	5 inches of loose, moist, dark brown, silty fine SAND with fine organics and fine roots (Topsoil) above loose, wet, gray, silty fine SAND				
1		S-1 @ 1 foot		16.0	
2	Medium dense, moist to wet, mottled rust-brown, fine SAND with trace to some silt				
3					
4	Medium dense, saturated, gray, fine SAND with interbeds of fine to coarse sand and with trace gravel				
5					
6					
7					
8					
	Test pit completed at 8 feet. Moderate groundwater seepage below 3.7 feet Severe caving below 3 feet.				
9					
	Note: N_C is the Dynamic Cone Penetrometer blow count per ASTM Special Technical Publication #399.				

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Test Pit TP-2

Location: See Site And Exploration Plan, Figure 1
Approx. Site-specific Ground Surface Elevation:

Project: Marysville Distribution Center
Project No: 1128.01
Date Drilled: 8 May 2013

Depth (ft)	Material Description	Sample	N_C	%M	Testing
1	Medium dense, moist, gray-brown, silty gravelly SAND with some cobbles, trace wood debris (Fill)				
2					
3		S-1 @ 2 feet		11.2	
4	Medium dense to dense, moist, orange-brown, fine SAND with some silt				
5		S-2 @ 4 feet		21.7	GSA
6	Medium dense, wet, gray, fine to medium SAND with interbeds of fine to coarse sand with some gravel				
7					
8					
9					
10	Test pit completed at 9 feet. Rapid groundwater seepage below 6 feet. Severe caving below 6 feet.				
11					
12					
13					
14					
15					
16					
17					
18					
	Note: N_C is the Dynamic Cone Penetrometer blow count per ASTM Special Technical Publication #399.				

Test Pit TP-3

Location: See Site And Exploration Plan, Figure 1
Approx. Ground Surface Elevation:

Project: Marysville Distr. Center
Project No: 1128.01
Date Drilled: 8 May 2013

Depth (ft)	Material Description	Sample	N_C	%M	Testing
	8 inches loose, moist, dark brown, silty fine SAND with fine organic and fine roots (Topsoil)	S-1 @ 0.5 feet			
1					
	Loose to medium dense, moist, mottled orange-brown, fine SAND				
2					
3					
4	Medium dense, moist to saturated, gray, fine to medium SAND with trace fine gravel				
		S-2 @ 4 feet			
5					
6					
7					
8	Test pit completed at 7.5 feet. Moderate groundwater seepage below 3.5 feet Severe caving below 3.5 feet.				
9					
	Note: N_C is the Dynamic Cone Penetrometer blow count per ASTM Special Technical Publication #399.				

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Test Pit TP-4

Location: See Site And Exploration Plan, Figure 1
Approx. Site-specific Ground Surface Elevation:

Project: Marysville Distribution Center
Project No: 1128.01
Date Drilled: 8 May 2013

Depth (ft)	Material Description	Sample	N_C	%M	Testing
	0.8 to 1.5 feet of loose, moist, dark brown, silty fine SAND with fine organics and fine roots (Topsoil)				
1		S-1 @ 6 inches			
2	Loose to medium dense, moist, mottled orange and brown, fine SAND with some silt, trace gravel				
3		S-2 @ 2.5 feet		16.4	GSA
4	Medium dense, wet to saturated, gray, fine to medium SAND with trace to some fine gravel				
5					
6					
	Medium dense, saturated, brown, fine to medium SAND				
7					
	Test pit completed at 7 feet. Rapid groundwater seepage below 3 feet. Severe caving below 3 feet.				
8					
9					
	Note: N_C is the Dynamic Cone Penetrometer blow count per ASTM Special Technical Publication #399.				

Test Pit TP-5

Location: See Site And Exploration Plan, Figure 1
Approx. Site-specific Ground Surface Elevation:

Project: Marysville Distribution Center
Project No: 1128.01
Date Drilled: 8 May 2013

Depth (ft)	Material Description	Sample	N_C	%M	Testing
	3 inches of loose, moist, dark brown, silty fine SAND with fine organics and fine roots mixed with sandy 5/8-inch CRUSHED ROCK above medium dense, moist, dark brown, silty SAND with gravel (Fill). 6-inch thick concrete slab exposed in south side of test pit.				
1					
2	Medium dense, moist, mottled orange and brown, fine SAND with trace gravel and a 1-inch thick discontinuous fine sandy SILT horizon at 2 feet				
		S-1 @ 2 feet		19.2	
3					
4	Medium dense, wet to saturated, gray-brown, fine SAND with trace silt	S-2 @ 3.5 feet		26.2	GSA
5					
6					
7	Medium dense, saturated, gray-brown, SAND with trace fine gravel				
8					
	Test pit completed at 8 feet. Rapid groundwater seepage below 3 feet. Severe caving below 3 feet.				
9					
	Note: N_C is the Dynamic Cone Penetrometer blow count per ASTM Special Technical Publication #399.				

Test Pit TP-6

Location: See Site And Exploration Plan, Figure 1
Approx. Site-specific Ground Surface Elevation:

Project: Marysville Distribution Center
Project No: 1128.01
Date Drilled: 8 May 2013

Depth (ft)	Material Description	Sample	N_C	%M	Testing
	9 inches of loose, moist, dark brown, silty fine SAND with fine organics and fine roots (Topsoil)				
1		S-1 @ 6 inches			
	Medium dense, moist, mottled rust-brown, fine SAND with silt	S-2 @ 1 foot			
2					
	Medium stiff, moist, gray-brown, silty fine SAND	S-3 @ 2.5 feet		29.6	200W= 39.7%
3	Medium dense, wet to saturated, gray-brown, fine SAND with trace fine gravel below 7 feet				
4					
5					
6					
7					
8	Test pit completed at 7.5 feet. Rapid groundwater seepage below 3 feet. Severe caving below 3 feet.				
9					
	Note: N_C is the Dynamic Cone Penetrometer blow count per ASTM Special Technical Publication #399.				

Test Pit TP-7

Location: See Site And Exploration Plan, Figure 1
Approx. Site-specific Ground Surface Elevation:

Project: Marysville Distribution Center
Project No: 1128.01
Date Drilled: 8 May 2013

Depth (ft)	Material Description	Sample	N_C	%M	Testing
	2 inches of forest DUFF above 4 inches of loose, moist, dark brown, organic fine sandy silt with fine roots (Topsoil) above loose, moist, gray, silty fine SAND				
1		S-1 @ 6 inches			
	Loose to medium dense, moist, mottled rust-brown, fine SAND with silt, trace gravel				
2					
		S-2 @ 2 feet		17.0	GSA
3					
	Medium dense, wet to saturated, gray, fine SAND with some silt, grades with some coarse sand and fine gravel below 7 feet	S-3 @ 3 feet		27.6	GSA
4					
5					
6					
7					
8	Test pit completed at 7.5 feet. Rapid groundwater seepage below 3.5 feet. Severe caving below 2.5 feet.				
9					
	Note: N_C is the Dynamic Cone Penetrometer blow count per ASTM Special Technical Publication #399.				

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Test Pit TP-8

Location: See Site And Exploration Plan, Figure 1
Approx. Site-specific Ground Surface Elevation:

Project: Marysville Distribution Center
Project No: 1128.01
Date Drilled: 8 May 2013

Depth (ft)	Material Description	Sample	N_C	%M	Testing
1	Loose, moist, mixed gray and brown, silty SAND with gravel and scattered cobbles and wood waste, piece of plastic conduit (Fill)				
2					
3					
4					
5					
6					
7					
8		S-1 @ 7 feet		11.6	
9					
10					
11					
12					
13					
14					
15					
16	Test pit completed at 15 feet. No groundwater seepage or caving observed.				
17					
19					
	Note: N_C is the Dynamic Cone Penetrometer blow count per ASTM Special Technical Publication #399.				

APPENDIX B

LABORATORY TESTING PROCEDURES & RESULTS

APPENDIX B
LABORATORY TESTING PROCEDURES AND RESULTS

A series of laboratory tests were performed by ZGA during the course of this study to evaluate the index and geotechnical engineering properties of the subsurface soils. Descriptions of the types of tests performed are given below.

Visual Classification

Samples recovered from the exploration locations were visually classified in the field during the exploration program. Representative portions of the samples were carefully packaged in moisture tight containers and transported to our laboratory where the field classifications were verified or modified as required. Visual classification was generally done in accordance with ASTM D2488. Visual soil classification includes evaluation of color, relative moisture content, soil type based upon grain size, and accessory soil types included in the sample. Soil classifications are presented on the exploration logs in Appendix A.

Moisture Content Determinations

Moisture content determinations were performed on representative samples obtained from the explorations in order to aid in identification and correlation of soil types. The determinations were made in general accordance with the test procedures described in ASTM D 2216. Moisture contents are presented on the exploration logs in Appendix A.

Grain Size Analysis

A grain size analysis indicates the range in diameter of soil particles included in a particular sample. Grain size analyses were performed on representative samples in general accordance with ASTM: D-2487. The results of the grain size determinations for the samples were used in classification of the soils, and are presented in this appendix.

Laboratory Maximum Density Test

The laboratory maximum density represents the highest degree of density which can be obtained from a particular soil type by imparting a predetermined compaction effort. The test determines the "optimum" moisture content of the soil at the laboratory maximum density. The laboratory maximum density test was performed on a bulk sample of material in general accordance with ASTM: D-1557. The test result is shown in this appendix and presented as a curve where the soil dry density is compared to the moisture content.

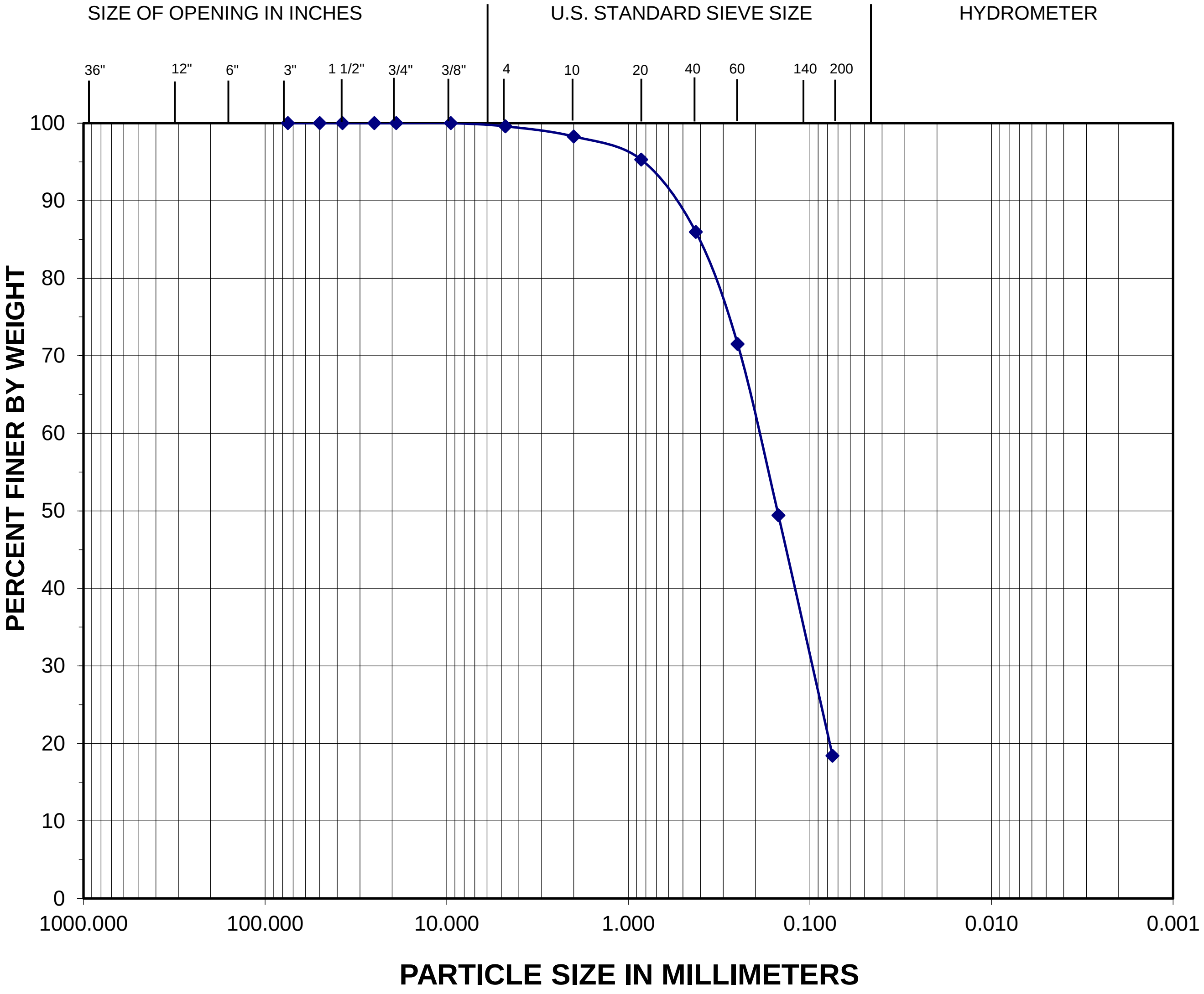
California Bearing Ratio Test

A California Bearing Ratio (CBR) test was performed on a representative sample in general accordance with ASTM: D-1883-73 to provide an evaluation of the relative quality and support characteristics of subgrade soils. Representative portions from the sample were compacted in a mold, generally in accordance with ASTM: D-1557, in order to obtain a moisture-density relationship curve. Following compaction, a 15 pound surcharge was applied to each sample which was then totally immersed in water and allowed to soak for a period of 72 to 96 hours, during which time it was monitored for swell. At the end of this period, the sample was removed, drained, and a vertical load applied to the surcharged soil with a penetration piston at a constant rate of strain. Measurements of the applied vertical load were obtained as selected penetration depths. CBR test results and moisture-density relationships plotted in terms of percent water content versus percent corrected CBR and dry density, respectively, are presented in this appendix.

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D 422



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
B-9	S-1	1.0	29.0	18.4	SAND with silt

Zipper Geo Associates, LLC
Geotechnical and Environmental Consultants

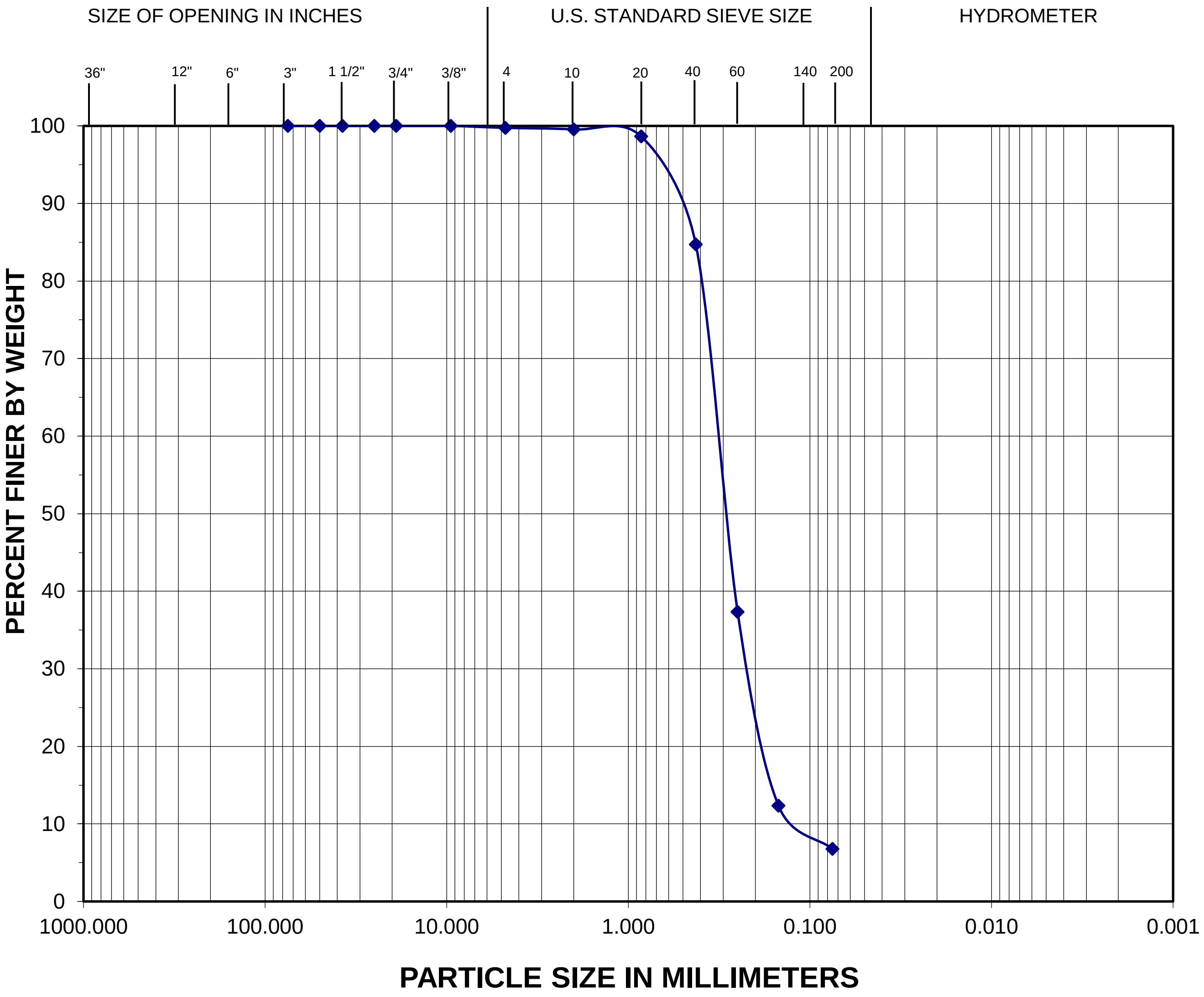
Project No.: 1128.01
DATE OF TESTING: 5/15/2013

PROJECT NAME:
Distribution Center

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D 422



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
B-9	S-2	2.5	21.7	6.8	SAND with some silt

Zipper Geo Associates, LLC
Geotechnical and Environmental Consultants

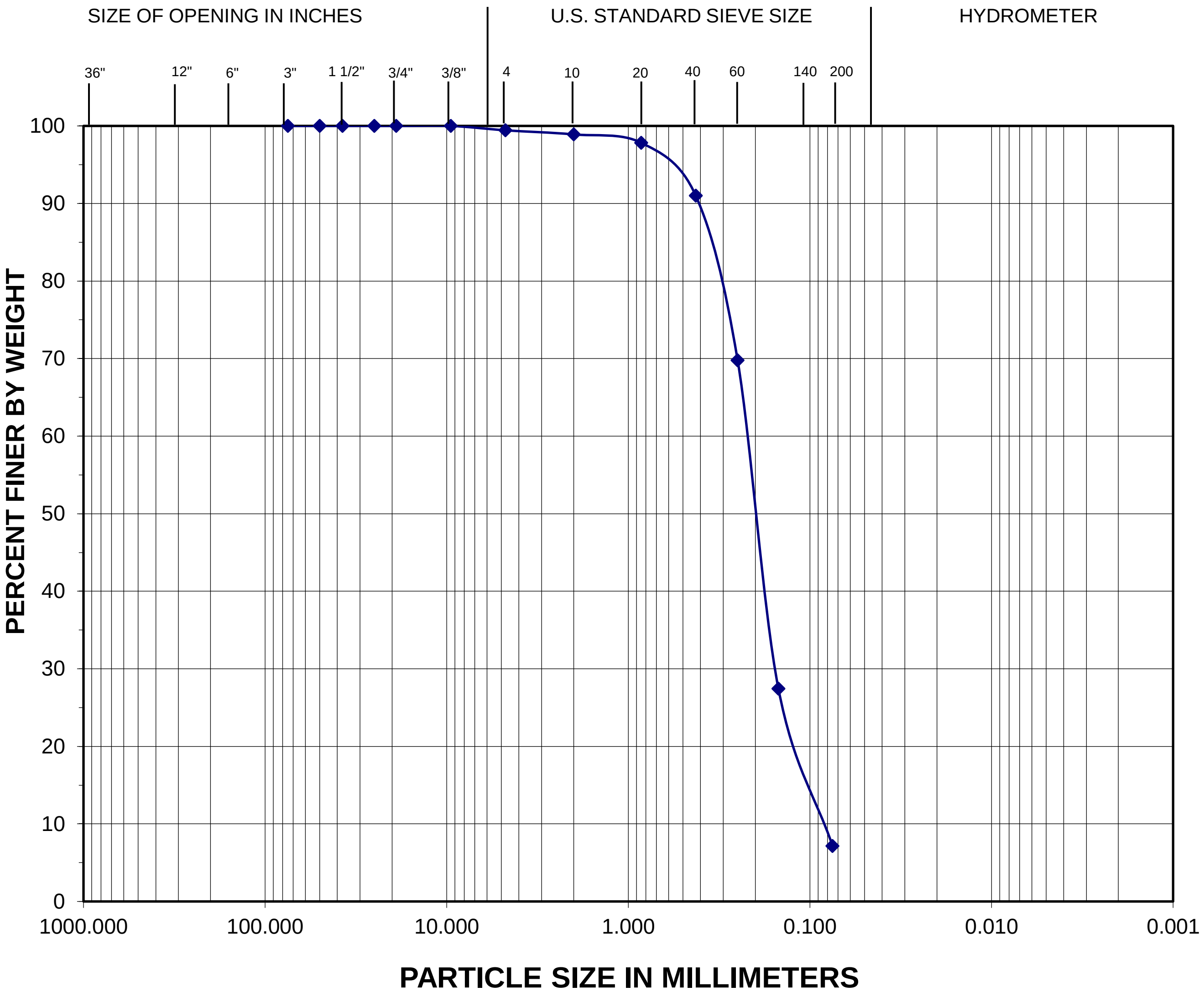
Project No.: 1128.01
DATE OF TESTING: 5/15/2013

PROJECT NAME:
Distribution Center

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D 422



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-2	S-2	4.0	21.7	7.2	SAND with some silt

Zipper Geo Associates, LLC
Geotechnical and Environmental Consultants

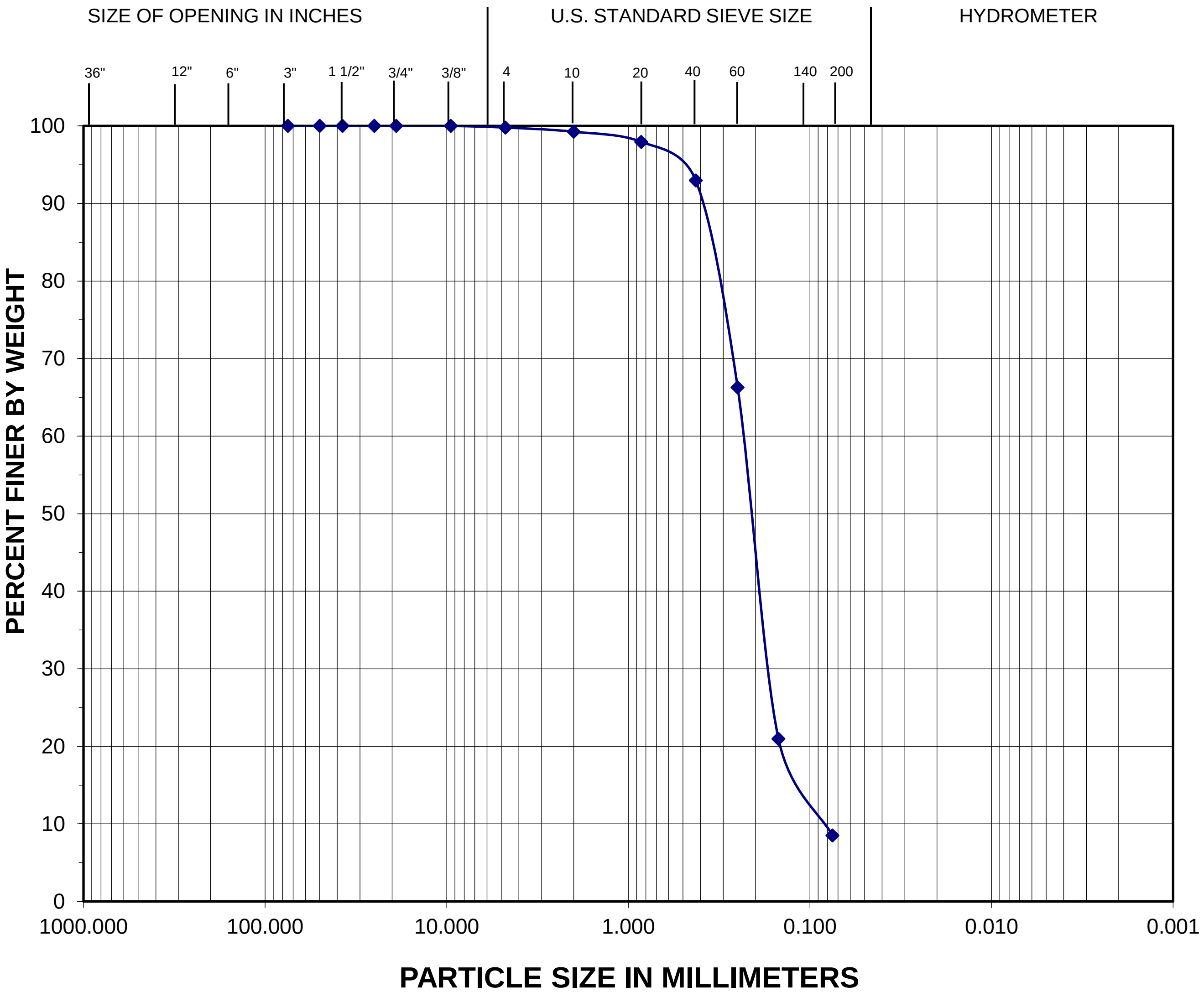
Project No.: 1128.01
DATE OF TESTING: 5/15/2013

PROJECT NAME:
Distribution Center

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D 422



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

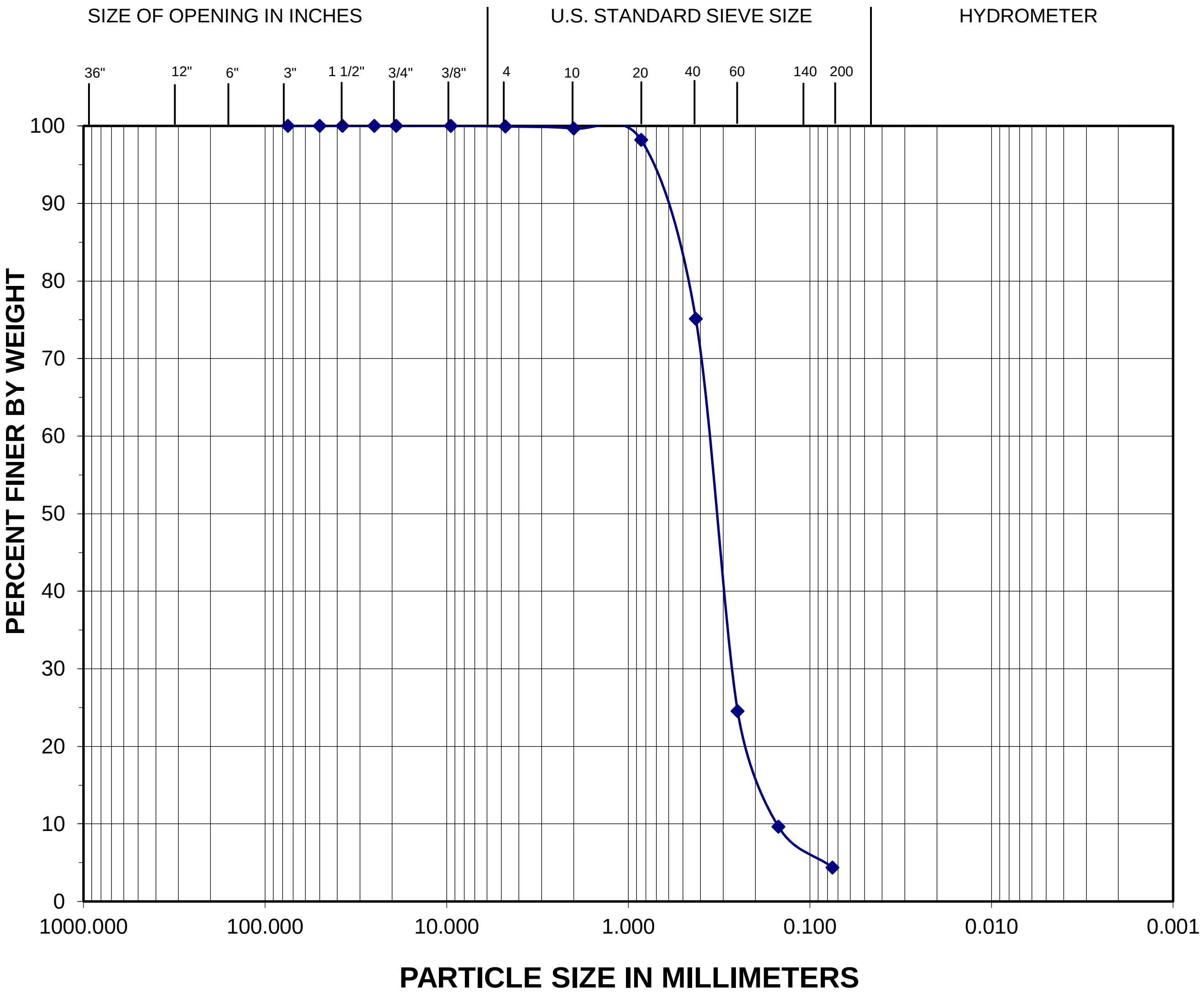
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-4	S-2	2.5	16.4	8.1	SAND with some silt

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	Project No.: 1128.01 DATE OF TESTING: 5/15/2013	PROJECT NAME: Distribution Center

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D 422



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

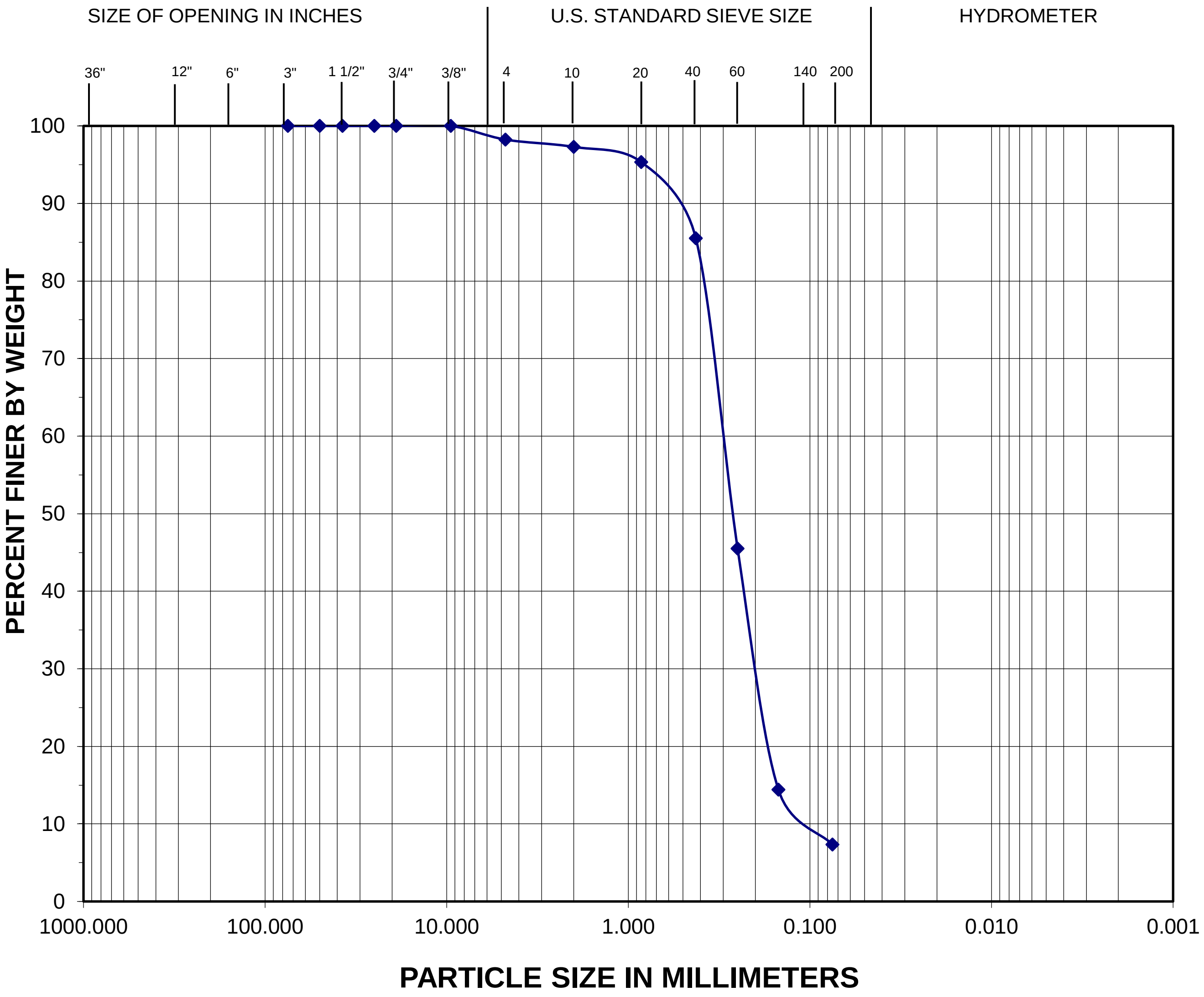
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-5	S-2	3.5	26.2	4.4	SAND with trace silt

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	Project No.: 1128.01 DATE OF TESTING: 5/15/2013	PROJECT NAME: Distribution Center

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D 422



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-7	S-2	2.0	17.0	6.2	SAND with some silt

Zipper Geo Associates, LLC
Geotechnical and Environmental Consultants

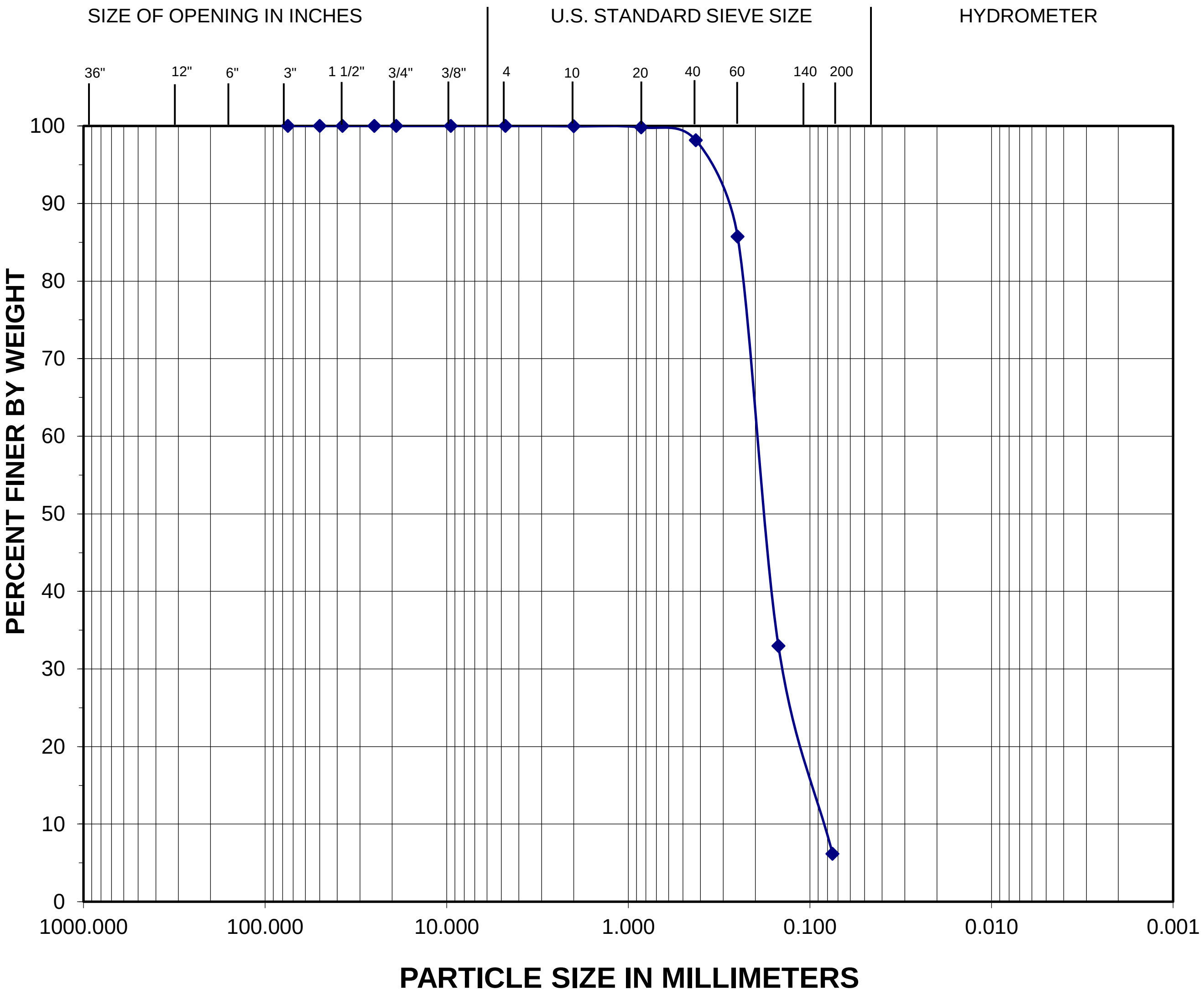
Project No.: 1128.01
DATE OF TESTING: 5/15/2013

PROJECT NAME:
Distribution Center

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D 422



BOULDERS	COBBLES	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
		GRAVEL		SAND			FINE GRAINED	

Comments:

Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-7	S-3	3.0	27.6	6.2	SAND with some silt

Zipper Geo Associates, LLC
Geotechnical and Environmental Consultants

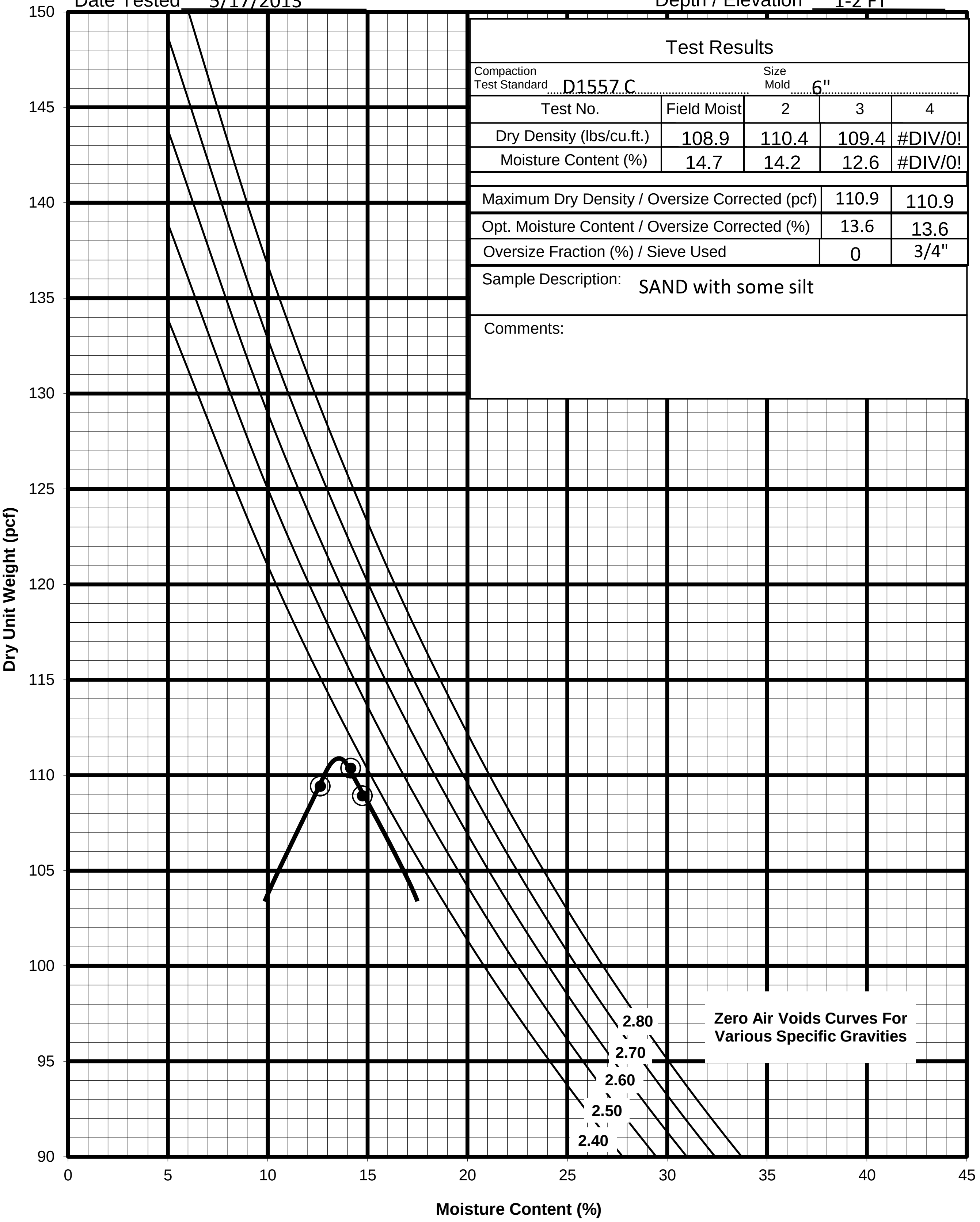
Project No.: 1128.01
DATE OF TESTING: 5/15/2013

PROJECT NAME:
Distribution Center

Job No. 1128.01
Job Name Marysville DC
Date Tested 5/17/2013

LABORATORY COMPACTION CURVE

Sample No. TP-6, S-2
Location See Fig 2.
Depth / Elevation 1-2 FT



Test Results

Compaction Test Standard D1557 C
Size Mold 6"

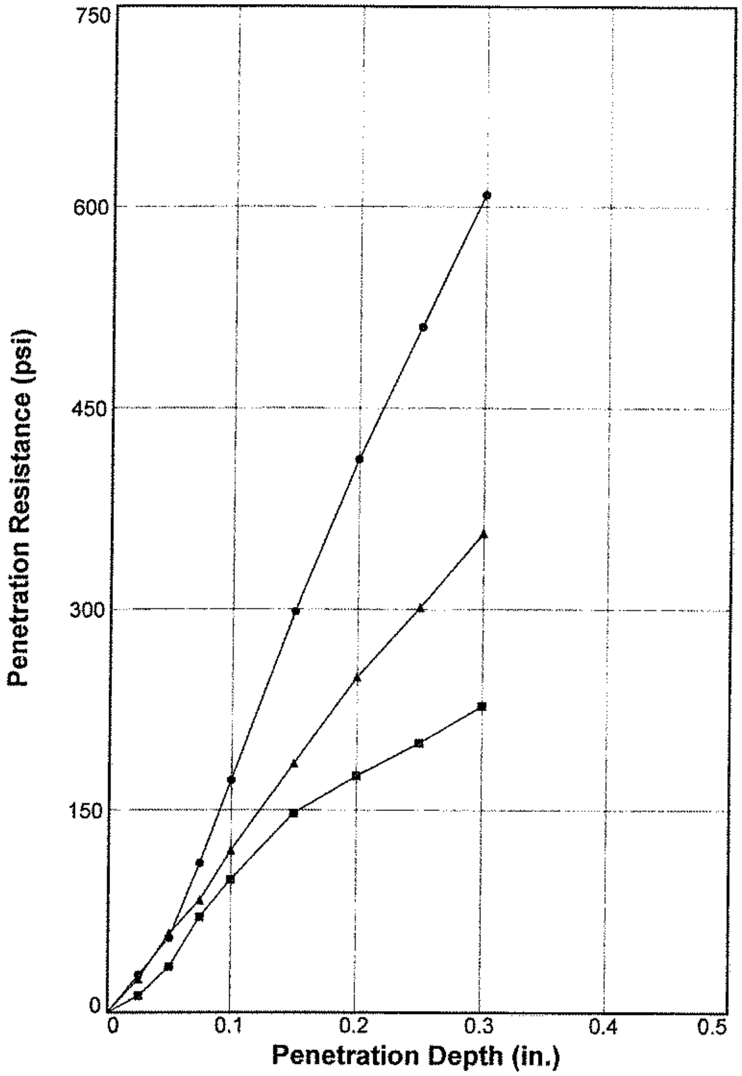
Test No.	Field Moist	2	3	4
Dry Density (lbs/cu.ft.)	108.9	110.4	109.4	#DIV/0!
Moisture Content (%)	14.7	14.2	12.6	#DIV/0!

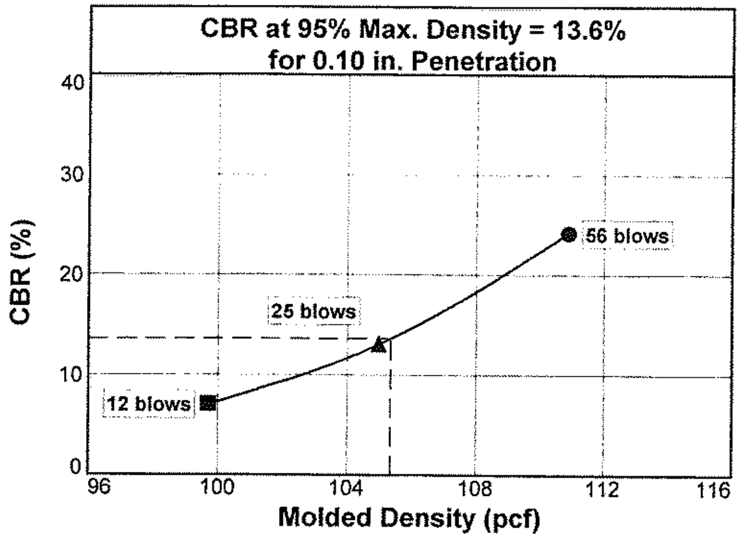
Maximum Dry Density / Oversize Corrected (pcf)	110.9	110.9
Opt. Moisture Content / Oversize Corrected (%)	13.6	13.6
Oversize Fraction (%) / Sieve Used	0	3/4"

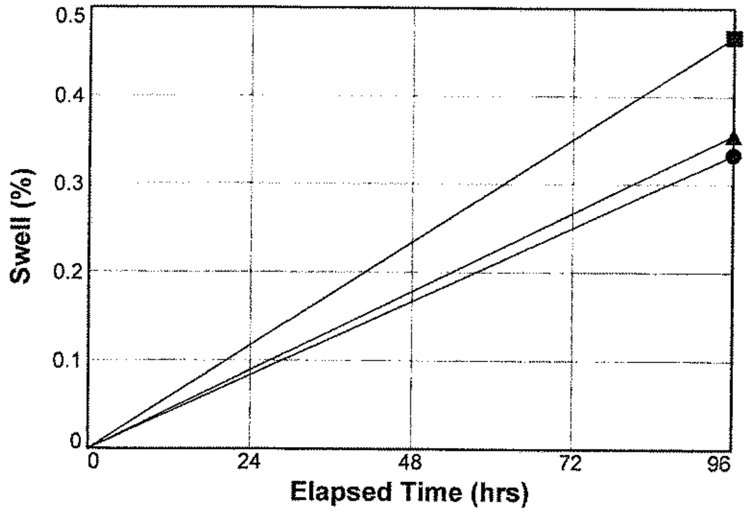
Sample Description: SAND with some silt

Comments:

BEARING RATIO TEST REPORT
ASTM D 1883-05




CBR at 95% Max. Density = 13.6%
for 0.10 in. Penetration



	Molded			Soaked			CBR (%)		Linearity Correction (in.)	Surcharge (lbs.)	Max. Swell (%)
	Density (pcf)	Percent of Max. Dens.	Moisture (%)	Density (pcf)	Percent of Max. Dens.	Moisture (%)	0.10 in.	0.20 in.			
1 ●	110.9	100	13.9	110.5	99.7	18.4	24.1	31.1	0.027	10	0.3
2 ▲	105.0	94.7	13.8	104.6	94.3	21.6	13.0	17.2	0.008	10	0.4
3 ■	99.7	89.9	13.5	99.3	89.5	23.5	7.0	10.7	-0.025	10	0.5

Material Description	USCS	Max. Dens. (pcf)	Optimum Moisture (%)	LL	PI
Yellowish-brown SAND with some silt.		110.9	13.6	NV	NP

Project No: 09613154

Project: Marysville DC - Lab

Location: Client Supplied; TP-6/S-2

Sample Number: 45494

Date: 5/17/13

Test Description/Remarks:

Sample ID: 45494.

Entire Gradation Used, No Oversize

2016 GEOTECHNICAL REPORT

REVISED GEOTECHNICAL ENGINEERING REPORT

PROPOSED UNDI COMMERCE PARK
14600 BLOCK SMOKEY POINT BOULEVARD
MARYSVILLE, WASHINGTON

Project No. 1128.01
September 25, 2016

Prepared for:
Smokey Point Investments

Prepared by:

ZGA

Zipper Geo Associates, LLC
Geotechnical and Environmental Consultants
19023 36th Avenue W., Suite D
Lynnwood, WA 9803

Zipper Geo Associates, LLC
Geotechnical and Environmental Consulting

Project No. 1128.01
September 25, 2016

Smokey Point Investments
4122 Factoria Boulevard SE, #402
Bellevue, Washington 98006

Attention: Mr. Shale Undi

Subject: ***Revised* Geotechnical Engineering Report**
Proposed Unid Commerce Park
14600 Block Smokey Point Boulevard
Marysville, Washington

Dear Mr. Undi:

In accordance with your request and written authorization, Zipper Geo Associates, LLC (ZGA) has completed this revised geotechnical engineering report for the proposed development of property located in the 14600 block of Smokey Point Boulevard in Marysville, Washington. ZGA previously completed a geotechnical report for the project dated June 24, 2013. At the time our previous report was completed, the project plans were at a conceptual level. We understand project plans progressed to near final. The purpose of this report is to provide an update to our previous report based on the most recent site and civil engineering plans. Our work was completed in general accordance with our Short Form Agreement (P1128.01 (1)) dated August 22, 2016. Written authorization to proceed was provided by you on August 23, 2016. We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Zipper Geo Associates, LLC

9/25/16

ROBERT A. ROSS
38384

Robert A. Ross, P.E.
Principal

(for) John E. Zipper, P.E.
Senior Consultant

Copies: Addressee (1)
Innova Architects – Connie Linden (1)

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Cover Photo Credit: Google Earth

REVISED GEOTECHNICAL ENGINEERING REPORT
PROPOSED UNDI COMMERCE PARK
14600 BLOCK SMOKEY POINT BOULEVARD
MARYSVILLE, WASHINGTON

Project No. 1128.01

September 25, 2016

INTRODUCTION

This report documents the surface and subsurface conditions encountered at the site and our geotechnical engineering recommendations for the proposed development of property located in the vicinity of 14600 Smokey Point Boulevard, Marysville, Washington. The project description, site conditions, and our geotechnical conclusions and design recommendations are presented in the text of this report. Supporting data including detailed exploration logs and field exploration procedures, results of laboratory testing and other supporting information are presented as appendices.

Our geotechnical engineering scope of services for the project included a literature review, site reconnaissance, subsurface exploration, laboratory testing, geotechnical engineering analysis, and preparation of this report. The subsurface evaluation consisted of completing 9 exploratory borings (designated B-1 through B-9) and 8 exploratory test pits. The conclusions and recommendations presented in this report are based on our review of civil engineering plans provided by Innova Architects including Site Development Phase 1 plans dated July 29, 2016 and Fill and Grade plans dated August 12, 2016. If changes in the referenced plans occur, we should be provided an opportunity to review them to assess the need to revise the conclusions and recommendations presented in this report and provide additional conclusions and recommendations if warranted.

PROJECT UNDERSTANDING

The project site consists of several parcels of undeveloped land totaling approximately 27.5 acres located in the vicinity of the 14600 Block of Smokey Point Boulevard in Marysville, Washington. Based on our review of the above-referenced plans, we understand the proposed development will consist of constructing four new buildings on the site and related site improvements. The buildings will be single story, concrete tilt up type construction with concrete slab-on-grade floors. A site plan showing the proposed building locations and slab subgrade elevations is provided on the attached Figure 1, Site and Exploration Plan.

Grading in the vicinity of the buildings will consist primarily of fills with a thickness ranging from about 1 to about 8 feet maximum. The project will include construction of a 153,000 (approximate) square foot stormwater control pond located in the southeast portion of the site. Grading for the pond will consist of cuts on the order of about 2 to 3 feet on the interior of the pond and fills around the perimeter with a thickness of about 3 to 5 feet. The proposed pond bottom elevation is 99.0 feet. We understand that the stormwater design for the project will not utilize infiltration.

The project will include related site improvements consisting of underground utility infrastructure, heavy-duty asphalt and/or concrete pavements to support truck traffic, and light duty pavements for support of passenger vehicle traffic and underground utilities.

SURFACE CONDITIONS

The approximate location of the project site is shown on the enclosed *Vicinity Map, Figure 1*. The project site is bordered to the north mostly by undeveloped land; to the south by developed industrial property; to the east by developed and undeveloped commercial/industrial property; and to the west by Smokey Point Boulevard.

Topographically, the project site slopes very gently downward to the south. Total vertical relieve from the north to south property boundaries is about 4 feet over a distance of about 1,000 feet. However, the northern half of the property is a few feet higher than the south half. The difference in elevation between these areas appears to be the result of grading activities (filling) that occurred in the past. Vegetation on about two-thirds of the project site consists of grass and sparse deciduous brush and trees. Vegetation on the remaining one-third of the project site consists of dense trees and brush.

There are several surface water drainage features on the project site. Near the northeast corner of the project site, there is an existing stormwater pond. Based on our review of aerial imagery and site observations, generally permanent ponded water occurs in the northern reaches of this existing stormwater pond. This area is likely below the groundwater elevation. The project topographic survey indicates water ponds in the area at about elevation 101 feet. The existing stormwater pond discharges to a ditch that parallels the east edge of the site. Based on our review of City of Marysville stream classification mapping, the ditch that parallels the east edge of the site is a “Non-regulated” stream. There is an existing drainage ditch that bisects the site from east to west near the center of project site. Standing water was not observed in the east drainage ditch nor the central drainage ditch during our site visits in May, 2013.

There are underground utilities on the site. Specifically, an existing sanitary sewer that crosses the site from east to west near the middle of the site. An existing gas main apparently parallels the sanitary sewer a few feet south.

SUBSURFACE CONDITIONS

Regional Geology

We assessed the geologic setting of the site and the surrounding vicinity by reviewing the following publication:

- *Geologic Map of the Arlington West 7.5 Minute Quadrangle.* U.S. Geologic Survey, Map MF-1740, 1985.

The above-referenced geologic mapping indicates the site is underlain by Vashon Recessional Outwash, Marysville Sand Member. The Marysville Sand Member is described as mostly well-drained, stratified to massive outwash sand, some fine gravel, and some areas of silt and clay. The sediments were deposited by melt water flowing south from the stagnating and receding Vashon glacier. The Marysville Sand is reported to be at least 20 meters thick and may be twice that and likely underlain by Vashon Till.

Soil Conditions

The subsurface evaluation for this project included 8 borings (B-1 to B-8) and 8 test pits (TP-1 to TP-8) completed across the project site. Borings B-1 to B-3 and B-5 to B-8 were advanced to a maximum depth of about 26.5 feet below existing site grades. Boring B-4 was advanced to a depth of about 51.5 feet below existing site grade. All borings were completed with hollow stem auger methods and fluid inside the auger to control heave. Tests pits were advanced to depths ranging from about 7 to 15 feet below existing site grade. The approximate exploration locations are shown on the *Site and Exploration Plan, Figure 2*. Soils were visually classified in general accordance with the Unified Soil Classification System. Descriptive logs of the subsurface explorations and the procedures utilized in the subsurface exploration program are presented in *Appendix A*. A generalized description of soil conditions encountered in the borings is presented below. Detailed descriptions of soils encountered are provided on the descriptive logs in *Appendix A*.

Borings B-1 to B-3 and test pits TP-1 to TP-3 were completed in the north half of the site in an area that appears to have been filled in the past. Surficial soil conditions observed in these borings generally consisted of about 5 to 8 inches of topsoil; however, in some explorations, about 6 inches of crushed gravel fill was observed. Below the surficial conditions, soils observed in explorations TP-1, TP-2, and B-1 to B-3 consisted of medium dense to dense, silty sand with variable gravel content (fill) extending to about 1 to 6 feet below existing site grades. Soils observed below the fill generally consisted of medium dense sands with trace to some silt to the completion depths. Test pit TP-8 was completed through an existing stockpile of fill material located near the northwest corner of the project site. Soils observed in this test pit generally consisted of silty sand with gravel, scattered coobles, wood waste and pieces of plastic conduit.

Surficial soil conditions observed in the remainder of the explorations completed on the project site generally consisted of about 6 to 18 inches of forest duff and/or topsoil. The forest duff and topsoil were generally underlain by loose to medium dense, mottled fine sand with variable silt content extending to a depth of about 3 ½ to 4 ½ feet below existing site grades. Thin lenses of discontinuous silt layers were observed within the mottled fine sand in some of the explorations. Soil conditions observed below the mottled sand generally consisted of medium dense to dense sands with trace to some silt. However, in boring B-4, very stiff, sandy silt was encountered between about 38 to 48 feet below existing site grade.

Groundwater Conditions

Groundwater was observed in all explorations completed for this study with the exception of test pit TP-8. In explorations completed through fill soils in the northern region of the project site, groundwater was observed at about 4 to 6 feet below existing site grades. In the remainder of the explorations, groundwater was observed at about 3 to 4 feet below existing site grades. Groundwater seepage rates observed in test pit explorations was rapid. Extending test pit explorations below the groundwater table was difficult as severe caving of the excavation sidewalls was experienced below the groundwater table. Groundwater observed in the explorations is interpreted to be a regional shallow aquifer within the Marysville Sand unit. The saturated zone of this aquifer is estimated to be as thick as the sand unit (20 to 40 meters).

During conceptual development of this project, a groundwater monitoring well was installed about 1800 feet south of the south project site property boundary. The monitoring well was installed in May of 2013 and monitored through December of 2013. Measurements of groundwater levels in the well indicated a low water elevation of about 4.5 feet below existing grade in August to a high water elevation of about 2 feet below existing grade in December.

As related to another project, two groundwater monitoring wells were installed about 1,300 feet southwest of the project site. These monitoring wells were installed in November of 2014 and monitored through June of 2014. Measurements of groundwater levels in the wells indicated a low water elevation of about 4 to 5 feet below existing site grade in June of 2014 and a high water elevation of about 2.6 feet between the months of December through March.

The above groundwater monitoring well information suggests groundwater elevations fluctuate in the project vicinity between about 2 feet below the natural ground surface in the winter months to about 3 to 5 feet in the summer months. Excavations that extend below the groundwater table for this project will require dewatering as discussed subsequently in this report.

Fluctuations in groundwater levels will likely occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the explorations were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher than predicted in this report. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

Summary of Laboratory Testing

Laboratory testing was completed on selected samples obtained from our borings. Testing completed included moisture content, grain size analysis, moisture density (Proctor) and California Bearing Ratio (CBR) testing. A summary of test results is provided in the following paragraphs. Detailed lab testing results can be found in Appendix B.

Moisture content testing was completed on several samples obtained from above the groundwater table to evaluate the suitability for reuse of site soils as structural fill. Testing results indicate moisture contents (at the time of exploration) of samples obtained within the upper 2.5 feet of existing site grades ranged from about 11 to 28 percent. A modified Proctor (ASTM D1557) test was completed on a bulk sample of the sands obtained from test pit TP-6 at a depth of 1 to 2 feet below existing site grade. The test indicated an optimum moisture content of about 14 percent and a maximum dry density of about 111 pounds per cubic foot.

Grain size analysis testing was completed on a total of six samples. Grain size analyses of sand samples obtained from on-site explorations within the upper 4 feet of existing site grades contain about 4.5 to 8 percent fines. Grain site analysis of one sample obtained from off-site boring B-9 at a depth of 1 foot indicated a fines content of about 18.4 percent.

A CBR test was completed on a bulk sample obtained from test pit TP-6 at a depth of 1 to 2 feet below existing site grade. The test indicated a CBR of 13.6%.

CONCLUSIONS AND RECOMMENDATIONS

General

Based on our subsurface exploration program and associated research, we conclude that the proposed development is feasible from a geotechnical standpoint, contingent on proper design and construction practices and implementation of the recommendations presented in this report. Geotechnical engineering recommendations for foundation systems and other earthwork related phases of the project are outlined below. The recommendations contained in this report are based upon the results of field and laboratory testing (which are presented in *Appendices A and B*), engineering analyses, and our current understanding of the proposed project. ASTM and Washington State Department of Transportation (WSDOT) specification codes cited herein respectively refer to the current manual published by the American Society for Testing & Materials and the current edition of the *Standard Specifications for Road, Bridge, and Municipal Construction, (M41-10)*.

Seismic Design Considerations

The tectonic setting of western Washington is dominated by the Cascadia Subduction Zone formed by the Juan de Fuca plate subducting beneath the North American Plate. This setting leads to intraplate, crustal, and interplate earthquake sources. Seismic hazards relate to risks of injury to people and damage to property resulting from these three principle earthquake sources.

The seismic performance of the development was evaluated relative to seismic hazards resulting from ground shaking associated with a design seismic event as specified in the 2009 International Building Code (IBC). Conformance to the above criteria for seismic excitation does not constitute any kind of guarantee or assurance that significant structural damage or ground failure will not occur if a design seismic event occurs. The primary goal of the IBC seismic design procedure is to protect life and not to avoid all damage, since such design may be economically prohibitive. Following a major earthquake, a building may be damaged beyond repair, yet not collapse. The results of our seismic hazard analyses and recommended seismic design parameters are presented in the following sections.

Ground Surface Rupture: Based on our review of the USGS Quaternary age fault database for Washington State, there does not appear to be a mapped Quaternary fault within a 10 mile radius of the site. Based on the reviewed database, the risk of ground surface rupture at the site is low.

Landsliding: Based on the relatively flat topography of the site and surrounding vicinity, the risk of earthquake-induced landsliding is low.

Soil Liquefaction: Liquefaction is a phenomenon wherein saturated cohesionless soils build up excess pore water pressures during earthquake loading. Liquefaction typically occurs in loose soils, but may occur in denser soils if the ground shaking is sufficiently strong. The potential hazardous impacts of liquefaction include liquefaction-induced settlement and lateral spreading. ZGA completed a liquefaction analysis for the 2009 IBC design earthquake. Our liquefaction analysis was completed in general accordance with the procedures presented in the *Evaluation of Liquefaction Hazards in Washington State, WSDOT Research Report WA-RD 668.1, December 2008* prepared by Professor Steven L. Kramer at the University of Washington. In general, the procedure includes 1) evaluating if the site soils are susceptible to liquefaction, 2) determining if liquefaction will likely be initiated during the seismic event of interest, and 3) estimating the effects of liquefaction such as settlement and lateral spread.

Our liquefaction analyses for the proposed development was based on the deepest boring completed, boring B-4 and site-specific laboratory testing results. In general, site soils encountered within potential liquefaction depths for this evaluation included post-glacial, medium dense sands with trace to some silt. The approximate location of boring B-4 is depicted on the enclosed *Site and Exploration Plan, Figure 2*.

Liquefaction Susceptibility: We evaluated the susceptibility of the site soils on a Deposit-Level and Layer-Level in general accordance with Sections 4.2 and 4.4 of the referenced 2008 WSDOT report. Based on our evaluation, the post-glacial sand deposits are considered to have a low to moderate potential for liquefaction. For the IBC design event, our analysis indicates factors of safety against liquefaction ranging from approximately 1.0 to about 2.8.

Liquefaction Settlement: We estimate total liquefaction-induced settlement resulting from the IBC design event would be less than 1 inch. Differential seismic settlement is estimated to be ½ inch or less in 40 feet.

Lateral Spread: Lateral spreading is a phenomenon in which soil deposits which underlie a site can experience significant lateral displacements associated with the reduction in soil strength caused by soil liquefaction. This phenomenon tends to occur most commonly at sites where the soil deposits can flow toward a "free-face", such as a water body. Due to the lack of a "free-face" condition, the risk of lateral spreading at the site is low for the IBC design earthquake.

IBC Seismic Design Parameters**:** Based on site location and soil conditions, the values provided below are recommended for seismic design. The values provided below are based on the 2009 IBC as the building code reference document which makes use of 2002 USGS hazard data. Upon request, we can provide seismic design parameters based on the 2012 IBC as the building code reference document.

SUMMARY OF IBC SEISMIC DESIGN PARAMETERS

Description	Value
2009 IBC Site Classification [1]	D [1]
S_s Spectral Acceleration for a Short Period	1.064 g (Site Class B)
S_1 Spectral Acceleration for a 1-Second Period	0.368 g (site Class B)
F_a Site Coefficient for a Short Period	1.073 (Site Class D)
F_v Site Coefficient for a 1-Second Period	1.665 (Site Class D)
S_{MS} Maximum considered spectral response acceleration for a Short Period	1.145 g (Site Class D)
S_{M1} Maximum considered spectral response acceleration for a 1-Second Period	0.612 g (Site Class D)
S_{DS} Five-percent damped design spectral response acceleration for a Short Period	0.763 g (Site Class D)
S_{D1} Five-percent damped design spectral response acceleration for a 1-Second Period	0.408 g (Site Class D)

1. In general accordance with the *2009 International Building Code,* Table 1613.5.2. IBC Site Class is based on the average characteristics of the upper 100 feet of the subsurface profile.
2. The borings completed for this study extended to a maximum depth of 51.5 feet below grade. ZGA therefore determined the Site Class assuming that medium dense alluvial soils extend to 100 feet as suggested by published geologic maps for the project area.
3. Per 2009 IBC, Table 1613.5.2, any profile containing soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils.

Site Preparation

Erosion Control Measures: Stripped surfaces and soil stockpiles are typically a source of runoff sediments. We recommend that silt fences, berms, and/or swales be installed around the downslope side of stripped areas and stockpiles in order to capture runoff water and sediment. If earthwork occurs during wet weather, we recommend that all stripped surfaces be covered with straw to reduce runoff erosion, whereas soil stockpiles should be protected with anchored plastic sheeting.

Temporary Drainage: Stripping, excavation, grading, and subgrade preparation should be performed in a manner and sequence that will provide drainage at all times and provide proper control of erosion. The site should be graded to prevent water from ponding in construction areas and/or flowing into and/or over excavations. Exposed grades should be crowned, sloped, and smooth-drum rolled at the end of each day to facilitate drainage if inclement weather is forecasted. Accumulated water must be removed from subgrades and work areas immediately and prior to performing further work in the area. Equipment access may be limited and the amount of soil rendered unfit for use as structural fill may be greatly increased if drainage efforts are not accomplished in a timely manner.

Demolition, Clearing, and Stripping: Based on conditions encountered in our borings, we expect stripping depths on the project site to remove forest duff and topsoil to vary from about 6 inches up to 1.5 feet. There are relic portions of previously existing buildings/houses in local areas along the west side of the project site. All elements of these previously existing structures should be demolished and properly disposed of off site.

Subgrade Preparation: Once site preparation is complete, all areas that are at design subgrade elevation or areas that will receive new structural fill should be compacted to a firm and unyielding condition. As indicated above, groundwater levels at the site are fairly shallow. Compaction of the subgrade should be achieved by *static* rolling with a heavy, smooth drum compactor. Vibratory compaction of the subgrade at this site will tend to increase pore water pressure in soils below the groundwater table resulting in “pumping” of the subgrade. Some moisture conditioning of site soils may be required to achieve an appropriate moisture content for compaction within ±2 percent of the soils laboratory optimum moisture content. Our laboratory testing indicates that, at the time our explorations were completed, *insitu* moisture contents of the surficial soils were up to 28 percent at the time of drilling. Optimum moisture content of a sample of the near-surface sands tested for this report was 14 percent. As a result, moisture conditioning of site soils during construction may be required to achieve suitable moisture contents (plus or minus two percent of optimum) for compaction in areas. During wet weather, the surficial sands will quickly become unstable and soft.

Once compacted, subgrades should be evaluated through proof rolling with a loaded dump truck or heavy rubber-tired construction equipment weighing at least 20 tons to assess the subgrade adequacy and to detect soft and/or yielding soils. In the event that soft or yielding areas are detected during proof rolling, the upper 12 inches of subgrade should be scarified, moisture conditioned and re-compacted as necessary to obtain at least 95 percent of the maximum laboratory density (per ASTM D1557) and a firm, non-yielding condition. Those soils which are soft, yielding, or unable to be compacted to the specified criteria should be over-excavated and replaced with suitable material as recommended in the *Structural Fill* section of this report. As an alternate to subgrade compaction during wet site conditions or wet weather, the upper 12 inches of subgrade should be overexcavated to a firm, non-yielding and undisturbed condition and backfilled with compacted imported structural fill consisting of free-draining Gravel Borrow or crushed rock. In the event that wet site conditions preclude proof rolling the subgrade, a ZGA representative should evaluate the conditions via hand probing.

Once subgrades are compacted, it may be desirable to protect prepared subgrades such as building pads or haul roads. To protect stable subgrades, we recommend using crushed rock, crushed recycled concrete, or pitrun sand and gravel. The thickness of the protective layer should be determined at the time of construction and be based on the moisture condition of the soil and the amount of anticipated traffic.

Earthwork should be completed during drier periods of the year when soil moisture content can be controlled by aeration and drying. If earthwork or construction activities take place during extended periods of wet weather, exposed site soils will quickly become unstable or not be compactable. In the event the exposed subgrade becomes unstable, yielding, or unable to be compacted due to high moisture conditions, we recommend that the materials be removed to a sufficient depth in order to develop stable subgrade soils that can be compacted to the minimum recommended levels. The severity of construction problems will be dependent, in part, on the precautions that are taken by the contractor to protect the subgrade soils.

<u>Subgrade Preparation at Existing Stormwater Pond Location</u>: As part grading, the existing stormwater pond located in the northeast portion of the site will be filled. As discussed above, the northern approximately 75 feet (or more during wet weather) of the existing pond may contain ponded water during construction. There is likely some thickness of "pond muck" in this area that may require removal during construction. The necessity for removal should be addressed during construction by a representative from Zipper Geo Associates based on observation and probing. Filling in the submerged

areas of the pond should consist of an initial lift of quarry spalls that extends to 1 foot above the ponded water elevation. The spalls should be choked off or capped at the top with 6 inches of material meeting the requirements for Permeable Ballast as specified in Section 9-03.9(2) of the WSDOT Standard Specifications. Subgrade preparation in other areas of the pond not submerged should be in accordance with the general subgrade preparation recommendations provided above.

Freezing Conditions: If earthwork takes place during freezing conditions, all exposed subgrades should be allowed to thaw and then be compacted prior to placing subsequent lifts of structural fill. Alternatively, the frozen material could be stripped from the subgrade to expose unfrozen soil prior to placing subsequent lifts of fill or foundation components. The frozen soil should not be reused as structural fill until allowed to thaw and adjusted to the proper moisture content, which may not be possible during winter months.

Structural Fill Materials and Preparation

Structural fill includes any material placed below foundations and pavement sections, within utility trenches, and behind retaining walls. Prior to the placement of structural fill, all surfaces to receive fill should be prepared as previously recommended in the *Site Preparation* section of this report.

Laboratory Testing: We recommend that representative samples of proposed imported materials be submitted for laboratory testing at least one week prior to use. Tests completed on the samples should include moisture content, grain size analysis and modified proctor. These tests will provide an indication of the suitability of the material for use as structural fill and an indicator of support characteristics.

Re-Use of Site Soils as Structural Fill: Field and laboratory test data indicates that the native soils encountered on the site are suitable for re-use as general structural fill from a compositional standpoint provided the soil is placed and compacted in accordance with the compaction recommendations presented in this report. We expect that site grades will be raised and therefore re-use of site soils for structural fill will generally be limited to underground utility work. As indicated above, site soils at the time of our evaluation were wet of optimum. Additionally, excavations that extend more than about two to three feet below existing site grades in the non-filled portion of the site will encounter groundwater. As a result, we expect drying of wet, over-optimum soils will be required for re-use of site soils as structural fill. Drying of over-optimum moisture soils may be achieved by scarifying or windrowing surficial materials during extended periods of dry weather. If encountered, soils which are dry of optimum may be moistened through the application of water and thorough blending to facilitate a uniform moisture distribution in the soil prior to compaction.

We recommend that site soils used as structural fill have less than 4 percent organics by weight and have no woody debris greater than ½ inch in diameter. We recommend that all pieces of organic material greater than ½ inch in diameter be picked out of the fill before it is compacted. Any organic-rich soil derived from earthwork activities should be utilized in landscape areas or wasted from the site.

Imported Structural Fill: Imported structural fill may be required for raising site grades or for other reasons. The appropriate type of imported structural fill will be mostly dependent on weather and desired support characteristics. During dry weather, lesser quality fill such as Common Borrow can be used. However, during wet weather, higher quality, free draining fill such as Gravel Borrow is typically required. The appropriate type of imported fill will also depend on the desired support characteristics. Specifically, the use of high-quality fill such as Gravel Borrow for raising site grades under heavily loaded pavements or building foundations will result in higher-quality support characteristics as compared to Common Borrow. Higher quality support characteristics result in thinner pavement sections and higher allowable bearing pressures for building foundations. The *Building Foundations* and *Pavements* sections of this report provide recommendations for both high- and low-quality fills. The following paragraphs present general recommendations regarding imported structural fills.

During extended periods of dry weather, we recommend imported fill, at a minimum, meet the requirements of Common Borrow as specified in Section 9-03.14(3) of the 2012 Washington State Department of Transportation, *Standard Specifications for Road, Bridge, and Municipal Construction* (WSDOT Standard Specifications). During wet weather, higher-quality structural fill might be required, as Common Borrow may contain sufficient fines to be moisture sensitive. During wet weather we recommend that imported structural fill meet the requirements of Gravel Borrow as specified in Section 9-03.14(1) of the WSDOT Standard Specifications.

Existing Pond Submerged Areas Fill: As discussed above in the Subgrade Preparation section of this report, then northern approximately 75 feet (or more during wet weather) of the existing stormwater pond located in the northeast portion of the site may contain standing water. Fill placed below the water surface in this area should consist of 4 to 6 inch quarry spalls extending to one foot above the water surface elevation. The spalls should be tamped in-place with an excavator bucket to produce a firm and unyielding surface. The spalls should be capped with 6 inches of material meeting the requirements or Permeable Ballast as specified in Section 9-03.9(2) of the WSDOT Standard Specifications.

Retaining Wall Backfill: Retaining walls should include a drainage fill zone extending at least two feet back from the back face of wall for the entire wall height. The drainage fill should meet the requirements of Gravel Backfill for Walls as specified in Section 9-03.12(2) of the WSDOT Standard Specifications.

Moisture Content: The suitability of soil for use as structural fill will depend on the time of year, the moisture content of the soil, and the fines content (that portion passing the U.S. No. 200 sieve) of the soil. As the amount of fines increases, the soil becomes increasingly sensitive to small changes in moisture content. Soils containing more than about 5 percent fines (such as the near-surface on-site soils) cannot be consistently compacted to the appropriate levels when the moisture content is more than approximately 2 percent above or below the optimum moisture content (per ASTM D1557). Optimum moisture content is that moisture content which results in the greatest compacted dry density with a specified compactive effort.

Fill Placement: Structural fill should be placed in horizontal lifts not exceeding 10 inches in loose thickness. Each lift of fill should be compacted using compaction equipment suitable for the soil type and lift thickness. Each lift of fill should be compacted to the minimum levels recommended below based on the maximum laboratory dry density as determined by the ASTM D1557 Modified Proctor Compaction Test. Moisture content of fill at the time of placement should be within plus or minus 2 percent of optimum moisture content for compaction as determined by the ASTM D1557 test method.

Compaction Criteria: Our recommendations for soil compaction are summarized in the following table. Structural fill for roadways and utility trenches in municipal rights-of-way should be placed and compacted in accordance with the jurisdiction codes and standards. We recommend that a geotechnical engineer be present during grading so that an adequate number of density tests may be conducted as structural fill placement occurs. In this way, the adequacy of the earthwork may be evaluated as it proceeds.

RECOMMENDED SOIL COMPACTION LEVELS

Location	**Minimum Percent Compaction***
Stripped native subgrade soils, prior to fill placement (upper 12 inches), except infiltration areas	Firm and Unyielding Condition
Footing subgrades, fill or native (upper 12 inches)	95
All fill below building floor slabs and foundations	95
Upper 2 feet of fill below floor slabs and pavements	95
Pavement fill below two feet	90
Retaining wall backfill less than 3 feet from wall	90
Retaining wall backfill more than 3 feet from wall	95
Upper two feet of utility trench backfill	95
Utility trenches below two feet	90
Landscape Areas	90

* *ASTM D1557 Modified Proctor Maximum Dry Density*

Placing Fill on Slopes: Permanent fill placed on slopes steeper than 5H:1V (Horizontal: Vertical) should be keyed and benched into natural soils of the underlying slope. We recommend that the base downslope key be cut into undisturbed native soil. The key slot should be at least 8 feet wide and 3 feet deep. The hillside benches cut into the native soil should be at least 4 feet in width. The face of the embankment should be compacted to the same relative compaction as the body of the fill. This may be accomplished by over-building the embankment and cutting back to the compacted core. Alternatively, the surface of the slope may be compacted as it is built, or upon completion of the embankment fill placement.

Construction Dewatering

Groundwater was observed in all explorations completed for this project. Groundwater flow rates into excavations that extend below the groundwater table at this site will be moderate to high. Based on our experience with other Marysville projects, dewatering methods for excavations that extend below the groundwater in Marysville Sand typically consisted of well points. For reference and planning purposes, a project completed in 2013 near the subject site used jetted wells installed at 15 feet on center to a depth of about 25 feet below existing site grades for dewatering.

Dewatering should be expected for this project for excavations that extend below the groundwater table. The appropriate type of dewatering system should be determined by the contractor based on the conditions encountered, and should be designed and maintained by the contractor. We recommend the contactor review the Groundwater section of this report along with proposed underground utility elevations and plan accordingly for dewatering.

Utility Trenches

We recommend that utility trenching conform to all applicable federal, state, and local regulations, such as OSHA and WISHA, for open excavations. Trench excavation safety guidelines are presented in WAC Chapter 296-155 and WISHA RCW Chapter 49.17.

Trench Dewatering: Excavations for utilities and underground structures that extend below the groundwater table should be expected to encounter moderate to heavy groundwater seepage. Some caving of utility trench sidewalls should be anticipated in association with groundwater seepage. We recommend that any excavations within groundwater seepage zones be undertaken only when suitable dewatering equipment and temporary excavation shoring are available, or where space is available to flatten the sidewalls. Dewatering should be expected for this project if utilities will extend below the groundwater table. The appropriate type of dewatering system should be determined by the contractor based on the conditions encountered, and should be designed and maintained by the contractor.

Utility Subgrade Preparation: We recommend that all utility subgrades be firm and unyielding and free of all soils that are loose, disturbed, or pumping. Such soils should be removed and replaced, if necessary. All structural fill used to replace over-excavated soils should be compacted as recommended in the *Structural Fill* section of this report. If utility foundation soils are soft, we recommend that they be over-excavated 12 inches and replaced with crushed rock.

Structures such as manholes and catch basins which extend into soft soils should be underlain by at least 12 inches of crushed rock fill compacted to at least 90 percent of the modified Proctor maximum dry density. This granular material could consist of crushed rock, quarry spalls, or coarse crushed concrete. Alternatively, quarry spalls or pea gravel could be used until above the water level. It may be necessary to place a geotextile fabric over the native subgrade soils if they are too soft, to provide a separation between the bedding and subgrade soils.

Bedding: We recommend that a minimum of 4 inches of bedding material be placed above and below all utilities or in general accordance with the utility manufacturer's recommendations and local ordinances. We recommend that pipe bedding consist of Gravel Backfill for Pipe Zone Bedding as specified in Section 9-03.12(3) of the WSDOT Standard Specifications. All trenches should be wide enough to allow for compaction around the haunches of the pipe, or material such as pea gravel should be used below the spring line of the pipes to eliminate the need for mechanical compaction in this portion of the trenches. If water is encountered in the excavations, it should be removed prior to fill placement.

Trench Backfill: Materials, placement and compaction of utility trench backfill should be in accordance with the recommendations presented in the *Structural Fill* section of this report. We recommend that the initial lift thickness not exceed one foot unless recommended by the manufacturer to protect utilities from damage by compacting equipment. Light, hand operated compaction equipment may be utilized directly above utilities if damage resulting from heavier compaction equipment is of concern.

Stormwater Pond Considerations

The project plans include an approximate 153,000 square foot stormwater detention pond located in the southern portion of the site. The proposed pond bottom elevation is 99 feet. The design maximum water surface elevation is 103.50 feet. Fill berms will be constructed along the east and south perimeters of the pond to contain water with a top elevation of 104.50 feet. General fill used to raise site grades will contain the water along the north and west sides.

Beyond the south and east perimeters of the proposed pond, the existing ground surface elevation is below the design maximum water surface elevation. The native soils exposed at the pond bottom elevation are expected to consist of relatively clean sands. Water building up on the interior of the pond will infiltrate through the relatively clean sands below the pond and raise the groundwater table outside the limits of the pond. Rising groundwater outside of the pond may daylight to the existing ditch east of the pond and may daylight to the south. In order to prevent flooding of areas outside of the pond, we recommend the pond include a low permeability liner to prevent pond water from infiltrating into the ground below. Other alteratives such as a seepage cutoff wall constructed around the east and south sides of the pond could be considered. However, considering a cutoff wall would need to be constructed below the groundwater table, this method may be economically unfavorable. Alternatives for low permeability liners include the following:

- Compacted till Liners
- Compacted clay liners
- Geomembrane liners
- Concrete Liners

Compacted till liners are typically more economical then clay liners. Till liners consist of a thickness of fill material that typically contains at least 30 percent passing the U.S. No. 200 sieve. The required thickness of a till liner is about 18 inches. An 18 inch till liner constructed below the pond bottom may likely result in excavations to construct the liner that would extend below the groundwater level, essentially making compaction of the liner impossible unless the pond excavation is dewatered. A compacted till liner may be feasible if constructed during the driest of summer months provided that the groundwater table is at least two feet below the bottom of the liner. Groundwater elevations observed in May 2013 in the vicinity of the proposed pond were at about elevation 99 feet. Groundwater monitoring wells at nearby sites (as discussed above) indicate groundwater might be as low as elevation 97.5 feet in August. Other concerns regarding a compacted till liner are as follows:

- There is no material on site that would meet the gradational requirements of a till liner. As such, the material would have to be imported. Additionally, 18 inches of soil below the pond bottom elevation would need to be over-excavated. This material could possibly be used as general fill in other areas of the site.
- Till material is weather-sensitive and is impossible to compact during wet weather.
- Use of a till liner would require that the east and south berms of the pond be constructed of a similar material to prevent seepage through the berms.

A geomembrane may be a more suitable alternative to line the proposed pond. Per the 2005 Department of Ecology Stormwater Management Manual for Wester Washington (SWMM), the design criteria (and our commentary) for geomembrane liners is as follows

- Geomembrane liners shall be ultraviolet (UV) light resistant and have a minimum thickness of 30 mils. A thickness of 40 mils shall be used in areas of maintenance access or where heavy machinery must be operated over the membrane.
- Geomembranes shall be bedded according to the manufacturer's recommendations.
- Liners shall be installed so that they can be covered with 12 inches of top dressing forming the bottom and sides of the water quality facility, except for liner sand filters. Top dressing shall consist of 6 inches of crushed rock covered with 6 inches of native soil. The rock layer is to mark the location of the liner for future maintenance operations. As an alternative to crushed rock, 12 inches of native

soil may be used if orange plastic "safety fencing" or another highly-visible, continuous marker is embedded 6 inches above the membrane.

- If possible, liners should be of a contrasting color so that maintenance workers are aware of any areas where a liner may have become exposed when maintaining the facility.
- Geomembrane liners shall not be used on slopes steeper than 5H:1V to prevent the top dressing material from slipping. Textured liners may be used on slopes up to 3H:1V upon recommendation by a geotechnical engineer that the top dressing will be stable for all site conditions, including maintenance.
    - The pond side slopes are currently proposed at 3H:1V. We recommend textured liner suitable for support of top dressing material inclined at 1 3H:1V angle be used.

There is a potential that the bottom of the liner will be located below the seasonal high groundwater elevation. Specifically, the pond bottom is proposed at elevation 99 feet. The existing ground surface in the vicinity of the pond is at about elevation 102. Groundwater monitoring data suggest a seasonal high groundwater elevation at about 2 feet (or elevation 100 feet) below existing site grade. We recommend the project team consult with a liner supplier to design a geomebrane liner for the pond. We recommend the pond liner be designed assuming a high groundwater elevation of 100 feet. The design should include a factor of safety against liner buoyancy.

The fill berms proposed along the east and south sides of the pond may require special design details. Specifically, if a compacted till liner is proposed, we recommend the pond berms be constructed using the till liner material. Additionally, the berms should be "keyed" into the subgrade in accordance with the 2005 SWMM requirements. If the pond will utilize a geomembrane liner, no special fill or keying is required for the south and east berms, in our opinion.

Temporary Shoring

We recommend that temporary shoring systems be used where excavations will be located adjacent to property lines, roadways or utilities, and might result in ground loss and damage to these facilities. A trench box is one type of support system which might be used. The zone between the trench box and the excavation face should be backfilled as necessary to limit ground movements. As an alternate, braced or unbraced shoring of various types could be considered. We anticipate that some form of temporary shoring system may be needed for utility installations, depending on their location and depth.

The lateral soil pressures acting on temporary excavation support systems will depend on the ground surface configuration adjacent to the trench, and the amount of lateral movement which can occur as the excavation is made. For support systems that are free to yield at the top at least one-thousandth of the height of the excavation, soil pressures will be less than if movements are limited by such factors as wall stiffness or bracing.

We recommend that yielding systems be designed using equivalent fluid densities of 35 and 85 pounds per cubic foot (pcf) for horizontal ground surfaces and ground surfaces inclined at 1.5H: 1V above the horizontal, respectively. For nonyielding systems, we recommend that the shoring be designed for a uniform lateral pressure of 25H in pounds per square foot (psf), where H is the depth of the planned excavation in feet below a level ground surface. Similarly, for a ground surface inclined at 1.5H: 1V, we recommend that nonyielding shoring be designed for a uniform lateral pressure of 55H.

The above recommended lateral soil pressures are based on a fully drained condition and do not include the effects of hydrostatic water pressures. In addition, the above values do not include the effects of surcharges (e.g., equipment loads, storage loads, traffic loads, or other surface loading). Hydrostatic water pressures and surcharge effects should be considered as appropriate.

Temporary and Permanent Slopes

Temporary excavation slope stability is a function of many factors, including:

- The presence and abundance of groundwater;
- The type and density of the various soil strata;
- The depth of cut;
- Surcharge loadings adjacent to the excavation; and
- The length of time the excavation remains open.

As the cut is deepened, or as the length of time an excavation is open, the likelihood of bank failure increases; therefore, maintenance of safe slopes and worker safety should remain the responsibility of the contractor, who is present at the site, able to observe changes in the soil conditions, and monitor the performance of the excavation.

It is exceedingly difficult under the variable circumstances to pre-establish a safe and “maintenance-free” temporary cut slope angle. Therefore, it should be the responsibility of the contractor to maintain safe temporary slope configurations since the contractor is continuously at the job site, able to observe the nature and condition of the cut slopes, and able to monitor the subsurface materials and groundwater conditions encountered. Unsupported vertical slopes or cuts deeper than 4 feet are not recommended if worker access is necessary. The cuts should be adequately sloped, shored, or supported to prevent injury to personnel from local sloughing and spalling. The excavation should conform to applicable Federal, State, and Local regulations.

According to Chapter 296-155 of the Washington Administrative Code (WAC), the contractor should make a determination of excavation side slopes based on classification of soils encountered at the time of excavation. Temporary cuts may need to be constructed at flatter angles based upon the soil moisture and groundwater conditions at the time of construction. Adjustments to the slope angles should be determined by the contractor at that time.

We recommend that all permanent cut or fill slopes constructed in native soils or with imported structural fill be designed at a 2H:1V (Horizontal: Vertical) inclination or flatter. If applicable, interior slopes of stormwater ponds should be inclined no steeper than 3H:1V.

All permanent cut and fill slopes should be adequately protected from erosion both temporarily and permanently. If the slopes are exposed to prolonged rainfall before vegetation becomes established, the surficial soils will be prone to erosion and possible shallow sloughing. We recommend covering permanent slopes with a rolled erosion protection material, such as Jute matting or Curlex II, if vegetation has not been established by the regional wet season (typically November through May).

Shallow Foundations

Based on our analyses, conventional spread footings will provide adequate support for the proposed building. We anticipate that foundation subgrade soils will generally consist of imported structural fill placed to raise site grades. Recommendations for shallow foundations are provided below.

<u>Allowable Bearing Pressure</u>: The allowable bearing capacity will be a function of the quality of fill used to raise site grades. Foundations supported on fill meeting the requirements for Common Borrow placed and compacted in accordance with this report may designed for a maximum allowable, net, bearing capacity of 2,000 psf. Foundations supported on fill meeting the requirements for Gravel Borrow placed and compacted in accordance with this report may be designed for a maximum allowable, net bearing capacity of 5,000 psf. A one-third increase of the bearing pressure may be used for short-term transient loads such as wind and seismic forces. The above-recommended allowable bearing pressure includes a 3.0 factor of safety.

<u>Shallow Foundation Depth and Width</u>: For frost protection, the bottom of all exterior footings should bear at least 18 inches below the lowest adjacent outside grade, whereas the bottoms of interior footings should bear at least 12 inches below the surrounding slab surface level. We recommend that all continuous wall and isolated column footings be at least 12 and 24 inches wide, respectively.

<u>Lateral Resistance</u>: Resistance to lateral loads can be developed through passive earth pressure on embedded foundation elements and base frictional resistance of foundation elements. For foundations support on and buried in Common Borrow fill, lateral resistance may be calculated assuming an ultimate passive resistance of 400 pcf equivalent fluid pressure (triangular distribution) and an ultimate base friction coefficient of 0.40. For foundations support on and buried in Gravel Borrow fill, lateral resistance may be calculated assuming an ultimate passive resistance of 500 pcf equivalent fluid pressure (triangular distribution) and an ultimate base friction coefficient of 0.55. An appropriate

safety factor (or load/resistance factors) should be included for calculating resistance to lateral loads. For allowable stress design, we recommend a minimum 1.5 safety factor. We recommend that passive resistance be neglected in the upper 18 inches of embedment.

Estimated Static Settlement: Assuming the foundation subgrade soils are prepared in accordance with recommendations presented herein, we estimate that total and differential static settlements will be approximately 1-inch and ½-inch respectively over a distance of about 40 feet.

Estimated Seismic Settlement: As discussed above in the *Seismic Considerations* section of this report, we expect building foundations will experience liquefaction-related total settlement of less than 1 inch and ½ inch or less differential settlement in 40 feet.

Backfilled Permanent Retaining Walls

We expect the project may include backfilled, cast-in-place (c.i.p.) concrete retaining walls. For recommended bearing capacities and lateral resistance parameters, refer to the Shallow Foundations section above. Additional recommendations for these structures are provided below.

Lateral Earth Pressures: The lateral soil pressures acting on backfilled retaining walls will depend on the nature and density of the soil behind the wall, and the ability of the wall to yield in response to the earth loads. Yielding walls (i.e. walls that are free to translate or rotate) that are able to displace laterally at least 0.001H, where H is the height of the wall, may be designed for active earth pressures. Non-yielding walls (i.e. walls that are not free to translate or rotate) should be designed for at-rest earth pressures. Non-yielding walls include walls that are braced to another wall or structure, and wall corners.

Assuming that walls are backfilled and drained as described in the following paragraphs, we recommend that yielding walls supporting horizontal backfill be designed using an equivalent fluid density of 35 pcf (active earth pressure). Non-yielding walls should be designed using an equivalent fluid density of 50 pcf (at-rest earth pressure).

Design of permanent retaining walls should consider additional earth pressure resulting from the design seismic event. For the seismic case, yielding walls should be designed for a uniform (rectangular), total earth pressure distribution of 26H and non-yielding walls should be designed for a uniform, total earth pressure distribution of 47H. The recommended total earth pressure distributions for the seismic case include both the seismic and static components of earth pressures (i.e. the active or at-rest static components of 35 pcf or 50 pcf should *not* be added to the total uniform pressure distribution). For cantilever c.i.p. walls, the total earth pressure distributions for the seismic case should be applied from finished grade at the bottom of the wall to the top of wall.

The above-recommended lateral earth pressures do not include the effects of sloping backfill surfaces, surcharges such as traffic loads, other surface loading, or hydrostatic pressures. If such conditions exist, we should be consulted to provide revised earth pressure recommendations.

Adequate drainage measures must be installed to collect and direct subsurface water away from subgrade walls. All backfilled walls should include a drainage aggregate zone extending two feet from the back of wall for the full height of the wall. The drainage aggregate should consist of material meeting the requirements of WSDOT 9-03.12(2) Gravel Backfill for Walls. A minimum 4-inch diameter, perforated PVC drain pipe should be provided at the base of backfilled walls to collect and direct subsurface water to an appropriate discharge point. Drain pipe perforations should be protected using a non-woven filter fabric such as Mirafi 140N. Wall drainage systems should be independent of other drainage systems such as roof drains.

On-Grade Concrete Slabs

The following sections provide recommendations for on-grade floor slabs.

Subgrade Preparation: Subgrades for on-grade slabs should be prepared in accordance with the *Site Preparation* and *Structural Fill* sections of this report.

Capillary Break: To provide a capillary break, uniform slab bearing surface, and a minimum subgrade modulus of 150 pci, we recommend the on-grade slabs be underlain by a 6-inch thick layer of compacted, well-graded granular fill contain less than 5 percent fines, based on that soil fraction passing the U.S. No. 4 sieve. Alternatively, a clean angular gravel such as No. 7 aggregate per WSDOT: 9-03.1(4) C could be used for this purpose. Alternative capillary break materials should be submitted to the geotechnical engineer for review and approval before use.

Vapor Retarder: The use of a vapor retarder should be considered beneath concrete slabs on grade that will be covered with wood, tile, carpet or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture or is otherwise considered moisture-sensitive. When conditions warrant the use of a vapor retarder, the slab designer and contractor should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Drainage Considerations

Surface Drainage: Final site grades should be sloped to carry surface water away from buildings and other drainage-sensitive areas. Additionally, site grades should be designed such that concentrated runoff on softscape surfaces is avoided. Any surface runoff directed towards softscaped slopes should be collected at the top of the slope and routed to the bottom of the slope and discharged in a manner that prevents erosion.

Building Perimeter Footing Drains: We recommend that the new buildings ***with footing elevations located below existing site grades*** be provided with a footing drain system to reduce the risk of future moisture problems and the buildup of hydrostatic pressures. The footing drains should consist of a minimum 4-inch diameter, Schedule 40, rigid, perforated PVC pipe placed at the base of the heel of the footing with the perforations facing down. The pipe should be surrounded by a minimum of 6 inches of clean free-draining granular material conforming to WSDOT Standard Specification 9-03.12(4), Gravel Backfill for Drains. A non-woven filter fabric such as Mirafi 140N, or equivalent, should envelope the free-draining granular material. At appropriate intervals such that water backup does not occur, the drainpipe should be connected to a tightline system leading to a suitable discharge. Cleanouts should be provided for future maintenance. The footing drain system must be independent from the roof drain system.

Pavements

Pavement Life and Maintenance: It should be realized that asphaltic pavements are not maintenance-free. The following pavement sections represent our minimum recommendations for an average level of performance during a 20-year design life; therefore, an average level of maintenance will likely be required. A 20-year pavement life typically assumes that an overlay will be placed after about 12 years. Thicker asphalt, base, and subbase courses would offer better long-term performance, but would cost more initially. Conversely, thinner courses would be more susceptible to “alligator” cracking and other failure modes. As such, pavement design can be considered a compromise between a high initial cost and low maintenance costs versus a low initial cost and higher maintenance costs. The recommendations presented below are based on AASHTO design methodologies as presented in the 1993 AASHTO Guide for Design of Pavement Structures.

Design Traffic Volumes: At the time this report was prepared, design traffic volumes were not available. Traffic volume will have a significant impact on the recommended design pavement thicknesses. For pavement design, traffic volumes are based on Equivalent 18 kip Single Axle Loads (ESALs) For planning purposes, we developed pavement sections based on three different design traffic volumes as follows; 5 million, 10 million, and 20 million. The upper end of the traffic volume range would represent that which is required for a national discount retailer type distribution center.

Soil Design Values: The required pavement sections for a 20 year design life will be a function of the quality of fill used to raise site grades. For planning purposes, we developed pavement sections based on imported fill meeting the requirements for Common Borrow and Gravel Borrow. The pavement section recommendations below assume a minimum California Bearing Ratios (CBR) of 15 and 50 for imported Common and Gravel Borrow, respectively. The pavement sections recommended below assume a **minimum of 12 inches** of imported fill will be placed between stripped site grades and the bottom of the pavement section.

Other Pavement Design Parameters: The preliminary pavement sections provided below are based on the additional assumed pavement design parameters listed below. The parameters summarized below are based on the requirements of a national discount retailer type distribution center and should be confirmed or updated for final design.

- Initial Serviceability: 4.2
- Terminal Serviceability: 2.0
- Reliability: 90%
- Standard Deviation: 0.45 (flexible pavements) and 0.35 (rigid pavements)

Table 1: Preliminary Heavy-Duty Asphalt Pavement Section Recommendations

Design Traffic (ESALs)	**Pavement Section[1]**	
	Common Borrow Subgrade	**Gravel Borrow Subgrade**
5 million	4” ACP[2] over 8” CSTC	4” ACP[2] over 6” CSTC[3]
10 million	4” ACP[2] over 9” CSTC	4” ACP[2] over 6” CSTC[3]
20 million	4” ACP[2] over 11” CSTC	4” ACP[2] over 6” CSTC[3]

[1] ACP = Asphalt Concrete Pavement, CSTC = Crushed Surface Top Course
[2] Minimum asphalt thickness recommended by AASHTO for design traffic volume.
[3] Minimum CSTC thickness recommended by AASHTO for design traffic volume.

The values in Table 1 above are based on a minimum 4 inch asphalt thickness considering the assumed truck loading. Thinner asphalt might be feasible depending on the actual traffic loading. For areas that will be exposed to lightly loaded, passenger vehicle traffic, we recommend a pavement section consisting of 2 inches of asphalt pavement underlain by 4 inches of crushed rock base course.

Table 2: Preliminary Heavy-Duty Concrete Pavement Section Recommendations

Design Traffic (ESALs)	**Pavement Section[1]**	
	Common Borrow Subgrade	**Gravel Borrow Subgrade**
5 million	6.5” CCP over 6” CSTC	6” CCP over 6” CSTC
10 million	7.5” CCP over 8” CSTC	7” CCP over 8” CSTC
20 million	8.5” CCP over 8” CSTC	8” CCP over 8” CSTC

[1] CCP = Cement Concrete Pavement, CSTC = Crushed Surface Top Course

Materials and Construction: We recommend the following regarding asphalt pavement materials and pavement construction.

- Subgrade Preparation and Compaction: Upper 12 inches of native stripped subgrade should be prepared in accordance with the recommendations presented in the *Subgrade Preparation* section of this report, and all fill should be compacted in accordance with the recommendations presented in the *Structural Fill* section of this report.

- Asphalt Concrete: We recommend that the asphalt concrete conform to Section 9-02.1(4) for PG 58-22 or PG 64-22 Performance Graded Asphalt Binder as presented in the 2012 WSDOT Standard Specifications. We also recommend that the gradation of the asphalt aggregate conform to the aggregate gradation control points for ½-inch mixes as presented in Section 9-03.8(6), HMA Proportions of Materials.

- Base Course: We recommend that the crushed aggregate base course conform to Section 9-03.9(3) of the WSDOT Standard Specifications.

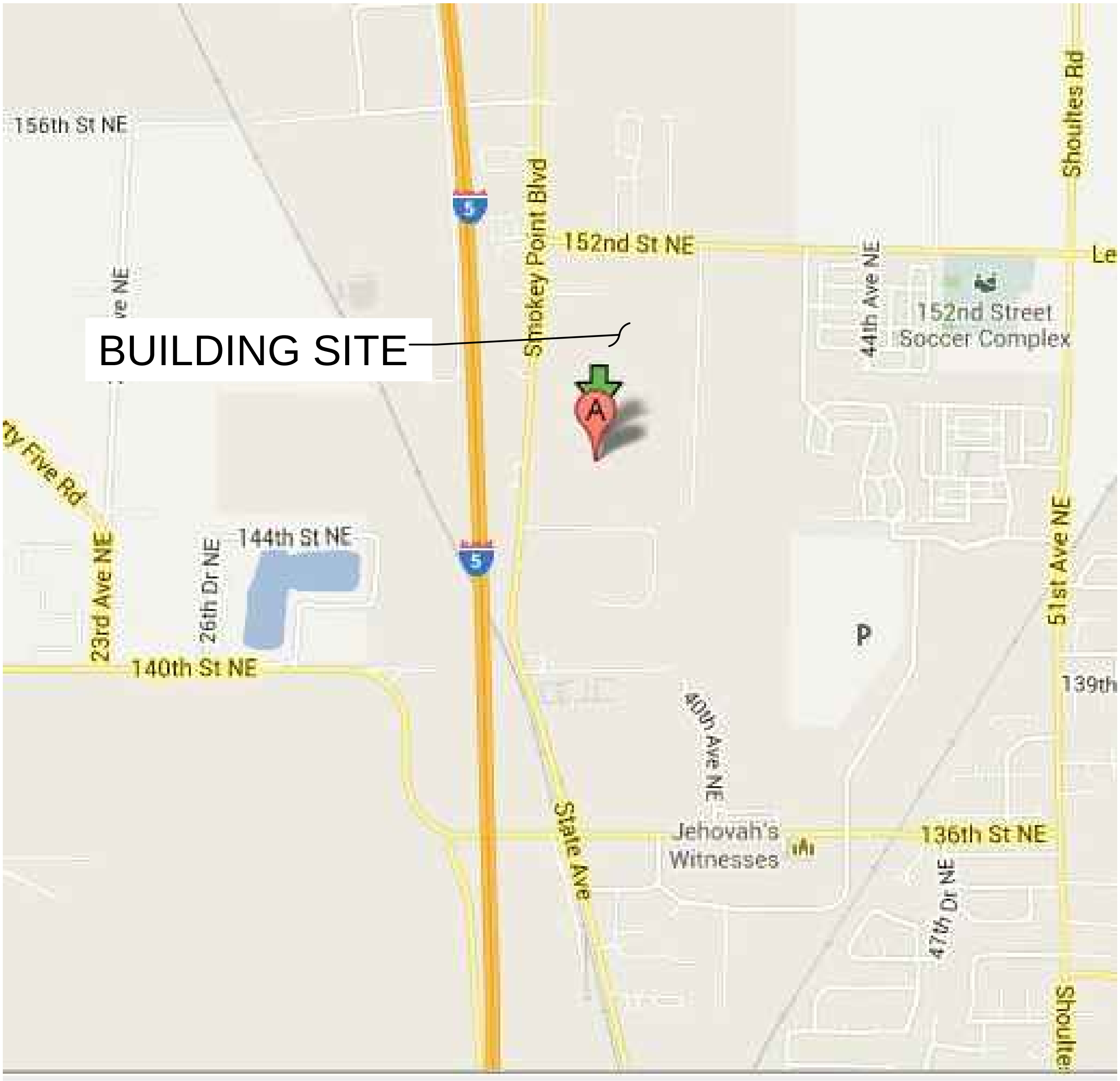
- Compaction and Paving: All base material should be compacted to at least 95 percent of the maximum dry density determined in accordance with ASTM D 1557. We recommend that asphalt be compacted to a minimum of 92 percent of the Rice (theoretical maximum) density or 96 percent of Marshall (Maximum laboratory) density. Placement and compaction of asphalt should conform to requirements of Section 5-04 of the 2012 WSDOT Standard Specifications.

CLOSURE

The analysis and recommendations presented in this report are based, in part, on the explorations completed for this study. The number, location, and depth of the explorations were completed within the constraints of budget and site access so as to yield the information to formulate our recommendations. Project plans were in the preliminary stage at the time this report was prepared. We therefore recommend Zipper Geo Associates, LLC be provided an opportunity to review the final plans and specifications when they become available in order to assess that the recommendations and design considerations presented in this report have been properly interpreted and implemented into the project design.

The performance of earthwork, structural fill, foundations, and pavements depend greatly on proper site preparation and construction procedures. We recommend that Zipper Geo Associates, LLC be retained to provide geotechnical engineering services during the earthwork-related construction phases of the project. If variations in subsurface conditions are observed at that time, a qualified geotechnical engineer could provide additional geotechnical recommendations to the contractor and design team in a timely manner as the project construction progresses.

This report has been prepared for the exclusive use of Smokey Point Investments, and their agents, for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Zipper Geo Associates, LLC reviews the changes and either verifies or modifies the conclusions of this report in writing.



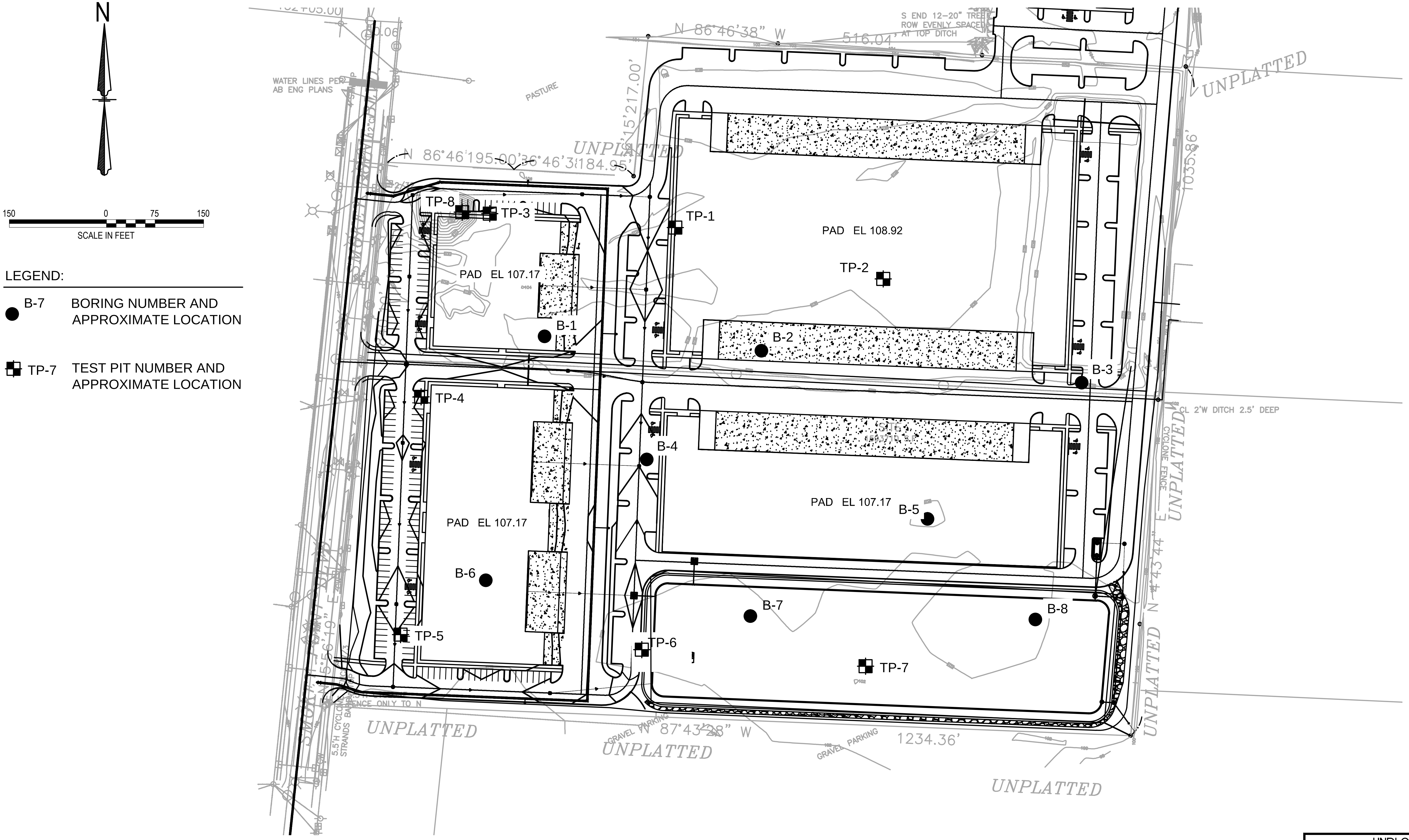
PROPOSED MARYSVILLE DEVELOPMENT
14600 BLOCK SMOKEY POINT BOULEVARD
MARYSVILLE, WASHINGTON

VICINITY MAP
(NOT TO SCALE)

DATE: SEPTEMBER 2016
Job No. 1128.01

Zipper Geo Associates, LLC
19023 36th Ave. W.,Suite D
Lynnwood, WA

FIGURE
1
SHT. 1 of 1



LEGEND:

●	B-7	BORING NUMBER AND APPROXIMATE LOCATION
▨	TP-7	TEST PIT NUMBER AND APPROXIMATE LOCATION

UNDI COMMERCE PARK
14600 BLOCK SMOKEY POINT BLVD.
MARYSVILLE, WASHINGTON

SITE AND EXPLORATION PLAN

DATE: SEPTEMBER, 2016
Job No. 1128.01

Zipper Geo Associates, LLC
19023 36th Ave. W.,Suite D
Lynnwood, WA

FIGURE 2
SHT. 1 of 1

APPENDIX A

SUBSURFACE EXPLORATION PROCEDURES & LOGS

APPENDIX A
SUBSURFACE EXPLORATION PROCEDURES AND LOGS

Field Exploration Description

Our field exploration for this project included 9 borings and 8 test pits completed on May 7 and 8, 2013. The approximate exploration locations are shown on the Site and Exploration Plan, Figure 2. Exploration locations were determined by hand-held GPS. The accuracy of the boring locations shown on Figure 2 should be considered to be about 15 feet. The approximate ground surface elevation at the exploration locations is not known. As such, the exploration locations and elevations should be considered accurate only to the degree implied by the means and methods used to define them. The vertical datum for the referenced survey is not known.

Boring Procedures

The borings were advanced using a Detrick D-50 track-mounted drill rig operated by an independent drilling company working under subcontract to ZGA. The borings were advanced using hollow stem auger drilling methods and drilling fluids (fluid cement grout) to limit heave inside the auger. An engineering geologist from our firm continuously observed the borings, logged the subsurface conditions encountered, and obtained representative soil samples. All samples were stored in moisture-tight containers and transported to our laboratory for further evaluation and testing. Samples were obtained by means of the Standard Penetration Test, thin wall Shelby tube sampler, and Dames and Moore ring sampler at 2.5- to 5-foot intervals throughout the drilling operation.

The Standard Penetration Test (ASTM: D-1586) procedure consists of driving a standard 2-inch outside diameter steel split spoon sampler 18 inches into the soil with a 140-pound hammer free falling 30 inches. The number of blows required to drive the sampler through each 6-inch interval is recorded, and the total number of blows struck during the final 12 inches is recorded as the Standard Penetration Resistance, or “blow count” (N value). If a total of 50 blows are struck within any 6-inch interval, the driving is stopped and the blow count is recorded as 50 blows for the actual penetration distance. The resulting Standard Penetration Resistance values indicate the relative density of granular soils and the relative consistency of cohesive soils.

The enclosed boring logs describe the vertical sequence of soils and materials encountered in each boring, based primarily upon our field classifications. Where a soil contact was observed to be gradational, our logs indicate the average contact depth. Where a soil type changed between sample intervals, we inferred the contact depth. Our logs also graphically indicate the blow count, sample type, sample number, and approximate depth of each soil sample obtained from the boring. If groundwater was encountered in a borehole, the approximate groundwater depth, and date of observation, are depicted on the log.

Test Pit Explorations

An independent contractor working under subcontract to our firm excavated the test pits through the use of a small trackhoe. An engineering geologist form our firm continuously observed the test pit excavations, logged the subsurface conditions, and obtained representative soil samples. The samples were stored in moisture tight containers and transported to our laboratory for further visual classification and testing. After we logged each test pit, the operator backfilled each with excavated soils tamped into place. Some settlement of the backfill should be expected over time.

The enclosed test pit logs indicate the vertical sequence of soils and materials encountered in each test pit, based primarily on our field classifications and supported by our subsequent laboratory testing. Where a soil contact was observed to be gradational or undulating, our logs indicate the average contact depth. We estimated the relative density and consistency of *in situ* soils by means of the excavation characteristics and by the sidewall stability. Our logs also indicate the approximate depths of any sidewall caving or groundwater seepage observed in the test pits, as well as all sample numbers and sampling locations.

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/7/2013

Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track

Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

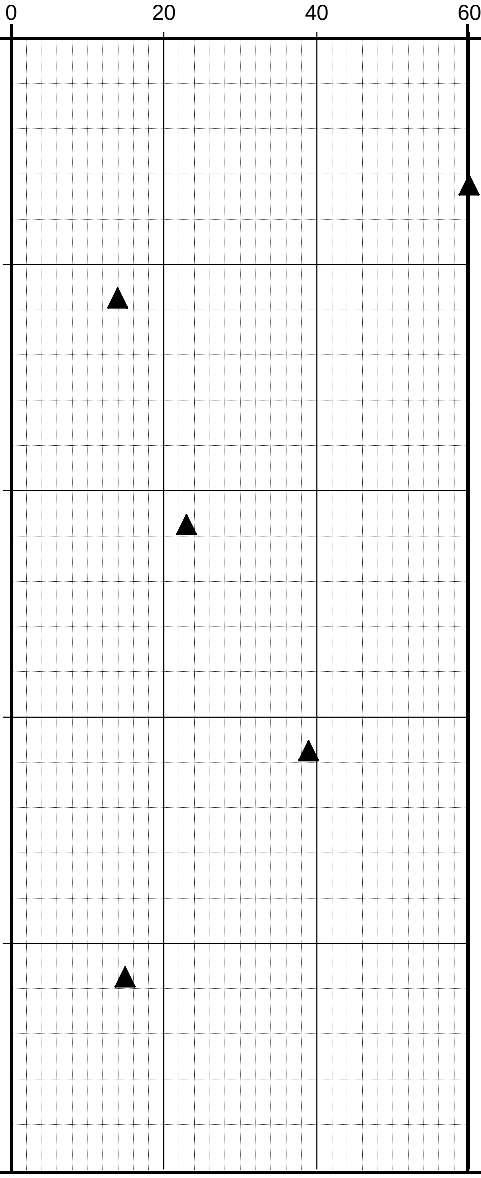
B-1

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	Sample Number	Recovery	Ground Water	Blow Counts	Testing
0	Brown, moist, sandy GRAVEL (fill)					
	No recovery. Blow counts overstated due to gravel.	S-1	0		60	
5	Medium dense, wet to saturated, orange and brown, mottled, fine to medium SAND with trace to some silt	S-2	12	▼ ATD	14	
10	grades to saturated	S-3	12		23	
	Dense, saturated, orange and brown, gravelly SAND with trace silt					
15		S-4	12		39	
20	Medium dense, saturated, gray, fine to medium SAND with trace silt	S-5	12		15	
25						

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test
△ Hammer Weight and Drop: ______



SAMPLE LEGEND
- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND
- ▨ Clean Sand
- ▨ Bentonite
- ■ Grout/Concrete
- ☰ Screened Casing
- ☐ Blank Casing
- ▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY
GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

Marysville Distribution Center
14400 Smokey Point Blvd.
Marysville, Washington

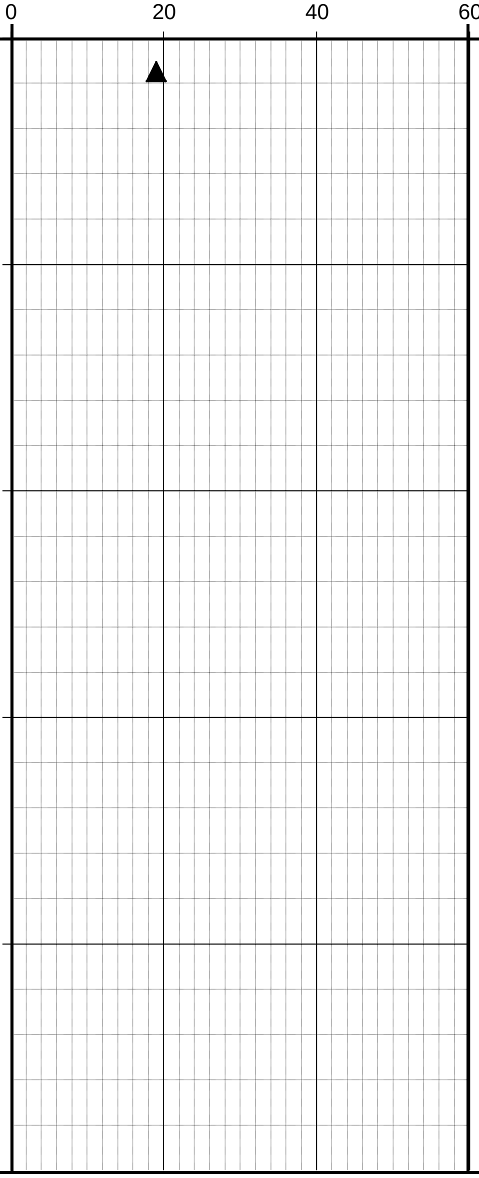
Date: -
Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-1

Boring Location:	See Figure 1, Site and Exploration Plan	Drilling Company:	Geologic Drill	Bore Hole Dia.:	6"	**B-1**
Top Elevation:	-	Drilling Method:	Hollow Stem Auger	Hammer Type:	Auto	
Date Drilled:	5/7/2013	Drill Rig:	Track	Logged by:	RAR	

Depth (ft)	SOIL DESCRIPTION *The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.*	Sample Number	SAMPLES	Recovery	Ground Water	PENETRATION RESISTANCE (blows/foot) ▲ Standard Penetration Test △ Hammer Weight and Drop:	Blow Counts	Testing
25		S-6	I	12		▲	19	
	Boring terminated at 26.5 feet. Groundwater observed at approximately 6 feet while drilling.							
30								
35								
40								
45								
50								



SAMPLE LEGEND

I 2-inch O.D. split spoon sample

II 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

▨ Clean Sand

▨ Bentonite

■ Grout/Concrete

☰ Screened Casing

☐ Blank Casing

▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis

200W = 200 Wash Analysis

Consol. = Consolidation Test

Att. = Atterberg Limits

◇ % Fines (<0.075 mm)

○ % Water (Moisture) Content

Plastic Limit ├──○──┤ Liquid Limit

Natural Water Content

Marysville Distribution Center
14400 Smokey Point Blvd.
Marysville, Washington

Date: - Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-1

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/7/2013

Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track

Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

B-2

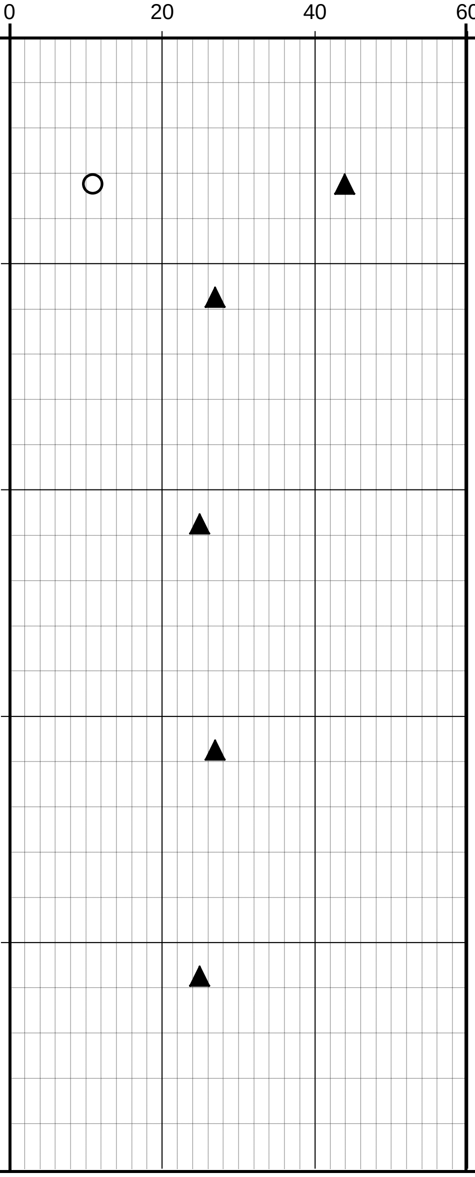
SOIL DESCRIPTION

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	Soil Description	Sample Number	Recovery	Ground Water	Blow Counts	Testing
0	4" Sod and topsoil. Moist, brown, silty, fine SAND with some gravel (fill)					
	Dense, moist, gray-brown, silty, fine SAND with some gravel (fill)	S-1	12		44	
5	grades to medium dense (fill)	S-2	12		27	
	Medium dense, wet to saturated, brown, fine SAND with some silt			▼ ATD		
10	Medium dense, saturated, gray, fine to medium SAND with trace silt	S-3	12		25	
15	grades to with trace gravel	S-4	12		27	
20		S-5	12		25	
25						

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test
△ Hammer Weight and Drop:



SAMPLE LEGEND

- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

▨	Clean Sand
▩	Bentonite
■	Grout/Concrete
☰	Screened Casing
☐	Blank Casing
▼ 11/2/12	Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

Marysville Distribution Center
14400 Smokey Point Blvd.
Marysville, Washington

Date: -
Project No.: 1128.01

Zipper Geo Associates
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Lynnwood, WA

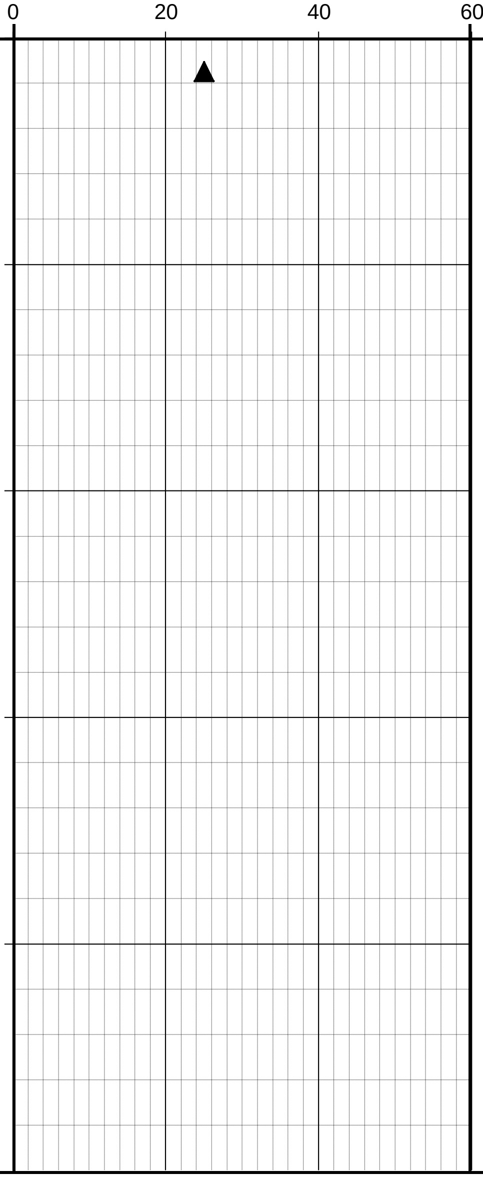
BORING LOG: **B-2**

Page 1 of 2

Boring Location:	See Figure 1, Site and Exploration Plan	Drilling Company:	Geologic Drill	Bore Hole Dia.:	6"
Top Elevation:	-	Drilling Method:	Hollow Stem Auger	Hammer Type:	Auto
Date Drilled:	5/7/2013	Drill Rig:	Track	Logged by:	RAR

B-2

Depth (ft)	SOIL DESCRIPTION *The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.*	SAMPLES Sample Number	Recovery	Ground Water	PENETRATION RESISTANCE (blows/foot) ▲ Standard Penetration Test △ Hammer Weight and Drop:	Blow Counts	Testing
25		S-6	12			25	
	Boring terminated at 26.5 feet. Groundwater observed at approximately 7 feet while drilling.						
30							
35							
40							
45							
50							



SAMPLE LEGEND

- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

- ▨ Clean Sand
- ▨ Bentonite
- ■ Grout/Concrete
- ☰ Screened Casing
- ☐ Blank Casing
- ▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis

200W = 200 Wash Analysis

Consol. = Consolidation Test

Att. = Atterberg Limits

◇ % Fines (<0.075 mm)

○ % Water (Moisture) Content

Plastic Limit ├──○──┤ Liquid Limit

Natural Water Content

Marysville Distribution Center
14400 Smokey Point Blvd.
Marysville, Washington

Date: -

Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-2

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/7/2013

Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track

Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

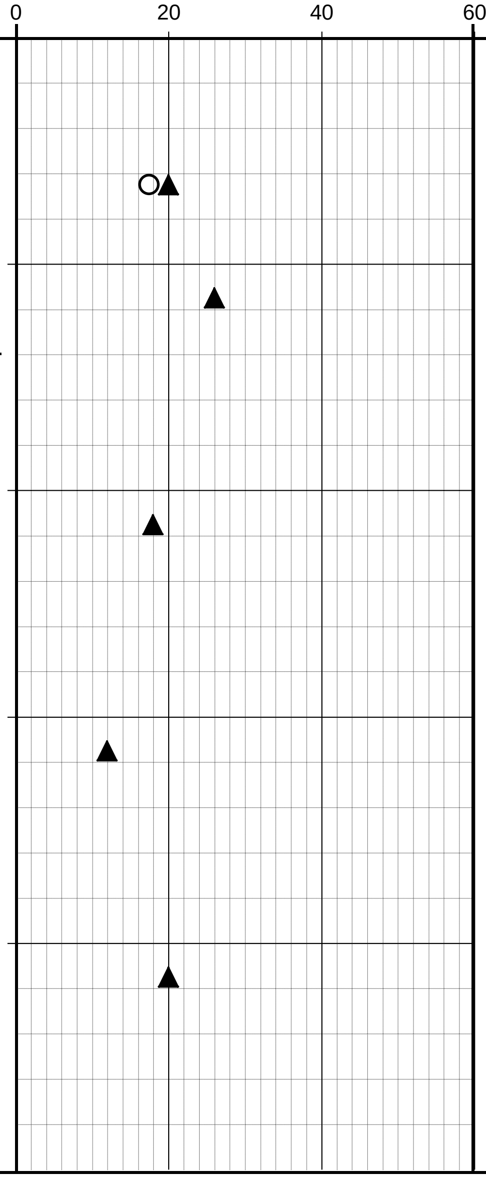
B-3

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	SAMPLES Sample Number	SAMPLES Recovery	Ground Water	Blow Counts	Testing
0	6" Crushed gravel					
	Medium dense, wet, brown, silty, fine SAND (fill)	S-1	12		20	
5	Medium dense, wet to saturated, brown, fine SAND with some silt	S-2	12		26	
				▼ ATD		
10	Medium dense, wet to saturated, gray, fine to coarse SAND with trace silt	S-3	12		18	
15	grades to fine to medium SAND with trace to some silt	S-4	12		12	
20	grades to fine SAND with some silt	S-5	12		20	
25						

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test
△ Hammer Weight and Drop:



SAMPLE LEGEND

- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

- ▨ Clean Sand
- ▨ Bentonite
- ■ Grout/Concrete
- ☰ Screened Casing
- ☐ Blank Casing
- ▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

Marysville Distribution Center
14400 Smokey Point Blvd.
Marysville, Washington

Date: -
Project No.: 1128.01

Zipper Geo Associates
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Lynnwood, WA

BORING LOG: B-3

Page 1 of 2

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/7/2013
Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track
Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

B-3

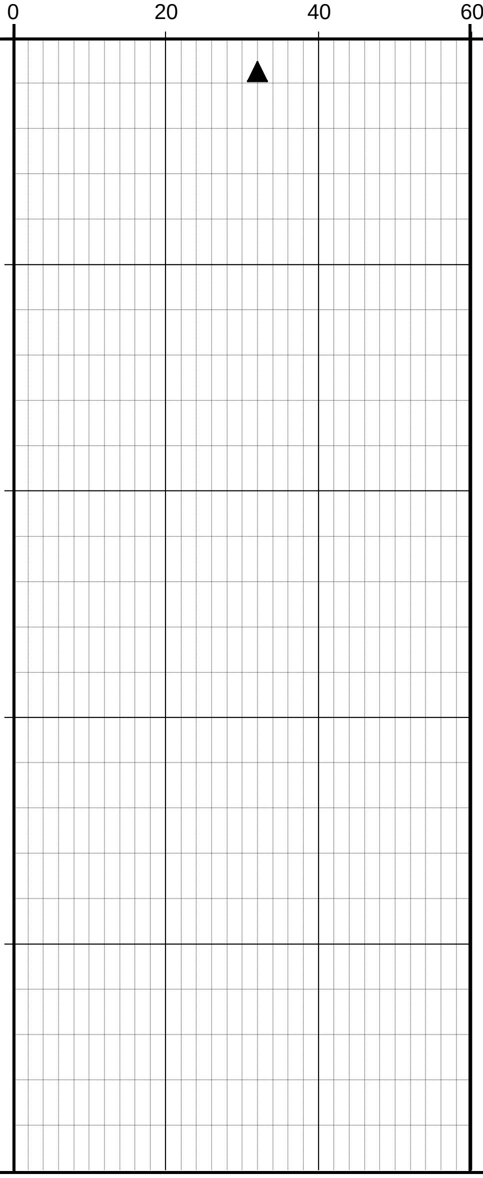
SOIL DESCRIPTION

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	SAMPLES Sample Number	SAMPLES Recovery	Ground Water	Blow Counts	Testing
25	grades to dense	S-6	12		32	
	Boring terminated at 26.5 feet. Groundwater observed at approximately 6 feet while drilling.					
30						
35						
40						
45						
50						

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test
△ Hammer Weight and Drop:



SAMPLE LEGEND
Ⅰ 2-inch O.D. split spoon sample
Ⅱ 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND
▨ Clean Sand
▨ Bentonite
■ Grout/Concrete
☰ Screened Casing
☐ Blank Casing
▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY
GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

Marysville Distribution Center
14400 Smokey Point Blvd.
Marysville, Washington

Date: -
Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

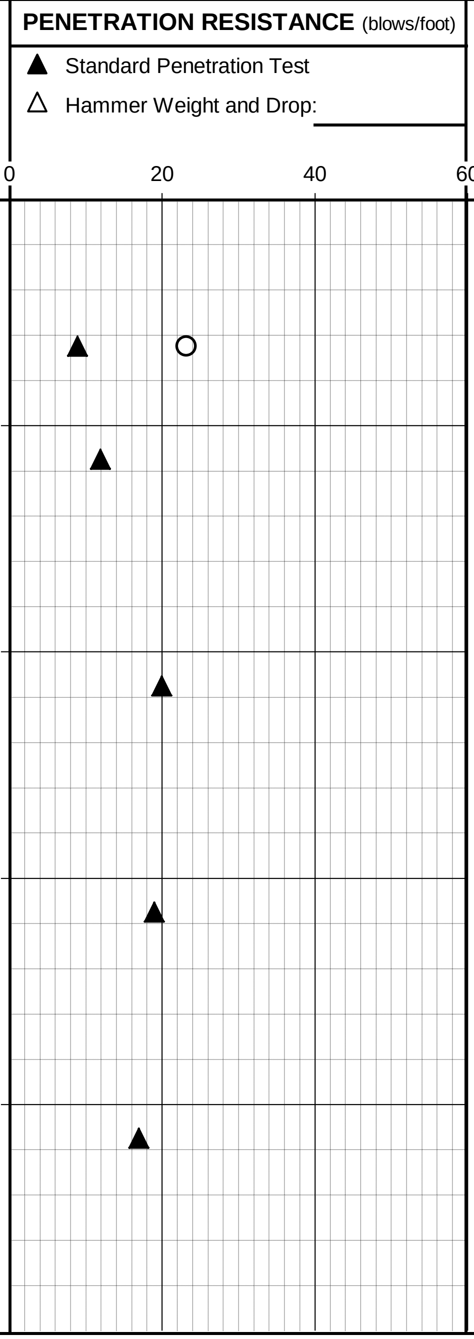
BORING LOG: B-3

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/8/2013
Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track
Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

B-4

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	SAMPLES Sample Number	SAMPLES Recovery	Ground Water	Blow Counts	Testing
0	12" Sod and topsoil					
	Loose, wet, orange and brown, mottled, fine to medium SAND with trace to some silt					
		S-1	12	▼ ATD	9	
5						
	Medium dense, saturated, gray, fine to medium sand with trace silt	S-2	12		12	
10	grades to with trace gravel	S-3	12		20	
15	Medium dense, saturated, gray, fine SAND with trace silt	S-4	12		19	
20		S-5	12		17	
25						



SAMPLE LEGEND

I 2-inch O.D. split spoon sample
II 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

▨ Clean Sand
▩ Bentonite
■ Grout/Concrete
☰ Screened Casing
☐ Blank Casing
▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

Marysville Distribution Center
14400 Smokey Point Blvd.
Marysville, Washington

Date: -
Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-4

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/8/2013

Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track

Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

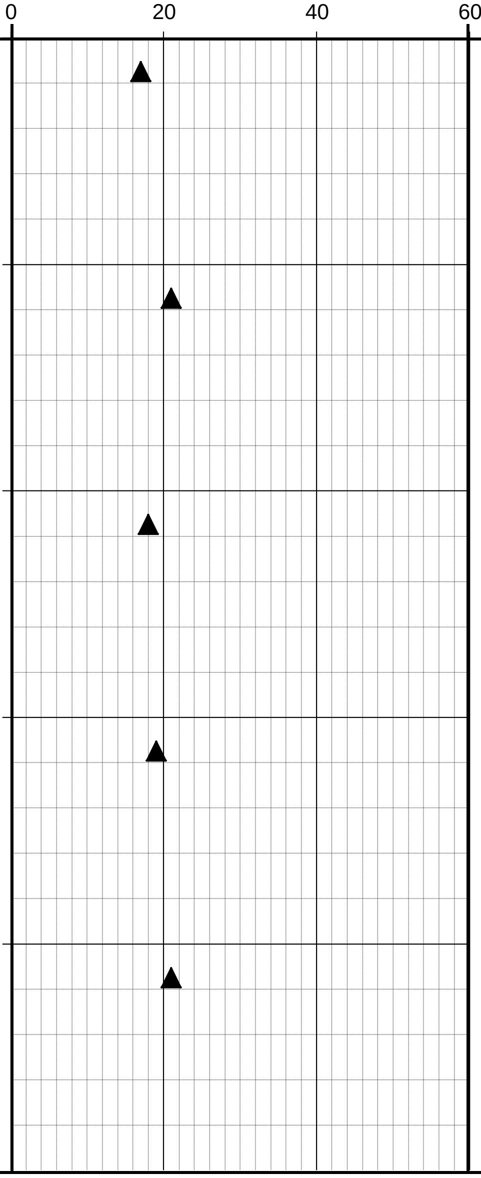
B-4

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	SAMPLES Sample Number	SAMPLES Recovery	Ground Water	Blow Counts	Testing
25	Medium dense, saturated, gray, fine SAND with trace silt	S-6	12		17	
30		S-7	12		21	
35		S-8	12		18	
40	Very stiff, saturated, gray, sandy SILT	S-9	12		19	
45		S-10	12		21	
50						

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test
△ Hammer Weight and Drop: ______



SAMPLE LEGEND
- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND
- ▨ Clean Sand
- ▨ Bentonite
- ■ Grout/Concrete
- ☰ Screened Casing
- ☐ Blank Casing
- ▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY
GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

Marysville Distribution Center
14400 Smokey Point Blvd.
Marysville, Washington

Date: -
Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-4

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/8/2013

Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track

Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

B-4

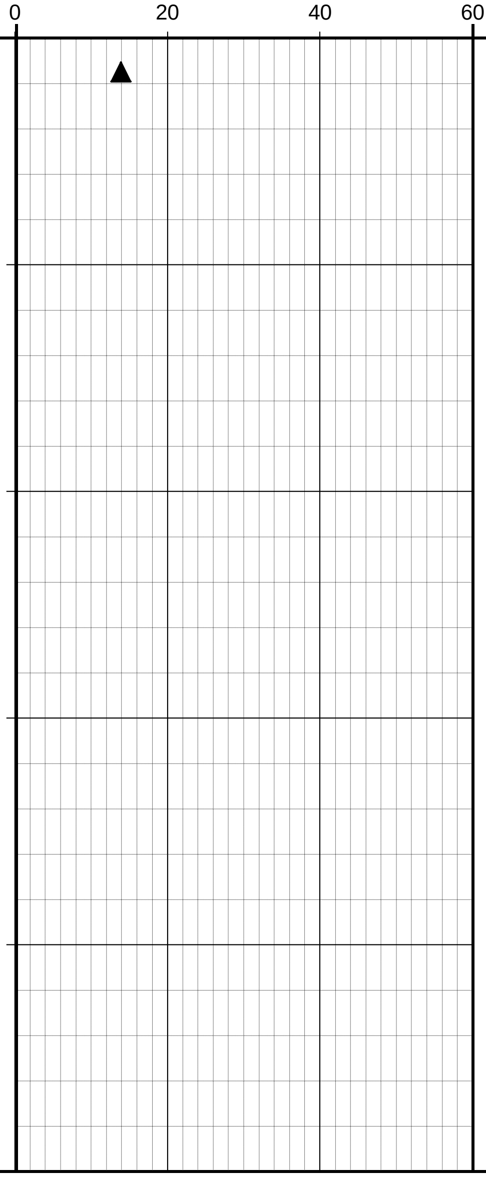
The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	Sample Number	Recovery	Ground Water	Blow Counts	Testing
50	Medium dense, saturated, gray, fine SAND with trace to some silt	S-11	12		14	
	Boring terminated at 51.5 feet. Groundwater observed at approximately 4 feet while drilling.					
55						
60						
65						
70						
75						

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test

△ Hammer Weight and Drop:



SAMPLE LEGEND

2-inch O.D. split spoon sample
3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

▨ Clean Sand
▨ Bentonite
■ Grout/Concrete
▤ Screened Casing
☐ Blank Casing
▼ Groundwater level at time of drilling (ATD) or on date of measurement. 11/2/12

TESTING KEY

GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

Marysville Distribution Center
14400 Smokey Point Blvd.
Marysville, Washington

Date: -
Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-4

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/8/2013

Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track

Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

B-5

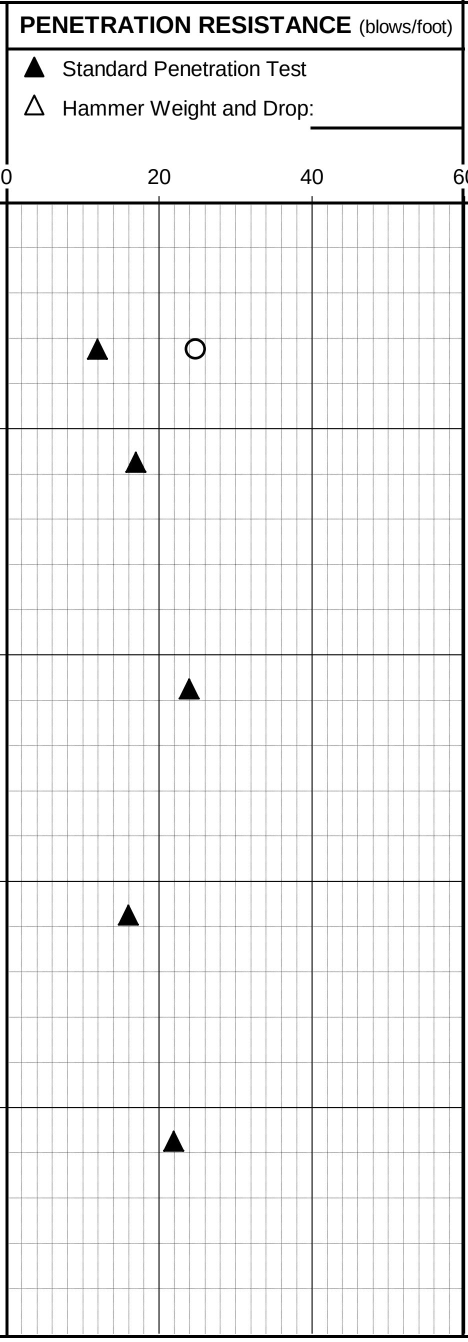
SOIL DESCRIPTION

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	Soil Description	Sample Number	Recovery	Ground Water	Blow Counts	Testing
0	18" Forest duff and topsoil					
	Medium dense, wet to saturated, orange and brown, mottled, fine SAND with some silt	S-1	12	▼ ATD	12	
5	Medium dense, saturated, gray, fine to medium SAND with trace silt	S-2	12		17	
10		S-3	12		24	
15		S-4	12		16	
20	grades to fine sand	S-5	12		22	
25						

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test
△ Hammer Weight and Drop:



SAMPLE LEGEND
2-inch O.D. split spoon sample
3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND
▨ Clean Sand
▨ Bentonite
■ Grout/Concrete
☰ Screened Casing
☐ Blank Casing
▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY
GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

Marysville Distribution Center
14400 Smokey Point Blvd.
Marysville, Washington

Date: -
Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-5

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/8/2013

Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track

Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

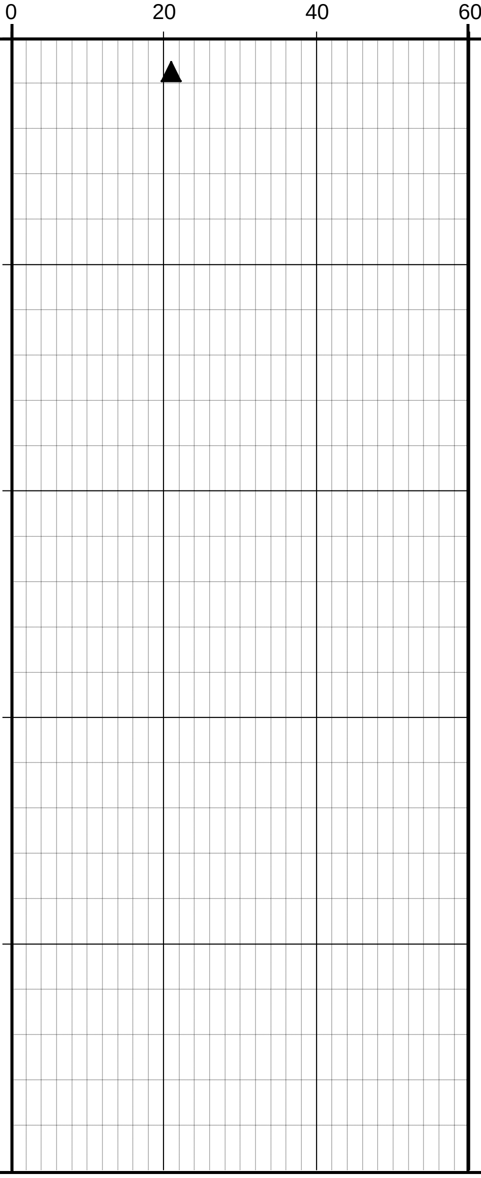
B-5

Depth (ft)	SOIL DESCRIPTION	SAMPLES Sample Number	Recovery	Ground Water	Blow Counts	Testing
	The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.					
25		S-6	12		21	
	Boring terminated at 26.5 feet. Groundwater observed at approximately 4 feet while drilling.					
30						
35						
40						
45						
50						

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test

△ Hammer Weight and Drop: ______



SAMPLE LEGEND

I 2-inch O.D. split spoon sample

II 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

▨ Clean Sand

▨ Bentonite

■ Grout/Concrete

☰ Screened Casing

☐ Blank Casing

▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis

200W = 200 Wash Analysis

Consol. = Consolidation Test

Att. = Atterberg Limits

◇ % Fines (<0.075 mm)

○ % Water (Moisture) Content

Plastic Limit ├──○──┤ Liquid Limit

Natural Water Content

Marysville Distribution Center
14400 Smokey Point Blvd.
Marysville, Washington

Date: -
Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

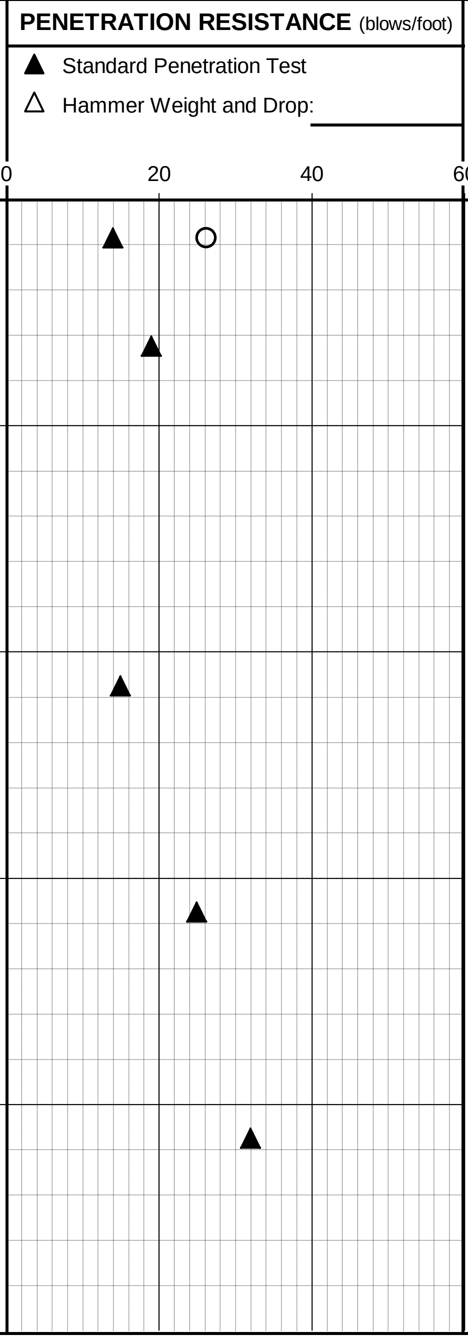
BORING LOG: B-5

Boring Location: See Figure 1, Site and Exploration Plan
Surface Elevation: __ feet
Date Drilled: 5/8/2013
Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: D-50 Track
Bore Hole Dia.: 6-inch
Hammer Type: Auto
Logged by: DCW

B-6

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	Sample Number	Recovery (inches)	Groundwater	Blow Counts	Testing
0	6 inches loose, moist, dark brown, silty fine SAND with fine roots (Topsoil) above loose to medium dense, dark brown and rust, silty fine SAND with trace organics	S-1	18		14	
	Medium dense moist, rust-brown, fine SAND with silt	S-2	18	▼ ATD	19	
5	Medium dense, saturated, gray-brown, fine SAND					
10		S-3	18		15	
	Medium dense, saturated, orange-brown, fine to medium SAND with trace coarse sand and fine gravel					
15		S-4	12		25	
20		S-5	14		32	
	Medium dense, saturated gray, fine SAND					
25						



SAMPLE LEGEND

- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

MONITORING WELL LEGEN

- ▨ Clean Sand
- ▨ Bentonite
- ■ Grout/Concrete
- ☰ Screened Casing
- ☐ Blank Casing
- ▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
CEC - Cation Exchange Capacity

○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

Marysville Distribution Center
0
Marysville, Washington

Date: 5/8/2013
Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-6

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: __ feet
Date Drilled: 5/8/2013
Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: D-50 Track
Bore Hole Dia.: 6-inch
Hammer Type: Auto
Logged by: DCW

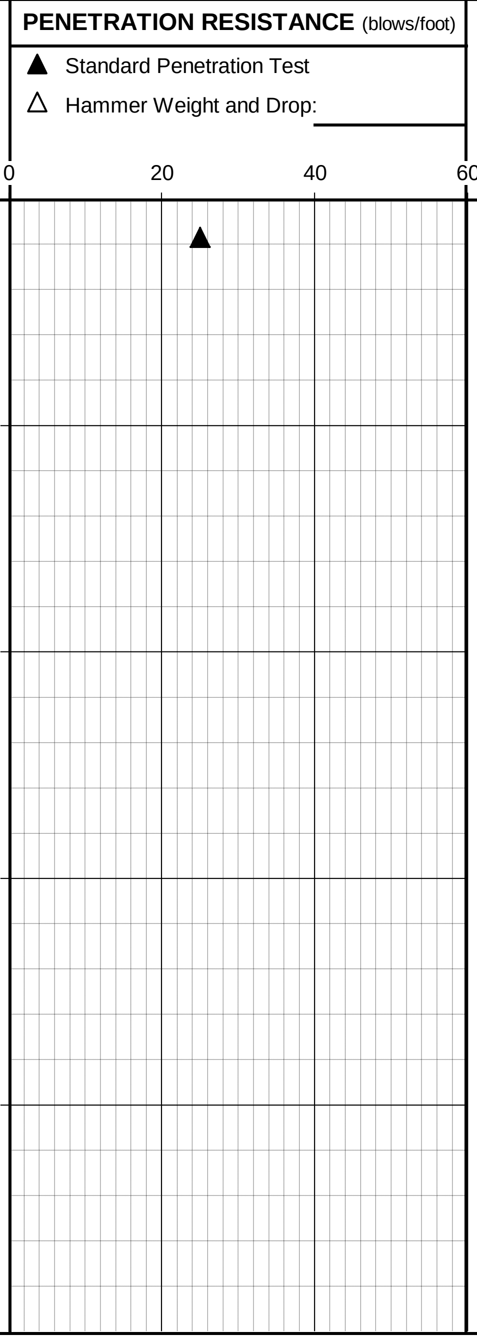
B-6

Depth (ft)	SOIL DESCRIPTION	Sample Number	SAMPLES Recovery (inches)	Ground Water	Blow Counts	Testing
25	Medium dense, saturated, gray, fine SAND	S-6	18		25	
	Boring terminated at 26.5 feet. Groundwater observed at approximately 4 feet while drilling.					
30						
35						
40						
45						
50						

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test
△ Hammer Weight and Drop: ______



SAMPLE LEGEND
- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND
- ⛆ Clean Sand
- ▨ Bentonite
- ■ Grout/Concrete
- ☰ Screened Casing
- ☐ Blank Casing
- ▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY
GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

Marysville Distribution Center
0
Marysville, Washington

Date: 5/8/2013
Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-6

Boring Location: See Figure 1, Site and Exploration Plan
Surface Elevation: __ feet
Date Drilled: 5/8/2013

Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: D-50 Track

Bore Hole Dia.: 6-inch
Hammer Type: Auto
Logged by: DCW

B-7

SOIL DESCRIPTION

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft): 0, 5, 10, 15, 20, 25

6 inches loose, wet, dark brown, organic silty SAND with fine roots (Topsoil) above loose, moist to wet, brown, fine to medium SAND

Medium dense, wet to saturated, gray-brown, fine to medium SAND

Medium dense, saturated, gray, fine to medium SAND with some coarse sand and trace fine gravel

Medium dense, saturated, gray, fine to medium SAND with trace coarse sand and fine gravel

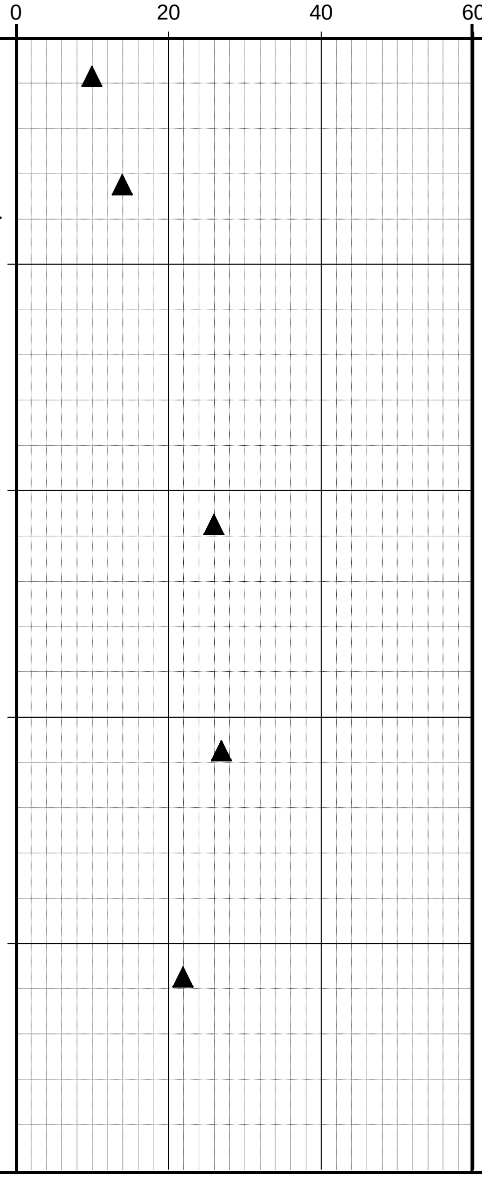
Sample Number	SAMPLES Recovery (inches)	Blow Counts
S-1	18	10
S-2	18	14
S-3	18	26
S-4	12	27
S-5	12	22

Groundwater: ▼ ATD

Testing

PENETRATION RESISTANCE (blows/foot)

▲ Standard Penetration Test
△ Hammer Weight and Drop: ______



SAMPLE LEGEND

- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

MONITORING WELL LEGEN

- ▨ Clean Sand
- ▨ Bentonite
- ■ Grout/Concrete
- ☰ Screened Casing
- ☐ Blank Casing
- ▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
CEC - Cation Exchange Capacity

○ % Water (Moisture) Content
Plastic Limit |—○—| Liquid Limit
Natural Water Content

Marysville Distribution Center
0
Marysville, Washington

Date: 5/8/2013
Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-7

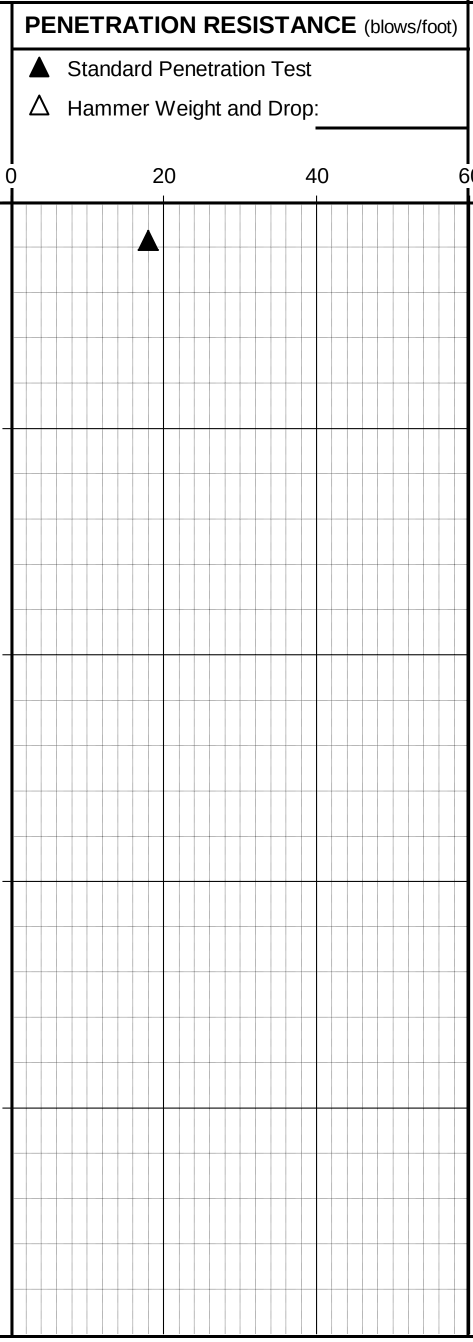
Page 1 of 2

Boring Location:	See Figure 1, Site and Exploration Plan	Drilling Company:	Geologic Drill	Bore Hole Dia.:	6-inch
Top Elevation:	__ feet	Drilling Method:	Hollow Stem Auger	Hammer Type:	Auto
Date Drilled:	5/8/2013	Drill Rig:	D-50 Track	Logged by:	DCW

B-7

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	Sample Number	SAMPLES Recovery (inches)	Ground Water	Blow Counts	Testing
25	Medium dense, saturated, gray, fine to medium SAND with trace coarse SAND and fine gravel	S-6	18		18	
	Boring terminated at 26.5 feet. Groundwater observed at approximately 4 feet while drilling.					
30						
35						
40						
45						
50						



SAMPLE LEGEND

- I 2-inch O.D. split spoon sample
- Ⅱ 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

- ▨ Clean Sand
- ▨ Bentonite
- ■ Grout/Concrete
- ☰ Screened Casing
- ☐ Blank Casing
- ▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis

200W = 200 Wash Analysis

Consol. = Consolidation Test

Att. = Atterberg Limits

◇ % Fines (<0.075 mm)

○ % Water (Moisture) Content

Plastic Limit ├──○──┤ Liquid Limit

Natural Water Content

Marysville Distribution Center
0
Marysville, Washington

Date: 5/8/2013 Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-7

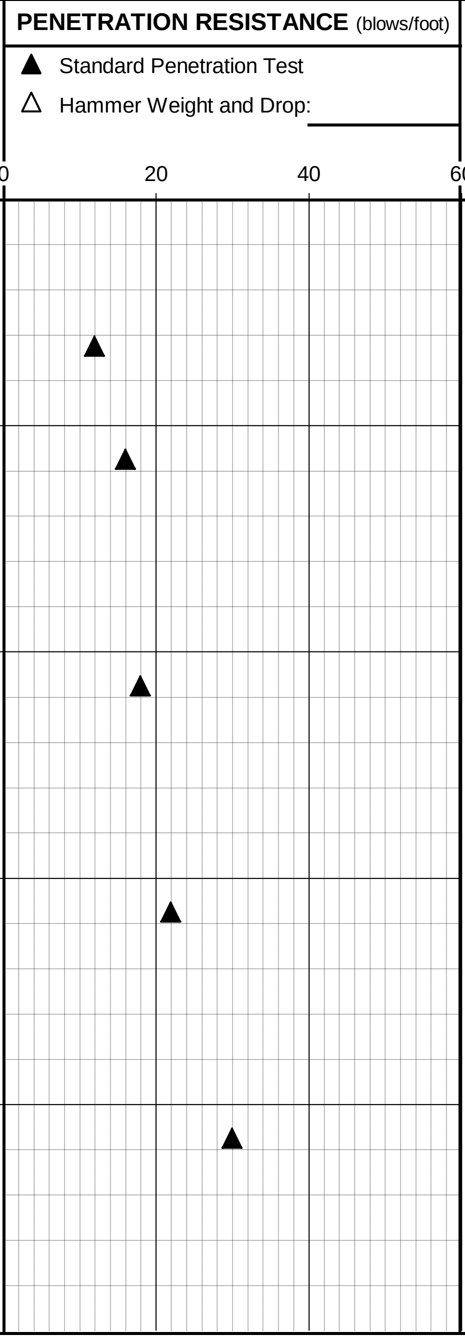
Page 2 of 2

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/8/2013
Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track
Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

B-8

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

Depth (ft)	SOIL DESCRIPTION	SAMPLES Sample Number	SAMPLES Recovery	Ground Water	Blow Counts	Testing
0	12" Forest duff and topsoil					
	Medium dense, wet, orange and brown, mottled, fine SAND with some silt	S-1	12	▼ ATD	12	
5	Medium dense, saturated, gray, fine to coarse SAND with trace to some gravel and trace silt	S-2	12		16	
10		S-3	12		18	
15		S-4	12		22	
20	grades to dense	S-5	12		30	
25						



SAMPLE LEGEND
- I 2-inch O.D. split spoon sample
- II 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND
- ▨ Clean Sand
- ▨ Bentonite
- ■ Grout/Concrete
- ☰ Screened Casing
- ☐ Blank Casing
- ▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY
GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

Marysville Distribution Center
14400 Smokey Point Blvd.
Marysville, Washington

Date: -
Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-8

Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/8/2013

Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track

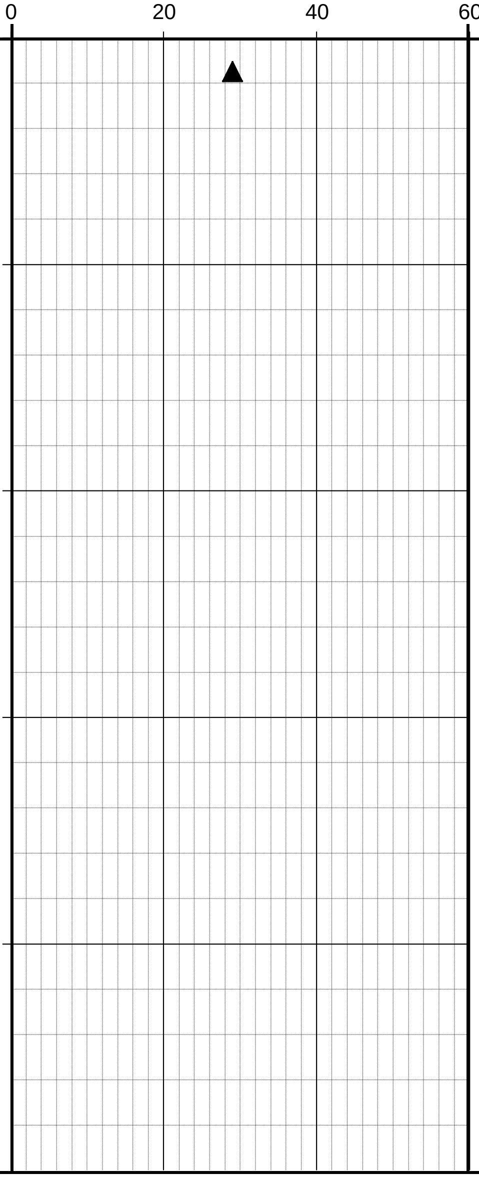
Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

B-8

The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.

PENETRATION RESISTANCE (blows/foot)
▲ Standard Penetration Test
△ Hammer Weight and Drop:

Depth (ft)	SOIL DESCRIPTION	SAMPLES Sample Number	SAMPLES Recovery	Ground Water	Blow Counts	Testing
25	Medium dense, saturated, gray, fine SAND with trace silt	S-6	12		29	
	Boring terminated at 26.5 feet. Groundwater observed at approximately 4 feet while drilling.					
30						
35						
40						
45						
50						



SAMPLE LEGEND
- I 2-inch O.D. split spoon sample
- Ⅱ 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND
- ▨ Clean Sand
- ▨ Bentonite
- ■ Grout/Concrete
- ☰ Screened Casing
- ☐ Blank Casing
- ▼ 11/2/12 Groundwater level at time of drilling (ATD) or on date of measurement.

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──○──┤ Liquid Limit
Natural Water Content

TESTING KEY
GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

Marysville Distribution Center
14400 Smokey Point Blvd.
Marysville, Washington

Date: -
Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-8

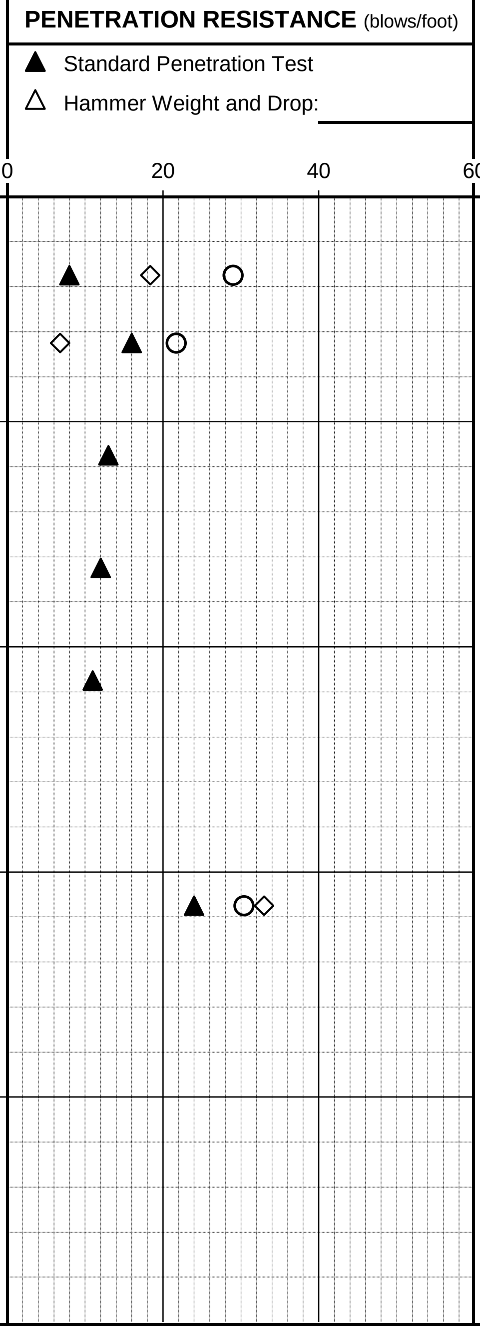
Boring Location: See Figure 1, Site and Exploration Plan
Top Elevation: -
Date Drilled: 5/8/2013

Drilling Company: Geologic Drill
Drilling Method: Hollow Stem Auger
Drill Rig: Track

Bore Hole Dia.: 6"
Hammer Type: Auto
Logged by: RAR

B-9

Depth (ft)	SOIL DESCRIPTION	SAMPLES Sample Number	SAMPLES Recovery	Ground Water	Blow Counts	Testing
	The stratification lines represent the approximate boundaries between soil types. The transition may be gradual. Refer to report text and appendices for additional information.					
0	4" crushed gravel (fill)					
	Loose, wet, brown, fine to medium SAND with silt	S-1	12		8	GSA
	Medium dense, saturated, gray, fine to medium SAND with some silt	S-2	12	▼ ATD	16	GSA
5	grades to medium to coarse with trace gravel	S-3	12		13	
		S-4	12		12	
10		S-5	12		11	
15	Medium dense, saturated, gray, silty fine SAND	S-6	12		24	200W
	Boring terminated at 16.5 feet. Groundwater observed at approximately 3 feet while drilling. Groundwater measured at 2.9 feet on 5-14-13 Groundwater measured at 3.5 feet on 6-18-13.					
20						
25						



SAMPLE LEGEND

- 2-inch O.D. split spoon sample
- 3-inch I.D. Shelby tube sample

GROUNDWATER LEGEND

▨	Clean Sand
☒	Bentonite
■	Grout/Concrete
☰	Screened Casing
☐	Blank Casing
▼ 11/2/12	Groundwater level at time of drilling (ATD) or on date of measurement.

TESTING KEY

GSA = Grain Size Analysis
200W = 200 Wash Analysis
Consol. = Consolidation Test
Att. = Atterberg Limits

◇ % Fines (<0.075 mm)
○ % Water (Moisture) Content
Plastic Limit ├──⊖──┤ Liquid Limit
Natural Water Content

Marysville Distribution Center
14400 Smokey Point Blvd.
Marysville, Washington

Date: -
Project No.: 1128.01

Zipper Geo Associates
19023 36th Ave. W, Suite D
Lynnwood, WA

BORING LOG: B-9

Page 1 of 1

ZIPPER GEO ASSOCIATES, LLC
19023 36th Avenue West, Suite D, Lynnwood, Washington 98036

Test Pit TP-1

Location: See Site And Exploration Plan, Figure 1
Approx. Ground Surface Elevation:

Project: Marysville Distr. Center
Project No: 1128.01
Date Drilled: 8 May 2013

Depth (ft)	Material Description	Sample	N_C	%M	Testing
	5 inches of loose, moist, dark brown, silty fine SAND with fine organics and fine roots (Topsoil) above loose, wet, gray, silty fine SAND				
1		S-1 @ 1 foot		16.0	
2	Medium dense, moist to wet, mottled rust-brown, fine SAND with trace to some silt				
3					
4	Medium dense, saturated, gray, fine SAND with interbeds of fine to coarse sand and with trace gravel				
5					
6					
7					
8					
	Test pit completed at 8 feet. Moderate groundwater seepage below 3.7 feet Severe caving below 3 feet.				
9					
	Note: N_C is the Dynamic Cone Penetrometer blow count per ASTM Special Technical Publication #399.				

Test Pit TP-2

Location: See Site And Exploration Plan, Figure 1
Approx. Site-specific Ground Surface Elevation:

Project: Marysville Distribution Center
Project No: 1128.01
Date Drilled: 8 May 2013

Depth (ft)	Material Description	Sample	N_C	%M	Testing
1	Medium dense, moist, gray-brown, silty gravelly SAND with some cobbles, trace wood debris (Fill)				
2					
3		S-1 @ 2 feet		11.2	
4	Medium dense to dense, moist, orange-brown, fine SAND with some silt				
5		S-2 @ 4 feet		21.7	GSA
6	Medium dense, wet, gray, fine to medium SAND with interbeds of fine to coarse sand with some gravel				
7					
8					
9					
10	Test pit completed at 9 feet. Rapid groundwater seepage below 6 feet. Severe caving below 6 feet.				
11					
12					
13					
14					
15					
16					
17					
18					
	Note: N_C is the Dynamic Cone Penetrometer blow count per ASTM Special Technical Publication #399.				

ZIPPER GEO ASSOCIATES, LLC
19023 36th Avenue West, Suite D, Lynnwood, Washington 98036

Test Pit TP-3

Location: See Site And Exploration Plan, Figure 1
Approx. Ground Surface Elevation:

Project: Marysville Distr. Center
Project No: 1128.01
Date Drilled: 8 May 2013

Depth (ft)	Material Description	Sample	N_C	%M	Testing
	8 inches loose, moist, dark brown, silty fine SAND with fine organic and fine roots (Topsoil)	S-1 @ 0.5 feet			
1					
	Loose to medium dense, moist, mottled orange-brown, fine SAND				
2					
3					
4	Medium dense, moist to saturated, gray, fine to medium SAND with trace fine gravel				
		S-2 @ 4 feet			
5					
6					
7					
8	Test pit completed at 7.5 feet. Moderate groundwater seepage below 3.5 feet Severe caving below 3.5 feet.				
9					
	Note: N_C is the Dynamic Cone Penetrometer blow count per ASTM Special Technical Publication #399.				

Test Pit TP-4

Location: See Site And Exploration Plan, Figure 1
Approx. Site-specific Ground Surface Elevation:

Project: Marysville Distribution Center
Project No: 1128.01
Date Drilled: 8 May 2013

Depth (ft)	Material Description	Sample	N$_C$	%M	Testing
	0.8 to 1.5 feet of loose, moist, dark brown, silty fine SAND with fine organics and fine roots (Topsoil)				
1		S-1 @ 6 inches			
2	Loose to medium dense, moist, mottled orange and brown, fine SAND with some silt, trace gravel				
3		S-2 @ 2.5 feet		16.4	GSA
4	Medium dense, wet to saturated, gray, fine to medium SAND with trace to some fine gravel				
5					
6					
	Medium dense, saturated, brown, fine to medium SAND				
7					
	Test pit completed at 7 feet. Rapid groundwater seepage below 3 feet. Severe caving below 3 feet.				
8					
9					
	Note: N$_C$ is the Dynamic Cone Penetrometer blow count per ASTM Special Technical Publication #399.				

Test Pit TP-5

Location: See Site And Exploration Plan, Figure 1
Approx. Site-specific Ground Surface Elevation:

Project: Marysville Distribution Center
Project No: 1128.01
Date Drilled: 8 May 2013

Depth (ft)	Material Description	Sample	N_C	%M	Testing
	3 inches of loose, moist, dark brown, silty fine SAND with fine organics and fine roots mixed with sandy 5/8-inch CRUSHED ROCK above medium dense, moist, dark brown, silty SAND with gravel (Fill). 6-inch thick concrete slab exposed in south side of test pit.				
1					
2	Medium dense, moist, mottled orange and brown, fine SAND with trace gravel and a 1-inch thick discontinuous fine sandy SILT horizon at 2 feet				
		S-1 @ 2 feet		19.2	
3					
4	Medium dense, wet to saturated, gray-brown, fine SAND with trace silt	S-2 @ 3.5 feet		26.2	GSA
5					
6					
7	Medium dense, saturated, gray-brown, SAND with trace fine gravel				
8					
	Test pit completed at 8 feet. Rapid groundwater seepage below 3 feet. Severe caving below 3 feet.				
9					
	Note: N_C is the Dynamic Cone Penetrometer blow count per ASTM Special Technical Publication #399.				

ZIPPER GEO ASSOCIATES, LLC

19023 36th Avenue West, Suite D, Lynnwood, Washington 98036

Test Pit TP-6

Location: See Site And Exploration Plan, Figure 1
Approx. Site-specific Ground Surface Elevation:

Project: Marysville Distribution Center
Project No: 1128.01
Date Drilled: 8 May 2013

Depth (ft)	Material Description	Sample	N$_C$	%M	Testing
	9 inches of loose, moist, dark brown, silty fine SAND with fine organics and fine roots (Topsoil)				
1		S-1 @ 6 inches			
	Medium dense, moist, mottled rust-brown, fine SAND with silt	S-2 @ 1 foot			
2					
	Medium stiff, moist, gray-brown, silty fine SAND	S-3 @ 2.5 feet		29.6	200W= 39.7%
3	Medium dense, wet to saturated, gray-brown, fine SAND with trace fine gravel below 7 feet				
4					
5					
6					
7					
8	Test pit completed at 7.5 feet. Rapid groundwater seepage below 3 feet. Severe caving below 3 feet.				
9					
	Note: N$_C$ is the Dynamic Cone Penetrometer blow count per ASTM Special Technical Publication #399.				

Test Pit TP-7

Location: See Site And Exploration Plan, Figure 1
Approx. Site-specific Ground Surface Elevation:

Project: Marysville Distribution Center
Project No: 1128.01
Date Drilled: 8 May 2013

Depth (ft)	Material Description	Sample	N_C	%M	Testing
	2 inches of forest DUFF above 4 inches of loose, moist, dark brown, organic fine sandy silt with fine roots (Topsoil) above loose, moist, gray, silty fine SAND				
1		S-1 @ 6 inches			
	Loose to medium dense, moist, mottled rust-brown, fine SAND with silt, trace gravel				
2					
		S-2 @ 2 feet		17.0	GSA
3					
	Medium dense, wet to saturated, gray, fine SAND with some silt, grades with some coarse sand and fine gravel below 7 feet	S-3 @ 3 feet		27.6	GSA
4					
5					
6					
7					
8	Test pit completed at 7.5 feet. Rapid groundwater seepage below 3.5 feet. Severe caving below 2.5 feet.				
9					
	Note: N_C is the Dynamic Cone Penetrometer blow count per ASTM Special Technical Publication #399.				

Test Pit TP-8

Location: See Site And Exploration Plan, Figure 1
Approx. Site-specific Ground Surface Elevation:

Project: Marysville Distribution Center
Project No: 1128.01
Date Drilled: 8 May 2013

Depth (ft)	Material Description	Sample	N_C	%M	Testing
1	Loose, moist, mixed gray and brown, silty SAND with gravel and scattered cobbles and wood waste, piece of plastic conduit (Fill)				
2					
3					
4					
5					
6					
7					
8		S-1 @ 7 feet		11.6	
9					
10					
11					
12					
13					
14					
15					
16	Test pit completed at 15 feet. No groundwater seepage or caving observed.				
17					
19					
	Note: N_C is the Dynamic Cone Penetrometer blow count per ASTM Special Technical Publication #399.				

APPENDIX B

LABORATORY TESTING PROCEDURES & RESULTS

APPENDIX B
LABORATORY TESTING PROCEDURES AND RESULTS

A series of laboratory tests were performed by ZGA during the course of this study to evaluate the index and geotechnical engineering properties of the subsurface soils. Descriptions of the types of tests performed are given below.

Visual Classification

Samples recovered from the exploration locations were visually classified in the field during the exploration program. Representative portions of the samples were carefully packaged in moisture tight containers and transported to our laboratory where the field classifications were verified or modified as required. Visual classification was generally done in accordance with ASTM D2488. Visual soil classification includes evaluation of color, relative moisture content, soil type based upon grain size, and accessory soil types included in the sample. Soil classifications are presented on the exploration logs in Appendix A.

Moisture Content Determinations

Moisture content determinations were performed on representative samples obtained from the explorations in order to aid in identification and correlation of soil types. The determinations were made in general accordance with the test procedures described in ASTM D 2216. Moisture contents are presented on the exploration logs in Appendix A.

Grain Size Analysis

A grain size analysis indicates the range in diameter of soil particles included in a particular sample. Grain size analyses were performed on representative samples in general accordance with ASTM: D-2487. The results of the grain size determinations for the samples were used in classification of the soils, and are presented in this appendix.

Laboratory Maximum Density Test

The laboratory maximum density represents the highest degree of density which can be obtained from a particular soil type by imparting a predetermined compaction effort. The test determines the "optimum" moisture content of the soil at the laboratory maximum density. The laboratory maximum density test was performed on a bulk sample of material in general accordance with ASTM: D-1557. The test result is shown in this appendix and presented as a curve where the soil dry density is compared to the moisture content.

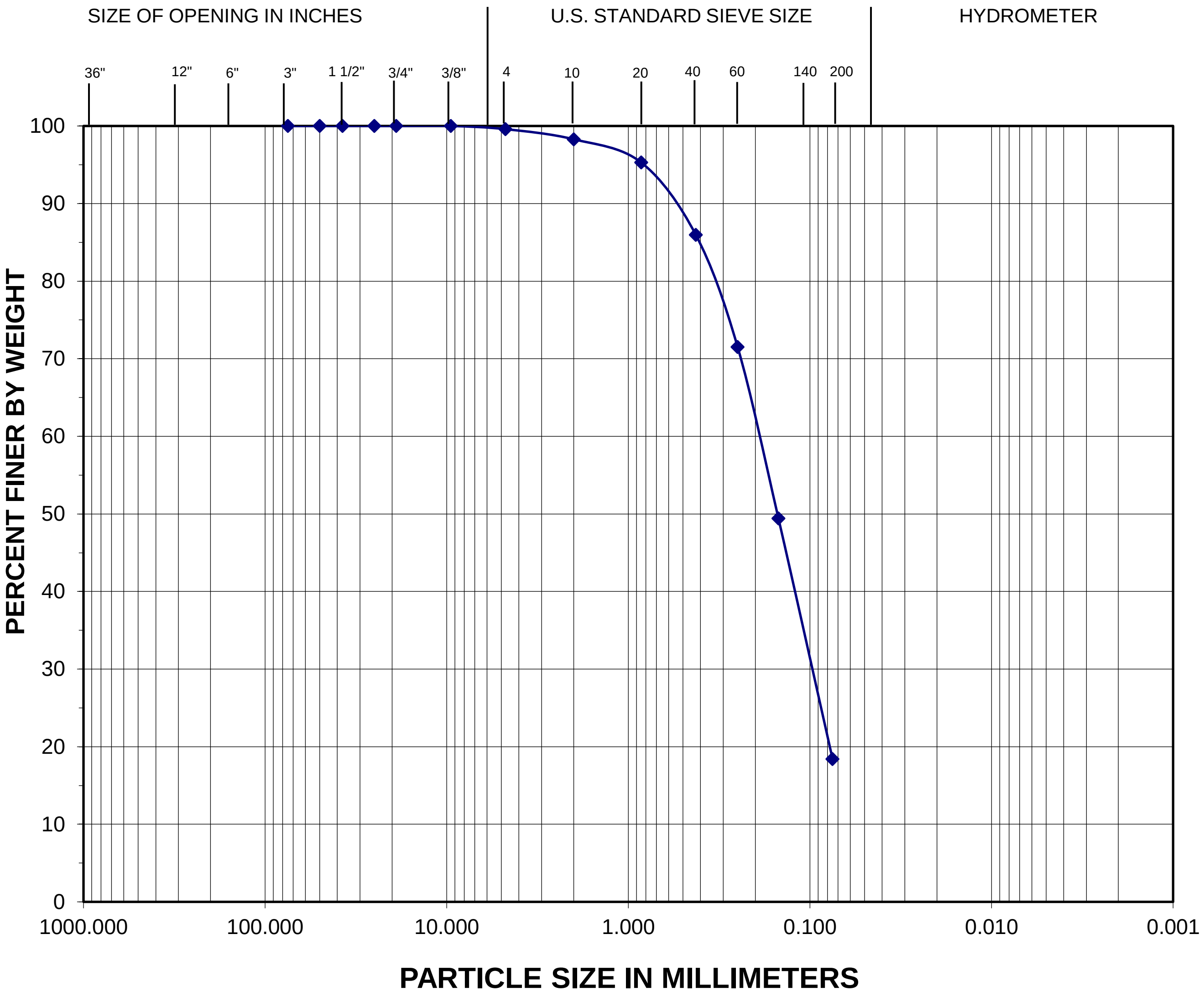
California Bearing Ratio Test

A California Bearing Ratio (CBR) test was performed on a representative sample in general accordance with ASTM: D-1883-73 to provide an evaluation of the relative quality and support characteristics of subgrade soils. Representative portions from the sample were compacted in a mold, generally in accordance with ASTM: D-1557, in order to obtain a moisture-density relationship curve. Following compaction, a 15 pound surcharge was applied to each sample which was then totally immersed in water and allowed to soak for a period of 72 to 96 hours, during which time it was monitored for swell. At the end of this period, the sample was removed, drained, and a vertical load applied to the surcharged soil with a penetration piston at a constant rate of strain. Measurements of the applied vertical load were obtained as selected penetration depths. CBR test results and moisture-density relationships plotted in terms of percent water content versus percent corrected CBR and dry density, respectively, are presented in this appendix.

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D 422



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

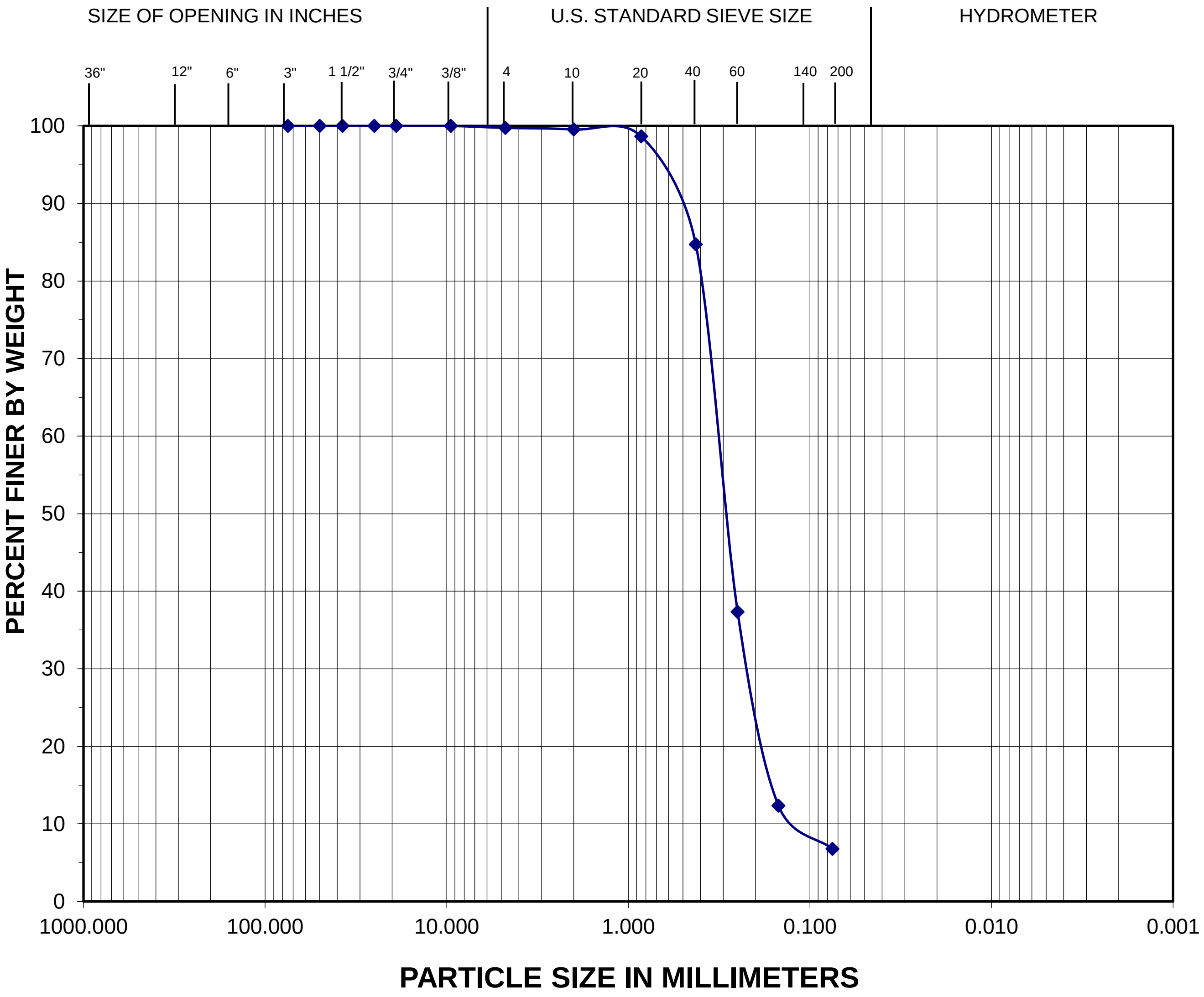
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
B-9	S-1	1.0	29.0	18.4	SAND with silt

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	Project No.: 1128.01 DATE OF TESTING: 5/15/2013	PROJECT NAME: Distribution Center

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D 422



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

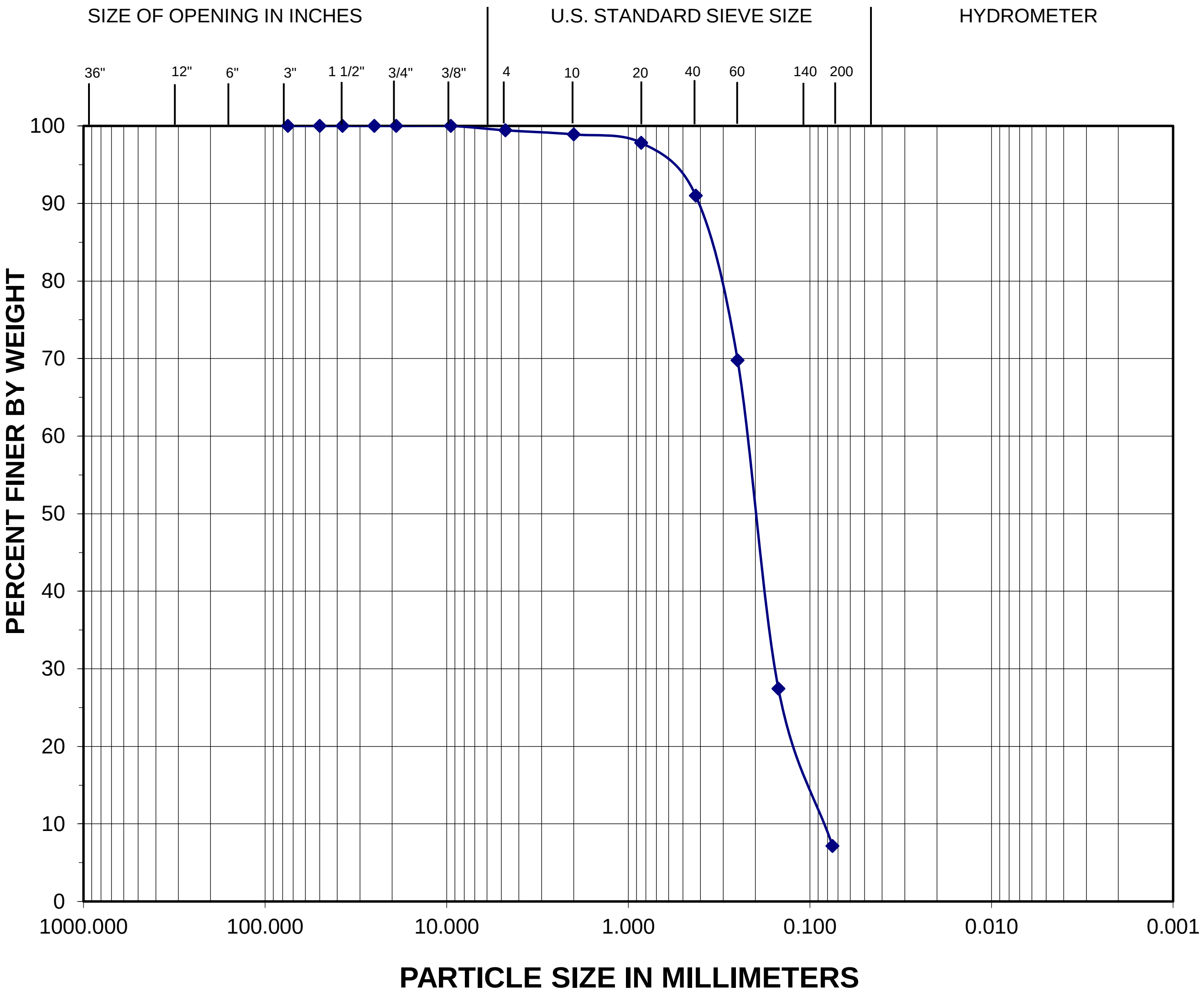
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
B-9	S-2	2.5	21.7	6.8	SAND with some silt

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	Project No.: 1128.01 DATE OF TESTING: 5/15/2013	PROJECT NAME: Distribution Center

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D 422



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

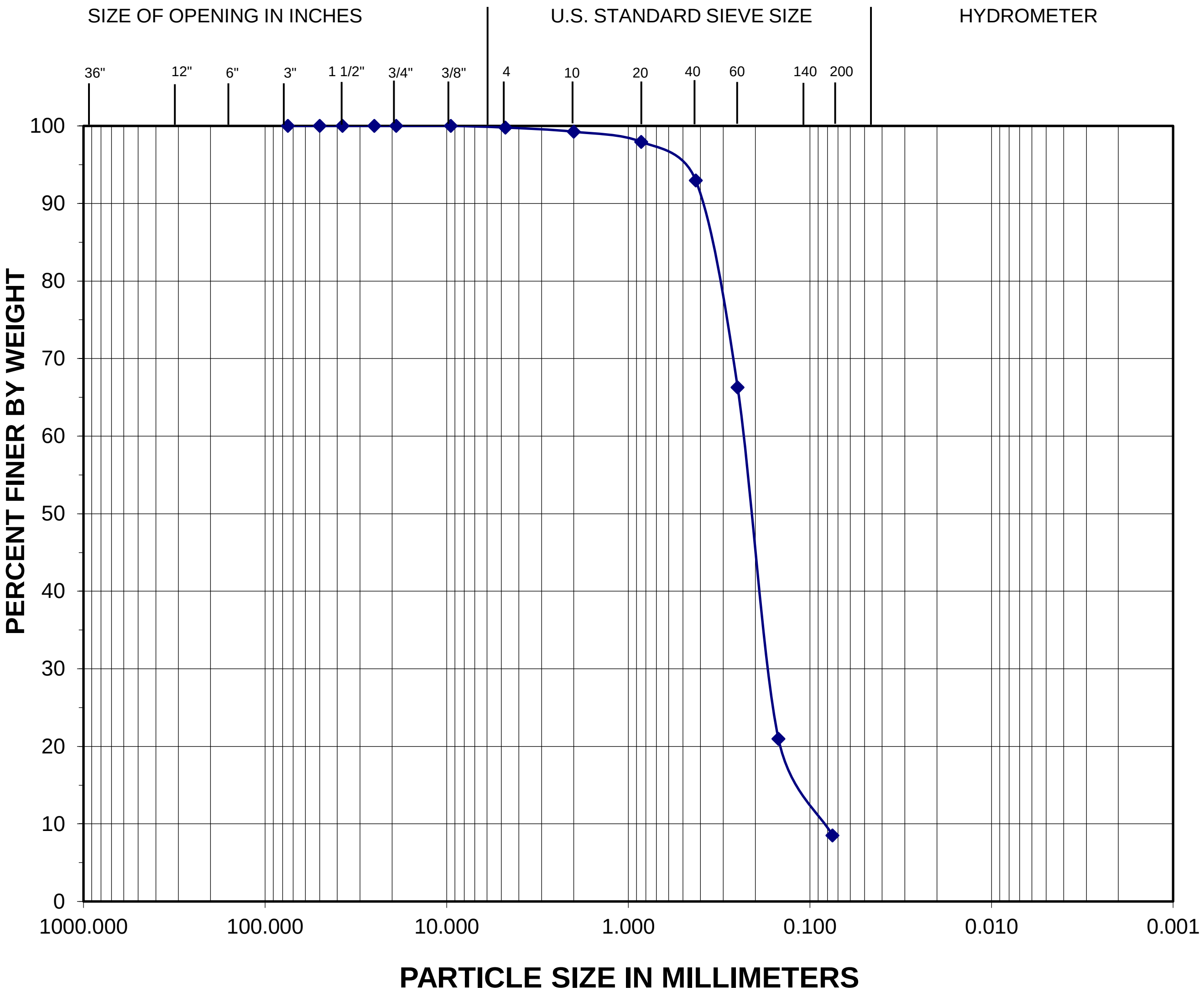
Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-2	S-2	4.0	21.7	7.2	SAND with some silt

Zipper Geo Associates, LLC Geotechnical and Environmental Consultants	Project No.: 1128.01 DATE OF TESTING: 5/15/2013	PROJECT NAME: Distribution Center

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D 422



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-4	S-2	2.5	16.4	8.1	SAND with some silt

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Geotechnical and Environmental Consultants

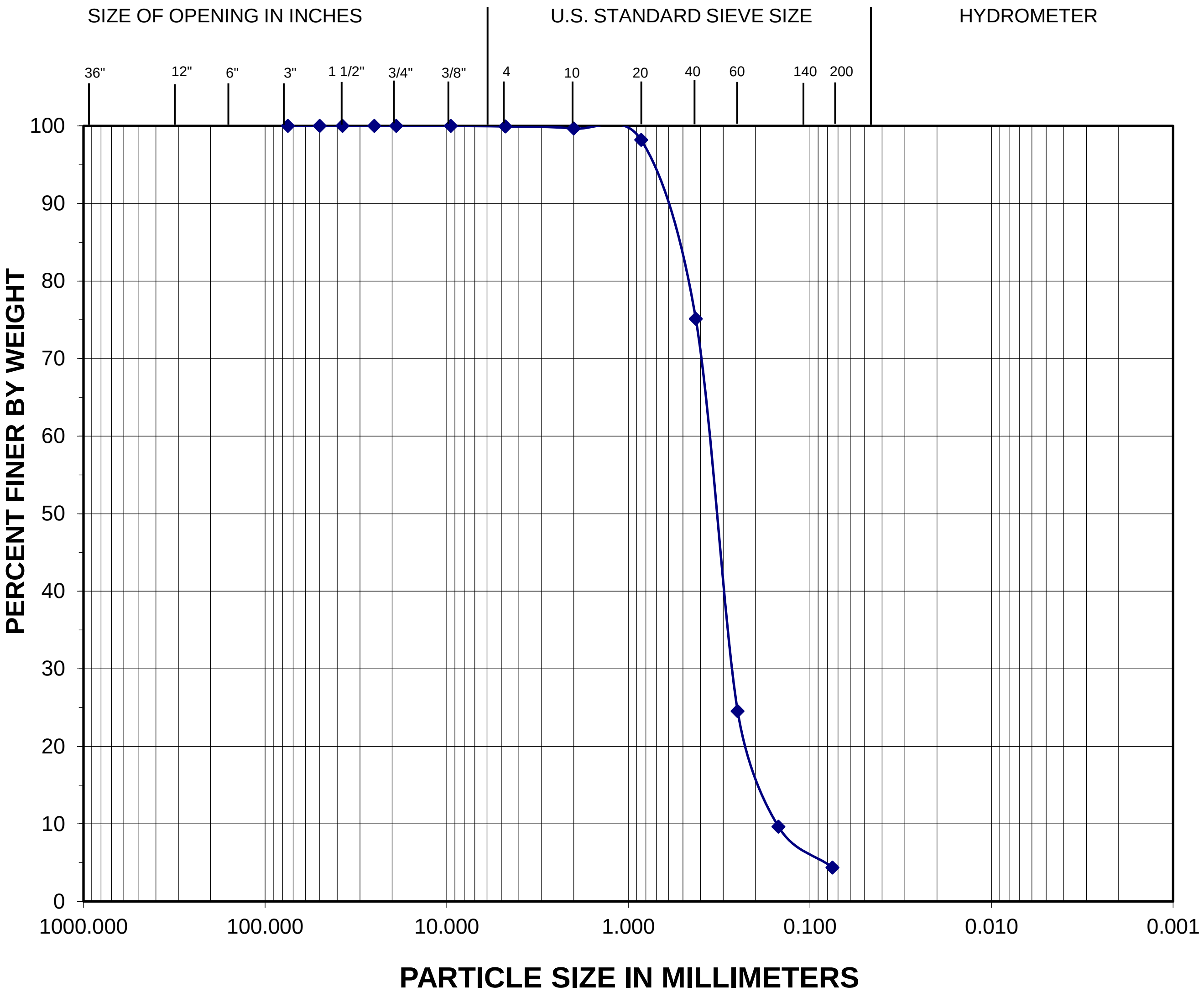
Project No.: 1128.01
DATE OF TESTING: 5/15/2013

PROJECT NAME:
Distribution Center

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D 422



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-5	S-2	3.5	26.2	4.4	SAND with trace silt

Zipper Geo Associates, LLC
Geotechnical and Environmental Consultants

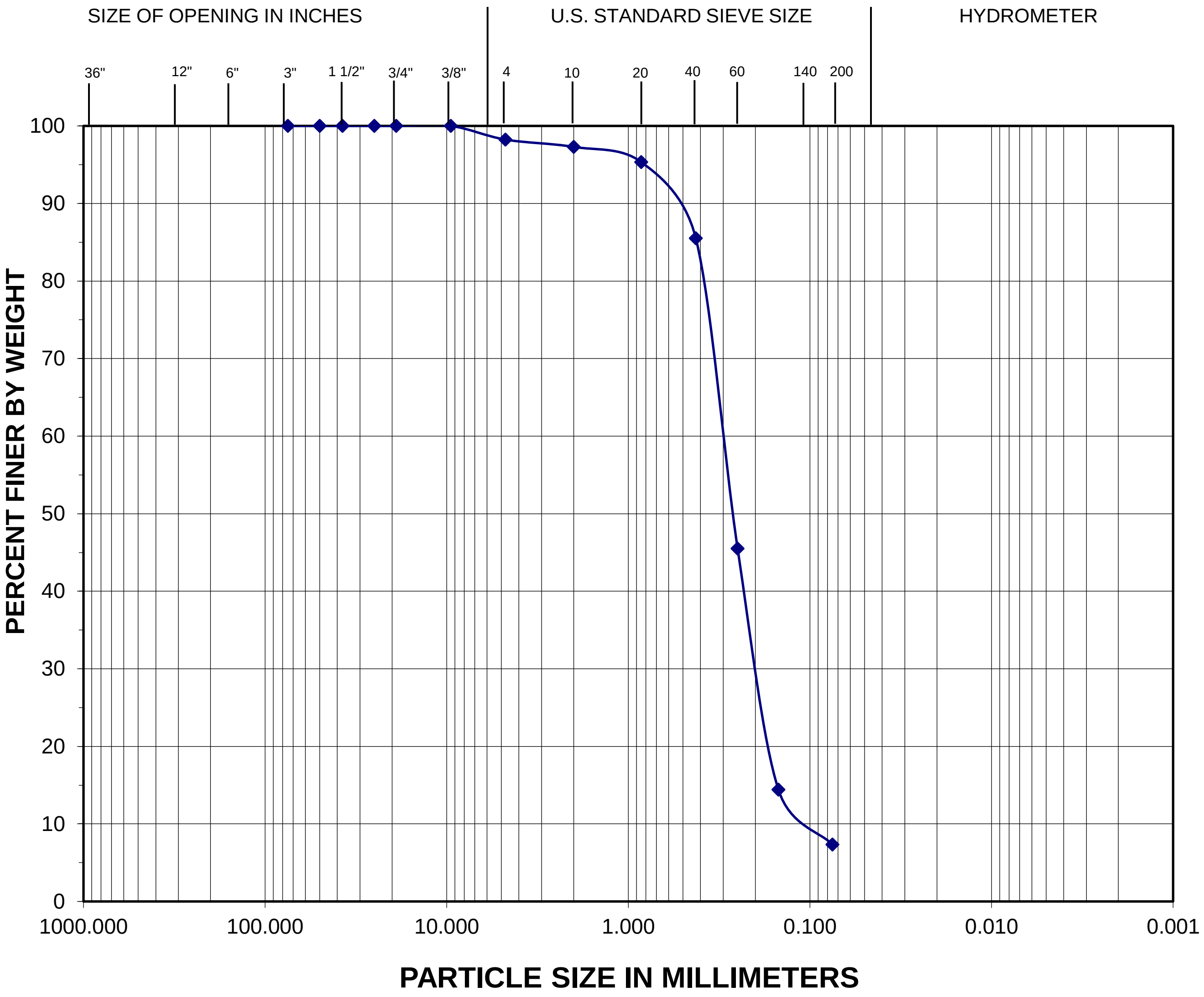
Project No.: 1128.01
DATE OF TESTING: 5/15/2013

PROJECT NAME:
Distribution Center

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D 422



		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
BOULDERS	COBBLES	GRAVEL		SAND			FINE GRAINED	

Comments:

Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-7	S-2	2.0	17.0	6.2	SAND with some silt

Zipper Geo Associates, LLC
Geotechnical and Environmental Consultants

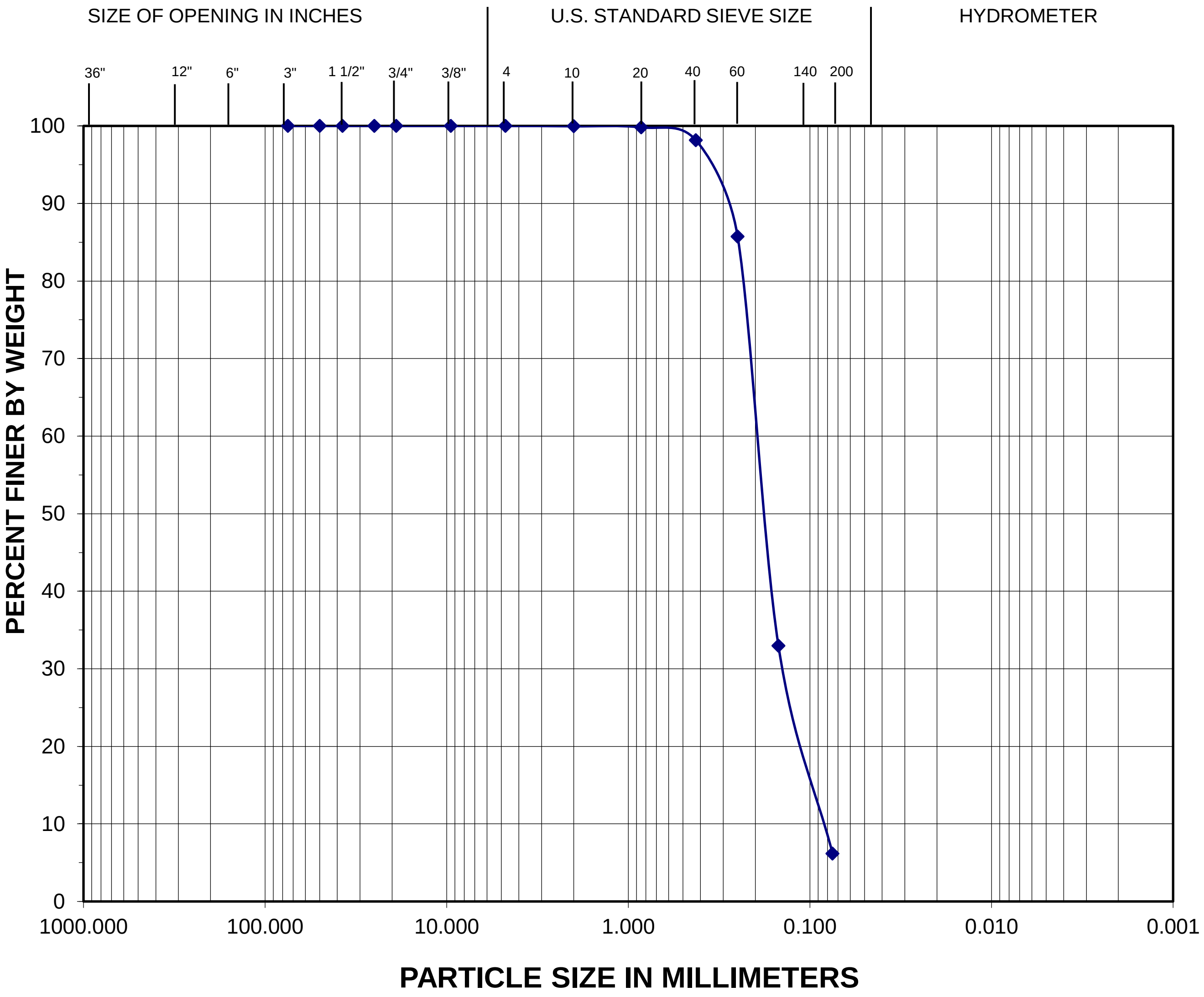
Project No.: 1128.01
DATE OF TESTING: 5/15/2013

PROJECT NAME:
Distribution Center

GRAIN SIZE ANALYSIS

Test Results Summary

ASTM D 422



BOULDERS	COBBLES	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
		GRAVEL		SAND			FINE GRAINED	

Comments:

Exploration	Sample	Depth (feet)	Moisture (%)	Fines (%)	Description
TP-7	S-3	3.0	27.6	6.2	SAND with some silt

Zipper Geo Associates, LLC
Geotechnical and Environmental Consultants

Project No.: 1128.01
DATE OF TESTING: 5/15/2013

PROJECT NAME:
Distribution Center

Job No. 1128.01

Job Name Marysville DC

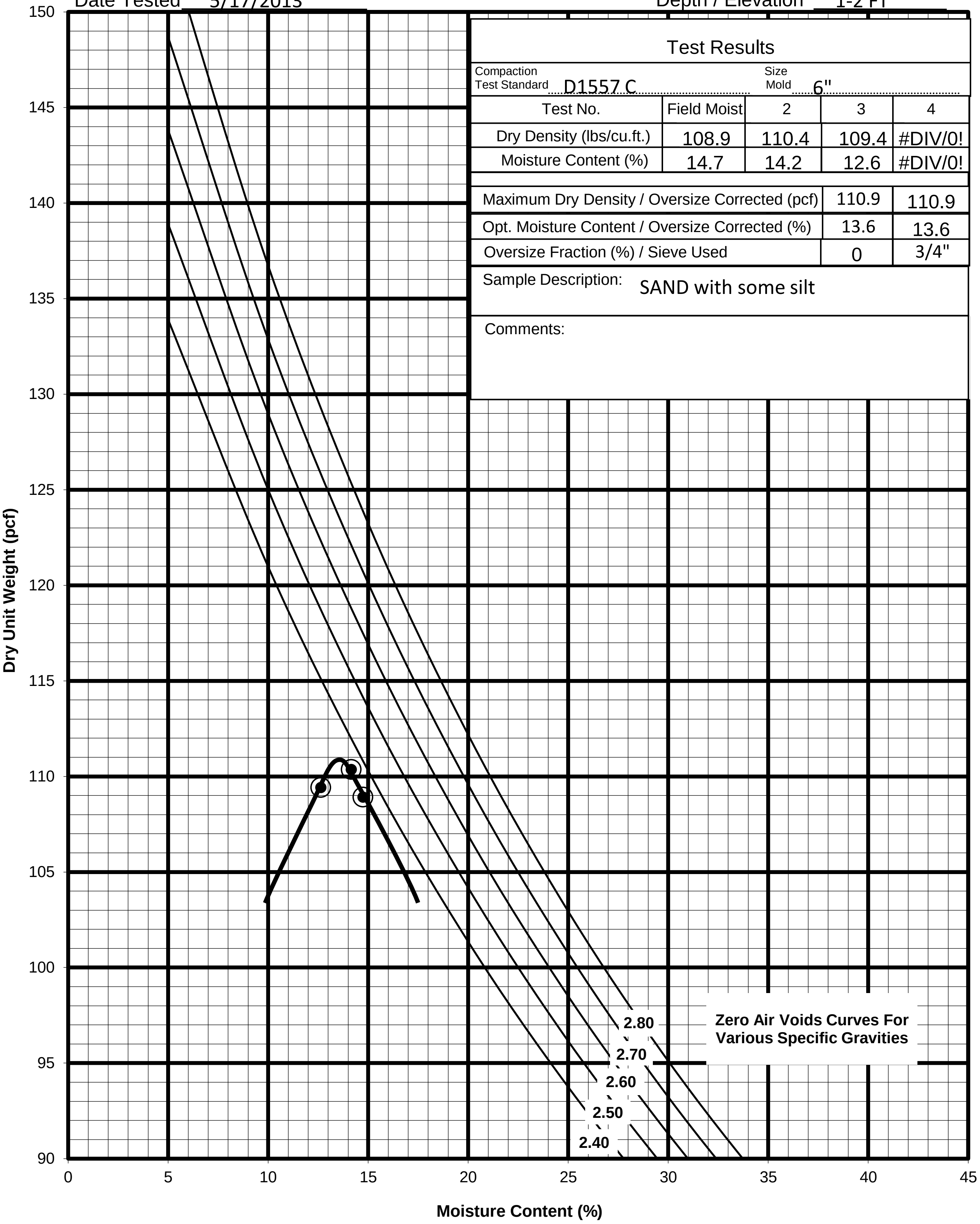
Date Tested 5/17/2013

LABORATORY COMPACTION CURVE

Sample No. TP-6, S-2

Location See Fig 2.

Depth / Elevation 1-2 FT



Test Results

Compaction Test Standard D1557 C

Size Mold 6"

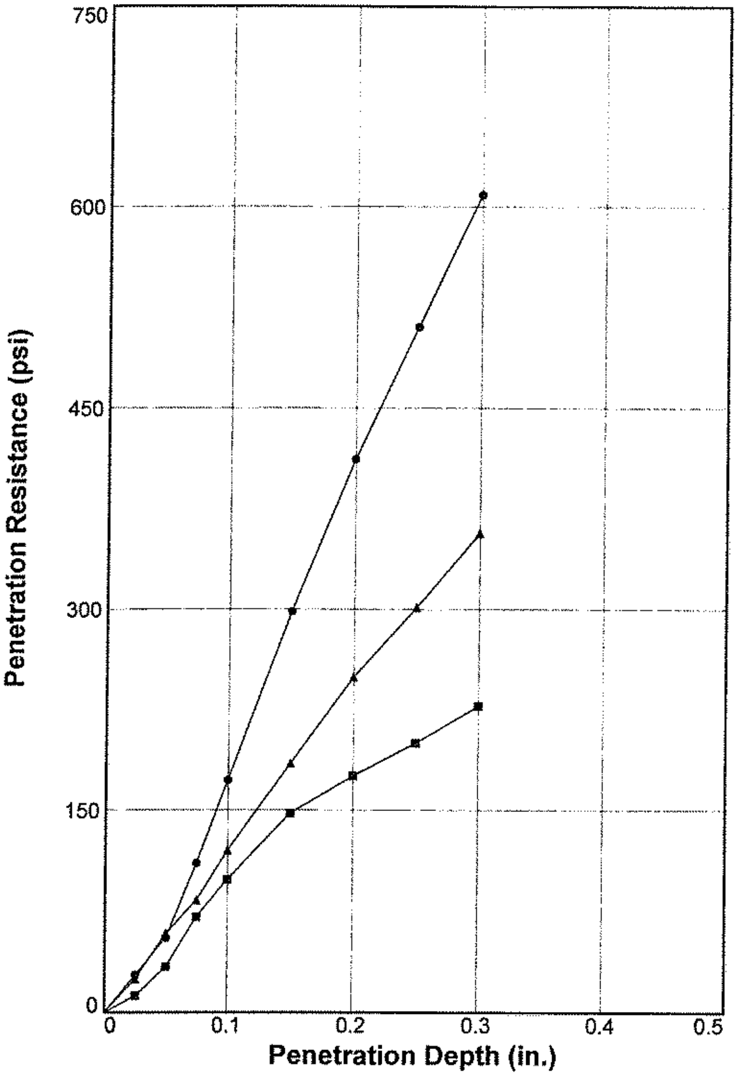
Test No.	Field Moist	2	3	4
Dry Density (lbs/cu.ft.)	108.9	110.4	109.4	#DIV/0!
Moisture Content (%)	14.7	14.2	12.6	#DIV/0!

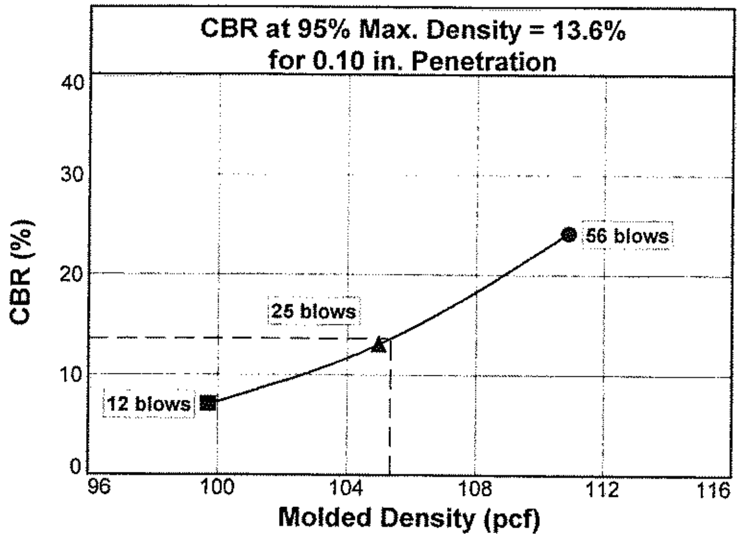
Maximum Dry Density / Oversize Corrected (pcf)	110.9	110.9
Opt. Moisture Content / Oversize Corrected (%)	13.6	13.6
Oversize Fraction (%) / Sieve Used	0	3/4"

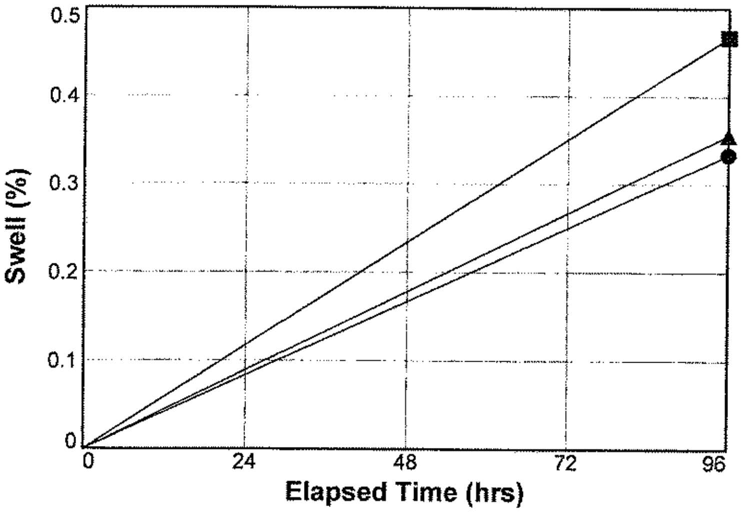
Sample Description: SAND with some silt

Comments:

BEARING RATIO TEST REPORT
ASTM D 1883-05




CBR at 95% Max. Density = 13.6%
for 0.10 in. Penetration



	Molded			Soaked			CBR (%)		Linearity Correction (in.)	Surcharge (lbs.)	Max. Swell (%)
	Density (pcf)	Percent of Max. Dens.	Moisture (%)	Density (pcf)	Percent of Max. Dens.	Moisture (%)	0.10 in.	0.20 in.			
1 ●	110.9	100	13.9	110.5	99.7	18.4	24.1	31.1	0.027	10	0.3
2 ▲	105.0	94.7	13.8	104.6	94.3	21.6	13.0	17.2	0.008	10	0.4
3 ■	99.7	89.9	13.5	99.3	89.5	23.5	7.0	10.7	-0.025	10	0.5

Material Description	USCS	Max. Dens. (pcf)	Optimum Moisture (%)	LL	PI
Yellowish-brown SAND with some silt.		110.9	13.6	NV	NP

Project No: 09613154

Project: Marysville DC - Lab

Location: Client Supplied; TP-6/S-2

Sample Number: 45494

Date: 5/17/13

Krazan

Test Description/Remarks:

Sample ID: 45494.

Entire Gradation Used, No Oversize