Conceptual Geotechnical Engineering Report
Gresham Vista Business Park
Gresham, Oregon

September 3, 2013

SHANNON & WILSON, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

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Excellence. Innovation. Service. Value
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Submitted To:
Robin McCaffrey
Port of Portland
7200 NE Airport Way
Portland, Oregon 97218

By:
Shannon & Wilson, Inc.
3990 Collins Way, Suite 100
Lake Oswego, Oregon 97035

(503) 210-4750
www.shannonwilson.com

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EXECUTIVE SUMMARY

Subsurface Soil Conditions

The site is underlain by varying amounts of fill overlying Catastrophic Flood Deposits that consist of silts, sands, and gravels. The flood deposits are underlain by Ancestral Sandy River Deposits. With the exception of Lot 11, where 15 feet of fill has been placed over native soils, the lots are generally underlain by 5 to 7 feet of medium stiff silty soils that overly sands and gravels. The gravel layer is generally between 6 and 10 feet below the ground surface except on Lot 10, where it was encountered at the surface at the south side of the hill near the existing storage barns and 15 feet below the surface near the reservoir.

Site Development Considerations

Based on the results of our field work and geotechnical engineering analysis, it is our opinion that the site is suitable for general industrial development. Based on our limited investigation, it is likely that the proposed structures will be able to be supported on conventional shallow-footing foundations. However, we recommend that lot-specific geotechnical evaluations be completed once the proposed development type is more certain. The primary geotechnical factors influencing the design and construction of this project are the presence of shallow perched groundwater in areas, instability of the soils in the reservoir area, possible difficult excavation conditions for utilities in the underlying gravels, and moisture-sensitive silts present at the ground surface.

Site Groundwater Conditions and On-Site Infiltration Potential

The static groundwater at the site is likely more than 20 feet below the elevation of SE Glisan Street to the north. However, shallower perched water is present above the silt and clay layers that are less permeable throughout the site. This perched water was observed between approximate elevations of 208 and 294 feet and generally follows the topography of the site.

Infiltration rates at the site were highly variable based on the subsurface conditions and soils at the specific location of the test. In general, the more granular materials (sand and gravel) do provide potential onsite infiltration candidates for localized areas. This is especially applicable to lots on the south side of the site, where the main perched groundwater levels are likely more than 20 feet below the ground surface. Note, though, that these higher-permeability materials were generally more than 5 to 10 feet below the ground surface in our explorations. Based on the collected information, it is our opinion that onsite infiltration is feasible on Lots 6 through 9 and the upper portions of Lot 10; however, due to the variability, we recommend that lot-specific infiltration testing be completed. Negligible infiltration will likely be possible on Lot 11 due to the presence of a large fill and the proximity to shallow perched groundwater.

Lot 10 Slope Stability Evaluation

We performed global stability analyses of the existing conditions on Lot 10. We performed our slope stability analysis for the groundwater conditions observed at the site and with raised or near-surface conditions in the case that infiltration is used at the site on the south side of Lot 10. Based on our analysis, with the elevated water levels, the static factor of safety for the slopes along Lot 10 is well above the standard 1.5 required for design, and the seismic factors of safety are above 1.1. Based on this analysis, the slopes on Lot 10 are generally stable in their existing condition, and it is our opinion that standard slope setback recommendations as recommended in the IBC are sufficient for development on Lot 10.

McGill Reservoir Berm Evaluation

Based on our hand-augured explorations, the reservoir berm was constructed with low plasticity medium stiff silt, sandy silt, and silty sand. Organics and other debris were present, and the soils were relatively soft and loose, indicating poor compaction. These soils are relatively high permeability for fine grained soils. Based on these observations, it is unlikely that the reservoir is lined. A liquefiable layer was encountered at the upper end of the reservoir between elevations 201 and 210, beginning approximately 7 feet below the ground surface. This layer will likely liquefy during a design-level seismic event, which may cause settlement and possible instability of the reservoir banks.

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1.0 INTRODUCTION

1.1 General

This report presents the results of our preliminary geotechnical investigation and conceptual geotechnical design recommendations for the proposed industrial development at the Gresham Vista Business Park site in Gresham, Oregon. The site is located between NE Glisan and SE Stark Streets on the east side of 223rd Avenue, as shown on the Vicinity Map, Figure 1.

1.2 Scope of Services

We performed this geotechnical investigation in accordance with the scope of services specified in the agreement referenced in Section 8. In general, our work included the following:

- Reviewing available published and in-house geologic information as well as geotechnical information provided by the Port;
- Exploring the subsurface conditions with seven drilled borings and four hand-augured borings, and collecting soil samples;
- Conducting infiltration testing in five borings;
- Conducting laboratory testing to characterize soils and develop soil properties for evaluation;
- Performing preliminary geotechnical analyses, including infiltration potential, groundwater levels, and slope stability on Lot 10;
- Evaluating berm conditions at the reservoir (irrigation pond);
- Providing preliminary infiltration recommendations for site development, generalized geotechnical characterization of the proposed lots, and a general discussion of geotechnical considerations for site development;
- Providing this report summarizing our explorations, preliminary geotechnical analysis, conclusions, and recommendations.

1.3 Project Description

1.3.1 Site Description

The proposed development is in Gresham, Oregon, and consists of 11 lots that have a total area of approximately 220 acres. The site is bounded by NE Glisan Street to the north, SE Stark Street to the south, 223rd Avenue to the west, and Hogan Drive/242nd Drive to the west.

The 11 lots surround an ON Semiconductor Components Industries facility and a PGE substation. The proposed lots are currently undeveloped and are used for agriculture, both planted and nursery components. The site elevations are highest in the southeast corner (approximately 365 feet above mean sea level, or MSL) and slope down to the north and west. Site grades in the northeast corner are on the order of 330 to 335 feet above MSL, and they are approximately 200 to 210 feet above MSL at Glisan Street in the northeast corner. The steepest slope occurs on the northern half of Lot 10. A reservoir is located at the toe of this slope and is contained by manmade soil berms. There has been a fill pad placed on Lot 11 in the northwest corner of the site, to the west of the gravel access road. This investigation focused on Lots 7 through 11 on the western half of the site, approximately 103 acres in area.

1.3.2 Project Understanding

We understand that the port is preparing the site for development and evaluating stormwater management options for lot development. Based on information provided by the Port, onsite stormwater infiltration may be required by the City of Gresham for the proposed development. Although future site tenants and development details are unknown at this time, S&W has evaluated the potential for onsite infiltration on the currently proposed Lots 7 through 11.

The geotechnical recommendations presented in this report are based on the available project information and the subsurface conditions described in this report. If any of the noted information changes during the course of design, please inform Shannon & Wilson, Inc., in writing so that we may reconsider and amend, if necessary, the recommendations presented in this report.

1.3.3 Existing Site Data Summary

The Port has provided Shannon & Wilson with overall site topography and two previous geotechnical studies at the site. The previous reports were prepared in 1998 by GeoDesign, Inc., for a portion of the site that is now the ON Semiconductor property, and in 2012 by Carlson Geotechnical for Lot 6. Both reports indicate that the subsurface of the site consists of silt and sand overlying interbedded stiff silt and medium dense to dense sand and gravel overlying very dense gravel. Perched groundwater was encountered on Lot 6 in one test pit. The previous geotechnical report indicated that based on the infiltration testing on Lot 6, the infiltration rates were approximately 1,000 in/hr at a depth of 7 feet and 5 to 6 in/hr at a depth of 10 feet.

2.0 GEOLOGIC SETTING

2.1 Regional Geology

The project site is located within the Portland structural basin, which was formed by folding and faulting of volcanic rocks of the Columbia River Basalt Group that are more than 9 million years old. Nearly 1,000 feet of Pliocene to Recent sediment has accumulated in the basin since formation of the structure; the Pliocene-age Sandy River Mudstone and Troutdale Formation (sandstone and conglomerate) account for at least several hundred feet of the sediment. In the Gresham area, the Troutdale Formation is overlain by middle to late Pleistocene alluvial deposits of the ancestral Sandy River, consisting of sandy gravel with some interbedded sand layers; these are believed to be part of a broad alluvial fan or braid plain (Evarts and O'Connor, 2008). The ancestral Sandy River deposits underlie late Pleistocene catastrophic flood deposits.

Near the end of the Pleistocene epoch or "Ice Ages," between about 18,000 and 15,000 years ago, a series of catastrophic floods occurred in the Columbia River system (Allen and others, 2009). A lobe of the continental ice sheet blocked the mouth of the Clark Fork River in western Montana, which then formed an immense glacial lake called Glacial Lake Missoula. The lake grew until its depth and pressure overcame the ice dam, allowing the entire massive lake to empty catastrophically. Once the lake had emptied, the ice sheet again blocked the Clark Fork Valley, and the lake began to refill. Consequently, catastrophic floods called the Missoula Floods were unleashed repeatedly some 40 or more times, probably at intervals of several decades. During each flood event, floodwaters passed through the Columbia River Gorge, inundated the entire Portland basin, and back-flooded up the Willamette Valley as far south as Eugene. Each of these events was short lived, but they profoundly shaped the surficial geology of the Portland basin below an elevation of 400 feet. The Missoula Floods deposited tremendous amounts of silt, sand, and gravel within the Portland Basin.

2.1.1 Site Geology

The primary geologic units that underlie the site and vicinity are Fill, Catastrophic Flood Deposits, Ancestral Sandy River Deposits, and Troutdale Formation. These units, listed in order from youngest to oldest, are generally described as follows:

- Fill: variable material placed by humans in the course of land development.
- Catastrophic Flood Deposits: sediments associated with catastrophic Missoula Flood episodes. These generally include fine-grained micaceous silt and fine sand overlying coarse gravel with cobbles and boulders in a silt and sand matrix.
- Ancestral Sandy River Deposits: variably cemented gravel with variable amounts of sand and fines that underlies Catastrophic Flood Deposits south of Interstate 84. The

gravel deposits are crudely stratified, well sorted, and contain abundant rounded clasts of basaltic and andesitic rocks; the unit also includes thin interstratified and discontinuous silty sand lenses.

- Troutdale Formation: weakly to moderately cemented gravel and cobble conglomerate with interbeds of sandstone. Sediment clasts include basalt, quartzite, and quartzofeldspathic metamorphic rocks.

Based on our interpretation of the material encountered in our borings, all units were encountered at the site except the Troutdale Formation. A nearby well log obtained from the Oregon Water Resources Department reported encountering Troutdale Formation at a depth of 85 feet below the ground surface, a depth deeper than our deepest boring. Troutdale Formation likely underlies the Ancestral Sandy River Deposits at the project site.

3.0 FIELD EXPLORATIONS

As shown on Figure 2b, Shannon & Wilson explored the subsurface conditions at the site with seven geotechnical borings and four hand auger holes. The borings, designated B-1 through B-7, were drilled between July 2 and July 5, 2013. A Shannon & Wilson engineering geologist located the borings, collected soil samples, and logged the materials encountered during drilling.

Infiltration tests were performed in or adjacent to the locations of borings B-1, B-4, B-5, B-6, and B-7. The hand augers, designated HA-1 through HA-4, were performed on Lot 10 along the berm retaining an irrigation pond (reservoir) by a Shannon & Wilson engineering geologist on July 5, 2013. The locations of the completed explorations were measured off of existing site features in the field. Details of the exploration program, including logs of the borings and hand augers, descriptions of the techniques used to advance and sample the borings, and infiltration test procedures and results, are presented in Appendix A.

4.0 LABORATORY TESTING

Laboratory tests were performed on selected samples from the borings to determine basic index and engineering properties of the soils encountered. The laboratory testing program included moisture content analyses, Atterberg Limits tests, and particle-size analyses. All laboratory testing was performed by Shannon & Wilson in general accordance with applicable ASTM International (ASTM) standards. Results of the laboratory tests and a brief description of the testing procedures are presented in Appendix B.

5.0 SUBSURFACE CONDITIONS

5.1 Project Geotechnical Engineering Units

We grouped the materials encountered in our field explorations into five geotechnical engineering units, based on their age, geologic origin, and engineering characteristics:

- Fill
- Catastrophic Flood Deposits – Fine-Grained Facies
- Catastrophic Flood Deposits – Sand Facies
- Catastrophic Flood Deposits – Gravel Facies
- Ancestral Sandy River Deposits

The following sections describe the general characteristics of these units. The specific terminology used in our soil description is defined in Appendix A, Figure A1. A generalized interpretation of subsurface stratigraphy is shown on the Lot 10 Geologic Profile, Figure 3. The location of the profile is shown on the Site Plan, Figure 2. Unit contacts may be more gradational than shown in the logs and profile, and conditions may vary significantly between explorations. The following discussion of units is intended to provide a general overview of subsurface conditions. Individual boring logs should be reviewed to understand the encountered subsurface conditions at specific locations.

5.1.1 Fill

Boring B-1 was drilled on the existing fill that has been placed on Lot 11. The fill was encountered from the ground surface to a depth of about 15 feet. It generally consisted of stiff to very stiff dark brown and gray Silty Sand with Gravel to Gravelly Silt with Sand (SM, ML). Sand and gravel clasts were fine to coarse. Gravel clasts were generally rounded to subrounded. Fines typically had low plasticity. Trace organics and pockets of Lean Clay (CL) were observed. Cobble-sized concrete fragments were observed at the ground surface.

Fill was also encountered in all hand augers within the berm on the northwest side of McGill Reservoir. There, the Fill generally consisted of gray to dark brown Silt or Elastic Silt with Sand to Silty Sand and Lean Clay (ML, MH, SM, CL). The sand was fine, and the fines ranged from nonplastic to medium plasticity. Trace organics were observed.

Fill was also encountered from the ground surface to a depth of about six feet in boring B-3, near the barns on the east side of Lot 10. There, the Fill consisted of soft, dark brown, nonplastic to low plasticity Silt with Sand (ML).

Standard Penetration Test (SPT) N-values in the Fill on Lots 10 and 11 ranged from 3 to 21 blows per foot (bpf) and averaged 12 bpf. The result of a single natural moisture content analysis was 14 percent. A single fines content determined by sieve analysis for one sample was 40 percent by dry weight.

5.1.2 Catastrophic Flood Deposits

The Catastrophic Flood Deposits include sediments deposited by the late Pleistocene Missoula Floods. To more clearly define the engineering properties of the materials encountered in our borings, we divided all flood deposits into three units based on material properties: Fine-Grained Facies consisting mostly of silt and clay; Sand Facies consisting mostly of sand; and Gravel Facies consisting mostly of gravel, cobbles, and boulders. The following paragraphs describe these flood deposit units in detail.

5.1.2.1 Catastrophic Flood Deposits – Fine-Grained Facies

The Catastrophic Flood Deposits – Fine-Grained Facies unit was encountered in boring B-1 and hand auger HA-1 below the Fill, and in borings B-2, B-5, B-6, and B-7 from the ground surface to depths ranging from 4.5 to 7.5 feet. The unit generally consists of soft to medium stiff or loose to medium dense brown to gray Silt to Sandy Silt (ML). The soil is typically moist and nonplastic to low plasticity, with mica and trace organics. SPT N-values in the unit ranged from 2 to 11 bpf and averaged 5 bpf. Results from two natural moisture content analyses were 24 and 42 percent, averaging 33 percent. A single fines content determined by sieve analysis for one sample was 91 percent by dry weight. A single Atterberg Limits test indicated a plasticity index of 3 for one sample, indicating low plasticity.

5.1.2.2 Catastrophic Flood Deposits – Sand-Grained Facies

The Catastrophic Flood Deposits – Sand Facies unit was encountered in borings B-2, B-3, B-5, B-6, and B-7. It ranged in thickness from about 1.5 to 8.2 feet, with the thinnest sections found in Lots 8 and 9, and the thickest sections found in the middle to north side of Lot 10. The Sand Facies deposits typically lay below the Fine-Grained Facies (if present) and above the Gravel Facies. In general, the Sand Facies consists of very loose to very dense, brown, micaceous Silty Sand to Silty Sand with Gravel (SM). In thicker sections, the Silty Sand may be interbedded with layers of Sandy Silt (ML) and Elastic Silt (MH). Within the Silty Sand, fines are nonplastic to low plasticity, sand is fine to coarse, and gravel is fine to coarse and subrounded to subangular. SPT N-values in the unit ranged from 3 to 59 bpf and averaged 23 bpf. Results from natural moisture content analyses ranged from 18 to 40 percent and averaged 28 percent. Fines contents determined by sieve analysis ranged from 15 to 59 percent and averaged 30 percent by dry weight.

5.1.2.3 Catastrophic Flood Deposits – Gravel-Grained Facies

The Catastrophic Flood Deposits – Gravel Facies unit was encountered in boring B-4 from the ground surface to a depth of 10 feet, and in borings B-3, B-6, and B-7 below the Sand Facies deposits. Borings B-6 and B-7 were terminated in the unit, and in Boring B-3 the unit was underlain by Ancestral Sandy River Deposits. In general, the Gravel Facies consists of medium dense to very dense, dark brown and gray Poorly Graded Gravel with Silt and Sand and Cobbles to Silty Gravel with Sand and Cobbles (GP-GM, GM). Based on drill action, the unit contains scattered cobbles at least 8 inches in diameter. While no boulders were observed during drilling, boulders up to 3 feet in diameter were observed at the ground surface near B-4, and were likely derived from this unit. Four of the nine SPTs attempted in the unit met refusal, where more than 50 blows were required to drive the sampler through a six-inch interval. The non-refusal SPT N-values ranged from 18 to 34 bpf and averaged 25 bpf. Results from two natural moisture content analyses were 11 and 27 percent, averaging 19 percent. Fines contents determined by sieve analysis for two samples were 10 and 37 percent, averaging 24 percent.

5.1.3 Ancestral Sandy River Deposits

The Ancestral Sandy River Deposits were encountered below the Sand Facies in borings B-2 and B-5, and below the Gravel Facies in borings B-3 and B-4. All borings that encountered the unit were terminated in it, with the thickest penetration being 55.4 feet in boring B-3. In general, the Ancestral Sandy River Deposits consist of dense to very dense, gray, red-yellow, and brown Poorly Graded Gravel with Clay and Sand to Clayey Gravel with Sand and Cobbles (GP-GC, GC). In boring B-4, the upper portion of the unit contained 3- to 5.5-foot-thick interbeds of stiff to very stiff gray to brown Lean Clay (CL) and a 7-foot-thick interbed of dense, brown, red, and gray Silty Sand (SM). Fines in the unit are low to medium plasticity, sand is fine to coarse, and gravel is fine to coarse and rounded to subangular. Some gravel clasts are predominantly decomposed. Based on drill action, the unit contains scattered cobbles at least 8 inches in diameter. Half of the 24 SPTs attempted in the unit met refusal. The non-refusal SPT N-values ranged from 27 to 99 bpf and averaged 52 bpf, with the exception of two SPTs taken in fine-grained layers, which yielded N-vales of 15 and 19 bpf. Results from natural moisture content analyses ranged from 21 to 37 percent and averaged 27 percent. A single fines content determined by sieve analysis for one sample was 13 percent. Two Atterberg Limits tests on samples from fine-grained layer indicated plasticity indices of 9 and 10.

5.2 Groundwater

After drilling, borings B-2 and B-4 were flushed with clean water and left open from July 3 to the morning of July 5, 2013, in order to observe the natural groundwater level. Boring B-3 was left open over the same time interval, but its total depth on July 3 was only 15.8 feet, as it was still in progress. On the morning of July 5, the measured water level in boring B-2 was 8.8 feet below the ground surface, and the measured water level in boring B-4 was 20.7 feet below the ground surface. In boring B-3, water was measured at 9.9 feet below the ground surface, but it contained drilling mud and the boring was still in progress, so that level may not reflect the actual depth to groundwater. In our opinion, the values obtained from borings B-2 and B-4 are likely representative of groundwater levels at the site at the time the explorations were performed. Groundwater levels should be expected to fluctuate seasonally and with changes in precipitation, land use, and other factors. In general, we expect groundwater levels in this area to be at a seasonal high during the winter and late spring and at a seasonal low during the late summer and early fall.

6.0 SEISMIC DESIGN CONSIDERATIONS

In accordance with the site classification criteria set forth in 2012 International Building Code (2010 IBC), we recommend a Site Class D for this site. The following paragraphs describe required seismically related hazard evaluations on-site.

- **Strong Ground Motions:** The maximum considered earthquake (MCE) ground motions at the bedrock level of S_S = 0.95 g and S_1 = 0.39 g were obtained from the United States Geological Survey's Earthquake Hazards Program – 2008 interactive deaggregation website. Based on the site class and these values, the design earthquake spectral response coefficients are Fa = 1.12 and Fv = 1.62. The ground motions are based on a probabilistic hazard analysis performed by the USGS and the seismic site classification of the project site.
- **Fault Rupture:** In the vicinity of the project site, the nearest mapped faults are the Damascus-Tickle Creek fault and Grant Butte fault, about 1.8 miles to the south, and the Lacamas Lake fault, about 4.5 miles to the northeast. All three faults are designated as Class A by the United States Geological Survey and are thought to have been active within the last 750 thousand years (Personius, 2002). Due to their mapped distance from the site, it is our opinion that the risk for fault rupture at the site is low.
- **Liquefaction and Lateral Spread**: A layer of loose sand was encountered in B-2 near the southern side of the reservoir. Based on the observed water level and the loose, non-plastic nature of the soil, it is likely that this layer will experience liquefaction,

settlement, and strength loss during a seismic event. This could cause instability of the berms surrounding the reservoir. Based on our explorations, this layer is limited to the area near the reservoir.

- **Other Seismic Risks:** Due to the dense gravelly soils at the site and the geography, it is our opinion that the risk for liquefaction and lateral spread away from the reservoir, and tsunami or seiche at the site is minimal.

7.0 CONCEPTUAL GEOTECHNICAL RECOMMENDATIONS

7.1 General

Based on the results of our field work and geotechnical engineering analysis, it is our opinion that the site is suitable for general industrial development. Based on our limited investigation, it is likely that the proposed structures will be able to be supported on conventional shallow-footing foundations. However, we recommend that lot-specific geotechnical evaluations be completed once the proposed development type is more certain. The primary geotechnical factors influencing the design and construction of this project are the presence of shallow perched groundwater in areas, instability of the soils in the reservoir area, possible difficult excavation conditions for utilities in the underlying gravels, and moisture-sensitive silts present at the ground surface.

7.2 Site Groundwater Conditions and On-Site Infiltration Potential

As discussed above, the static groundwater at the site is likely more than 20 feet below the elevation of SE Glisan Street to the north. However, shallower perched water is present above the silt and clay layers that are less permeable throughout the site, and within the gravel layers above the cemented or fine-grained portions of the Ancestral Sandy River mudflow deposits that act as an aquitard in this area. The perched water in the area of the reservoir is an indication of the presence of this aquitard. These perched water levels were present during the previous August 2012 and our July 2013 explorations, indicating that they will likely be present year-round, even in the drier summer months. Based on our observations and the previous studies at the site, this perched water was observed between approximate elevations of 208 and 294 feet and generally follows the topography of the site.

Further, infiltration rates at the site were highly variable based on the subsurface conditions and soils at the specific location of the test. In general, the more granular materials (sand and gravel) do provide potential onsite infiltration candidates for localized areas. This is especially applicable to lots on the south side of the site, where the main perched groundwater levels are likely more than 20 feet below the ground surface. Note, though, that these higher-permeability materials were generally more than 5 to 10 feet below the ground surface in our explorations.

Based on the collected information, it is our opinion that onsite infiltration is feasible on Lots 6 through 9 and the upper portions of Lot 10; however, due to the variability, we recommend that lot-specific infiltration testing be completed. Rain gardens and other shallow installations may require over-excavation to communicate with deeper, more permeable layers. In general, all infiltration features and installations should be placed to avoid shallow perched groundwater. Negligible infiltration will likely be possible on Lot 11 due to the presence of a large fill and the proximity to shallow perched groundwater.

7.3 Lot 10 Slope Stability Evaluation

Slope stability is influenced by various factors including: (1) the geometry of the soil mass and subsurface materials; (2) the weight of soil materials overlying the failure surface; (3) the shear strength of soils and/or rock along the failure surface; and (4) the hydrostatic pressure (groundwater levels) present within the landslide mass and along the failure surface. The stability of a slope is expressed in terms of factor of safety (FS), which is defined as the ratio of resisting forces to driving forces. At equilibrium, the FS is equal to 1.0 and the driving forces are balanced by the resisting forces. Failure occurs when the driving forces exceed the resisting forces, i.e., FS less than 1.0. An increase in the factor of safety above 1.0, whether by increasing the resisting forces or decreasing the driving forces, reflects a corresponding increase in the stability of the mass. In general, a static factor of safety of 1.5 is desirable for slopes that will support structures and roads. A seismic factor of safety of greater than 1.1 is also recommended.

The actual factor of safety may differ from the calculated factor of safety due to variations in soil strengths, subsurface geometry, failure surface location and orientation, groundwater levels, and other factors that are not completely known or understood. To develop the slope stability models, we used site-specific historical information, information developed from our field explorations, laboratory testing, and our experience with similar materials. Our engineering analyses and conclusions are based upon the assumption that subsurface conditions are not significantly different from those encountered by the field explorations and interpreted in the geologic profiles.

We performed global stability analyses of the existing conditions at the profile A-A' as shown on Figure 2a and Figure 3 using the limit-equilibrium stability methods as included in SLOPE/W, Version 7.19, (Geo-Slope International, 2007). The results of the analysis are shown on Figure 4. The Morgenstern-Price method, which satisfies both force and moment equilibrium, was used to calculate the FS values for optimized failure surfaces. We performed our slope stability analysis for the groundwater conditions observed at the site and with raised or near-surface conditions in the case that infiltration is used at the site on the south side of Lot 10.

Based on our analysis, with the elevated water levels, the static factor of safety for the slopes along Lot 10 is well above the standard 1.5 required for design, and the seismic factors of safety are above 1.1. Based on this analysis, the slopes on Lot 10 are generally stable in their existing condition, and it is our opinion that standard slope setback recommendations as recommended in the IBC are sufficient for development on Lot 10. Further, infiltration at the site will not adversely affect global stability of the slope shown in Figure 3. However, we recommend that once the infiltration facilities and lot layouts are complete, local slope stability be analyzed based on the final design.

7.4 McGill Reservoir Berm Evaluation

Based on our hand-augured explorations, the reservoir berm was constructed with low plasticity medium stiff silt, sandy silt, and silty sand. Organics and other debris were present, and the soils were relatively soft and loose, indicating poor compaction. These soils are relatively high permeability for fine grained soils. Groundwater was observed in two of the four hand augers and rose to 2 to 3 feet below the reservoir level within a few minutes of excavation. Based on these observations, it is unlikely that the reservoir is lined. During our explorations, the reservoir water level was between 3 and 5 feet below the top of the surrounding berm. We anticipate that the water level is higher in winter months and during periods of wet weather. We also understand that the pond is used for irrigation purposes and thus can have a variable water level throughout the year.

As discussed above, a liquefiable layer was encountered in B-2 between elevations 201 and 210, beginning approximately 7 feet below the ground surface. This layer will likely liquefy during a design-level seismic event, which may cause settlement and possible instability of the reservoir banks.

We understand that the Port is considering using this reservoir as additional storage capacity for onsite stormwater disposal. Based on our observations, it is likely that there is limited capacity within the reservoir for large amounts of additional runoff. Further, seepage will likely occur within the permeable material of the berm. If this area is needed for temporary stormwater storage, it is likely that the height of the berm will need to be increased. We recommend also that the berm be further evaluated for instability during seismic events and that the installation of a liner be considered to prevent excessive seepage and possible stability issues within the berm.

7.5 Construction Considerations

7.5.1 Earthwork Considerations

The contractor may encounter difficulties during excavation at the site due to shallow perched groundwater and dense to very dense gravels with frequent cobbles and possible boulders. Temporary earth slopes may be cut at a steepness of about 1.5 horizontal to 1 vertical (1.5H:1V) above the groundwater table. Permanent earth slopes should be dressed to 2H:1V or flatter and protected from erosion.

Excavation and construction operations may expose the on-site silty surficial soils to inclement weather conditions. These soils can be easily disturbed when wet, and the stability of exposed soils may rapidly deteriorate due to a change in moisture content (i.e. wetting or drying) or the actions of heavy or repeated construction traffic. Accordingly, foundation and pavement area excavations should be adequately protected from the elements and from the actions of repetitive or heavy construction loadings.

7.5.2 Dewatering Considerations

The previous explorations on Lot 6 and our explorations have shown the potential for the presence of shallow perched groundwater at the site. Utility trench and other excavations may encounter groundwater seepage and the associated instability, especially in sandy soils.

8.0 LIMITATIONS

Our services are being performed based on the Shannon & Wilson proposal (Proposal #24-2-04550-001) executed June 28, 2013, as PO #107591 assigned under our on-call contract (Contract #612) with the Port of Portland. The analyses, conclusions, and recommendations contained in this report are based on site conditions as they presently exist, and further assume that the explorations are representative of the subsurface conditions throughout the site; that is, the subsurface conditions everywhere are not significantly different from those disclosed by the explorations. If subsurface conditions different from those encountered in the explorations are encountered or appear to be present during construction, we should be advised at once so that we can review these conditions and reconsider our recommendations, where necessary. If there is a substantial lapse of time between the submission of this report and the start of construction at the site, or if conditions have changed because of natural forces or construction operations at or adjacent to the site, we recommend that we review our report to determine the applicability of the conclusions and recommendations.

Within the limitations of scope, schedule, and budget, the analyses, conclusions, and recommendations presented in this report were prepared in accordance with generally accepted professional geotechnical engineering principles and practice in this area at the time this report was prepared. We make no other warranty, either express or implied. These conclusions and recommendations were based on our understanding of the project as described in this report and the site conditions as observed at the time of our explorations.

Unanticipated soil conditions are commonly encountered and cannot be fully determined by merely taking soil samples from test borings. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

This report was prepared for the exclusive use of the owner and architect/engineer in the design of the Gresham Vista Business Park. The data and report can be provided to the contractors for their information, but our report, conclusions, and interpretations should not be construed as a warranty of subsurface conditions included in this report.

The scope of our present work did not include environmental assessments or evaluations regarding the presence or absence of wetlands, or hazardous or toxic substances in the soil, surface water, groundwater, or air, on or below or around this site, or for the evaluation or disposal of contaminated soils or groundwater, should any be encountered.

Shannon & Wilson, Inc., has prepared and included in Appendix C, "Important Information About Your Geotechnical/Environmental Report," to assist you and others in understanding the use and limitations of our reports.

SHANNON & WILSON, INC.

REGISTERED PROFESSIONAL ENGINEER
58419PE
OREGON
JULY 13, 1999
RISHENG PIAO
EXPIRES: 12/31/14

REGISTERED PROFESSIONAL ENGINEER
69452PE
OREGON
Nov. 14, 2006
ALLISON MARIE PYRCH
EXPIRES: 12/31/14

Risheng "Park" Piao, PE, GE
Vice President Geotechnical Engineer

Allison M. Pyrch, PE, GE
Principal Geotechnical Engineer

AMP/RPP/GLP/amn

9.0 REFERENCES

Allen, J.E., Burns, M., and Burns, S., 2009, Cataclysms on the Columbia: The Great Missoula Floods (2d ed.): Portland, Ore., Ooligan Press, 204 p.

Beeson, M.H., Tolan, T.L., and Madin, I.P., 1989, Geologic Map of the Lake Oswego Quadrangle, Clackamas, Multnomah, and Washington Counties, Oregon: Oregon Department of Geology and Mineral Industries, Geological Map Series GMS-59, scale 1:24,000.

Carlson Geotechnical, *Report of Geotechnical Investigation & Infiltration Testing – Fresenius Medical Clinic – Phases I through III*, August 22, 2012.

Evarts, R.C., and O'Connor, J.E., 2008, Geologic Map of the Camas Quadrangle, Clark County, Washington, and Multnomah County, Oregon. U.S. Geological Survey Scientific Investigations Map 3017.

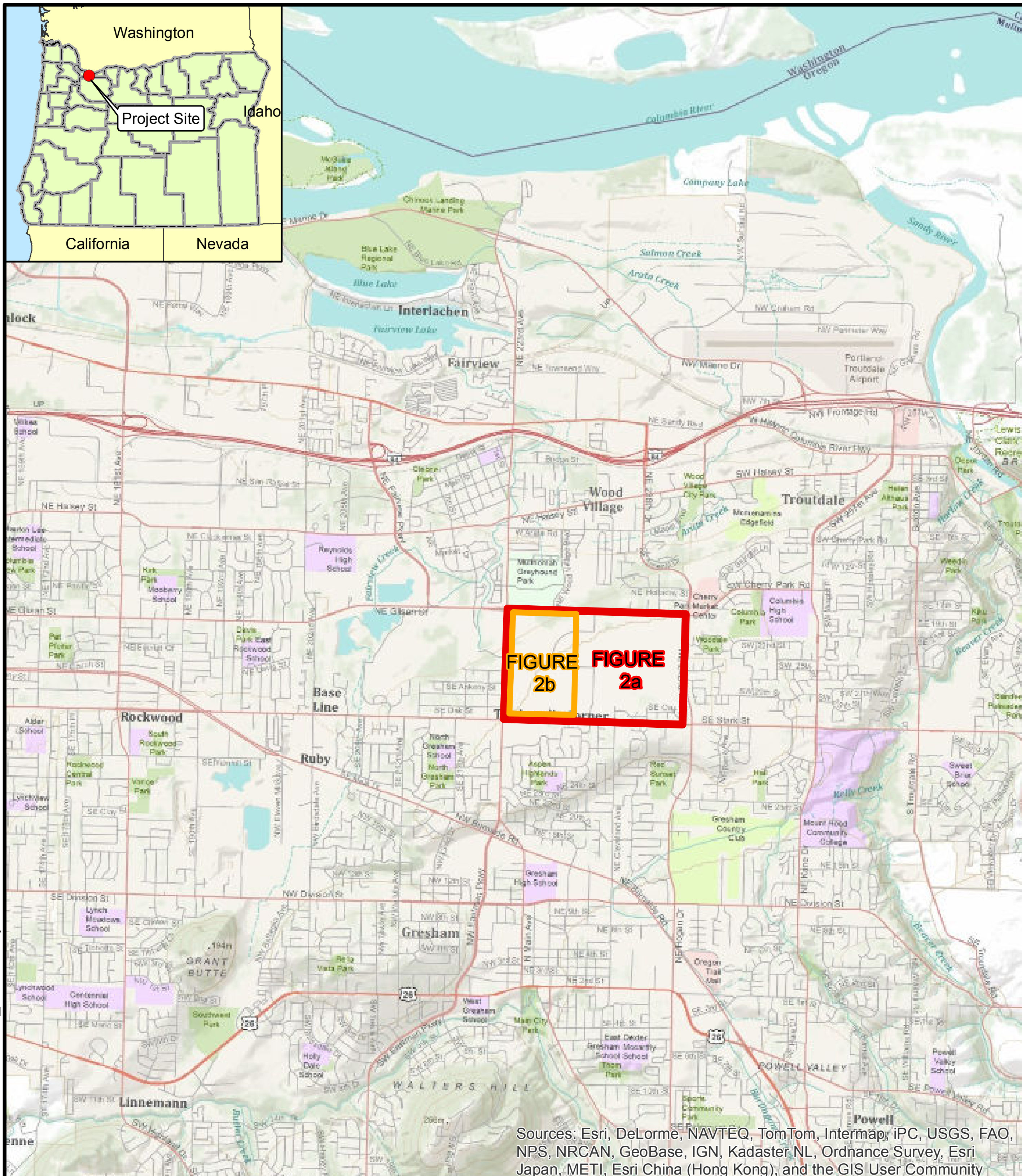
GeoDesign, Inc., *Geotechnical Engineering Service Report – LSI Logic Central Processing Building, Gresham, Oregon,* April 15, 1998.

International Building Code, 2012.

Personius, S.F., compiler, 2002, Fault number 880, Lacamas Lake fault, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, http://earthquakes.usgs.gov/hazards/qfaults, accessed 07/26/2013 04:33 PM.

Personius, S.F., compiler, 2002, Fault number 878, Grant Butte fault, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, http://earthquakes.usgs.gov/hazards/qfaults, accessed 07/26/2013 04:32 PM.

Personius, S.F., compiler, 2002, Fault number 879, Damascus-Tickle Creek fault zone, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, http://earthquakes.usgs.gov/hazards/qfaults, accessed 07/26/2013 04:29 PM.



0 4,000 8,000 Feet

Gresham Vista Business Park
Gresham, Oregon

VICINITY MAP

September 2013 24-1-03793-001

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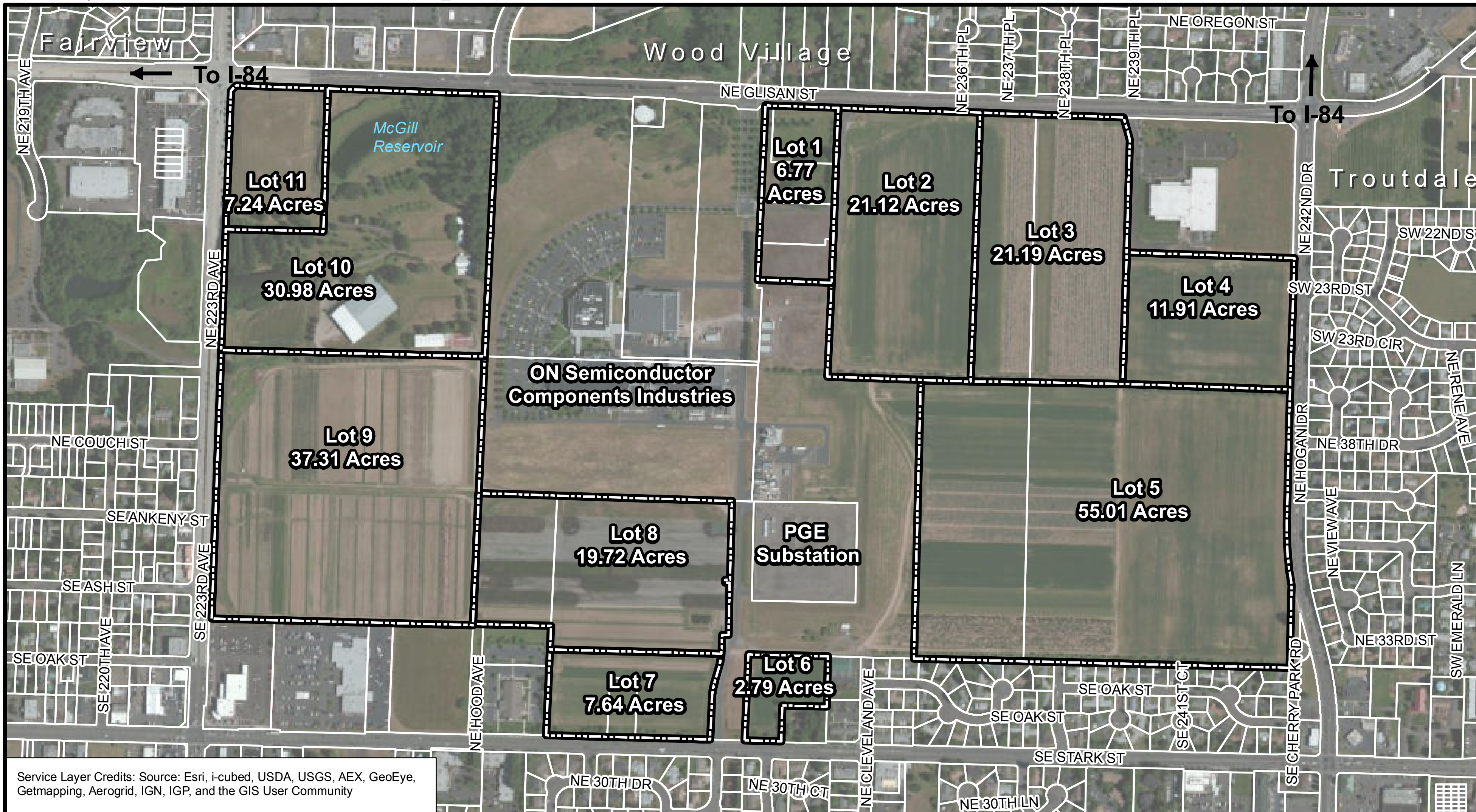
FIG. 1

Path: T:\Projects\24-1\3793 Gresham Vista Business Park\AV_mxd\Vicinity.mxd 8/23/2013 ath

Path: T:\Projects\24-1\3793 Gresham Vista Business Park\AV_mxd\SitePlan2a.mxd 8/23/2013 ath



Service Layer Credits: Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

LEGEND

Gresham Vista Business Park Proposed Lot

Taxlot

NOTE
Lot boundaries georeferenced from Port of Portland figure.

0 700 1,400 Feet

Gresham Vista Business Park
Gresham, Oregon

SITE PLAN

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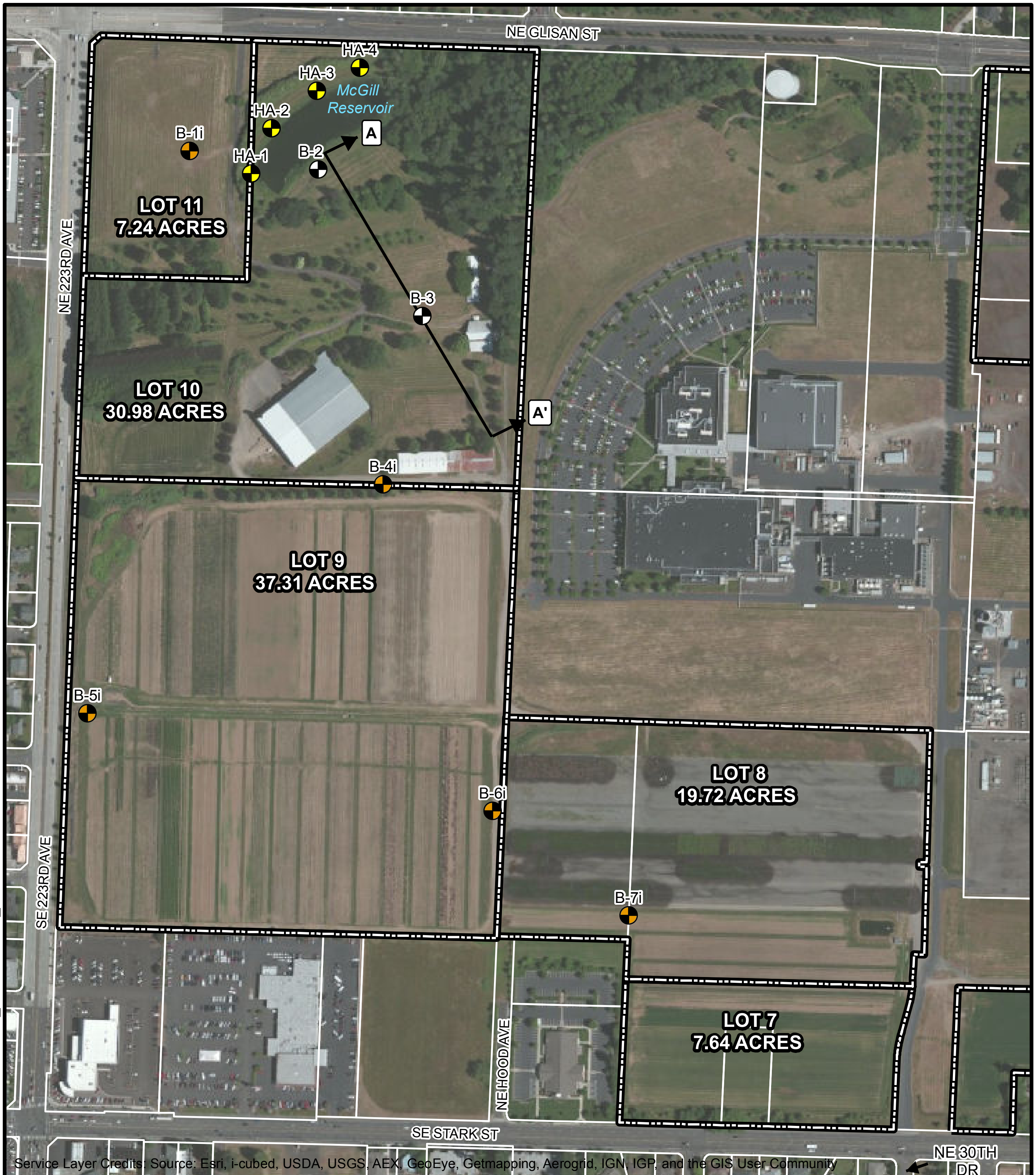
FIG. 2a



LEGEND

- Boring
- Boring with Infiltration Test
- Hand Auger
- Cross Section
- Gresham Vista Business Park Proposed Lot
- Taxlot

NOTE
Lot boundaries georeferenced from Port of Portland figure.

0 400 800 Feet

N W E S

Gresham Vista Business Park
Gresham, Oregon

PLAN OF EXPLORATIONS

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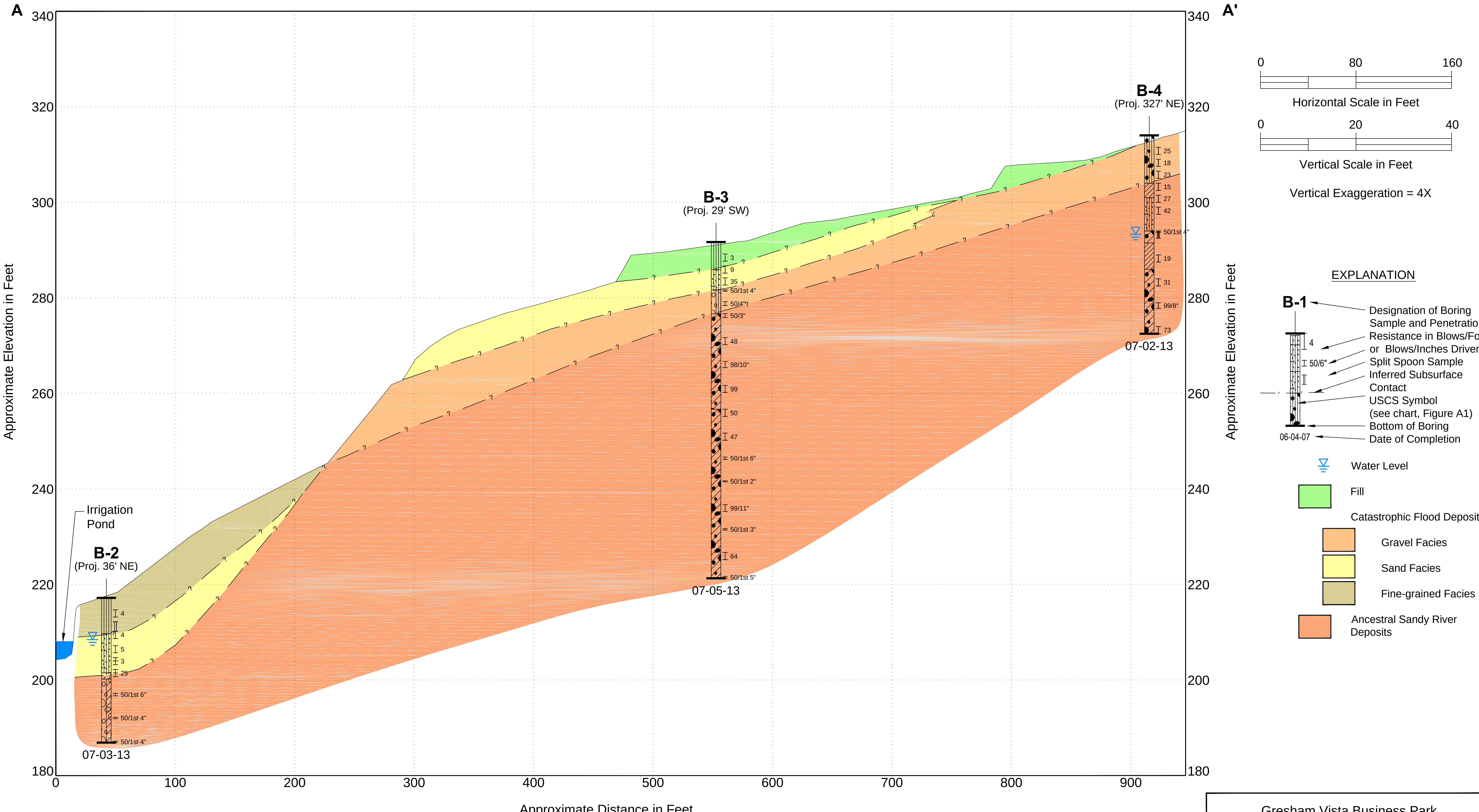
FIG. 2b

Path: T:\Projects\24-1\3793 Gresham Vista Business Park\AV_mxd\SitePlan_2b.mxd 8/23/2013 ath



NOTE

This subsurface profile is generalized from materials observed in soil borings. Variations may exist between profile and actual conditions.

Gresham Vista Business Park
Gresham, Oregon

LOT 10 GEOLOGIC PROFILE

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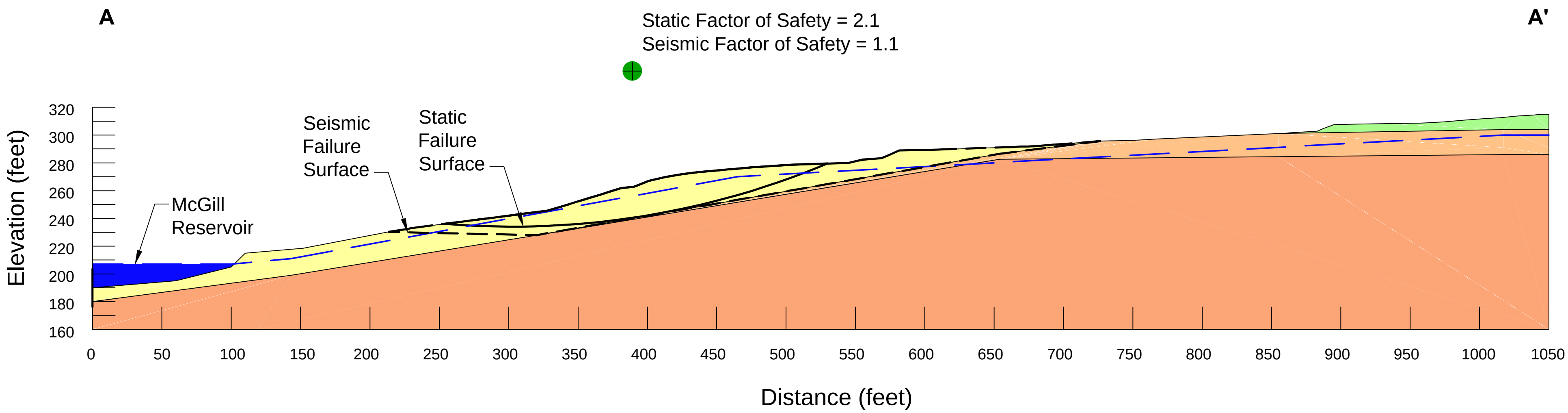
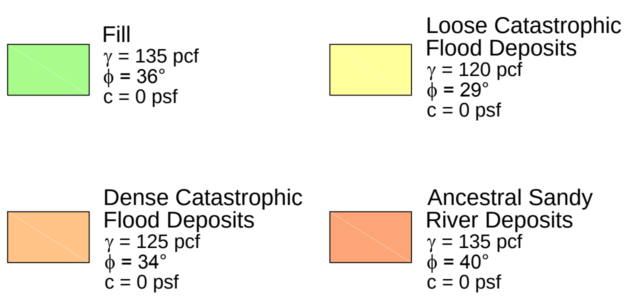
FIG. 3

File: I:\WIP\Projects\24-1 Portland\3700\3793 Gresham Vista Business Park\Graphics\CAD\24-1-03793-Profile.dwg Date: 08-23-2013 Author: mas

Filename: I:\WIP\Projects\24-1 Portland\3700\3793 Gresham Vista Business Park\Graphics\CAD\24-1-03793-Profile.dwg Layout: SlopeStabAnalysis Date: 08-23-2013 Login: mas





Gresham Vista Business Park
Gresham, Oregon

LOT 10
SLOPE STABILITY ANALYSIS

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FIG. 4

FIG. 4

APPENDIX A

FIELD EXPLORATIONS

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TABLES

FIGURES

APPENDIX A

FIELD EXPLORATIONS

A.1 GENERAL

Shannon & Wilson, Inc., explored subsurface conditions at the project site with seven geotechnical borings and four hand auger holes. The borings were designated B-1 through B-7 and ranged in depth from 9.3 to 70.4 feet below the ground surface (bgs). The hand auger holes were designated HA-1 through HA-4 and ranged in depth from 5.7 to 8.0 feet bgs. Infiltration tests were performed in or adjacent to the locations of borings B-1, B-4, B-5, B-6, and B-7. The locations of the completed explorations were measured off of existing site features in the field using a tape measure. Approximate locations of the explorations are shown on the Site Plan, Figure 2. This appendix describes the techniques used to advance and sample the explorations and presents logs of the materials encountered during drilling. It also presents infiltration testing procedures and results.

A.2 BORINGS

A.2.1 Drilling

Borings B-1 through B-7 were drilled between July 2 and July 5, 2013. The borings were drilled using a CME 75 truck-mounted drill rig provided and operated by Western States Soil Conservation, Inc., of Hubbard, Oregon. Borings B-1, B-5, B-6, and B-7 were drilled using hollow-stem auger drilling techniques. Borings B-2, B-3, and B-4 were drilled using mud-rotary drilling techniques. For each boring with an associated infiltration test (B-1, B-4, B-5, B-6, and B-7), the tests were conducted through the hollow-stem auger used for the geotechnical hole or in an adjacent hollow-stem auger set within 5 feet of the geotechnical hole location. A Shannon & Wilson engineering geologist was present during the explorations to locate the borings, observe the drilling, collect soil samples, log the materials encountered, and conduct infiltration testing.

A.2.2 Disturbed Sampling

Disturbed samples were collected in the borings, typically at 2.5- to 5-foot depth intervals, using a standard 2-inch outside diameter (O.D.) split spoon sampler in conjunction with Standard Penetration Testing. In a Standard Penetration Test (SPT), ASTM D1586, the sampler is driven 18 inches into the soil using a 140-pound hammer dropped 30 inches. The number of blows required to drive the sampler the last 12 inches is defined as the standard penetration resistance, or N-value. The SPT N-value provides a measure of in situ relative density of cohesionless soils (silt, sand, and gravel), and the consistency of cohesive soils (silt and clay). In some instances, a 3-inch O.D. split spoon sampler was used through the same interval as, or in lieu of, an SPT sample in order to obtain additional material for testing. All disturbed samples were visually identified and described in the field, sealed to retain moisture, and returned to our laboratory for additional examination and testing.

SPT N-values can be significantly affected by several factors, including the efficiency of the hammer used. The same automatic hammer system was used for all borings performed at the site. Automatic hammers generally have higher energy transfer efficiencies than cathead-driven hammers. Based on information we received from Western States Soil Conservation, the energy efficiency of the hammer used at the site was 73.0 percent, as previously measured on March 17, 2013. All N-values presented in this report are in blows per foot, as counted in the field. No corrections of any kind have been applied.

An SPT was considered to have met refusal where more than 50 blows were required to drive the sampler 6 inches. If refusal was encountered in the first six-inch interval (for example, 50 for 1.5"), the count is reported as 50/1st 1.5". If refusal was encountered in the second six-inch interval (for example, 48, 50 for 1.5"), the count is reported as 50/1.5". If refusal was encountered in the last six-inch interval (for example, 39, 48, 50 for 1.5"), the count is reported as 98/7.5". N-values from samples acquired using a 3-inch O.D. sampler are not shown on the logs.

A.2.3 Undisturbed Sampling

Undisturbed samples were collected in 3-inch O.D. thin-wall Shelby tubes, which were pushed into the undisturbed soil at the bottoms of boreholes hydraulically. The soils exposed at the ends of the tubes were examined and described in the field. After examination, the ends of the tubes were sealed to preserve the natural moisture of the samples. The sealed tubes were stored in the upright position, and care was taken to avoid shock and vibration during their transport and storage in our laboratory.

A.2.4 Borehole Abandonment

After drilling, borings B-2 and B-4 were flushed with water and left open from July 3 to the morning of July 5, 2013, in order to observe the natural groundwater level. Boring B-3 was left open over the same time interval, but its total depth on July 3 was only 15.8 feet as it was still in progress. Borings B-2 through B-4 were backfilled on July 5, 2013. All other borings were backfilled as soon as they were completed. All borings were backfilled with bentonite cement grout or bentonite chips in accordance with Oregon Water Resource Department regulations. No wells or other instruments were installed in the boreholes.

A.3 HAND AUGERS

A Shannon & Wilson engineering geologist advanced four hand auger borings manually using a 2.5-inch-diameter hand auger on July 5, 2013. The holes, designated HA-1 through HA-4, were advanced to depths ranging from 5.7 to 8 feet below the ground surface in the berm on the northwest side of McGill Reservoir. The purpose of the hand auger holes was to define the nature of the material in the berm. The Shannon & Wilson engineering geologist advanced the hand auger holes, logged the materials encountered, and collected jar samples for further examination and testing. After each hole was completed to practical refusal, it was backfilled with the excavated materials.

A.4 MATERIAL DESCRIPTIONS

Soil samples were described and identified visually in the field in general accordance with ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). The specific terminology used is defined in the Soil Description and Log Key, Figure A1. Consistency, color, relative moisture, degree of plasticity, peculiar odors, and other distinguishing characteristics of the samples were noted. Once transported to our laboratory, the samples were re-examined, various classification tests were performed, and the field descriptions and identifications were modified where necessary. We refined our visual-manual soil descriptions and identifications based on the results of the laboratory tests, using elements of the Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), ASTM D2487. However, ASTM D2487 was not followed in full because it requires that a suite of tests be performed to fully classify a single sample.

A.5 LOGS OF BORINGS AND HAND AUGERS

Summary logs of the borings and hand augers are presented in Figures A2 through A12. Soil descriptions and interfaces on the logs are interpretive, and actual changes may be gradual. The left-hand portion of the logs gives our description, identification, and geotechnical unit designation for the soils encountered in the exploration. The right-hand portion of the logs shows a graphic log, sample locations and designations, groundwater information, and a graphical representation of N-values, natural water contents, sample recovery, Atterberg Limits, and fines content.

A.6 INFILTRATION TESTING

A Shannon & Wilson engineering geologist performed infiltration tests in or adjacent to the locations of borings B-1, B-4, B-5, B-6, and B-7. The tests were conducted through 4.25-inch inside diameter (I.D.) hollow-stem augers used in the geotechnical holes or set within 5 feet of the geotechnical hole locations. The tests were performed in general accordance with the Encased Falling Head Test method, described in the 2008 Portland Stormwater Management Manual, Appendix F2. At each test location, 4.25-inch I.D. hollow-stem auger was advanced to the test depth, and approximately 1 foot of water was added to pre-saturate soil. After the pre-saturation period, multiple tests were conducted by raising the head of water over the soil to approximately 1 foot and periodically measuring the depth to water from the top of the casing. Infiltration Test Results are presented in Table A1.

TABLE A1: INFILTRATION TEST RESULTS

Boring Designation	Depth[1] (feet)	Infiltration Rate[2]	Soil Type	Approximate Fines Content (percent by dry weight)	Geotechnical Unit[4]
B-1	4.5	<0.5 in/hr	*Gravelly Silt with Sand (ML)*	70	FILL
B-4	4.6	7 to 9 in/hr	*Silty Gravel with Sand (GM)*	37 (3)	CFD-GF
B-5	4.6	<0.5in hr	*Silt (ML)*	90	CFD-FGF
B-5	6.6	15 to 19 in/hr	*Silty Sand with Gravel (SM)*	15 (3)	CFD-SF
B-6	4.6	0 in/hr	*Silt (ML)*	90	CFD-FGF
B-6	10.0	23 gal/min	*Poorly Graded Gravel with Silt and Sand (GP-GM)*	10 (3)	CFD-GF
B-7	4.0	<0.2 in/hr	*Silt with Sand to Sandy Silt (ML)*	75	CFD-FGF

[1]Depth in feet below the ground surface at the time the explorations were performed
[2]Measured infiltration rates for head levels less than 1 foot; in = inches; hr = hour; gal = gallons; min = minute
[3]Value determined from laboratory testing
[4]CFD = Catastrophic Flood Deposits; FGF = Fine-grained Facies; SF = Sand Facies; GF = Gravel Facies

Shannon & Wilson, Inc. (S&W), uses a soil identification system modified from the Unified Soil Classification System (USCS). Elements of the USCS and other definitions are provided on this and the following pages. Soil descriptions are based on visual-manual procedures (ASTM D2488) and laboratory testing procedures (ASTM D2487), if performed.

S&W INORGANIC SOIL CONSTITUENT DEFINITIONS

CONSTITUENT[2]	FINE-GRAINED SOILS (50% or more fines)[1]	COARSE-GRAINED SOILS (less than 50% fines)[1]
Major	***Silt, Lean Clay, Elastic Silt,*** or ***Fat Clay***[3]	***Sand*** or ***Gravel***[4]
Modifying (Secondary) Precedes major constituent	30% or more coarse-grained: ***Sandy*** or ***Gravelly***[4]	More than 12% fine-grained: ***Silty*** or ***Clayey***[3]
Minor Follows major constituent	15% to 30% coarse-grained: ***with Sand*** or ***with Gravel***[4]	5% to 12% fine-grained: ***with Silt*** or ***with Clay***[3]
	30% or more total coarse-grained *and* lesser coarse-grained constituent is 15% or more: ***with Sand*** or ***with Gravel***[5]	15% or more of a second coarse-grained constituent: ***with Sand*** or ***with Gravel***[5]

[1]All percentages are by weight of total specimen passing a 3-inch sieve.
[2]The order of terms is: *Modifying Major with Minor*.
[3]Determined based on behavior.
[4]Determined based on which constituent comprises a larger percentage.
[5]Whichever is the lesser constituent.

MOISTURE CONTENT TERMS

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, from below water table

STANDARD PENETRATION TEST (SPT) SPECIFICATIONS

Hammer:	140 pounds with a 30-inch free fall. Rope on 6- to 10-inch-diam. cathead 2-1/4 rope turns, > 100 rpm
Sampler:	10 to 30 inches long Shoe I.D. = 1.375 inches Barrel I.D. = 1.5 inches Barrel O.D. = 2 inches
N-Value:	Sum blow counts for second and third 6-inch increments. Refusal: 50 blows for 6 inches or less; 10 blows for 0 inches.

NOTE: Penetration resistances (N-values) shown on boring logs are as recorded in the field and have not been corrected for hammer efficiency, overburden, or other factors.

PARTICLE SIZE DEFINITIONS

DESCRIPTION	SIEVE NUMBER AND/OR APPROXIMATE SIZE
FINES	< #200 (0.075 mm = 0.003 in.)
SAND	
Fine	#200 to #40 (0.075 to 0.4 mm; 0.003 to 0.02 in.)
Medium	#40 to #10 (0.4 to 2 mm; 0.02 to 0.08 in.)
Coarse	#10 to #4 (2 to 4.75 mm; 0.08 to 0.187 in.)
GRAVEL	
Fine	#4 to 3/4 in. (4.75 to 19 mm; 0.187 to 0.75 in.)
Coarse	3/4 to 3 in. (19 to 76 mm)
COBBLES	3 to 12 in. (76 to 305 mm)
BOULDERS	> 12 in. (305 mm)

RELATIVE DENSITY / CONSISTENCY

COHESIONLESS SOILS		COHESIVE SOILS	
N, SPT, BLOWS/FT.	RELATIVE DENSITY	N, SPT, BLOWS/FT.	RELATIVE CONSISTENCY
< 4	Very loose	< 2	Very soft
4 - 10	Loose	2 - 4	Soft
10 - 30	Medium dense	4 - 8	Medium stiff
30 - 50	Dense	8 - 15	Stiff
> 50	Very dense	15 - 30	Very stiff
		> 30	Hard

WELL AND BACKFILL SYMBOLS

Bentonite Cement Grout	Surface Cement Seal
Bentonite Grout	Asphalt or Cap
Bentonite Chips	Slough
Silica Sand	Inclinometer or Non-perforated Casing
Perforated or Screened Casing	Vibrating Wire Piezometer

PERCENTAGES TERMS [1, 2]

Trace	< 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

[1]Gravel, sand, and fines estimated by mass. Other constituents, such as organics, cobbles, and boulders, estimated by volume.

[2]Reprinted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

Gresham Vista Business Park
Gresham, Oregon

SOIL DESCRIPTION AND LOG KEY

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FIG. A1
Sheet 1 of 3

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)
(Modified From USACE Tech Memo 3-357, ASTM D2487, and ASTM D2488)

MAJOR DIVISIONS			GROUP/GRAPHIC SYMBOL	TYPICAL IDENTIFICATIONS
COARSE-GRAINED SOILS *(more than 50% retained on No. 200 sieve)*	Gravels *(more than 50% of coarse fraction retained on No. 4 sieve)*	Gravel *(less than 5% fines)*	GW	Well-Graded Gravel; Well-Graded Gravel with Sand
			GP	Poorly Graded Gravel; Poorly Graded Gravel with Sand
		Silty or Clayey Gravel *(more than 12% fines)*	GM	Silty Gravel; Silty Gravel with Sand
			GC	Clayey Gravel; Clayey Gravel with Sand
	Sands *(50% or more of coarse fraction passes the No. 4 sieve)*	Sand *(less than 5% fines)*	SW	Well-Graded Sand; Well-Graded Sand with Gravel
			SP	Poorly Graded Sand; Poorly Graded Sand with Gravel
		Silty or Clayey Sand *(more than 12% fines)*	SM	Silty Sand; Silty Sand with Gravel
			SC	Clayey Sand; Clayey Sand with Gravel
FINE-GRAINED SOILS *(50% or more passes the No. 200 sieve)*	Silts and Clays *(liquid limit less than 50)*	Inorganic	ML	Silt; Silt with Sand or Gravel; Sandy or Gravelly Silt
			CL	Lean Clay; Lean Clay with Sand or Gravel; Sandy or Gravelly Lean Clay
		Organic	OL	Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
	Silts and Clays *(liquid limit 50 or more)*	Inorganic	MH	Elastic Silt; Elastic Silt with Sand or Gravel; Sandy or Gravelly Elastic Silt
			CH	Fat Clay; Fat Clay with Sand or Gravel; Sandy or Gravelly Fat Clay
		Organic	OH	Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
HIGHLY-ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor		PT	Peat or other highly organic soils (see ASTM D4427)

NOTE: No. 4 size = 4.75 mm = 0.187 in.; No. 200 size = 0.075 mm = 0.003 in.

NOTES

1. Dual symbols *(symbols separated by a hyphen, i.e., SP-SM, Sand with Silt)* are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart. Graphics shown on the logs for these soil types are a combination of the two graphic symbols (e.g., SP and SM).

2. Borderline symbols *(symbols separated by a slash, i.e., CL/ML, Lean Clay to Silt; SP-SM/SM, Sand with Silt to Silty Sand)* indicate that the soil properties are close to the defining boundary between two groups.

Gresham Vista Business Park
Gresham, Oregon

SOIL DESCRIPTION AND LOG KEY

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FIG. A1
Sheet 2 of 3

GRADATION TERMS

Poorly Graded	Narrow range of grain sizes present or, within the range of grain sizes present, one or more sizes are missing (Gap Graded). Meets criteria in ASTM D2487, if tested.
Well-Graded	Full range and even distribution of grain sizes present. Meets criteria in ASTM D2487, if tested.

CEMENTATION TERMS[1]

Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

PLASTICITY[2]

DESCRIPTION	VISUAL-MANUAL CRITERIA	APPROX. PLASITICTY INDEX RANGE
Nonplastic	A 1/8-in. thread cannot be rolled at any water content.	< 4
Low	A thread can barely be rolled and a lump cannot be formed when drier than the plastic limit.	4 to 10
Medium	A thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. A lump crumbles when drier than the plastic limit.	10 to 20
High	It take considerable time rolling and kneading to reach the plastic limit. A thread can be rerolled several times after reaching the plastic limit. A lump can be formed without crumbling when drier than the plastic limit.	> 20

ADDITIONAL TERMS

Mottled	Irregular patches of different colors.
Bioturbated	Soil disturbance or mixing by plants or animals.
Diamict	Nonsorted sediment; sand and gravel in silt and/or clay matrix.
Cuttings	Material brought to surface by drilling.
Slough	Material that caved from sides of borehole.
Sheared	Disturbed texture, mix of strengths.

PARTICLE ANGULARITY AND SHAPE TERMS[1]

Angular	Sharp edges and unpolished planar surfaces.
Subangular	Similar to angular, but with rounded edges.
Subrounded	Nearly planar sides with well-rounded edges.
Rounded	Smoothly curved sides with no edges.
Flat	Width/thickness ratio > 3.
Elongated	Length/width ratio > 3.

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ACRONYMS AND ABBREVIATIONS

ATD	At Time of Drilling
Diam.	Diameter
Elev.	Elevation
ft.	Feet
FeO	Iron Oxide
gal.	Gallons
Horiz.	Horizontal
HSA	Hollow Stem Auger
I.D.	Inside Diameter
in.	Inches
lbs.	Pounds
MgO	Magnesium Oxide
mm	Millimeter
MnO	Manganese Oxide
NA	Not Applicable or Not Available
NP	Nonplastic
O.D.	Outside Diameter
OW	Observation Well
pcf	Pounds per Cubic Foot
PID	Photo-Ionization Detector
PMT	Pressuremeter Test
ppm	Parts per Million
psi	Pounds per Square Inch
PVC	Polyvinyl Chloride
rpm	Rotations per Minute
SPT	Standard Penetration Test
USCS	Unified Soil Classification System
q_u	Unconfined Compressive Strength
VWP	Vibrating Wire Piezometer
Vert.	Vertical
WOH	Weight of Hammer
WOR	Weight of Rods
Wt.	Weight

STRUCTURE TERMS[1]

Interbedded	Alternating layers of varying material or color with layers at least 1/4-inch thick; singular: bed.
Laminated	Alternating layers of varying material or color with layers less than 1/4-inch thick; singular: lamination.
Fissured	Breaks along definite planes or fractures with little resistance.
Slickensided	Fracture planes appear polished or glossy; sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps that resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay.
Homogeneous	Same color and appearance throughout.

Gresham Vista Business Park
Gresham, Oregon

SOIL DESCRIPTION AND LOG KEY

September 2013 24-1-03793-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

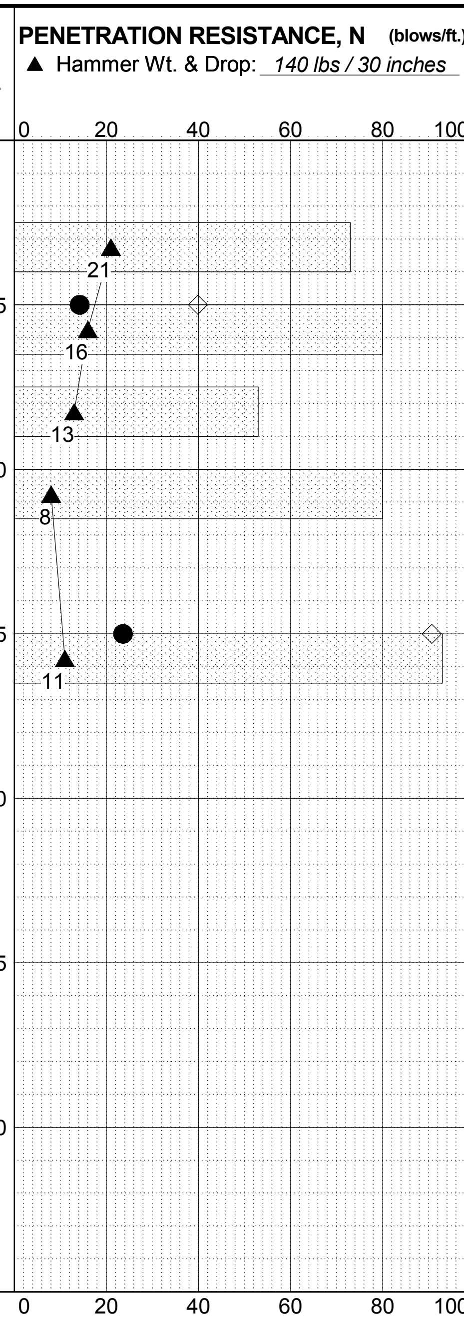
FIG. A1
Sheet 3 of 3

Total Depth:	16.5 ft.	Northing:	~ 684,077 ft.	Drilling Method:	Hollow Stem Auger	Hole Diam.:	8 in.
Top Elevation:	~ 216 ft.	Easting:	~ 7,706,924 ft.	Drilling Company:	Western States	Rod Type:	NWJ
Vert. Datum:	NAVD88	Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:	NAD83	Offset:	~	Other Comments:	Hammer Efficiency = 73%		

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Soil Description	Elev. Depth (ft.)	Samples	Depth, ft.
Stiff to very stiff, dark brown and gray, *Silty Sand with Gravel to Gravelly Silt with Sand (SM, ML)*; moist; fine to coarse, rounded to subrounded gravel; fine to coarse, subrounded to subangular sand; low plasticity; trace organics; lensed. **FILL** *S-4: 3-in. sampler used to obtain more sample, N-value is from SPT S-3.* Pockets of red-yellow *Lean Clay (CL)*; medium to high plasticity; observed at 8.0 ft.		S-1, S-2, S-3, S-4 *, S-5	5, 10
Medium dense, light gray and brown mottled, *Silt (ML)*; moist; 5-10% fine sand; nonplastic; trace organics; homogenous. **CATASTROPHIC FLOOD DEPOSITS FINE-GRAINED FACIES**	*201.0* 15.0 / *199.5* 16.5	S-6	15
Completed - July 2, 2013			20, 25, 30



Recovery (%)
◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit ├──┤ Liquid Limit

LEGEND

- * Sample Not Recovered
- Standard Penetration Test
- 3" O.D. Split Spoon Sample

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. Group symbol is based on visual-manual identification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Gresham Vista Business Park
Gresham, Oregon

LOG OF BORING B-1

September 2013 24-1-03793-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A2

REV 3

MASTER_LOG_E 24-1-03793.GPJ SHAN_WIL.GDT 8/23/13 Log: AAH Rev: Typ: MAS

Total Depth:	30.3 ft.	Northing:	~ 684,023 ft.	Drilling Method:	Mud Rotary
Top Elevation:	~ 217 ft.	Easting:	~ 7,707,294 ft.	Drilling Company:	Western States
Vert. Datum:	NAVD88	Station:	~	Drill Rig Equipment:	CME-75
Horiz. Datum:	NAD83	Offset:	~	Other Comments:	Hammer Efficiency = 73%

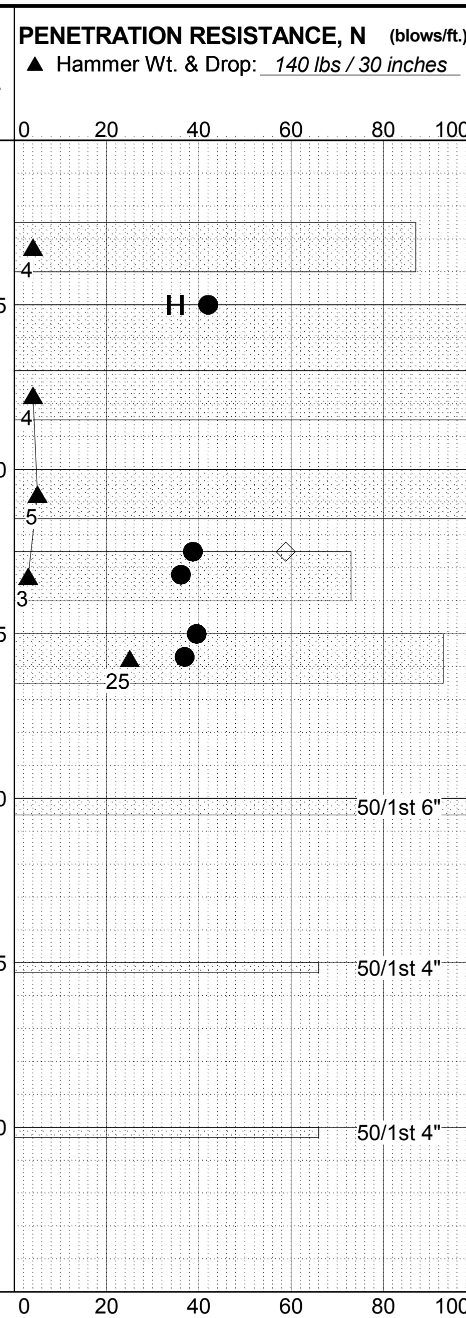
Hole Diam.:	5 in.
Rod Type:	NWJ
Hammer Type:	Automatic

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Soil Description	Elev. Depth (ft.)	Samples
Soft to medium stiff, dark brown and brown to gray mottled, *Silt grading down to Sandy Silt (ML)*; moist; fine sand; nonplastic to low plasticity; micaceous. **CATASTROPHIC FLOOD DEPOSITS FINE-GRAINED FACIES**		S-1, S-2
Very loose to loose, dark brown and brown to gray mottled, *Silty Sand (SM)*; wet; interbedded with soft to medium stiff, *Sandy Silt (ML) and Elastic Silt (MH)*; Silty Sand contains fine sand; nonplastic fines; fine-grained layers are low to high plasticity; micaceous. **CATASTROPHIC FLOOD DEPOSITS SAND FACIES**	209.5 / 7.5	S-3, S-4, S-5a, S-5b, S-6a
Medium dense, gray to dark red-brown, *Poorly Graded Sand (SP)*; wet; fine to medium sand; homogenous.	201.3 / 15.7	S-6b
Very dense, gray, red-yellow, and brown, *Poorly Graded Gravel with Clay and Sand (GP-GC)*; moist to wet; fine to coarse, rounded to subrounded gravel; fine to coarse, subrounded to subangular sand; low to medium plasticity fines; weakly cemented. **ANCESTRAL SANDY RIVER DEPOSITS**	200.0 / 17.0	S-7, S-8, S-9
Completed - July 3, 2013	186.7 / 30.3	

Ground Water: 7/5/2013



LEGEND

- * Sample Not Recovered
- Standard Penetration Test
- 3" O.D. Shelby Tube

Recovery (%)

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ├──┤ Liquid Limit

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. Group symbol is based on visual-manual identification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Gresham Vista Business Park
Gresham, Oregon

LOG OF BORING B-2

September 2013 24-1-03793-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A3

REV 3

Typ: MAS Rev: Log: AAH

MASTER_LOG_E 24-1-03793.GPJ SHAN_WIL.GDT 8/23/13

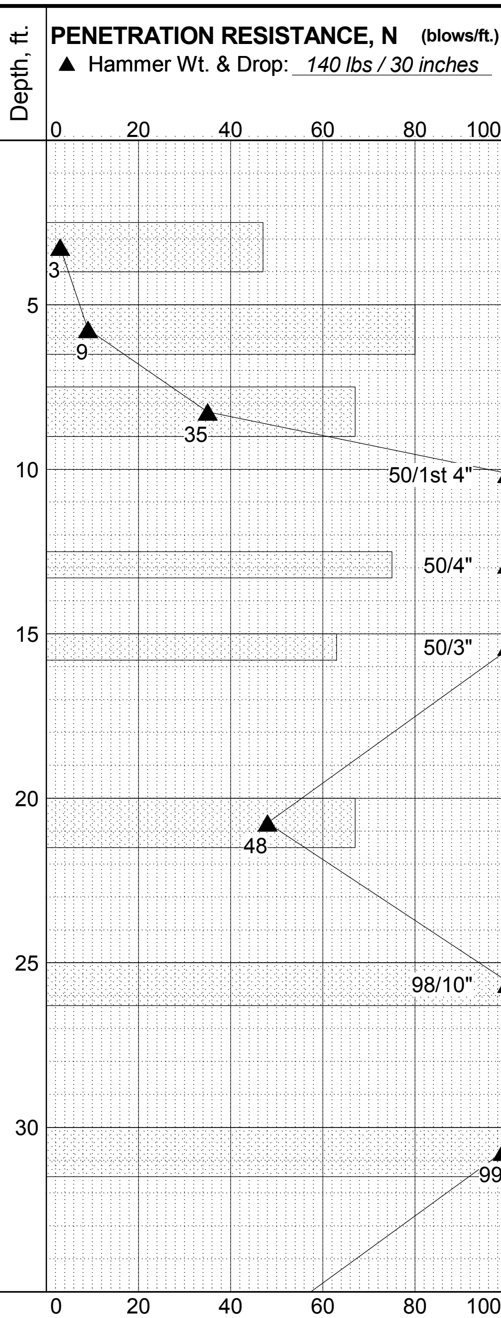
Total Depth:	70.4 ft.	Northing:	~ 683,601 ft.	Drilling Method:	Mud Rotary	Hole Diam.:	5 in.
Top Elevation:	~ 292 ft.	Easting:	~ 7,707,594 ft.	Drilling Company:	Western States	Rod Type:	NWJ
Vert. Datum:	NAVD88	Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:	NAD83	Offset:	~	Other Comments:	Hammer Efficiency = 73%		

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Soil Description	Elev. Depth (ft.)	Samples
Soft, dark brown, *Silt with Sand (ML)*; moist; fine sand; nonplastic to low plasticity; trace charcoal; disturbed texture. **FILL**		S-1
Medium dense to dense, dark brown, gray, and red-brown, *Silty Sand (SM)*; moist; 5-10% fine to coarse, subrounded to subangular gravel; fine to medium, subrounded to subangular sand; nonplastic to low plasticity fines. **CATASTROPHIC FLOOD DEPOSITS SAND FACIES**	286.2 / 5.8	S-2, S-3
Very dense, dark brown and gray, *Poorly Graded Gravel with Silt and Sand and Cobbles (GP-GM)*; moist; few subrounded cobbles up to 8-in.-diam., some predominantly decomposed; fine to coarse, subrounded to subangular gravel, some predominantly decomposed; fine to medium sand; nonplastic to low plasticity fines. **CATASTROPHIC FLOOD DEPOSITS GRAVEL FACIES**	282.0 / 10.0	S-4 *, S-5
Dense to very dense, gray, yellow, red-yellow, and brown, *Poorly Graded Gravel with Clay and Sand to Clayey Gravel with Sand and Cobbles (GP-GC, GC)*; moist; few subrounded cobbles up to 8-in.-diam.; fine to coarse, rounded to subangular gravel, some predominantly decomposed; fine to coarse, subrounded to subangular sand; medium plasticity fines; weakly cemented. *Slight drilling mud loss near 15.0 ft.* *Lost ~50 gal. of mud at 22.0 ft.* **ANCESTRAL SANDY RIVER DEPOSITS**	277.0 / 15.0	S-6, S-7, S-8, S-9

PENETRATION RESISTANCE, N (blows/ft.)
▲ Hammer Wt. & Drop: 140 lbs / 30 inches



CONTINUED NEXT SHEET

LEGEND
- * Sample Not Recovered
- Standard Penetration Test
- Recovery (%)
- ● % Water Content
- Plastic Limit ├──┤ Liquid Limit

NOTES
1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. Group symbol is based on visual-manual identification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Gresham Vista Business Park
Gresham, Oregon

LOG OF BORING B-3

September 2013 24-1-03793-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A4
Sheet 1 of 3

REV 3

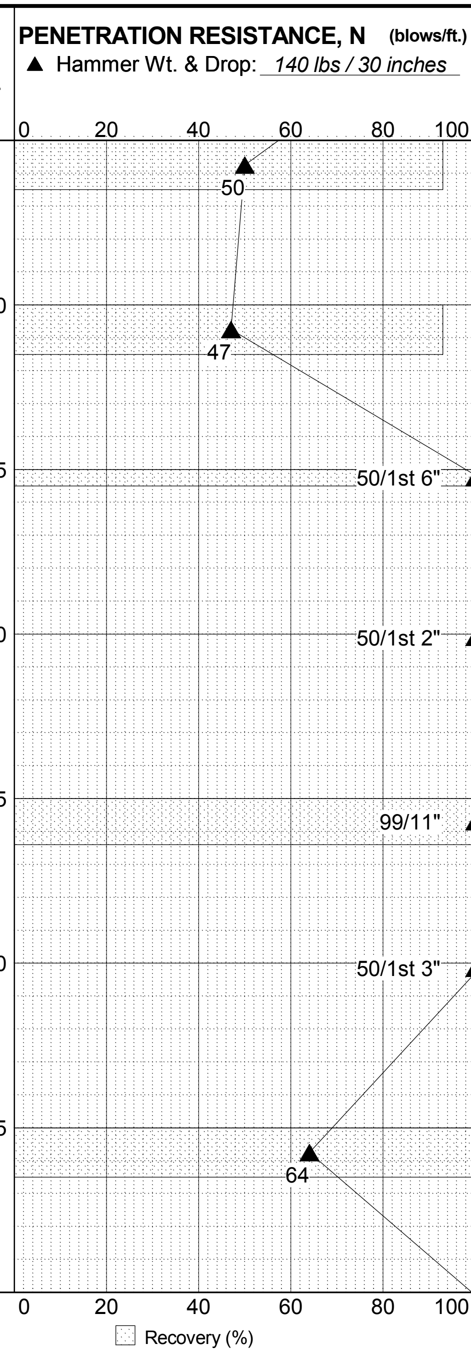
MASTER_LOG_E 24-1-03793.GPJ SHAN_WIL.GDT 8/23/13
Log: AAH Rev: Typ: MAS

Total Depth:	70.4 ft.	Northing:	~ 683,601 ft.	Drilling Method:	Mud Rotary	Hole Diam.:	5 in.
Top Elevation:	~ 292 ft.	Easting:	~ 7,707,594 ft.	Drilling Company:	Western States	Rod Type:	NWJ
Vert. Datum:	NAVD88	Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:	NAD83	Offset:	~	Other Comments:	Hammer Efficiency = 73%		

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Soil Description	Elev. Depth (ft.)	Samples	Depth, ft.
Dense to very dense, gray, yellow, red-yellow, and brown, *Clayey Gravel with Sand and Cobbles (GC)*; moist; few subrounded cobbles up to 8-in.-diam.; fine to coarse, rounded to subangular gravel, some predominantly decomposed; fine to coarse, subrounded to subangular sand; medium plasticity fines; weakly cemented.	*257.0* 35.0	S-10	
		S-11	40
		S-12	45
Hard drilling at 50.0 ft.		S-11 *	50
ANCESTRAL SANDY RIVER DEPOSITS			
		S-14	55
		S-15 *	60
		S-16	65



CONTINUED NEXT SHEET

LEGEND

* Sample Not Recovered
Standard Penetration Test

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. Group symbol is based on visual-manual identification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Gresham Vista Business Park
Gresham, Oregon

LOG OF BORING B-3

September 2013 24-1-03793-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A4
Sheet 2 of 3

REV 3

Log: AAH Rev: Typ: MAS

MASTER_LOG_E 24-1-03793.GPJ SHAN_WIL.GDT 8/23/13

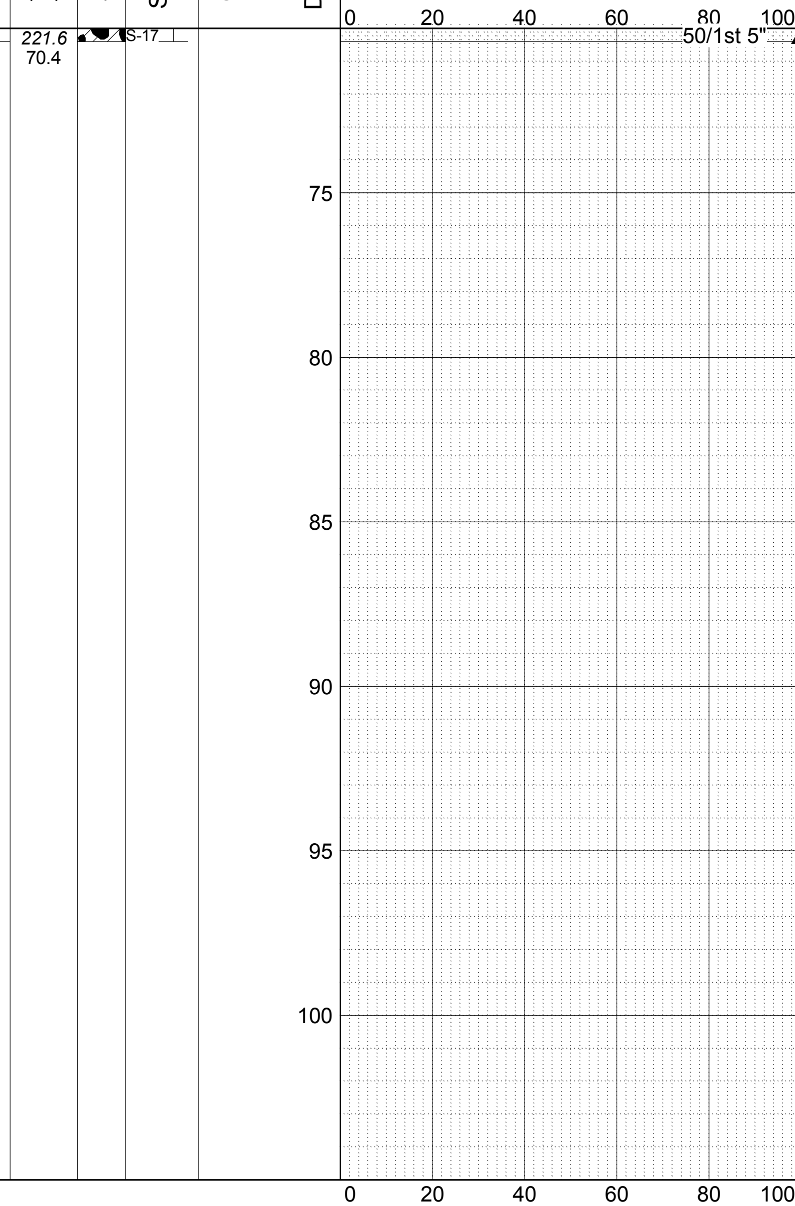
Total Depth:	70.4 ft.	Northing:	~ 683,601 ft.	Drilling Method:	Mud Rotary	Hole Diam.:	5 in.
Top Elevation:	~ 292 ft.	Easting:	~ 7,707,594 ft.	Drilling Company:	Western States	Rod Type:	NWJ
Vert. Datum:	NAVD88	Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:	NAD83	Offset:	~	Other Comments:	Hammer Efficiency = 73%		

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Elev. Depth (ft.) | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE, N (blows/ft.)
▲ Hammer Wt. & Drop: 140 lbs / 30 inches



Completed - July 5, 2013

NOTE: Groundwater level is uncertain; on morning of 07/05/2013, muddy water was 9.9 ft. below ground surface and the total depth of the boring at that time was 15.8 ft.

LEGEND

* Sample Not Recovered
Standard Penetration Test

● % Water Content
Plastic Limit ├───┤ Liquid Limit

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. Group symbol is based on visual-manual identification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Gresham Vista Business Park
Gresham, Oregon

LOG OF BORING B-3

September 2013 24-1-03793-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

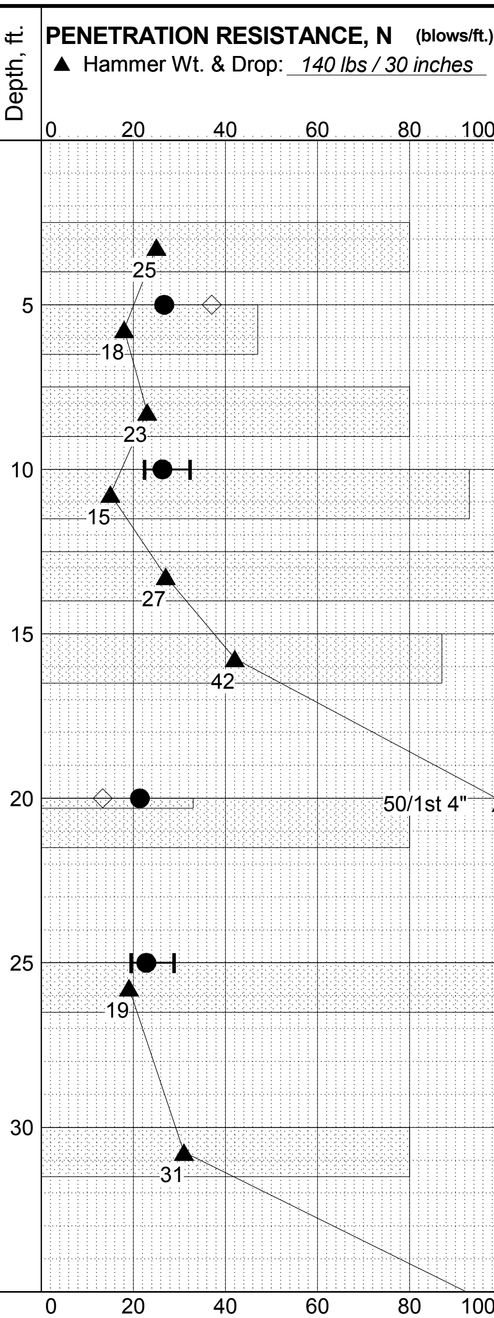
FIG. A4
Sheet 3 of 3

Total Depth:	41.5 ft.	Northing:	~ 683,115 ft.	Drilling Method:	Mud Rotary	Hole Diam.:	5 in.
Top Elevation:	~ 314 ft.	Easting:	~ 7,707,481 ft.	Drilling Company:	Western States	Rod Type:	NWJ
Vert. Datum:	NAVD88	Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:	NAD83	Offset:	~	Other Comments:	Hammer Efficiency = 73%		

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

SOIL DESCRIPTION	Elev. Depth (ft.)	Samples	Ground Water
Medium dense, dark brown, red-brown, red-yellow, and gray, *Silty Sand with Gravel to Silty Gravel with Sand (GM)*; moist; fine to coarse, subrounded to subangular gravel, some predominantly decomposed; fine to coarse, subrounded to subangular sand; low to medium plasticity fines. **CATASTROPHIC FLOOD DEPOSITS GRAVEL FACIES**		S-1, S-2, S-3	
Stiff to very stiff, light gray and brown mottled, *Lean Clay (CL)*; moist; trace fine to coarse, subangular sand; low to medium plasticity. **ANCESTRAL SANDY RIVER DEPOSITS**	*304.0* 10.0	S-4, S-5	
Dense, dark brown, red, and gray, *Silty Sand with Gravel (SM)*; moist; fine to coarse, subrounded to subangular gravel, some predominantly decomposed; fine to medium, subrounded to subangular sand; low plasticity fines.	*301.0* 13.0	S-6	
S-8: 3-in. sampler used to obtain more sample, N-value is from SPT S-7.			
Very dense, dark brown, red, yellow, and green, *Clayey Gravel with Sand (GC)*; moist; fine to coarse, rounded to subrounded gravel; fine to coarse, subrounded to subangular sand; low to medium plasticity fines.	*294.0* 20.0	S-7, S-8	▽ 7/5/2013
Very stiff, dark brown, *Lean Clay (CL)*; moist; trace fine gravel; trace fine to coarse, subrounded to subangular sand; gravel and sand weathered; low plasticity.	*291.5* 22.5	S-9	
Dense to very dense, gray, dark brown, red, and yellow, *Clayey Gravel with Sand and Cobbles (GC);* moist; trace subrounded cobbles up to 6-in.-diam.; fine to coarse, rounded to subangular gravel, some	*286.0* 28.0	S-10	



CONTINUED NEXT SHEET

LEGEND

- * Sample Not Recovered
- Standard Penetration Test
- 3" O.D. Split Spoon Sample

- Recovery (%)
- ◇ % Fines (<0.075mm)
- ● % Water Content
- Plastic Limit ├──┤ Liquid Limit

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. Group symbol is based on visual-manual identification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Gresham Vista Business Park
Gresham, Oregon

LOG OF BORING B-4

September 2013 24-1-03793-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A5
Sheet 1 of 2

REV 3

MASTER_LOG_E 24-1-03793.GPJ SHAN_WIL.GDT 8/23/13
Log: AAH Rev: Typ: MAS

Total Depth:	41.5 ft.	Northing:	~ 683,115 ft.	Drilling Method:	Mud Rotary	Hole Diam.:	5 in.
Top Elevation:	~ 314 ft.	Easting:	~ 7,707,481 ft.	Drilling Company:	Western States	Rod Type:	NWJ
Vert. Datum:	NAVD88	Station:	~	Drill Rig Equipment:	CME-75	Hammer Type:	Automatic
Horiz. Datum:	NAD83	Offset:	~	Other Comments:	Hammer Efficiency = 73%		

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.*	Elev. Depth (ft.)	Symbol	Samples	Ground Water	Depth, ft.
predominantly decomposed; fine to coarse, subrounded to subangular sand; low to medium plasticity fines.			S-11		
			S-12		40
Completed - July 3, 2013	272.5 41.5				
					45
					50
					55
					60
					65

LEGEND

- * Sample Not Recovered
- Standard Penetration Test
- 3" O.D. Split Spoon Sample

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. Group symbol is based on visual-manual identification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Gresham Vista Business Park
Gresham, Oregon

LOG OF BORING B-4

September 2013 24-1-03793-001

SHANNON & WILSON, INC.
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FIG. A5
Sheet 2 of 2

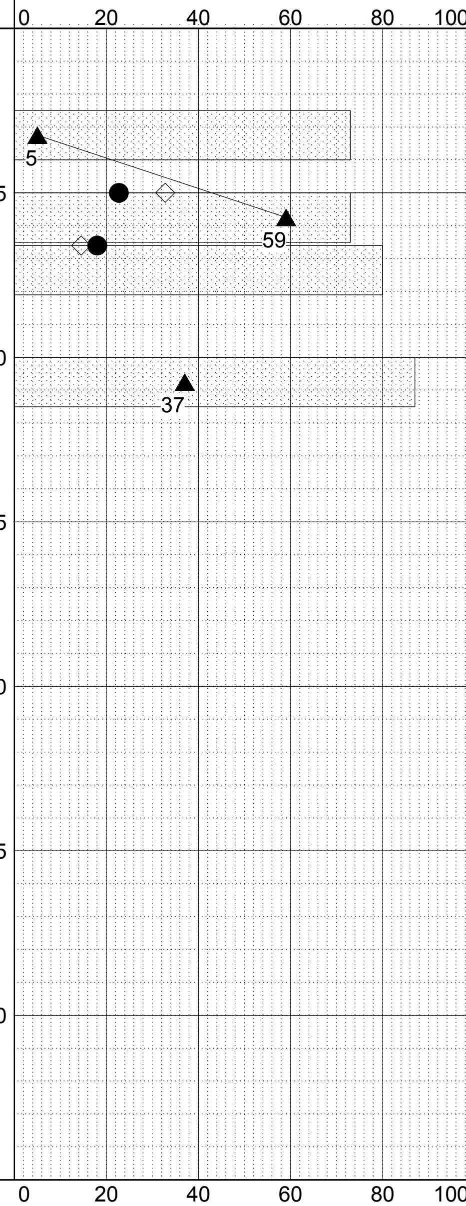
REV 3

Total Depth:	*11.5 ft.*	Northing:	*~ 682,455 ft.*	Drilling Method:	*Hollow Stem Auger*	Hole Diam.:	*8 in.*
Top Elevation:	*~ 315 ft.*	Easting:	*~ 7,706,629 ft.*	Drilling Company:	*Western States*	Rod Type:	*NWJ*
Vert. Datum:	*NAVD88*	Station:	*~*	Drill Rig Equipment:	*CME-75*	Hammer Type:	*Automatic*
Horiz. Datum:	*NAD83*	Offset:	*~*	Other Comments:	*Hammer Efficiency = 73%*		

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.*	*Elev.* Depth (ft.)	Symbol	Samples	Ground Water	Depth, ft.
Loose, dark brown, *Silt (ML)*; moist; 5-10% fine sand; nonplastic fines; trace organics; micaceous. **CATASTROPHIC FLOOD DEPOSITS FINE-GRAINED FACIES**	*310.0* 5.0		S-1		5
Dense to very dense, dark brown to gray, *Silty Sand with Gravel (SM)*; moist; fine to coarse, subrounded to subangular gravel; medium to coarse, subrounded to subangular sand; nonplastic to low plasticity fines. **CATASTROPHIC FLOOD DEPOSITS SAND FACIES**	*306.0* 9.0		S-2a S-2b S-3		10
Dense, dark brown, gray, red, and yellow, *Clayey Gravel with Sand (GC)*; moist; fine to coarse, subrounded to subangular gravel; medium, subrounded to subangular sand; medium plasticity fines. **ANCESTRAL SANDY RIVER DEPOSITS**	*303.5* 11.5		S-4		15
Completed - July 2, 2013					20 25 30

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



Recovery (%)
◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit ⊢—⊣ Liquid Limit

LEGEND

- * Sample Not Recovered
- Standard Penetration Test
- 3" O.D. Split Spoon Sample

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. Group symbol is based on visual-manual identification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Gresham Vista Business Park
Gresham, Oregon

LOG OF BORING B-5

September 2013 24-1-03793-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A6

REV 3

Total Depth:	*11.5 ft.*	Northing:	*~ 682,174 ft.*	Drilling Method:	*Hollow Stem Auger*	Hole Diam.:	*8 in.*
Top Elevation:	*~ 327 ft.*	Easting:	*~ 7,707,797 ft.*	Drilling Company:	*Western States*	Rod Type:	*NWJ*
Vert. Datum:	*NAVD88*	Station:	*~*	Drill Rig Equipment:	*CME-75*	Hammer Type:	*Automatic*
Horiz. Datum:	*NAD83*	Offset:	*~*	Other Comments:	*Hammer Efficiency = 73%*		

SOIL DESCRIPTION

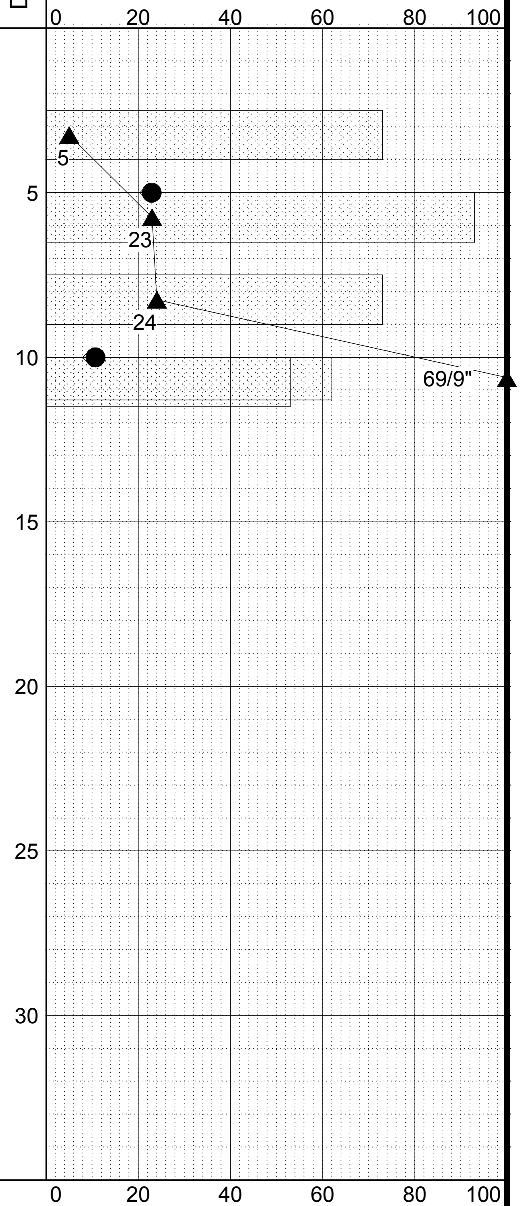
Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Soil Description	Elev. Depth (ft.)	Samples
Medium stiff, dark brown, *Silt (ML)*; moist; 5-10% fine sand; low plasticity; trace organics; micaceous. **CATASTROPHIC FLOOD DEPOSITS FINE-GRAINED FACIES**	*322.0* 5.0	S-1
Medium dense, gray to dark brown, *Silty Sand (SM)*; wet; trace fine to coarse, subrounded to subangular gravel; fine to coarse, subrounded to subangular sand; nonplastic to low plasticity fines. **CATASTROPHIC FLOOD DEPOSITS SAND FACIES**	*321.0* 6.0	S-2
Medium dense to very dense, gray to dark brown, *Poorly Graded Gravel with Silt and Sand (GP-GM)*; moist; fine to coarse, subrounded to subangular gravel; fine to coarse, subrounded to subangular sand; nonplastic fines. *S-5: 3-in. sampler used to obtain more sample, N-value is from SPT S-4.* **CATASTROPHIC FLOOD DEPOSITS GRAVEL FACIES**	*315.5* 11.5	S-3, S-4, S-5

Completed - July 2, 2013

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



Recovery (%)

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ⊢—⊣ Liquid Limit

LEGEND

- * Sample Not Recovered
- Standard Penetration Test
- 3" O.D. Split Spoon Sample

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. Group symbol is based on visual-manual identification and selected lab testing.
4. The hole location and elevation should be considered approximate.

Gresham Vista Business Park
Gresham, Oregon

LOG OF BORING B-6

September 2013 24-1-03793-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A7

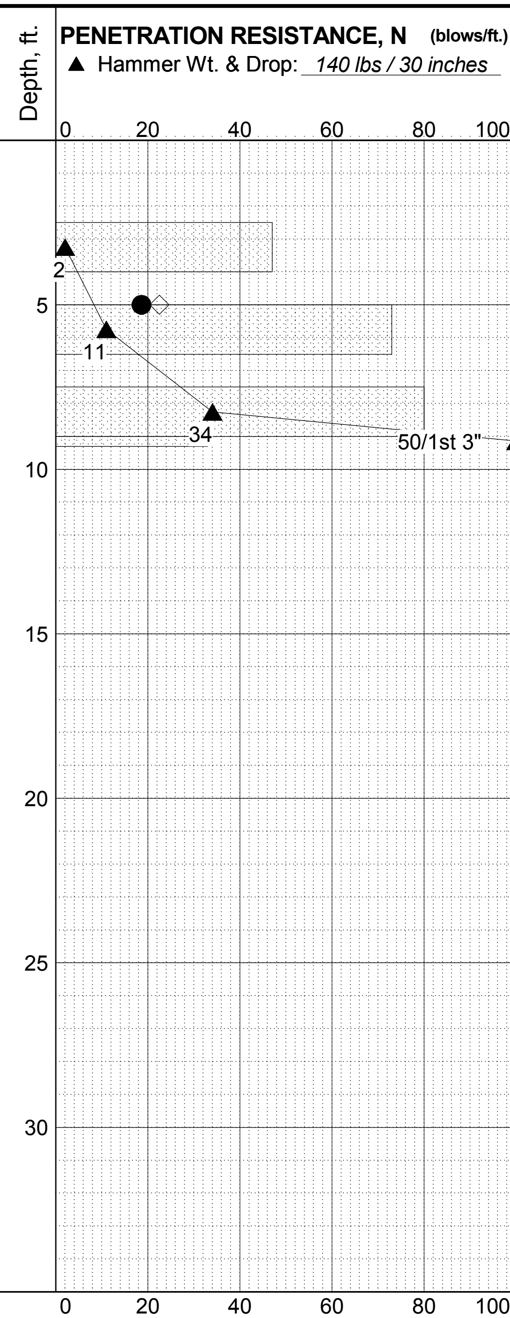
REV 3

Total Depth:	9.3 ft.	Northing:	~ 681,872 ft.	Drilling Method:	Hollow Stem Auger
Top Elevation:	~ 333 ft.	Easting:	~ 7,708,189 ft.	Drilling Company:	Western States
Vert. Datum:	NAVD88	Station:	~	Drill Rig Equipment:	CME-75
Horiz. Datum:	NAD83	Offset:	~	Other Comments:	Hammer Efficiency = 73%

Hole Diam.: 8 in.
Rod Type: NWJ
Hammer Type: Automatic

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.*	Elev. Depth (ft.)	Symbol	Samples	Ground Water
Soft, dark brown, *Silt with Sand to Sandy Silt (ML)*; moist; fine sand; nonplastic to low plasticity; trace organics. **CATASTROPHIC FLOOD DEPOSITS FINE-GRAINED FACIES**			S-1	
Medium dense, dark brown, *Silty Sand with Gravel (SM)*; moist; fine, subrounded to subangular gravel; fine to medium, subrounded to subangular sand; nonplastic fines. **CATASTROPHIC FLOOD DEPOSITS SAND FACIES**	327.8 5.2		S-2	
Dense to very dense, gray and dark brown, *Silty Gravel with Sand and Cobbles (GM)*; moist; few subrounded cobbles; fine to coarse, subrounded to subangular gravel; fine to medium, subrounded to subangular sand; nonplastic fines. **CATASTROPHIC FLOOD DEPOSITS GRAVEL FACIES**	326.0 7.0		S-3 S-4	
Completed - July 2, 2013 Auger refusal on cobble or boulder at 9.0 ft.	323.7 9.3			

PENETRATION RESISTANCE, N (blows/ft.)
▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



LEGEND
* Sample Not Recovered
Standard Penetration Test

Recovery (%)
◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit ├──┤ Liquid Limit

NOTES
1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. Group symbol is based on visual-manual identification and selected lab testing.
4. The hole location and elevation should be considered approximate.

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LOG OF BORING B-7

September 2013 24-1-03793-001

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FIG. A8

REV 3

MASTER_LOG_E 24-1-03793.GPJ SHAN_WIL.GDT 8/23/13 Log: AAH Rev: Typ: MAS

Total Depth:	8 ft.	Northing:	~ 684,012 ft.	Drilling Method:	hand auger	Hole Diam.:	2.5 in.
Top Elevation:	~ 211 ft.	Easting:	~ 7,707,101 ft.	Drilling Company:	Shannon & Wilson, Inc.	Rod Type:	N/A
Vert. Datum:	NAVD88	Station:	~	Drill Rig Equipment:	hand auger	Hammer Type:	N/A
Horiz. Datum:	NAD83	Offset:	~	Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.*	*Elev.* Depth (ft.)	Symbol	Samples	Ground Water	Depth, ft.	PENETRATION RESISTANCE, N (blows/ft.) ▲ Hammer Wt. & Drop: *140 lbs / 30 inches*
Dark brown, *Silt with Sand (ML)*; moist; fine sand; low plasticity; trace organics; micaceous. **FILL**			S-1			
Gray to brown, *Silt with Sand (ML)*; moist to wet; fine sand; low plasticity; organic odor. **CATASTROPHIC FLOOD DEPOSITS FINE-GRAINED FACIES**	*206.0* 5.0		S-2	▽ During Drilling	5	
Completed - July 5, 2013	*203.0* 8.0					

0 20 40 60 80 100

LEGEND

* Sample Not Recovered

Jar Sample

Groundwater Level

Plastic Limit ├──┤ Liquid Limit
Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. Group symbol is based on visual-manual identification and selected lab testing.
4. The hole location and elevation should be considered approximate.

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LOG OF HAND AUGER HA-1

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FIG. A9

REV 3

Total Depth:	7.6 ft.	Northing:	~ 684,142 ft.	Drilling Method:	hand auger
Top Elevation:	~ 213 ft.	Easting:	~ 7,707,159 ft.	Drilling Company:	Shannon & Wilson, Inc.
Vert. Datum:	NAVD88	Station:	~	Drill Rig Equipment:	hand auger
Horiz. Datum:	NAD83	Offset:	~	Other Comments:	

Hole Diam.: 2.5 in.
Rod Type: N/A
Hammer Type: N/A

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Soil Description	Elev. Depth (ft.)	Samples	Ground Water
Dark brown, *Sandy Silt to Silty Sand (SM/ML)*; moist; fine sand; nonplastic to low plasticity fines; trace organics; micaceous. **FILL**	*210.0* 3.0	S-1	
Gray, *Silty Sand (SM)*; wet; fine sand; nonplastic fines; micaceous.	*209.0* 4.0	S-2	During Drilling ▽
Gray and dark red-brown, *Lean Clay with Sand to Sandy Lean Clay (CL)*; moist; medium plasticity.	*205.4* 7.6	S-3, S-4	

Completed - July 5, 2013

Depth, ft.: 5

PENETRATION RESISTANCE, N (blows/ft.)
▲ Hammer Wt. & Drop: 140 lbs / 30 inches

0 20 40 60 80 100

LEGEND

* Sample Not Recovered
Jar Sample
▽ Groundwater Level

Plastic Limit ├──┤ Liquid Limit
Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. Group symbol is based on visual-manual identification and selected lab testing.
4. The hole location and elevation should be considered approximate.

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LOG OF HAND AUGER HA-2

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FIG. A10

REV 3

Total Depth: 8 ft.	Northing: ~ 684,250 ft.	Drilling Method:	hand auger	Hole Diam.:	2.5 in.
Top Elevation: ~ 213 ft.	Easting: ~ 7,707,289 ft.	Drilling Company:	Shannon & Wilson, Inc.	Rod Type:	N/A
Vert. Datum: NAVD88	Station: ~	Drill Rig Equipment:	hand auger	Hammer Type:	N/A
Horiz. Datum: NAD83	Offset: ~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*

Soil Description	Elev. Depth (ft.)	Samples	Ground Water	Depth, ft.
Dark brown, *Silty Sand to Sandy Silt (SM/ML)*; moist; fine sand; low plasticity fines; micaceous. **FILL**	210.5 2.5	S-1		
Gray, red, and red-brown, *Silt with Sand to Elastic Silt with Sand (ML/MH)*; moist to wet; fine sand; medium plasticity. Grades to wet at 3.0 ft.	208.0 5.0	S-2	▽ During Drilling	
Gray and red-brown, *Silty Sand (SM)*; wet; fine sand; nonplastic fines; micaceous.	206.0 7.0	S-3		5
Gray and red-brown *Sandy Silt to Silt with Sand (ML)*; wet; fine sand; nonplastic to low plasticity; micaceous.	205.0 8.0	S-4		
Completed - July 5, 2013				

0 20 40 60 80 100

Log: AAH Rev: Typ: MAS

LEGEND

* Sample Not Recovered

Jar Sample

▽ Groundwater Level

Plastic Limit ├───┤ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. Group symbol is based on visual-manual identification and selected lab testing.
4. The hole location and elevation should be considered approximate.

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LOG OF HAND AUGER HA-3

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FIG. A11

REV 3

Total Depth:	5.7 ft.	Northing:	~ 684,317 ft.	Drilling Method:	hand auger
Top Elevation:	~ 213 ft.	Easting:	~ 7,707,414 ft.	Drilling Company:	Shannon & Wilson, Inc.
Vert. Datum:	NAVD88	Station:	~	Drill Rig Equipment:	hand auger
Horiz. Datum:	NAD83	Offset:	~	Other Comments:	

Hole Diam.: 2.5 in.
Rod Type: N/A
Hammer Type: N/A

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.*	Elev. Depth (ft.)	Symbol	Samples	Ground Water	Depth, ft.
Gray to brown, *Silty Sand to Sandy Silt (SM/ML)*; moist; fine sand; low plasticity fines; micaceous. **FILL**			S-1	Groundwater not observed	
Gray, red-brown, and brown, *Silt with Sand (ML)*; moist; trace fine gravel; fine sand; low plasticity; micaceous.	209.0 4.0				
Gray and brown, *Gravelly Silt with Sand (ML)*; moist; fine, rounded gravel; fine sand; low plasticity.	208.0 5.0		S-2		5
Completed - July 5, 2013 Refusal on gravel at 5.7 ft.	207.3 5.7				

PENETRATION RESISTANCE, N (blows/ft.)
▲ Hammer Wt. & Drop: 140 lbs / 30 inches

0 20 40 60 80 100

Plastic Limit ├──┤ Liquid Limit
Natural Water Content

LEGEND

* Sample Not Recovered
Jar Sample

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. Group symbol is based on visual-manual identification and selected lab testing.
4. The hole location and elevation should be considered approximate.

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LOG OF HAND AUGER HA-4

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FIG. A12

REV 3

Typ: MAS Rev: Log: AAH

MASTER_LOG_E 24-1-03793.GPJ SHAN_WIL.GDT 8/23/13

APPENDIX B

LABORATORY TESTING

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FIGURES

APPENDIX B

LABORATORY TESTING

B.1 GENERAL

The soil samples obtained during the field explorations were described and identified in the field in general accordance with the Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), ASTM D2488. The specific terminology used is presented in Appendix A, Figure A1. The samples were reviewed in the laboratory. The physical characteristics of the samples were noted, and the field descriptions and identifications were modified where necessary in accordance with terminology presented in Appendix A, Figure A1. Representative samples were selected for various laboratory tests. We refined our visual-manual soil descriptions and identifications based on the results of the laboratory tests, using elements of the Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), ASTM D2487. The refined descriptions and identifications were then incorporated into the Logs of Borings, presented in Appendix A. Note that ASTM D2487 was not followed in full because it requires that a suite of tests be performed to fully classify a single sample.

The soil testing program included moisture content analyses, Atterberg Limits tests, and particle-size analyses. The testing procedures from our laboratory program are summarized in the following paragraphs. All test procedures were performed by Shannon & Wilson, Inc., in accordance with applicable ASTM International (ASTM) standards.

B.2 SOIL TESTING

B.2.1 Moisture (Natural Water) Content

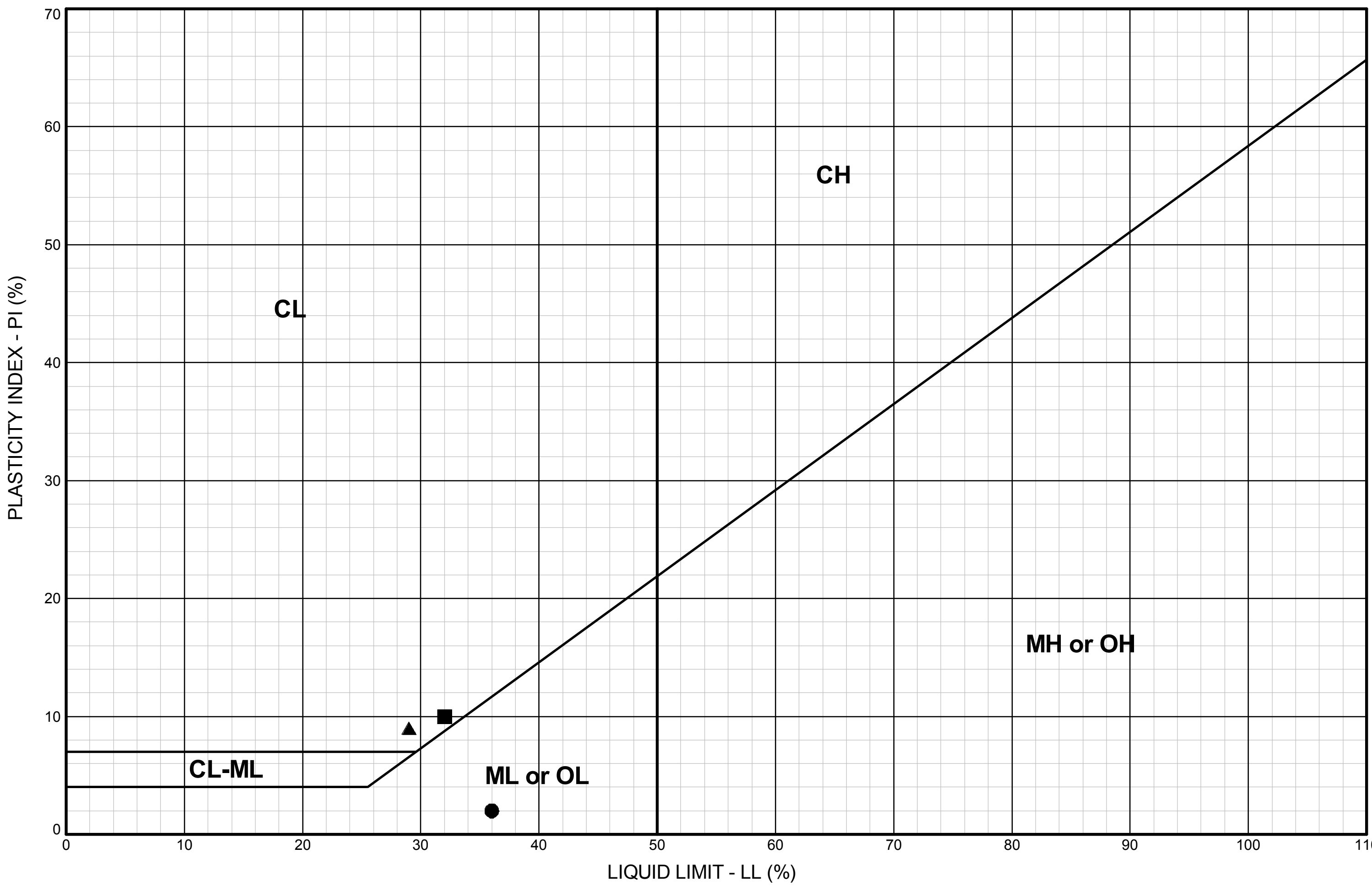
Natural moisture content determinations were performed in accordance with ASTM D2216 on selected soil samples. The natural moisture content is a measure of the amount of moisture in the soil at the time the explorations are performed, and is defined as the ratio of the weight of water to the dry weight of the soil, expressed as a percentage. The results of the moisture content determinations are presented graphically in the Logs of Borings in Appendix A.

B.2.2 Atterberg Limits

Atterberg Limits were determined on selected samples in accordance with ASTM D4318. This analysis yields index parameters of the soil that are useful in soil identification, as well as in a number of analyses, including liquefaction analysis. An Atterberg Limits test determines a soil's liquid limit (LL) and plastic limit (PL). These are the maximum and minimum moisture contents at which the soil exhibits plastic behavior. A soil's plasticity index (PI) can be determined by subtracting PL from LL. The LL, PL, and PI of tested samples are presented on the Atterberg Limits Results, Figure B1. The results are also shown graphically in the Logs of Borings in Appendix A. For the purposes of soil description, we use the term nonplastic to refer to soils with a PI range of 0 to 4, low plasticity for soils with a PI range of >4 to 10, medium plasticity for soils with a PI range of >10 to 20, high plasticity for soils with a PI range of >20 to 40, and very high plasticity for soils with a PI greater than 40.

B.2.3 Particle-Size Analyses

Particle-size analyses were conducted on selected samples to determine their grain-size distributions. Grain-size distributions were determined by sieve analysis in accordance with ASTM D422. A wet sieve analysis was performed to determine a percentage (by weight) of the sample passing the No. 200 (0.075 mm) sieve. For several samples, the material retained on the No. 200 sieve was shaken through a series of sieves to determine the distribution of the plus No. 200 fraction. For some samples, only the percentage of the sample passing the No. 200 (0.075mm) sieve was determined. Results of the particle-size analyses are presented on Figure B2, Grain Size Distribution. For all particle-size analyses, the percentage of material passing the No. 200 sieve is also shown graphically in the Logs of Borings in Appendix A.



NOTES

1) Atterberg limits tests were performed in general accordance with ASTM D4318 unless otherwise noted in the report.

2) Plasticity adjectives used in sample descriptions correspond to plasticity index as follows:
- Nonplastic (0 - 4%)
- Low Plasticity (>4 - 10%)
- Medium Plasticity (>10 - 20%)
- High Plasticity (>20 - 40%)
- Very High Plasticity (>40%)

BORING AND SAMPLE NO.	DEPTH (feet)	GROUP SYMBOL	SAMPLE DESCRIPTION	LL %	PL %	PI %	NAT. W.C. %	FINES %
● B-2, S-2	5.0	ML	Sandy Silt; nonplastic	36	34	2	42	
■ B-4, S-4	10.0	CL	Lean Clay; low plasticity	32	22	10	26	
▲ B-4, S-9	25.0	CL	Lean Clay; low plasticity	29	20	9	23	

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ATTERBERG LIMITS RESULTS

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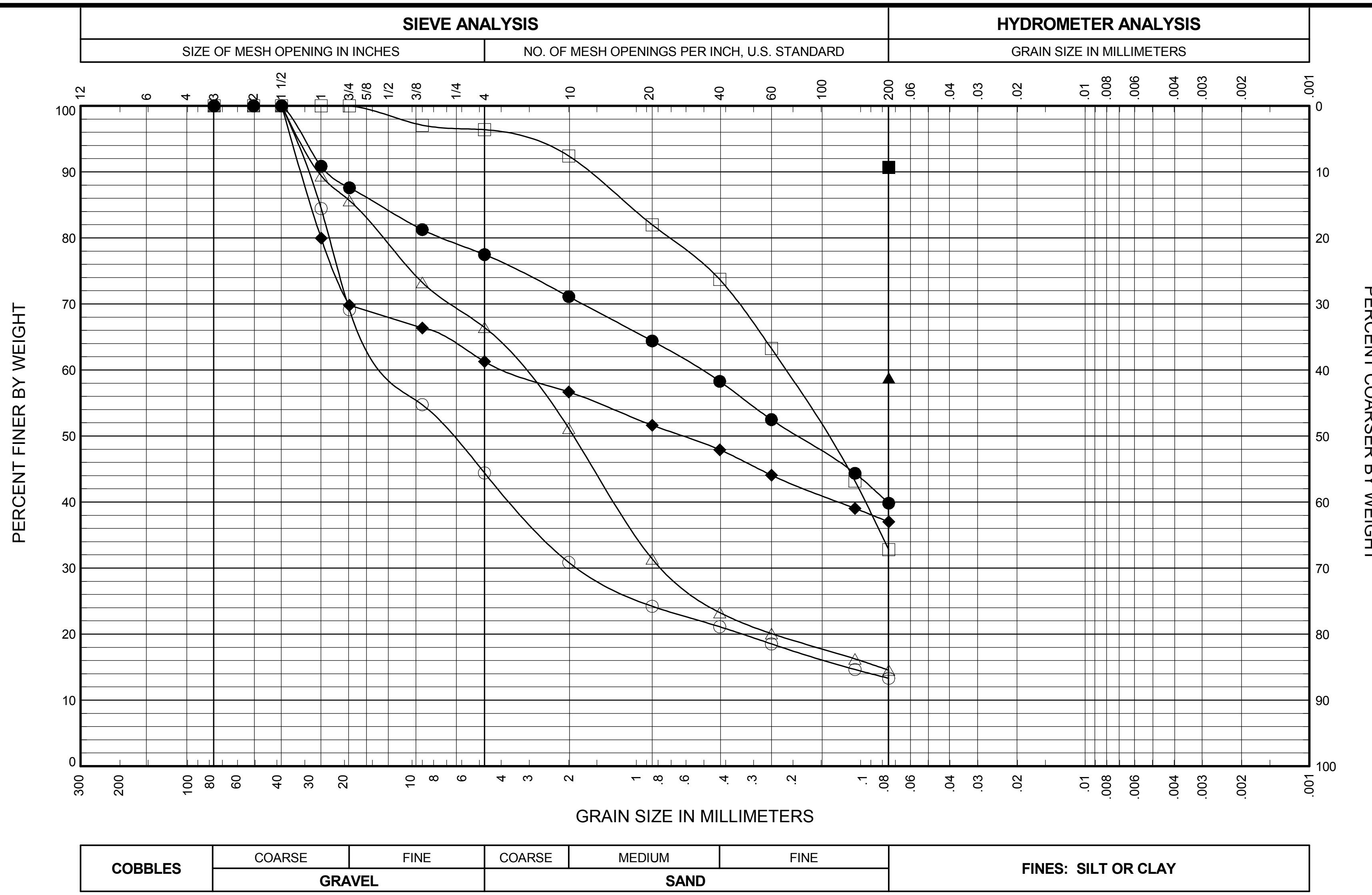
FIG. B1



NOTE: Sieve and hydrometer analyses were performed in general accordance with ASTM D422 unless otherwise noted in the report.

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BORING AND SAMPLE NO.	DEPTH (feet)	GROUP SYMBOL	SAMPLE DESCRIPTION	GRAVEL %	SAND %	FINES %	NAT. W.C. %	DRY DENSITY PCF
● B-1, S-2	5.0	SM	Silty Sand with Gravel	23	38	40	14	
■ B-1, S-6	15.0	ML	Silt	-	-	91	24	
▲ B-2, S-5a	12.5	ML	Sandy Silt	-	-	59	39	
◆ B-4, S-2	5.0	GM	Silty Gravel with Sand	39	24	37	27	
○ B-4, S-8	20.0	GC	Clayey Gravel with Sand	56	31	13	21	
□ B-5, S-2a	5.0	SM	Silty Sand	4	64	33	23	
△ B-5, S-3	6.6	SM	Silty Sand with Gravel	34	52	15	18	

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GRAIN SIZE DISTRIBUTION

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FIG. B2
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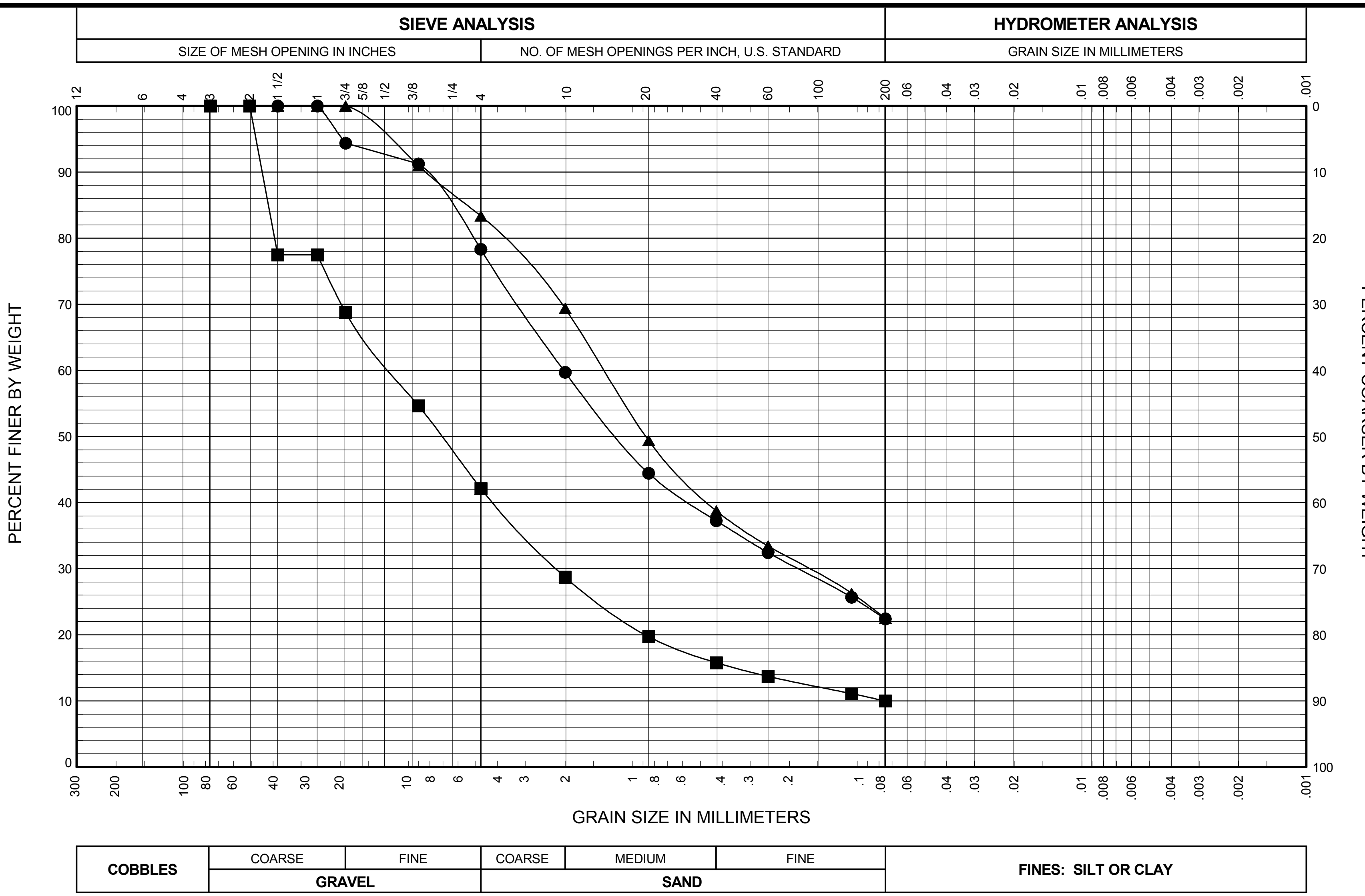
FIG. B2



NOTE: Sieve and hydrometer analyses were performed in general accordance with ASTM D422 unless otherwise noted in the report.

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BORING AND SAMPLE NO.	DEPTH (feet)	GROUP SYMBOL	SAMPLE DESCRIPTION	GRAVEL %	SAND %	FINES %	NAT. W.C. %	DRY DENSITY PCF
● B-6, S-2	5.0	SM	Silty Sand with Gravel	22	56	22	23	
■ B-6, S-5	10.0	GP	Poorly Graded Gravel with Silt and Sand	58	32	10	11	
▲ B-7, S-2	5.0	SM	Silty Sand with Gravel	17	61	22	19	

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GRAIN SIZE DISTRIBUTION

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FIG. B2
Sheet 2 of 2

FIG. B2

APPENDIX C

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

Important Information About Your Geotechnical/Environmental Report

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used: (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors, which were considered in the development of the report, have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based on interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the
ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland