December 19, 2017

Mr. David Mooney
The Cove, LLC
1961 Collingwood St. #212
Vancouver, BC V6R3K6

Re: Geologic Hazard Evaluation
OCMC Chapter 17.44 Geologic Hazards
The Cove Waterfront Development
Oregon City, Oregon
2367-00

Dear Mr. Mooney,

Apex Companies, LLC has prepared this letter to address specific requirements of the City of Oregon City Municipal Code (OCMC) with respect to Geologic and Geotechnical Hazards.

We have previously completed a number of geotechnical studies on the project site, related to past developments. We have recently completed a comprehensive geotechnical report for this project, entitled "Geotechnical Assessment, The Cove Waterfront Development, Oregon City, Oregon," and issued on December 19, 2017.

We have also reviewed the Grading Plans developed by Dowl Engineering for the Cove Waterfront project. The grading within the Cove uses 3H:1V slopes or flatter adjacent to the Cove with maximum slopes of 2H:1V elsewhere. The grading plans appear to be consistent with Apex's recommendations for grading, graded slopes and erosion control. These grading plans also appear to have been completed in significant compliance with the OCMC.

Consistency of Documentation with City Requirements

The requirements cited in the OCMC are summarized below.

16. Geologic Assessment Report
    A preliminary engineering geologic assessment report, prepared by a suitably qualified and experienced engineering geologist who is registered in the state of Oregon and who derives his or her livelihood principally from that profession, containing a description of:
    a. Geologic formations, bedrock and surficial materials including artificial fill;
    b. Location of any faults, folds, etc.;
    c. Structural data including bedding, jointing, and shear zones;

17. Geotechnical Report
    A geotechnical report demonstrating compliance with the Geologic Hazards Overlay District. The report(s) will be peer reviewed (OCMC 17.44.060 K, L) by the City's Geotechnical Engineer. Comments from the City's Geotechnical Engineer will be addressed by the applicant's engineering geologist and geotechnical engineer. Costs for City's geotechnical review and consultation shall be paid by the applicant. The report shall be prepared by a suitably qualified and experienced geotechnical engineer who is licensed in Oregon and who derives his or her livelihood principally from that profession, discussing:

a. Engineering feasibility of the proposed development and addressing strength properties of surface and subsurface soils with regard to stability of slopes
b. Appropriate types of foundations together with bearing values and settlement criteria for foundation design, soil erosion potential, permeability and infiltration rates
c. Excavation, filling and grading criteria including recommended final slopes
d. Surface and subsurface drainage
e. Planting and maintenance of slopes
f. Other identified soil or subsurface constraints together with geotechnical remediation and other recommendations to alleviate or minimize their effects
g. Signature and seal of the geotechnical engineer.
h. The report shall also contain a statement as to whether the proposed development, constructed in accordance with the recommended methods, is reasonably likely to be safe and prevent landslide or other damage to other properties over the long term, and whether any specific areas should not be disturbed by construction.

We have detailed in the following sections where the prepared documents meet the requirements of the code.

a. Geologic formations, bedrock and surficial materials including artificial fill

Geologic conditions as well as site specific materials are described in depth in Section 3.0 Geologic Setting and Section 4.0 Subsurface Conditions. Further, extensive subsurface exploration logs have been included in Appendix A.

b. ***Location of any faults, folds, etc.;***

The seismic section of the report addresses the seismic setting of the project. No active or inactive faults have been mapped in or around the site.

c. Structural data including bedding, jointing, and shear zones;

This is addressed in the geologic setting portion of the report.

a. Engineering feasibility of the proposed development and addressing strength properties of surface and subsurface soils with regard to stability of slopes

Existing slopes that would trigger slope stability review are located on the banks of Clackamette Cove and various localized oversteepened fill piles throughout the development. Development along the Cove will result in significant flattening of the existing slopes (to 3H:1V or flatter) in accordance with our recommendations. Proposed finished slopes address geologic hazards associated with slopes.

b. Appropriate types of foundations together with bearing values and settlement criteria for foundation design, soil erosion potential, permeability and infiltration rates

Foundation design is addressed in Section 5.5 of the report. Erosion potential and control is discussed in Section 5.4. Due to the presence of random fill soils at the surface throughout the site, infiltration potential has not been tested.

c. Excavation, filling and grading criteria including recommended final slopes

The Geotechnical Report includes extensive grading recommendations in Section 5.1 and recommendations for finished cut and fill slope gradients in Section 5.2.

d. Surface and subsurface drainage

Drainage issues are addressed in throughout the report.

e. Planting and maintenance of slopes

The Erosion Control section of the report (Section 5.4) addresses planting and vegetation on slopes.

f. Other identified soil or subsurface constraints together with geotechnical remediation and other recommendations to alleviate or minimize their effects

A number of constraints are identified in the report including the presence of undocumented fills. These are addressed in the discussion section as well as the recommendations.

g. Signature and seal of the geotechnical engineer.

The Geotechnical Report was signed and sealed by Stuart Albright, P.E. who is registered in Oregon as a Geotechnical and a Civil Engineer.

h. The report shall also contain a statement as to whether the proposed development, constructed in accordance with the recommended methods, is reasonably likely to be safe and prevent landslide or other damage to other properties over the long term, and whether any specific areas should not be disturbed by construction.

The specific developments currently under consideration differ somewhat from what was anticipated at the time the report was written. However, based on our review of the current scheme, it is our opinion that the development is appropriate for the site and that landslide hazards have been adequately addressed.

Geologic Hazards

The City of Oregon City's Geologic Hazards Map indicates steep slopes and buffer zones developed from aerial photography interpretation. We have annotated each of the slope hazards by their source and provided a discussion of each.

Stockpiles. A number of large, temporary fill stockpiles are present throughout the site. These stockpiles were placed at their angle of repose and as such, feature steep sides that trigger the geologic hazard designation. The geologic hazards associated with stockpiles will be completely eliminated through removal. The stockpiles will be excavated and where appropriate, the materials will be placed as compacted, engineered fills.

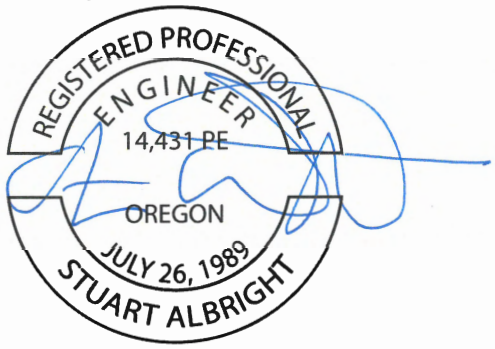
Cove Banks. The banks of Clackemette Cove generally consist of granular fills that were dumped or pushed into the original quarry excavation in order to create upland. The banks generally raveled off into final slopes of approximately 1.5V:1H or steeper. Vegetation eventually established itself and the Cove banks have for decades been as found today for decades. This is in spite of periodic inundation such as during the 1996 floods. Over the past 10+ years during which Apex representatives have been associated the project, the banks have shown little to no evidence of sloughing or erosion. The steepness of the banks triggers the Geologic Hazard Designation.

Within the proposed grading for the Cove site, the banks are proposed to be graded to a finish slope of 3H:1V. The geologic hazards associated with the Cove slopes will be completely eliminated through the proposed grading.

The redevelopment of the Cove site will require providing a higher level of stability and also fill removal to offset fill placement elsewhere. As such, the Cove banks are proposed to be graded to a finish slope of 3H:1V. These slopes will be completed within the fill soils present which generally consist of sands and gravels with varying fill contents. The slopes will be subject to periodic inundation during extreme high water events. The banks of Clackamette Cove have stood at 1:5H to 1V for decades, in spite of periodic inundation such as during the 1996 floods. The current banks show no signs of instability or ongoing failures.

Closure. We hope that this letter meets your needs at this time. If you have any questions or need clarification, please contact me at your convenience.

Sincerely,



RENEWS: 12/31/19

Stuart Albright, P.E.
Principal Geotechnical Engineer

Geotechnical Assessment
Cove Waterfront
Oregon City, Oregon

Prepared for:
The Cove, LLC

December 19, 2017
2367-00

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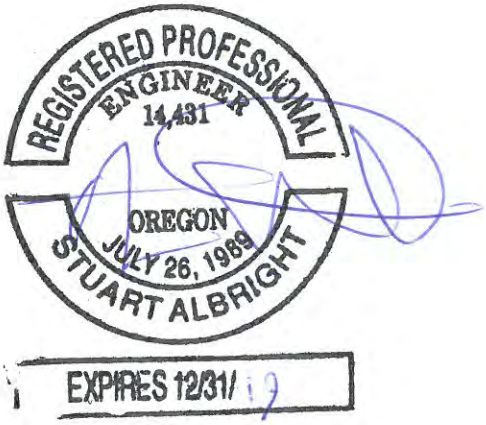


Stu Albright, P.E.
Principal Engineer

Table of Contents

Figures

Appendix

1.0 Introduction and Limitations

This report presents Apex Companies, LLC's (Apex's) geologic assessment and geotechnical engineering evaluation and recommendations for the proposed Cove Waterfront development in Oregon City, Oregon (Figure 1). Our scope of work included a geologic site reconnaissance and numerous phases of subsurface explorations. Additional aspects of our work scope included a site vicinity geologic reference review, as well as the preparation of this report.

The work was performed for the exclusive use of The Cove, LLC for specific geotechnical-related application to this project. This work was conducted in accordance with generally accepted professional practices in the same or similar localities related to the nature of the work accomplished, at the time the services were performed. No other warranty, express or implied, is made.

2.0 Site Description and Project Understanding

Site Description. The Clackamette Cove site is located in Oregon City, Oregon in the area generally bounded by Highway 99E on the west, the Clackamas River on the north, the old Rossman Landfill and Tri-Cities Wastewater Treatment Plant on the east, and Main Street on the south. It consists of the tax lots that surround and totally contain Clackamette Cove.

The overall topography of the Site is relatively flat, although steep slopes surround Clackamette Cove. Lot 1 is southwest of Clackamette Cove and mostly vacant, with the exception of a series of stockpiles placed by the Oregon City Department of Public Works. Lots 3 through 7 are east of Clackamette Cove and are vacant, with the exception of a small single-story building used by the Clackamas County Sherriff for equipment storage an apparently inactive truck scale, left over from historical activities at the site, and a paved pathway. Figure 2 shows a plan view of the Site.

The Site is located southeast of the confluence of the Clackamas River and the Willamette River. Oregon Highway 99 runs in a north-south alignment west of the Site, and Oregon Highway 205 runs in a north-south alignment east of the Site. Residential property is north of the Site; industrial properties, including the Tri-Cities Service District wastewater treatment plant, are east of the Site; retail-commercial property (the Oregon City Mall) is south of the Site; and Clackamas Cove, a pedestrian pathway, and open undeveloped land is west of the Site.

Clackamette Cove is a former sand/gravel mining pit that is now connected to the Clackamas River. The Clackamette Cove area was undeveloped and used for agricultural purposes through the early 1950s. From the mid-1950s through 1986, the property was used for mining sand and gravel and manufacturing asphalt concrete. Since 1986, the property has been generally undeveloped. The eastern portion of the site was

previously in use as a railroad right-of-way. East of the railroad, the site was used for an unlined municipal waste landfill (Rossman Landfill).

Project Understanding. Although the final development details may change somewhat, the overall development scheme and site work needs have been identified at this time. As we understand it, the overall approach to site development includes excavation of the lake front to soften grades at the waterfront with filling on the eastern half of the site. We understand that the project will include construction of a mixed-use development featuring apartments, and commercial parcels as well as the installation of services, parking areas, and access drives.

The project will feature a significant amount of roadway construction including the development of a new City Street, Agnes Avenue, and an emergency access roadway called the Agnes Extension.

We anticipate that structural loading will be moderate, with wall loads not exceeding 5 kips per lineal foot (Klf) and column loads of less than 450 kips.

3.0 Geologic Setting

3.1 Site Geologic Conditions

Geology. The Clackamette Cove area lies at the confluence of the Clackamas River and the Willamette River. The geology in the vicinity of the Site is composed of fluvial sediments, including Quaternary alluvium overlying the Troutdale Formation (Miocene to Pliocene age). The local basement rock underlying the Troutdale Formation is the Columbia River Basalt (CRB).

Quaternary alluvium consists of approximately 40 to 60 feet of gravel and sand, interbedded with silt lenses. These deposits were mined for aggregate, creating Clackamette Cove. The Troutdale Formation is composed of semi-impermeable clay overlying a lower sandy conglomerate interbedded with the Sandy River Mudstone. The CRB is a series of lava flows or flood basalts.

Hydrogeology. A shallow, unconfined alluvial aquifer is present within the Quaternary alluvium. The alluvial aquifer is separated from a deeper aquifer in the CRB by approximately 120 feet of low permeability, fine-grained deposits (GRI, 1991). A network of groundwater monitoring wells was installed as part of numerous studies of impacts from the Rossman Landfill. The regional groundwater flow direction in the shallow alluvial aquifer is generally to toward the confluence of the Clackamas and Willamette Rivers.

Water levels beneath the site vary seasonally in direct response to changes in river flows. Groundwater levels are likely to vary seasonally.

Area Seismicity. The seismicity of Oregon City, and hence the potential for ground shaking, is controlled by three separate fault mechanisms. These include the Cascadia Subduction Zone (CSZ), the mid-depth intraplate zone, and the relatively shallow crustal zone. Descriptions of these potential earthquake sources are presented below.

The CSZ is located offshore and extends from Northern California to British Columbia. Within this zone, the oceanic Juan De Fuca Plate is being subducted beneath the continental North American Plate to the east. The interface between these two plates is located at a depth of approximately 15 to 20 kilometers (km). The seismicity of the CSZ is subject to several uncertainties, including the maximum earthquake moment magnitude (Mw) and the recurrence intervals associated with various Mw earthquakes. (Moment magnitude is used by seismologists to measure larger earthquakes and is based on fault displacement and area of fault rupture, while for smaller earthquakes the moment magnitude is approximately equal to the familiar Richter Scale Magnitude.) Anecdotal evidence of previous CSZ earthquakes has been observed within coastal marshes along the Oregon coast. Sequences of interlayered peat and sands have been interpreted to be the result of large subduction zone earthquakes occurring at intervals on the order of 300 to 500 years, with the most recent event taking place approximately 300 years ago. A definitive study of Oregon seismic hazards completed by Geomatrix (1995) suggests that the maximum earthquake associated with the CSZ is Mw 8 to 9. This is based on an empirical expression relating Mw to the area of fault rupture derived from earthquakes that have occurred within subduction zones in other parts of the world. An Mw 9 earthquake would involve a rupture of the entire CSZ. As discussed by Geomatrix (1995), this has not occurred in other subduction zones that have exhibited much higher levels of historical seismicity than the CSZ and is considered unlikely. For the purpose of this study, an earthquake of Mw 8.5 was assumed to occur within the CSZ.

The intraplate zone encompasses the portion of the subducting Juan De Fuca Plate located at a depth of approximately 30 to 50 km below western Oregon. Very low levels of seismicity have been observed within the intraplate zone in Oregon. However, much higher levels of seismicity within this zone have been recorded in Washington and California. Several reasons for this seismic quiescence were suggested in the Geomatrix (1995) study and include changes in the direction of subduction between Oregon and British Columbia as well as the effects of volcanic activity along the Cascade Range. Historical activity associated with the intraplate zone includes the 1949 Olympia Mw 7.1 and the 1965 Puget Sound Mw 6.5 earthquakes. Based on the data presented within the Geomatrix (1995) report, an earthquake of Mw 7.25 has been chosen to represent the seismic potential of the intraplate zone.

The third source of regional seismicity that can result in ground shaking is near-surface crustal earthquakes occurring within the North American Plate. The historical seismicity of crustal earthquakes in western Oregon is higher than the seismicity associated with the CSZ and the intraplate zone. The 1993 Scotts Mills (Mw 5.6) and Klamath Falls (Mw 6.0) earthquakes were crustal earthquakes.

3.2 Site Seismic Soil Coefficient and Ground Shaking

IBC Seismic Design Parameters. The site coefficient was determined based on the International Building Code (IBC) Section 1615.1.5. The subsurface shear wave velocity profile is based upon correlations developed for normalized SPT blow counts. The site subsurface conditions have been modeled as consisting of surface fills overlying native silt to a depth of 20 feet below the ground surface (bgs) and very dense cobbles and gravels at depths from 20 feet bgs to 50 feet bgs. Below 50 feet bgs, we have assumed that the Eocene- to Oligocene-aged Marine Sedimentary bedrock contact is present. Shear wave velocity based upon correlation to normalized SPT blow counts was in excess of 650 feet per second. While our borings only extended to a maximum depth of 30 feet bgs, based upon review of near-vicinity geologic studies for the project site area, we estimate that this dense gravel unit underlying the site extends to depths in excess of 100 feet bgs.

We recommend that the seismic design of the building utilize the IBC site soil classification "D". A site classification of "D" equates to a moderately stiff to stiff soil profile.

3.3 Liquefaction

The potential for soil liquefaction during seismic ground shaking is generally associated with loose, saturated, non-plastic sands and some very soft, recently deposited silt soils. The soils present on this site that are located below the seasonal groundwater table consist of dense or very dense gravels. This type of subsurface profile is not typically associated with liquefaction issues.

A liquefaction assessment was conducted in accordance with the 26th Annual ASCE Geotechnical Seminar, April 30, 2003 "Recent Advances in Soil Liquefaction Engineering, A Unified And Consistent Framework" by R.B. Seed et al. The Seed et al. methodology developed for liquefaction susceptibility based upon standard penetration testing was employed. The soil profile assumed for our model is detailed in the above section regarding Site Seismic Soil Coefficient. Based upon our understanding of the site subsurface conditions, we estimate the probability of soil liquefaction beneath the project site to be very low.

3.4 Fault Displacement and Subsidence

There are no mapped faults in the near vicinity of the project site. It is our opinion that the potential for on-site fault displacement and associated ground rupture is remote.

3.5 Dynamic Landslides

The current slopes adjacent to the Cove are oversteepened and in places, overhanging. Those slopes are susceptible to static failure and would be particularly susceptible to failure during a seismic event. The project plans call for regrading those slopes with 3H:1V slopes. Such slopes would be stable during a

design seismic event. We therefore estimate that the potential for post-development dynamic landsliding is very low.

3.6 Tsunami

There is no potential for tsunami at the site due to the site's elevation and distance from coastal areas.

4.0 Subsurface Conditions

Numerous phases of field explorations have been undertaken from 2006 to 2017. Past explorations consisted of 30 backhoe and trackhoe test pits excavated throughout the site. Those explorations were supplemented in 2017 by 11 drilled borings. The approximate locations of the explorations are indicated on the accompanying site plan (Figure 2). In addition to the geotechnical explorations completed for the project development, more than 50 past environmental explorations have been completed across the site. Subsurface conditions encountered during field explorations are described below.

Topsoil. Soils near the ground surface generally consist of imported, mineral fill soils with little to no organics. As such, the development of topsoil over the past 20 to 30 years has been minimal except adjacent to trees. The upper 2 to 6 inches of the site may contain sufficient organics to require stripping from structural areas. This material should be stripped during initial site work. Topsoil strippings should not be reemployed as structural fill, but can potentially be reused in landscaping areas.

Fill. The entire site has been previously filled. The fills generally consist of a mix of silts, sands, and gravels with some boulders. Large slabs of concrete and other debris were encountered at depth throughout the site. Although some organic material including sticks and branches has been encountered in the explorations, the occurrences were generally random and widely spread. Significant deposits of topsoil, stripping, and/or refuse have not been encountered within the fill. This is consistent with the site history wherein the site fills would have been placed under the control of the quarry operators.

Native Sandy Silt. The majority of the test pits excavated for this project terminated in fills. Boring logs for deeper explorations indicate that the shallow, native soils (where encountered) consist of sandy silts. These soils are generally encountered as stiff to hard. For the majority of the site, these soils were removed during site quarrying.

Dense Troutdale Gravels. The fills and sandy silts (where encountered) are underlain at depths of 20 to 25 feet below the ground surface by dense to very dense, partially cemented, gravels with varying amounts of silts, sands, and cobbles.

Groundwater. The static groundwater table was not observed in any of our exploratory test pits. Previous work in the area by environmental consultants indicates that the groundwater table is controlled by the water

levels in the Cove. Generally, the water table is located below the surface of the dense gravels which is consistent with the site history where quarrying was stopped above the cove level. Shallow, perched water is anticipated throughout the site during prolonged wet weather.

5.0 Conclusions and Recommendations

The presence of variable fill throughout the site will have the most significant impact on the future development. The majority of the fills encountered consisted of mineral soils or inert materials. However, the consistency of the fills is highly variable. Without treatment, the variability would inevitably result in differential and unpredictable foundation settlement.

In working with the design team, we evaluated a number of options for foundation support. Although we considered deep foundations, installation would encounter frequent boulders and concrete and be impractical. We considered a variety of options for support that would involve a combination of site improvement and foundation stiffening. The most cost-effective solution, and one that will be a compromise between future settlement potential and practicality. The approach consists of densifying the upper surface of the site, placing densified crushed rock, and tying the foundation elements together with grade beams. That approach has ultimately been selected by the project team.

5.1 Grading Recommendations

We have provided recommendations for wet weather and dry weather construction as well as other geotechnical concerns and issues relative to the project site. Because of the potential for the presence of erosion- and moisture-sensitive near-surface fill soils, Apex recommends that site grading and utility trenching be conducted during extended periods of relatively dry weather conditions. If wet weather construction is attempted, development costs may be significantly higher due in part to the increased cost of imported granular fill, maintenance of soft subgrade areas generated as a result of construction activities, and installation of a granular working blanket over construction-trafficked portions of the site.

Removal of Old Concrete, Old Fills, and Other Buried Features. In general, the fills encountered during our explorations consisted of relatively dense, non-organic soils with limited quantities of debris. Given the developed nature of the site, old foundations and concrete slabs may be encountered during site preparation and grading. Our borings were advanced in discrete locations across widely spaced intervals and variation was noted between the fill soils encountered; therefore, it is possible that organic fills or other unsuitable material could also be encountered. Landscaping, organic soils, and other unsuitable fills should be removed from building and pavement areas as encountered. Further, all fill soils should be removed from beneath foundation bearing areas. Overexcavated areas should be backfilled with compacted structural fill. Old utilities and structural features associated with past developments such as footings, retaining walls, etc., should be removed during initial site work. Removal of such features can be limited to areas that will function as foundation subgrade for the new structure. Failure to remove these features can

result in additional settlement or other issues within new structures and pavements. For other areas of the site, such improvements can be removed as they are encountered and conflict with proposed improvements. We would generally recommend that the improvements be removed to a depth of 2 feet below planned surface improvements. If encountered, any vaults or basement structures encountered should be perforated to allow for drainage and subsequently filled with structural fill.

Building Pad Recompaction. Prior to commencing development of structures, we recommend that the building pads and a zone 20 feet outside of the structures horizontally be recompacted using a large (greater than 40 kip weight) surface roller with vibratory compaction. Studies have shown that the effectiveness of vibratory rollers generally increases significantly with each overlapping pass up to a maximum of approximately seven where returns diminish significantly. Further, studies show measurable densification to depths of six feet or more with repeated passes of a large roller.

After rough grading but prior to recompaction, the upper three feet of material should be overexcavated. The resulting subgrade should be visually evaluated and proof rolled with a with a loaded 10- to 12-yard dump truck or other suitable equipment. Any areas of subgrade that pump, weave, or contain obvious debris should be overexcavated and backfilled with clean material from on site

The exposed site surface should then be recompacted through a minimum of seven passes of a vibratory roller of at least 40,000 pounds in weight. As with the proofroll, any areas that roll or pump should be overexcavated and backfilled with select on-site material.

Wet Weather Construction. Ideally, construction would be scheduled to occur during summer months when extended periods of warm, dry weather are typical. This will minimize the impacts of rain and wet soil conditions on construction.

If wet weather construction is conducted, it is recommended that all haul roads be armored with 12 to 18 inches of imported gravel fill. All structural fill material placed during wet weather construction should consist of imported granular fill. The import fill should contain less than 5 to 8 percent fines content by weight.

Measures to ensure stormwater runoff does not enter trenches and excavations will be required during wet weather construction. In addition, the potential for presence of groundwater seeps during winter months may necessitate dewatering within trenches and excavations.

Compaction Recommendations. Structural fills should be installed on a subgrade that has been prepared in accordance with the above recommendations. Fills should be installed in horizontal lifts not exceeding 8 inches in thickness (loose—prior to compaction), and should be compacted to at least 92 percent of the maximum dry density for fine-grained native soils. The maximum dry densities should be determined in accordance with ASTM D 1557 (Modified Proctor Test). The compaction criteria may be reduced to

85 percent in non-structural landscape or planter areas. Fills placed over ground that slopes in excess of 3H:1V should be keyed and benched into firm soils beneath all topsoil and tree or brush roots.

A summary of recommended compaction specifications is provided in the following table.

Recommended Fill Compaction Specifications

Material	Percent of Maximum Dry Density ASTM D 1557
Structural Fill and Trench Backfill	92
Landscaping Fill	85
Base Rock for Slabs and Pavements	95

Structural Fills During Summer Grading. During dry weather, structural fills may consist of virtually any well-graded soil that is free of debris, organic matter, and high percentages of clay or clay lumps, and that can be compacted to the preceding specifications. However, if excess moisture causes the fill to pump or weave, those areas should be dried and re-compacted, or removed and backfilled with compacted granular fill. In order to achieve adequate compaction during wet weather, or if proper moisture content cannot be achieved by drying, we recommend that fills consist of well-graded granular soils (sand or sand and gravel) that do not contain more than 5 percent material by weight passing the No. 200 sieve. In addition, it is usually desirable to limit this material to a maximum 6 inches in diameter for ease of compaction and future installation of utilities.

5.2 Finished Cut and Fill Slopes

Although steeper rock slopes may be feasible for portions of the site, we recommend that upland finished cut and fill slopes not exceed gradients of 2H:1V. Slopes that are subject to inundation, such as those that intersect the Cove) should be finished at cut slopes that do not exceed 3H:1V. Cut and fill slopes should be protected immediately from erosion following completion of grading. Erosion protection should consist of placement of jute mesh and seeding with erosion-resistant vegetation or other engineer-approved erosion control methods.

5.3 Excavations

Subsurface conditions encountered during the site investigation indicate that precautions in utility excavations will be required due to the potential for caving/sloughing. Any excavations deeper than 4 feet should be sloped or shored in accordance with Occupational Safety and Health Act (OSHA) regulations. Normally, shoring systems (for excavations less than 20 feet in depth) are contractor-designed and -installed items.

5.4 Erosion Control

We recommend that finished cut and fill slopes be protected immediately following grading with vegetation, gravel, or other approved erosion control methods. Water should not be allowed to flow over slope faces or drop from outfalls but should be collected and routed to stormwater disposal systems. Riprap, gabion baskets, or similar erosion control methods may be necessary at stormwater outfalls or to reduce water velocity in ditches. Silt fences should be established and maintained throughout the construction period. Silt fence barriers should be established downslope from all construction areas to protect natural drainage channels from erosion and/or siltation. In order to decrease erosion potential, care should be taken to maintain native vegetation and organic soil cover over as much of the site as possible.

5.5 Foundation Support

For the purpose of our initial foundation assessments we have assumed that the proposed structure/structures will be five stories or less, and that column loads will not exceed maximum factored loads of about 450 kips, and factored loads for continuous wall footing will not exceed 5 Klf. If structural loading exceeds the above assumptions by greater than 20 percent, Apex should be informed in order to re-assess the validity of our foundation recommendations.

Under the current development scheme, the project is proposed to feature spread footings that would bear within five feet of the existing ground surface. Unfortunately, some 15 to 20 feet old fill will still be in place under the foundations. Our recommendations for foundations assume that the building pads will be recompacted in accordance with our site preparation recommendations and that the structures will be underlain by a minimum of three feet of compacted granular fill.

Spread Footings. For spread footings established on recompacted fills and a granular fill pad as previously described, the foundations can be designed for an allowable bearing capacity of 2.5 kips per square foot (Ksf). We estimate that foundations designed in accordance with the above recommendations will experience less than 2 inches of total settlement and less than 1 inch of differential settlement between adjacent foundation elements. In order to even out such movements throughout the structure, we recommend connecting adjacent foundations through grade beams.

For sliding resistance, the native soils underlying spread footings can be assumed to have an ultimate coefficient of friction of 0.40. Passive soil pressure can be developed along the sides of footings if granular backfill is used around footings and the backfill is compacted to at least 95 percent of the material's maximum dry density as determined by ASTM D-1557 testing. An equivalent passive fluid weight of 350 pcf can be used for resistance against sliding.

Minimum allowable foundation size and minimum allowable foundation embedment depth should comply with IBC requirements.

The sliding coefficient, allowable bearing, and passive soil resistance may each be increased by 1/3 for short-term, temporary loading conditions such as high wind or seismic shaking.

Site Work Observation and Inspection. With any of the above described approaches to foundation support, we recommend that Apex be involved closely with the project general contractor and earth work contractor or pier contractor during initial site work and preparation of foundation subgrade areas. All structural fill placement and compaction should be monitored routinely with regular density testing conducted and documented.

5.6 Slabs on Grade and Vapor Retarders for Finished Areas

For slab-on-grade construction, we recommend installation of at least 6 inches of clean crushed rock or a clean gravel section between the bottom of the slab, and subgrade. For the gravel to be defined as "clean", it should contain less than 6 or 7 percent fines by weight passing a standard No. 200 sieve.

We would normally recommend the use of a vapor retarder between the slab and the subgrade soils. The vapor retarder discussion is rendered moot by the need to provide methane collection and venting as well as radon collection and venting under the slabs.

5.7 Retaining Structures

We have prepared lateral pressure recommendations for restrained and unrestrained walls. The loads and pressures developed from these recommendations are our best estimate of actual loads that may develop and do not contain a factor of safety. The recommendations assume that the retaining wall backfill material will consist of clean, durable, well-drained granular backfill as described in the Structural Fill Section of this report. If traffic loads are expected within a horizontal distance from the top of the wall equal to the wall height, a surcharge equivalent to an additional 2 feet of backfill height should be added to earth loads acting on the wall. Retaining wall pressures are assumed to act horizontally (normal to the wall), based on the practice of installing drainage membranes or impervious wall coatings that prevent friction between the wall and backfill.

Non-Restrained Walls. Non-restrained walls have no restraint at the top and are free to rotate about their base during backfilling. Most cantilever retaining walls fall into this category. We recommend that non-restrained walls be designed for pressures developed from the equivalent fluid weights shown in the following table.

Non-Restrained Retaining Wall Pressure Design Recommendations

Backfill Slope Horizontal/Vertical	Equivalent Fluid Weight (pounds per cubic foot)
Level	35
3H:1V	45
2H:1V	85

Restrained Walls. Restrained walls are any walls that are prevented from rotation during backfilling. Walls with corners and jogs and those that are restrained by a floor slab, floor diaphragm, and/or roof fall into the category of restrained walls. We recommend that restrained walls be designed for pressures developed from the equivalent fluid weights shown in the following table.

Restrained Retaining Wall Pressure Design Recommendations

Backfill Slope Horizontal/Vertical	Equivalent Fluid Weight (pounds per cubic foot)
Level	55
3H:1V	65
2H:1V	105

Seismic Lateral Earth Pressure. Lateral earth pressure acting on retaining walls should be increased to account for seismic loadings. We have prepared recommendations for seismic lateral earth pressures on non-restrained walls in accordance with the Mononobe-Okabe methodology. The peak ground acceleration used in preparing these recommendations was developed based on SDs/2.5 in accordance with the OSSC. Recent research indicates that for peak ground acceleration values less than 0.4g, seismic earth pressure can be ignored. However, we recommend utilizing the accepted practice of calculating the load based on one half of the peak ground acceleration for even low levels of site shaking.

The Mononobe-Okabe methodology was developed for non-restrained walls. Recent research indicates that at-rest (restrained) walls may not be subject to any load increases during seismic events. Further, methodologies for evaluating the loading on restrained walls are known to be quite conservative and as such, the factors of safety have been shown to more than address the seismic loading on restrained walls.

Seismic Earth Pressures may be approximated by a uniformly distributed rectangular pressure which is applied over the entire back of the wall. "H" represents the height of the wall in feet. The resultant force acts at a distance approximately 0.6H above the base of the wall.

Unrestrained Wall Seismic Surcharge Design Pressure Recommendations

Design Condition	Seismic Pressure Surcharge (pounds per square foot)
Seismic Active Earth Pressure (Unrestrained)	7H

These pressures represent our best estimate of actual pressures that may develop and do not contain a factor of safety. These pressures assume retaining wall backfill material is well-drained.

Retaining Wall Backfill. The backfill behind and within 4 feet of the retaining walls should consist of free-draining granular material and should meet recommended specifications provided in the Suitable Fill section of this report.

Mechanically-Stabilized Earth Walls. Mechanically-stabilized earth (MSE) retaining wall backfills should consist of clean, granular soils (i.e., sand, gravels, crushed rock). MSE walls require high-quality backfill for durability, good drainage, constructability, and good soil reinforcement interaction. These characteristics can be obtained from well-graded granular materials. MSE systems depend on friction between the reinforcing elements and the soil. In such cases, a material with high friction characteristics is specified and required. Some systems rely on passive pressure on reinforcing elements and, in those cases, the quality of backfill is still critical. These performance requirements generally eliminate predominantly fine-grained soils, particularly soils with high clay content.

Recommended soil strength parameters for use in the reinforced retaining wall design are summarized in the following tables. Soil cohesion should be assumed as zero.

MSE Backfill, Soil Strength Design Recommendations

Backfill Type	Design Friction Angle (Φ)	Moist Soil Unit Weight (γ)	Active Lateral Earth Pressure Coefficient[2]	At-Rest Lateral Earth Pressure Coefficient[3]
Select Borrow, Imported Clean Sand[1]	34 degrees	120 pcf	0.28	0.44
Crushed Rock	40 degrees	135 pcf	0.22	0.36

MSE Backfill, Active and At-Rest Earth Pressure Coefficients for Sloping Backfill

Backfill Type	Active Earth Pressure Coefficient 3:1 Backslope	At-Rest Earth Pressure Coefficient 3:1 Backslope	Active Earth Pressure Coefficient 2:1 Backslope	At-Rest Earth Pressure Coefficient 2:1 Backslope
Select Borrow, Imported Clean Sand[1]	0.33	0.49	0.41	0.57

Backfill Type	Active Earth Pressure Coefficient 3:1 Backslope	At-Rest Earth Pressure Coefficient 3:1 Backslope	Active Earth Pressure Coefficient 2:1 Backslope	At-Rest Earth Pressure Coefficient 2:1 Backslope
Crushed Rock	0.30	0.45	0.36	0.51
WSDOT Gravel Backfill for Walls	0.24	0.38	0.28	0.42

Notes:
1. Select Borrow, Imported Clean Sand: The sand should contain less than 9 percent or 10 percent fines by weight passing a standard No. 200 sieve.
2. Coulomb Active Lateral Earth Pressure with wall friction. The value assumes level backfill.
3. At-Rest Earth Pressure, Ko = 1-sin(Φ). The value assumes level backfill.

Traffic Surcharging Loads. If traffic loads are expected within a horizontal distance from the top of the wall equal to the wall height, a uniform lateral earth pressure acting horizontally on reinforced walls equal to 60 psf should be added to earth loads acting on the wall.

External and Global MSE Wall Stability. MSE wall stability should be determined for overturning, bearing, and sliding stability. Appropriate factors of safety should be utilized in design. The following soil parameters should be employed in external stability checks.

MSE Wall External Stability, Soil Design Parameters

Parameter	Symbol	Units	Value
WSDOT Gravel Backfill for Retaining Walls			
Backfill Soil Unit Weight	γ	pcf	See Table 4
Backfill Soil Friction Angle	Φ	degrees	See Table 4
Active Lateral Earth Pressure Coefficient (Coulomb with wall friction)	Ka	--	See Tables 4 & 5
At-Rest Lateral Earth Pressure Coefficient (Ko = 1-sin(Φ)	Ko	--	See Tables 4 & 5
In-place Soils at Foundation Grade			
Foundation Soil Friction Angle	φ	degrees	28
Foundation Soil Unit Weight	γ	pcf	120
Base Sliding Coefficient (Ultimate)	d	--	0.34
Allowable Bearing Capacity for footing embedded a minimum of 3 feet	q_{all}	Ksf	2 [2.]
Allowable Bearing Capacity for footing embedded a minimum of 6 feet	q_{all}	Ksf	4 [3.]
Passive Lateral Earth Pressure Coefficient	kp	--	2.77

Notes:
1. Ksf = Kips per square foot.
2. The bottom of footing is a minimum of 3 feet below all adjacent grades.
3. The bottom of footing is a minimum of 6 feet below all adjacent grades.

MSE Wall Foundation Embedment. To reduce long-term MSE wall stability issues associated with sloughing of existing slopes, we recommend that the toe of the MSE wall be embedded. The forward edge (toe) of wall should be set back a horizontal distance from the face of the slope a minimum of the height of the slope divided by two (H / 2).

Total and Differential Settlement Estimate. For MSE backfill heights of 15 feet or less in which foundations are embedded a minimum of 3 feet below all surrounding grades, our estimated total settlement is less than 2 inches. Differential settlement over either a 50-foot section or 100-foot section of MSE wall is estimated to be less than 1 inch.

Suitable Fill Materials. Backfill selection should be based on the ability of the material to drain and the drainage design developed for MSE walls. Weather conditions will also affect the ability to place and properly compact fill materials utilized in MSE wall construction. Additionally, for MSE walls and reinforced slopes, the susceptibility of the backfill reinforcement to damage due to placement and compaction of backfill on the soil reinforcement should be taken into account with regard to backfill selection.

Additional Design Considerations. Utility trenching should not be conducted in the reinforced zone of MSE walls. Trenching will invariably cut through reinforcement layers within the wall zone and undermine wall stability.

5.8 Pavements

The following recommendations for parking lot pavements and access driveways are specific to non-public right-of-way areas. Our designs assume that the subgrade within 8 inches of the bottom of the pavement section will be compacted to 95 percent of the material's maximum dry density in accordance with ASTM D 1557 (Modified Proctor) testing. If the road subgrade is not re-compacted to a uniform density and stiffness, the gravel base will have to be increased significantly. If re-compaction of the subgrade is not conducted, the gravel base thickness should be increased by 50 percent from those thicknesses indicated in the following table.

Specifications for pavements, base course, and sub-base should conform to Oregon Department of Transportation (ODOT) specifications. Our pavement design sections are provided in the following table.

Flexible Asphalt Concrete Pavement Design

Approximate Number of Trucks	Equivalent Single Axle Loads (ESALs x 1000)	Asphalt Concrete Thickness (inches)	Base Rock Thickness (inches)
Auto parking	10	2.5	10
6	25	3	10
15	66	3.5	11

Intermediate truck loading conditions and the resultant asphalt concrete and base rock sections can be interpolated from the above table. These designs are intended for use on private streets. Construction traffic should be limited to unpaved and untreated roadways, or specially constructed haul roads. If this is not possible, the pavement design selected from the above table should include an allowance for construction traffic.

5.9 Agnes Avenue

Agnes Road is planned to be developed as a City street in accordance with the requirements of the City of Oregon City. In general, the Agnes Road alignment follows the old railroad right-of-way that previously formed the east boundary of the Clackamette Cove quarry site. The railroad right-of-way predates the quarry by decades and was generally filled above adjacent grades (to avoid flooding).

We completed a series of five borings within the Agnes Avenue right-of-way. Shallow soils, likely subgrade soils, encountered consisted generally of dense gravel fills associated with past railroad and roadway development. Portions of the right-of-way have been filled over with sand and silt fills. It is possible that remnants of track and ties could be found at depth, although none were seen within our borings.

The pavement subgrade resilient modulus (M_R) was developed from correlation with soil types present throughout the corridor. The soils present at subgrade throughout the area generally consist of sandy silt and sand fills. Based on our experience, we selected a conservative resilient modulus of 6,000 pounds per square inch (psi).

Based on our explorations and evaluation of past site history, the proposed alignment of Agnes Avenue is appropriate for the development of the City street. The subgrade soils will require recompaction in accordance with City requirements as preparation for final subgrade grades.

5.10 Agnes Extension

The Agnes Extension portion of the project consists of extending a ¾ width roadway from the west end of Agnes Avenue to the east. The roadway will cross the old Rossman Landfill.

The Rossman Landfill has been extensively studied and consisted of a municipal solid waste (MSW) landfill that was open until 1969. The MSW was placed in unlined trenches and pits. Compaction of the waste and daily cover were no typical. The cells of the landfill were subsequently capped with on-site silts and sands.

An exploration program completed by AGRA Earth and Environmental in 1998 included five borings and four test pits within or near the proposed Agnes Extension footprint. In general, the explorations encountered 6 to 15 feet of surface fill (gravels, sands, and silts) overlying 5 to 13 feet of MSW.

Ideally, roadways would not be developed over MSW landfills but the nature of this site results in a requirement for an emergency outlet at the north end. The original Agnes Avenue was developed over the Rossman Landfill and ultimately had to be closed when differential settlement made the roadway undriveable. However, the total depth of removal and complications associated with landfill removal and relocation preclude excavating and removing the existing landfill material.

The failed Agnes Avenue was constructed directly over the landfill with no preparation. Further, the amount of MSW under the original Agnes was closer to 20 feet and the landfill was recently closed. Settlements during the initial 10 to 20 years after closure are much higher than the long-term settlement after that time.

Based on our research, we recommend that the roadway area be preloaded in order to reduce the total amount of settlement that will occur post construction. Surcharging landfills is a common approach to developing roadways and was applied over the portions of Rossman Landfill located east of the 205 freeway.

The long-term settlement after surcharging can be approximated by consolidation theory. Published guidance indicates that the compression index (C'c) for mature solid waste ranges up to 0.22 and the mean secondary compression coefficient (Cα) for mature landfill waste is 0.05 strain/log time. Based on this value, we evaluated the time rate of settlement associated with ongoing collapse of the waste as well as the addition of the roadway section and roadway fill. We also evaluated the level of consolidation that would occur under surcharge loads of varying heights.

With a net four foot fill over the roadway (approximately) our analysis indicates that the MSW compression would approach four inches with a further four inches of settlement occurring over the next 20 years. In order to accelerate the long-term settlements, we propose placing a surcharge fill over the roadway above and beyond the net fill for the roadway. Based on published values, and attempting to limit long-term settlements to one inch, our analysis indicates that a 20-foot surcharge, left in place for approximately 90 days would reduce the long-term settlement to less than an inch.

6.0 Recommendations for Additional Services

We have prepared recommendations relative to the overall site work and development of this site. As specific building plans are developed, we recommend significant geotechnical involvement in the subsequent planning and design of those structures.

7.0 Closing

This report presented Apex's geotechnical engineering evaluation and recommendations for the proposed project. Subject to the recommendations provided within this report, construction of the proposed project is feasible from a geotechnical standpoint. We trust that this report meets your needs. If you have any questions, or if we can be of further assistance, please call. We look forward to working with you in the future.

Note: Base map prepared from USGS 7.5-minute quadrangle of Oregon City, OR, dated 2017 as provided by USGS.gov.

0 2,000 4,000

Approximate Scale in Feet

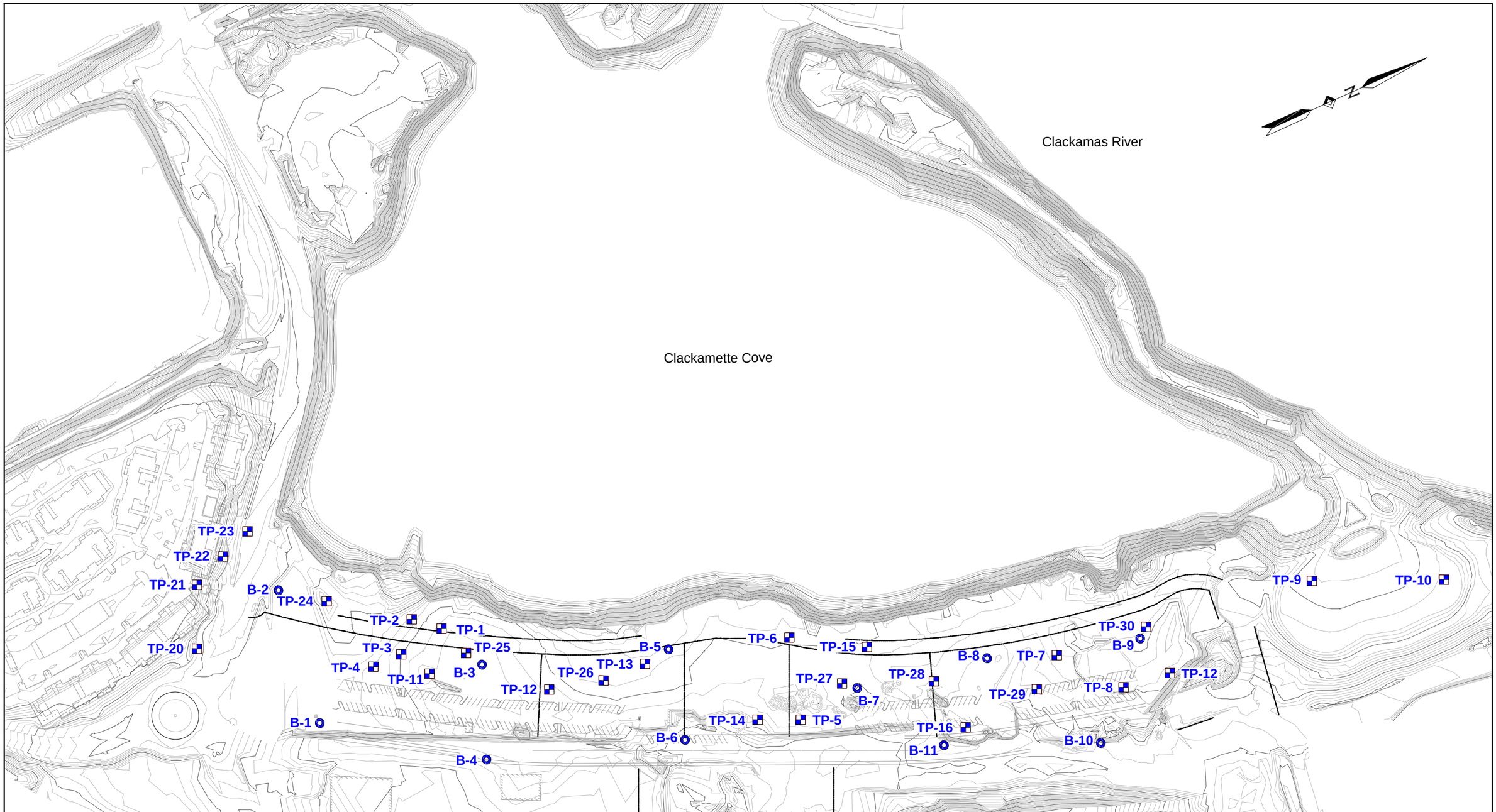
N

Site Location Map

Clackamette Cove
Proposed Cove Waterfront Development
Oregon City, Oregon

Apex Companies, LLC
3015 SW First Avenue
Portland, Oregon 97201

Project Number	2367-00	Figure
September 2017		1



Legend:

TP-1 Test Pit Location

B-1 Boring Location

NOTE: Base map prepared from X-site 2017-08-08 bound.dwg (2017).

Site Vicinity Plan

Clackamette Cove
Proposed Cove Waterfront Development
Oregon City, Oregon

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Project Number	2367-00	Figure
September 2017		2

Appendix A

Soil Boring Logs

Sample Descriptions

Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, and grain size, and should not be construed to imply field nor laboratory testing unless presented herein. Visual-manual classification methods of ASTM D 2488 were used as an identification guide.

Soil descriptions consist of the following:
MAJOR CONSTITUENT with additional remarks; color, moisture, minor constituents, density/consistency.

Density/Consistency

Soil density/consistency in borings is related primarily to the Standard Penetration Resistance. Soil density/consistency in test pits and Geoprobe® explorations is estimated based on visual observation and is presented parenthetically on test pit and Geoprobe® exploration logs.

SAND and GRAVEL Density	Standard Penetration Resistance in Blows/Foot
Very loose	0 - 4
Loose	4 - 10
Medium dense	10 - 30
Dense	30 - 50
Very dense	>50

SILT or CLAY Density	Standard Penetration Resistance in Blows/Foot
Very soft	0 - 2
Soft	2 - 4
Medium stiff	4 - 8
Stiff	8 - 15
Very Stiff	15 - 30
Hard	>30

Moisture

Dry	Little perceptible moisture.
Sl. Moist	Some perceptible moisture, probably below optimum.
Moist	Probably near optimum moisture content.
Wet	Much perceptible moisture, probably above optimum.

Minor Constituents

	Estimated Percentage
Not identified in description	0 - 5
Slightly (clayey, silty, etc.)	5 - 12
Clayey, silty, sandy, gravelly	12 - 30
Very (clayey, silty, etc.)	30 - 50

Sampling Symbols

BORING AND PUSH-PROBE SYMBOLS

- Split Spoon
- Sonic
- Tube (Shelby, Push-Probe)
- Cuttings
- Core Run
- * No Sample Recovery
- SSA Solid Stem Auger
- HSA Hollow Stem Auger
- MR Mud Rotary

TEST PIT SOIL SAMPLES

- Grab
- Bag
- Shelby Tube

Key to Exploration Logs

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Oregon City, Oregon

Apex Companies, LLC
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Portland, Oregon 97201

Project Number 2367-00

September 2017

Figure Key

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Clackamette Cove
Proposed Cove Waterfront Development
Oregon City, Oregon

Boring Number: **B-1**

Project Number: **2367-00**
Logged By: J. Munsey
Date: August 16-18, 2017
Site Conditions: --
Drilling Contractor: Darryl Metzger
Drilling Equipment: CME 75, 8.5" OD Auger
Sampler Type: --
Depth to Water (ATD): 24'
Surface Elevation: Not Measured

▲ Standard Penetration Resistance (Blows per Foot)

Depth, feet	Sample ID	Sample	Lithologic Description
			GRAVEL surface over GRAVEL FILL with silt and sand.
		☒	SILT (FILL); mottled medium brown/orangish brown, slightly moist, trace burnt organic material.
5		☒	SILT (native); medium brown, slightly moist.
		☒	SILT with fine sand; light brown, slightly moist, 85% silt, 15% sand, poorly graded, micaceous.
10		☒	
15		☒	Silty SAND; medium brown, slightly moist, 75% sand, 25% silt, poorly graded, micaceous
			GRAVEL; medium brown, moist, 90% weathered gravel 10% sand matrix.
20		☒	
25		☒	Becomes wet.
30		☒	Becomes dark gray.
			Bottom of Boring at 31.5' BGS.
			Groundwater estimated to be 24' at time of drilling. (Note: groundwater depth observed only at the time of drilling; with no substantive equilibration period)
35			

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Clackamette Cove
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Oregon City, Oregon

Boring Number: **B-2**

Project Number: **2367-00**
Logged By: J. Munsey
Date: August 16-18, 2017
Site Conditions: --
Drilling Contractor: Darryl Metzger
Drilling Equipment: CME 75, 8.5" OD Auger
Sampler Type: --
Depth to Water (ATD): 25'
Surface Elevation: Not Measured

▲ Standard Penetration Resistance
(Blows per Foot)

Depth, feet	Sample ID	Sample	Lithologic Description
			GRAVEL surface over GRAVEL FILL with concrete and asphalt debris.
5			
10			SILT (native); blueish gray, slightly moist, poorly graded, trace well-rounded gravels.
15			Becomes moist, trace organic material.
20			GRAVEL with sand; medium brown, moist, 85% gravel, 15% sand, subangular to well-rounded, fining upward, micaceous.
25			Becomes medium gray. Gravels become basalt-like in composition.
30			
35			Bottom of Boring at 31.5' BGS. Groundwater estimated to be 25' at time of drilling. (Note: groundwater depth observed only at the time of drilling; with no substantive equilibration period)

10 20 30 40

87/9"

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Clackamette Cove
Proposed Cove Waterfront Development
Oregon City, Oregon

Boring Number: **B-3**

Project Number: **2367-00**
Logged By: J. Munsey
Date: August 16-18, 2017
Site Conditions: --
Drilling Contractor: Darryl Metzger
Drilling Equipment: CME 75, 8.5" OD Auger
Sampler Type: --
Depth to Water (ATD): --
Surface Elevation: Not Measured

▲ Standard Penetration Resistance (Blows per Foot)

Depth, feet	Sample ID	Sample	Lithologic Description	10 20 30 40
			Straw erosion control surface over GRAVEL FILL with silt and sand.	
			SILT FILL with gravel; medium brown, slightly moist.	
		☒	1 Foot of concrete debris.	
5		☒		
		☒	GRAVEL FILL with fine to coarse sand; medium brown, slightly moist, well-rounded, well graded.	
10		☒		
15		☒	SILT (native); blueish gray, slightly moist, poorly graded.	
20		☒	GRAVEL with sand; medium brown, moist, well rounded gravels, micaceous, poorly graded, fining upward.	
25		☒	Gravels become basalt-like in composition.	83/10"
			Bottom of Boring at 26.33' BGS.	
30				
35				

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Clackamette Cove
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Boring Number: **B-4**

Project Number: **2367-00**
Logged By: J. Munsey
Date: August 16-18, 2017
Site Conditions: --
Drilling Contractor: Darryl Metzger
Drilling Equipment: CME 75, 8.5" OD Auger
Sampler Type: --
Depth to Water (ATD): --
Surface Elevation: Not Measured

Depth, feet | Sample ID | Sample

Lithologic Description

GRAVEL surface over gravel FILL with sand.

GRAVEL with sand FILL; medium brown, large gravels, some concrete debris.

SILT (native); blueish-gray, moist, non-plastic, 10% woody debris and organic material.

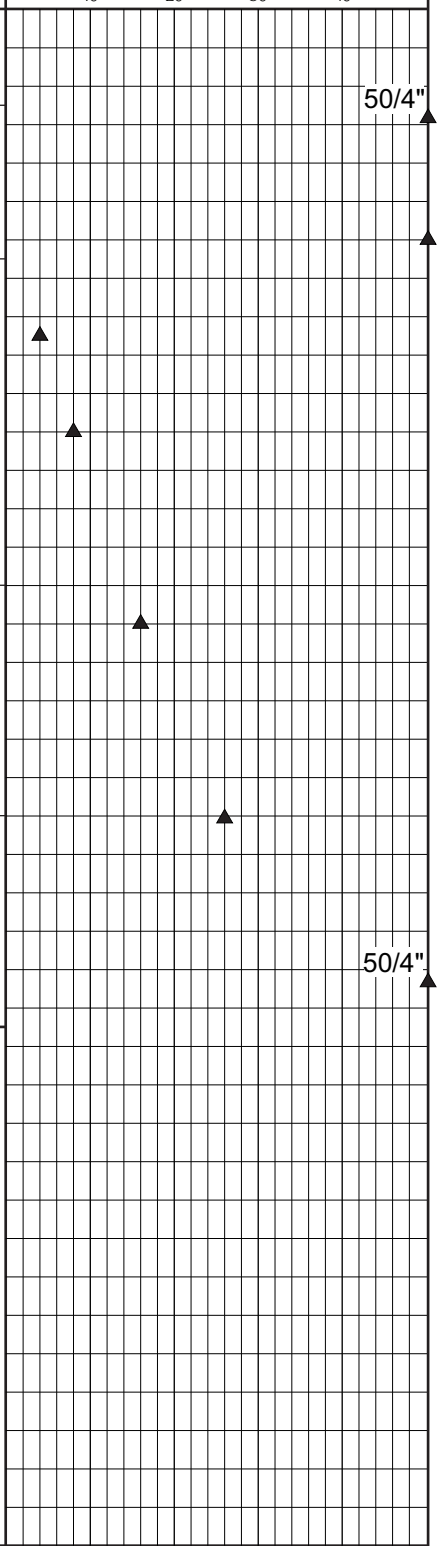
No organic material present.

Fine SAND, blueish-gray, poorly graded, fining upward.

GRAVEL; blueish-gray, moist, well-rounded, slight cementation.

Bottom of Boring at 26.5' BGS.

▲ Standard Penetration Resistance (Blows per Foot)



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Clackamette Cove
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Boring Number: **B-5**

Project Number: **2367-00**
Logged By: J. Munsey
Date: August 16-18, 2017
Site Conditions: --
Drilling Contractor: Darryl Metzger
Drilling Equipment: CME 75, 8.5" OD Auger
Sampler Type: --
Depth to Water (ATD): --
Surface Elevation: Not Measured

Lithologic Description

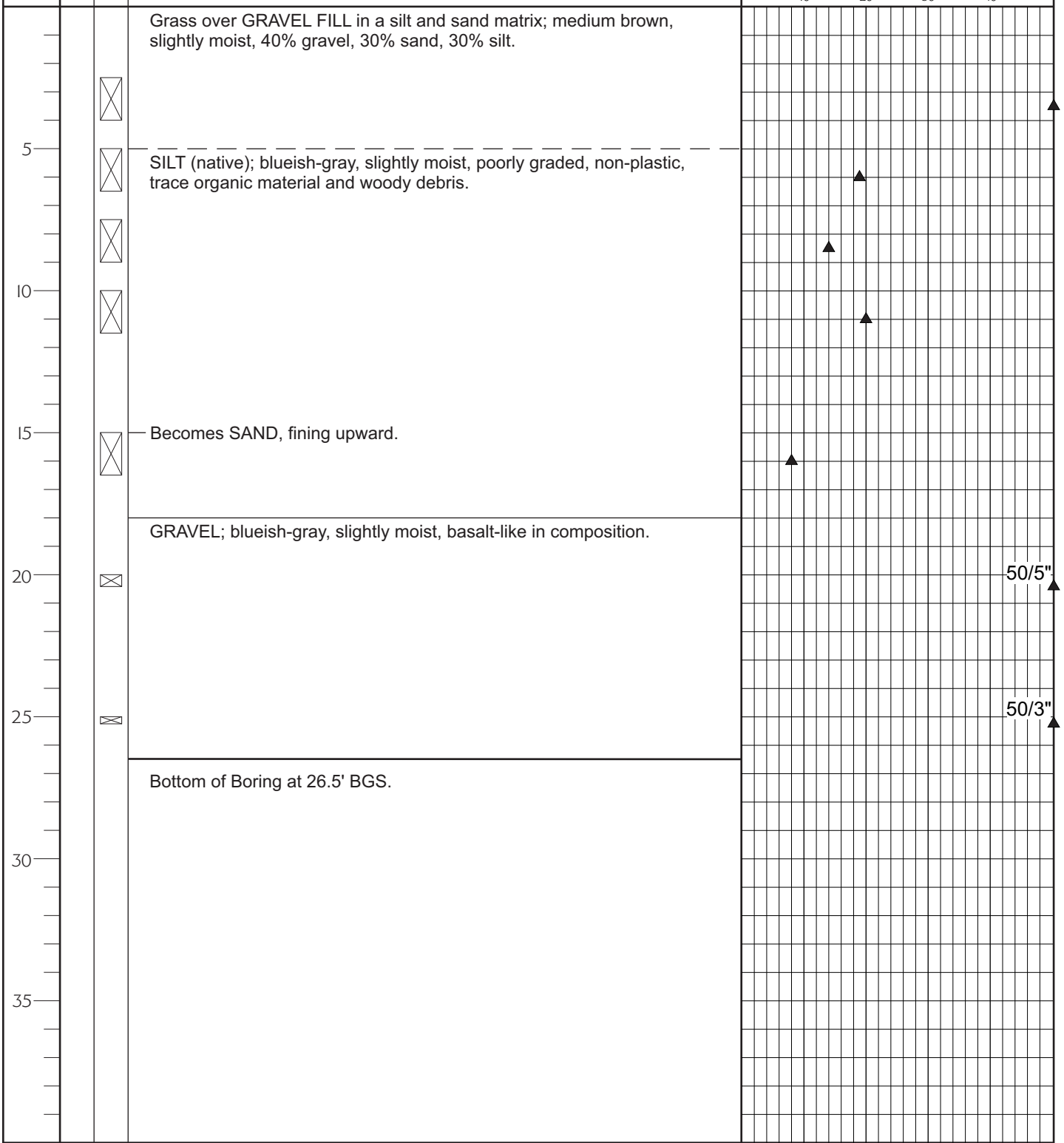
Grass over GRAVEL FILL in a silt and sand matrix; medium brown, slightly moist, 40% gravel, 30% sand, 30% silt.

SILT (native); blueish-gray, slightly moist, poorly graded, non-plastic, trace organic material and woody debris.

Becomes SAND, fining upward.

GRAVEL; blueish-gray, slightly moist, basalt-like in composition.

Bottom of Boring at 26.5' BGS.



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Clackamette Cove
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Boring Number: **B-6**

Project Number: **2367-00**
Logged By: J. Munsey
Date: August 16-18, 2017
Site Conditions: --
Drilling Contractor: Darryl Metzger
Drilling Equipment: CME 75, 8.5" OD Auger
Sampler Type: --
Depth to Water (ATD): --
Surface Elevation: Not Measured

Depth, feet | Sample ID | Sample | Lithologic Description | ▲ Standard Penetration Resistance (Blows per Foot) 10 20 30 40

Grass over GRAVEL FILL in a silt and sand matrix; medium brown, dry, matrix supported, trace woody debris and organic material.

5

SILT (native); mottled blueish-gray/dark brown, slightly moist, non-plastic, trace organic material.

SAND; blueish-gray, slightly moist, fine grained trace silt.

10

15

SILT; blueish-gray, slightly moist, poorly graded, non-plastic, micaceous, some thin sand lenses present.

20

25

Becomes moist.

30

Becomes SAND, fining upward.

GRAVEL; blueish-gray, moist, poorly graded, well-rounded, basalt in composition.

35

Bottom of Boring at 36.5' BGS.

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Clackamette Cove
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Boring Number: **B-7**

Project Number: **2367-00**
Logged By: J. Munsey
Date: August 16-18, 2017
Site Conditions: --
Drilling Contractor: Darryl Metzger
Drilling Equipment: CME 75, 8.5" OD Auger
Sampler Type: --
Depth to Water (ATD): --
Surface Elevation: Not Measured

Depth, feet | Sample ID | Sample

Lithologic Description

Grass and wood chip erosion control cover over GRAVEL and fine sand FILL; medium brown, slightly moist, well graded, frequent concrete and metal debris.

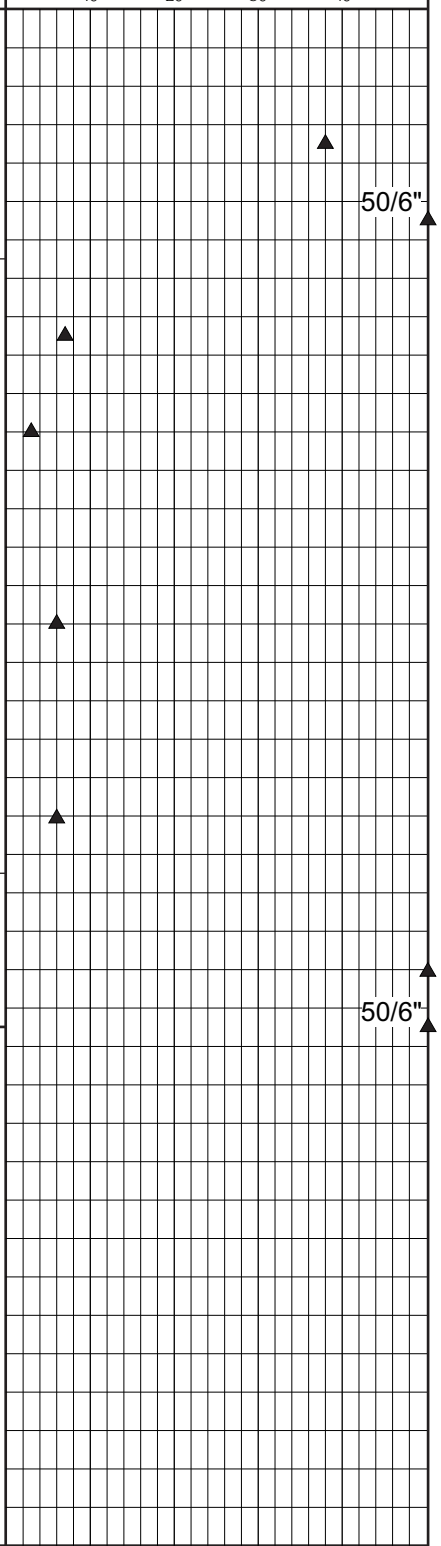
SILT (native); mottled medium brown/orangish-brown, slightly moist, non-plastic.

Becomes blueish-gray, micaceous, some thin sand lenses present.

GRAVEL in sand matrix; medium brown, slightly wet, poorly graded, well-rounded, 90% gravel 10% sand.

Bottom of Boring at 26.5' BGS.

▲ Standard Penetration Resistance
(Blows per Foot)



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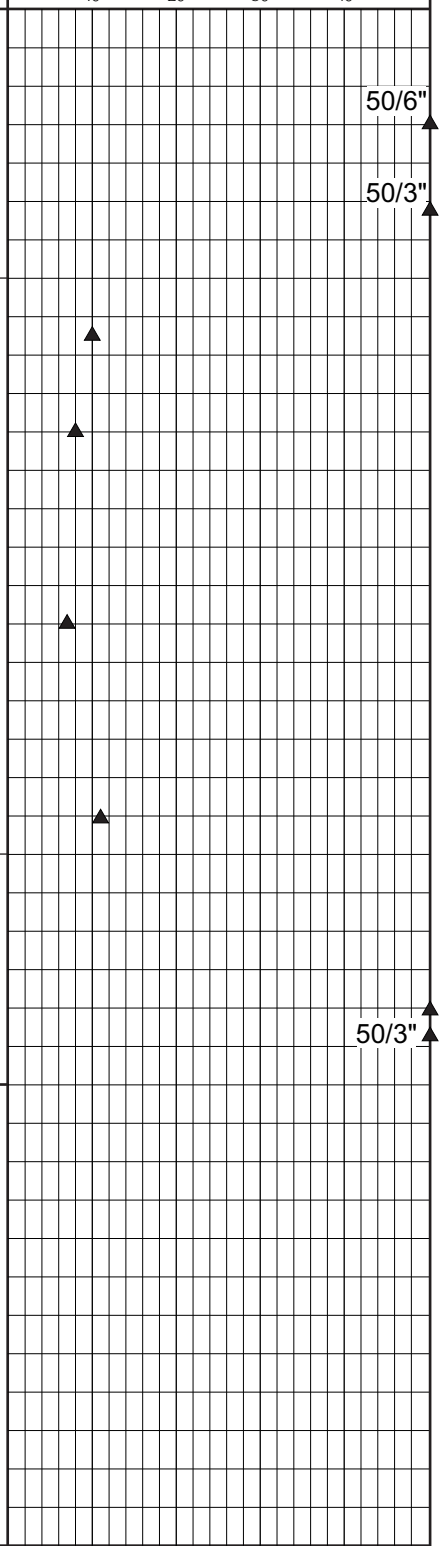
Clackamette Cove
Proposed Cove Waterfront Development
Oregon City, Oregon

Boring Number: **B-8**

Project Number: **2367-00**
Logged By: J. Munsey
Date: August 16-18, 2017
Site Conditions: --
Drilling Contractor: Darryl Metzger
Drilling Equipment: CME 75, 8.5" OD Auger
Sampler Type: --
Depth to Water (ATD): 28'
Surface Elevation: Not Measured

Depth, feet	Sample ID	Sample	Lithologic Description
			Grass over GRAVEL FILL with silt and sand; medium brown, slightly moist, 5% woody debris.
5			Becomes gray.
			SILT (native); blueish-gray, slightly moist, non-plastic, micaceous.
10			Some thin sand lenses present.
15			
20			Becomes fine sand.
			GRAVEL with sand; medium brown, moist, well graded, 85% gravel 15% sand, well-rounded.
25			Becomes wet.
			Bottom of Boring at 28.0' BGS.
30			Groundwater estimated to be 28' at time of drilling. (Note: groundwater depth observed only at the time of drilling; with no substantive equilibration period)
35			

▲ Standard Penetration Resistance (Blows per Foot)



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Clackamette Cove
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Boring Number: **B-9**

Project Number: **2367-00**
Logged By: J. Munsey
Date: August 16-18, 2017
Site Conditions: --
Drilling Contractor: Darryl Metzger
Drilling Equipment: CME 75, 8.5" OD Auger
Sampler Type: --
Depth to Water (ATD): --
Surface Elevation: Not Measured

Depth, feet	Sample ID	Sample	Lithologic Description
		⊠	GRAVEL FILL with silt and sand; medium brown, red and gray gravels, slightly moist, well graded, well-rounded, 60% gravel 20% silt 20% sand.
5		⊠	
		▨	SILT (native); blueish-gray, slightly moist, non-plastic, poorly graded, micaceous, trace organics.
10		▨	
15		▨	Becomes moist.
		⊠	GRAVEL with sand; blueish-gray, moist, poorly graded, 85%gravel, 15%sand matrix, well-rounded.
20			Bottom of Boring at 21.5' BGS.
25			
30			
35			

▲ Standard Penetration Resistance (Blows per Foot)

10 20 30 40

50/4"
50/6"
50/6"

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3015 SW First Avenue
Portland, Oregon 97201

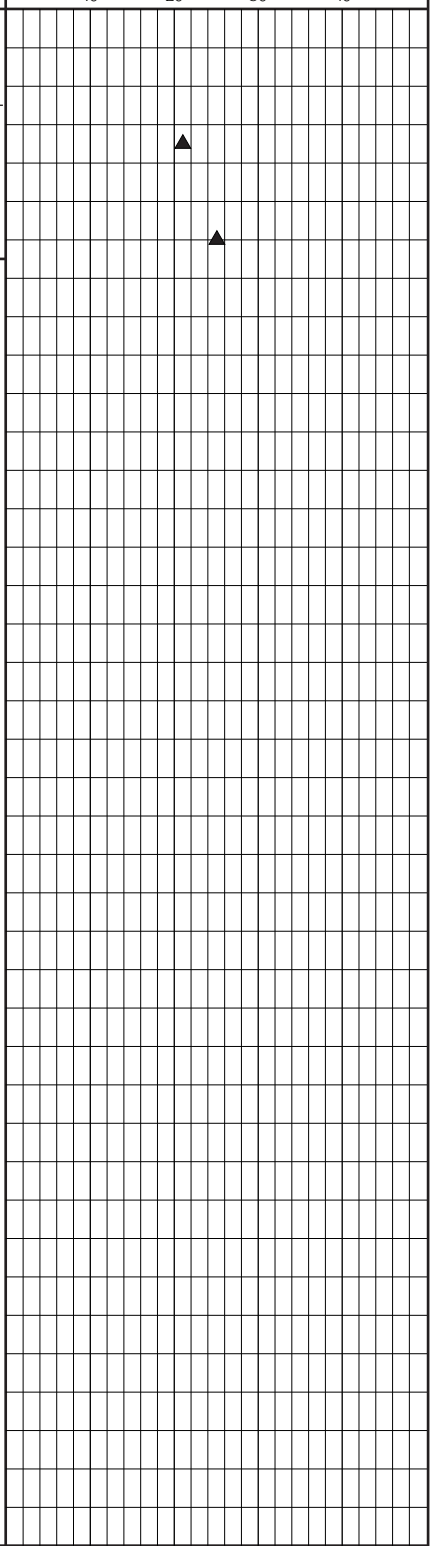
Clackamette Cove
Proposed Cove Waterfront Development
Oregon City, Oregon

Boring Number: **B-10**

Project Number: **2367-00**
Logged By: J. Munsey
Date: August 16-18, 2017
Site Conditions: --
Drilling Contractor: Darryl Metzger
Drilling Equipment: CME 75, 8.5" OD Auger
Sampler Type: --
Depth to Water (ATD): --
Surface Elevation: Not Measured

▲ Standard Penetration Resistance
(Blows per Foot)

Depth, feet	Sample ID	Sample	Lithologic Description
			GRAVEL road surface over GRAVEL and silt FILL; medium brown, slightly moist, well graded, 85% gravel, 15% silt matrix, well-rounded.
		☒	SILT with gravel FILL; dark brown, slightly moist, 75% silt, 25% gravel, trace sand.
5		☒	
			Bottom of Boring at 6.5' BGS.
10			
15			
20			
25			
30			
35			



Apex Companies, LLC
3015 SW First Avenue
Portland, Oregon 97201

Clackamette Cove
Proposed Cove Waterfront Development
Oregon City, Oregon

Boring Number: **B-11**

Project Number: **2367-00**
Logged By: J. Munsey
Date: August 16-18, 2017
Site Conditions: --
Drilling Contractor: Darryl Metzger
Drilling Equipment: CME 75, 8.5" OD Auger
Sampler Type: --
Depth to Water (ATD): --
Surface Elevation: Not Measured

▲ Standard Penetration Resistance
(Blows per Foot)

Depth, feet	Sample ID	Sample	Lithologic Description
			GRAVEL road surface over GRAVEL FILL; medium gray, dry, well-rounded, gravels basalt-like in composition.
		⊠	SAND with gravel FILL; blueish-gray, slightly moist, well-rounded gravels, well graded, 75% sand, 25% gravel.
5		⊠	
			Bottom of Boring at 6.5' BGS.
10			
15			
20			
25			
30			
35			

10 20 30 40

50/5.5"

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Environmental and Geotechnical Consultants

Clackamette Cove
Oregon City, Oregon

Project Number **1195-00**

Test Pit Number **TP-1**

Test Pit Location: See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Greg VanDeHey Soil Explorations	Date Completed: 6/6/06
Excavation Equipment: Case Track-Hoe	Logged By: J. Duquette

Depth, feet	Material Description
	4" to 6" silty TOPSOIL.
	(Medium stiff), dry, brown, gravelly SILT. (Fill)
	(Medium stiff to stiff), brown, ASPHALT DEBRIS and SILT.
5	(Medium stiff), dry, brown, COBBLES and SILT. (Fill)
10	Refusal on Concrete Slab/Concrete Debris at 9.0' BGS. No Seepage or Groundwater Noted.

Test Pit Number **TP-2**

Test Pit Location: See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Greg VanDeHey Soil Explorations	Date Completed: 6/6/06
Excavation Equipment: Case Track-Hoe	Logged By: J. Duquette

Depth, feet	Material Description
	4" to 6" TOPSOIL.
	(Stiff), dry, brown SILT, ASPHALT DEBRIS, and GRAVEL.
5	(Stiff), dry, brown, COBBLES and SILT with some tree branches and roots. (Fill)
10	Refusal on Concrete Slab/Concrete Debris at 9.0' BGS. No Seepage or Groundwater Noted.

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Oregon City, Oregon

Project Number **1195-00**

Test Pit Number **TP-3**

Test Pit Location See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Greg VanDeHey Soil Explorations	Date Completed: 6/6/06
Excavation Equipment Case Track-Hoe	Logged By: J. Duquette

Depth, feet	Material Description
	TOPSOIL.
	(Dense), dry, gray, crushed ROCK. (Fill)
	(Dense), dry, brown-gray SAND and COBBLES.
	Large chunk of concrete at 2.0'. Some asphalt debris.
	Refusal on Large Concrete Chunk Debris at 4.0' BGS.
5	No Seepage or Groundwater Noted.
10	

Test Pit Number **TP-4**

Test Pit Location: See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Greg VanDeHey Soil Explorations	Date Completed: 6/6/06
Excavation Equipment Case Track-Hoe	Logged By: J. Duquette

Depth, feet	Material Description
	TOPSOIL.
	(Dense), dry, brown-gray, SILT and COBBLES.
	(Medium dense), dry, blue-gray SILT and COBBLES. Trace organic debris with an organic odor.
5	(Medium stiff), dry, blue-gray SILT with a little gravel. Trace organic debris with an organic odor. (Fill)
	Intermittent sticks/branches from 8' to 13'.
10	
	Test Pit Terminated at 13.0' BGS in Blue-gray SILT. (Fill)
	No Seepage or Groundwater Noted.

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Oregon City, Oregon

Project Number **1195-00**

Test Pit Number **TP-5**

Test Pit Location: See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Greg VanDeHey Soil Explorations	Date Completed: 6/6/06
Excavation Equipment: Case Track-Hoe	Logged By: J. Duquette

Depth, feet	Material Description
	TOPSOIL.
	(Stiff), damp, brown, gravelly SILT. (Fill)
	Concrete slab.
	(Soft), red, moist to damp, silty CLAY with trace organics.
5	Scraps of steel chains.
	(Soft to medium stiff), damp, layers of red, silty CLAY and blue-gray SILT with occasional cobbles. (Fill)
	Hit 12" ribbed steel pipe.
10	Test Pit Terminated at 10.0' BGS.
	Light Seepage at 3.0' BGS.

Test Pit Number **TP-6**

Test Pit Location: See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Greg VanDeHey Soil Explorations	Date Completed: 6/6/06
Excavation Equipment: Case Track-Hoe	Logged By: J. Duquette

Depth, feet	Material Description
	TOPSOIL.
	(Medium stiff), dry, gray-brown SILT with some gravel.
	(Very dense), dry SILT and GRAVEL/COBBLES with trace organics.
	Very slow digging to 4.5'
5	Refusal at 4.5' BGS in (Very dense), silty GRAVEL and COBBLES.
	No Seepage or Groundwater Noted.
10	

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Clackamette Cove
Oregon City, Oregon

Project Number **1195-00**

Test Pit Number **TP-7**

Test Pit Location See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Greg VanDeHey Soil Explorations	Date Completed: 6/6/06
Excavation Equipment Case Track-Hoe	Logged By: J. Duquette

Depth, feet	Material Description
	TOPSOIL.
	(Very dense), dry, brown and gray, SAND and GRAVEL with a little silt.
5	(Dense), dry, gray, silty SAND. (Fill)
	(Very dense), dry, gray, silty SAND and GRAVEL.
	Trace wood and root fragments.
	Test Pit Terminated at 8.0' BGS.
	Slow, Hard Digging Over Full Depth of Test Pit.
10	No Seepage or Groundwater Noted.

Test Pit Number **TP-8**

Test Pit Location: See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Greg VanDeHey Soil Explorations	Date Completed: 6/6/06
Excavation Equipment Case Track-Hoe	Logged By: J. Duquette

Depth, feet	Material Description
	TOPSOIL.
	(Medium stiff), dry, gray-brown SILT with some gravel.
	(Very dense), dry to damp, gray, sandy GRAVEL and COBBLES.
5	
	(Medium stiff), dry, blue-gray SILT with an organic odor.
10	
	Test Pit Terminated at 13.5' BGS in (Soft to medium stiff), blue-gray SILT.
	Light Seepage at 5.0' BGS.

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Clackamette Cove
Oregon City, Oregon

Project Number **1195-00**

Test Pit Number **TP-9**

Test Pit Location See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Greg VanDeHey Soil Explorations	Date Completed: 6/6/06
Excavation Equipment Case Track-Hoe	Logged By: J. Duquette

Depth, feet	Material Description
	TOPSOIL.
	(Soft), damp, red wood debris and SILT. (Fill)
	(Soft), damp, red-brown, organics and clayey SILT to silty CLAY with some wood debris.
5	
	Log or wood debris.
	(Dense), dry, pink SANDSTONE. (Fill)
	(Soft to very soft), damp, blue-gray SILT with large amounts of organic branches, roots, and wood debris. (Fill)
10	
	Test Pit Terminated at 13.5' BGS. No Seepage or Groundwater Noted.

Test Pit Number **TP-10**

Test Pit Location: See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Greg VanDeHey Soil Explorations	Date Completed: 6/6/06
Excavation Equipment Case Track-Hoe	Logged By: J. Duquette

Depth, feet	Material Description
	TOPSOIL.
	(Soft), damp, red-brown, wood debris and SILT.
	(Dense), dry, light-gray GRAVEL.
	(Soft), damp to moist, red-brown, clayey SILT to silty CLAY with trace to a little GRAVEL or ROCK fragments.
5	
	(Soft), damp to moist, blue-gray SILT with organic material.
10	
	(Soft), moist, tan CLAY.
	Test Pit Terminated at 14.0' BGS in (Soft to Medium stiff), Blue-gray SILT. Light Seepage at 12.0' BGS.

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Project Number **1195-00**

Test Pit Number **TP-11**

Test Pit Location: See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Robinson Construction Co.	Date Completed: 1/7/07
Excavation Equipment: CAT 330 Track Hoe	Logged By: S. Albright

Depth, feet	Material Description
	(Very dense), moist, gray, sandy GRAVEL FILL (Crushed Rock).
5	(Medium dense to dense), moist to wet, gray, silty SAND with gravel.
10	Bottom of Test Pit at 10.5' BGS. No Seepage or Groundwater Noted.

Test Pit Number **TP-12**

Test Pit Location: See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Robinson Construction Co.	Date Completed: 1/7/07
Excavation Equipment: CAT 330 Track Hoe	Logged By: S. Albright

Depth, feet	Material Description
	(Very dense), moist, gray, sandy GRAVEL FILL (Crushed Rock).
	Very heavy seepage from 3.0' to 4.0'.
5	(Soft to medium stiff), moist to wet, brown and gray, clayey SILT FILL.
10	(Medium stiff to stiff), moist to wet, tan to brown SILT with some clay. Light seepage at 8.0'.
	Bottom of Test Pit at 12.0' BGS. No Groundwater Noted.

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Oregon City, Oregon

Project Number **1195-00**

Test Pit Number **TP-13**

Test Pit Location: See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Robinson Construction Co.	Date Completed: 1/7/07
Excavation Equipment: CAT 330 Track Hoe	Logged By: S. Albright

Depth, feet	Material Description
	(Very dense), moist, gray, sandy GRAVEL FILL (Crushed Rock).
5	(Medium stiff), moist, gray, sandy SILT with gravel. Mild organic odor.
10	Bottom of Test Pit at 11.0' BGS. No Seepage or Groundwater Noted.

Test Pit Number **TP-14**

Test Pit Location: See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Robinson Construction Co.	Date Completed: 1/7/07
Excavation Equipment: CAT 330 Track Hoe	Logged By: S. Albright

Depth, feet	Material Description
	(Soft), moist to wet, brown to red, clayey SILT FILL with cobbles, gravel and concrete.
5	(Hard), gray GRAVEL and SAND FILL (Cemented). Potentially a concrete truck washout area.
10	Bottom of Test Pit at 13.0' BGS. No Seepage or Groundwater Noted.

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Oregon City, Oregon

Project Number **1195-00**

Test Pit Number **TP-15**

Test Pit Location: See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Robinson Construction Co.	Date Completed: 1/7/07
Excavation Equipment: CAT 330 Track Hoe	Logged By: S. Albright

Depth, feet	Material Description
	(Soft), moist to wet, silty CLAY FILL.
5	
10	
	Bottom of Test Pit at 14.5' BGS. No Seepage or Groundwater Noted.

Test Pit Number **TP-16**

Test Pit Location: See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Robinson Construction Co.	Date Completed: 1/7/07
Excavation Equipment: CAT 330 Track Hoe	Logged By: S. Albright

Depth, feet	Material Description
	(Very dense), moist, gray, sandy GRAVEL FILL (Crushed Rock).
5	(Medium stiff), moist, gray, sandy SILT.
10	Bottom of Test Pit at 10.0' BGS. No Seepage or Groundwater Noted.

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Oregon City, Oregon

Project Number **1195-00**

Test Pit Number **TP-17**

Test Pit Location: See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Robinson Construction Co.	Date Completed: 1/7/07
Excavation Equipment: CAT 330 Track Hoe	Logged By: S. Albright

Depth, feet	Material Description
5	Debris FILL. Logs, boulders, cables, chain, concrete, asphalt and random garbage in a sandy silt matrix.
10	Bottom of Test Pit at 14.0' BGS. No Seepage or Groundwater Noted.

Test Pit Number **TP-18**

Test Pit Location: See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Robinson Construction Co.	Date Completed: 1/7/07
Excavation Equipment: CAT 330 Track Hoe	Logged By: S. Albright

Depth, feet	Material Description
5	Moist to wet, dark gray to black, silty SAND FILL. Some asphalt concrete chunks. Mild organic odor.
10	Bottom of Test Pit at 14.0' BGS. No Seepage or Groundwater Noted.

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Project Number **1195-00**

Test Pit Number **TP-19**

Test Pit Location: See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Robinson Construction Co.	Date Completed: 1/7/07
Excavation Equipment: CAT 330 Track Hoe	Logged By: S. Albright

Depth, feet	Material Description
	Moist to wet, dark gray to black, silty sand FILL. Some asphalt concrete chunks. Mild organic odor.
5	
10	
	(Medium dense to dense), moist to wet, gray, silty SAND with gravels and cobbles.
	Bottom of Test Pit at 14.5' BGS. No Seepage or Groundwater Noted.

Test Pit Number **TP-20**

Test Pit Location: See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Erickson Excavating	Date Completed: 11/6/07
Excavation Equipment: Link Belt LS 2650	Logged By: J. Duquette

Depth, feet	Material Description
	(Very dense), dry, silty gravel FILL. Hard digging.
5	
	Increasing sand content.
	Becomes (very hard).
	Test Pit Refusal at 8.5' BGS. No Seepage or Groundwater Noted.
10	

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Project Number **1195-00**

Test Pit Number **TP-21**

Test Pit Location: See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Erickson Excavating	Date Completed: 11/6/07
Excavation Equipment: Link Belt LS 2650	Logged By: J. Duquette

Depth, feet	Material Description
	(Dense), dry, gray, sandy gravel FILL.
	(Medium dense), gray, sand FILL.
5	(Soft), moist, gray, silty CLAY to clayey SILT. Large chunk of concrete in east pit wall.
	Grab sample taken.
10	Light seepage from 10.0' to 11.0'.
	Bottom of Test Pit at 14.5' BGS. No Groundwater Noted.

Test Pit Number **TP-22**

Test Pit Location: See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Erickson Excavating	Date Completed: 11/6/07
Excavation Equipment: Link Belt LS 2650	Logged By: J. Duquette

Depth, feet	Material Description
	Silty, sandy TOPSOIL.
	(Medium dense to dense), brown/gray, dry, sand and gravel FILL with a little silt.
	Chunk of rebar.
	Very hard drilling.
5	Test Pit Refusal at 3.5' BGS. No Seepage or Groundwater Noted.
10	

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Clackamette Cove
Oregon City, Oregon

Project Number **1195-00**

Test Pit Number **TP-23**

Test Pit Location See Figure 2	Surface Elevation: Not Measured
Excavation Contractor: Erickson Excavating	Date Completed: 11/6/07
Excavation Equipment Link Belt LS 2650	Logged By: J. Duquette

Depth, feet

Material Description

TOPSOIL.

(Medium dense), gray/brown, dry, sand and gravel FILL with some silt.

Test Pit Refusal on Concrete at 3.5' BGS. No Seepage or Groundwater Noted.

5

10