Geotechnical Engineering Services

Lambert Property Detention Pond
Stayton, Oregon

for
City of Stayton

November 16, 2017

GeoEngineers
Earth Science + Technology

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Stayton, Oregon

File No. 11615-002-00

November 16, 2017

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INTRODUCTION

This report presents the results of our geotechnical engineering services for the proposed Lambert Detention Pond project in Stayton, Oregon. The site is shown relative to surrounding physical features on the Vicinity Map, Figure 1, and the Site Plan, Figure 2.

The purpose of this study is to evaluate subsurface conditions and provide geotechnical recommendations in support of the construction of the new stormwater detention pond.

Our geotechnical engineering services were completed in general accordance with the proposal dated October 17, 2017. The conclusions and recommendations provided in this report are conversations with Lance Ludwick with the City of Stayton (City) and information provided to us by Peter Olsen with Keller Associates (Keller).

Our scope of work includes:

- reviewing background data including geologic maps, topographical maps, and geotechnical engineering studies in the site vicinity, as available and appropriate;
- completing site reconnaissance and explorations to characterize subsurface conditions for project components;
- completing laboratory testing on selected soil samples obtained from the explorations;
- evaluating pertinent physical and engineering characteristics of the soils based on the results of the field explorations, laboratory testing and our experience, and completing appropriate geotechnical analyses; and
- preparing this report presenting our design conclusions and recommendations together with detailed boring logs, site plans and other supporting information for review.

Project Description

Our understanding of the project is based on discussions with the City and Keller, and our experience with similar projects. We understand that the project consists of construction of a new detention pond in an existing grassy field located just east of SE Kindle Way and approximately 1,000 feet north of SE Shaff Road in Stayton, Oregon. Current site grades range from about Elevation 435 feet to 438 feet over most of the project site. The proposed detention pond bottom will be at about Elevation 431 feet, requiring a cut on the order of 4 to 7 feet, with high pond storage at Elevation 435 feet based on elevations of the outlet weir located on the north end of the pond.

FIELD EXPLORATIONS AND LABORATORY TESTING

Field Explorations

Subsurface soil and groundwater conditions at the site were evaluated by excavating 11 test pits to depths ranging between 7 to 9 feet. The approximate locations of the explorations completed for this project are presented on Figure 2. Details of the field exploration program and logs of the explorations are presented in Appendix A.

Laboratory Testing

Soil samples were collected from the test pit sidewalls or excavation spoil and taken to GeoEngineers' laboratory for further evaluation. Selected samples were tested for the determination of moisture content, fines content, and grain size distribution (sieve and hydrometer analysis). A description of the laboratory testing and the test results are presented in Appendix B.

SITE CONDITIONS

Site Geology

The site is mapped as underlain by "Older Alluvium (Holocene and Pleistocene)" by the Geologic Map of the Salem 1° by 2° Quadrangle, Western Oregon (Walker and Duncan, 1989). The project site lies within the Willamette Valley geophysical province on an elevated terrace the extends between the North Santiam and Willamette River valleys. The Willamette Valley is a broad north-south structural basin that has been filled by repeated glacial outburst ("Missoula") floods during the late Pleistocene. The flood deposits, described as "poorly consolidated clay, silt, sand and gravel" (Walker and Duncan, 1989) are typically mantled by a veneer of Holocene alluvium.

Our field investigation suggests that the site geology largely conforms to the published mapping, although the shallow subsurface conditions are dominated by relatively coarse sand and gravel with minor silt and clay.

Surface Conditions

The proposed Lambert stormwater detention pond site is an undeveloped grassy field located northeast of the intersection of SE Kindle Way and SE Schaff Road. The site is bounded to the south by SE Schaff Road, to the west by SE Kindle Way and, to the north and east by private lots. The ground surface is level to gently undulatory and ranges from about Elevation 435 to 438 feet above mean sea level.

Subsurface Conditions

Subsurface conditions in the project area were evaluated by completing eleven test pits at the site on October 25, 2017. The logs of the test pits are presented in Appendix A. The soil and groundwater conditions encountered at the site are summarized below.

The site is mantled by a layer of organic-rich topsoil consisting of silty fine to medium sand typically containing some rounded gravel and occasional rounded to subrounded cobbles. Fine grass roots and organic matter were observed to approximately 12 inches below ground surface (bgs) and trace to some organics to as much as 2 to 2½ feet bgs.

Below this topsoil layer we encountered a mixture of dense (occasionally medium dense to very dense) silty gravel, poorly graded gravel with silt and sand, and poorly graded gravel with sand alluvium to the maximum depths explored. This alluvium typically contained occasional to some cobbles up to 10 inches maximum dimension and trace boulders up to 14 inches. We observed slight to moderate caving of the test pit sidewalls in the cleaner gravel deposits below 3 to 4 feet bgs. We observed severe caving below 7 feet bgs in TP-3, -4, -6 and -7.

Groundwater

Rapid groundwater seepage was encountered at approximately 6½ feet bgs in TP-10. No groundwater was encountered to depths ranging between 7 and 9 feet bgs in the remaining test pits, including TP-1, which was allowed to stand open to a depth of 8 feet bgs for 4 hours without any groundwater accumulation.

Our field investigation suggests that, although locally perched water-bearing zones may be encountered at any time of the year, the regional groundwater level is typically below the maximum depths explored during the late summer and early autumn period. Groundwater conditions at the site will vary based on precipitation and the base level of Mill Creek; however, perched groundwater is more likely to be encountered above 9 feet bgs during the wettest winter and spring months of the year.

CONCLUSIONS AND RECOMMENDATIONS

Stormwater Detention Pond

General

Recommendations in this section apply to construction of the detention pond. Much of the proposed detention pond will be cut below existing ground surface, with a portion of the berm along the northeast corner to be constructed above existing ground surface.

Based on gradation data, infiltration rates of native soils are relatively high. The soils are well suited to be compacted as structural fill in order to build on-site berms, but even in a well-compacted state will be fairly permeable based on the sand and gravel content encountered in our explorations. In order to control seepage through the berm, some form of pond lining or construction of the berm with imported less-permeable soil will be required if proposed pond elevations are above surrounding ground elevations. These items are further discussed in the following sections.

Infiltration Considerations

We evaluated the permeability of the native soil encountered in our explorations based on empirical correlations applied to laboratory particle-size gradation data. Using laboratory gradation data, representative particle-size distributions were correlated to hydraulic conductivity using the relationship developed by Massmann (2003; and Massmann et al., 2003). Based on the laboratory test results of four representative samples within the proposed underlying alluvium layer, the saturated hydraulic conductivity of the soil portion passing the 3-inch sieve is between 0.006 and 0.1 centimeters per second (cm/s). This is a rate greater than 50 inches per hour (in/hr).

We wish to emphasize that hydraulic conductivity is not equal to infiltration rate. Hydraulic conductivity is a measure of the rate of water flow through saturated soil, whereas infiltration rate is the measure of rate of water flow through the unsaturated zone. Infiltration rates can be on the order of three times lower than hydraulic conductivity. Accordingly, to use equations provided by Massmann to derive an allowable infiltration rate it is important to know where the high groundwater table is at the site. Multiple jurisdictional standards in the Northwest reference formulas developed by Massmann to determine the infiltration rate from the estimated hydraulic conductivity and hydraulic gradient. However, Massmann and Butchart (2000) compared infiltration measurements from infiltration facilities to soil gradation data using the ASTM D422 procedure and came up with estimated long-term (design) infiltration rates provided in Oregon Department

of Transportation Hydraulic Manual (2014) as shown in Table 1 below. These rates are based on D_{10} size from ASTM D422 Soil Gradation Test.

Four gradation tests were performed with D_{10} ranging from 0.02 to 0.48-mm on soil samples recovered at the site to establish the rates described above.

TABLE 1. INFILTRATION RATES BASED ON ASTM GRADATION TESTING (MASSMANN AND BUTCHART, 2000)

D_{10} Size from ASTM D422 Soil Gradation Test (mm)	Estimated Long-Term (Design) Infiltration Rate (in/hr)
≥0.4	9
0.3	6.5
0.2	3.5
0.1	2.0
0.05	0.8

It is important to note, that if the groundwater table is close to the bottom of pond elevation, then infiltration will be very limited or create a condition of inflow of water into the proposed pond area.

Fill Berms and Permanent Slopes

We understand that a fill berm will be required along the northeast side of the detention pond. In 2010 the City of Stayton adapted the City of Portland's Stormwater Management Manual (SWMM) for the City's stormwater design standard which stated that for dry pond's the berm material should be constructed with Natural Resources Conservation Service (NRCS) hydrologic soil group B, C and D soils. These soil groups allow for the use of a soil with a saturated hydraulic conductivity up to 5.7 in/hr. Based on gradation testing and the correlations discussed above, native soils at the site exceed that allowable rate. The soils are well-suited to be used as structural fill to build proposed berms, but would likely be subject to excessive seepage through the berms when water levels in the pond are higher than surrounding elevations.

Common on-site borrow consisting of granular or nongranular soil and or aggregate which is free of deleterious material and containing 12 to 35 percent fines will be suitable for use as structural fill for embankment construction during dry weather conditions only. If structural fill is placed during wet weather, the structural fill can consist of imported gravel borrow, meeting the grading requirements shown in Table 2 below, provided that the pond is lined with a geomembrane liner. The fill should be compacted as outlined in the "Earthwork" section below. The berm slopes should be constructed as described below.

TABLE 2. GRAVEL BORROW GRADING REQUIREMENTS

Sieve Size	Percent Passing[1]
4-inch	99 to 100
2-inch	75 to 100
No. 4	50 to 80
No. 40	30 maximum
No. 200	7 maximum
Sand Equivalent	50 minimum

Note:

[1] All percentages are by weight.

In accordance with the City's SWMM all ponds shall have an emergency overflow spillway or structure to convey the 100-year, 24-hour design storm. The subgrade of this spillway shall be set at or above the 100-year flood elevation, which based on information provided by Keller Associates Pond Sections Sheet No. C-407 dated October 19, 2017, that elevation is approximately 434.4 feet. Generally, across the site the 100-year flood elevation is well below the top of cut and/or fill berm; however, along the north edge of berm, the 100-year flood event comes close to the fill berm. To prevent erosion of the embankment berm, we recommend placing quarry spalls below the 100-year flood elevation along the outboard side of the embankment berm.

We recommend that permanent cut and fill slopes on the outboard side of the pond be constructed no steeper than 2H:1V (horizontal to vertical). Cut and fill slopes within the detention ponds should be no steeper than 3H:1V. For the portion of the berm to be constructed above existing grade, to achieve uniform compaction we recommend that fill slopes be overbuilt slightly (1 to 2 feet laterally of the final slope) and subsequently cut back to expose properly compacted fill. In addition, we recommend that the finished slope faces be compacted by track walking with the equipment running perpendicular to the slope contours so that the track grouser marks help provide an erosion resistant slope texture. Pond berm embankments shall be constructed on alluvium soils, free of loose surface soil materials, roots, and other organic debris and shall be constructed by excavating a key equal to 50 percent of the berm embankment cross-sectional height and width, measured through the center of the berm, per Portland SWMM recommendations.

To reduce potential erosion and to help establish permanent vegetation on the inboard and outboard slopes, we recommend that erosion protection of the slopes include hydroseeding. Hydroseeding should occur as soon as possible and prior to the wet winter months to allow proper germination before the winter. If the native granular soils are used for the cover soil, we also recommend that the hydroseed mix include a tackifier to increase adhesion to the hydroseed mixture.

Seepage Control Recommendations

In areas where freeboard heights require detention berms above surrounding ground elevations, the relatively high anticipated permeability of on-site alluvial sands and gravels encountered in our explorations will not adequately retain water in the pond. Berms constructed with on-site soils will be subject to relatively high levels of seepage.

If on-site sandy and gravelly soils are used to construct the portion of the embankment that extends above existing grade, we recommend the pond be lined with 30 to 40-mil polyvinyl chloride (PVC) or high-density polyethylene (HDPE) geomembrane liner system, per Portland SWMM. Alternatively, it may be possible to control potential seepage through the berm by implementing seepage control amendment products into the alluvial soils by blending (tilling) in or spraying on commercially available products specific to pond sealing applications that may be available through local earthwork contractors. Seepage control product evaluation should be provided and designed by potential suppliers.

Seepage may also be controlled by providing a bentonite clay pond liner along the inside of the pond berms in order to seal the outward flow of water. Berms may also be constructed of imported fine-grained clay soils that are less permeable and conform to the NRCS hydrologic groups that have sufficiently limited hydraulic conductivity. There are several areas of clayey exposures near Stayton that may be able to provide clayey imported fill material.

If a liner option is selected, prior to liner placement, the subgrade surface should be prepared in accordance with the manufacturer's recommendations. Prior to placing the PVC liner, we recommend an 8- to 12-ounce nonwoven cushion geotextile be placed between the liner and subgrade. We also recommend that a cushion geotextile be placed directly over the liner, especially on the pond bottom. Again, an 8- to 12-ounce cushion can be used. The cushion geotextile layers should meet the requirements of non-woven geotextile for soil separation with a minimum grab tensile strength (ASTM D 4632) of 160 pounds, such as Mirafi 160N or equivalent. We recommend that the cover topsoil on the liner slopes be a minimum of 8 inches or as thick as required for the planned vegetation.

We recommend that the pond liner have fully bonded seams to help prevent leakage. Seams can be bonded with solvent glues (PVC) or with heat fusion (linear low-density polyethylene [LLDPE]). We also recommend that the liner be completed within an anchor trench at the top of the pond berm. The trench should be at least 2 feet wide and 2 feet deep, and the liner should extend down the inboard trench wall and across the trench bottom.

Groundwater Considerations

Groundwater was measured in test pit TP-10 approximately 6½ feet below existing ground surface and groundwater was not encountered in any of the other test pits as noted previously. Groundwater is known to fluctuate with season and Mill Creek flow stages. It is our understanding that the City has acquired long-term groundwater elevation levels recorded by others. Groundwater data readings had not been provided to us at the time this report was prepared.

The detention pond deepest bottom of elevation is planned at Elevation 431 feet with the base of excavation as deep as Elevation 429 feet for installation of the 10-inch perforated PVC pipe. Because the native soils at the project consist mostly of sand and gravel, we recommend that all excavations extending below groundwater depth be fully dewatered. Otherwise, excessive groundwater flow into excavations could cause lateral movement of the granular soils into the excavations, possibly destabilizing the excavations or causing excessive ground settlement adjacent to the excavations.

Provided that construction is completed during the dry season, temporary dewatering for the detention pond excavation may consist of sumps and pumps to address isolated perched water zones, but a more

robust temporary dewatering program is not anticipated to be required based on groundwater conditions encountered during the exploration phase of the investigation.

Pond design should also consider high groundwater scenarios. Ballast to resist hydrostatic uplift pressures should be incorporated into the design if a pond liner is used for portions of the pond extending below the design groundwater elevation.

Earthwork

General

The earthwork recommendations in this section apply to the proposed detention pond.

We anticipate that the soils observed in the explorations can be excavated with conventional grading equipment, such as track excavators or dozers. Cobbles and boulders are frequently encountered in alluvial soils, and the contractor should be prepared to excavate and handle material with large cobbles and boulders.

Clearing and Grubbing

The existing ground surface along the project alignment is typically vegetated as discussed in the "Surface Conditions" section of this report.

Areas where the pond embankment will be built above existing site grades should be cleared and grubbed. Based on our observations at the site, we estimate that the depth of stripping should generally be on the order of about 3 to 6 inches. Upper soils that remain in place may be within the upper zone of soil regularly disturbed or tilled during agricultural use and will require compaction after stripping and grubbing and prior to placement of additional fill. Greater stripping depths may be required to remove localized zones of loose or organic soil, and in areas where moderate to heavy vegetation may be present, or where surface disturbance has occurred.

Erosion and Sedimentation Control

Potential sources or causes of erosion and sedimentation depend upon construction methods, slope length and gradient, amount of soil exposed and/or disturbed, soil type, construction sequencing and weather. The project's impact on erosion-prone areas can be reduced by implementing an erosion and sedimentation control plan. The plan should be designed in accordance with applicable City and/or county standards. The plan should incorporate basic planning principles including:

- scheduling grading and construction to reduce soil exposure;
- retaining existing vegetation whenever feasible;
- revegetating or mulching denuded areas;
- directing runoff away from denuded areas;
- minimizing the length and steepness of slopes with exposed soils;
- decreasing runoff velocities;
- confining sediment to the project site;

- inspecting and maintaining control measures frequently;
- covering soil stockpiles; and
- implementing proper erosion control best management practices (BMPs).

Temporary erosion protection should be used and maintained in areas with exposed or disturbed soils to help reduce the potential for erosion and reduce transport of sediment to adjacent areas. Temporary erosion protection should include the construction of a silt fence around the perimeter of the work area prior to the commencement of grading activities. Permanent erosion protection should be provided by reestablishing vegetation using hydroseeding and/or landscape planting.

Until the permanent erosion protection is established, and the site is stabilized, site monitoring should be performed by qualified personnel to evaluate the effectiveness of the erosion control measures and repair and/or modify them as appropriate. Provisions for modifications to the erosion control system based on monitoring observations should be included in the erosion and sedimentation control plan.

Subgrade Preparation

Prior to the placement of new embankment fill, we recommend that the subgrade be compacted to a firm, nonyielding condition. If soft or pumping soils are observed, such unsuitable subgrade soils should be recompacted or overexcavated and replaced with properly compacted structural fill. The depth of overexcavation should be determined by the Geotechnical Engineer.

Structural Fill

General

Materials used to construct embankments and backfill utility trenches, vaults or other structures are classified as structural fill for the purpose of this report and should generally meet the criteria for structural fill presented below. All structural fill soils should be free of debris, clay balls, roots, organic matter, frozen soil, man-made contaminants, particles with greatest dimension exceeding 4 inches, and other deleterious materials. The suitability of soil for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines in the soil matrix increases, the soil becomes increasingly more sensitive to small changes in moisture content and achieving the required degree of compaction becomes more difficult or impossible. Recommendations for suitable fill material are provided in the following sections.

On-Site Soils

The native alluvium gravel deposits are anticipated to be suitable for re-use as structural fill, provided they can be properly compacted. The on-site soils might require moisture-conditioning in order to meet the required compaction criteria.

Fill Placement and Compaction Criteria

Structural fill should be mechanically compacted to a firm, non-yielding condition. Structural fill should be placed in loose lifts not exceeding 6 inches in thickness and compacted at moisture contents that are within 3 percent of the optimum moisture content as determined by ASTM Standard Practices Test Method D 1557 (Modified Proctor). The optimum moisture content varies with gradation and should be evaluated during construction. Each lift should be conditioned to the proper moisture content and compacted to the specified density before placing subsequent lifts. Structural fill should be compacted to the following criteria:

1. Structural fill in utility trench backfill, including new pavement and roadway areas, should be compacted to at least 95 percent maximum dry density (MDD) (ASTM D 1557).
2. Structural fill for pipe bedding and in the pipe zone should consist of well-graded granular material with a maximum particle size of ¾-inch and less than 5 percent passing the U.S. No. 200 sieve. The material should be free of organic matter and other deleterious materials. Further, the backfill should meet the pipe manufacturer's recommendations and be compacted to at least 90 percent MDD (ASTM D 1557). Above the pipe zone backfill, structural fill may be used as described above.
3. Structural fill placed below embankment and as part of the above grade embankment berm should be compacted to at least 95 percent MDD (ASTM D 1557).

We recommend that monitoring of the placement of backfill be provided to observe that the required compaction criteria are being met, the proper materials are used for structural backfill and that the contractor is placing the material in appropriate lifts for the compaction equipment being employed.

Wet Weather Considerations

The on-site near-surface soils contain a sufficient percentage of fines (silt and clay) to be moisture-sensitive. When the moisture content of these soils is more than a few percent above the optimum moisture content, these soils become muddy and unstable, and operation of equipment on these soils is difficult. Additionally, disturbance of near-surface soils should be expected if earthwork is completed during periods of wet weather. During wet weather, we recommend that:

- The ground surface in and around the work area should be sloped so that surface water is directed away from the work area.
- The ground surface should be graded such that areas of ponded water do not develop.
- The contractor should take measures to prevent surface water from collecting in excavations and trenches.
- Measures should be implemented to remove surface water from the work area.
- Earthwork activities should not take place during periods of heavy precipitation.
- Slopes with exposed soils should be covered with plastic sheeting. Plastic sheeting should be anchored, monitored and maintained by the contractor.
- The contractor should take necessary measures to prevent soils to be used as fill from becoming wet or unstable. These measures may include covering stockpiles with plastic sheeting, sumps with pumps, and grading. The site soils should not be left uncompacted and exposed to moisture. Sealing the surficial soils by rolling with a smooth-drum roller prior to periods of precipitation will help reduce the extent that these soils become wet or unstable.
- Construction traffic should be restricted to specific areas of the site, preferably areas that are surfaced with materials not susceptible to wet weather disturbance.
- Construction activities should be scheduled so that the length of time that soils are left exposed to moisture is reduced to the extent practicable.

Temporary Slopes

We recommend that temporary unsupported cut slopes higher than 4 feet be inclined no steeper than 1½H:1V. This recommendation applies to fully dewatered conditions. Flatter slopes may be necessary if seepage is present on the face of the cut. Temporary cut slopes should encroach no closer than 5 feet laterally from roadways, pavements, structures or other improvements.

Some sloughing and raveling of the cut slopes should be expected. Temporary covering, such as heavy plastic sheeting, should be used to protect these slopes during periods of rainfall. Surface water runoff from above cut slopes must be prevented from flowing over the slope face by using curbs, berms, drainage ditches, swales or other appropriate methods.

If temporary cut slopes experience excessive sloughing or raveling during construction, it may become necessary to modify the cut slopes to maintain safe working conditions and protect adjacent facilities or structures. Slopes experiencing excessive sloughing or raveling can be flattened or can be regraded to add intermediate slope benches, or additional dewatering can be provided if the poor slope performance is related to groundwater seepage.

Permanent Slopes

We recommend that permanent cut and fill slopes be constructed no steeper than 2H:1V. Permanent slopes within the detention ponds (inboard slopes) should be constructed no steeper than 3H:1V. Additional recommendations for detention ponds are provided in the "Stormwater Detention Pond" section of this report.

LIMITATIONS

We have prepared this report for the exclusive use of the City of Stayton, Keller Associates, Inc. and other project team members for the Lambert Detention Pond project in Stayton, Oregon. The data should be provided to prospective contractors for their bidding or estimating purposes, but our report and interpretations should not be construed as a warranty of the subsurface conditions.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers and will serve as the official document of record.

Please refer to Appendix C titled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.

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FIGURES

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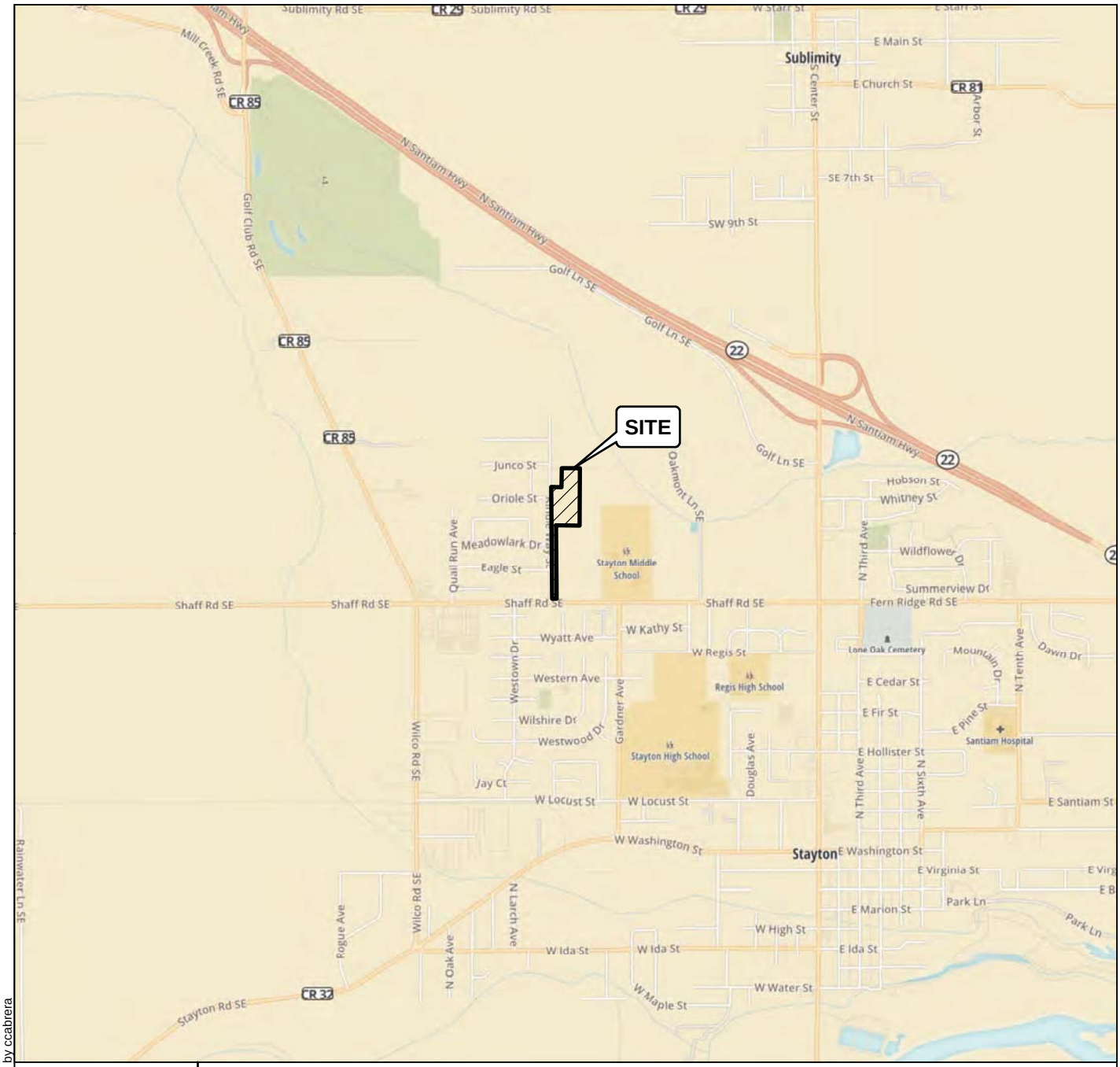

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Feet

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Mapbox Open Street Map, 2017

Projection: NAD 1983 UTM Zone 10N

Vicinity Map

Lambert Property Detention Pond
Stayton, Oregon

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Figure 1

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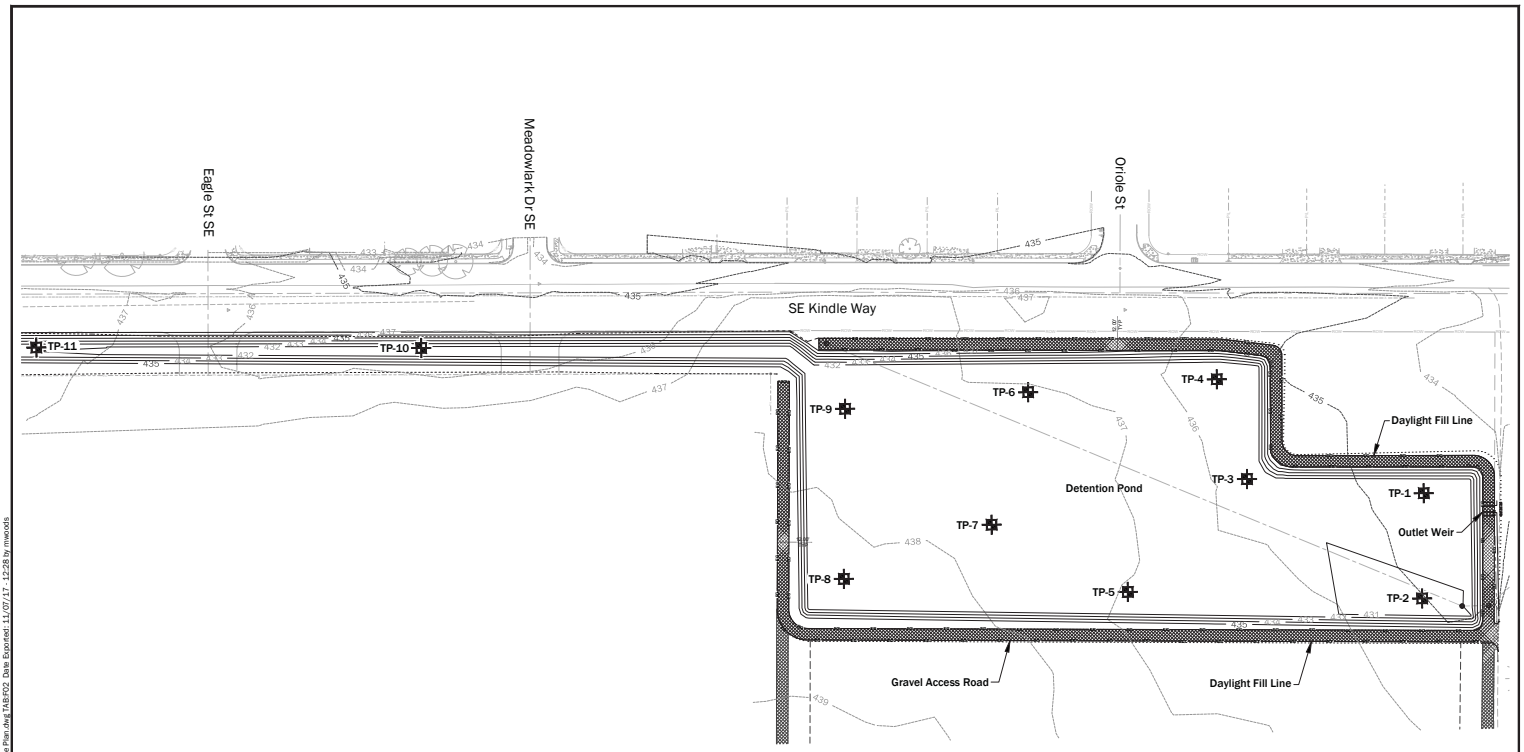

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Data Source: Base from Keller Associates dated 09/01/17.

Projection: NAD83 Oregon State Planes (Polyconic), North Zone, US Foot

Legend

TP-1 Test Pit

100 0 100
Feet

Site Plan

Lambert Property Detention Pond
Stayton, Oregon

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Figure 2

P:\111\161502\CAD\05\SiteTech\161502000_F02_Site Plan.dwg TABF02 Date Exported: 11/07/17 - 12:28 by mwoods

APPENDICES

GeoEngineers

APPENDIX A
Field Explorations

APPENDIX A
FIELD EXPLORATIONS

General

Subsurface conditions at the sites were explored by excavating 11 test pits to depths ranging between 7 and 9 feet below ground surface. The test pits were excavated by a Cat 305E2 rubber-tracked excavator provided by K&E Excavating under subcontract to GeoEngineers on October 25, 2017.

The locations of the explorations were estimated by taping/pacing from existing site features. The approximate locations of the explorations are shown on the Site Plan, Figure 2.

The test pits were continuously observed by a geologist from our firm who examined and classified the soils encountered, obtained representative soil samples, observed groundwater conditions, and maintained a detailed log of each test pit.

Grab samples of representative soil types were obtained from the test pits and transported to our laboratory in Portland, Oregon. The soils encountered were visually classified in general accordance with the Unified Soil Classification System, ASTM D 2488, and the system summarized in Figure A-1. Test pit logs are shown on Figures A-2 through A-12. The logs are based on our interpretation of the field and laboratory data and indicate the various soils encountered. They also indicate the depths at which the soils or their characteristics change, although the change may be gradual. The densities noted on the test pit logs are based on observations of the conditions encountered during excavation and our judgment.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% RETAINED ON NO. 200 SIEVE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	SOD	Sod/Forest Duff
	TS	Topsoil

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata

Approximate contact between soil strata

Material Description Contact

Contact between geologic units

Contact between soil of the same geologic unit

Sampler Symbol Descriptions

2.4-inch I.D. split barrel

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

"P" indicates sampler pushed using the weight of the drill rig.

"WOH" indicates sampler pushed using the weight of the hammer.

Laboratory / Field Tests

%F	Percent fines
%G	Percent gravel
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DD	Dry density
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
Mohs	Mohs hardness scale
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

Key to Exploration Logs

GeoEngineers

Figure A-1

Date Excavated	10/26/2017	Total Depth (ft)	8	Logged By JLL Checked By TKC	Excavator K&E Excavating Equipment CAT 305E2 CE RTE	Groundwater not observed See "Remarks" section for caving observed
Surface Elevation (ft) Vertical Datum	435 NAVD88	Easting (X) Northing (Y)	7603473 427003	Coordinate System Horizontal Datum	OR State Plane North WGS84	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
434	1				SM	Black silty fine to medium sand with gravel, fine roots to 10 to 12 inches (loose, moist) (topsoil)			
433	2		1 %F				29.5	19.8	
					GM	Red-brown silty poorly graded gravel with sand, occasional cobbles to 5 to 6 inches (medium dense, moist) (older alluvium)			
432	3								
431	4		2 SA				27	26	Slight caving observed from 4 to 8 feet below ground surface
430	5				GP-GM	Brown poorly graded gravel with silt and sand, occasional rounded cobbles to 6 to 8 inches (dense, moist)			
429	6		3						
						Becomes light brown			
428	7								
			4			Becomes moist to wet			
427	8								

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery, Vertical approximated based on project drawings provided by Keller Associates dated August 23, 2017

Log of Test Pit TP-1

GeoEngineers

Project: Lambert Property Detention Pond
Project Location: Stayton, Oregon
Project Number: 11615-002-00

Figure A-2
Sheet 1 of 1

Date:11/8/17 Path:P:\11\11615002\GINT\11615002OO.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_TESTPIT_1P_GEOTEC_%F

Date Excavated	10/26/2017	Total Depth (ft)	8	Logged By JLL Checked By TKC	Excavator K&E Excavating Equipment CAT 305E2 CE RTE	Groundwater not observed Caving not observed
Surface Elevation (ft) Vertical Datum	435 NAVD88	Easting (X) Northing (Y)	7603582 426999	Coordinate System Horizontal Datum	OR State Plane North WGS84	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
434	1				SM	Black silty fine to medium sand with gravel, fine roots to 10 to 12 inches, rounded gravel to 2 to 3 inches (loose, moist) (topsoil)			
433	2				GM	Red-brown silty fine to coarse gravel with sand, rounded gravel, occasional cobbles to 6 to 8 inches (dense, moist) (older alluvium)			
432	3		1 MC				16.7		
431	4				GP-GM	Red-brown fine to coarse gravel with silt and sand (dense to very dense, moist)			
430	5		2						
429	6								
428	7					Becomes moist to wet			
427	8								

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery, Vertical approximated based on project drawings provided by Keller Associates dated August 23, 2017

Log of Test Pit TP-2

GeoEngineers

Project: Lambert Property Detention Pond
Project Location: Stayton, Oregon
Project Number: 11615-002-00

Figure A-3
Sheet 1 of 1

Date:11/8/17 Path:P:\11\11615002\GINT\11615002OO.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_TESTPIT_1P_GEOTEC_%F

Date Excavated 10/26/2017	Total Depth (ft) 7	Logged By JLL Checked By TKC	Excavator K&E Excavating Equipment CAT 305E2 CE RTE	Groundwater not observed See "Remarks" section for caving observed
Surface Elevation (ft) 436 Vertical Datum NAVD88		Easting (X) 7603454 Northing (Y) 426819	Coordinate System OR State Plane North Horizontal Datum WGS84	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
435	1				SM	Black silty fine to medium sand with occasional rounded gravels, fine roots to 10 to 12 inches (loose, moist) (topsoil)			
434	2				GM	Brown silty fine to coarse gravel with sand, occasional subrounded cobbles to 6 to 8 inches (dense, moist) (older alluvium)			
433	3								
432	4		1 MC		GP-GM	Gray-brown poorly graded gravel with sand and silt, rounded gravel, occasional cobbles to 8 inches (dense, moist)	6 6.1		Slight to moderate caving observed at 4 to 7 feet below ground surface
431	5								
430	6								
429	7								Severe caving observed at 7 feet below ground surface

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery, Vertical approximated based on project drawings provided by Keller Associates dated August 23, 2017

Log of Test Pit TP-3

GeoEngineers

Project: Lambert Property Detention Pond
Project Location: Stayton, Oregon
Project Number: 11615-002-00

Figure A-4
Sheet 1 of 1

Date:11/8/17 Path:P:\11\11615002\GINT\11615002OO.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_TESTPIT_1P_GEOTEC_%F

Date Excavated	10/26/2017	Total Depth (ft)	8.5	Logged By JLL Checked By TKC	Excavator K&E Excavating Equipment CAT 305E2 CE RTE	Groundwater not observed See "Remarks" section for caving observed
Surface Elevation (ft) Vertical Datum	436 NAVD88	Easting (X) Northing (Y)	7603349 426790	Coordinate System Horizontal Datum	OR State Plane North WGS84	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
435	1				SM	Black silty fine to medium sand with gravel, fine roots to 10 to 12 inches, rounded gravel (loose, moist) (topsoil)			
434	2								
433	3				GM	Red-brown silty fine to coarse gravel with sand, rounded to subrounded gravel, occasional cobbles to 6 inches (dense, moist) (older alluvium)			
432	4		1		GP-GM	Brown fine to coarse gravel with silt and sand, occasional subrounded cobbles to 8 to 10 inches (dense, moist)			Moderate caving observed from 4 to 7 feet below ground surface
431	5								
430	6								
429	7								Severe caving observed below 7 feet below ground surface
428	8		2						

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery, Vertical approximated based on project drawings provided by Keller Associates dated August 23, 2017

Log of Test Pit TP-4

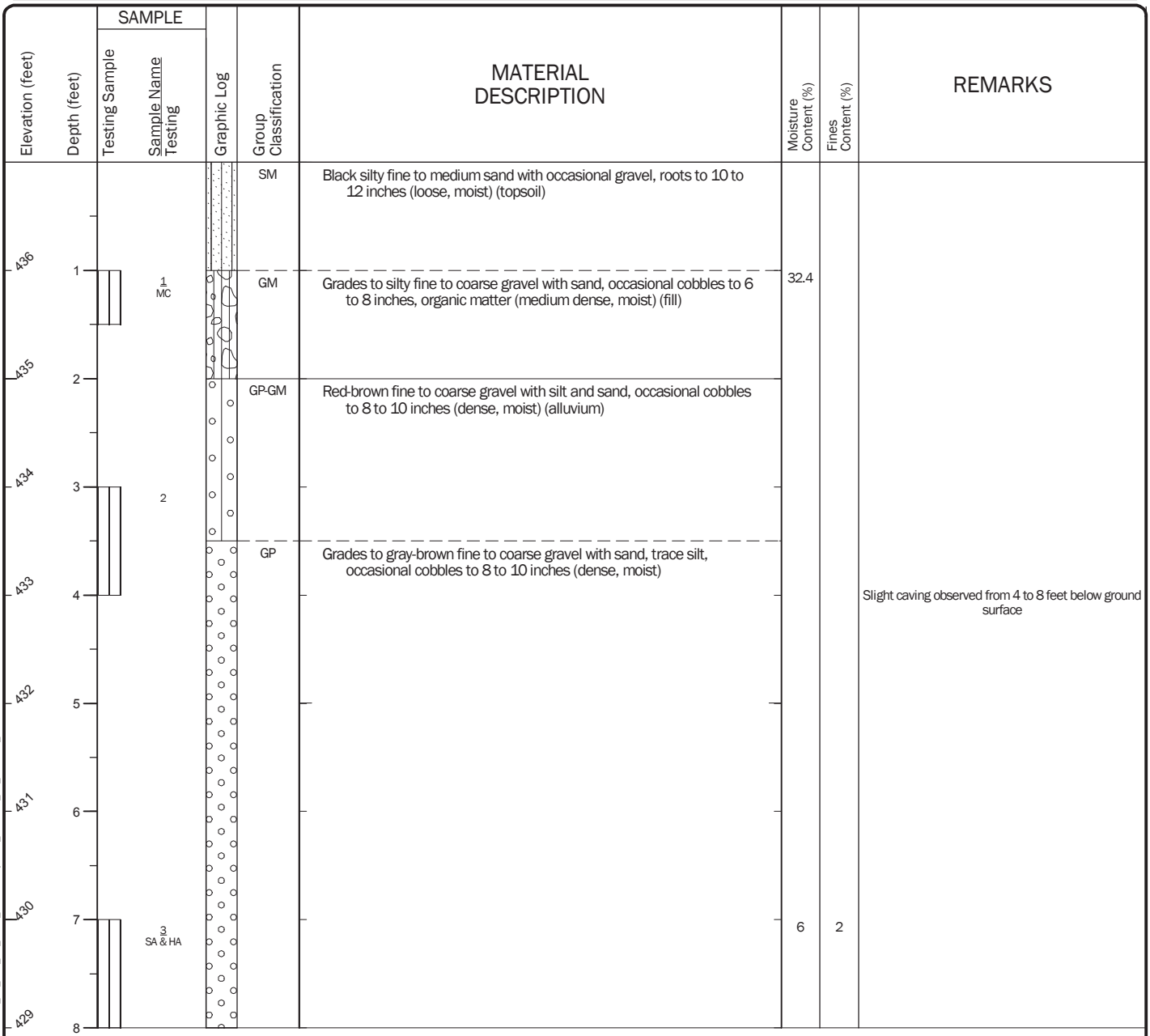
GeoEngineers

Project: Lambert Property Detention Pond
Project Location: Stayton, Oregon
Project Number: 11615-002-00

Figure A-5
Sheet 1 of 1

Date:11/8/17 Path:P:\11\11615002\GINT\11615002OO.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_TESTPIT_1P_GEOTEC_%F

Date Excavated 10/26/2017	Total Depth (ft) 8	Logged By JLL Checked By TKC	Excavator K&E Excavating Equipment CAT 305E2 CE RTE	Groundwater not observed See "Remarks" section for caving observed
Surface Elevation (ft) 437 Vertical Datum NAVD88		Easting (X) 7603359 Northing (Y) 426593		Coordinate System OR State Plane North Horizontal Datum WGS84



Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery, Vertical approximated based on project drawings provided by Keller Associates dated August 23, 2017

Log of Test Pit TP-5

GeoEngineers

Project: Lambert Property Detention Pond
Project Location: Stayton, Oregon
Project Number: 11615-002-00

Figure A-6
Sheet 1 of 1

Date:11/8/17 Path:P:\11\11615002\GINT\11615002OO.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEIR_TESTPIT_1P_GEOTEC_%F

Date Excavated	10/26/2017	Total Depth (ft)	9	Logged By JLL Checked By TKC	Excavator K&E Excavating Equipment CAT 305E2 CE RTE	Groundwater not observed See "Remarks" section for caving observed
Surface Elevation (ft) Vertical Datum	437 NAVD88	Easting (X) Northing (Y)	7603569 426693	Coordinate System Horizontal Datum	OR State Plane North WGS84	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
436	1				SM	Black silty fine to medium sand with gravel, roots to 10 to 12 inches, occasional cobbles to 6 inches (loose, moist) (topsoil)			
435	2								
434	3				SM	Red-brown fine to coarse silty gravel with sand, occasional subrounded cobbles to 6 to 7 inches (dense, moist) (older alluvium)			
433	4				GP-GM	Gray-brown fine gravel with silt and sand, occasional subrounded cobbles to 10 inches (dense, moist)			Moderate caving observed from 4 to 7 feet below ground surface
432	5								
431	6								
430	7	1				12 to 14 inch boulder			Severed caving observed from 7 to 9 feet below ground surface
429	8								
428	9								

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery, Vertical approximated based on project drawings provided by Keller Associates dated August 23, 2017

Log of Test Pit TP-6

GeoEngineers

Project: Lambert Property Detention Pond
Project Location: Stayton, Oregon
Project Number: 11615-002-00

Figure A-7
Sheet 1 of 1

Date:11/8/17 Path:P:\11\11615002\GINT\11615002OO.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_TESTPIT_1P_GEOTEC_%F

Date Excavated	10/26/2017	Total Depth (ft)	8	Logged By JLL Checked By TKC	Excavator K&E Excavating Equipment CAT 305E2 CE RTE	Groundwater not observed See "Remarks" section for caving observed
Surface Elevation (ft) Vertical Datum	438 NAVD88	Easting (X) Northing (Y)	7603496 426552	Coordinate System Horizontal Datum	OR State Plane North WGS84	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
437	1				SM	Black silty fine to medium sand with gravel, fine roots to 10 to 12 inches (loose, moist) (topsoil)			
					GM	Black silty fine to coarse gravel with sand, organic matter, occasional cobbles to 6 inches (loose to medium dense, moist) (fill)			
436	2				GP-GM	Brown fine to coarse gravel with silt and sand, rounded to subrounded cobbles to 8 inches (dense, moist) (Qoal)			
435	3								
434	4				GP	Grades to gray-brown fine to coarse gravel with sand, trace silt, occasional subrounded cobbles to 8 to 10 inches (dense, moist)			
433	5								Slight to moderate caving observed from 5 to 7 feet below ground surface
432	6		1						
431	7								Severe caving observed from 7 to 8 feet below ground surface
430	8								

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery, Vertical approximated based on project drawings provided by Keller Associates dated August 23, 2017

Date:11/8/17 Path:P:\11\11615002\GINT\11615002OO.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEIR_TESTPIT_1P_GEOTEC_%F

Log of Test Pit TP-7

GeoEngineers

Project: Lambert Property Detention Pond
Project Location: Stayton, Oregon
Project Number: 11615-002-00

Figure A-8
Sheet 1 of 1

Date Excavated 10/26/2017	Total Depth (ft) 8	Logged By JLL Checked By TKC	Excavator K&E Excavating Equipment CAT 305E2 CE RTE	Groundwater not observed See "Remarks" section for caving observed
Surface Elevation (ft) 438 Vertical Datum NAVD88		Easting (X) 7603549 Northing (Y) 426397	Coordinate System OR State Plane North Horizontal Datum WGS84	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
437	1				SM	Black silty fine to medium sand, occasional round gravel, fine roots to 10 to 12 inches (loose, moist) (topsoil) Becomes gravel, trace cobbles to 5 to 6 inches			
436	2				GP-GM	Brown fine to coarse gravel with silt and sand, occasional subrounded cobbles to 8 inches (dense, moist) (older alluvium)			
435	3								
434	4		1 SA		GP	Gray-brown fine to coarse gravel with sand, trace silt, occasional subrounded cobbles to 8 inches (dense, moist)	7.8	3	Moderate to slight caving observed from 4 to 8 feet below ground surface
433	5								
432	6								
431	7								
430	8								

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery, Vertical approximated based on project drawings provided by Keller Associates dated August 23, 2017

Log of Test Pit TP-8

GeoEngineers

Project: Lambert Property Detention Pond
Project Location: Stayton, Oregon
Project Number: 11615-002-00

Figure A-9
Sheet 1 of 1

Date:11/8/17 Path:P:\11\11615002\GINT\11615002OO.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_TESTPIT_1P_GEOTEC_%F

Date Excavated 10/26/2017	Total Depth (ft) 8	Logged By JLL Checked By TKC	Excavator K&E Excavating Equipment CAT 305E2 CE RTE	Groundwater not observed See "Remarks" section for caving observed
Surface Elevation (ft) 438 Vertical Datum NAVD88		Easting (X) 7603372 Northing (Y) 426402	Coordinate System OR State Plane North Horizontal Datum WGS84	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
437	1				SM	Black silty fine to medium sand, fine roots to 10 to 12 inches, occasional rounded to subrounded gravel (loose, moist) (topsoil)			
436	2								
435	3				GM	Brown silty fine to coarse gravel with sand, occasional subrounded cobbles to 8 to 10 inches (dense, moist) (older alluvium)			
434	4				GP-GM	Gray-brown fine to coarse gravel with sand and silt, occasional cobbles to 10 inches, single 12-inch boulder (dense, moist)			Slight to moderate caving observed from 4 to 8 feet below ground surface
433	5								
432	6				GP	Gray-brown fine to coarse gravel with sand, trace silt, occasional cobbles to 10 inches (dense, moist)			
431	7								
430	8								

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery, Vertical approximated based on project drawings provided by Keller Associates dated August 23, 2017

Log of Test Pit TP-9

GeoEngineers

Project: Lambert Property Detention Pond
Project Location: Stayton, Oregon
Project Number: 11615-002-00

Figure A-10
Sheet 1 of 1

Date:11/8/17 Path:P:\11\11615002\GINT\11615002OO.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_TESTPIT_1P_GEOTEC_%F

Date Excavated	10/26/2017	Total Depth (ft)	8	Logged By JLL Checked By TKC	Excavator K&E Excavating Equipment CAT 305E2 CE RTE	See "Remarks" section for groundwater observed Caving not observed
Surface Elevation (ft) Vertical Datum	436 NAVD88	Easting (X) Northing (Y)	7603299 425962	Coordinate System Horizontal Datum	OR State Plane North WGS84	

Elevation (feet)	Depth (feet)	SAMPLE: Testing Sample	SAMPLE: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
435	1				SM	Black silty fine to medium sand with occasional rounded to subrounded gravel, fine roots to 10 to 12 inches (loose, moist) (topsoil)			
434	2		1 SA		GP-GM	Brown fine to coarse gravel with silt and sand, subrounded cobbles to 10 inches (dense, moist) (older alluvium)	8	7	
433	3								
432	4								
431	5								
430	6				GP	Brown fine to coarse gravel with sand and trace silt, occasional cobbles to 8 inches (dense, moist to wet) Becomes wet			Rapid groundwater observed at 6½ feet below ground surface
429	7		2						
428	8								

Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery, Vertical approximated based on project drawings provided by Keller Associates dated August 23, 2017

Log of Test Pit TP-10

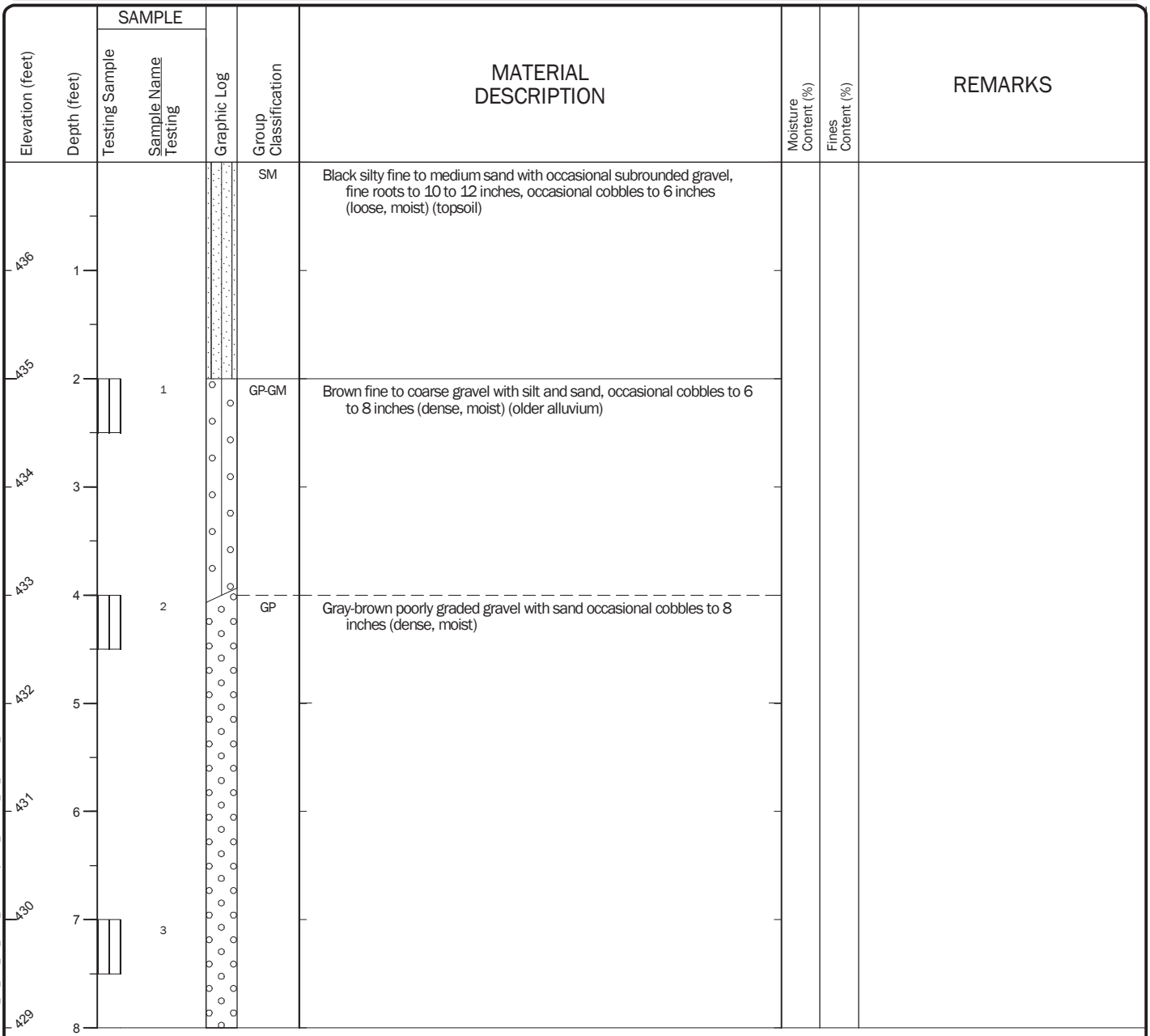
GeoEngineers

Project: Lambert Property Detention Pond
Project Location: Stayton, Oregon
Project Number: 11615-002-00

Figure A-11
Sheet 1 of 1

Date:11/8/17 Path:P:\11\11615002\GINT\11615002OO.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_TESTPIT_1P_GEOTEC_%F

Date Excavated 10/26/2017	Total Depth (ft) 8	Logged By JLL Checked By TKC	Excavator K&E Excavating Equipment CAT 305E2 CE RTE	Groundwater not observed Caving not observed	
Surface Elevation (ft) 437 Vertical Datum NAVD88		Easting (X) 7603290 Northing (Y) 425561		Coordinate System OR State Plane North Horizontal Datum WGS84	



Notes: See Figure A-1 for explanation of symbols.
The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to ½ foot.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery, Vertical approximated based on project drawings provided by Keller Associates dated August 23, 2017

Log of Test Pit TP-11

GeoEngineers

Project: Lambert Property Detention Pond
Project Location: Stayton, Oregon
Project Number: 11615-002-00

Figure A-12
Sheet 1 of 1

Date:11/8/17 Path:P:\11\11615002\GINT\11615002OO.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_TESTPIT_1P_GEOTEC_%F

APPENDIX B
Laboratory Testing

APPENDIX B
LABORATORY TESTING

General

Soil samples obtained from the explorations were transported to our laboratory and examined to confirm or modify field classifications, as well as to evaluate index properties of the soil samples. Representative samples were selected for laboratory testing consisting of the determination of the moisture content, fines content, grain size distribution (sieve analyses). The tests were performed in general accordance with test methods of the American Society for Testing and Materials (ASTM) or other applicable procedures.

Moisture Content Testing

Moisture content tests were completed in general accordance with ASTM D 2216 for representative samples obtained from the explorations. The results of these tests are presented on the exploration logs in Appendix A at the depths at which the samples were obtained.

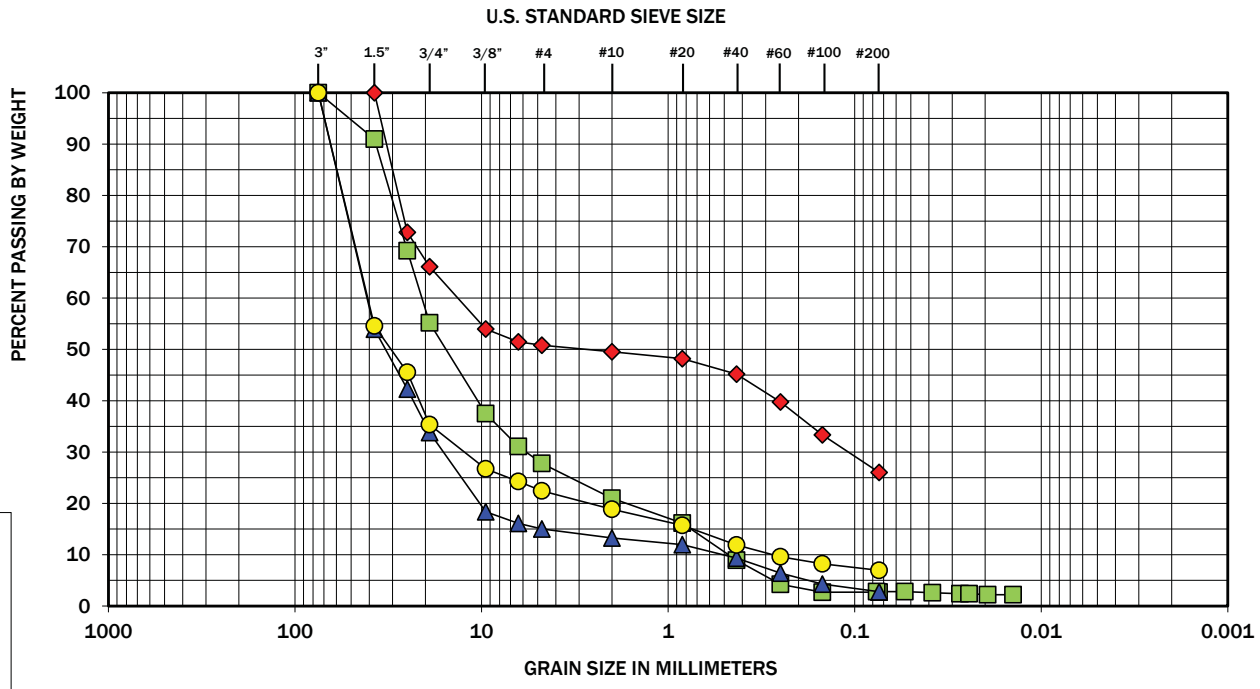
Percent Passing U.S. No. 200 Sieve (%F)

Selected samples were "washed" through the U.S. No. 200 mesh sieve to estimate the relative percentages of coarse- and fine-grained particles in the soil. The percent passing value represents the percentage by weight of the sample finer than the U.S. No. 200 sieve. These tests were conducted to verify field descriptions and to estimate the fines content for analysis purposes. The tests were conducted in accordance with ASTM D 1140, and the results are shown on the exploration logs in Appendix A at the respective sample depths.

Grain Size Analyses

Sieve analyses were performed on selected samples in general accordance with ASTM D 422. The wet sieve analysis method was used to determine the percentage of soil passing the U.S. No. 200 mesh sieve. The results of the sieve analyses were plotted, classified in general accordance with the Unified Soil Classification System, and are presented in Figure B-1.

Combined sieve and hydrometer testing were performed on one sample in general accordance with ASTM D 422-63. The sieve analysis procedure described above was used to evaluate the grain size distribution for soils retained on the U.S. No. 200 mesh sieve, and a hydrometer was used to evaluate the grain size distribution of a representative sample of soil passing the U.S. No. 10 sieve suspended in liquid. The results of the combined sieve and hydrometer testing are presented in Figure B-1.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Boring Number	Depth (feet)	Moisture (%)	Soil Description
◆	TP-1	4.0	27	Silty fine to coarse gravel with sand (GM)
■	TP-5	7.0 – 8.0	6	Fine to coarse gravel with sand (GP)
▲	TP-8	4.0	8	Fine to coarse gravel with sand (GP)
●	TP-10	2.0 – 3.0	8	Fine to coarse gravel with silt and sand (GP-GM)

Note: This report may not be reproduced, except in full, without written approval of GeoEngineers, Inc. Test results are applicable only to the specific sample on which they were performed, and should not be interpreted as representative of any other samples obtained at other times, depths or locations, or generated by separate operations or processes.

The grain size analysis results were obtained in general accordance with ASTM D 6913. Minus 200 Wash results were obtained in general accordance with ASTM D 1140.

GeoEngineers

Figure B-1

Lambert Property Detention Pond
Stayton, Oregon

Sieve Analysis Results

APPENDIX C
Report Limitations and Guidelines for Use

APPENDIX C
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

Geotechnical Services Are Performed for Specific Purposes, Persons and Projects

This report has been prepared for the exclusive use of the City of Stayton, Keller Associates, Inc. and other project team members for the Lambert Detention Pond project. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

A Geotechnical Engineering or Geologic Report Is Based on a Unique Set of Project-specific Factors

This report has been prepared for Lambert Detention Pond project in Stayton, Oregon. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, do not rely on this report if it was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

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[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org .

If important changes are made after the date of this report, GeoEngineers should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. Always contact GeoEngineers before applying a report to determine if it remains applicable.

Most Geotechnical and Geologic Findings Are Professional Opinions

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

Geotechnical Engineering Report Recommendations Are Not Final

Do not over-rely on the preliminary construction recommendations included in this report. These recommendations are not final, because they were developed principally from GeoEngineers' professional judgment and opinion. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for this report's recommendations if we do not perform construction observation.

Sufficient monitoring, testing and consultation by GeoEngineers should be provided during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

A Geotechnical Engineering or Geologic Report Could Be Subject to Misinterpretation

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having GeoEngineers confer with appropriate members of the design team after submitting the report. Also retain GeoEngineers to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having GeoEngineers participate in pre-bid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

Give Contractors a Complete Report and Guidance

Some owners and design professionals believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might an owner be in a position to give contractors the best information available, while requiring them to at least share the financial responsibilities stemming from unanticipated conditions. Further, a contingency for unanticipated conditions should be included in your project budget and schedule.

Contractors Are Responsible for Site Safety on Their Own Construction Projects

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and to adjacent properties.

Read These Provisions Closely

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or site.

Geotechnical, Geologic and Environmental Reports Should Not Be Interchanged

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.

Biological Pollutants

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings, or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants and no conclusions or inferences should be drawn regarding Biological Pollutants, as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and/or any of their byproducts.

If Client desires these specialized services, they should be obtained from a consultant who offers services in this specialized field.

GeoEngineers