March 21, 2024

Faye Stewart
Public Works Director
Cottage Grove, Oregon
Via Email: pwdirector@cottagegrove.org

C/O: Damien Gilbert P.E.
Branch Engineering Inc.
Via Email: damieng@branchengineering.com

RE: **GEOTECHNICAL ENGINEERING INVESTIGATION**
BOHEMIA PARK EXPANSION
S. 10TH STREET
COTTAGE GROVE, OREGON
BRANCH ENGINEERING INC. PROJECT NO. 22-001K

Pursuant to your authorization, Branch Engineering Inc. (BEI) performed a geotechnical engineering investigation at the subject site located at the above listed address. This report is intended fulfill the requirements in Section 1803 of the 2022 Oregon Structural Specialty Code (OSSC, 2022) and presents the results of our site research, field exploration and testing, data analyses, as well as our conclusions and recommended geotechnical design parameters for the project.

We appreciate the opportunity to be of service to you. Please contact the undersigned if you have questions or concerns regarding this report.

Sincerely,
Branch Engineering Inc.

REGISTERED PROFESSIONAL ENGINEER
#16,170
Ronald J. Derrick
OREGON
SEPT 15, 1992
RONALD J. DERRICK
EXPIRES: 12/31/25

Digitally signed by Ronald J. Derrick
Date: 2024.03.21 14:27:23 -07'00'

Ronald J. Derrick, P.E., G.E.
Principal Geotechnical Engineer

Matthew Renner P.E.
Construction Engineer

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1.0 INTRODUCTION

1.1 Purpose and Scope of Work

The purpose of this work is to establish and present geotechnical engineering criteria and requirements related to the site and subsurface conditions that may influence the design and construction of the proposed project. Our scope of work included a field reconnaissance with subsurface investigations performed by BEI personnel, an engineering data review of existing geologic and geotechnical reports, and other pertinent site research activities that culminated in the preparation of this report.

1.2 Project Location and Description

The project site is located within Bohemia Park, at the approximate coordinates of 43.796678° North Latitude, and 123.058363° West Longitude, in Cottage Grove, Oregon (see Figure-1 Vicinity Map) in the northern portion of a triangular shaped 14.6-acre parcel of land. The southern and central portions of the land parcel are developed with an amphitheater and community park facilities. The northern portion of the park property is relatively undeveloped and is the location of our investigation for planned improvements. The site is bordered by the Union Pacific Railroad line along the western boundary, with commercial properties and Highway 99 to the west of the railroad. South 10th Street runs along the eastern property boundary, with residential and commercial properties across the street from the park. Main Street runs east-west at the northern boundary with Trailhead Park located across the street from the site. The subject site topography is relatively flat, with grass covering the ground surface.

As part of our research of the site, historical photos available on Google Earth were reviewed. Prior to 2005, a building was present to the south of the proposed improvements, gravel covered areas parallel to the railroad were also present. Mapping resources used during our site research show railroad spurs crossing the area now developed as the park, parallel with the present railroad alignment. This information is consistent with some of the low-resolution aerial photos showing what appear to be railroad cars on the site parallel with the railroad tracks. Between 2006 and 2012 the park was developed into its current configuration, with the amphitheater.

Our understanding of the project is that an expansion of the existing park facilities is planned. Improvements include a new restroom building, a water tower feature, splash play area, concrete flatwork with decorative elements, and playground equipment. Anticipated structural loads are expected to be less than 2 kips per foot line loads for the restroom foundations, and less than 20-kips for column loads at the water tower feature.

1.3 Site information Resources

The following site investigation activities were performed and literature resources were reviewed for pertinent site information:

- Google Earth Professional, earth.google.com
- Lane County Zone and Plan Maps
  https://lcmaps.lanecounty.org/LaneCountyMaps/ZoneAndPlanMapsApp/index.html
- Civil and landscape drawings of the proposed improvements by BEI and Daughtry Landscape Architects.

- Five (5) exploratory test pit excavations were advanced to a maximum depth of 4-feet below ground surface (BGS) at the locations shown on the attached Figure-2 Site Exploration Map.
- Review of Oregon Department of Water Resources Well Logs (attached in Appendix A).
- Oregon Department of Geology and Mineral Industries (DOGAMI) web hazard viewer.
- DOGAMI Geologic Map of Oregon.
- United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Web Soil Survey of Lane County, Oregon
- Oregon Structural Specialty Code 2022 (OSSC 2022), applicable building code criteria

2.0 GEOLOGIC SETTING

The following sections describe the regional and local site geology:

2.1 Regional Geology

The subject site is located near the southernmost portion of the Willamette Valley, where the Coast Range and the Cascade Mountains are differentiated more by geology than topography. In Oregon, the Willamette Valley is an elongate basin which narrows at both ends before terminating in the Calapooya Divide to the south and the Columbia River to the north. The basin is approximately 130 miles long and 40 miles wide. The valley is drained by the Willamette River and drops from an elevation of approximately 400-feet at Eugene, to near sea level at the northern end of the basin where the Willamette River drains into the Columbia River. The Coast Fork of the Willamette River drains the Cottage Grove region and the southern portion of the Willamette River watershed.

The Willamette River Valley in the area of the subject site is believed to be underlain by undifferentiated sedimentary rock, tuffs and basalt from the Miocene and Oligocene epochs (approximately 15 to 35 million years ago). Subsequent compression forces and uplifting of the Cascade and Coast Range Mountains depressed the Willamette River Valley. The rapid uplift of the Cascade and Coast Range mountains steepened stream gradients causing increased erosion of the mountains and resulting deposition of thick gravel layers incised within the fluvial deposits.

2.2 Site Geology

The DOGAMI interactive Geologic Map of Oregon maps the geologic unit on the site as recent Quaternary Surficial Deposits which are described as deposits of unconsolidated sediments; including alluvium, colluvium, river and coastal terrace deposits.

The nearest mapped active fault to the site is located 22-miles to the east of the site. Seismic activity is not uncommon in the Willamette Valley as evidenced by the 1993 Scotts Mills Earthquake east of Salem that registered a 5.7 Richter magnitude, and most recently a 4.2 magnitude earthquake about 12-miles east of Eugene on July 4, 2015.

3.0 SITE SUBSURFACE CONDITIONS

The analyses, conclusions, and recommendations contained in this report are based on site conditions as they presently exist and assume that the results from the subsurface explorations presented in Appendix A are representative of the subsurface conditions throughout the site. If during construction the subsurface conditions differ from those encountered in the exploratory borings, BEI requests that we be informed to review the site conditions and adjust our recommendations, if necessary.

3.1 Subsurface Soils

BEI personnel observed and logged five (5) exploratory test pits to a maximum depth of 4-feet BGS excavated by a rubber tire backhoe. The test pits were excavated at the locations shown on the attached Figure-2 Site Exploration Map. The results of our exploration activities are summarized below:

- Undocumented Fill was observed in all of the test pit excavations. At the ground surface the fill consists of a layer of dark brown silt with clay, scattered gravels, and organics. This near-surface fill appears to have been imported during the construction of the park around 2012 and forms a topsoil zone for the existing vegetation, ranging from 12- to 28-inches in thickness. Beneath the near-surface fill, or topsoil zone, another layer of fill consisting of rounded gravels with other material such as, tan coarse sand, volcanic rocks, isolated boulders up to 18-inches in diameter, minor wood debris, and cinders. A steel pipe was encountered in test pit TP-1 and was assumed to be abandoned. The fill material underlying the near-surface layer was generally dense and ranges in depth from 38- to 42-inches BGS.

- Alluvial clay/silt was observed to underlie the granular fill and was gray to dark brown with some reddish-brown staining or mottling and scattered rounded gravel. The clay has moderate plasticity. The fine grain soil with scattered gravel extended to the maximum depth of the test pits, at approximately 4-feet.

We also reviewed nearby well logs obtained from the Oregon Department of Water Resources online database (attached in Appendix A) to determine soil conditions beneath the extent of our onsite explorations. The nearby well logs generally agree with our onsite explorations with fine-grained soils and gravel to a depth of 13-feet BGS at a location adjacent to the southwest corner of Bohemia Park.

3.2 Laboratory Testing

Representative soil samples were collected at the site for laboratory testing. The resulting in-situ moisture contents (ASTM D2216) and Free Swell (IS-2720) test results are presented below in Table 1. The shrink/swell potential of the soil underlying the previously placed fill is considered to be moderate to high.

Table 1: Laboratory testing results

Location	*Depth BGS (inches)*	*Soil Description*	*Moisture content*	*Free Swell*	*Swell Rating*
TP-1	24	Tan SAND (SP) (Fill)	19%	0%	None
TP-1	44	Brown-gray CLAY (CL)	29%	38%	High
TP-2	48	Brown-gray CLAY (CL)	32%	40%	High
TP-3	44	Brown-gray CLAY (CL)	30%	50%	High
TP-4	42	Brown-gray CLAY (CL)	31%	25%	Moderate

3.3 Groundwater

Slow groundwater seepage was encountered in pockets of the near-surface fill material, and moderate seepage was observed in test pit TP-5 from the near-surface fill material, TP-5 was located near an area of wet grass with standing water. The nearby well logs list static water levels at 3.24-feet and 10-feet BGS. In the winter months of 2021 BEI performed an investigation on S. 10th Street, approximately 0.5-miles south of the site where groundwater was encountered at 5- to 7-feet BGS in sandy soil overlying gravel deposits.

We expect that groundwater levels (from the regional water table or perched lenses) will fluctuate with the seasons and should be expected to be highest during the late winter and spring months when rainstorms are more intense and frequent, and soils are near saturation. The presence of groundwater is not expected to impact shallow foundations if they are founded within 4-feet of the current ground surface elevation, dewatering and shoring may be required in excavations advanced during the wet season below 4-feet BGS.

4.0 GEOLOGIC HAZARDS

OSSC 2022 (1803.5.11) required criteria for hazards the geotechnical investigation shall address for seismic site class designations C through F are listed below:

- Slope Instability: The site is not mapped as being at risk for land sliding. The potential for landslides to occur onsite is unlikely due to the flat topography on-site and surrounding terrain.

- Liquefaction: Liquefaction is caused by a rapid increase in porewater pressure within a saturated soil that reduces the interparticle friction between soil grains that can lead to the sudden loss of shear strength within the soil. This can cause a loss of bearing capacity, densification of subsurface soils that can lead to large surficial settlements, and the migration of soil particles to the surface in the form of sand boils. Loose, granular sands with a low fine-grained soil content and a recent depositional history are especially vulnerable to liquefaction. Saturation is required for a soil to experience liquefaction.

The DOGAMI online hazard viewer map does not map the site as being at risk for liquefaction. In addition, no soil deposits that would be especially vulnerable to liquefaction were identified during the onsite explorations or in the nearby well logs. Therefore, it is our opinion that the risk of liquefaction to the proposed development is low.

- Expected Earthquake Shaking: The site is mapped within a zone of very strong shaking that would typically be associated with very large earthquakes generated from the Cascadia Subduction Zone off the Oregon coastline.

- Surface Displacement Due to Faulting or Seismically Induced Lateral Spreading or Lateral Flow: There are no known faults on the site that could cause large surficial displacements. The site soils are not at risk for liquefaction that would allow for lateral spreading to occur. Surface displacement or seismically induced lateral spreading is not expected at the site.

- Tsunami/seiche: No major bodies of water capable of generating a Tsunami are near to the site. Therefore, the risk of a tsunami or seiche to affect the site is none.

- Total and Differential Settlement: See Section 6.3 below for a discussion of settlement risk.

- Expansive Soils: Free Swell test results indicate that the surficial soils have a moderate to high shrink/swell potential. This potential risk for damage to the development is low provided that subgrade soils beneath structural elements are mitigated from undergoing fluctuations in moisture content. Recommendations for mitigating the shrink/swell potential are presented in Section 7.5-below.

- Flood Risk: The site is not mapped within the 100-year floodplain. The site is mapped within the 500-year floodplain.

5.0 CONCLUSIONS

Based on our field observations, subsurface explorations, and data analyses, our investigation did not reveal any specific site features or subsurface conditions that would impede the project as proposed and the development can proceed as planned, provided that the recommendations contained within this report are incorporated into the design and construction of the project.

6.0 DESIGN RECOMMENDATIONS

The following sections present site-specific recommendations for site preparation. Earthwork shall be performed in general accordance with the standard of practice as generally described by the International Building Code Appendix J, the OSSC, and as specified in this report. General material and construction specifications for the items discussed herein are provided in Appendix B.

The subsurface conditions observed in our site investigation represent specific locations on the site. Should soft or unsuitable soils extend to a depth or extent greater than that described herein, or areas of distinct soil variation be discovered, this office shall be notified to perform site observations and additional excavation may be required.

6.1 Foundation Subgrade Preparation Recommendations

The following recommendations are for restroom foundations, foundations for the water tank feature, and concrete bases for basalt columns and art installations. All areas intended to directly or laterally support these structures shall be stripped of vegetation, organic soil, unsuitable fill, and/or other deleterious material such as moisture softened exposed soil in areas of new foundations. These stripping's shall be removed from the site or reserved for use in landscaping or non-structural areas.

The depth to subgrade for the placement of structural fill to support foundations is anticipated to be 1- to 2-feet BGS, below the near-surface fill material that is described as the existing topsoil zone above. Following the removal of the near-surface fill, older, denser fill consisting of gravels with other components is expected to encountered. Prior to the placement of structural fill, the subgrade soil shall be observed by the Geotechnical Engineer of Record, or designated representative. Provided the underlying material is found to be dense, and free of deleterious material such as organics the fill may be left in place and covered with the recommended structural fill thickness.

We recommend assessing the subgrade soil consistency by observing proof rolls with a loaded haul truck. Areas of excessive deflection under wheel loads, or rutting shall be corrected by removal and replacement with compacted aggregate, or scarification and re-compaction, depending on the material and moisture conditions.

Upon excavation to approved subgrade material, new foundations shall be underlain by a 12-inch-thick crushed aggregate section that extends a minimum of 12-inches horizontally beyond footing perimeters. The fill shall be prepared in accordance with Section 6.7 below. The minimum relative compaction is 90% maximum dry density as determined by modified Proctor testing (ASTM D-1557).

6.2 Bearing Capacity

Following the foundation preparation described above a bearing capacity of 1.500 psf may be used. The above bearing capacity may be increased by 1/3 for short term loading, such as wind or seismic events.

6.3 Settlement

The estimated total and differential settlement for new shallow foundations after project completion is not expected to exceed 1-inch and ½-inch between equivalently loaded footings, respectively.

6.4 Friction Coefficient and Lateral Earth Pressures

For use in design of subsurface structures or retaining walls, the following parameters are given based on an internal angle of friction of 24˚ for the materials encountered in the upper 5-feet of the site. These values assume that there are no hydrostatic pressures and the retained soil is not inclined. If these assumptions change during the course of the project, our office should be notified so we can reevaluate our recommendations.

1. The coefficient of friction for concrete poured neat against the existing site soil is 0.30 and if poured atop a minimum thickness of 12-inches of compacted aggregate placed on the on-site material the coefficient is 0.5.
2. The passive earth pressure is 260 pcf.

3. The active earth pressure is 50 pcf unrestrained walls and the at rest earth pressure for a restrained wall is 65 pcf.

6.5 Slabs-On-Grade

Based on drawings reviewed as part of our investigation new concrete flatwork will be installed across a substantial portion of the site. Installation of compacted aggregate base rock with an equivalent thickness as recommended for the new structures on the site such as the restroom building and water tower feature is not expected to be feasible. In lieu of excavation to remove the near-surface fill material, we recommend moisture conditioning the material and compacting it in-place to an unyielding condition. If areas of plastic clay, organics, or other deleterious materials are encountered we recommend removal and replacement with compacted aggregate. Following the preparation described above, we do not take any exceptions with the minimum aggregate shown on the drawings.

6.6 Pavement Design

We are not aware of any new pavement areas. For any pullouts, or extensions of the existing S. 10th Street pavement we recommend matching the existing base rock and asphalt concrete (AC) thickness, or placing 4-inches of new AC on 12-inches of base rock thickness, whichever is greater.

6.7 Structural Fill

All engineered fill placed on the site shall consist of homogenous material and shall meet the following recommendations.

- The recommended compaction level for crushed aggregate in structural areas and beneath pavements is 90 percent of the maximum dry density as determined by modified Proctor testing (ASTM D-1557).

- Utility trenches located in pavement and load bearing areas should be backfilled with approved material and compacted to at least 90% of the maximum dry density as determined by modified Proctor testing.

- Prior to placement onsite, the aggregate or soil to be used shall be approved by the GER. If no recent Proctor curve (moisture-density relationship) is available for the material, a material sample will be required for testing to determine the maximum dry density and optimum moisture content of the aggregate or fill material. Use of the onsite soils for fill will require careful moisture conditioning and appropriate compaction equipment selection. Compaction of clayey soils during the wet season (November through June) will be difficult, if not impossible, to achieve due to insitu moisture contents being significantly higher than optimum moisture contents.

- Compaction shall be measured by on site testing with a nuclear densometer (ASTM D-6938), or sand cone method (ASTM D-1556) on structural fill with thicknesses in excess of 12-inches. If compaction testing is not feasible for any onsite or imported material due to factors such as oversize rock content or variable material, proof rolls with a fully loaded 10 cubic yard haul-truck or equivalent equipment shall be observed at regular intervals. Any observed areas of excessive yielding or rutting will require removal and replacement with granular fill or moisture conditioning and recompaction.

- Structural fill shall be moisture conditioned to within +/- 2% of optimum moisture content and compacted in lifts with loose thicknesses not exceeding 8-inches. Periodic visits to the site to verify lift thickness, source material, and compaction effort shall be conducted by the GER, or designated representative, and documented.

6.8 Seismic Design Parameters

Based on the soil properties encountered in our explorations and from nearby well logs, we recommend a Seismic Site Class D, stiff soil (Table 20.3-1 ASCE 7-16) for the design of site structures.

7.0 CONSTRUCTION CONSIDERATIONS

7.1 Wet Weather/Dry Weather Construction Practices

The near surface fine-grained soils, if left exposed to prolonged precipitation, will become saturated and soften. Subgrade soil below foundations, slabs, and pavements shall be covered with compacted aggregate in a timely manner after excavation to minimize moisture fluctuations. BEI recommends that foundation subgrade preparation and general site earthwork be performed during the dry season—generally June through October.

Construction during the wet season may require special drainage considerations, such as covering of excavations, pumping to mitigate standing water in footing excavations, or over-excavation of moisture softened soils. Construction traffic should not be allowed to drive directly on exposed subgrades. Construction traffic routes will also be more susceptible to "pumping" and rutting during the wet season and will likely require thicker rock sections.

7.2 Excavations

Conventional excavation equipment in proper working order should be capable of demolishing the existing concrete slab and make the excavations necessary for foundations and other site improvements. The site soils are typically classified as OSHA Type B and C soils.

We expect that the soils in the upper 4-feet will stand vertically, provided there is no groundwater seepage. Excavations below this depth will likely require sloping, benching, or shoring. Temporary construction slopes should not exceed 1:1 (H:V) and should be shallowed or shored if groundwater seepage is encountered. The crest of excavations or slopes should also be positioned at least 5-feet from any adjacent structure or improvement and heavy equipment or construction materials should not be stored within 5-feet of open excavations.

As previously mentioned, caving and soil piping may occur in excavations that extend below the water table and dewatering will likely be necessary. The contractor is responsible for selecting an appropriate excavation method, shoring system, dewatering method, and should monitor excavations for safety. Excavations should be performed in accordance with the applicable safety guidelines outlined by OSHA and the state. Based on our site explorations, and expected excavation depths for the planned improvements, we do not anticipate that the static groundwater level will be encountered.

7.3 Slopes

Temporary slopes cut into native soil should not be graded steeper than 1:1 and permanent slopes (fill or cut) should not exceed a gradient of 2:1 unless specifically evaluated for stability.

7.4 Site Drainage

Alteration of existing grades for this project will likely change drainage patterns that should not adversely affect adjacent properties. Perimeter landscape and hardscape grades shall be sloped away from foundations and water shall not be allowed to pond adjacent to footings during or after construction.

7.5 Expansive Soil Mitigation Strategies

Portions of the site soil profile were observed to be moderately expansive. Although the risk to onsite structures is low, we recommend the following precautions be adhered to during and after construction to help minimize the risk:

- Subgrade soils should not be allowed to dry out and should be covered with crushed rock in a timely manner to prevent moisture changes. Soils can be periodically wetted to maintain their insitu moisture content if excavation takes place during the drier months.
- Install roof gutters immediately after roof construction—unless during the dry season—and tightline them to a suitable disposal location.
- Sources of water should be prevented from saturating subgrades or becoming trapped below pavement surfaces and drainage structures should also not be located adjacent to pavement or other hardscapes.

7.6 Geotechnical Construction Site Observations

Periodic site observations by a geotechnical representative of BEI are recommended during the construction of the project; the specific phases of construction that should be observed are shown in the following table.

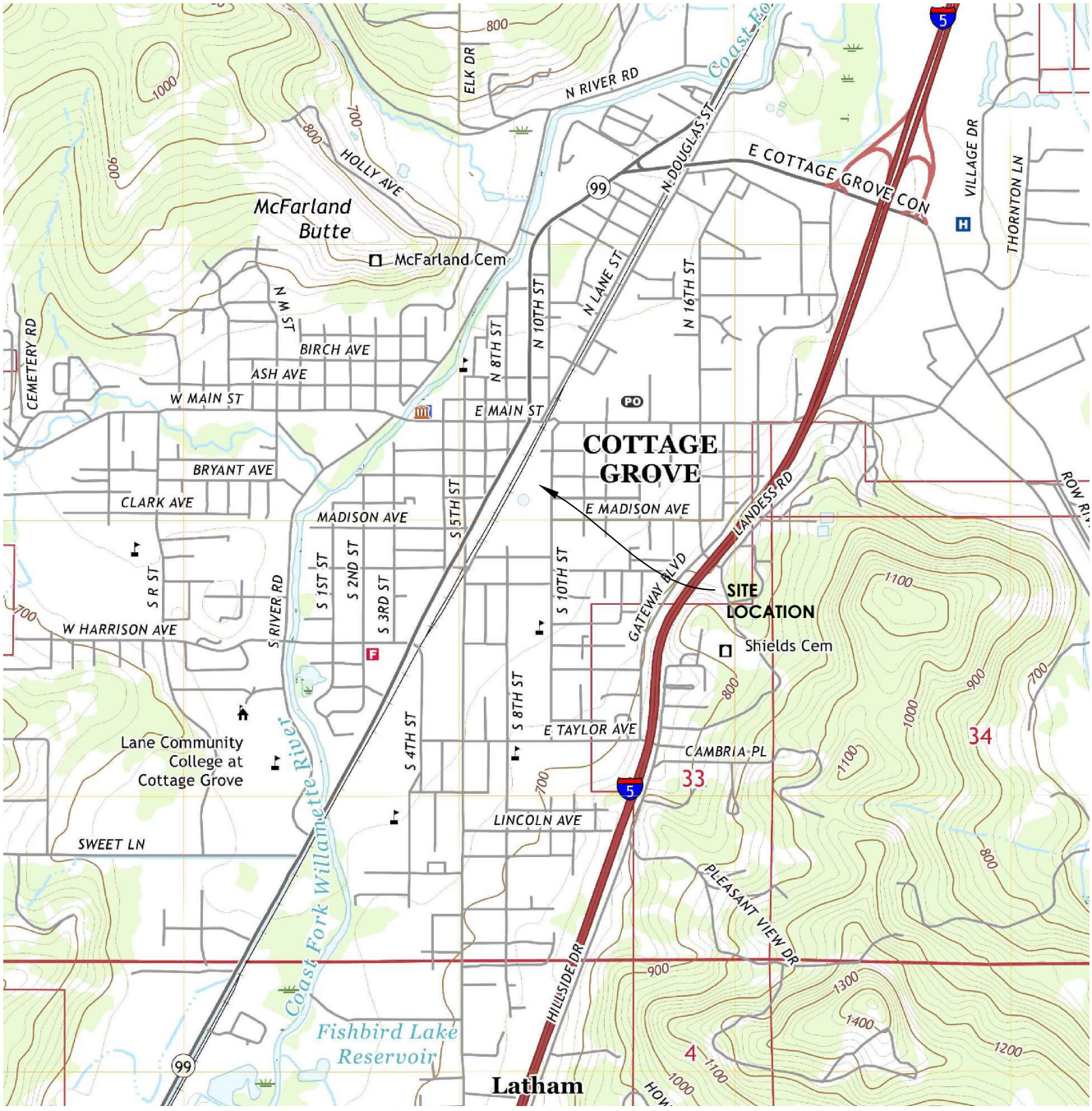
Table 2:

Recommended Construction Phases to be Observed by the Geotechnical Engineer	
At completion of subgrade excavation	Subgrade observation by the geotechnical engineer before aggregate and geogrid (if applicable) placement.
Imported fill material	Observation of material or information on material type and source.
Placement or Compaction of fill material	Observation by geotechnical engineer or test results by qualified testing agency.

8.0 REPORT LIMITATIONS

This report has presented BEI's site observations and research, subsurface explorations, geotechnical engineering analyses, and recommendations for the proposed site development. The conclusions in this report are based on the conditions described in this report and are intended for the exclusive use of the addressee and their designated representatives for use in design and construction of the development described herein. The analysis and recommendations may not be suitable for other structures or purposes.

Services performed by the geotechnical engineer for this project have been conducted with the level of care and skill exercised by other current geotechnical professionals in this area. No warranty is herein expressed or implied. The conclusions in this report are based on the site conditions as they currently exist and it is assumed that the limited site locations that were physically investigated generally represent the subsurface conditions at the site. This report represents our findings and should site development or site conditions change, or if a substantial amount of time goes by between our site investigation and site development, we reserve the right to review this report for its applicability and adjust our recommendations. If you have any questions regarding the contents of this report, please contact our office.



NOTE: MAP BY LANE COUNTY GIS, 2024

SCALE: NOT TO SCALE

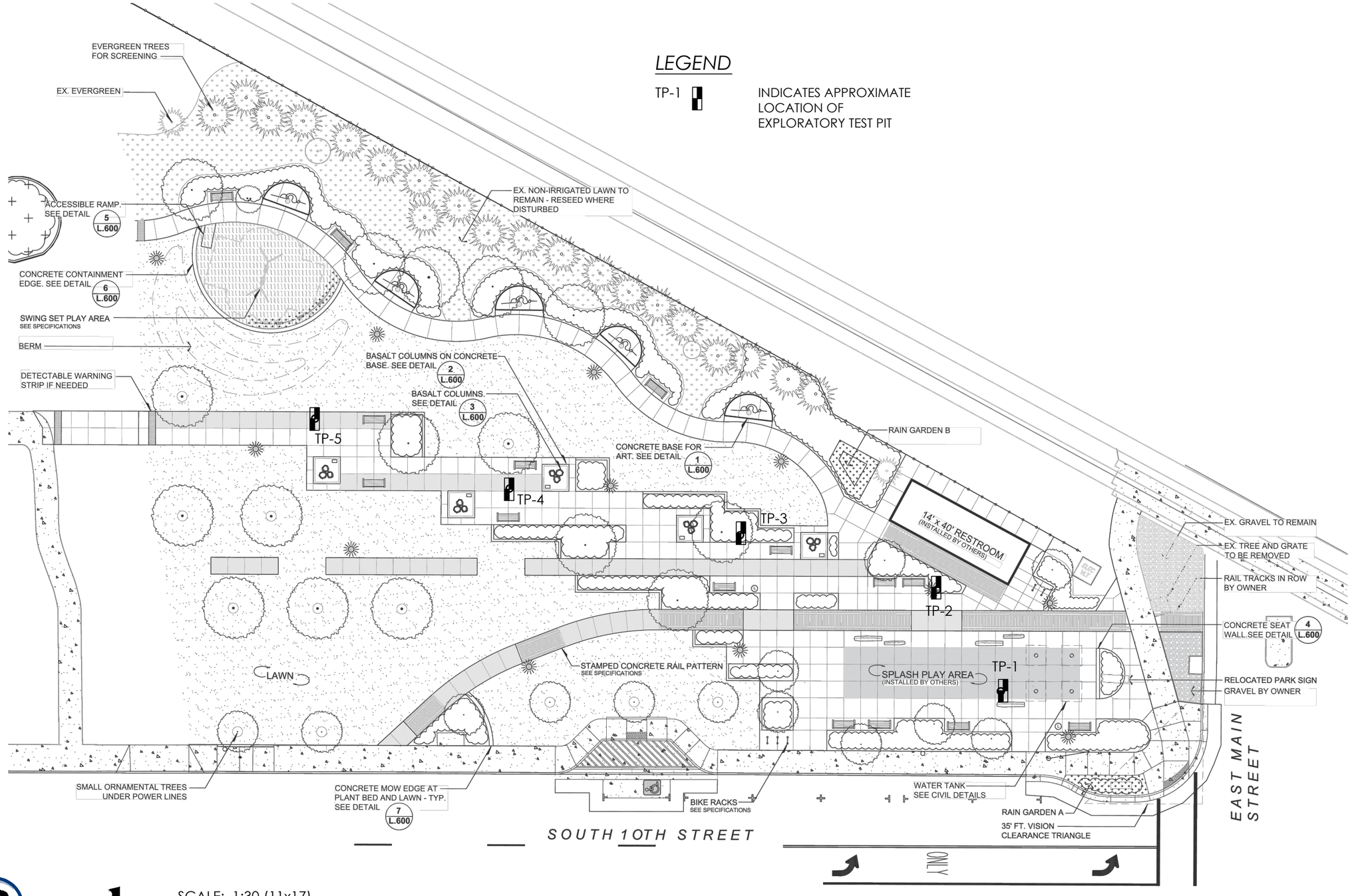
SITE VICINITY MAP - BOHEMIA PARK

FIGURE-1

SOUTH 10th STREET COTTAGE GROVE, OREGON

03-08-2024

PROJECT NO. 22-001K



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SITE EXPLORATION MAP - BOHEMIA PARK EXPANSION

SOUTH 10th STREET COTTAGE GROVE, OREGON

FIGURE-2

03-08-2024

PROJECT NO. 22-001K

Branch ENGINEERING Inc
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310 5th STREET, SPRINGFIELD, OREGON 97477

APPENDIX A

Test Pit Log Summaries, Well Logs

RELATIVE DENSITY - COARSE GRAINED SOILS

RELATIVE DENSITY	SPT N-VALUE	D&M SAMPLER (140 lbs hammer)	D&M SAMPLER (300 lbs hammer)
VERY LOOSE	< 4	< 11	< 4
LOOSE	4 - 10	11 - 26	4 - 10
MEDIUM DENSE	10 - 30	26 - 74	10 - 30
DENSE	30 - 50	74 - 120	30 - 47
VERY DENSE	> 50	> 120	> 47

USCS GRAIN SIZE

FINES		< #200 (.075 mm)
SAND	Fine	#200 - #40 (.425 mm)
	Medium	#40 - #10 (2 mm)
	Coarse	#10 - #4 (4.75 mm)
GRAVEL	Fine	#4 - 0.75 inch
	Coarse	0.75 - 3 inch
COBBLES		3 - 12 inches

CONSISTENCY - FINE GRAINED SOILS

CONSISTENCY	SPT N-VALUE	D&M SAMPLER (140 lbs hammer)	D&M SAMPLER (300 lbs hammer)	POCKET PEN. / UNCONFINED (TSF)	MANUAL PENETRATION TEST
VERY SOFT	< 2	< 3	< 2	< 0.25	Easy several inches by fist
SOFT	2 - 4	3 - 6	2 - 5	0.25 - 0.50	Easy several inches by thumb
MEDIUM STIFF	4 - 8	6 - 12	5 - 9	0.50 - 1.00	Moderate several inches by thumb
STIFF	8 - 15	12 - 25	9 - 19	1.00 - 2.00	Readily indented by thumb
VERY STIFF	15 - 30	25 - 65	19 - 31	2.00 - 4.00	Readily indented by thumbnail
HARD	> 30	> 65	> 31	> 4.00	Difficult by thumbnail

UNIFIED SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS: More than 50% retained on No. 200 sieve	GRAVELS: 50% or more *retained* on the No. 4 sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines.
			GP	Poorly-graded gravels and gravel-sand mixtures, little or no fines.
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS: 50% or more *passing* the No. 4 sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines.
			SP	Poorly-graded sands and gravelly sands, little or no fines.
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures.
			SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS: Less than 50% retained on No. 200 sieve	SILT AND CLAY	LIQUID LIMIT LESS THAN 50	ML	Inorganic silts, rock flour, clayey silts.
			CL	Inorganic clays of low to medium plasticity, lean clays.
			OL	Organic silt and organic silty clays of low plasticity.
		LIQUID LIMIT 50 OR GREATER	MH	Inorganic silts, clayey silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity.
HIGHLY ORGANIC SOILS			PT	Peat, muck, and other highly organic soil.

MOISTURE CONTENT

DRY: Absence of moisture, dusty, dry to the touch
DAMP: Some moisture but leaves no moisture on hand
MOIST: Leaves moisture on hand
WET: Visble free water, usually saturated

	PLASTICITY	DRY STRENGTH	DILATANCY	TOUGHNESS
ML	Non to Low	Non to Low	Slow to Rapid	Low, can't roll
CL	Low to Med.	Med. to High	None to Slow	Medium
MH	Med. to High	Low to Med.	None to Slow	Low to Med.
CH	Med. to High	High to V.High	None	High

STRUCTURE

STRATIFIED: Alternating layers of material or color > 6mm thick.
LAMINATED: Alternating layers < 6mm thick.
FISSURED: Breaks along definate fracture planes.
SLICKENSIDED: Striated, polished, or glossy fracture planes.
BLOCKY: Cohesive soil that can be broken down into small angular lumps which resist further breakdown.
LENSES: Has small pockets of different soils, note thickness.
HOMOGENEOUS: Same color and appearance throughout.

LIST OF ABBREVIATION & EXPLANATIONS

SPT	Standard Penetration Test split barrel sampler
D&M	Dames and Moore sampler
LL	Atterberg Liquid Limit
PL	Atterberg Plastic Limit
PP	Pocket Penetrometer
VS	Vane Shear
G	Grab sample
MC	Moisture Content
MD	Moisture Density
UC	Unconfined Compressive Strength
DCP	Dynamic Cone Penetrometer

TABLE A-1

Branch ENGINEERING Inc.
civil · transportation · structural · geotechnical · SURVEYING

Borehole ID: TP-1
Sheet 1 of 1

Client: City of Cottage Grove
Project Name: Bohemia Park Expansion
Project Number: 22-001K
Project Location: Bohemia Park Cottage Grove, Oregon
Date Started: Mar 08 2024 **Completed:** Mar 08 2024
Logged By: MWR **Checked By:** RJD
Drilling Contractor:
Latitude: 43.796678 **Longitude:** -123.058363 **Elevation:** 647.00
Drilling Method: Test Pit Excavation
Ground Water Levels
Equipment: Backhoe
Hammer Type:
Notes:

Depth	Graphic	Material Description	Sample	Pocket Pen. (tsf)	Free Swell	Moisture Content: ⊗ PL and LL: ●–■ (10 20 30 40 50 60 70 80 90)
1		Soft, dark brown, SILT/CLAY (OL) with grass roots, rounded gravel, moist - Landscaping Fill				
2		Dense, tan SAND (SP), with rocks, sand is medium to coarse grain - Previously Placed Fill	S-1 BAG	4.00	0.00	⊗
3		Medium dense to loose, gray-brown GRAVEL (GC) with clay and silt, gravel is rounded - Previously Placed Fill				
4		Medium stiff, gray-brown CLAY (CL), with scattered gravel, red staining, moist	S-2 BAG		38.00	
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Branch ENGINEERING Inc.
civil · transportation
structural · geotechnical
SURVEYING

Borehole ID: TP-2
Sheet 1 of 1

Client: City of Cottage Grove
Project Name: Bohemia Park Expansion
Project Number: 22-001K
Project Location: Bohemia Park Cottage Grove, Oregon
Date Started: Mar 08 2024 **Completed:** Mar 08 2024
Logged By: MWR **Checked By:** RJD
Drilling Contractor:
Latitude: 43.796678 **Longitude:** -123.058363 **Elevation:** 647.00
Drilling Method: Test Pit Excavation
Ground Water Levels
Equipment: Backhoe
Hammer Type:
Notes:

Depth	Graphic	Material Description	Sample	Pocket Pen. (tsf)	Free Swell	Moisture Content: ⊗ PL and LL: ●–■ (10 20 30 40 50 60 70 80 90)
1		Soft, dark brown, SILT/CLAY (OL) with grass roots, rounded gravel, moist - Landscaping Fill				
2		Dense, gray-brown GRAVEL (GP), with minor clay and silt, moist - Previously Placed Fill				
3						
4		Soft-medium stiff, dark gray CLAY (CL) with scattered gravel, moist	S-1 BAG		40.00	⊗
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Branch ENGINEERING Inc.
civil · transportation
structural · geotechnical
SURVEYING

Borehole ID: TP-3
Sheet 1 of 1

Client: City of Cottage Grove
Project Name: Bohemia Park Expansion
Project Number: 22-001K
Project Location: Bohemia Park Cottage Grove, Oregon
Date Started: Mar 08 2024 **Completed:** Mar 08 2024
Logged By: MWR **Checked By:** RJD
Drilling Contractor:
Latitude: 43.796678 **Longitude:** -123.058363 **Elevation:** 647.00
Drilling Method: Test Pit Excavation
Ground Water Levels
Equipment: Backhoe
Hammer Type:
Notes:

Depth	Graphic	Material Description	Sample	Pocket Pen. (tsf)	Free Swell	Moisture Content: ⊗ PL and LL: ●–■ (10 20 30 40 50 60 70 80 90)
0		Soft, dark brown, SILT/CLAY (OL) with grass roots, rounded gravel - Landscaping Fill				
1		Dense, gravel and black, friable cinder type material - Previously Placed Fill				
2		Dense, tan SAND (SP), with rocks, sand is medium to coarse grain - Previously Placed Fill		4.00		
3		Medium dense/stiff gravel and clay mixture - Previously Placed Fill				
4		Soft-medium stiff, dark gray CLAY (CL), moist	S-1 BAG	0.50	50.00	⊗ at 30
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Branch ENGINEERING Inc.
civil · transportation
structural · geotechnical
SURVEYING

Borehole ID: TP-4
Sheet 1 of 1

Client: City of Cottage Grove
Project Name: Bohemia Park Expansion
Project Number: 22-001K
Project Location: Bohemia Park Cottage Grove, Oregon
Date Started: Mar 08 2024 **Completed:** Mar 08 2024
Logged By: MWR **Checked By:** RJD
Drilling Contractor:
Latitude: 43.796678 **Longitude:** -123.058363 **Elevation:** 647.00
Drilling Method: Test Pit Excavation
Ground Water Levels
Equipment: Backhoe
Hammer Type:
Notes:

Depth	Graphic	Material Description	Sample	Pocket Pen. (tsf)	Free Swell	Moisture Content: ⊗ PL and LL: ●–■ (10 20 30 40 50 60 70 80 90)
1		Soft, dark brown, SILT/CLAY (OL) with grass roots, rounded gravel, moist - Landscaping Fill				
2		Medium dense, rounded gravel, with clay and trace debris - Previously Placed Fill				
3		Soft-medium stiff, dark gray CLAY (CL), moist	S-1 BAG	0.50	22.00	⊗ at ~30
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Branch ENGINEERING Inc.
civil · transportation · structural · geotechnical · SURVEYING

Borehole ID: TP-5
Sheet 1 of 1

Client: City of Cottage Grove
Project Name: Bohemia Park Expansion
Project Number: 22-001K
Project Location: Bohemia Park Cottage Grove, Oregon
Date Started: Mar 08 2024 **Completed:** Mar 08 2024
Logged By: MWR **Checked By:** RJD
Drilling Contractor:
Latitude: 43.796678 **Longitude:** -123.058363 **Elevation:** 647.00
Drilling Method: Test Pit Excavation
Ground Water Levels
Equipment: Backhoe
Hammer Type:
Notes:

Depth	Graphic	Material Description	Sample	Pocket Pen. (tsf)	Free Swell	Moisture Content: ⊗ PL and LL: ●–■ 10 20 30 40 50 60 70 80 90
1		Soft, dark brown, SILT/CLAY (OL) with grass roots, rounded gravel, wet with seepage - Landscaping Fill				
2						
3		Dense, gravel and volcanic rocks with clay - Previously Placed Fill				
4		Soft-medium stiff, dark gray CLAY (CL) moist, with scattered gravel				
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Amended 3/14/2024

LANE 79408

STATE OF OREGON
MONITORING WELL REPORT
(as required by ORS 537.545 & ORS 537.765 & OAR 690-240-0395)

2/28/2024

WELL I.D. LABEL# L 153136
START CARD # 1072265
ORIGINAL LOG #

(1) LAND OWNER

Owner Well I.D. MW-20
First Name _____ Last Name _____
Company CENTRAL OREGON PACIFIC RAILROAD
Address 333 SE MOSHER ROAD
City ROSEBURG State OR Zip 97470

(2) TYPE OF WORK

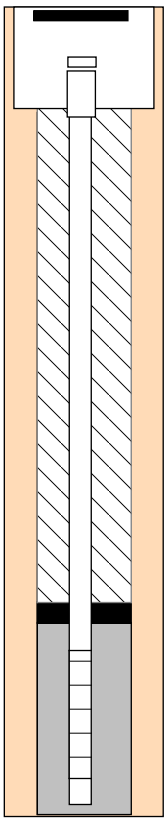
[X] New [ ] Deepening [ ] Conversion
[ ] Alteration (repair/recondition) [ ] Abandonment

(3) DRILL METHOD

[ ] Rotary Air [ ] Rotary Mud [ ] Cable [X] Hollow Stem Auger [ ] Cable Mud
[ ] Reverse Rotary [ ] Other _____

(4) CONSTRUCTION

Piezometer Well [ ]
Depth of Completed Well 13.00 ft. Special Standard [X]



MONUMENT/VAULT Below Ground
From 0 To 1

BORE HOLE
Diameter 6.25 From 0 To 13

CASING
Dia. 2 From [ ] 0.5 To 3
Gauge .40 Wld [ ] Thrd [X]
Material ( ) Steel (•) Plastic

LINER
Dia. _____ From [ ] _____ To _____
Gauge _____ Wld [ ] Thrd [ ]
Material ( ) Steel ( ) Plastic

SEAL
From 1 To 2.5
Material Bentonite Chips
Amount 150 Pounds Grout weight _____
CEMENT FROM 0 TO 1, 0.5 SACKS

SCREEN
Casing/Liner Casing Material PVC
Diameter 2 From 3 To 13
Slot Size 0.010

FILTER
From 2.5 To 13 Material SILICA SAND Size of pack 10/20
Seal Placement Begin Date 12/8/2023 Begin Time 13 36

(5) WELL TESTS

( ) Pump ( ) Bailer ( ) Air ( ) Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)

Temperature 56 °F Lab analysis [ ] Yes By _____
Supervising Geologist/Engineer _____
Water quality concerns? [ ] Yes (describe below) TDS amount 100 ppm

From	To	Description	Amount	Units

(6) LOCATION OF WELL (legal description)

County LANE Twp 20.00 S N/S Range 3.00 W E/W WM
Sec 33 NE 1/4 of the NW 1/4 Tax Lot ROAD
Tax Map Number _____ Lot _____
Lat ° ' " or 43.79288400 DMS or DD
Long ° ' " or -123.06181900 DMS or DD
( ) Street address of well (•) Nearest address
424 HWY 99, COTTAGE GROVE, OREGON 97424

(7) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Predeepening			[ ]	
Completed Well	12/8/2023		[ ]	3.24

Flowing Artesian? [ ] Dry Hole? [ ]
WATER BEARING ZONES
Depth water was first found 4.84

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
12/8/2023	4.84	13			[ ]	3.24
					[ ]	
					[ ]	
					[ ]	
					[ ]	

(8) WELL LOG

Ground Elevation 651.36 FT

Material	From	To
Med. brown silt with gravels and cobbles	0	13

Construction Begin Date 12/8/2023 Begin Time 11 57 End Date 12/8/2023

(unbonded) Monitor Well Constructor Certification
I certify that the work I performed on the construction, deepening, alteration, or abandonment of this well is in compliance with Oregon monitoring well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.

License Number 10707 Date 2/28/2024
Password : (if filing electronically) _____
Signed KEENAN BOHACH (E-filed)

(bonded) Monitor Well Constructor Certification
I accept responsibility for the construction, deepening, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon monitoring well construction standards. This report is true to the best of my knowledge and belief.

License Number 2056 Date 2/28/2024
Password : (if filing electronically) _____
Signed RYAN GALBRETH (E-filed)
Contact Info (optional) Cascade Remediation Services

ORIGINAL - WATER RESOURCES DEPARTMENT
THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK

STATE OF OREGON
WELL LOCATION MAP

This map is supplemental to the WATER SUPPLY WELL REPORT

Oregon Water Resources Department
725 Summer St NE, Salem OR 97301
(503)986-0900

LOCATION OF WELL

Latitude: 43.792884 Datum: WGS84

Longitude: -123.061819

Township/Range/Section/Quarter-Quarter Section:
WM 20S 3W 33 NENW

Address of Well:
424 HWY 99, COTTAGE GROVE, OREGON 97424

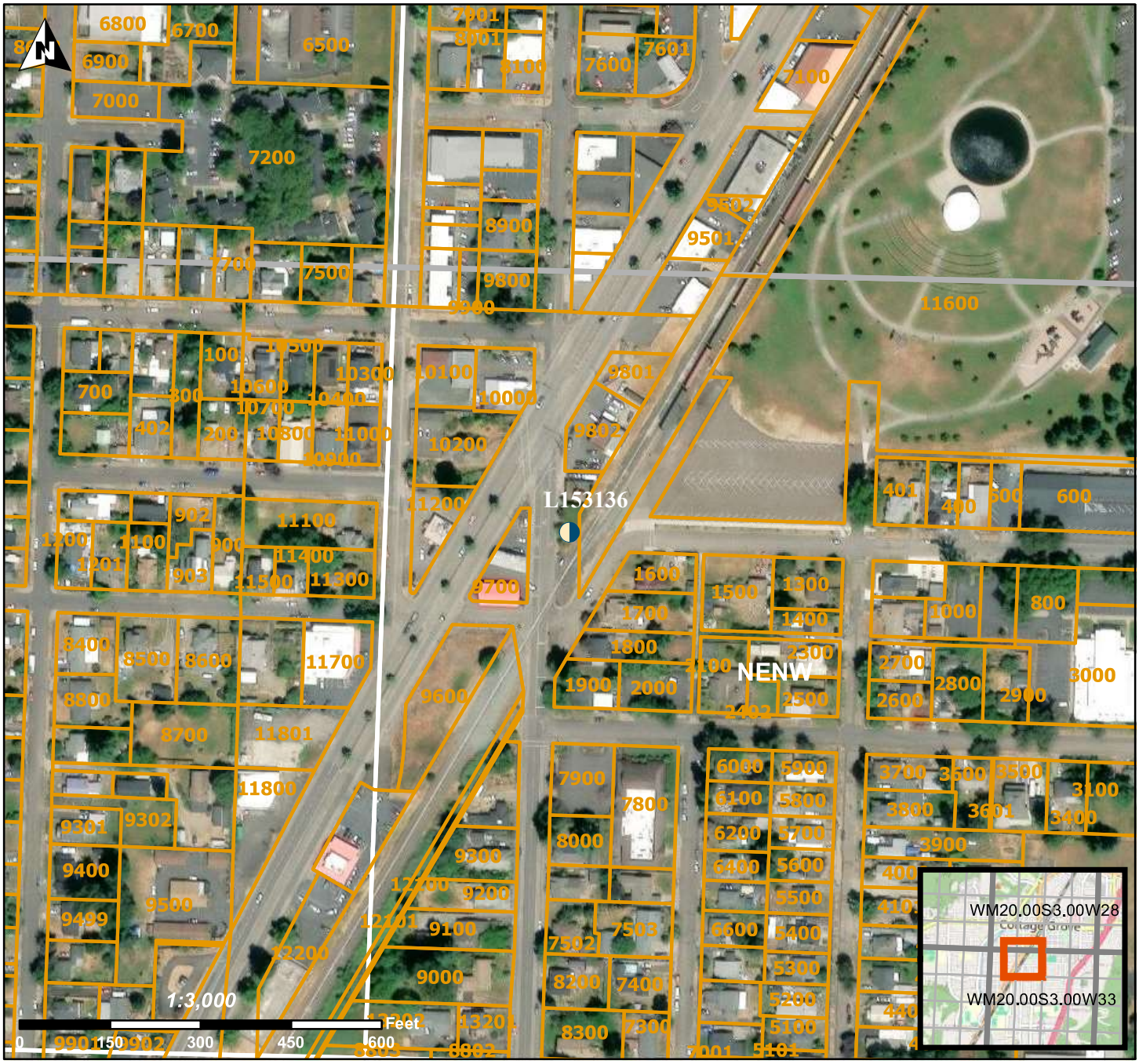
Well Label: L153136

Well Log: LANE 79408

Printed: March 14, 2024

DISCLAIMER: This map is intended to represent the approximate location of the well as provided by the land owner, well driller or OWRD staff. It is not intended to be construed as survey accurate in any manner.

Generated by OWRD



LANE 77209

STATE OF OREGON
GEOTECHNICAL HOLE REPORT
(as required by OAR 690-240-0035)

3/6/2020

(1) OWNER/PROJECT

Hole Number B1

PROJECT NAME/NBR: EE10OS.20D

First Name _____ Last Name _____
Company CITY OF COTTAGE GROVE
Address 628 E WASHINGTON AVENUE
City COTTAGE GROVE State OR Zip 97472

(2) TYPE OF WORK

☒ New ☐ Deepening ☒ Abandonment
☐ Alteration (repair/recondition)

(3) CONSTRUCTION

☐ Rotary Air ☐ Hand Auger ☒ Hollow stem auger
☐ Rotary Mud ☐ Cable ☐ Push Probe
☐ Other _____

(4) TYPE OF HOLE:

◉ Uncased Temporary ○ Cased Permanent
○ Uncased Permanent ○ Slope Stablity
○ Other
Other: _____

(5) USE OF HOLE

GEOTECHNICAL - SOIL SAMPLING

(6) BORE HOLE CONSTRUCTION

Special Standard ☐ (Attach copy)
Depth of Completed Hole 30.00 ft.

BORE HOLE Dia	From	To	SEAL Material	From	To	Amt	sacks/ lbs
8	0	30	Bentonite Chips	0	30	600	P

Backfill placed from _____ ft. to _____ ft. Material _____
Filter pack from _____ ft. to _____ ft. Material _____ Size _____

(7) CASING/SCREEN

Casing	Screen	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

(8) WELL TESTS

○ Pump ○ Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration(hr)

Temperature 55 °F Lab analysis ☐ Yes By _____
Supervising Geologist/Engineer Earth Engineers, Inc.
Water quality concerns? ☐ Yes (describe below) TDS amount _____ _____

From	To	Description	Amount	Units

(9) LOCATION OF HOLE (legal description)

County LANE Twp 20.00 S N/S Range 3.00 W E/W WM
Sec 28 SE 1/4 of the SW 1/4 Tax Lot 3300
Tax Map Number _____ Lot _____
Lat ° ' " or 43.79689603 DMS or DD
Long ° ' " or -123.06122623 DMS or DD
◉ Street address of hole ○ Nearest address

628 E WASHINGTON AVENUE
COTTAGE GROVE, OR 97472

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Predeepening			☐	
Completed Well	3/5/2020		☐	10

Flowing Artesian? ☐
Depth water was first found 10.00

WATER BEARING ZONES

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
3/5/2020	10	11.5	0.3		☐	10
					☐	
					☐	
					☐	
					☐	

(11) SUBSURFACE LOG

Ground Elevation _____

Material	From	To
Gravels (fill) silty, clayey	0	1.5
Clay Silty, brown, ocass. gravel, moist	1.5	11.5
Silty Sandy Ash, grey, dense,tiny gravel	11.5	30

Date Started 3/5/2020 Completed 3/5/2020

(12) ABANDONMENT LOG:

Material	From	To	Amt	sacks/ lbs
Bentonite Chips	0	30	600	P

Date Started 3/5/2020 Completed 3/5/2020

Professional Certification

(to be signed by an Oregon licensed water or monitoring well constructor, Oregon registered geologist or professional engineer).

I accept responsibility for the construction, deepening, alteration, or abandonment work performed during the construction dates reported above. All work performed during this time is in compliance with Oregon geotechnical hole construction standards. This report is true to the best of my knowledge and belief.

License/Registration Number 10288 Date 3/6/2020
First Name ROBERT Last Name BOESE
Affiliation BB&A ENVIRONMENTAL, INC.

ORIGINAL - WATER RESOURCES DEPARTMENT
THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK

Form Version:

GEOTECHNICAL HOLE REPORT - Map with location identified must be attached and shall include an approximate scale and north arrow

LANE 77209

3/6/2020

Map of Hole

STATE OF OREGON
WELL LOCATION MAP

This map is supplemental to the WATER SUPPLY WELL REPORT

Oregon Water Resources Department
725 Summer St NE, Salem OR 97301
(503)986-0900

LOCATION OF WELL

Latitude: 43.79689603 Datum: WGS84

Longitude: -123.06122623

Township/Range/Section/Quarter-Quarter Section:
WM20.00S3.00W28SESW

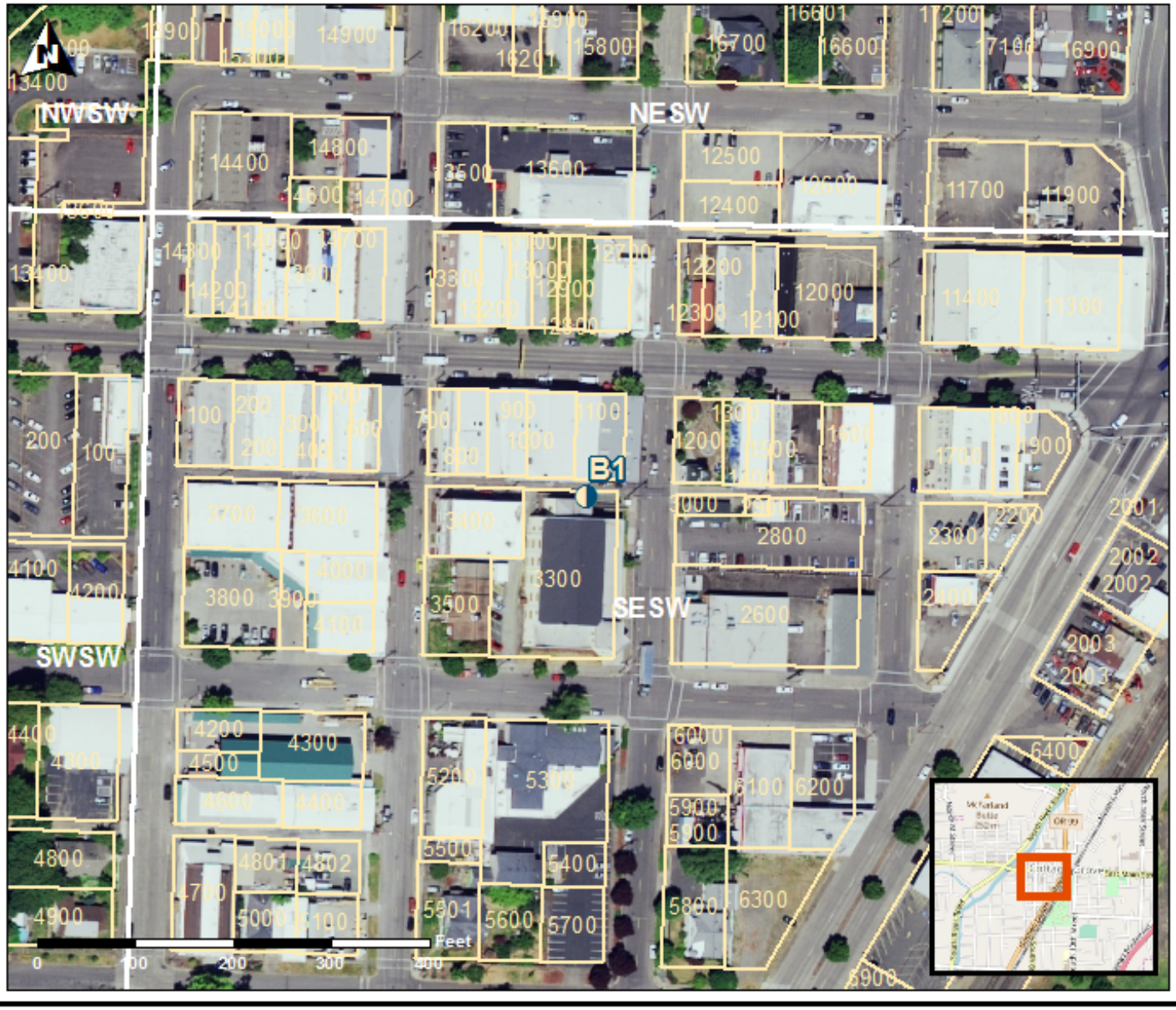
Address of Well:
628 E WASHINGTON AVENUE
COTTAGE GROVE, OR 97472

Hole Nbr: B1

Printed: March 6, 2020

DISCLAIMER: This map is intended to represent the approximate location the well. It is not intended to be construed as survey accurate in any manner.

Provided by well constructor



APPENDIX B:

Recommended Earthwork Specifications

GEOTECHNICAL SPECIFICATIONS

General Earthwork

1. All areas where structural fills, fill slopes, structures, or roadways are to be constructed shall be stripped of organic topsoil and cleared of surface and subsurface deleterious material, including but limited to vegetation, roots, or other organic material, undocumented fill, construction debris, soft or unsuitable soils as directed by the Geotechnical Engineer of Record. These materials shall be removed from the site or stockpiled in a designated location for reuse in landscape areas if suitable for that purpose. Existing utilities and structures that are not to be used as part of the project design or by neighboring facilities, shall be removed or properly abandoned, and the associated debris removed from the site.

2. Upon completion of site stripping and clearing, the exposed soil and/or rock shall be observed by the Geotechnical Engineer of Record or a designated representative to assess the subgrade condition for the intended overlying use. Pits, depressions, or holes created by the removal of root wads, utilities, structures, or deleterious material shall be properly cleared of loose material, benched and backfilled with fill material approved by the Geotechnical Engineer of Record compacted to the project specifications.

3. In structural fill areas, the subgrade soil shall be scarified to a depth of 4-inches, if soil fill is used, moisture conditioned to within 2% of the materials optimum moisture for compaction, and blended with the first lift of fill material. The fill placement and compaction equipment shall be appropriate for fill material type, required degree of blending, and uncompacted lift thickness. Assuming proper equipment selection, the total uncompacted thickness of the scarified subgrade and first fill lift shall not exceed 8-inches, subsequent lifts of uncompacted fill shall not exceed 8-inches unless otherwise approved by the Geotechnical Engineer of Record. The uncompacted lift thickness shall be assessed based on the type of compaction equipment used and the results of initial compaction testing. Fine-grain soil fill is generally most effectively compacted using a kneading style compactor, such as a sheeps-foot roller; granular materials are more effectively compacted using a smooth, vibratory roller or impact style compactor.

4. All structural soil fill shall be well blended, moisture conditioned to within 2% of the material's optimum moisture content for compaction and compacted to at least 90% of the material's maximum dry density as determined by ASTM Method D-1557, or an equivalent method. Soil fill shall not contain more than 10% rock material and no solid material over 3-inches in diameter unless approved by the Geotechnical Engineer of Record. Rocks shall be evenly distributed throughout each lift of fill that they are contained within and shall not be clumped together in such a way that voids can occur.

5. All structural granular fill shall be well blended, moisture conditioned at or up to 3% above of the material's optimum moisture content for compaction and compacted to at least 90% of the material's maximum dry density as determined by ASTM Method D-1557, or an equivalent method. 95% relative compaction may be required for pavement base rock or in upper lifts of the granular structural fill where a sufficient thickness of the fill section allows for higher compaction percentages to be achieved. The granular fill shall not contain solid particles over 2-inches in diameter unless special density testing methods or proof-rolling is approved by the Geotechnical Engineer of Record. Granular fill is generally considered to be a crushed aggregate with a fracture surface of at least 70% and a maximum size not exceeding 1.5-inches in diameter, well-graded with less than 10%, by weight, passing the No. 200 Sieve.

6. Structural fill shall be field tested for compliance with project specifications for every 2-feet in vertical rise or 500 cy placed, whichever is less. In-place field density testing shall be performed by a competent individual, trained in the testing and placement of soil and aggregate fill placement, using either ASTM Method D-1556/4959/4944 (Sand Cone), D-6938 (Nuclear Densometer), or D-2937/4959/4944 (Drive Cylinder). Should the fill materials not be suitable for testing by the above methods, then observation of placement, compaction and proof-rolling with a loaded 10 cy dump-truck, or equivalent ground pressure equipment, by a trained individual may be used to assess and document the compliance with structural fill specifications.

Utility Excavations

1. Utility excavations are to be excavated to the design depth for bedding and placement and shall not be over-excavated. Trench widths shall only be of sufficient width to allow placement and proper construction of the utility and backfill of the trench.
2. Backfilling of a utility trench will be dependent on its location, use, depth, and utility line material type. Trenches that are required to meet structural fill specifications, such as those under or near buildings, or within pavement areas, shall have granular material strategically compacted to at least the spring-line of the utility conduit to mitigate pipeline movement and deformation. The initial lift thickness of backfill overlying the pipeline will be dependent on the pipeline material, type of backfill, and the compaction equipment, so as not to cause deflection or deformation of the pipeline. Trench backfill shall conform to the General Earthwork specifications for placement, compaction, and testing of structural fill.

Geotextiles

1. All geotextiles shall be resistant to ultraviolet degradation, and to biological and chemical environments normally found in soils. Geotextiles shall be stored so that they are not in direct sunlight or exposed to chemical products. The use of a geotextile shall be specified and shall meet the following specification for each use.

Subgrade/Aggregate Separation

Woven or nonwoven fabric conforming to the following physical properties:

• Minimum grab tensile strength	ASTM Method D-4632	180 lb
• Minimum puncture strength (CBR)	ASTM Method D-6241	371 lb
• Elongation	ASTM Method D-4632	15%
• Maximum apparent opening size	ASTM Method D-4751	No. 40
• Minimum permittivity	ASTM Method D-4491	0.05 s^{-1}

Drainage Filtration

Woven fabric conforming to the following physical properties:

• Minimum grab tensile strength	ASTM Method D-4632	110 lb
• Minimum puncture strength (CBR)	ASTM Method D-6241	220 lb
• Elongation	ASTM Method D-4632	50%
• Maximum apparent opening size	ASTM Method D-4751	No. 40
• Minimum permittivity	ASTM Method D-4491	0.5 s^{-1}

Geogrid Base Reinforcement

Extruded biaxially or triaxially oriented polypropylene conforming to the following physical properties:

• Peak tensile strength lb/ft	ASTM Method D-6637	925
• Tensile strength at 2% strain lb/ft	ASTM Method D-6637	300
• Tensile strength at 5% strain lb/ft	ASTM Method D-6637	600
• Flexural Rigidity	ASTM Method D-1388	250,000 mg-cm
• Effective Opening Size rock size	ASTM Method D-4751	1.5x