Preliminary Storm Drainage Report

PREPARED FOR:

Panattoni Development Company, Inc.
1821 Dock Street, Suite 100
Tacoma, WA 98402

PROJECT:

Panattoni Rock Creek Industrial
13700 SW Tonquin Road
Sherwood, OR 97140
2230336.10

PREPARED BY:

Eric Bisch, EIT
Project Engineer

REVIEWED BY:

Bart Brynestad, PE
Associate Principal

DATE:

October 2023

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BARTON EDWARD BRYNESTAD
54242

10/23/2023

I hereby state that this Storm Drainage Report for the Panattoni Rock Creek Industrial project has been prepared by me or under my supervision and meets the standard of care and expertise that is usual and customary in this community for professional engineers. I understand that Washington County does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities prepared by me.

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Geotechnical Report

1.0 Project Overview

The proposed project will develop a new industrial park in Sherwood, Oregon. The existing site area of 29.91 acres will decrease to 25.60 acres after dedicating a right-of-way for future road improvements by others. The project will consist of an approximately 413,250-square foot, tilt-up concrete, industrial building; associated parking for passenger vehicles and trailers; truck docks; maneuvering areas; landscape; utilities; and stormwater facilities.

Proposed impervious surface area exceeds 1,000 square feet; therefore, a hydromodification assessment is required. Based on Clean Water Services' (CWS) Hydromodification Planning Tool, the development is located within an expansion area and a portion of the site has a hydromodification risk of high. Because a portion of the site is within a high hydromodification risk zone, the project will have a high-risk designation. The site development is approximately 29.91 acres; therefore, the development is classified as a Category 3 large project based on CWS Table 4-2. Because of a Category 3 large project classification, the development is required to have at least 30 percent of the proposed impervious area treated and detained in LIDA facilities.

1.1 Location

The proposed project is situated at the end of Commerce Court and adjacent to other proposed industrial development sites. The site is an assemblage of two vacant tax parcels, 2S133BB/100 and 2S133/400, which are located approximately 75 feet above SW Tonquin Road and sit approximately 200 feet to the east of SW Tonquin Road.

Refer to Appendix A-1 for the Vicinity Map.

1.2 Methodology

The proposed storm design will meet the requirements of the CWS *Design and Construction Standards for Sanitary Sewer and Surface Water Management*, December 2019 *(CWS Standards)*.

2.0 Existing Conditions

2.1 Topography

Parcel 2S133BB/100 is an approximately 8-acre, triangular-shaped property that generally slopes toward the west toward SW Tonquin Road. Elevations within the parcel range from 135.00 along the west parcel boundary to 195 along the east parcel boundary. Maximum slopes of approximately 2:1 can be observed on the topographic survey. Portions of the site have been previously cleared and currently consist of bare soils. Site vegetation generally consists of grasses, brush, and scattered deciduous and coniferous trees.

Parcel 2S133/400 is an approximately 20-acre rectangular property that was previously used by a construction company for stockpiling, material processing, and heavy equipment parking. Grades are generally flat; however, there is an overall slope toward the west. Elevations within the parcel range from 160 at the west parcel boundary to 220 at the east parcel boundary. Although grades are generally flat, there are localized slope areas near the southwest corner of the property that are generally between 2:1 and 1:1. Most of the existing site has been previously cleared and currently consists of bare soils. Site vegetation generally consists of grasses, brush, and scattered deciduous trees.

2.2 Climate

The site is located in Sherwood, Oregon. Average daily temperatures range from 48°F to 71°F. Record temperatures recorded for this region of the state are 7°F to 108°F. Average annual rainfall recorded in this area is 40 inches. Average annual snowfall is approximately 5.3 inches between December and February.

2.3 Site Geology

Based on subsurface exploration by the geotechnical consultant, Columbia River Basalt Bedrock was encountered in all but two out of 26 test pits. This correlates with the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey Map of Washington County, Oregon, which shows approximately 80 percent of the site as Xerochrepts-Rock outcrop complex. Therefore, the majority of the site is assigned soil Group D. Group D soils have very slow infiltration rates when saturated; therefore, stormwater infiltration is infeasible for this project. Soil types on the site, as classified by the USDA Soil Survey Map, are identified in Table 2-1.

Refer to Appendix A-2 for the NRCS Soils Map.

Table 2-1: Soil Characteristics

Soil Type	Hydrologic Group
Briedwell Stony Silt Loam	B
Laurelwood Silt Loam	B
Xerochrepts-Rock Outcrop Complex	D

2.4 Curve Number

The curve number represents runoff potential from the soil. The major factors for determining the curve number values are hydrologic soil group, cover type, treatment, hydrologic condition, and antecedent runoff condition. The pervious curve number of 85 was used, representing a combination of D-Poor condition open space and B-Poor condition open space.

Refer to Appendix A-6 for the Runoff Curve Number Table.

2.5 Time of Concentration

The time of concentration, as described in NEH4 Chapter 15, is defined as the time for runoff to travel from the furthermost point of the watershed to the point in question, and the time from the end of excess rainfall to the point of inflection on the trailing limb of the unit hydrograph. A time of concentration of 16 minutes was used for the existing condition.

2.6 Hydrology

Because the existing site soils have a poor infiltration rate, most stormwater runoff surface flows toward the west to a drainage ditch adjacent to SW Tonquin Road. Water within the drainage ditch crosses SW Tonquin Road and flows west, where it discharges into Rock Creek.

2.7 Basin Area

Impervious and pervious surface areas for the existing site are shown in Table 2-2. The site is 100 percent pervious in existing conditions.

Table 2-2: Existing Basin Areas

Basin	Impervious Area (ac)	Pervious Area (ac)	Total Area (ac)
Basin 1	0	25.60	25.60

3.0 Proposed Conditions

3.1 Curve Number

The pervious curve number of 80 was used for the landscaped areas and an impervious curve number of 98 was used for all impervious surfaces.

3.2 Time of Concentration

A time of concentration of 10 minutes was used for the developed basins.

3.3 Basin Area

Impervious and pervious surface areas for proposed conditions are shown in Table 3-1. The site is 70 percent impervious in proposed conditions.

Table 3-1: Proposed Basin Areas

Basin	Impervious Area (ac)	Pervious Area (ac)	Total Area (ac)
Basin 1	17.92	7.68	25.60

Refer to Appendix B-2 for the Proposed Basin Map.

3.4 Hydrology

Onsite runoff will be collected in catch basins and downspouts prior to being routed to stormwater LIDA facilities sized to meet CWS water quality and flow requirements. Runoff will be treated and detained through these systems before exiting the site through stormwater improvements that will be built as part of the future road improvements by others. The stormwater system was designed to meet CWS hydromodification requirements, which classify this as a Category 3 (large) project. To meet this requirement, LIDA facilities must be used to treat at least 30 percent of the impervious area onsite and post-developed release rates must match pre-developed release rates for 50 percent of the 2-, 5-, and 10-year, 24-hour storms (Table 4-7 in the *CWS Standards*). In addition, the 25-year post-developed release rate will be less than or equal to the 25-year pre-developed release rate.

Pretreatment will be provided with water quality manholes prior to onsite treatment, which will be provided in a single LIDA stormwater treatment and detention pond designed per *CWS Standards* Section 4.09.2. There will be a flow control structure at the pond outlet, with orifice controls and standpipes designed to meet CWS requirements for the post-developed release rate. The outlet of the pond will connect to the storm drain system being installed within the proposed road improvements by others. Flow from the proposed storm drainage system will ultimately discharge to Rock Creek.

4.0 Hydrologic and Hydraulic Analysis

4.1 Design Guidelines

The analysis and design criteria used for stormwater management described in this section will follow the *CWS Standards*. Section 5.04.2 of the *CWS Standards* describes the allowable flow determination methods, including the selected Santa Barbara Urban Hydrograph (SBUH) method. Autodesk 2023 Storm and Sanitary Sewer Analysis (SSA) was used for the hydrology and hydraulic analysis.

4.2 Hydrologic Method

SBUH was used for this analysis. The SBUH method is based on the curve number (CN) approach and uses the Soil Conservation Service's (SCS) equations for computing soil absorption and precipitation excess. The SBUH method converts the incremental runoff depths into instantaneous hydrographs, which are then routed through an imaginary reservoir with a time delay equal to the basin time of concentration.

4.3 Design Storm

The rainfall distribution to be used within the CWS jurisdiction is the design storm of 24-hour duration, based on the standard Type 1A rainfall distribution. Table 4-1 shows total precipitation depths for different storm events.

Table 4-1: Precipitation Depth

Recurrence Interval	Total 24-Hour Precipitation Depth (in)
2-year	2.5
5-year	3.10
10-year	3.45
25-year	3.90

4.4 Basin Runoff

Table 4-2 lists the runoff rates for proposed conditions for the entire site during the 2-, 5-, 10-, and 25-year storm events, as calculated from the SSA model. These values do not include onsite detention.

Table 4-2: Proposed Discharge Flows

Recurrence Interval (Years)	Existing Peak Runoff Rate (cfs)	Proposed Peak Runoff Rate (cfs)
2-year	5.69	10.97
5-year	8.55	14.29
10-year	10.08	15.97
25-year	12.69	18.80

5.0 Conveyance Analysis

5.1 Design Guidelines

The analysis and design criteria described in this section will follow the requirements set forth in the *CWS Standards*. The manual requires that storm drainage systems and facilities be designed to provide a minimum of 1 foot of freeboard between the HGL and finished grade during the 25-year storm event. A complete conveyance analysis will be provided with the final drainage report.

5.2 System Capacity

The proposed conveyance system will be designed to convey and contain the peak runoff from a 25-year design storm and maintain 1 foot of freeboard between the hydraulic grade line and finish grade, per section 5.05.2 of the *CWS Standards*.

6.0 Water Quality

6.1 Design Guidelines

The proposed water quality facilities were designed per the requirements set forth in the *CWS Standards*. The facilities were designed using a rainfall depth of 0.36 inch over a 4-hour period, with a return period of 96 hours. Per *CWS Standards* Section 4.08.5, the water quality volume and flow rate are calculated according to the equations below:

$$\text{Water Quality Volume (cf)} = \frac{0.36\text{ (in)} \times \text{Area (sf)}}{12\text{ (in/ft)}} \qquad \text{Water Quality Flow} = \frac{\text{WQV (cf)}}{14{,}400}$$

Refer to Appendix B-4 for Water Quality Calculations.

6.2 Pretreatment Facilities

CWS requires pretreatment prior to proposed water quality facilities. In accordance with *CWS Standards* Section 4.07.1, water quality manholes are approved pre-treatment devices and will be used on the site. Water quality manholes will be designed per *CWS Standards* Section 4.09.1 and CWS Drawing No. 250.

6.3 Water Quality Facilities

Water quality treatment will be provided in the proposed LIDA ponds, designed as extended dry basins per *CWS Standards* Section 4.09.5 (see Appendix A-7 for the CWS LIDA Handbook – Extended Dry Basin). The LIDA facility is designed to meet the following criteria:

- Permanent pool depth of 0.2 foot.
- 3:1 side slopes.
- Drain down the water quality storm event within 48 hours.
- Minimum of 1 foot of freeboard during the 25-year storm event.

Hydrographs and pond stage graphs can be found in the Appendix. Refer to Table 6-1 below for specific facility information. Please note there is a 0.2-foot permanent pool depth in addition to the facility depths listed below. The permanent pool depth/volume was not accounted for in the pond sizing.

See Appendix B-4 for Water Quality Calculations

Table 6-1: Extended Dry Basin Table

Contributing Impervious Area (ac)	17.92
Water Quality Volume (cf)	23,601
Facility Bottom Area (sf)	11,277
Surface Area at Water Surface (sf)	15,009
Water Quality Depth (ft)	2.06

7.0 Water Quantity

7.1 Design Guidelines

The water quantity facilities were designed in accordance with Section 4.03.5(c) of the *CWS Standards*. The detention standards require the post-developed runoff rates do not exceed the pre-developed runoff rates, as listed in *CWS Standards* Section 4.08.6(c) and as shown in Table 7-1 below. In accordance with *CWS Standards* Section 4.09.2(c), the water quantity facility will be combined with the water quality facility.

Table 7-1: Required Release Rates

Post-Development Peak Runoff Rate	Pre-Development Peak Runoff Rate Target
2-year, 24-hour	50% of 2-year, 24-hour
5-year, 24-hour	5-year, 24-hour
10-year, 24-hour	10-year, 24-hour
25-year, 24-hour	25-year, 24-hour

7.2 Design Guidelines

Table 7-2 below lists the pre-developed and the proposed design release rates generated at each site outfall. In all cases, the proposed release rates meet the criteria listed in *CWS Standards* Section 4.08.6(c).

Table 7-2: Existing and Proposed Release Rates

Storm Event	Existing Peak Flow (cfs)	Proposed Peak Flow (cfs)
2-year, 24-hour	5.69	2.63
5-year, 24-hour	8.55	5.47
10-year, 24-hour	10.08	7.15
25-year, 24-hour	12.69	9.85

Each pond will have its own control structure with orifice and weir controls, as described in Table 7-4 below. In each control structure, the bottom orifice was designed as the WQ orifice and sized to drawdown the pond in 48 hours. Table 7-3 below shows the inputs and results of the orifice sizing equation listed in *CWS Standards* Section 4.09.5(b)5.

Table 7-3: Existing and Proposed Release Rates

Contributing Impervious Area (ac)	17.92
Water Quality Volume (cf)	23,601
WQ Height (ft)	2.06
Design WQ Orifice Diameter (in)	2.18
Actual WQ Orifice Diameter (in)	2.25

The WQ height was determined by determining how high the WQ storm event staged up. The bottom orifice was sized to meet the drawdown requirement of 48 hours, based on the WQ height.

The second orifice and the rectangular notch were designed to meet the flow control standards listed in Table 7-1 above. Maximum stage during the 25-year storm event does not exceed the minimum freeboard requirement of 1.0 foot listed in *CWS Standards* Section 4.09.2(c)

Refer to Appendix B-3 for the Hydromodification Calculations and B-5 for the SSA Report.

Table 7-4: Control Structure

Top of Berm	148.25
Rectangular notch	147.25
8-inch Orifice	144.06
2.25-inch Orifice	142.20
Bottom of Pond	142.00

8.0 Downstream Analysis

8.1 Design Guidelines

CWS requires a review of the downstream conveyance system for sites that add greater than 12,000 square feet of new impervious area. *CWS Standards* Section 2.04.2 m.4(b) requires the downstream analysis shall follow the conveyance system to the Point of Discharge and extend downstream for 0.25 mile from the Point of Discharge, which is Rock Creek. The project is classified as hydromodification Category 3.

8.2 Hydraulic Analysis

A full downstream analysis will be performed to confirm that the proposed project does not cause any deficiencies in the existing downstream system. The downstream system will be analyzed to 0.25 mile downstream of the site using Autodesk Storm and SSA 2023, based on a 25-year storm event, per *CWS Standards* Section 5.05.4.

9.0 Conclusion

The proposed stormwater management design follows Clean Water Services *Design and Construction Standards for Sanitary Sewer and Surface Water Management*, December 2019.

Onsite water quality treatment and flow control will be provided by proposed extended dry basin LIDA facilities. The proposed private conveyance system is designed using the 25-year storm event. Treated and detained runoff will exit the site and be conveyed to Rock Creek by a new drainage system that will be constructed as part of the proposed roadway improvements by others.

This project meets the intent of the standards set forth by Clean Water Services.

This analysis is based on data and records either supplied to or obtained by AHBL. These documents are referenced within the text of the analysis. The analysis has been prepared using procedures and practices within the standard accepted practices of the industry.

AHBL, Inc.

Eric Bisch, EIT
Project Engineer

EB/lsk

October 2023

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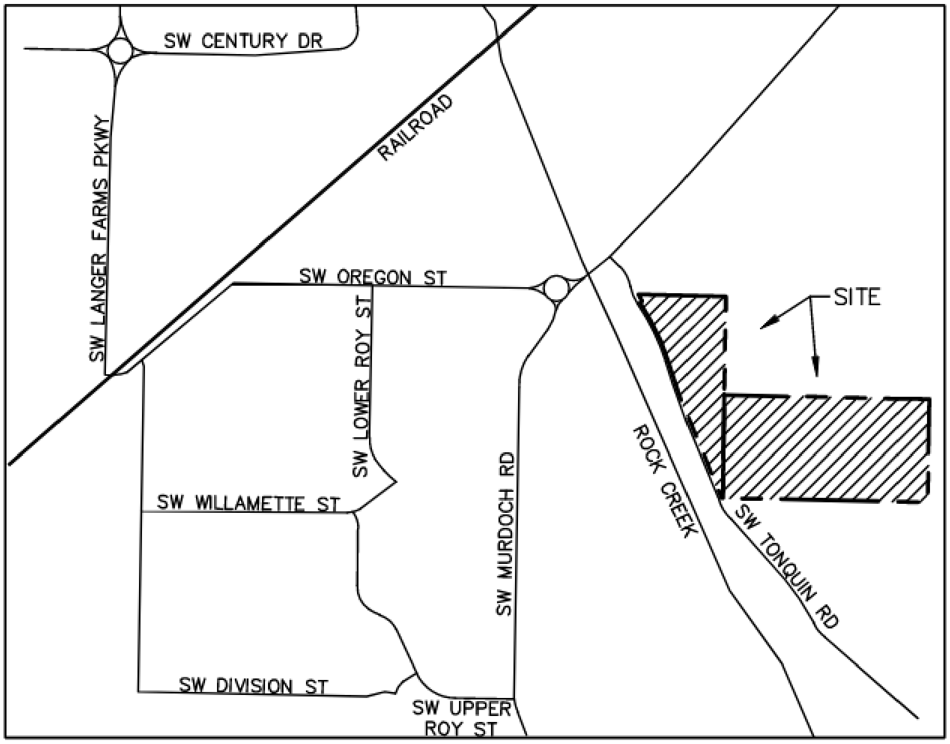
Appendix A

Exhibits

A-1 ....Vicinity Map
A-2 ....Existing Conditions
A-3 ....Preliminary Drainage Plan
A-4 ....FEMA Flood Map
A-5 ....NRCS Soils Map
A-6 ....CN Table
A-7 ....Extended Dry Basin Cutsheets
A-8 ....Downstream Drainage Map

VICINITY MAP

1"-1000'



2215 North 30th Street
Suite 300
Tacoma, WA 98403
253.383.2422 TEL
253.383.2572 FAX

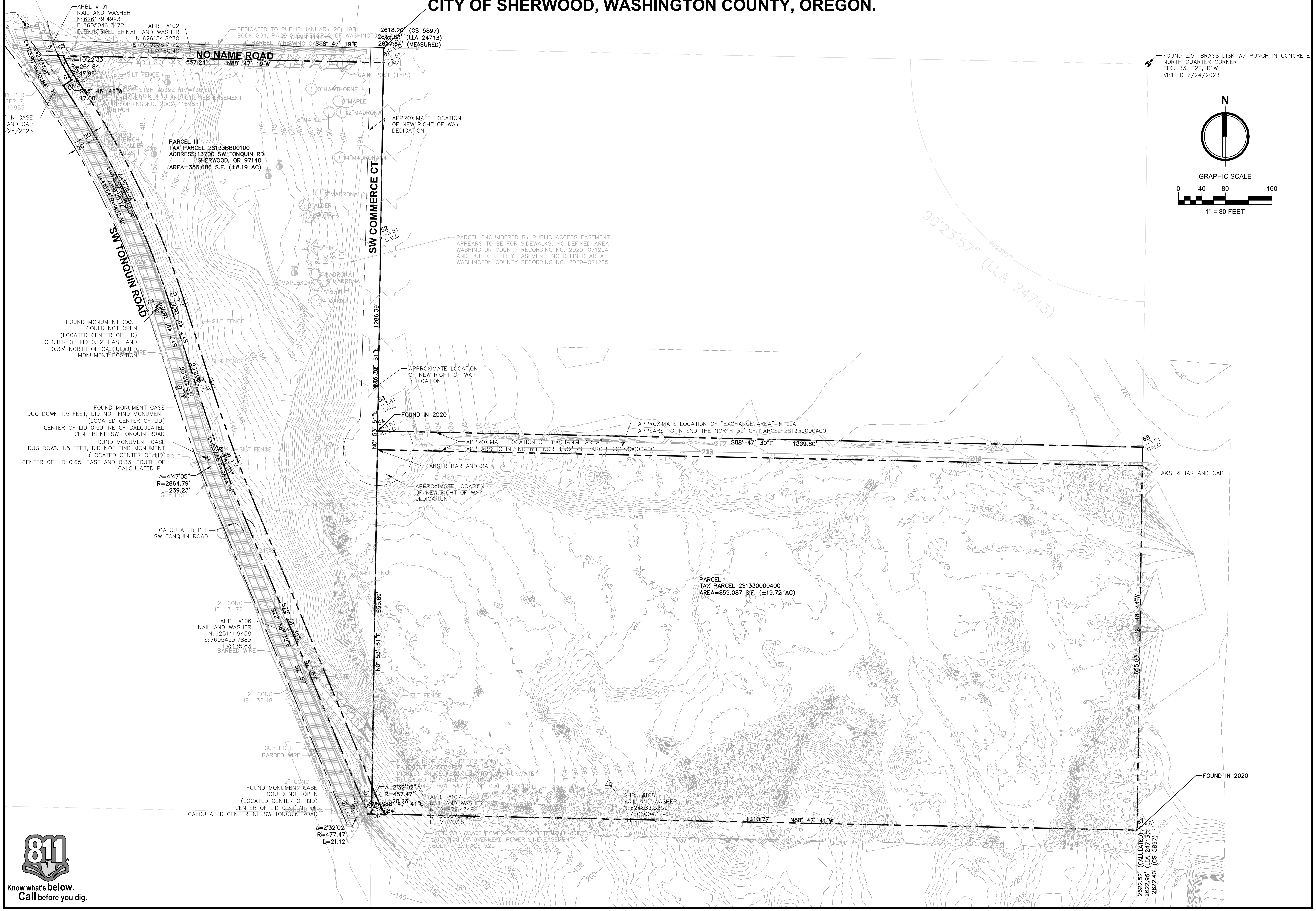
Panattoni Rock Creek Industrial

Vicinity Map

A-1

ROCK CREEK INDUSTRIAL

A PORTION OF THE NE 1/4 AND THE NW 1/4 OF THE NW 1/4 OF SEC. 33, TWN. 02 S., RGE. 01 W., W.M., CITY OF SHERWOOD, WASHINGTON COUNTY, OREGON.



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Project Title:

ROCK CREEK INDUSTRIAL

Client:

PANATTONI DEVELOPMENT COMPANY, LLC

1821 DOCK STREET, SUITE 100
TACOMA, WA 98402

MR BRENDA FODGE

Project No.

2230336.10

Issue Set & Date:

SITE PLAN REVIEW

9/27/2023

REGISTERED PROFESSIONAL ENGINEER
101868PE
OREGON
JAN 10, 2023
BARTON EDWARD BRYNESTAD

EXPIRATION DATE: 12/31/2025

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4
3
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Revisions:

Sheet Title:

EXISTING CONDITIONS

Designed by:	Drawn by:	Checked by:
BB	TS	BB

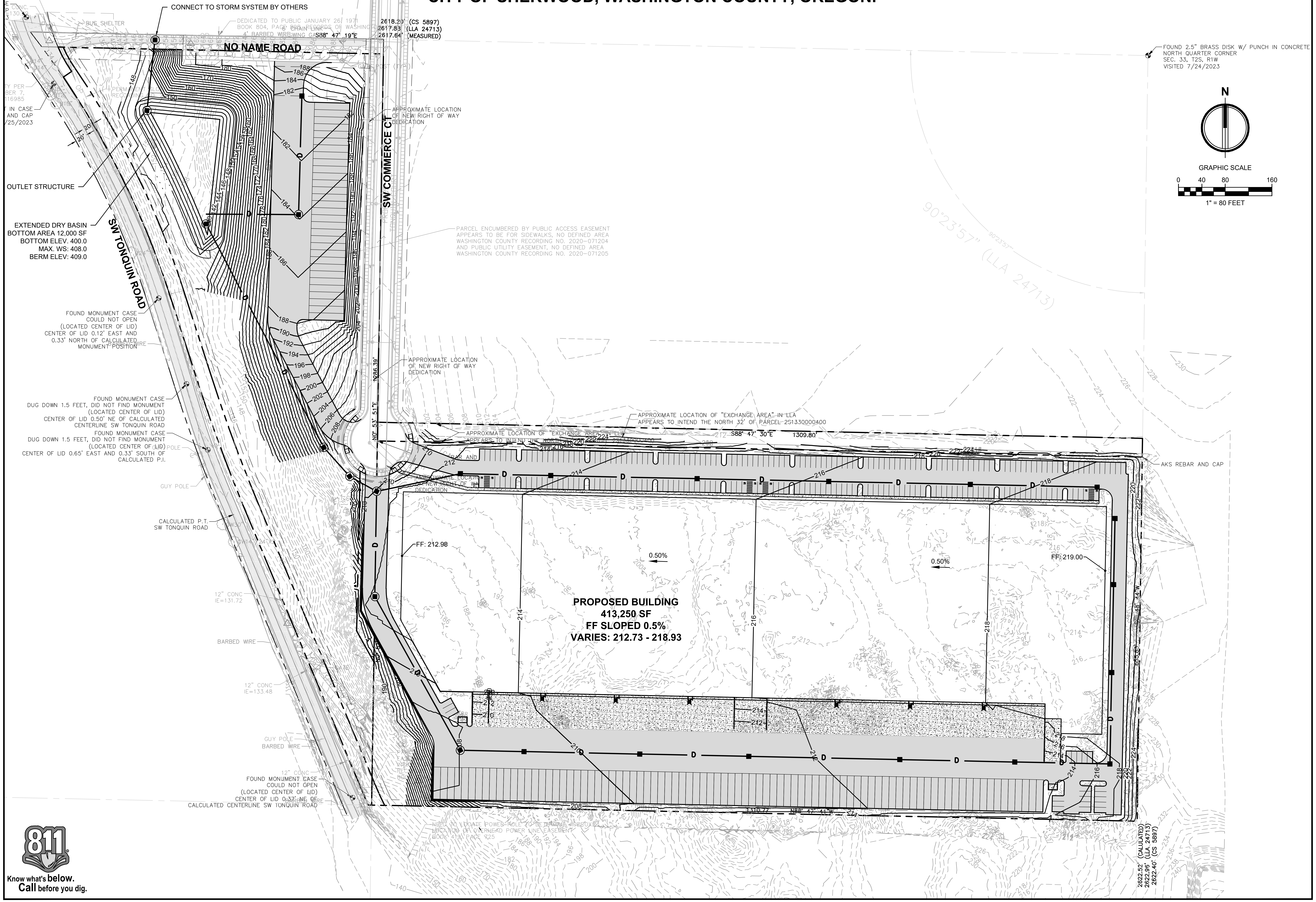
Sheet No.

A-2

1 of 1 Sheets

ROCK CREEK INDUSTRIAL

A PORTION OF THE NE 1/4 AND THE NW 1/4 OF THE NW 1/4 OF SEC. 33, TWN. 02 S., RGE. 01 W., W.M., CITY OF SHERWOOD, WASHINGTON COUNTY, OREGON.



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4
3
2
1
Revisions:

Sheet Title:
PRELIMINARY DRAINAGE PLAN

Designed by:	Drawn by:	Checked by:
BB	TS	BB

Sheet No.
A-3
1 of 1 Sheets

DATE: October 12, 2023 FILENAME: Q:\2023\2230336\10_CIV\CAD_Site Plan Review\2230336-SH-STRM.dwg

National Flood Hazard Layer FIRMette

A-4

FEMA

122°49'27"W 45°21'41"N

Feet
0 250 500 1,000 1,500 2,000

1:6,000

122°48'49"W 45°21'15"N

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- ▨ Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- ▨ Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- ▨ 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- ▨ Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- ▨ Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- ▨ Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- ▭ Effective LOMRs
- ▨ Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- – — – Channel, Culvert, or Storm Sewer
- IIIIIII Levee, Dike, or Floodwall

OTHER FEATURES
- (B) 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 — — Coastal Transect
- ~~~ 513 ~~~ Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- --- --- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- ☐ Digital Data Available
- ☐ No Digital Data Available
- ☒ Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

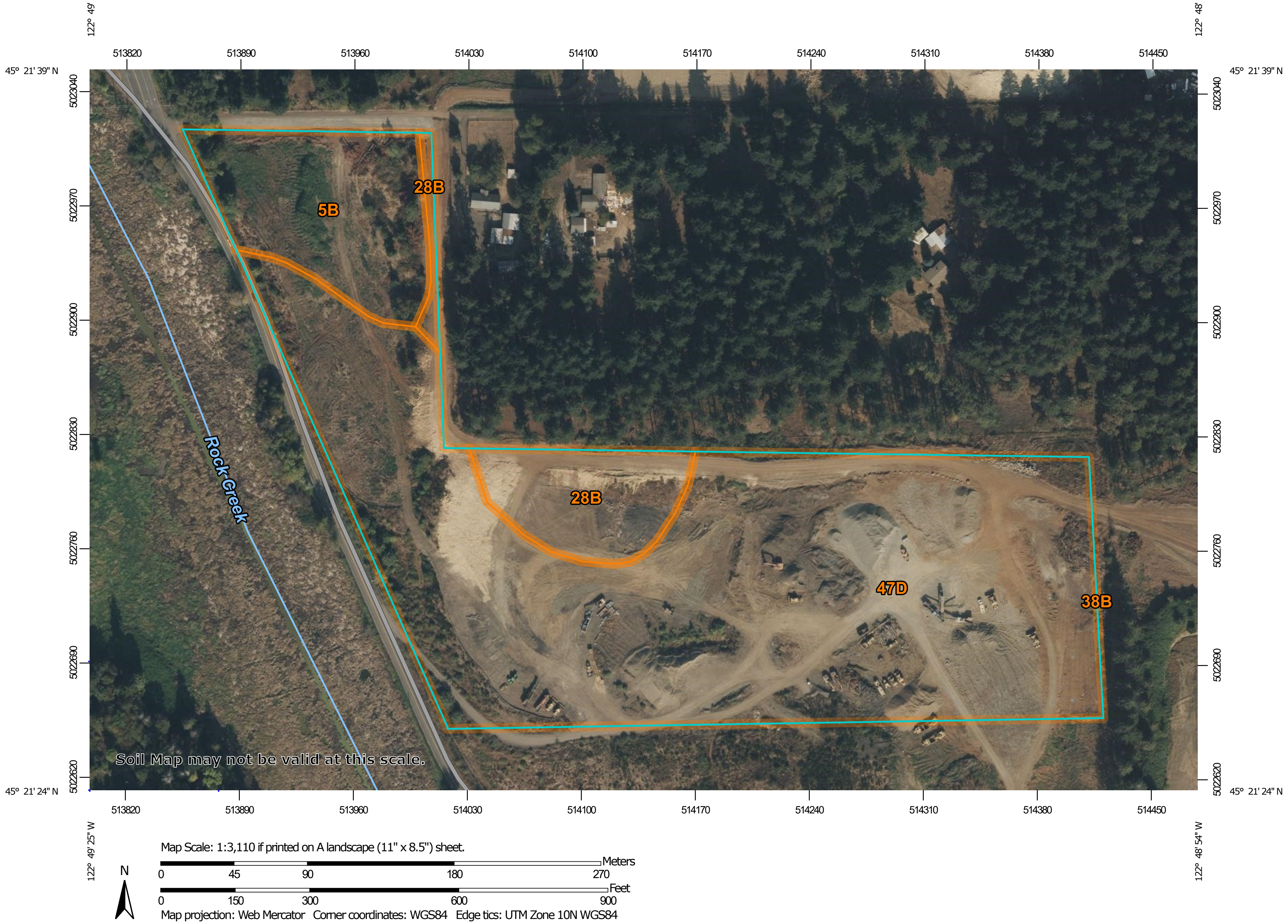
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 10/17/2023 at 6:35 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

A-5 NRCS Soils Map

Soil Map—Washington County, Oregon



Map Scale: 1:3,110 if printed on A landscape (11" x 8.5") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Washington County, Oregon
Survey Area Data: Version 23, Sep 7, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 26, 2022—Oct 11, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
5B	Briedwell stony silt loam, 0 to 7 percent slopes	3.1	13.2%
28B	Laurelwood silt loam, 3 to 7 percent slopes	2.0	8.5%
38B	Saum silt loam, 2 to 7 percent slopes	0.0	0.0%
47D	Xerochrepts-Rock outcrop complex	18.4	78.3%
Totals for Area of Interest		**23.5**	**100.0%**

A-6 CN Table

Table 2-2a Runoff curve numbers for urban areas [1]

---------- Cover description ----------		Curve numbers for ----hydrologic soil group----			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

---

[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

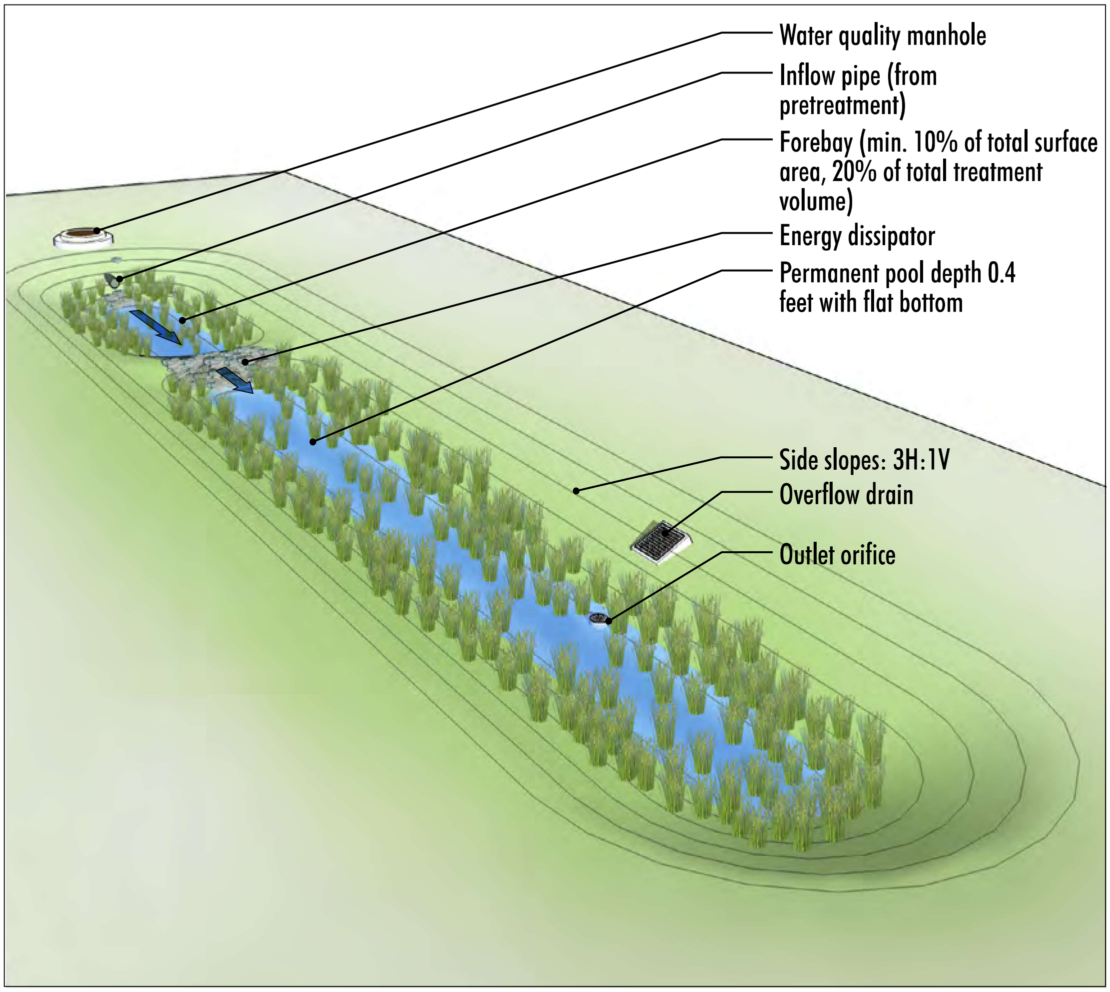
[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

A-7

Extended Dry Basin



parking areas & impermeable landscape

impermeable soils

permeable soils

Description

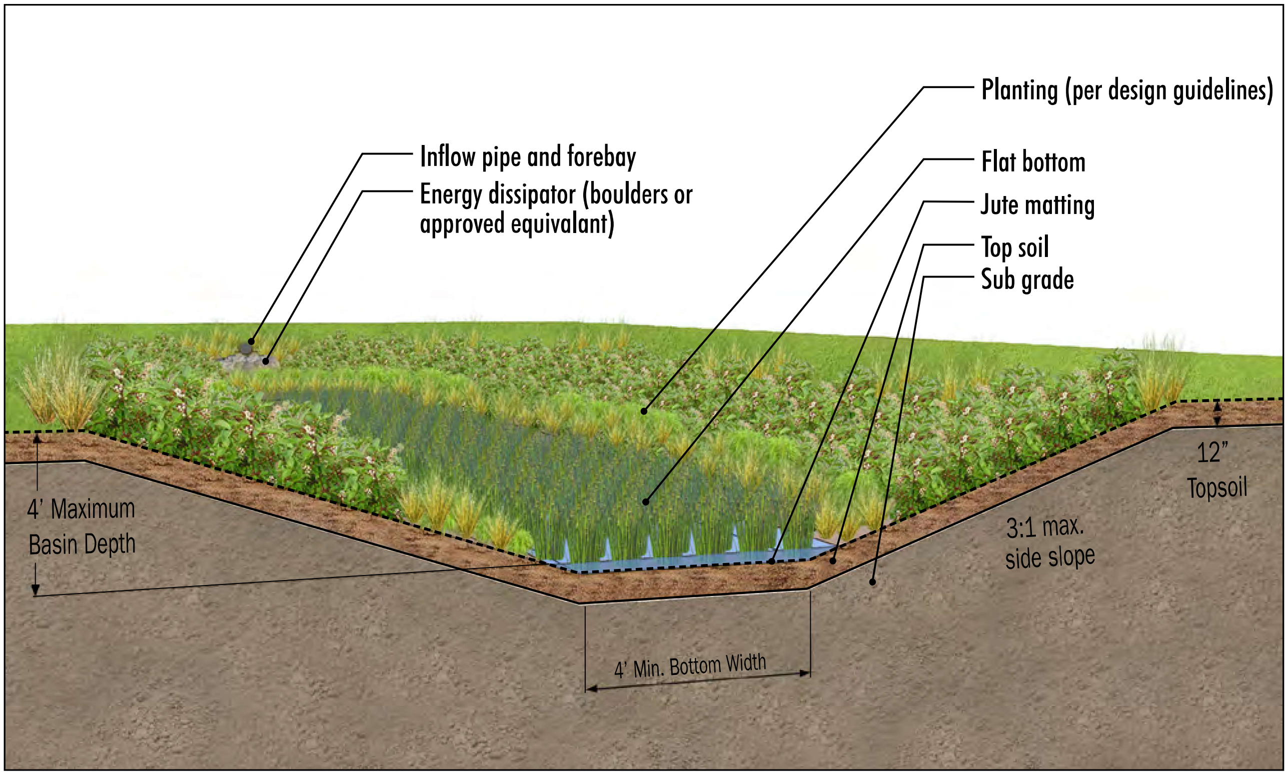
An extended dry basin is a shallow landscaped depression with a flat bottom that collects and holds stormwater runoff, allowing pollutants to settle and filter out as the water infiltrates into the ground or is discharged to an approved location. An extended dry basin has two or more cells (the first cell is the forebay). An inflow pipe conveys stormwater into the basin where it is temporarily stored. Extended dry basins may infiltrate stormwater where soils have high infiltration rates, or may overflow to an approved discharge point.

Application & Limitations

Extended dry basins may help fulfill a site's landscaping area requirement. This type of swale is approved to treat stormwater from all types of impervious surfaces, including private property and the public right-of-way, rooftops, parking lots, and streets.

Home Depot, Glenn Widing Drive, North Portland

A-7
Extended Dry Basin



Design Factors

Sizing

Sizing of the detention basin is determined by the volume of runoff and the detention period required for treatment. At a minimum, the detention basin must accommodate the water quality design storm and be sized for a 48 hour drawdown time.

The minimum water quality detention volume is equal to (1) x the water quality volume (WQV). The outlet orifice size is determined by the following equation:

D = 24 * [(Q/ (C[2gH]0.5) / pi] 0.5

Where:
D (in) = diameter of orifice
Q(cfs) = WQV(cf) /(48*60*60)
C = 0.62
H(ft) = 2/3 x temporary detention height to centerline of orifice.

Geometry/Slopes

An extended dry basin has two or more cells. The first cell, the forebay, is at least 10% of the entire surface area and constitutes 20% of the treatment volume. The minimum width of the bottom of the extended dry basin is 4 feet, and the permanent pool depth is 0.4 feet and covers the entire bottom of the basin. The maximum depth of the water quality pool, not including the permanent pool, is 4 feet unless otherwise limited by the jurisdiction.
The maximum side slopes of the basin treatment area are 3H: 1V (33.33%); the minimum freeboard is 1 foot above the 25-year design water surface elevation.

Piping for Extended Dry Basins

Incoming flows are pretreated using a water quality manhole in accordance with the District Standards. Other pretreatment may include proprietary devices, filter strip, trapped catch basin, or methods approved by the District or City. An approved outlet structure is provided for all flows.

Setbacks

Check with the local building department to confirm site-specific requirements.

Soil Amendment/Mulch

If required, place ¾" to 2-inch river run rock 2.5 to 3 inches deep where sustained flow is anticipated. River rock (if required), topsoil, and high density jute or coconut matting extend to the top of the treatment area. Topsoil and low density jute matting extend to the edge of the water quality tract or easement area.

Extended Dry Basin

Washington County

Vegetation

The entire facility area (side slopes and treatment areas) is planted with vegetation appropriate for the varying planting conditions within the extended dry basin. Planting conditions vary from saturated soil to relatively dry, and several planting zones should be considered. The flat bottom of the extended dry basin to the top of the 0.4 foot permanent pool is a saturated zone and will be constantly inundated with water. The saturated zone should be planted with rushes, sedges, and other wetland species (oxygenators) that are well-suited to water-saturated, oxygen-deprived (anaerobic) planting conditions.

The side slopes above the permanent pool depth will vary from wet at the bottom to relatively dry near the top where inundation rarely occurs. This moisture gradient will vary depending upon the designed maximum water depth, basin depth, and side slope steepness. This wet-to-moist transition zone from the top of the permanent pool to the designed high water line or top of freeboard should be planted with sedges, rushes, perennials, ferns and shrubs that can tolerate occasional standing water and wet-to-moist planting conditions. The areas above the designed high water line and immediately adjacent to the extended dry basin will not be regularly inundated. The dry zone should be planted with self-sustaining, low maintenance grasses, perennials, and shrubs suitable for the local climate and site.

The use of native plants is encouraged, but appropriate, adapted non-invasive ornamentals are acceptable for added aesthetic and functional value. All vegetation should be densely and evenly planted to ensure proper hydrological function of the extended dry basin.

Plant Spacing

A) Extended Dry Basins in tracts or easements *less than* 30 feet wide are planted as follows to achieve the specified per acre densities:
i. Treatment area = 6 plugs per square foot (min. 1-inch diameter by 6-inch tall)
ii. Total number of shrubs per acre = area in square feet x 0.05
iii. Groundcover = plant and seed to achieve 100% coverage

B) Extended Dry Basins in tracts or easements 30 feet wide or more are planted as followings to achieve the specified per acre densities:
i. Treatment area = 6 plugs per square foot (min. 1-inch diameter by 6-inch tall)
ii. Total number of trees per acre = area in square feet x 0.01
iii. Total number of shrubs per acre = area in square feet x 0.05
iv. Groundcover = plant and seed to achieve 100% coverage

Extended Dry Basin

Home Depot, Glenn Widing Drive, North Portland

Washington County

Required Maintenance Period

- Water-efficient irrigation should be applied for the first two years after construction of the facility, particularly during the dry summer months, while plantings become established. Irrigation after these two years is at the discretion of the owner.
- If public, the permittee is responsible for the maintenance of the extended dry basin for a minimum of two years following construction and acceptance of the facility.

Long Term Maintenance

If private, the property owner will be responsible for ongoing maintenance per a recorded maintenance agreement (see page 88 for example maintenance agreement).

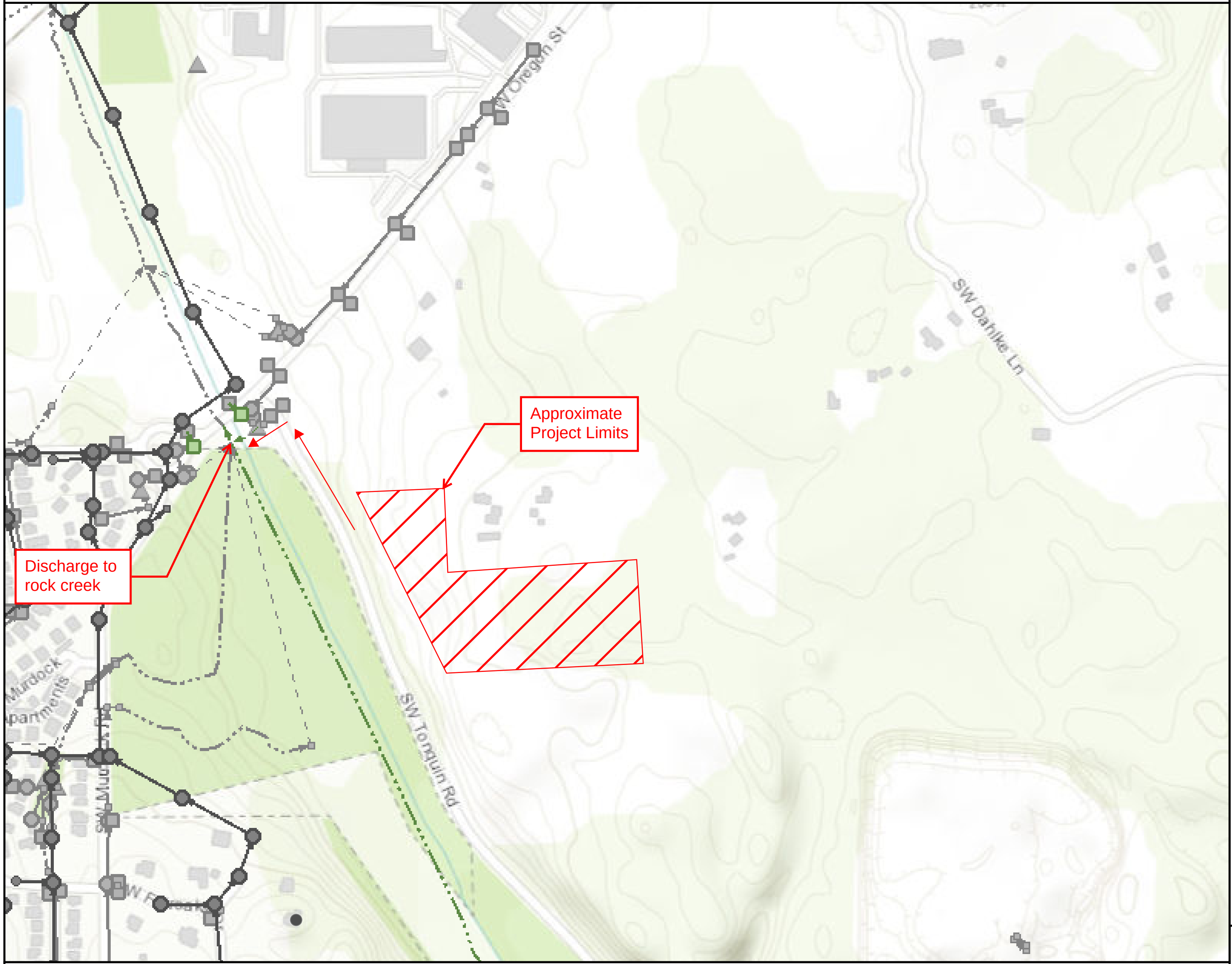
For detailed Operation and Maintenance Plans that describe proper maintenance activities please refer to page 91.

All publicly maintained facilities must have a public easement.

References

Clean Water Services Design and Construction Standards

A-8 Downstream Map



Approximate Project Limits

Discharge to rock creek

Legend

- o Cleanout
- ▫ Fitting
- ◐ Valve
- ○ Manhole
- □ Inlet
- △ Pond
- □ Vault
- ☆ Treatment Plant
- Ⓟ Pump Station
- → Gravity Line
- → Pressure Line
- → Open Channel
- -→ Virtual Flow
- ⬚ Pond Outline
- ▭ CWS Boundary
- ▭ County Boundary
- ▭ Urban Growth Boundary

X Abandoned

🟥 CWS Sani	🟩 CWS Storm
■ Partner Sani	■ Partner Storm

N

0 0.05 0.1 0.19 mi

Disclaimer: This product and its associated data is for informational purposes only and was derived from several databases. It was not prepared for, and is not suitable for legal, engineering or surveying purposes. Users of this information should review or consult the primary data and information sources to ensure accuracy. Clean Water Services cannot accept any responsibility for errors, omissions or positional accuracy. There are no warranties for this product. Mainline and service lateral locations are depicted using best available information but must be field verified and located before digging. Service laterals are marked in the field as “Unlocatable underground facilities” as defined in OAR 952-001-0010 (20). Easement data is not currently completed District-wide and should be used for general reference only. All sanitary or storm sewer data, with the exception of sanitary lines 24” and larger located within the city limits of Beaverton, Cornelius, Forest Grove, Hillsboro, Lake Oswego, Portland, Sherwood, Tigard or Tualatin, need to be verified by contacting the individual city. Notification of any errors would be appreciated. Clean Water Services, Development Services, 2550 SW Hillsboro Highway, Hillsboro OR 97123, (503) 681-5100.

Clean Water Services

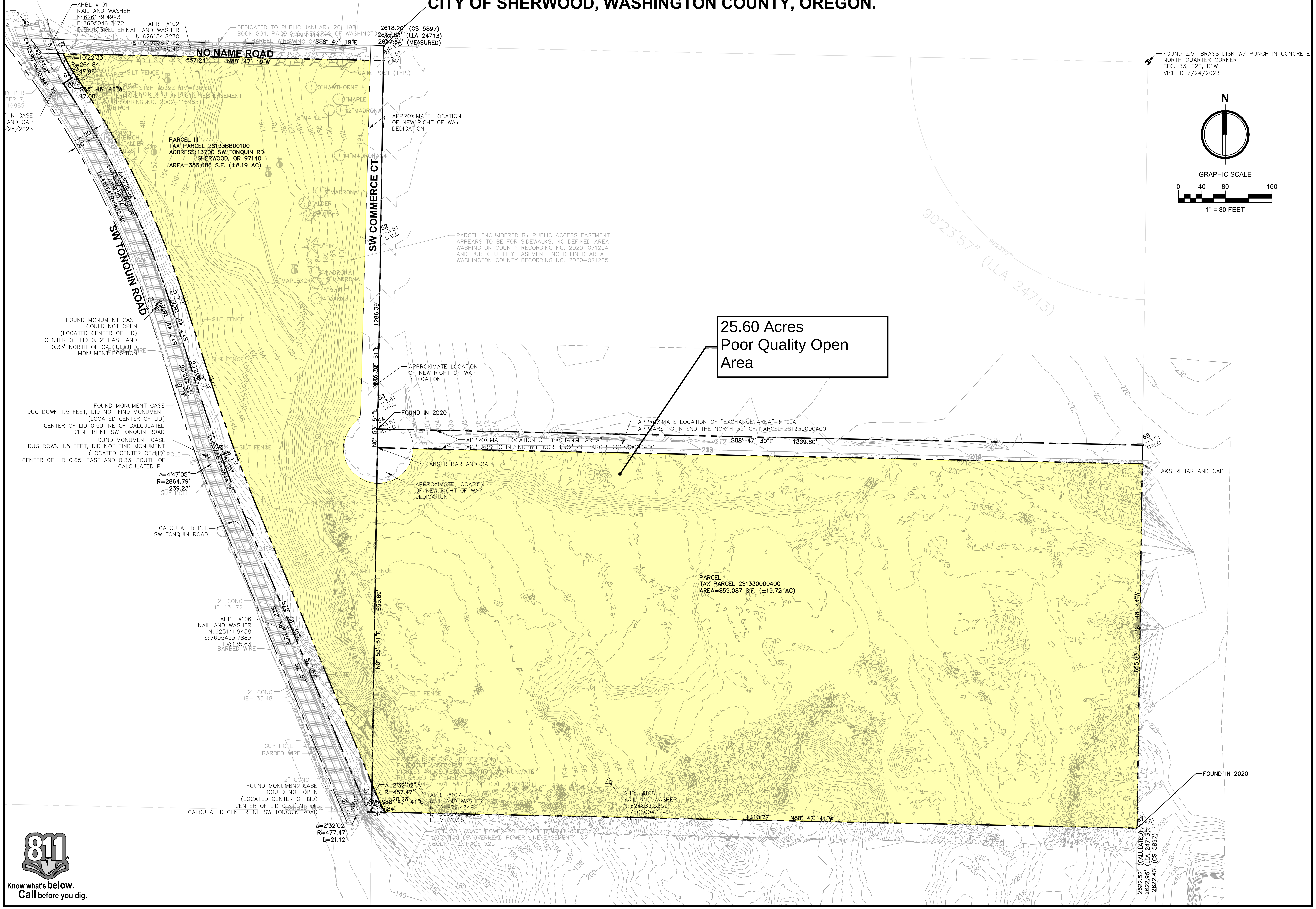
Appendix B

Calculations

B-1 ....Existing Basin Map
B-2 ....Developed Basin Map
B-3 ....Hydromodification Calculations
B-4 ....Water Quality Calculations
B-5 ....SSA Report

ROCK CREEK INDUSTRIAL

A PORTION OF THE NE 1/4 AND THE NW 1/4 OF THE NW 1/4 OF SEC. 33, TWN. 02 S., RGE. 01 W., W.M., CITY OF SHERWOOD, WASHINGTON COUNTY, OREGON.



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TACOMA · SEATTLE · SPOKANE · TRI-CITIES

2215 North 30th Street, Suite 300 Tacoma, WA 98403
253.383.2422 TEL 253.383.2572 FAX www.ahbl.com WEB

Project Title:

ROCK CREEK INDUSTRIAL

Client:

PANATTONI DEVELOPMENT COMPANY, LLC

1821 DOCK STREET, SUITE 100
TACOMA, WA 98402

MR BRENDA FODGE

Project No.

2230336.10

Issue Set & Date:

SITE PLAN REVIEW

9/27/2023

REGISTERED PROFESSIONAL ENGINEER
101868PE
OREGON
JAN 10, 2023
BARTON EDWARD BRYNESTAD

EXPIRATION DATE: 12/31/2025

NOTICE
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4
3
2
1

Revisions:

Sheet Title:

Existing Basin Map

Designed by:	Drawn by:	Checked by:
BB	TS	BB

Sheet No.

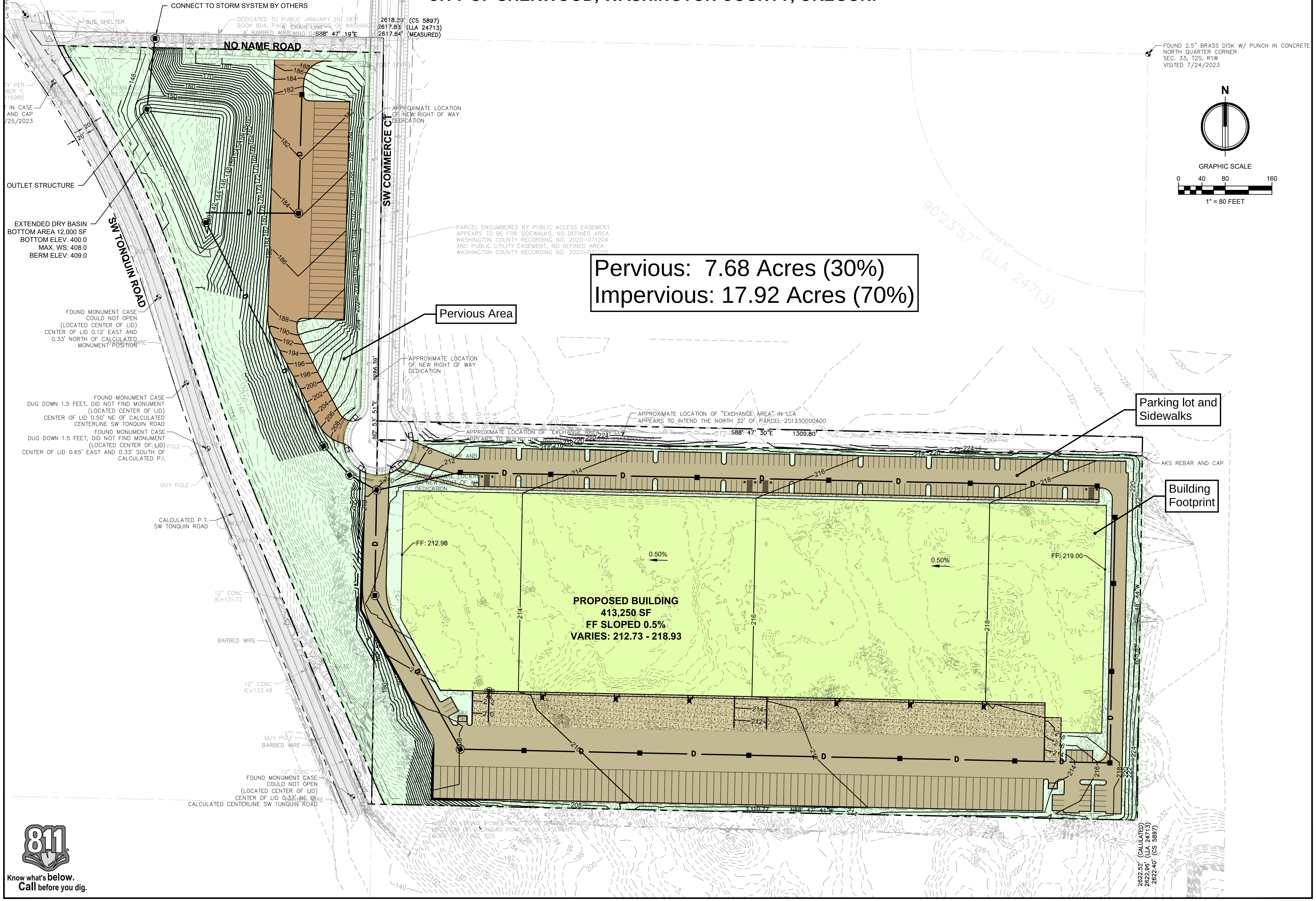
B-1

1 of 1 Sheets

DATE: October 12, 2023 FILENAME: Q:\2023\2230336\10_CIV\CAD_Site Plan Review\2230336-SH-EXST-COND.dwg

ROCK CREEK INDUSTRIAL

A PORTION OF THE NE 1/4 AND THE NW 1/4 OF THE NW 1/4 OF SEC. 33, TWN. 02 S., RGE. 01 W., W.M., CITY OF SHERWOOD, WASHINGTON COUNTY, OREGON.



Pervious: 7.68 Acres (30%)
Impervious: 17.92 Acres (70%)

DATE: October 12, 2023 FILENAME: Q:\2023\2230336\10_CIV\CAD_Site Plan Review\2230336-SH-STRM.dwg

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Project Title:
ROCK CREEK INDUSTRIAL

Client:
PANATTONI DEVELOPMENT COMPANY, LLC

1821 DOCK STREET, SUITE 100
TACOMA, WA 98402

MR BRENDA FODGE

Project No.
2230336.10

Issue Set & Date:
SITE PLAN REVIEW

9/27/2023

REGISTERED PROFESSIONAL ENGINEER
101868PE
OREGON
JAN 10, 2023
BARTON EDWARD BRYNESTAD

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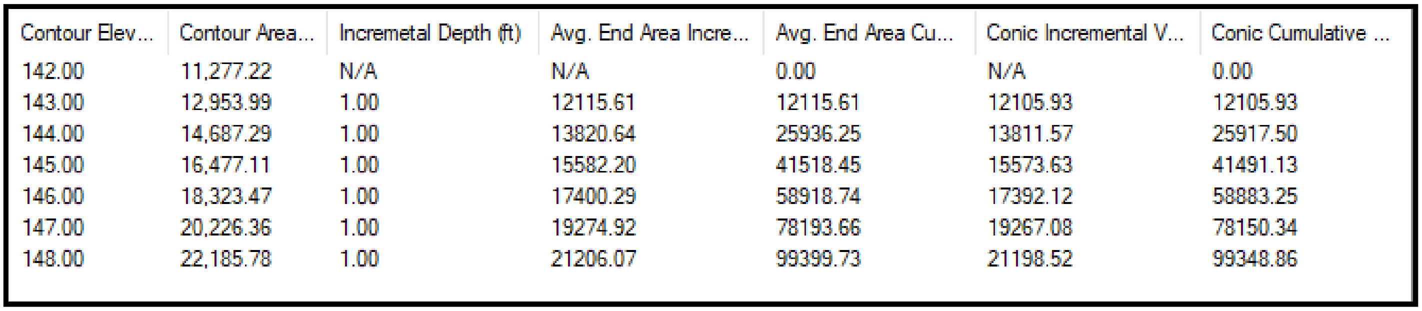
4
3
2
1
Revisions:

Sheet Title:
Proposed Basin Map

Designed by:	Drawn by:	Checked by:
BB	TS	BB

Sheet No.
B-2
1 of 1 Sheets

Pond Dimensions
3:1 Side slope
5.25' Water depth
6.25' to berm



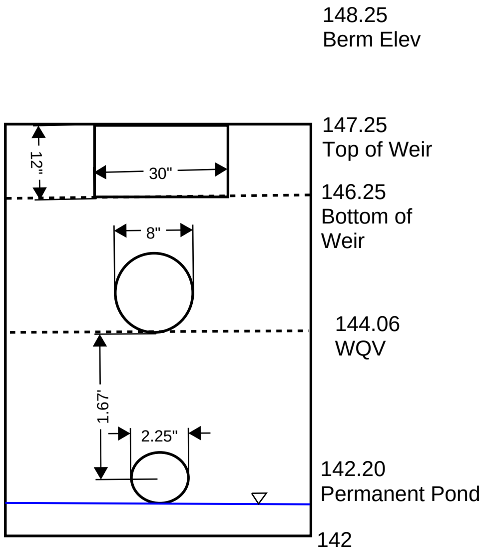
Contour Elev...	Contour Area...	Incremetal Depth (ft)	Avg. End Area Incre...	Avg. End Area Cu...	Conic Incremental V...	Conic Cumulative ...
142.00	11,277.22	N/A	N/A	0.00	N/A	0.00
143.00	12,953.99	1.00	12115.61	12115.61	12105.93	12105.93
144.00	14,687.29	1.00	13820.64	25936.25	13811.57	25917.50
145.00	16,477.11	1.00	15582.20	41518.45	15573.63	41491.13
146.00	18,323.47	1.00	17400.29	58918.74	17392.12	58883.25
147.00	20,226.36	1.00	19274.92	78193.66	19267.08	78150.34
148.00	22,185.78	1.00	21206.07	99399.73	21198.52	99348.86

Proposed Site Areas	Area (AC)	%	CN
Pavement	8.57	33%	98
Building	9.49	37%	98
Landscaping - D	7.54	29%	80
Total	25.6		

Existing Site Areas	Area (AC)		CN
Poor Condition Open Area - D	25.6		85

Peak Flows (w/o pond)	Existing (CFS)	Proposed (CFS)
2 Year	5.687	10.986
5 Year	8.55	14.288
10 Year	10.075	15.967
25 Year	12.691	18.798

Hydromodification w/pond		
	Existing (cfs)	Proposed (cfs)
2 year 24 hr	5.687	2.63
5 year 24 hr	8.55	5.47
10 year 24hr	10.075	7.15
25 year 24hr	12.691	9.85



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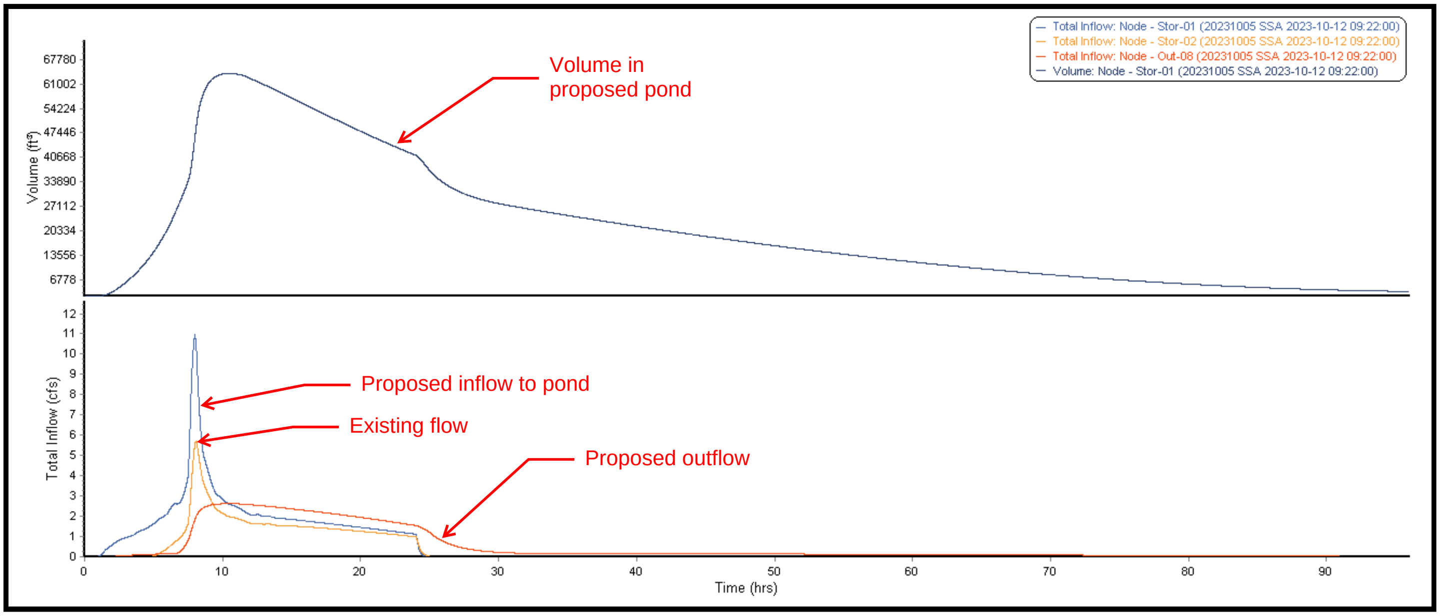
Panattoni Rock Creek

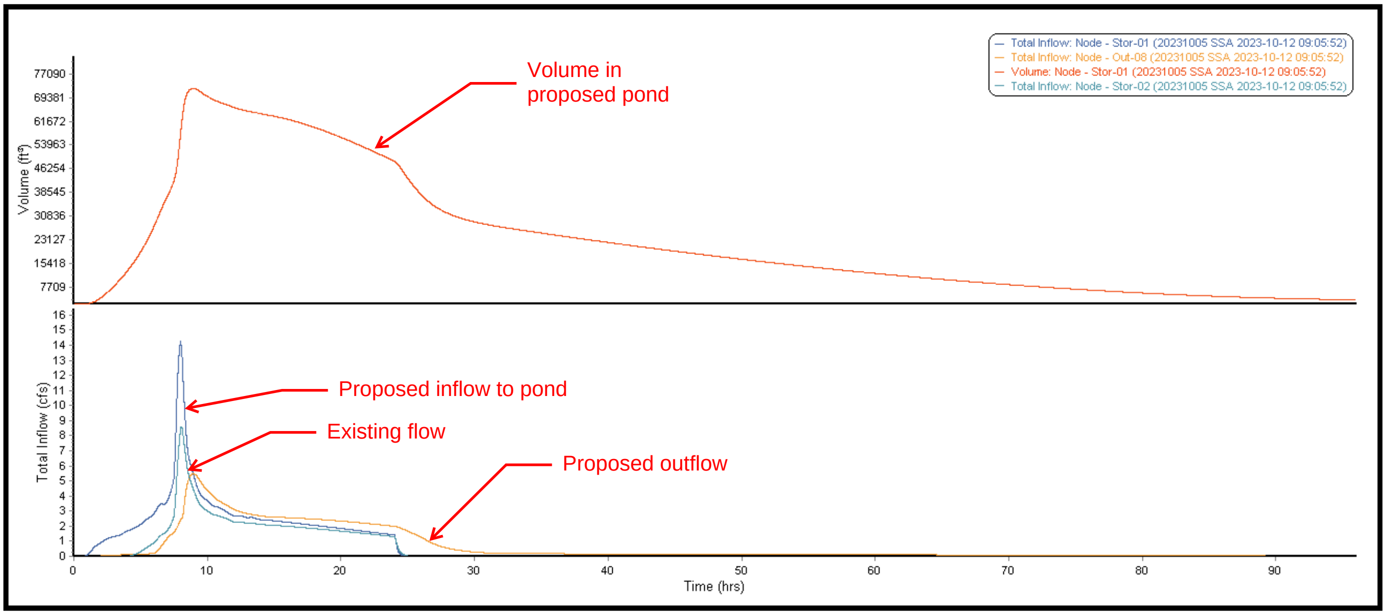
Hydromodification Calculations

B-3

2 Year - 24 Hr



5 Year - 24 Hr



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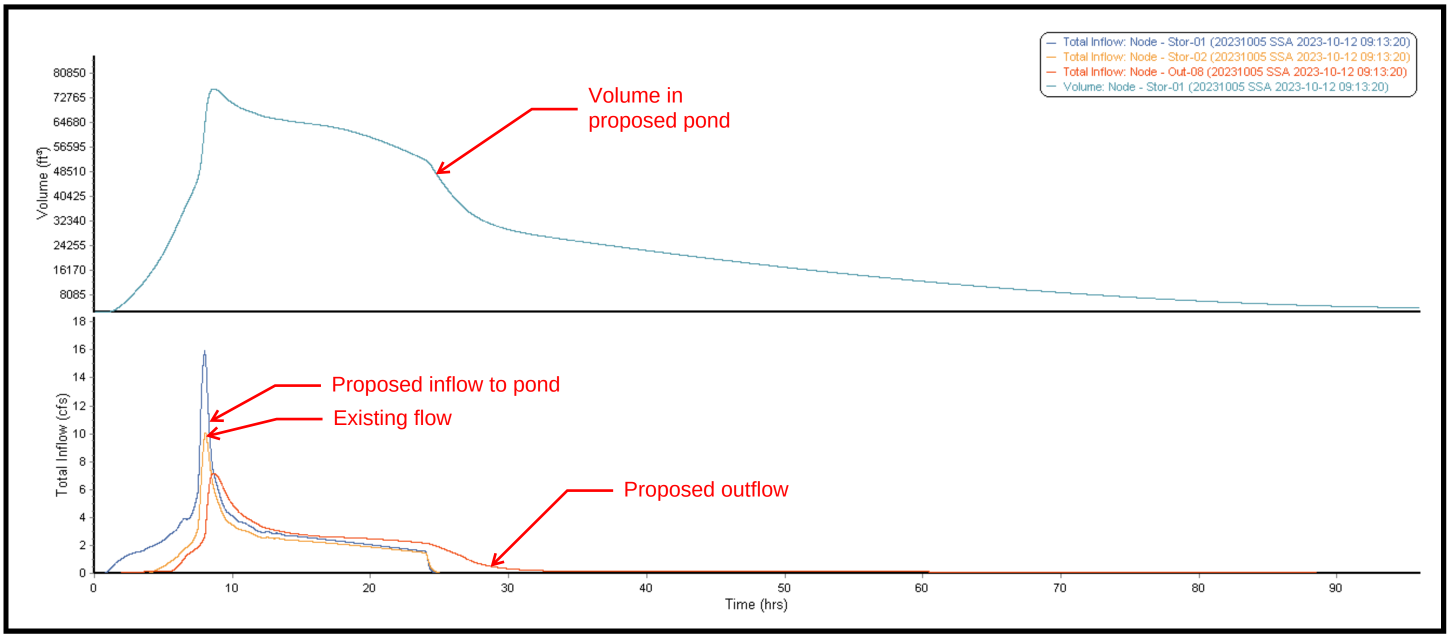
Panattoni Rock Creek

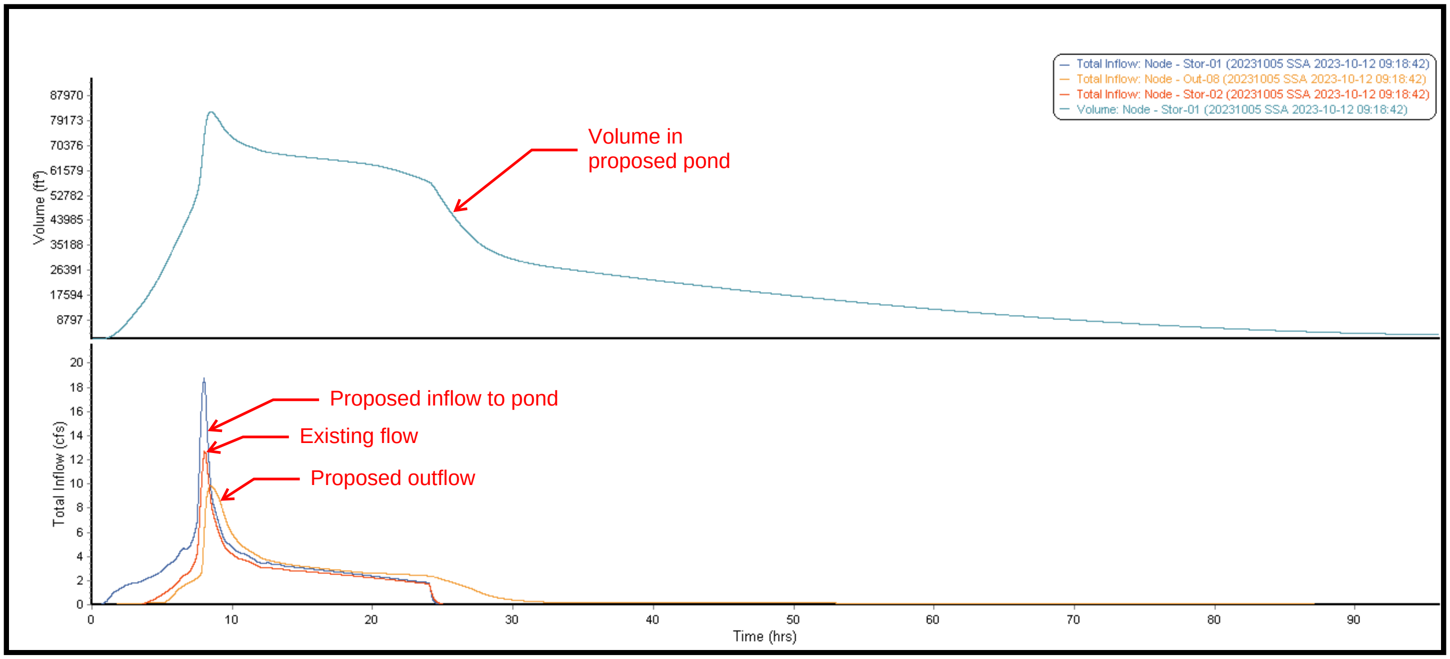
Hydromodification Calculations

B-3

10 Year - 24 Hr



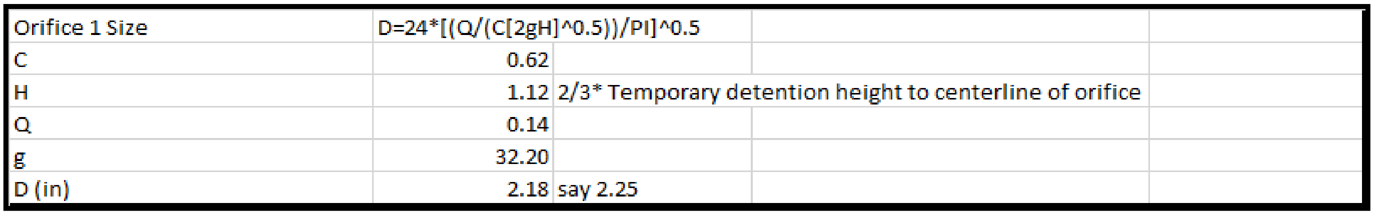
25 Year - 24 Hr



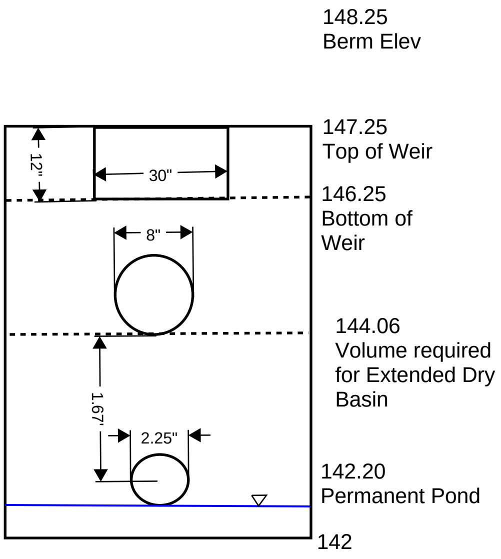
Water Quality & LID

Water quality requirements will be met using an extended dry basin

Impervious area: 786,694 SF
WQV: 786,694*0.36/12 = 23,601 CF (Volume of pond at 2' water depth = 25,917 CF)
WQF: 23,601/14400 = 1.64 CFS
Storm: 0.36 in over 4 hours, 96 hour reaccurance
Permanent Pool Depth: 0.2'
Drawdown time req: 48 hours
Orifice Size:



Orifice 1 Size	D=24*[(Q/(C[2gH]^0.5))/PI]^0.5		
C	0.62		
H	1.12	2/3* Temporary detention height to centerline of orifice	
Q	0.14		
g	32.20		
D (in)	2.18	say 2.25	



Project Description

File Name	20231020 Panattoni Rock Creek SSA.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Santa Barbara UH
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	2
Nodes	4
Junctions	1
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links	4
Channels	0
Pipes	1
Pumps	0
Orifices	2
Weirs	1
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	2 YEAR	Cumulative	inches	Oregon	Washington	2.00	2.50	SCS Type IA 24-hr

Appendix B-5
Panattoni Rock Creek SSA

Subbasin Summary

SN	Subbasin ID	Area (ac)	Impervious Area (%)	Impervious Area Curve Number	Pervious Area Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	EXISTING	25.60	0.00	95.00	85.00	2.50	1.18	30.16	5.69	0 00:16:00
2	PROPOSED	25.60	70.00	98.00	80.00	2.50	1.86	47.51	10.99	0 00:10:00

Node Summary

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Combined-Outflow	142.00	150.00	0.00	0.00	0.00	2.64	142.54	0.00	7.46	0 00:00	0.00	0.00
2	Existing-outflow	142.00					5.69	142.00					
3	Proposed-outflow	141.00					2.64	141.48					
4	Proposed-pond	142.00	148.25	142.20		0.00	10.98	146.27				0.00	0.00

Link Summary

SN	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio
1	Combined-Outflow	Proposed-outflow	56.40	0.00	0.00	0.0000	18.000	0.0150	2.64	12.12	0.22	5.05	0.51	0.34
2	Proposed-pond	Combined-Outflow		142.00	142.00		8.000		2.36					
3	Proposed-pond	Combined-Outflow		142.00	142.00		2.250		0.26					
4	Proposed-pond	Combined-Outflow		142.00	142.00				0.02					

Project Description

File Name	20231020 Panattoni Rock Creek SSA.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Santa Barbara UH
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods ...	YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins..	2
Nodes..	4
Junctions	1
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links..	4
Channels	0
Pipes	1
Pumps	0
Orifices	2
Weirs	1
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	5 YEAR	Cumulative	inches	Oregon	Washington	5.00	3.10	SCS Type IA 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Impervious Area (%)	Impervious Area Curve Number	Pervious Area Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	EXISTING	25.60	0.00	95.00	85.00	3.10	1.67	42.83	8.55	0 00:16:00
2	PROPOSED	25.60	70.00	98.00	80.00	3.10	2.41	61.57	14.29	0 00:10:00

Node Summary

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Combined-Outflow	142.00	150.00	0.00	0.00	0.00	5.47	142.84	0.00	7.16	0 00:00	0.00	0.00
2	Existing-outflow	142.00					8.55	142.00					
3	Proposed-outflow	141.00					5.47	141.71					
4	Proposed-pond	142.00	148.25	142.20		0.00	14.28	146.71				0.00	0.00

Link Summary

SN	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio
1	Combined-Outflow	Proposed-outflow	56.40	0.00	0.00	0.0000	18.000	0.0150	5.47	12.12	0.45	5.97	0.77	0.51
2	Proposed-pond	Combined-Outflow		142.00	142.00		8.000		2.62					
3	Proposed-pond	Combined-Outflow		142.00	142.00		2.250		0.27					
4	Proposed-pond	Combined-Outflow		142.00	142.00				2.59					

Project Description

File Name .... 20231020 Panattoni Rock Creek SSA.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Santa Barbara UH
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods ...	YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins...	2
Nodes...	4
Junctions	1
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links...	4
Channels	0
Pipes	1
Pumps	0
Orifices	2
Weirs	1
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	10 YEAR	Cumulative	inches	Oregon	Washington	10.00	3.40	SCS Type IA 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Impervious Area (%)	Impervious Area Curve Number	Pervious Area Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	EXISTING	25.60	0.00	95.00	85.00	3.40	1.93	49.38	10.08	0 00:16:00
2	PROPOSED	25.60	70.00	98.00	80.00	3.40	2.68	68.71	15.97	0 00:10:00

Node Summary

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Combined-Outflow	142.00	150.00	0.00	0.00	0.00	7.15	143.01	0.00	6.99	0 00:00	0.00	0.00
2	Existing-outflow	142.00					10.07	142.00					
3	Proposed-outflow	141.00					7.15	141.83					
4	Proposed-pond	142.00	148.25	142.20		0.00	15.96	146.88				0.00	0.00

Link Summary

SN	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio
1	Combined-Outflow	Proposed-outflow	56.40	0.00	0.00	0.0000	18.000	0.0150	7.15	12.12	0.59	6.31	0.92	0.61
2	Proposed-pond	Combined-Outflow		142.00	142.00		8.000		2.71					
3	Proposed-pond	Combined-Outflow		142.00	142.00		2.250		0.27					
4	Proposed-pond	Combined-Outflow		142.00	142.00				4.17					

Project Description

File Name	20231020 Panattoni Rock Creek SSA.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Santa Barbara UH
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods ...	YES

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins...	2
Nodes..	4
Junctions	1
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links..	4
Channels	0
Pipes	1
Pumps	0
Orifices	2
Weirs	1
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	25 YEAR	Cumulative	inches	Oregon	Washington	25.00	3.90	SCS Type IA 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Impervious Area (%)	Impervious Area Curve Number	Pervious Area Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	EXISTING	25.60	0.00	95.00	85.00	3.90	2.37	60.65	12.69	0 00:16:00
2	PROPOSED	25.60	70.00	98.00	80.00	3.90	3.15	80.72	18.80	0 00:10:00

Node Summary

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Combined-Outflow	142.00	150.00	0.00	0.00	0.00	9.85	143.32	0.00	6.68	0 00:00	0.00	0.00
2	Existing-outflow	142.00					12.69	142.00					
3	Proposed-outflow	141.00					9.85	142.03					
4	Proposed-pond	142.00	148.25	142.20		0.00	18.80	147.20				0.00	0.00

Link Summary

SN	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio
1	Combined-Outflow	Proposed-outflow	56.40	0.00	0.00	0.0000	18.000	0.0150	9.85	12.12	0.81	6.64	1.17	0.78
2	Proposed-pond	Combined-Outflow		142.00	142.00		8.000		2.88					
3	Proposed-pond	Combined-Outflow		142.00	142.00		2.250		0.27					
4	Proposed-pond	Combined-Outflow		142.00	142.00				6.70					

Appendix C

Geotechnical Report

DRAFT

GEOTECHNICAL REPORT

Sherwood Industrial
13700 Southwest Tonquin Road
Sherwood, Oregon

Project No. T-8912

Terra Associates, Inc.

Prepared for:

Panattoni Development Company
Tacoma, Washington

July 20, 2023

TERRA ASSOCIATES, Inc.
Consultants in Geotechnical Engineering, Geology
and
Environmental Earth Sciences

July 20, 2023
Project No. T-8912

DRAFT

Ms. Brenda Fodge
Panattoni Development Company
1821 Dock Street, Suite 100
Tacoma, Washington 98402

Subject: Geotechnical Report
Sherwood Industrial
13700 Southwest Tonquin Road
Sherwood, Oregon

Dear Ms. Fodge:

As requested, we have conducted a geotechnical engineering study for the subject project. The attached report presents our findings and recommendations for the geotechnical aspects of project design and construction.

Basalt bedrock underlies the entire site at relatively shallow depths. Where encountered, soils overlying the bedrock consist mainly of fill composed predominantly of silty sand with gravel to silty gravel with sand containing numerous angular basalt cobbles and scattered basalt boulders. Native soils encountered in several of the test pits included slightly clayey to clayey silt, fine sandy silt, and silty fine sand. We did not observe groundwater seepage in any of the test pits.

In our opinion, the building can be supported on conventional spread footings bearing on properly prepared native materials, on structural fill that is placed and compacted on a competent subgrade, or on existing medium dense to dense fill that is composed primarily of mineral soil and/or rock fragments. Pavement and floor slabs can be similarly supported. Excavations at the site extending more than a few feet below existing grade will likely require the use of hard rock excavation methods.

We trust the information presented in this report is sufficient for your current needs. If you have any questions or require additional information, please call.

Sincerely yours,
TERRA ASSOCIATES, INC.

John C. Sadler, R.G.
Senior Engineering Geologist

DRAFT

Carolyn S. Decker, P.E.
President

12220 113th Avenue NE, Ste. 130, Kirkland, Washington 98034
Phone (425) 821-7777

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Geotechnical Report
Sherwood Industrial
13700 Southwest Tonquin Road
Sherwood, Oregon

1.0 PROJECT DESCRIPTION

The proposed project consists of developing the property with an approximately 407,150 square-foot industrial building along with associated infrastructure improvements. A schematic site plan by Twinsteps Architecture, dated May 8, 2023, shows the building located in the southern portion of the site with dock high loading located on the south side of the building. A stormwater detention pond and a semi-trailer parking area are located northwest of the building.

Site development and building plans are currently not available. We expect the building will be constructed using precast concrete tilt-up perimeter wall panels with interior columns supporting the roof structure. The floor slab will be constructed at grade. Structural loading is expected to be light to moderate, with isolated columns carrying loads of 80 to 150 kips and bearing walls carrying 6 to 8 kips per foot. Maximum product loading on the floors is not expected to exceed 350 pounds per square foot (psf).

The recommendations in the following sections of this report are based on our understanding of the design features outlined above. We should review design drawings as they become available to verify that our recommendations have been properly interpreted and to supplement them, if required.

2.0 SCOPE OF WORK

Our work was completed in accordance with our authorized proposal, dated June 13, 2023. Accordingly, on June 29, 2023, we explored subsurface conditions at the site by excavating 26 test pits to maximum depths ranging from about 1 to 10.5 feet below existing ground surface using a track-mounted excavator. Using the results of our field study and laboratory testing, we performed analyses to develop geotechnical engineering recommendations for project design and construction. Specifically, this report addresses the following:

- Soil and groundwater conditions.
- Seismic considerations.
- Site preparation and grading.
- Excavations.
- Foundations.
- Slab-on-grade floors.
- Lateral earth pressures for retaining wall design.
- Infiltration feasibility.
- Stormwater detention pond.

- Drainage.
- Utilities.
- Pavements.

It should be noted that recommendations outlined in this report regarding drainage are associated with soil strength, design earth pressures, erosion, and stability. Design and performance issues with respect to moisture as it relates to the structure environment are beyond Terra Associates' purview. A building envelope specialist or contractor should be consulted to address these issues, as needed.

3.0 SITE CONDITIONS

3.1 Surface

The site is an approximately 28-acre assemblage of two vacant tax parcels located east of and adjacent to Southwest Tonquin Road, and approximately 300 to 1,700 feet south of the intersection with Southwest Oregon Street in Sherwood, Oregon. The approximate site location is shown on Figure 1.

The two site parcels are individually referred to in this report as the West Parcel and the East Parcel. The parcel locations and existing site topography are shown on Figure 2. Generalized parcel descriptions are presented below.

West Parcel

The West Parcel is a vacant, 8.16-acre, triangular-shaped property. The western and northern parcel margins are bordered by Southwest Tonquin Road and a private road/driveway, respectively. The northern approximately 600 feet of the eastern property margin is bordered by a new development that is currently being cleared and graded. The southern approximately 600 feet of the eastern parcel margin adjoins the East Parcel of the subject site.

Topography generally slopes down to the west-southwest to Southwest Tonquin Road with a topographic relief of about 60 feet. Existing surface gradients are relatively flat in the upper eastern portion of the parcel. Elevation contours obtained for the site using the Washington County GIS Intermap website (https://wcgis1.co.washington.or.us/Html5Viewer/index.html?viewer=Intermap) shows slope gradients in the northern portion of the West Parcel typically ranging between about 7 and 40 percent. Slope gradients in the southern portion of the West Parcel are generally steeper, with inclinations typically ranging between about 25 and 50 percent. Localized slope areas as steep as 100 percent are located adjacent to a road cut for an access road that traverses down the slope form the East Parcel to Southwest Tonquin Road, and the cut for a former haul road between the East Parcel and the central portion of the West Parcel. We did not observe any obvious on-site indications of instability, significant active erosion, groundwater seepage, or persistently wet surface conditions.

Site vegetation generally consists of grasses, brush, with scattered deciduous and coniferous trees near the western and northeastern site margins. We observed an area in the east-central portion of the West Parcel where hand-held GPS positioning indicates that active grading associated with a new fill embankment for the east-adjacent site development work extends more than 100 feet into the subject property.

East Parcel

The East Parcel is a rectangular, 20-acre property that is adjacent to the southeastern margin of the West Parcel. Areas of the site are currently being used by a construction company for stockpiling and dumping mineral soil and aggregates, material processing, and heavy equipment parking. Surface indications of past rock quarrying are visible in the central portion of the site, including a large rectangular excavation that is bordered by a vertical rock ledge. We observed surface indications of fill placement throughout much of the western and central areas of the parcel, including a relatively steep fill embankment near the western parcel margin and windrowed mineral soil fill within the rectangular rock excavation area. At the time of our fieldwork, imported vegetation debris was being stockpiled in the east-central portion of the parcel. We did not observe any other areas where significant amounts of vegetation had been dumped.

Existing topography is relatively flat to undulating with a gentle overall slope down to the west. Topographic relief between the eastern and western parcel margins is generally about 40 feet, but increases to about 70 feet at the southwest parcel corner. Surface gradients near the southwestern parcel corner slope down to the southwest at about 26 percent. Localized slope areas adjacent to the road cuts described above are generally between about 50 and 100 percent. We did not observe any obvious on-site indications of instability, significant active erosion, groundwater seepage, or persistently wet surface conditions. The vast majority of the parcel has been cleared of vegetation. The slope areas in the western portion of the parcel are generally vegetated with grasses, brush, and scattered younger deciduous trees.

3.2 Subsurface Exploration

Columbia River Basalt bedrock was encountered in all the test pits except Test Pits TP-17 and TP-18, which were terminated due to excavator refusal in materials interpreted to be fill at depths of about 7.5 feet and 10.5 feet, respectively. The competent basalt is generally brown to gray, moderately weak to moderately strong (R2 to R3), highly fractured with closely- to moderately-spaced fractures, and slightly to moderately weathered. Completely- to highly-weathered basalt consisting of medium dense to dense silty sand with gravel to silty gravel with sand, scattered to numerous angular to subangular basalt cobbles, and scattered angular to subangular basalt boulders was encountered in eight of the test pits between the ground surface and a maximum depth of about six and one-half feet.

We observed native soils consisting of medium stiff to stiff, slightly clayey to clayey silt; medium dense, dark brown organic silty sand; and medium dense, silty fine sand, overlying the basalt in Test Pits TP-5, TP-11, and TP-23, respectively. Test Pit TP-16 was terminated in medium dense to dense, fine sandy silt at a depth of about 10 feet. The fine sandy silt and silty fine sand observed in Test Pits TP-16 and TP-23 are interpreted to be fine grained Missoula flood deposits. The slightly clayey to clayey silt observed in Test Pit TP-5 and organic silty sand observed in Test Pit TP-11 are interpreted to be a localized lacustrine deposit and a former topsoil horizon.

Fill soils consisting predominantly of medium dense to dense, silty sand with gravel with scattered angular basalt cobbles and occasional trace amounts of debris and organics were observed in 13 of the test pits. Fill thicknesses ranged between about one foot at Test Pits TP-2, TP-5, and TP-15 to at least 10.5 feet in Test Pit TP-18. Test Pits TP-17 and TP-18 were terminated in materials interpreted to be fill or possible fill due to excavator refusal or reach limitations.

The *Lidar-Based Surficial Geologic Map and Database of the Greater Portland Area, Clackamas, Columbia, Marion, Multnomah, Washington, and Yamhill Counties, Oregon, and Clark County, Washington* by Lina Ma, Ian P. Madin, Serin Duplantis, and Kendra J. Williams (2012) shows surficial geology at the subject site mapped as fine-grained Missoula flood deposits (Mff) in the area of the West Parcel and Columbia River Basalt bedrock (Br) in the area of the East Parcel. Based on our site explorations, basalt bedrock consistent with the Br geologic map unit underlies the vast majority of the site. The fine-grained soils observed Test Pits TP-16 and TP-23 are generally consistent with the Mff geologic map unit.

Detailed descriptions of the subsurface conditions observed in the test pits are presented on the Test Pit Logs in Appendix A. The approximate test pit locations are shown on Figure 3.

3.3 Groundwater

We observed indications of localized perched groundwater in Test Pit TP-9, where the basalt fracture faces were generally iron-oxide stained and wet, but exhibited no sustained seepage. Although not observed at other site locations, we expect that shallow perched groundwater develops at the site at times, with the most prevalent development occurring during the normally wet winter and spring months.

3.4 Seismic Site Class

Based on the conditions observed in the subsurface explorations and our knowledge of the area geology, per Chapter 16 of the current International Building Code (IBC), site class “C” should be used in structural design.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 General

Based on our study, in our opinion, there are no geotechnical considerations that would preclude development of the site, as currently planned. The primary geotechnical consideration is the presence of relatively hard basalt bedrock that underlies the entire site at relatively shallow depths. We expect that site excavations extending more than a few feet into the basalt would require the use of hard-rock excavation methods.

In our opinion, the building can be supported on conventional spread footings bearing on competent native soils and bedrock, on structural fill that is placed and compacted on a competent subgrade, or on existing medium dense to dense fill that is composed primarily of mineral soil and/or rock fragments. Pavement and floor slabs can be similarly supported. Fill materials that are in a loose condition and/or contain excessive organic material or debris will not be suitable and should be removed and replaced with structural fill.

The building will be subject to differential settlement where foundation support and pavement subgrades transition from rock to native soil or fill. In our opinion, overexcavating the rock at least 12 inches and restoring grade with granular structural fill to create a uniform subgrade condition beneath the building foundations and pavement section would significantly reduce the potential for differential building settlement and pavement distress.

Most of the native soils and existing fill soils encountered at the site contain a significant amount of soil fines that will make compaction as structural fill difficult when too wet. The ability to use the native soil from site excavations as structural fill will depend on its moisture content and the prevailing weather conditions at the time of construction. If grading activities will take place during the wet winter months, the owner should be prepared to import clean granular material for use as structural fill and backfill. The use of excavated rock and some of the existing fill materials as structural fill will require efforts by the contractor to maintain a maximum rock fragment size of three inches in diameter or less.

Detailed recommendations regarding these issues and other geotechnical design considerations are provided in the following sections. These recommendations should be incorporated into the final design drawings and construction specifications.

4.2 Site Preparation and Grading

To prepare the site for construction, all vegetation, organic surface soils, and other deleterious material should be stripped and removed from the site. Organic surface soils are generally absent or sparsely distributed across the site. Based on conditions observed in the test pits, we expect that stripping depths would generally be less than four to six inches. Soil containing organic material will not be suitable for use as structural fill but may be used for limited depths in nonstructural areas.

Once stripping operations are complete, cut and fill operations can be initiated to establish desired site grades. As noted above, site excavations extending more than a few feet below existing grade will likely encounter relatively-hard basalt bedrock that will require the use of hard rock excavation methods.

Prior to placing fill, all exposed bearing surfaces should be observed by a representative of Terra Associates, Inc. to verify conditions are as expected and suitable for support of new fill or building elements. In areas underlain by soil, our representative may request a proofroll using heavy rubber-tired equipment to determine if any isolated soft and yielding areas are present. If excessively yielding areas are observed, and they cannot be stabilized in place by compaction, the affected soils should be excavated and removed to firm bearing and grade restored with new structural fill. If the depth of excavation to remove unstable soils is excessive, the use of geotextile fabrics, such as Mirafi 500X, or an equivalent fabric, can be used in conjunction with clean granular structural fill. Our experience has shown that, in general, a minimum of 18 inches of a clean, granular structural fill place and compacted over the geotextile fabric should establish a stable bearing surface.

Our study indicates that most of the site soils and existing fill materials contain a sufficient percentage of fines (silt and clay size particles) that may make them difficult to compact as structural fill if they are too wet or too dry. Accordingly, the ability to use these materials as structural fill will depend on their moisture content and the prevailing weather conditions when site grading activities take place. Soils that are too wet to properly compact could be dried by aeration during dry weather conditions or mixed with an additive such as cement or lime to stabilize the soil and facilitate compaction. If an additive is used, additional Best Management Practices (BMPs) for its use will need to be incorporated into the Temporary Erosion and Sedimentation Control plan (TESC) for the project. Soils that are dry of optimum should be moisture conditioned by controlled addition of water and blending prior to material placement. The use of excavated rock and some of the existing fill materials as structural fill will require efforts by the contractor to maintain a maximum rock fragment size of three inches in diameter or less.

If grading activities are planned during the wet winter months, or if they are initiated during the summer and extend into fall and winter, the owner should be prepared to import wet weather structural fill. For this purpose, we recommend importing a granular soil that meets the following grading requirements:

U.S. Sieve Size	Percent Passing
6 inches	100
No. 4	75 maximum
No. 200	5 maximum*

* Based on the ¾-inch fraction.

Prior to use, Terra Associates, Inc. should observe and test all materials imported to the site for use as structural fill.

Structural fill should be placed in uniform loose layers not exceeding 6 inches and compacted to a minimum of 95 percent of the soil's maximum dry density, as determined by American Society for Testing and Materials (ASTM) Test Designation D-698 (Standard Proctor). The moisture content of the soil at the time of compaction should be within two percent of its optimum, as determined by this ASTM standard. In nonstructural areas, the degree of compaction can be reduced to 90 percent.

4.3 Excavations

All excavations at the site associated with confined spaces, such as utility trenches, must be completed in accordance with local, state, and federal requirements. Based on regulations outlined in the Occupational Safety and Health Administration (OSHA), the fine-grained native silt soils would be classified as Type B soil. Existing fill soils would be classified as Type C soil.

Accordingly, for temporary excavations of more than 4 feet and less than 20 feet in depth, the side slopes in Type B soil can be sloped at an inclination of 1:1 (Horizontal:Vertical) or flatter. Type C soils should be sloped at an inclination of 1.5:1 or flatter. If there is insufficient room to complete the excavations in this manner, the use of temporary shoring may need to be considered to support the excavation. A properly designed and installed shoring trench box can be used to support utility trench excavation sidewalls. Excavations made in the moderately weak to moderately strong (R2 to R3) basalt bedrock that requires hard rock excavation methods can be made vertical.

Based on the conditions observed in the test pits, we do not expect that site excavations will encounter significant groundwater seepage during the normally dry summer and fall months. If groundwater is encountered, conventional sump pumping procedures, along with a system of collection trenches if necessary, should be capable of maintaining a relatively dry excavation for construction purposes.

The above information is provided solely for the benefit of the owner and other design consultants and should not be construed to imply that Terra Associates, Inc. assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor.

4.4 Foundations

The industrial building may be supported on conventional spread footing foundations bearing on foundation subgrade prepared as recommended in Section 4.2 of this report. Perimeter foundations exposed to the weather should bear at a minimum depth of one and one-half feet below final exterior grades for frost protection. Interior foundations can be constructed at any convenient depth below the floor slab.

We recommend designing foundations for a net allowable bearing capacity of 2,500 pounds per square foot (psf). For short-term loads, such as wind and seismic, a one-third increase in this allowable capacity can be used in design. Based on the structural loading as anticipated and this bearing stress applied, estimated immediate maximum foundation settlements of about one-inch and differential settlement of one half-inch should be expected.

For designing foundations to resist lateral loads, a base friction coefficient of 0.35 can be used. Passive earth pressures acting on the sides of the footings can also be considered. We recommend calculating this lateral resistance using an equivalent fluid weight of 350 pounds per cubic foot (pcf). We recommend not including the upper 12 inches of soil in this computation because it can be affected by weather or disturbed by future grading activity. This value assumes the foundations will be backfilled with structural fill, as described in Section 4.2 of this report. The values recommended include a safety factor of 1.5.

4.5 Slab-on-Grade Floors

Slab-on-grade floors may be supported on a subgrade as recommended in Section 4.2. Immediately below the floor slab, we recommend placing a four-inch thick capillary break layer composed of clean, coarse sand or fine gravel that has less than five percent passing the No. 200 sieve. This material will reduce the potential for upward capillary movement of water through the underlying soil and subsequent wetting of the floor slab.

The capillary break layer will not prevent moisture intrusion through the slab caused by water vapor transmission. Where moisture by vapor transmission is undesirable, such as covered floor areas, a common practice is to place a durable plastic membrane on the capillary break layer and then cover the membrane with a layer of clean sand or fine gravel to protect it from damage during construction, and to aid in uniform curing of the concrete slab. It should be noted that if the sand or gravel layer overlying the membrane is saturated prior to pouring the slab, it will not be effective in assisting uniform curing of the slab and can actually serve as a water supply for moisture bleeding through the slab, potentially affecting floor coverings. Therefore, in our opinion, covering the membrane with a layer of sand or gravel should be avoided if floor slab construction occurs during the wet winter months and the layer cannot be effectively drained. We recommend floor designers and contractors refer to the current American Concrete Institute (ACI) Manual of Concrete Practice for further information regarding vapor barrier installation below slab-on-grade floors.

4.6 Lateral Earth Pressures for Retaining Walls

The magnitude of earth pressures developing on below-grade walls will depend upon the quality and compaction of the wall backfill. We recommend placing and compacting wall backfill as structural fill, as described in Section 4.2 of this report. To prevent overstressing the walls during backfilling, heavy construction machinery should not be operated within five feet of the back of the wall. Wall backfill in this zone should be compacted with hand-operated equipment. To prevent hydrostatic pressure development, wall drainage must also be installed. A typical wall drainage detail is shown on Figure 4.

With wall backfill placed and compacted as recommended, and drainage properly installed, we recommend designing unrestrained walls for an active earth pressure equivalent to a fluid weighing 35 pounds per cubic foot (pcf). For restrained walls, an additional uniform load of 100 psf should be added to the 35 pcf. To account for typical traffic surcharge loading, the walls can be designed for an additional imaginary height of two feet (two-foot soil surcharge). For evaluation of wall performance under seismic loading, a uniform pressure equivalent to 8H psf, where H is the height of the below-grade portion of the wall should be applied in addition to the static lateral earth pressure. These values assume a horizontal backfill condition and that no other surcharge loading, sloping embankments, or adjacent buildings will act on the wall. If such conditions exist, then the imposed loading must be included in the wall design. Friction at the base of foundations and passive earth pressure will provide resistance to these lateral loads. Values for these parameters are provided in Section 4.4 of this report.

4.7 Infiltration Feasibility

Based on our study, it is our opinion that subsurface conditions at the site would not support infiltration of site stormwater or the use of low impact development (LID) techniques.

4.8 Stormwater Detention Pond

The schematic site plan shows a stormwater detention pond occupying most of the central portion of the West Parcel. Proposed pond elevations and grading plans are currently not available; however, with existing slope gradients in the area ranging between about 15 and 25 percent, we expect pond construction would require both rock cuts and construction of a structural fill berm on the downgradient perimeter.

Berm locations should be stripped of any organic surface soils prior to the placement of fill. The fill soil used for berm construction should be moisture conditioned to within 2 percent of its optimum moisture, placed in loose lifts of 12 inches or less, and mechanically compacted to at least 95 percent of the maximum dry density determined by ASTM Test Designation D-1557 (Modified Proctor). Material used to construct pond berms should consist of predominately granular soils with a maximum size of 3 inches and a minimum of 20 percent soil fines (material passing the No. 200 sieve). Terra Associates, Inc. should examine and test all onsite or imported materials proposed for use as berm fill prior to their use.

Because of exposure to fluctuating stored water levels, soils exposed on the interior pond slopes may be subject to some risk of periodic shallow instability or sloughing. Establishing interior slopes at a 3:1 gradient will significantly reduce or eliminate this potential. Exterior berm slopes and interior slopes above the maximum water surface should be graded to a finished inclination no steeper than 2:1. Finished slope faces should be thoroughly compacted and vegetated to guard against erosion.

Lining the pond with either a compacted soil liner or a flexible membrane liner (FML) would adequately mitigate the potential for water loss into the underlying fractured basalt bedrock. The liner can consist of soils meeting the gradation recommended above for pond containment berms. A compacted soil liner should have a minimum thickness of two feet. If a FML is used, we recommend that it have a minimum thickness of 40 mils. Plastic, HDPE, or a composite liners can be considered. The liner should be installed on a properly prepared subgrade in accordance with the liner manufacturer's specifications. If the pond slopes are required to be vegetated, it will be necessary to specify a liner that will exhibit sufficient friction to ensure topsoil will not slide off the liner when the pond is in service. Alternatively, a geo-cell confinement system could be installed over the liner and infilled with topsoil.

As penetrations through the liner would not be allowed, the geo-cell system would need to be anchored at the top of the pond in a keyway and supported by tendons that extend through the geo-cell webbing. Geo-Web cellular confinement or similar systems could be considered for this purpose.

4.9 Drainage

Surface

Final exterior grades should promote free and positive drainage away from the building at all times. Water must not be allowed to pond or collect adjacent to foundations or within the immediate building area. We recommend providing a positive drainage gradient away from the building perimeter. If this gradient cannot be provided, surface water should be collected adjacent to the structures and disposed to appropriate storm facilities.

Surface water must not be allowed to flow uncontrolled over the crest of the site slopes and embankments. Surface water should be directed away from the slope crests to a point of collection and controlled discharge. If site grades do not allow for directing surface water away from the slopes, then water should be collected and tightlined down the slope face in a controlled manner.

Subsurface

With positive drainage away from the building provided and with paved surfaces extending to the building perimeter, in our opinion, customary installation of the perimeter foundation drains would not be required. Foundation drains should be installed where positive drainage is not provided or where soft landscaping will occur at the building perimeter. The drains can consist of 4-inch diameter perforated PVC pipe that is enveloped in washed ½- to ¾-inch gravel-sized drainage aggregate. The aggregate should extend six inches above and to the sides of the pipe. The drains can be laid to grade at an invert elevation equivalent to the bottom of footing grade. The foundation drains and roof downspouts should be tight-lined separately to an approved point of controlled discharge. All drains should be provided with cleanouts at easily accessible locations. These cleanouts should be serviced at least once each year.

4.10 Utilities

Utility pipes should be bedded and backfilled in accordance with American Public Works Association (APWA) or local jurisdictional requirements. At a minimum, trench backfill should be placed and compacted as structural fill as described in Section 4.2 of this report.

As noted, we anticipate that most site excavations extending more than a few feet below existing site grades would encountered moderately weak to moderately strong (R2 to R3) basalt bedrock that will likely require hard rock excavation methods. Utility trenches that terminate in intact rock or cobble- to boulder-size rock fragments should be over excavated to allow for the placement of a leveling course of at least four inches of structural fill or pipe bedding material. Native soils and existing fill materials observed at the site would generally be suitable for use as trench backfill material provided they can be adequately moisture conditioned to facilitate proper compaction and do not contain rock fragments greater than three inches in diameter. Imported material used for utility trench backfilling should meet the gradation recommended for wet weather fill in Section 4.2.

4.11 Pavements

Pavement subgrade should be prepared as described in the Section 4.2 of this report. Regardless of the degree of relative compaction achieved, the subgrade must be firm and relatively unyielding before paving. The subgrade should be proofrolled with heavy rubber-tired construction equipment such as a load ten-yard dump truck to verify this condition. As noted, pavement subgrades consisting of moderately weak to moderately strong (R2 to R3) basalt bedrock should be overexcavated to allow placement of at least 12 inches granular structural fill to create a uniform subgrade condition.

The pavement design section is dependent upon the supporting capability of the subgrade soils and the traffic conditions to which it will be subjected. We expect traffic at the facility will consist of cars and light trucks, along with heavy traffic in the form of tractor-trailer rigs. For design considerations, we have assumed traffic in parking and in car/light truck access pavement areas can be represented by an 18-kip Equivalent Single Axle Loading (ESAL) of 50,000 over a 20-year design life. For heavy traffic pavement areas, we have assumed an ESAL of 500,000 would be representative of the expected loading. These ESALs represent traffic loading equivalent to 3 and 29, loaded (80,000 pound gross vehicle weight) tractor-trailer rigs, respectively, traversing the pavement per day over a 20-year design life.

With a stable subgrade prepared as recommended, we recommend the following pavement sections:

Light Traffic and Parking:

- Two inches of hot mix asphalt (HMA) over six inches of crushed rock base (CRB)
- Four inches of full depth HMA

Heavy Traffic:

- Three inches of HMA over eight inches of CRB
- Six inches of full depth HMA

For exterior Portland cement concrete (PCC) pavement, we recommend the following:

- 6 inches of PCC over two inches of crushed surfacing top course
    - 28-day compressive strength – 4,000 psi
    - Control joints spaced at a maximum of 15 feet

The paving materials used should conform to the Oregon Department of Transportation (ODOT) specifications for ½-inch class HMA, PCC, and CRB.

Long-term pavement performance will depend on surface drainage. A poorly-drained pavement section will be subject to premature failure resulting from surface water infiltrating the subgrade soils and reducing their supporting capability. For optimum performance, we recommend surface drainage gradients of at least two percent. Some degree of longitudinal and transverse cracking of the pavement surface should be expected over time. Regular maintenance should be planned to seal cracks as they occur.

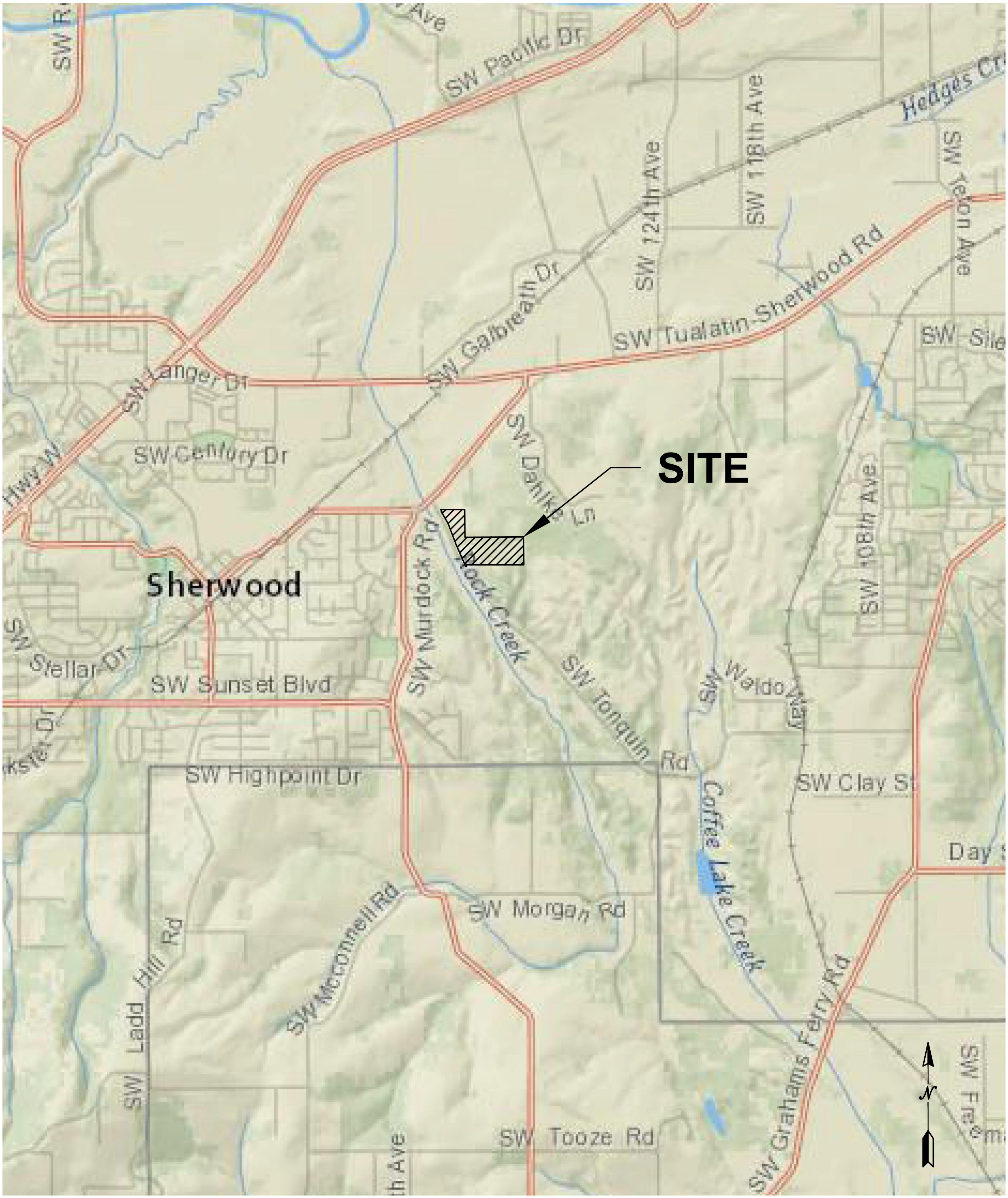
5.0 ADDITIONAL SERVICES

Terra Associates, Inc. should review the final design drawings and specifications in order to verify that earthwork and foundation recommendations have been properly interpreted and implemented in project design. We should also provide geotechnical services during construction to observe compliance with our design concepts, specifications, and recommendations. This will allow for design changes if subsurface conditions differ from those anticipated prior to the start of construction.

6.0 LIMITATIONS

We prepared this report in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made. This report is the copyrighted property of Terra Associates, Inc. and is intended for specific application to the Sherwood Industrial project in Sherwood, Oregon. This report is for the exclusive use of Panattoni Development Company and their authorized representatives.

The analyses and recommendations presented in this report are based on data obtained from the onsite subsurface explorations. Variations in subsurface conditions can occur, the nature and extent of which may not become evident until construction. If variations appear evident, Terra Associates, Inc. should be requested to reevaluate the recommendations in this report prior to proceeding with construction.



REFERENCE: DOGAMI LIDAR VIEWER

NOT TO SCALE

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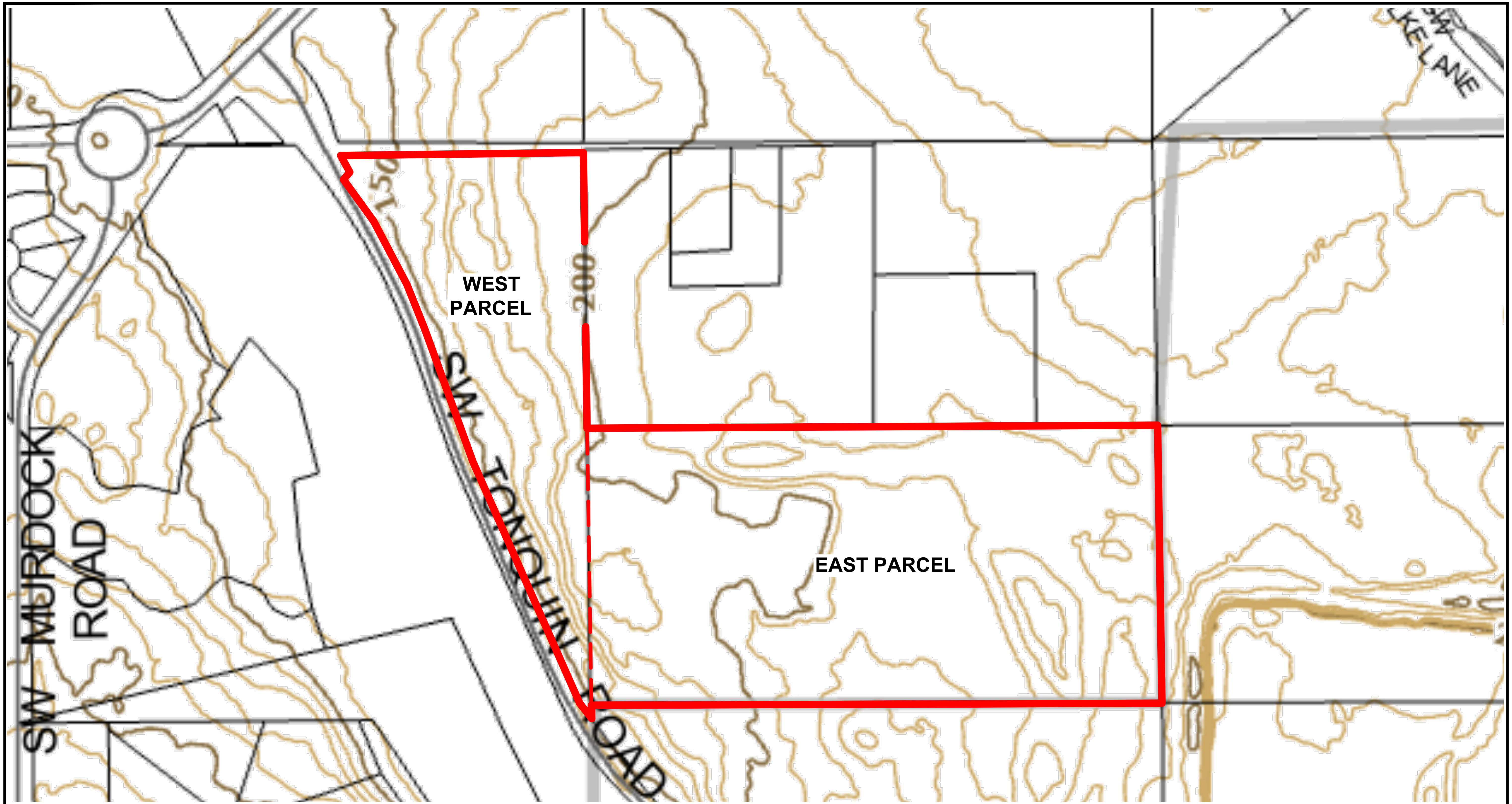
Environmental Earth Sciences

VICINITY MAP
SHERWOOD INDUSTRIAL
SHERWOOD, OREGON

Proj. No.T-8912	Date JULY 2023	Figure 1



NOTE:

THIS SITE PLAN IS SCHEMATIC. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE. IT IS INTENDED FOR REFERENCE ONLY AND SHOULD NOT BE USED FOR DESIGN OR CONSTRUCTION PURPOSES.

REFERENCE:

WASHINGTON COUNTY INTERMAP

LEGEND:

▚ APPROXIMATE TEST PIT LOCATION

0 200 400

APPROXIMATE SCALE IN FEET

CONTOUR INTERVAL = 10 FEET

N

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PARCEL LOCATION MAP
SHERWOOD INDUSTRIAL
SHERWOOD, OREGON

Proj. No.T-8912	Date JULY 2023	Figure 2

NOTE:

THIS SITE PLAN IS SCHEMATIC. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE. IT IS INTENDED FOR REFERENCE ONLY AND SHOULD NOT BE USED FOR DESIGN OR CONSTRUCTION PURPOSES.

REFERENCE:

GOOGLE EARTH

LEGEND:

▚ APPROXIMATE TEST PIT LOCATION

0 200 400

APPROXIMATE SCALE IN FEET

N

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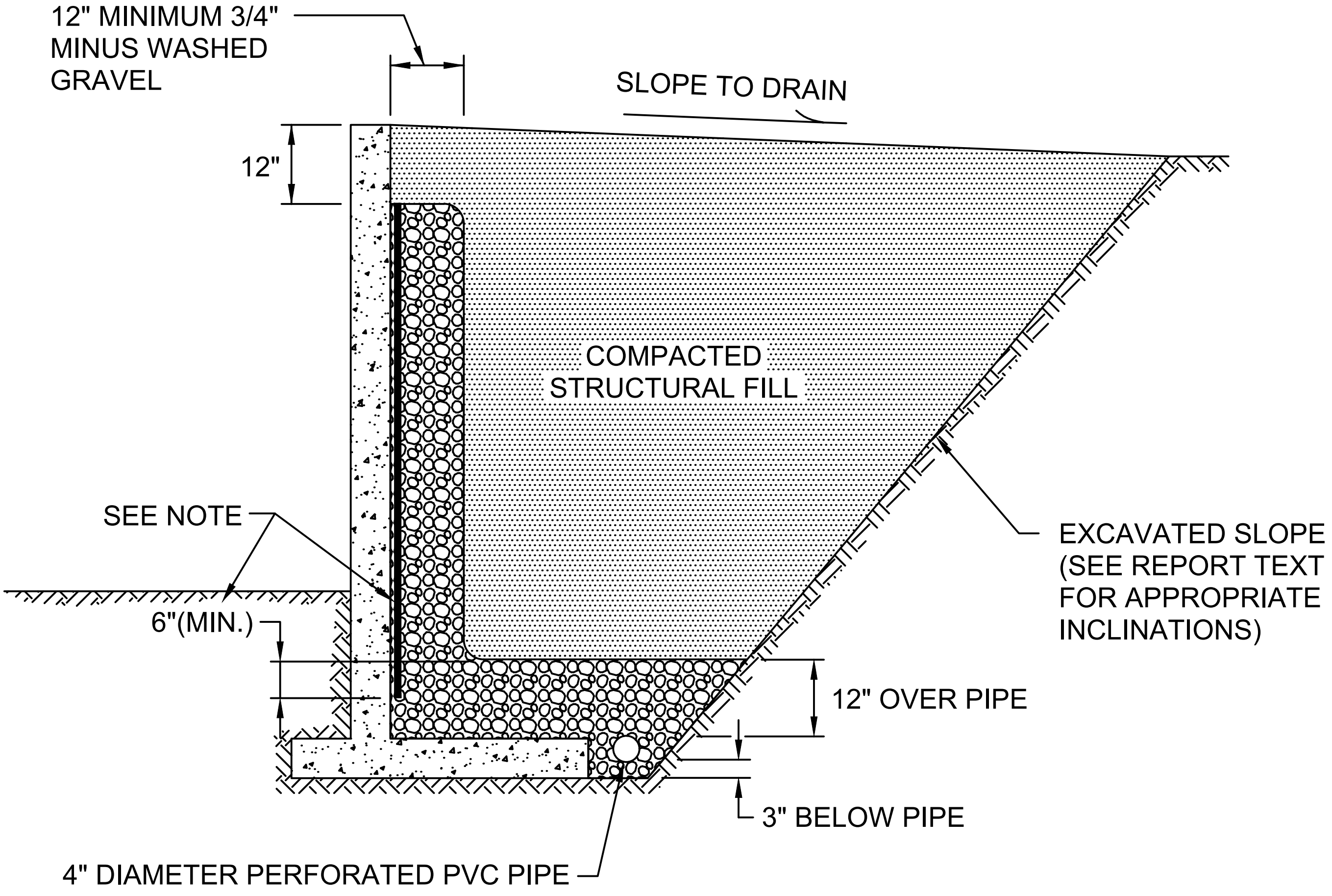
EXPLORATION LOCATION PLAN
SHERWOOD INDUSTRIAL
SHERWOOD, OREGON

Proj. No.T-8912	Date JULY 2023	Figure 3



NOT TO SCALE

NOTE:

MIRADRAIN G100N PREFABRICATED DRAINAGE PANELS OR SIMILAR PRODUCT CAN BE SUBSTITUTED FOR THE 12-INCH WIDE GRAVEL DRAIN BEHIND WALL. DRAINAGE PANELS SHOULD EXTEND A MINIMUM OF SIX INCHES INTO 12-INCH THICK DRAINAGE GRAVEL LAYER OVER PERFORATED DRAIN PIPE.

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TYPICAL WALL DRAINAGE DETAIL
SHERWOOD INDUSTRIAL
SHERWOOD, OREGON

Proj. No.T-8912	Date JULY 2023	Figure 4

APPENDIX A
FIELD EXPLORATION AND LABORATORY TESTING

Sherwood Industrial
Sherwood, Oregon

We explored subsurface conditions at the site in 26 test pits excavated to depths ranging between about 1 foot and 10.5 feet using a track-mounted excavator. Test pit locations were determined in the field using hand-held GPS locating and by sighting relative to existing surface features. The approximate location of the test pits is shown on Figure 3. The Test Pit Logs are attached as Figures A-3 through A-28.

An engineering geologist from our office conducted the field exploration, classified the observed soils and rock, maintained a log of each test pit, obtained representative soil samples, and performed a visual reconnaissance of the site and surrounding areas. All soil samples were visually classified in accordance with the Unified Soil Classification System (USCS) described on Figure A-1. A generalized rock description key is attached as Figure A-2.

Representative soil samples obtained from the test borings were placed in closed containers and taken to our laboratory for further examination and testing. Laboratory testing included determining the moisture content of all soil samples, grain size distributions on six soil samples, and Atterberg Limit determinations of one soil sample. The soil moisture contents and Atterberg Limits are reported on the Test Pit Logs. The result of the grain size analyses are shown on Figures A-29 and A-30.

MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS More than 50% material larger than No. 200 sieve size	**GRAVELS** More than 50% of coarse fraction is larger than No. 4 sieve	Clean Gravels (less than 5% fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines.
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines.
			GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines.
	SANDS More than 50% of coarse fraction is smaller than No. 4 sieve	Clean Sands (less than 5% fines)	SW	Well-graded sands, sands with gravel, little or no fines.
			SP	Poorly-graded sands, sands with gravel, little or no fines.
		Sands with fines	SM	Silty sands, sand-silt mixtures, non-plastic fines.
			SC	Clayey sands, sand-clay mixtures, plastic fines.
FINE GRAINED SOILS More than 50% material smaller than No. 200 sieve size	**SILTS AND CLAYS** Liquid Limit is less than 50%		ML	Inorganic silts, rock flour, clayey silts with slight plasticity.
			CL	Inorganic clays of low to medium plasticity. (Lean clay)
			OL	Organic silts and organic clays of low plasticity.
	SILTS AND CLAYS Liquid Limit is greater than 50%		MH	Inorganic silts, elastic.
			CH	Inorganic clays of high plasticity. (Fat clay)
			OH	Organic clays of high plasticity.
HIGHLY ORGANIC SOILS			PT	Peat.

DEFINITION OF TERMS AND SYMBOLS

COHESIONLESS

Density	Standard Penetration Resistance in Blows/Foot
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	>50

COHESIVE

Consistancy	Standard Penetration Resistance in Blows/Foot
Very Soft	0-2
Soft	2-4
Medium Stiff	4-8
Stiff	8-16
Very Stiff	16-32
Hard	>32

I	2" OUTSIDE DIAMETER SPILT SPOON SAMPLER
II	2.4" INSIDE DIAMETER RING SAMPLER OR SHELBY TUBE SAMPLER
▼	WATER LEVEL (Date)
Tr	TORVANE READINGS, tsf
Pp	PENETROMETER READING, tsf
DD	DRY DENSITY, pounds per cubic foot
LL	LIQUID LIMIT, percent
PI	PLASTIC INDEX
N	STANDARD PENETRATION, blows per foot

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UNIFIED SOIL CLASSIFICATION SYSTEM
SHERWOOD INDUSTRIAL
SHERWOOD, OREGON

Proj. No.T-8912 | Date JULY 2023 | Figure A-1

GRAIN SIZE

Fine Grained	<0.04 in.	Few crystal boundaries/grains are distinguishable in the field or with hand lens.
Medium Grained	0.04 TO 0.2 in.	Most crystal boundaries/grains are distinguishable with the aid of a hand lens.
Coarse Grained	> 0.2 in.	Most crystal boundaries/grains are distinguishable with the naked eye.

RELATIVE ROCK STRENGTH

Grade	Description	Field Identification	Approx. Uniaxial Compressive Strength
R1	Very Weak	Specimen crumbles under sharp blow from point of geological hammer, and can be peeled with a pocket knife.	0.15 to 3.6 ksi
R2	Moderately Weak	Shallow cuts or scrapes can be made in a specimen with a pocket knife. Geological hammer point indents deeply with firm blow.	3.6 to 7.3 ksi
R3	Moderately Strong	Specimen cannot be scraped or cut with a pocket knife. Shallow indentation can be made under firm blows from a hammer.	7.3 to 15 ksi
R4	Strong	Specimen breaks with one firm blow from the hammer end of a geological hammer.	15 to 29 ksi
R5	Very Strong	Specimen requires many blows of a geological hammer to break intact sample.	> 29 ksi

WEATHERING OR ALTERATION

Term	Description	Grade
Fresh	No visible sign of rock material weathering; perhaps slight discoloration in major discontinuity surfaces.	I
Slightly Weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than its fresh condition.	II
Moderately Weathered	Less than half the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a continuous fremework or as core stones.	III
Highly Weathered	More than half the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a continuous fremework or as core stones.	IV
Completely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.	V
Residual Soil	All rock material is converted to soil. The mass structure and material fabric is destroyed. There is a large change in volume, but the soil has not been significantly transported.	VI

DISCONTINUITIES

Spacing		Condition	
Very Widely	> 10 ft	Excellent	Very rough surfaces, no separation, hard discontinuity wall
Widely	3 ft to 10 ft	Good	Slightly rough surfaces, separation less than 0.05 in, hard discontinuity wall.
Moderately	1 ft to 3 ft	Fair	Slightly rough surfaces, separation greater than 0.05 in, soft discontinuity wall.
Closely	2 in to 12 in	Poor	Slickensided surfaces, or soft gouge less than 0.2 in thick, or open discontinuities 0.05 to 0.2 in.
Very Closely	< 2 in	Very Poor	Soft gouge greater than 0.2 in thick, or open discontinuities greater than 0.2 in.

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ROCK DESCRIPTION KEY
SHERWOOD INDUSTRIAL
SHERWOOD, OREGON

Proj. No.T-8912

Date JULY 2023

Figure A-2

LOG OF TEST PIT NO. 1

FIGURE A-3

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Gray-brown GRAVEL with sand, fine to coarse angular basalt gravel, fine sand, dry to moist, numerous angular basalt cobbles. (GP)		
1			Dense	
2		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular gravel- to cobble-size blocks, slightly to moderately weathered (Columbia River Basalt).		
3				
4		Test pit terminated at 3.5 feet due to excavator refusal. No groundwater seepage.		
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 2

FIGURE A-4

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Gray-brown GRAVEL with sand, fine to coarse angular basalt gravel, fine sand, dry to moist, numerous angular basalt cobbles. (GP)	Dense	
1		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular gravel- to cobble-size blocks, slightly to moderately weathered (Columbia River Basalt).		
2				
3		Test pit terminated at 3 feet due to excavator refusal. No groundwater seepage.		
4				
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 3

FIGURE A-5

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Brown silty GRAVEL with sand, fine to coarse angular gravel, fine sand, moist. (GM)	Medium Dense	
1				
2		Fill: Dark gray silty SAND with gravel to silty GRAVEL with sand, fine to coarse sand, fine to coarse gravel, moist, scattered cobbles and organics. (SM/GM)	Medium Dense to Dense	
3				
4	1			15.2
5		BASALT: moderately weak to moderately strong (R2 to R3), gray to brown; angular gravel- to cobble-size blocks, completely weathered to soil between blocks, slightly to moderately weathered (Columbia River Basalt).		
6				
7		Test pit terminated at 6.5 feet due to excavator refusal. No groundwater seepge.		
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 4

FIGURE A-6

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Gray-brown GRAVEL with silt and sand, fine to coarse angular basalt gravel, fine sand, moist, numerous angular basalt cobbles. (GP-GM) (Mechanically-ripped basalt)	Loose	
1				
2				
3		BASALT: strong (R4), gray to brown; angular gravel-size blocks, slightly weathered (Columbia River Basalt).		
4		Test pit terminated at about 3.5 feet due to excavator refusal. No groundwater seepge.		
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 5

FIGURE A-7

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Hog Fuel.	Loose	
1		Gray slightly clayey to clayey SILT, moist, trace of organics. (ML) (LL=42, PI=14)	Medium Stiff to Stiff	
2				
3	1			27.9
4		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular gravel- to cobble-size blocks, slightly to moderately weathered (Columbia River Basalt).		
5		Test pit terminated at about 4.5 feet due to excavator refusal. No groundwater seepge.		
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 6

FIGURE A-8

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular cobble- to boulder-size blocks, slightly to moderately weathered (Columbia River Basalt).		
1				
2				
3				
4				
5				
6		Test pit terminated at 6 feet due to excavator refusal. No groundwater seepge.		
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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Environmental Earth Sciences

LOG OF TEST PIT NO. 7

FIGURE A-9

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Brown silty GRAVEL with sand, fine to coarse angular basalt gravel, fine sand, dry. (GM)	Loose	
1				
		Dark brown silty SAND with gravel, fine sand, fine to coarse angular basalt gravel, moist. (SM) (Completely weathered basalt)	Medium Dense	
2		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular gravel- to boulder-size blocks, slightly to moderately weathered (Columbia River Basalt).		
3		Test pit terminated at 2.5 feet due to excavator refusal. No groundwater seepge.		
4				
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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Geology and
Environmental Earth Sciences

LOG OF TEST PIT NO. 8

FIGURE A-10

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Dark gray silty SAND with gravel, fine to coarse sand, fine to coarse gravel, moist, trace of wood fragments. (SM)	Medium Dense	
1				
2				
3	1	Gray-brown to brown silty SAND with gravel to silty GRAVEL with sand, fine sand, fine to coarse angular basalt gravel, moist, scattered angular basalt cobbles. (SM/GM) (Completely weathered basalt)	Dense	19.4
4				
		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular gravel- to boulder-size blocks, slightly to moderately weathered (Columbia River Basalt).		
5		Test pit terminated at about 4.75 feet due to excavator refusal. No groundwater seepge.		
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 9

FIGURE A-11

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		BASALT: moderately weak to moderately strong (R2 to R3), gray to brown, angular gravel- to boulder-size blocks, stained, wet, fracture faces, slightly to moderately weathered (Columbia River Basalt).		
1				
2				
3				
4		Test pit terminated at 4 feet due to excavator refusal. No groundwater seepage. Wet, stained fracture faces.		
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 10

FIGURE A-12

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		BASALT: moderately weak to moderately strong (R2 to R3), gray-brown, angular gravel- to boulder-size blocks, slightly to moderately weathered (Columbia River Basalt).		
1		Test pit terminated at 1 foot due to excavator refusal. No groundwater seepge.		
2				
3				
4				
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 11

FIGURE A-13

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Brown to gray silty SAND with gravel and gray SILT, fine sand, fine to coarse gravel, moist, trace of wire debris and organics. (SM)	Medium Dense	
1				
2	1			20.5
3				
	2			19.2
4				
5		Dark brown organic silty SAND, fine grained, moist. (OL/SM) (Topsoil horizon)		
		Gray-brown silty SAND with gravel to silty GRAVEL with sand, fine to coarse sand, fine to coarse angular basalt gravel, moist. (SM/GM) (Completely to highly weathered basalt)	Dense	
6				
		Test pit terminated at 6.5 feet due to excavator refusal. No groundwater seepge.		
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 12

FIGURE A-14

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		BASALT: strong (R4), gray, angular gravel- to cobble-size blocks, slightly to moderately weathered (Columbia River Basalt).		
1		Test pit terminated at 1 foot due to excavator refusal. No groundwater seepge.		
2				
3				
4				
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 13

FIGURE A-15

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Brown sandy SILT with gravel, fine sand, fine to coarse gravel, moist, trace of debris and organics, 2-foot diameter boulder. (ML)		
1				
	1			17.8
2				
3			Medium Dense	
4				
5				
6				
		Dark brown silty SAND with gravel, fine to medium sand, fine to coarse angular bassalt gravel, moist. (SM) (Possible fill)	Medium Dense to Dense	
7				
		Test pit terminated at 7.5 feet due to excavator refusal. No groundwater seepge.		
8				
9				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 14

FIGURE A-16

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0 1		Fill: Brown sandy SILT with gravel, fine sand, fine to coarse gravel, moist, trace of debris and organics. (ML)	Medium Dense	
2 3		Brown silty SAND with gravel, fine sand, fine to coarse angular basalt gravel, moist, numerous angular basalt cobbles, scattered angular basalt boulders. (SM) (Completely to highly weathered basalt)	Medium Dense to Dense	
4 5 6 7 8		Test pit terminated at 3.5 feet due to excavator refusal. No groundwater seepge.		

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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FIGURE A-17

LOG OF TEST PIT NO. 15

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Dark gray to brown silty SAND with gravel, fine to medium sand, fine to coarse gravel, moist, 2-inch thick asphalt pavement between 4 and 6 inches. (ML)	Medium Dense to Dense	
1		BASALT: moderately weak to moderately strong (R2 to R3), orange-brown, angular gravel- to cobble-size blocks, slightly to moderately weathered (Columbia River Basalt).		
2				
3		Test pit terminated at 3 feet due to excavator refusal. No groundwater seepge.		
4				
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 16

FIGURE A-18

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Fill: Brown silty SAND with gravel to silty GRAVEL with sand, fine sand, fine to coarse angular basalt gravel, moist, scattered angular basalt cobbles, scattered debris (wires, aluminum conduit, plastic, wood). (SM/GM)		
1				
2				
3	1		Medium Dense	12.9
4				
5				
6		Red-brown sandy SILT, fine grained, trace of fine gravel, moist. (ML)		
7	2			31.1
8			Medium Dense to Dense	
9				
10		Test pit terminated at 10 feet. No groundwater seepage.		
11				
12				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 17

FIGURE A-19

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0 1 2 3	1	Fill: Dark brown silty SAND, fine to coarse angular sand, scattered fine angular gravel, moist. (SM) (Processed material)	Medium Dense	7.1
4 5 6 7		Gray angular basalt cobbles and boulders, moist. (Possible fill)	Dense	
8 9 10 11 12		Test pit terminated at 7.5 feet due to excavator refusal. No groundwater seepage.		

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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FIGURE A-20

LOG OF TEST PIT NO. 18

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0 1 2		Fill: Dark brown silty SAND, fine to coarse angular sand, scattered fine angular gravel, moist. (SM) (Processed material)	Medium Dense	
3 4 5 6 7 8 9 10		Fill: Dark gray-brown sandy SILT with gravel to silty SAND with gravel, fine to medium sand, fine to coarse angular to subrounded gravel, moist, scattered wood fragments, 6"x6" timber at 7 feet, faint organic odor. (ML/SM)	Dense to Very Dense	
11 12		Test pit terminated at 10.5 feet. No groundwater seepage.		

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 19

FIGURE A-21

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0 1		Brown silty GRAVEL with sand, fine to coarse angular basalt gravel, fine to medium sand, moist. (GM) (Highly to completely weathered basalt)	Medium Dense to Dense	
2		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular gravel- to boulder-size blocks, moderately weathered (Columbia River Basalt).		
3 4 5 6 7 8		Test pit terminated at 3 feet due to excavator refusal. No groundwater seepage.		

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 20

FIGURE A-22

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		4 inches Sod and Topsoil. Red-brown silty GRAVEL with sand, fine to coarse angular basalt gravel, fine to coarse sand, dry to moist, numerous angular basalt cobbles. (GM) (Highly weathered basalt)		
1			Medium Dense to Dense	
2		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular cobble- to boulder-size blocks, moderately to slightly weathered (Columbia River Basalt).		
3				
4		Test pit terminated at 4 feet due to excavator refusal. No groundwater seepage.		
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 21

FIGURE A-23

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		2 inches Sod and Topsoil. Red-brown to gray silty GRAVEL with sand, fine to coarse angular basalt gravel, fine to coarse sand, dry to moist, numerous angular basalt cobbles, scattered angular basalt boulders. (GM) (Highly weathered basalt)		
1			Medium Dense to Dense	
2		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular cobble- to boulder-size blocks, moderately to slightly weathered (Columbia River Basalt).		
3		Test pit terminated at 3 feet due to excavator refusal. No groundwater seepage.		
4				
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 22

FIGURE A-24

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		2 inches Sod and Topsoil. Red-brown to gray silty GRAVEL with sand, fine to coarse angular basalt gravel, fine to coarse sand, dry to moist, numerous angular basalt cobbles, scattered angular basalt boulders. (GM) (Highly weathered basalt)	Medium Dense to Dense	
1				
2				
3		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular cobble- to boulder-size blocks, moderately to slightly weathered (Columbia River Basalt).		
4		Test pit terminated at 4 feet due to excavator refusal. No groundwater seepage.		
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 23

FIGURE A-25

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		Red-brown silty SAND, fine grained, trace of fine to coarse subrounded to subangular gravel, dry. (SM)		
1			Medium Dense	
2		BASALT: moderately weak to moderately strong (R2 to R3), red-brown to gray-brown, angular gravel- to cobble-size blocks, highly weathered (Columbia River Basalt).		
3				
4				
5		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular gravel- to boulder-size blocks, moderately to slightly weathered (Columbia River Basalt).		
6		Test pit terminated at 5.5 feet due to excavator refusal. No groundwater seepage.		
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 24

FIGURE A-26

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Bare **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		BASALT: moderately weak to moderately strong (R2 to R3), gray-brown, angular gravel- to boulder-size blocks, moderately to slightly weathered (Columbia River Basalt).		
1		Test pit terminated at 1 foot due to excavator refusal. No groundwater seepage.		
2				
3				
4				
5				
6				
7				
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 25

FIGURE A-27

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Sparse brush **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		BASALT: moderately weak to moderately strong (R2 to R3), gray-brown, angular gravel- to cobble-size blocks, highly weathered (Columbia River Basalt).		
1				
2				
3				
4		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular gravel- to boulder-size blocks, moderately to slightly weathered (Columbia River Basalt).		
5				
6				
7		Test pit terminated at 7 feet due to excavator refusal. No groundwater seepage.		
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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LOG OF TEST PIT NO. 26

FIGURE A-28

PROJECT NAME: Sherwood Industrial **PROJ. NO:** T-8912 **LOGGED BY:** JCS

LOCATION: Sherwood, Oregon **SURFACE CONDITIONS:** Grass, Brush **APPROX. ELEV:** NA

DATE LOGGED: June 29, 2023 **DEPTH TO GROUNDWATER:** NA **DEPTH TO CAVING:** NA

Depth (ft)	Sample No.	Description	Consistency/ Relative Density	W (%)
0		BASALT: moderately weak to moderately strong (R2 to R3), gray-brown, angular gravel- to cobble-size blocks, highly weathered (Columbia River Basalt).		
1				
2				
3				
4		BASALT: moderately weak to moderately strong (R2 to R3), gray, angular gravel- to boulder-size blocks, moderately to slightly weathered (Columbia River Basalt).		
5				
6				
7		Test pit terminated at 7 feet due to excavator refusal. No groundwater seepage.		
8				

NOTE: This subsurface information pertains only to this test pit location and should not be interpreted as being indicative of other locations at the site.

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Particle Size Distribution Report

	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	20.5	22.1	8.8	13.7	10.5	24.4	
□	0.0	7.5	35.6	11.1	12.1	9.1	24.6	
△	0.0	2.0	28.2	13.0	13.0	10.9	32.9	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			23.5340	5.7678	2.3759	0.2217				
□			14.3510	5.6474	2.9545	0.2224				
△			10.3281	2.5703	0.9046					

Material Description	USCS	AASHTO
○ silty GRAVEL with sand	GM	
□ silty GRAVEL with sand	GM	
△ silty SAND with gravel	SM	

Project No. T-8912 **Client:** Panattoni Development Co.

Project: Sherwood Industrial

○ **Location:** TP-3 **Depth:** 4'
□ **Location:** TP-8 **Depth:** 3'
△ **Location:** TP-11 **Depth:** 2'

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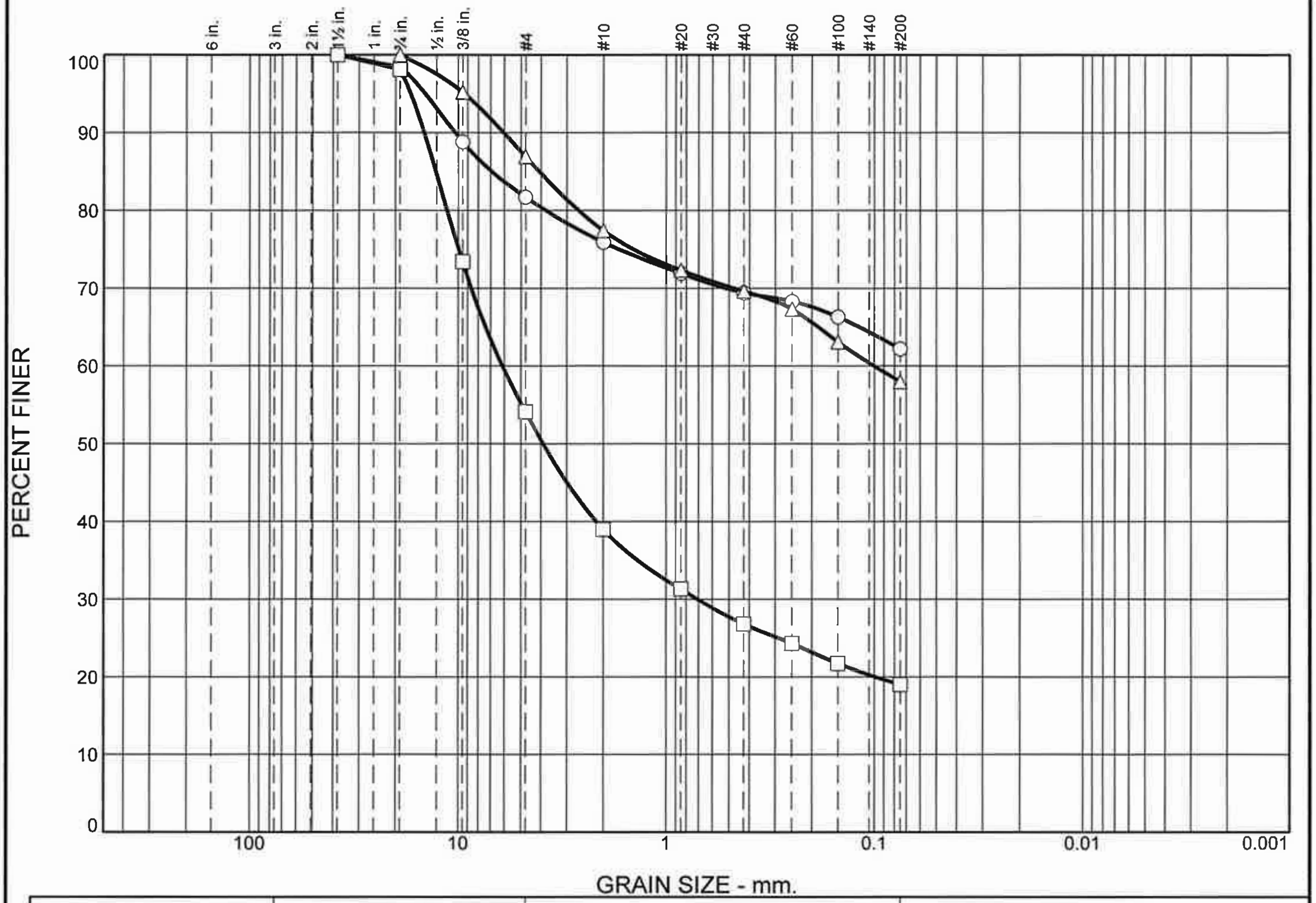
Kirkland, WA

Remarks:
○Tested July 13, 2023
□Tested July 13, 2023
△Tested July 13, 2023

Figure A-29

Tested By: KJ

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	1.6	16.7	5.8	6.5	7.2	62.2	
□	0.0	1.9	44.0	15.1	12.2	7.8	19.0	
△	0.0	0.0	13.1	9.5	7.8	11.6	58.0	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			6.9082							
□			12.7716	6.1247	3.9022	0.7072				
△			4.0826	0.1002						

Material Description	USCS	AASHTO
○ sandy SILT with gravel	ML	
□ silty GRAVEL with sand	GM	
△ sandy SILT	ML	

Project No. T-8912 **Client:** Panattoni Development Co.

Project: Sherwood Industrial

○ **Location:** TP-13 **Depth:** 1.5'

□ **Location:** TP-16 **Depth:** 3'

△ **Location:** TP-16 **Depth:** 7'

Terra Associates, Inc.

Kirkland, WA

Remarks:

○Tested July 13, 2023

□Tested July 13, 2023

△Tested July 13, 2023

Figure A-30

Tested By: KJ