# EXHIBIT E: PRELIMINARY DRAINAGE REPORT

# Preliminary Drainage Report

## Bonaventure Senior Living

2322.14497.01

Prepared for

**Bonaventure, Inc.**

3425 Boone Road SE

Salem, Oregon 97317

February 6, 2019

| | |
|---|---|
| Prepared for | Bonaventure, Inc. |
| Project Name | Preliminary Drainage Report |
| Job Number | 2322.14497.01 |
| Date | February 6, 2019 |

**DOWL**
720 SW Washington Street, Suite 750
Portland, Oregon
97205

Telephone: 971-229-8316
Facsimile: 800-865-9847
semmens@dowl.com

| Name | Title | Date | Revision | Reviewer |
|---|---|---|---|---|
| Scott Emmens | WR Project Manager | 11/30/18 | - | Kyle Glidden |
| Scott Emmens | WR Project Manager | 02/05/19 | - | Kyle Glidden |
| | | | | |

# Executive Summary

The proposed Bonaventure senior housing development is located at 13333 Rusk Road in Milwaukie, Oregon (See Figure 1-1 Vicinity Map. The development requires just over 5 acres of the 14 total acres and will include a multilevel building and private perimeter roadway. Frontage improvements to SE Kellogg Creek Drive will also be completed as part of this project.

**Stormwater Management Standards**

The proposed storm design will meet the requirements of the City of Milwaukie as listed in the *Public Works Standards* dated February 2015. The City of Milwaukie follows the current City of Portland's *Stormwater Management Manual* for water quality facility design.

The proposed project will fill a small area of wetlands located on the site. Therefore, the project must comply with the National Marine Fisheries Service (NMFS) criteria as part of the March 2014 Programmatic Biological Opinion and Essential Fish Habitat Consultation for Revisions to Standard Local Operating Procedures for Endangered Species (SLOPES V) as part of the Wetland Fill Permit with the Army Corp of Engineers.

Additionally, the project is located within the FEMA map (GIS) version of the 100-year floodplain of Mt. Scott Creek. The actual 100-year elevation is applied to the existing conditions and is not impacted by this development. A Conditional Letter of Map Revision (CLOMR) will be submitted to FEMA for review and is intended to demonstrate that no impact to the flood plain will occur.

**Water Quality**

The project will discharge into Mt. Scott Creek, a tributary of Kellogg Creek and the Willamette River. Mt. Scott and Kellogg Creek are not listed as water quality limited and the Willamette River is listed for E. Coli. Typical pollutants from single -family residential projects include: nutrients, pesticides, metals, oil, grease and other petroleum products, and sediment. Dissolved copper, dissolved zinc, and PAHs are generally the primary constituents of concern for stormwater runoff in Oregon streams for their impact on ESA listed species. These pollutants are specially targeted for treatment in the selected stormwater management systems.

Water quality treatment will occur through stormwater swales and flow control ponds. These facilities are landscaped reservoirs that collect and treat stormwater runoff through vegetation and soil media. They provide pollution reduction and flow attenuation to reduce hydraulic impacts from urban developments on downstream rivers. Specific elements are incorporated into the design to increase the effectiveness of this stormwater facility type. Design elements include trapped catch basins to remove coarse sediment, soil media to provide stormwater filtration, and vegetation to will provide plant uptake.

The basins are designed using the BMP Sizing Tool developed by Clackamas County. This continuous simulation software is a regional tool for the Portland metro area. City of Milwaukie standards were checked using the City of Portland Presumptive Approach Calculator (PAC). The stormwater facilities were designed to the standards below:

- Water Quality: 50% of the cumulative rainfall from the 2-year storm event. (Using a continuous rainfall/runoff model).

The calculated peak water quality flow from the 3.84 ac of impervious area is 0.778 cfs.

**Water Quantity**

Water quantity control will occur within the proposed bioretention facilities. Control structures will be placed within each facility to limit runoff to the SLOPES V criteria listed below. The City of Milwaukie does not require water quantity control for this project as the site discharge location into Mt. Scott Creek and Kellogg Creek.

- City of Milwaukie = Match existing flow rate to proposed flow from the 2 through 25-year storm event. – Not required for this project.
- SLOPES V = limit pre-developed discharge rates using a continuous simulation for flows between 42% of the 2-year event and the 10-year flow event.

**Conveyance**

The proposed conveyance system will be designed using the 100-year storm event in the final Drainage Report.

# Table of Contents

# Tables



# Figures

# 1 Project Overview

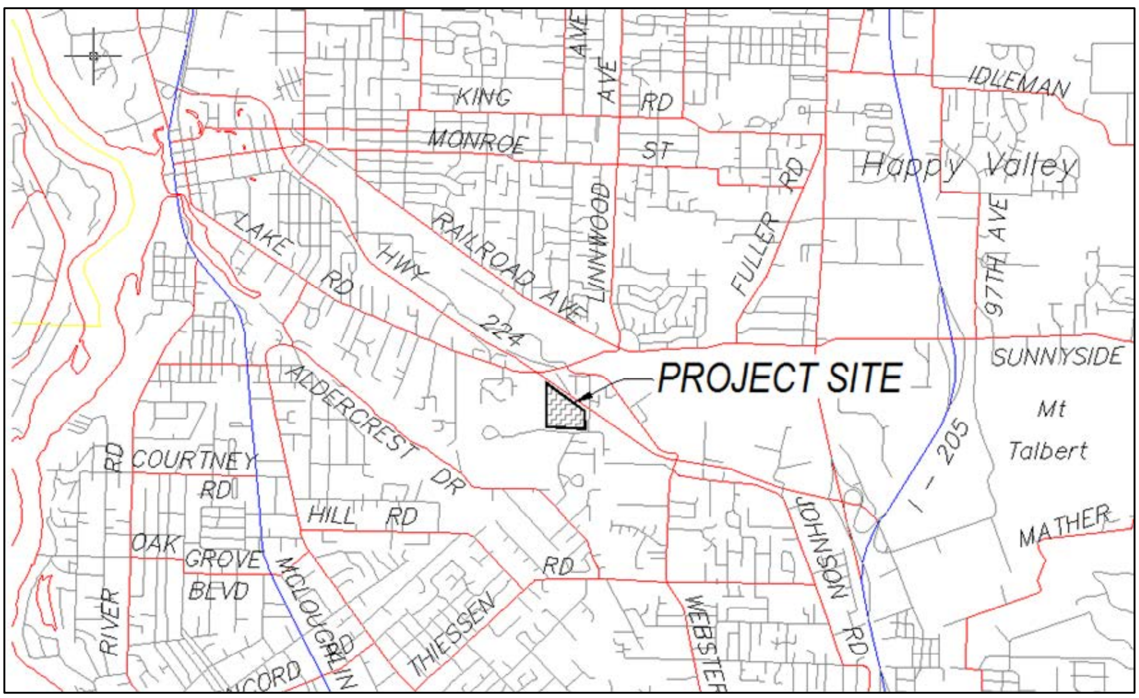
## 1.1 Project Overview

The proposed Bonaventure senior housing development is located at 13333 Rusk Road in Milwaukie, Oregon (See Figure 1-1 Vicinity Map. The development requires just over 5 acres of the 14 total acres and will include a multilevel building and private perimeter roadway. Frontage improvements to SE Kellogg Creek Drive will also be completed as part of this project.

## 1.2 Location

The proposed project is located at 13333 Rusk Road in Milwaukie, Oregon (See Figure 1-1 Vicinity Map). The property includes the following tax lots: TL 22E 06AD 600, TL 22E 06AD 700, TL 22E 06AD 900, and TL 22E 06AD 901.

**Figure 1-1 Vicinity Map**




## 1.3 Methodology

The proposed storm design will meet the requirements of the City of Milwaukie as listed in the *Public Works Standards* dated February 2015. The City of Milwaukie follows the current City of Portland's *Stormwater Management Manual* for water quality facility design.

Additionally, the project must conform to Standard Local Operating Procedures for Endangered Species (SLOPES V) as part of the Wetland Fill Permit with the Army Corp of Engineers.

# 2 Existing Conditions

## 2.1 Topography

The existing site contains a driveway entrance for the adjacent Turning Point Church, grass, blackberry bushes and a scattering of trees. Fill material was previously placed at the site adjacent to the church parking lot. Mt. Scott Creek runs through the northern portion of the site. The site has gradual slopes between 0.5 and 5% and generally drains towards the northwest - west. Steeper slopes occur at the end of fill placed at the site and along Mt. Scott Creek. The highest elevation within the project area is 78; located along the southeast property corner. The lowest elevation of 66 is located in the western property boundary.

## 2.2 Climate

The site is in Milwaukie, Oregon and is located approximately 65 miles inland from the Pacific Ocean. There is a gradual change in seasons with defined seasonal characteristics. Average daily temperatures range from 36°F to 83°F. Record temperatures recorded for this region of the state are -3°F and 107°F. Average annual rainfall recorded in this area is 42-inches. Average annual snowfall is approximately 1-inches between December and February.

## 2.3 Site Geology

The underlying soil types on the site, as classified by the United States Department of Agriculture Soil Survey of Clackamas County, Oregon are identified in Table 2-1 (See Technical Appendix: Hydrologic Soils Map - Clackamas County).

**Table 2-1 Soil Characteristics**

| Soil Type | Hydrologic Group |
|---|---|
| Cove Silty Clay Loam | D |
| Salem Silt Loam | B |
| Wapato Silty Clay Loam | C/D |
| Woodburn Silt Loam | C |

A majority of the site is classified as Cove Silty Clay Loam. Therefore, the entire site has conservatively been assigned a soil Group D. Group D soils have very slow infiltration rates when thoroughly saturated.

Groundwater was encountered during the geotechnical evaluation completed by GEO Consultants Northwest. Groundwater depths varied across the site from 3 to 12 feet below the ground surface. This variation of groundwater depths is a result of the varying amount of existing fill at the site. The elevation of groundwater is approximately 65 ft across the site.

## 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, hydrologic condition and antecedent runoff condition. The pervious curve numbers of 79 representing Woods-Grass Combination in Good Condition was used at the site. A pre-development condition of forested was used in conformance with SLOPES V criteria. (See Technical Appendix: Table 2-2c – Technical Release 55-Urban Hydrology for Small Watersheds).

## 2.5 Time of Concentration

The time of concentration ($T_C$) as described in NEH-4 Chapter 15 is defined in two ways; 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. Time of concentration can be estimated from the following formulas. The time of concentration was calculated to be 24 minutes (See Technical Appendix: Time of Concentration Calculation).

Sheet Flow

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}}$$

$T_t$ = Travel Time (hours) n = Manning's "n" of slope
L = Length of flow (ft) $P_2$ = 2-Year, 24-hour rainfall (in)
s = Slope (ft / ft)

Shallow Concentrated Flow

$$T_t = \frac{L}{3600V}$$

$T_t$ = Travel Time (hours) L = Flow Length (ft)
V = Average Velocity (ft / s) 3600 = seconds / hour

## 2.6 Hydrology

Stormwater runoff from the site sheet flows north to Mt. Scott Creek with the exception of the church driveway entrance and a small area of pervious area. Catch basins collect this impervious area and the adjacent church and sends runoff south to a public storm sewer in SE Kellogg Creek Dr. The SE Kellogg Creek Dr. storm sewer heads south and outfalls into a tributary of Kellogg Creek. Water quality treatment is not provided at the site.

## 2.7 Basin Area

Impervious and pervious surface areas for the existing conditions are shown in Table 2-2. The site is 1.4% impervious. Approximately 1.466 acres of the site drains south to Kellogg Creek (See Technical Appendix: Figure 1 – Existing Basin Delineation).

**Table 2-2 Existing Basin Areas**

| Basin | Impervious Area, ac | Pervious Area, ac | Total Area, ac |
|---|---|---|---|
| Site (Mt Scott Creek) | 0.202 | 13.846 | 14.048 |
| Kellogg Creek Dr. | 0.319 | 0.044 | 0.363 |
| Total | 0.521 | 13.890 | 14.411 |

# 3 Proposed Conditions

## 3.1 Curve Number

The pervious curve numbers of 80 representing Open Space in Good Condition was used at the site. (See Technical Appendix: Table 2-2a – Technical Release 55-Urban Hydrology for Small Watersheds).

## 3.2 Time of Concentration

A time of concentration of 5 minutes was used for the delineated basins.

## 3.3 Hydrology

Stormwater runoff outside the limits of work will continue to sheet flow to Mt. Scott Creek. Floodplain grading will occur so that floodwaters will recede back into the creek channel. Two new outfalls are proposed as part of this project. These outfalls are included as part of the wetland fill permit. The church entrance will be modified as part of this project.

Water quality treatment and quantity facilities will be added to the site. A summary of each facility is provided below.

- Bioretention Basin A: Dry Pond to the tributary of Kellogg Creek
- Bioretention Basin B & C: Bioretention Pond, Outfall to wetland to Mt. Scott Creek through a flow dispersion trench.
- Bioretention Basin D: Bioretention Pond connects to existing storm pipe.
- Untreated: Street outflow constraints prohibit portions of Kellogg Creek Drive from flowing to a treatment facility.

## 3.4 Basin Area

Impervious and pervious surface areas for proposed conditions are shown in Table 3-1. The site is 28.2 % impervious in proposed conditions. The majority of the project will occur at the site, although some work is being done within church property. Street improvements to SE Kellogg Creek Dr. will also occur as part of this project. The Creek basin will not be developed but includes grading to balance the floodplain. The amount of area draining to the tributary of Kellogg Creek is 0.94 acres, slightly more than in existing conditions (See Technical Appendix: Figure 2 – proposed Basin Delineation).

**Table 3-1 Proposed Basin Areas**

| Basin | Impervious Area, ac | Pervious Area, ac | Total Area, ac |
|---|---|---|---|
| Basin A | 0.910 | 0.390 | 1.300 |
| Basin B | 0.710 | 0.290 | 1.000 |
| Basin C | 1.090 | 0.430 | 1.520 |
| Basin D | 1.130 | 0.790 | 1.920 |
| Total | 3.840 | 1.900 | 5.740 |

# 4 Hydrologic and Hydraulic Analysis

## 4.1 Design Guidelines

The proposed storm design will meet the requirements of the City of Milwaukie as listed in the *Public Works Standards* dated February 2015. Section 2.0013 describes the allowable flow determination methods including the selected Unity Hydrograph Method.

## 4.2 Hydrologic Method

The Santa Barbara Urban Hydrograph (SBUH) was used for this analysis. The SBUH method is based on the curve number (CN) approach, and uses the Natural Resources Conservation Service's (NRCS) 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.

The runoff function of xpswmm generates surface and subsurface runoff based on design or measured rainfall conditions, land use and topography. xpswmm Version 17.1 was used for our hydrology and hydraulics analysis. xpswmm is based on the public EPA SWMM program. xpswmm is an approved method of analysis by City of Milwaukie.

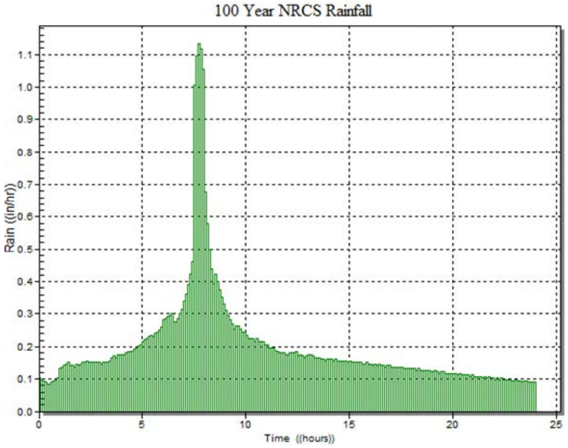
## 4.3 Design Storm

The rainfall distribution to be used within the City of Milwaukie 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. The NRCS Distribution for a type 1A 24-hour rainfall distribution for a 25-year storm event is shown in Figure 4-1.

**Table 4-1 Precipitation Depth**

| Recurrence interval (years) | Total Precipitation Depth (in) |
|---|---|
| 2 | 2.40 |
| 10 | 3.50 |
| 25 | 4.00 |
| 100 | 4.70 |

**Figure 4-1 100-Year Type 1A Rainfall Ditribution**



### 4.4 Basin Runoff

Table 4-2 lists the runoff rates for existing and proposed conditions for the site during the 2, 5, 10, and 25-year storm events. These values do not include onsite detention. (See Technical Appendix: Existing and Proposed Hydrographs).

**Table 4-2 Runoff Rates**

| Recurrence Interval (years) | Existing* Peak Runoff Rate (cfs) | Proposed* Peak Runoff Rate (cfs) |
|---|---|---|
| 2 | 1.556 | 3.423 |
| 5 | 2.856 | 5.047 |
| 10 | 4.063 | 6.493 |
| 25 | 5.357 | 8.002 |

*Existing and proposed peak runoff rates are calculated for entire site.

## 5 Conveyance Analysis

### 5.1 Design Guidelines

The analysis and design criteria described in this section will follow the City of Milwaukie's *Public Works Standards.* The manual requires storm drainage system and facilities be designed to convey the 100-year storm event.

### 5.2 System Capacity

The proposed conveyance system was designed to convey and contain the peak runoff from a 100-year design storm.

### 5.3 System Performance

A complete conveyance analysis will be completed in the final Drainage Report.

## 6 Water Quality & Quantity

### 6.1 Design Guidelines

The proposed water quality and quantity facilities were designed per the City of Milwaukie requirements as listed in the *Public Works Standards* dated February 2015. The City of Milwaukie follows the current City of Portland's *Stormwater Management Manual* for water quality facility design. The City of Milwaukie requires the proposed discharge rate for the 2, 5, 10, and 25-year events to be that of the existing discharge rate. The City of Milwaukie does not require water quantity control for this project as the site discharge location into Mt. Scott Creek and Kellogg Creek.

Detention is also required to meet SLOPES V criteria. SLOPES V limits the proposed discharge rates using a continuous simulation for flows between 42% of the 2-year event and the 10-year flow event of existing flows. Existing conditions are assumed to be forested.

## 6.2 Water Quality and Quantity Facilities

The project will discharge into Mt. Scott Creek, a tributary of Kellogg Creek and the Willamette River. Mt. Scott and Kellogg Creek are not listed as water quality limited and the Willamette River is listed for E. Coli. Typical pollutants from single-family residential projects include: nutrients, pesticides, metals, oil, grease and other petroleum products, and sediment. Dissolved copper, dissolved zinc, and PAHs are generally the primary constituents of concern for stormwater runoff in Oregon streams for their impact on ESA listed species. These pollutants are specially targeted for treatment in the selected stormwater management systems.

Water quality treatment will occur through stormwater bioretention basins, planters and a pond. These facilities are landscaped reservoirs that collect and treat stormwater runoff through vegetation and soil media. They provide pollution reduction and flow attenuation to reduce hydraulic impacts from urban developments on downstream rivers. Specific elements are incorporated into the design to increase the effectiveness of this stormwater facility type. Design elements include trapped catch basins to remove coarse sediment, soil media to provide stormwater filtration, and vegetation to will provide plant uptake.

The basins are designed using the BMP Sizing Tool developed by Clackamas County. This continuous simulation software is a regional tool for the Portland metro area. City of Milwaukie standards were checked using the City of Portland Presumptive Approach Calculator (PAC).

Bioretention facilities are designed to incorporate the following criteria:

- Water Depth: 10 to 18 inches
- Drain Rock Depth: 6 to 18 inches
- Growing Medium Depth: 18 inches
- Minimum Freeboard: 2 inches
- Perforated Pipe Under Drain
- Minimum Orifice Size: 1 inch

There are five (5) proposed bioretention facilities located in the proposed project. Each facility was designed to maximize water contact with vegetation for biological treatment. A control structure with one or two orifices will control the allowable release rate. Appropriate vegetation will be planted in the basin as specified by the City of Portland's *Stormwater Management Manual* (See Technical Appendix: WES BMP Sizing Report). Table 6-1 provides a summary of each facility.

**Table 6-1 Bioretention Facility Summary**

| Basin ID | Facility Type | Minimum Top Area (not including Freeboard) (sf) | Minimum Bottom Area (sf) | Water Depth (in) | Soil Depth (in) | Rock Depth (in) | Total Depth (in) |
|---|---|---|---|---|---|---|---|
| Basin A | Bioretention Basin | 5,244 | 2,817 | 18 | 18 | 6 | 42 |
| Basin B | Bioretention Basin | 3,414 | 2,393 | 18 | 18 | 6 | 42 |
| Basin C | Bioretention Basin | 4,031 | 2,585 | 18 | 18 | 6 | 42 |
| Basin D | Bioretention Basin | 3,600 | 1,749 | 18 | 18 | 6 | 42 |

*Basin A is treated and detained using two separate facilities that are tied together and are modeled as one facility.

**Table 6-2 Bioretention Facility Volume Provided vs Volume Calculated**

| Basin ID | Facility Type | Facility Top Area Calculated by PAC (Including Freeboard) (sf) | Facility Top Area Calculated by WES (sf) | Provided on Plan Minimum Top Area (including Freeboard) (sf) |
|---|---|---|---|---|
| Basin A | Bioretention Basin | 2,812 | 2,837 | 6,109 |
| Basin B | Bioretention Basin | 3,993 | 2,304 | 4,037 |
| Basin C | Bioretention Basin | 3,231 | 3,943 | 4,542 |
| Basin D | Bioretention Basin | 5,177 | 4,036 | 5,236 |

### 6.3 Flow Dispersion

A flow dispersion trench will be used at the outfall of Bioretention Basin B, C and D. This flow spreader was designed to disperse flow over a large area in an effort to reduce erosive velocities of the stormwater discharge entering the wetland during the 100-year event. The flow spreader will be a gravel filled trench with a perforation pipe in the bottom of the trench.

Soils in the proposed discharge location were conservatively assumed to consist of silty clay loam. This soil type has a maximum permissible velocity of 0.5-fps, which was used to determine the facility length (See Technical Appendix: Chow – Fig. 7-3 U.S. and U.S.S.R. data on Permissible Velocities for Non-cohesive Soils). The flow spreader was treated as a broad crested weir with a weir coefficient of 2.4. The broad crested weir equation is shown below.

$$q = 2.4H^{3/2}$$

Where:

q= Volumetric flow rate per unit length, cfs/ft

H= Depth of flow over weir

**Table 6-3 Flow Dispersion Trench**

| Trench | Length (ft) | Discharge (cfs) | Depth (ft) | q (cfs/ft) | Velocity (fps) |
|---|---|---|---|---|---|
| B | 70 | 1.45 | 0.04 | 0.02 | 0.492 |
| C | 60 | 1.30 | 0.04 | 0.02 | 0.500 |

# 7 Floodplain Analysis

FEMA Flood Insurance Rate Maps were used to determine the 10, 25 and 100-year flood stage for Mt. Scott Creek. The site is located on map number FM41005C0036D, with an effective date of June 17, 2008. Elevations are provided in the NAVD 1988 datum, the same as used for this project. The upstream most cross section is C located just downstream of Hwy 224. The 100-year elevation at cross section C is 69.9.

The 25-year elevation was interpolated from the FEMA profile. These elevations were used to balance the floodplain and determine the elevation of the stormwater facilities. FEMA determined elevations are listed in Table 7-1 (See Technical Appendix: Flood Insurance Study, Clackamas County - Mt. Scott Creek Profile).

**Table 7-1 Mt. Scott Creek Water Surface Elevations**

| Recurrence Interval (years) | Water Surface Elevation | |
|---|---|---|
| | Upstream Property Boundary | Downstream Property Boundary |
| 10 | 69.4 | 67.5 |
| 25 | 69.7 | 67.3 |
| 100 | 69.9 | 67.3 |

# 8 Operation & Maintenance

Maintenance of water quality and quantity facilities is very important to ensure they operate as designed. Inadequate maintenance can be attributed to premature failures of these facilities. Stormwater facilities for the site will be maintained and operated privately by the homeowners. Prior to creation of an HOA, please contact Daniel Dobson at 503-373-3154 about inspection and maintenance of the proposed stormwater facilities.

The owners must insure the water quality systems efficiently perform their function of removing petroleum hydrocarbons, sediments, metals, bacteria and nutrients from stormwater runoff and that the water quantity system performs their function of regulating the rate and volume of stormwater runoff leaving the property.

The Operation and Maintenance Plan is provided within the Technical Appendix.

# 9 Summary

The proposed water quality and quantity facility design follows the City of Milwaukie's *Public Works Standards* dated February 2015. The City of Milwaukie follows the current City of Portland's *Stormwater Management Manual* for water quality facility design. Stormwater facility sizing meets and exceeds the larger calculated area from the WES BMP Sizing Tool or the BES PAC Calculator.

Additionally, the project must comply with the National Marine Fisheries Service (NMFS) criteria as part of the March 2014 Programmatic Biological Opinion and Essential Fish Habitat Consultation for Revisions to Standard Local Operating Procedures for Endangered Species (SLOPES V) as part of the Wetland Fill Permit with the Army Corp of Engineers.

Bioretention facilities are proposed to provide a high level of treatment and detention.

# Technical Appendix

**Technical Appendix**

- Figure 1 – Existing Basin Delineation
- Figure 2 – Proposed Basin Delineation

- Hydrologic Soil Map – Washington County
- Table 2-2c – Runoff Curve Numbers for Other Agricultural Lands
- Table 2-2a – Runoff Curve Numbers for Urban Areas
- Time of Concentration
- WES BMP Sizing Report
- PAC
- Existing & Proposed Hydrographs
- Flood Insurance Study, Clackamas County - Mt. Scott Creek Profile
- Chow – Fig. 7-3 U.S. and U.S.S.R. data on Permissible Velocities for Non-cohesive Soils
- Operation and Maintenance Plan
- Geotechnical Evaluation – Kellogg Creek Development, GEO Consultants Northwest, October 7, 2016.

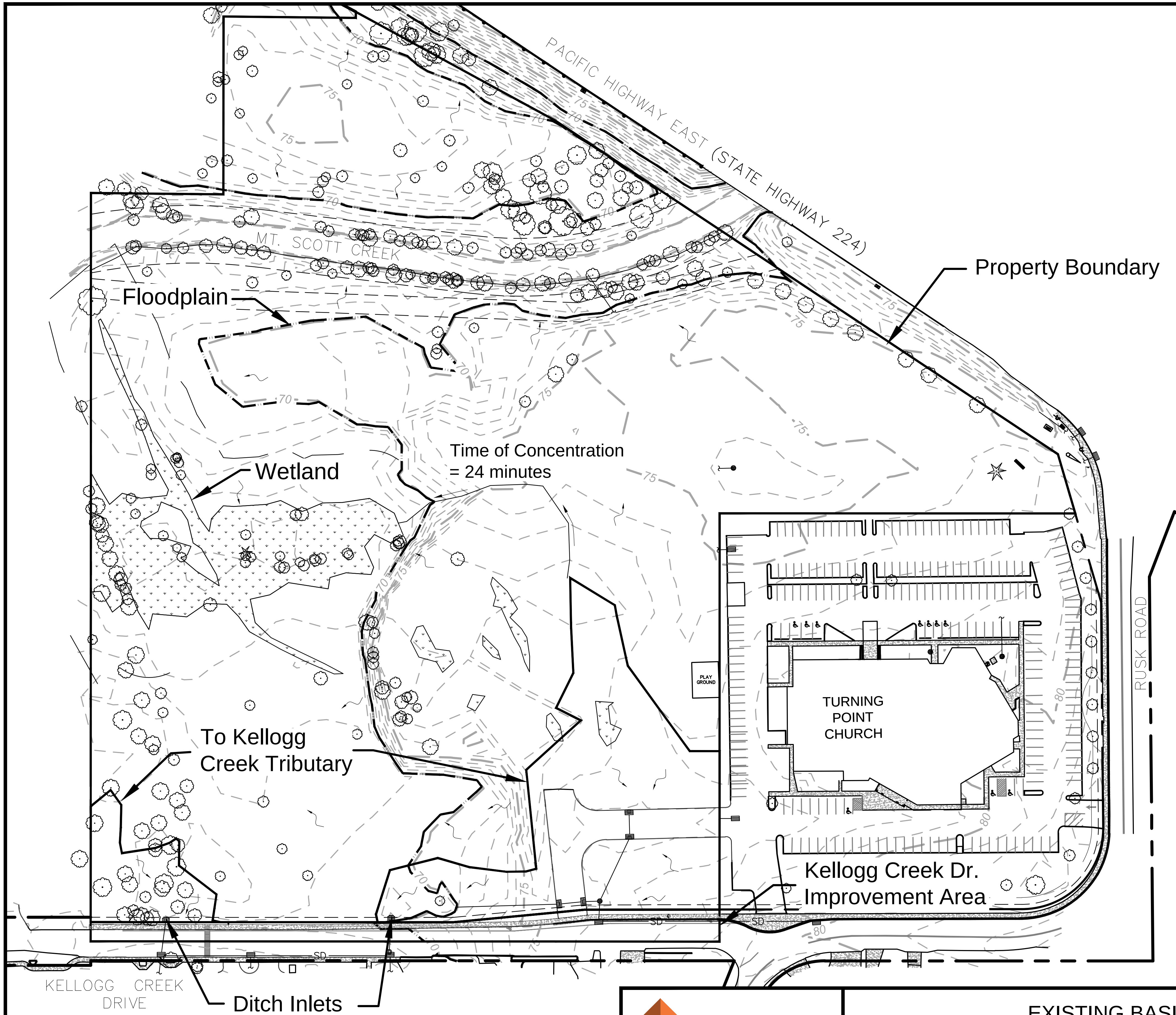
**References**

*Flood Insurance Study (FIS)* **–** *Clackamas County*, Oregon and Incorporated Areas, FEMA, June 17, 2008.

*Public Works Standards,* City of Milwaukie, February 2015.

*Stormwater Management Manual,* City of Portland, August 2016.

*Programmatic Biological Opinion and Essential Fish Habitat Consultation for Revisions to Standard Local Operating Procedures for Endangered Species (SLOPES V)*, National Marine Fisheries Service (NMFS), March 2014.




Existing Basin Area
Impervious Area = 0.202 acres
Pervious Area = 13.846 acres
Total Area = 14.048 acres

Kellogg Creek Dr. Improvement Area
Impervious Area = 0.319 acres
Pervious Area = 0.044 acres
Total Area = 0.363 acres

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SCALE IN FEET

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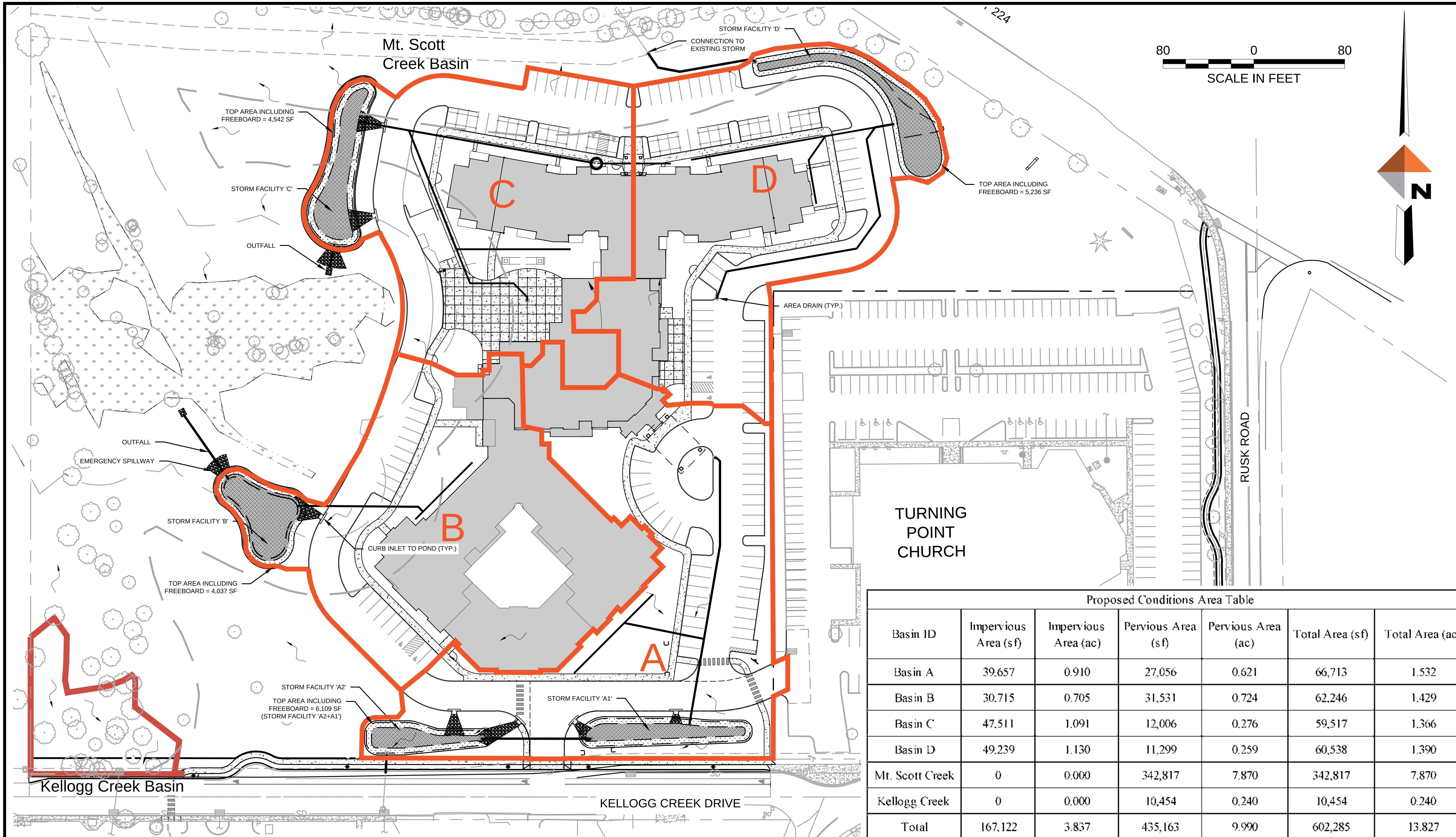
EXISTING BASIN DELINEATION
KELLOGG CREEK SUBDIVISION
MILWAUKIE, OREGON

| | |
|---|---|
| PROJECT | 14497.01 |
| DATE | 11/15/2018 |
| | ASR |

FIGURE 1




Proposed Conditions Area Table

| Basin ID | Impervious Area (sf) | Impervious Area (ac) | Pervious Area (sf) | Pervious Area (ac) | Total Area (sf) | Total Area (ac) |
|---|---|---|---|---|---|---|
| Basin A | 39,657 | 0.910 | 27,056 | 0.621 | 66,713 | 1.532 |
| Basin B | 30,715 | 0.705 | 31,531 | 0.724 | 62,246 | 1.429 |
| Basin C | 47,511 | 1.091 | 12,006 | 0.276 | 59,517 | 1.366 |
| Basin D | 49,239 | 1.130 | 11,299 | 0.259 | 60,538 | 1.390 |
| Mt. Scott Creek | 0 | 0.000 | 342,817 | 7.870 | 342,817 | 7.870 |
| Kellogg Creek | 0 | 0.000 | 10,454 | 0.240 | 10,454 | 0.240 |
| Total | 167,122 | 3.837 | 435,163 | 9.990 | 602,285 | 13.827 |

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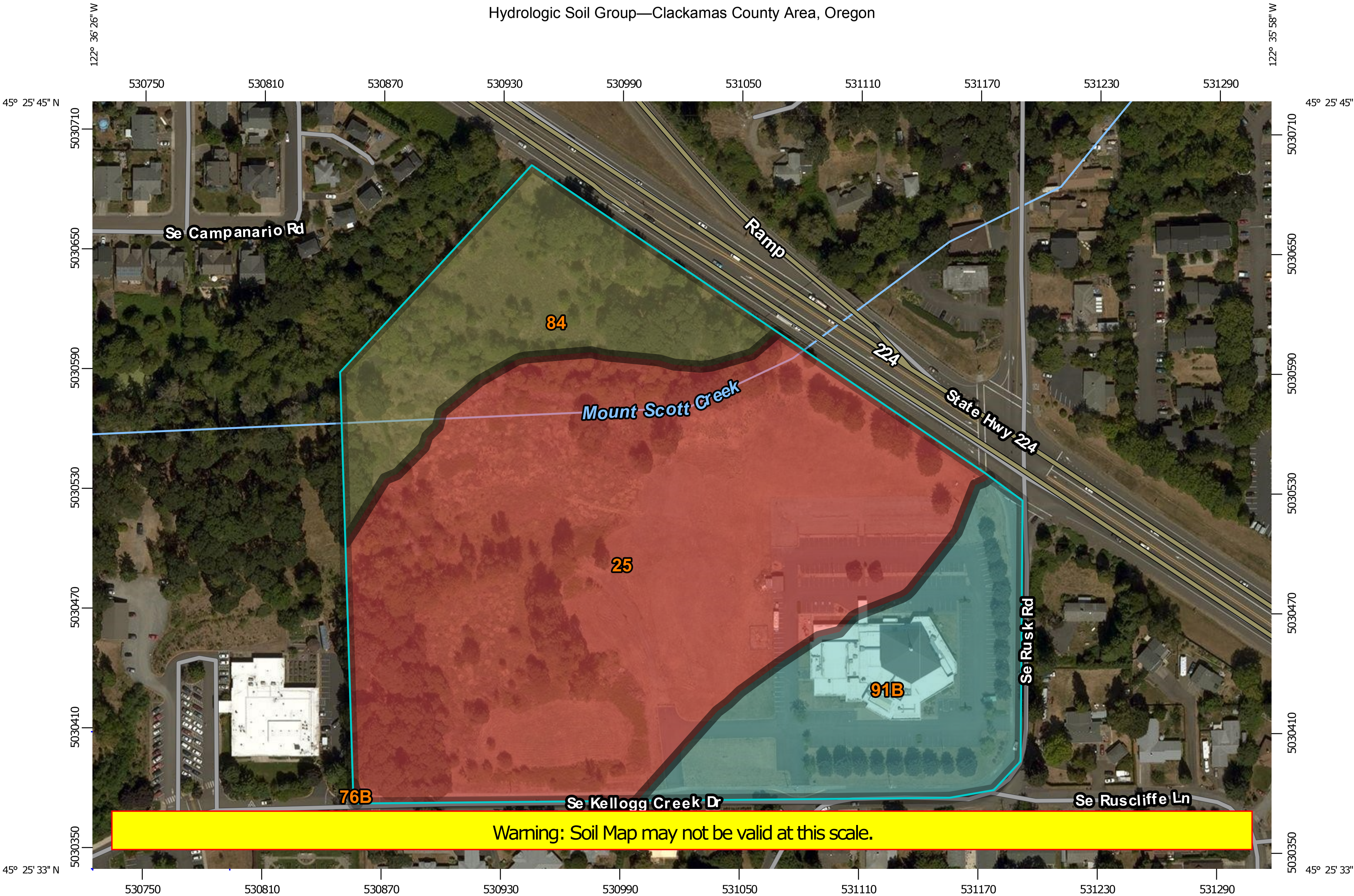
PROPOSED BASIN DELINEATION
KELLOGG CREEK SUBDIVISION
MILWAUKIE, OREGON

PROJECT 14497.01
DATE 02/04/19
OAG

FIGURE 2

Q:\22\14497-01\40Study\Drain\Exhibit\MC14-CS-Drain-BONA-14497.dwg PLOT DATE 2019-2-6 10:45 SAVED DATE 2019-01-11 16:48 USER: semmens




Map Scale: 1:2,710 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 40 80 160 240

Feet: 0 100 200 400 600

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 Rating Polygons**
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

**Soil Rating Lines**
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

**Soil Rating Points**
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

**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: http://websoilsurvey.nrcs.usda.gov
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: Clackamas County Area, Oregon
Survey Area Data: Version 10, Sep 18, 2015

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

Date(s) aerial images were photographed: Jul 26, 2014—Sep 5, 2014

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.

# Hydrologic Soil Group

| Hydrologic Soil Group— Summary by Map Unit — Clackamas County Area, Oregon (OR610) | | | | |
|---|---|---|---|---|
| **Map unit symbol** | **Map unit name** | **Rating** | **Acres in AOI** | **Percent of AOI** |
| 25 | Cove silty clay loam | D | 12.9 | 63.1% |
| 76B | Salem silt loam, 0 to 7 percent slopes | B | 0.0 | 0.0% |
| 84 | Wapato silty clay loam | C/D | 3.6 | 17.6% |
| 91B | Woodburn silt loam, 3 to 8 percent slopes | C | 4.0 | 19.3% |
| **Totals for Area of Interest** | | | **20.5** | **100.0%** |

## Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

**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.

**Table 2-2c** Runoff curve numbers for other agricultural lands [1]

| Cover description | | Curve numbers for hydrologic soil group | | | |
|---|---|---|---|---|---|
| Cover type | Hydrologic condition | A | B | C | D |
| Pasture, grassland, or range—continuous forage for grazing. [2] | Poor | 68 | 79 | 86 | 89 |
| | Fair | 49 | 69 | 79 | 84 |
| | Good | 39 | 61 | 74 | 80 |
| Meadow—continuous grass, protected from grazing and generally mowed for hay. | — | 30 | 58 | 71 | 78 |
| Brush—brush-weed-grass mixture with brush the major element. [3] | Poor | 48 | 67 | 77 | 83 |
| | Fair | 35 | 56 | 70 | 77 |
| | Good | 30 [4] | 48 | 65 | 73 |
| Woods—grass combination (orchard or tree farm). [5] | Poor | 57 | 73 | 82 | 86 |
| | Fair | 43 | 65 | 76 | 82 |
| | Good | 32 | 58 | 72 | $\boxed{79}$ |
| Woods. [6] | Poor | 45 | 66 | 77 | 83 |
| | Fair | 36 | 60 | 73 | 79 |
| | Good | 30 [4] | 55 | 70 | 77 |
| Farmsteads—buildings, lanes, driveways, and surrounding lots. | — | 59 | 74 | 82 | 86 |

1 Average runoff condition, and $I_a = 0.2S$.
2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
*Fair:* 50 to 75% ground cover and not heavily grazed.
*Good:* > 75% ground cover and lightly or only occasionally grazed.
3 *Poor:* <50% ground cover.
*Fair:* 50 to 75% ground cover.
*Good:* >75% ground cover.
4 Actual curve number is less than 30; use CN = 30 for runoff computations.
5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.
6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
*Fair:* Woods are grazed but not burned, and some forest litter covers the soil.
*Good:* Woods are protected from grazing, and litter and brush adequately cover the soil.

# Time of Concentration

| | | | |
|---|---|---|---|
| **SUBJECT** | Time of Concentration - Mt Scott Creek | | |
| **PROJECT NO.** | 2322.14497.01 | **BY** KRG | **DATE** 11/12/2018 |

| | | |
|---|---|---|
| | **Existing** | |
| **SHEET FLOW** | | |
| **INPUT** | **VALUE** | |
| Surface Description | **Type** | **5** |
| | **Grass (short prairie)** | |
| Manning's "n" | **0.15** | |
| Flow Length, L (<300 ft) | **163** | ft |
| 2-Yr 24 Hour Rainfall, $P_2$ | **2.6** | in |
| Land Slope, s | **0.02** | ft/ft |
| **OUTPUT** | | |
| Travel Time | 0.25 | hr |
| **SHALLOW CONCENTRATED FLOW** | | |
| **INPUT** | **VALUE** | |
| Surface Description | **Unpaved** | |
| Flow Length, L | **100** | ft |
| Watercourse Slope*, s | **0.073** | ft/ft |
| **OUTPUT** | | |
| Average Velocity, V | 4.36 | ft/s |
| Travel Time | 0.006 | hr |
| **SHALLOW CONCENTRATED FLOW** | | |
| **INPUT** | **VALUE** | |
| Surface Description | **Unpaved** | |
| Flow Length, L | **0** | ft |
| Watercourse Slope*, s | **0.01** | ft/ft |
| **OUTPUT** | | |
| Average Velocity, V | 1.61 | ft/s |
| Travel Time | 0.000 | hr |
| **Watershed or Subarea $T_c$ =** | **0.26** | **hr** |
| **Watershed or Subarea $T_c$ =** | **15** | **minutes** |

# Time of Concentration

| | | | | | |
|---|---|---|---|---|---|
| **SUBJECT** | Time of Concentration - Kellogg Creek | | | | |
| **PROJECT NO.** | 2322.14497.01 | **BY** | KRG | **DATE** | 11/12/2018 |

| | | |
|---|---|---|
| | **Existing** | |
| **SHEET FLOW** | | |
| **INPUT** | **VALUE** | |
| Surface Description | **Type** | **5** |
| | **Grass (short prairie)** | |
| Manning's "n" | **0.15** | |
| Flow Length, L (<300 ft) | **270** | ft |
| 2-Yr 24 Hour Rainfall, $P_2$ | **2.6** | in |
| Land Slope, s | **0.01** | ft/ft |
| **OUTPUT** | | |
| Travel Time | 0.49 | hr |
| **SHALLOW CONCENTRATED FLOW** | | |
| **INPUT** | **VALUE** | |
| Surface Description | **Paved** | |
| Flow Length, L | **12** | ft |
| Watercourse Slope*, s | **0.02** | ft/ft |
| **OUTPUT** | | |
| Average Velocity, V | 2.87 | ft/s |
| Travel Time | 0.001 | hr |
| **SHALLOW CONCENTRATED FLOW** | | |
| **INPUT** | **VALUE** | |
| Surface Description | **Unpaved** | |
| Flow Length, L | **0** | ft |
| Watercourse Slope*, s | **0.01** | ft/ft |
| **OUTPUT** | | |
| Average Velocity, V | 1.61 | ft/s |
| Travel Time | 0.000 | hr |
| **Watershed or Subarea $T_c$ =** | **0.49** | **hr** |
| **Watershed or Subarea $T_c$ =** | **29** | **minutes** |

WES BMP Sizing Software Version 1.6.0.2, May 2018

# WES BMP Sizing Report

## Project Information

| | |
|---|---|
| Project Name | Bonaventure Senior Living |
| Project Type | MultiFamily |
| Location | 13333 SE Rusk Rd, Portland, OR 97222 |
| Stormwater Management Area | 34104 |
| Project Applicant | Bonaventure |
| Jurisdiction | CCSD1NCSA |

## Drainage Management Area

| Name | Area (sq-ft) | Pre-Project Cover | Post-Project Cover | DMA Soil Type | BMP |
|---|---|---|---|---|---|
| Basin A - Imp | 39,657 | Forested | ConventionalConcrete | D | Ponds A1 & A2 |
| Basin A - Per | 27,056 | Forested | Grass | D | Ponds A1 & A2 |
| Basin B - Imp | 30,715 | Forested | ConventionalConcrete | D | Pond B |
| Basin B - Per | 31,531 | Forested | Grass | D | Pond B |
| Basin C - Imp | 47,511 | Forested | ConventionalConcrete | D | Pond C |
| Basin C - Per | 12,006 | Forested | Grass | D | Pond C |
| Basin D - Imp | 49,239 | Forested | ConventionalConcrete | D | Pond D |
| Basin D - Per | 11,299 | Forested | Grass | D | Pond D |

## LID Facility Sizing Details

## Pond Sizing Details

| Pond ID | Design Criteria(1) | Facility Soil Type | Max Depth (ft)(2) | Top Area (sq-ft) | Side Slope (1:H) | Facility Vol. (cu-ft)(3) | Water Storage Vol. (cu-ft)(4) | Adequate Size? |
|---|---|---|---|---|---|---|---|---|
| Ponds A1 & A2 | FCWQT | Lined | 4.00 | 2,837.0 | 3 | 7,001.8 | 4,318.3 | Yes |
| Pond B | FCWQT | Lined | 4.00 | 2,304.0 | 3 | 5,376.0 | 3,367.2 | Yes |
| Pond C | FCWQT | Lined | 4.00 | 3,943.0 | 3 | 10,512.0 | 6,351.8 | Yes |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Pond D | FCWQT | Lined | 4.00 | 4,036.0 | 3 | 10,814.2 | 6,525.8 | Yes |

1. FCWQT = Flow control and water quality treatment, WQT = Water quality treatment only

2. Depth is measured from the bottom of the facility and includes the three feet of media (drain rock, separation layer and growing media).

3. Maximum volume of the facility. Includes the volume occupied by the media at the bottom of the facility.

4. Maximum water storage volume of the facility. Includes water storage in the three feet of soil media assuming a 40 percent porosity.

# Simple Pond Geometry Configuration

Pond ID: Ponds A1 & A2
Design: FlowControlAndTreatment

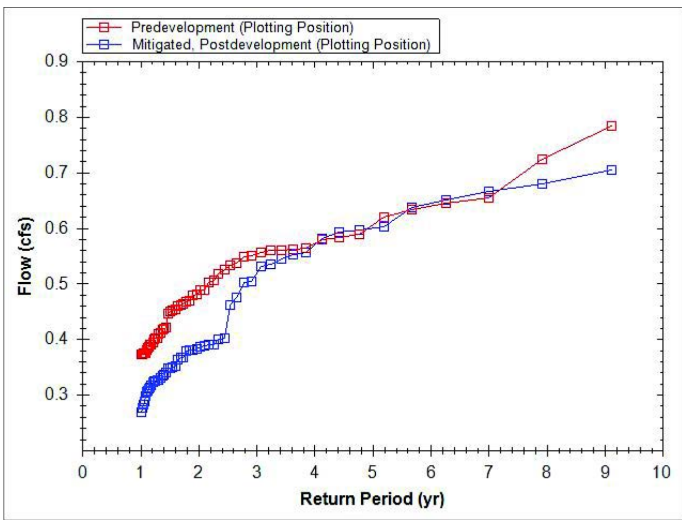
Shape Curve

| Depth (ft) | Area (sq ft) |
|---|---|
| 4.0 | 2,837.0 |

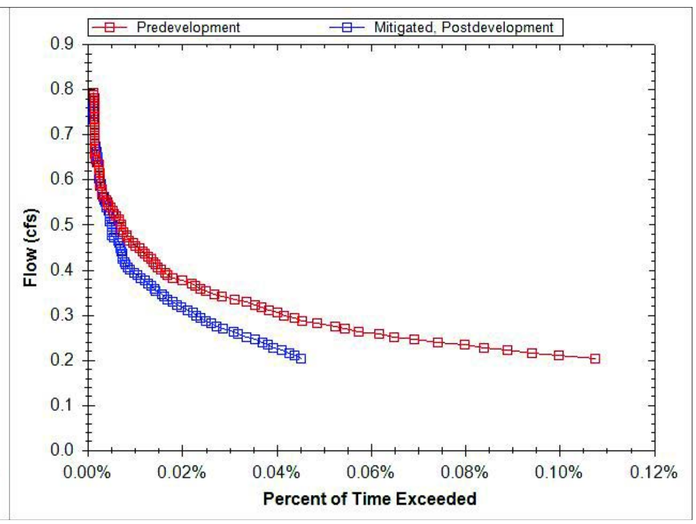
Outlet Structure Details

| | |
|---|---|
| Lower Orifice Invert (ft) | 0.0 |
| Lower Orifice Dia (in) | 2.0 |
| Upper Orifice Invert(ft) | 2.7 |
| Upper Orifice Dia (in) | 4.4 |
| Overflow Weir Invert(ft) | 3.0 |
| Overflow Weir Length (ft) | 6.3 |

Flow Frequency Chart




Flow Duration Chart



# Simple Pond Geometry Configuration

Pond ID: Pond B
Design: FlowControlAndTreatment

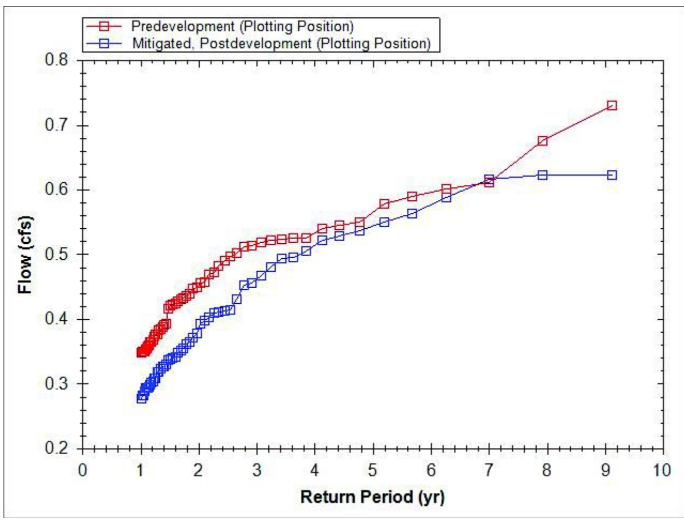
## Shape Curve

| Depth (ft) | Area (sq ft) |
| --- | --- |
| 4.0 | 2,304.0 |

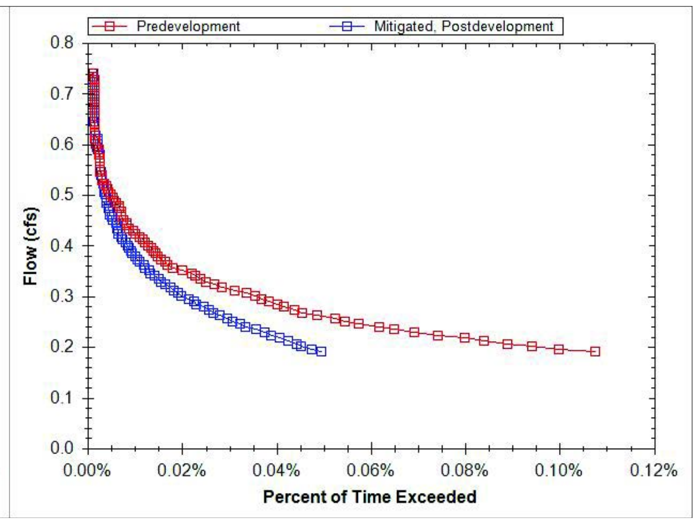
## Outlet Structure Details

| | |
| --- | --- |
| Lower Orifice Invert (ft) | 0.0 |
| Lower Orifice Dia (in) | 1.9 |
| Upper Orifice Invert(ft) | 2.7 |
| Upper Orifice Dia (in) | 4.3 |
| Overflow Weir Invert(ft) | 3.0 |
| Overflow Weir Length (ft) | 6.3 |

Flow Frequency Chart




Flow Duration Chart



# Simple Pond Geometry Configuration

Pond ID: Pond C
Design: FlowControlAndTreatment

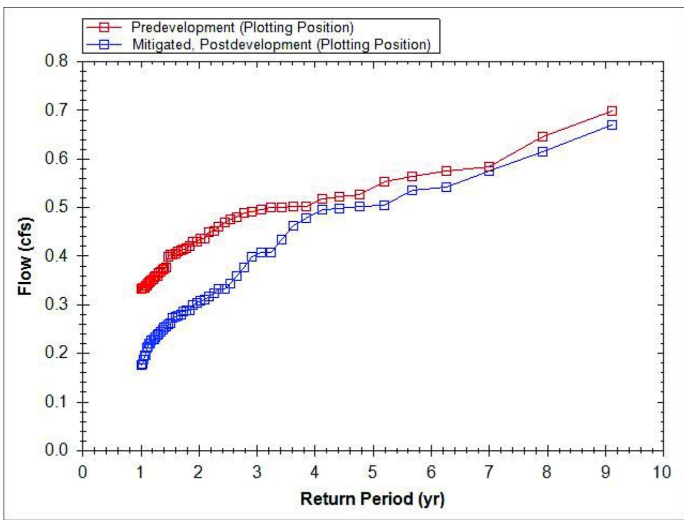
## Shape Curve

| Depth (ft) | Area (sq ft) |
|---|---|
| 4.0 | 3,943.0 |

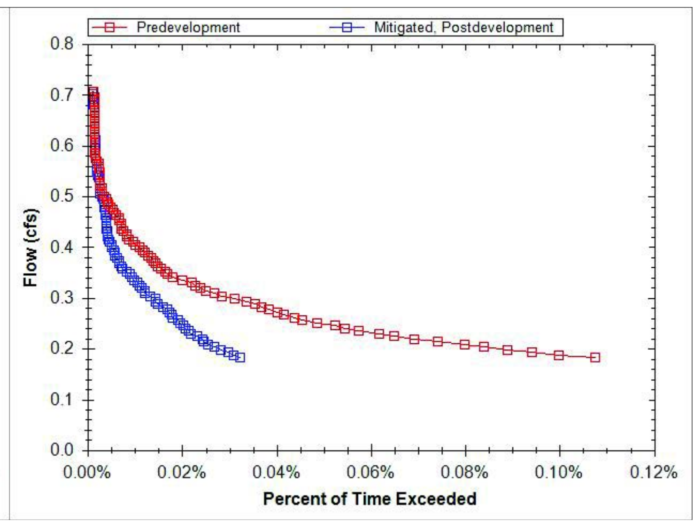
## Outlet Structure Details

| | |
|---|---|
| Lower Orifice Invert (ft) | 0.0 |
| Lower Orifice Dia (in) | 1.9 |
| Upper Orifice Invert(ft) | 2.7 |
| Upper Orifice Dia (in) | 4.2 |
| Overflow Weir Invert(ft) | 3.0 |
| Overflow Weir Length (ft) | 6.3 |

Flow Frequency Chart




Flow Duration Chart



# Simple Pond Geometry Configuration

Pond ID: Pond D
Design: FlowControlAndTreatment

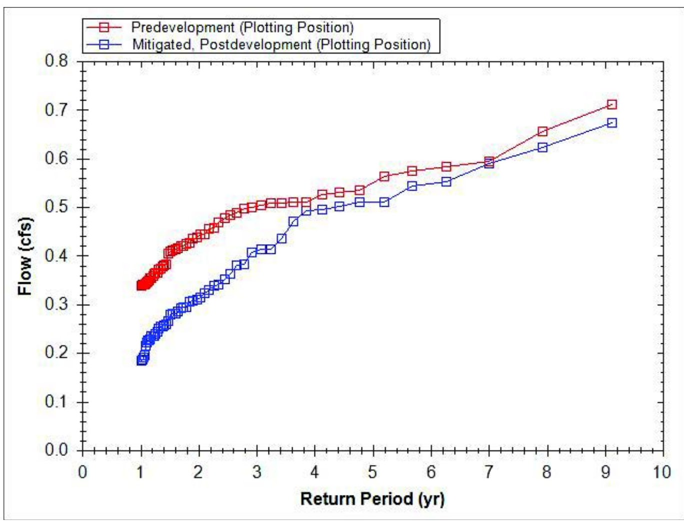
## Shape Curve

| Depth (ft) | Area (sq ft) |
|---|---|
| 4.0 | 4,036.0 |

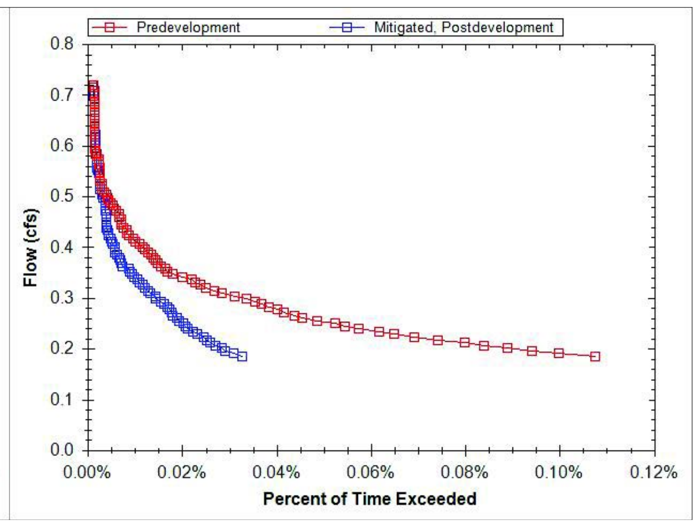
## Outlet Structure Details

| | |
|---|---|
| Lower Orifice Invert (ft) | 0.0 |
| Lower Orifice Dia (in) | 1.9 |
| Upper Orifice Invert(ft) | 2.7 |
| Upper Orifice Dia (in) | 4.2 |
| Overflow Weir Invert(ft) | 3.0 |
| Overflow Weir Length (ft) | 6.3 |

Flow Frequency Chart




Flow Duration Chart



# PAC Report

| Project Name | Permit No. | Created |
|---|---|---|
| Bonaventure Sr Living - Milwaukie | | 11/8/18 12:30 PM |
| **Project Address** | **Designer** | **Last Modified** |
| 13333 Rusk road<br>Milwaukie, OR 97222 | JSE | 11/8/18 4:03 PM |
| | **Company** | **Report Generated** |
| | DOWL | 11/8/18 4:03 PM |

## Project Summary

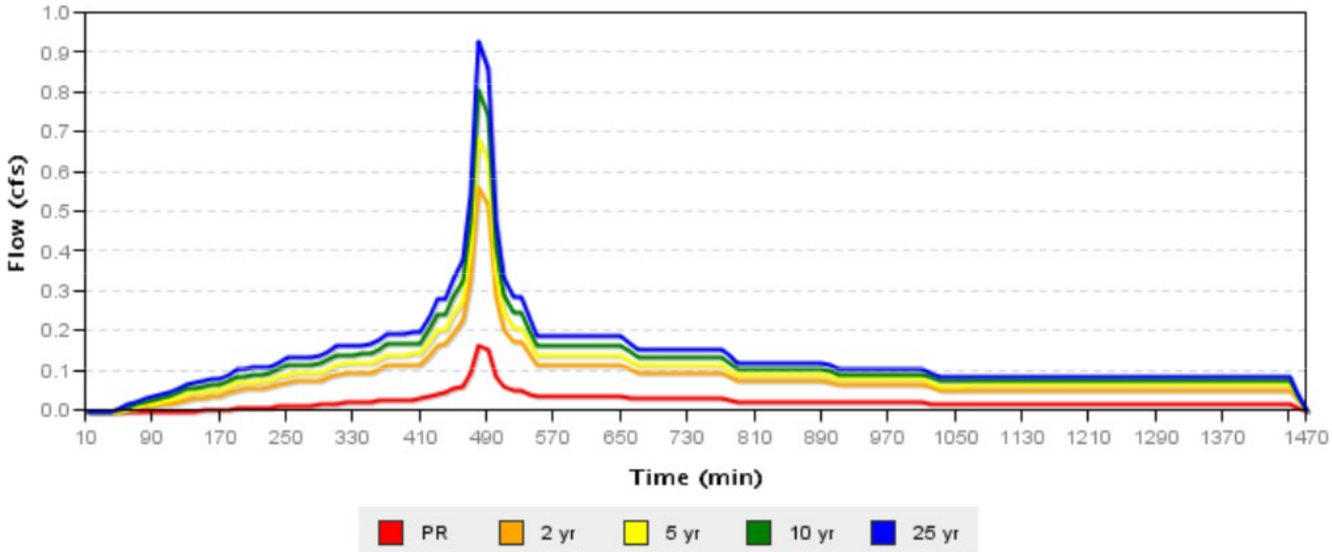
Senior Housing Development

| Catchment Name | Impervious Area (sq ft) | Native Soil Design Infiltration Rate | Hierarchy Category | Facility Type | Facility Config | Facility Size (sq ft) | Facility Sizing Ratio | PR Results | Flow Control Results |
|---|---|---|---|---|---|---|---|---|---|
| Basin A | 39657 | 4.00 | 3 | Basin | B | 1400 | 7.1% | Pass | Pass |
| Basin B | 30718 | 4.00 | 3 | Basin | B | 865 | 13% | Pass | Pass |
| Basin C | 47511 | 4.00 | 3 | Basin | B | 1736 | 6.8% | Pass | Pass |
| Basin D | 49239 | 4.00 | 3 | Basin | B | 2046 | 10.5% | Pass | Pass |

## Catchment Basin A

| | | |
|---|---|---|
| **Site Soils & Infiltration Testing Data** | Infiltration Testing Procedure | **Encased Falling Head** |
| | Native Soil Infiltration Rate ($I_{test}$) | **4.00** |
| **Correction Factor** | $CF_{test}$ | **2** |
| **Design Infiltration Rates** | Native Soil ($I_{dsgn}$) | **2.00 in/hr** |
| | Imported Growing Medium | **2.00 in/hr** |
| **Catchment Information** | Hierarchy Category | **3** |
| | Disposal Point | **B** |
| | Hierarchy Description | **Off-site flow to drainageway, river, or storm-only pipe system** |
| | Pollution Reduction Requirement | **Pass** |
| | 10-year Storm Requirement | **N/A** |
| | Flow Control Requirement | **If discharging to an overland drainage system or to a storm sewer that discharges to an overland drainage system, including streams, drainageways, and ditches, the 2-year post-development peak flow must be equal or less than half of the 2-year pre-development rate and the 5, 10, and 25-year post-development peak rate must be equal or less than the pre-development rates for the corresponding design storms.** |
| | Impervious Area | **39657 sq ft<br>0.910 acre** |
| | Time of Concentration (Tc) | **5** |
| | Pre-Development Curve Number ($CN_{pre}$) | **79** |
| | Post-Development Curve Number ($CN_{post}$) | **98** |

## SBUH Results BASIN A




| | Pre-Development Rate and Volume | | Post-Development Rate and Volume | |
|---|---|---|---|---|
| | Peak Rate (cfs) | Volume (cf) | Peak Rate (cfs) | Volume (cf) |
| **PR** | 0.003 | 99.498 | 0.164 | 2072.19 |
| **2 yr** | 0.141 | 2548.512 | 0.56 | 7175.771 |
| **5 yr** | 0.227 | 3687.731 | 0.684 | 8819.381 |
| **10 yr** | 0.321 | 4919.802 | 0.807 | 10465.451 |
| **25 yr** | 0.425 | 6221.614 | 0.93 | 12113.073 |

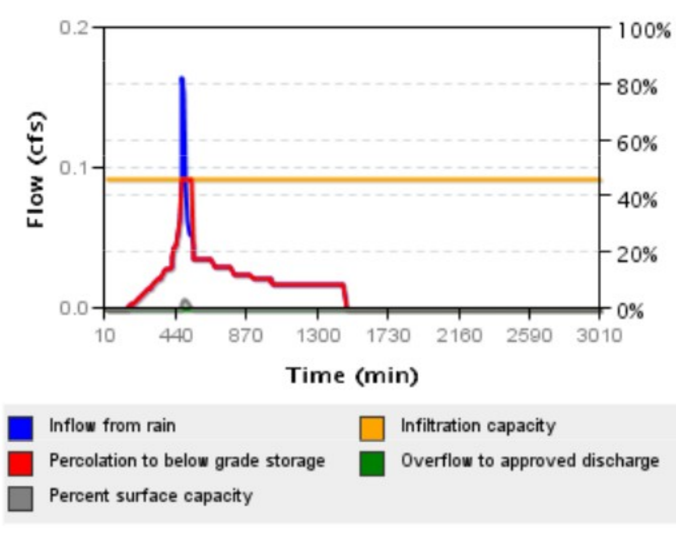
## Facility Basin A

| | | |
|---|---|---|
| **Facility Details** | Facility Type | **Basin** |
| | Facility Configuration | **B: Infl. with rock storage (RS)** |
| | Facility Shape | **Rectangle** |
| | **Above Grade Storage Data** | |
| | Bottom Area | **1400 sq ft** |
| | Bottom Width | **24.00 ft** |
| | Side Slope | **3.0:1** |
| | Storage Depth 1 | **18.0 in** |
| | Growing Medium Depth | **18 in** |
| | Freeboard Depth | **12.00 in** |
| | Surface Capacity at Depth 1 | **2687.6 cu ft** |
| | Design Infiltration Rate for Native Soil | **0.065 in/hr** |
| | Infiltration Capacity | **0.092 cfs** |
| | **Below Grade Storage Data** | |
| | Rock Storage Bottom Area | **1400 sq ft** |
| | Rock Storage Depth | **18 in** |
| | Rock Porosity | **0.30 in** |
| **Facility Facts** | Total Facility Area Including Freeboard | **2811.72 sq ft** |
| | Sizing Ratio | **7.1%** |
| **Pollution Reduction Results** | Pollution Reduction Score | **Pass** |
| | Overflow Volume | **0.000 cf** |
| | Surface Capacity Used | **3%** |
| | Rock Capacity Used | **18%** |
| **Flow Control Results** | Flow Control Score | **Pass** |
| | Overflow Volume | **1857.428 cf** |
| | Surface Capacity Used | **100%** |
| | Rock Capacity Used | **100%** |

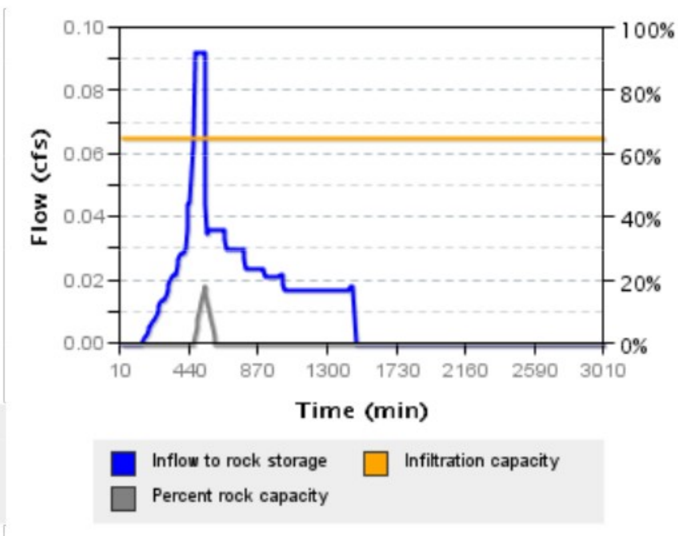
| | Post-development outflow (cfs) | | Pre-development inflow (cfs) | |
|---|---|---|---|---|
| **2 year** | 0 | ≤ ½ of | 0.141 | **Pass** |

| | | | | |
|---|---|---|---|---|
| 5 year | 0.049 | ≤ | 0.227 | Pass |
| 10 year | 0.099 | ≤ | 0.321 | Pass |
| 25 year | 0.385 | ≤ | 0.425 | Pass |

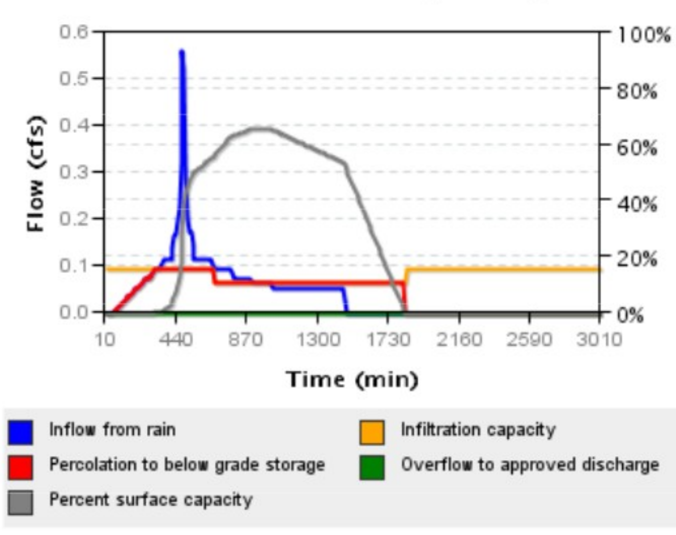
Pollution Reduction Event Surface Facility Modeling



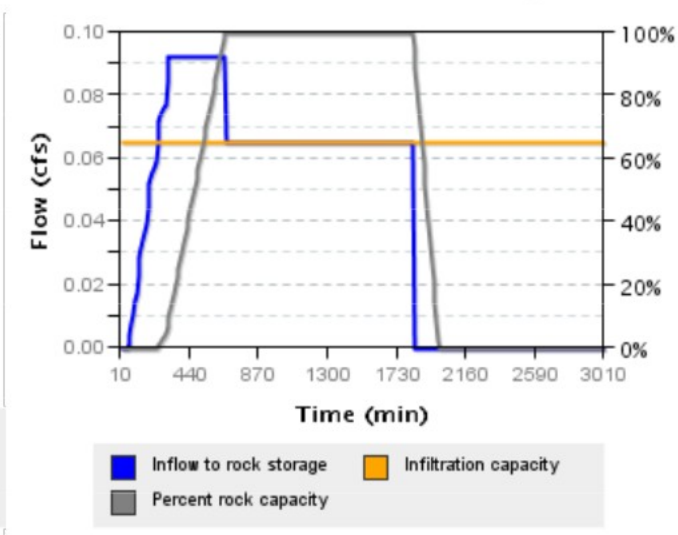

Pollution Reduction Event Below Grade Modeling

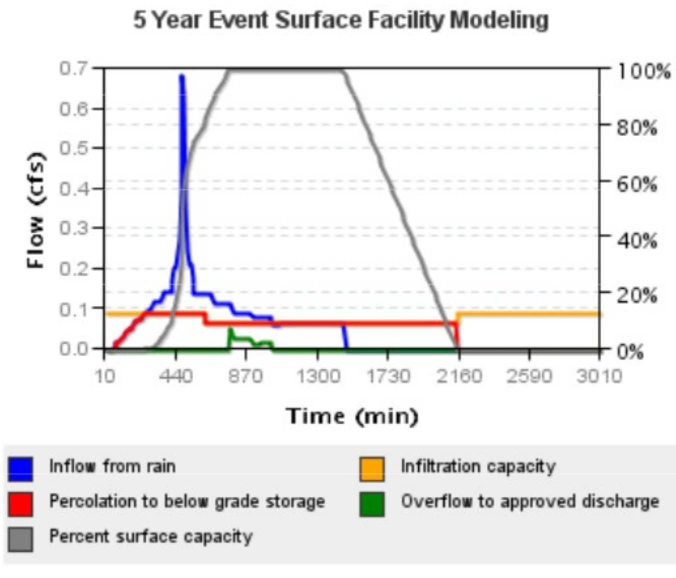


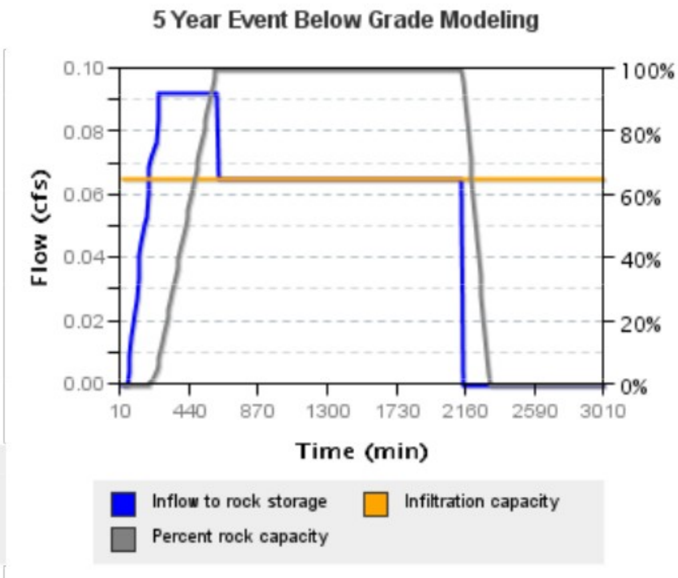

2 Year Event Surface Facility Modeling



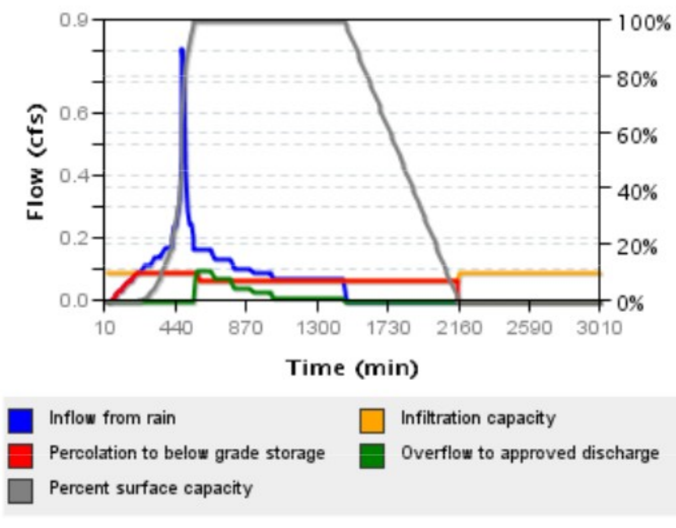

2 Year Event Below Grade Modeling



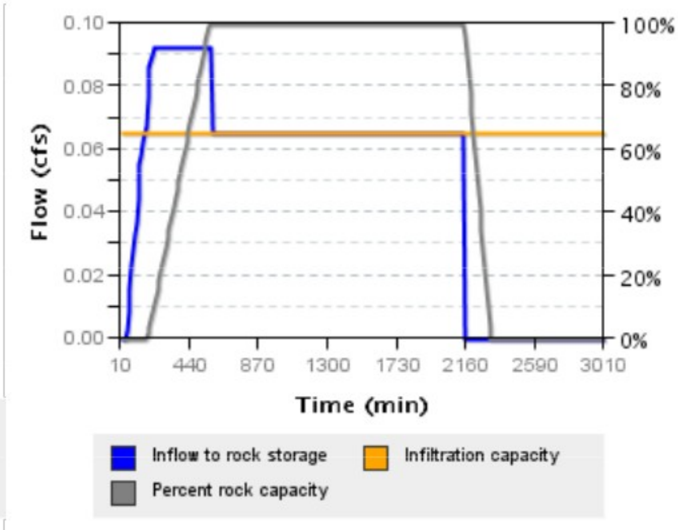

5 Year Event Surface Facility Modeling
Flow (cfs)
Time (min)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
100%
80%
60%
40%
20%
0%
10
440
870
1300
1730
2160
2590
3010
Inflow from rain
Percolation to below grade storage
Percent surface capacity
Infiltration capacity
Overflow to approved discharge


5 Year Event Below Grade Modeling
Flow (cfs)
Time (min)
0.10
0.08
0.06
0.04
0.02
0.00
100%
80%
60%
40%
20%
0%
10
440
870
1300
1730
2160
2590
3010
Inflow to rock storage
Percent rock capacity
Infiltration capacity

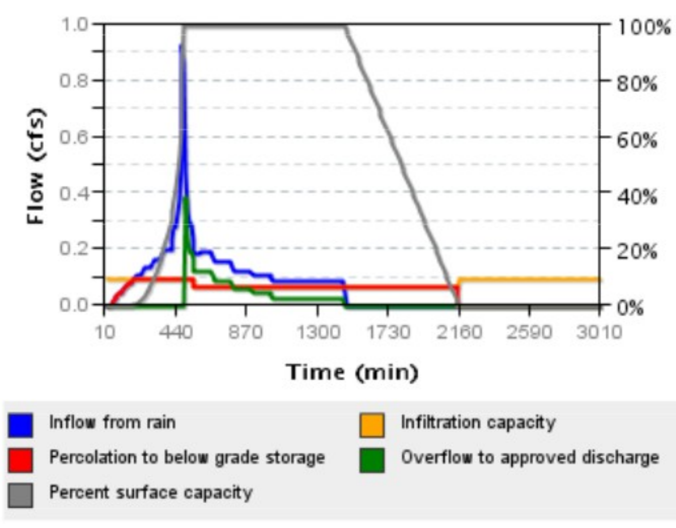
### 10 Year Event Surface Facility Modeling



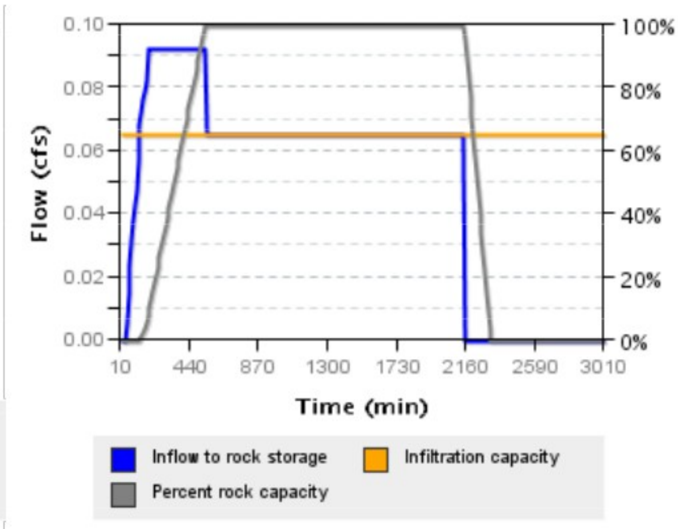

### 10 Year Event Below Grade Modeling




### 25 Year Event Surface Facility Modeling



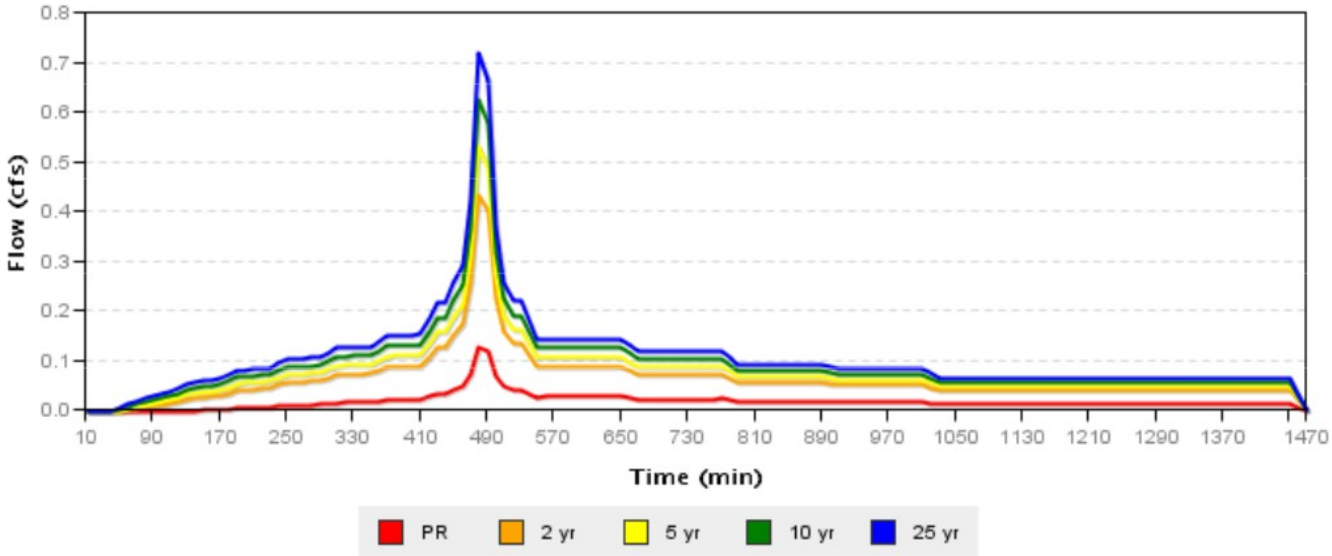

### 25 Year Event Below Grade Modeling



## Catchment Basin B

| | | |
|---|---|---|
| **Site Soils & Infiltration Testing Data** | Infiltration Testing Procedure | **Encased Falling Head** |
| | Native Soil Infiltration Rate ($I_{test}$) | **4.00** |
| **Correction Factor** | $CF_{test}$ | **2** |
| **Design Infiltration Rates** | Native Soil ($I_{dsgn}$) | **2.00 in/hr** |
| | Imported Growing Medium | **2.00 in/hr** |
| **Catchment Information** | Hierarchy Category | **3** |
| | Disposal Point | **B** |
| | Hierarchy Description | **Off-site flow to drainageway, river, or storm-only pipe system** |
| | Pollution Reduction Requirement | **Pass** |
| | 10-year Storm Requirement | **N/A** |
| | Flow Control Requirement | **If discharging to an overland drainage system or to a storm sewer that discharges to an overland drainage system, including streams, drainageways, and ditches, the 2-year post-development peak flow must be equal or less than half of the 2-year pre-development rate and the 5, 10, and 25-year post-development peak rate must be equal or less than the pre-development rates for the corresponding design storms.** |
| | Impervious Area | **30718 sq ft<br>0.705 acre** |
| | Time of Concentration (Tc) | **5** |
| | Pre-Development Curve Number ($CN_{pre}$) | **79** |
| | Post-Development Curve Number ($CN_{post}$) | **98** |

## **SBUH Results** BASIN B



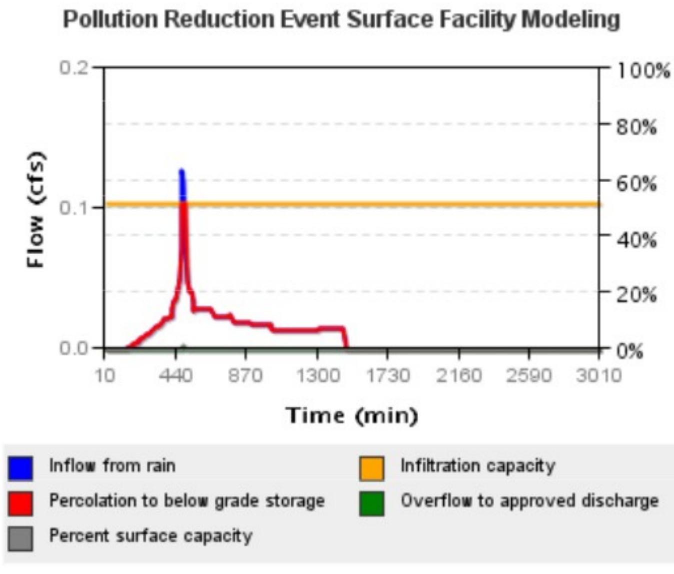

| | Pre-Development Rate and Volume | | Post-Development Rate and Volume | |
|---|---|---|---|---|
| | **Peak Rate (cfs)** | **Volume (cf)** | **Peak Rate (cfs)** | **Volume (cf)** |
| **PR** | 0.003 | 77.07 | 0.127 | 1605.102 |
| **2 yr** | 0.109 | 1974.058 | 0.434 | 5558.296 |
| **5 yr** | 0.176 | 2856.487 | 0.53 | 6831.423 |
| **10 yr** | 0.249 | 3810.84 | 0.625 | 8106.456 |
| **25 yr** | 0.329 | 4819.213 | 0.72 | 9382.691 |

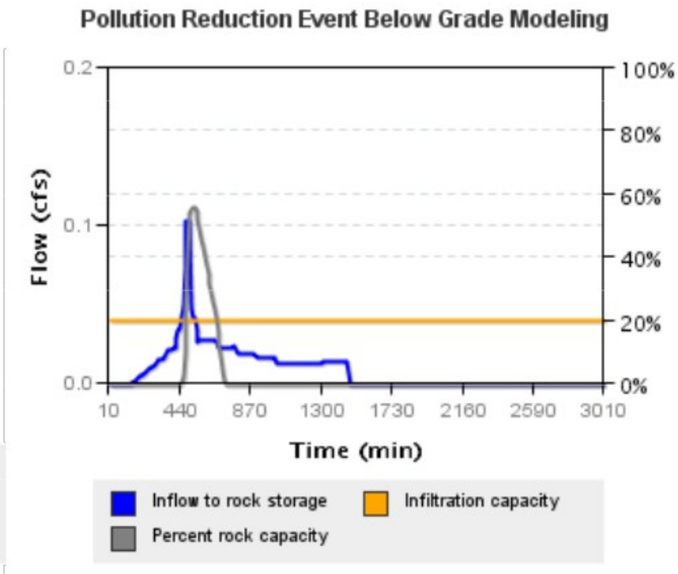
## Facility Basin B

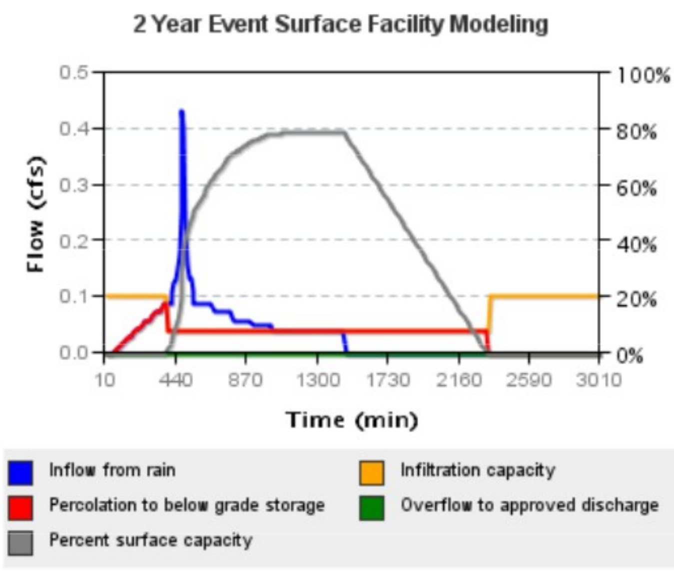
| | | |
|---|---|---|
| **Facility Details** | Facility Type | **Basin** |
| | Facility Configuration | **B: Infl. with rock storage (RS)** |
| | Facility Shape | **Rectangle** |
| | **Above Grade Storage Data** | |
| | Bottom Area | **865 sq ft** |
| | Bottom Width | **4.50 ft** |
| | Side Slope | **3.0:1** |
| | Storage Depth 1 | **18.0 in** |
| | Growing Medium Depth | **18 in** |
| | Freeboard Depth | **12.00 in** |
| | Surface Capacity at Depth 1 | **2657.2 cu ft** |
| | Design Infiltration Rate for Native Soil | **0.040 in/hr** |
| | Infiltration Capacity | **0.103 cfs** |
| | **Below Grade Storage Data** | |
| | Rock Storage Bottom Area | **865 sq ft** |
| | Rock Storage Depth | **12 in** |
| | Rock Porosity | **0.30 in** |
| **Facility Facts** | Total Facility Area Including Freeboard | **3992.55 sq ft** |
| | Sizing Ratio | **13%** |
| **Pollution Reduction Results** | Pollution Reduction Score | **Pass** |
| | Overflow Volume | **0.000 cf** |
| | Surface Capacity Used | **1%** |
| | Rock Capacity Used | **56%** |
| **Flow Control Results** | Flow Control Score | **Pass** |
| | Overflow Volume | **1896.602 cf** |
| | Surface Capacity Used | **100%** |
| | Rock Capacity Used | **100%** |

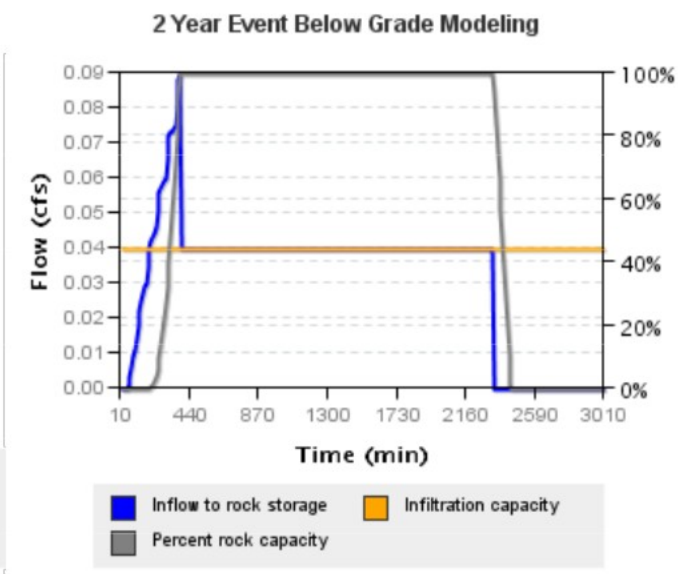
| | Post-development outflow (cfs) | | Pre-development inflow (cfs) | |
|---|---|---|---|---|
| **2 year** | 0 | ≤ ½ of | 0.109 | **Pass** |

| | | | | |
|---|---|---|---|---|
| **5 year** | 0.048 | ≤ | 0.176 | **Pass** |
| **10 year** | 0.087 | ≤ | 0.249 | **Pass** |
| **25 year** | 0.218 | ≤ | 0.329 | **Pass** |

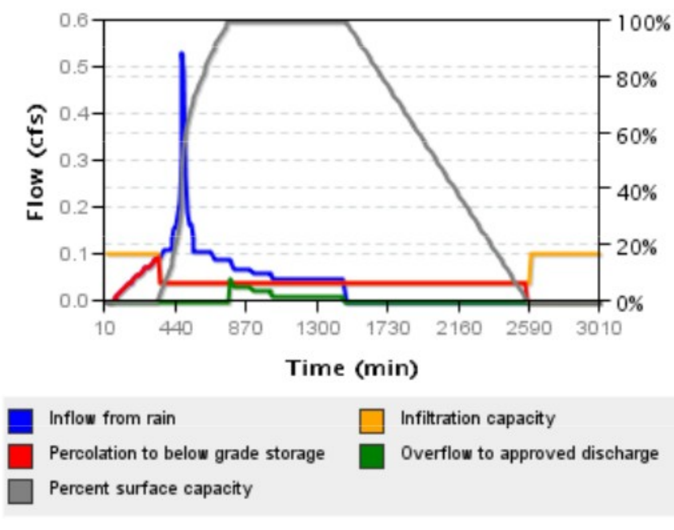


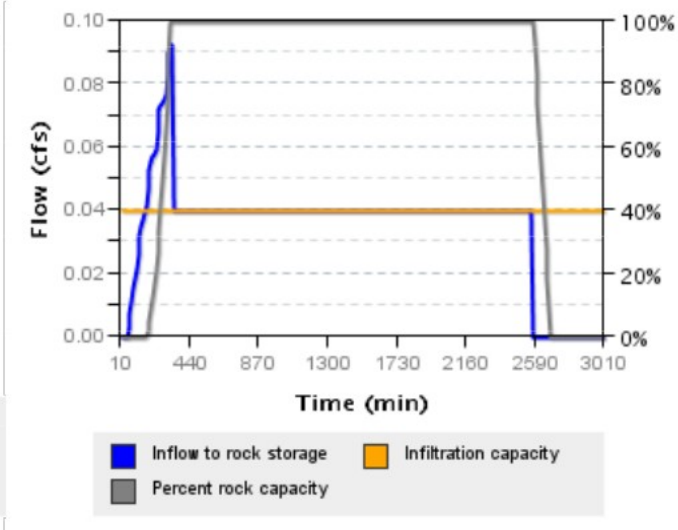



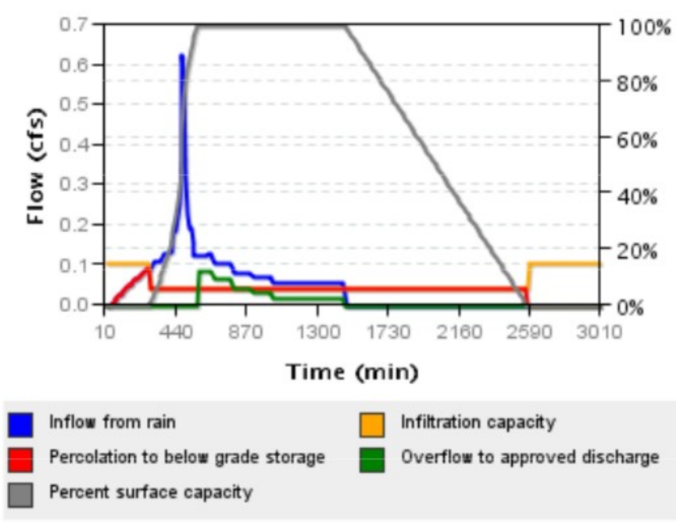
## 5 Year Event Surface Facility Modeling



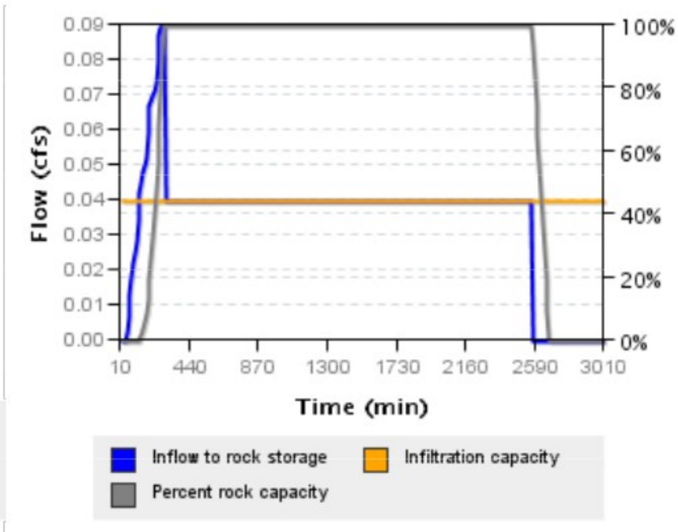

## 5 Year Event Below Grade Modeling



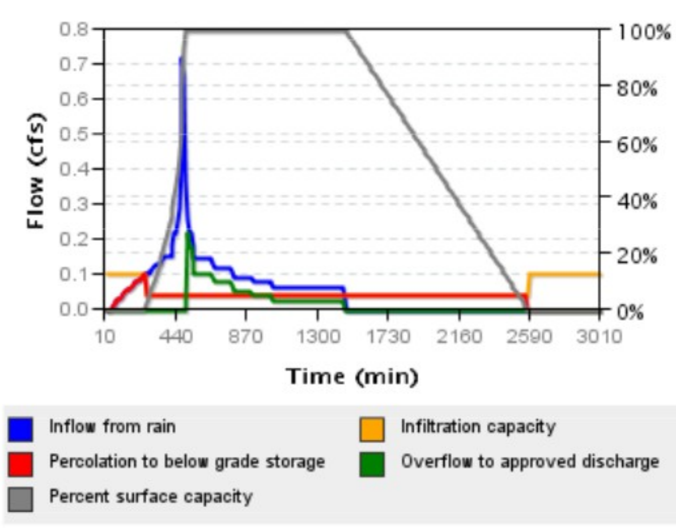
## 10 Year Event Surface Facility Modeling



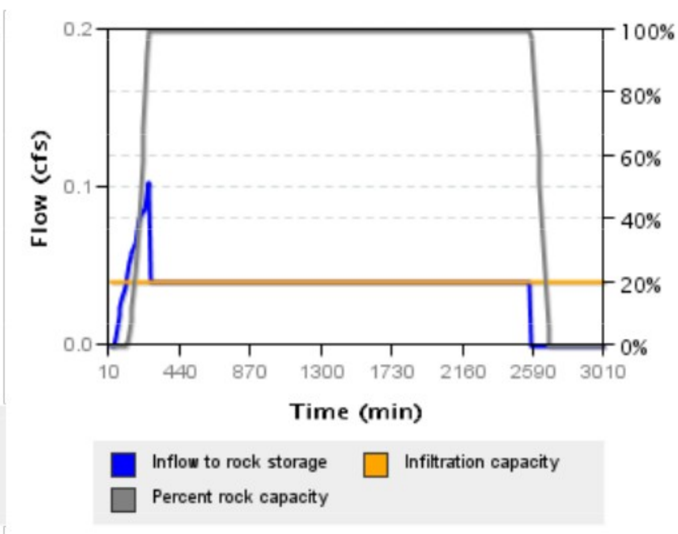

## 10 Year Event Below Grade Modeling




## 25 Year Event Surface Facility Modeling




## 25 Year Event Below Grade Modeling

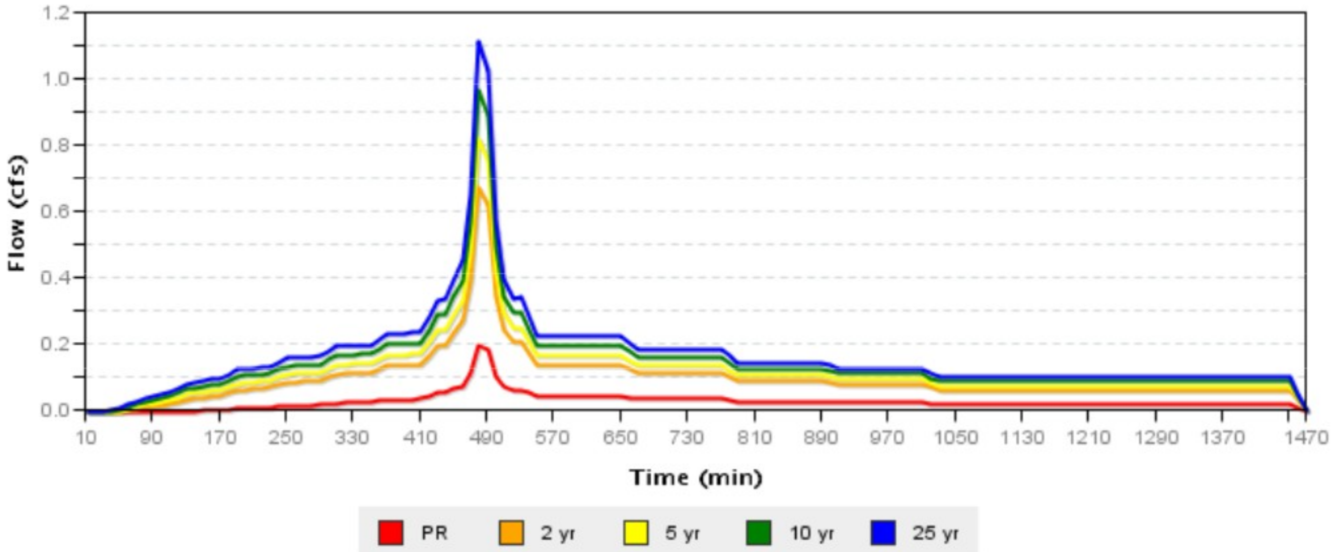


## Catchment Basin C

| | | |
|---|---|---|
| **Site Soils & Infiltration Testing Data** | Infiltration Testing Procedure | **Encased Falling Head** |
| | Native Soil Infiltration Rate ($I_{test}$) | **4.00** |
| **Correction Factor** | $CF_{test}$ | **2** |
| **Design Infiltration Rates** | Native Soil ($I_{dsgn}$) | **2.00 in/hr** |
| | Imported Growing Medium | **2.00 in/hr** |
| **Catchment Information** | Hierarchy Category | **3** |
| | Disposal Point | **B** |
| | Hierarchy Description | **Off-site flow to drainageway, river, or storm-only pipe system** |
| | Pollution Reduction Requirement | **Pass** |
| | 10-year Storm Requirement | **N/A** |
| | Flow Control Requirement | **If discharging to an overland drainage system or to a storm sewer that discharges to an overland drainage system, including streams, drainageways, and ditches, the 2-year post-development peak flow must be equal or less than half of the 2-year pre-development rate and the 5, 10, and 25-year post-development peak rate must be equal or less than the pre-development rates for the corresponding design storms.** |
| | Impervious Area | **47511 sq ft** ⚠<br>**1.091 acre** |
| | Time of Concentration (Tc) | **5** |
| | Pre-Development Curve Number ($CN_{pre}$) | **79** |
| | Post-Development Curve Number ($CN_{post}$) | **98** |

⚠ Indicates value is outside of recommended range

## **SBUH Results** BASIN C




| | Pre-Development Rate and Volume | | Post-Development Rate and Volume | |
|---|---|---|---|---|
| | **Peak Rate (cfs)** | **Volume (cf)** | **Peak Rate (cfs)** | **Volume (cf)** |
| **PR** | 0.004 | 119.203 | 0.196 | 2482.583 |
| **2 yr** | 0.169 | 3053.241 | 0.671 | 8596.92 |
| **5 yr** | 0.272 | 4418.079 | 0.819 | 10566.044 |
| **10 yr** | 0.385 | 5894.16 | 0.967 | 12538.116 |
| **25 yr** | 0.509 | 7453.794 | 1.114 | 14512.046 |

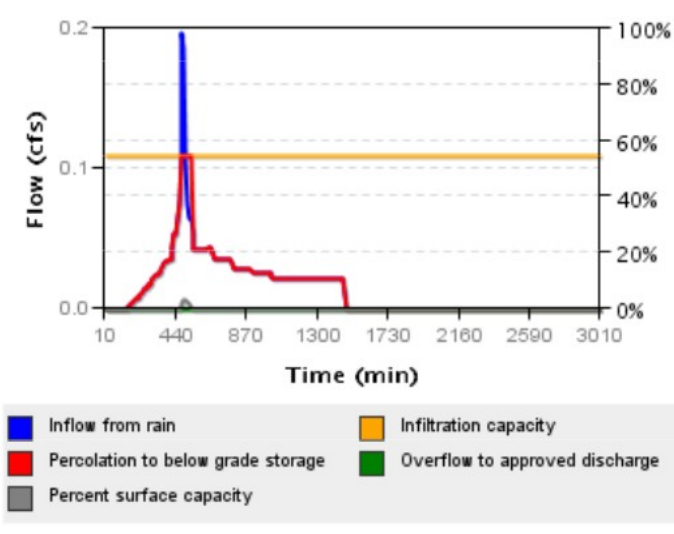
## Facility Basin C

| | | |
|---|---|---|
| **Facility Details** | Facility Type | **Basin** |
| | Facility Configuration | **B: Infl. with rock storage (RS)** |
| | Facility Shape | **Rectangle** |
| | **Above Grade Storage Data** | |
| | Bottom Area | **1736 sq ft** |
| | Bottom Width | **30.00 ft** |
| | Side Slope | **3.0:1** |
| | Storage Depth 1 | **18.0 in** |
| | Growing Medium Depth | **18 in** |
| | Freeboard Depth | **12.00 in** |
| | Surface Capacity at Depth 1 | **3228.9 cu ft** |
| | Design Infiltration Rate for Native Soil | **0.080 in/hr** |
| | Infiltration Capacity | **0.109 cfs** |
| | **Below Grade Storage Data** | |
| | Rock Storage Bottom Area | **1736 sq ft** |
| | Rock Storage Depth | **18 in** |
| | Rock Porosity | **0.30 in** |
| **Facility Facts** | Total Facility Area Including Freeboard | **3230.72 sq ft** |
| | Sizing Ratio | **6.8%** |
| **Pollution Reduction Results** | Pollution Reduction Score | **Pass** |
| | Overflow Volume | **0.000 cf** |
| | Surface Capacity Used | **3%** |
| | Rock Capacity Used | **16%** |
| **Flow Control Results** | Flow Control Score | **Pass** |
| | Overflow Volume | **2027.270 cf** |
| | Surface Capacity Used | **100%** |
| | Rock Capacity Used | **100%** |

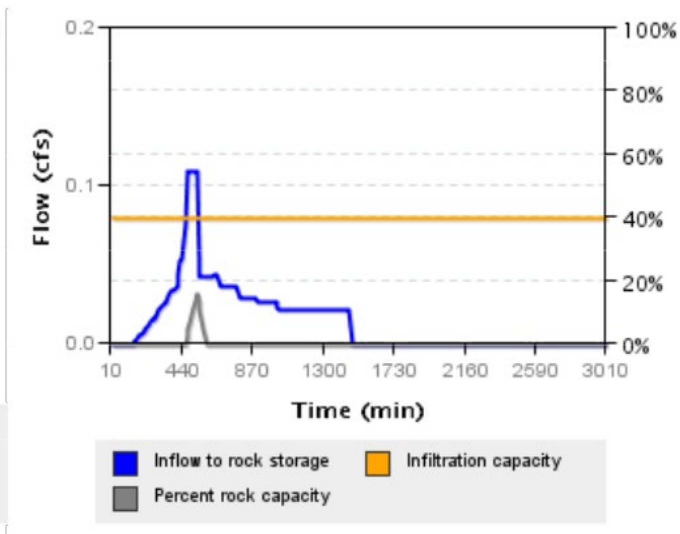
| | **Post-development outflow (cfs)** | | **Pre-development inflow (cfs)** | |
|---|---|---|---|---|
| **2 year** | 0 | ≤ ½ of | 0.169 | **Pass** |

| | | | | |
|---|---|---|---|---|
| **5 year** | 0.028 | ≤ | 0.272 | **Pass** |
| **10 year** | 0.115 | ≤ | 0.385 | **Pass** |
| **25 year** | 0.463 | ≤ | 0.509 | **Pass** |

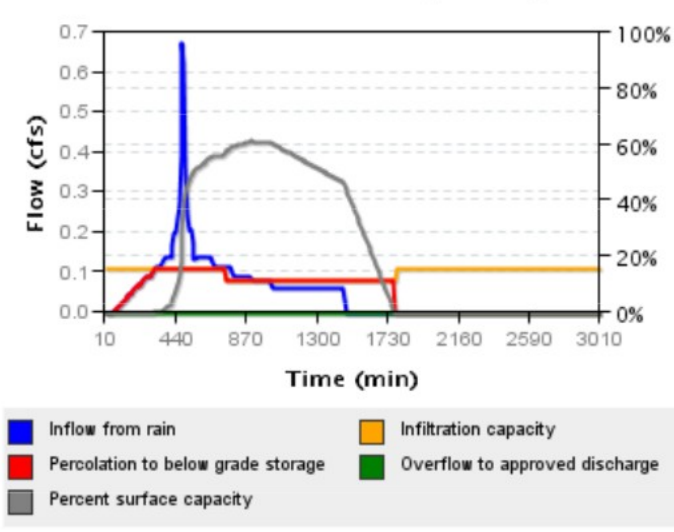
**Pollution Reduction Event Surface Facility Modeling**



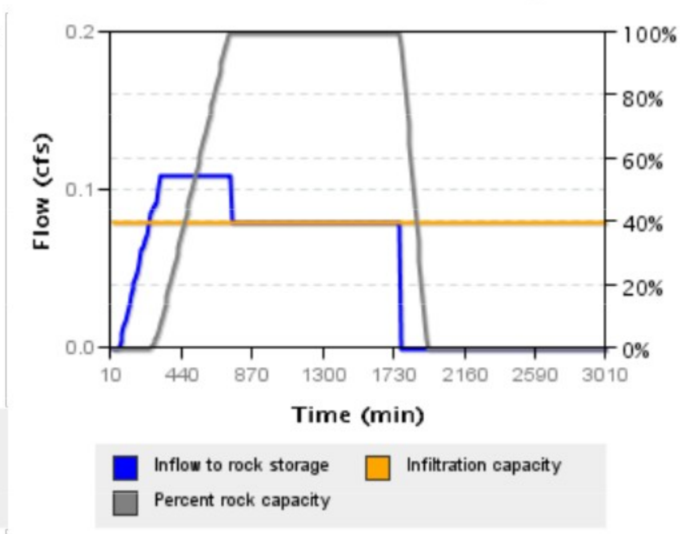

**Pollution Reduction Event Below Grade Modeling**



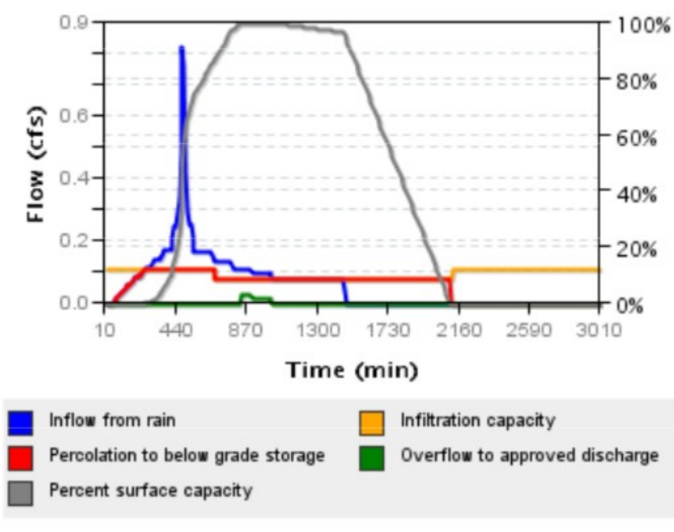

**2 Year Event Surface Facility Modeling**



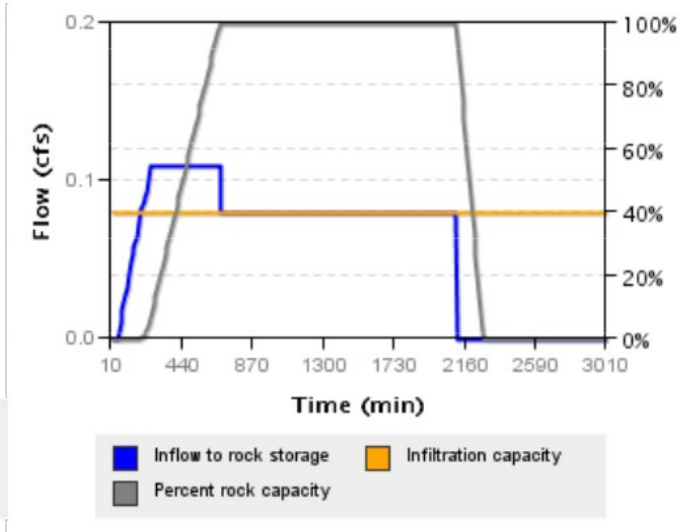

**2 Year Event Below Grade Modeling**



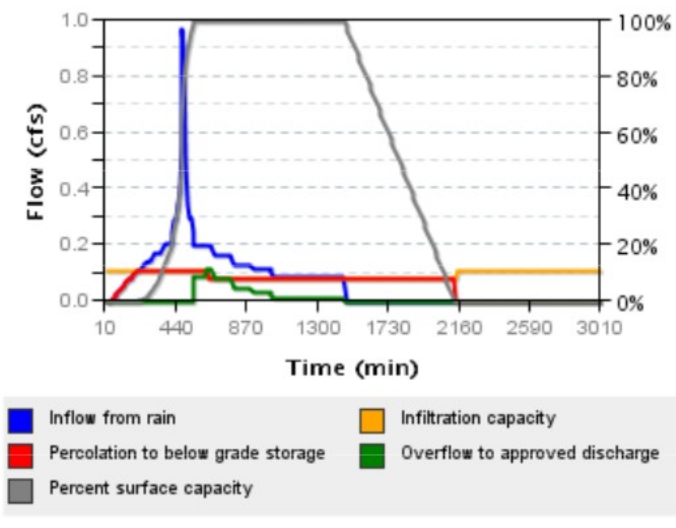
5 Year Event Surface Facility Modeling



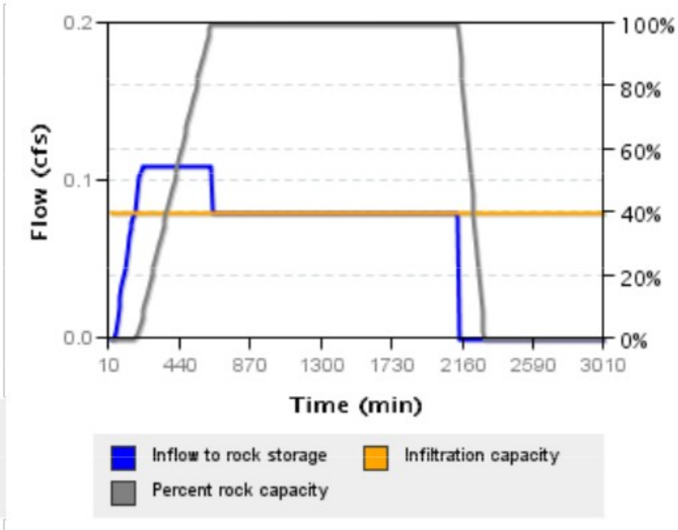

5 Year Event Below Grade Modeling



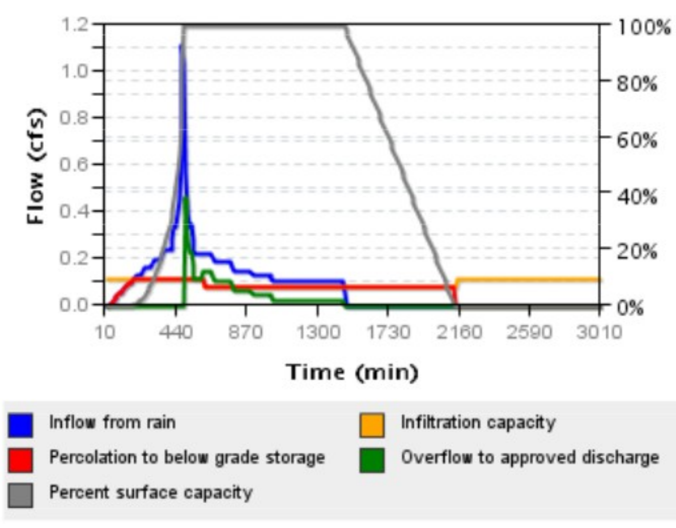
10 Year Event Surface Facility Modeling



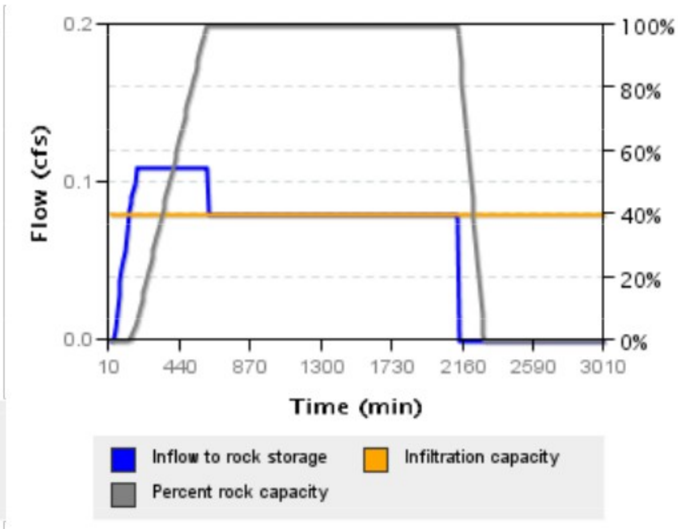

10 Year Event Below Grade Modeling




25 Year Event Surface Facility Modeling




25 Year Event Below Grade Modeling

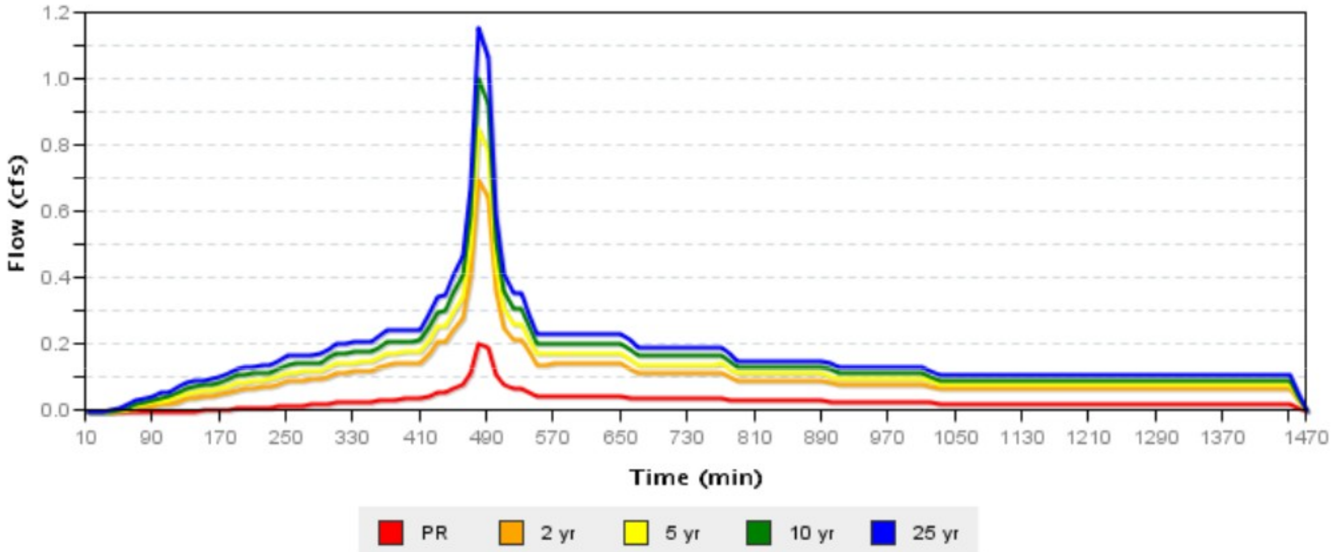


## Catchment Basin D

| | | |
|---|---|---|
| **Site Soils & Infiltration Testing Data** | Infiltration Testing Procedure | **Encased Falling Head** |
| | Native Soil Infiltration Rate ($I_{test}$) | **4.00** |
| **Correction Factor** | $CF_{test}$ | **2** |
| **Design Infiltration Rates** | Native Soil ($I_{dsgn}$) | **2.00 in/hr** |
| | Imported Growing Medium | **2.00 in/hr** |
| **Catchment Information** | Hierarchy Category | **3** |
| | Disposal Point | **B** |
| | Hierarchy Description | **Off-site flow to drainageway, river, or storm-only pipe system** |
| | Pollution Reduction Requirement | **Pass** |
| | 10-year Storm Requirement | **N/A** |
| | Flow Control Requirement | **If discharging to an overland drainage system or to a storm sewer that discharges to an overland drainage system, including streams, drainageways, and ditches, the 2-year post-development peak flow must be equal or less than half of the 2-year pre-development rate and the 5, 10, and 25-year post-development peak rate must be equal or less than the pre-development rates for the corresponding design storms.** |
| | Impervious Area | **49239 sq ft** ⚠<br>**1.130 acre** |
| | Time of Concentration (Tc) | **5** |
| | Pre-Development Curve Number ($CN_{pre}$) | **79** |
| | Post-Development Curve Number ($CN_{post}$) | **98** |

⚠ Indicates value is outside of recommended range

## SBUH Results BASIN D



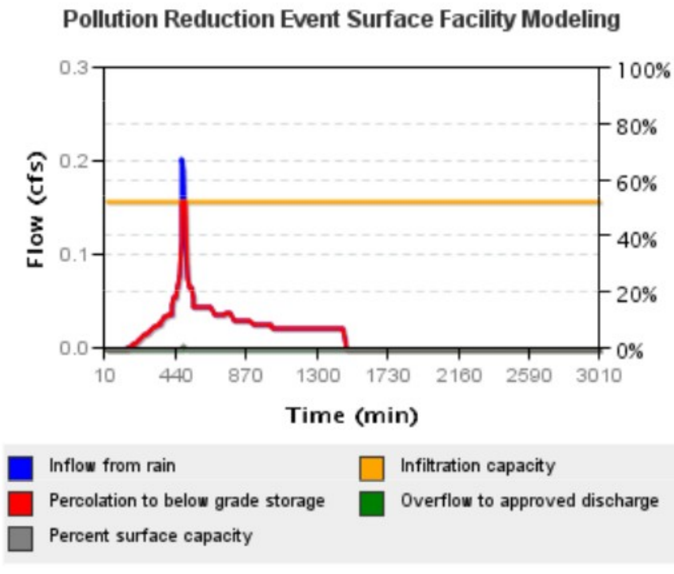

| | Pre-Development Rate and Volume | | Post-Development Rate and Volume | |
|---|---|---|---|---|
| | Peak Rate (cfs) | Volume (cf) | Peak Rate (cfs) | Volume (cf) |
| **PR** | 0.004 | 123.539 | 0.203 | 2572.876 |
| **2 yr** | 0.175 | 3164.289 | 0.695 | 8909.594 |
| **5 yr** | 0.282 | 4578.767 | 0.849 | 10950.337 |
| **10 yr** | 0.399 | 6108.534 | 1.002 | 12994.133 |
| **25 yr** | 0.527 | 7724.893 | 1.155 | 15039.857 |

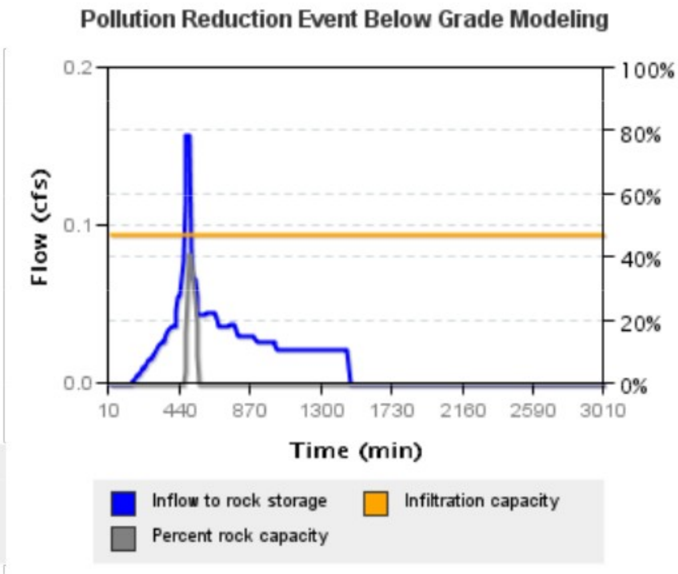
## Facility Basin D

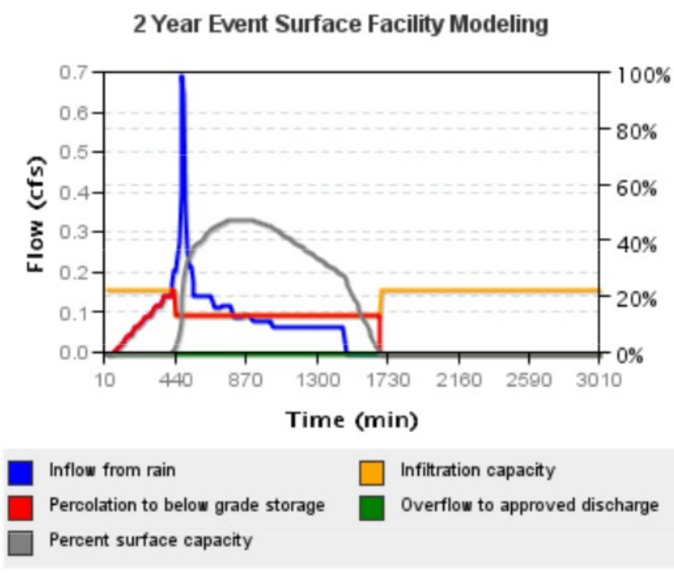
| | | |
|---|---|---|
| **Facility Details** | Facility Type | **Basin** |
| | Facility Configuration | **B: Infl. with rock storage (RS)** |
| | Facility Shape | **Rectangle** |
| | **Above Grade Storage Data** | |
| | Bottom Area | **2046 sq ft** |
| | Bottom Width | **11.00 ft** |
| | Side Slope | **3.0:1** |
| | Storage Depth 1 | **18.0 in** |
| | Growing Medium Depth | **18 in** |
| | Freeboard Depth | **12.00 in** |
| | Surface Capacity at Depth 1 | **4430.6 cu ft** |
| | Design Infiltration Rate for Native Soil | **0.095 in/hr** |
| | Infiltration Capacity | **0.158 cfs** |
| | **Below Grade Storage Data** | |
| | Rock Storage Bottom Area | **2046 sq ft** |
| | Rock Storage Depth | **6 in** |
| | Rock Porosity | **0.30 in** |
| **Facility Facts** | Total Facility Area Including Freeboard | **5177.72 sq ft** |
| | Sizing Ratio | **10.5%** |
| **Pollution Reduction Results** | Pollution Reduction Score | **Pass** |
| | Overflow Volume | **0.000 cf** |
| | Surface Capacity Used | **1%** |
| | Rock Capacity Used | **41%** |
| **Flow Control Results** | Flow Control Score | **Pass** |
| | Overflow Volume | **652.790 cf** |
| | Surface Capacity Used | **100%** |
| | Rock Capacity Used | **100%** |

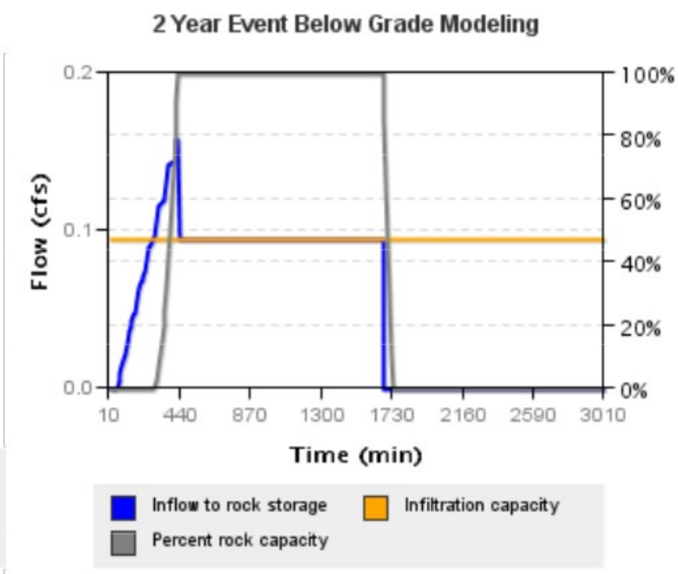
| | **Post-development outflow (cfs)** | | **Pre-development inflow (cfs)** | |
|---|---|---|---|---|
| **2 year** | 0 | ≤ ½ of | 0.175 | **Pass** |

| | | | | |
|---|---|---|---|---|
| **5 year** | 0 | ≤ | 0.282 | **Pass** |
| **10 year** | 0.072 | ≤ | 0.399 | **Pass** |
| **25 year** | 0.138 | ≤ | 0.527 | **Pass** |

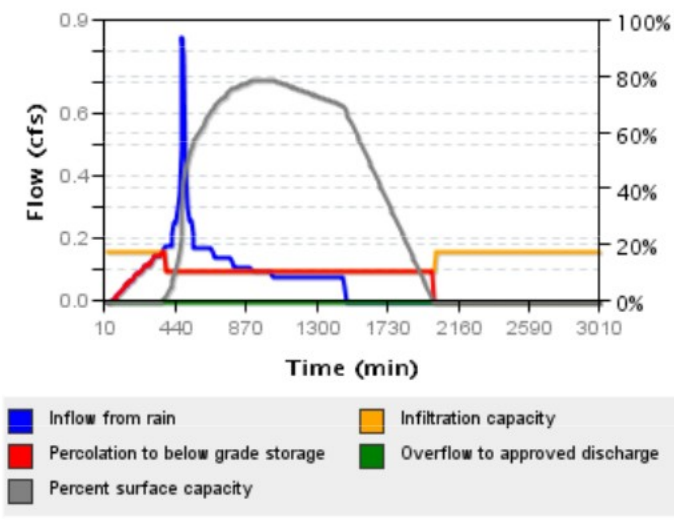


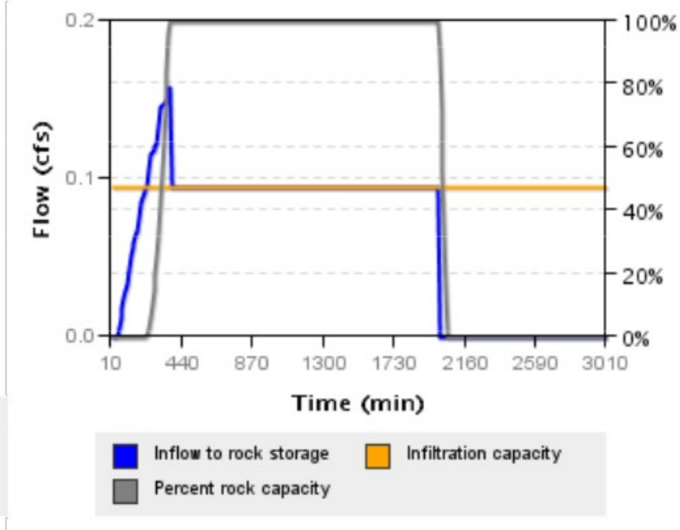



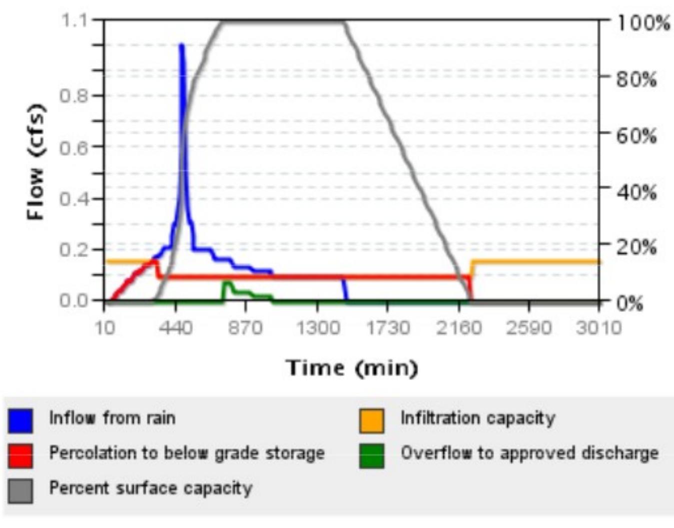
**5 Year Event Surface Facility Modeling**



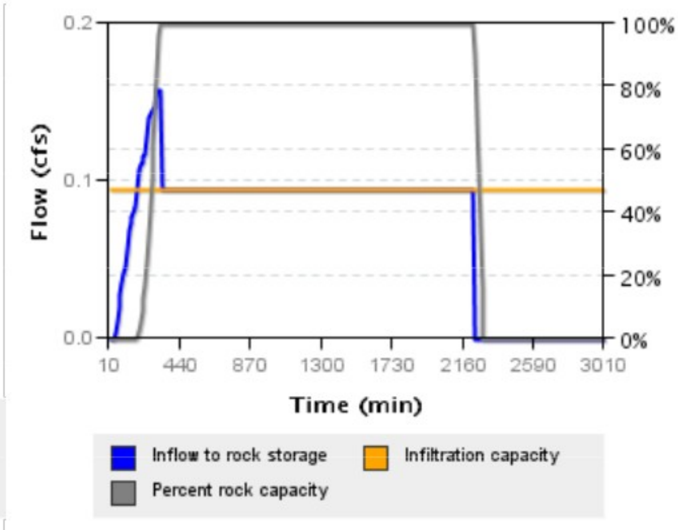

**5 Year Event Below Grade Modeling**



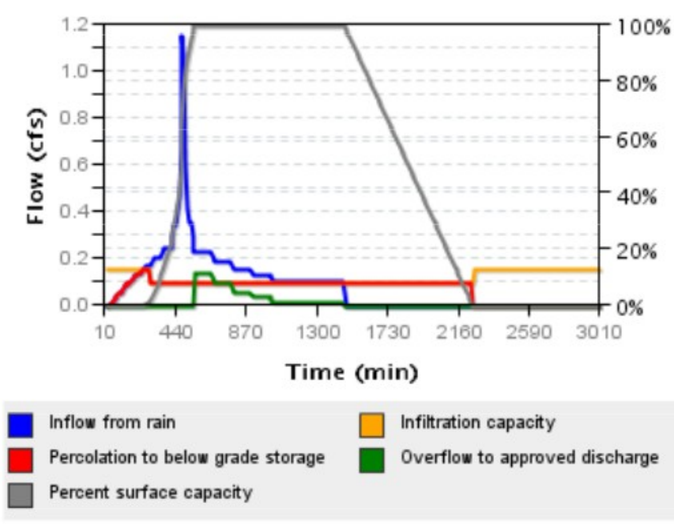
## 10 Year Event Surface Facility Modeling



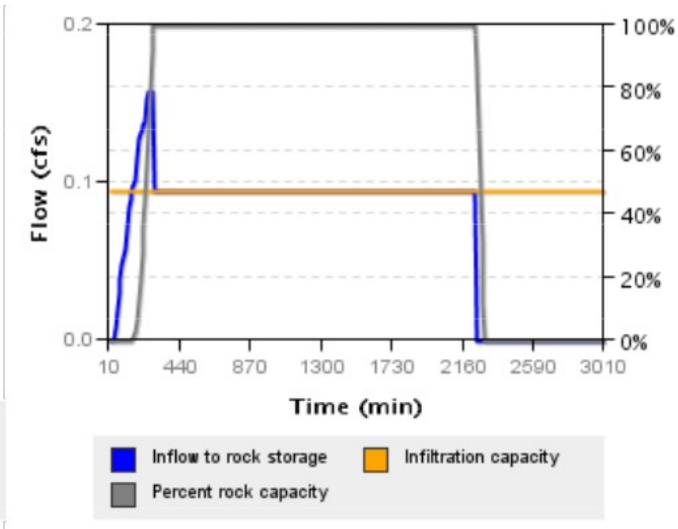

## 10 Year Event Below Grade Modeling



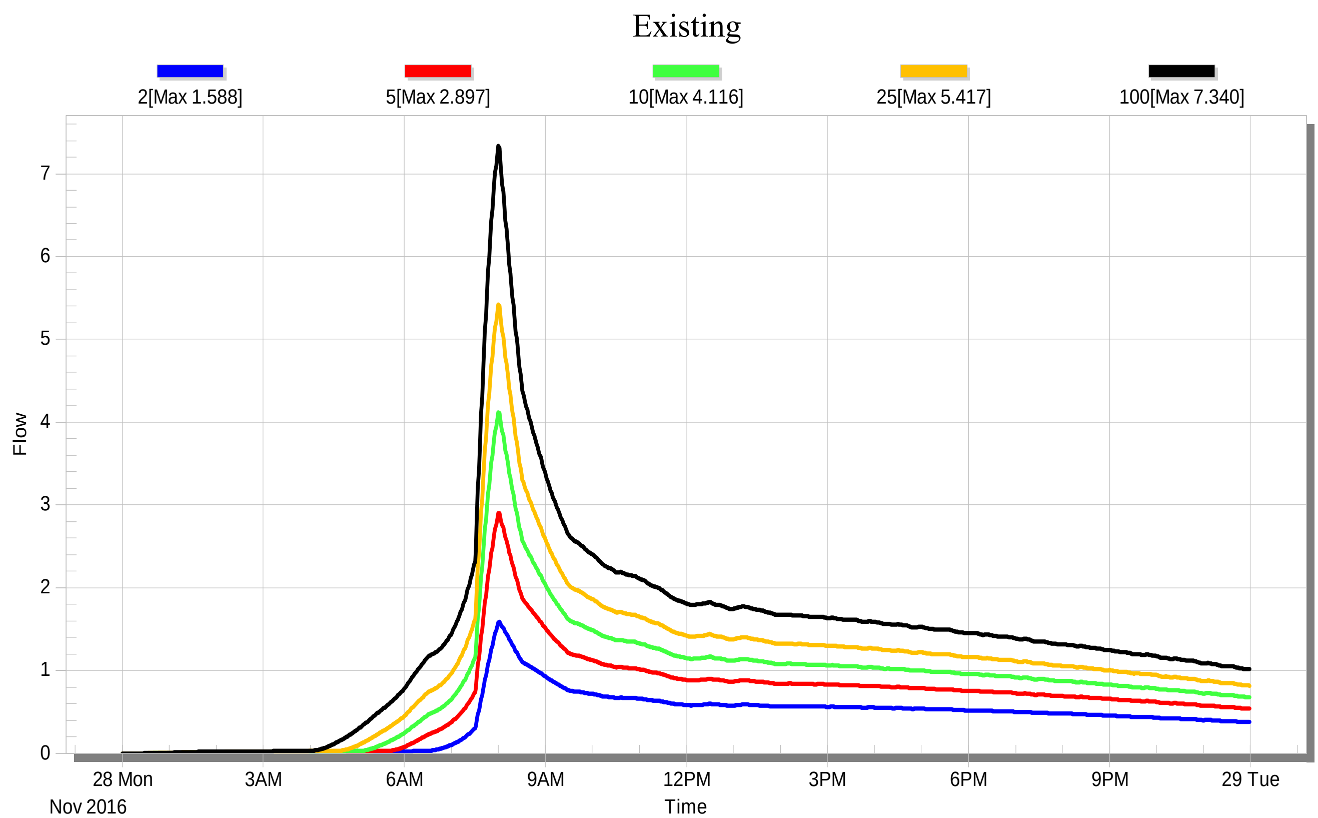

## 25 Year Event Surface Facility Modeling

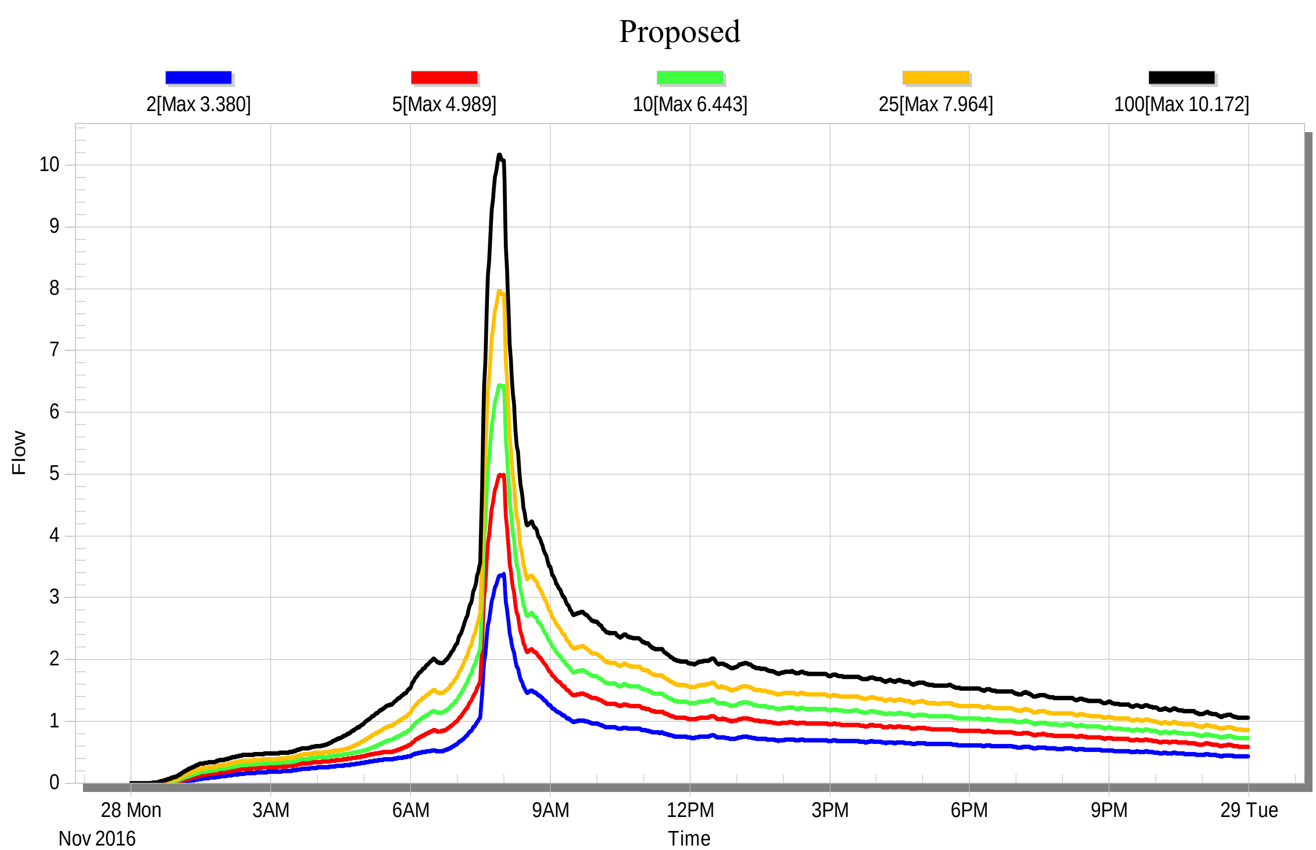


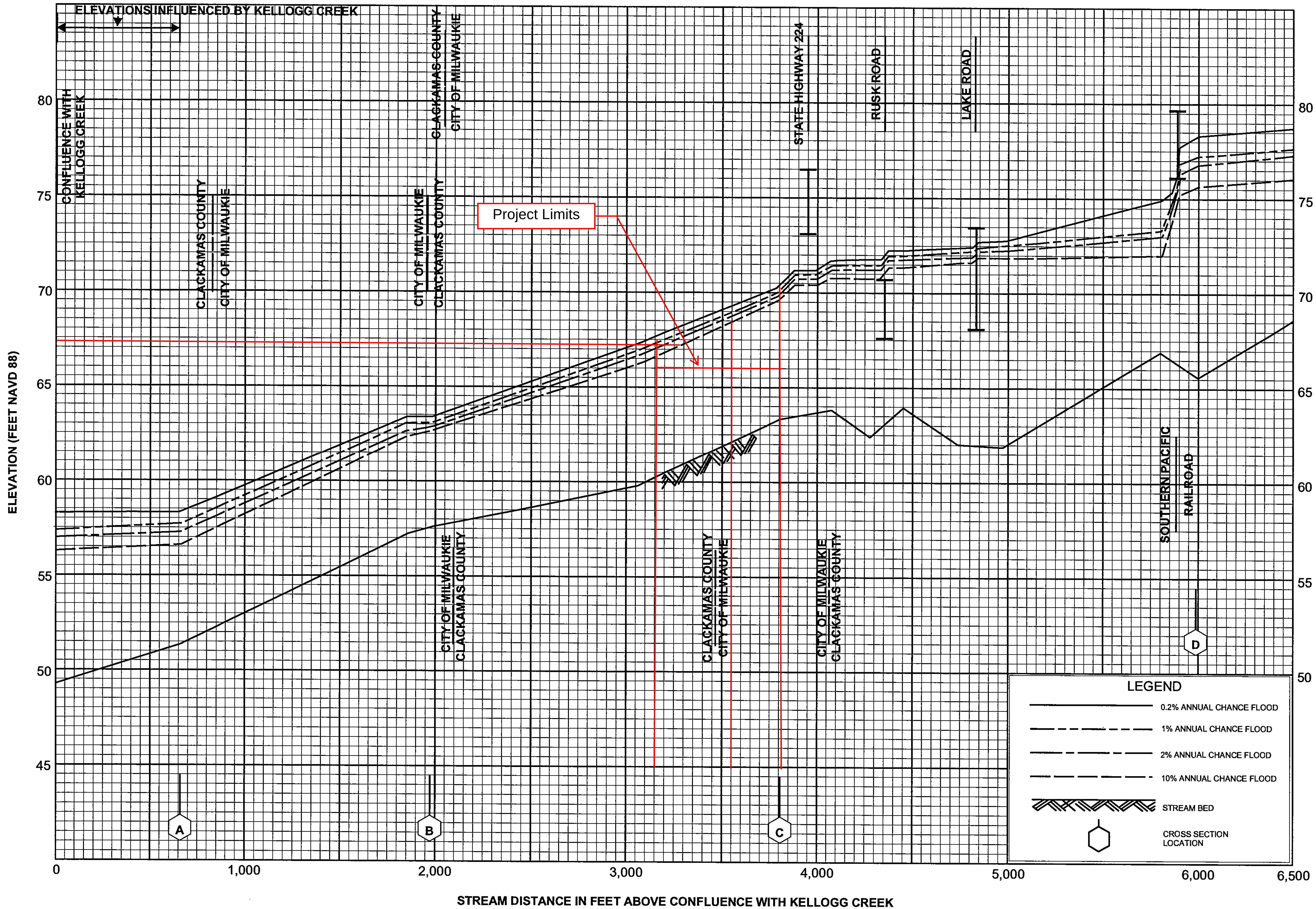

## 25 Year Event Below Grade Modeling



## Bonaventure Senior Living — Hydrographs






FLOOD PROFILES

MT SCOTT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CLACKAMAS COUNTY, OR**

AND INCORPORATED AREAS

**53P**

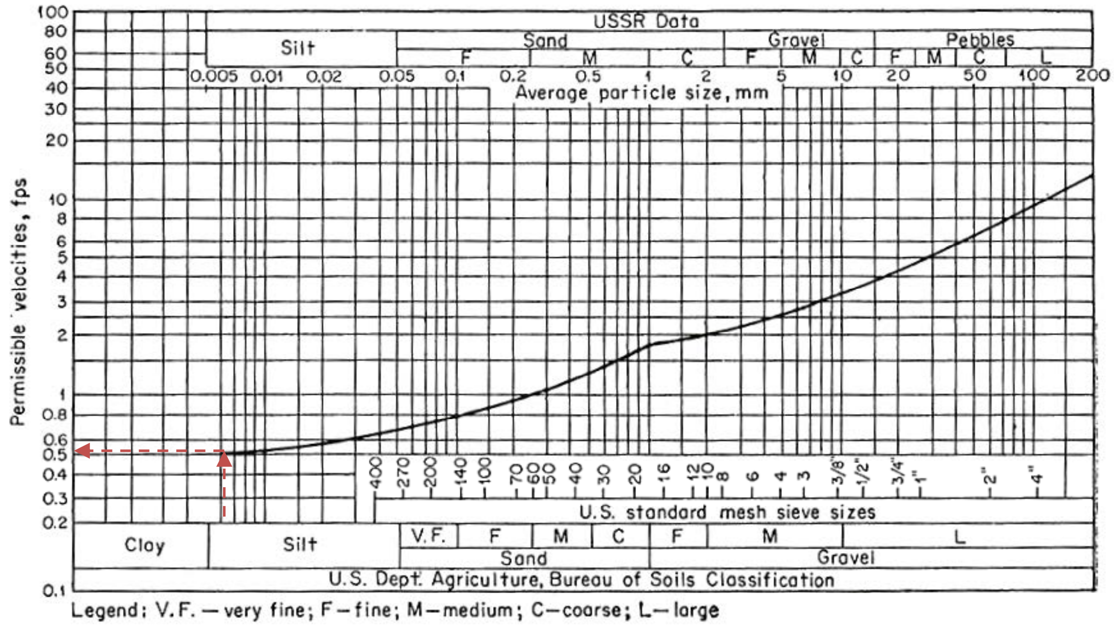



FIG. 7-3. U.S. and U.S.S.R. data on permissible velocities for noncohesive soils.

**Source:** Chow, V.T., 1959: *Open-channel hydraulics*. New York: McGraw-Hill. Page 166

# Operation & Maintenance Plan

## Bonaventure Senior Living

2322.14497.01

Prepared for

**Bonaventure, Inc.**

3425 Boone Road SE
Salem, Oregon 97317

November 16, 2018

| | |
|---|---|
| Prepared for | Bonaventure, Inc. |
| Project Name | Operation & Maintenance Plan |
| Job Number | 2322.14497.01 |
| Date | November 16, 2018 |

**DOWL**
720 SW Washington Street, Suite 750
Portland, Oregon
97205

Telephone: 971-280-8641
Facsimile: 800-865-9847
semmens@dowl.com

| Name | Title | Date | Revision | Reviewer |
|---|---|---|---|---|
| Scott Emmens | WR Project Manager | 11/16/2018 | 1 | Kyle Gildden |
| | | | | |
| | | | | |

## EXECUTIVE SUMMARY

Maintenance of water quality facilities is very important to ensure they operate as designed. Inadequate maintenance can be attributed to premature failures of these facilities. This Operation and Maintenance Plan provides guidance on how to maintain your facility, control source pollution, frequency of inspection and maintenance, potential problems with each facility, different conditions to check for, and the actual conditions that should exist. Maintenance guidelines and checklists have been provided in the Technical Appendix of this document.

The purpose of this Operation and Maintenance Plan is to describe the required type and frequency of long-term maintenance of the stormwater facilities and to identify the responsible maintenance organization. Several sources were used for obtaining maintenance information including City of Portland's *Stormwater Management Manual* dated August 2016.

This Plan should be kept onsite or within reasonable access to the site. Maintenance logs must be kept and made available for City inspection.

# I. STORMWATER APPROACH DECRIPTION

### I.1 Stormwater Approach

Water quality treatment and flow control at Kellogg Creek site will be accomplished through bioretention ponds and planters. All stormwater runoff will be released to Mt. Scott Creek and the public storm sewer in Kellogg Creek Drive. The Technical Appendix of this manual contains stormwater plans showing facility locations.

**Table I-1 Stormwater Facility Summary**

| Facility | Facility Type | Facility Parameters | Stormwater Source | Contributing Impervious Area (ac) | Latitude | Longitude | Discharge Point |
|---|---|---|---|---|---|---|---|
| Pond A1 | Pond | *Volume: 3,860 cf<br>Depth: 18 inch | Roof & Roadway | *0.91 | 45.42637 | 122.60323 | SE Kellogg Creek Dr. |
| Pond A2 | Pond | *Volume: 3,860 cf<br>Depth: 18 inch | Roof & Roadway | *0.91 | 45.42635 | 122.60412 | SE Kellogg Creek Dr. |
| Pond B | Pond | Volume: 6,400 cf<br>Depth: 18 inch | Roof & Roadway | 0.710 | 45.42699 | 122.60459 | Mt. Scott Creek |
| Pond C | Pond | Volume: 5,700 cf<br>Depth: 18 inch | Roof & Roadway | 1.090 | 45.42771 | 122.60439 | Mt. Scott Creek |
| Pond D | Pond | Volume: 5,970 cf<br>Depth: 18 inch | Roof & Roadway | 1.130 | 45.42791 | 122.60279 | Mt. Scott Creek |

*Facility volumes and contributing impervious area for ponds A1 & A2 are combined.

# II. INSPECTION

### II.1 Inspection Schedule

In accordance with SLOPES V, inspection and maintenance will be required at least

- Quarterly for the first three (3) years.
- Twice a year thereafter.
- Within 48 hours of major rainfall events (defined as more than one inch of rain over a 24-hour period).

A recommended maintenance calendar is provided below.

| Recommended Maintenance Schedule | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Purpose of Visit** | **Frequency** | **J** | **F** | **M** | **A** | **M** | **J** | **J** | **A** | **S** | **O** | **N** | **D** |
| Routine inspection | Min. 4/year (first 3 years) | | | ✓ | | ✓ | | | | | ✓ | | ✓ |
| Vegetation | Min. 12/year | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Soil | Min. 8/year | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | ✓ | ✓ |
| Sediment & Trash | Min. 2/year | | | | ✓ | | | | | | ✓ | | |
| Flow Control Structures | Min. 2/year | | | | ✓ | | | | | | ✓ | | |

# III. MAINTENANCE ACTIVIES AND VISUAL INDICATORS OF DIMINISHED PERFORMANCE

### Site Best Management Practices

Onsite maintenance practices can reduce maintenance needs for stormwater facilities. Good housekeeping procedures such as trash or source control practices can reduce spills and prevent pollutants from entering facilities.

Remove trash, debris and sediment from catch basins. Identify sources of visible pollutants or spills and clean up sources to protect the stormwater system. Sweep or vacuum driveways or other ground-level surfaces. Report all spills that threaten or enter the public sanitary or storm system.

### Sediment and Oil Removal and Disposal

Stormwater facilities are designed to remove pollutants by capturing sediment, dirt, leaves and litter. Removing sediment and oil helps maintain facility infiltration rates, provide good water quality treatment, and prevent clogging and flooding.

In vegetated facilities, sediment should be removed when it reaches a depth of four inches, when the quantity reaches 30 percent of total capacity (as designed or measured) or when accumulated sediment is impeding facility function. Examples include when sediment is damaging vegetation, preventing the facility from draining, blocking inlets or causing bypass.

Remove sediment by hand unless professionals are needed because of confined space entry requirements or the need for a vactor truck. Dispose of sediment per solid waste disposal requirements. Removing sediment during dry periods is easier because the material weighs substantially less.

**Vegetation Management**

Healthy plants play important roles: the root systems absorb stormwater, help maintain infiltration rates, prevent erosion, and capture pollutants. If a vegetated stormwater facility has bare soil, or if vegetation is stressed, unhealthy, or dead, replant per the approved planting plan and/or address cause of stress. Remove nuisance and invasive plants.

Healthy vegetation must cover at least 90% of stormwater facility surface area. Grass must be mowed to keep it four to nine inches tall. Prune or trim vegetation or roots to ensure free conveyance of stormwater or improve sight lines. Remove leaves or other debris. Use weed-free mulch to inhibit weeds. Irrigate as needed.

The use of fertilizers and pesticides (including herbicides) is strongly discouraged in stormwater management facilities because of the potential for negative impacts to downstream systems. Integrated Pest Management strategies are encouraged to reduce or eliminate the need for pesticides. If pesticides are required, use the services of a licensed applicator and products approved for aquatic use.

**Erosion, Bank Failure, and Channel Formation**

Erosion in the flow path, inside or outside a facility, can clog inlets and outlets and reduce both conveyance efficiency and infiltration rates. Forms of erosion include channels, undercutting, scouring, and slumping. Any area with erosion more than two inches deep must be addressed. Install long-term erosion control practices and fill the eroded areas.

**Structural Repairs**

Structural components control the conveyance of stormwater. Examples include inlets, outlets, trash racks, concrete curbs, retaining walls, manholes and check dams. Repair or replace items when damaged, loose, broken, cracked, or askew. Monitor minor damage such as dents, rust, or minor cracks in concrete for indications of when repair or replacement is required.

**Ponding Water**

Most stormwater facilities are designed to drain in a certain amount of time. The facilities have an anticipated ponding depth of 10 to 12 inches are designed to have a long-term infiltration rate of 2 inches/hour. The anticipated drawdown time is approximately 24 hours, after the completion of the storm event. When the facility does not drain as anticipated, inspect the facility to determine the cause. Clearly clogged inlets or outlets, remove sediment that may be preventing infiltration, or add vegetation.

**Pests**

Stormwater facilities are designed to drain quickly enough to avoid providing breeding areas for pests. If mosquitos are found, the stormwater facility may be ponding water longer than the approved design but also search for nearby sources of standing water. If rodents are found, remove plant debris, fruit or nuts that are providing shelter and food and contact the appropriate county vector control office for trapping and removal.

**Safety**

Stormwater facilities must be maintained to protect workers, visitors, and the general public. Vegetation should be pruned for adequate visual clearance. Avoid maintenance in wet weather to reduce potential injuries from slipping and always use appropriate safety gear. Only personnel approved for confined space entry should enter underground stormwater facilities.

## IV. FINANCIAL RESPONSIBILITY

Stormwater facilities for the property site will be maintained and operated privately by the home owners association (HOA). The proposed property is located at 13333 Rusk Road in Milwaukie, Oregon.

The owner must ensure that the water quality systems efficiently perform their function of removing petroleum hydrocarbons, sediments, metals, bacteria and nutrients from stormwater runoff and that detention systems perform their function of detaining runoff onsite.

All appropriate property owners should be knowledgeable regarding stormwater operation and maintenance. They should recognize that protection and successful operation of the stormwater drainage system is essential to the continued successful operation of the system and to protecting the natural environment.

This plan should be reviewed and adjusted as needed. After the first year, evaluate if additional maintenance practices are necessary.

## V. INSPECTION AND MAINTENANCE LOG

Maintenance Logs are to be kept for stormwater facilities by the property owner. Maintenance logs should be completed at the time of stormwater facility maintenance, and must be kept onsite.

The checklist included in the Technical Appendix should be used to determine the frequency of inspection/maintenance, the different drainage system feature to be inspected/maintained, the potential problem with the particular drainage feature, different conditions to check for and the actual conditions that should exist for that drainage feature.

The Maintenance Log has been included in this manual that can be used for catch basins, pipes, landscaping and detention facilities. Additionally, manufacture maintenance guidance documents have been included in the Technical Appendix.

## VI. TECHNICAL APPENDIX

- *Operations and Maintenance Specifications – Catch Basins* – 2008 City of Portland Stormwater Management Manual
- *Standard O&M Plan and Maintenance Log - Planters* - 2016 City of Portland Stormwater Management Manual
- *Standard O&M Plan and Maintenance Log - Basins* - 2016 City of Portland Stormwater Management Manual

- Civil Plans

# CATCH BASINS

## Catch Basins

The performance of catch basins for removing sediment and other pollutants depends on routine maintenance to retain the storage available in the sump in order to capture sediment and most floatables.

- Remove debris and sediment every 6 months (or when one-third full of sediment).
- Dewater and dispose of sediment properly. Test sediment that has a heavy oil sheen and/or odors to determine the appropriate disposal.
- Maintain the hooded outlet to prevent floatable materials, such as trash and debris, from entering the storm drain system.
- Maintain the grate as designed for safety reasons and to prevent trash and debris from collecting in the catch basin.
- Repair/seal cracks. Replace when repair is insufficient.
- Keep a log of the amount of sediment collected and the date of removal.

# 3.1.1.8. Planters

| Structural components must be operated and maintained in accordance with the design specifications. | | |
|---|---|---|
| | **MAINTENANCE INDICATOR** | **CORRECTIVE ACTION** |
| | Clogged inlets or outlets | Remove sediment and debris from catch basins, trench drains, curb inlets, and pipes; maintain at least 50% conveyance at all times. |
| | Broken inlets or outlets | Repair/replace broken downspouts, curb cuts, standpipes, and screens. |
| | Damaged liners and walls | Extend and secure liner to planter walls above the high water mark. The facility must be water tight to protect abutting foundations from moisture damage. |
| | Cracked or exposed drain pipes | Repair or seal cracks. Replace when repair is insufficient. Cover with 6 inches of growing medium to prevent freeze/thaw and UV damage |
| **Vegetation must cover at least 90% of the facility at maturity.** | | |
| | **MAINTENANCE INDICATOR** | **CORRECTIVE ACTION** |
| | Dead or stressed vegetation | Replant per original planting plan, or substitute from the plant list in Section 2.4.1. Irrigate and mulch as needed; prune tall, dry grasses and remove clippings. |
| | Tall grass and vegetation | Maintain grass height at 6”-9”. Trim to allow sight lines and foot traffic, also to ensure inlets and outlets freely convey stormwater into and/or out of facility. |
| | Weeds | Manually remove weeds. |
| **Growing medium must sustain healthy plant cover and infiltrate within 48 hours.** | | |
| | **MAINTENANCE INDICATOR** | **CORRECTIVE ACTION** |
| | Gullies, erosion, exposed soils, sediment accumulations | Fill in and lightly compact areas of erosion with City-approved soil mix (see Section 2.3.6) and replant according to planting plan or substitute from the plant list in Section 2.4.1. Sediment more than 4 inches deep must be removed. |
| | Scouring at the inlet(s) | Ensure splash blocks or inlet gravel/rock are adequate. |
| | Ponding | Rake, till, or amend soil surface with City-approved soil mix to restore infiltration rate. Remove and replace sediment at entrances. |

## Annual Maintenance Schedule

| | |
|---|---|
| **Summer** | Make structural repairs; clean gutters and downspouts; remove any build-up of weeds or organic debris. |
| **Fall** | Replant exposed soil and replace dead plants. Remove sediment and plant debris. |
| **Winter** | Clear gutters and downspouts. |
| **Spring** | Remove sediment and plant debris. Replant exposed soil and replace dead plants. |
| **All seasons** | Weed as necessary. |

**Maintenance Records:** All facility operators are required to keep an inspection and maintenance log. Record date, description, and contractor (if applicable) for all repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the City inspector.

**Fertilizers/Pesticides/Herbicides:** Their use is strongly discouraged because of the potential for damage to downstream systems. If pesticides or herbicides are required, use the services of a licensed applicator and products approved for aquatic use.

**Access:** Maintain ingress/egress per design standards.

**Infiltration/Flow Control:** All facilities must drain within 48 hours. Record time/date, weather, and conditions when ponding occurs.

**Pollution Prevention:** All sites must implement Best Management Practices to prevent contamination of stormwater. Call 503-823-7180 to report spills. Never wash spills into a stormwater facility. If contamination occurs, document the circumstances and the corrective action taken; include the time/date, weather, and site conditions.

**Vectors (Mosquitoes and Rats):** Stormwater facilities must not harbor mosquito larvae or rodents that pose a threat to public health or that undermine facility structures. Record the time/date, weather, and site conditions when vector activity observed. Record when vector abatement started and ended.

## Operations and Maintenance Log

| Date | Work Performed By | Type of Work Performed | | | | | Notes | Initials |
|---|---|---|---|---|---|---|---|---|
| | | Clean inlets and Outlets | Sediment and Trash Removal | Plant Replacement type, location | Structural Repairs – type, location | Other | | |
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# 3.1.1.9. Basins

| | | |
|---|---|---|
| **Structural components must be operated and maintained in accordance with the design specifications.** | | |
| | **MAINTENANCE INDICATOR** | **CORRECTIVE ACTION** |
| | Clogged inlets or outlets | Remove sediment, debris, and blockages from catch basins, trench drains, curb inlets, and pipes to maintain at least 50% conveyance at all times |
| | Broken inlets or outlets, including grates | Repair or replace broken downspouts, curb cuts, standpipes, and screens as needed. |
| | Cracked or exposed drain pipes | Repair or seal cracks. Replace when repair is insufficient. Cover with 6 inches of growing medium to prevent freeze/thaw and UV damage. |
| | Check dams missing/broken | Maintain or replace rock check dams as per design specifications. |
| | Perforated liner | Replace or repair liner as needed. |
| **Vegetation must cover at least 90% of the facility at maturity.** | | |
| | **MAINTENANCE INDICATOR** | **CORRECTIVE ACTION** |
| | Dead or stressed vegetation | Replant per original planting plan, or substitute from the plant list in Section 2.4.1. Irrigate and mulch as needed; prune tall, dry grasses and remove clippings. |
| | Tall grass and vegetation | Maintain grass height at 6"-9". Trim to allow sight lines and foot traffic, also to ensure inlets and outlets freely convey stormwater into and/or out of facility. |
| | Weeds | Manually remove weeds. |
| **Growing medium must sustain healthy plant cover and infiltrate within 48 hours.** | | |
| | **MAINTENANCE INDICATOR** | **CORRECTIVE ACTION** |
| | Gullies, erosion, exposed soil, sediment accumulation | Fill in and lightly compact areas of erosion with City-approved soil mix (see Section 2.3.6) and replant according to planting plan or substitute from the plant list in Section 2.4.1. Erosion more than 2 inches deep must be addressed. Sediment more than 4 inches deep must be removed. |
| | Scouring at the inlet(s) | Ensure splash blocks or inlet gravel/rock are adequate. |
| | Slope slippage | Stabilize 3:1 slopes/banks with plantings from the original planting plan or from the plant list in Section 2.4.1. |
| | Ponding | Rake, till, or amend soil surface with City-approved soil mix to restore infiltration rate. Remove sediment at entrance. |

## Annual Maintenance Schedule

| | |
|---|---|
| **Summer** | Make structural repairs; clean gutters and downspouts; remove any build-up of weeds or organic debris. |
| **Fall** | Replant exposed soil and replace dead plants. Remove sediment and plant debris. |
| **Winter** | Clear gutters and downspouts. |
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**Access:** Maintain ingress/egress per design standards.

**Infiltration/Flow Control:** All facilities must drain within 48 hours. Record time/date, weather, and conditions when ponding occurs.

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## Operations and Maintenance Log

| Date | Work Performed By | Type of Work Performed | | | | | Notes | Initials |
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| | | Clean inlets and Outlets | Sediment and Trash Removal | Plant Replacement type, location | Structural Repairs – type, location | Other | | |
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REDMOND GEOTECHNICAL SERVICES

# Geotechnical Investigation and Consultation Services

# Proposed Bonaventure of Milwaukie Development Site

# Tax Lot No's. 600 and 901

# 13333 SE Rusk Road

# Milwaukie (Clackamas County), Oregon

for

Bonaventure

Project No. 1004.032.G
September 28, 2018

REDMOND GEOTECHNICAL SERVICES

September 28, 2018

Mr. Daniel Dobson
Development Project Manager
Bonaventure
3425 Boone Road SE
Salem, Oregon 97317

Dear Mr. Dobson:

**Re: Geotechnical Investigation and Consultation Services, Proposed Bonaventure of Milwaukie Development Site, Tax Lot No's. 600 and 901, 13333 SE Rusk Road, Milwaukie (Clackamas County), Oregon**

Submitted herewith is our report entitled "Geotechnical Investigation and Consultation Services, Proposed Bonaventure of Milwaukie Development Site, Tax Lot No's. 600 and 901, 13333 SE Rusk Road, Milwaukie (Clackamas County), Oregon". The scope of our services was outlined in our formal proposal to Mr. Daniel Dobson of Bonaventure dated June 25, 2018. Written authorization of our services was provided by Mr. Daniel Dobson on August 16, 2018.

During the course of our investigation, we have kept you and/or others advised of our schedule and preliminary findings. We appreciate the opportunity to assist you with this phase of the project. Should you have any questions regarding this report, please do not hesitate to call.

Sincerely,

Daniel M. Redmond, P.E., G.E.
President/Principal Engineer

REGISTERED PROFESSIONAL
ENGINEER
12,309
OREGON
July 15, 1983
DANIEL M. REDMOND
Exp. 12-31-18

PO Box 20547 • Portland, Oregon 97294 • Fax 503/286-7176 • Phone 503/285-0598

# TABLE OF CONTENTS

**Table of Contents** (continued)

# GEOTECHNICAL INVESTIGATION AND CONSULTATION SERVICES
# PROPOSED BONAVENTURE OF MILWAUKIE SITE
# TAX LOT NO'S. 600 AND 901
# 13333 SE RUSK ROAD
# MILWAUKIE (CLACKAMAS COUNTY) OREGON

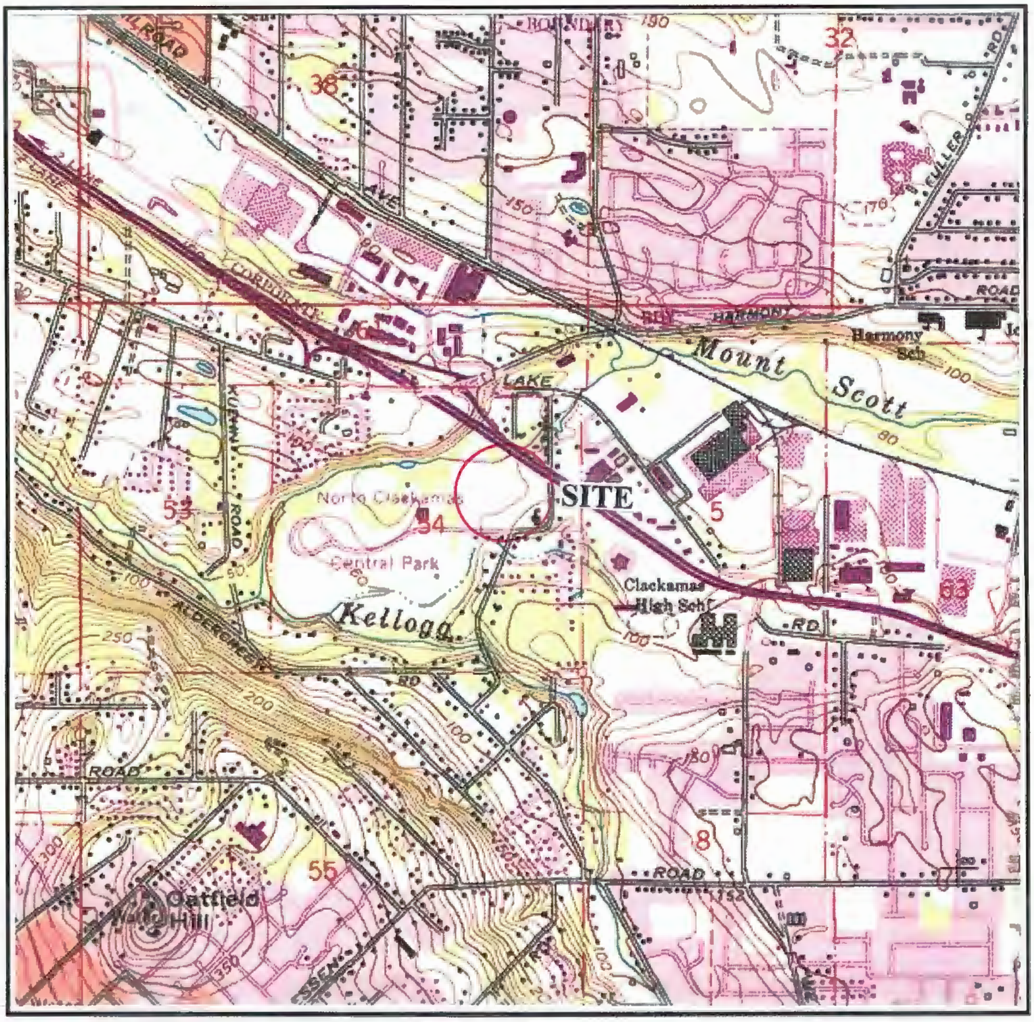
## INTRODUCTION

Redmond Geotechnical Services, LLC is please to submit to you the results of our Geotechnical Investigation and Consultation Services at the site of the proposed new Bonaventure of Milwaukie development located to the west of SE Rusk Road and to the north of SE Kellogg Creek Drive in Milwaukie (Clackamas County), Oregon. The general location of the subject site is shown on the Site Vicinity Map, Figure No. 1. The purpose of our geotechnical investigation and consultation services at this time was to explore the existing subsurface soils and/or groundwater conditions across the subject site and to evaluate any potential concerns with regard to development at the site as well as to develop and/or provide appropriate geotechnical design and construction recommendations for the proposed new Bonaventure of Milwaukie development project.

## PROJECT DESCRIPTION

Although the project is still in the preliminary planning stages, we understand that present plans for the project is to develop the subject property into a new senior living and/or care facility. Specifically, we understand that the project will consist of the construction of a new single- and/or four-story senior living building which will be constructed with wood-framing and a concrete slab-on-grade floor system. The new senior care and/or living facility reportedly will total approximately 170,000 square feet and will include a single-story memory care (MC) wing totaling approximately 20 to 30 units, a three- and/or four-story assisted living and memory care (AL/MC) wing totaling approximately 50 to 60 units, and a three- and/or four-story independent living (IL) wing totaling approximately 70 to 80 units. Support of the new senior living and/or care facility structure is anticipated to consist primarily of conventional shallow strip (continuous) footings although some individual (column) footings may also be required. Structural loading information, although unavailable at this time, is anticipated to be fairly typical for this type of single- and/or four-story wood-frame structure and is expected to result in maximum dead plus live continuous (strip) and individual (column) footing loads on the order of about 2.0 to 4.0 kips per lineal foot (klf) and 15 to 125 kips, respectively.

Although a site grading plan is not available at this time, we understand that both cuts and/or fills are presently planned for the project. In general, both cuts and/or fills of less than five (5) feet are generally anticipated across the site.




GLADSTONE QUADRANGLE
OREGON
7.5 MINUTE SERIES (TOPOGRAPHIC)

SCALE 1:24 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
DEPTH CURVES AND SOUNDINGS IN FEET—COLUMBIA RIVER DATUM

**SITE VICINITY MAP**

| Project No. 1004.032.G | **BONAVENTURE OF MILWAUKIE**<br>**TL'S 600 & 901/13333 SE RUSK RD** | Figure No. 1 |
| --- | --- | --- |

Other associated site improvements for the project will include construction of new paved access drives and parking areas. Additionally, the project will include the construction of new underground utility services and new concrete curbs and sidewalks as well as possible on-site storm water collection and/or disposal systems.

## SCOPE OF WORK

The purpose of our geotechnical studies was to evaluate the overall subsurface soil and/or groundwater conditions underlying the subject site with regard to the proposed new senior living and/or care facility development and construction at the site and any associated impacts or concerns with respect to development at the site as well as provide appropriate geotechnical design and construction recommendations for the project. Specifically, our geotechnical investigation included the following scope of work items:

1. Review of available and relevant geologic and/or geotechnical investigation reports for the subject site and/or area including a Geotechnical Engineering Report prepared by GeoPacific Engineering, Inc dated August 8, 2013 and a Geotechnical Evaluation prepared by GEO Consultants Northwest dated October 7, 2016.

2. A detailed field reconnaissance and subsurface exploration program of the soil and ground water conditions underlying the site by means of eleven (11) exploratory test pit excavations. The exploratory test pits were excavated to depths ranging from about five (5) to eight (8) feet beneath existing site grades at the approximate locations as shown on the Site Exploration Plan, Figure No. 2. Additionally, field infiltration testing was also performed within various test pits excavated across the subject site.

3. Laboratory testing to evaluate and identify pertinent physical and engineering properties of the subsurface soils encountered relative to the planned site development and construction at the site. The laboratory testing program included tests to help evaluate the natural (field) moisture content and dry density, maximum dry density and optimum moisture content, gradational characteristics, Atterberg Limits and (remolded) direct shear strength tests as well as consolidation and "R"-value tests.

4. A literature review and engineering evaluation and assessment of the regional seismicity to evaluate the potential ground motion hazard(s) at the subject site. The evaluation and assessment included a review of the regional earthquake history and sources such as potential seismic sources, maximum credible earthquakes, and reoccurrence intervals as well as a discussion of the possible ground response to the selected design earthquake(s), fault rupture, landsliding, liquefaction, and tsunami and seiche flooding.

5. Engineering analyses utilizing the field and laboratory data as a basis for furnishing recommendations for foundation support of the proposed new senior living structure. Recommendations include maximum design allowable contact bearing pressure(s), depth of footing embedment, estimates of foundation settlement, lateral soil resistance, and foundation subgrade preparation. Additionally, construction and/or permanent subsurface water drainage considerations have also been prepared. Further, our report includes recommendations regarding site preparation, placement and compaction of structural fill materials, suitability of the on-site soils for use as structural fill, criteria for import fill materials, and preparation of foundation, pavement and/or floor slab subgrades.

6. Flexible pavement design and construction recommendations for the proposed new private access drives and parking area improvements.

## SITE CONDITIONS

### Site Geology

The site is located within the Columbia River/Puget Sound lowland which is a broad structural depression situated between the Coast Range to the west and the Cascade Range to the east. A series of discontinuous faults subdivide the Columbia River basin into a mosaic of fault-bounded, structural blocks (Yeats et al., 1996). Uplifted structural blocks form bedrock highlands while down-warped structural blocks form sedimentary basins.

Available geologic mapping of the area and/or subject site indicates that the near surface soils consist of fine grained alluvial soil deposits (Qff) comprised of crudely to complexly layered, poorly consolidated medium sand to silt deposited by one or more phases of catastrophic glacial outburst floods from late Pleistocene lake Missoula. Sediments of unit Qff occur along both sides of the Willamette and/or Columbia Rivers and throughout the Tualatin basin. The thickness of unit Qff is typically 30 to 60 feet with a maximum thickness of about 180 feet. However, the site is also underlain at relatively shallow depths by more recent alluvial deposits comprised of silty clay as well as silty and sandy gravel associated with the nearby Mount Scott and Kellogg Creek.

### Surface Conditions

The subject proposed new Bonaventure of Milwaukie development property consists of two (2) rectangular and/or irregular shaped tax lots (TL's 600 and 901) which encompass a total plan area of approximately 12 acres. The proposed Bonaventure of Milwaukie development property is roughly located to the west of SE Rusk Road and to the north of SE Kellogg Creek Drive. The subject property is presently unimproved and void of existing structures and/or site improvements.

Surface vegetation across the site generally consists of a light to moderate growth of grass, weeds and brush as well as several small to large sized trees across the northerly and westerly portions of the subject property. Additionally, the northerly and/or northwesterly portions of the subject property are generally low lying and contains an existing seasonal drainage basin and/or wetland.

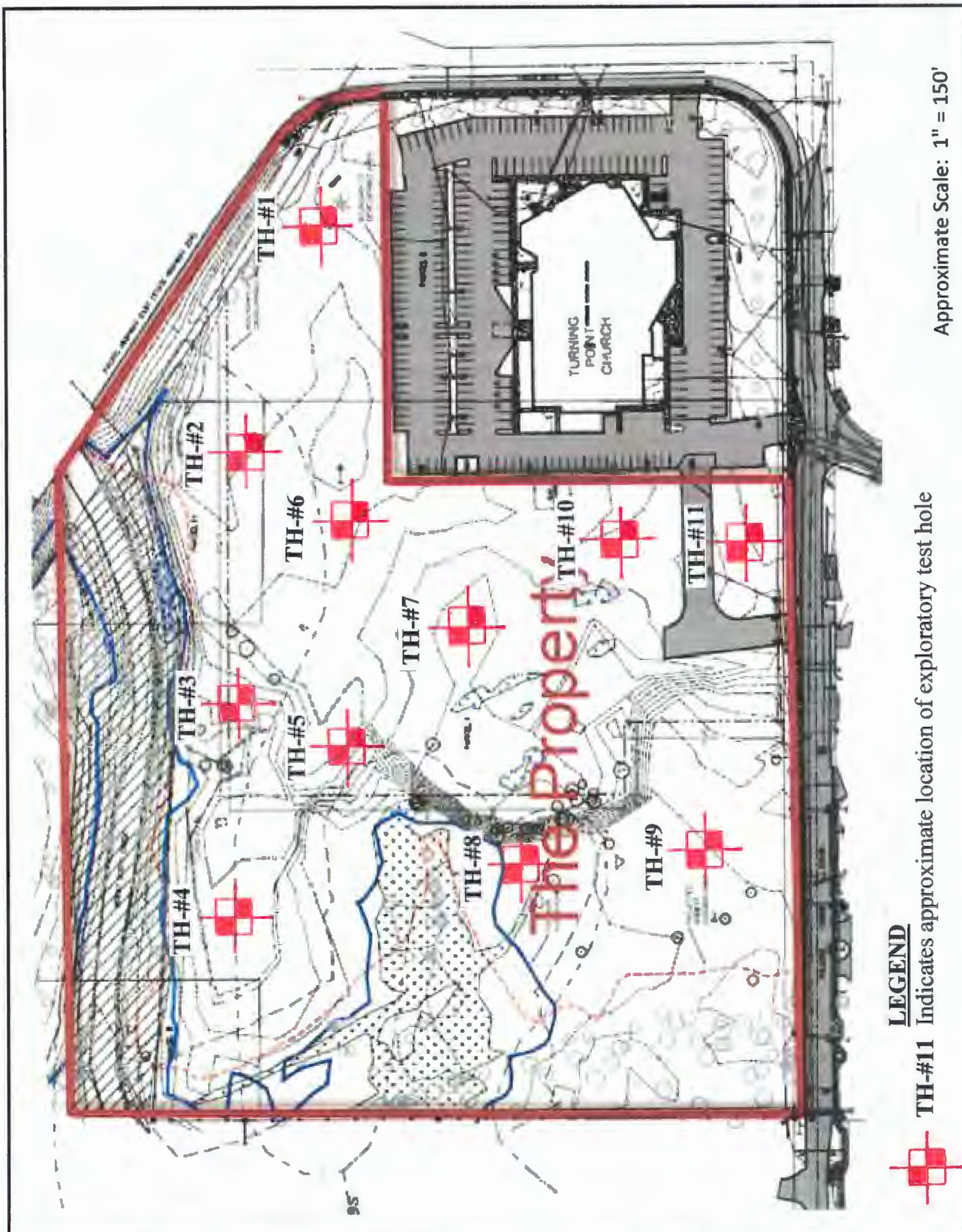
Topographically, the site is characterized as relatively flat-lying to gently to moderately sloping terrain (10 to 20 percent) descending downward towards the north and west with overall topographic relief estimated at about ten (10) to fifteen (15) feet and is estimated to lie at about Elevation 70 feet.

## Subsurface Soil Conditions

Our understanding of the subsurface soil conditions underlying the site was developed by means of eleven (11) exploratory test pits excavated to depths ranging from about five (5) to eight (8) feet beneath existing site grades on September 9, 2018 with a John Deere 200C track-mounted excavator. The location of the exploratory test pits were located in the field by marking off distances from existing and/or known site features and are shown in relation to the existing site features and/or site improvements on the Site Exploration Plan, Figure No. 2. Detailed logs of the test pit explorations, presenting conditions encountered at each location explored, are presented in the Appendix, Figure No's. A-5 through A-10.

The exploratory test pit excavations were observed by staff from Redmond Geotechnical Services, LLC who logged each of the test pit explorations and obtained representative samples of the subsurface soils encountered across the site. Additionally, the elevation of the exploratory test pit excavations were referenced from the USGS Map of the Gladstone Quadrangle and should be considered as approximate. All subsurface soils encountered at the site and/or within the exploratory test pit excavations were logged and classified in general conformance with the Unified Soil Classification System (USCS) which is outlined on Figure No. A-4.

The test pit explorations revealed that the subject site is underlain by both manmade fill soils and native soil deposits. Specifically, the test pit excavations found that much of the subject property contains fill soils consisting of a highly variable mixture of clay, silt, sand and gravel which also contained various amounts of construction debris (i.e., concrete and asphalt rubble) as well as organics and/or deleterious materials. The fill materials, which are believed to be undocumented, were found to be poorly to moderately compacted and ranged in depth from about 1.5 to at least 6.0 feet below the existing ground surface. However, the existing fill depth across the subject property has been reported at about 12 to 13 feet by others. The upper fill materials were fund to be underlain by native soil deposits consisting of an upper layer of old topsoil remnants consisting of approximately 12 to 18 inches of dark brown to dark gray-brown, moist to very moist, slightly to moderately organic, soft to medium stiff, sandy, clayey silt. The old topsoil zone was inturn underlain by other native alluvial soil deposits consisting of an upper unit of medium to gray-brown, moist to very moist, medium stiff to medium dense, clayey, sandy silt to silty sand to depths of approximately 5.0 to 7.0 feet beneath the existing site and/or surface grades. These underlying clayey, sandy silt to silty sand subgrade soils are best characterized by relatively low to moderate strength and moderate compressibility. All soils were found to be underlain at depth by medium to gray-brown, moist to very moist, medium dense to dense, slightly clayey, silty and sandy gravel with cobbles to the maximum depth explored of 8.0 feet beneath the existing site and/or surface grades.




**SITE EXPLORATION PLAN**

| Project No. 1004.032.G | **BONAVENTURE OF MILWAUKIE**<br>**TL'S 600 & 901/13333 SE RUSK RD** | Figure No. 2 |
|---|---|---|

These underlying medium dense to dense gravel deposits are best characterized by relatively moderate to high strength and low compressibility.

### Groundwater

Groundwater was generally not encountered within any of the exploratory test pit explorations excavated across the site at the time of the excavations to depths of up to 8.0 feet beneath existing surface grades except. However, the test pits were excavated near the end of the dry season. Additionally, the northerly and northwesterly portions of the subject property are bounded by and/or contain an existing seasonal drainage basin and/or wetlands. Further, Mount Scott Creek and Kellogg Creek are located to the north and south of the subject property.

In this regard, groundwater elevations at the site may fluctuate seasonally in accordance with rainfall conditions and/or runoff associated with Mount Scott Creek and Kellogg Creek as well as changes in site utilization. Additionally, according to USGS mapping, the regional groundwater elevation in the vicinity of the subject property is at about Elevation 65 to Elevation 70 feet.

## INFILTRATION TESTING

We performed three (3) field infiltration tests at the site on September 9, 2018. The infiltration tests were performed in test holes TH-#1 , TH-#4 and TH-#9 at depths of between four (4) to six (6) feet beneath the existing site and/or surface grades. The subgrade soils encountered in the infiltration test hole consisted of clayey, sandy silt to silty sand. The infiltration testing was performed in general conformance with current EPA and/or the City of Milwaukie/Clackamas County Encased Falling Head test method which consisted of advancing a 6-inch diameter PVC pipe approximately 6 inches into the exposed soil horizon at each test location. Using a steady water flow, water was discharged into the pipe and allowed to penetrate and saturate the subgrade soils. The water level was adjusted over a two (2) hour period and allowed to achieve a saturated subgrade soil condition consistent with the bottom elevation of the surrounding test pit excavation. Following the required saturating period, water was again added into the PVC pipe and the time and/or rate at which the water level dropped was monitored and recorded. Each measurable drop in the water level was recorded until a consistent infiltration rate was observed and/or repeated.

Based on the results of the field infiltration testing at the site, we have found that the underlying native clayey, sandy silt to silty sand subgrade soil deposits posses an ultimate infiltration rate on the order of about 4 to 6 inches per hour (in/hr).

## LABORATORY TESTING

Representative samples of the on-site subsurface soils were collected at selected depths and intervals from various test pit excavations and returned to our laboratory for further examination and testing and/or to aid in the classification of the subsurface soils as well as to help evaluate and identify their engineering strength and compressibility characteristics.

The laboratory testing consisted of visual and textural sample inspection, moisture content and dry density determinations, maximum dry density and optimum moisture content, gradation analyses and Atterberg Limits as well as direct shear strength, consolidation and "R"-value tests. Results of the various laboratory tests are presented in the Appendix, Figure No's. A-11 through A-16.

## SEISMICITY AND EARTHQUAKE SOURCES

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

The CSZ is located offshore and extends from northern California to British Columbia. Within this zone, the oceanic Juan de Fuca Plate is being subducted beneath the continental North American Plate to the east. The interface between these two plates is located at a depth of approximately 15 to 20 kilometers (km). The seismicity of the CSZ is subject to several uncertainties, including the maximum earthquake magnitude and the recurrence intervals associated with various magnitude earthquakes. Anecdotal evidence of previous CSZ earthquakes has been observed within coastal marshes along the Washington and Oregon coastlines. Sequences of interlayered peat and sands have been interpreted to be the result of large Subduction zone earthquakes occurring at intervals on the order of 300 to 500 years, with the most recent event taking place approximately 300 years ago. A study by Geomatrix (1995) and/or USGS (2008) suggests that the maximum earthquake associated with the CSZ is moment magnitude (Mw) 8 to 9. This is based on an empirical expression relating moment magnitude to the area of fault rupture derived from earthquakes that have occurred within Subduction zones in other parts of the world. An Mw 9 earthquake would involve a rupture of the entire CSZ. As discussed by Geomatrix (1995) this has not occurred in other subduction zones that have exhibited much higher levels of historical seismicity than the CSZ. However, the 2008 USGS report has assigned a probability of 0.67 for a Mw 9 earthquake and a probability of 0.33 for a Mw 8.3 earthquake. For the purpose of this study an earthquake of Mw 9.0 was assumed to occur within the CSZ.

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

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

## Liquefaction

Seismic induced soil liquefaction is a phenomenon in which lose, granular soils and some silty soils, located below the water table, develop high pore water pressures and lose strength due to ground vibrations induced by earthquakes. Soil liquefaction can result in lateral flow of material into river channels, ground settlements and increased lateral and uplift pressures on underground structures. Buildings supported on soils that have liquefied often settle and tilt and may displace laterally. Soils located above the ground water table cannot liquefy, but granular soils located above the water table may settle during the earthquake shaking.

Our review of the subsurface soil test pit logs from our exploratory field explorations (TH-#1 through TH-#11) and laboratory test results indicate that the site is generally underlain at depth by medium dense to dense, slightly clayey, silty and sandy gravel with cobbles deposits to depths of at least 8.0 feet beneath existing site grades. Additionally, groundwater was generally not encountered within any of the exploratory test pit excavations (TH-#1 through TH-#11) at the site during our field exploration work. As such, due to the medium dense to dense nature of the slightly clayey, silty and sandy gravel with cobbles subgrade soil deposits beneath the site, it is our opinion that the native subgrade soil deposits located beneath the subject site have a very low potential for liquefaction during the design earthquake motions previously described.

## Landslides

No ancient and/or active landslides were observed or are known to be present on the subject site. Additionally, the subject property does not contain any steep slopes. As such, development of the subject site into the planned senior living and/or care facility does not appear to present a potential geologic and/or landslide hazard provided that the site grading and development activities conform with the recommendations presented within this report.

## Surface Rupture

Although the site is generally located within a region of the country known for seismic activity, no known faults exist on and/or immediately adjacent to the subject site. The closest known faults to the subject property are the Oatfield Fault and the Portland Hills Fault which are sited approximately 0.2 miles and 1.5 miles to the southwest of the subject site, respectively, and the East Bank Fault which is sited approximately 3.0 miles to the northeast of the subject site. As such, the risk of surface rupture due to faulting is considered negligible.

### Tsunami and Seiche

A tsunami, or seismic sea wave, is produced when a major fault under the ocean floor moves vertically and shifts the water column above it. A seiche is a periodic oscillation of a body of water resulting in changing water levels, sometimes caused by an earthquake. Tsunami and seiche are not considered a potential hazard at this site because the site is not near to the coast and/or there are no adjacent significant bodies of water.

### Flooding and Erosion

Stream flooding is a potential hazard that should be considered in lowland areas of Lane County and Eugene. The FEMA (Federal Emergency Management Agency) flood maps should be reviewed as part of the design for the proposed new senior living and/or care facility structure and site improvements. Elevations of structures on the site should be designed based upon consultants reports, FEMA (Federal Emergency Management Agency), and Lane County requirements for the 100-year flood levels of any nearby creeks, streams and/or drainage basins.

## CONCLUSIONS AND RECOMMENDATIONS

## General

Based on the results of our field explorations, laboratory testing, and engineering analyses, it is our opinion that the site is generally suitable for the proposed new Bonaventure of Milwaukie senior living and/or care facility development and its associated site improvements provided that the recommendations contained within this report are properly incorporated into the design and construction of the project.

The primary feature of concern at the site is the presence of the existing fill soil materials present across the site.

With regard to the existing fill soil materials present across the site, we understand that the existing fill soils were likely placed prior to 1995 during two (2) or more events and are "undocumented". Additionally, the existing fill materials were found to contain various amounts of construction debris (i.e., asphalt and concrete) as well as some organic matter. Further, the results of our field and laboratory work indicates that the existing fill soil materials are generally only moderately compacted. In addition to the above, the existing fill soil materials were found to be placed directly above the old topsoil zone which is characterized as soft to medium stiff and contains some organics. In this regard, due to the variable nature (composition) and/or depth (thickness) of the existing undocumented fill soil materials across the site, it is our professional opinion that construction of the proposed single- and/or four-story wood-frame structure directly on and/or above the existing undocumented fill soil materials would expose the proposed senior living and/or care facility of potential excessive post-construction settlements.

As such, we are of the opinion that the existing fill soil materials as well as the underlying old topsoil zone subgrade soils be removed in their entirety from beneath the proposed senior living and/or care facility down to an approved native subgrade soil following which the area over-excavated may then be filled with properly placed and compacted structural fill materials back to the required design grades and/or elevations.

Secondary features of concern for the project are 1) the moisture sensitive clayey and silty fill and/or native subgrade soils across and/or beneath the site and 2) the anticipated relatively high seasonal groundwater elevations beneath the subject property.

With regard to the moisture sensitive clayey and silty fill and/or native subgrade soils across and/or beneath the site, we are generally of the opinion that all site grading and earthwork activities be scheduled for the drier summer months which is typically June through September. In regards to the anticipated relatively high seasonal groundwater elevations beneath the subject property, w are again of the opinion that all site grading and earthwork associated with removal of the existing undocumented fill soil materials as well as the placement and compaction of any required structural fill soil be performed during the drier summer months.

The following sections of this report provide specific recommendations regarding subgrade preparation and grading as well as foundation and floor slab design and construction for the new Bonaventure of Milwaukie senior living and/or care facility development project.

## Site Preparation

As an initial step in site preparation, we recommend that the proposed new senior living and/or care facility building as well as its associated structural and/or site improvement area(s) be stripped and cleared of all existing improvements, any existing unsuitable fill materials, surface debris, existing vegetation, topsoil materials, and/or any other deleterious materials present at the time of construction. In general, we envision that the site stripping to remove existing vegetation and topsoil materials will generally be about 16 to 12 inches. However, localized areas requiring deeper removals, such as the existing undocumented and/or unsuitable fill materials as well as the old topsoil remnants located within the proposed senior living and/or care facility building foot print, will likely be encountered and should be evaluated at the time of construction by the Geotechnical Engineer. The stripped and cleared materials should be properly disposed of as they are generally considered unsuitable for use/reuse as fill materials.

Following the completion of the site stripping and clearing work and prior to the placement of any required structural fill materials and/or structural improvements, the exposed subgrade soils within the planned structural improvement area(s) should be inspected and approved by the Geotechnical Engineer and possibly proof-rolled with a half and/or fully loaded dump truck. Areas found to be soft or otherwise unsuitable should be over-excavated and removed or scarified and recompacted as structural fill. During wet and/or inclement weather conditions, proof rolling and/or scarification and recompaction as noted above may not be appropriate.

The on-site native clayey, sandy silt and/or silty sand subgrade soil materials are generally considered suitable for use/reuse as structural fill materials provided that they are free of organic materials, debris, and rock fragments in excess of about 6 inches in dimension. However, if site grading is performed during wet or inclement weather conditions, the use of some of the on-site native soil materials which contain significant silt and clay sized particles will be difficult at best. In this regard, during wet or inclement weather conditions, we recommend that an import structural fill material be utilized which should consist of a free-draining (clean) granular fill (sand & gravel) containing no more than about 5 percent fines. Representative samples of the materials which are to be used as structural fill materials should be submitted to the Geotechnical Engineer and/or laboratory for approval and determination of the maximum dry density and optimum moisture content for compaction.

In general, all site earthwork and grading activities should be scheduled for the drier summer months (June through September) if possible. However, if wet weather site preparation and grading is required, it is generally recommended that the stripping of topsoil materials be accomplished with a tracked excavator utilizing a large smooth-toothed bucket working from areas yet to be excavated. Additionally, the loading of strippings into trucks and/or protection of moisture sensitive subgrade soils will also be required during wet weather grading and construction. In this regard, we recommend that areas in which construction equipment will be traveling be protected by covering the exposed subgrade soils with a geotextile fabric such as Mirafi FW404 followed by at least 12 inches or more of crushed aggregate base rock. Further, the geotextile fabric should have a minimum Mullen burst strength of at least 250 pounds per square inch for puncture resistance and an apparent opening size (AOS) between the U.S. Standard No. 70 and No. 100 sieves.

All structural fill materials placed within the new building and/or pavement areas should be moistened or dried as necessary to near (within 3 percent) optimum moisture conditions and compacted by mechanical means to a minimum of 92 percent of the maximum dry density as determined by the ASTM D-1557 (AASHTO T-180) test procedures. Structural fill materials should be placed in lifts (layers) such that when compacted do not exceed about 8 inches. Additionally, all fill materials placed within five (5) lineal feet of the perimeter (limits) of the proposed senior living and/or care facility structure and/or pavements should be considered structural fill. Additionally, due to the sloping site conditions, we recommend that all structural fill materials planned in areas where existing surface and/or slope gradients exceed about 20 percent (1V:5H) be properly benched and/or keyed into the native (natural) slope subgrade soils. In general, a bench width of at least eight (8) feet and a keyway depth of at least one (1) foot is recommended. However, the actual bench width and keyway depth should be determined at the time of construction by the Geotechnical Engineer. Further, all fill slopes should be constructed with a finish slope surface gradient no steeper than about 2H:1V.

All aspects of the site grading, including a review of the proposed site grading plan(s), should be approved and/or monitored by a representative of Redmond Geotechnical Services, LLC.

## Foundation Support

Based on the results of our investigation, it is our opinion that the site of the proposed new Bonaventure of Milwaukie senior living and/or care facility development is generally suitable for support of the planned single- and/or four-story wood-frame structure provided that the following foundation design recommendations are followed. As previously noted, the subject site contains existing undocumented fill soil materials which are only moderately compacted and contain various amounts of construction debris as well as organics and/or other deleterious materials. Additionally, the existing fill soil materials are underlain by the old topsoil zone which are also considered to be moderately compressible. In this regard, in order to prevent the potential for excessive port-construction settlements, we are of the opinion that the proposed new senior living and/or care facility not be supported directly by the existing fill soils materials. As such, it is our professional opinion that all of the existing undocumented fill materials as well as the underlying old topsoil remnants be removed in their entirety from beneath the proposed building area down to an approved native subgrade soil following which the area over-excavated can then be filled to the required design grades and/or elevations with properly placed and compacted structural fill materials.

The following sections of this report present specific foundation design and construction recommendations for the planned new senior living and/or care facility structure.

### Shallow Foundations

In general, conventional shallow continuous (strip) footings and individual (spread) column footings may be supported by approved native (untreated) subgrade soil materials and/or by properly placed and compacted structural fill soils based on an allowable contact bearing pressure of about 2,500 pounds per square foot (psf). This recommended allowable contact bearing pressure is intended for dead loads and sustained live loads and may be increased by one-third for the total of all loads including short-term wind or seismic loads. In general, continuous strip footings should have a minimum width of at least 16 inches and be embedded at least 18 inches below the lowest adjacent finish grade (includes frost protection). Individual column footings (where required) should be embedded at least 18 inches below grade and have a minimum width of at least 24 inches. Additionally, if foundation excavation and construction work is planned to be performed during wet and/or inclement weather conditions, we recommend that a 2 to 4 inch layer of compacted crushed rock be used to help protect the exposed foundation bearing surfaces until the placement of concrete.

Total and differential settlements of foundations constructed as recommended above and supported by approved native subgrade soils or by properly compacted structural fill materials are expected to be well within the tolerable limits for this type of single- and/or four- wood-frame structure and should generally be less than about 1-inch and 1/2-inch, respectively.

Allowable lateral frictional resistance between the base of the footing element and the supporting subgrade bearing soil can be expressed as the applied vertical load multiplied by a coefficient of friction of 0.30 and 0.45 for native silty subgrade soils and/or import gravel fill materials, respectively. In addition, lateral loads may be resisted by passive earth pressures on footings poured "neat" against in-situ (native) subgrade soils or properly backfilled with structural fill materials based on an equivalent fluid density of 300 pounds per cubic foot (pcf). This recommended value includes a factor of safety of approximately 1.5 which is appropriate due to the amount of movement required to develop full passive resistance.

## Floor Slab Support

In order to provide uniform subgrade reaction beneath concrete slab-on-grade floors, we recommend that the floor slab area be underlain by a minimum of 6 inches of free-draining (less than 5 percent passing the No. 200 sieve), well-graded, crushed rock. The crushed rock should help provide a capillary break to prevent migration of moisture through the slab. However, additional moisture protection can be provided by using a 10-mil polyolefin geo-membrane sheet such as StegoWrap.

The base course materials should be compacted to at least 95 percent of the maximum dry density as determined by the ASTM D-1557 (AASHTO T-180) test procedures. Where floor slab subgrade materials are undisturbed, firm and stable and where the underslab aggregate base rock section has been prepared and compacted as recommended above, we recommend that a modulus of subgrade reaction of 150 pci be used for design.

## Retaining/Below Grade Walls

Retaining and/or below grade walls should be designed to resist lateral earth pressures imposed by native soils or granular backfill materials as well as any adjacent surcharge loads. For walls which are unrestrained at the top and free to rotate about their base, we recommend that active earth pressures be computed on the basis of the following equivalent fluid densities:

**Non-Restrained Retaining Wall Pressure Design Recommendations**

| Slope Backfill (Horizontal/Vertical) | Equivalent Fluid Density/Silt (pcf) | Equivalent Fluid Density/Gravel (pcf) |
|---|---|---|
| Level | 35 | 30 |
| 3H:1V | 60 | 50 |
| 2H:1V | 90 | 80 |

For walls which are fully restrained at the top and prevented from rotation about their base, we recommend that at-rest earth pressures be computed on the basis of the following equivalent fluid densities:

**Restrained Retaining Wall Pressure Design Recommendations**

| Slope Backfill (Horizontal/Vertical) | Equivalent Fluid Density/Silt (pcf) | Equivalent Fluid Density/Gravel (pcf) |
|---|---|---|
| Level | 45 | 35 |
| 3H:1V | 65 | 60 |
| 2H:1V | 95 | 90 |

The above recommended values assume that the walls will be adequately drained to prevent the buildup of hydrostatic pressures. Where wall drainage will not be present and/or if adjacent surcharge loading is present, the above recommended values will be significantly higher.

Backfill materials behind walls should be compacted to 90 percent of the maximum dry density as determined by the ASTM D-1557 (AASHTO T-180) test procedures. Special care should be taken to avoid over-compaction near the walls which could result in higher lateral earth pressures than those indicated herein. In areas within three (3) to five (5) feet behind walls, we recommend the use of hand-operated compaction equipment.

## Pavements

Flexible pavement design for the project was determined on the basis of projected (anticipated) traffic volume and loading conditions relative to laboratory subgrade soil strength ("R"-value) characteristics. Based on an average laboratory subgrade "R"-value of 30 (Resilient Modulus = 5,000 to 10,000) and utilizing the Asphalt Institute Flexible Pavement Design Procedures and/or the American Association of State Highway and Transportation Officials (AASHTO) 1993 "Design of Pavement Structures" manual, we recommend that the asphaltic concrete pavement section(s) for the new senior living and/or care facility development areas at the site consist of the following:

| | Asphaltic Concrete Thickness (inches) | Crushed Base Rock Thickness (inches) |
|---|---|---|
| Automobile Parking Areas | 3.0 | 8.0 |
| Automobile Drive Areas | 3.5 | 10.0 |

Note: Where heavy vehicle traffic is anticipated such as those required for fire and/or garbage trucks, we recommend that the automobile drive area pavement section be increased by adding 0.5 inches of asphaltic concrete and 2.0 inches of aggregate base rock. Additionally, the above recommended flexible pavement section(s) assumes a design life of 20 years.

### Pavement Subgrade, Base Course & Asphalt Materials

The above recommended pavement section(s) were based on the design assumptions listed herein and on the assumption that construction of the pavement section(s) will be completed during an extended period of reasonably dry weather.

All thicknesses given are intended to be the minimum acceptable. Increased base rock sections and the use of a woven geotextile fabric may be required during wet and/or inclement weather conditions and/or in order to adequately support construction traffic and protect the subgrade during construction. Additionally, the above recommended pavement section(s) assume that the subgrade will be prepared as recommended herein, that the exposed subgrade soils will be properly protected from rain and construction traffic, and that the subgrade is firm and unyielding at the time of paving. Further, it assumes that the subgrade is graded to prevent any ponding of water which may tend to accumulate in the base course.

Pavement base course materials should consist of well-graded 1-1/2 inch and/or 3/4-inch minus crushed base rock having less than 5 percent fine materials passing the No. 200 sieve. The base course and asphaltic concrete materials should conform to the requirements set forth in the latest edition of the Oregon Department of Transportation, Standard Specifications for Highway Construction. The base course materials should be compacted to at least 95 percent of the maximum dry density as determined by the ASTM D-1557 (AASHTO T-180) test procedures. The asphaltic concrete paving materials should be compacted to at least 92 percent of the theoretical maximum density as determined by the ASTM D-2041 (Rice Gravity) test method.

**Wet Weather Grading and Soft Spot Mitigation**

Construction of the proposed new paved site improvements is generally recommended during dry weather. However, during wet weather grading and construction, excavation to subgrade can proceed during periods of light to moderate rainfall provided that the subgrade remains covered with aggregate. A total aggregate thickness of 8- to 12-inches may be necessary to protect the subgrade soils from heavy construction traffic. Construction traffic should not be allowed directly on the exposed subgrade but only atop a sufficient compacted base rock thickness to help mitigate subgrade pumping. If the subgrade becomes wet and pumps, no construction traffic shall be allowed on the road alignment. Positive site drainage shall be maintained if site paving will not occur before the on-set of the wet season.

Depending on the timing for the project, any soft subgrade found during proof-rolling or by visual observations can either be removed and replaced with properly dried and compacted fill soils or removed and replaced with compacted crushed aggregate. However, and where approved by the Geotechnical Engineer, the soft area may be covered with a bi-axial geogrid and covered with compacted crushed aggregate.

**Soil Shrink-Swell and Frost Heave**

The results of the laboratory "R"-value tests indicate that the native subgrade and/or existing fill soils possess a low to moderate expansion potential. As such, the exposed subgrade soils should not be allowed to completely dry and should be moistened to near optimum moisture content (plus or minus 3 percent) at the time of the placement of the crushed aggregate base rock materials.

Additionally, exposure of the subgrade soils to freezing weather may result in frost heave and softening of the subgrade. As such, all subgrade soils exposed to freezing weather should be evaluated and approved by the Geotechnical Engineer prior to the placement of the crushed aggregate base rock materials.

## Excavation/Slopes

Temporary excavations of up to about four (4) feet in depth may be constructed with near vertical inclinations. Temporary excavations greater than about four (4) feet but less than eight (8) feet should be excavated with inclinations of at least 1 to 1 (horizontal to vertical) or properly braced/shored. Where excavations are planned to exceed about eight (8) feet, this office should be consulted. All shoring systems and/or temporary excavation bracing for the project should be the responsibility of the excavation contractor. Permanent slopes should be constructed no steeper than about 2H to 1V unless approved by the Geotechnical Engineer.

Depending on the time of year in which trench excavations occur, trench dewatering may be required in order to maintain dry working conditions if the invert elevations of the proposed utilities are located at and/or below the groundwater level. If groundwater is encountered during utility excavation work, we recommend placing trench stabilization materials along the base of the excavation. Trench stabilization materials should consist of 1-foot of well-graded gravel, crushed gravel, or crushed rock with a maximum particle size of 4 inches and less than 5 percent fines passing the No. 200 sieve. The material should be free of organic matter and other deleterious material and placed in a single lift and compacted until well keyed.

## Surface Drainage/Groundwater

We recommend that positive measures be taken to properly finish grade the site so that drainage waters from the senior living and/or care facility structure and landscaping areas as well as adjacent properties or buildings are directed away from the new structures foundations and/or floor slabs. All roof drainage should be directed into conduits that carry runoff water away from the senior living and/or care facility structure to a suitable outfall. Roof downspouts should not be connected to foundation drains. A minimum ground slope of about 2 percent is generally recommended in unpaved areas around the proposed new structure.

Groundwater was not encountered at the site within any of the exploratory test pits excavated across the site at the time of excavation to depths of at least 8.0 feet beneath existing site grades. However, the northerly and/or northwesterly portions of the site are bounded by an existing seasonal drainage basin and/or wetland. Additionally, although groundwater elevations in the area and/or across the subject property may fluctuate seasonally and may temporarily pond/perch near the ground surface during periods of prolonged rainfall, the depth to the seasonal high groundwater is approximately Elevation 65 to Elevation 70 feet.

As such, based on our current understand of the possible site grading required to bring the subject site to finish design grade(s), we are of the opinion that an underslab drainage system is generally not required for the proposed senior living and/or care facility structure. However, a perimeter foundation drain is recommended for any perimeter footings and/or below grade retaining walls. A typical recommended perimeter footing/retaining wall drain detail is shown on Figure No. 3.

Further, due to our anticipation that various surface infiltration ditches and/or swales may be utilized for the project as well as the relatively low infiltration rates of the anticipated new structural fill soil materials within and/or near to the foundation bearing level of the proposed senior living and/or care facility structure, we are generally of the opinion that storm water detention and/or disposal systems should not be utilized around and/or up-gradient of the proposed senior living and/or care facility structure unless approved by the Geotechnical Engineer.

## Design Infiltration Rates

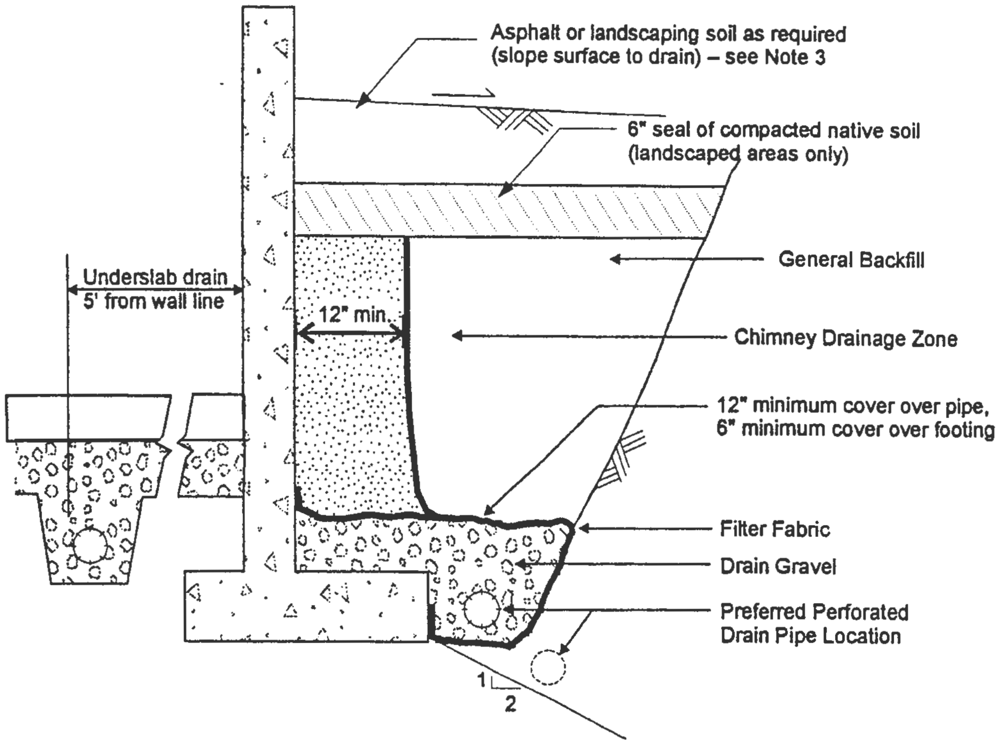
Based on the results of our field infiltration testing, we recommend using the following infiltration rate to design any on-site subsurface storm water infiltration and/or disposal systems for the project:

| Subgrade Soil Type | Recommended Infiltration Rate |
|---|---|
| clayey, sandy SILT/silty SAND (ML/SM) | 2 to 3 inches per hour (in/hr) |

Note: A safety factor of two (2) was used to calculate the above recommended design infiltration rate. Additionally, given the gradational variability of the native clayey, sandy silt to silty sand subgrade soils beneath the site as well as the anticipation of some site grading for the project, it is generally recommended that field testing be performed during and/or following construction of any on-site storm water infiltration system(s) in order to confirm that the above recommended design infiltration rates are appropriate.

## Seismic Design Considerations

Structures at the site should be designed to resist earthquake loading in accordance with the methodology described in the 2014 and/or latest edition of the State of Oregon Structural Specialty Code (OSSC) and/or Amendments to the 2015 International Building Code (IBC). The maximum considered earthquake ground motion for short period and 1.0 period spectral response may be determined from the Oregon Structural Specialty Code and/or from the National Earthquake Hazard Reduction Program (NEHRP) "Recommended Provisions for Seismic Regulations for New Buildings and Other Structures" published by the Building Seismic Safety Council. We recommend Site Class "D" be used for design. Using this information, the structural engineer can select the appropriate site coefficient values ($F_a$ and $F_v$) from the 2015 IBC to determine the maximum considered earthquake spectral response acceleration for the project. However, we have assumed the following response spectrum for the project:




**SCHEMATIC - NOT TO SCALE**

NOTES:

1. Filter Fabric to be non-woven geotextile (Amoco 4545, Mirafi 140N, or equivalent)

2. Lay perforated drain pipe on minimum 0.5% gradient, widening excavation as required. Maintain pipe above 2:1 slope, as shown.

3. All-granular backfill is recommended for support of slabs, pavements, etc. (see text for structural fill).

4. Drain gravel to be clean, washed ¾" to 1½" gravel.

5. General backfill to be on-site gravels, or ¾""-0 or 1½"-0 crushed rock compacted to 92% Modified Proctor (AASHTO T-180).

6. Chimney drainage zone to be 12" wide (minimum) zone of clean washed, medium to coarse sand or drain gravel if protected with filter fabric. Alternatively, prefabricated drainage structures (Miradrain 6000 or similar) may be used.

| PERIMETER FOOTING/RETAINING WALL DRAIN DETAIL | | |
|---|---|---|
| Project No. 1004.032.G | BONAVENTURE OF MILWAUKIE<br>TL'S 600 & 901/13333 SE RUSK RD | Figure No. 3 |

**Table 1. Recommended Seismic Design Parameters**

| Site Class | $S_S$ | $S_1$ | Fa | Fv | $S_{MS}$ | $S_{M1}$ | $S_{DS}$ | $S_{D1}$ |
|---|---|---|---|---|---|---|---|---|
| D | 0.965 | 0.412 | 1.114 | 1.588 | 1.075 | 0.654 | 0.717 | 0.436 |

Notes: 1. $S_S$ and $S_1$ were established based on the USGS 2015 mapped maximum considered earthquake spectral acceleration maps for 2% probability of exceedence in 50 years.

2. Fa and Fv were established based on IBC 2015 tables using the selected $S_S$ and $S_1$ values.

## CONSTRUCTION MONITORING AND TESTING

We recommend that **Redmond Geotechnical Services, LLC** be retained to provide construction monitoring and testing services during all earthwork operations for the proposed new Bonaventure of Milwaukie senior living and/or care facility development. The purpose of our monitoring services would be to confirm that the site conditions reported herein are as anticipated, provide field recommendations as required based on the actual conditions encountered, document the activities of the grading contractor and assess his/her compliance with the project specifications and recommendations. It is important that our representative meet with the contractor prior to any site grading to help establish a plan that will minimize costly over-excavation and site preparation work. Of primary importance will be observations made during site preparation and stripping, structural fill placement, footing excavations and construction as well as retaining wall backfill.

## CLOSURE AND LIMITATIONS

This report is intended for the exclusive use of the addressee and/or their representative(s) to use to design and construct the proposed new Bonaventure of Milwaukie senior living and/or care facility structure and its associated site improvements described herein as well as to prepare any related construction documents. The conclusions and recommendations contained in this report are based on site conditions as they presently exist and assume that the explorations are representative of the subsurface conditions between the explorations and/or at other locations across the study area. The data, analyses, and recommendations herein may not be appropriate for other structures and/or purposes. We recommend that parties contemplating other structures and/or purposes contact our office. In the absence of our written approval, we make no representation and assume no responsibility to other parties regarding this report. Additionally, the above recommendations are contingent on Redmond Geotechnical Services, LLC being retained to provide all site inspections and constriction monitoring services for this project. Redmond Geotechnical Services, LLC will not assume any responsibility and/or liability for any engineering judgment, inspection and/or testing services performed by others.

It is the owners/developers responsibility for insuring that the project designers and/or contractors involved with this project implement our recommendations into the final design plans, specifications and/or construction activities for the project. Further, in order to avoid delays during construction, we recommend that the final design plans and specifications for the project be reviewed by our office to evaluate as to whether our recommendations have been properly interpreted and incorporated into the project.

If during any future site grading and construction, subsurface conditions different from those encountered in the explorations are observed or appear to be present beneath excavations, we should be advised immediately so that we may review these conditions and evaluate whether modifications of the design criteria are required. We also should be advised if significant modifications of the proposed site development are anticipated so that we may review our conclusions and recommendations.

## LEVEL OF CARE

The services performed by the Geotechnical Engineer for this project have been conducted with that level of care and skill ordinarily exercised by members of the profession currently practicing in the area under similar budget and time restraints. No warranty or other conditions, either expressed or implied, is made.

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# Appendix "A"

**Test Pit Logs and Laboratory Test Data**

# APPENDIX

# FIELD EXPLORATIONS AND LABORATORY TESTING

## FIELD EXPLORATION

Subsurface conditions at the site were explored by excavating eleven (11) exploratory test pits (TH-#1 through TH-#11) on September 7, 2018. The approximate location of the test pit explorations are shown in relation to the existing site improvements on the Site Exploration Plan, Figure No. 2.

The test pits were excavated using track-mounted excavating equipment in general conformance with ASTM Methods in Vol. 4.08, D-1586-94 and D-1587-83. The test pits were excavated to depths ranging from about 5.0 to 8.0 feet beneath existing site grades. Detailed logs of the test pits are presented on the Log of Test Pits, Figure No's. A-5 through A-10. The soils were classified in accordance with the Unified Soil Classification System (USCS), which is outlined on Figure No. A-4.

The exploration program was coordinated by a field engineer who monitored the excavating and exploration activity, obtained representative samples of the subsurface soils encountered, classified the soils by visual and textural examination, and maintained continuous logs of the subsurface conditions. Disturbed and/or undisturbed samples of the subsurface soils were obtained at appropriate depths and/or intervals and placed in plastic bags and/or with a thin walled ring sample.

Groundwater was not encountered within any of the exploratory test pits (TH-#1 through TH-#11) excavated at the site at the time of excavating to depths of up to 8.0 feet beneath existing surface grades.

## LABORATORY TESTING

Pertinent physical and engineering characteristics of the soils encountered during our subsurface investigation were evaluated by a laboratory testing program to be used as a basis for selection of soil design parameters and for correlation purposes. Selected tests were conducted on representative soil samples. The program consisted of tests to evaluate the existing (in-situ) moisture-density, maximum dry density and optimum moisture content, gradational characteristics, and Atterberg Limits as well as direct shear strength, consolidation and "R"-value tests.

### Dry Density and Moisture Content Determinations

Density and moisture content determinations were performed on both disturbed and relatively undisturbed samples from the test pit explorations in general conformance with ASTM Vol. 4.08 Part D-216. The results of these tests were used to calculate existing overburden pressures and to correlate strength and compressibility characteristics of the soils. Test results are shown on the test pit logs at the appropriate sample depths.

**Maximum Dry Density**

Two (2) Maximum Dry Density and Optimum Moisture Content tests were performed on representative samples of the on-site sandy, clayey silt subgrade soils in accordance with ASTM Vol. 4.08 Part D-1557. This test was conducted to help establish various engineering properties for use as structural fill. The test results are presented on Figure No. A-11.

**Atterberg Limits**

Two (2) Liquid Limit (LL) and Plastic Limit (PL) tests were performed on representative samples of the clayey, sandy silt and/or silty sand subgrade soils in accordance with ASTM Vol. 4.08 Part D-4318-85. These tests were conducted to facilitate classification of the soils and for correlation purposes. The test results appear on Figure No. A-12.

**Gradation Analysis**

Two (2) Gradation analyses were performed on representative samples of the subsurface soils in accordance with ASTM Vol. 4.08 Part D-422. The test results were used to classify the soil in accordance with the Unified Soil Classification System (USCS). The test results are shown graphically on Figure No. A-13.

**Direct Shear Strength Test**

One (1) Direct Shear Strength test was performed on a undisturbed and/or remolded sample at a continuous rate of shearing deflection (0.02 inches per minute) in accordance with ASTM Vol. 4.08 Part D-3080-79. The test results were used to determine engineering strength properties and are shown graphically on Figure No. A-14.

**Consolidation Test**

One (1) Consolidation test was performed on a representative sample of the sandy, clayey silt subgrade soil to assess the compressibility characteristics of the underlying subgrade soils in accordance with ASTM Vol. 4.08 Part D-2435-80.

Conventional loading increments of 100, 200, 400, ... 12,800 psf were applied after the 100 percent time of primary consolidation was identified for each loading increment. The samples were unloaded and allowed to rebound after the completion of the loading sequence. Deflection versus time readings were recorded for all load increments from 100 through 12,800 psf. The deflection corresponding to 100 percent primary consolidation was plotted on the consolidation strain versus consolidation pressure curve, which is presented on Figure No. A-15.

**"R"-Value Tests**

Two (2) "R"-value tests were performed on remolded subgrade soil samples in accordance with ASTM Vol. 4.08 Part D-2844. The test results were used to help evaluate the subgrade soils supporting and performance capabilities when subjected to traffic loading. The test results are shown on Figure No. A-16.

The following figures are attached and complete the Appendix:

| PRIMARY DIVISIONS | | | GROUP SYMBOL | SECONDARY DIVISIONS |
|---|---|---|---|---|
| COARSE GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE | GRAVELS MORE THAN HALF 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 or gravel-sand mixtures, little or no fines. |
| | | GRAVEL WITH FINES | GM | Silty gravels, gravel-sand-silt mixtures, non-plastic fines. |
| | | | GC | Clayey gravels, gravel-sand-clay mixtures, plastic fines. |
| | SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE | CLEAN SANDS (LESS THAN 5% FINES) | SW | Well graded sands, gravelly sands, little or no fines. |
| | | | SP | Poorly graded sands or gravelly sands, 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 HALF OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE | SILTS AND CLAYS LIQUID LIMIT IS LESS THAN 50% | | ML | Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity. |
| | | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. |
| | | | OL | Organic silts and organic silty clays of low plasticity. |
| | SILTS AND CLAYS LIQUID LIMIT IS GREATER THAN 50% | | MH | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts. |
| | | | CH | Inorganic clays of high plasticity, fat clays. |
| | | | OH | Organic clays of medium to high plasticity, organic silts. |
| HIGHLY ORGANIC SOILS | | | Pt | Peat and other highly organic soils. |

## DEFINITION OF TERMS

U.S. STANDARD SERIES SIEVE: 200, 40, 10, 4 — CLEAR SQUARE SIEVE OPENINGS: 3/4", 3", 12"

| | 200 | 40 | 10 | 4 | 3/4" | 3" | 12" |
|---|---|---|---|---|---|---|---|
| SILTS AND CLAYS | SAND | | | GRAVEL | | COBBLES | BOULDERS |
| | FINE | MEDIUM | COARSE | FINE | COARSE | | |

### GRAIN SIZES

| SANDS, GRAVELS AND NON-PLASTIC SILTS | BLOWS/FOOT† |
|---|---|
| VERY LOOSE | 0 - 4 |
| LOOSE | 4 - 10 |
| MEDIUM DENSE | 10 - 30 |
| DENSE | 30 - 50 |
| VERY DENSE | OVER 50 |

**RELATIVE DENSITY**

| CLAYS AND PLASTIC SILTS | STRENGTH‡ | BLOWS/FOOT† |
|---|---|---|
| VERY SOFT | 0 - 1/4 | 0 - 2 |
| SOFT | 1/4 - 1/2 | 2 - 4 |
| FIRM | 1/2 - 1 | 4 - 8 |
| STIFF | 1 - 2 | 8 - 16 |
| VERY STIFF | 2 - 4 | 16 - 32 |
| HARD | OVER 4 | OVER 32 |

**CONSISTENCY**

†Number of blows of 140 pound hammer falling 30 inches to drive a 2 inch O.D. (1-3/8 inch I.D.) split spoon (ASTM D-1586).
‡Unconfined compressive strength in tons/sq. ft. as determined by laboratory testing or approximated by the standard penetration test (ASTM D-1586), pocket penetrometer, torvane, or visual observation.

REDMOND GEOTECHNICAL SERVICES
PO Box 20547 • Portland, Oregon 97294

**KEY TO EXPLORATORY TEST PIT LOGS**
**Unified Soil Classification System (ASTM D-2487)**

BONAVENTURE OF MILWAUKIE
Milwaukie, Oregon

| PROJECT NO. | DATE | Figure A-4 |
|---|---|---|
| 1004.032.G | 9/28/18 | |

BACKHOE COMPANY: Jim Smith Excavating BUCKET SIZE: 24 inches DATE: 9/07/18

TEST PIT NO. TH-#1 ELEVATION

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 0 | X | | | 13.1 | GM | FILL: Gray-brown, dry, medium dense, crushed aggregate base rock |
| | | | | | ML/SM | FILL: Medium brown, moist, moderately compacted, clayey, sandy SILT to silty SAND with occasional debris |
| 5 | | | | | ML | NATIVE GROUND: Dark gray-brown, moist, soft to medium stiff, sandy, clayey SILT with organics (Old Topsoil Zone) |
| | | | | | ML/SM | Medium brown with gray mottling, moist to very moist, medium stiff to medium dense, clayey, sandy SILT to silty SAND |
| 10 | | | | | | Total Depth = 5.0 feet<br>No groundwater encountered at time of exploration |
| 15 | | | | | | |

TEST PIT NO. TH-#2 ELEVATION

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 0 | X | | | 12.8 | ML/SM | FILL: Medium brown, damp to moist, poorly to moderately compacted, clayey, sandy SILT to silty SAND with occasional concrete debris and trace of organics |
| 5 | | | | | ML | NATIVE GROUND: Dark gray-brown, moist, soft to medium stiff, sandy, clayey SILT with organics (Old Topsoil Zone) |
| | | | | | ML/SM | GRay-brown with brown mottling, moist to very moist, medium stiff to medium dense, clayey, sandy SILT to silty SAND |
| 10 | | | | | | Total Depth = 6.0 feet<br>No groundwater encountered at time of exploration |
| 15 | | | | | | |

# LOG OF TEST PITS

PROJECT NO. 1004.032.G BONAVENTURE OF MILWAUKIE FIGURE NO. A-5

BACKHOE COMPANY: Jim Smith Excavating BUCKET SIZE: 24 inches DATE: 9/07/18

## SOIL DESCRIPTION

TEST PIT NO. TH-#3 ELEVATION

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 0 | | | | | GM | FILL: Gray-brown, damp to moist, poorly to moderately compacted, slightly clayey, silty and sandy GRAVEL with cobbles and trace of organics |
| | | | | | ML/ SM | FILL: Medium brown, moist to very moist, poorly to moderately compacted, clayey, sandy SILT to silty SAND with occasional debris and trace of organics |
| 5 | | | | | ML | NATIVE GROUND: Dark gray-brown, very moist, soft to medium stiff, sandy, clayey SILT with organics (Old Topsoil Zone) |
| 10 | | | | | GM | Medium brown, very moist, medium dense to dense, slightly clayey, silty and sandy GRAVEL with cobbles |
| 15 | | | | | | Total Depth = 7.0 feet<br>No groundwater encountered at time of exploration |

TEST PIT NO. TH-#4 ELEVATION

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 0 | | | | | ML/ SM | FILL: Medium brown, damp to moist, poorly to moderately compacted, clayey, sandy SILT to silty SAND with gravel and trace organics |
| | | | | | ML | NATIVE GROUND: Dark gray-brown, moist to very moist, soft to medium stiff, sandy, clayey SILT with organics (Old Topsoil Zone) |
| 5 | | | | | ML/ SM | Medium brown with gray mottling, very moist to wet, soft to loose, clayey, sandy SILT to silty SAND |
| 10 | | | | | GM | Gray-brown, very moist to wet, medium dense to dense, slightly clayey, silty and sandy GRAVEL with cobbles |
| 15 | | | | | | Total Depth = 7.0 feet<br>No groundwater encountered at time of exploration |

# LOG OF TEST PITS

PROJECT NO. 1004.032.G | BONAVENTURE OF MILWAUKIE | FIGURE NO. A-6

BACKHOE COMPANY: Jim Smith Excavating BUCKET SIZE: 24 inches DATE: 9/07/18

SOIL DESCRIPTION

TEST PIT NO. TH-#5 ELEVATION

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 0 | X | X | 101.2 | 12.6 | ML/SM | FILL: Medium brown, damp to moist, poorly to moderately compacted, clayey, sandy SILT to silty SAND with occasional gravel and debris |
| 5 | X | | | 17.7 | ML | NATIVE GROUND: Dark gray-brown, moist to very moist, soft to medium stiff, sandy, clayey SILT with trace organics (Old Topsoil Zone) |
| | | | | | GM | Dark gray-brown, very moist, medium dense to dense, slightly clayey, silty and sandy GRAVEL with cobbles |
| 10 | | | | | | Total Depth = 7.0 feet<br>No groundwater encountered at time of exploration |
| 15 | | | | | | |

TEST PIT NO. TH-#6 ELEVATION

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 0 | X | X | 97.7 | 13.4 | ML/SM | FILL: Medium brown, damp to moist, poorly to moderately compacted, clayey, sandy SILT to silty SAND with occasional gravel and denris |
| 5 | X | | | 24.4 | ML | NATIVE GROUND: Dark gray-brown, moist to very moist, soft to medium stiff, sandy, clayey SILT with organics (Old Topsoil Zone) |
| | | | | | ML/SM | Medium brown with gray mottling, moist to very moist, medium stiff to medium dense, clayey, sandy SILT to silty SAND |
| 10 | | | | | | Total Depth = 7.0 feet<br>No groundwater encountered at time of exploration |
| 15 | | | | | | |

## LOG OF TEST PITS

PROJECT NO. 1004.032.G | BONAVENTURE OF MILWAUKIE | FIGURE NO. A-7

BACKHOE COMPANY: Jim Smith Excavating BUCKET SIZE: 24 inches DATE: 9/07/18

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| | | | | | | TEST PIT NO. TH-#7 ELEVATION |
| 0 | | | | | ML/ SM | FILL: Medium brown, damp to moist, poorly to moderately compacted, clayey, sandy SILT to silty SAND with concrete, brick and organics |
| 5 | | | | | GM | FILL: Gray-brown, moist, moderately compacted, slightly clayey, silty and sandy GRAVEL with cobbles and trace organics |
| | | | | | ML | NATIVE GROUND: Dark gray-brown, moist to very moist, soft to medium stiff, sandy, clayey SILT with organics (Old Topsoil ZOne) |
| 10 | | | | | GM | Gray0brown, moist to very moist, medium dense to dense, slightly clayey, silty and sandy GRAVEL with cobbles |
| | | | | | | Total Depth = 8.0 feet<br>No groundwater encountered at time of exploration |
| 15 | | | | | | |

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| | | | | | | TEST PIT NO. TH-#8 ELEVATION |
| 0 | | | | | GM | FILL: Medium brown, moist, moderately compacted, slightly clayey, silty and sandy GRAVEL with cobbles and trace organics |
| | | | | | ML | NATIVE GROUND: Dark brown, moist to very moist, soft, organic, sandy, clayey SILT (Old Topsoil Zone) |
| 5 | X | | | 18.8 | | |
| | | | | | SM/ SP | Gray-brown to bluish-gray, very moist to wet, loose, silty to slightly silty, fine to medium SAND |
| | | | | | | Total Depth = 7.0 feet<br>No groundwater encountered at time of exploration |
| 10 | | | | | | |
| 15 | | | | | | |

# LOG OF TEST PITS

PROJECT NO. 1004.032.G BONAVENTURE OF MILWAUKIE FIGURE NO. A-8

BACKHOE COMPANY: Jim Smith Excavating BUCKET SIZE: 24 inches DATE: 9/07/18

## SOIL DESCRIPTION

TEST PIT NO. TH_#9 ELEVATION

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 0 | | | | | ML/SM | FILL: Medium brown, damp to moist, poorly to moderately compacted, clayey, sandy SILT to silty SAND with gravel and miscellaneous construction debris |
| 5 | | | | | ML | NATIVE GROUND: Dark brown, moist to very moist, soft, organic, sandy, clayey SILT (OLd Topsoil Zone) |
| | | | | | SM | Medium to olive-brown, very moist, loose to medium dense, silty, fine to medium SAND |
| 10 | | | | | GM | Gray-brown, very moist, medium dense to dense, slightly clayey, silty and sandy GRAVEL with cobbles |
| 15 | | | | | | Total Depth = 7.0 feet<br>No groundwater encountered at time of exploration |

TEST PIT NO. TH-#10 ELEVATION

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 0 | X | X | 99.1 | 14.4 | ML/SM | FILL: Medium brown, damp to moist, poorly to moderately compacted, clayey, sandy SILT to silty SAND with organics and construction debris |
| 5 | X | X | 90.3 | 17.7 | | |
| | | | | | ML | NATIVE GROUND: Dark gray-brown, very moist, soft to medium stiff, sandy, clayey SILT with organics (Old Topsoil Zone) |
| 10 | | | | | SM | Gray-brown, very moist, loose to medium dense, slightly clayey, silty SAND |
| 15 | | | | | | Total Depth = 8.0 feet<br>No groundwater encountered at time of exploration |

# LOG OF TEST PITS

PROJECT NO. 1004.032.G | BONAVENTURE OF MILWAUKIE | FIGURE NO. A-9

REDMOND GEOTECHNICAL SERVICES

BACKHOE COMPANY: Jim Smith Excavating BUCKET SIZE: 24 inches DATE: 9/07/18

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | SOIL DESCRIPTION — TEST PIT NO. TH-#11 ELEVATION |
|---|---|---|---|---|---|---|
| 0 | | | | | ML/SM | FILL: Medium brown, moist, moderately compacted, clayey, sandy SILT to silty SAND with occasional gravel and trace organics |
| | | | | | ML | NATIVE GROUND: Dark gray-brown, moist, soft to medium stiff, slightly organic, sandy, clayey SILT (OLd Topsoil Zone) |
| 5 | | | | | ML/SM | Medium brown with gray mottling, moist to very moist, medium stiff to medium dense, clayey, sandy SILT to silty SAND |
| | | | | | | Total Depth = 5.0 feet<br>No groundwater encountered at time of exploration |
| 10 | | | | | | |
| 15 | | | | | | |

| DEPTH (FEET) | BAG SAMPLE | DENSITY TEST | DRY DENSITY (pcf) | MOISTURE CONTENT (%) | SOIL CLASS. (U.S.C.S.) | TEST PIT NO. ELEVATION |
|---|---|---|---|---|---|---|
| 0 | | | | | | |
| 5 | | | | | | |
| 10 | | | | | | |
| 15 | | | | | | |

# LOG OF TEST PITS

PROJECT NO. 1004.032.G | BONAVENTURE OF MILWAUKIE | FIGURE NO. A-10

MAXIMUM DENSITY TEST RESULTS

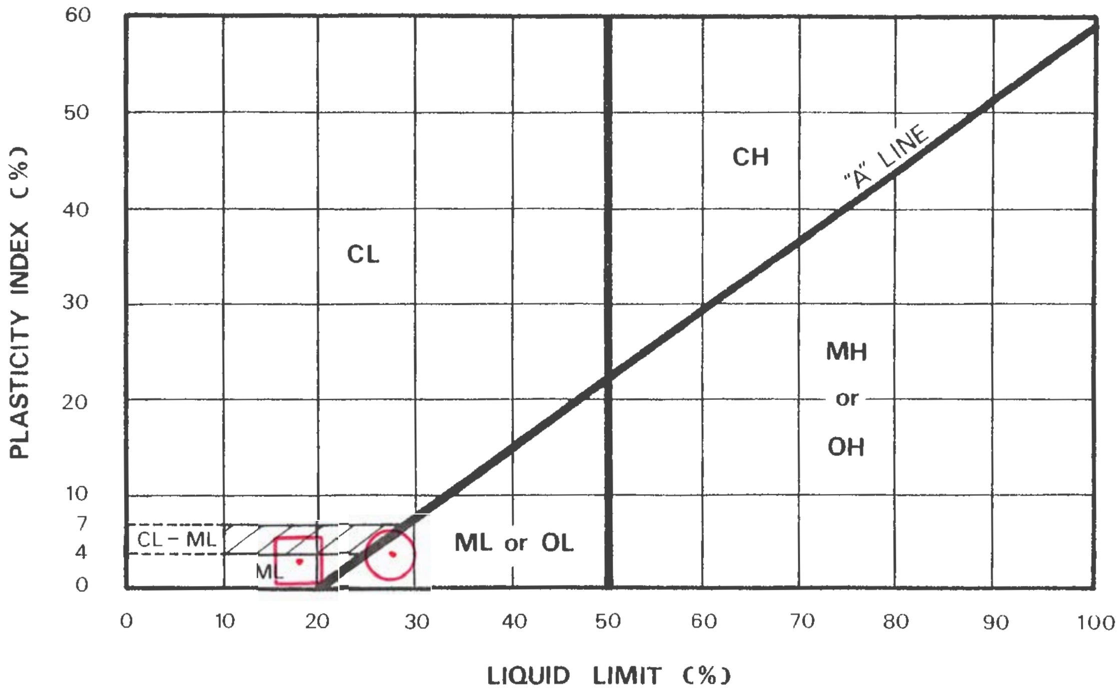
| SAMPLE LOCATION | SOIL DESCRIPTION | MAXIMUM DRY DENSITY (pcf) | OPTIMUM MOISTURE CONTENT (%) |
|---|---|---|---|
| TH-#5 @ 1.5' | Medium brown, clayey, sandy SILT to silty SAND with gravel (ML/SM) | 110.0 | 17.0 |
| TH-#10 @ 1.5' | Medium brown, clayey, sandy SILT to silty SAND with gravel (ML/SM) | 112.0 | 16.0 |

EXPANSION INDEX TEST RESULTS

| SAMPLE LOCATION | INITIAL MOISTURE (%) | COMPACTED DRY DENSITY (pcf) | FINAL MOISTURE (%) | VOLUMETRIC SWELL (%) | EXPANSION INDEX | EXPANSIVE CLASS. |
|---|---|---|---|---|---|---|
| | | | | | | |

## MAXIMUM DENSITY & EXPANSION INDEX TEST RESULTS

PROJECT NO.: 1004.032.G | BONAVENTURE OF MILWAUKIE | FIGURE NO.: A-11




| KEY SYMBOL | BORING NO. | SAMPLE DEPTH (feet) | NATURAL WATER CONTENT % | LIQUID LIMIT % | PLASTICITY INDEX % | PASSING NO. 200 SIEVE % | LIQUIDITY INDEX | UNIFIED SOIL CLASSIFICATION SYMBOL |
|---|---|---|---|---|---|---|---|---|
| ⊡ | TH-#6 | 5.5 | 24.4 | 27.8 | 4.1 | 60.3 | | ML |
| ⊙ | TH-#8 | 5.5 | 18.8 | 18.5 | 3.7 | 23.2 | | SM |

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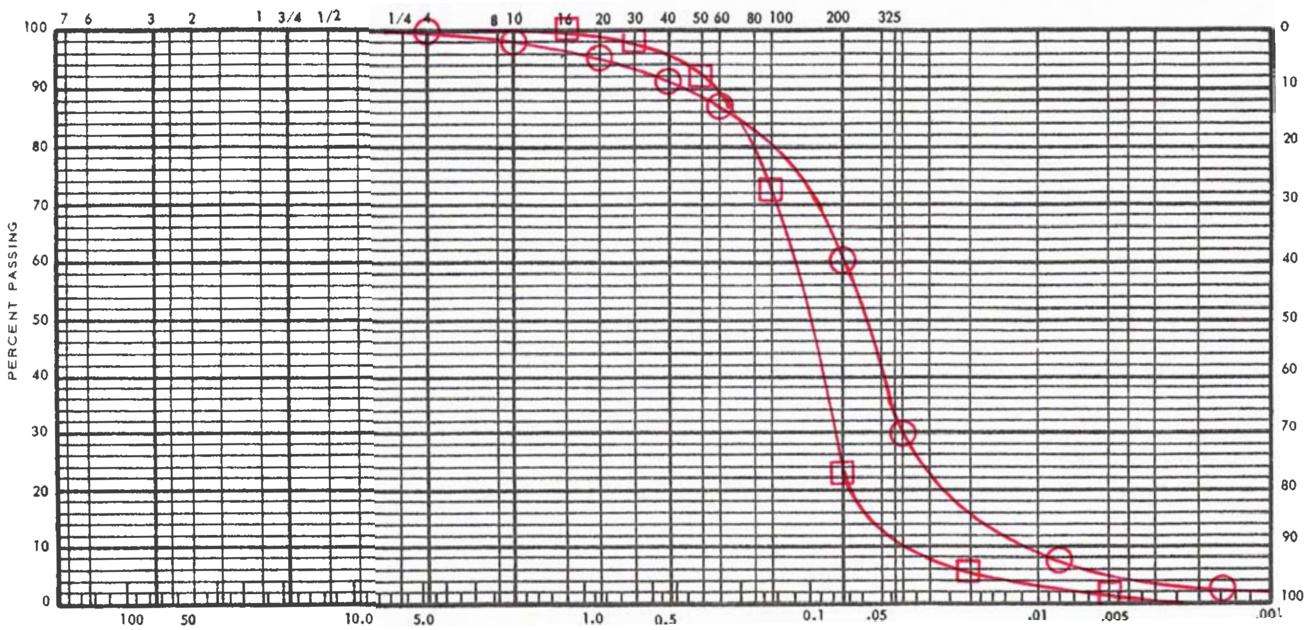
## PLASTICITY CHART AND DATA

BONAVENTURE OF MILWAUKIE
Milwaukie, Oregon

| PROJECT NO. | DATE | |
|---|---|---|
| 1004.032.G | 9/28/18 | Figure A-12 |

UNIFIED SOIL CLASSIFICATION SYSTEM

(ASTM D 422-72)




| COBBLES | GRAVEL | | SAND | | | SILT AND CLAY |
|---|---|---|---|---|---|---|
| | COARSE | FINE | COARSE | MEDIUM | FINE | |

| KEY SYMBOL | BORING NO. | SAMPLE DEPTH (feet) | ELEV. (feet) | UNIFIED SOIL CLASSIFICATION SYMBOL | SAMPLE DESCRIPTION |
|---|---|---|---|---|---|
| —□— | TH-#6 | 5.5 | | ML | Medium brown, clayey, sandy SILT to silty SAND |
| —○— | TH-#8 | 5.5 | | SM | GRay-brown, silty fine to medium SAND |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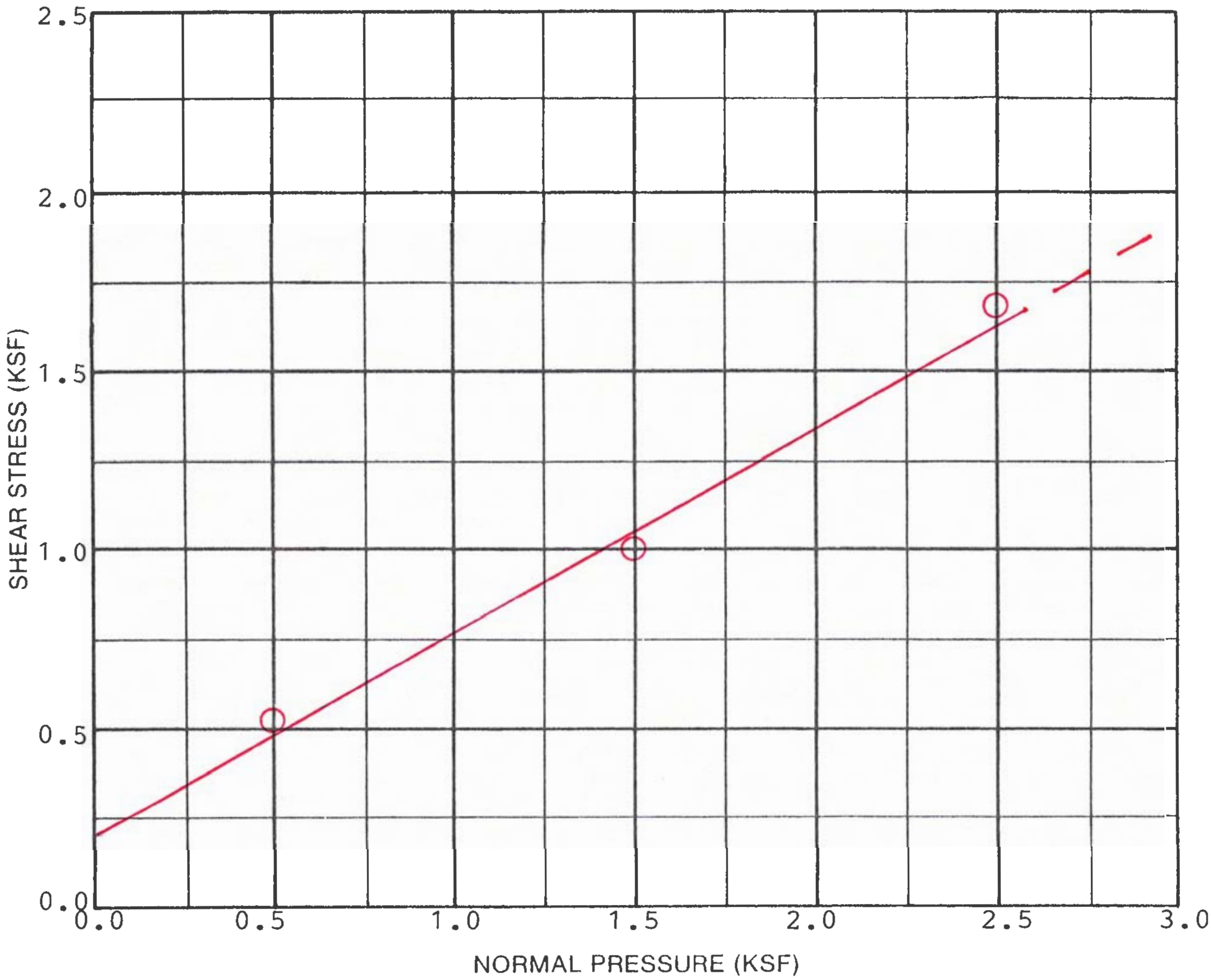
GRADATION TEST DATA

BONAVENTURE OF MILWAUKIE
Milwaukie, Oregon

| PROJECT NO. | DATE | FIGURE |
|---|---|---|
| 1004.032.G | 9/28/18 | A-13 |




## SAMPLE DATA

DESCRIPTION: Medium brown, clayey, sandy SILT to silty SAND (ML/SM) (Remolded)

BORING NO.: TH-#5

DEPTH (ft.): 1.5 | ELEVATION (ft):

## TEST RESULTS

APPARENT COHESION (C): 200 psf

APPARENT ANGLE OF INTERNAL FRICTION (ϕ): 28°

## TEST DATA

| TEST NUMBER | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| NORMAL PRESSURE (KSF) | 0.5 | 1.5 | 2.5 | |
| SHEAR STRENGTH (KSF) | 0.5 | 1.0 | 1.6 | |
| INITIAL $H_2O$ CONTENT (%) | 16.0 | 16.0 | 16.0 | |
| FINAL $H_2O$ CONTENT (%) | 16.4 | 12.1 | 7.8 | |
| INITIAL DRY DENSITY (PCF) | 98.0 | 98.0 | 98.0 | |
| FINAL DRY DENSITY (PCF) | 98.8 | 102.9 | 106.8 | |

STRAIN RATE: 0.02 inches per minute

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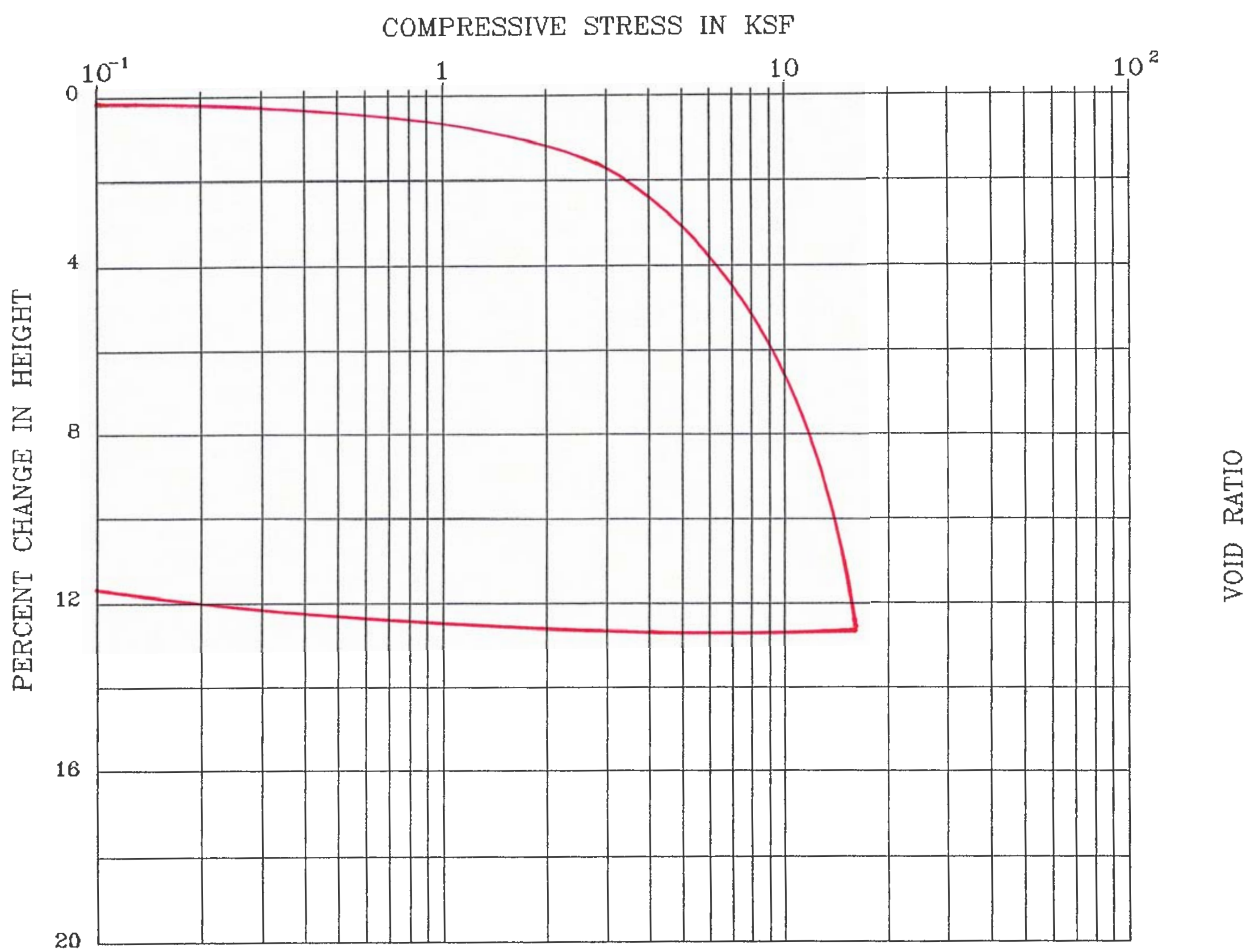
**DIRECT SHEAR TEST DATA**

BONAVENTURE OF MILWAUKIE
Milwaukie, Oregon

| PROJECT NO. | DATE | |
|---|---|---|
| 1004.032.G | 9/28/18 | Figure A-14 |




| | | | |
|---|---|---|---|
| BORING | : TH-#5 | DESCRIPTION | : clayey, sandy SILT (FILL) |
| DEPTH (ft) | : 1.5 | LIQUID LIMIT | : 18.5 |
| SPEC. GRAVITY | : 2.5 (assumed) | PLASTIC LIMIT | : 14.8 |

| | MOISTURE CONTENT (%) | DRY DENSITY (pcf) | PERCENT SATURATION | VOID RATIO |
|---|---|---|---|---|
| INITIAL | 16.0 | 98.0 | 91.1 | |
| FINAL | 7.8 | 106.6 | 97.2 | |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## CONSOLIDATION TEST DATA

BONAVENTURE OF MILWAUKIE
Milwaukie, Oregon

| PROJECT NO. | DATE | Figure A-15 |
|---|---|---|
| 1004.032.G | 9/28/18 | |

# RESULTS OF R (RESISTANCE) VALUE TESTS

**SAMPLE LOCATION: TH-#6**

**SAMPLE DEPTH: 1.5 feet bgs**

| Specimen | A | B | C |
|---|---|---|---|
| Exudation Pressure (psi) | 219 | 329 | 431 |
| Expansion Dial (o.ooo1”) | 0 | 1 | 2 |
| Expansion Pressure (psf) | 0 | 3 | 8 |
| Moisture Content (%) | 17.6 | 14.4 | 11.1 |
| Dry Density (pcf) | 96.4 | 101.2 | 107.6 |
| Resistance Value, “R” | 18 | 29 | 36 |
| “R”-Value at 300 psi Exudation Pressure = 28 | | | |

**SAMPLE LOCATION: TH-#10**

**SAMPLE DEPTH: 1.5 feet bgs**

| Specimen | A | B | C |
|---|---|---|---|
| Exudation Pressure (psi) | 208 | 326 | 439 |
| Expansion Dial (0.0001”) | 0 | 1 | 2 |
| Expansion Pressure (psf) | 0 | 3 | 8 |
| Moisture Content (%) | 17.3 | 14.1 | 10.7 |
| Dry Density (pcf) | 98.9 | 103.1 | 109.7 |
| Resistance Value “R” | 19 | 33 | 40 |
| “R”-Value at 300 psi Exudation Pressure = 32 | | | |